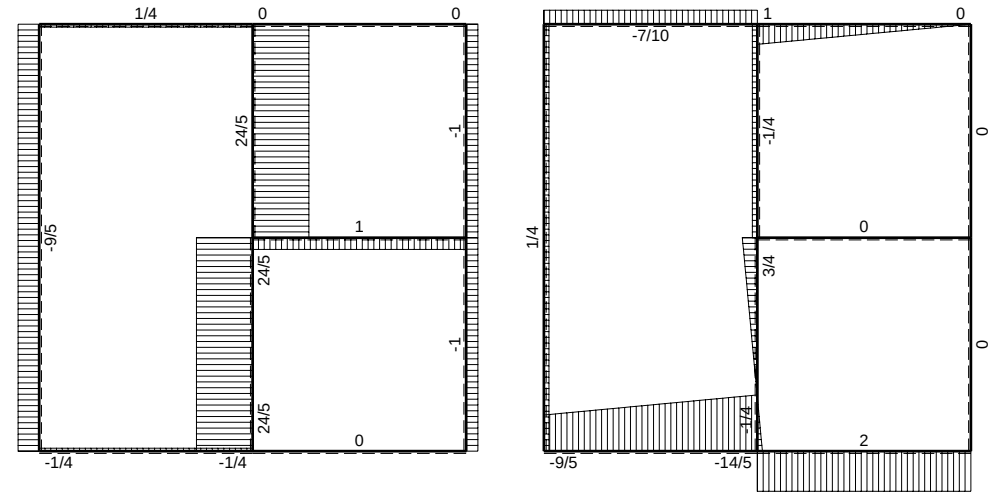
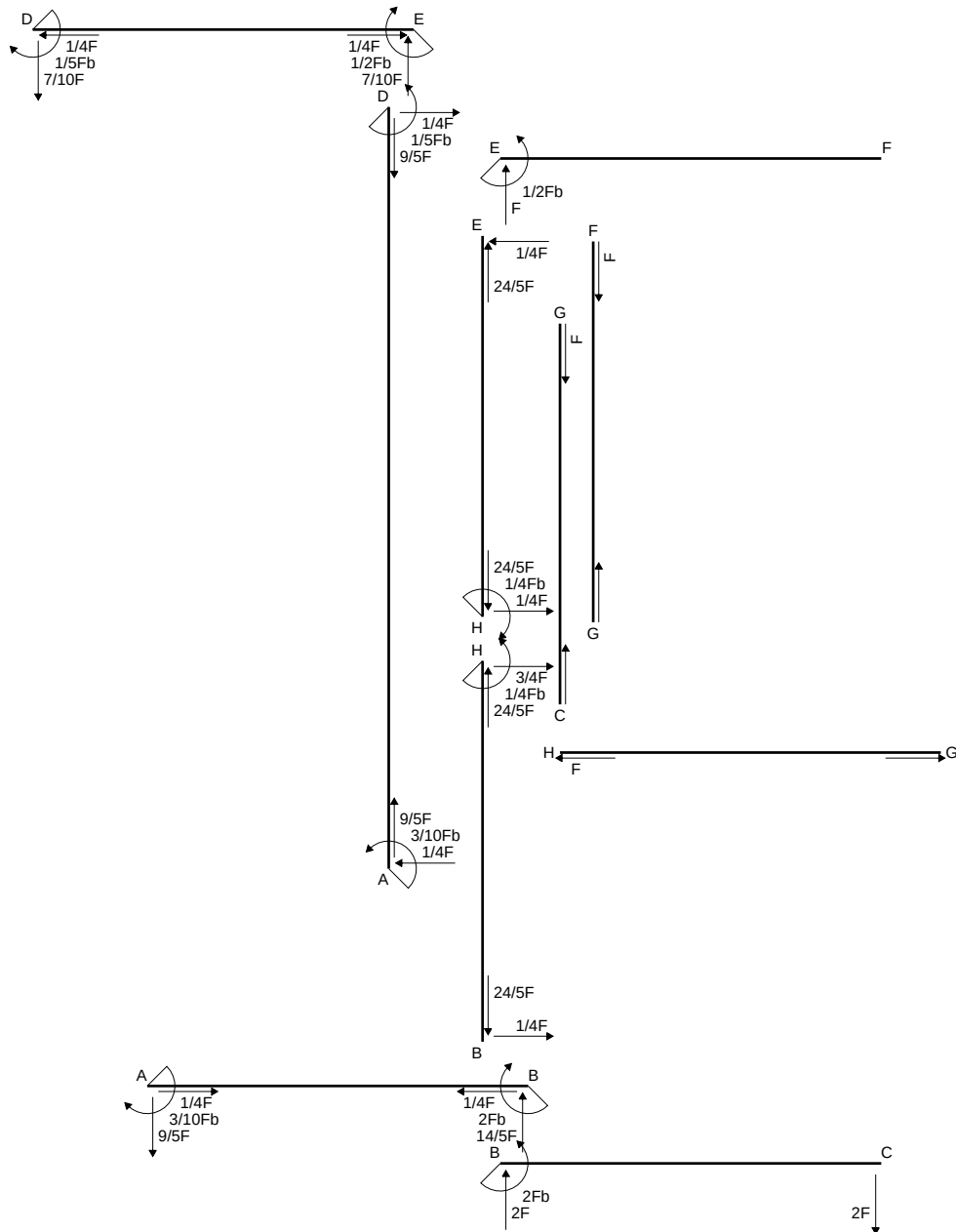
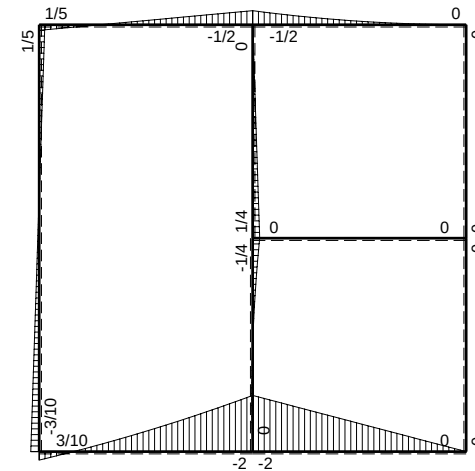


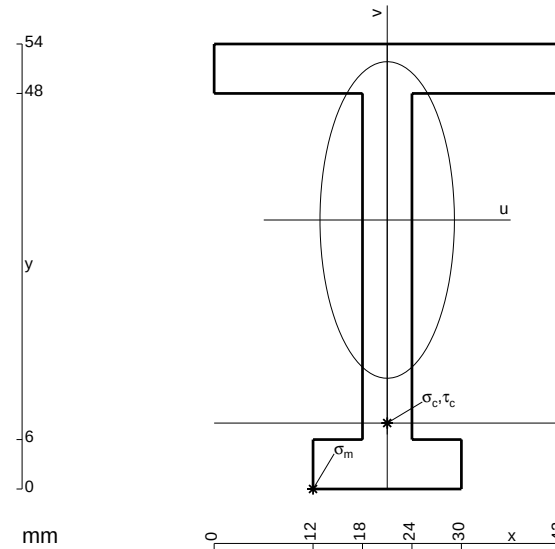

$$\leftarrow \boxed{+} \rightarrow F$$


Quadro contributi PLV per iperstatica $X=W_{AB}$

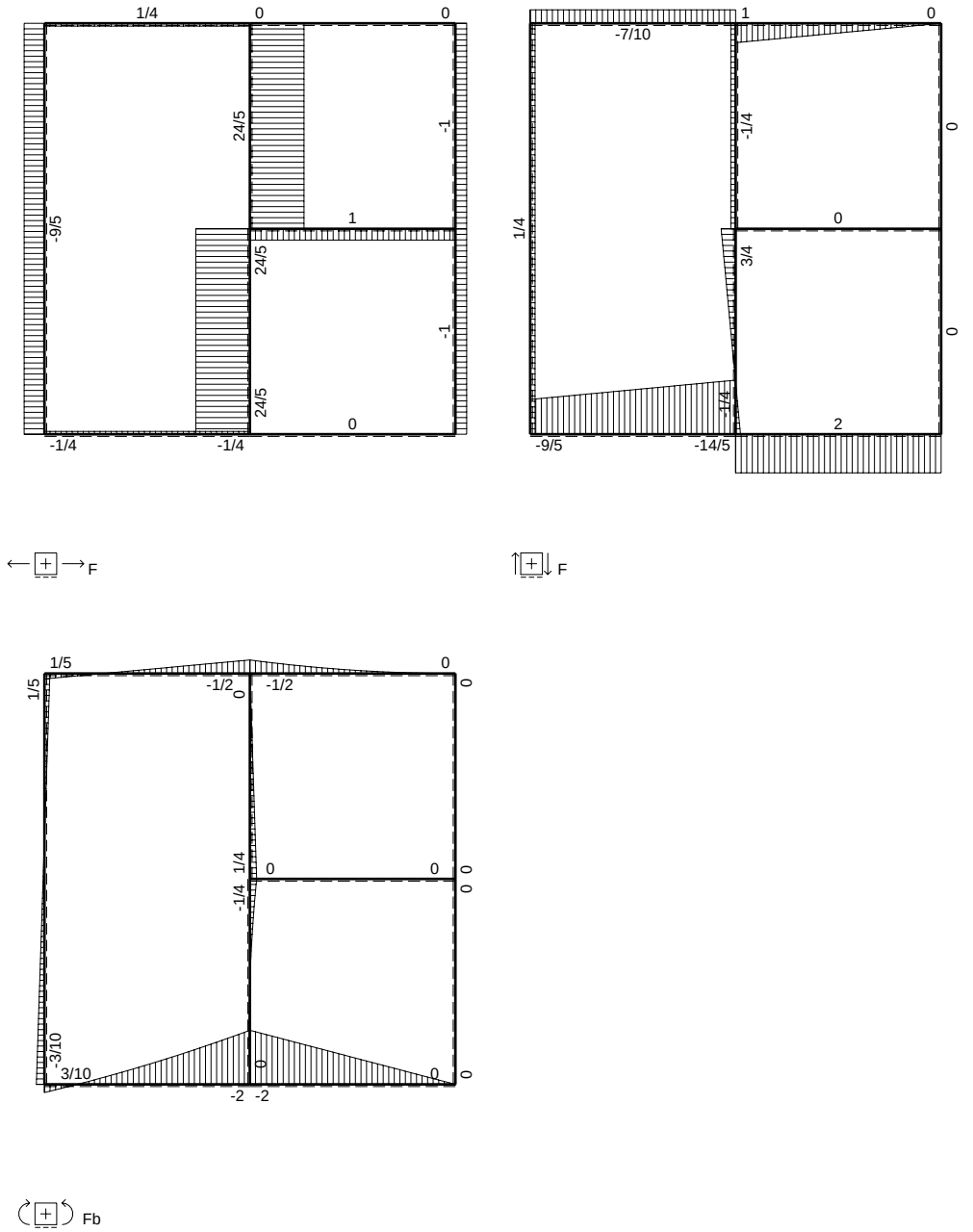
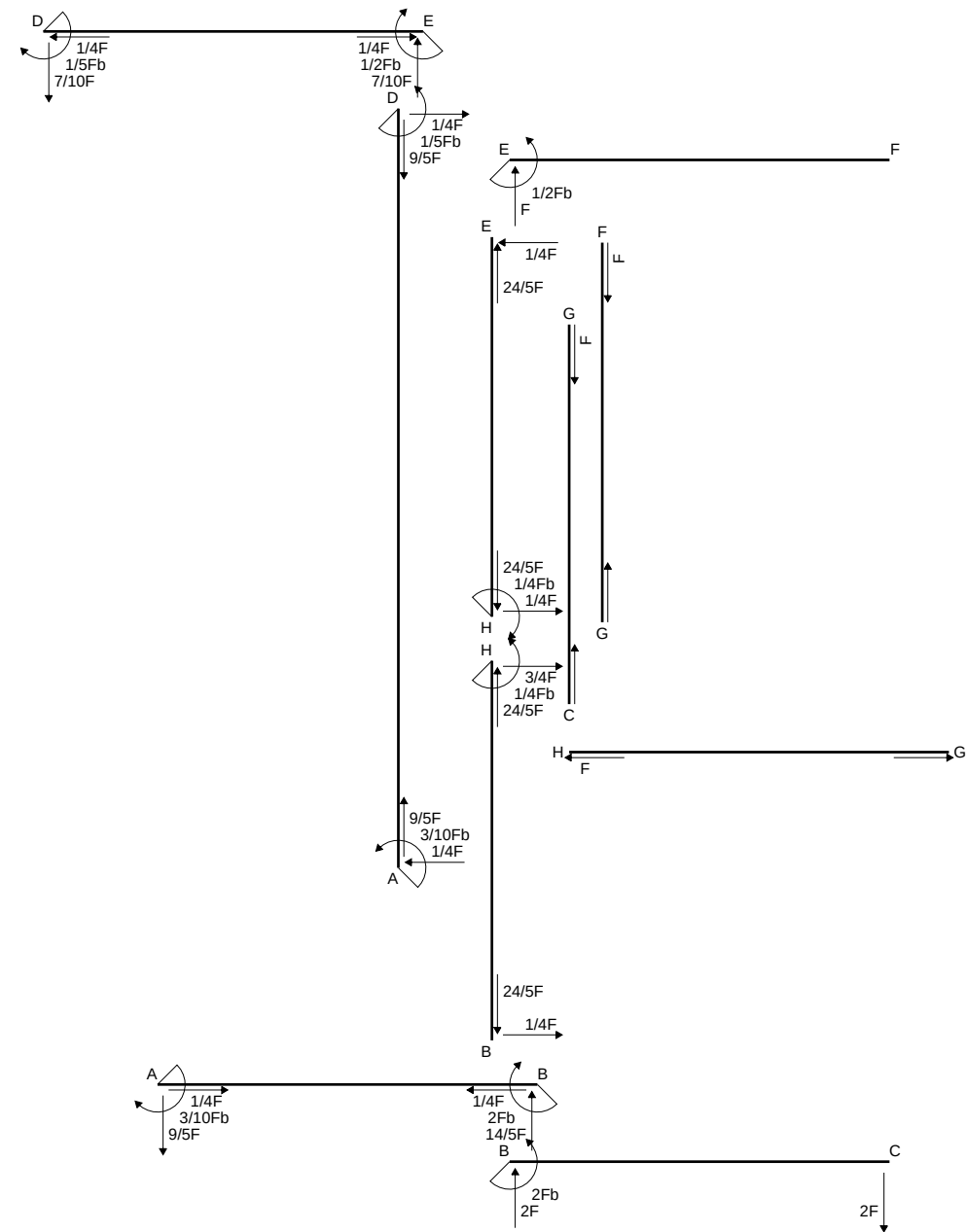
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 612. \text{ mm}^2 \\
J_u &= 225968. \text{ mm}^4 \\
J_v &= 40716. \text{ mm}^4 \\
y_g &= 32.65 \text{ mm} \\
T_y &= 2740. \text{ N} \\
M_x &= -1452200. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -32.65 \text{ mm} \\
\sigma_m &= -Mv/J_u = -209.8 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 8. \text{ mm} \\
v_c &= -24.65 \text{ mm} \\
\sigma_c &= -Mv/J_u = -158.4 \text{ N/mm}^2 \\
\tau_c &= 7.093 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 158.9 \text{ N/mm}^2 \\
S &= 3510. \text{ mm}^3
\end{aligned}$$

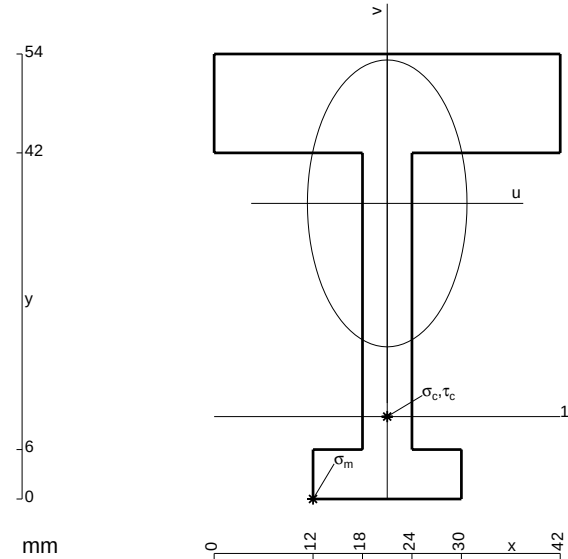


Quadro contributi PLV per iperstatica $X=W_{AB}$

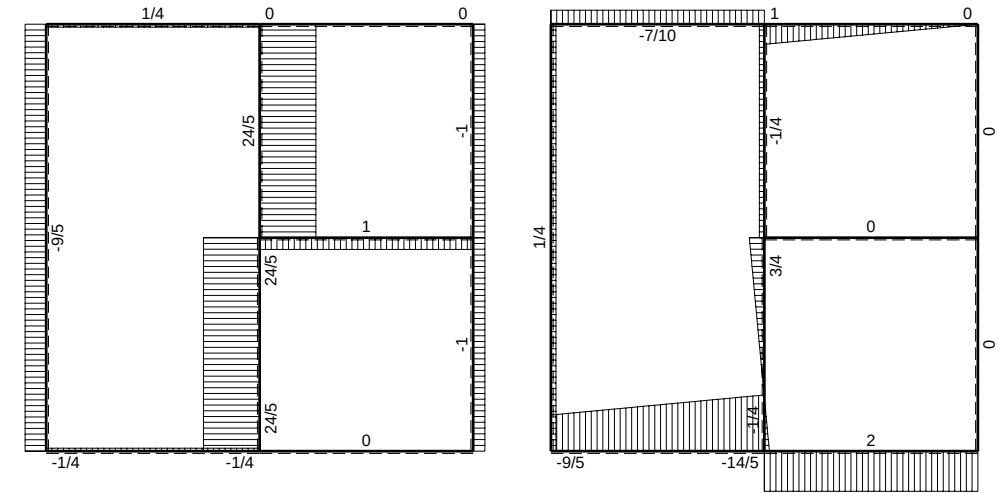
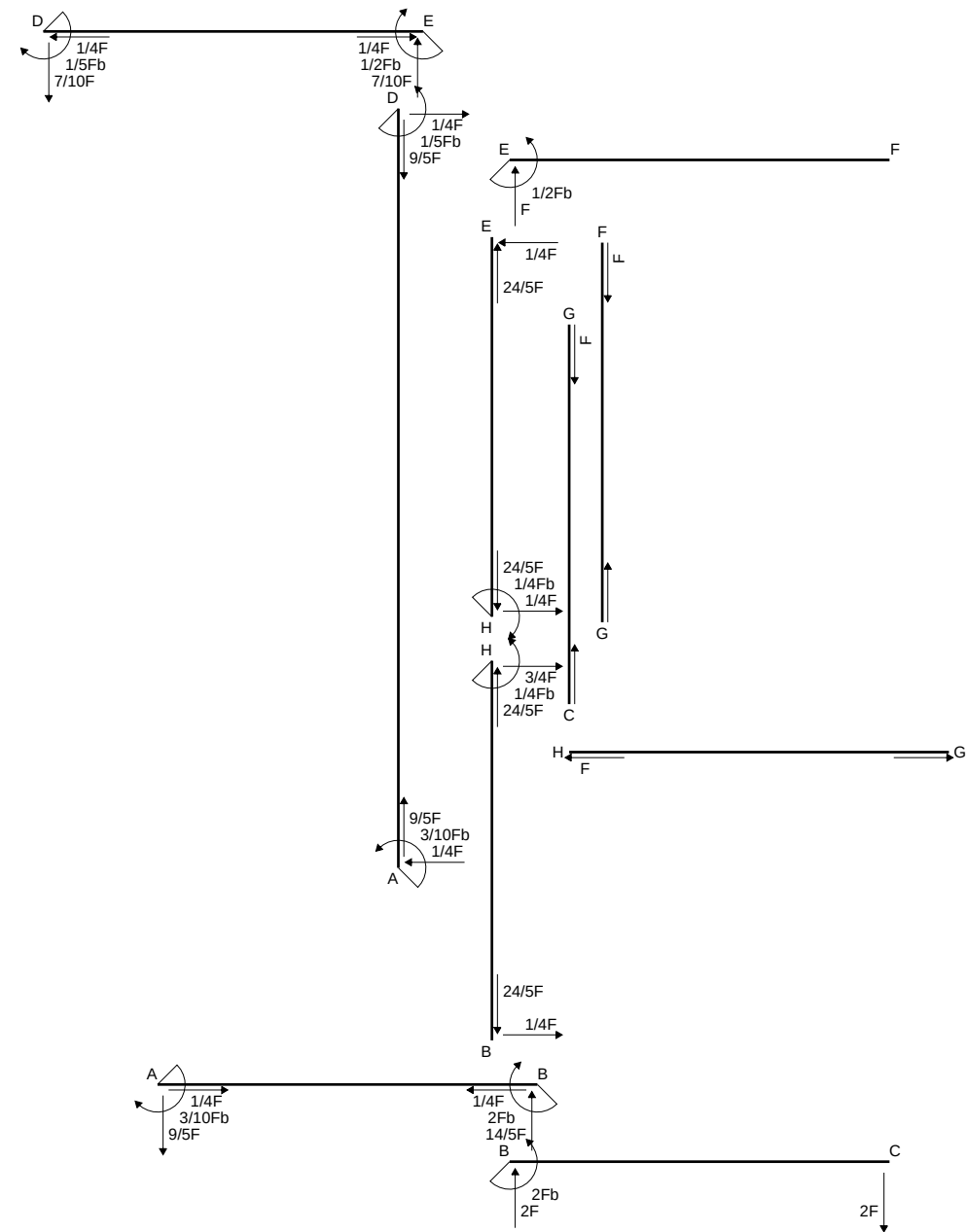
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-1/4Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
 L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
 &= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
 L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
 &= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
 L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
 &= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
 L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
 &= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
 L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
 &= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
 L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
 &= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
 L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
 &= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
 &= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
 L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
 &= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
 &= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
 L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
 &= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
 L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
 &= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
 L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
 &= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
 L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
 &= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
 \end{aligned}$$

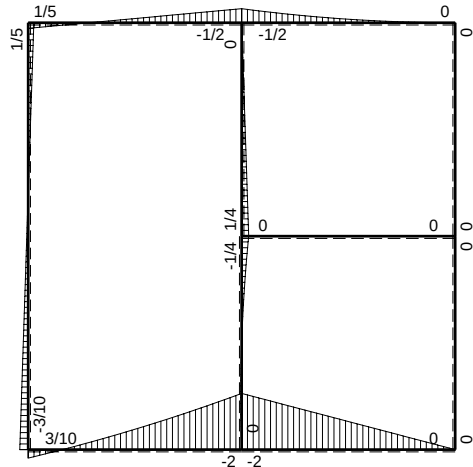


$$\begin{aligned}
 A &= 828. \text{ mm}^2 \\
 J_u &= 250978. \text{ mm}^4 \\
 J_v &= 77652. \text{ mm}^4 \\
 y_g &= 35.87 \text{ mm} \\
 T_y &= 2640. \text{ N} \\
 M_x &= -1531200. \text{ Nmm} \\
 x_m &= 12. \text{ mm} \\
 u_m &= -9. \text{ mm} \\
 v_m &= -35.87 \text{ mm} \\
 \sigma_m &= -Mv/J_u = -218.8 \text{ N/mm}^2 \\
 x_c &= 21. \text{ mm} \\
 y_c &= 10. \text{ mm} \\
 v_c &= -25.87 \text{ mm} \\
 \sigma_c &= -Mv/J_u = -157.8 \text{ N/mm}^2 \\
 \tau_c &= 7.396 \text{ N/mm}^2 \\
 \sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 158.3 \text{ N/mm}^2 \\
 S &= 4219. \text{ mm}^3
 \end{aligned}$$



← ⊕ → F

↑ ⊕ ↓ F



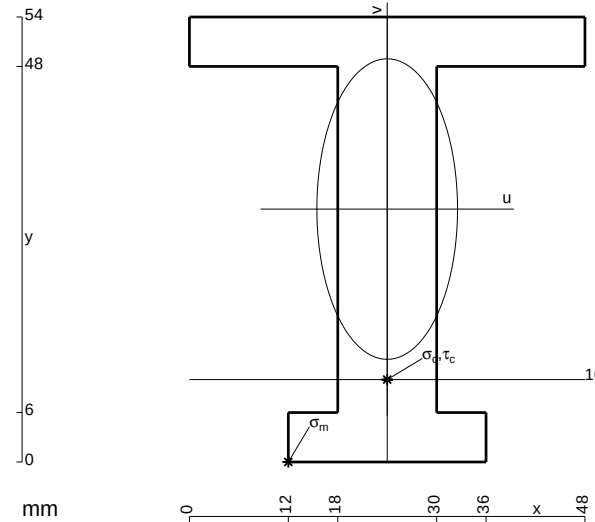
⊕ ⊕ F_b

Quadro contributi PLV per iperstatica $X=W_{AB}$

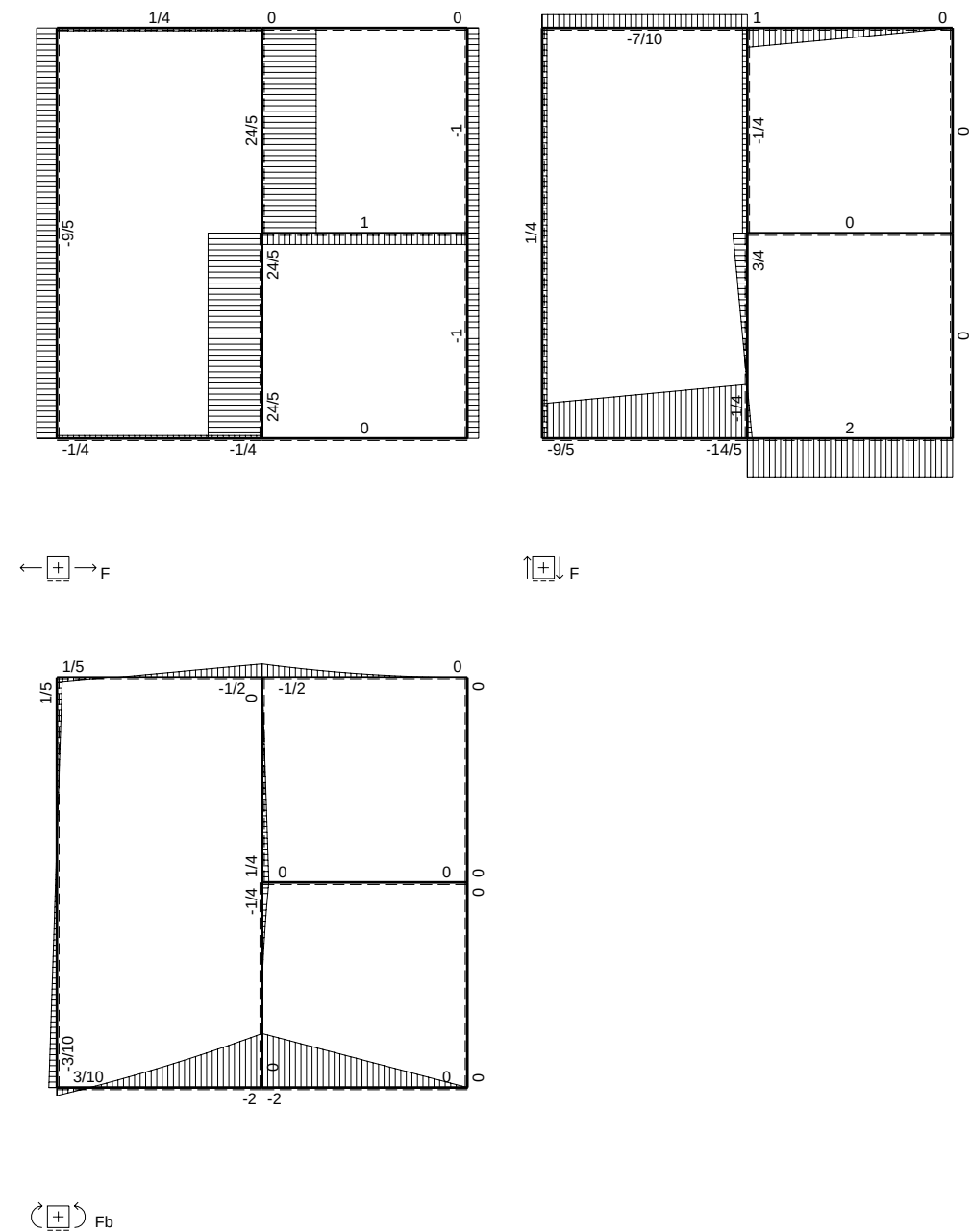
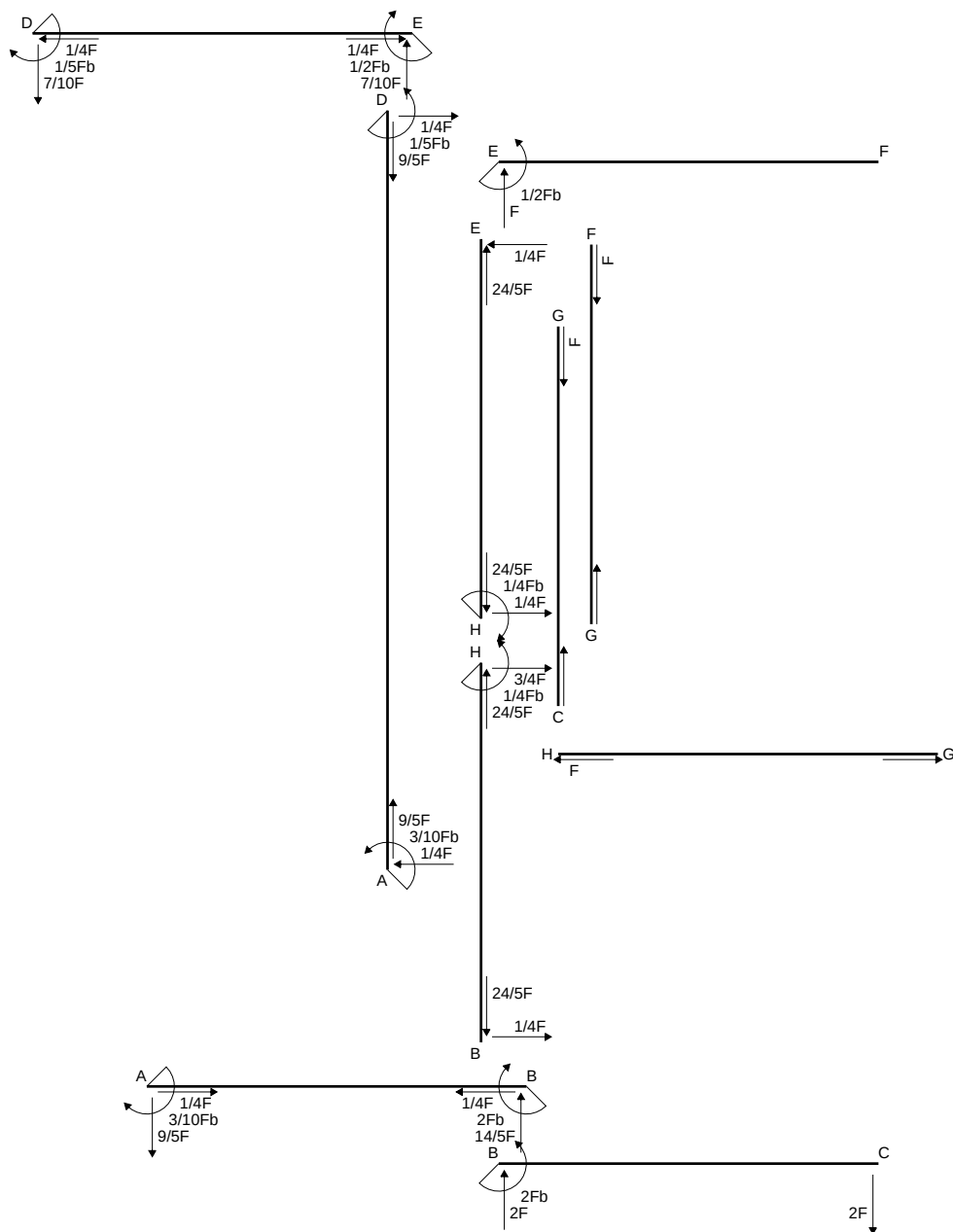
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 936. \text{ mm}^2 \\
J_u &= 311455. \text{ mm}^4 \\
J_v &= 68256. \text{ mm}^4 \\
y_g &= 30.69 \text{ mm} \\
T_y &= 3700. \text{ N} \\
M_x &= -2331000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -30.69 \text{ mm} \\
\sigma_m &= -Mv/J_u = -229.7 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 10. \text{ mm} \\
v_c &= -20.69 \text{ mm} \\
\sigma_c &= -Mv/J_u = -154.9 \text{ N/mm}^2 \\
\tau_c &= 5.026 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 155.1 \text{ N/mm}^2 \\
S &= 5077. \text{ mm}^3
\end{aligned}$$

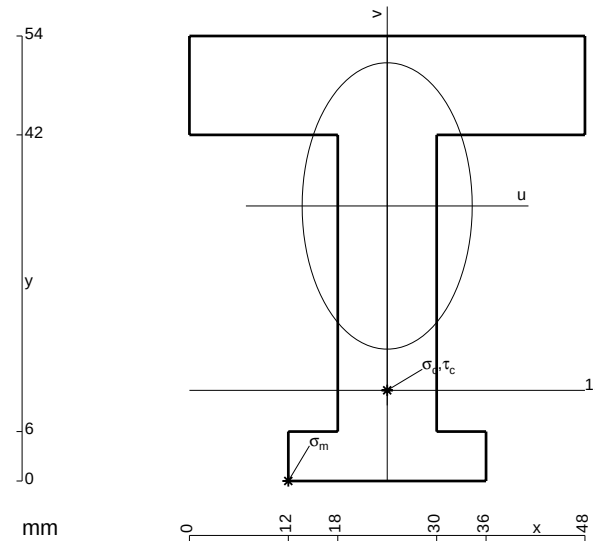


Quadro contributi PLV per iperstatica $X=W_{AB}$

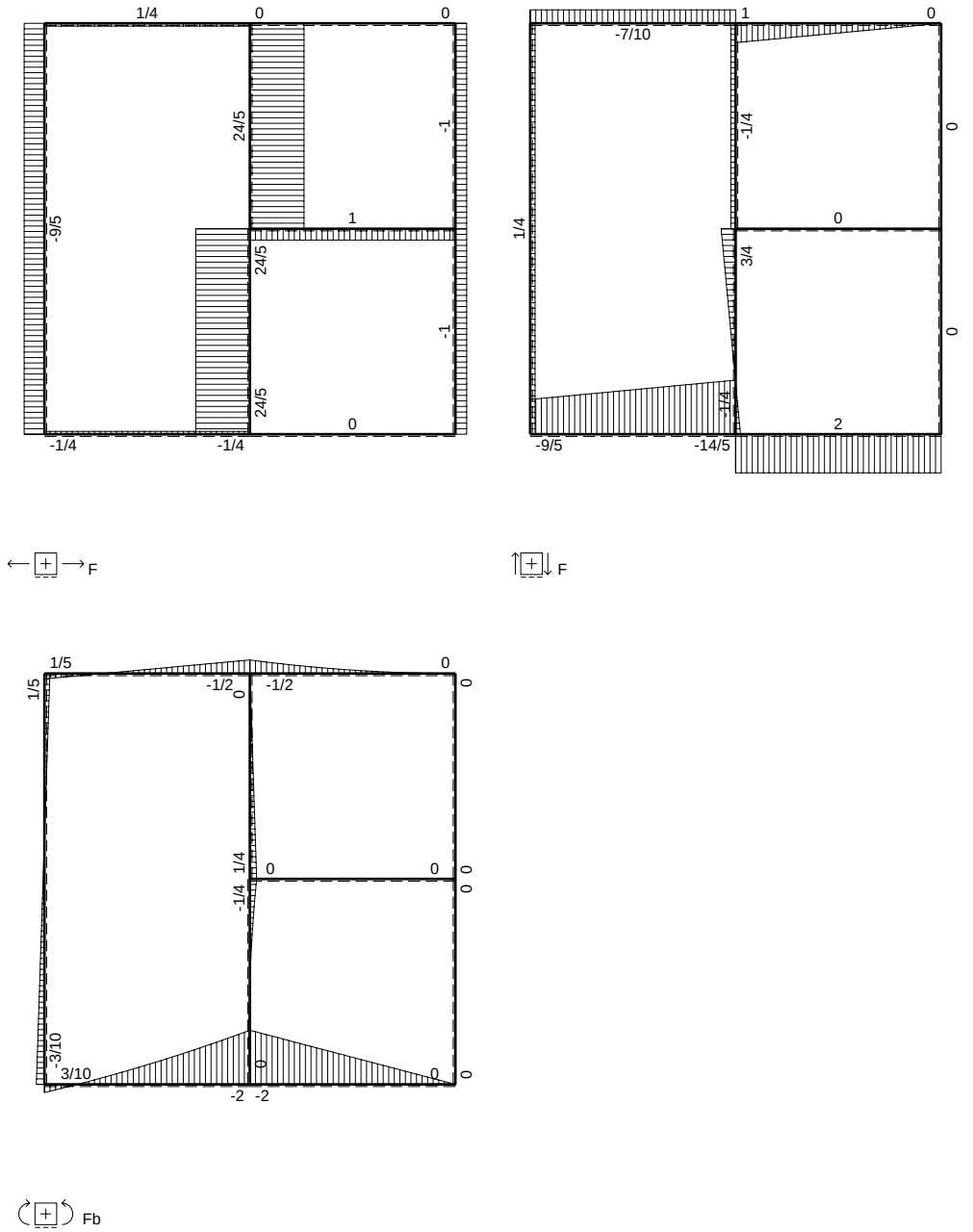
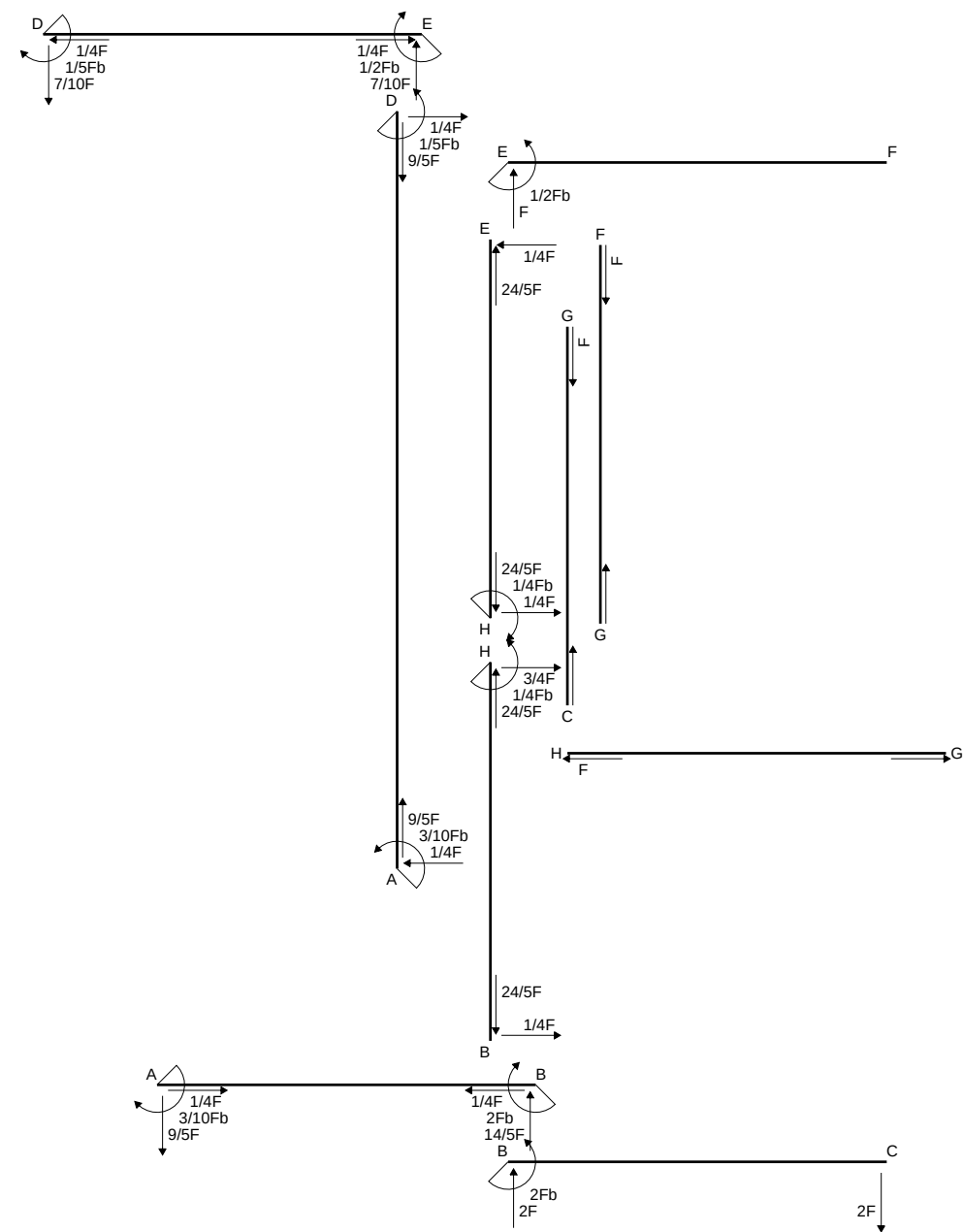
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

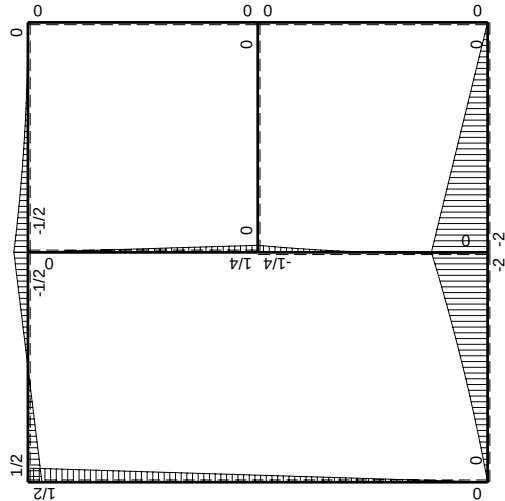
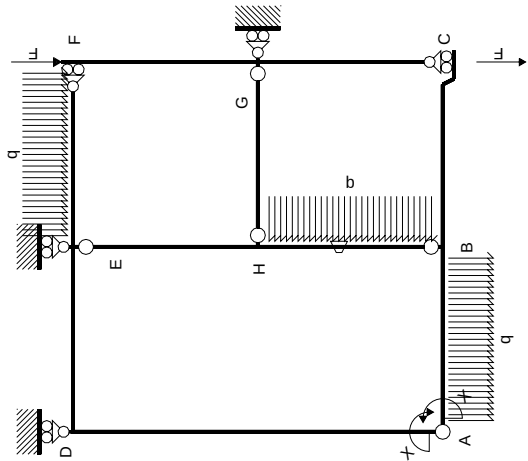
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



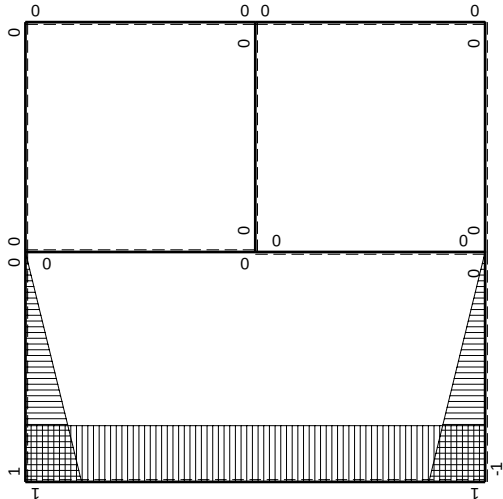
$$\begin{aligned}
A &= 1152. \text{ mm}^2 \\
J_u &= 348030. \text{ mm}^4 \\
J_v &= 122688. \text{ mm}^4 \\
y_g &= 33.38 \text{ mm} \\
T_y &= 3680. \text{ N} \\
M_x &= -2502400. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -33.38 \text{ mm} \\
\sigma_m &= -Mv/J_u = -240. \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 11. \text{ mm} \\
v_c &= -22.38 \text{ mm} \\
\sigma_c &= -Mv/J_u = -160.9 \text{ N/mm}^2 \\
\tau_c &= 5.169 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 161.1 \text{ N/mm}^2 \\
S &= 5867. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



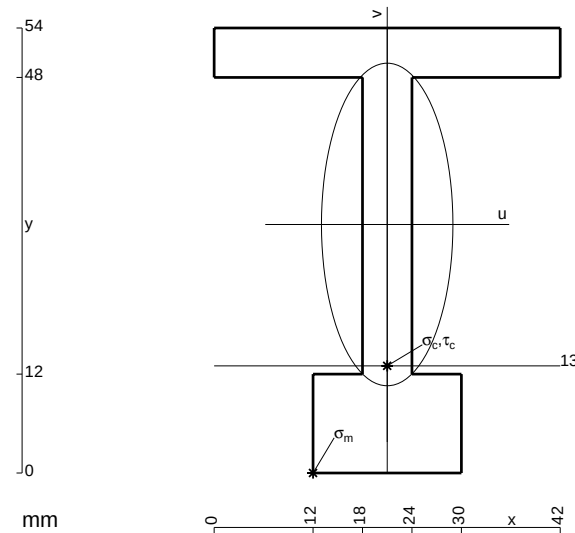
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

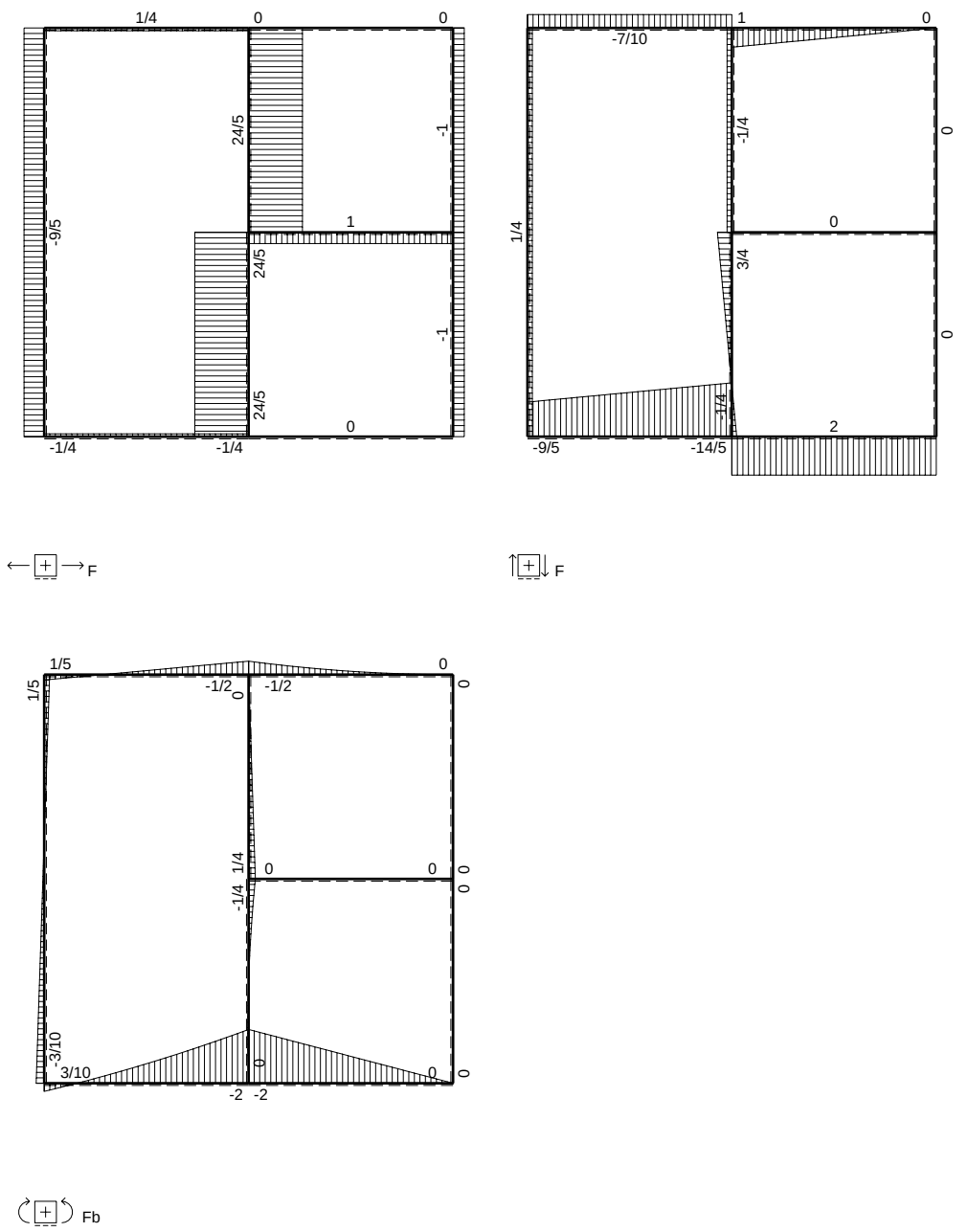
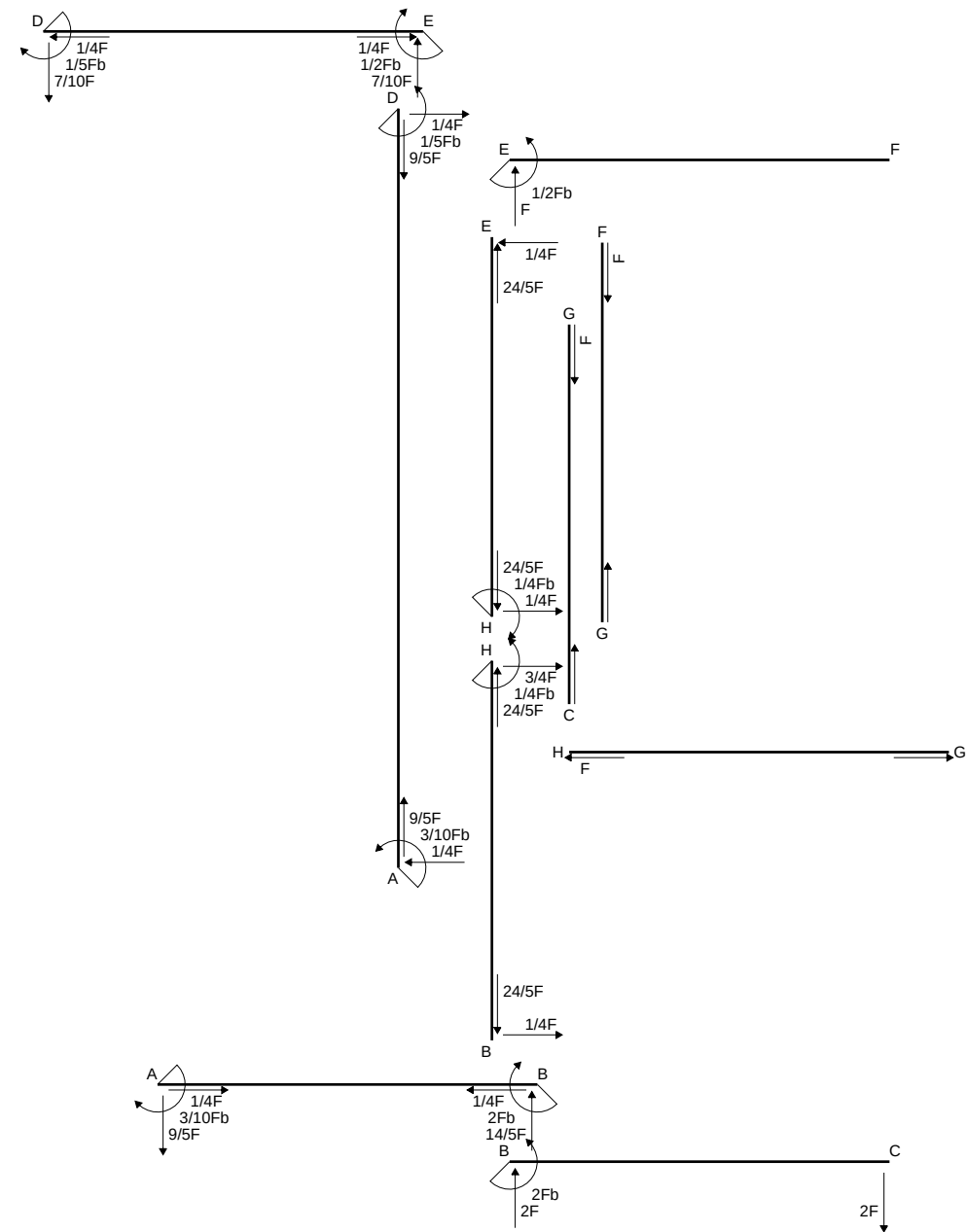
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	Fb/EJ	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 684. \text{ mm}^2 \\
J_u &= 262207. \text{ mm}^4 \\
J_v &= 43524. \text{ mm}^4 \\
y_g &= 30.16 \text{ mm} \\
T_y &= 2380. \text{ N} \\
M_x &= -1737400. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -30.16 \text{ mm} \\
\sigma_m &= -Mv/J_u = -199.8 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -17.16 \text{ mm} \\
\sigma_c &= -Mv/J_u = -113.7 \text{ N/mm}^2 \\
\tau_c &= 8.054 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 114.5 \text{ N/mm}^2 \\
S &= 5324. \text{ mm}^3
\end{aligned}$$

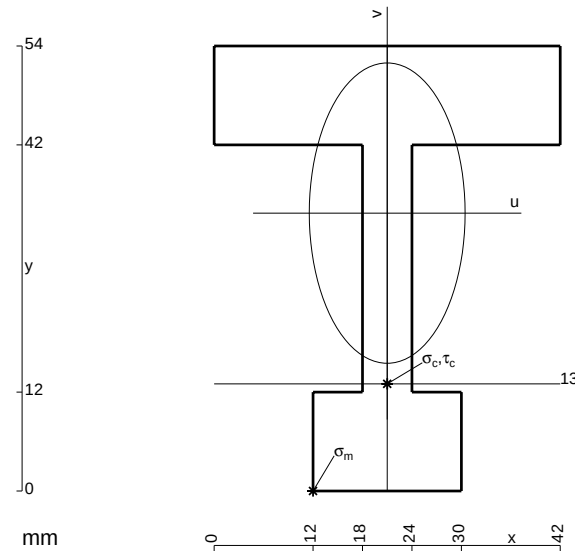


Quadro contributi PLV per iperstatica $X=W_{AB}$

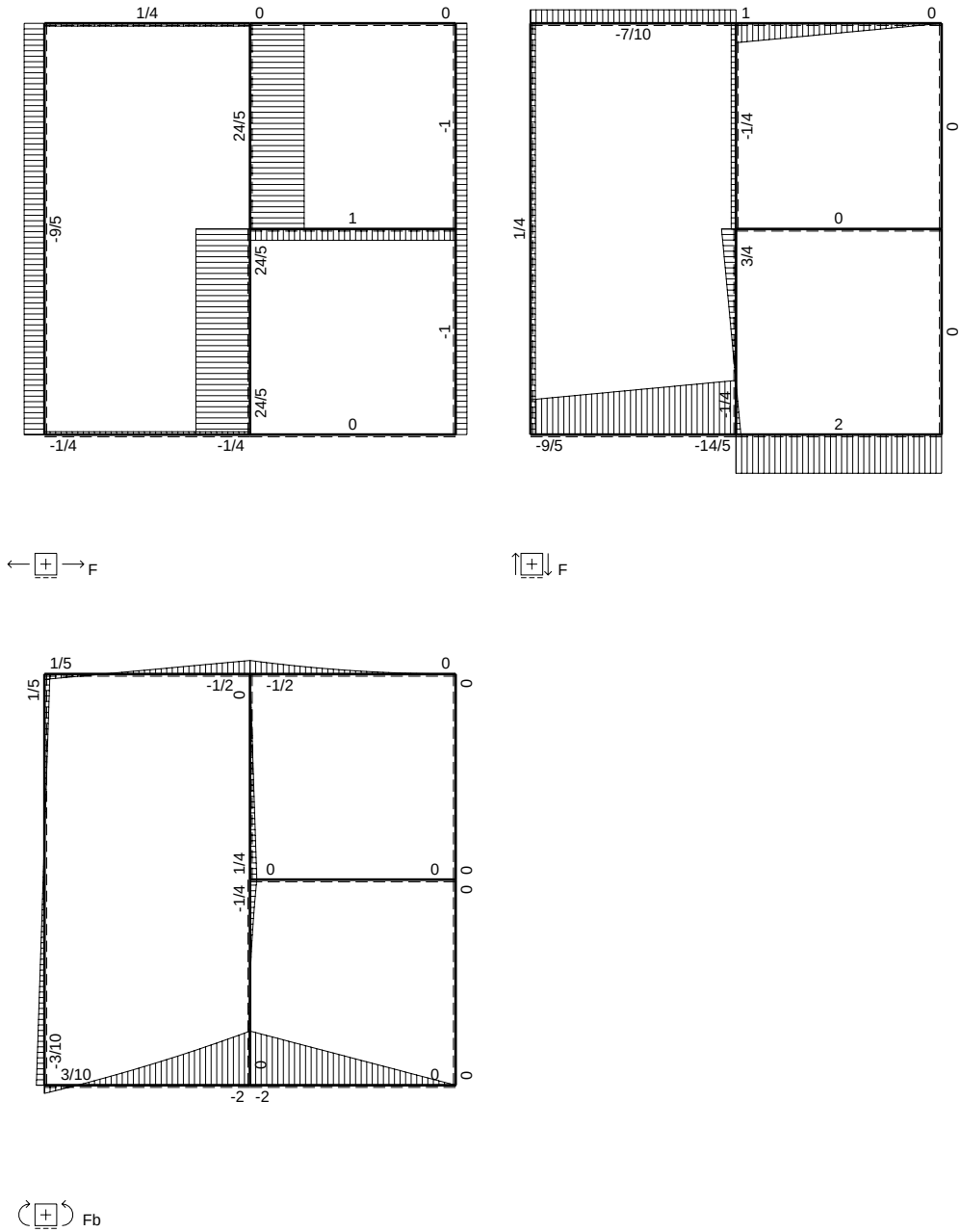
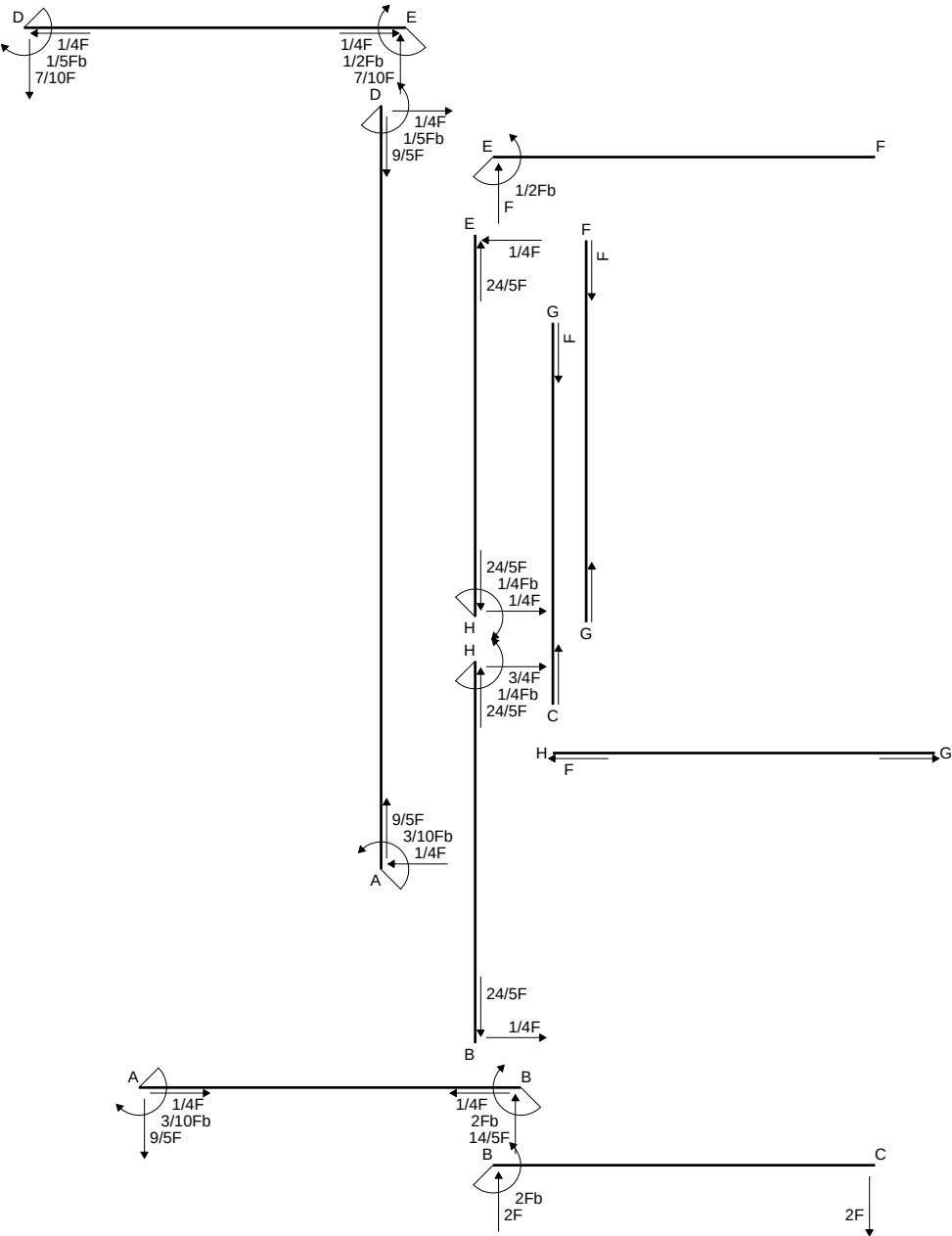
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 900. \text{ mm}^2 \\
J_u &= 299017. \text{ mm}^4 \\
J_v &= 80460. \text{ mm}^4 \\
y_g &= 33.72 \text{ mm} \\
T_y &= 2380. \text{ N} \\
M_x &= -1856400. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -33.72 \text{ mm} \\
\sigma_m &= -Mv/J_u = -209.3 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -20.72 \text{ mm} \\
\sigma_c &= -Mv/J_u = -128.6 \text{ N/mm}^2 \\
\tau_c &= 8.112 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 129.4 \text{ N/mm}^2 \\
S &= 6115. \text{ mm}^3
\end{aligned}$$

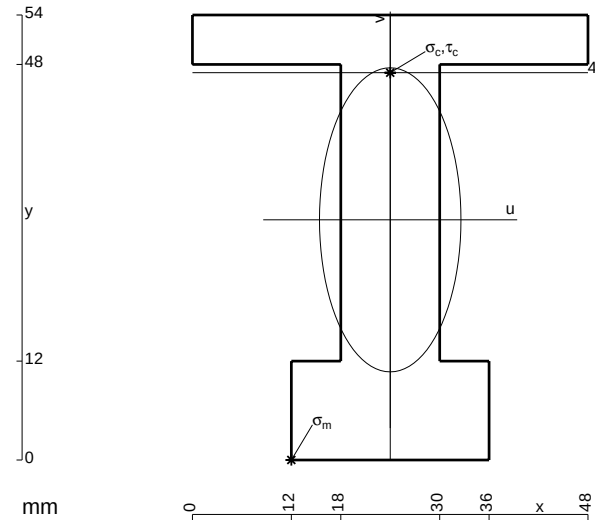


Quadro contributi PLV per iperstatica $X=W_{AB}$

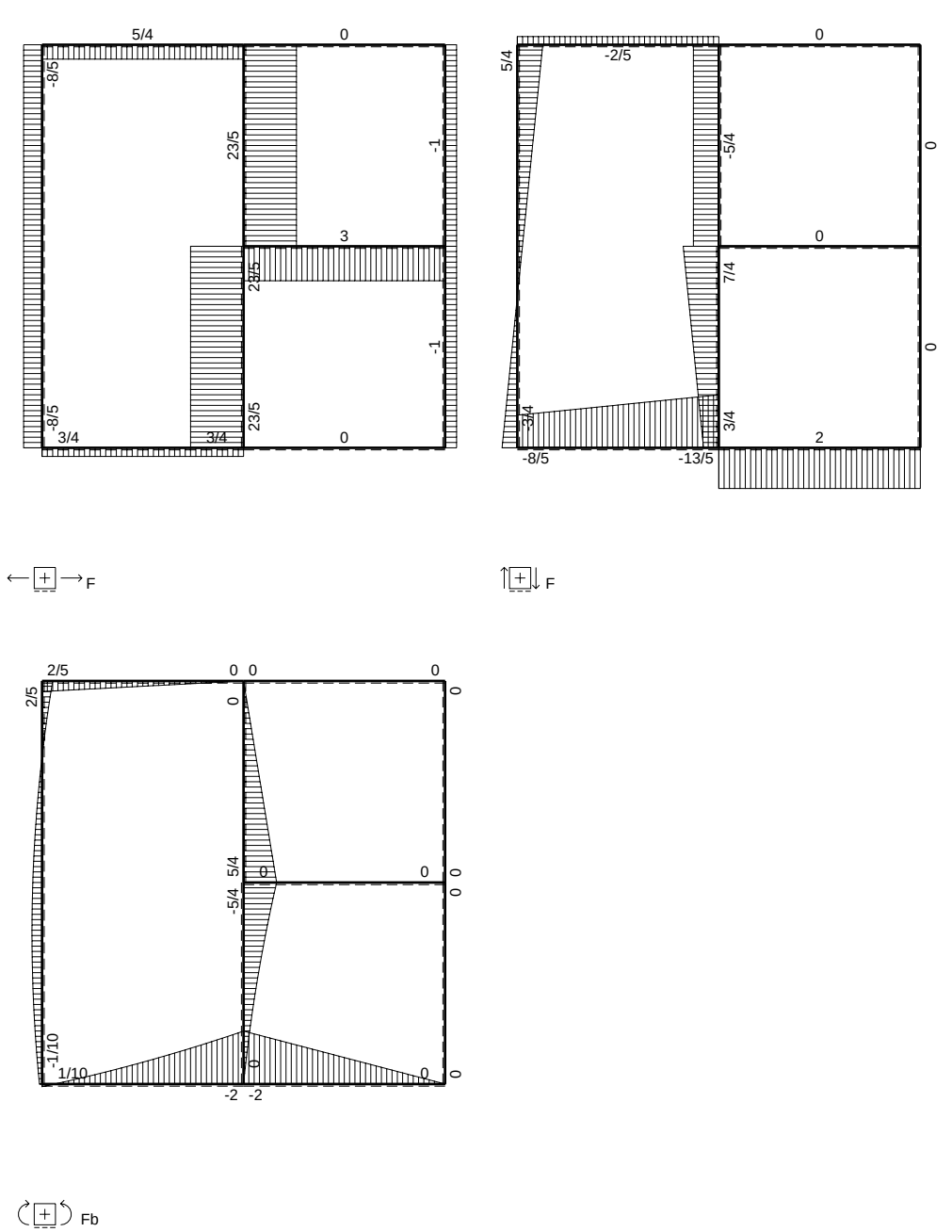
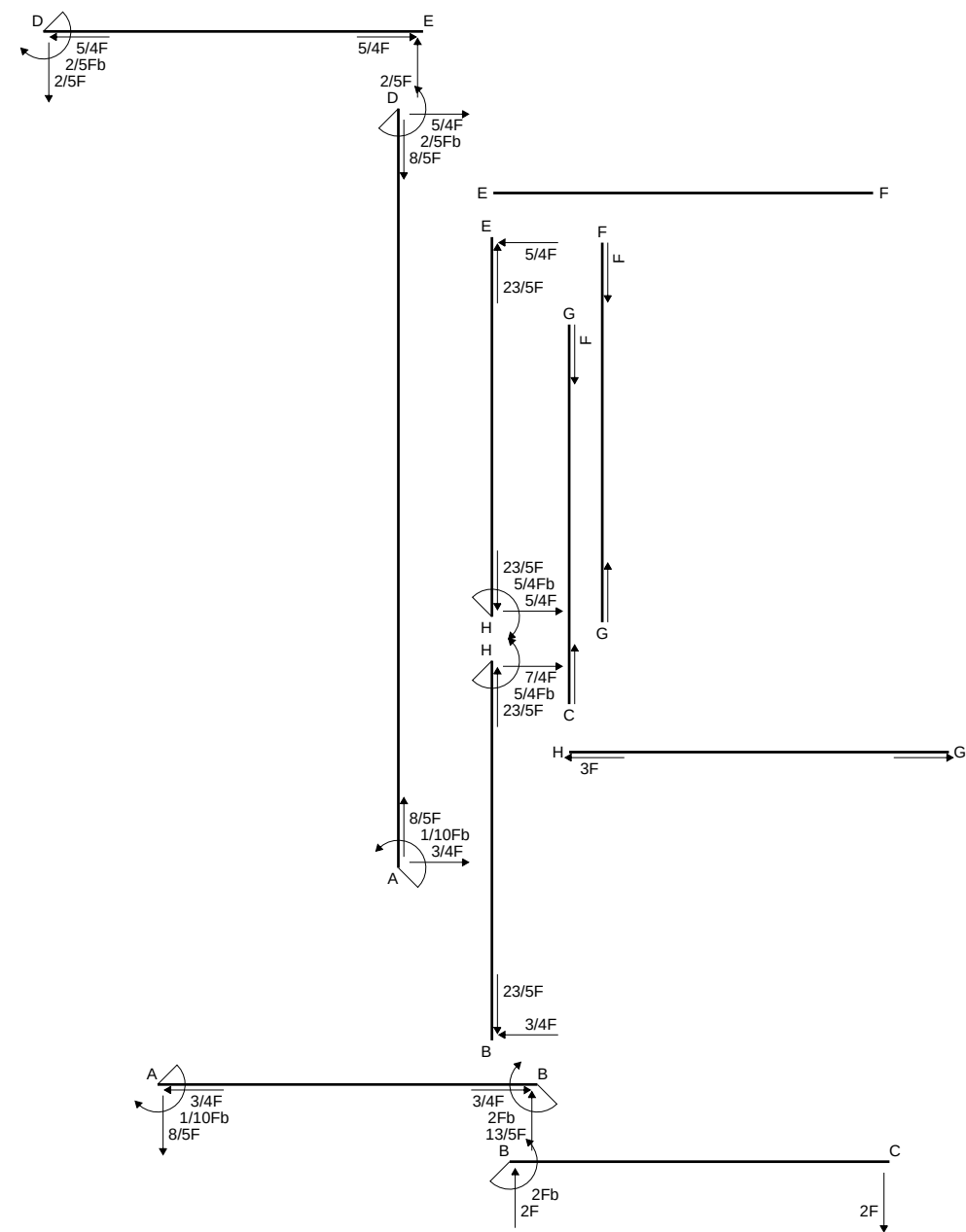
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	$1/2qx^2$	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

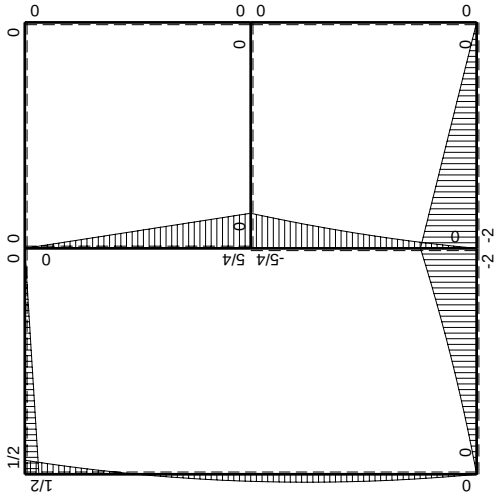
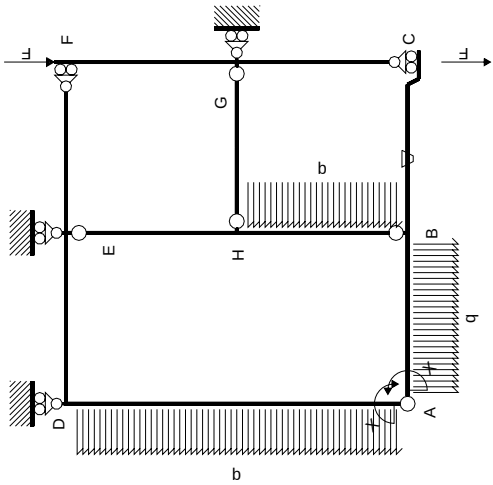
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} Fb^2/EJ \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} Fb^2/EJ \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} Fb^2/EJ = 7/24 Fb^2/EJ \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} Fb^2/EJ \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} Fb^2/EJ \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} Fb^2/EJ = 7/24 Fb^2/EJ \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 Fb^2/EJ \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 Fb^2/EJ \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 Fb^2/EJ \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 Fb^2/EJ
\end{aligned}$$



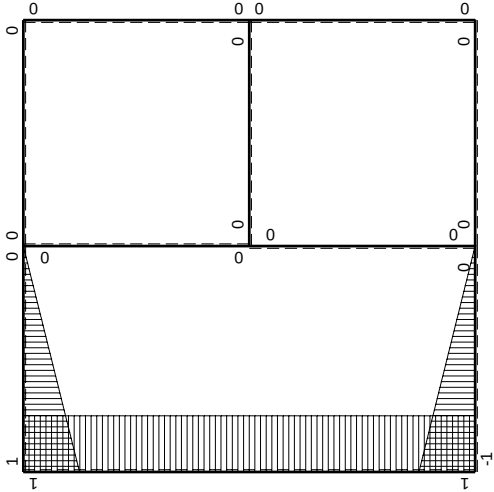
$$\begin{aligned}
A &= 1008. \text{ mm}^2 \\
J_u &= 343131. \text{ mm}^4 \\
J_v &= 74304. \text{ mm}^4 \\
y_g &= 29.14 \text{ mm} \\
T_y &= 3120. \text{ N} \\
M_x &= -2589600. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -29.14 \text{ mm} \\
\sigma_m &= -Mv/J_u = -219.9 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 47. \text{ mm} \\
v_c &= 17.86 \text{ mm} \\
\sigma_c &= -Mv/J_u = 134.8 \text{ N/mm}^2 \\
\tau_c &= 4.937 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 135. \text{ N/mm}^2 \\
S &= 6515. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



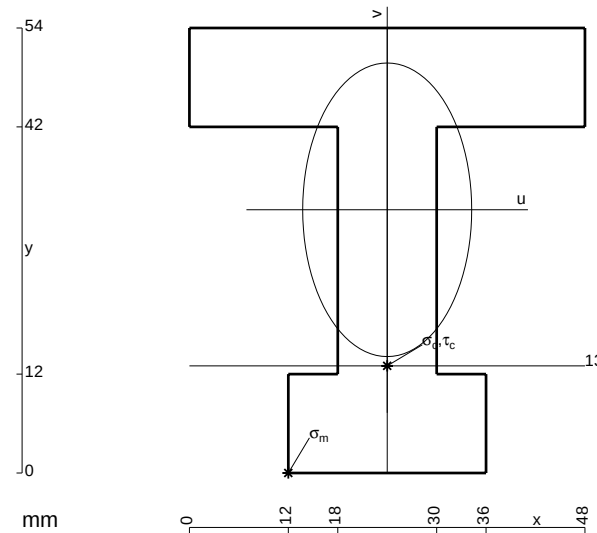
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

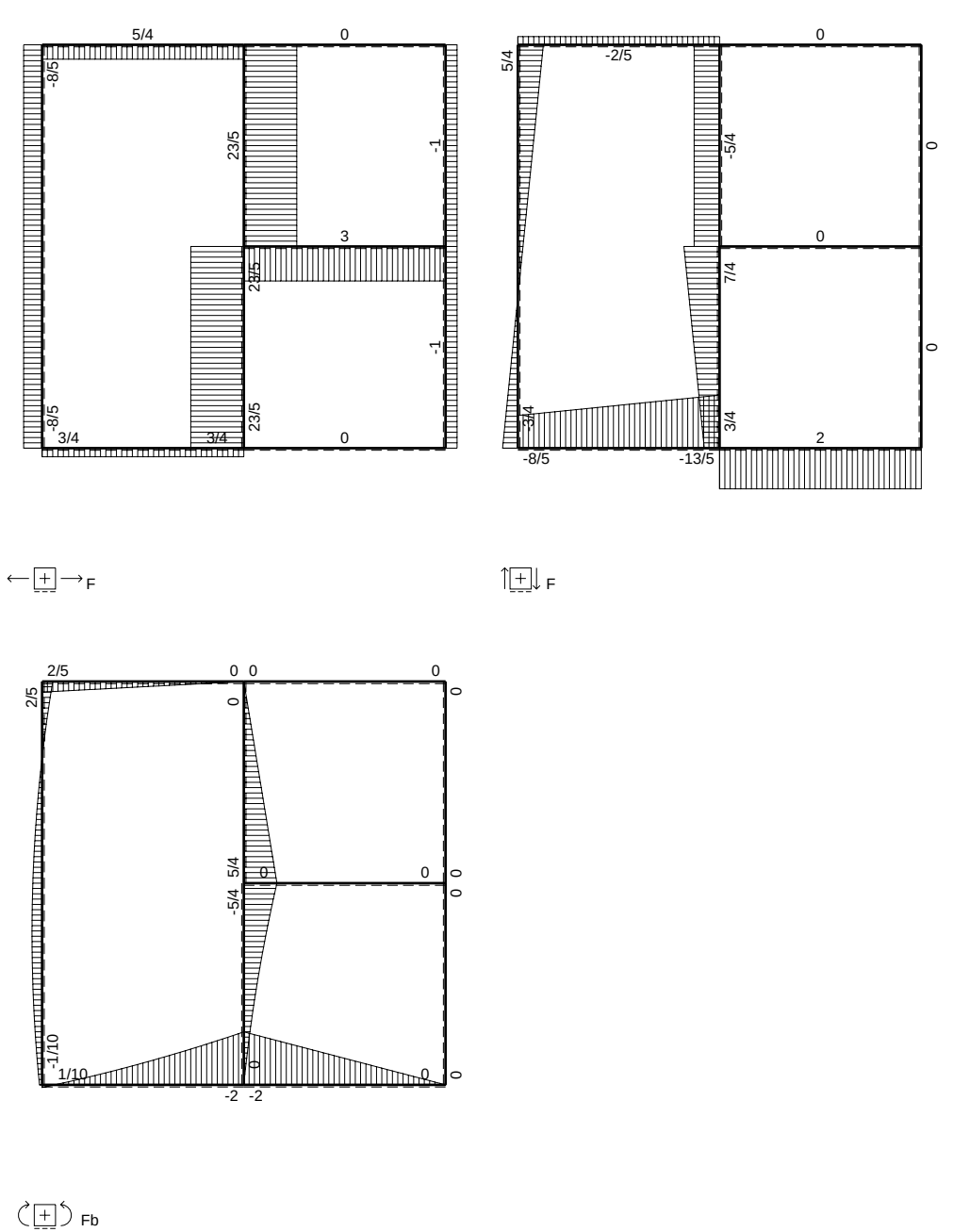
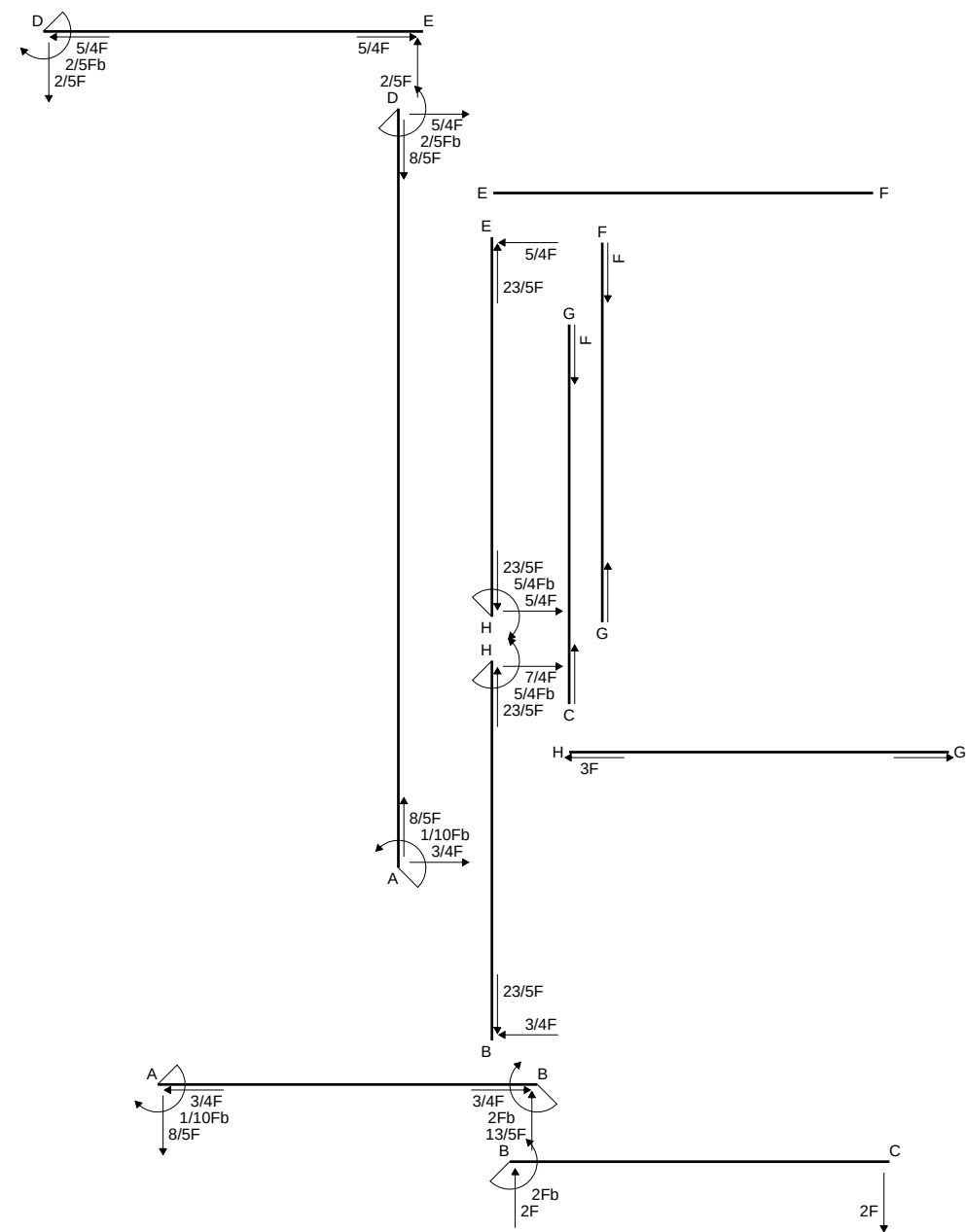
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

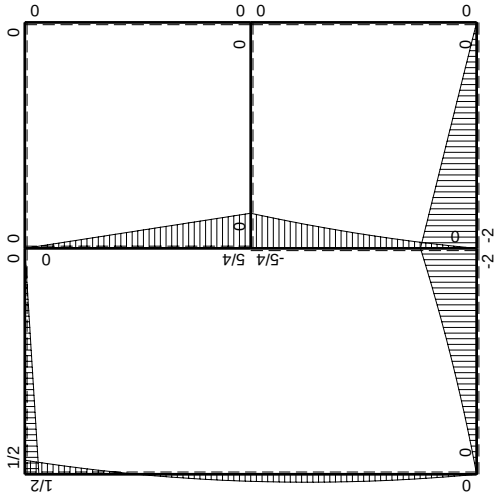
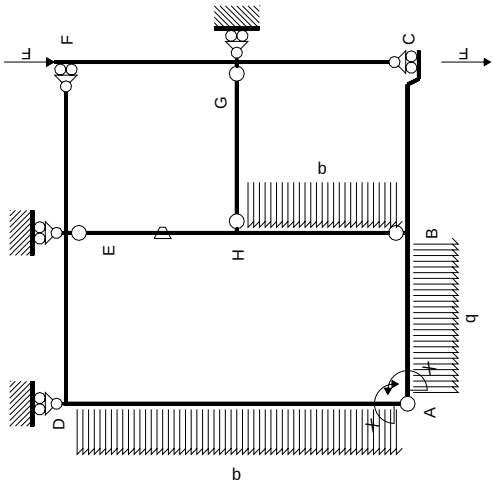
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



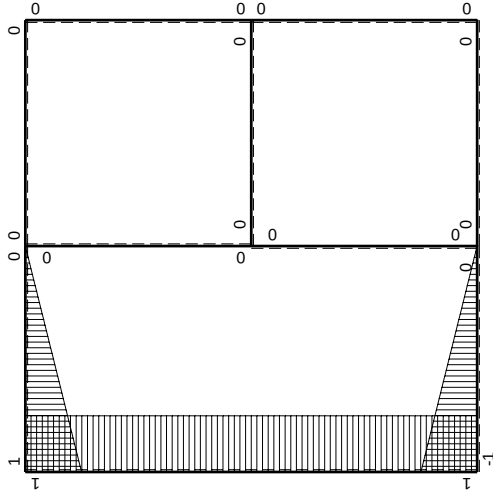
$$\begin{aligned}
A &= 1224. \text{ mm}^2 \\
J_u &= 388508. \text{ mm}^4 \\
J_v &= 128736. \text{ mm}^4 \\
y_g &= 31.94 \text{ mm} \\
T_y &= 3160. \text{ N} \\
M_x &= -2780800. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -31.94 \text{ mm} \\
\sigma_m &= -Mv/J_u = -228.6 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -18.94 \text{ mm} \\
\sigma_c &= -Mv/J_u = -135.6 \text{ N/mm}^2 \\
\tau_c &= 5.222 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 135.9 \text{ N/mm}^2 \\
S &= 7704. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



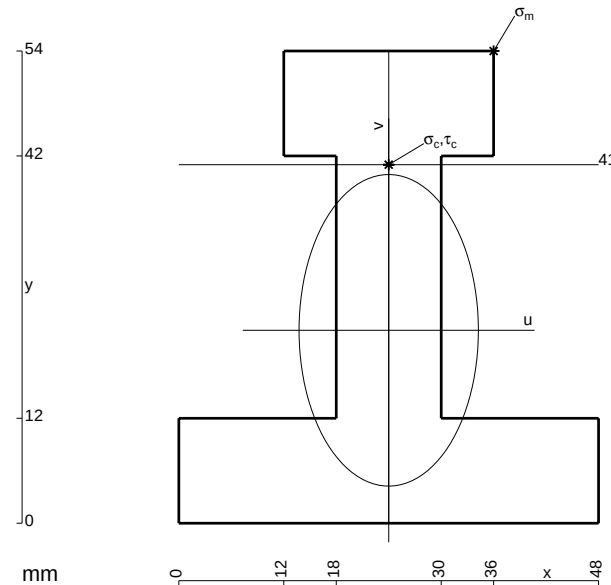
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

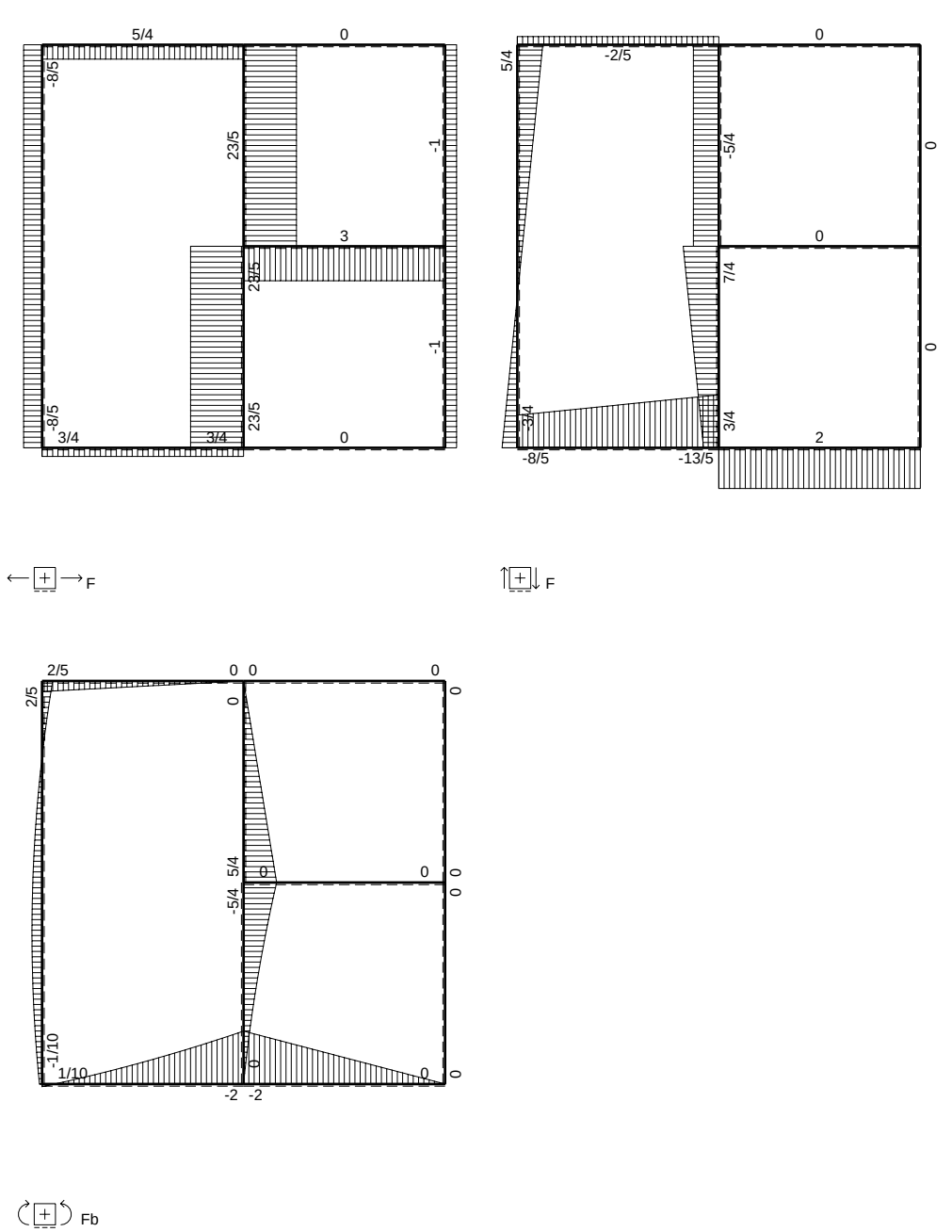
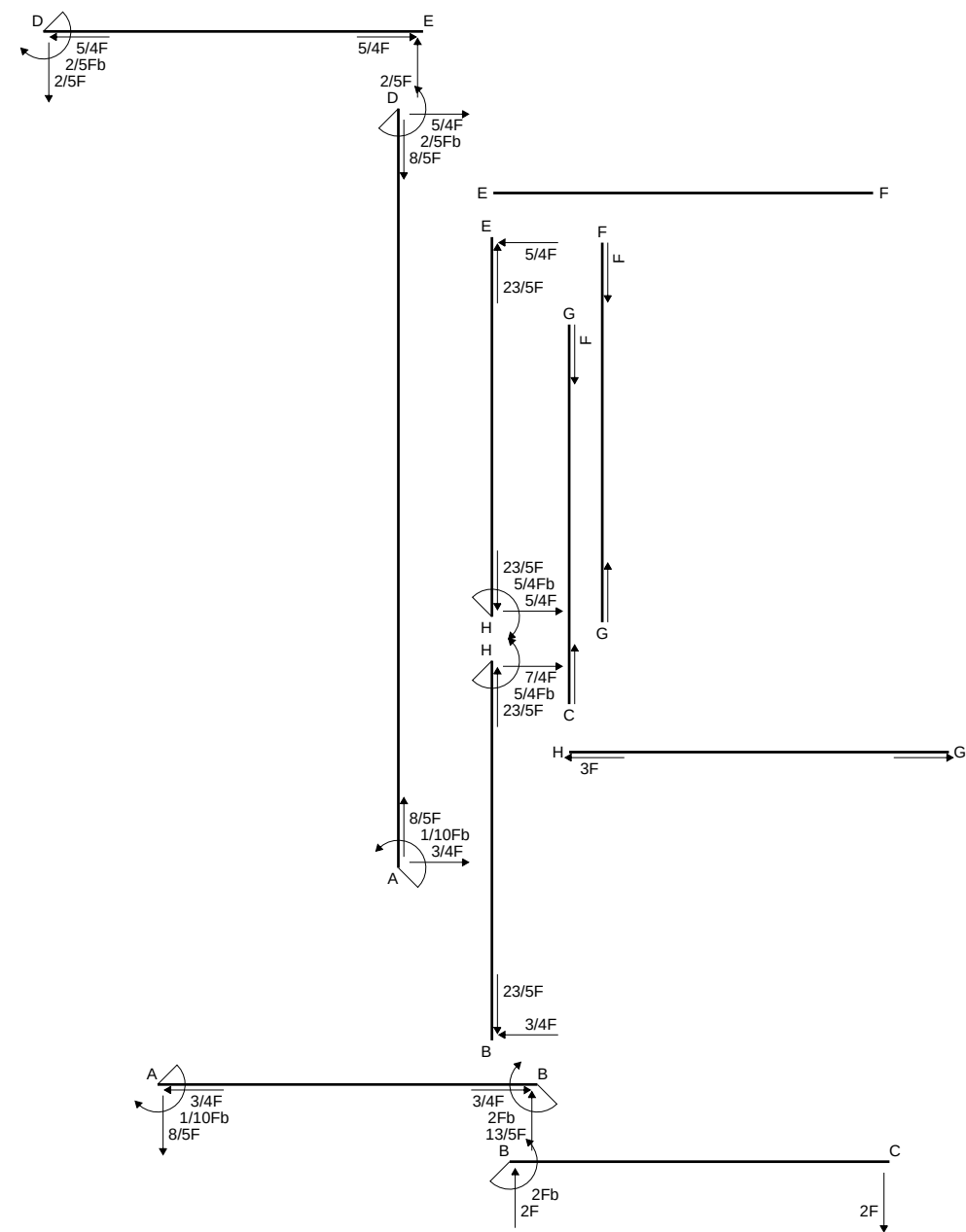
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-5/4Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

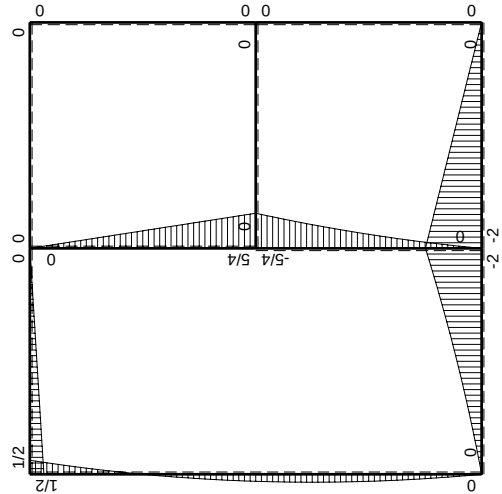
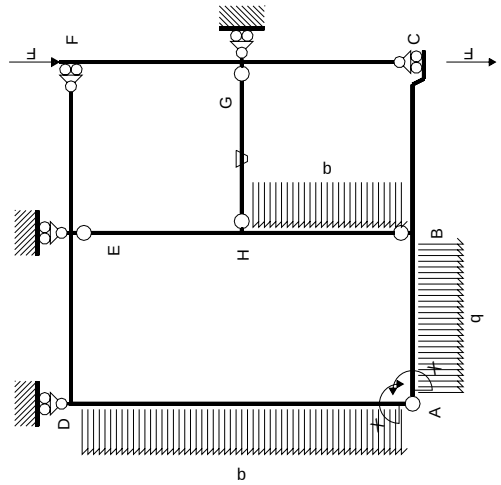
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



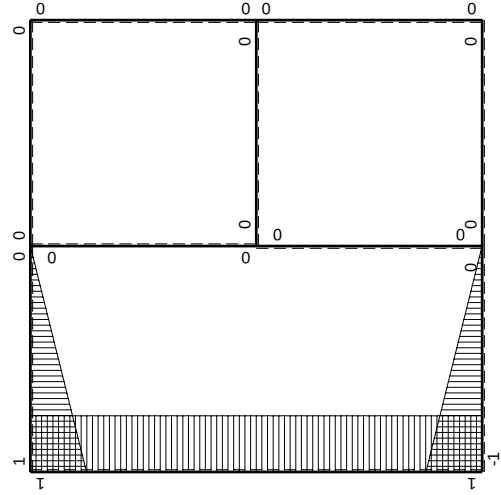
$$\begin{aligned}
A &= 1224. \text{ mm}^2 \\
J_u &= 388508. \text{ mm}^4 \\
J_v &= 128736. \text{ mm}^4 \\
y_g &= 22.06 \text{ mm} \\
T_y &= 3120. \text{ N} \\
M_x &= -2901600. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 31.94 \text{ mm} \\
\sigma_m &= -Mv/J_u = 238.6 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 41. \text{ mm} \\
v_c &= 18.94 \text{ mm} \\
\sigma_c &= -Mv/J_u = 141.5 \text{ N/mm}^2 \\
\tau_c &= 5.156 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 141.7 \text{ N/mm}^2 \\
S &= 7704. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



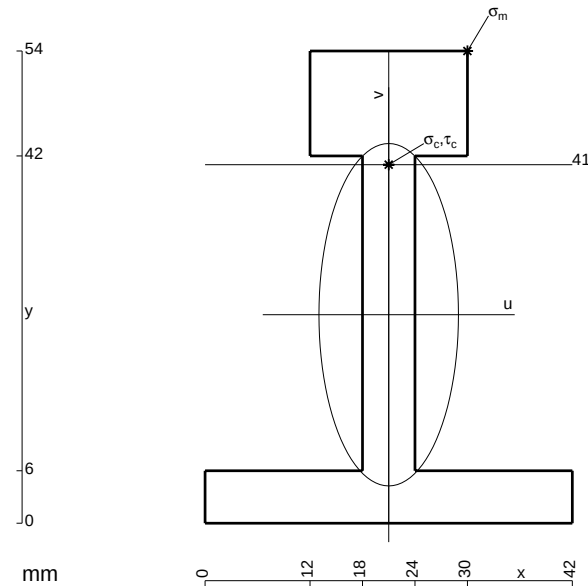
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

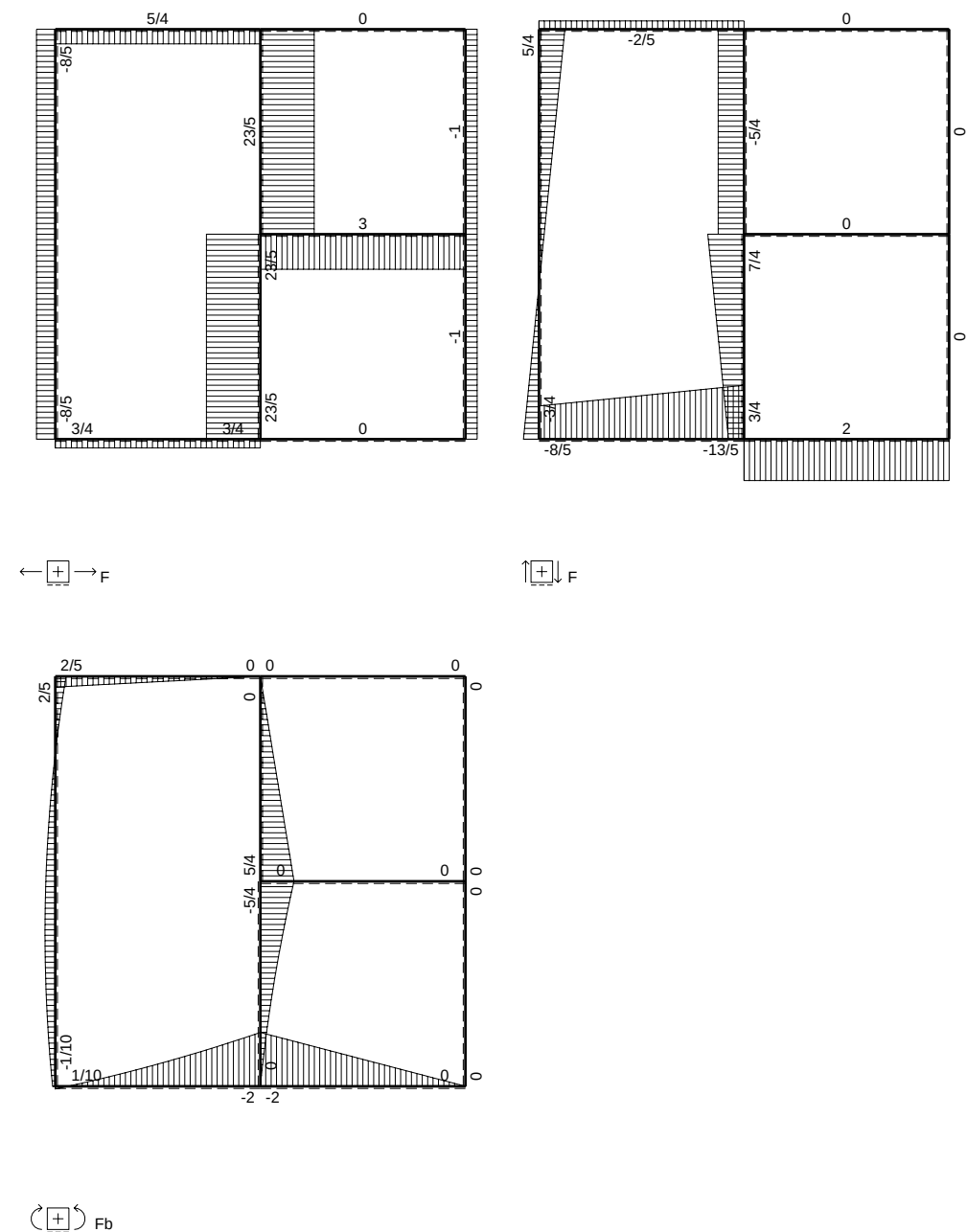
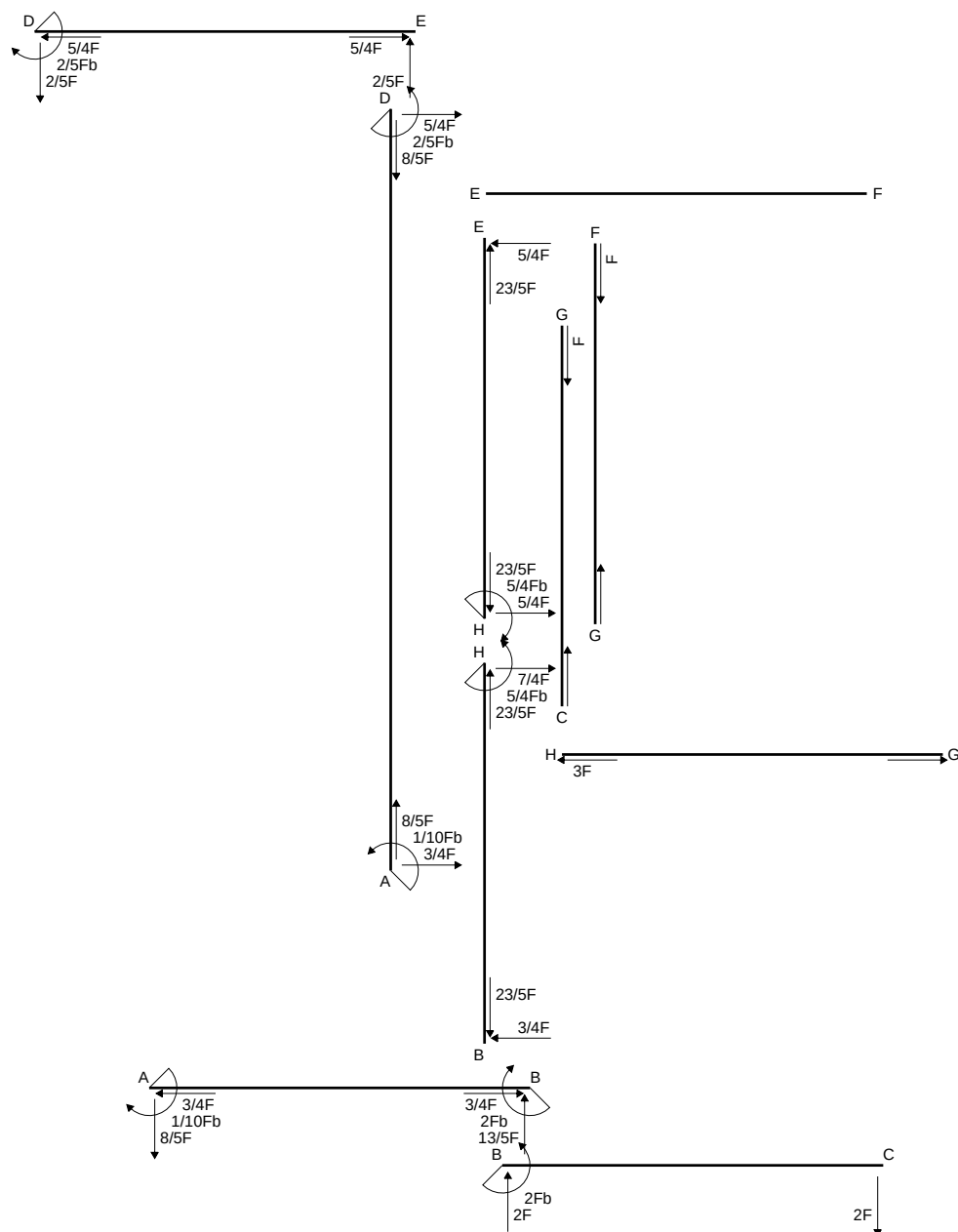
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

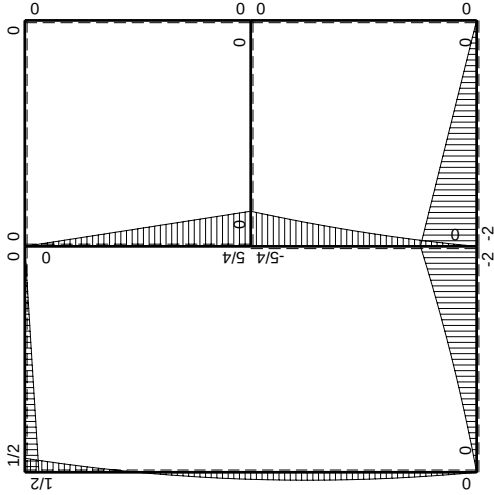
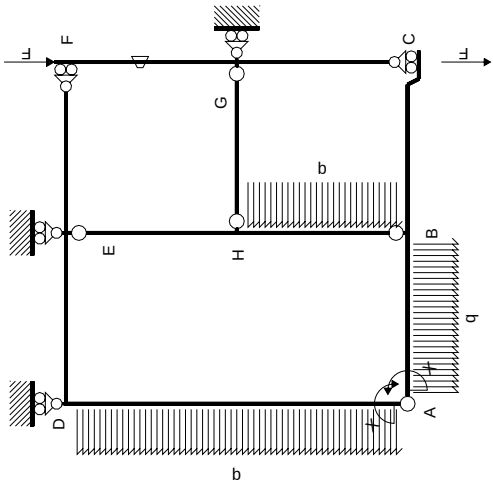
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



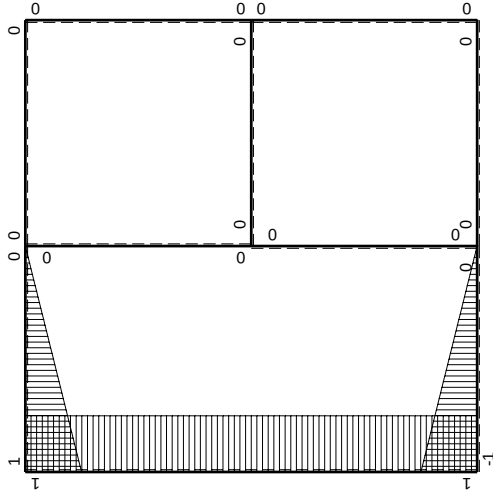
$$\begin{aligned}
A &= 684. \text{ mm}^2 \\
J_u &= 262207. \text{ mm}^4 \\
J_v &= 43524. \text{ mm}^4 \\
y_g &= 23.84 \text{ mm} \\
T_y &= 3540. \text{ N} \\
M_x &= -1734600. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 30.16 \text{ mm} \\
\sigma_m &= -Mv/J_u = 199.5 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 41. \text{ mm} \\
v_c &= 17.16 \text{ mm} \\
\sigma_c &= -Mv/J_u = 113.5 \text{ N/mm}^2 \\
\tau_c &= 11.98 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 115.4 \text{ N/mm}^2 \\
S &= 5324. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_k flessione da carichi assegnati



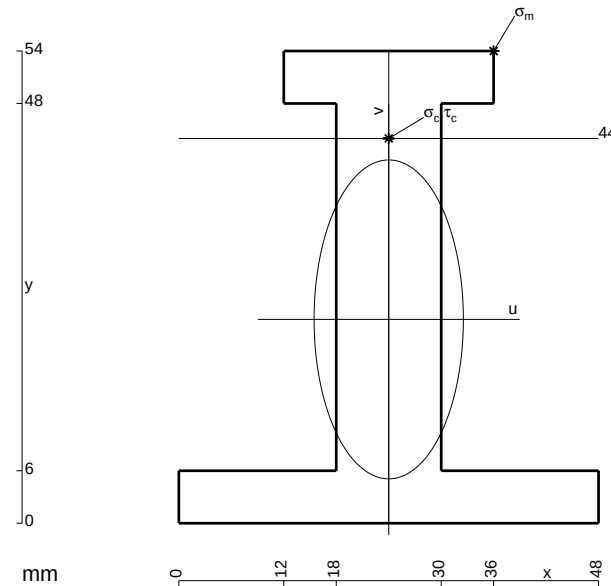
M_k flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

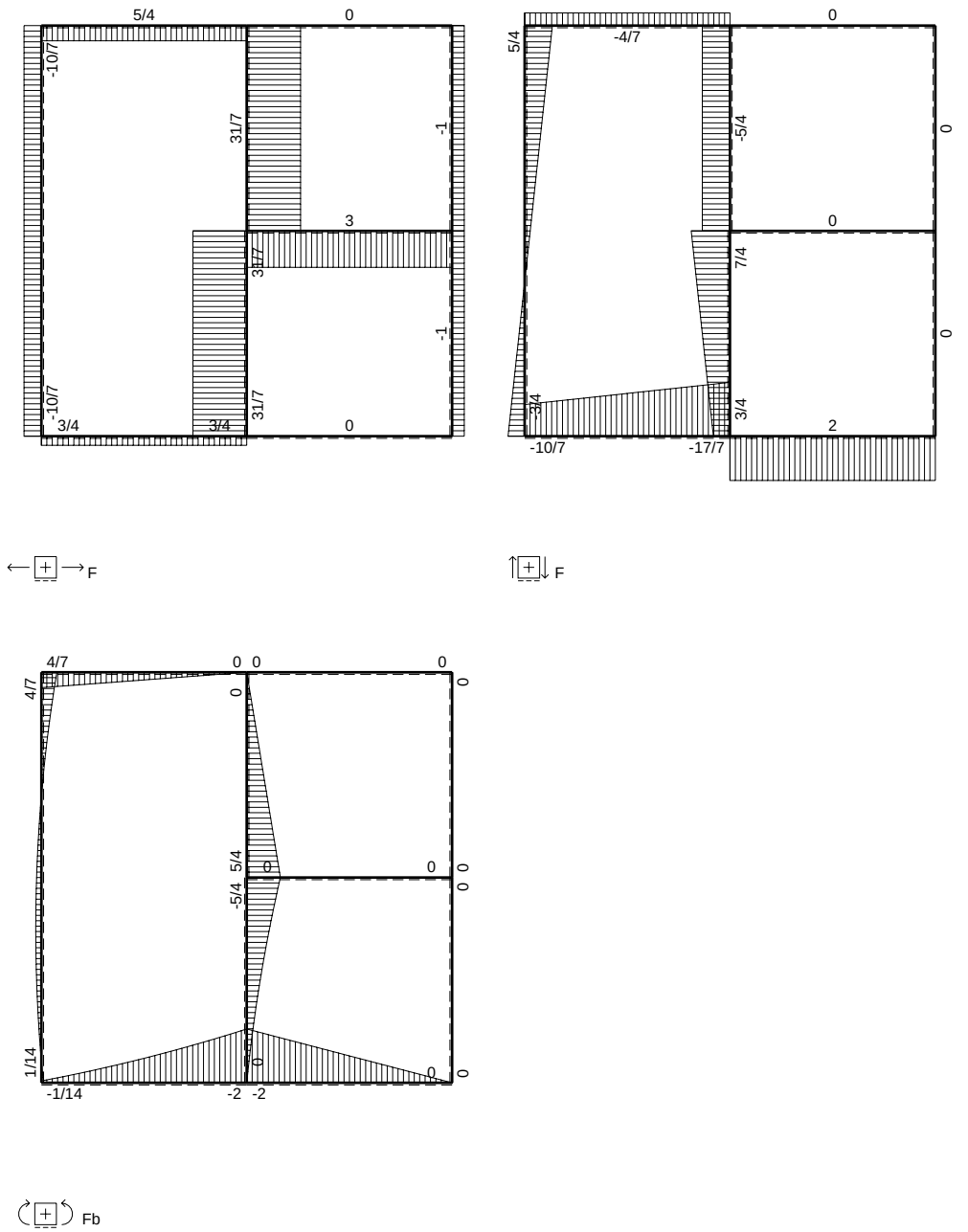
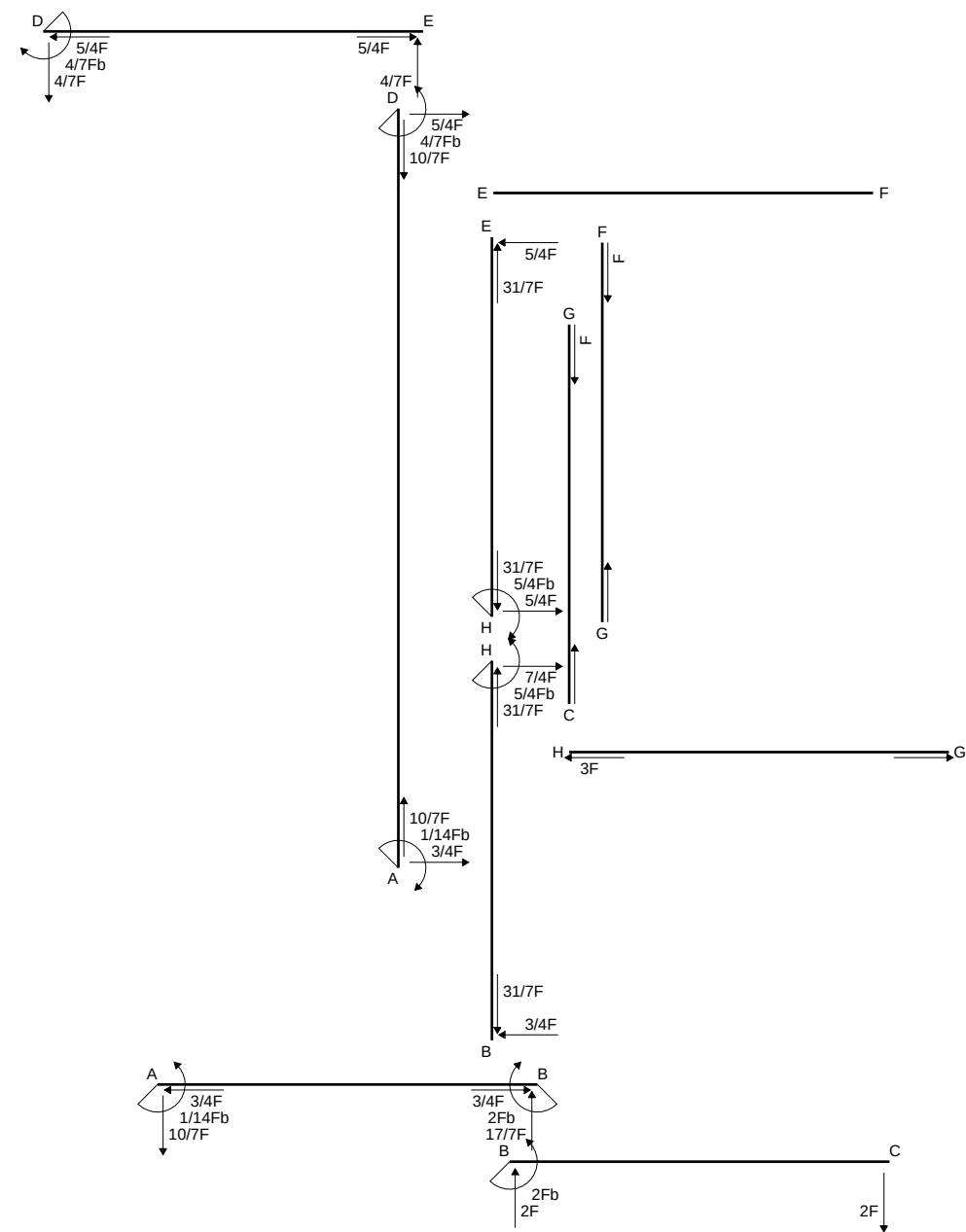
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

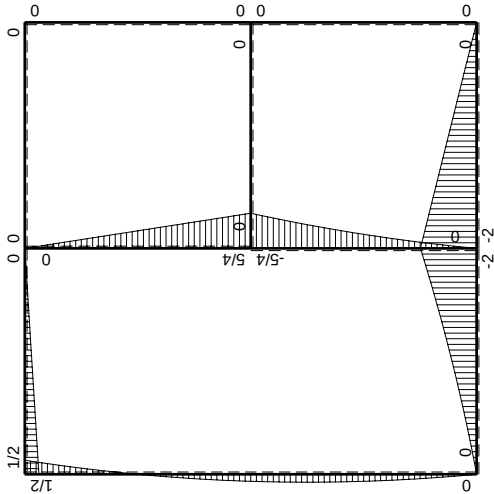
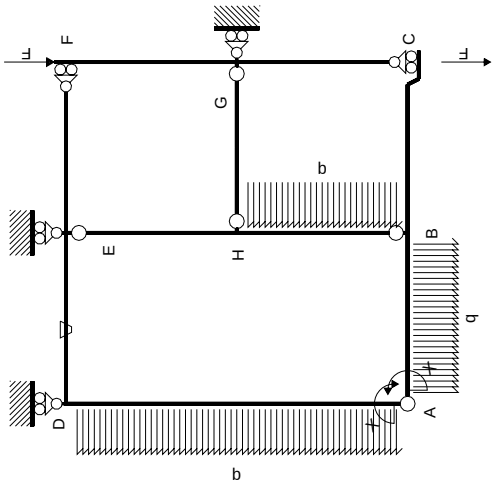
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



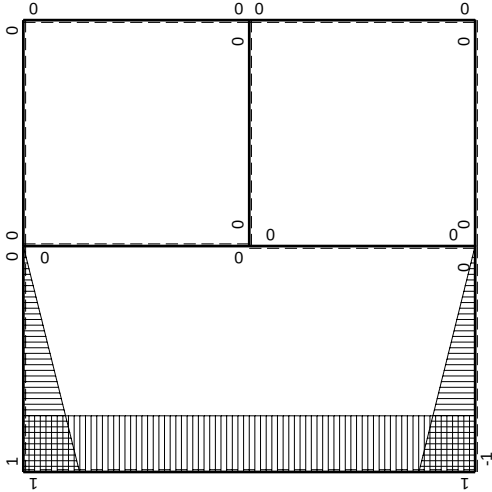
$$\begin{aligned}
A &= 936. \text{ mm}^2 \\
J_u &= 311455. \text{ mm}^4 \\
J_v &= 68256. \text{ mm}^4 \\
y_g &= 23.31 \text{ mm} \\
T_y &= 4020. \text{ N} \\
M_x &= -2130600. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 30.69 \text{ mm} \\
\sigma_m &= -Mv/J_u = 210. \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 44. \text{ mm} \\
v_c &= 20.69 \text{ mm} \\
\sigma_c &= -Mv/J_u = 141.6 \text{ N/mm}^2 \\
\tau_c &= 5.461 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma_c^2 + 3\tau_c^2} = 141.9 \text{ N/mm}^2 \\
S &= 5077. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$-Fb/EJ+Fx/EJ$	$1-2x/b+x^2/b^2$	$(1/6-1/2)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	Fb/EJ	$1/2Fx^2/b$	$-Fx/EJ$	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/14Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{AD}^{xo} = \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}$$

$$L_{DA}^{xo} = \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}$$

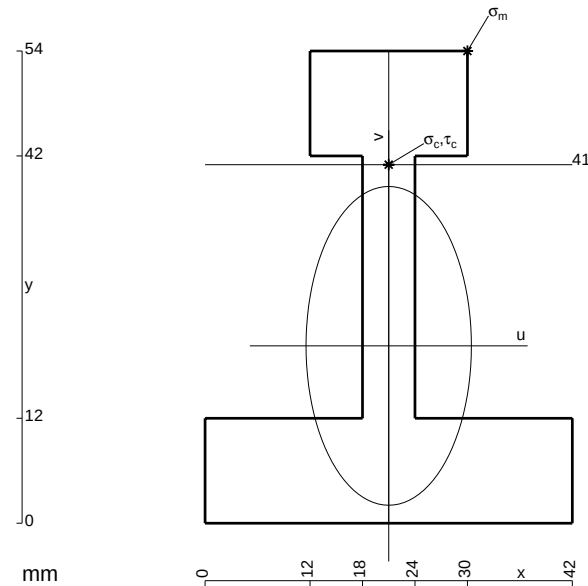
$$L_{DE}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1 + x/b) \theta dx$$

$$= \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} + \left[-x + 1/2 x^2/b \right]_0^b \theta$$

$$= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b + 1/2 b) \theta = -1/3 \frac{Fb^2}{EJ}$$

$$L_{ED}^{xo} = \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (x/b) \theta dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} + \left[1/2 x^2/b \right]_0^b \theta$$

$$= (1/6 b) Fb \frac{1}{EJ} + (1/2 b) \theta = -1/3 \frac{Fb^2}{EJ}$$



$$A = 900. \text{ mm}^2$$

$$J_u = 299017. \text{ mm}^4$$

$$J_v = 80460. \text{ mm}^4$$

$$y_g = 20.28 \text{ mm}$$

$$T_y = 3360. \text{ N}$$

$$M_x = -1948800. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 54. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 33.72 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 219.8 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 41. \text{ mm}$$

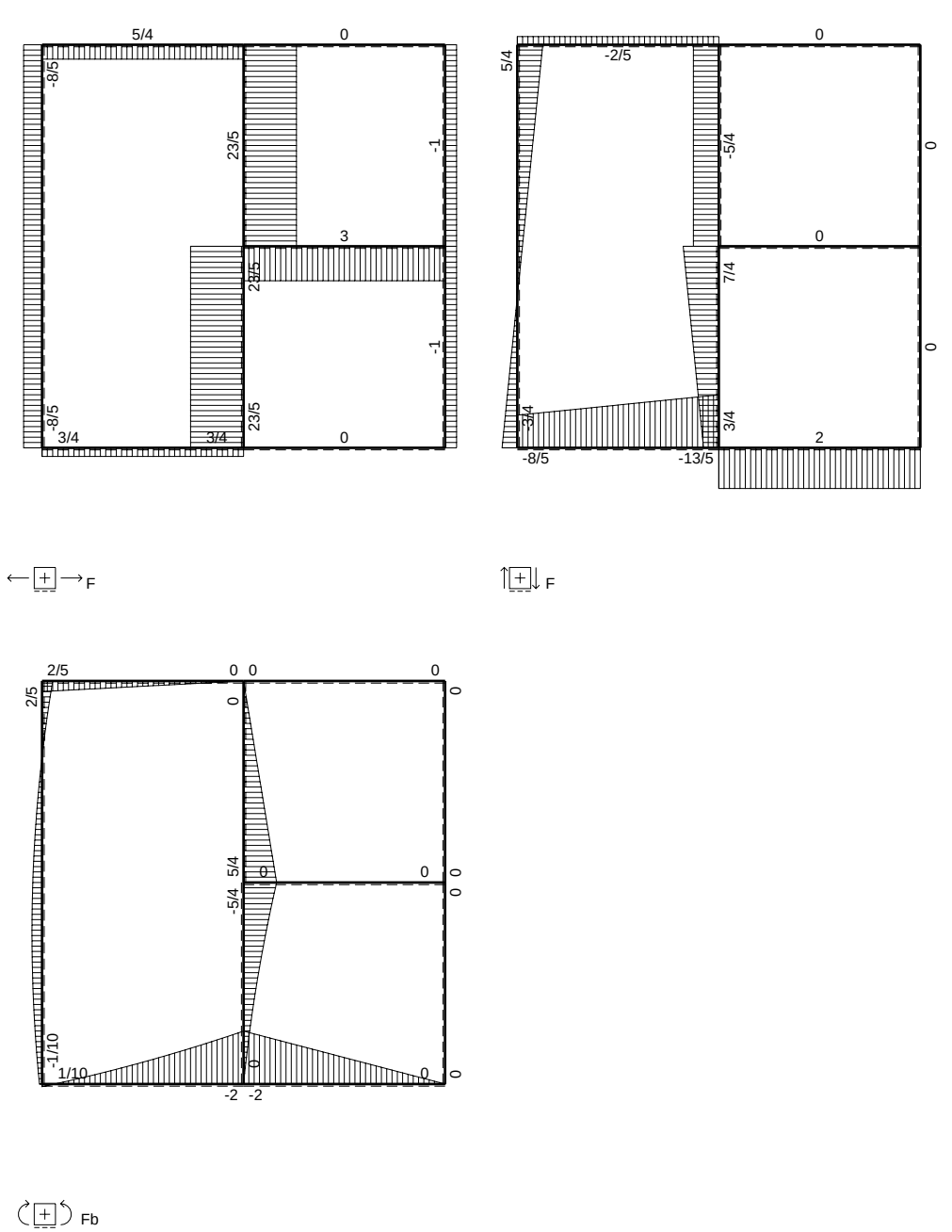
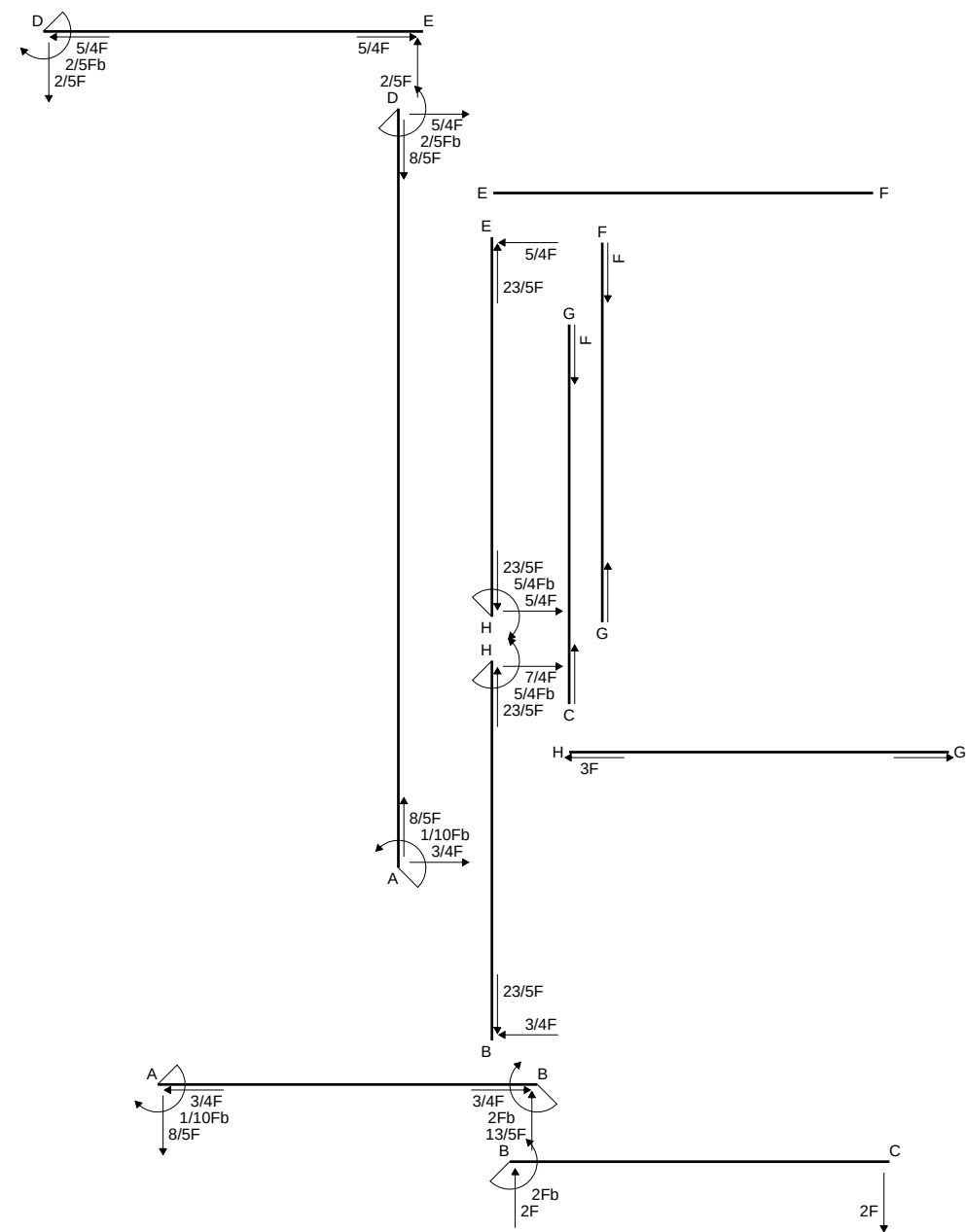
$$v_c = 20.72 \text{ mm}$$

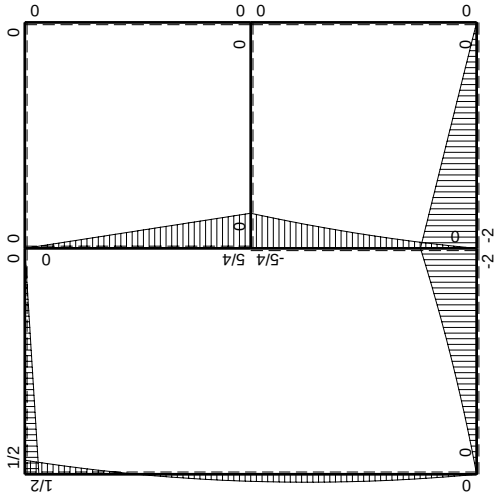
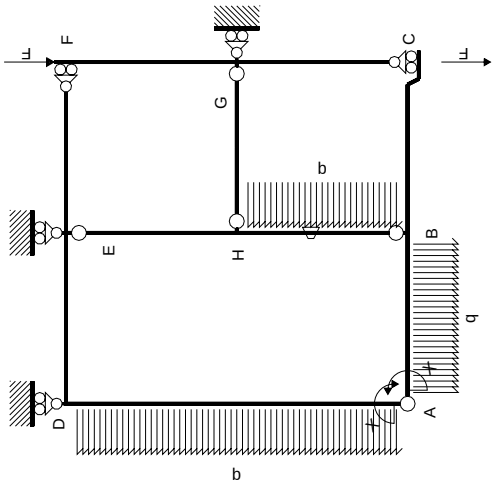
$$\sigma_c = -Mv/J_u = 135. \text{ N/mm}^2$$

$$\tau_c = 11.45 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 136.5 \text{ N/mm}^2$$

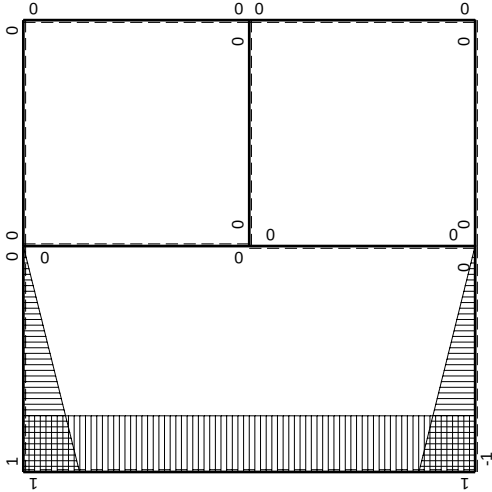
$$S = 6115. \text{ mm}^3$$





Schema di calcolo iperstatico

 M_0 flessione da carichi assegnati



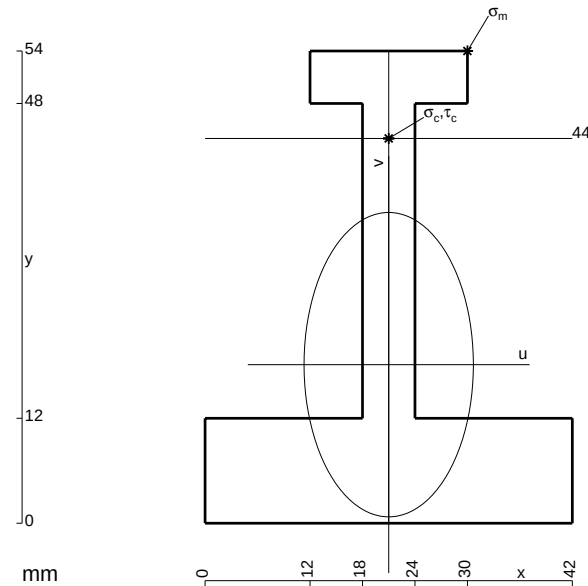
 M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

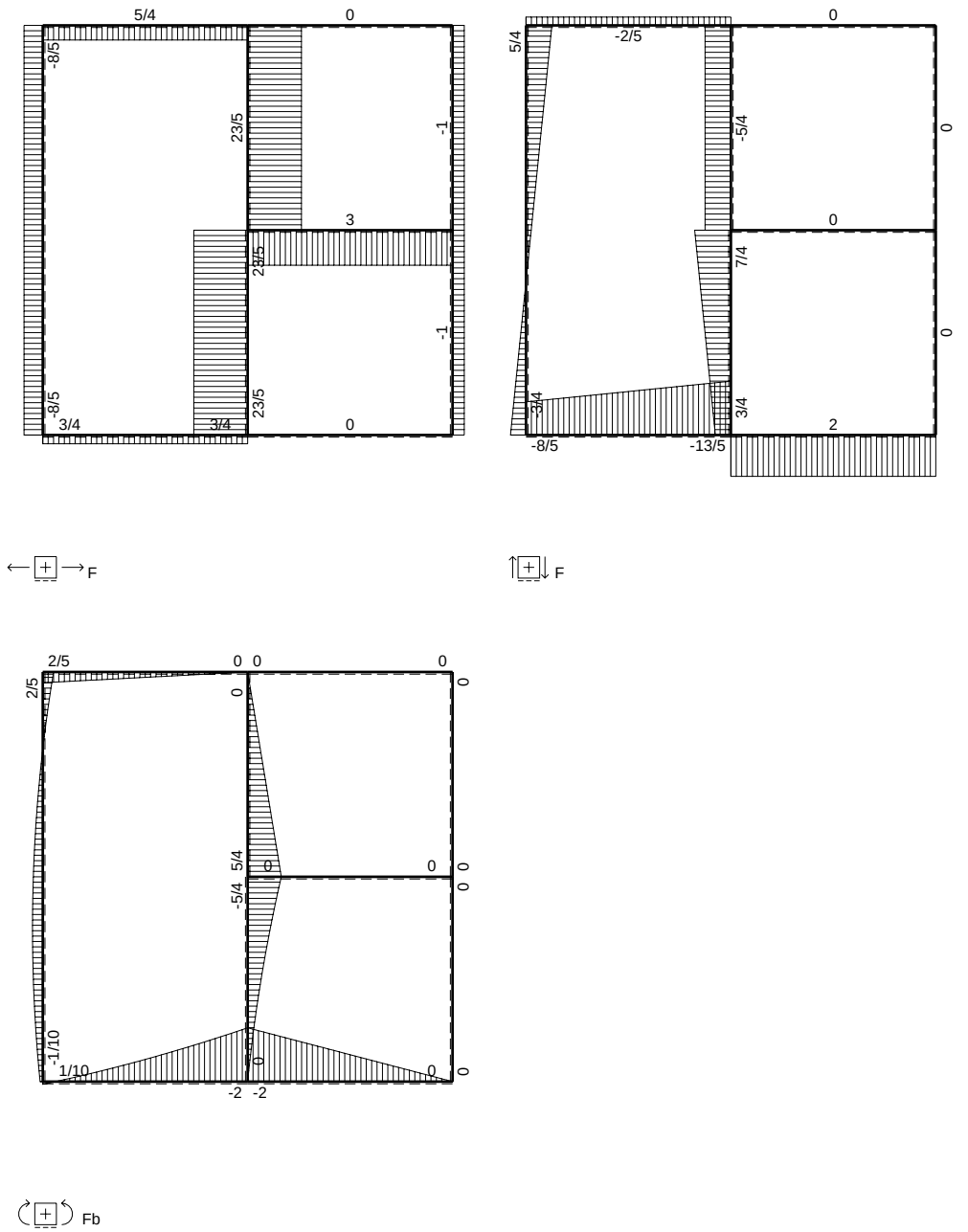
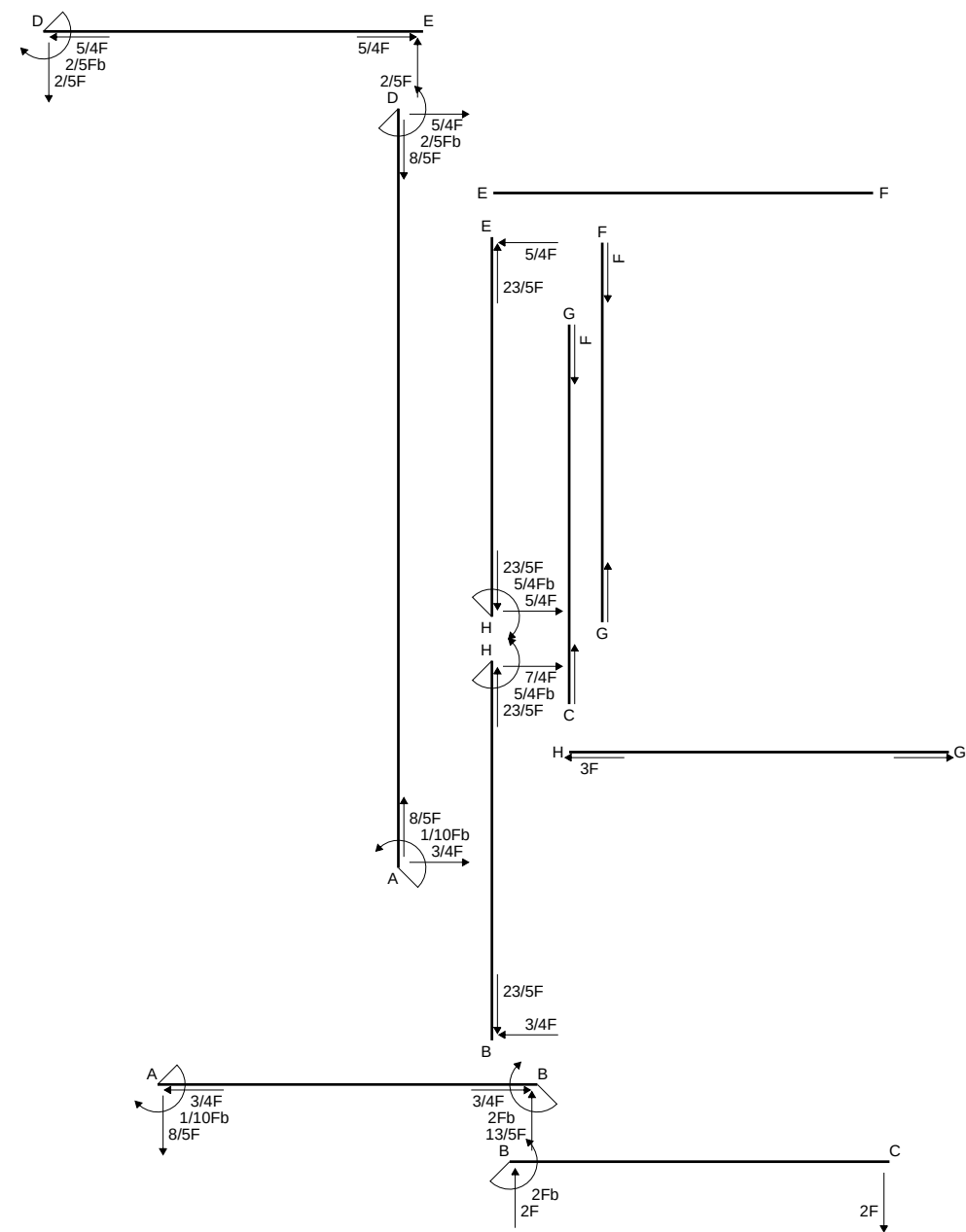
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	Fb/EJ	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 828. \text{ mm}^2 \\
J_u &= 250978. \text{ mm}^4 \\
J_v &= 77652. \text{ mm}^4 \\
y_g &= 18.13 \text{ mm} \\
T_y &= 2540. \text{ N} \\
M_x &= -1600200. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 35.87 \text{ mm} \\
\sigma_m &= -Mv/J_u = 228.7 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 44. \text{ mm} \\
v_c &= 25.87 \text{ mm} \\
\sigma_c &= -Mv/J_u = 164.9 \text{ N/mm}^2 \\
\tau_c &= 7.116 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 165.4 \text{ N/mm}^2 \\
S &= 4219. \text{ mm}^3
\end{aligned}$$

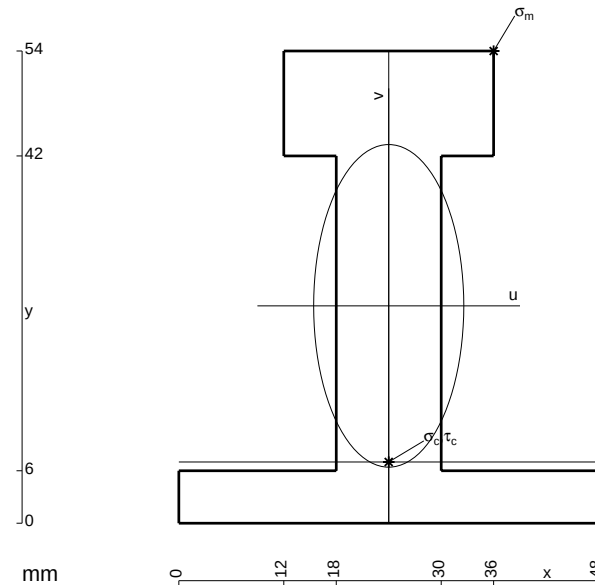


Quadro contributi PLV per iperstatica $X=W_{AB}$

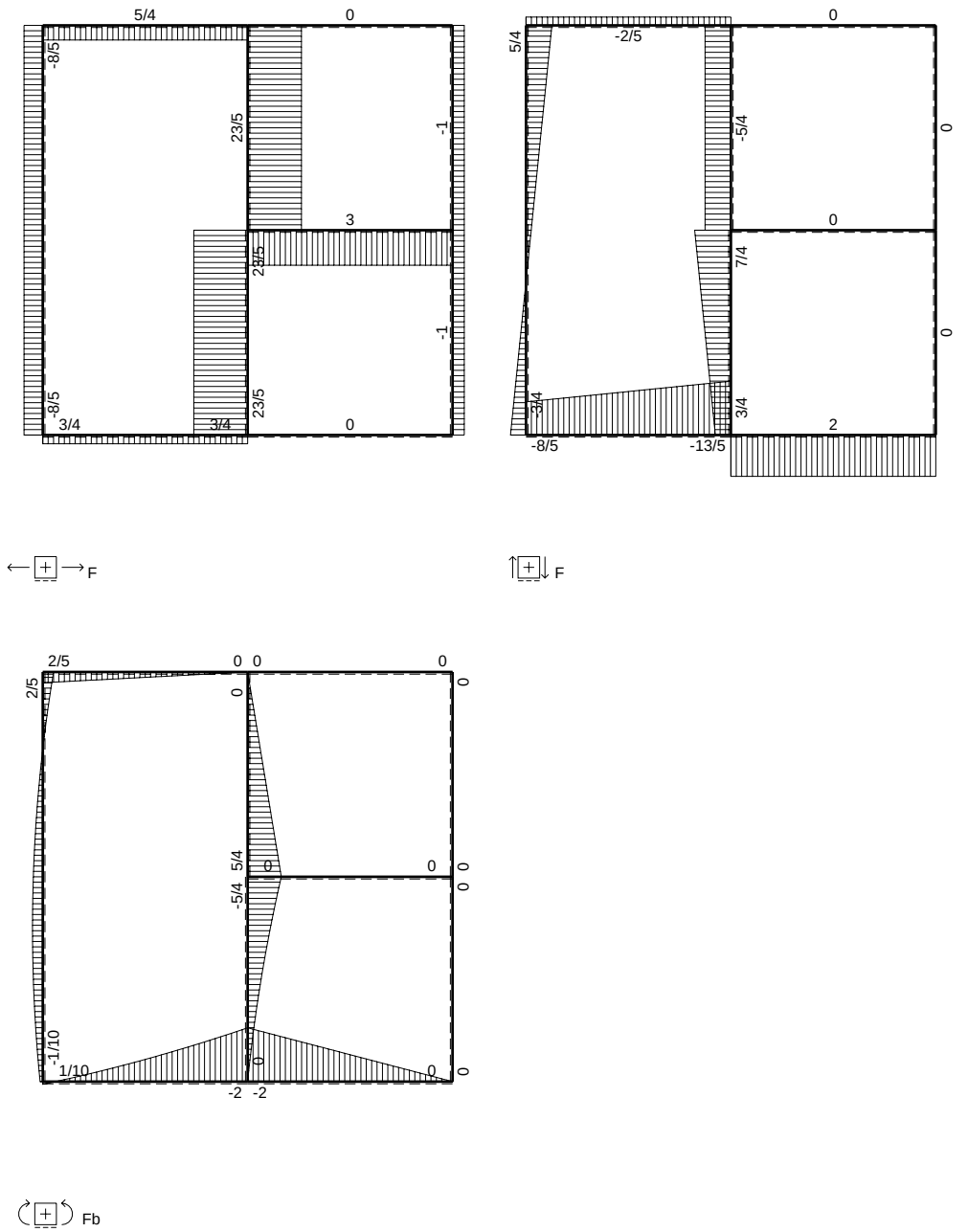
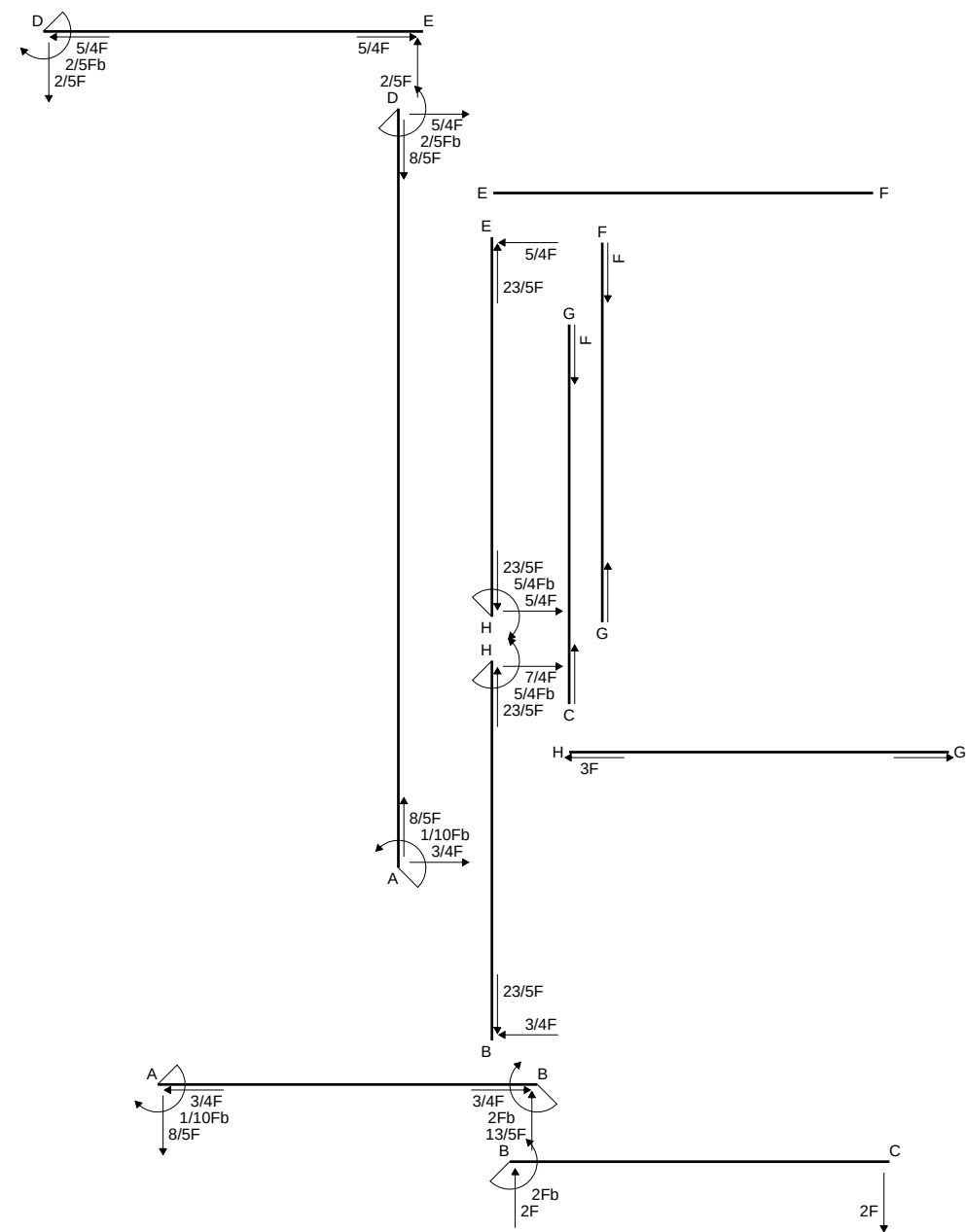
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

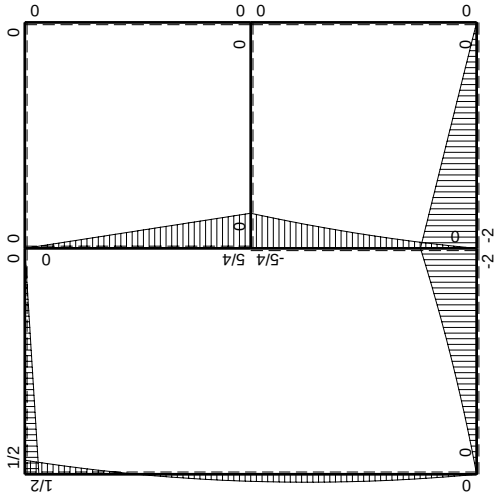
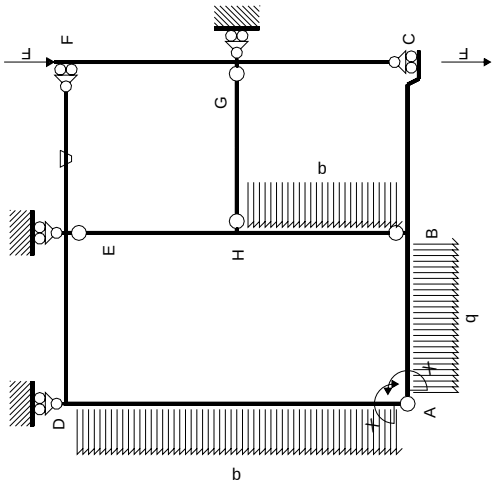
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



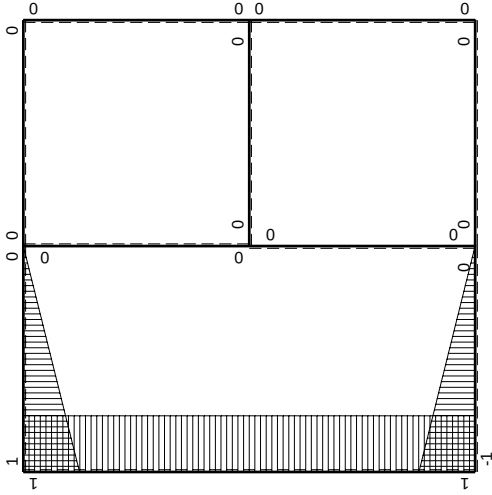
$$\begin{aligned}
A &= 1008. \text{ mm}^2 \\
J_u &= 343131. \text{ mm}^4 \\
J_v &= 74304. \text{ mm}^4 \\
y_g &= 24.86 \text{ mm} \\
T_y &= 4140. \text{ N} \\
M_x &= -2815200. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 29.14 \text{ mm} \\
\sigma_m &= -Mv/J_u = 239.1 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 7. \text{ mm} \\
v_c &= -17.86 \text{ mm} \\
\sigma_c &= -Mv/J_u = -146.5 \text{ N/mm}^2 \\
\tau_c &= 6.551 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 146.9 \text{ N/mm}^2 \\
S &= 6515. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



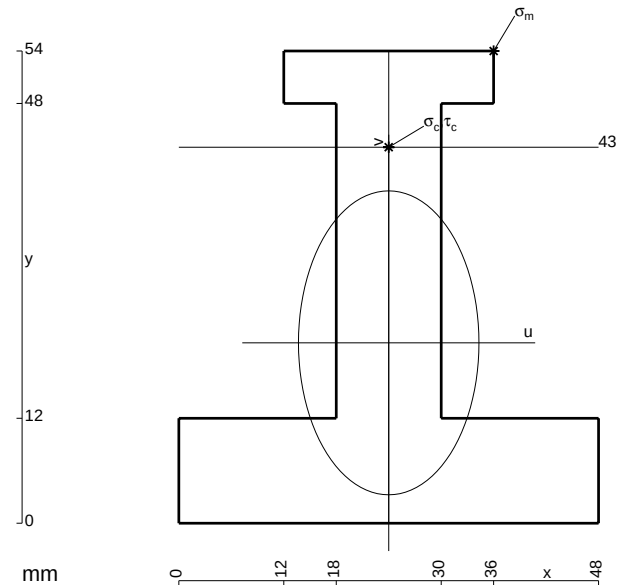
M_X flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

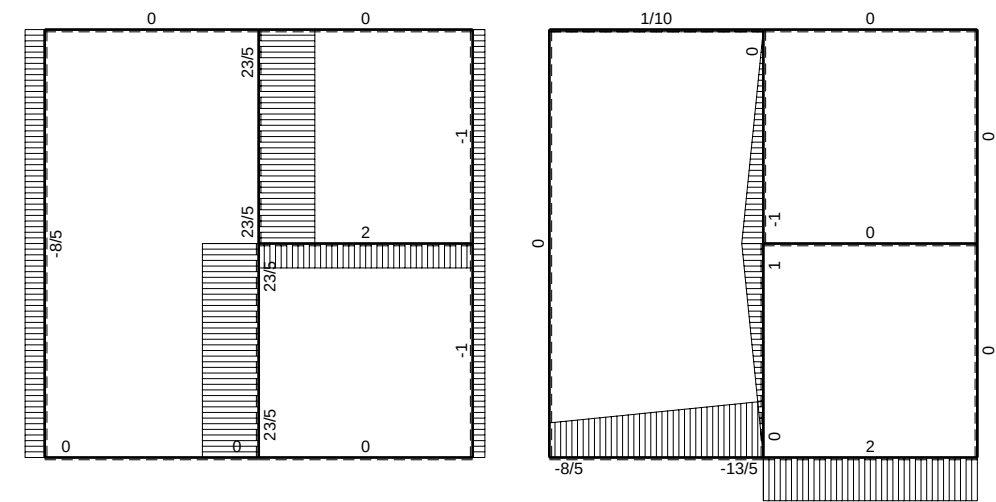
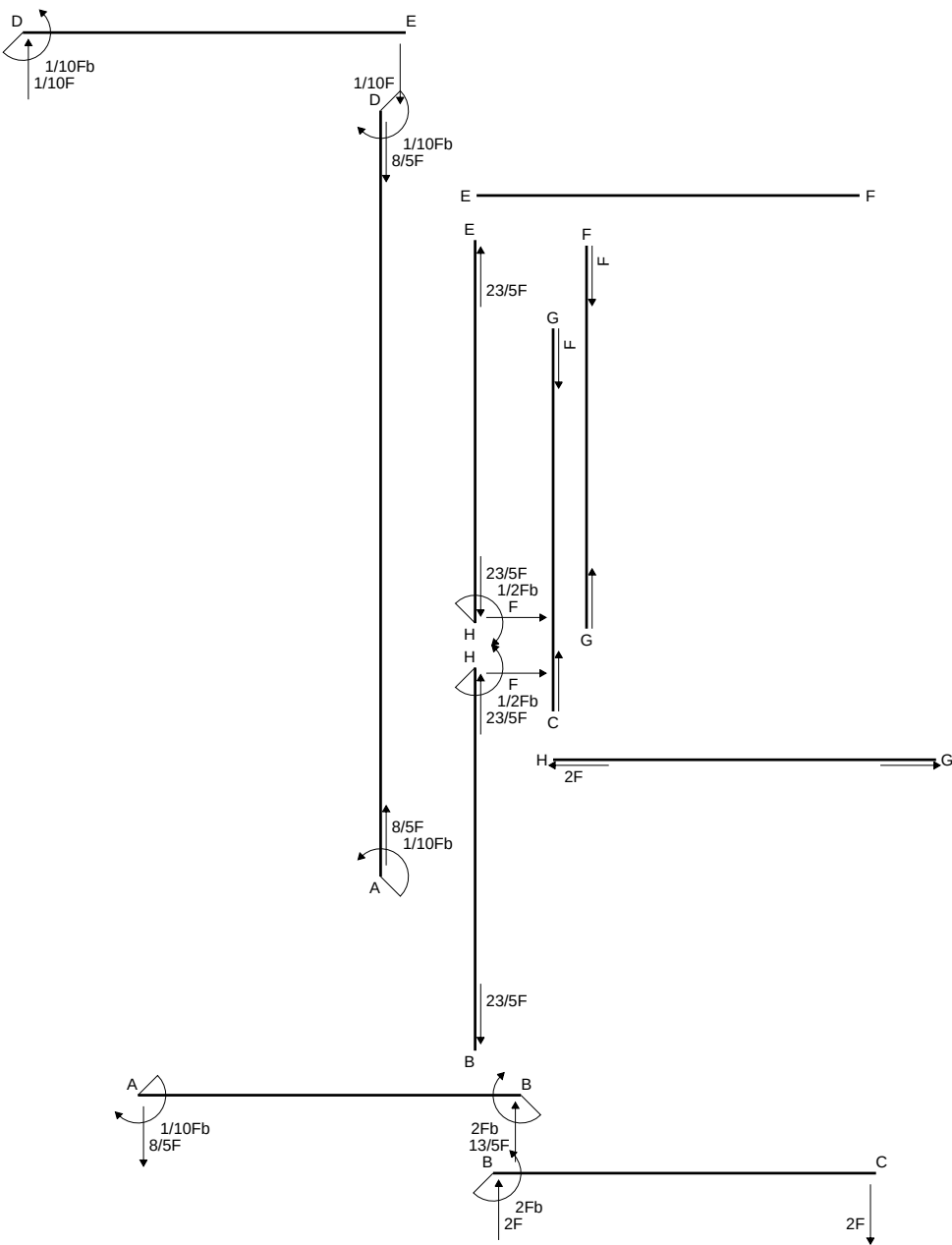
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

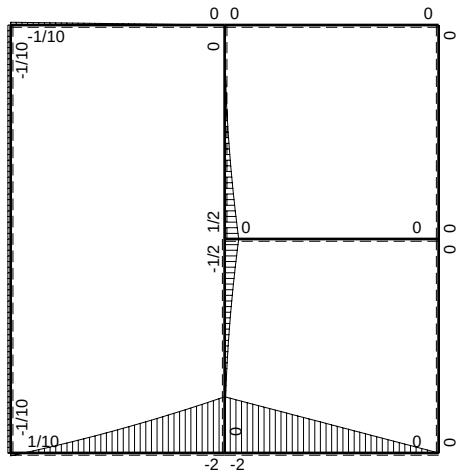


$$\begin{aligned}
A &= 1152. \text{ mm}^2 \\
J_u &= 348030. \text{ mm}^4 \\
J_v &= 122688. \text{ mm}^4 \\
y_g &= 20.63 \text{ mm} \\
T_y &= 2840. \text{ N} \\
M_x &= -2073200. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 33.38 \text{ mm} \\
\sigma_m &= -Mv/J_u = 198.8 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 43. \text{ mm} \\
v_c &= 22.38 \text{ mm} \\
\sigma_c &= -Mv/J_u = 133.3 \text{ N/mm}^2 \\
\tau_c &= 3.989 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 133.5 \text{ N/mm}^2 \\
S &= 5867. \text{ mm}^3
\end{aligned}$$

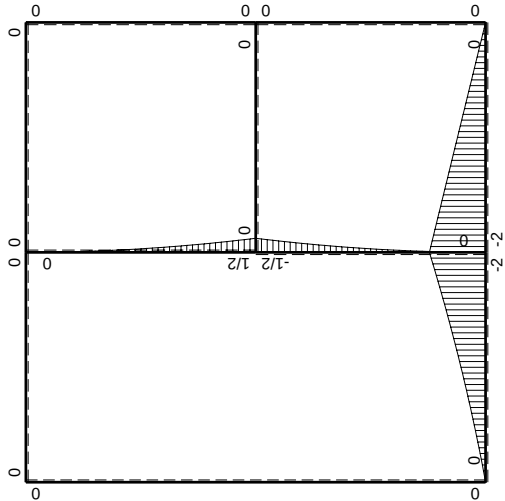
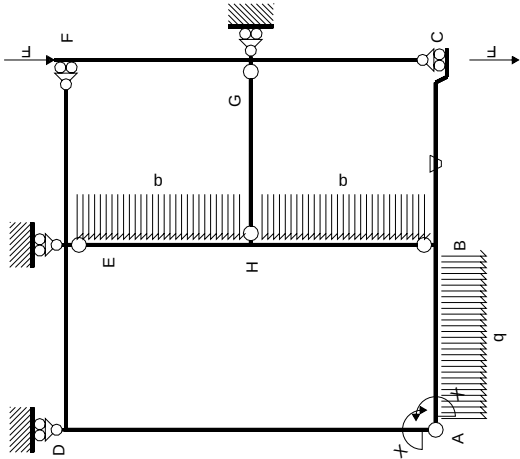


← ⊕ → F

↑ ⊕ ↓ F

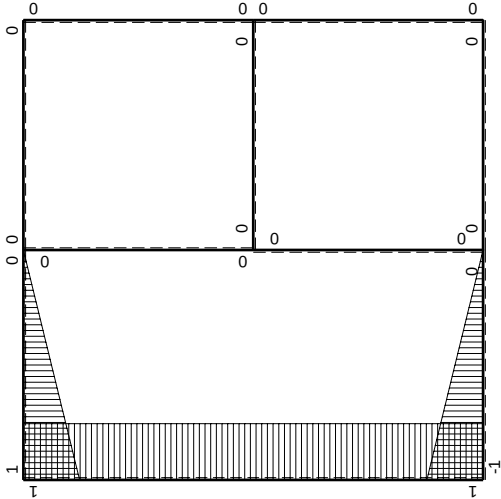


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

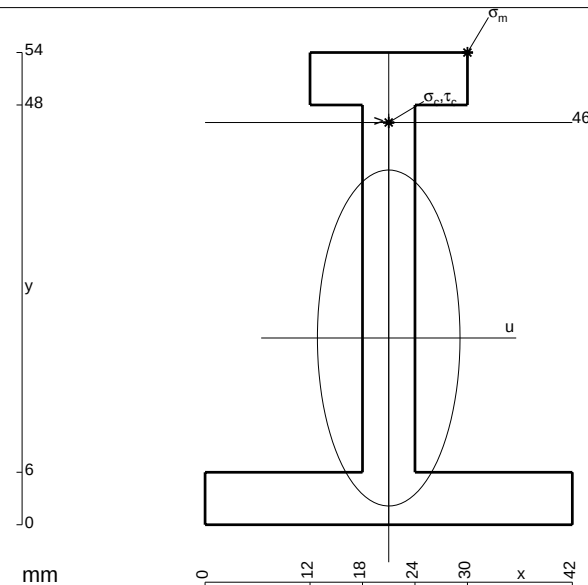
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 612. \text{ mm}^2$$

$$J_u = 225968. \text{ mm}^4$$

$$J_v = 40716. \text{ mm}^4$$

$$y_g = 21.35 \text{ mm}$$

$$T_y = 1860. \text{ N}$$

$$M_x = -1450800. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 54. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 32.65 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 209.6 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 46. \text{ mm}$$

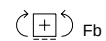
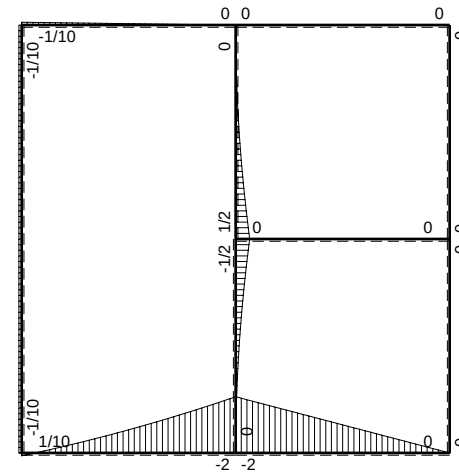
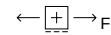
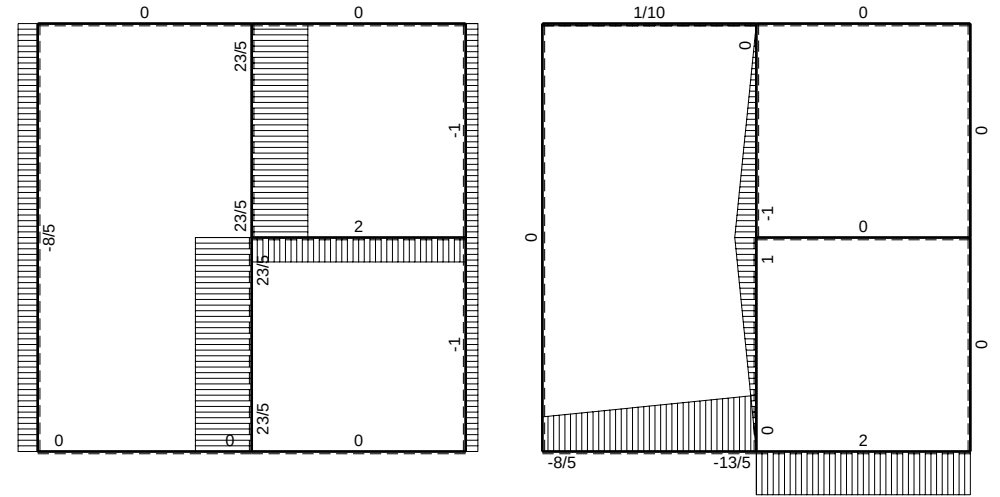
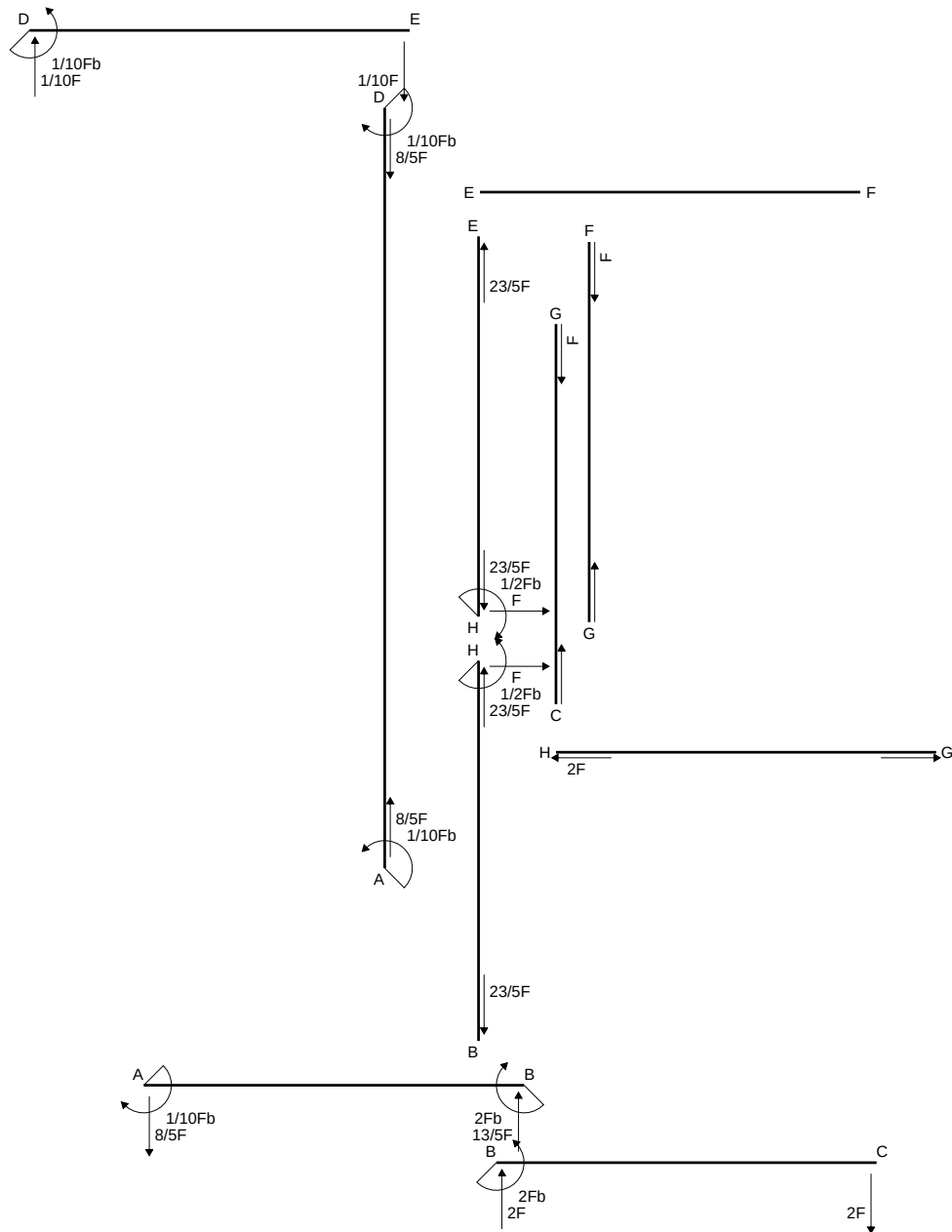
$$v_c = 24.65 \text{ mm}$$

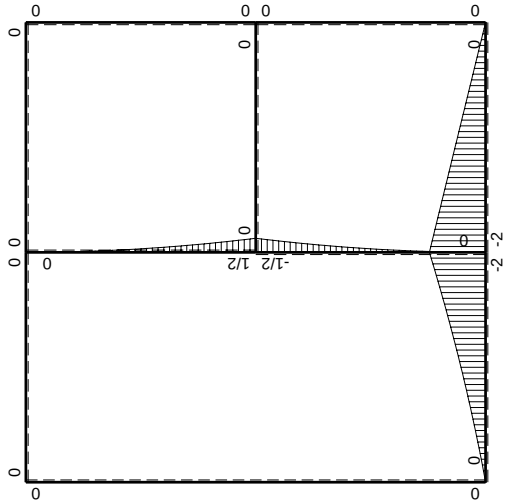
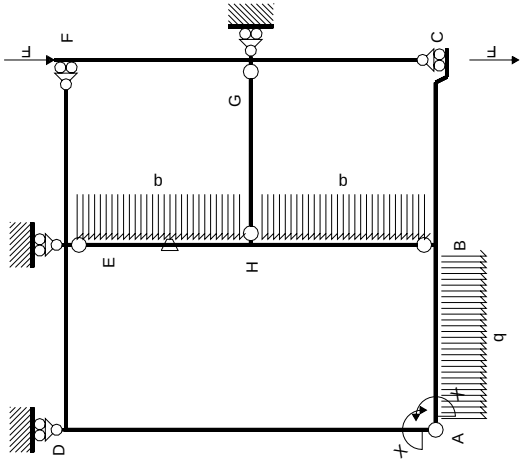
$$\sigma_c = -Mv/J_u = 158.2 \text{ N/mm}^2$$

$$\tau_c = 4.815 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 158.5 \text{ N/mm}^2$$

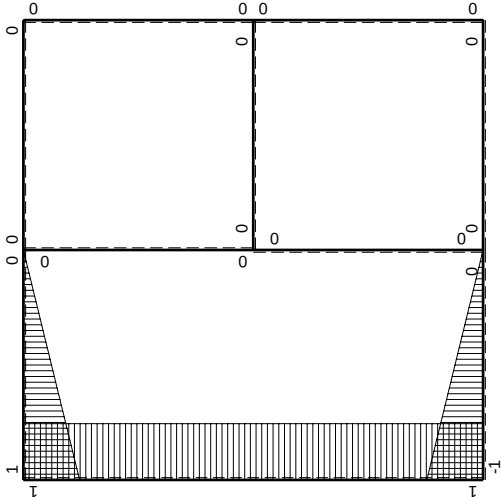
$$S = 3510. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

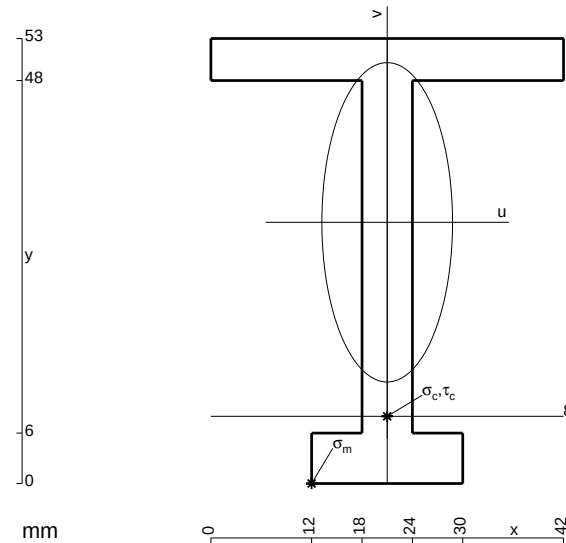
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 570. \text{ mm}^2$$

$$J_u = 206355. \text{ mm}^4$$

$$J_v = 34542. \text{ mm}^4$$

$$y_g = 31.11 \text{ mm}$$

$$T_y = 1800. \text{ N}$$

$$M_x = -1458000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -31.11 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -219.8 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 8. \text{ mm}$$

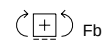
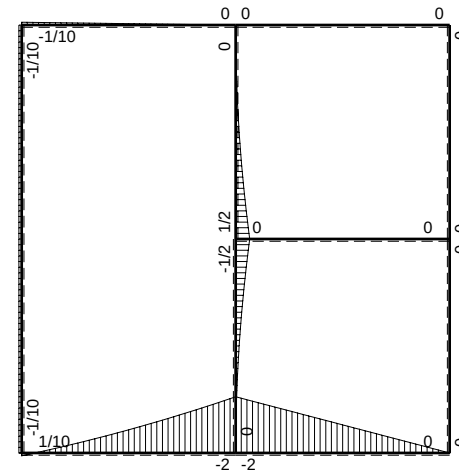
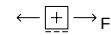
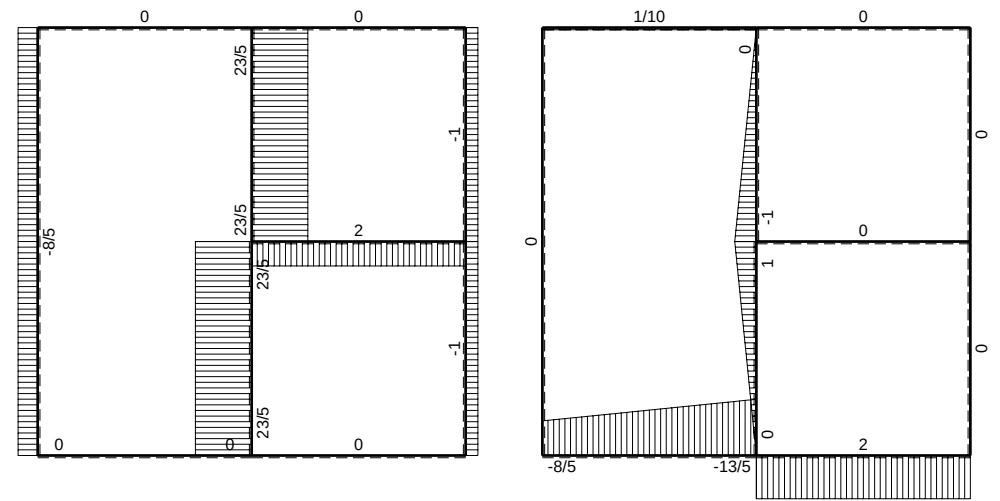
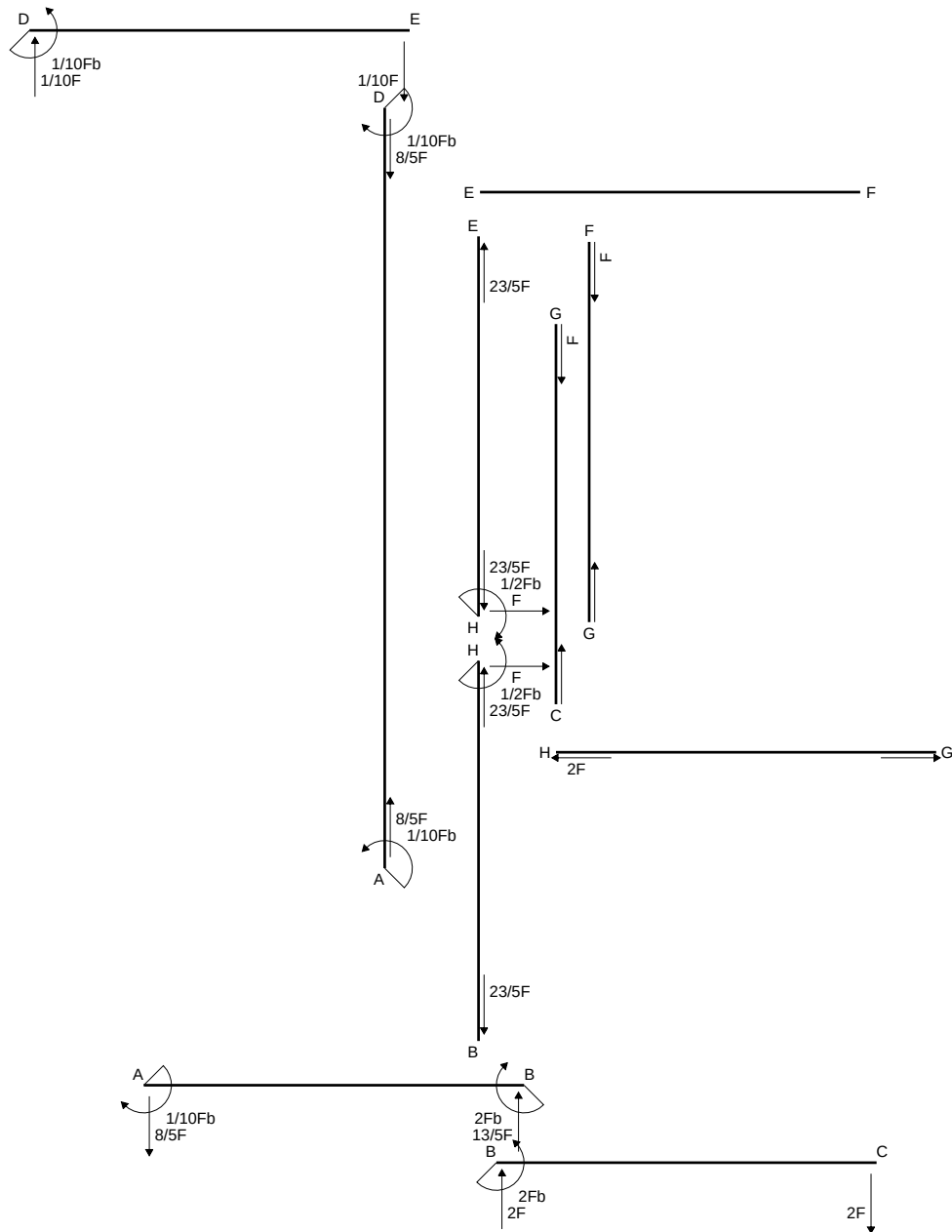
$$v_c = -23.11 \text{ mm}$$

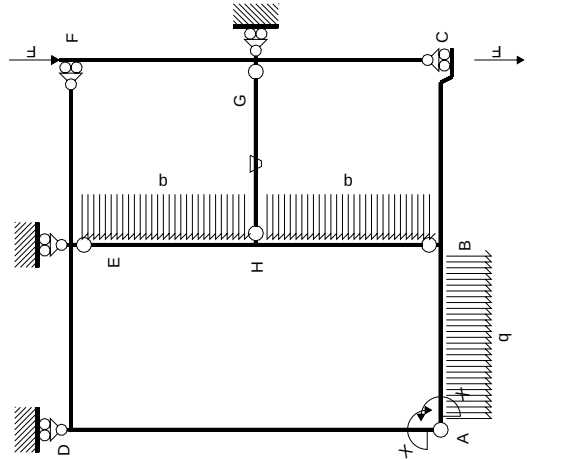
$$\sigma_c = -Mv/J_u = -163.3 \text{ N/mm}^2$$

$$\tau_c = 4.834 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 163.5 \text{ N/mm}^2$$

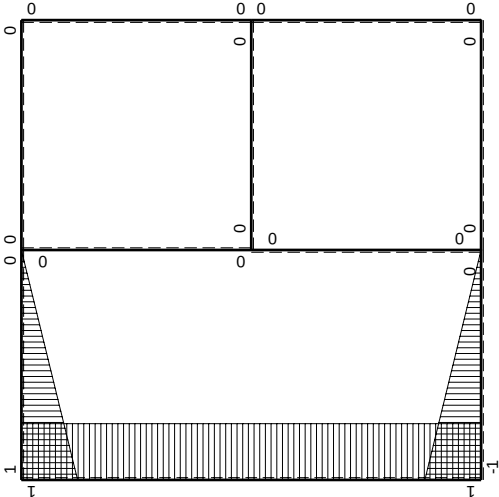
$$S = 3325. \text{ mm}^3$$



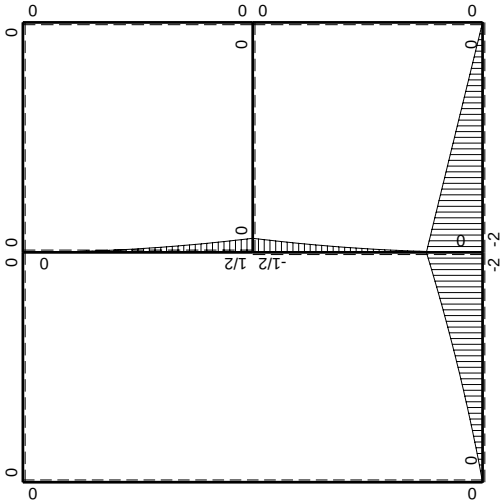


Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1



Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

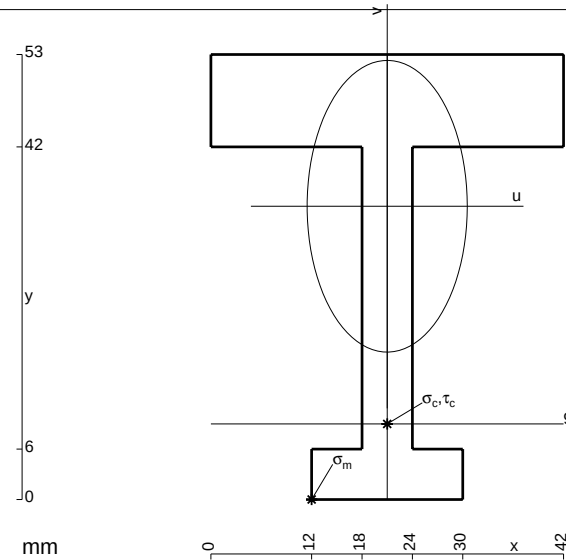
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 786. \text{ mm}^2$$

$$J_u = 237222. \text{ mm}^4$$

$$J_v = 71478. \text{ mm}^4$$

$$y_g = 34.93 \text{ mm}$$

$$T_y = 1800. \text{ N}$$

$$M_x = -1548000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -34.93 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -227.9 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 9. \text{ mm}$$

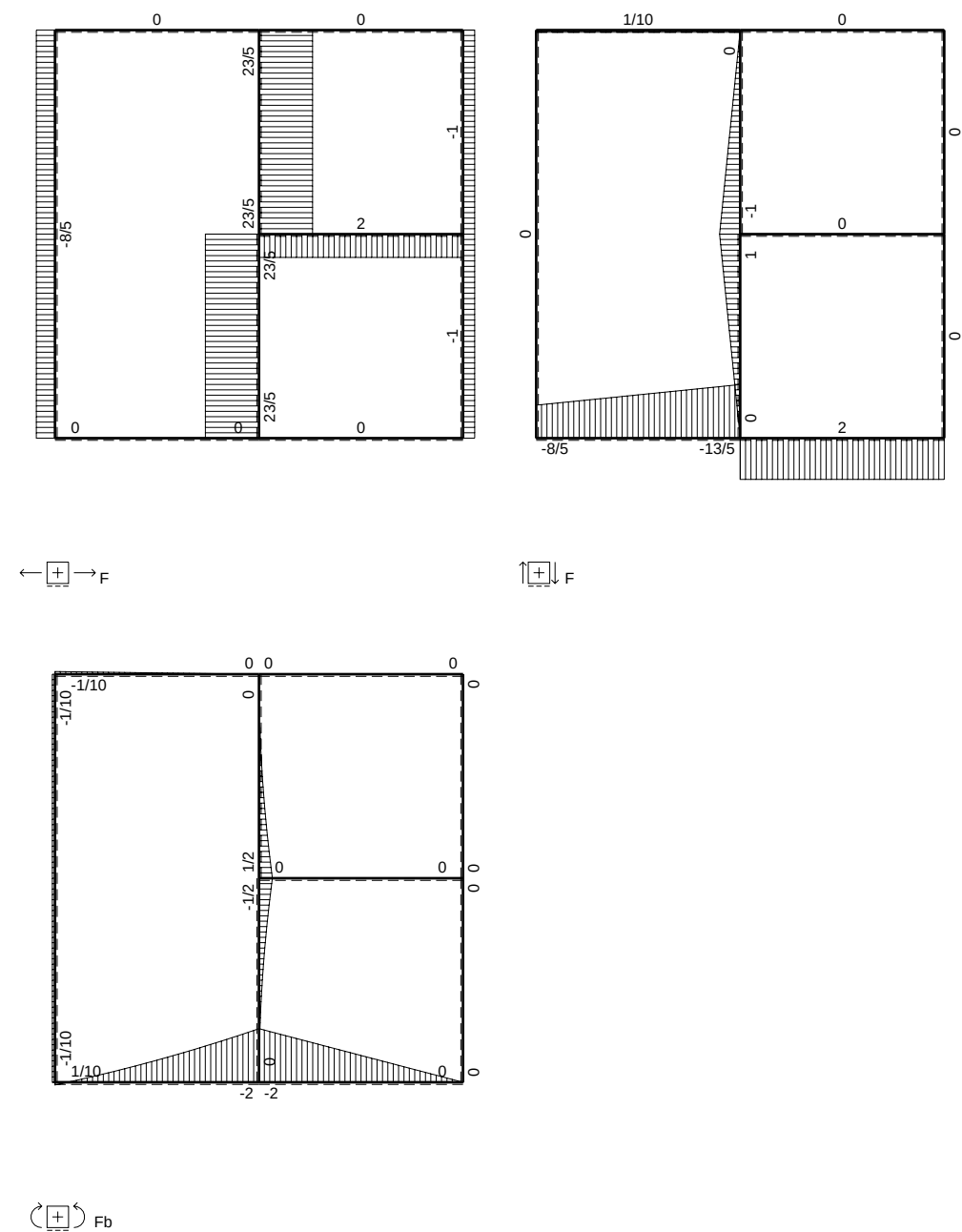
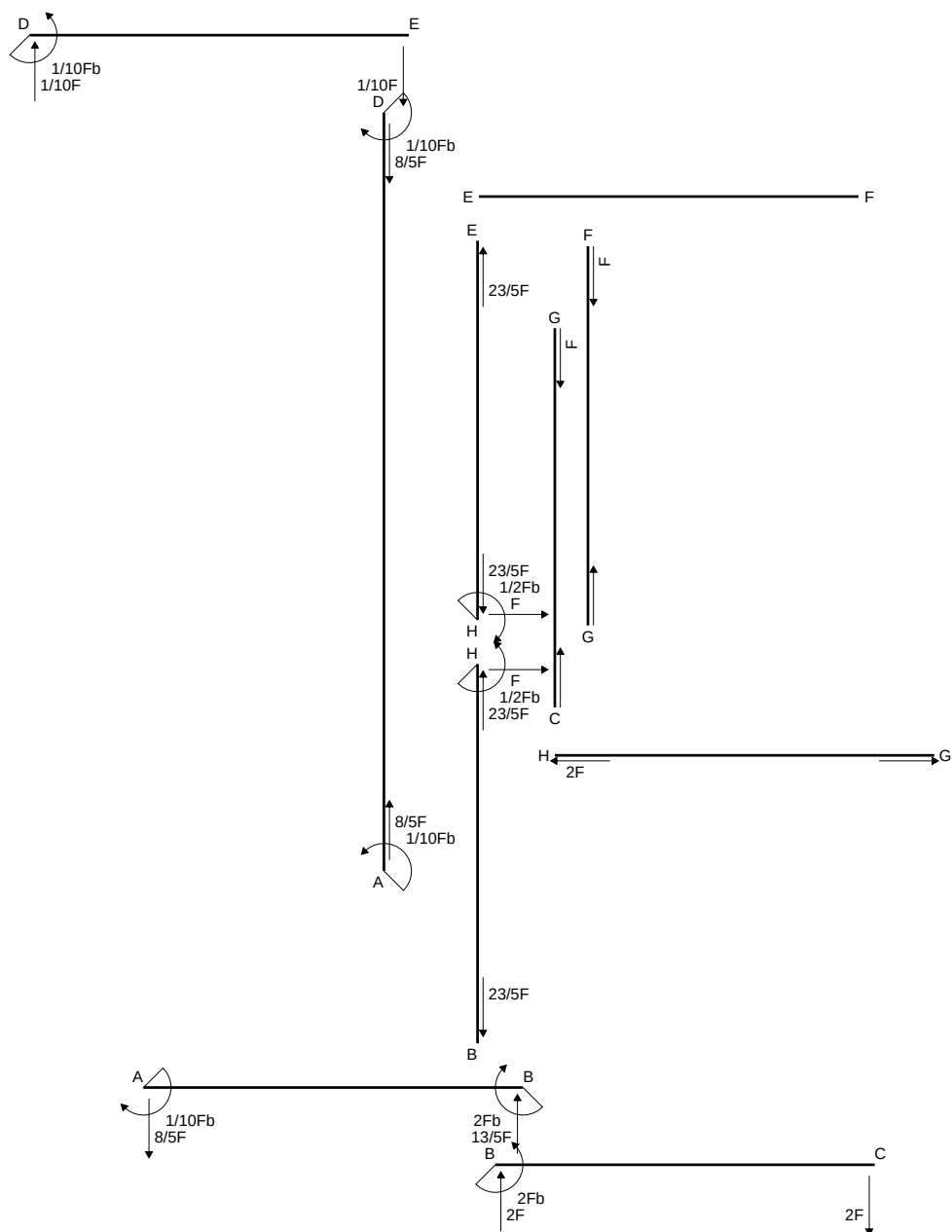
$$v_c = -25.93 \text{ mm}$$

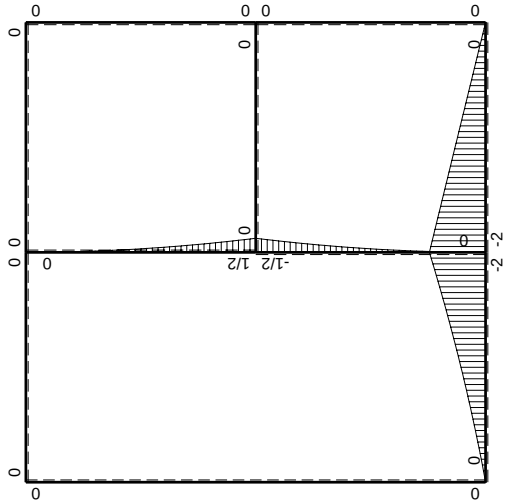
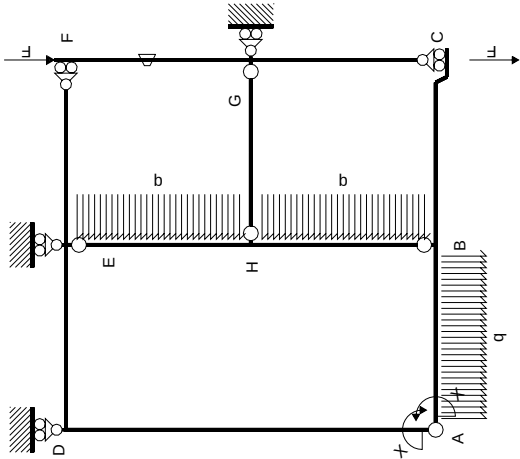
$$\sigma_c = -Mv/J_u = -169.2 \text{ N/mm}^2$$

$$\tau_c = 4.985 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 169.4 \text{ N/mm}^2$$

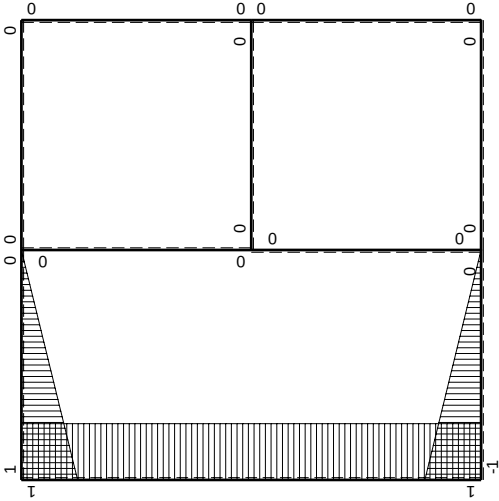
$$S = 3942. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

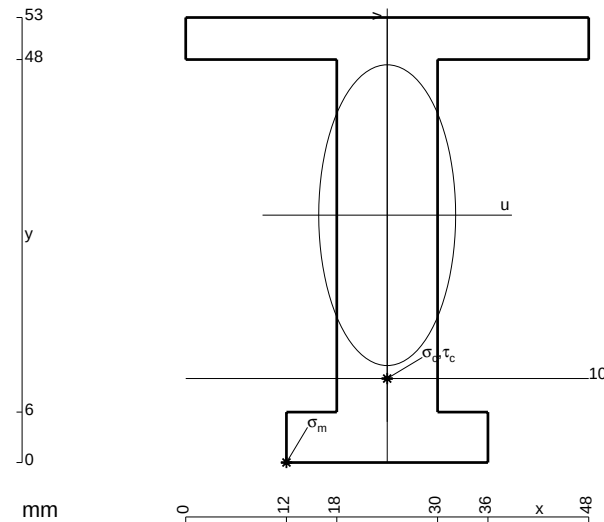
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 888. \text{ mm}^2$$

$$J_u = 285133. \text{ mm}^4$$

$$J_v = 59040. \text{ mm}^4$$

$$y_g = 29.46 \text{ mm}$$

$$T_y = 2540. \text{ N}$$

$$M_x = -2311400. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -29.46 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -238.8 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 10. \text{ mm}$$

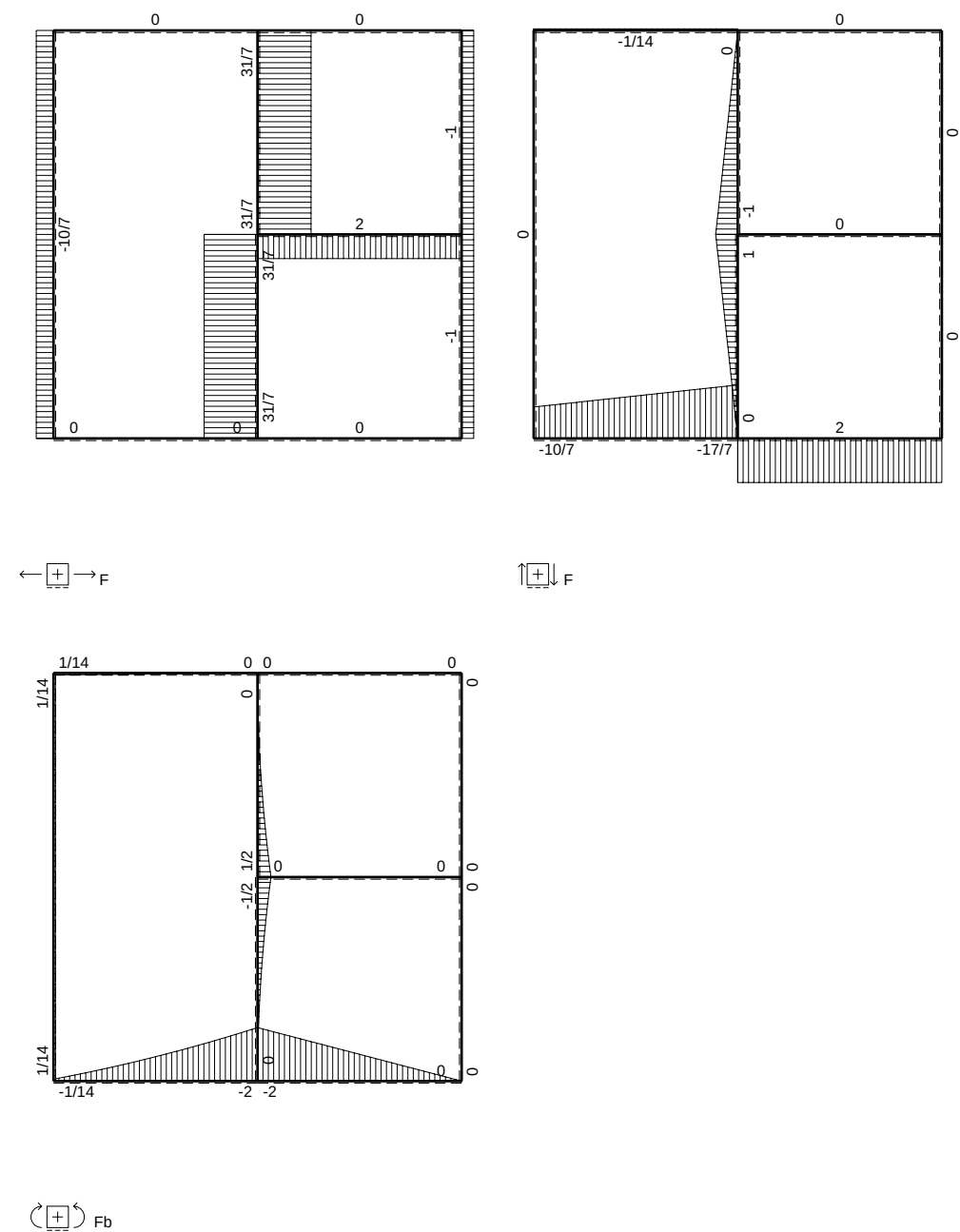
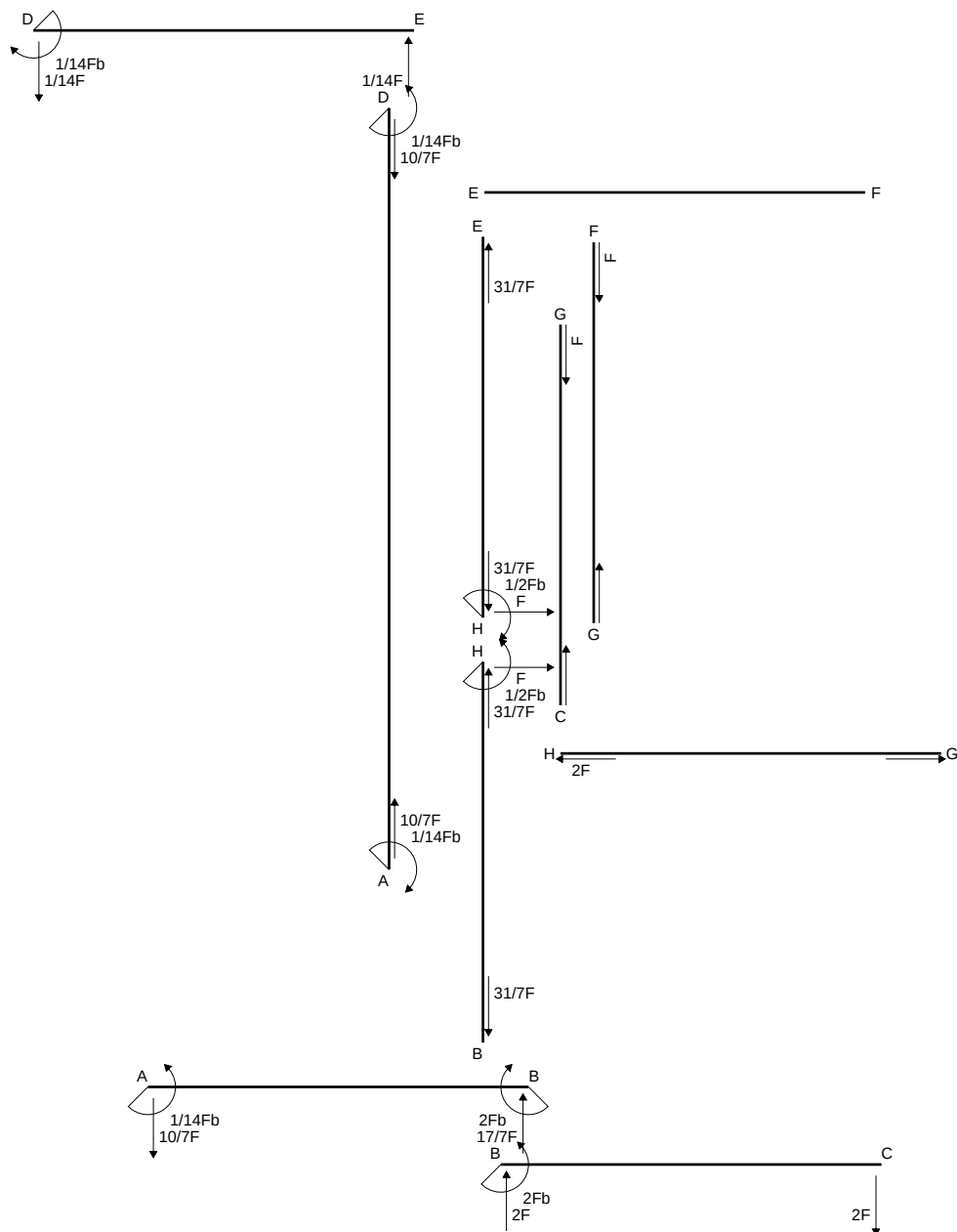
$$v_c = -19.46 \text{ mm}$$

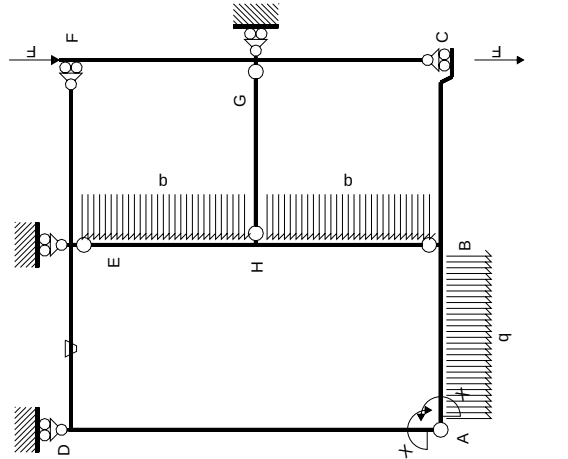
$$\sigma_c = -Mv/J_u = -157.7 \text{ N/mm}^2$$

$$\tau_c = 3.593 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 157.9 \text{ N/mm}^2$$

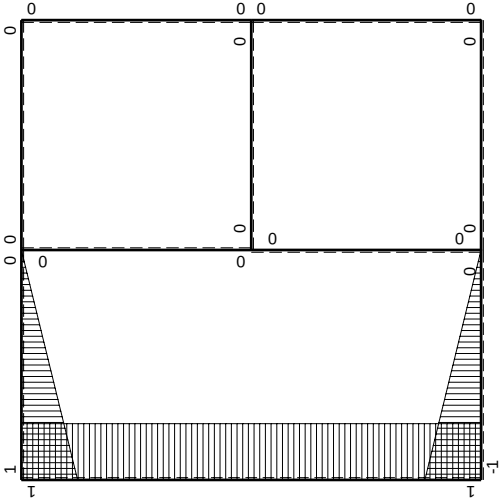
$$S = 4840. \text{ mm}^3$$



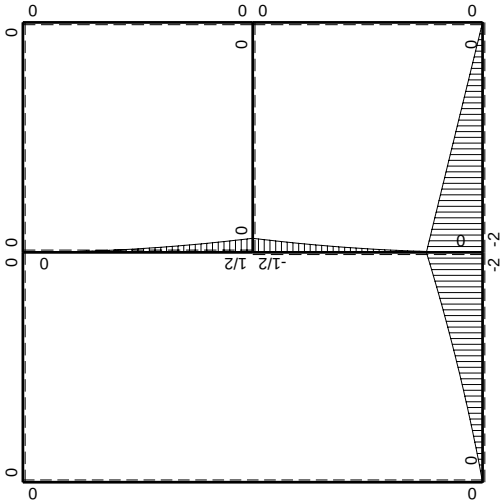


Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$



Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	$-Fb/EJ$	0	$-Fb/EJ+Fx/EJ$	$1-2x/b+x^2/b^2$	$(0-1/2)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	0	Fb/EJ	0	$-Fx/EJ$	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/14Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

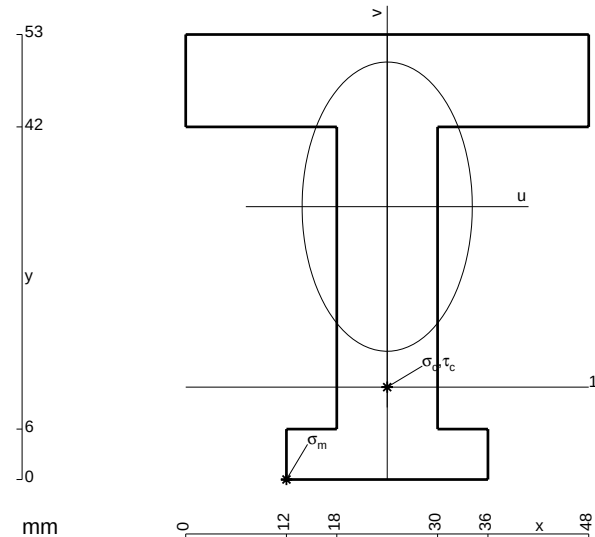
$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{DE}^{x_0} = \int_0^b (-1 + x/b) \theta \frac{1}{EJ} dx = \left[-x + 1/2 x^2/b \right]_0^b \theta$$

$$= (-b + 1/2 b) \theta = -1/2 \frac{Fb^2}{EJ}$$

$$L_{ED}^{x_0} = \int_0^b (x/b) \theta \frac{1}{EJ} dx = \left[1/2 x^2/b \right]_0^b \theta$$

$$= (1/2 b) \theta = -1/2 \frac{Fb^2}{EJ}$$



$$A = 1104. \text{ mm}^2$$

$$J_u = 327740. \text{ mm}^4$$

$$J_v = 113472. \text{ mm}^4$$

$$y_g = 32.5 \text{ mm}$$

$$T_y = 4200. \text{ N}$$

$$M_x = -2016000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -32.5 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -199.9 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 11. \text{ mm}$$

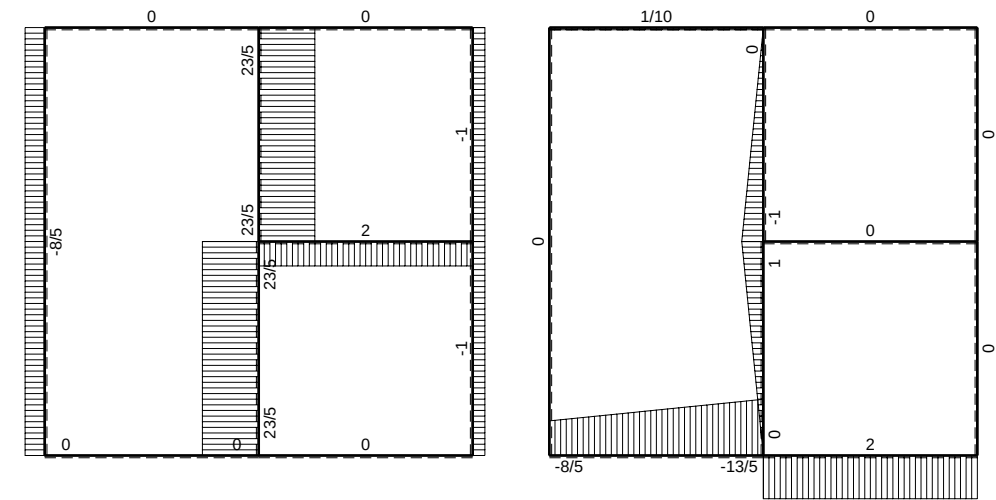
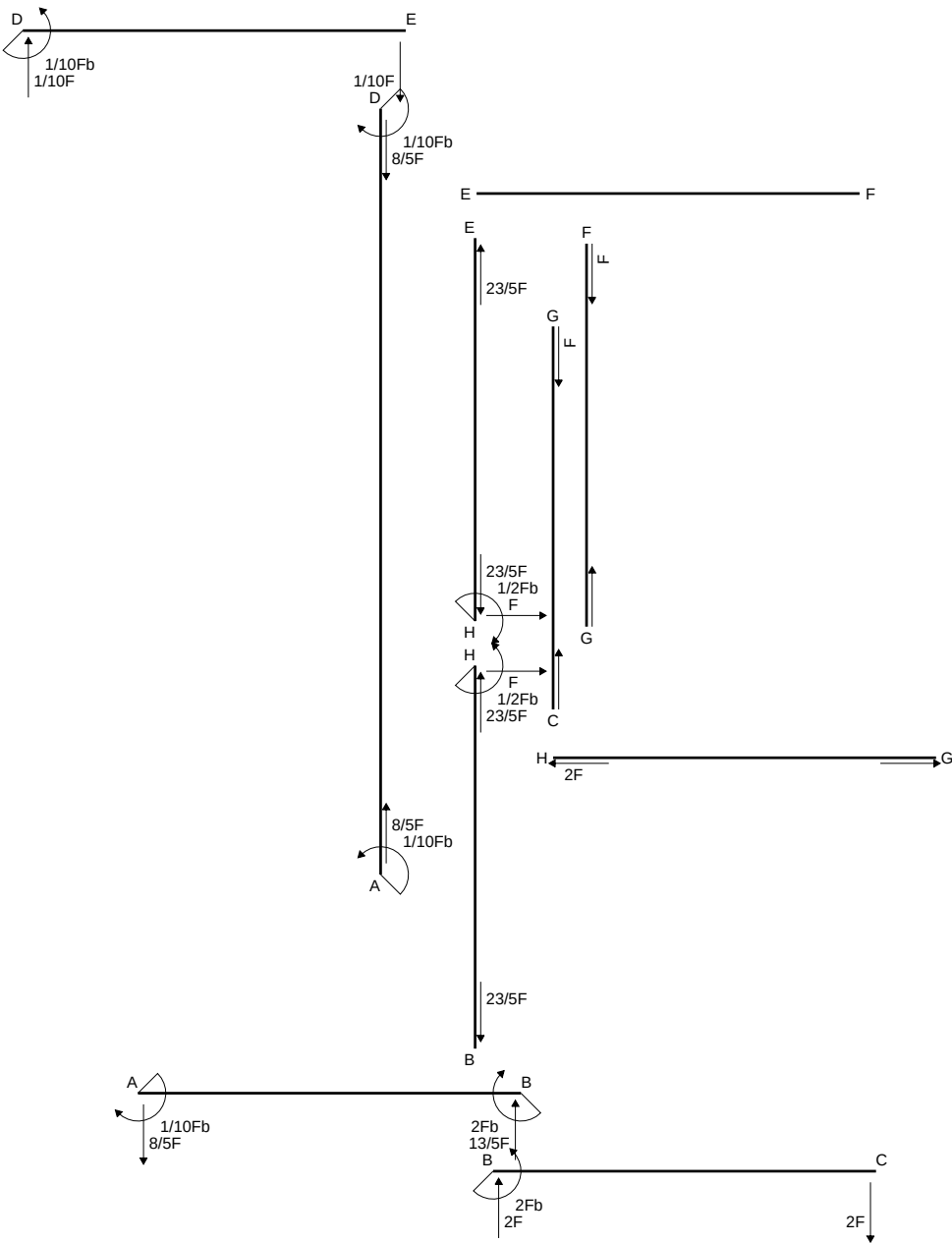
$$v_c = -21.5 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -132.3 \text{ N/mm}^2$$

$$\tau_c = 6.074 \text{ N/mm}^2$$

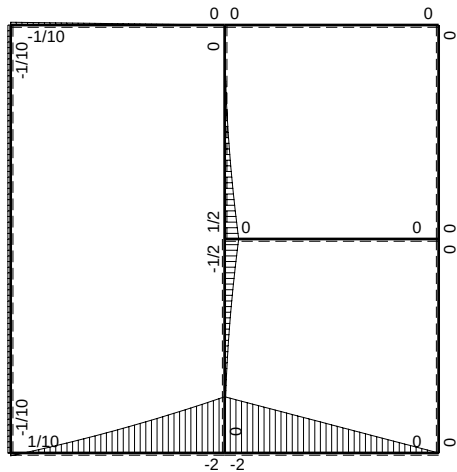
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 132.7 \text{ N/mm}^2$$

$$S = 5688. \text{ mm}^3$$

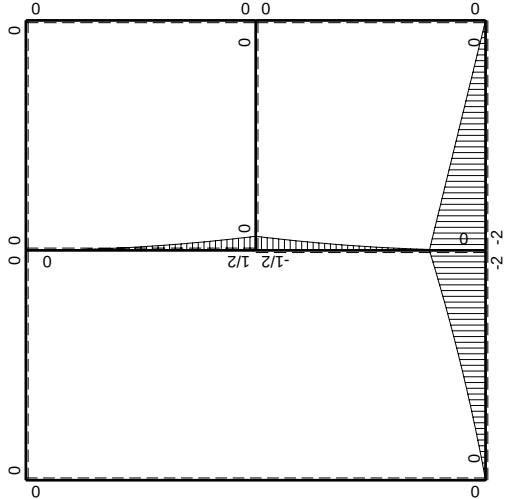
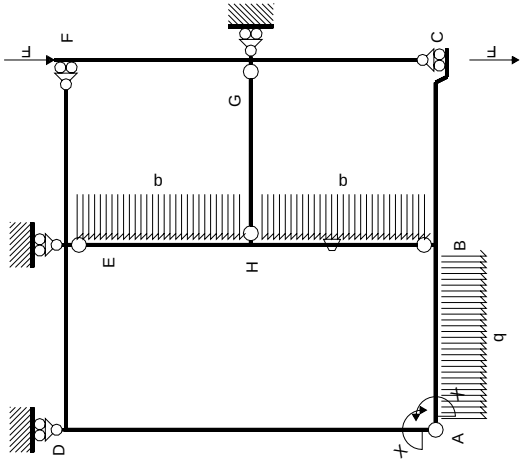


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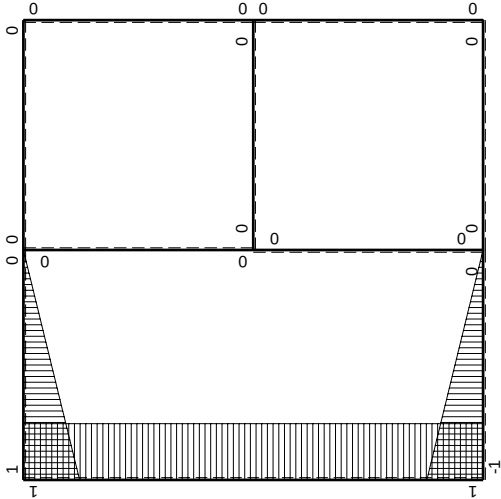


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Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$1/2qx^2$	Fb/EJ	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

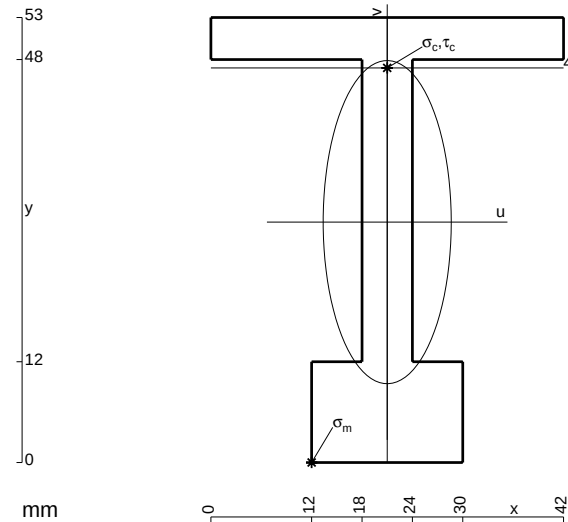
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 642. \text{ mm}^2$$

$$J_u = 237823. \text{ mm}^4$$

$$J_v = 37350. \text{ mm}^4$$

$$y_g = 28.63 \text{ mm}$$

$$T_y = 3340. \text{ N}$$

$$M_x = -1736800. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -28.63 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -209.1 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 47. \text{ mm}$$

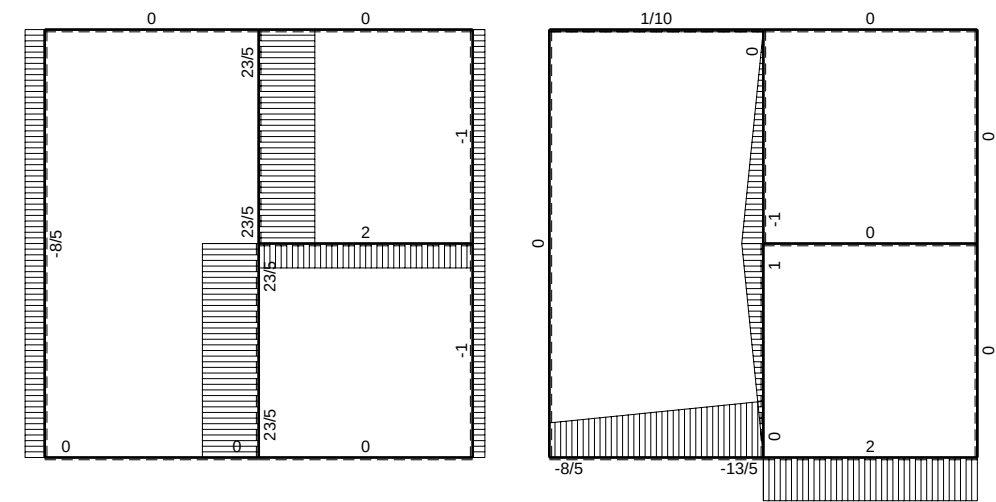
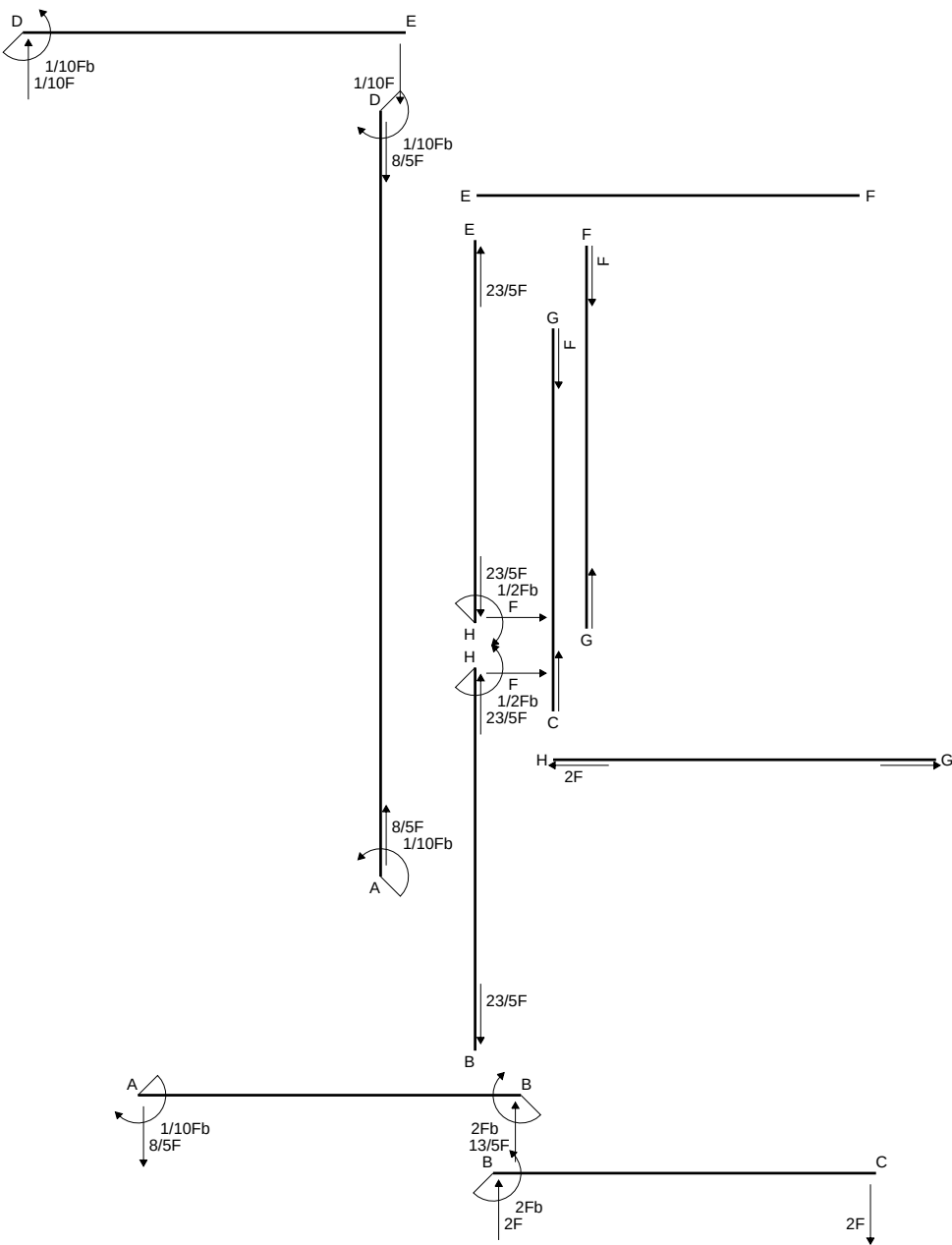
$$v_c = 18.37 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 134.1 \text{ N/mm}^2$$

$$\tau_c = 11.01 \text{ N/mm}^2$$

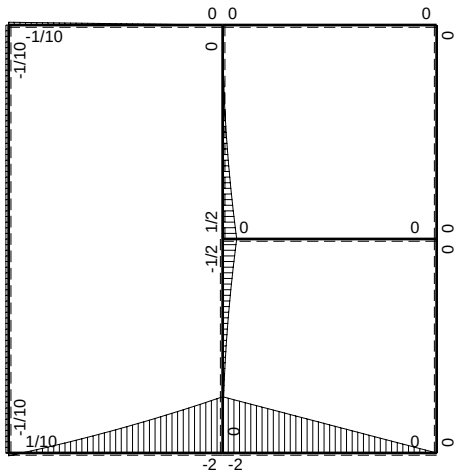
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 135.5 \text{ N/mm}^2$$

$$S = 4706. \text{ mm}^3$$

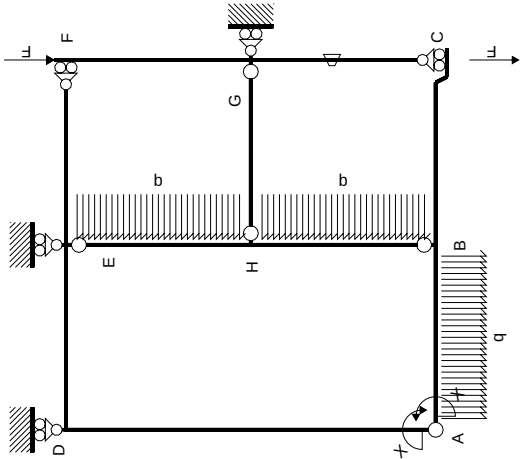


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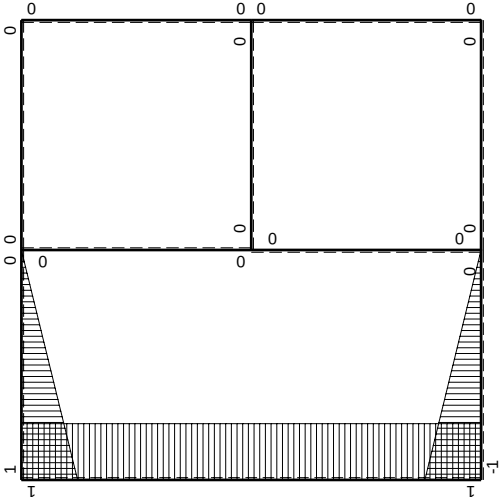
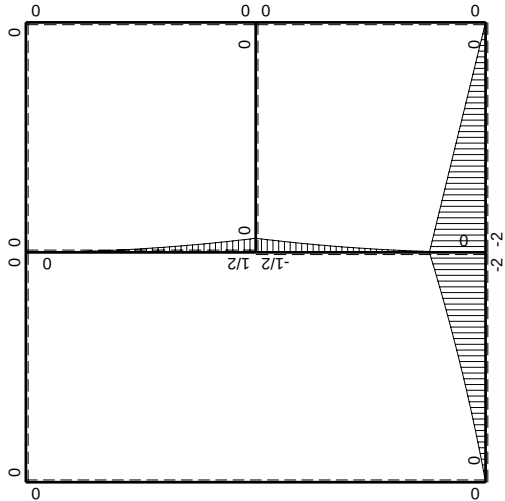


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

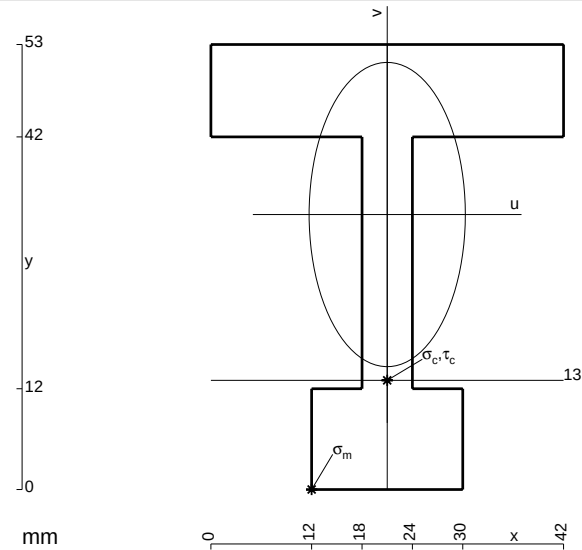
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 858. \text{ mm}^2$$

$$J_u = 281777. \text{ mm}^4$$

$$J_v = 74286. \text{ mm}^4$$

$$y_g = 32.75 \text{ mm}$$

$$T_y = 3320. \text{ N}$$

$$M_x = -1892400. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -32.75 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -220. \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

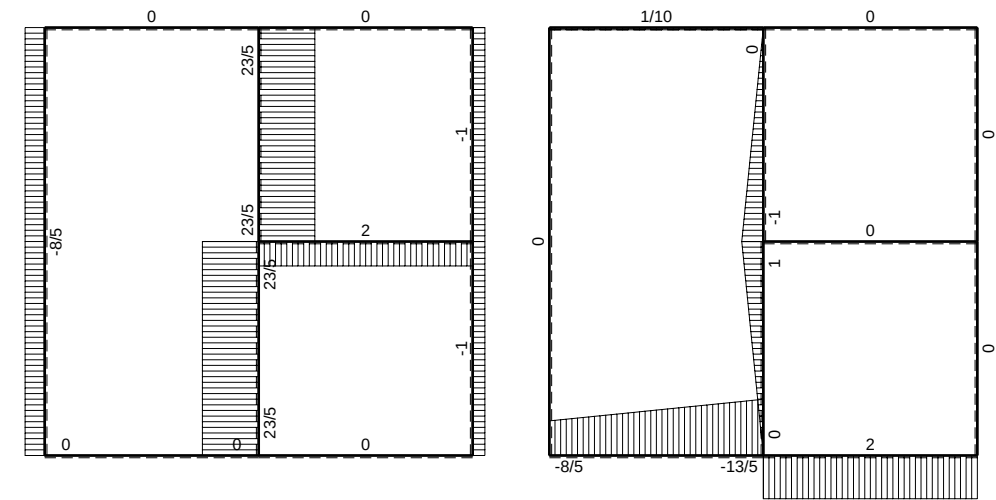
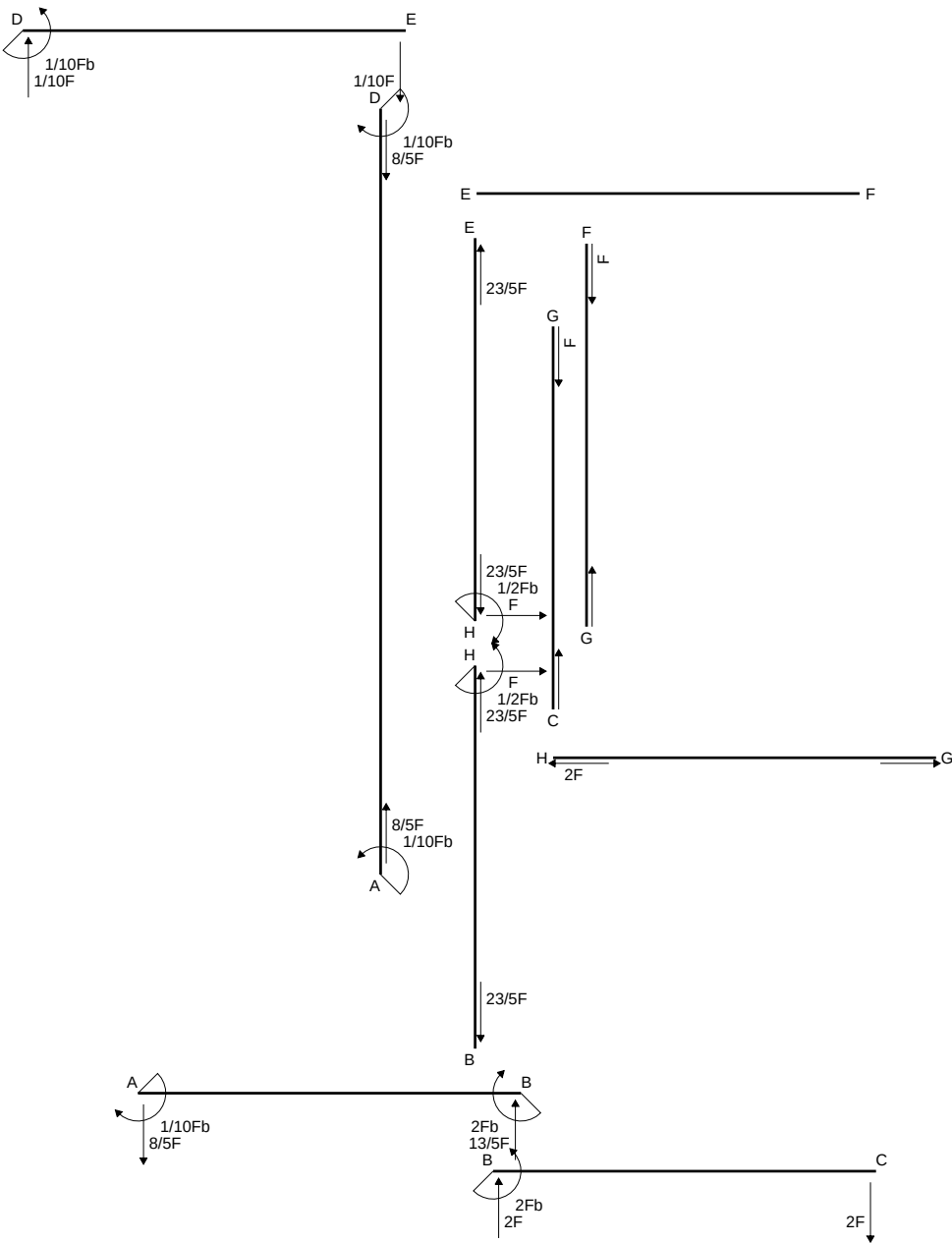
$$v_c = -19.75 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -132.7 \text{ N/mm}^2$$

$$\tau_c = 11.59 \text{ N/mm}^2$$

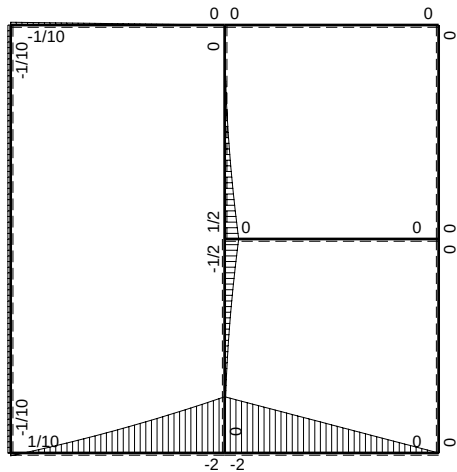
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 134.2 \text{ N/mm}^2$$

$$S = 5900. \text{ mm}^3$$

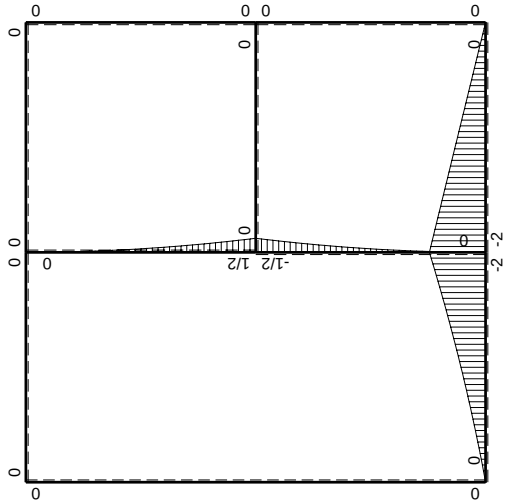
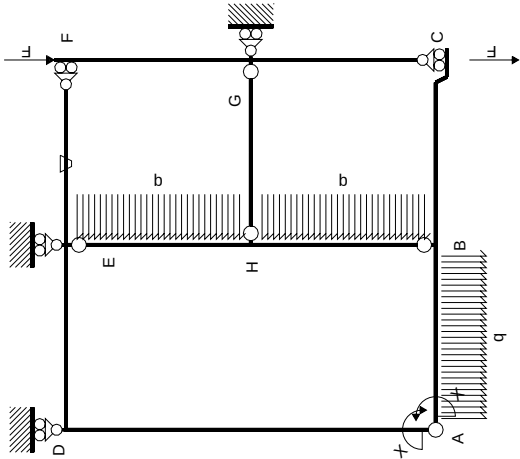


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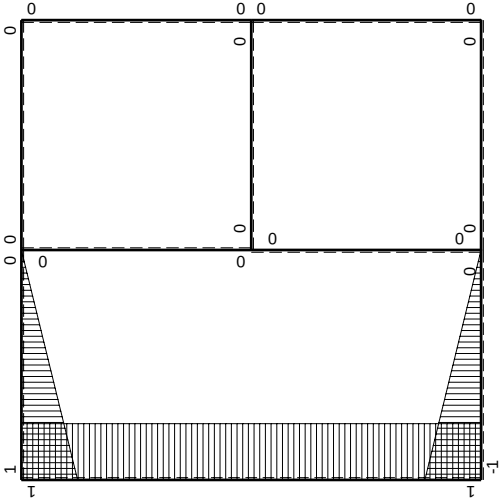


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

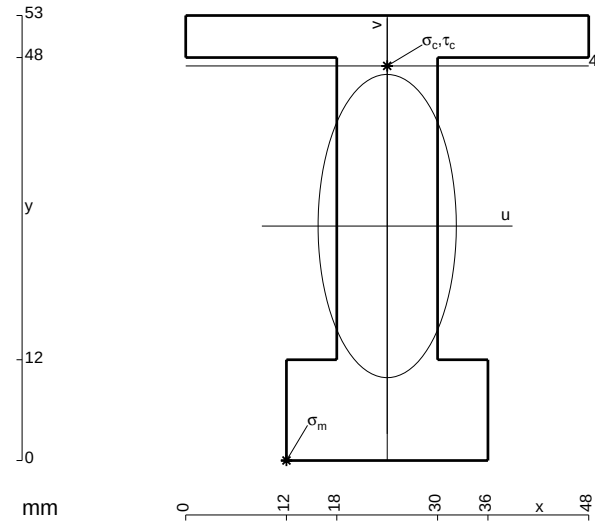
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 960. \text{ mm}^2$$

$$J_u = 313227. \text{ mm}^4$$

$$J_v = 65088. \text{ mm}^4$$

$$y_g = 27.92 \text{ mm}$$

$$T_y = 4160. \text{ N}$$

$$M_x = -2579200. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -27.92 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -229.9 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 47. \text{ mm}$$

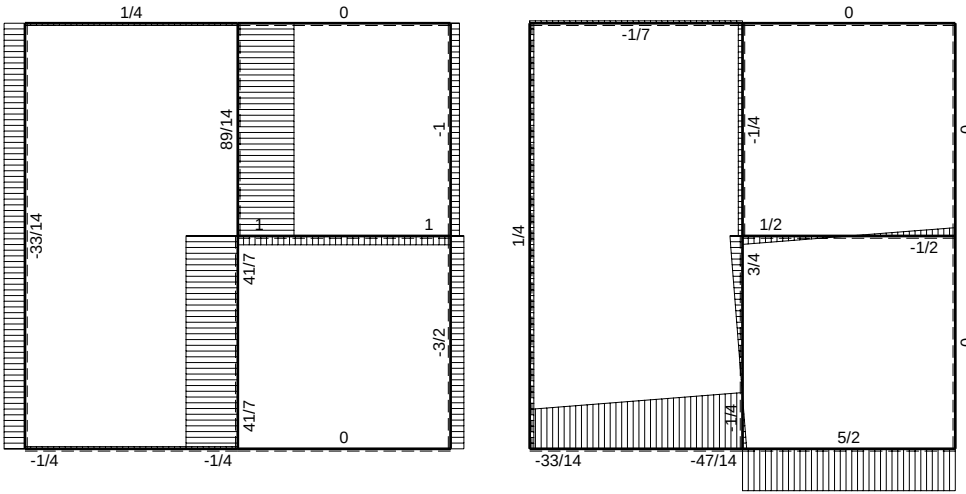
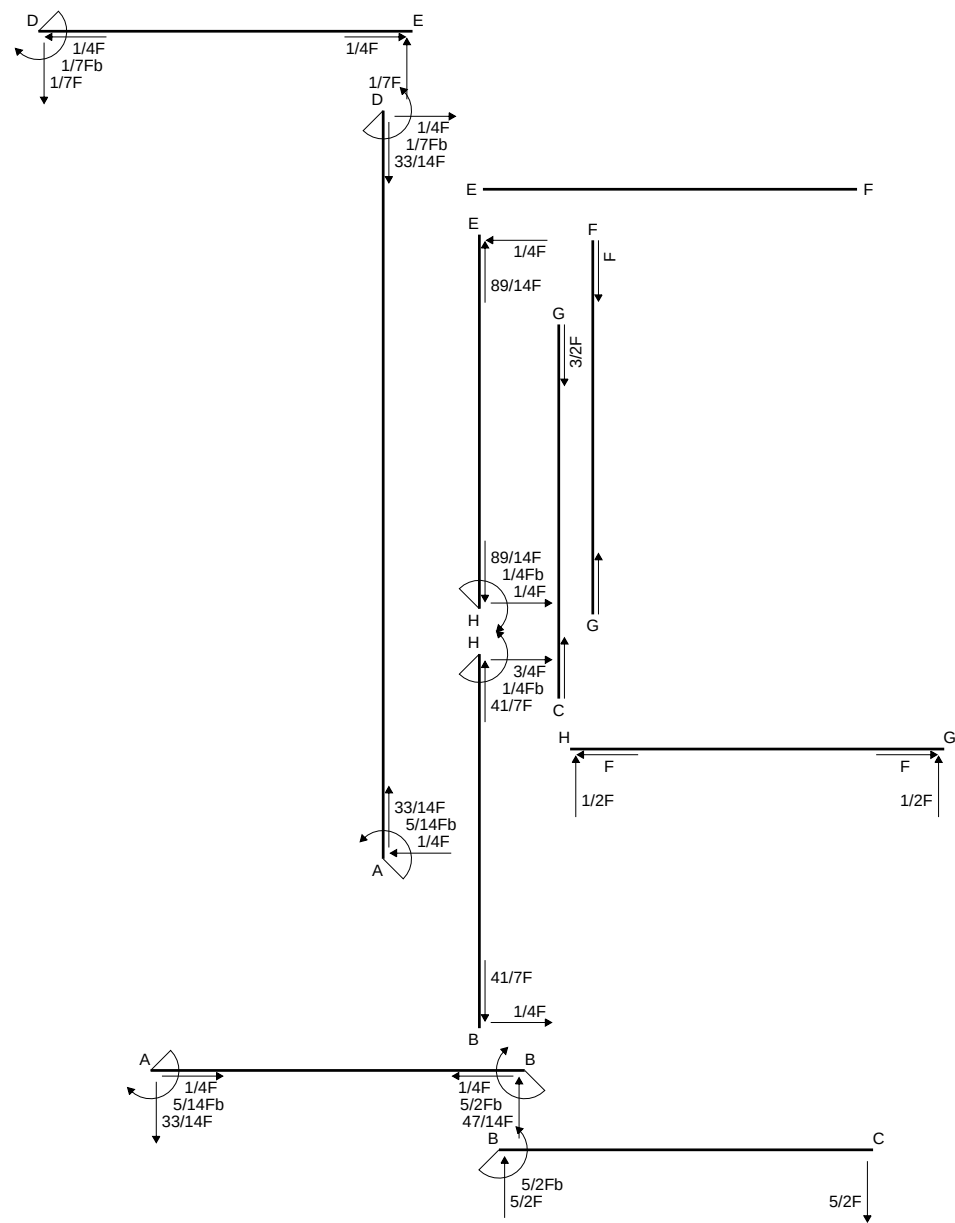
$$v_c = 19.08 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 157.1 \text{ N/mm}^2$$

$$\tau_c = 6.256 \text{ N/mm}^2$$

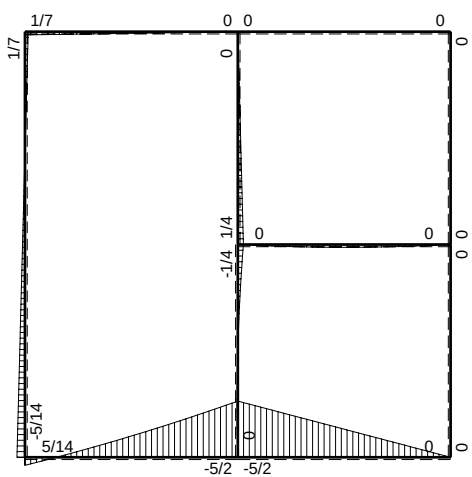
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 157.4 \text{ N/mm}^2$$

$$S = 5653. \text{ mm}^3$$

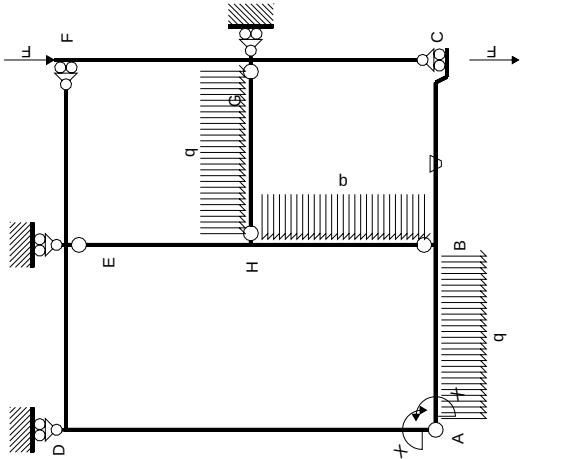


← ⊕ → F

↑ ⊕ ↓ F

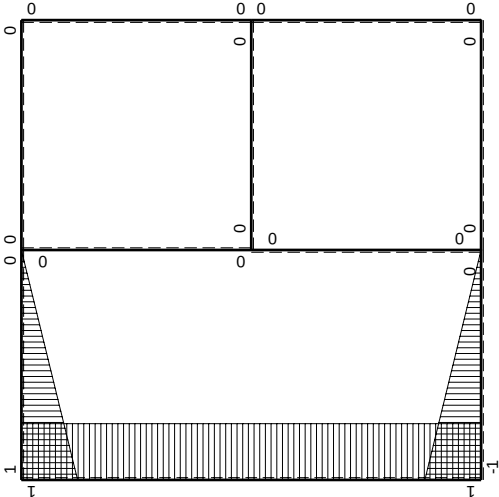


⊕ ⊕ F_b

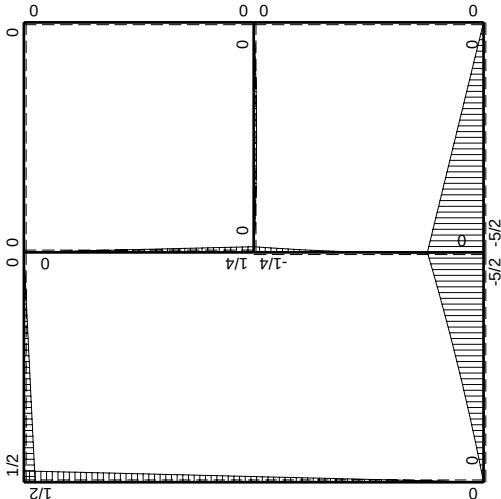


Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

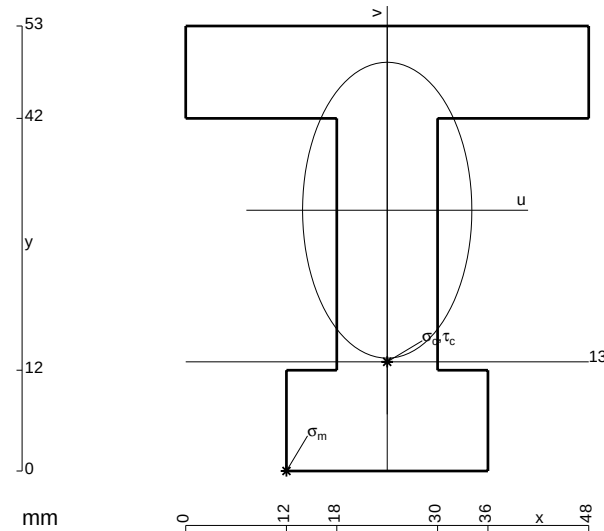


Quadro contributi PLV per iperstatica $X=W_{AB}$

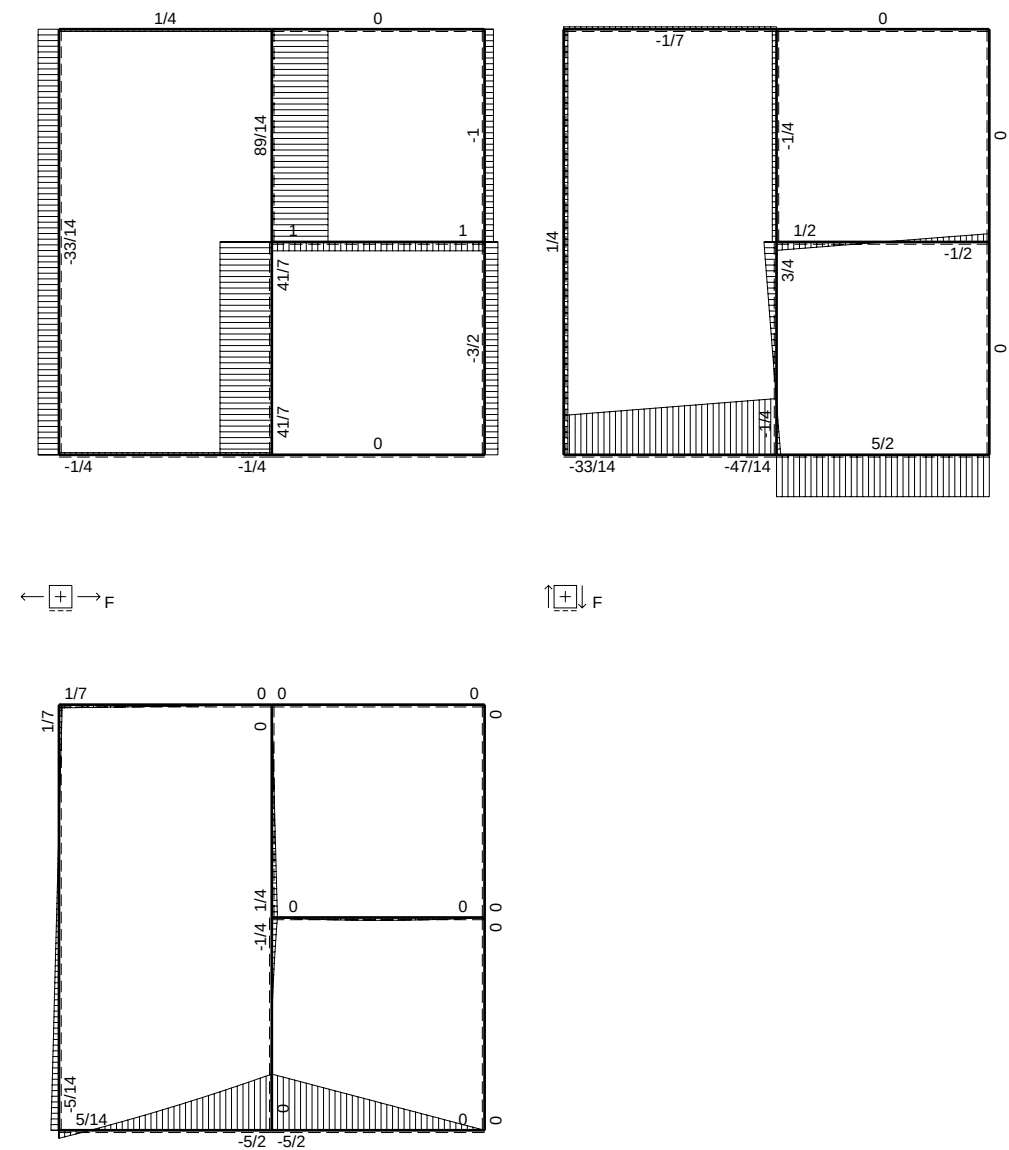
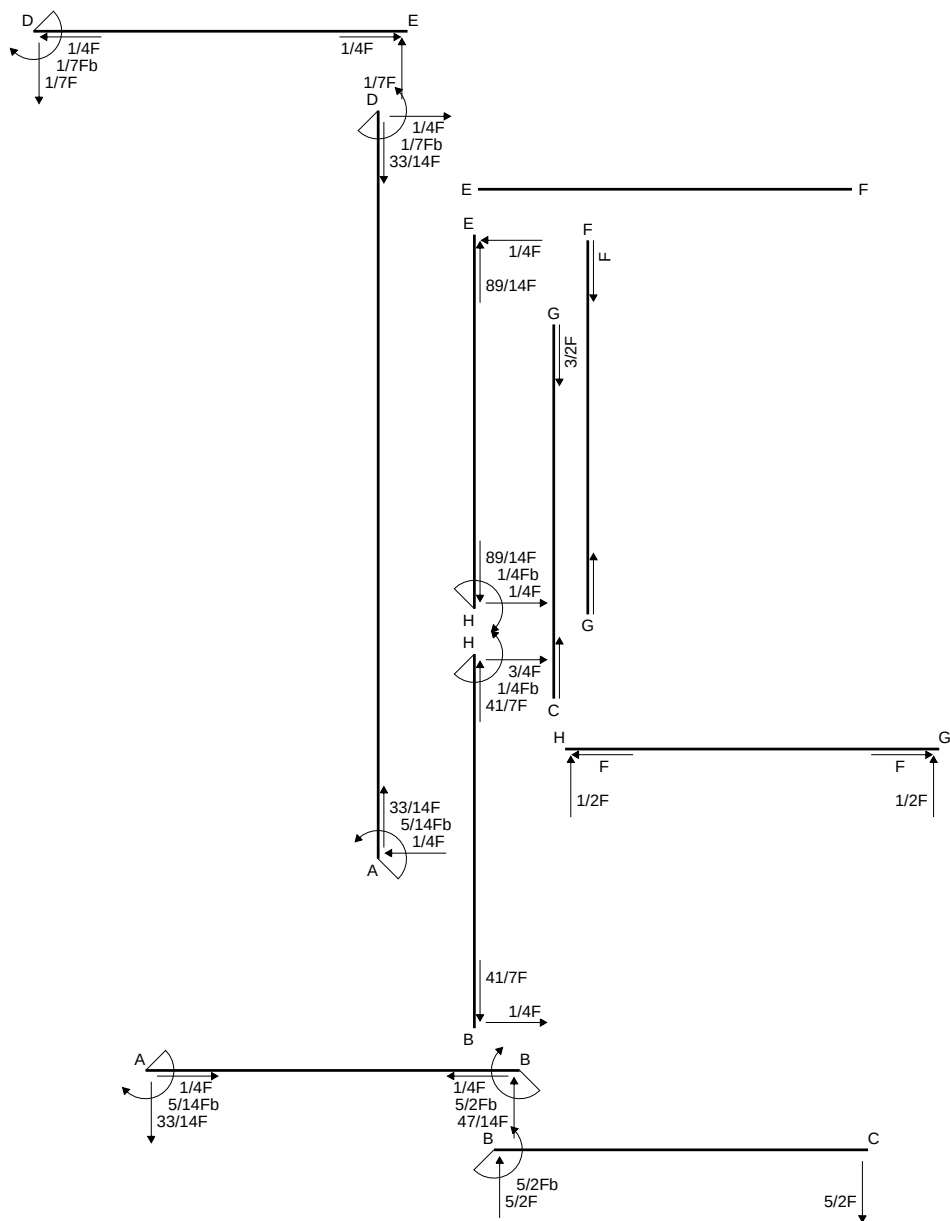
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$5/2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

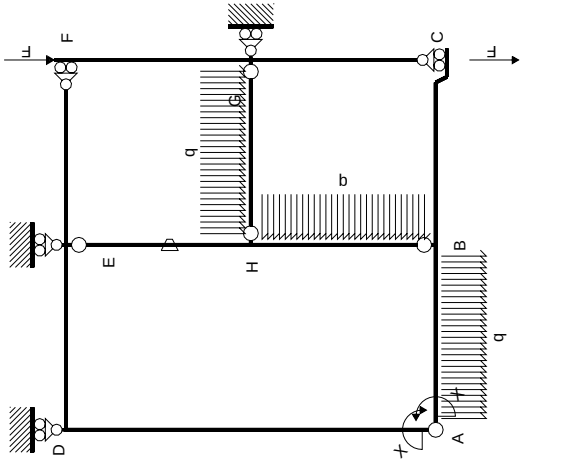
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



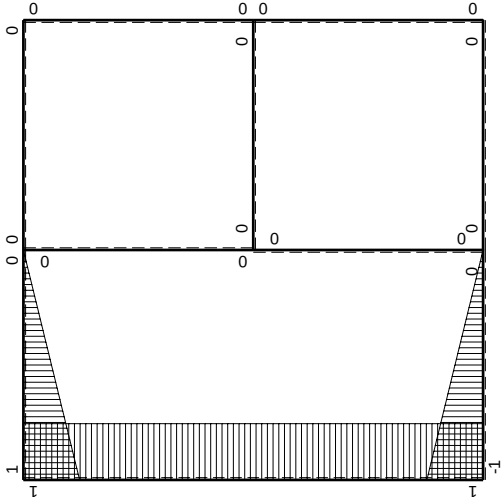
$$\begin{aligned}
A &= 1176. \text{ mm}^2 \\
J_u &= 365284. \text{ mm}^4 \\
J_v &= 119520. \text{ mm}^4 \\
y_g &= 31.06 \text{ mm} \\
T_y &= 4200. \text{ N} \\
M_x &= -2814000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -31.06 \text{ mm} \\
\sigma_m &= -Mv/J_u = -239.3 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -18.06 \text{ mm} \\
\sigma_c &= -Mv/J_u = -139.1 \text{ N/mm}^2 \\
\tau_c &= 7.129 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 139.7 \text{ N/mm}^2 \\
S &= 7440. \text{ mm}^3
\end{aligned}$$



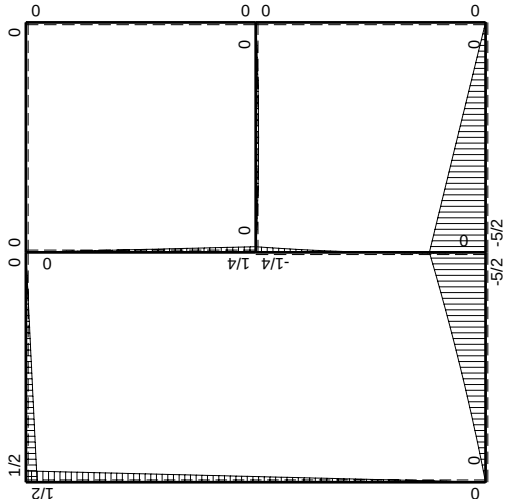


Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

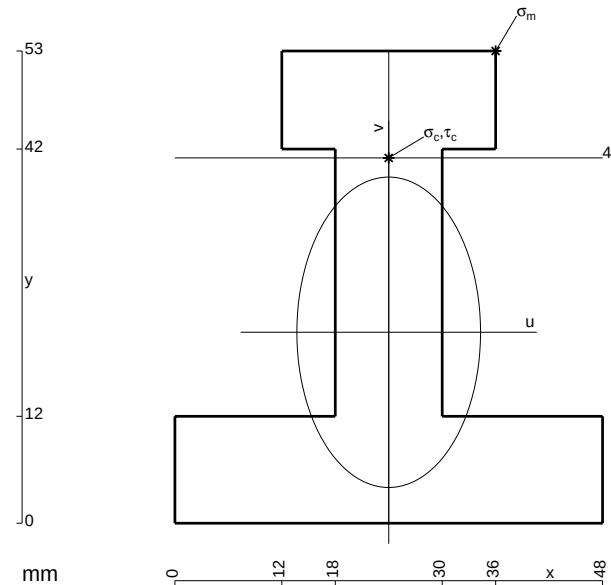


Quadro contributi PLV per iperstatica $X=W_{AB}$

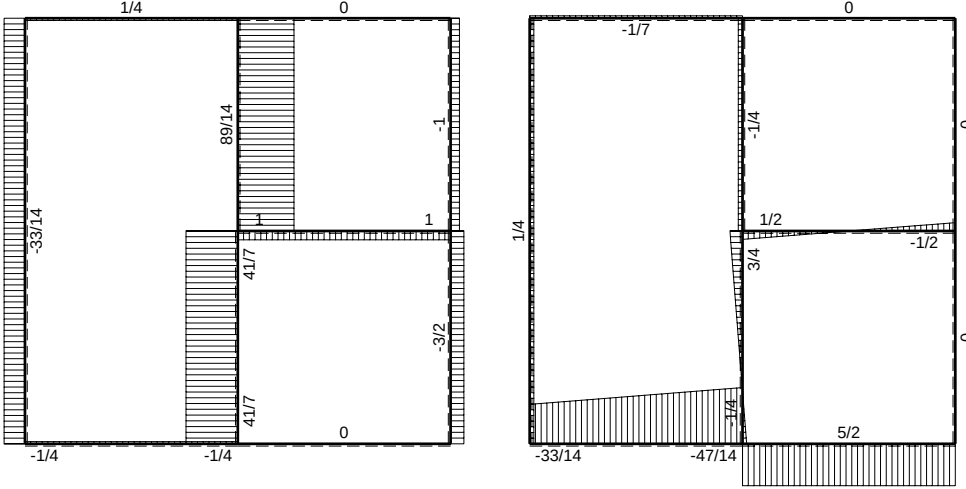
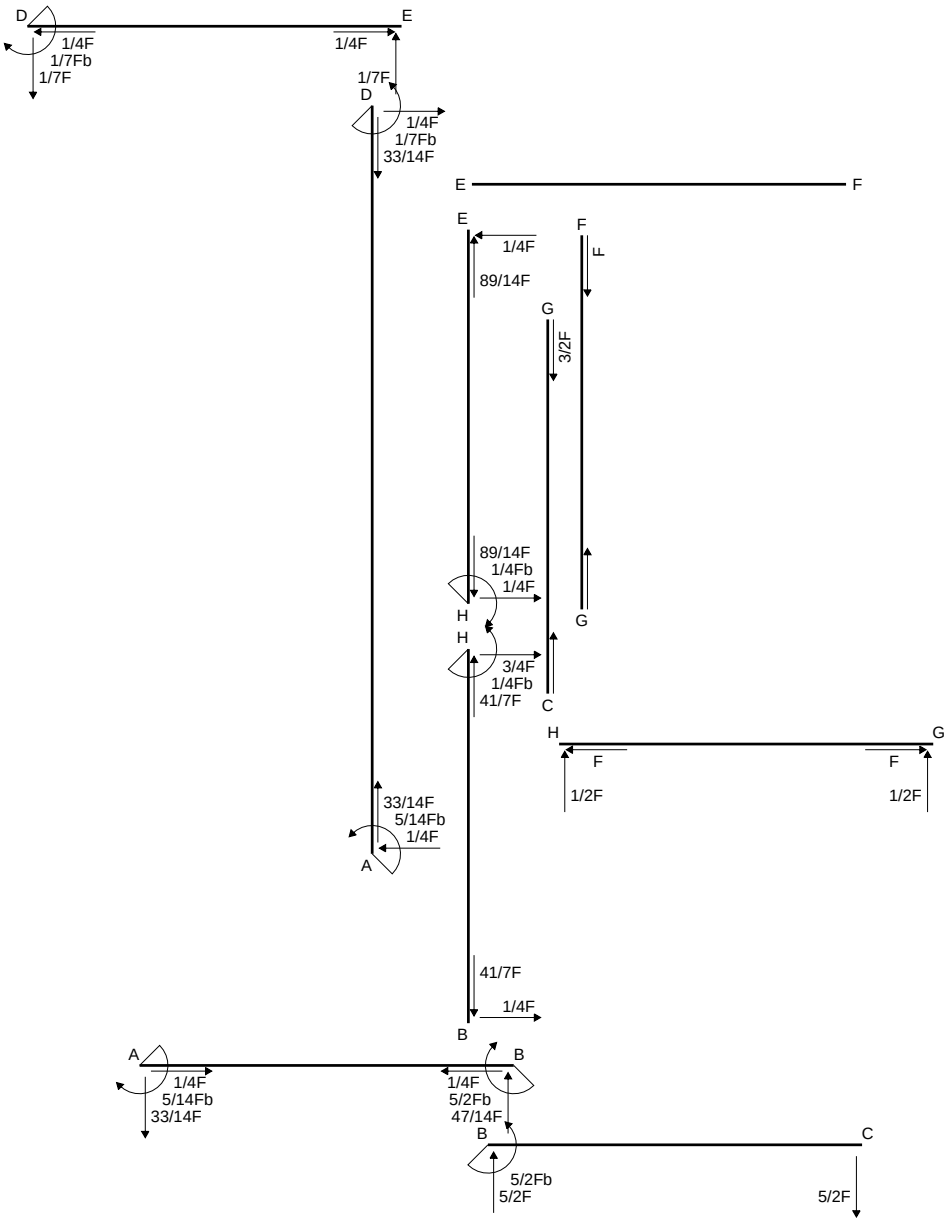
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-1/4Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
 L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
 &= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
 L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
 &= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
 L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
 &= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
 L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
 &= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
 L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
 &= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
 L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
 &= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
 L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
 L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
 L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
 &= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
 L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
 &= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
 L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
 &= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
 L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
 &= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
 \end{aligned}$$

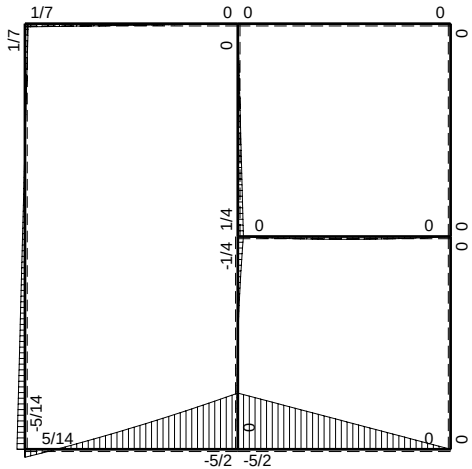


$$\begin{aligned}
 A &= 1200. \text{ mm}^2 \\
 J_u &= 364306. \text{ mm}^4 \\
 J_v &= 127584. \text{ mm}^4 \\
 y_g &= 21.43 \text{ mm} \\
 T_y &= 3200. \text{ N} \\
 M_x &= -2304000. \text{ Nmm} \\
 x_m &= 36. \text{ mm} \\
 y_m &= 53. \text{ mm} \\
 u_m &= 12. \text{ mm} \\
 v_m &= 31.57 \text{ mm} \\
 \sigma_m &= -Mv/J_u = 199.7 \text{ N/mm}^2 \\
 x_c &= 24. \text{ mm} \\
 y_c &= 41. \text{ mm} \\
 v_c &= 19.57 \text{ mm} \\
 \sigma_c &= -Mv/J_u = 123.8 \text{ N/mm}^2 \\
 \tau_c &= 5.214 \text{ N/mm}^2 \\
 \sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 124.1 \text{ N/mm}^2 \\
 S &= 7123. \text{ mm}^3
 \end{aligned}$$

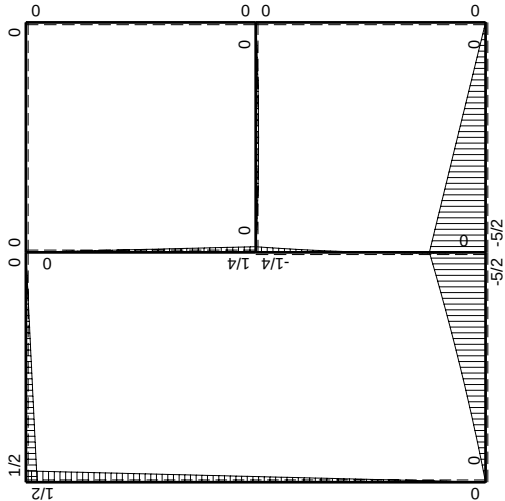
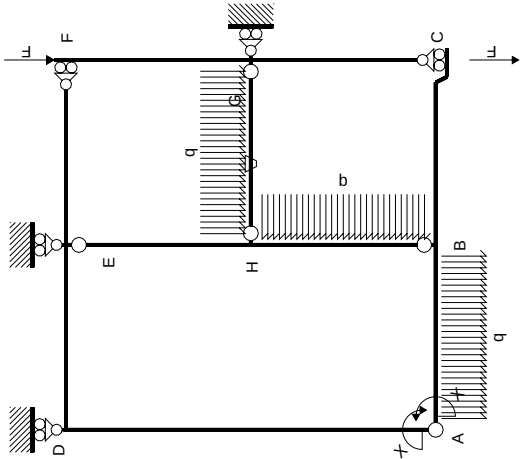


← ⊕ → F

↑ ⊕ ↓ F

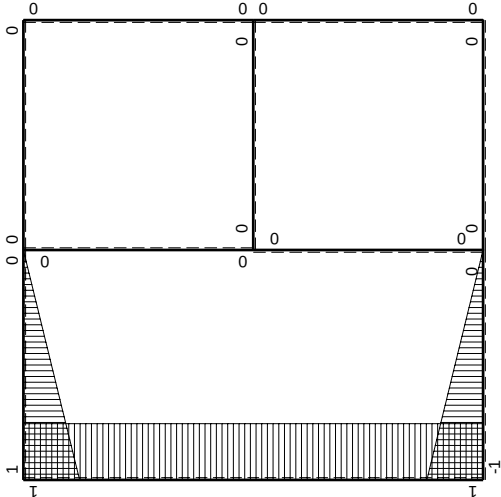


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



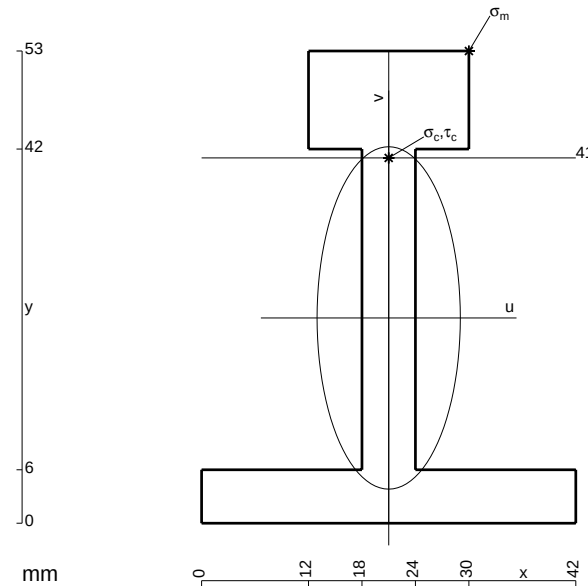
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

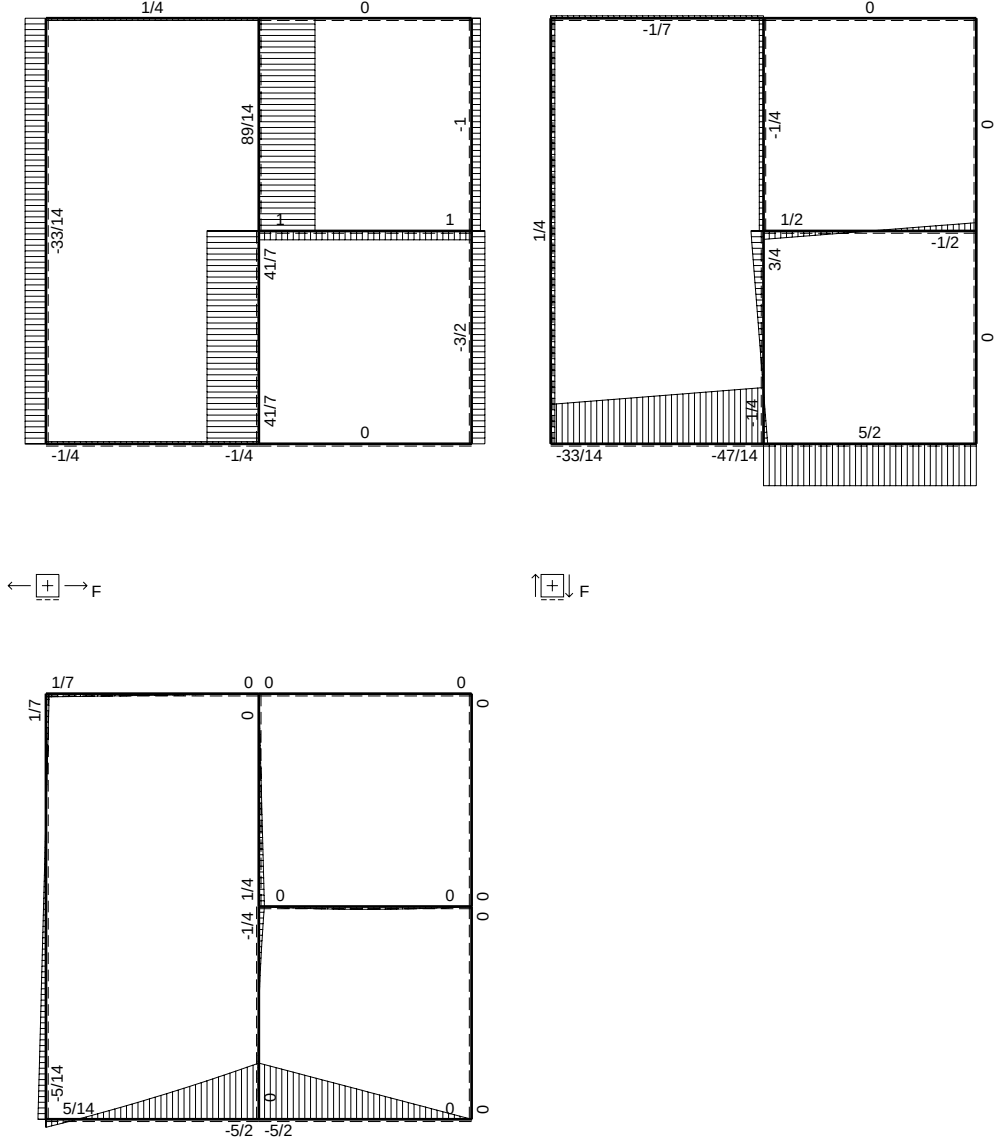
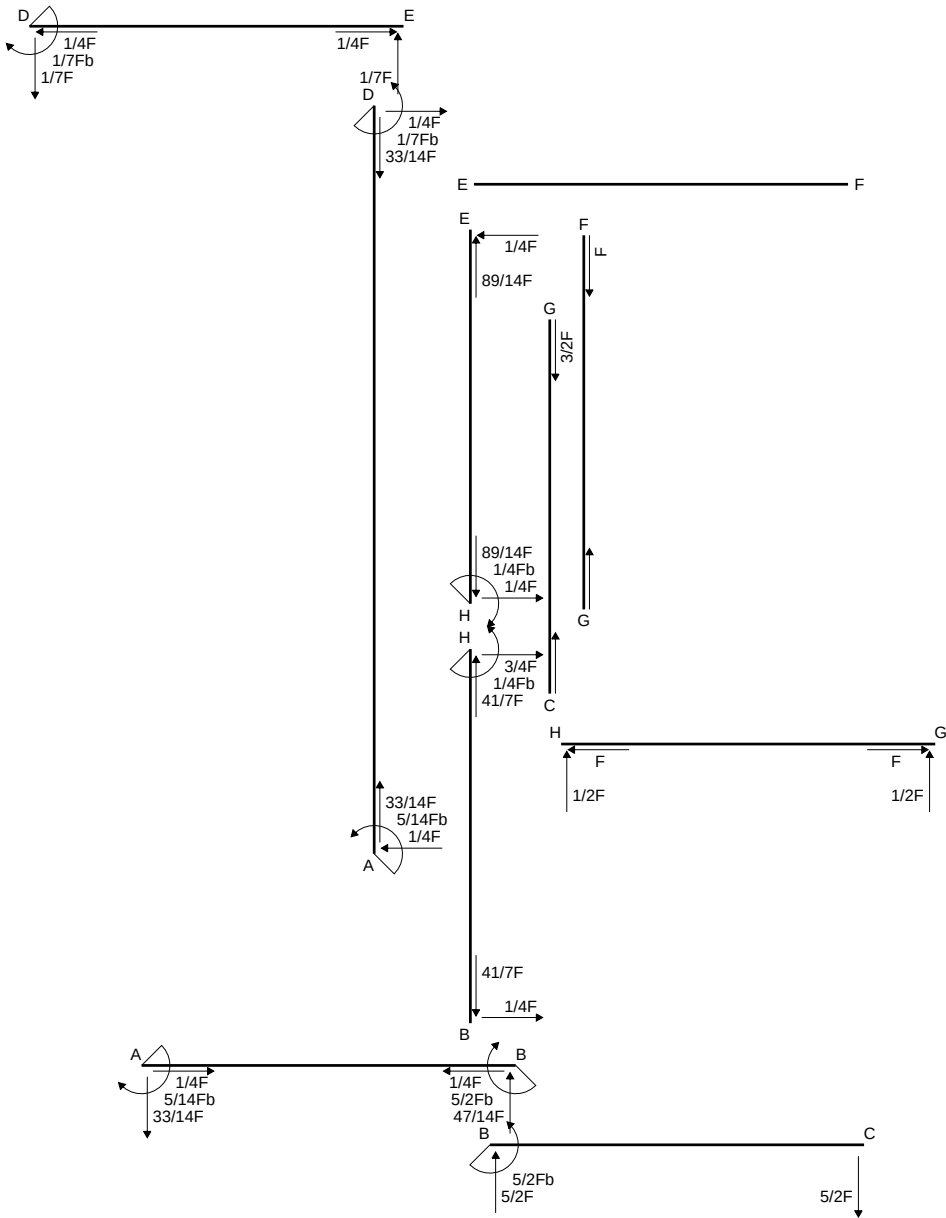
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	Fb/EJ	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

Sviluppi di calcolo iperstatica

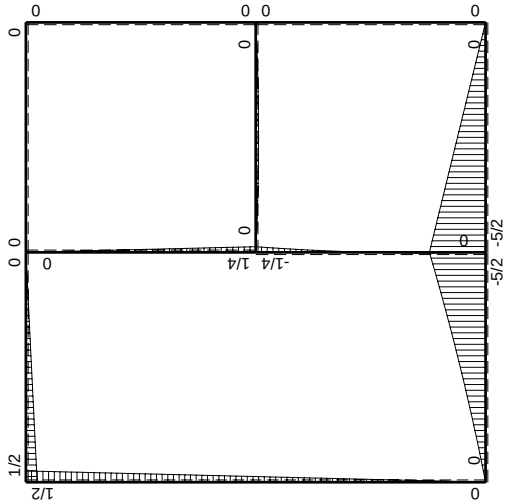
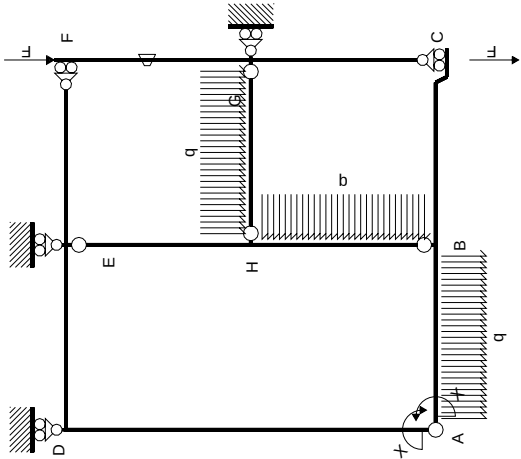
$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2xb - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 xb - 3x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 666. \text{ mm}^2 \\
J_u &= 245945. \text{ mm}^4 \\
J_v &= 43038. \text{ mm}^4 \\
y_g &= 23.04 \text{ mm} \\
T_y &= 2250. \text{ N} \\
M_x &= -1710000. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 29.96 \text{ mm} \\
\sigma_m &= -Mv/J_u = 208.3 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 41. \text{ mm} \\
v_c &= 17.96 \text{ mm} \\
\sigma_c &= -Mv/J_u = 124.9 \text{ N/mm}^2 \\
\tau_c &= 7.553 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 125.6 \text{ N/mm}^2 \\
S &= 4954. \text{ mm}^3
\end{aligned}$$

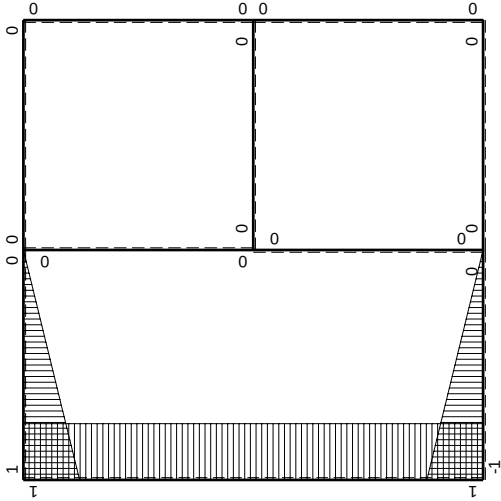


$\left(\begin{smallmatrix} + \\ - \end{smallmatrix} \right) F_b$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati

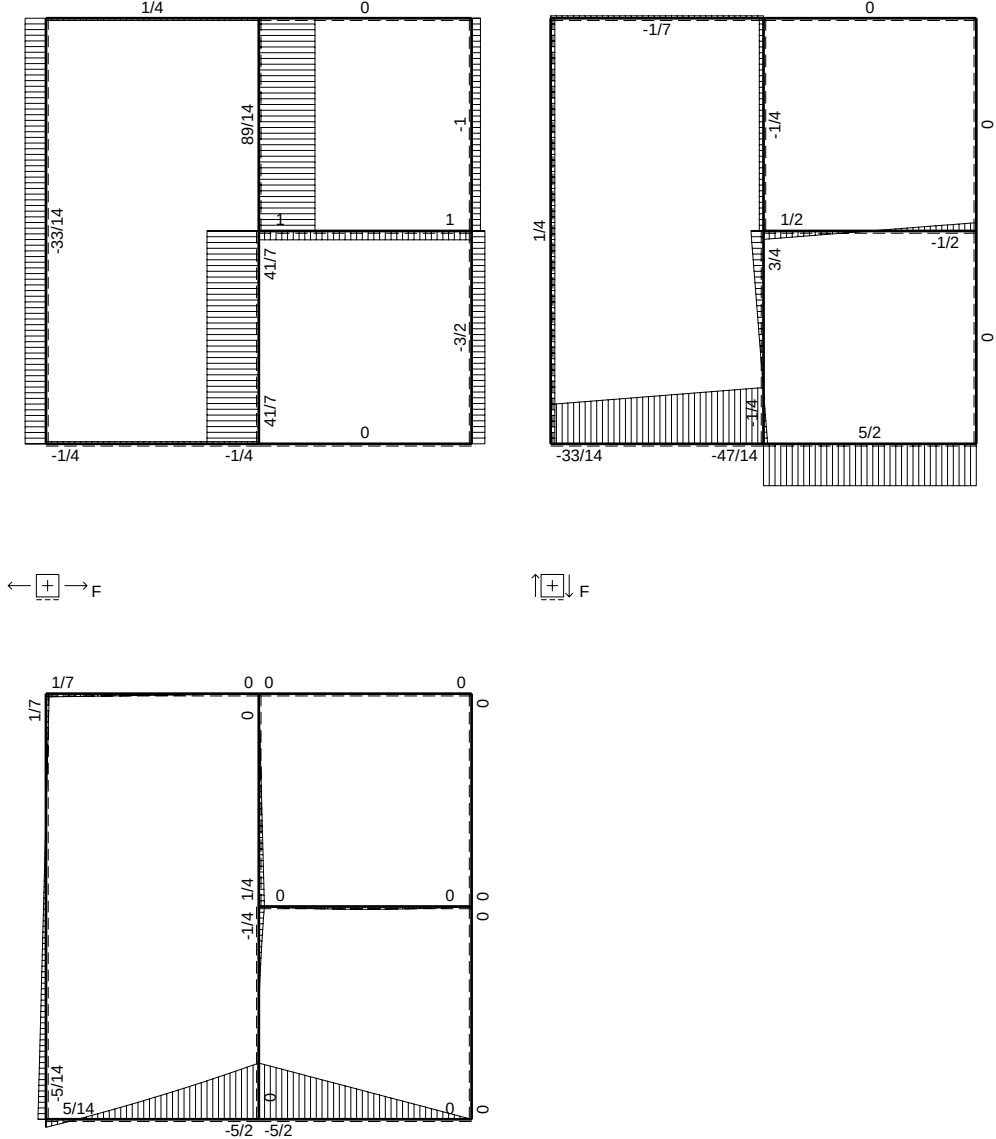
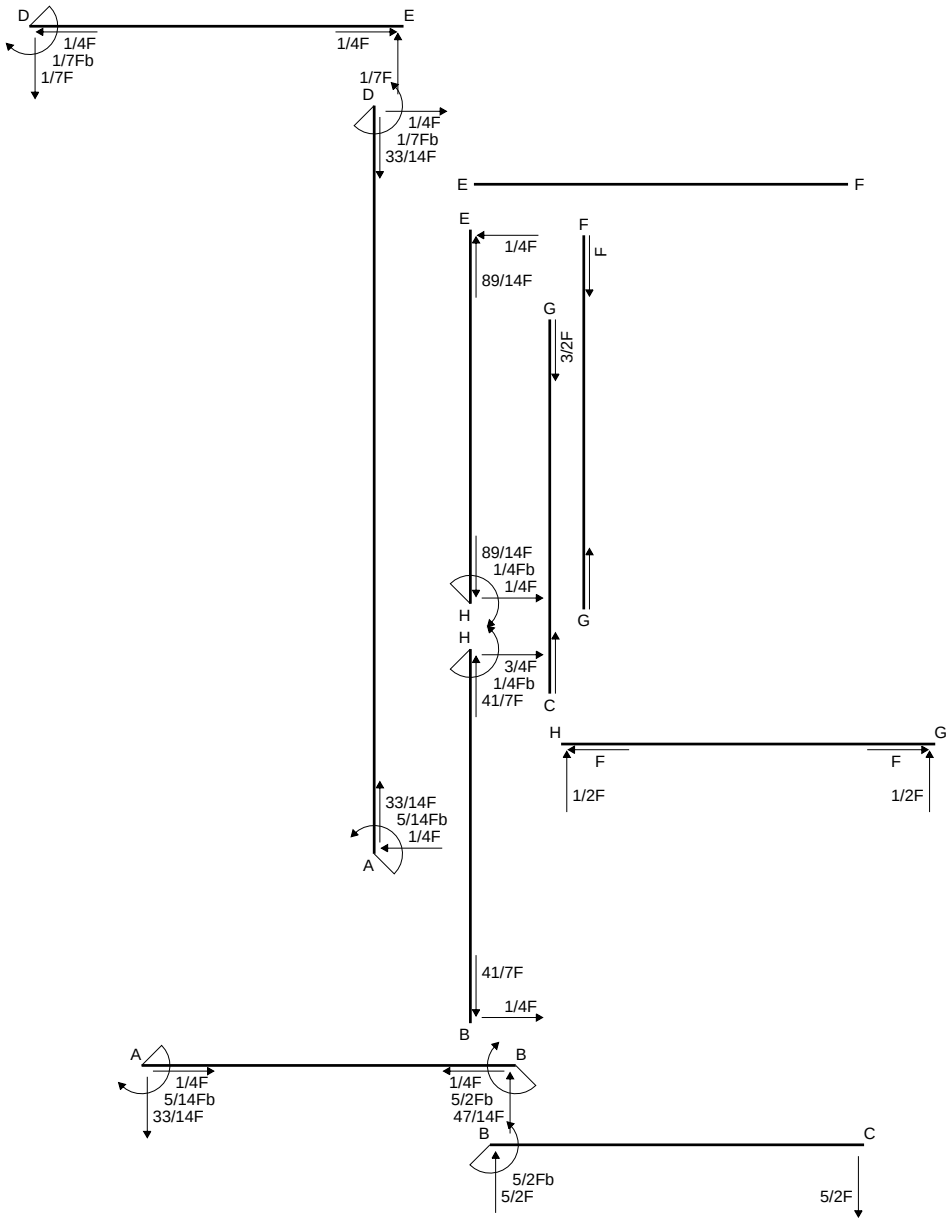


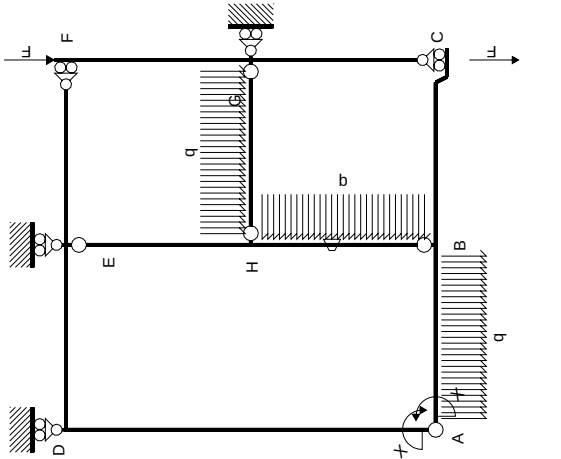
M_X flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

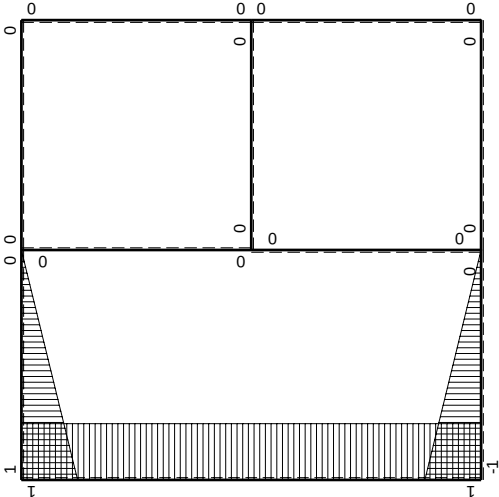
Sviluppi di calcolo iperstatica





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



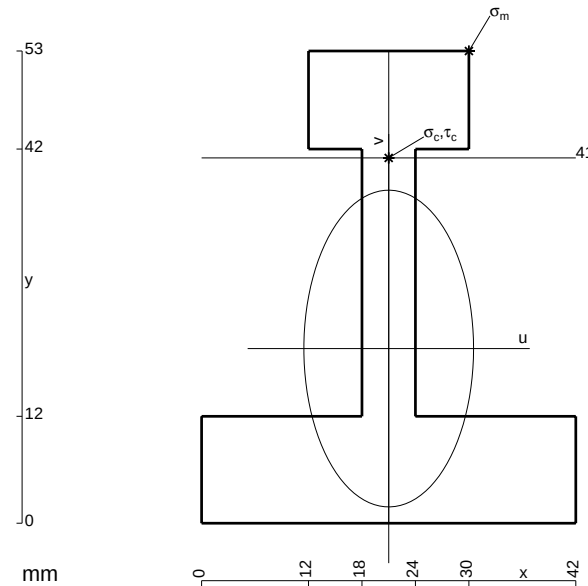
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

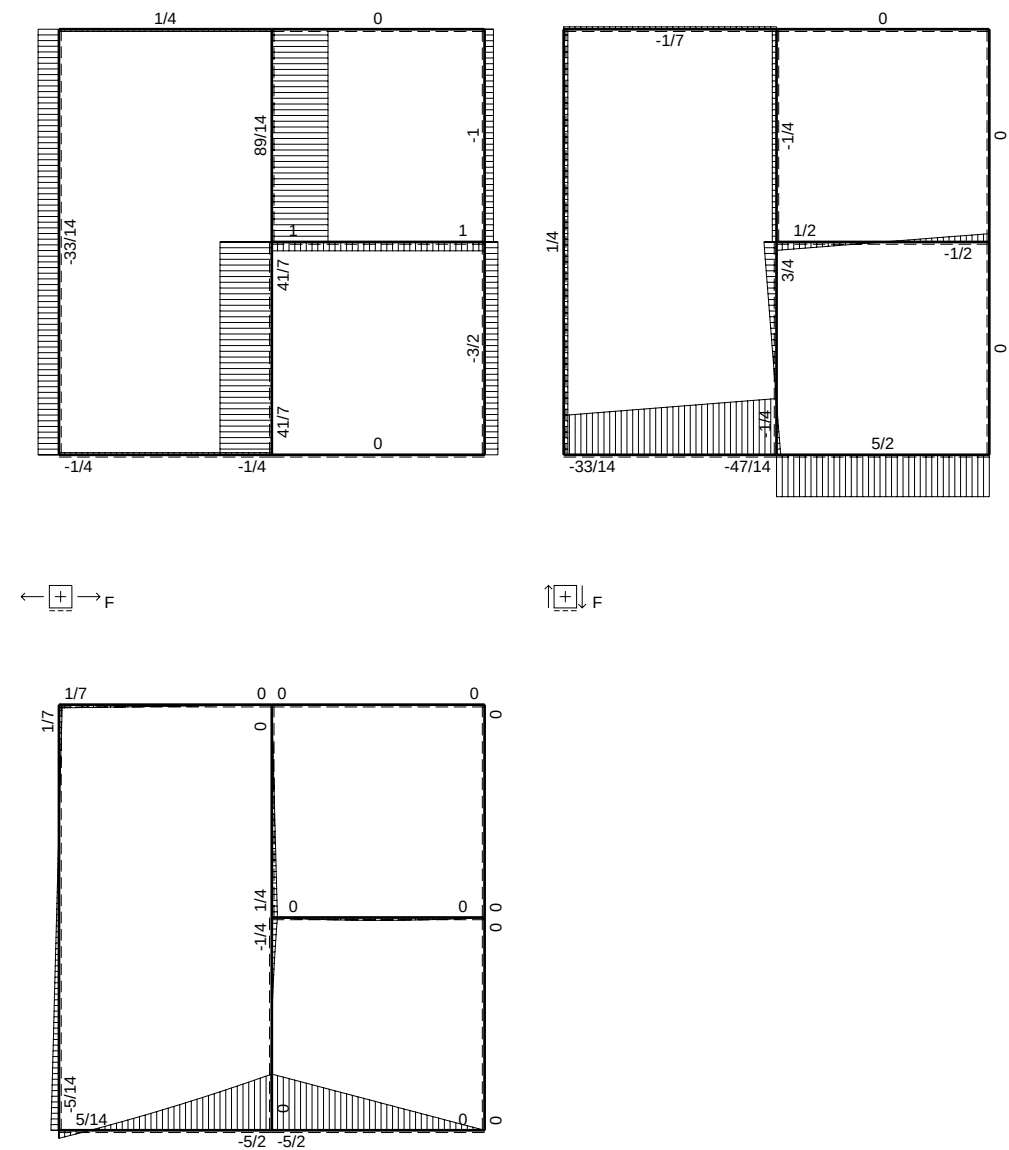
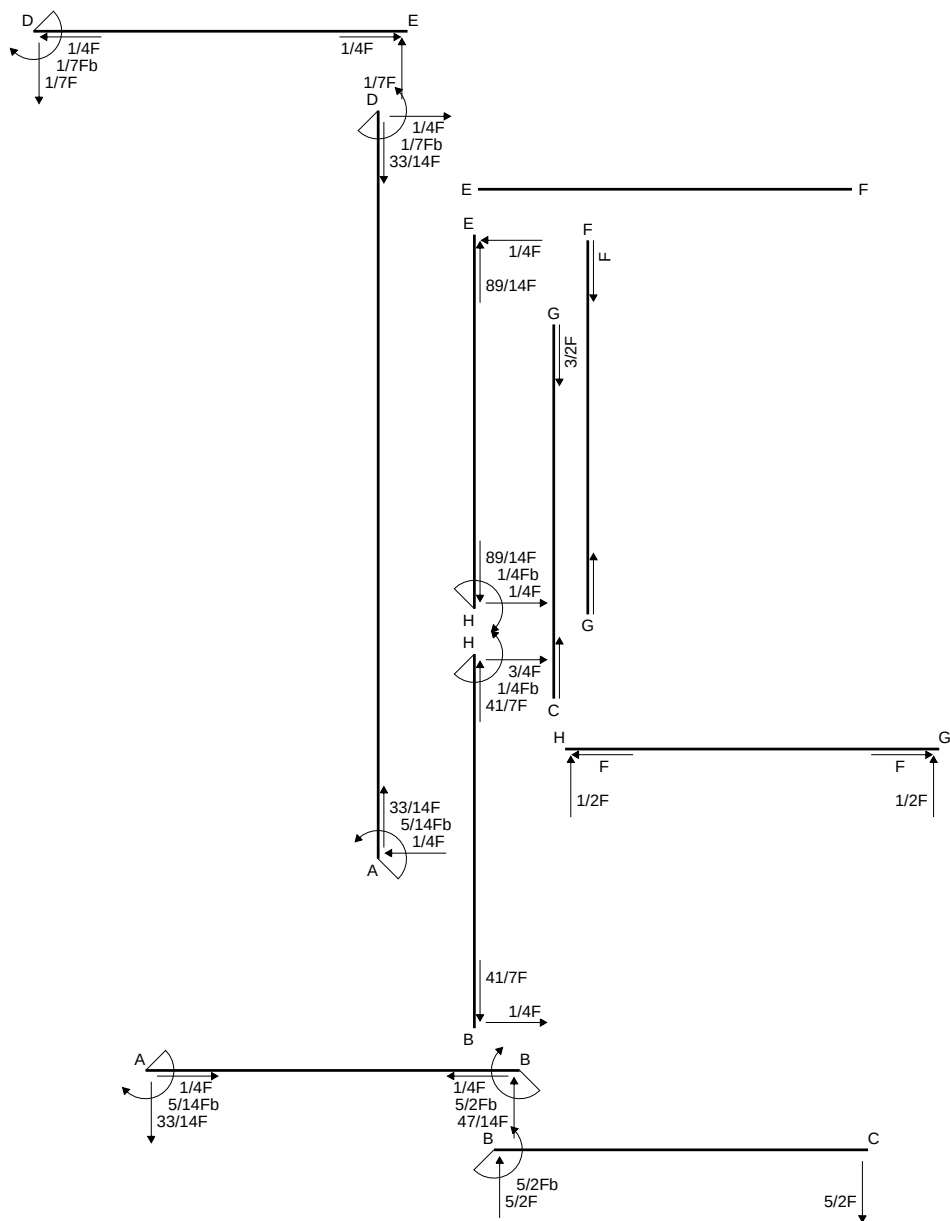
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	Fb/EJ	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

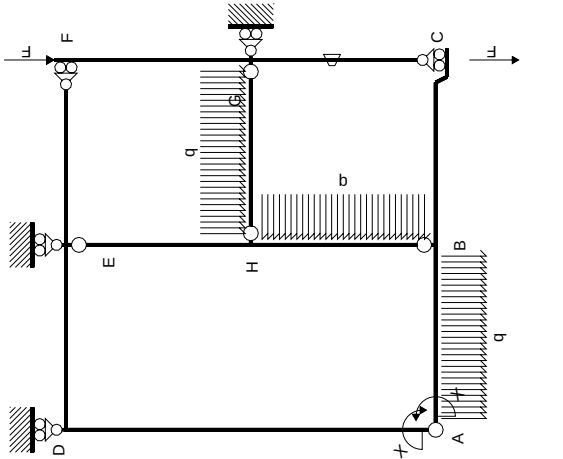
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



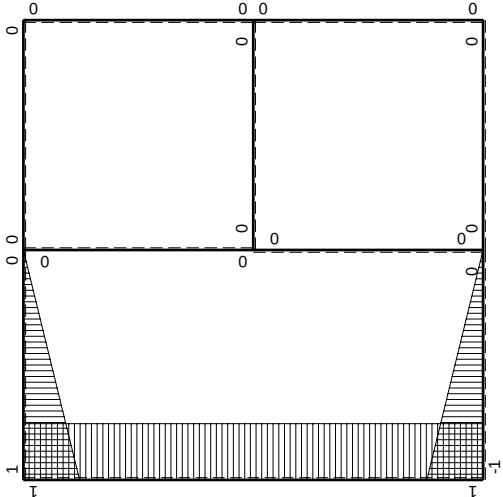
$$\begin{aligned}
A &= 882. \text{ mm}^2 \\
J_u &= 278746. \text{ mm}^4 \\
J_v &= 79974. \text{ mm}^4 \\
y_g &= 19.6 \text{ mm} \\
T_y &= 2225. \text{ N} \\
M_x &= -1913500. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 33.4 \text{ mm} \\
\sigma_m &= -Mv/J_u = 229.3 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 41. \text{ mm} \\
v_c &= 21.4 \text{ mm} \\
\sigma_c &= -Mv/J_u = 146.9 \text{ N/mm}^2 \\
\tau_c &= 7.523 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 147.5 \text{ N/mm}^2 \\
S &= 5655. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



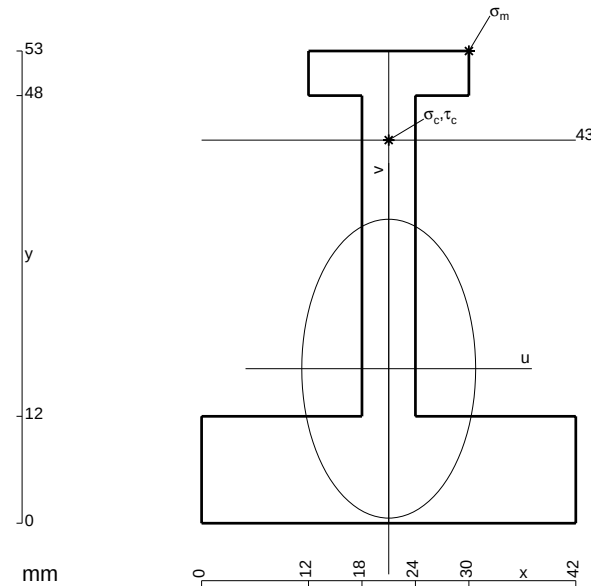
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

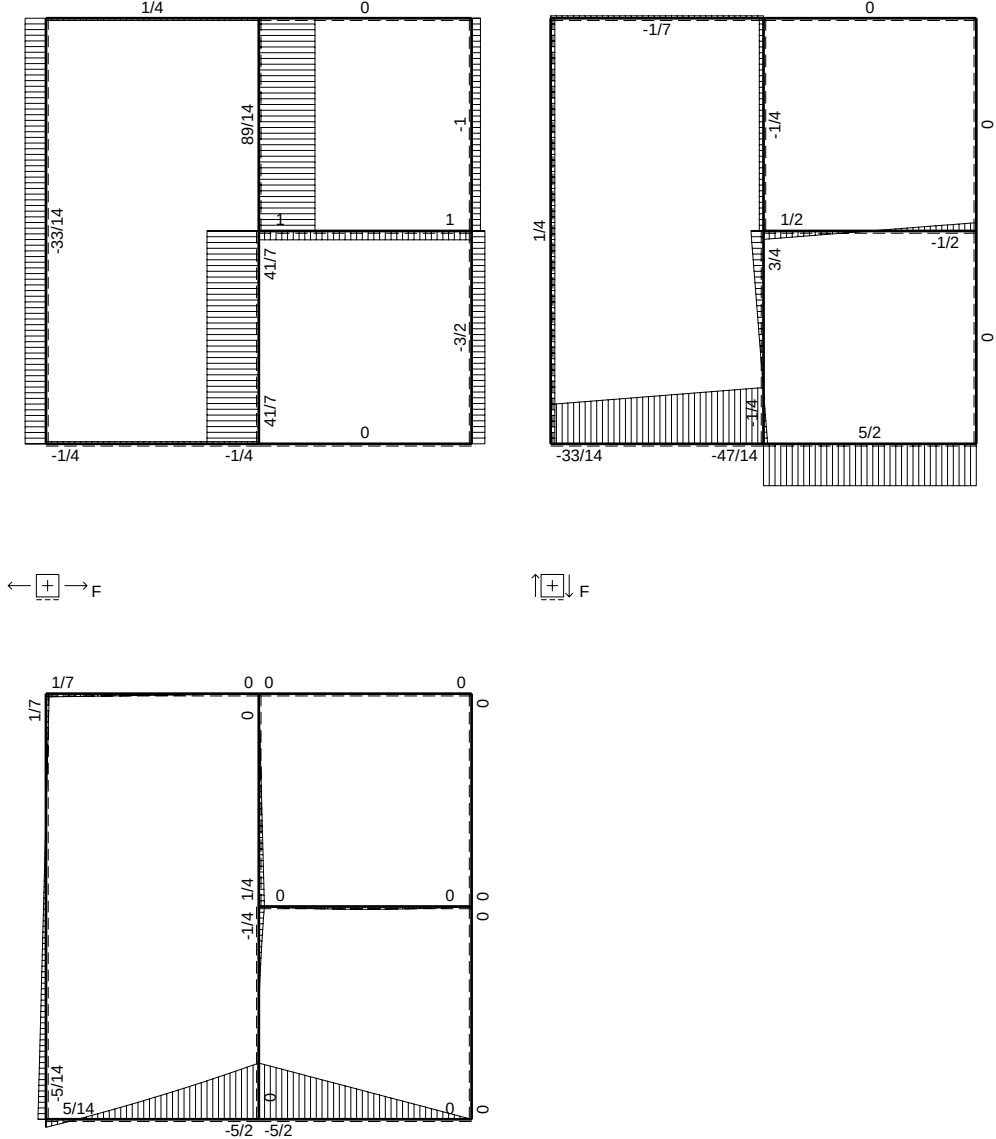
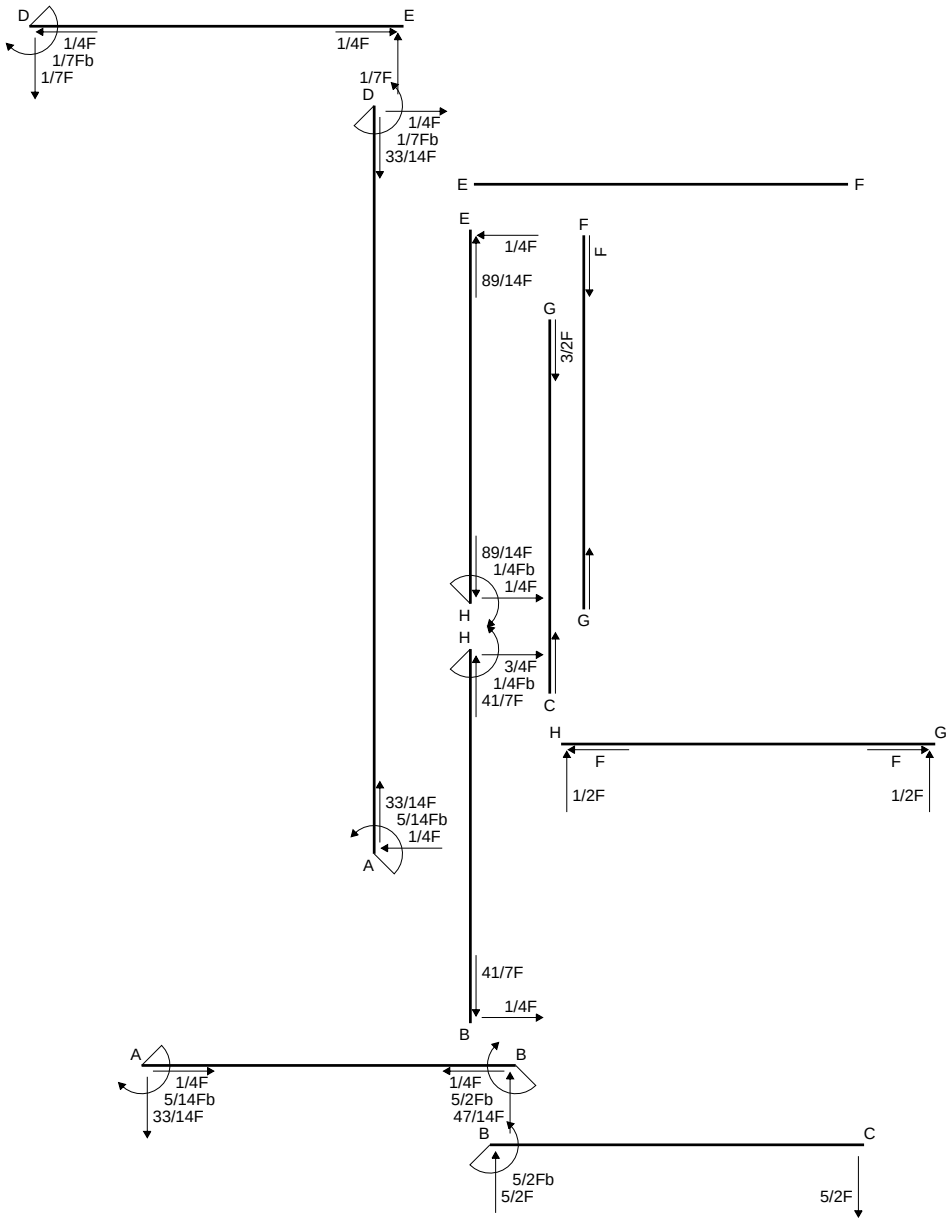
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

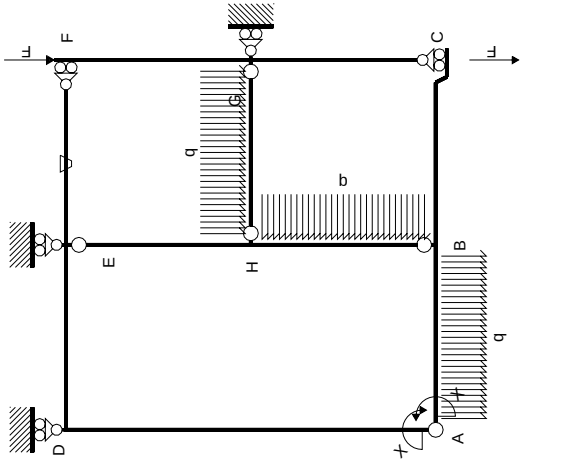
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



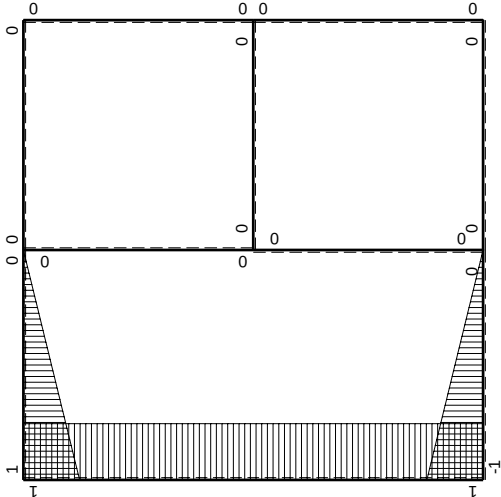
$$\begin{aligned}
A &= 810. \text{ mm}^2 \\
J_u &= 227958. \text{ mm}^4 \\
J_v &= 77166. \text{ mm}^4 \\
y_g &= 17.34 \text{ mm} \\
T_y &= 1675. \text{ N} \\
M_x &= -1524250. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 35.66 \text{ mm} \\
\sigma_m &= -Mv/J_u = 238.4 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 43. \text{ mm} \\
v_c &= 25.66 \text{ mm} \\
\sigma_c &= -Mv/J_u = 171.5 \text{ N/mm}^2 \\
\tau_c &= 4.689 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 171.7 \text{ N/mm}^2 \\
S &= 3829. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



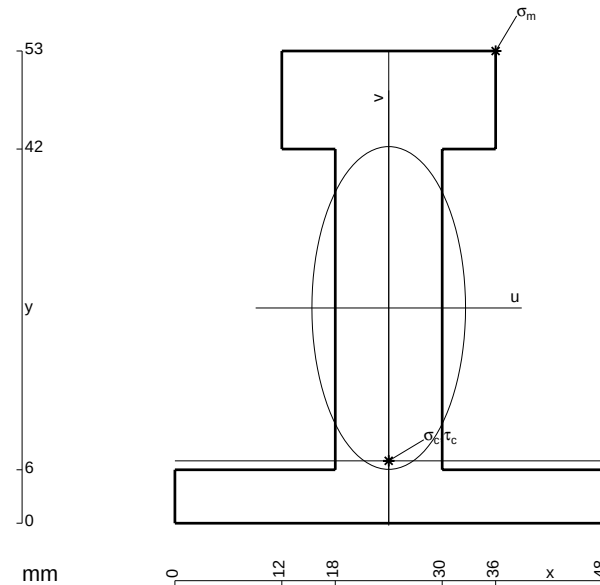
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

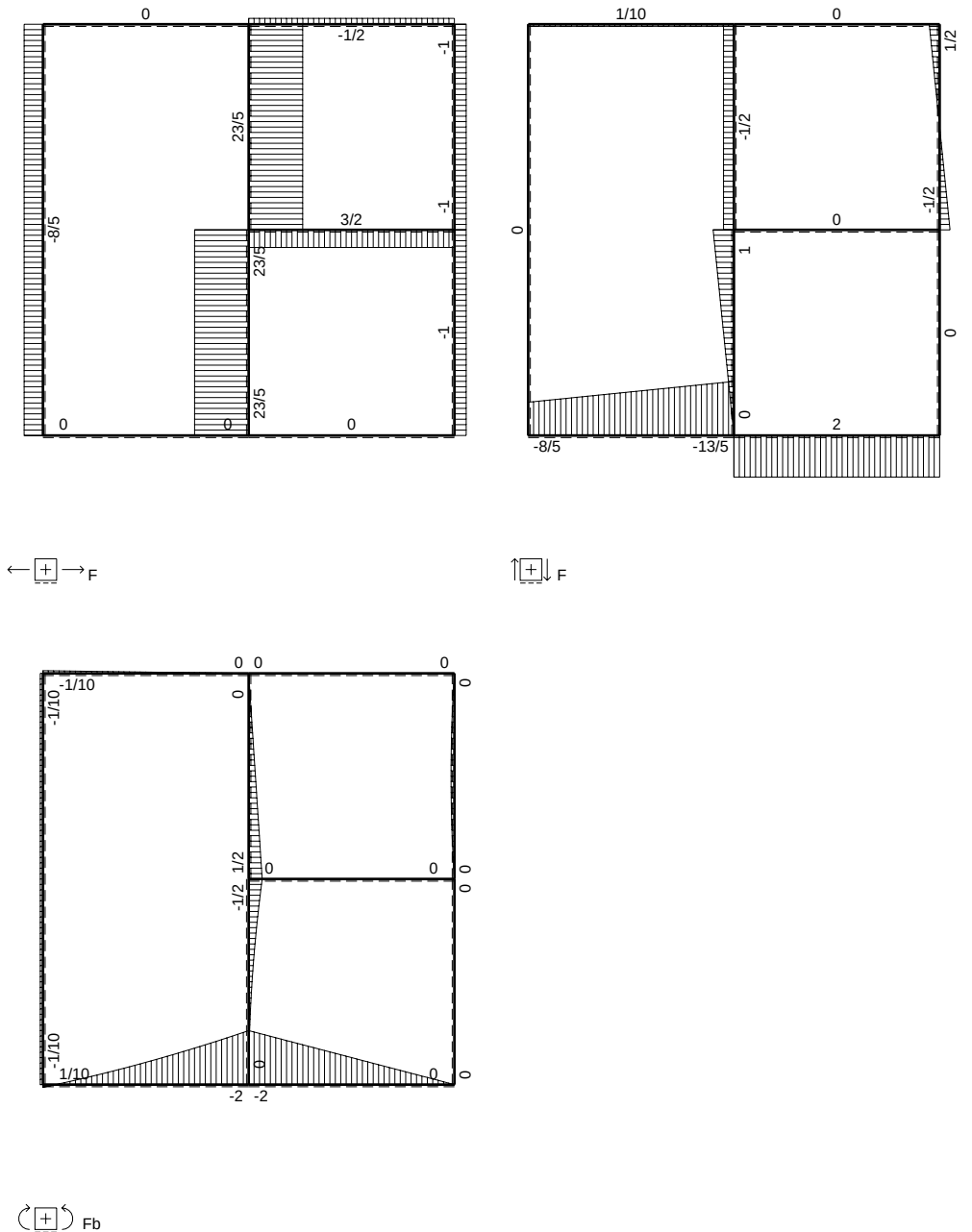
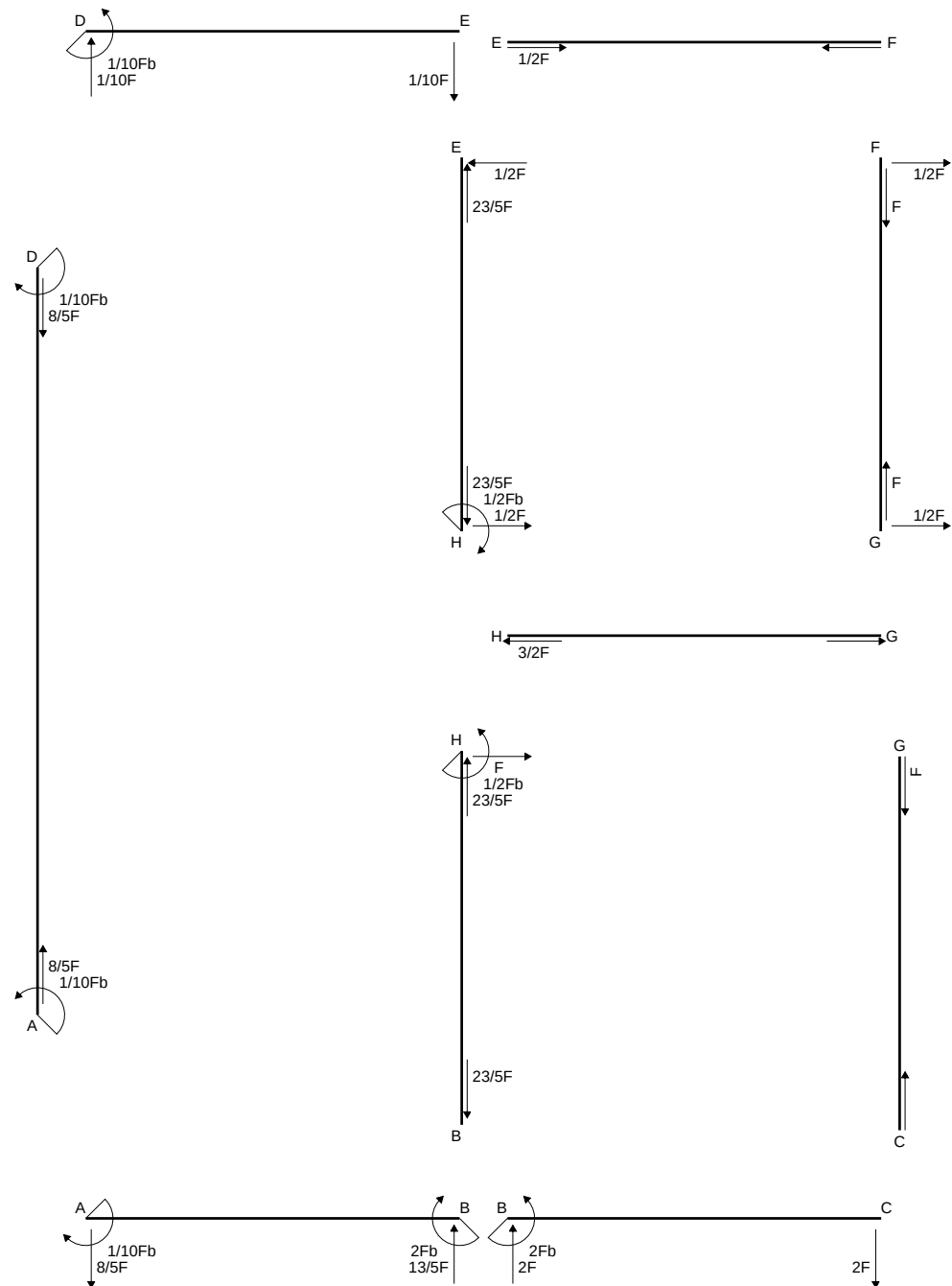
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

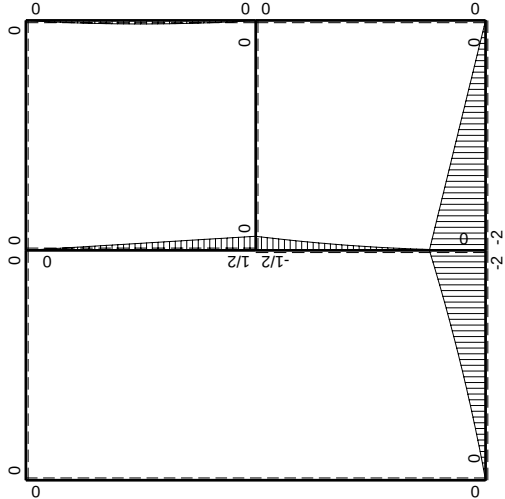
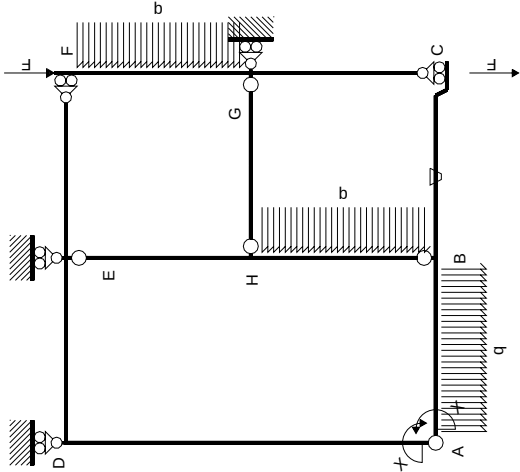
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{xo} &= \int_0^b (2xb - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{xo} &= \int_0^b (5/2 xb - 3x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{xo} &= \int_0^{2b} (1/4 xb) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{xo} &= \int_0^{2b} (1/2 - 1/4 xb) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{xo} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{xo} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



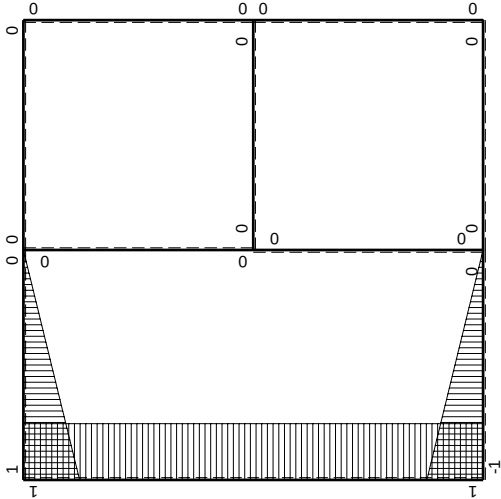
$$\begin{aligned}
A &= 984. \text{ mm}^2 \\
J_u &= 322959. \text{ mm}^4 \\
J_v &= 73152. \text{ mm}^4 \\
y_g &= 24.16 \text{ mm} \\
T_y &= 4650. \text{ N} \\
M_x &= -2232000. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 28.84 \text{ mm} \\
\sigma_m &= -Mv/J_u = 199.3 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 7. \text{ mm} \\
v_c &= -17.16 \text{ mm} \\
\sigma_c &= -Mv/J_u = -118.6 \text{ N/mm}^2 \\
\tau_c &= 7.566 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 119.3 \text{ N/mm}^2 \\
S &= 6306. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
EH b	0	$-1/2Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

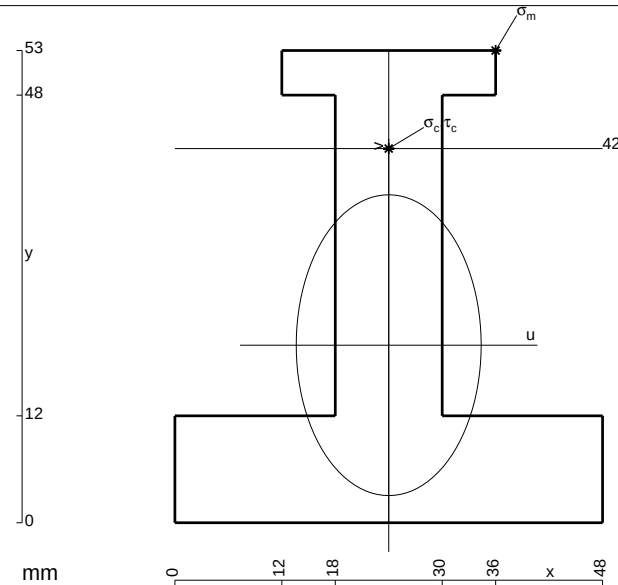
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 1128. \text{ mm}^2$$

$$J_u = 321538. \text{ mm}^4$$

$$J_v = 121536. \text{ mm}^4$$

$$y_g = 19.93 \text{ mm}$$

$$T_y = 3920. \text{ N}$$

$$M_x = -2038400. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 33.07 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 209.7 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 42. \text{ mm}$$

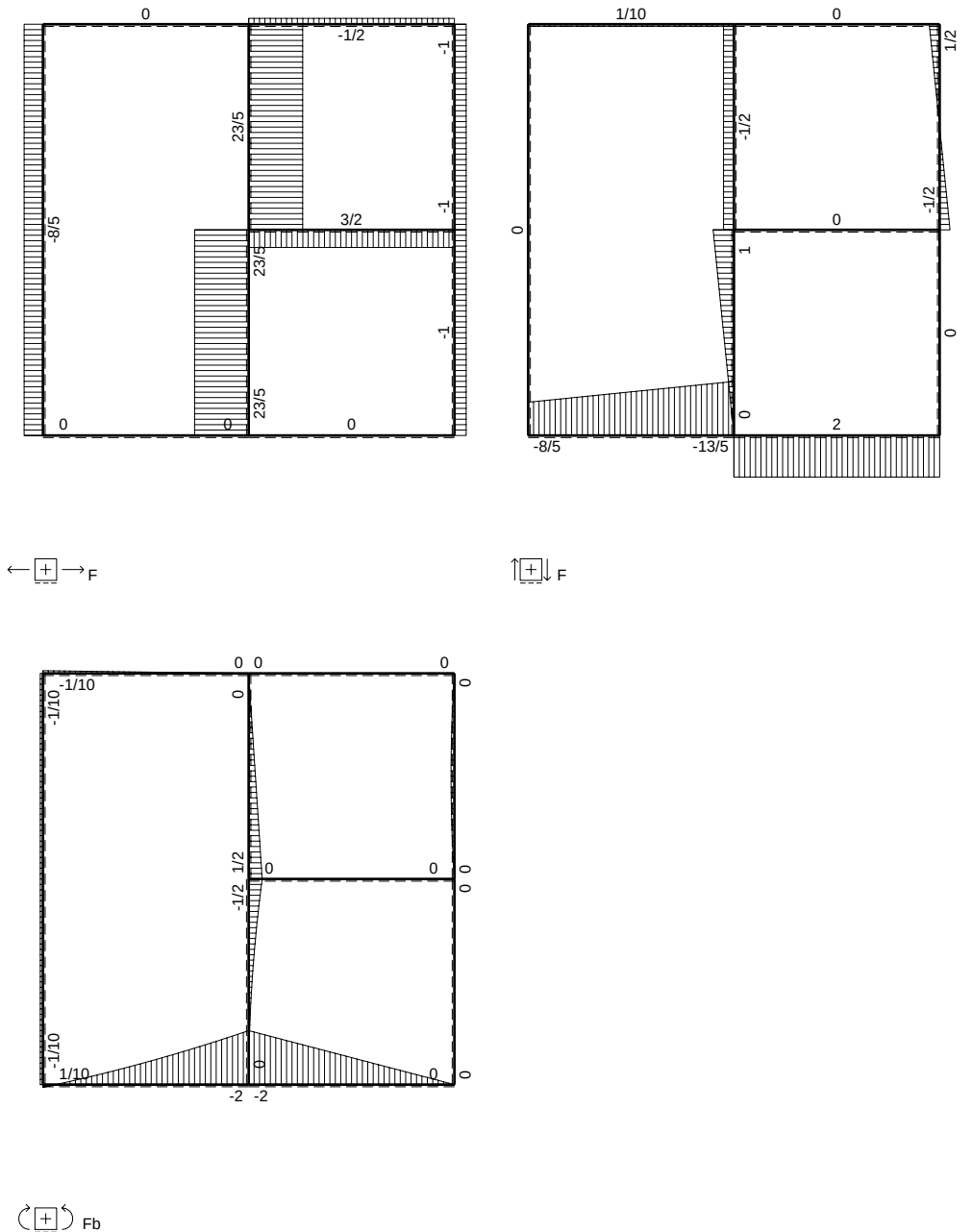
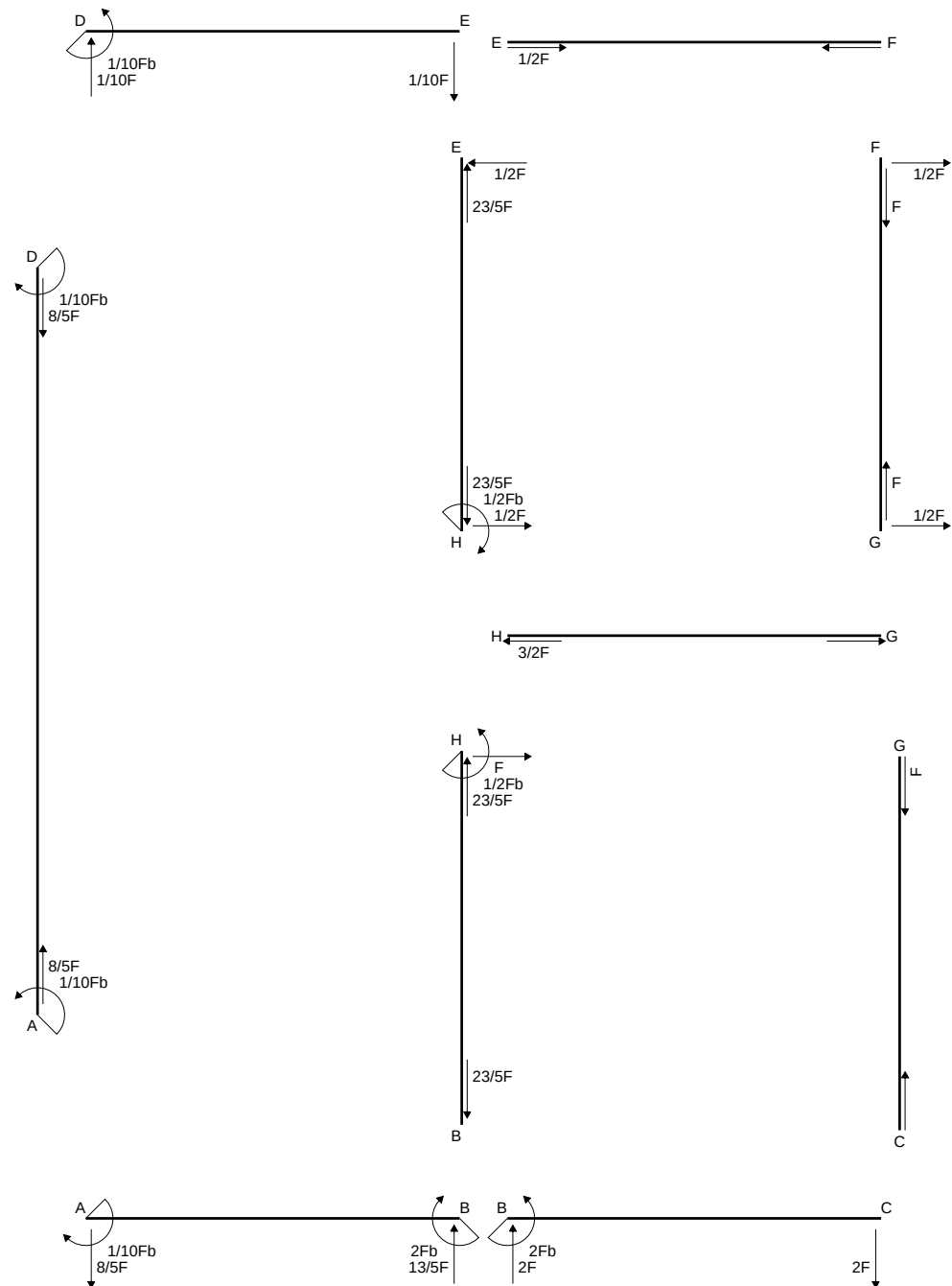
$$v_c = 22.07 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 139.9 \text{ N/mm}^2$$

$$\tau_c = 5.562 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 140.3 \text{ N/mm}^2$$

$$S = 5474. \text{ mm}^3$$



Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-1/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-1/2Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

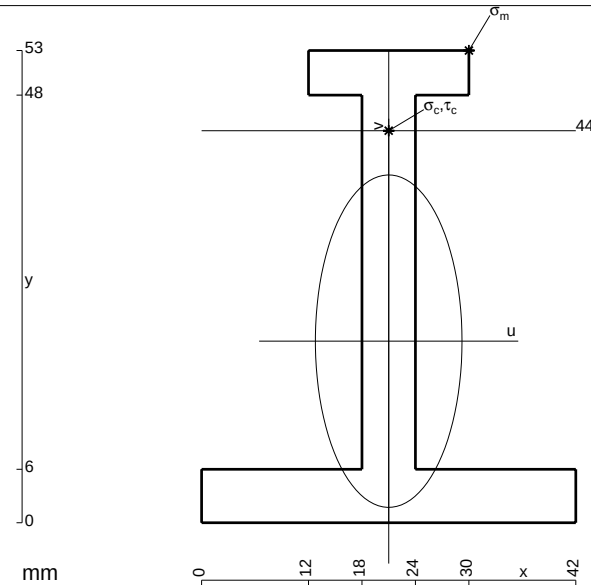
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 594. \text{ mm}^2$$

$$J_u = 206801. \text{ mm}^4$$

$$J_v = 40230. \text{ mm}^4$$

$$y_g = 20.38 \text{ mm}$$

$$T_y = 2440. \text{ N}$$

$$M_x = -1390800. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 32.62 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 219.4 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 44. \text{ mm}$$

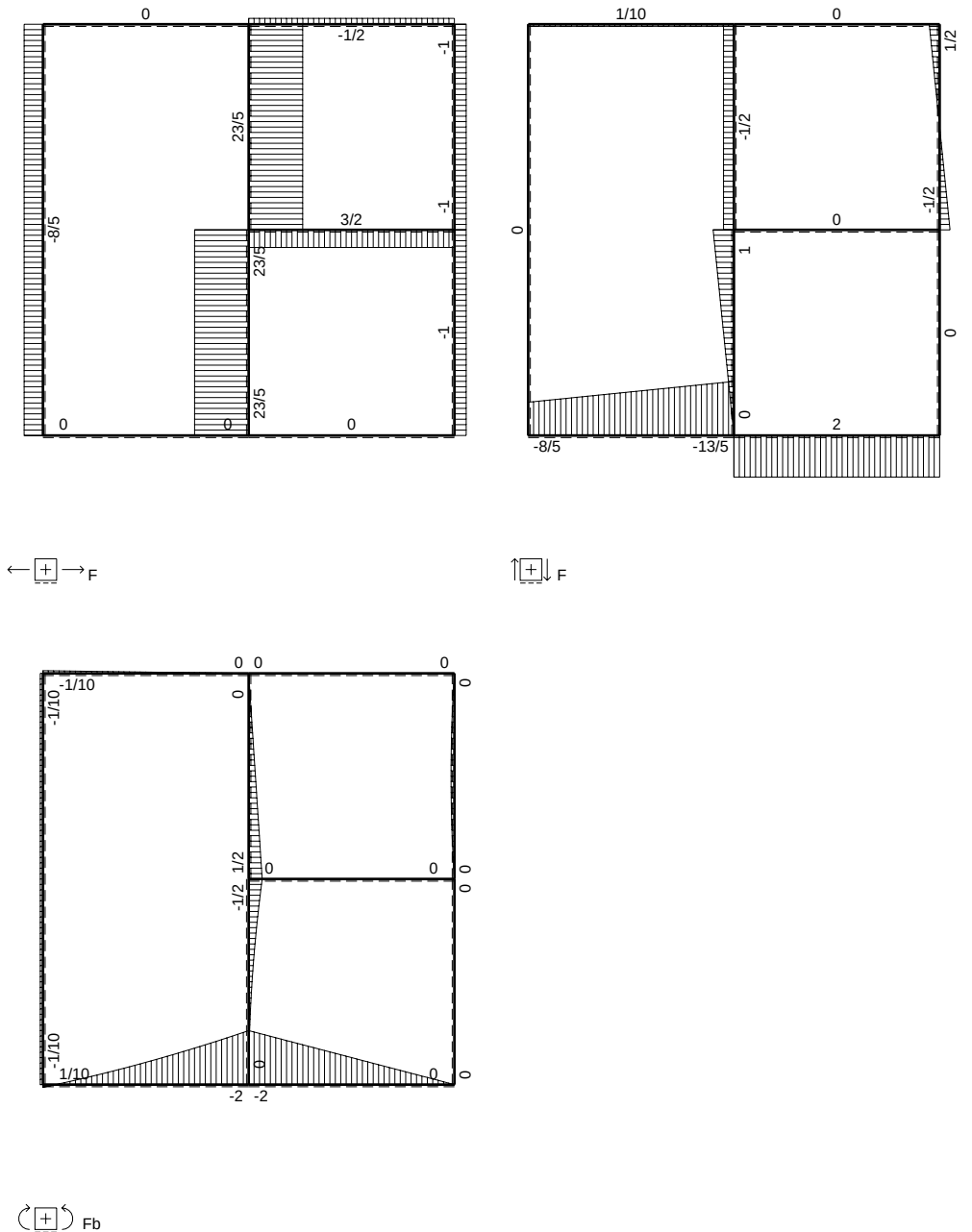
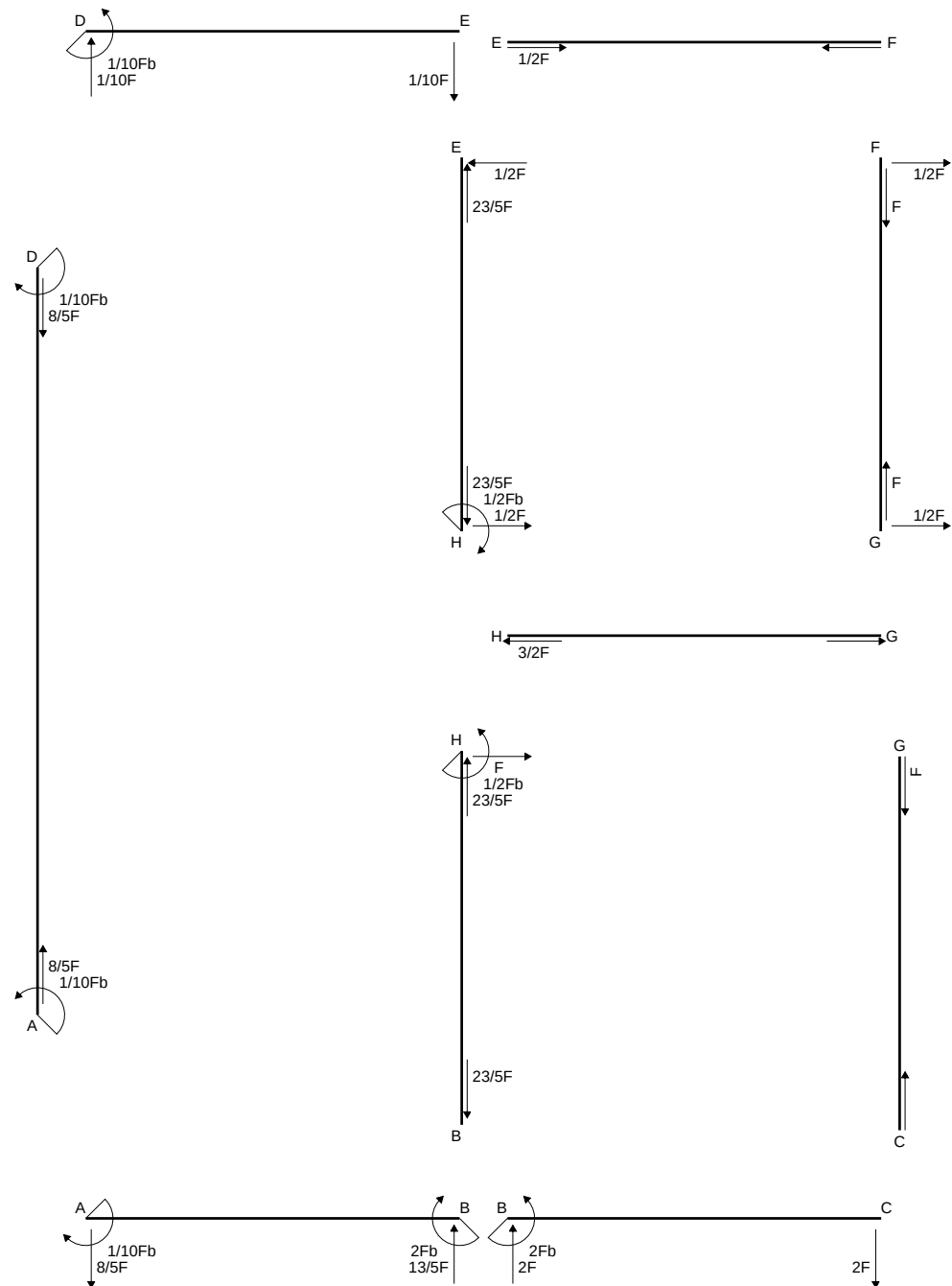
$$v_c = 23.62 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 158.9 \text{ N/mm}^2$$

$$\tau_c = 6.54 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 159.3 \text{ N/mm}^2$$

$$S = 3326. \text{ mm}^3$$



Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
EH b	0	$-1/2Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

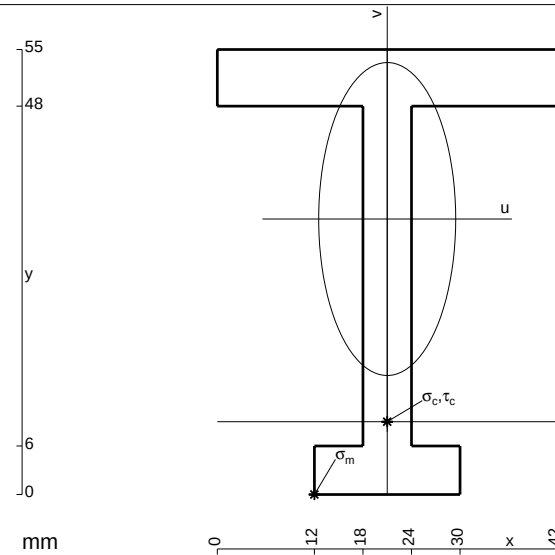
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 654. \text{ mm}^2$$

$$J_u = 244740. \text{ mm}^4$$

$$J_v = 46890. \text{ mm}^4$$

$$y_g = 34.05 \text{ mm}$$

$$T_y = 2540. \text{ N}$$

$$M_x = -1651000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -34.05 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -229.7 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 9. \text{ mm}$$

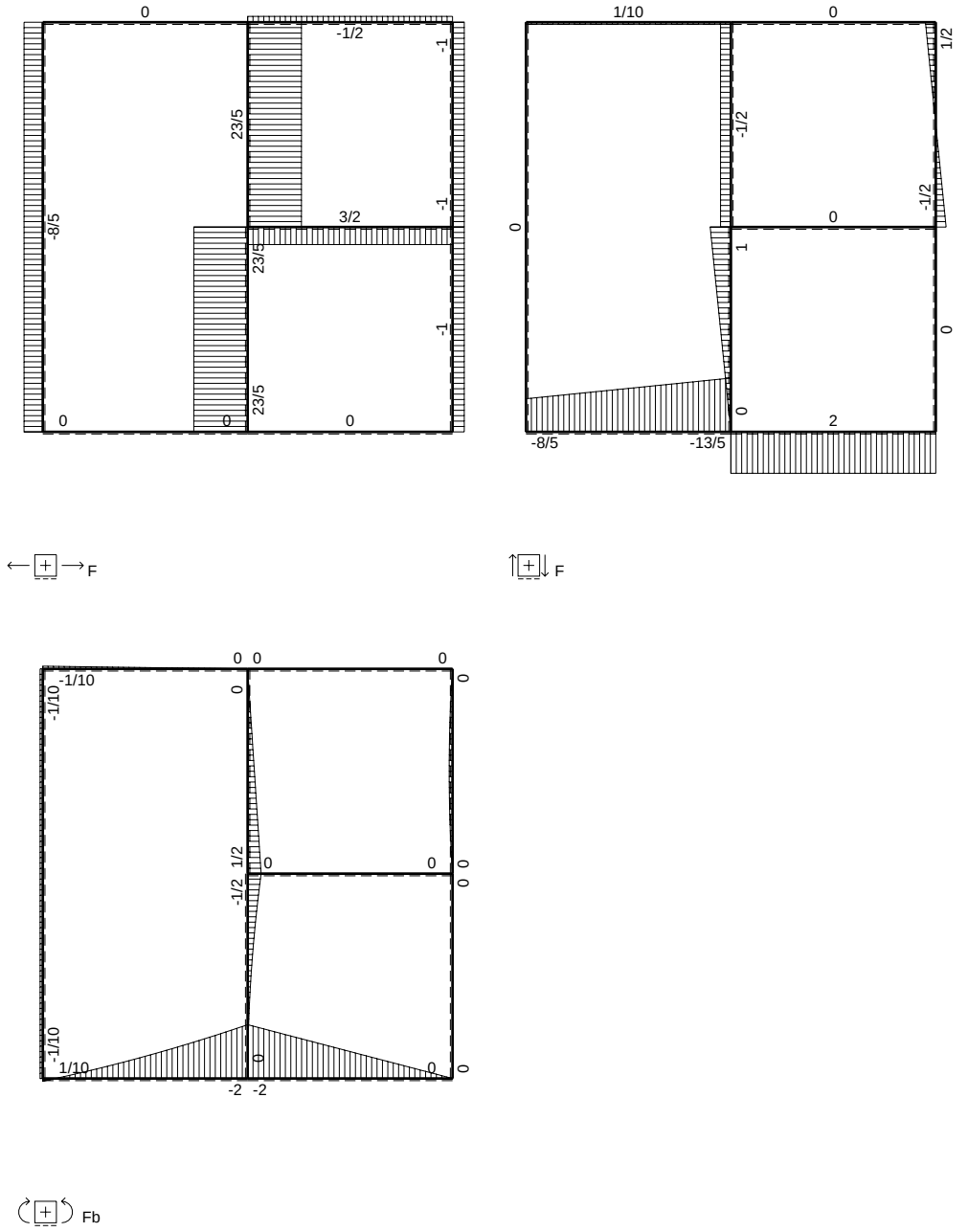
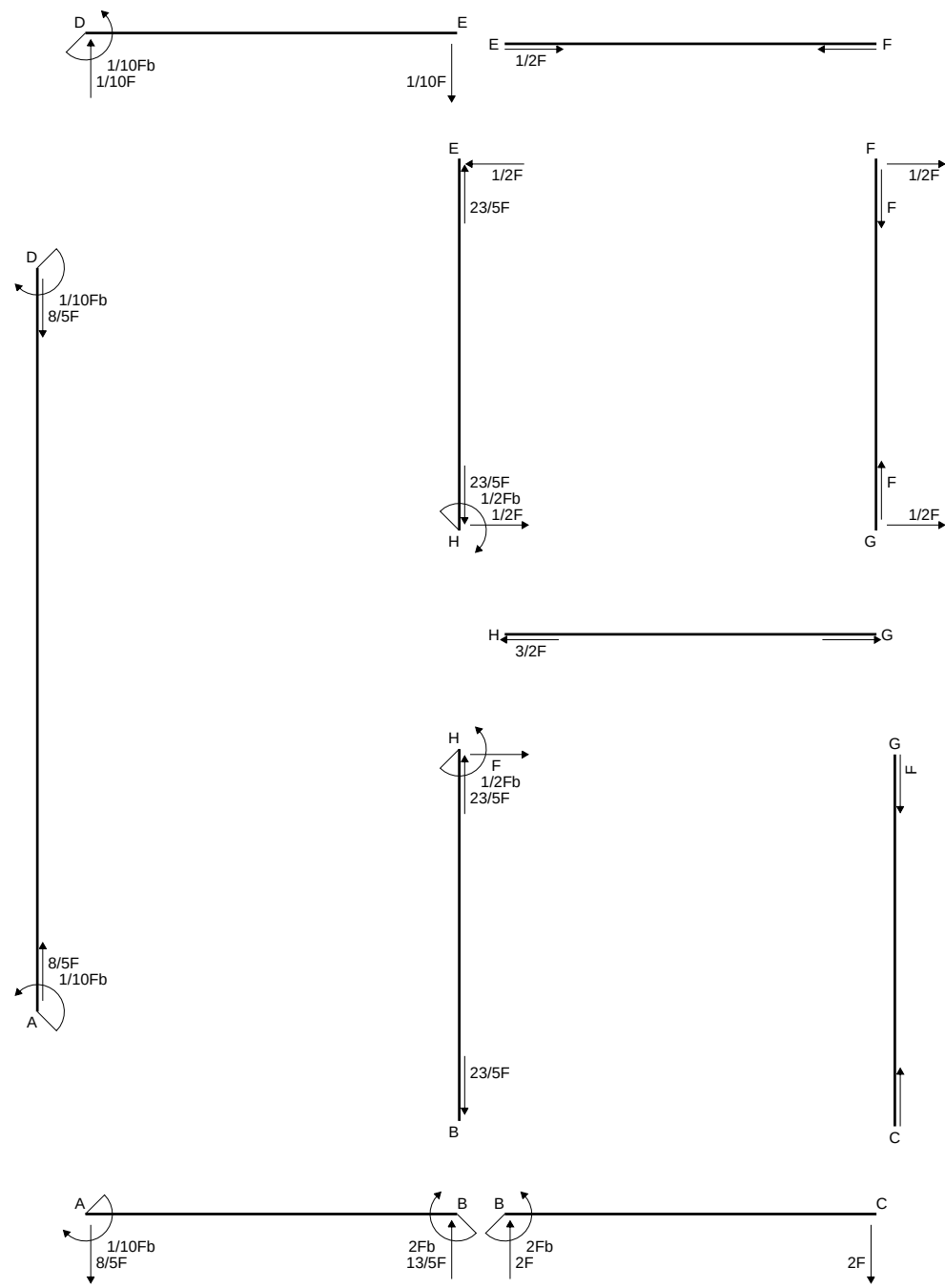
$$v_c = -25.05 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -169. \text{ N/mm}^2$$

$$\tau_c = 6.627 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 169.4 \text{ N/mm}^2$$

$$S = 3831. \text{ mm}^3$$



Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
EH b	0	$-1/2Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

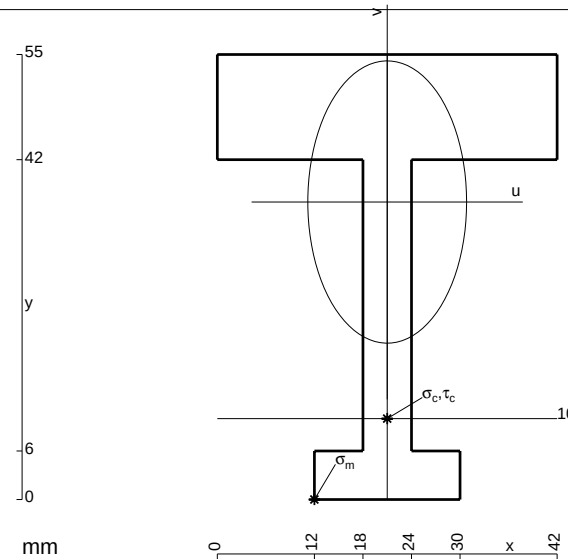
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 870. \text{ mm}^2$$

$$J_u = 264856. \text{ mm}^4$$

$$J_v = 83826. \text{ mm}^4$$

$$y_g = 36.77 \text{ mm}$$

$$T_y = 2460. \text{ N}$$

$$M_x = -1722000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -36.77 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -239.1 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 10. \text{ mm}$$

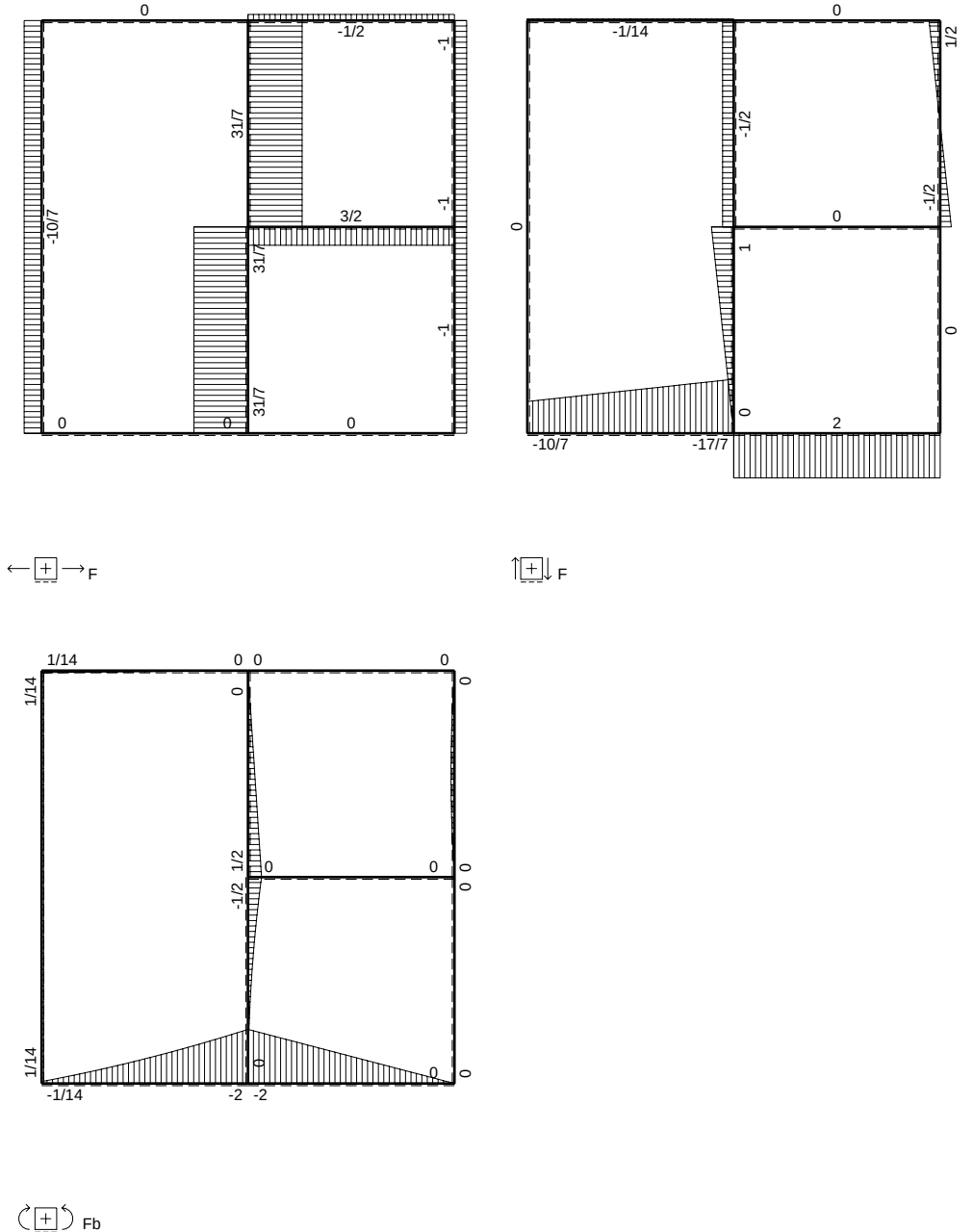
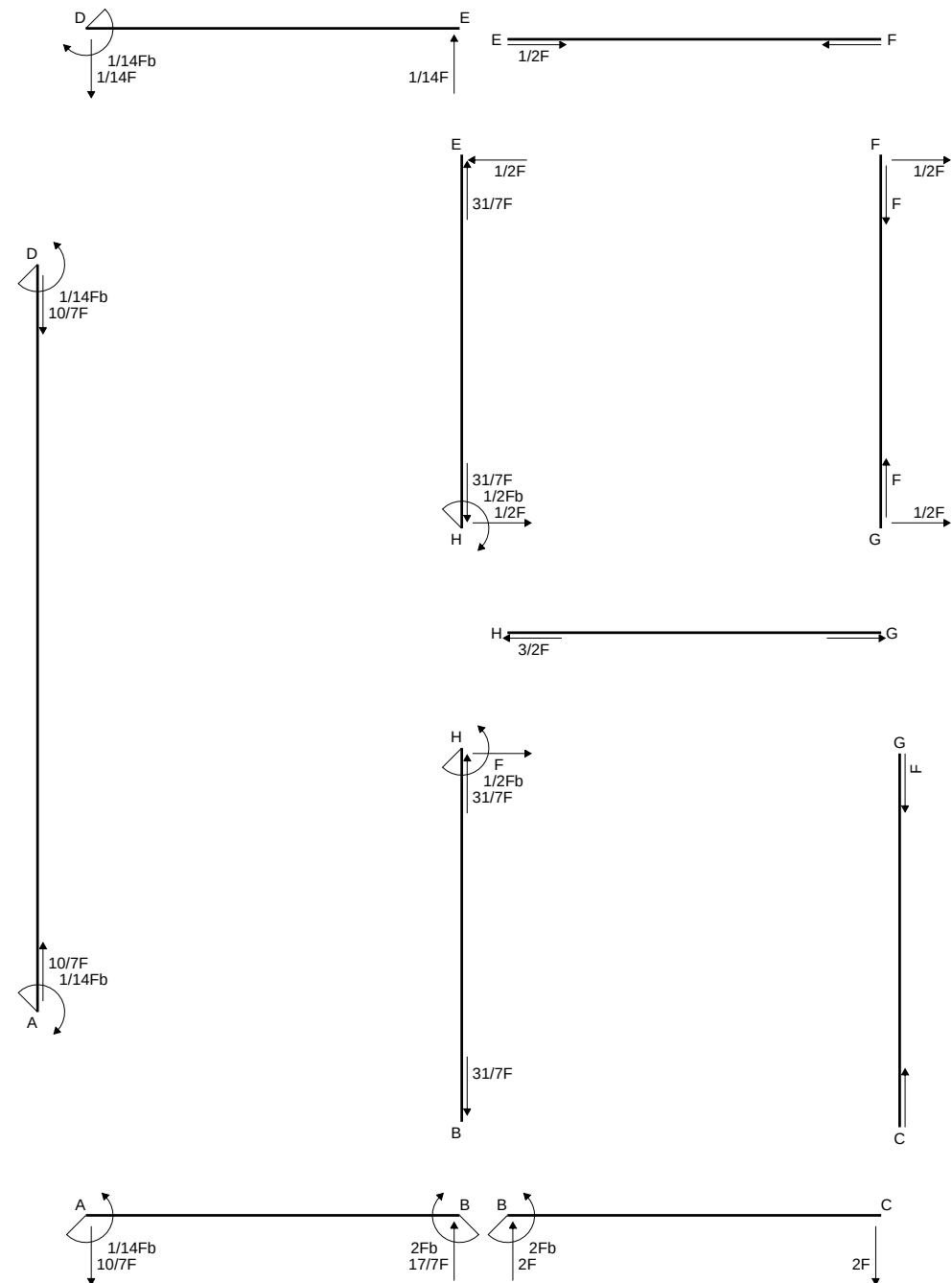
$$v_c = -26.77 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -174. \text{ N/mm}^2$$

$$\tau_c = 6.715 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 174.4 \text{ N/mm}^2$$

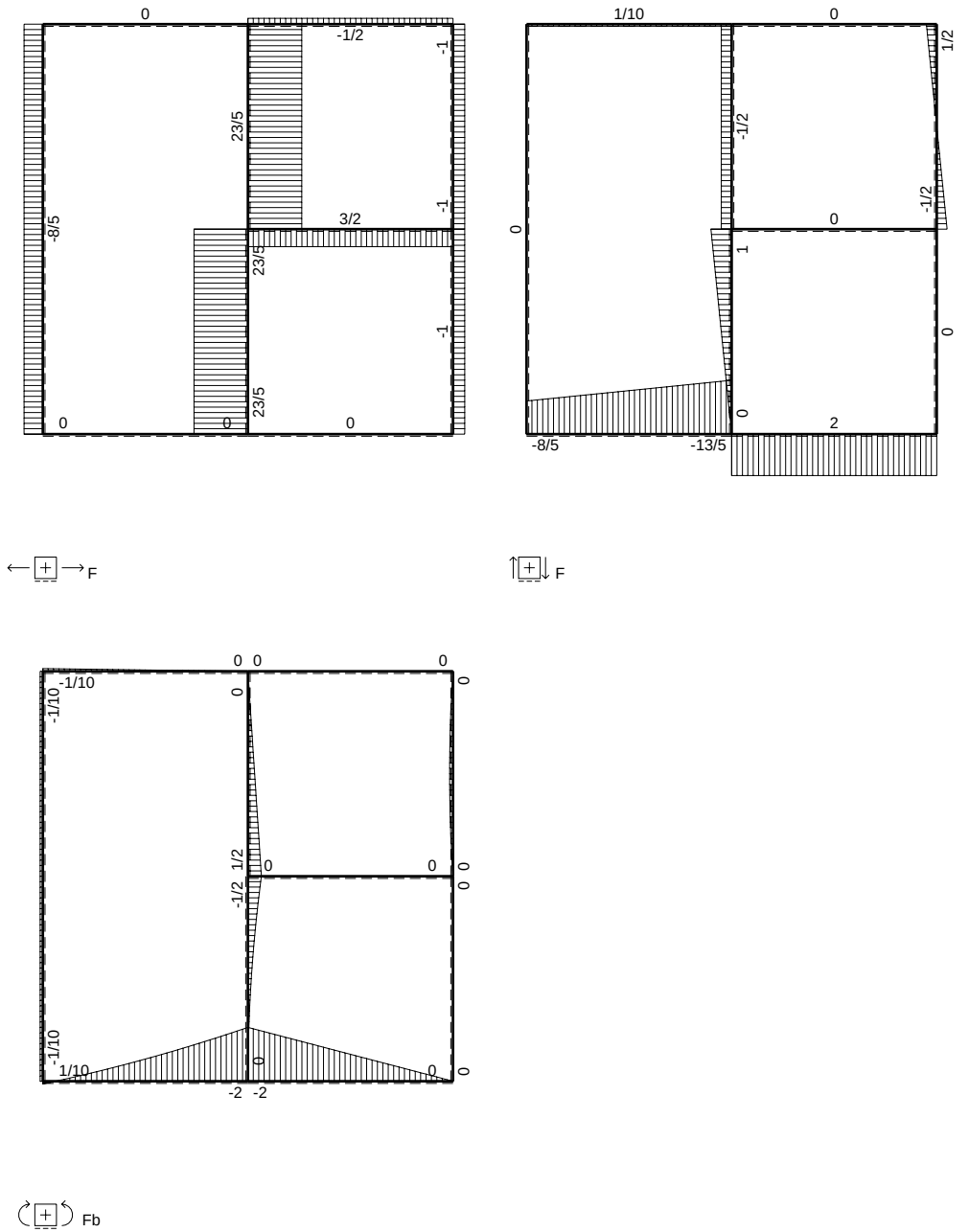
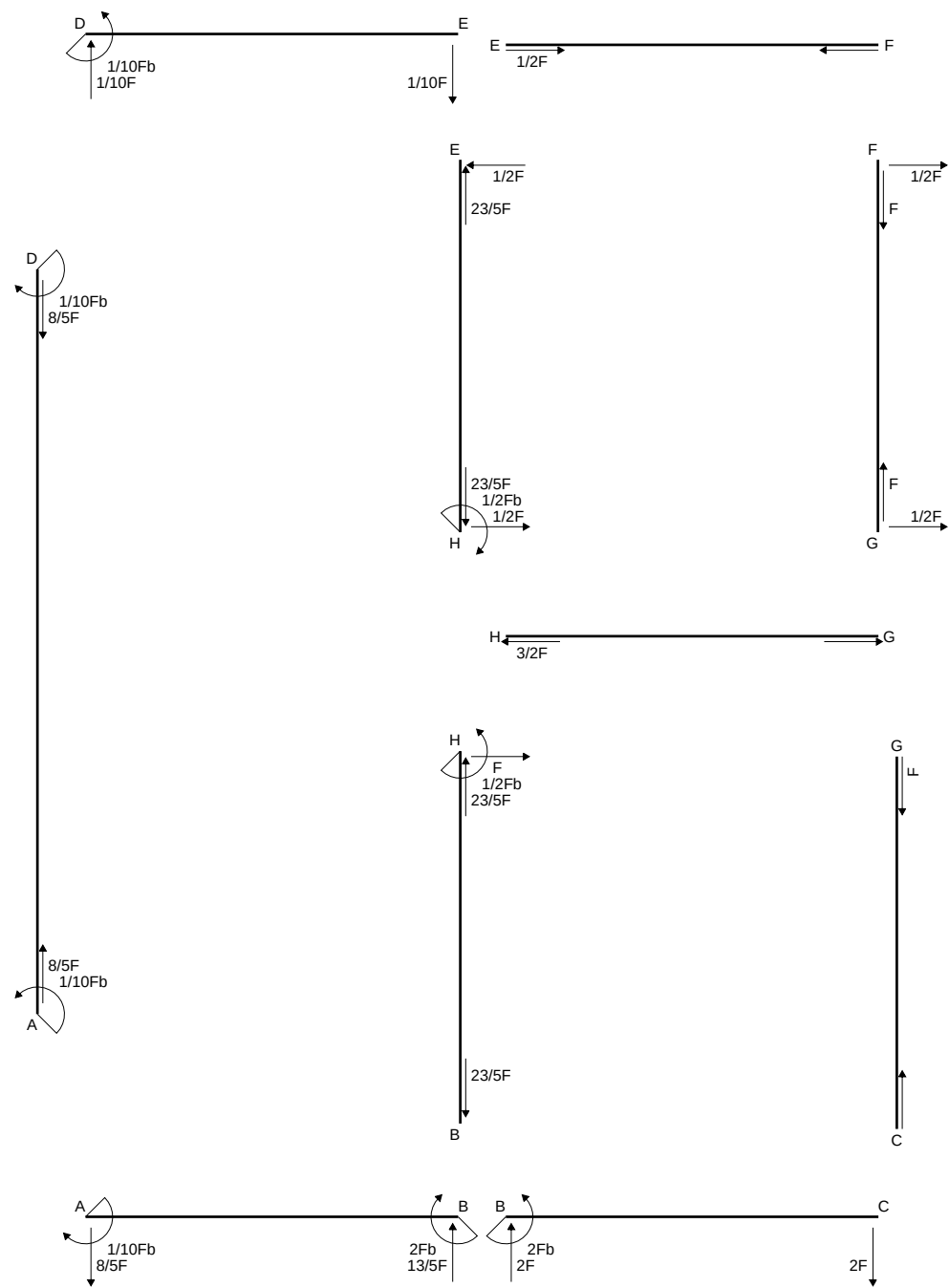
$$S = 4338. \text{ mm}^3$$



Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	$-Fb/EJ$	0	$-Fb/EJ+Fx/EJ$	$1-2x/b+x^2/b^2$	$(0-1/2)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	0	Fb/EJ	0	$-Fx/EJ$	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
EH b	0	$-1/2Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/14Fb$	

Sviluppi di calcolo iperstatica



Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$1/2qx^2$	Fb/EJ	0	0	0		
HE b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
EH b	0	$-1/2Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

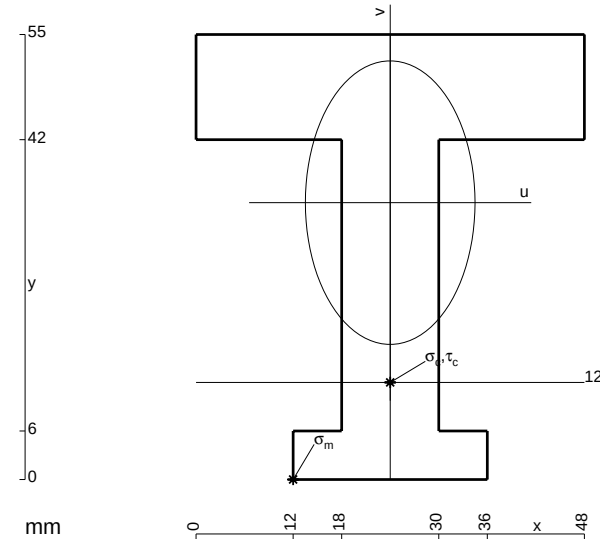
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 1200. \text{ mm}^2$$

$$J_u = 368598. \text{ mm}^4$$

$$J_v = 131904. \text{ mm}^4$$

$$y_g = 34.22 \text{ mm}$$

$$T_y = 2820. \text{ N}$$

$$M_x = -2256000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -34.22 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -209.4 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 12. \text{ mm}$$

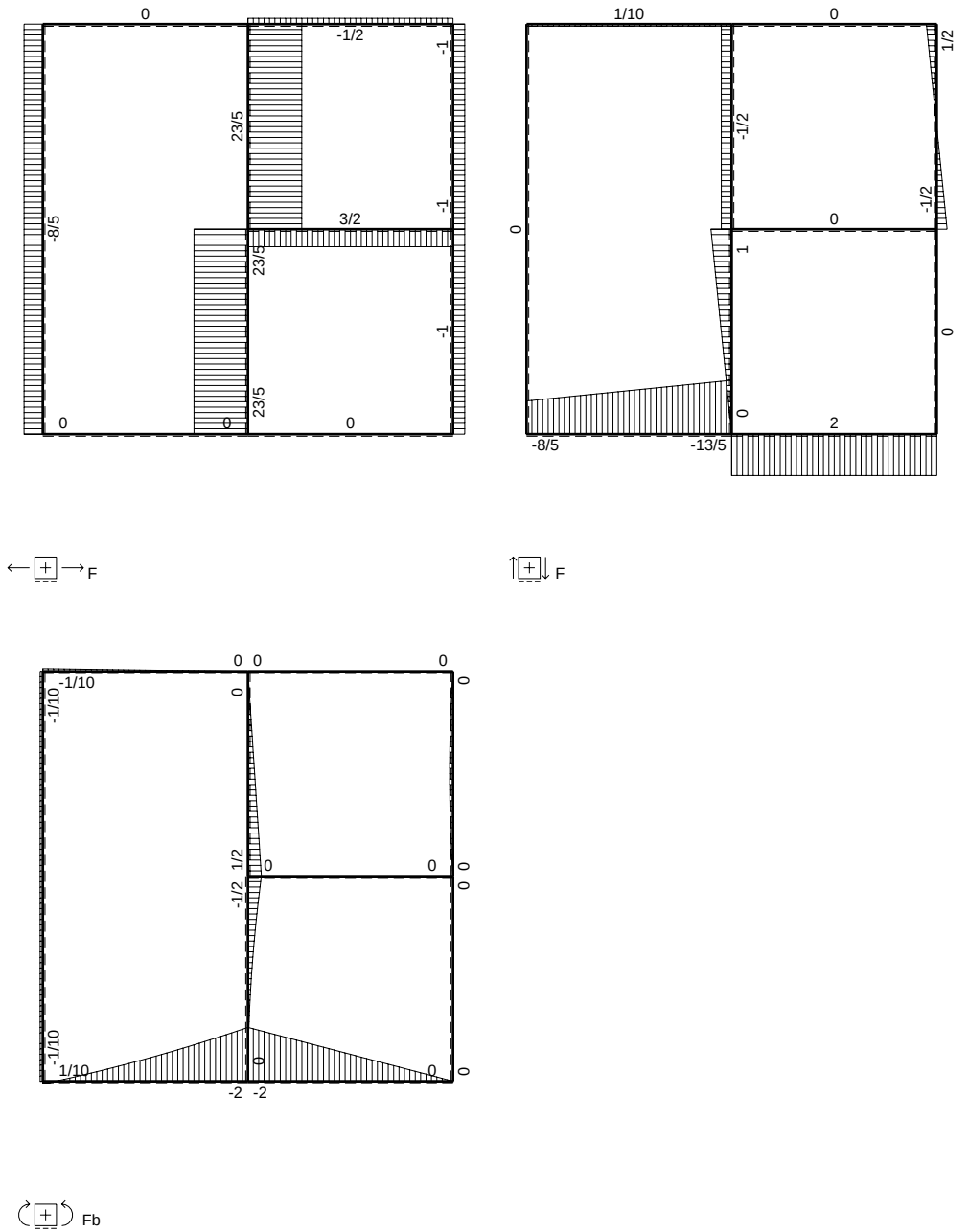
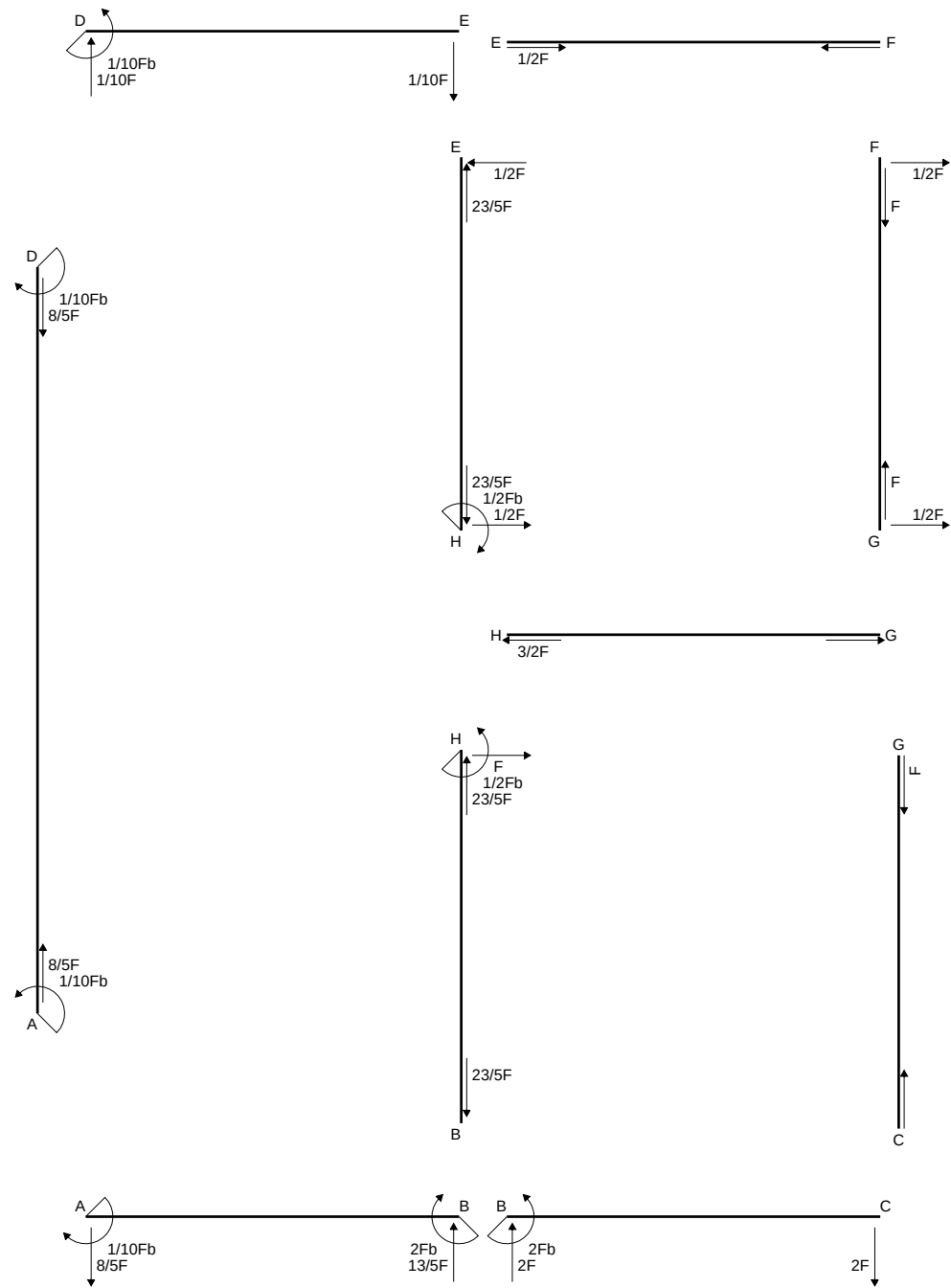
$$v_c = -22.22 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -136. \text{ N/mm}^2$$

$$\tau_c = 4.024 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 136.2 \text{ N/mm}^2$$

$$S = 6312. \text{ mm}^3$$



Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
EH b	0	$-1/2Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

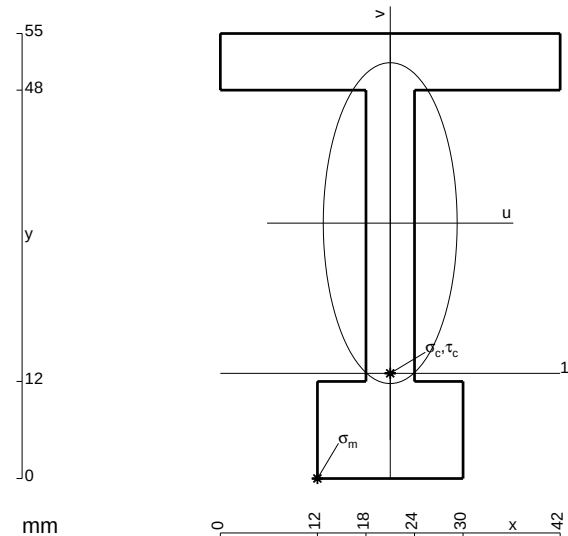
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 726. \text{ mm}^2$$

$$J_u = 285657. \text{ mm}^4$$

$$J_v = 49698. \text{ mm}^4$$

$$y_g = 31.57 \text{ mm}$$

$$T_y = 2340. \text{ N}$$

$$M_x = -1989000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -31.57 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -219.8 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

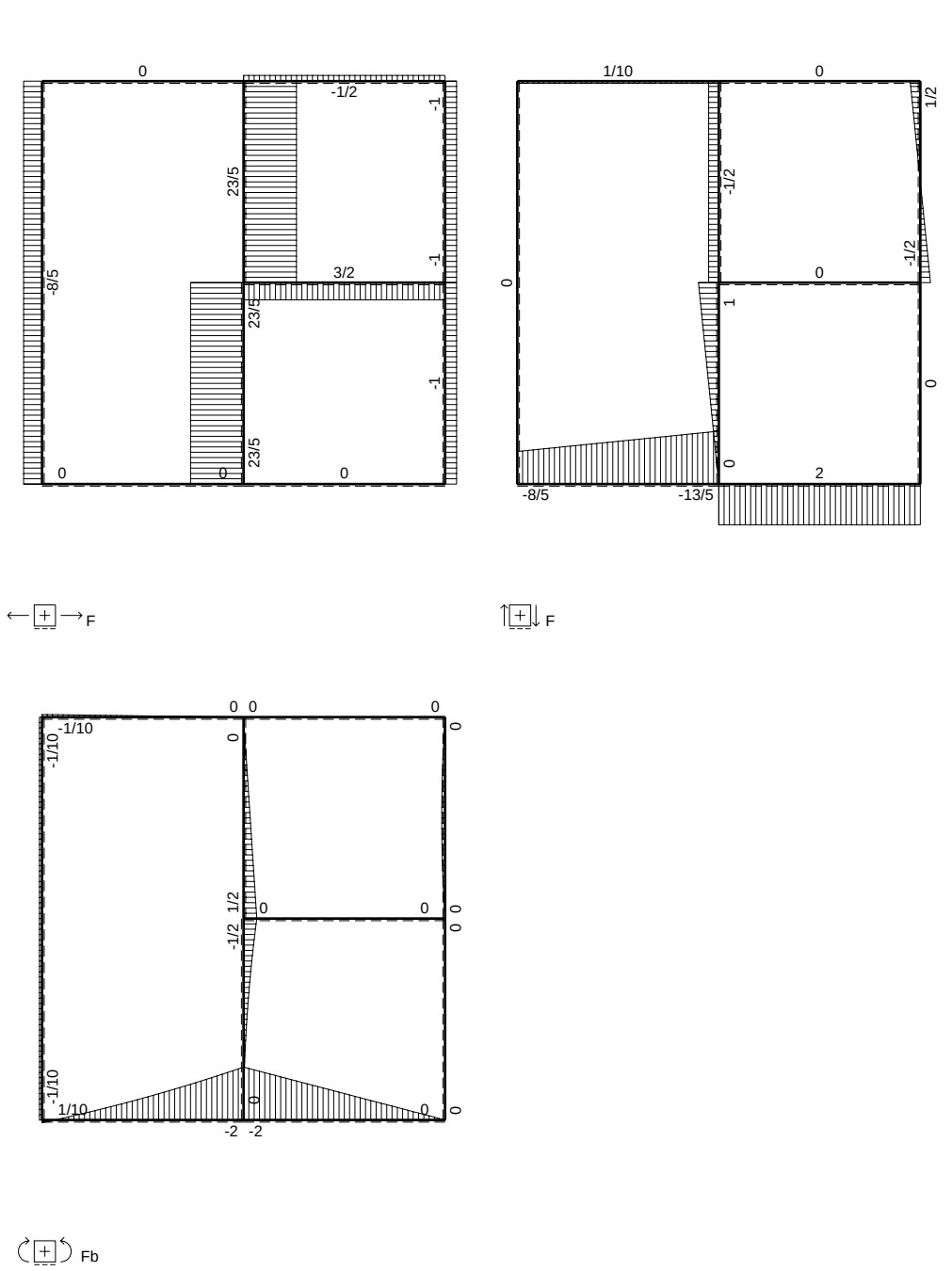
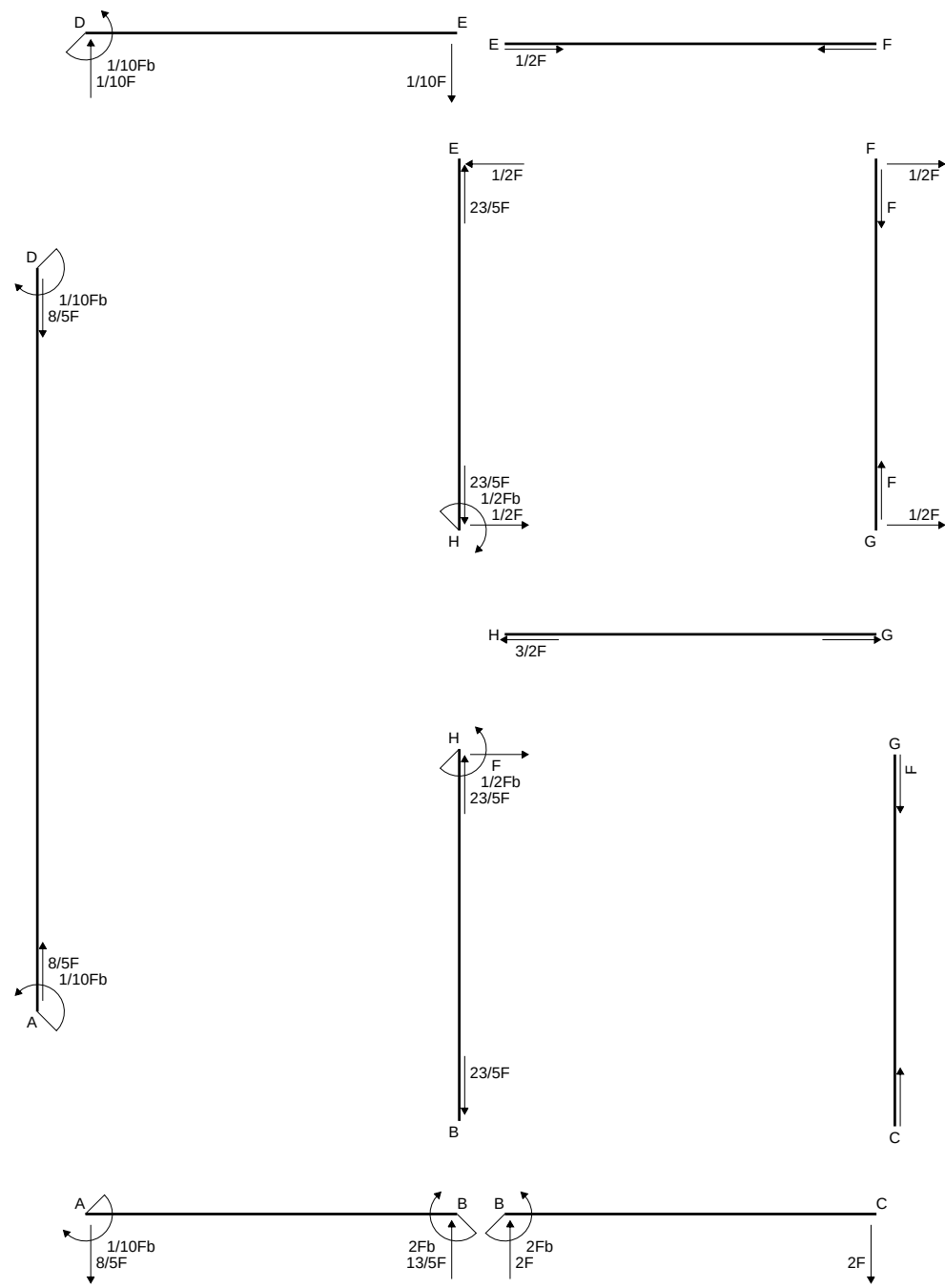
$$v_c = -18.57 \text{ mm}$$

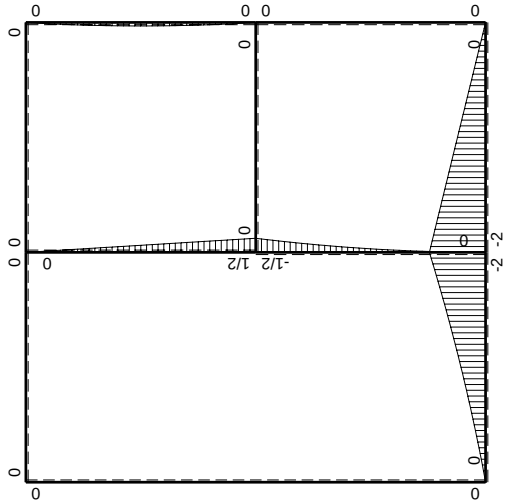
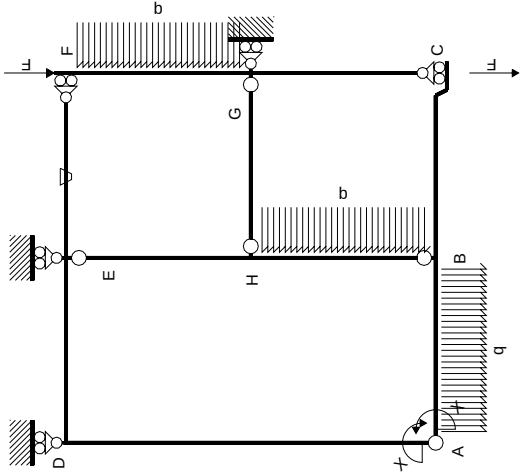
$$\sigma_c = -Mv/J_u = -129.3 \text{ N/mm}^2$$

$$\tau_c = 7.696 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 130. \text{ N/mm}^2$$

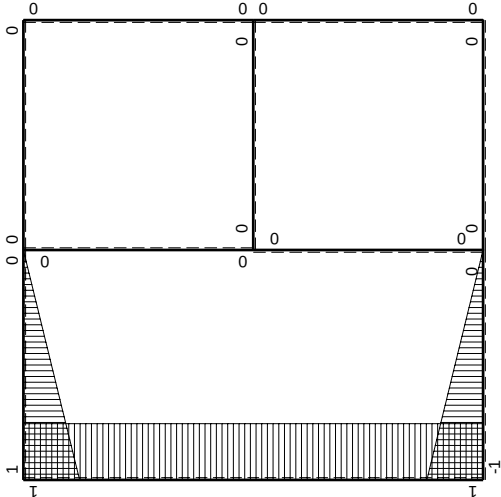
$$S = 5637. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
EH b	0	$-1/2Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

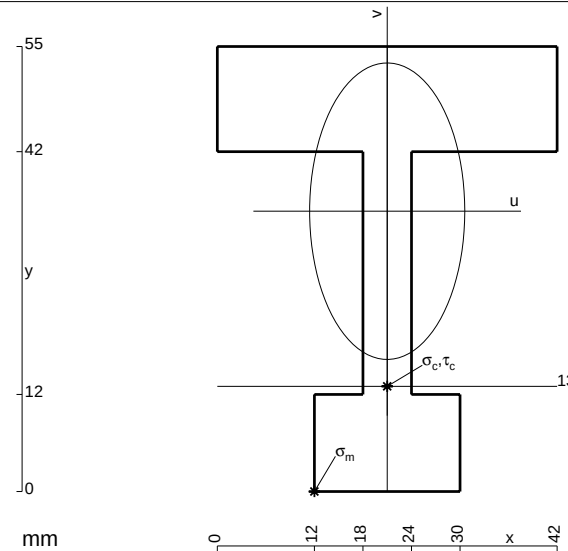
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 942. \text{ mm}^2$$

$$J_u = 316348. \text{ mm}^4$$

$$J_v = 86634. \text{ mm}^4$$

$$y_g = 34.65 \text{ mm}$$

$$T_y = 2320. \text{ N}$$

$$M_x = -2088000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -34.65 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -228.7 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

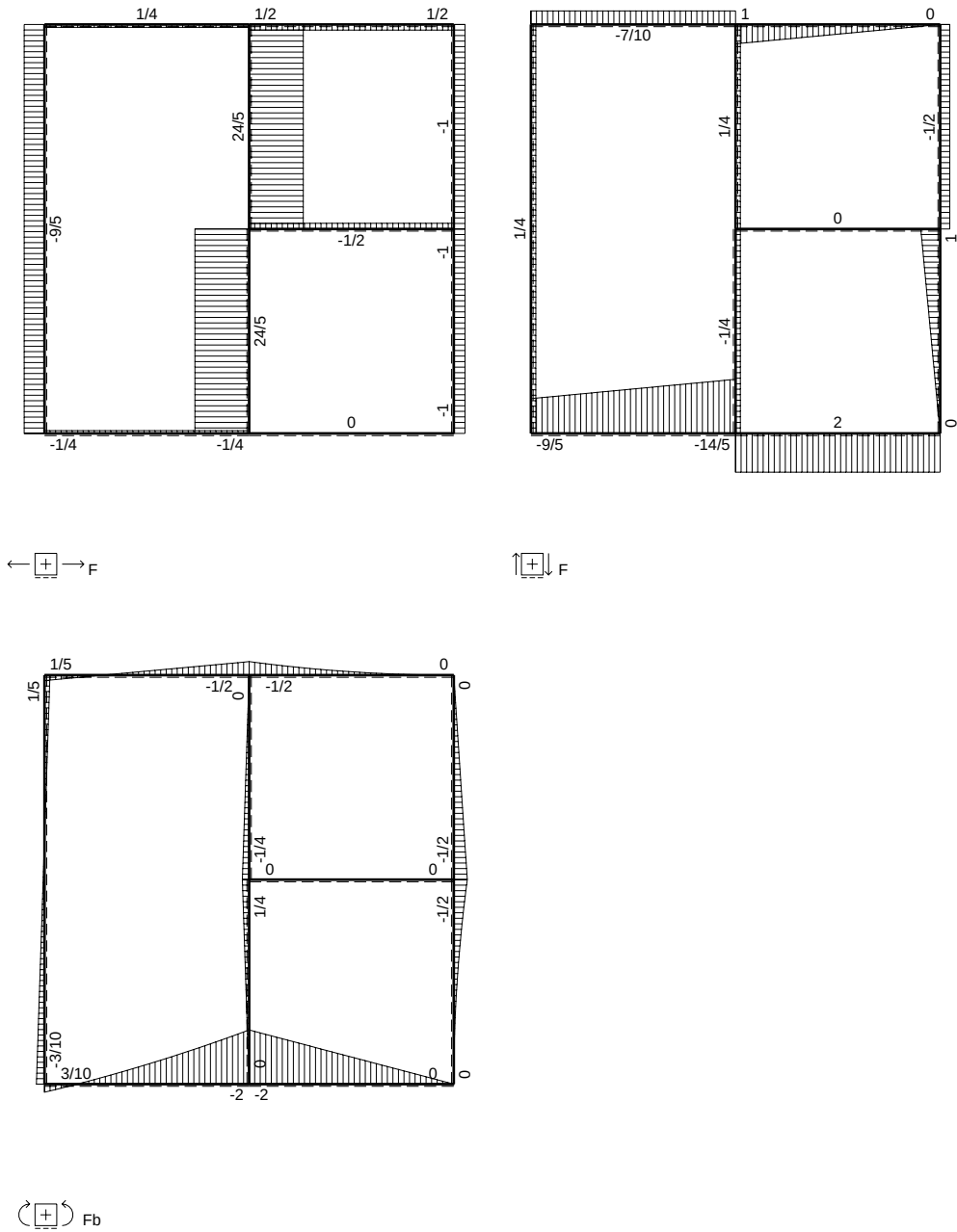
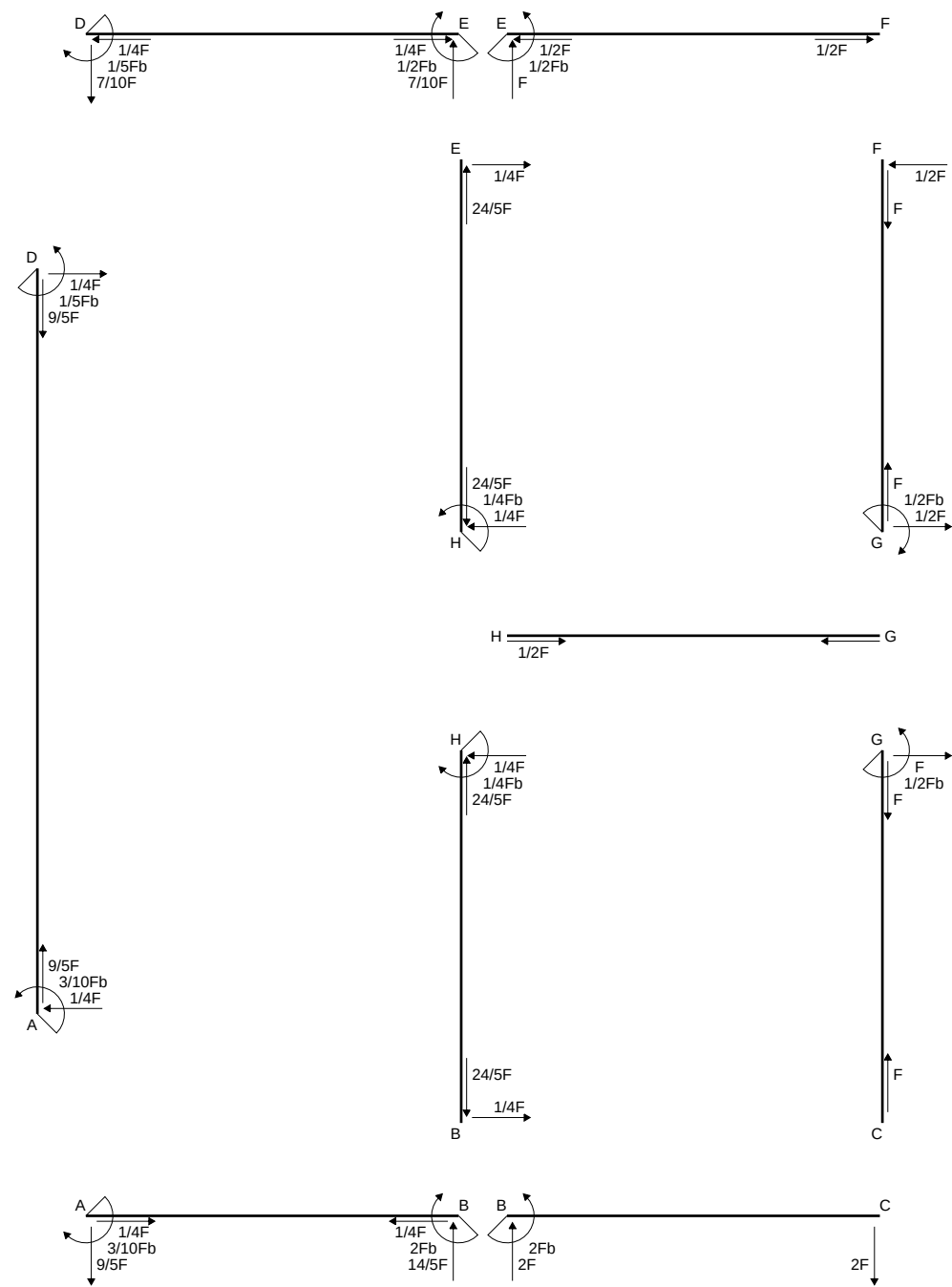
$$v_c = -21.65 \text{ mm}$$

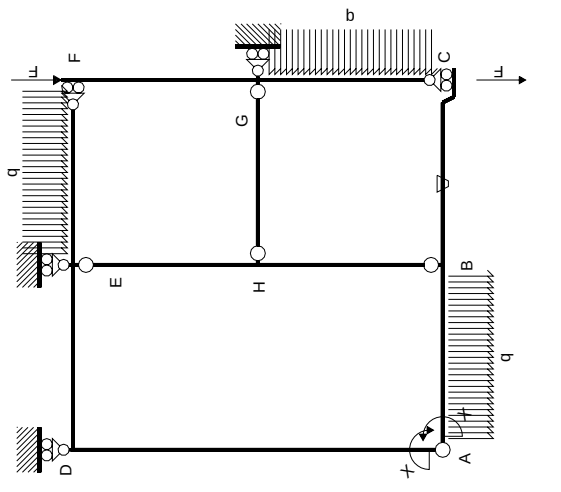
$$\sigma_c = -Mv/J_u = -142.9 \text{ N/mm}^2$$

$$\tau_c = 7.725 \text{ N/mm}^2$$

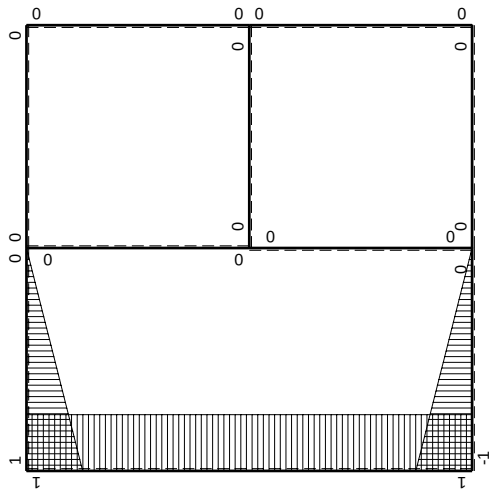
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 143.5 \text{ N/mm}^2$$

$$S = 6321. \text{ mm}^3$$

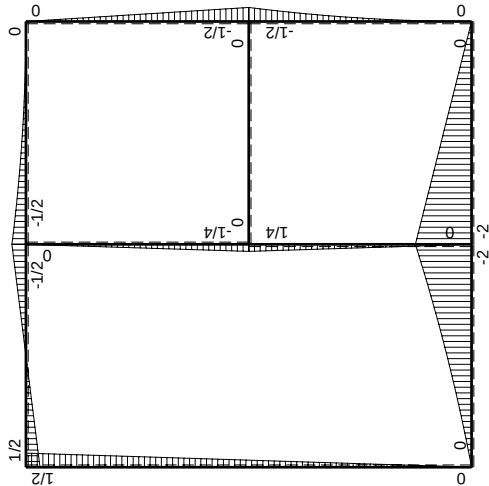




M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

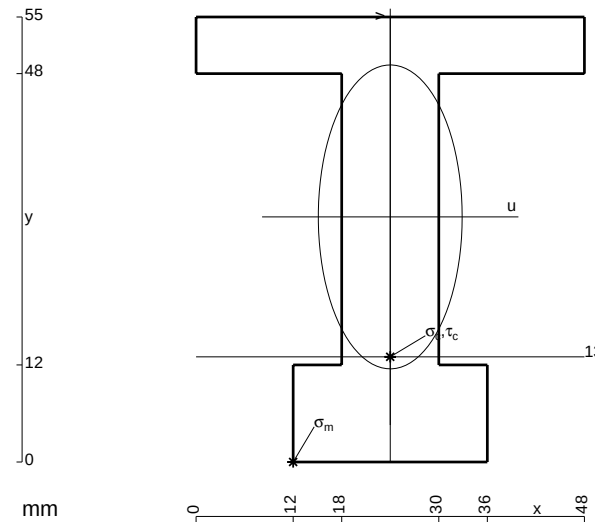


Quadro contributi PLV per iperstatica $X=W_{AB}$

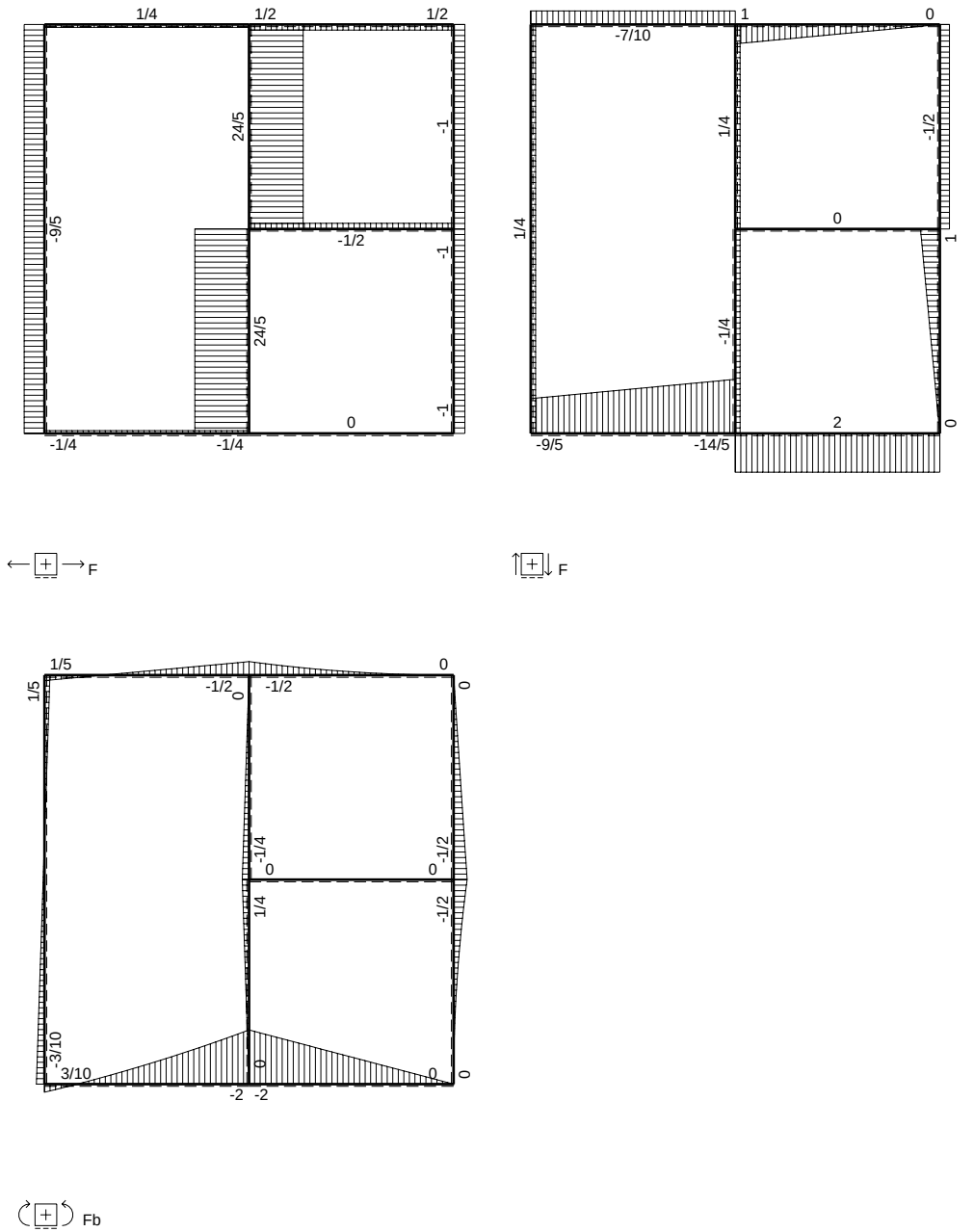
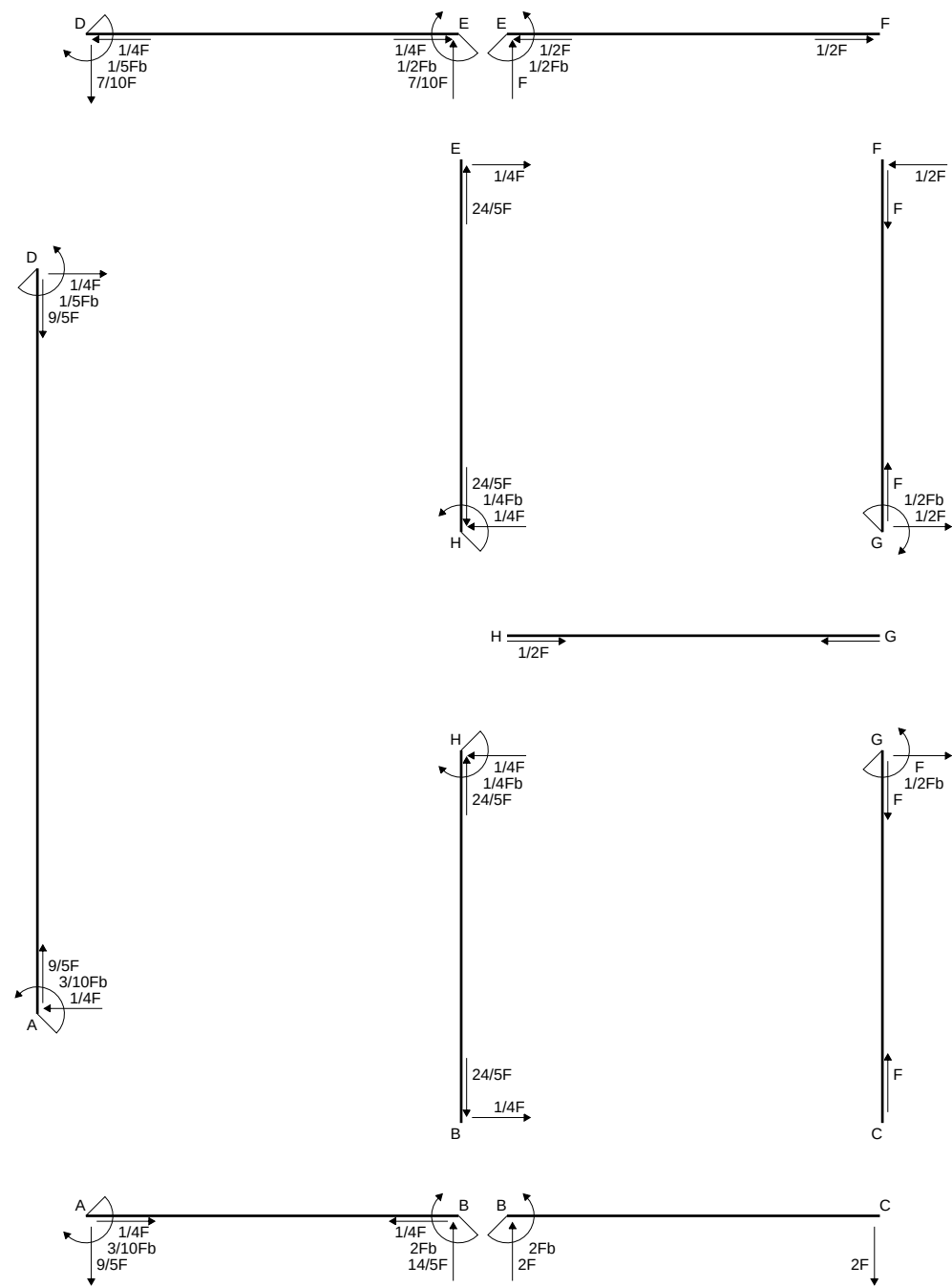
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

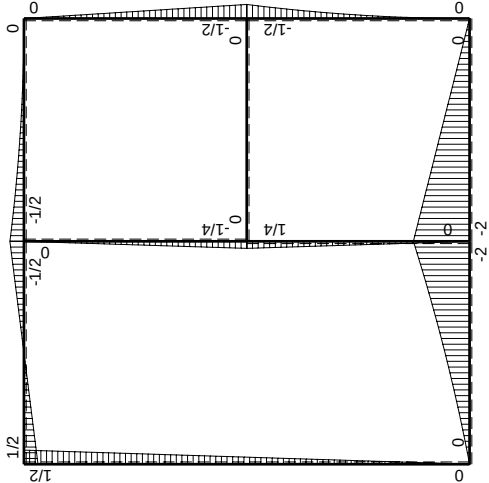
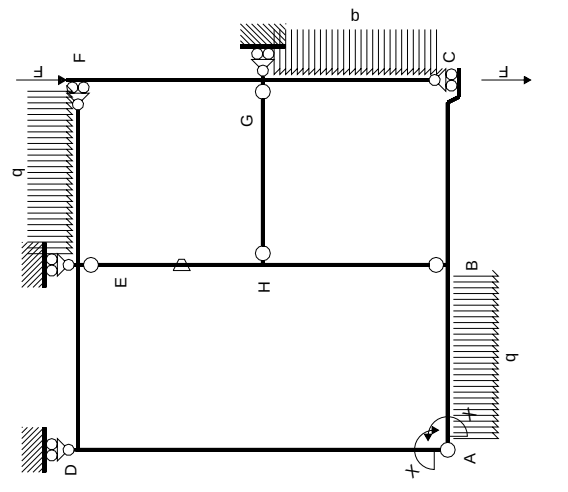
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$

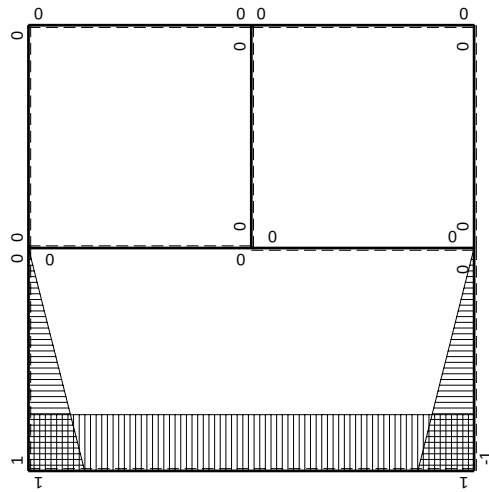


$$\begin{aligned}
A &= 1056. \text{ mm}^2 \\
J_u &= 372596. \text{ mm}^4 \\
J_v &= 83520. \text{ mm}^4 \\
y_g &= 30.3 \text{ mm} \\
T_y &= 3100. \text{ N} \\
M_x &= -2945000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -30.3 \text{ mm} \\
\sigma_m &= -Mv/J_u = -239.5 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -17.3 \text{ mm} \\
\sigma_c &= -Mv/J_u = -136.7 \text{ N/mm}^2 \\
\tau_c &= 4.999 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 137. \text{ N/mm}^2 \\
S &= 7211. \text{ mm}^3
\end{aligned}$$





M_0 flessione da carichi assegnati



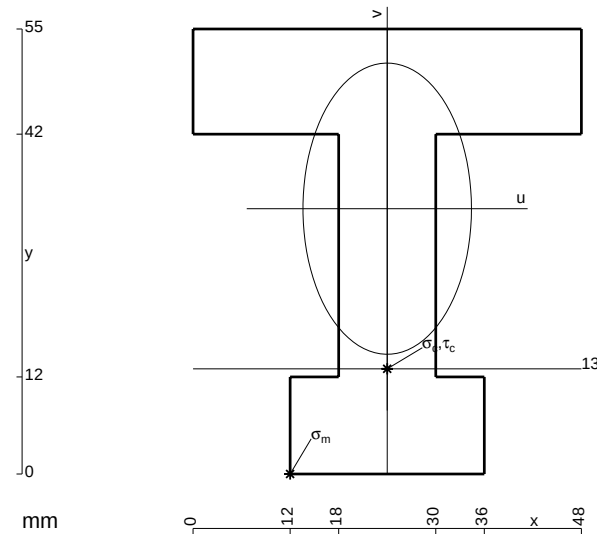
M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

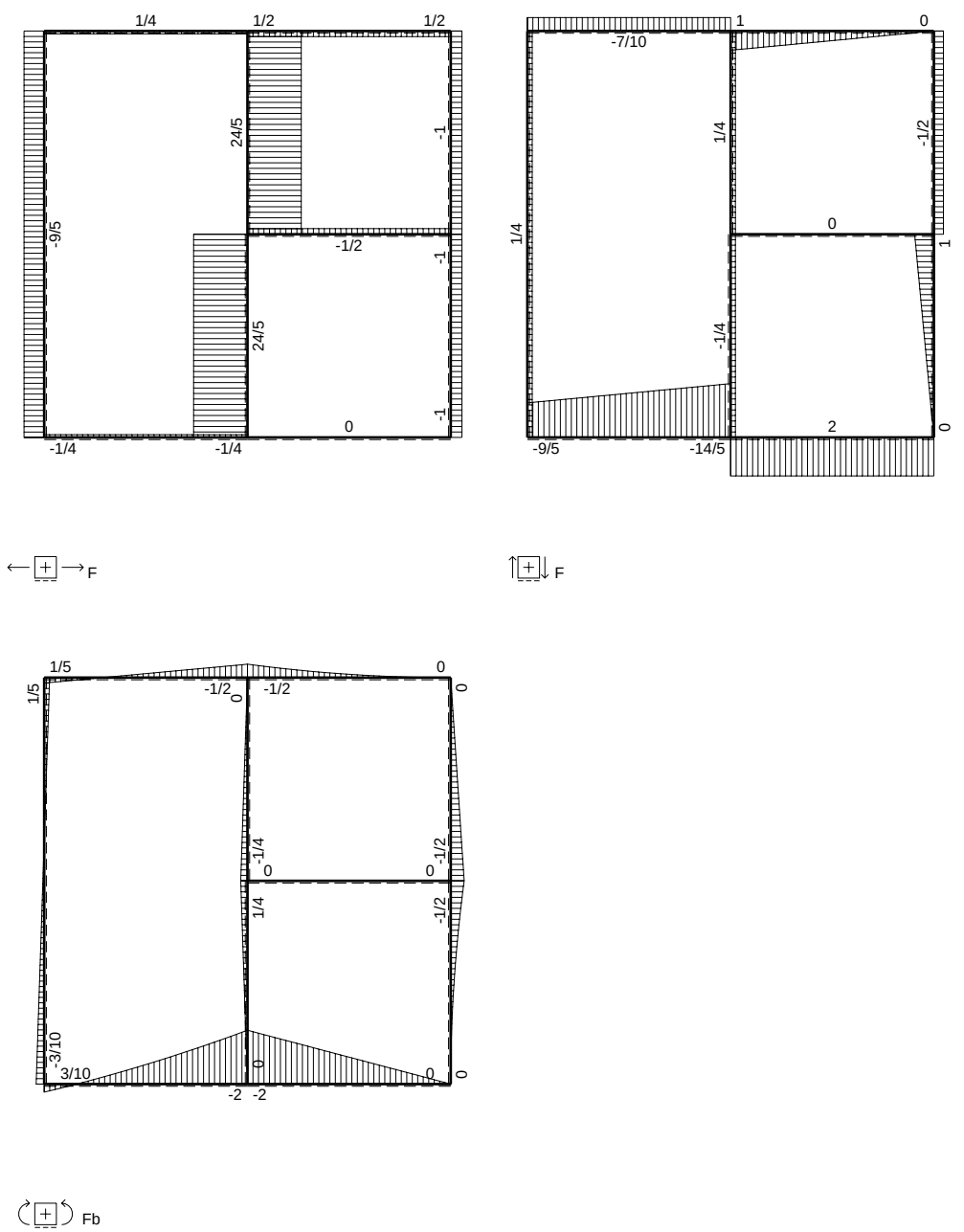
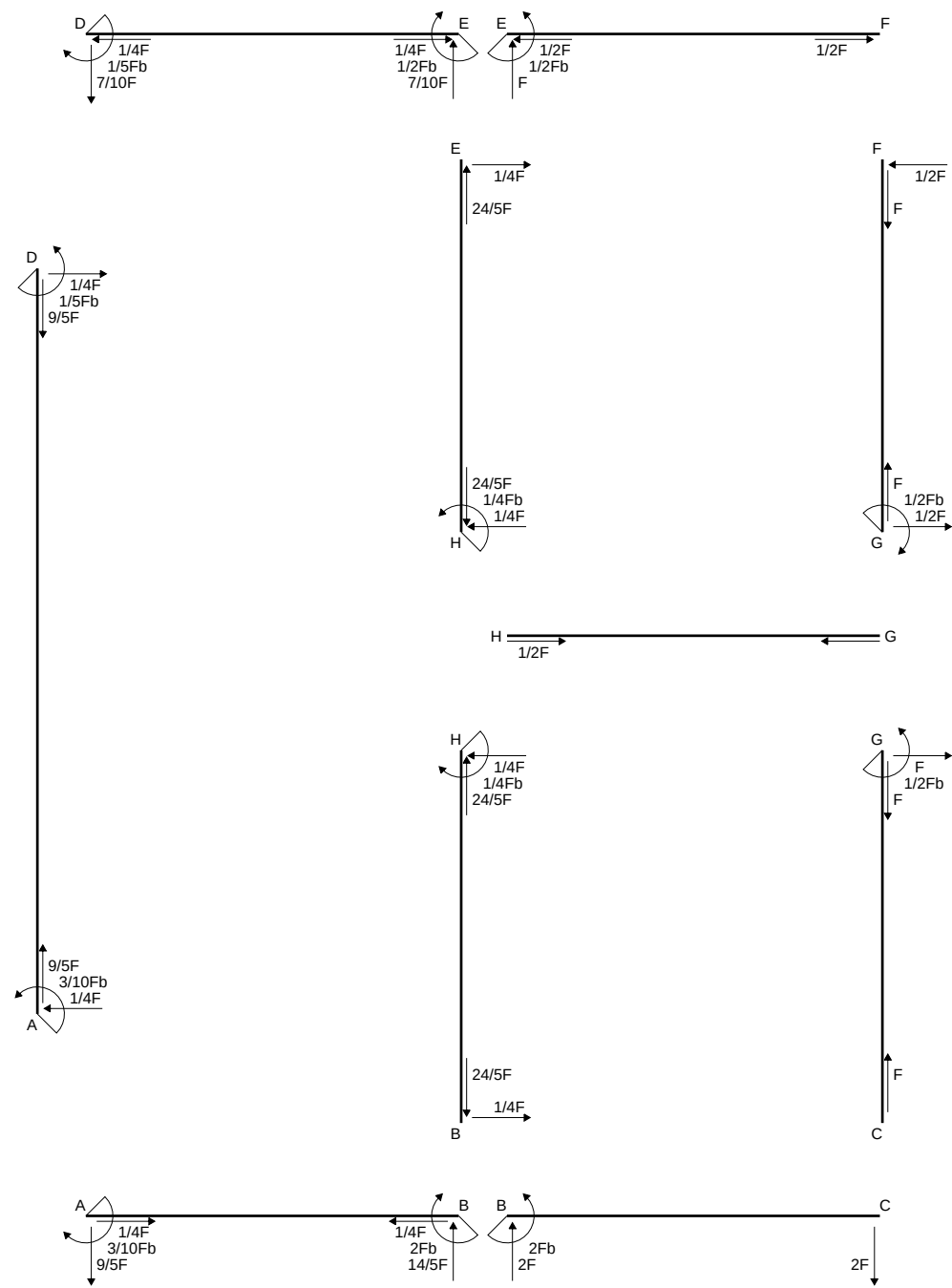
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$1/4Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 1272. \text{ mm}^2 \\
J_u &= 412017. \text{ mm}^4 \\
J_v &= 137952. \text{ mm}^4 \\
y_g &= 32.79 \text{ mm} \\
T_y &= 5020. \text{ N} \\
M_x &= -2510000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -32.79 \text{ mm} \\
\sigma_m &= -Mv/J_u = -199.8 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -19.79 \text{ mm} \\
\sigma_c &= -Mv/J_u = -120.6 \text{ N/mm}^2 \\
\tau_c &= 8.082 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 121.4 \text{ N/mm}^2 \\
S &= 7960. \text{ mm}^3
\end{aligned}$$

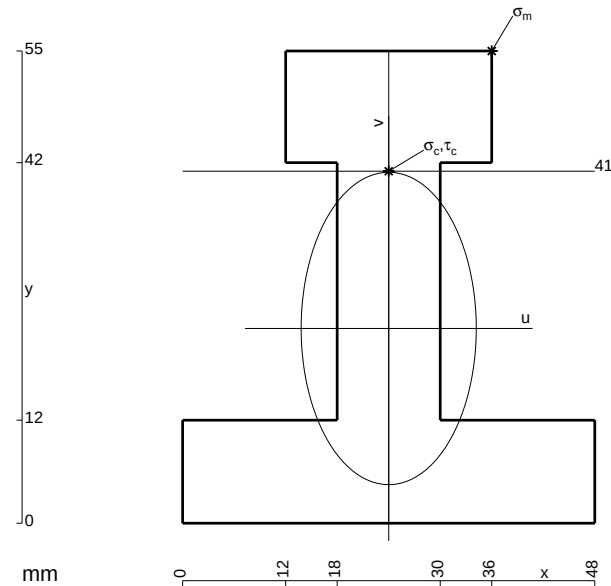


Quadro contributi PLV per iperstatica $X=W_{AB}$

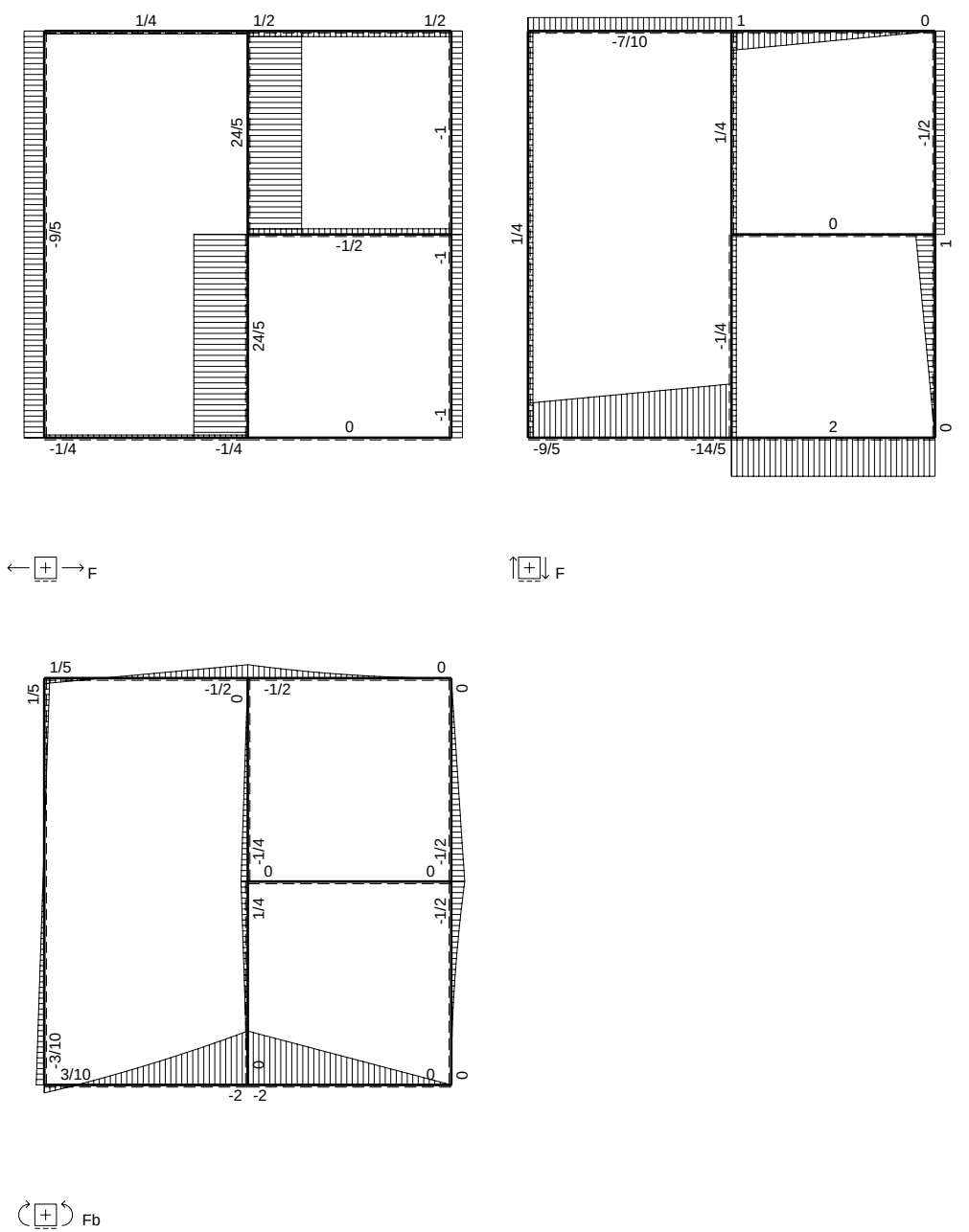
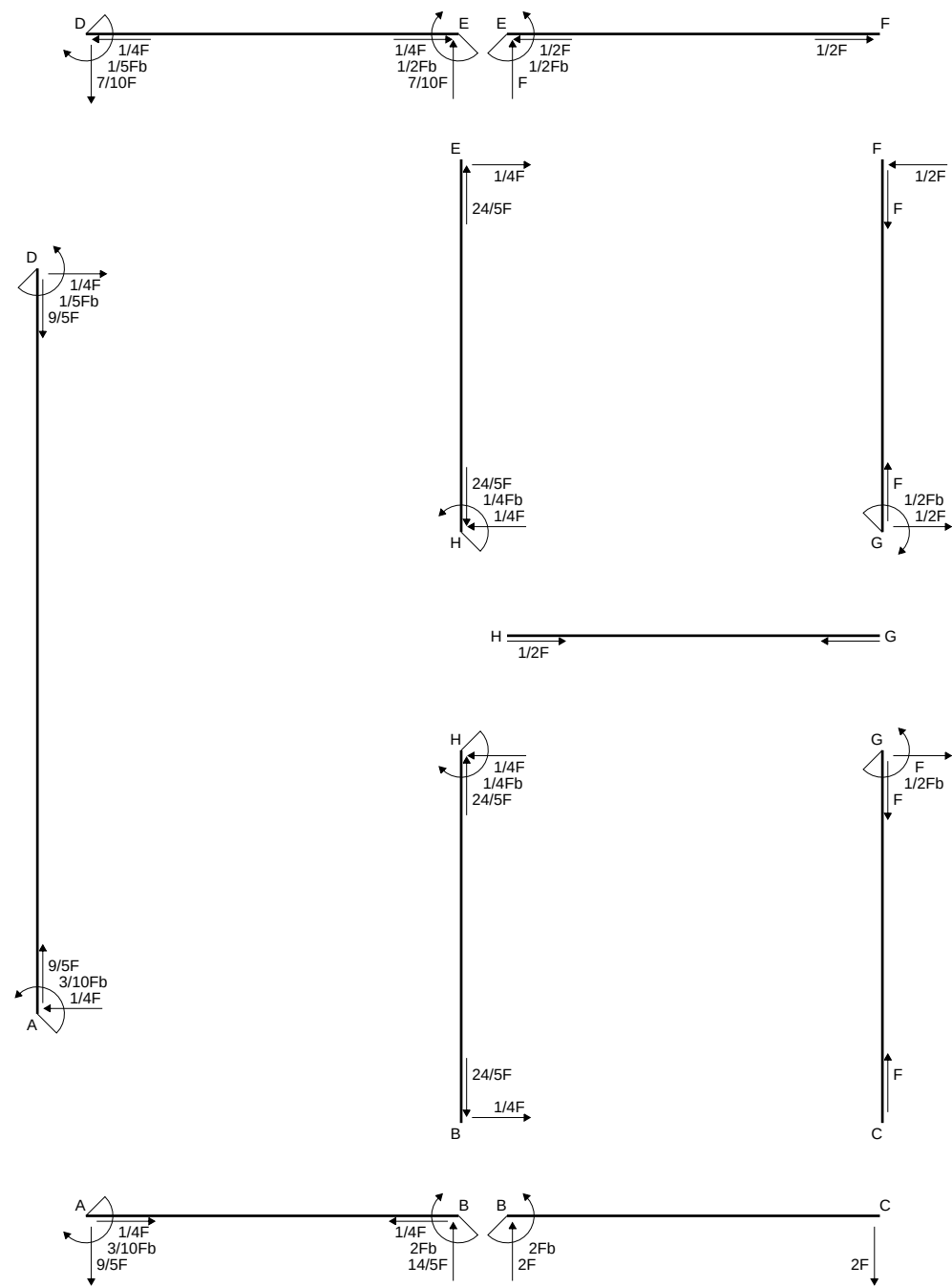
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 1248. \text{ mm}^2 \\
J_u &= 413282. \text{ mm}^4 \\
J_v &= 129888. \text{ mm}^4 \\
y_g &= 22.68 \text{ mm} \\
T_y &= 4880. \text{ N} \\
M_x &= -2684000. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 32.32 \text{ mm} \\
\sigma_m &= -Mv/J_u = 209.9 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 41. \text{ mm} \\
v_c &= 18.32 \text{ mm} \\
\sigma_c &= -Mv/J_u = 119. \text{ N/mm}^2 \\
\tau_c &= 8.148 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 119.8 \text{ N/mm}^2 \\
S &= 8281. \text{ mm}^3
\end{aligned}$$

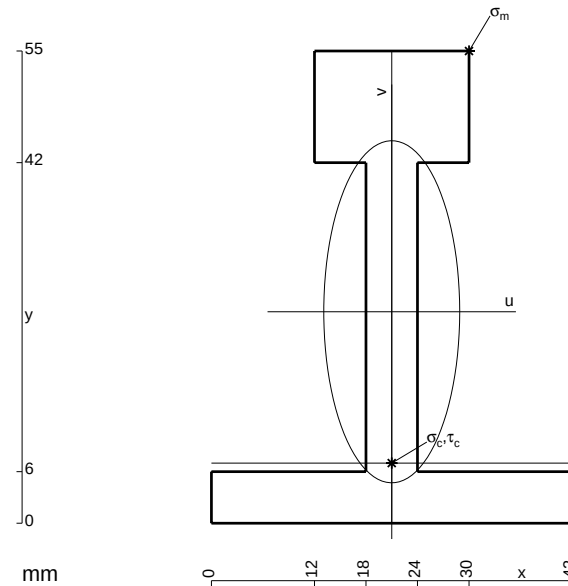


Quadro contributi PLV per iperstatica $X=W_{AB}$

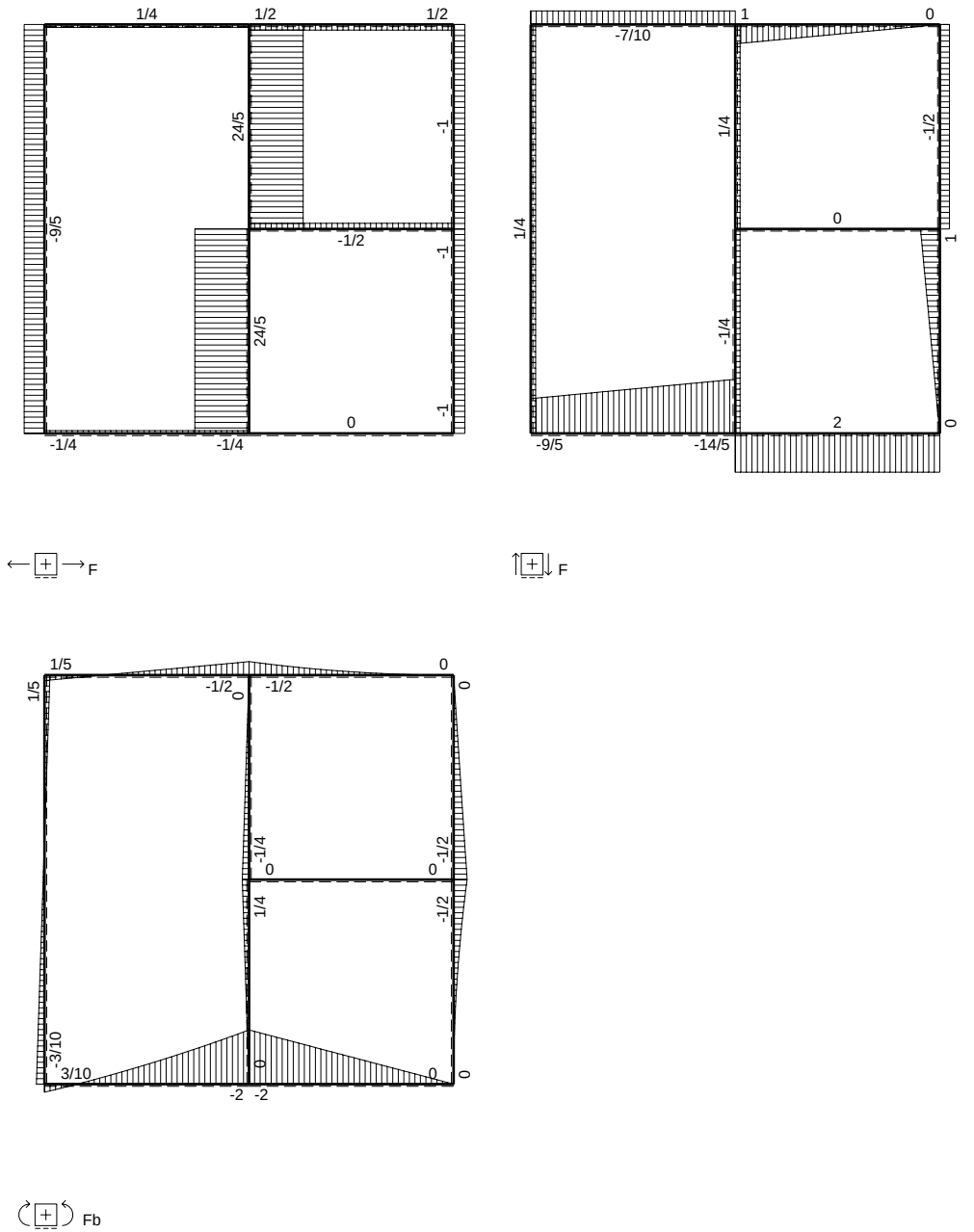
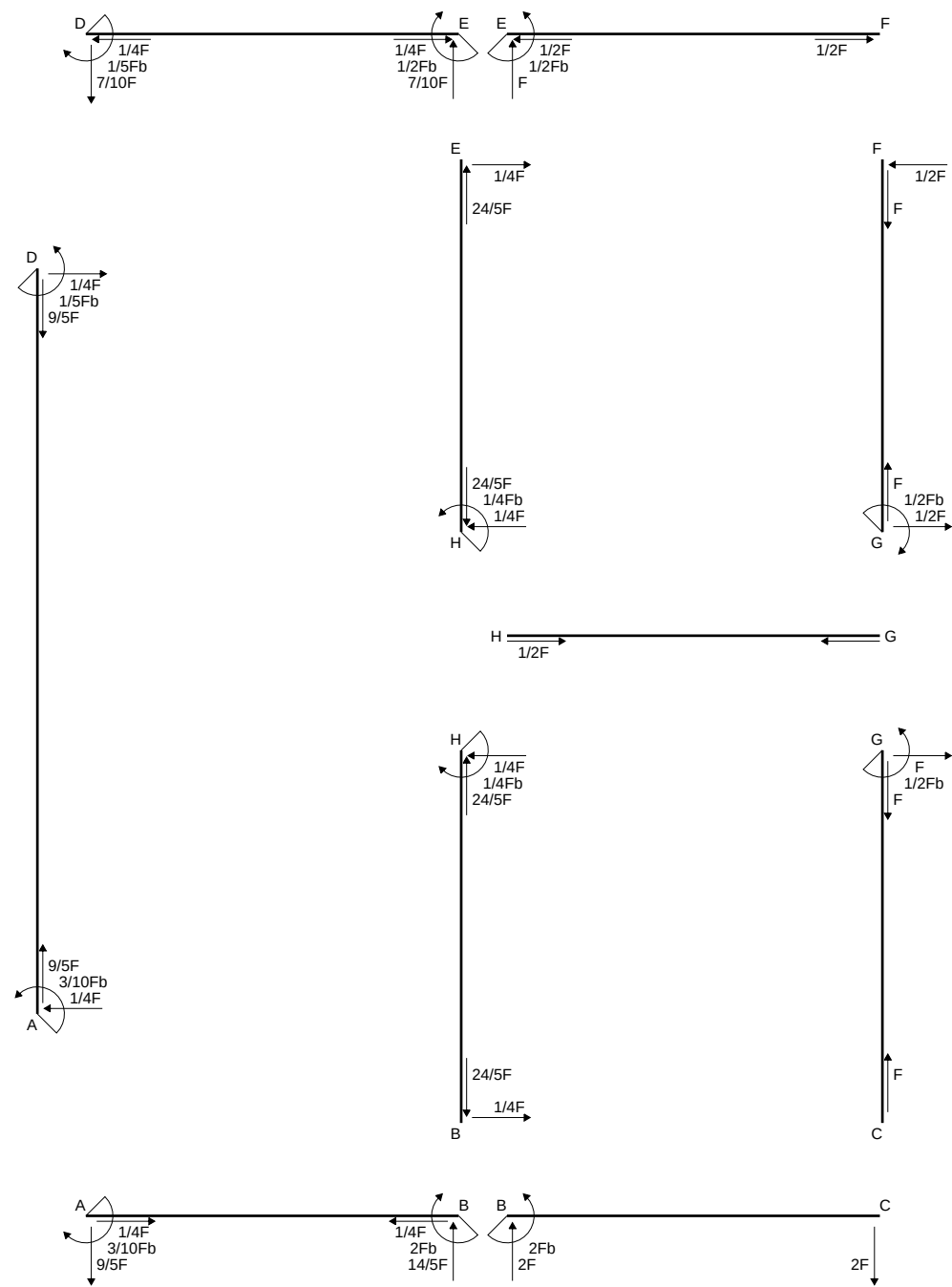
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	$-1/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	Fb/EJ	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

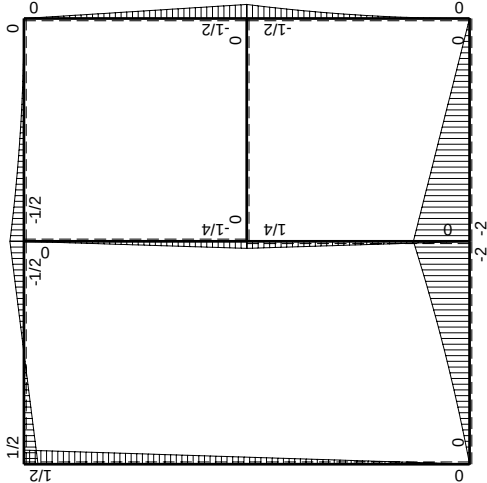
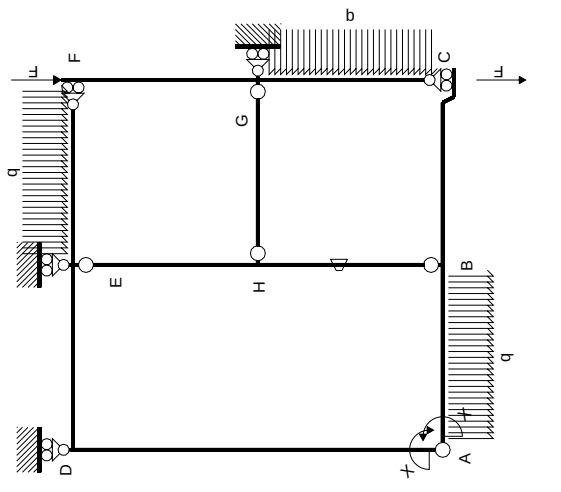
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$

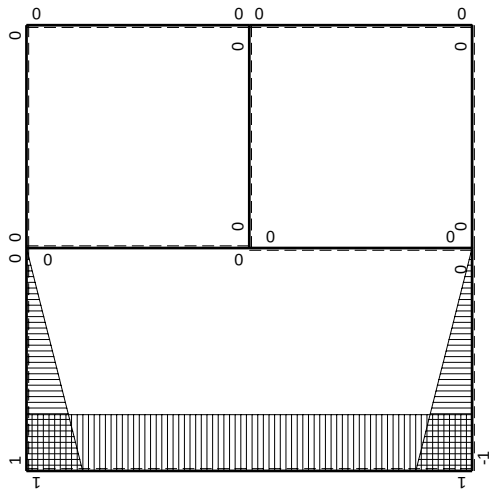


$$\begin{aligned}
A &= 702. \text{ mm}^2 \\
J_u &= 278693. \text{ mm}^4 \\
J_v &= 44010. \text{ mm}^4 \\
y_g &= 24.63 \text{ mm} \\
T_y &= 3360. \text{ N} \\
M_x &= -2016000. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 30.37 \text{ mm} \\
\sigma_m &= -Mv/J_u = 219.7 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 7. \text{ mm} \\
v_c &= -17.63 \text{ mm} \\
\sigma_c &= -Mv/J_u = -127.5 \text{ N/mm}^2 \\
\tau_c &= 11.17 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 129. \text{ N/mm}^2 \\
S &= 5559. \text{ mm}^3
\end{aligned}$$





M_0 flessione da carichi assegnati



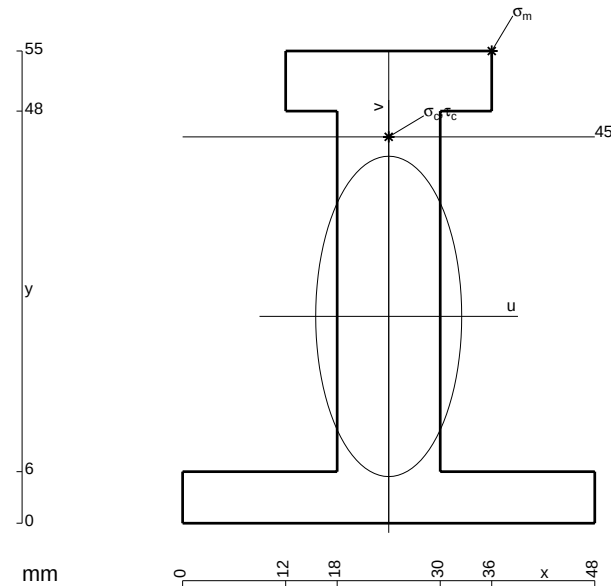
M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

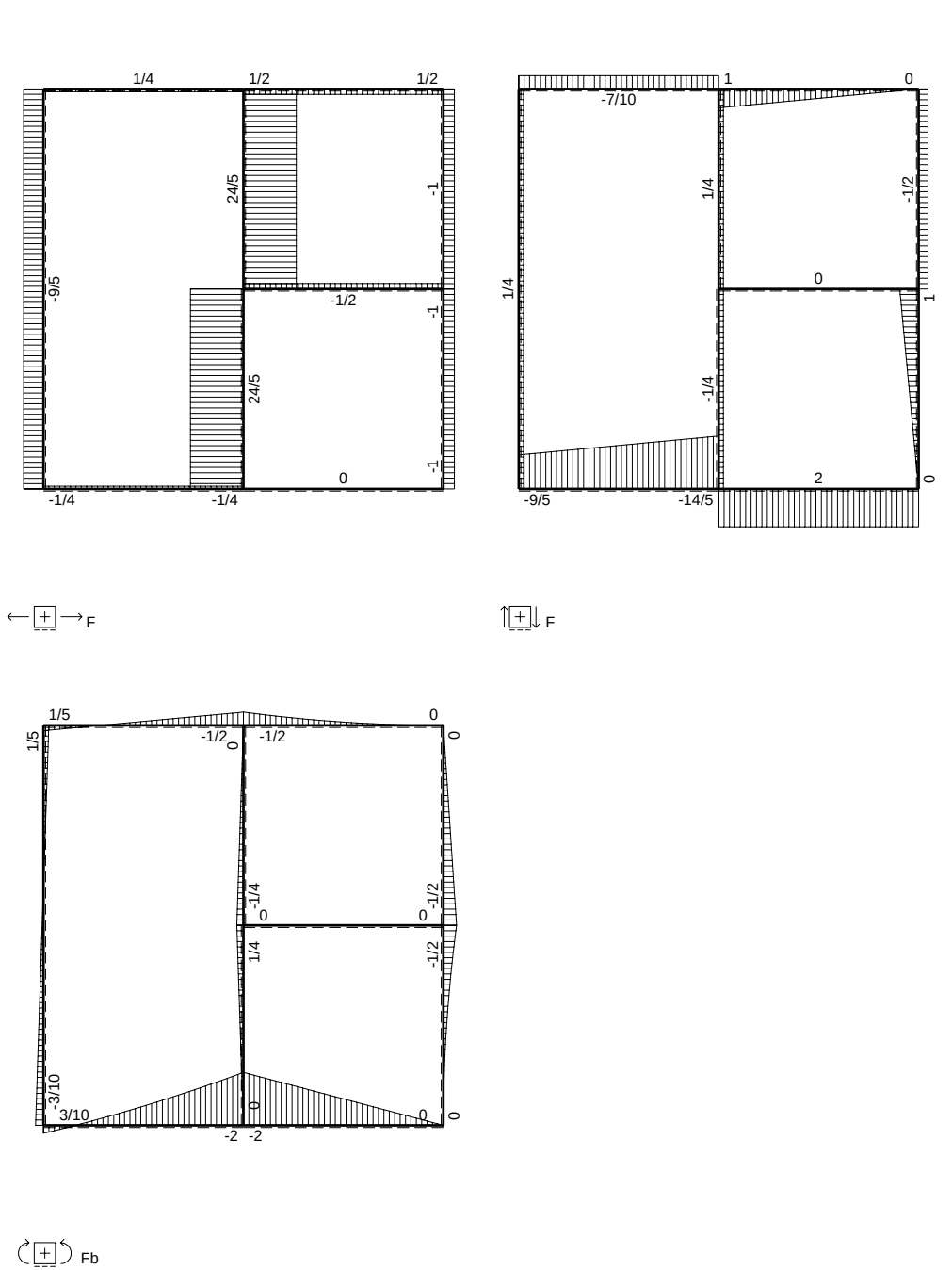
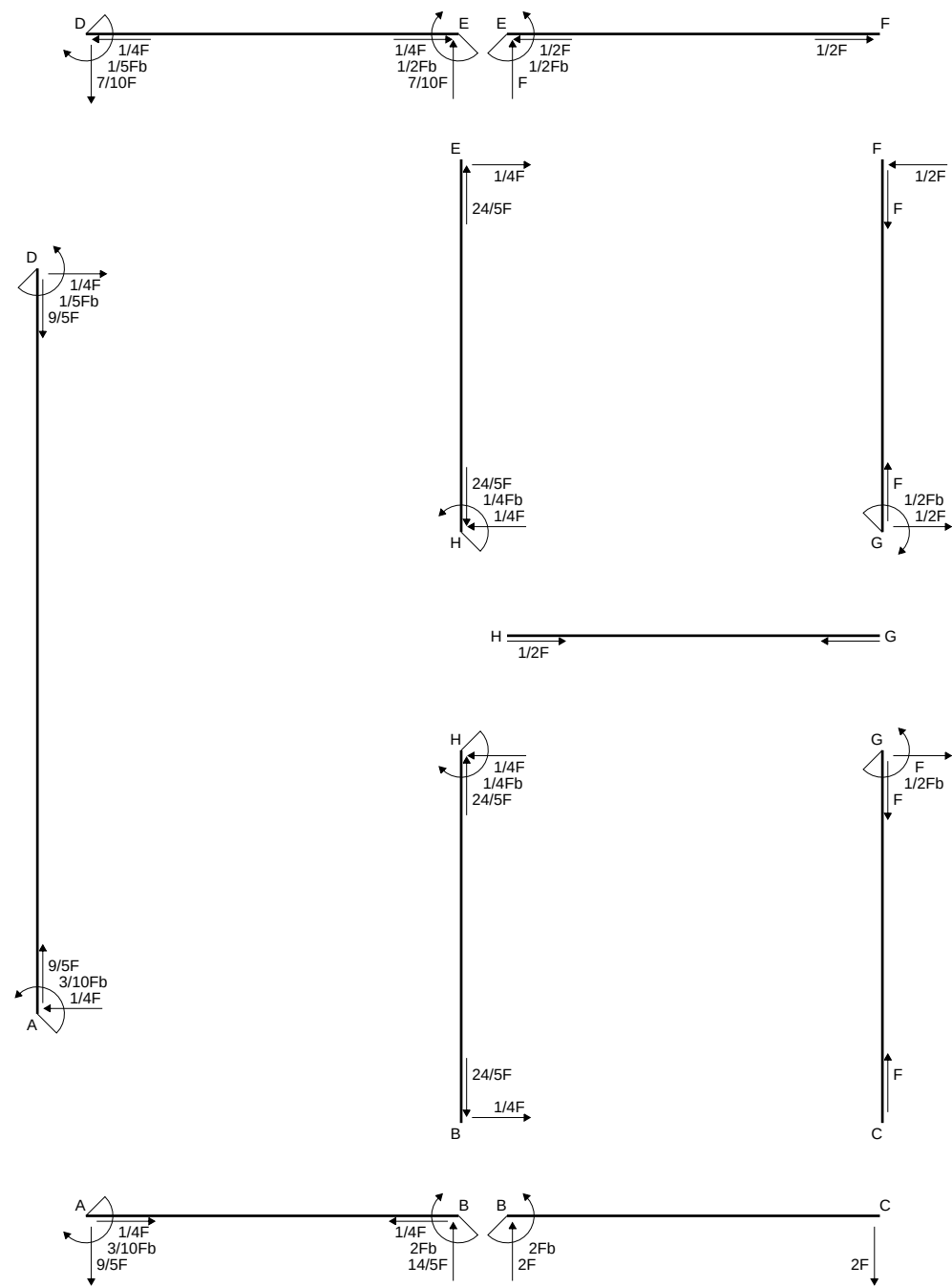
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$-1/4Fx$	Fb/EJ	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

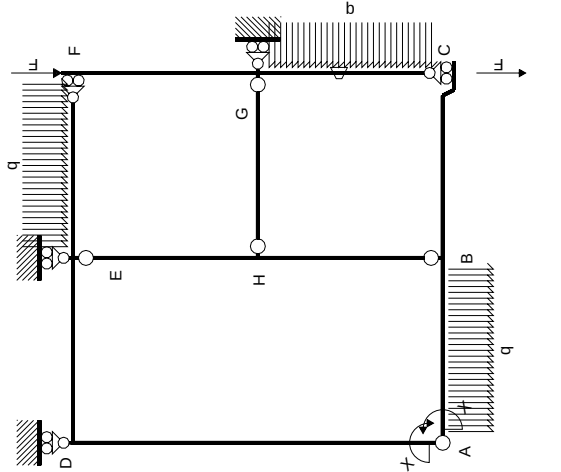
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$

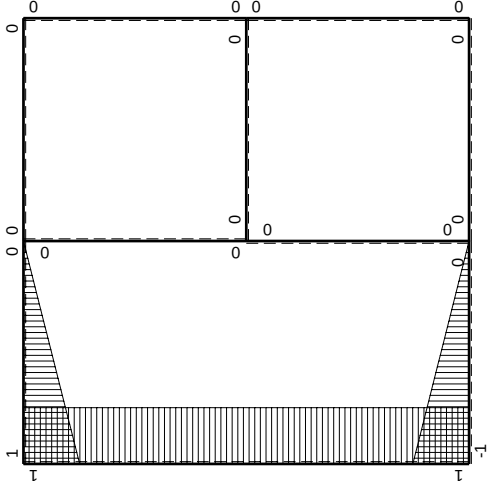


$$\begin{aligned}
A &= 960. \text{ mm}^2 \\
J_u &= 334225. \text{ mm}^4 \\
J_v &= 69408. \text{ mm}^4 \\
y_g &= 24.09 \text{ mm} \\
T_y &= 3820. \text{ N} \\
M_x &= -2483000. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 30.91 \text{ mm} \\
\sigma_m &= -Mv/J_u = 229.7 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 45. \text{ mm} \\
v_c &= 20.91 \text{ mm} \\
\sigma_c &= -Mv/J_u = 155.4 \text{ N/mm}^2 \\
\tau_c &= 5.155 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 155.6 \text{ N/mm}^2 \\
S &= 5412. \text{ mm}^3
\end{aligned}$$





M_0 flessione da carichi assegnati



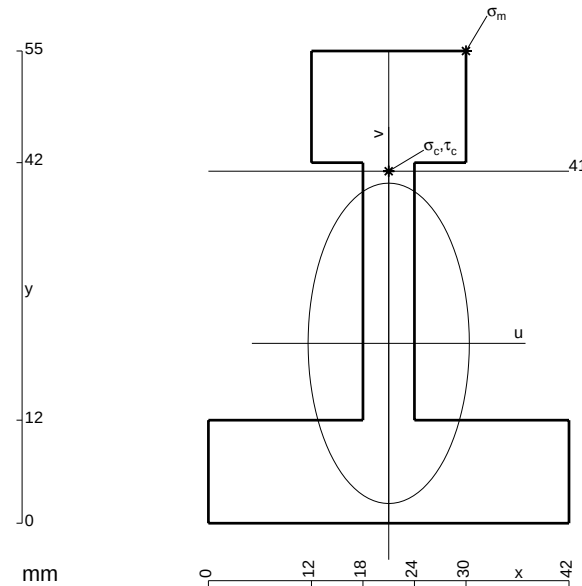
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

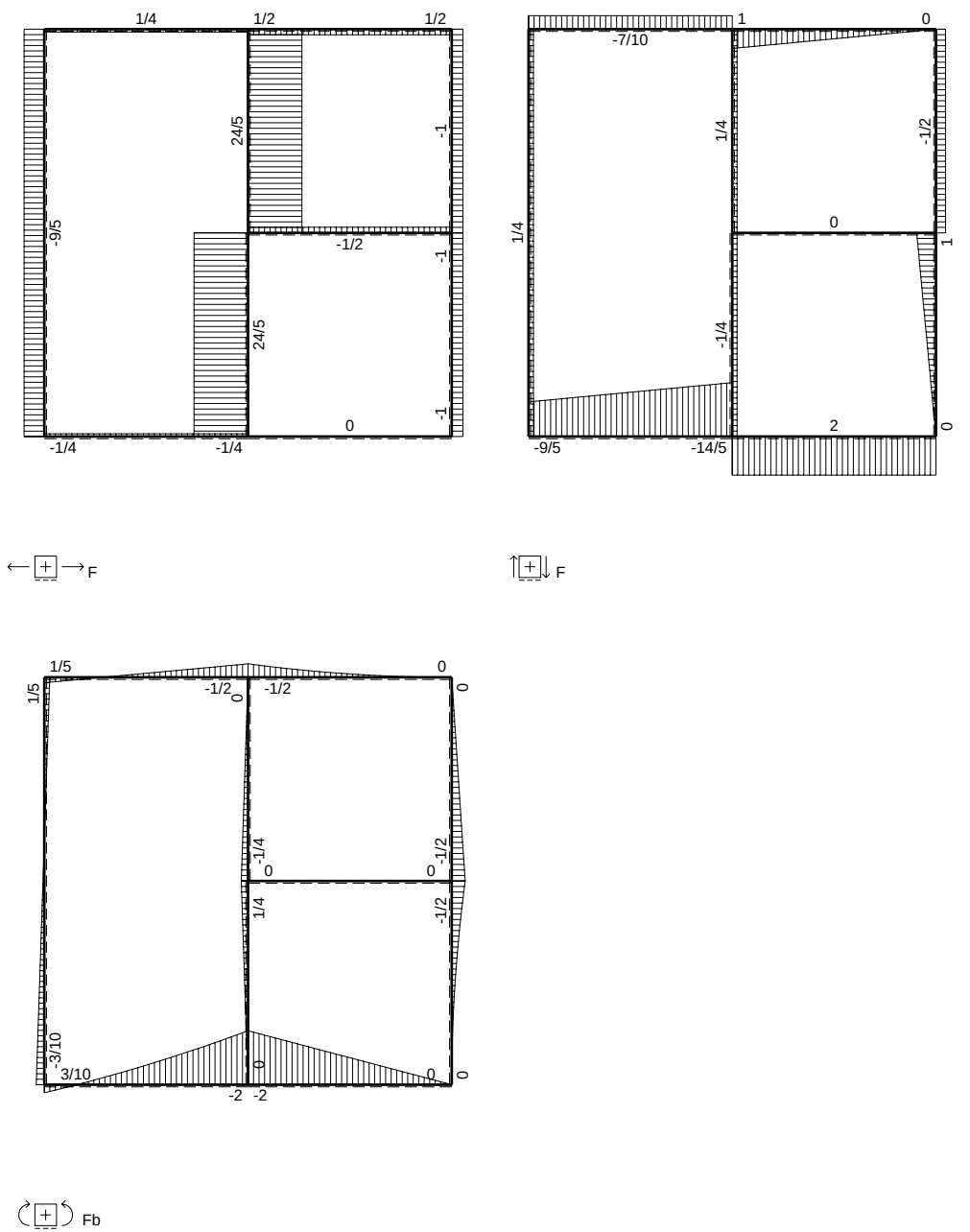
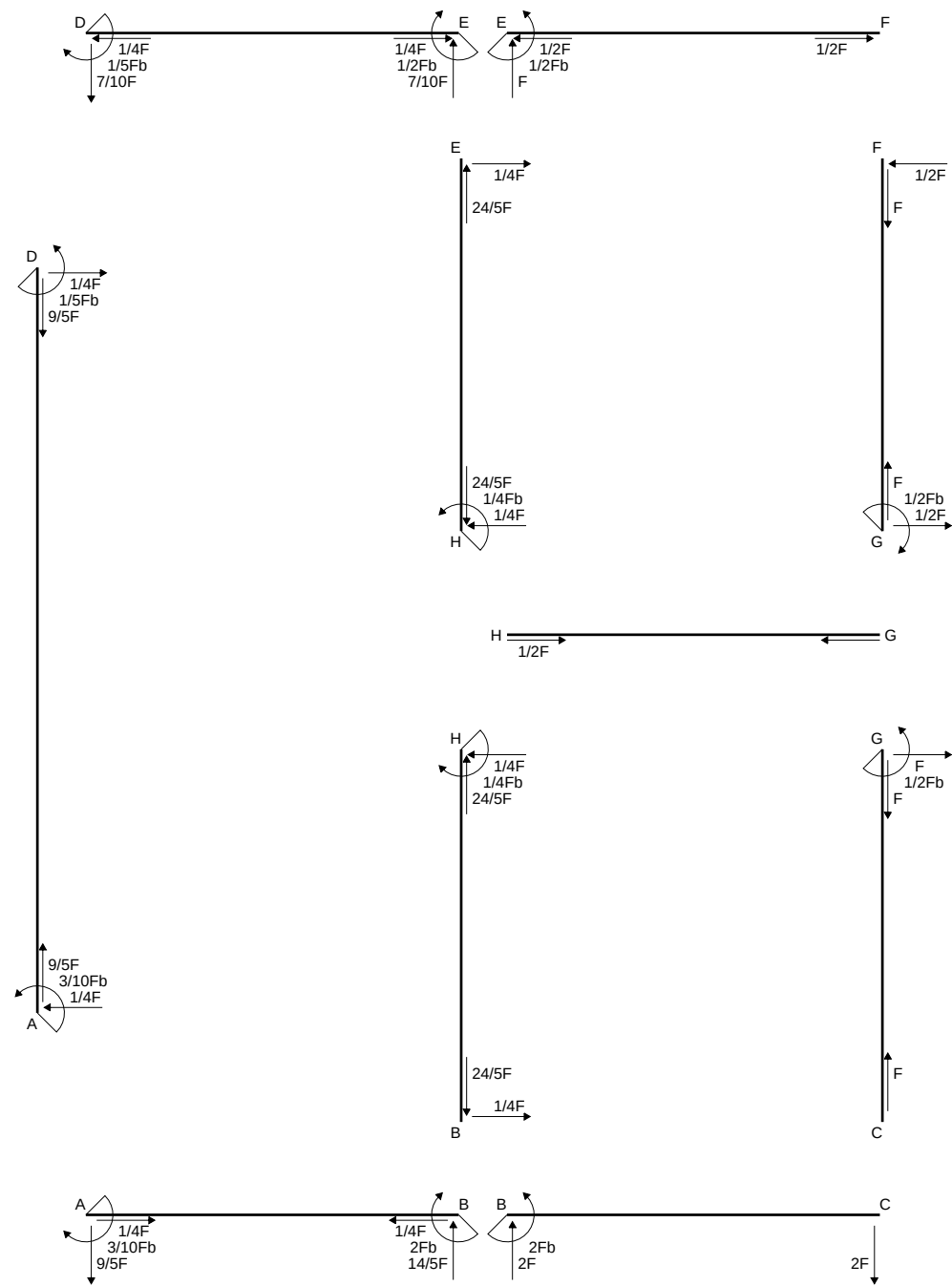
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	$1/2qx^2$	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

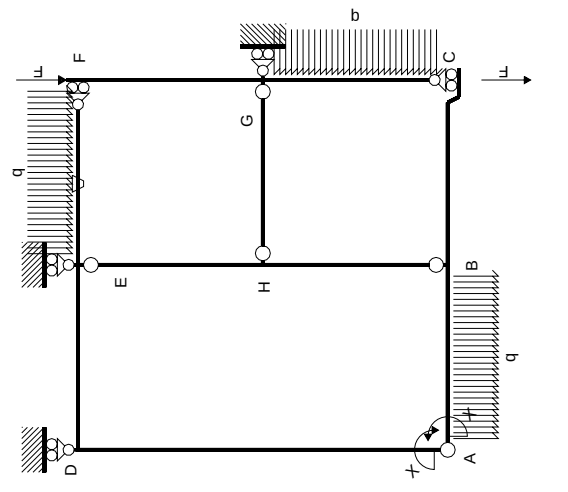
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$

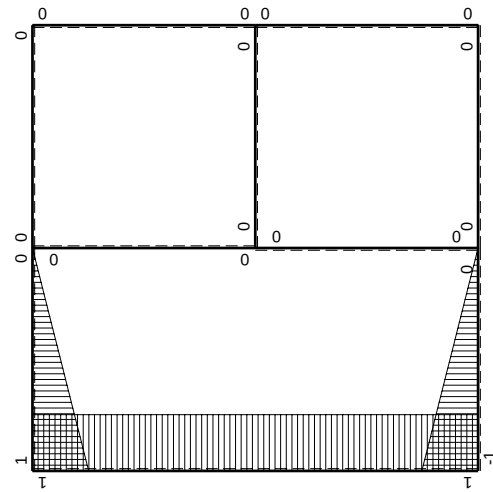


$$\begin{aligned}
A &= 918. \text{ mm}^2 \\
J_u &= 319684. \text{ mm}^4 \\
J_v &= 80946. \text{ mm}^4 \\
y_g &= 20.95 \text{ mm} \\
T_y &= 3200. \text{ N} \\
M_x &= -2240000. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 34.05 \text{ mm} \\
\sigma_m &= -Mv/J_u = 238.6 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 41. \text{ mm} \\
v_c &= 20.05 \text{ mm} \\
\sigma_c &= -Mv/J_u = 140.5 \text{ N/mm}^2 \\
\tau_c &= 10.96 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 141.8 \text{ N/mm}^2 \\
S &= 6570. \text{ mm}^3
\end{aligned}$$

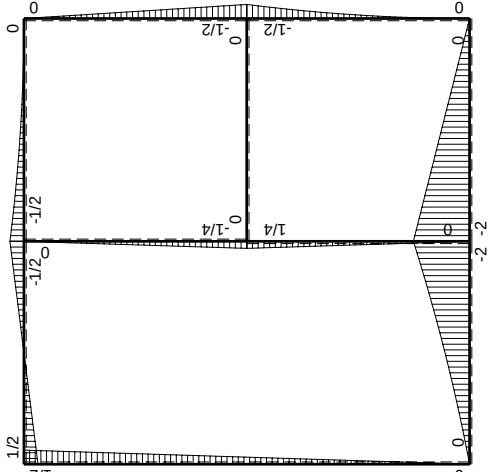




M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

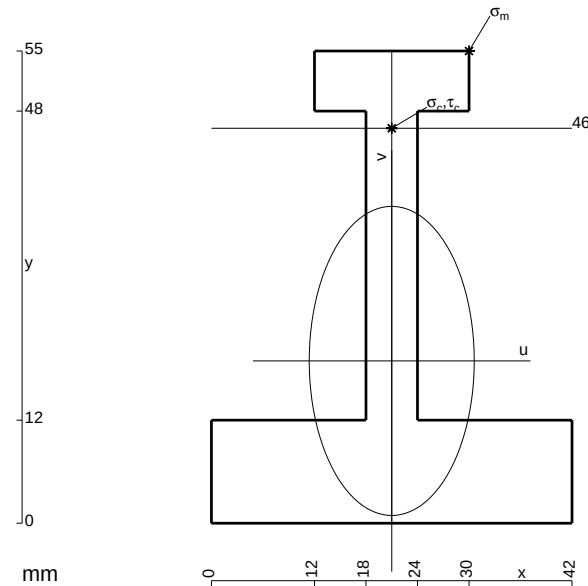


Quadro contributi PLV per iperstatica $X=W_{AB}$

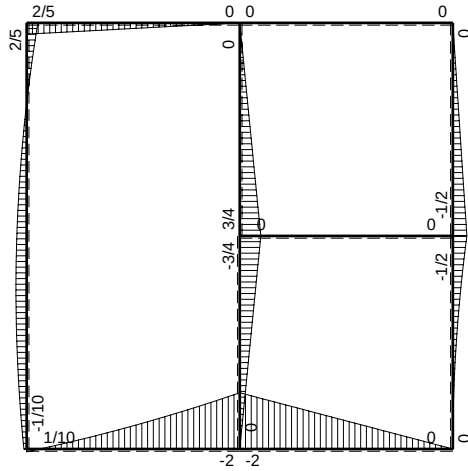
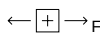
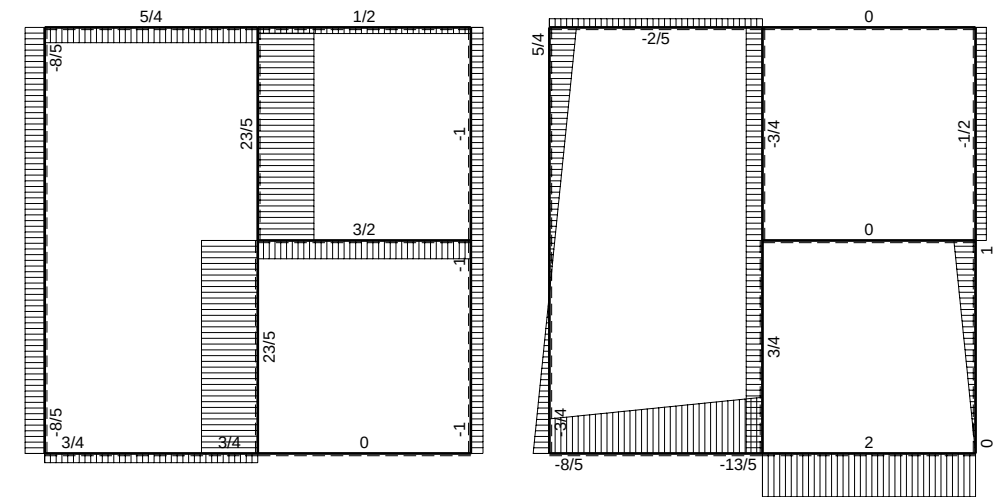
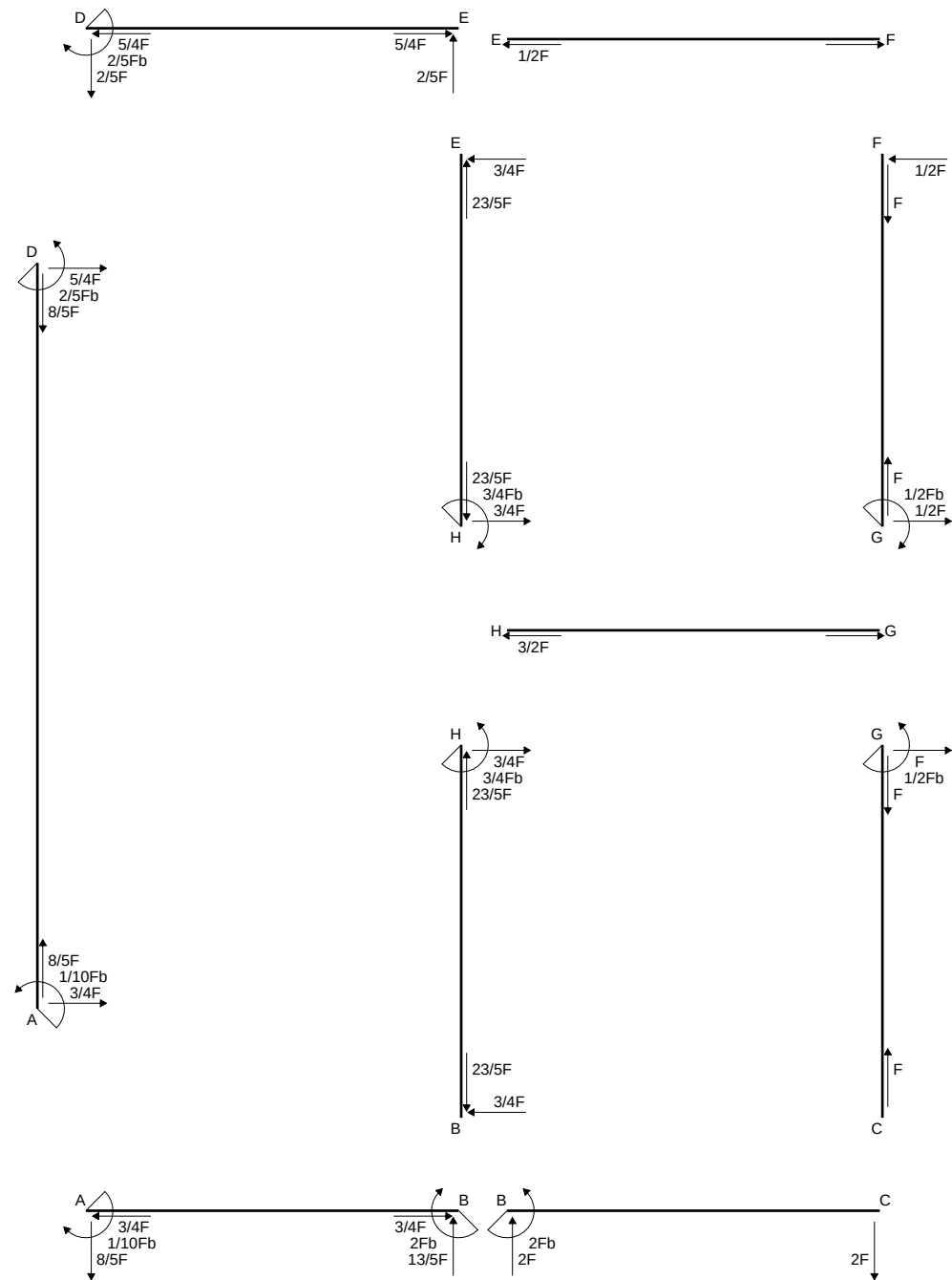
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	$1/2qx^2$	Fb/EJ	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

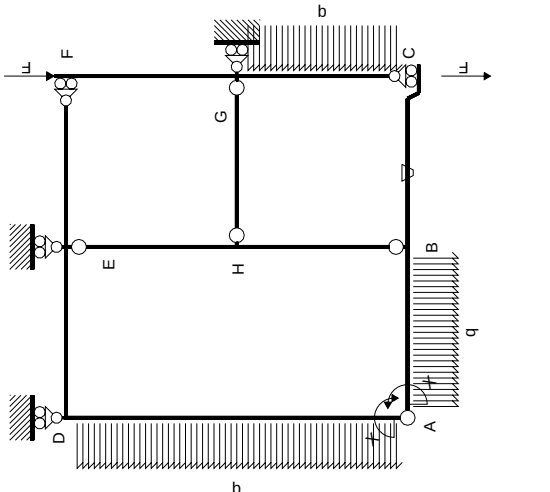
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



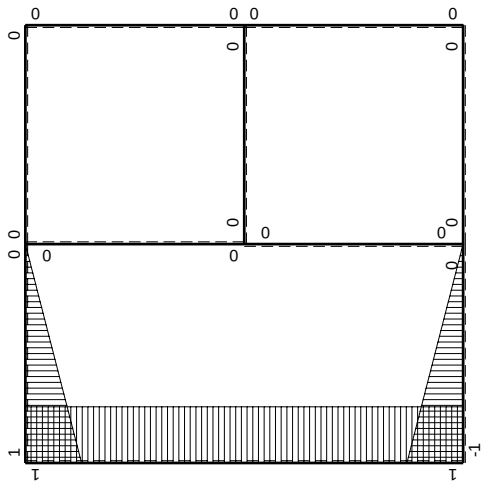
$$\begin{aligned}
A &= 846. \text{ mm}^2 \\
J_u &= 274282. \text{ mm}^4 \\
J_v &= 78138. \text{ mm}^4 \\
y_g &= 18.9 \text{ mm} \\
T_y &= 2020. \text{ N} \\
M_x &= -1515000. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 36.1 \text{ mm} \\
\sigma_m &= -Mv/J_u = 199.4 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 46. \text{ mm} \\
v_c &= 27.1 \text{ mm} \\
\sigma_c &= -Mv/J_u = 149.7 \text{ N/mm}^2 \\
\tau_c &= 5.455 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 150. \text{ N/mm}^2 \\
S &= 4444. \text{ mm}^3
\end{aligned}$$



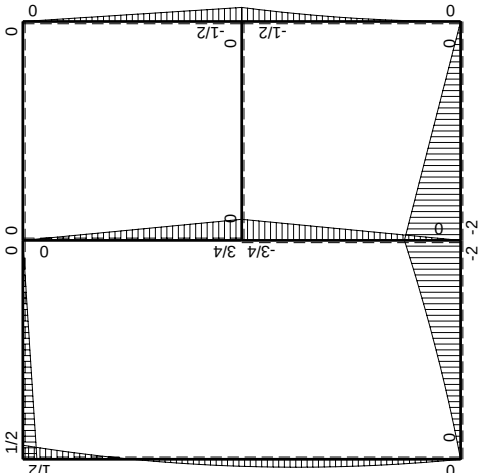


Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

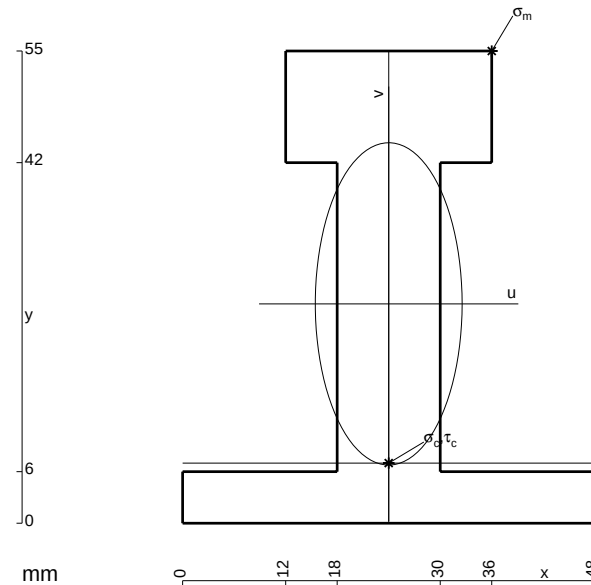


Quadro contributi PLV per iperstatica $X=W_{AB}$

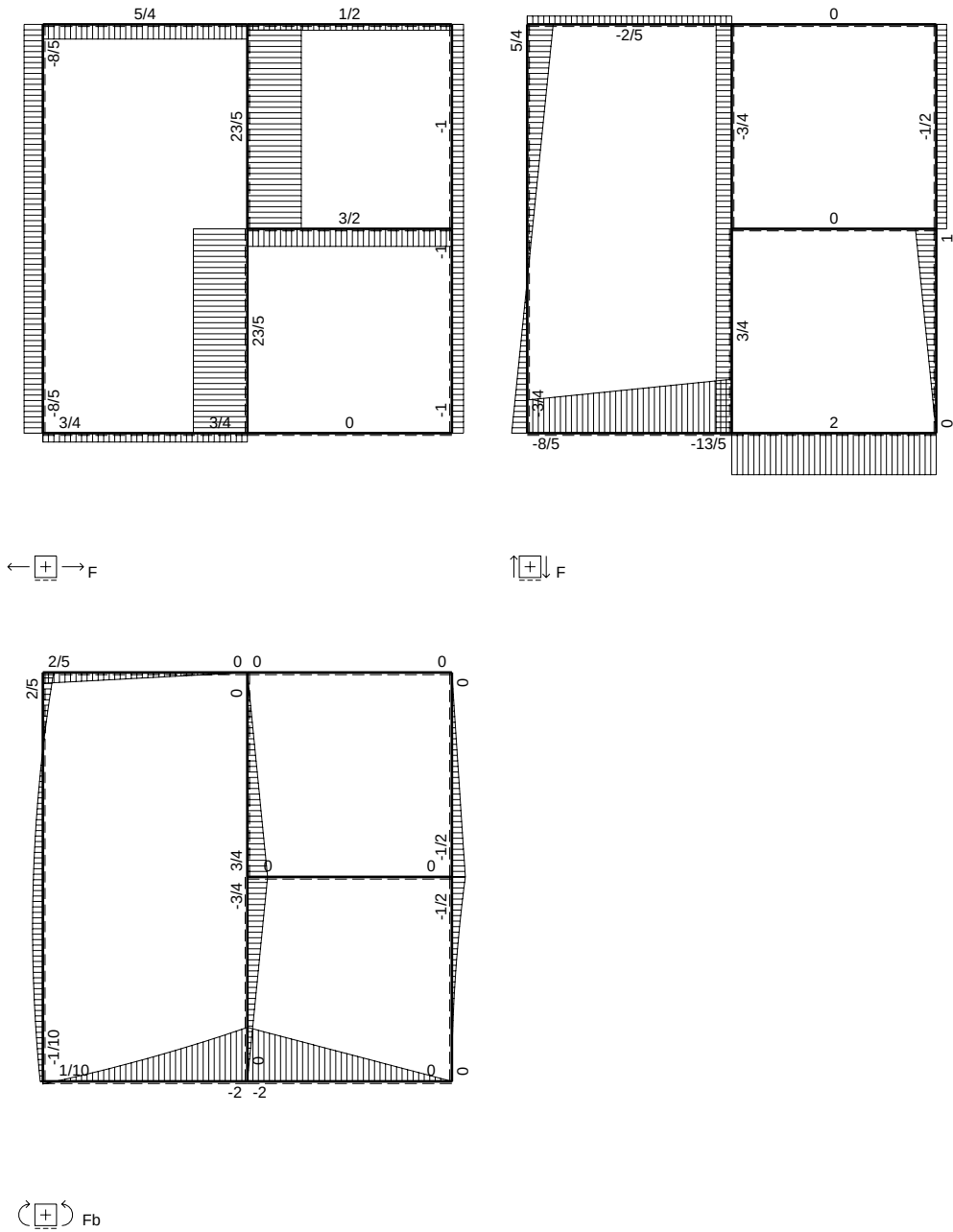
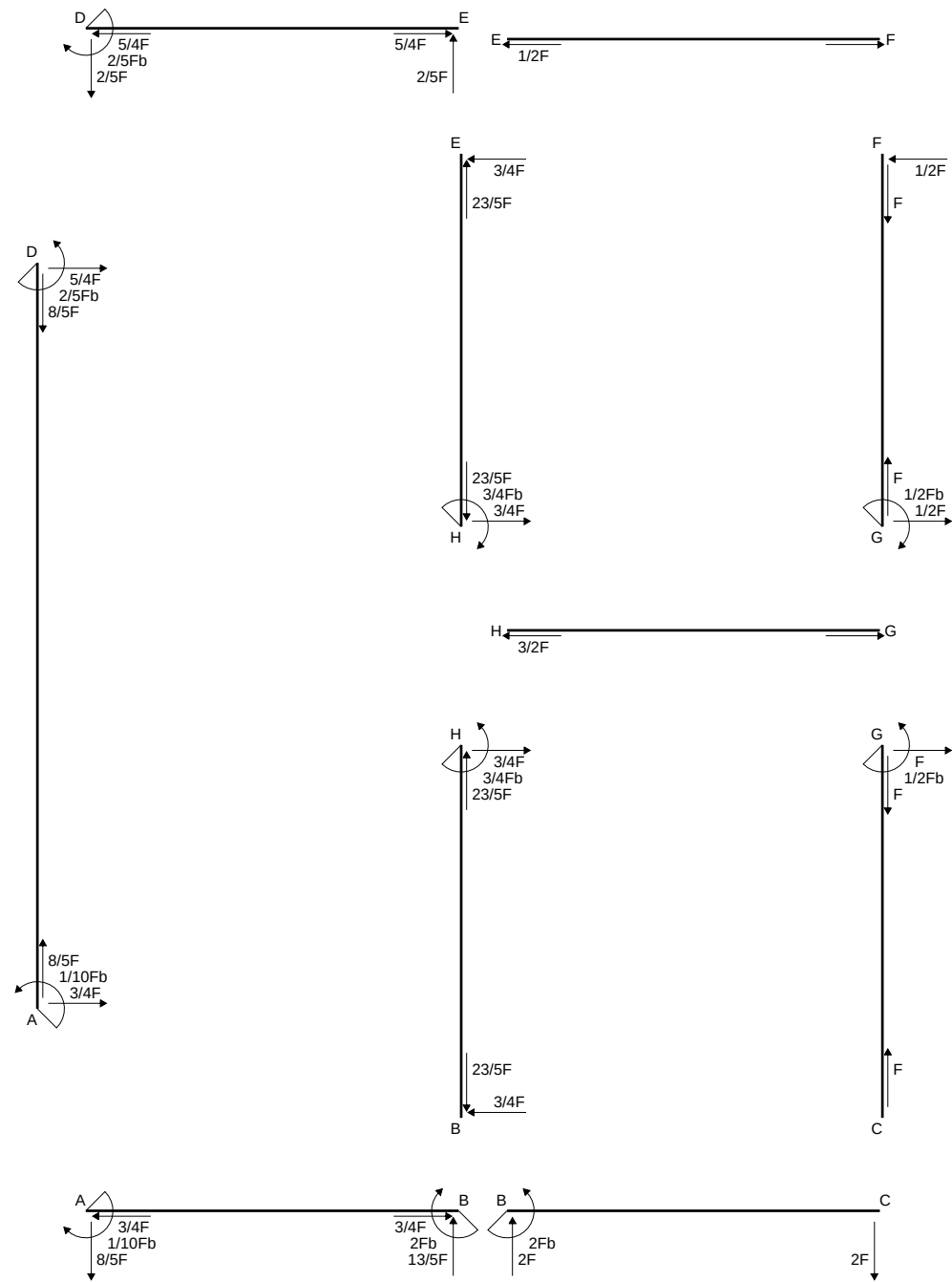
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

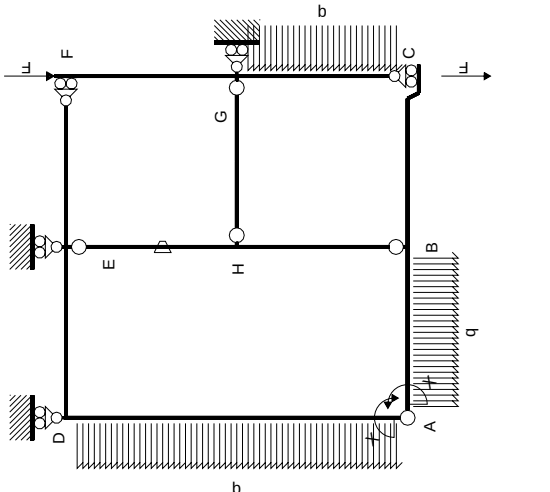
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



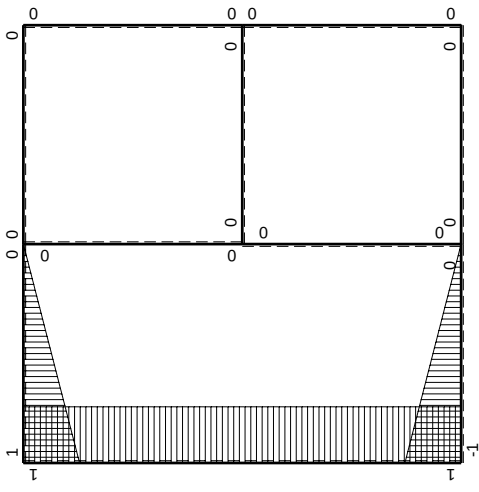
$$\begin{aligned}
A &= 1032. \text{ mm}^2 \\
J_u &= 363732. \text{ mm}^4 \\
J_v &= 75456. \text{ mm}^4 \\
y_g &= 25.55 \text{ mm} \\
T_y &= 3240. \text{ N} \\
M_x &= -2592000. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 29.45 \text{ mm} \\
\sigma_m &= -Mv/J_u = 209.9 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 7. \text{ mm} \\
v_c &= -18.55 \text{ mm} \\
\sigma_c &= -Mv/J_u = -132.2 \text{ N/mm}^2 \\
\tau_c &= 4.99 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 132.4 \text{ N/mm}^2 \\
S &= 6722. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



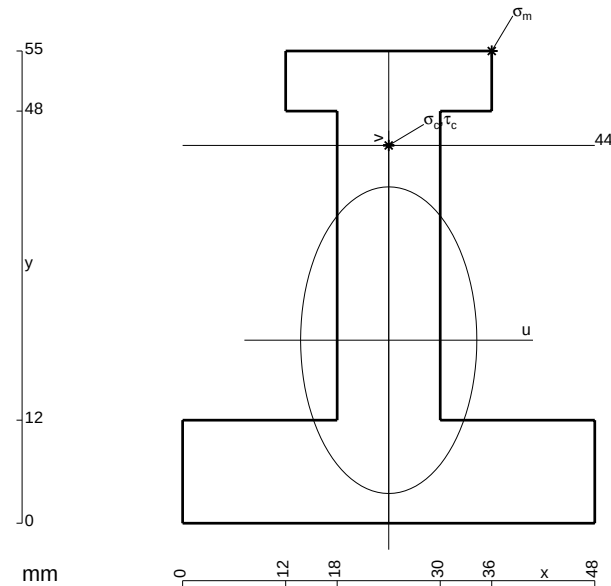
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

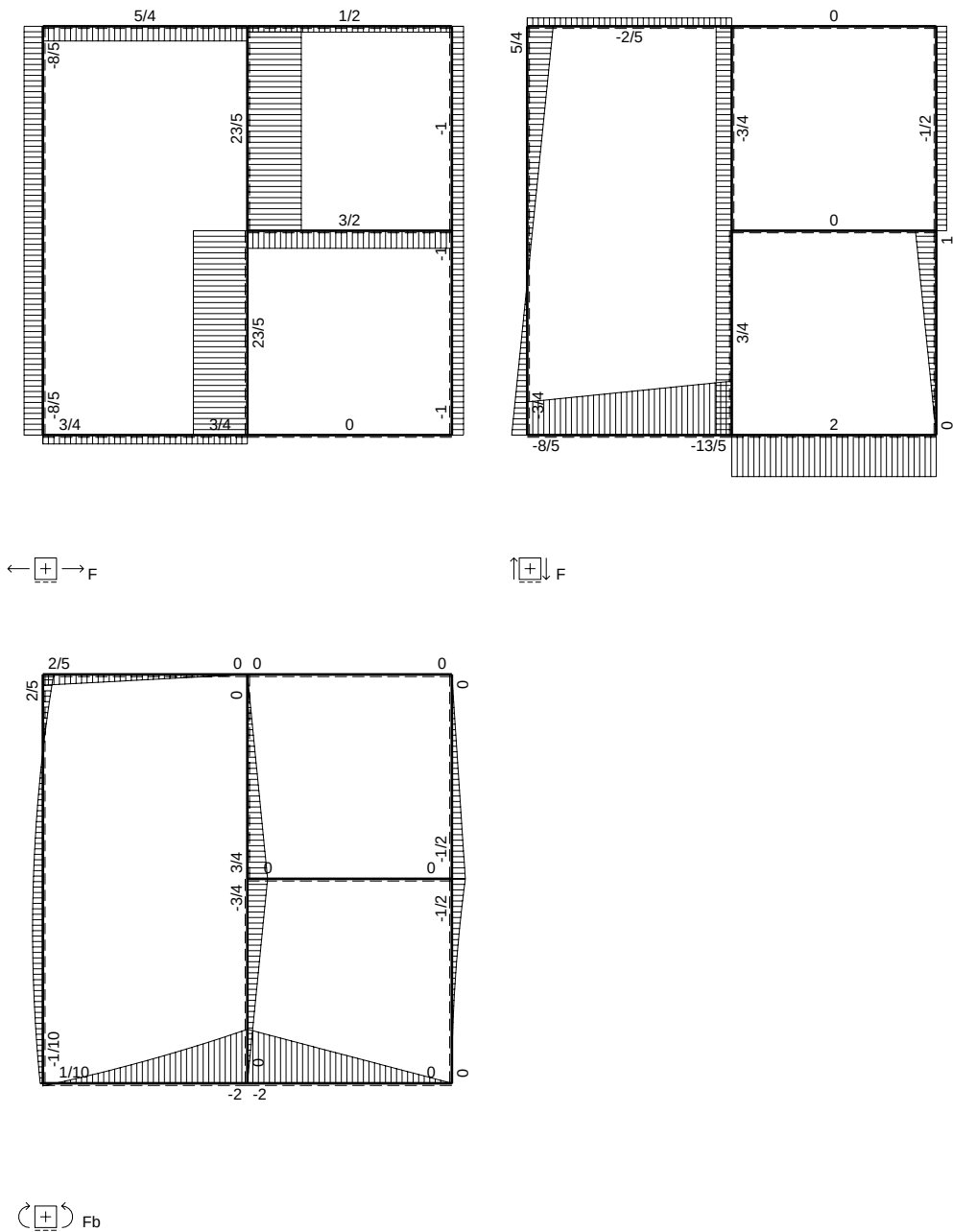
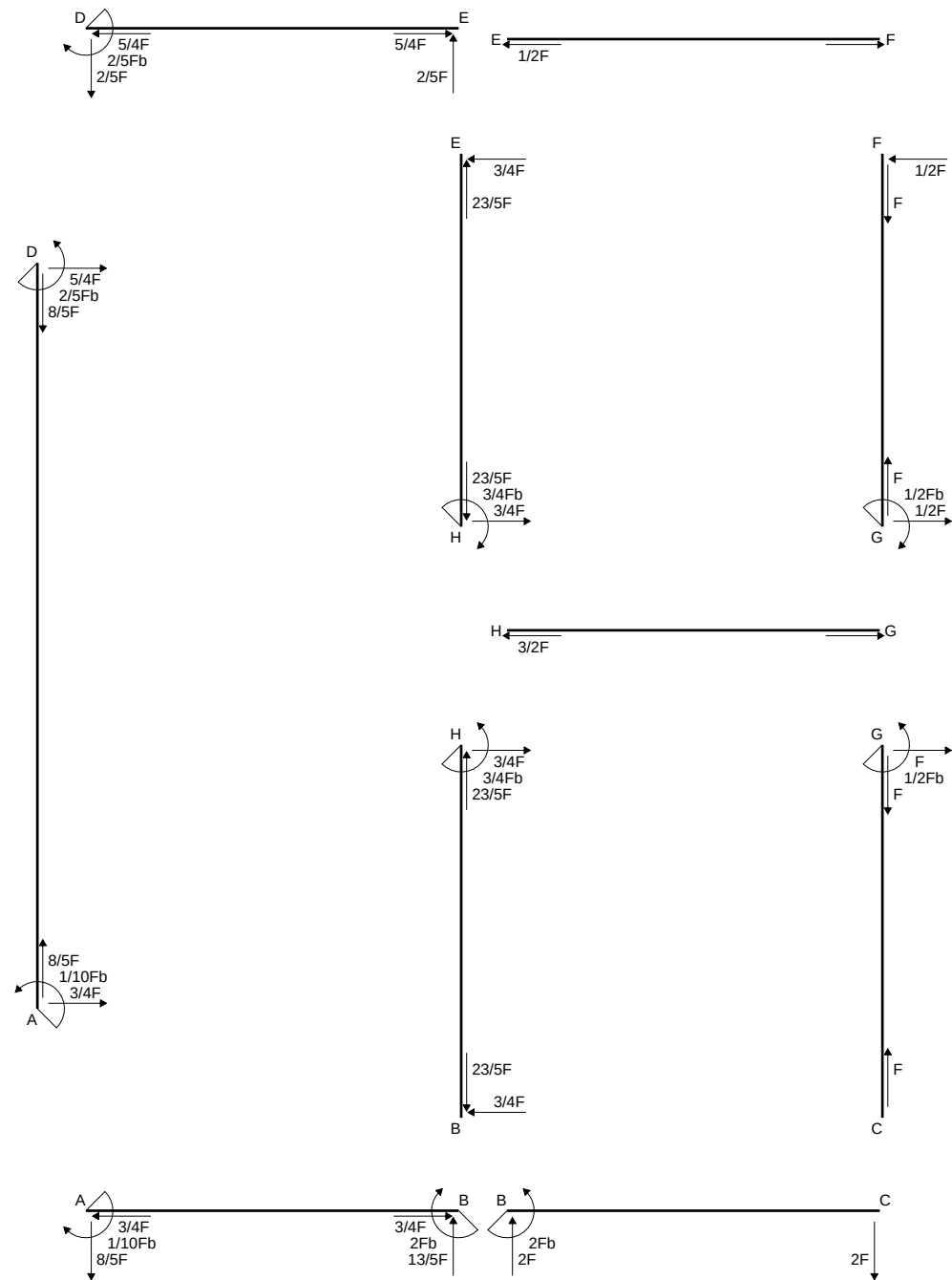
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-3/4Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

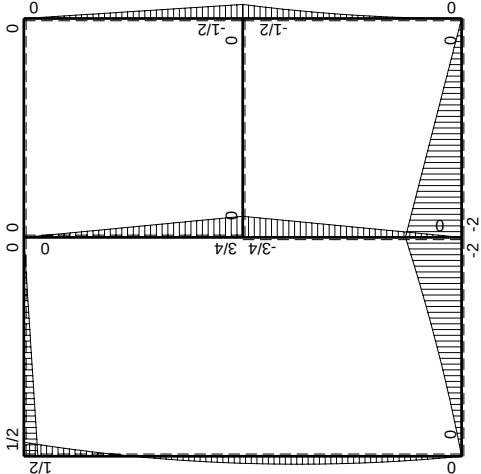
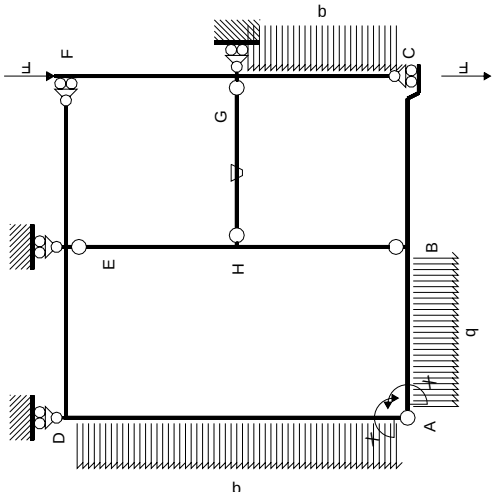
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



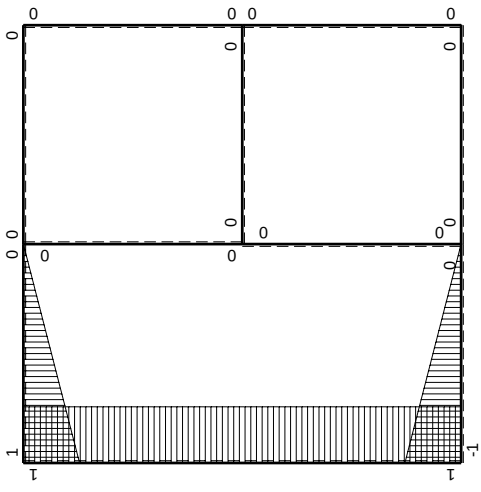
$$\begin{aligned}
A &= 1176. \text{ mm}^2 \\
J_u &= 375010. \text{ mm}^4 \\
J_v &= 123840. \text{ mm}^4 \\
y_g &= 21.32 \text{ mm} \\
T_y &= 2880. \text{ N} \\
M_x &= -2448000. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 33.68 \text{ mm} \\
\sigma_m &= -Mv/J_u = 219.9 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 44. \text{ mm} \\
v_c &= 22.68 \text{ mm} \\
\sigma_c &= -Mv/J_u = 148.1 \text{ N/mm}^2 \\
\tau_c &= 4.004 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 148.2 \text{ N/mm}^2 \\
S &= 6256. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



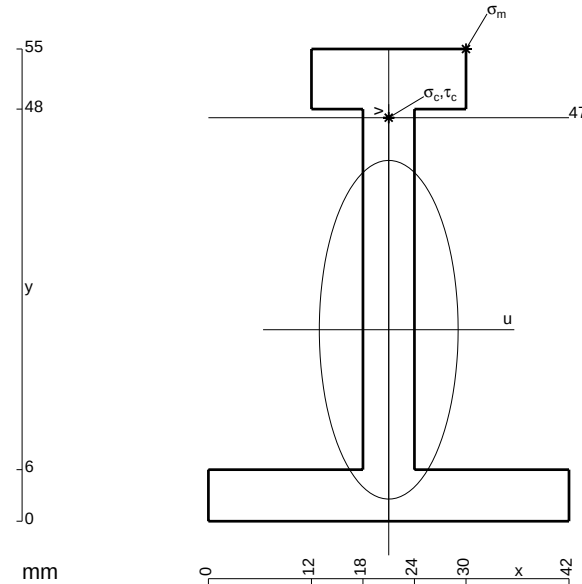
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

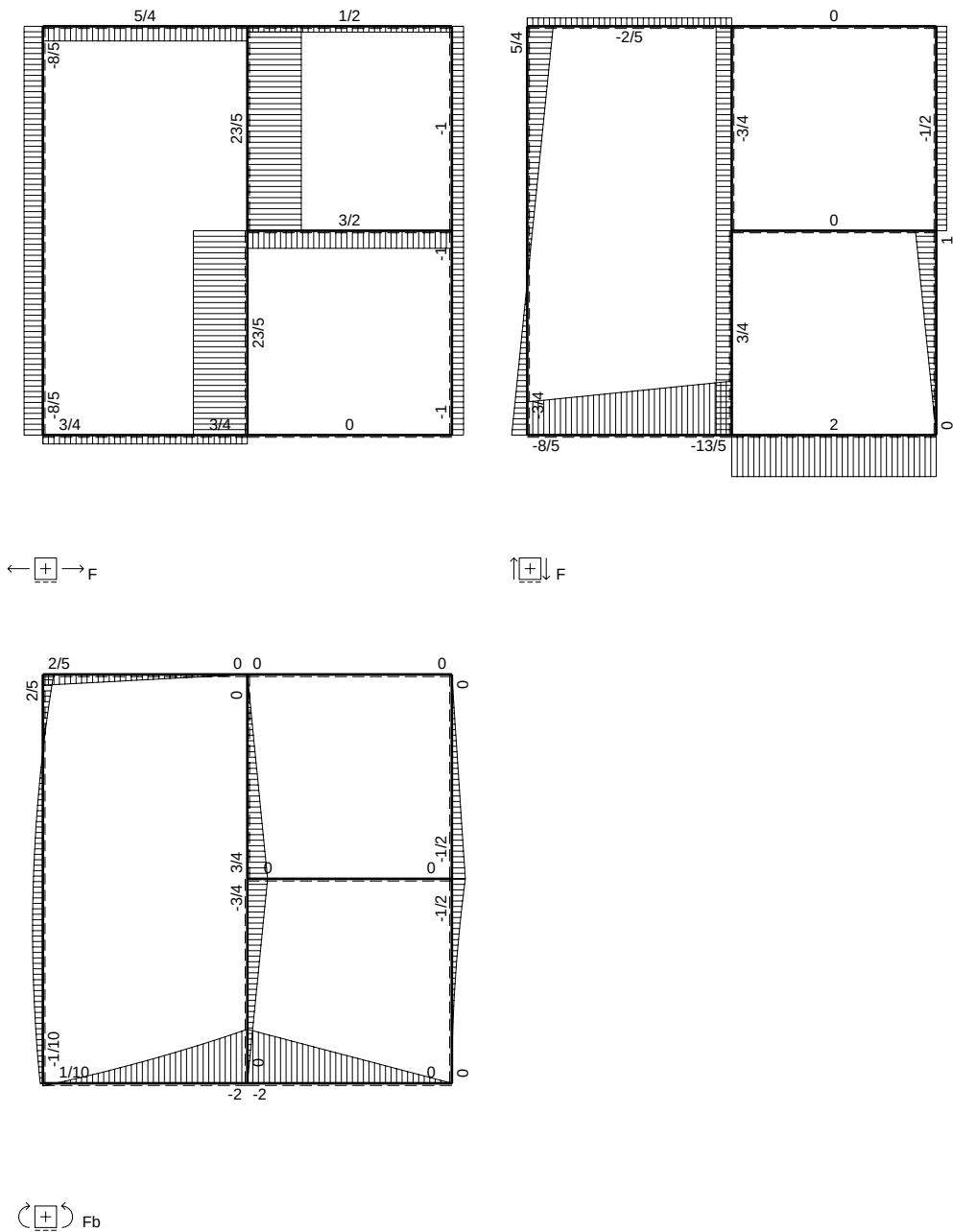
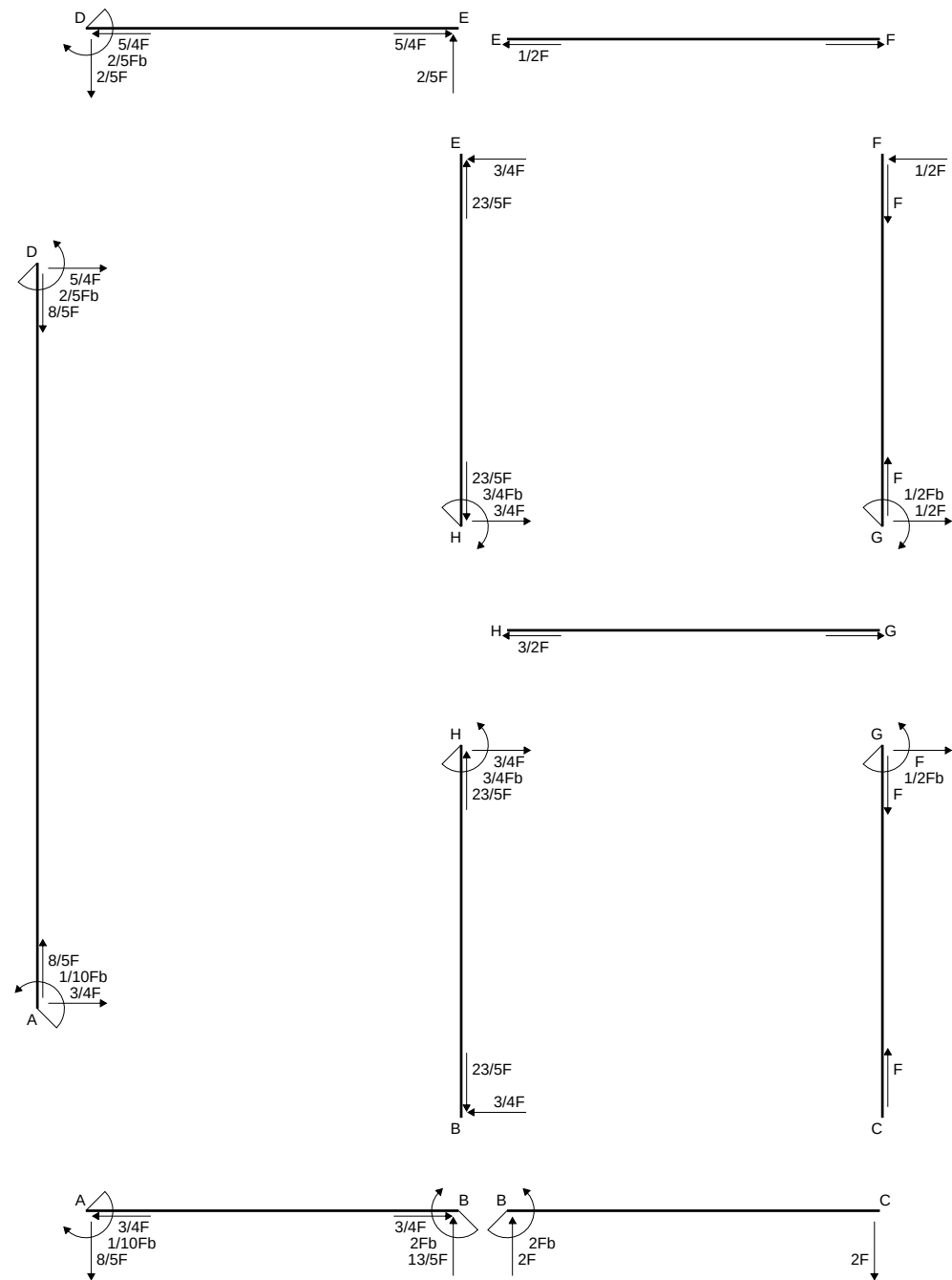
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

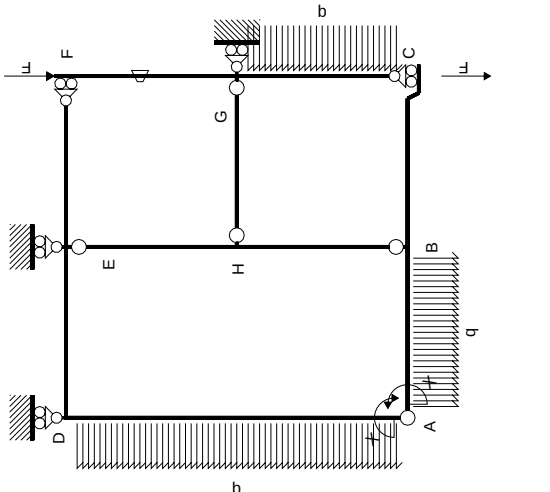
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{xo} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{xo} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{xo} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{xo} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{xo} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{xo} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



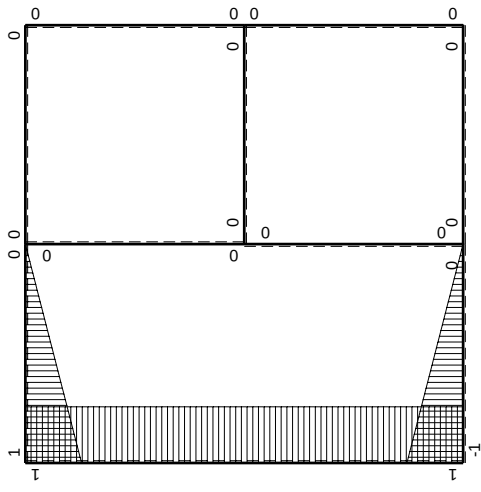
$$\begin{aligned}
A &= 630. \text{ mm}^2 \\
J_u &= 245181. \text{ mm}^4 \\
J_v &= 41202. \text{ mm}^4 \\
y_g &= 22.3 \text{ mm} \\
T_y &= 1900. \text{ N} \\
M_x &= -1710000. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 32.7 \text{ mm} \\
\sigma_m &= -Mv/J_u = 228.1 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 47. \text{ mm} \\
v_c &= 24.7 \text{ mm} \\
\sigma_c &= -Mv/J_u = 172.3 \text{ N/mm}^2 \\
\tau_c &= 4.947 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 172.5 \text{ N/mm}^2 \\
S &= 3830. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



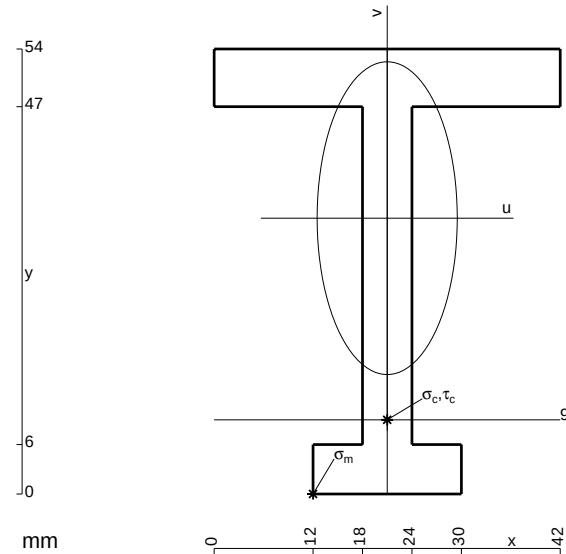
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

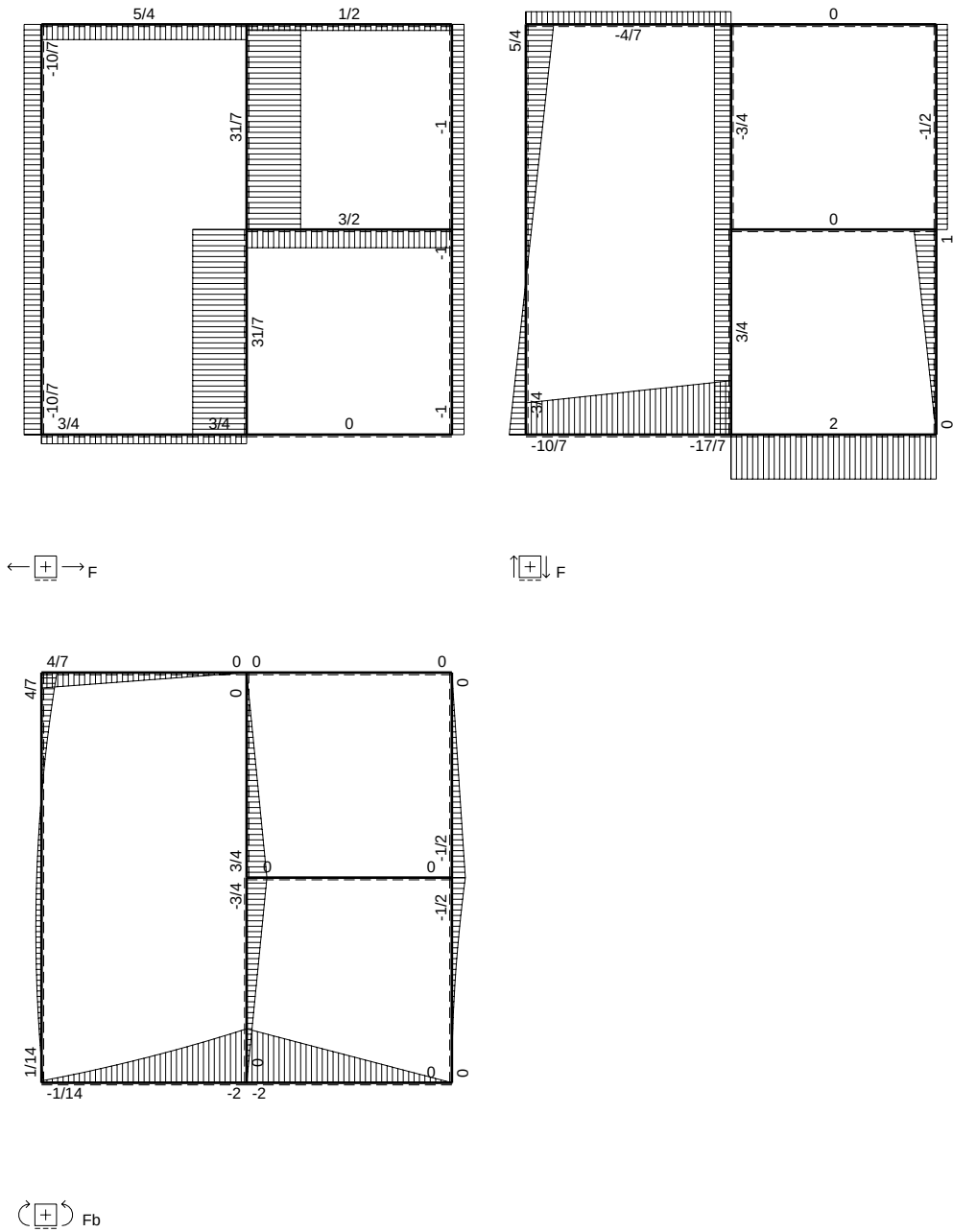
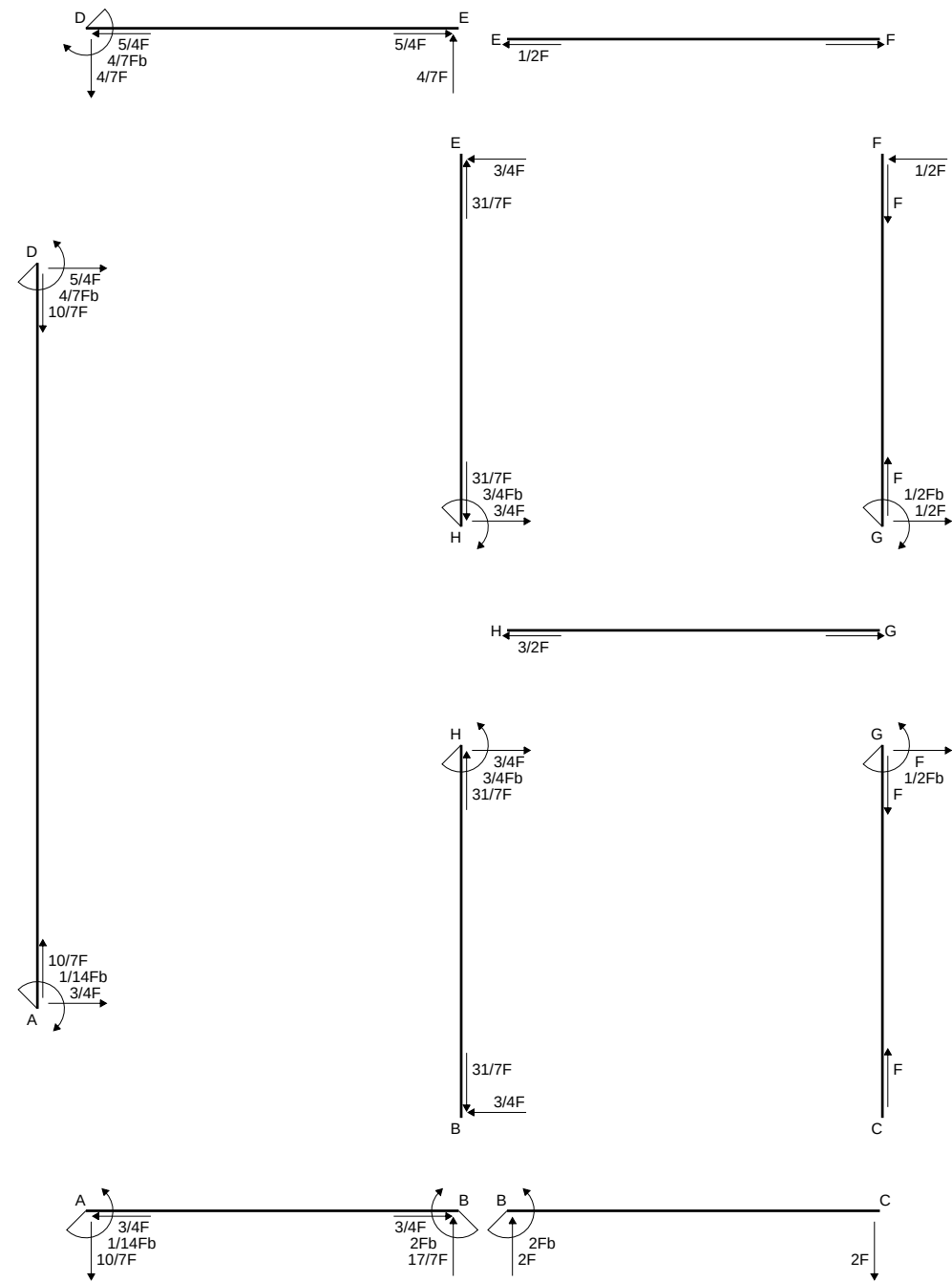
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	Fb/EJ	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

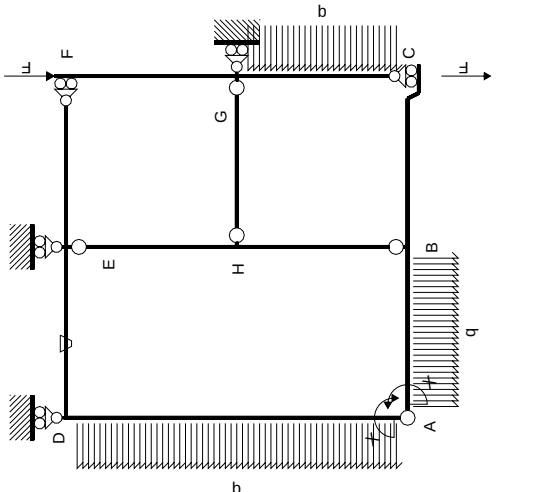
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



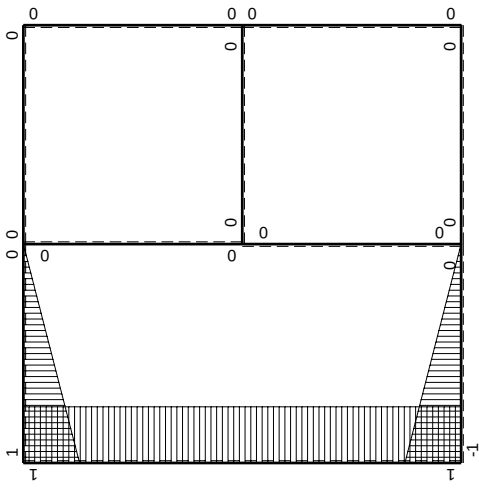
$$\begin{aligned}
A &= 648. \text{ mm}^2 \\
J_u &= 233472. \text{ mm}^4 \\
J_v &= 46872. \text{ mm}^4 \\
y_g &= 33.47 \text{ mm} \\
T_y &= 1800. \text{ N} \\
M_x &= -1674000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -33.47 \text{ mm} \\
\sigma_m &= -Mv/J_u = -240. \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 9. \text{ mm} \\
v_c &= -24.47 \text{ mm} \\
\sigma_c &= -Mv/J_u = -175.5 \text{ N/mm}^2 \\
\tau_c &= 4.83 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 175.7 \text{ N/mm}^2 \\
S &= 3759. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$-Fb/EJ+Fx/EJ$	$1-2x/b+x^2/b^2$	$(1/6-1/2)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	Fb/EJ	$1/2Fx^2/b$	$-Fx/EJ$	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/14Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ}$$

$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{AD}^{x_0} = \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}$$

$$L_{DA}^{x_0} = \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}$$

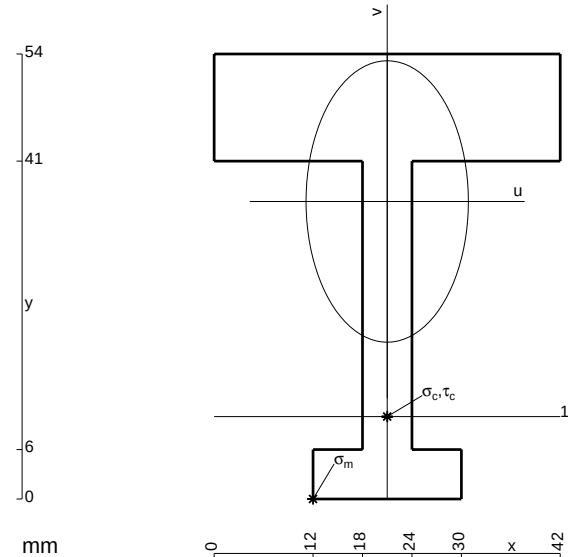
$$L_{DE}^{x_0} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1 + x/b) \theta dx$$

$$= \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} + \left[-x + 1/2 x^2/b \right]_0^b \theta$$

$$= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b + 1/2 b) \theta = -1/3 \frac{Fb^2}{EJ}$$

$$L_{ED}^{x_0} = \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (x/b) \theta dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} + \left[1/2 x^2/b \right]_0^b \theta$$

$$= (1/6 b) Fb \frac{1}{EJ} + (1/2 b) \theta = -1/3 \frac{Fb^2}{EJ}$$



$$A = 864. \text{ mm}^2$$

$$J_u = 252075. \text{ mm}^4$$

$$J_v = 83808. \text{ mm}^4$$

$$y_g = 36.1 \text{ mm}$$

$$T_y = 2840. \text{ N}$$

$$M_x = -1391600. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -36.1 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -199.3 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 10. \text{ mm}$$

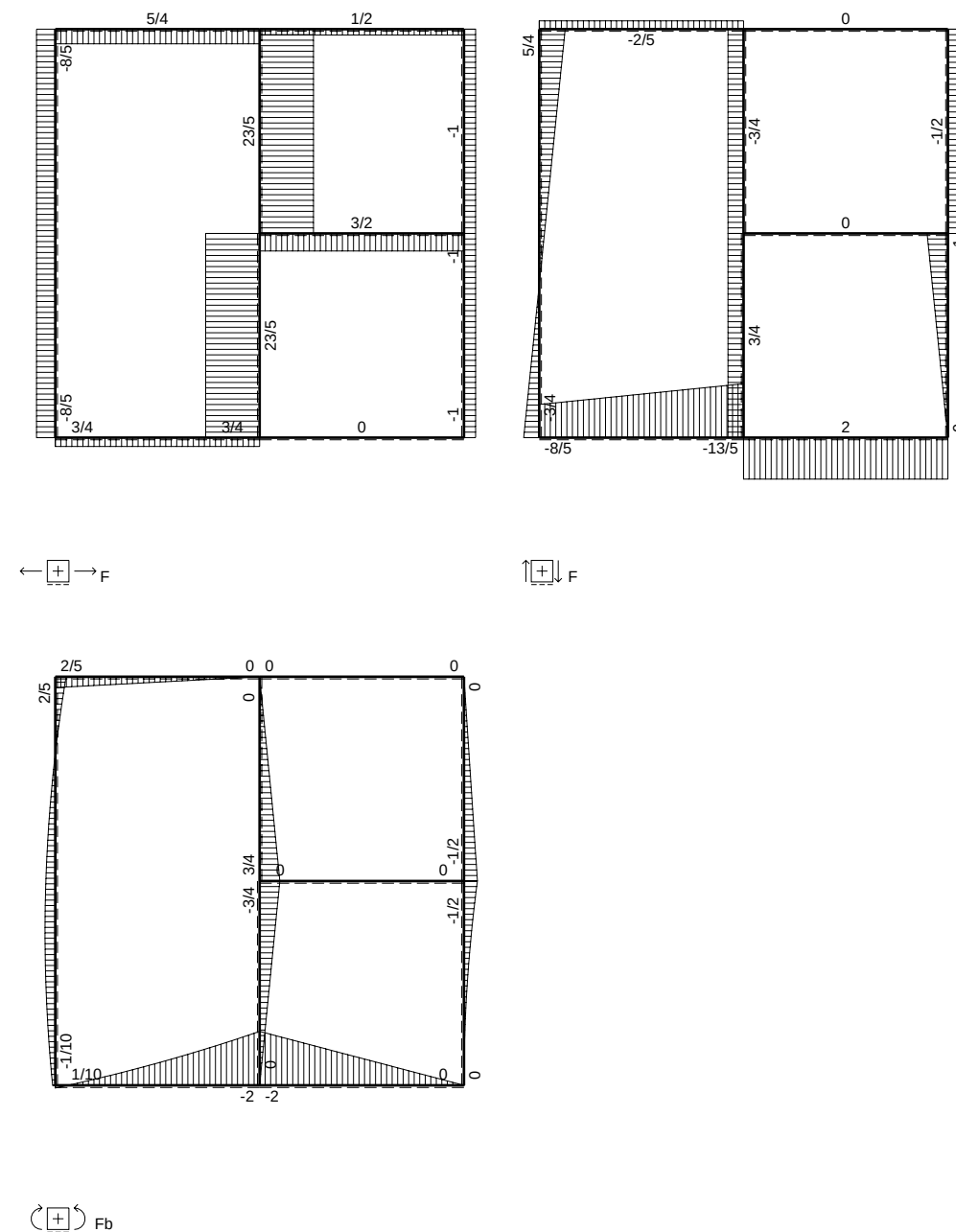
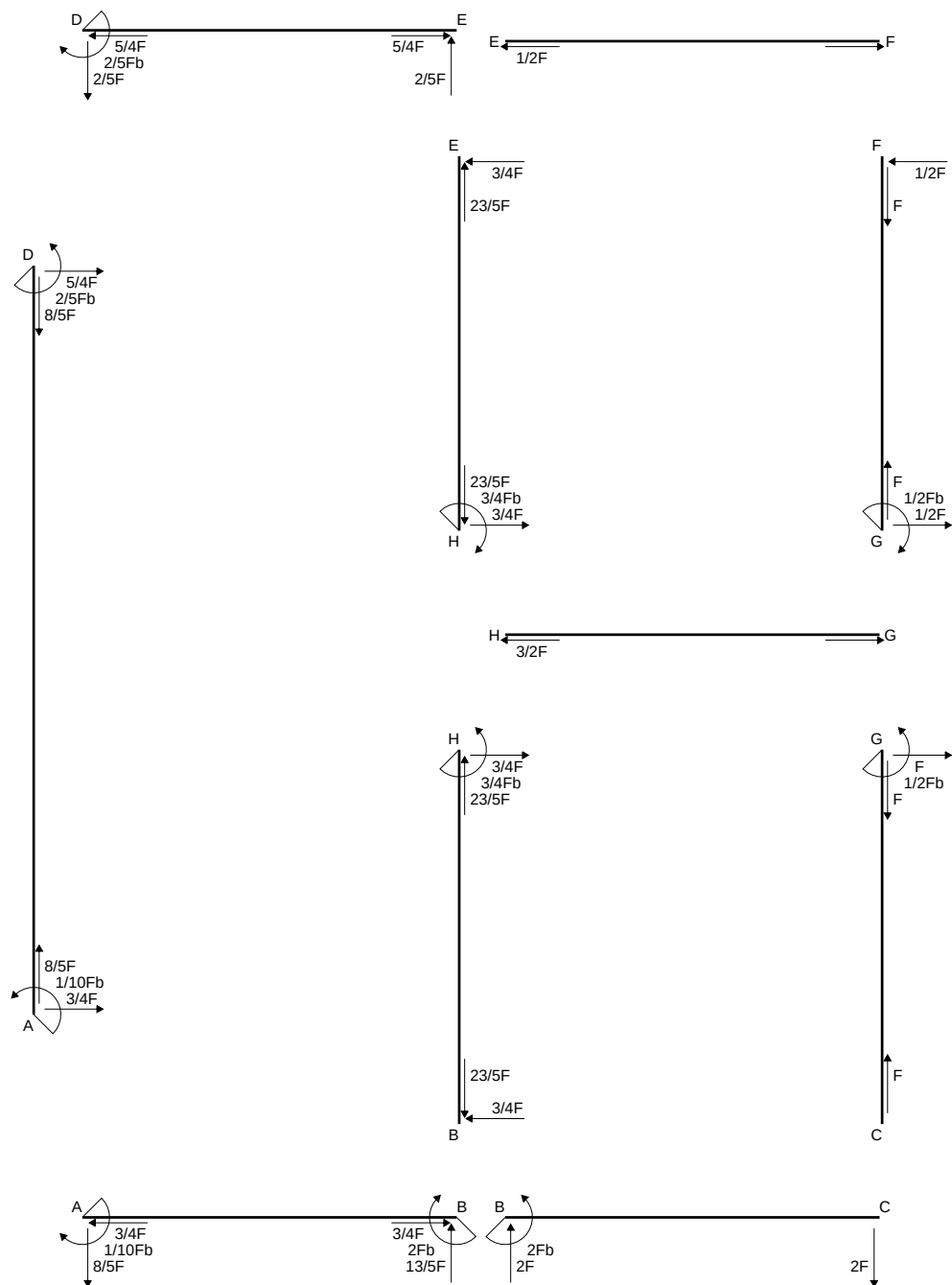
$$v_c = -26.1 \text{ mm}$$

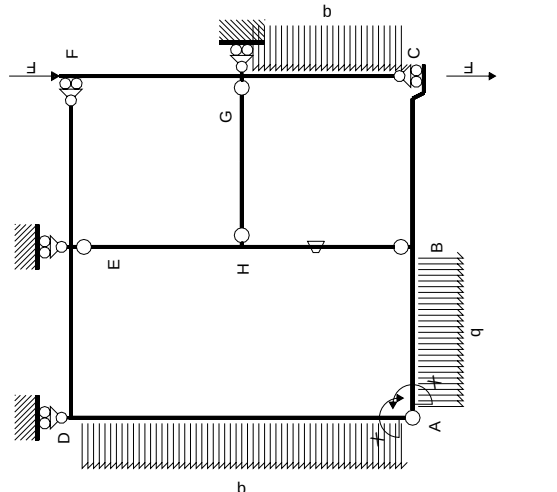
$$\sigma_c = -Mv/J_u = -144.1 \text{ N/mm}^2$$

$$\tau_c = 7.98 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 144.8 \text{ N/mm}^2$$

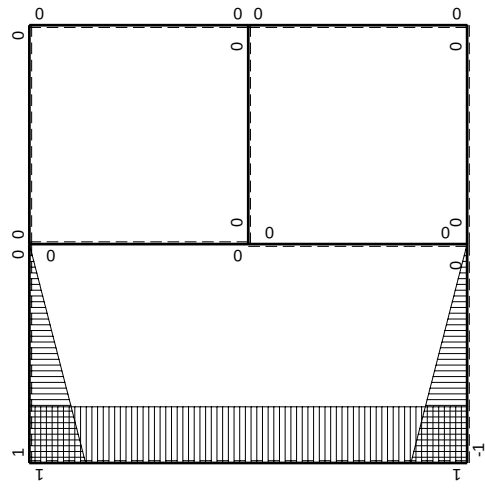
$$S = 4250. \text{ mm}^3$$



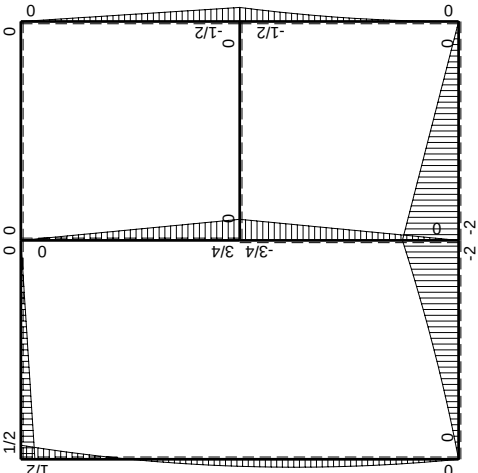


Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

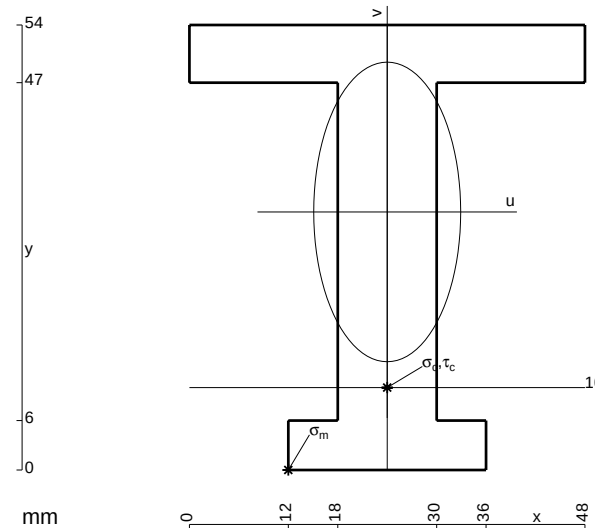


Quadro contributi PLV per iperstatica $X=W_{AB}$

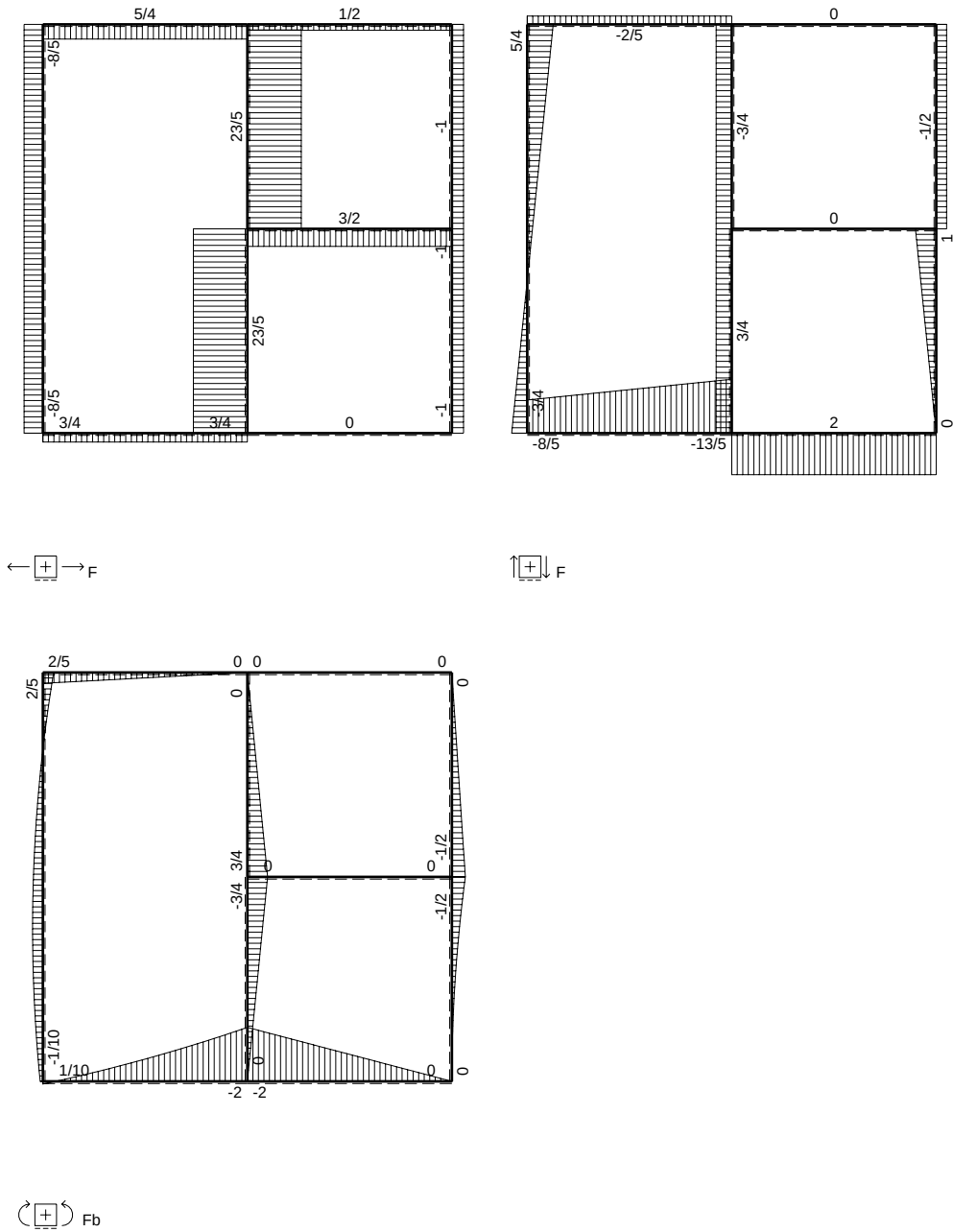
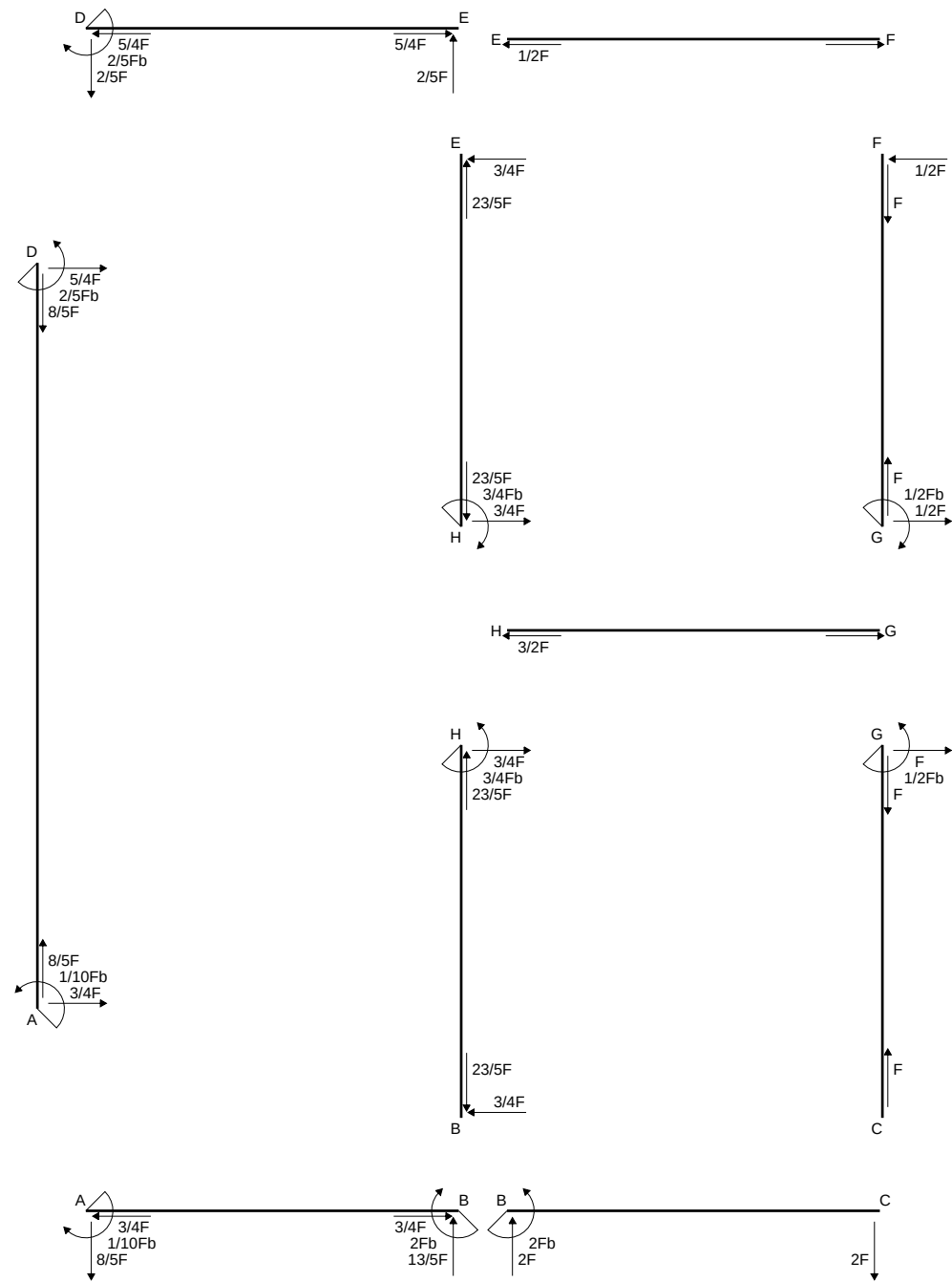
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$3/4Fx$	Fb/EJ	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

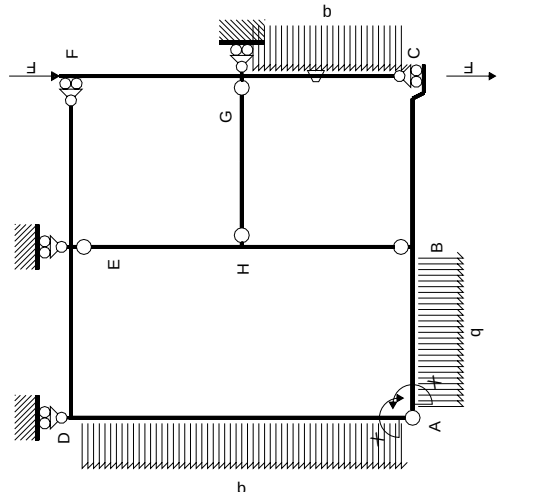
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



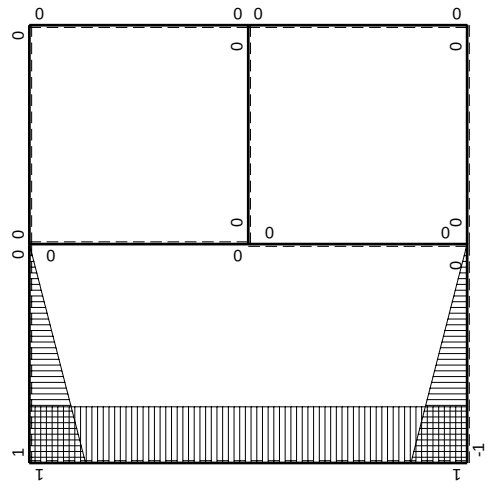
$$\begin{aligned}
A &= 972. \text{ mm}^2 \\
J_u &= 321252. \text{ mm}^4 \\
J_v &= 77328. \text{ mm}^4 \\
y_g &= 31.31 \text{ mm} \\
T_y &= 4060. \text{ N} \\
M_x &= -2151800. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -31.31 \text{ mm} \\
\sigma_m &= -Mv/J_u = -209.8 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 10. \text{ mm} \\
v_c &= -21.31 \text{ mm} \\
\sigma_c &= -Mv/J_u = -142.8 \text{ N/mm}^2 \\
\tau_c &= 5.473 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 143.1 \text{ N/mm}^2 \\
S &= 5196. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



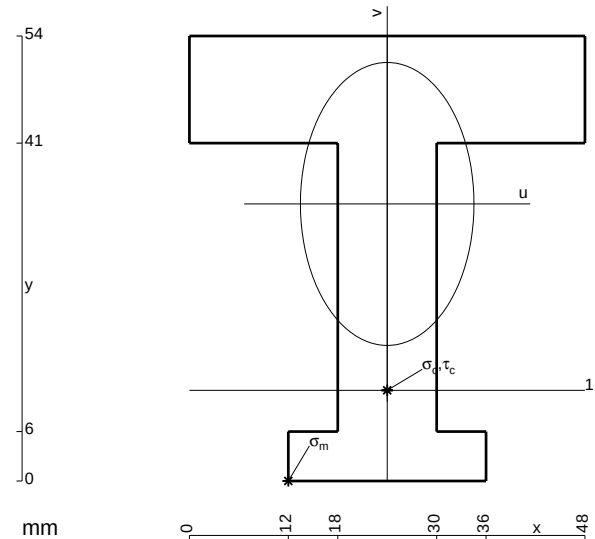
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

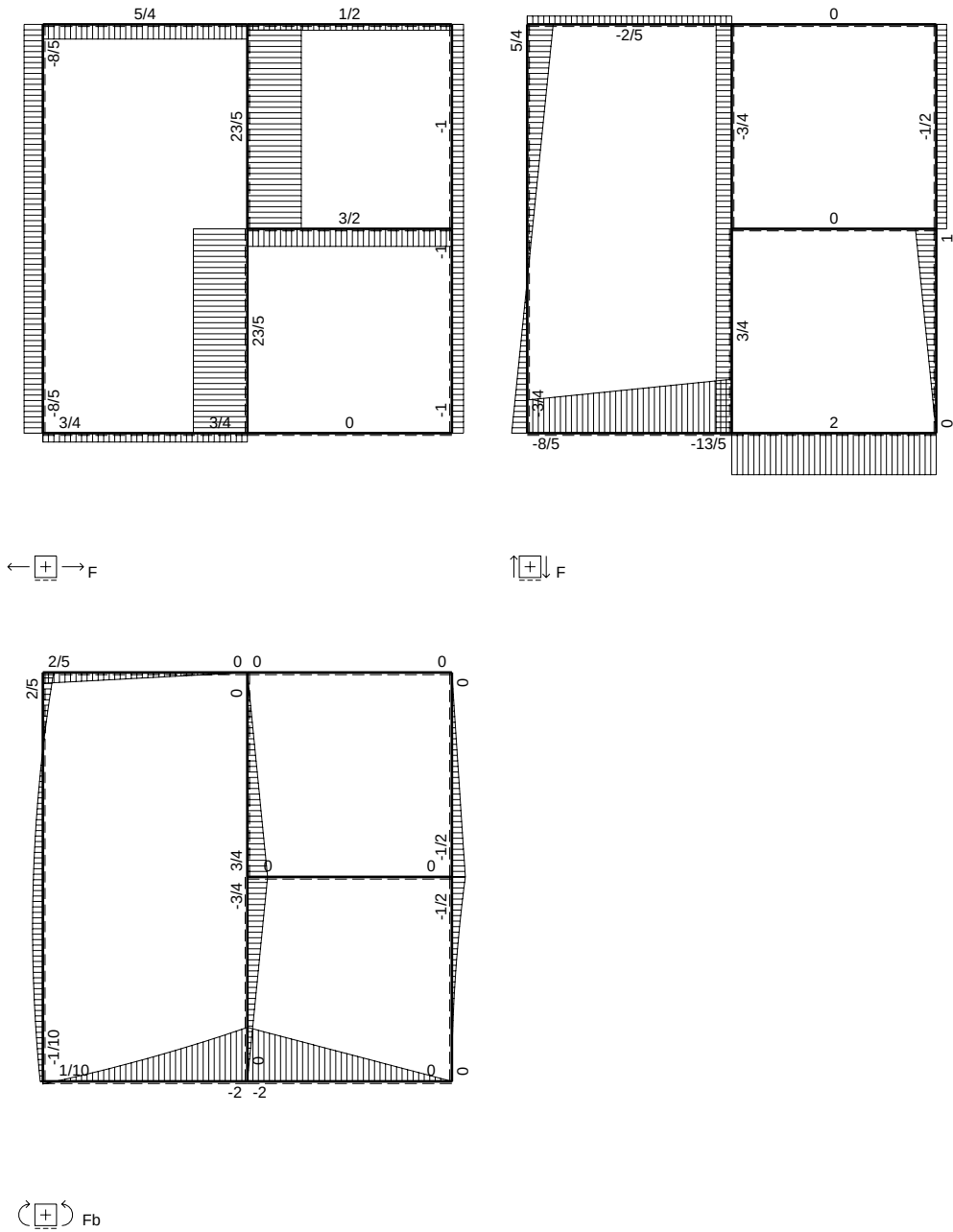
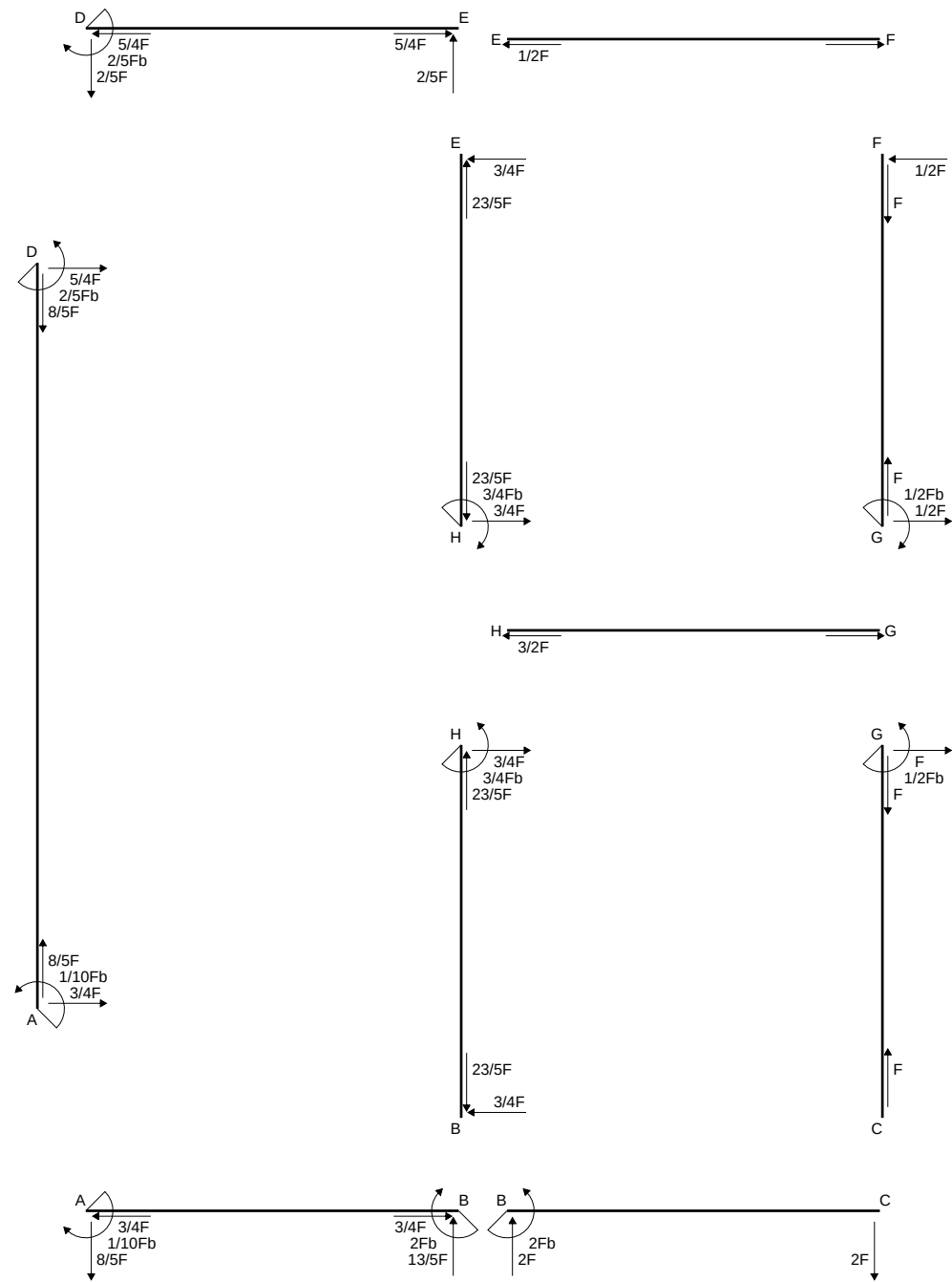
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	$1/2qx^2$	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

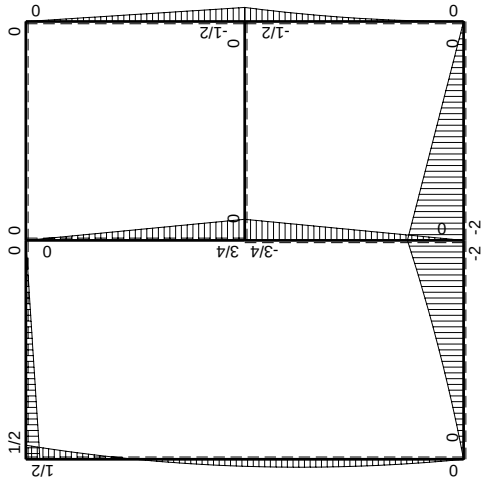
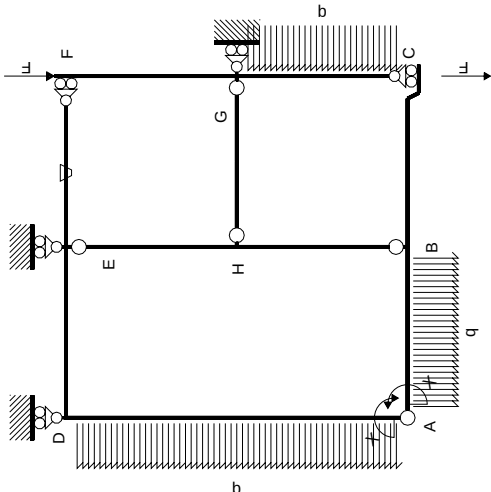
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



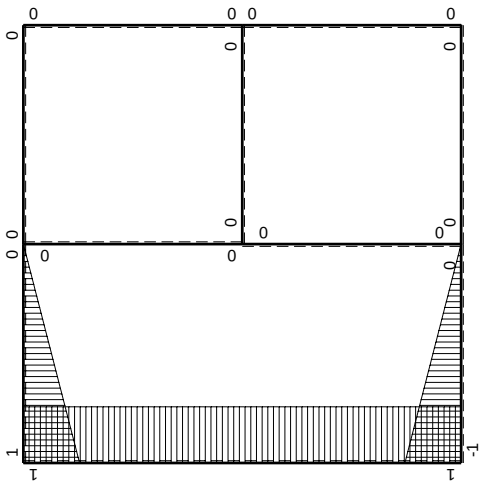
$$\begin{aligned}
A &= 1188. \text{ mm}^2 \\
J_u &= 350338. \text{ mm}^4 \\
J_v &= 131760. \text{ mm}^4 \\
y_g &= 33.62 \text{ mm} \\
T_y &= 3940. \text{ N} \\
M_x &= -2285200. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -33.62 \text{ mm} \\
\sigma_m &= -Mv/J_u = -219.3 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 11. \text{ mm} \\
v_c &= -22.62 \text{ mm} \\
\sigma_c &= -Mv/J_u = -147.6 \text{ N/mm}^2 \\
\tau_c &= 5.545 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma_c^2 + 3\tau_c^2} = 147.9 \text{ N/mm}^2 \\
S &= 5917. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



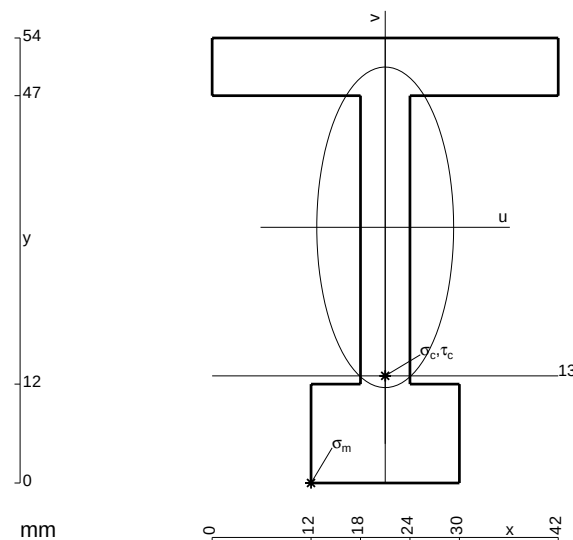
M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

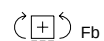
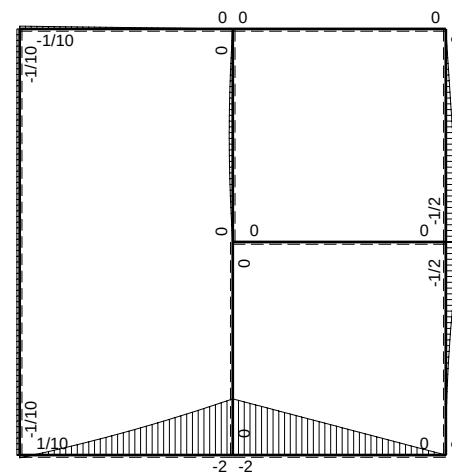
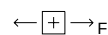
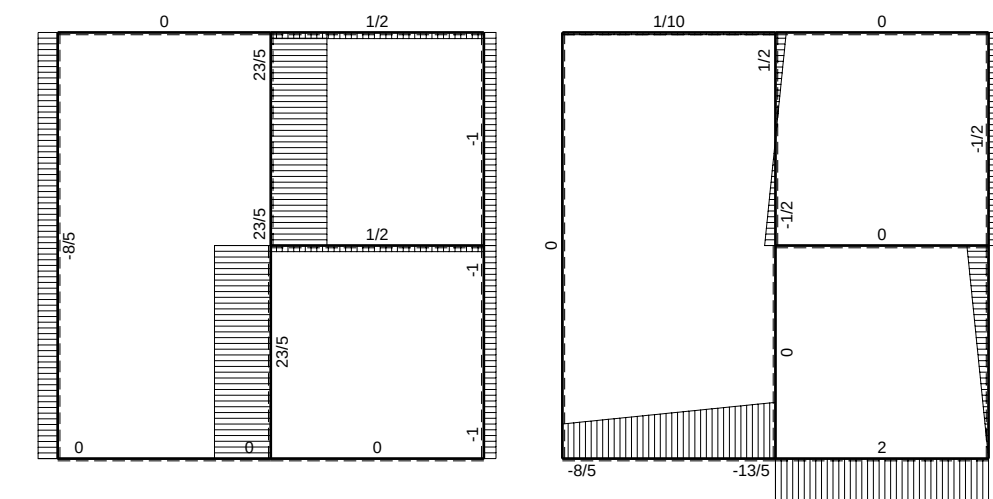
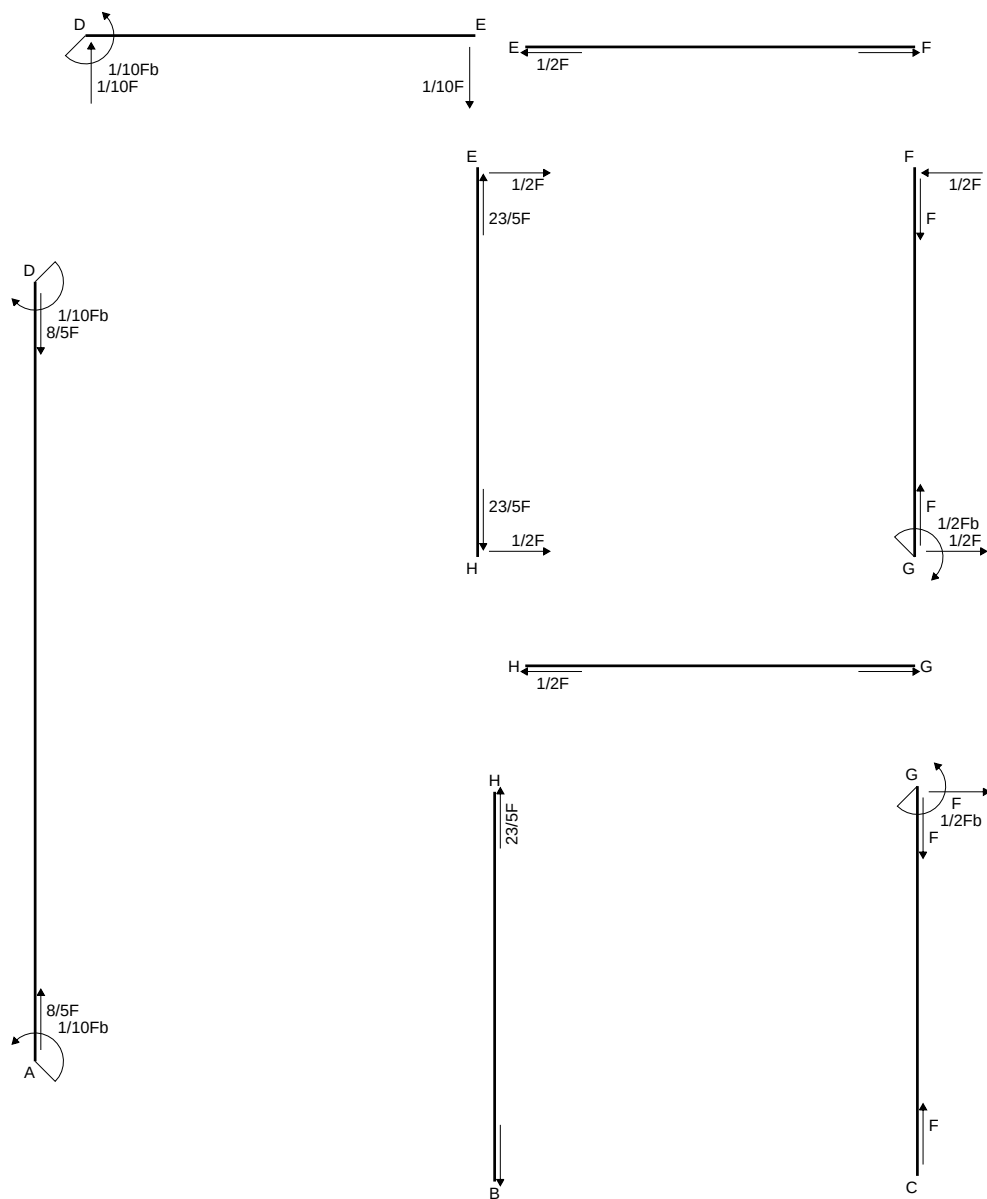
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

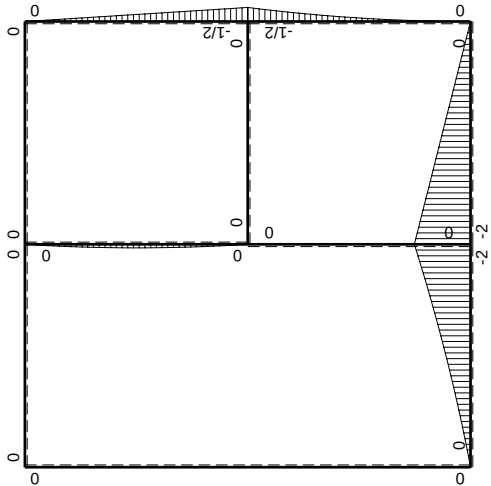
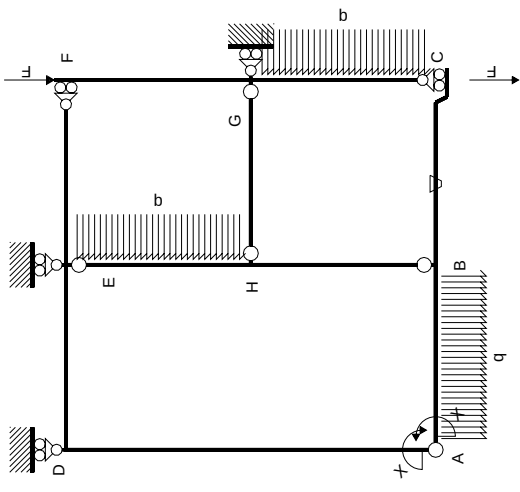
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

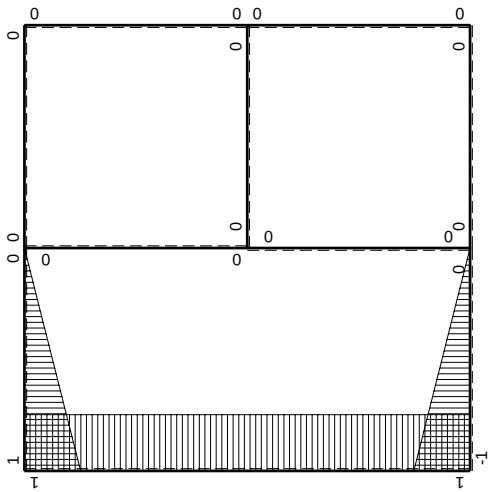


$$\begin{aligned} A &= 720. \text{ mm}^2 \\ J_u &= 272496. \text{ mm}^4 \\ J_v &= 49680. \text{ mm}^4 \\ y_g &= 31.02 \text{ mm} \\ T_y &= 3200. \text{ N} \\ M_x &= -2016000. \text{ Nmm} \\ x_m &= 12. \text{ mm} \\ u_m &= -9. \text{ mm} \\ v_m &= -31.02 \text{ mm} \\ \sigma_m &= -M_v/J_u = -229.5 \text{ N/mm}^2 \\ x_c &= 21. \text{ mm} \\ y_c &= 13. \text{ mm} \\ v_c &= -18.02 \text{ mm} \\ \sigma_c &= -M_v/J_u = -133.4 \text{ N/mm}^2 \\ \tau_c &= 10.8 \text{ N/mm}^2 \\ \sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 134.7 \text{ N/mm}^2 \\ S &= 5517. \text{ mm}^3 \end{aligned}$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

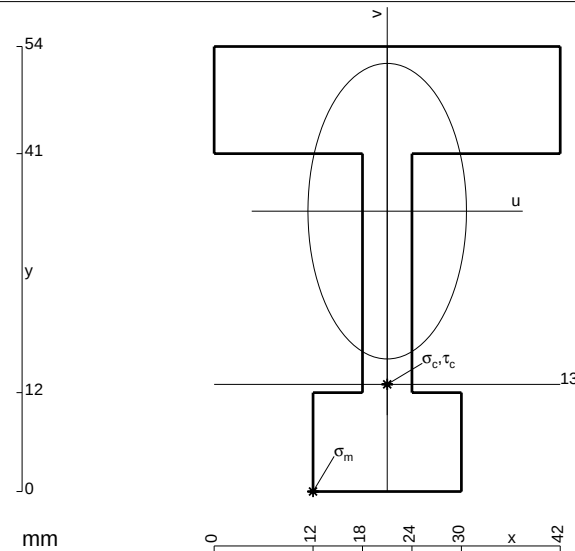
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 936. \text{ mm}^2$$

$$J_u = 301116. \text{ mm}^4$$

$$J_v = 86616. \text{ mm}^4$$

$$y_g = 34.02 \text{ mm}$$

$$T_y = 3120. \text{ N}$$

$$M_x = -2121600. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -34.02 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -239.7 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

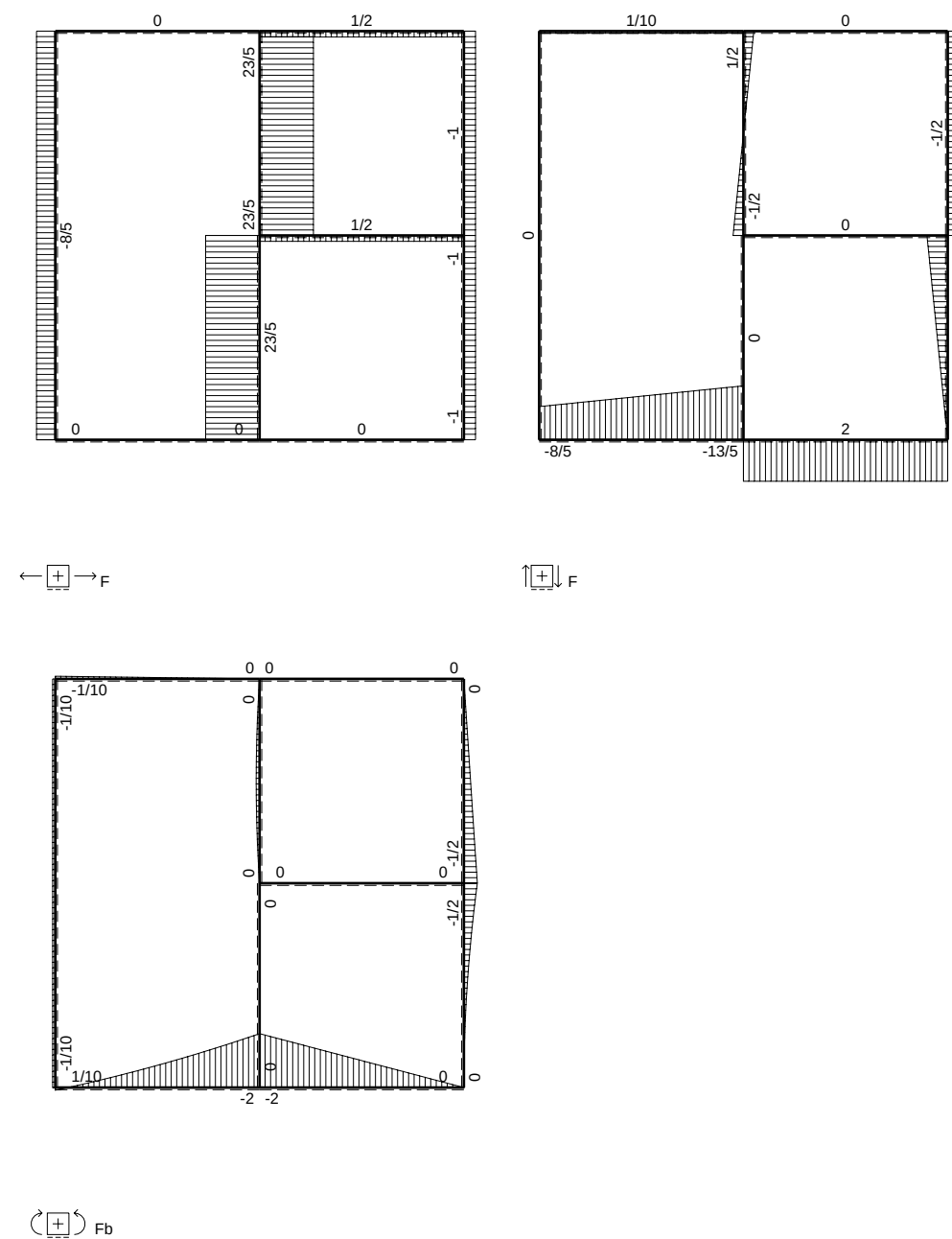
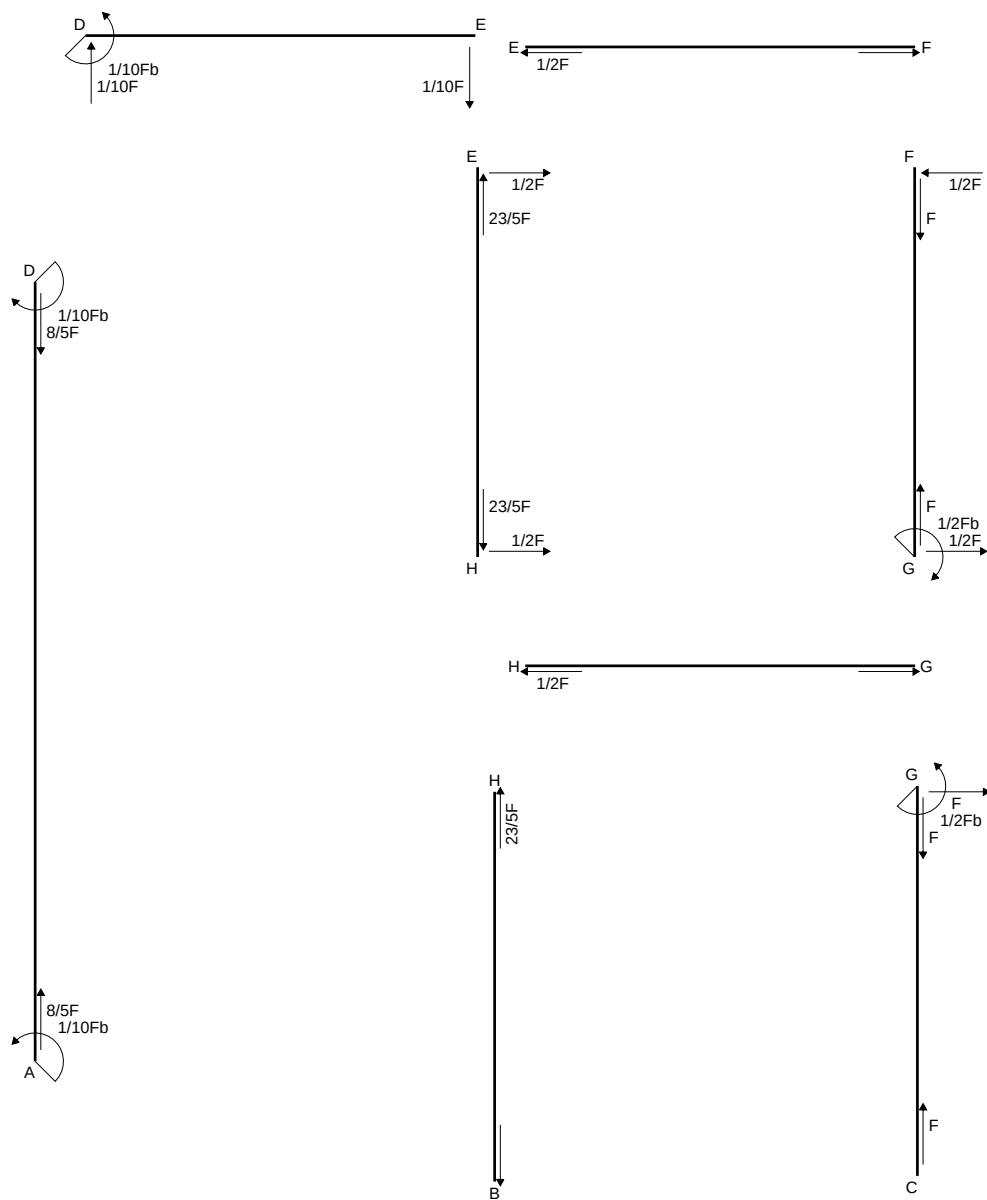
$$v_c = -21.02 \text{ mm}$$

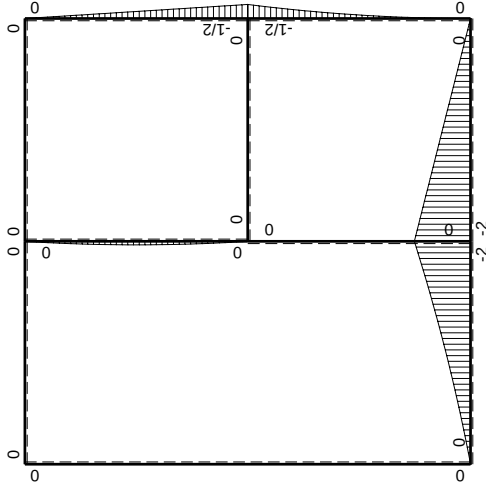
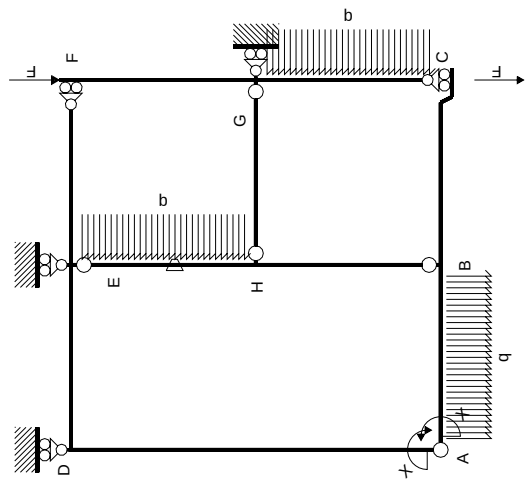
$$\sigma_c = -Mv/J_u = -148.1 \text{ N/mm}^2$$

$$\tau_c = 10.67 \text{ N/mm}^2$$

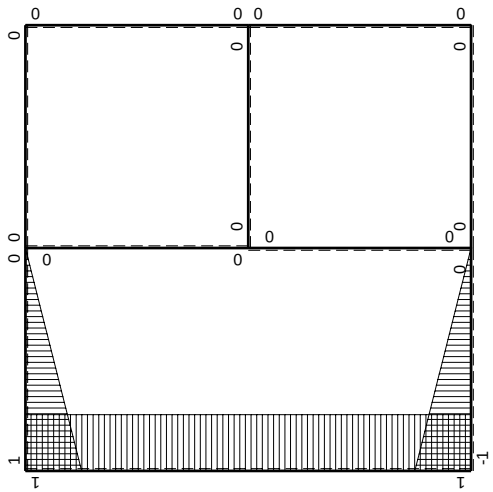
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 149.2 \text{ N/mm}^2$$

$$S = 6181. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

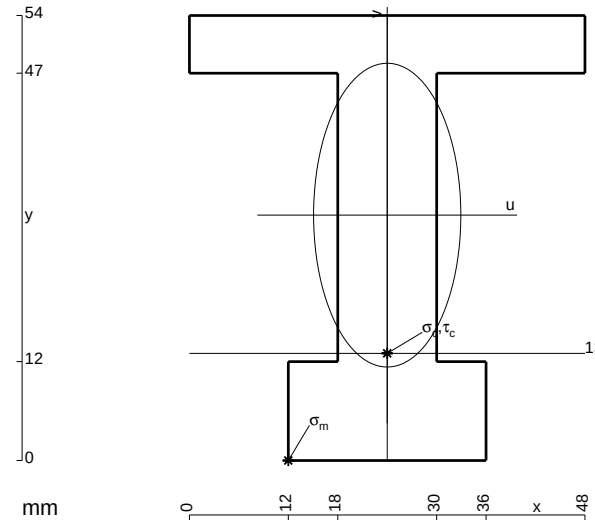
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 1044. \text{ mm}^2$$

$$J_u = 354848. \text{ mm}^4$$

$$J_v = 83376. \text{ mm}^4$$

$$y_g = 29.78 \text{ mm}$$

$$T_y = 3260. \text{ N}$$

$$M_x = -2379800. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -29.78 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -199.7 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

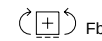
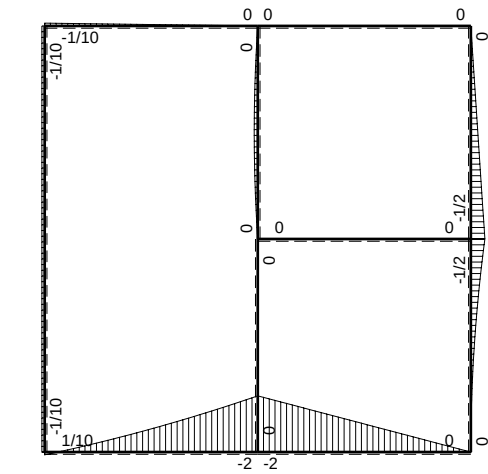
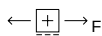
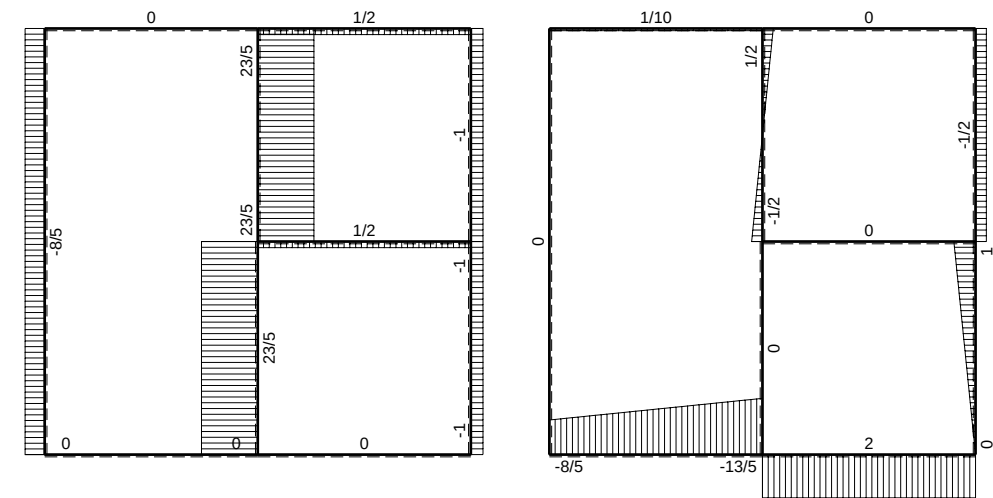
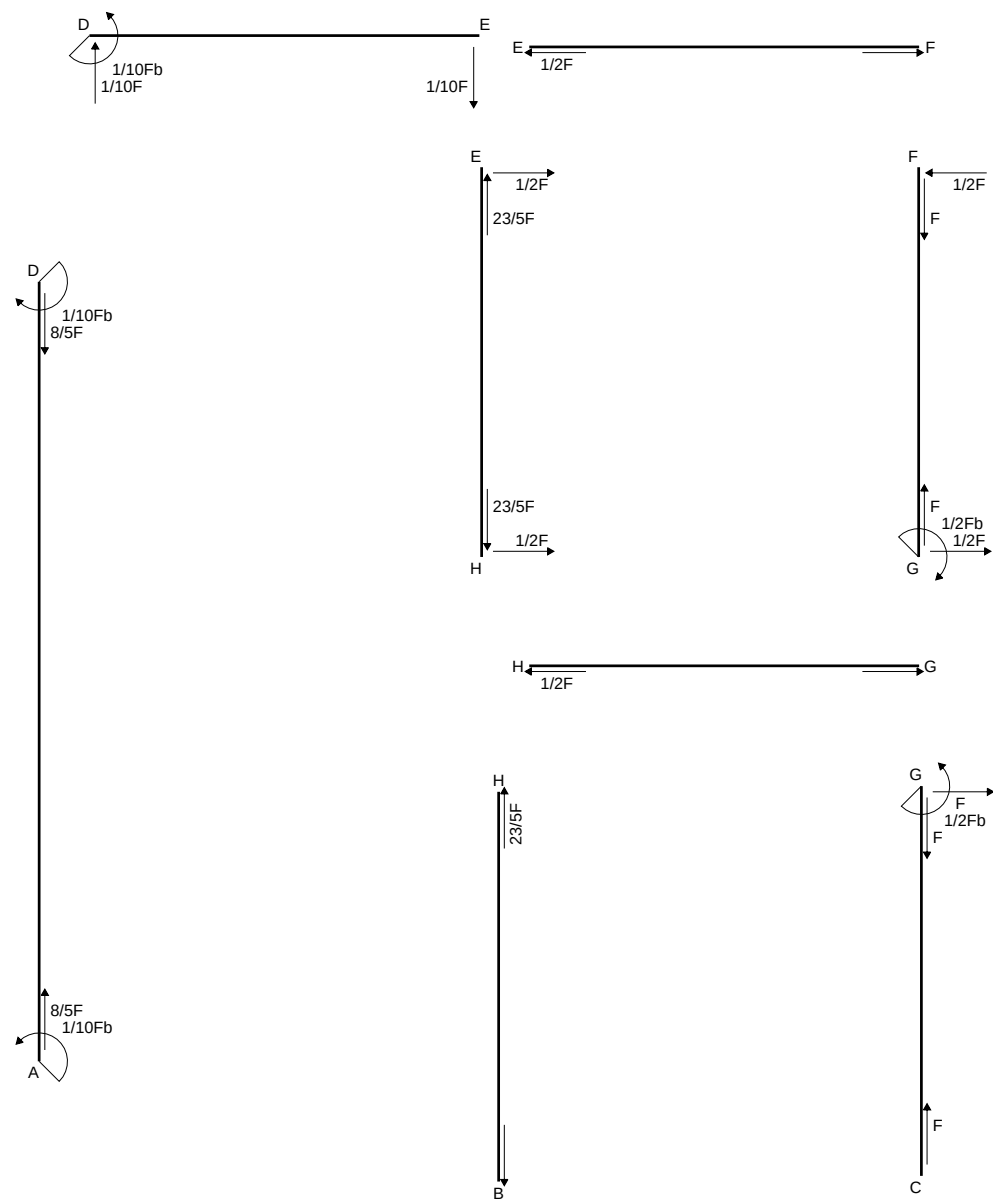
$$v_c = -16.78 \text{ mm}$$

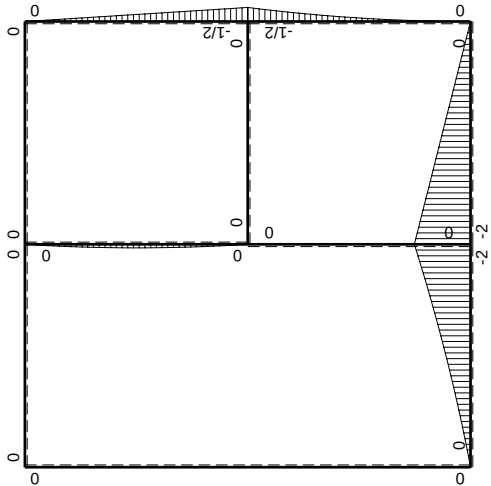
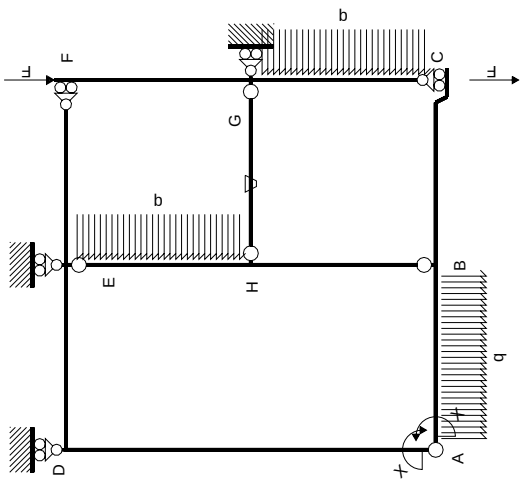
$$\sigma_c = -Mv/J_u = -112.5 \text{ N/mm}^2$$

$$\tau_c = 5.401 \text{ N/mm}^2$$

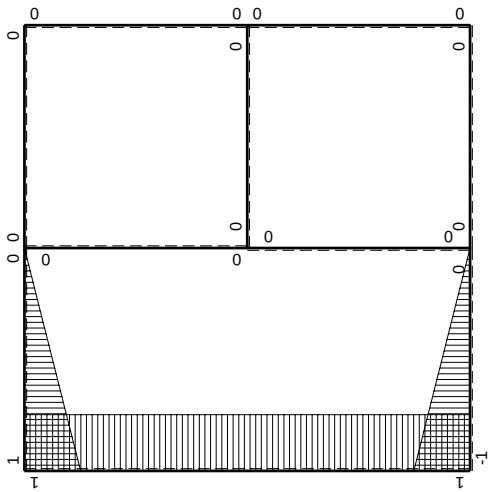
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 112.9 \text{ N/mm}^2$$

$$S = 7055. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

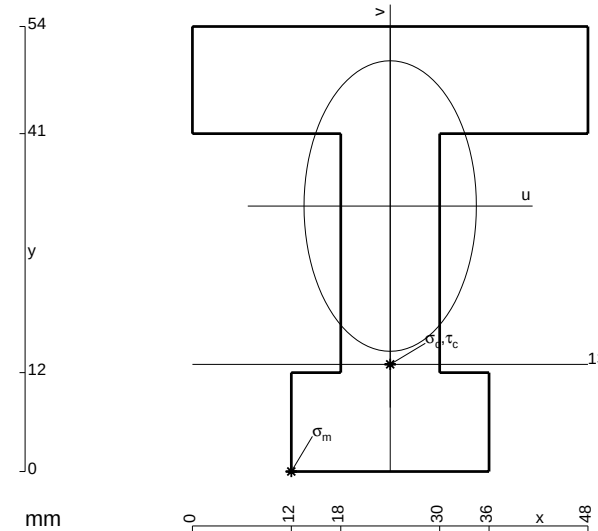
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 1260. \text{ mm}^2$$

$$J_u = 391706. \text{ mm}^4$$

$$J_v = 137808. \text{ mm}^4$$

$$y_g = 32.21 \text{ mm}$$

$$T_y = 3260. \text{ N}$$

$$M_x = -2542800. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -32.21 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -209.1 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

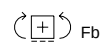
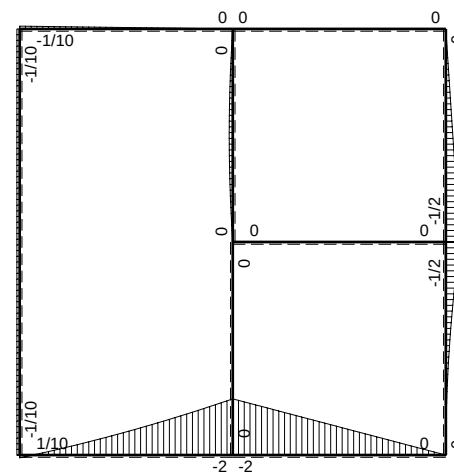
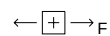
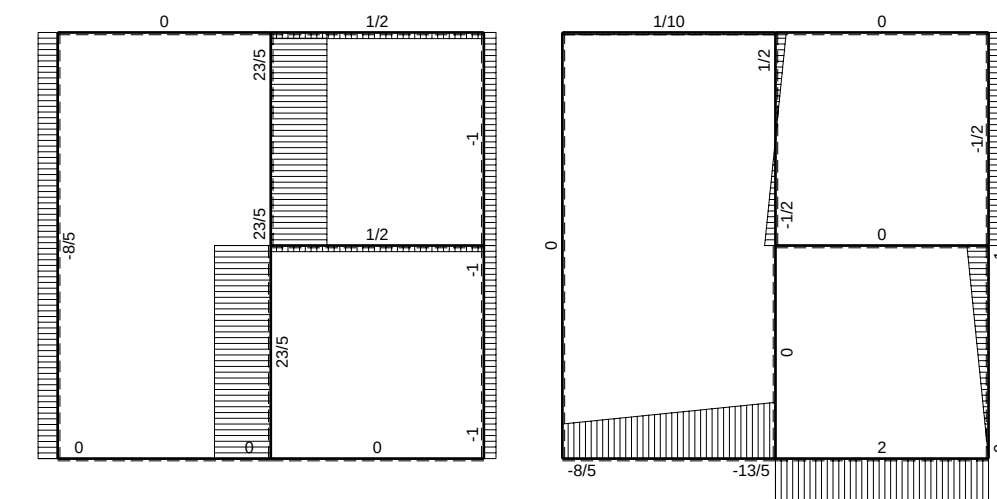
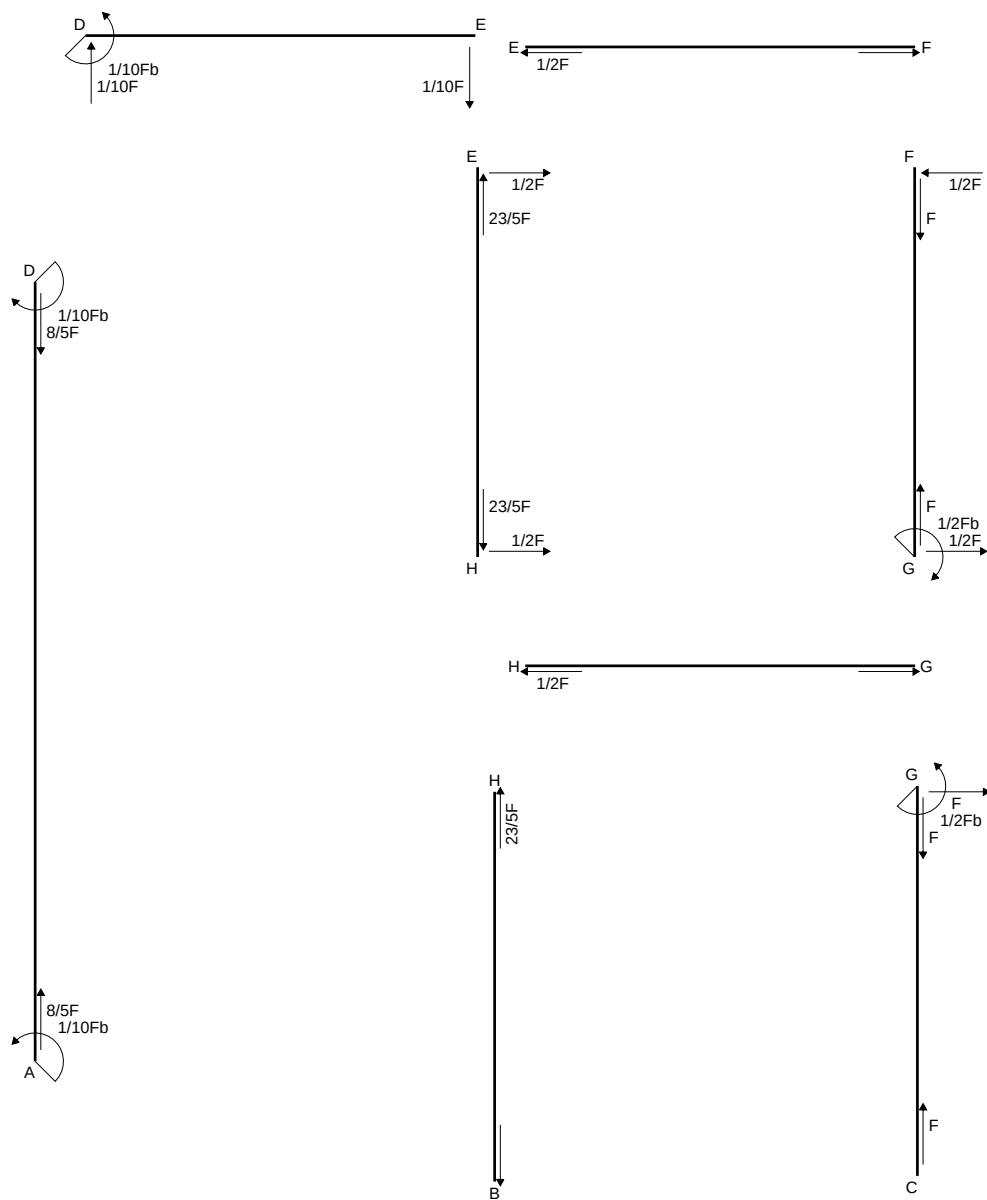
$$v_c = -19.21 \text{ mm}$$

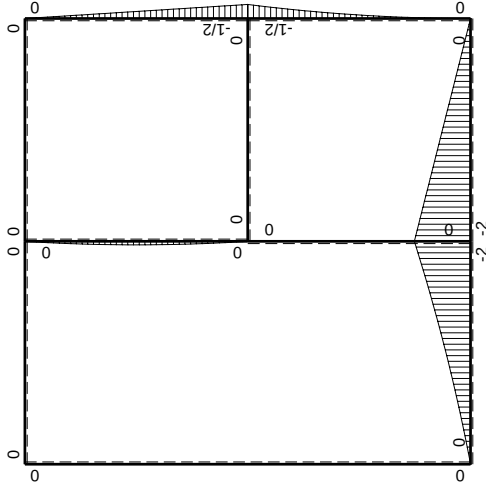
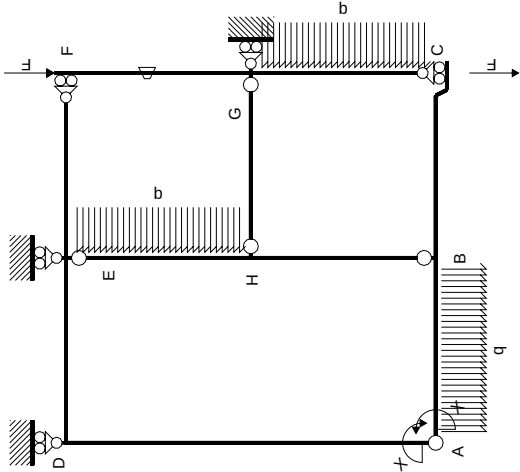
$$\sigma_c = -Mv/J_u = -124.7 \text{ N/mm}^2$$

$$\tau_c = 5.4 \text{ N/mm}^2$$

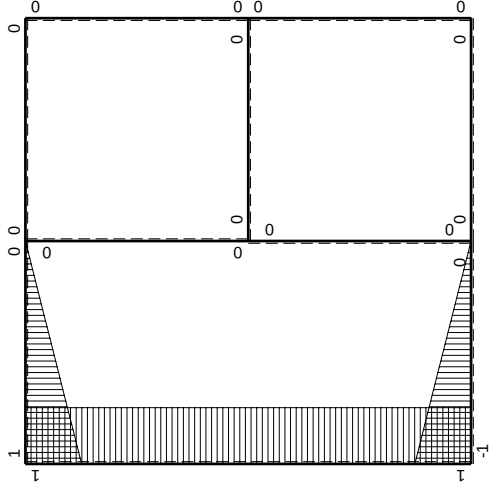
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 125.1 \text{ N/mm}^2$$

$$S = 7786. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	Fb/EJ	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

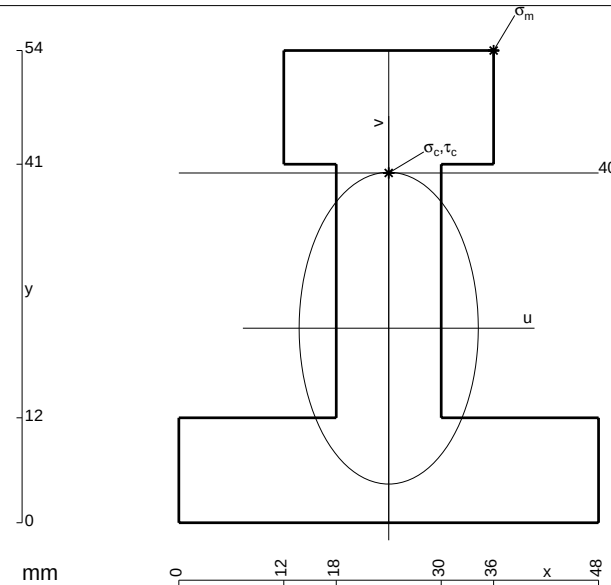
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 1236. \text{ mm}^2$$

$$J_u = 393000. \text{ mm}^4$$

$$J_v = 129744. \text{ mm}^4$$

$$y_g = 22.25 \text{ mm}$$

$$T_y = 3280. \text{ N}$$

$$M_x = -2722400. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 54. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 31.75 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 220. \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

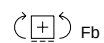
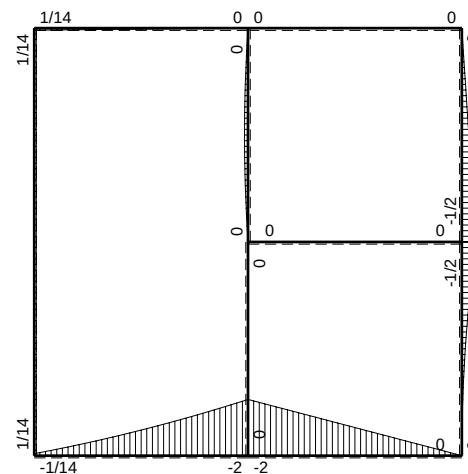
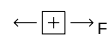
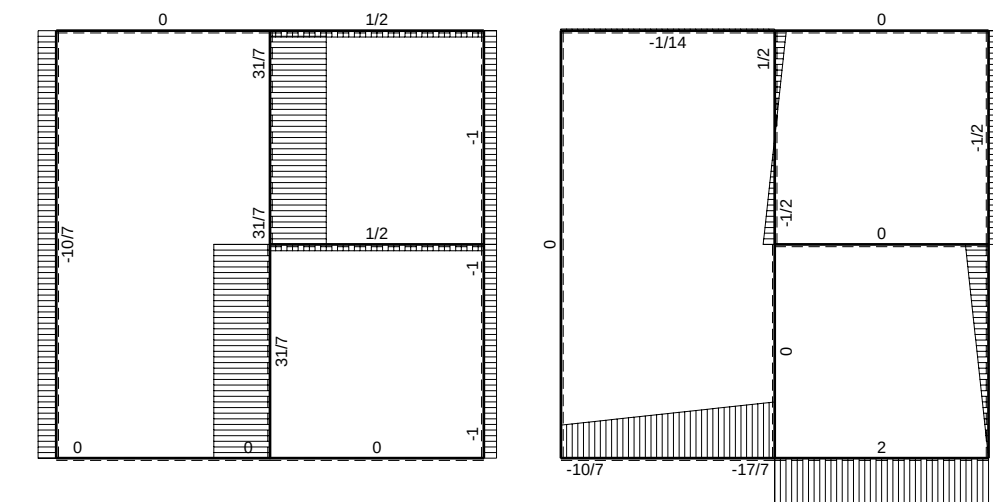
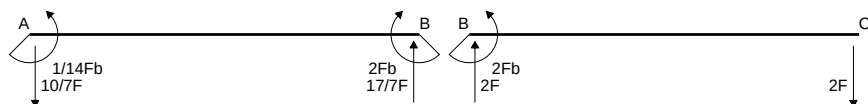
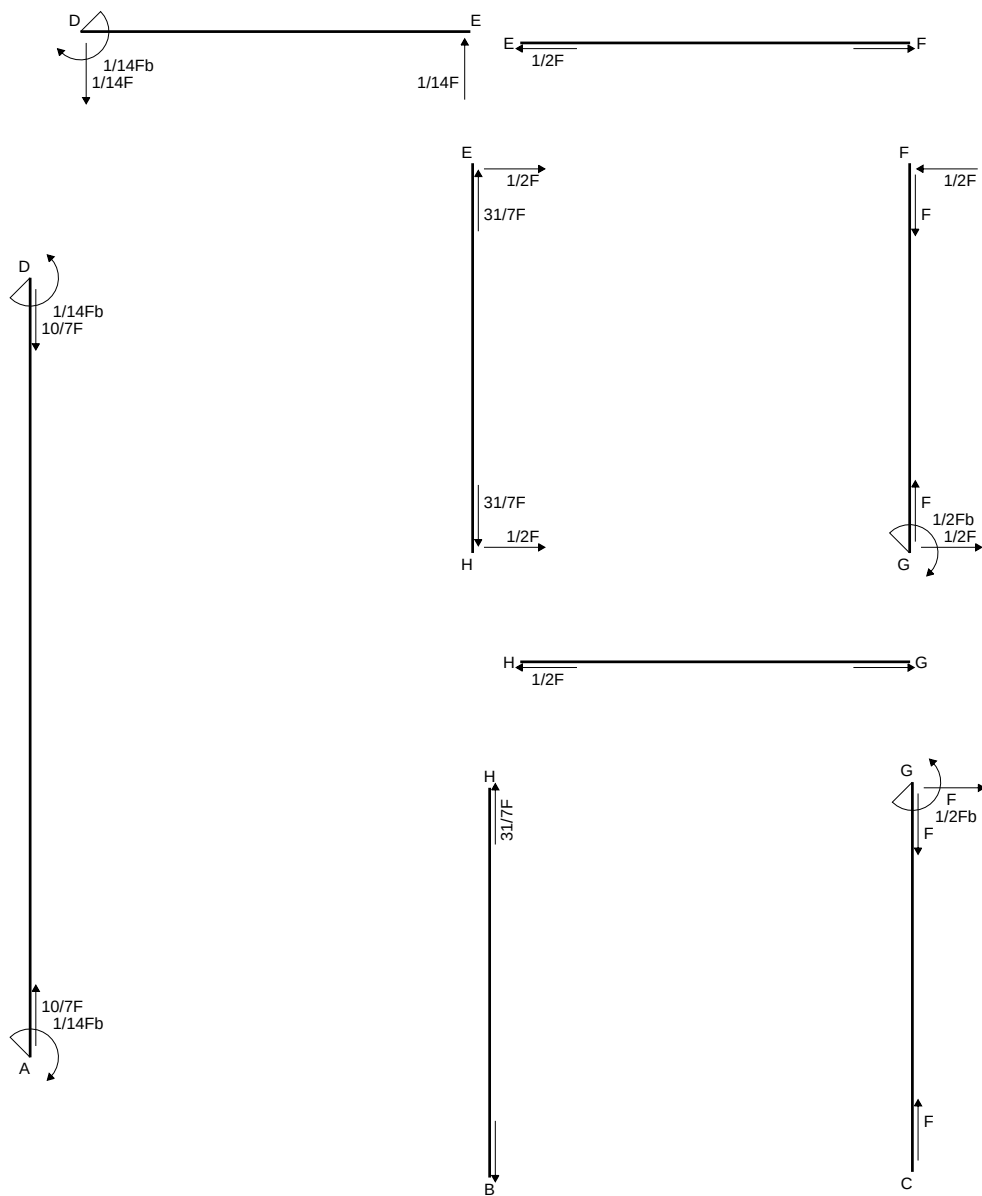
$$v_c = 17.75 \text{ mm}$$

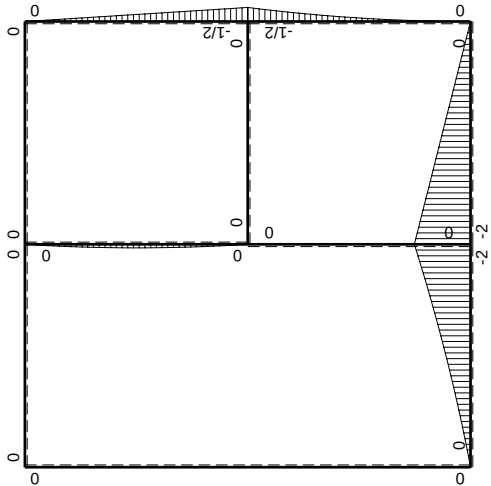
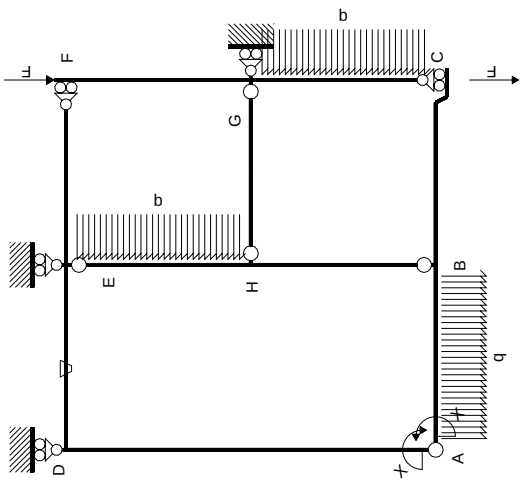
$$\sigma_c = -Mv/J_u = 123. \text{ N/mm}^2$$

$$\tau_c = 5.632 \text{ N/mm}^2$$

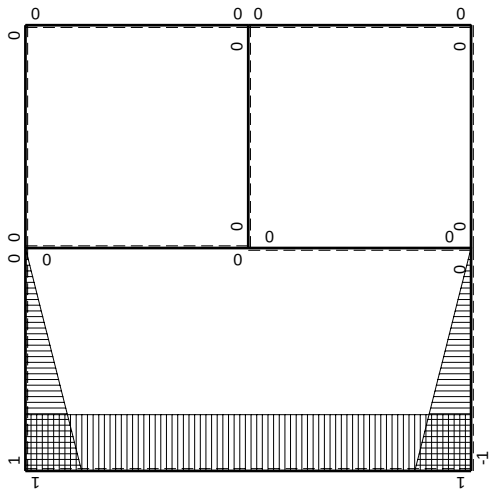
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 123.4 \text{ N/mm}^2$$

$$S = 8098. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	$-Fb/EJ$	0	$-Fb/EJ+Fx/EJ$	$1-2x/b+x^2/b^2$	$(0-1/2)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	0	Fb/EJ	0	$-Fx/EJ$	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/14Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

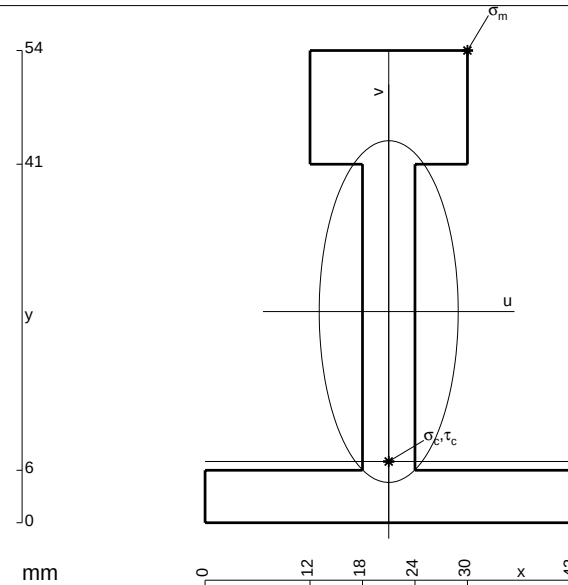
$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{DE}^{x_0} = \int_0^b (-1 + x/b) \theta dx = \left[-x + 1/2 x^2/b \right]_0^b \theta$$

$$= (-b + 1/2 b) \theta = -1/2 \frac{Fb^2}{EJ}$$

$$L_{ED}^{x_0} = \int_0^b (x/b) \theta dx = \left[1/2 x^2/b \right]_0^b \theta$$

$$= (1/2 b) \theta = -1/2 \frac{Fb^2}{EJ}$$



$$A = 696. \text{ mm}^2$$

$$J_u = 265885. \text{ mm}^4$$

$$J_v = 43992. \text{ mm}^4$$

$$y_g = 24.15 \text{ mm}$$

$$T_y = 2320. \text{ N}$$

$$M_x = -2041600. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 54. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 29.85 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 229.2 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 7. \text{ mm}$$

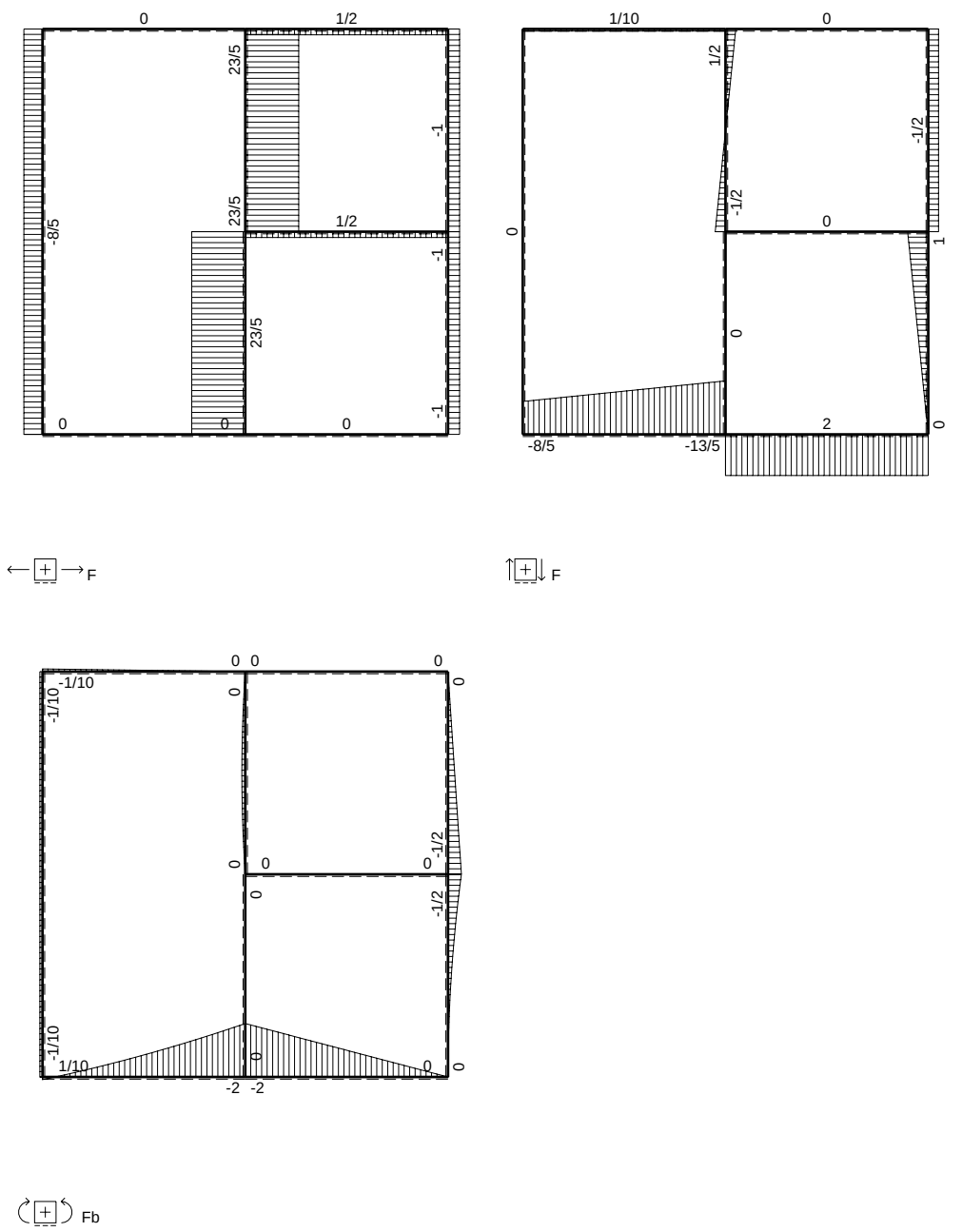
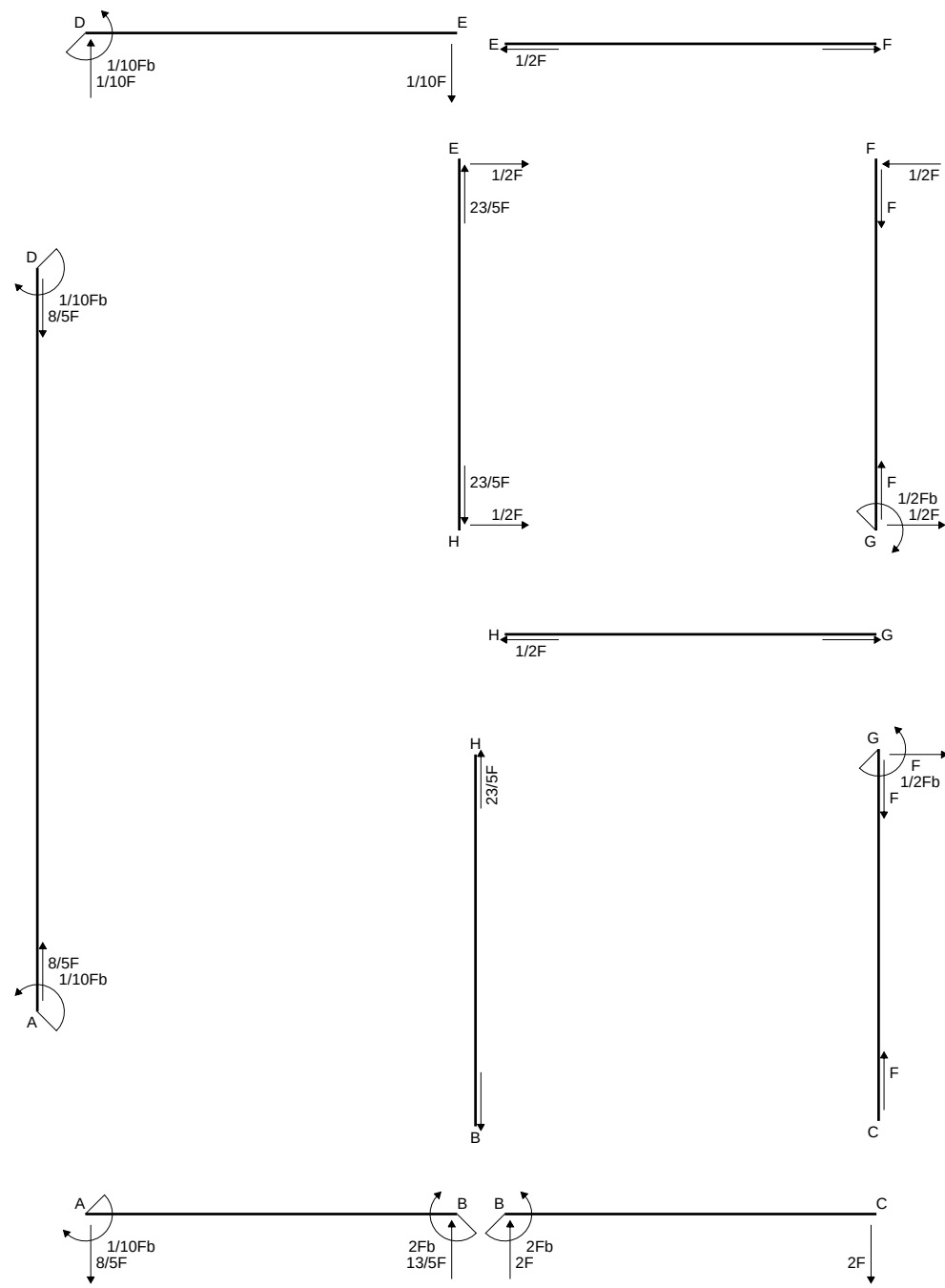
$$v_c = -17.15 \text{ mm}$$

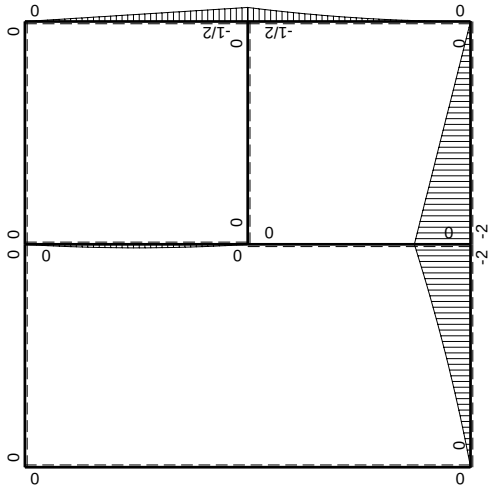
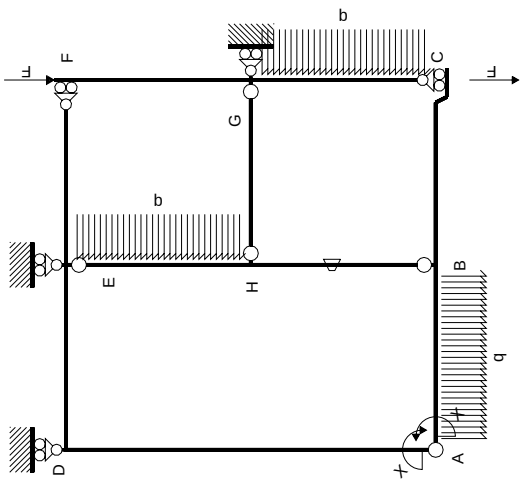
$$\sigma_c = -Mv/J_u = -131.7 \text{ N/mm}^2$$

$$\tau_c = 7.904 \text{ N/mm}^2$$

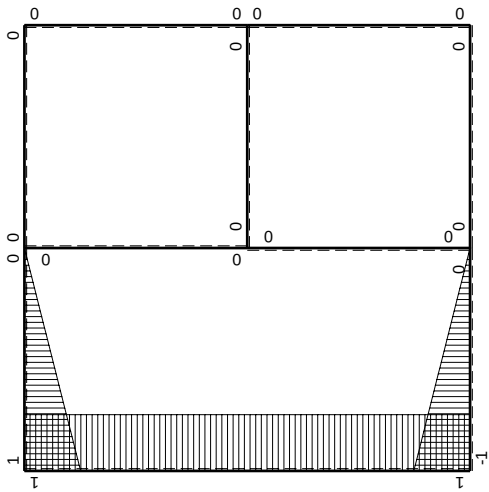
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 132.4 \text{ N/mm}^2$$

$$S = 5435. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	0	Fb/EJ	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

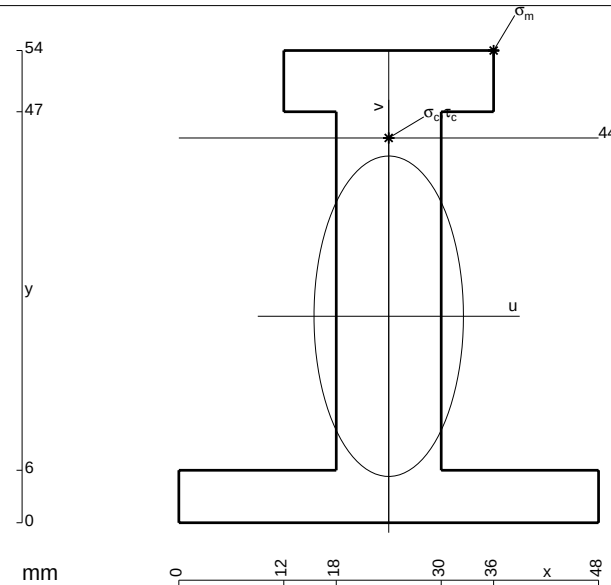
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 948. \text{ mm}^2$$

$$J_u = 318391. \text{ mm}^4$$

$$J_v = 69264. \text{ mm}^4$$

$$y_g = 23.61 \text{ mm}$$

$$T_y = 2700. \text{ N}$$

$$M_x = -2511000. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 54. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 30.39 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 239.6 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 44. \text{ mm}$$

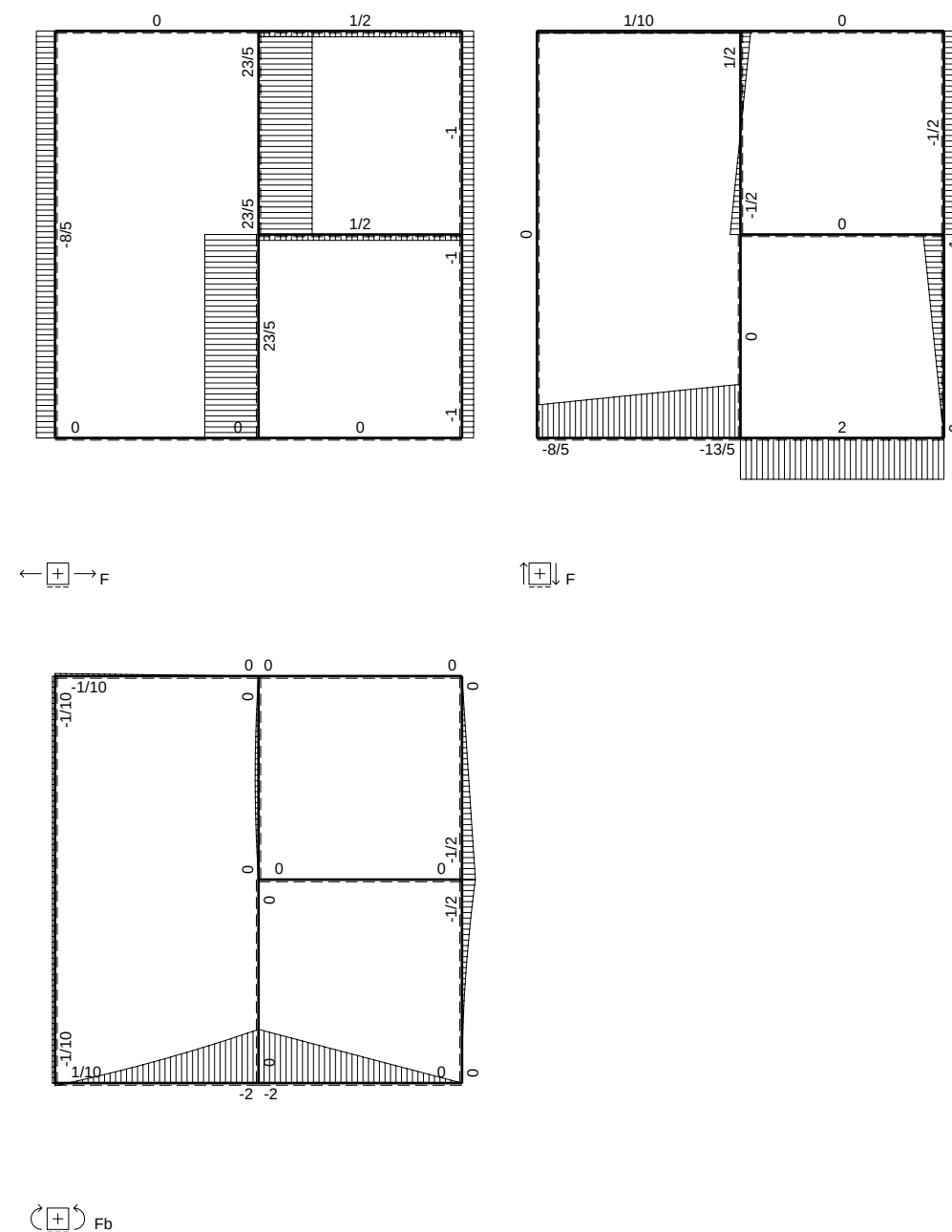
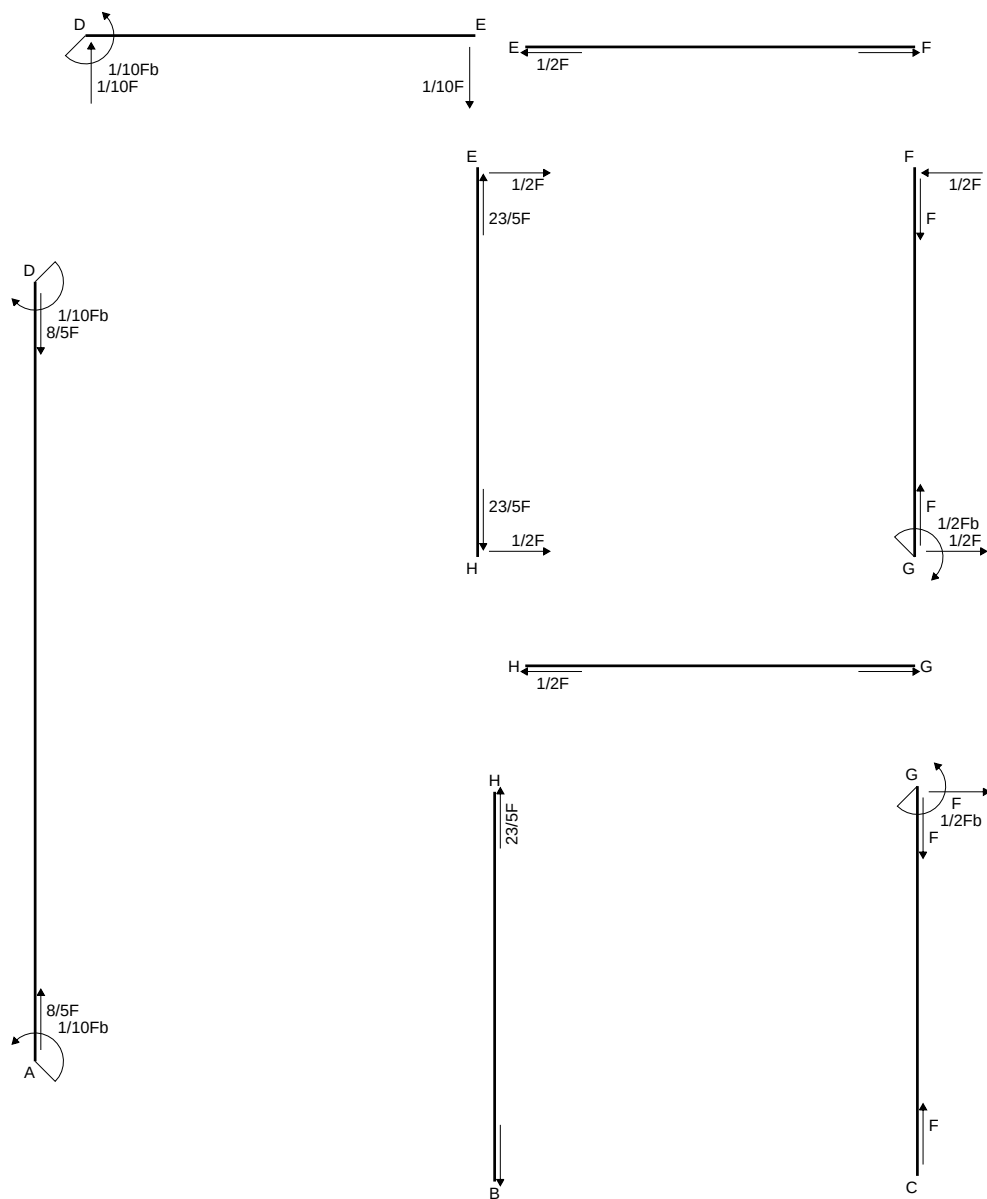
$$v_c = 20.39 \text{ mm}$$

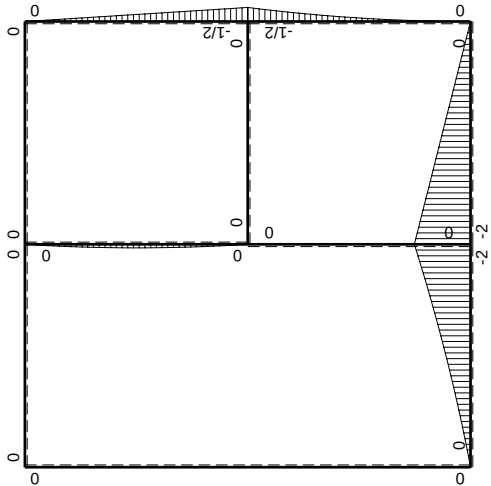
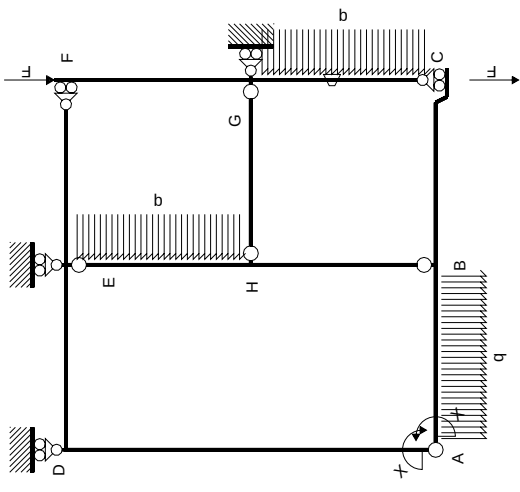
$$\sigma_c = -Mv/J_u = 160.8 \text{ N/mm}^2$$

$$\tau_c = 3.749 \text{ N/mm}^2$$

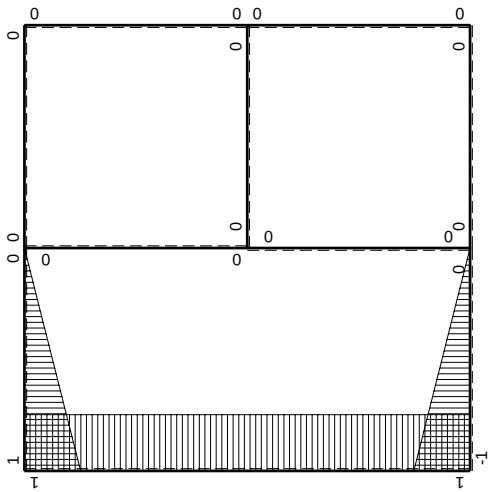
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 160.9 \text{ N/mm}^2$$

$$S = 5305. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	$1/2qx^2$	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

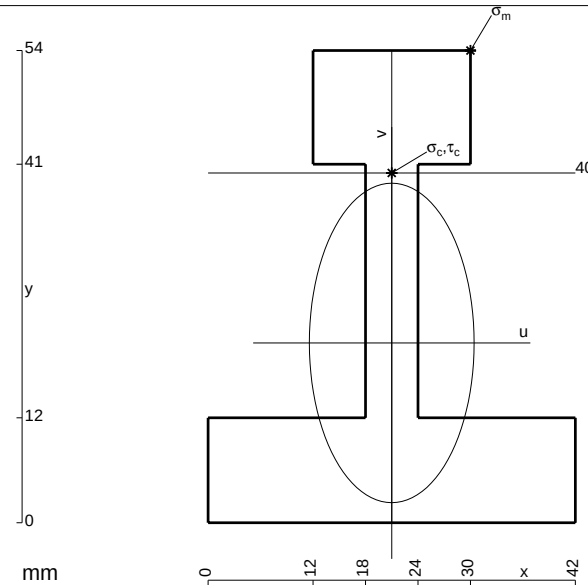
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 912. \text{ mm}^2$$

$$J_u = 304351. \text{ mm}^4$$

$$J_v = 80928. \text{ mm}^4$$

$$y_g = 20.56 \text{ mm}$$

$$T_y = 3700. \text{ N}$$

$$M_x = -1813000. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 54. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 33.44 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 199.2 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

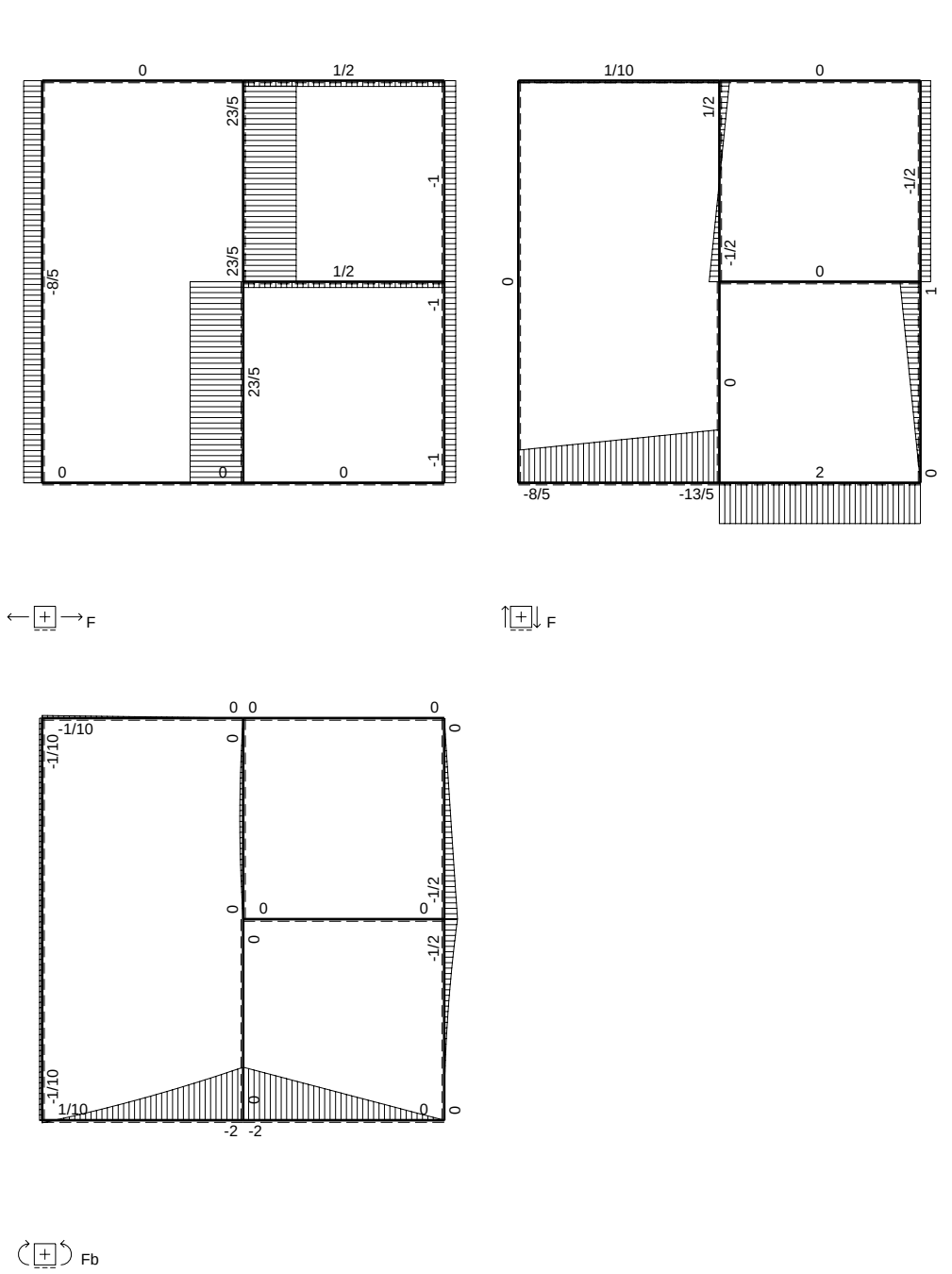
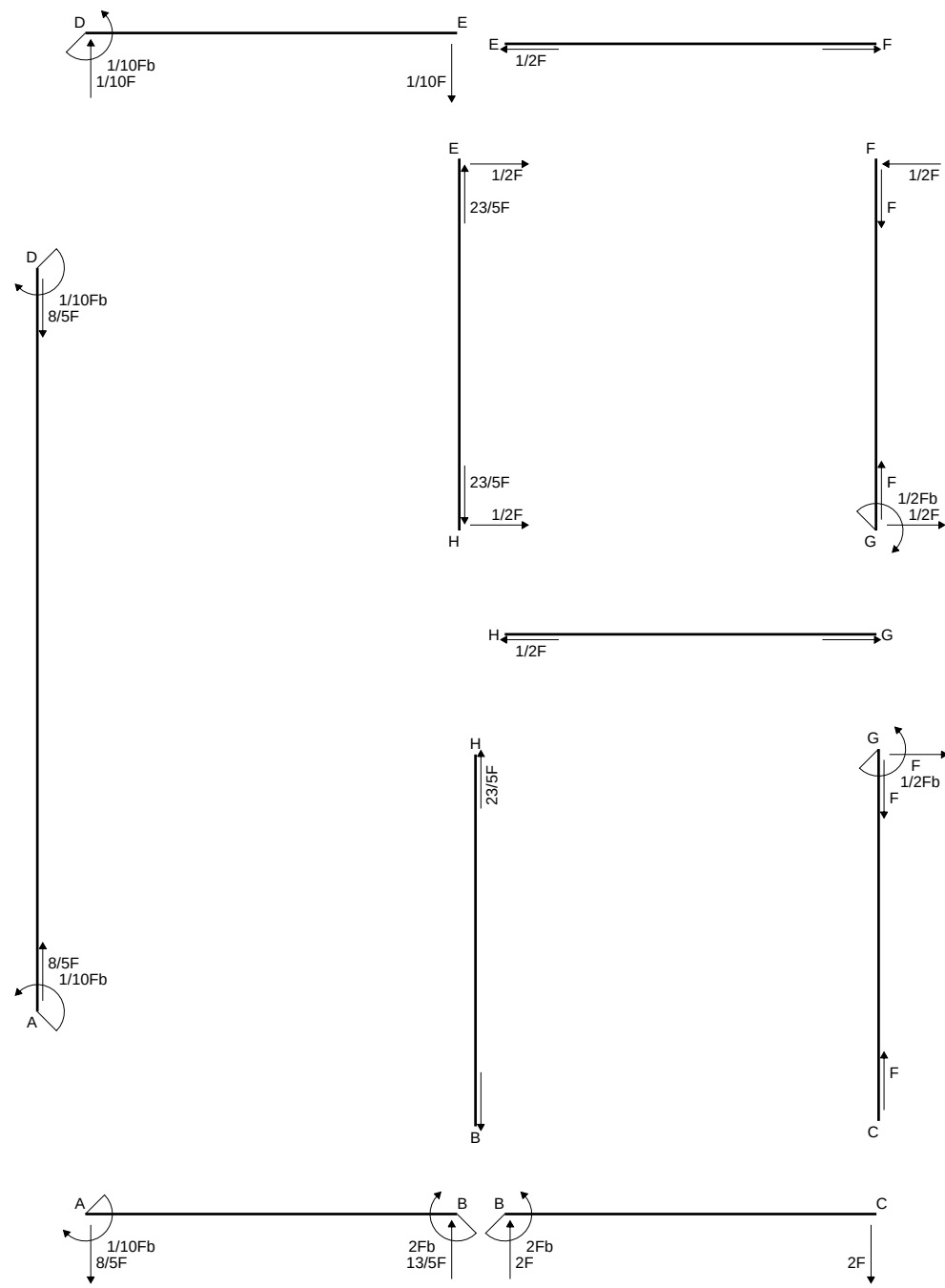
$$v_c = 19.44 \text{ mm}$$

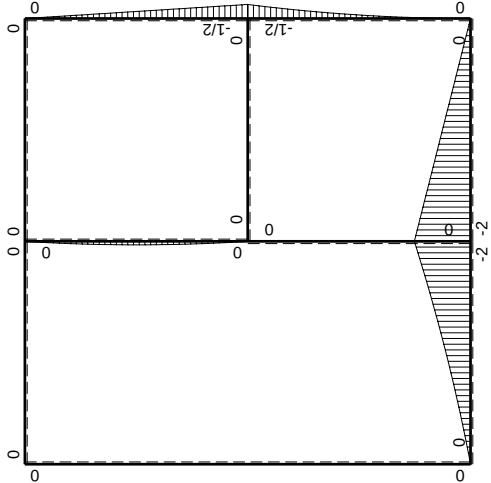
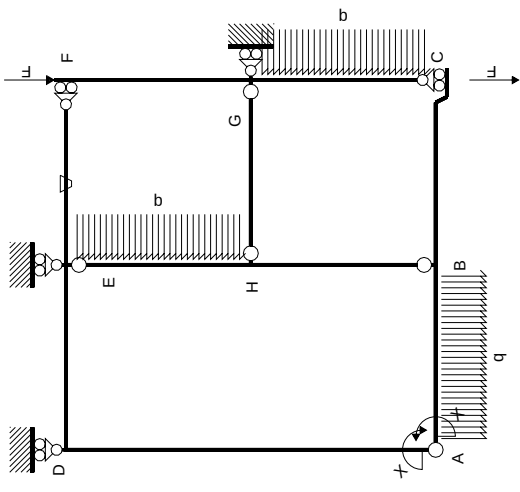
$$\sigma_c = -Mv/J_u = 115.8 \text{ N/mm}^2$$

$$\tau_c = 13.02 \text{ N/mm}^2$$

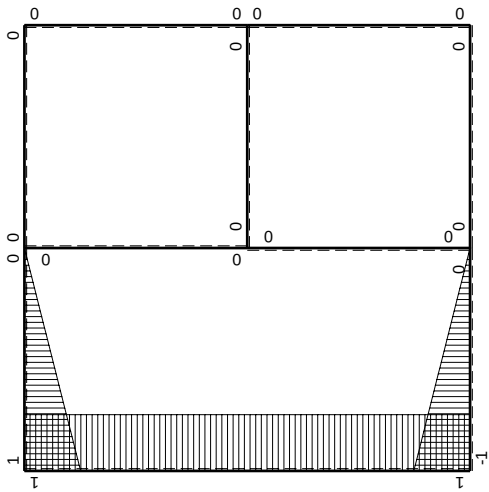
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 118. \text{ N/mm}^2$$

$$S = 6424. \text{ mm}^3$$





 M_0 flessione da carichi assegnati



 M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

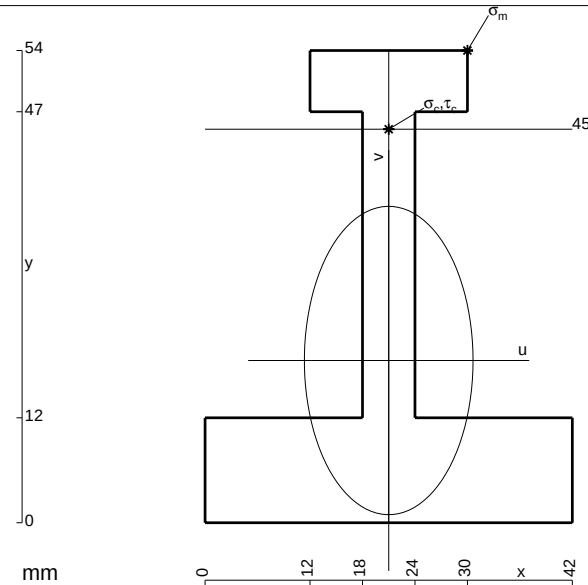
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 840. \text{ mm}^2$$

$$J_u = 261182. \text{ mm}^4$$

$$J_v = 78120. \text{ mm}^4$$

$$y_g = 18.55 \text{ mm}$$

$$T_y = 2900. \text{ N}$$

$$M_x = -1537000. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 54. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 35.45 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 208.6 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 45. \text{ mm}$$

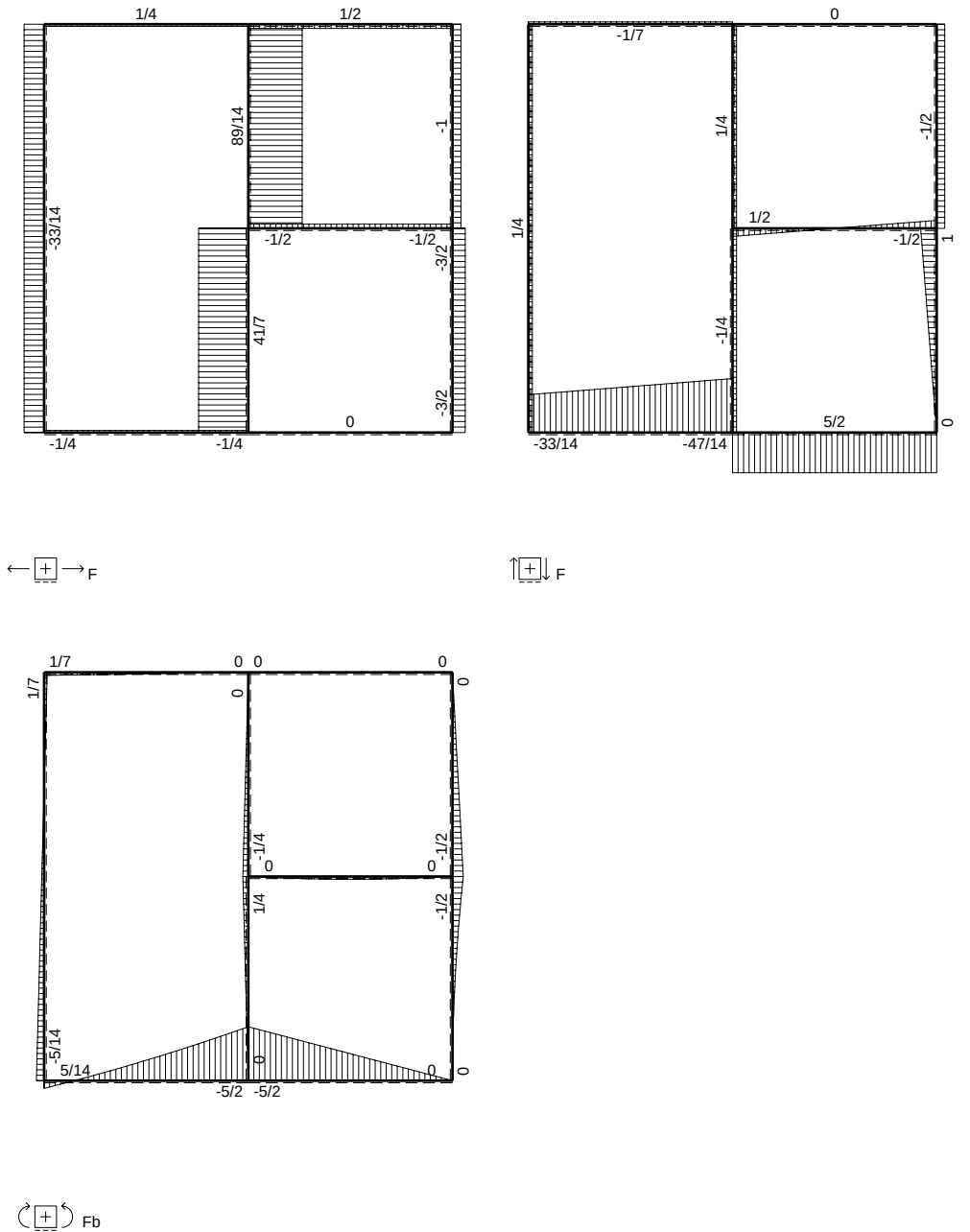
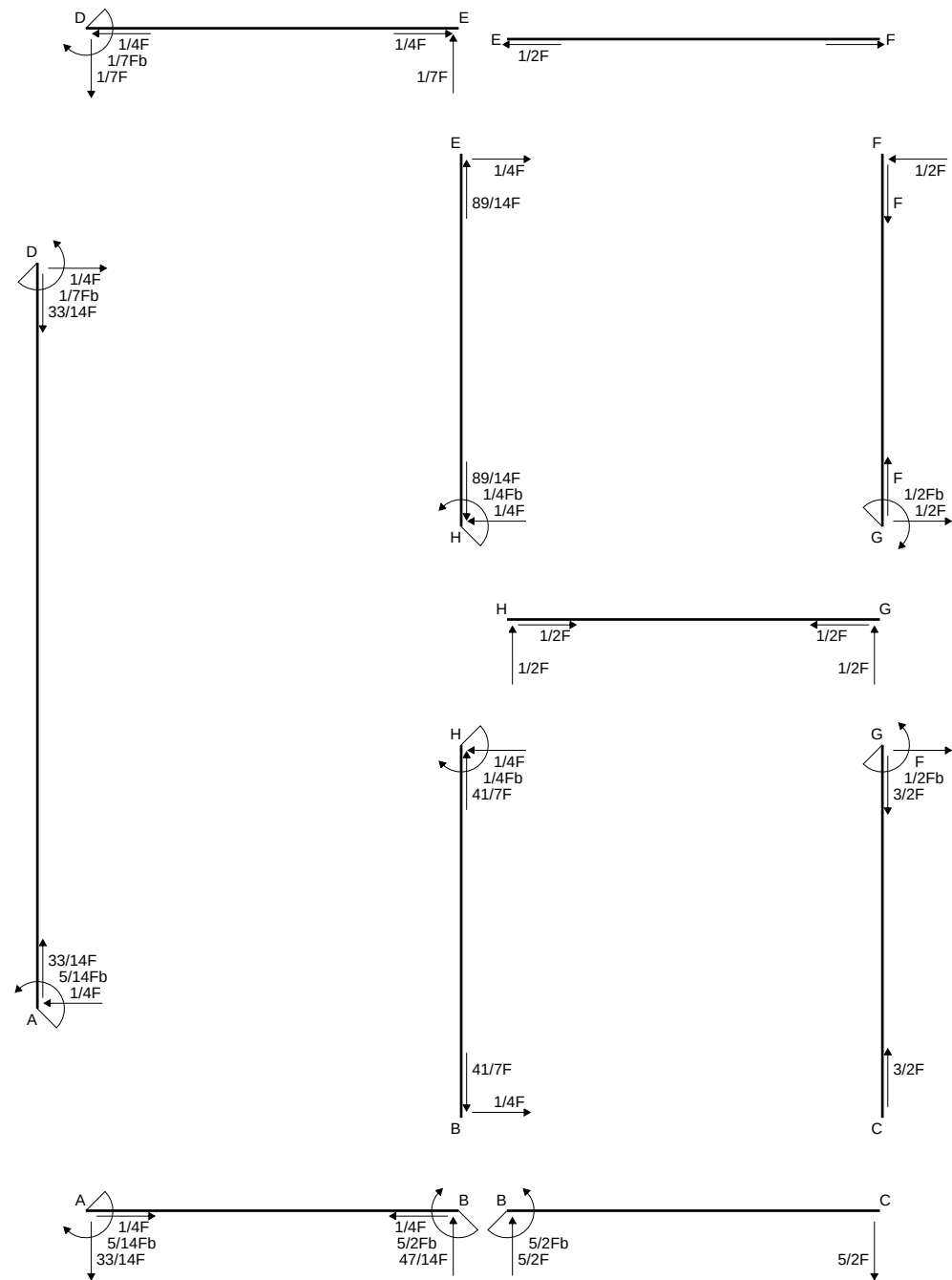
$$v_c = 26.45 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 155.7 \text{ N/mm}^2$$

$$\tau_c = 8.059 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 156.3 \text{ N/mm}^2$$

$$S = 4355. \text{ mm}^3$$

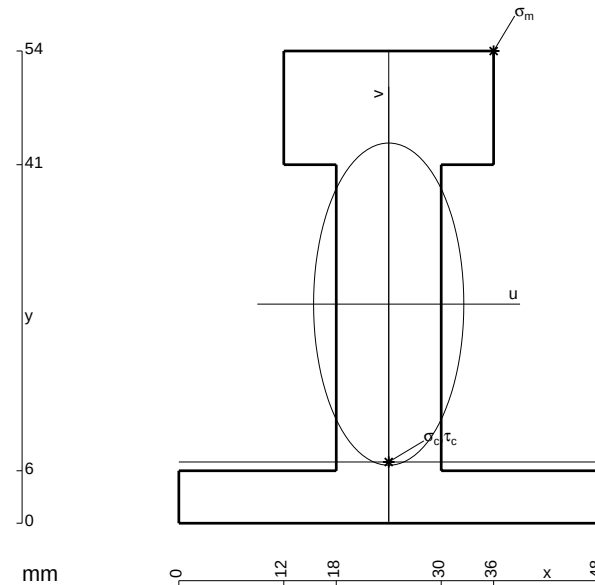


Quadro contributi PLV per iperstatica $X=W_{AB}$

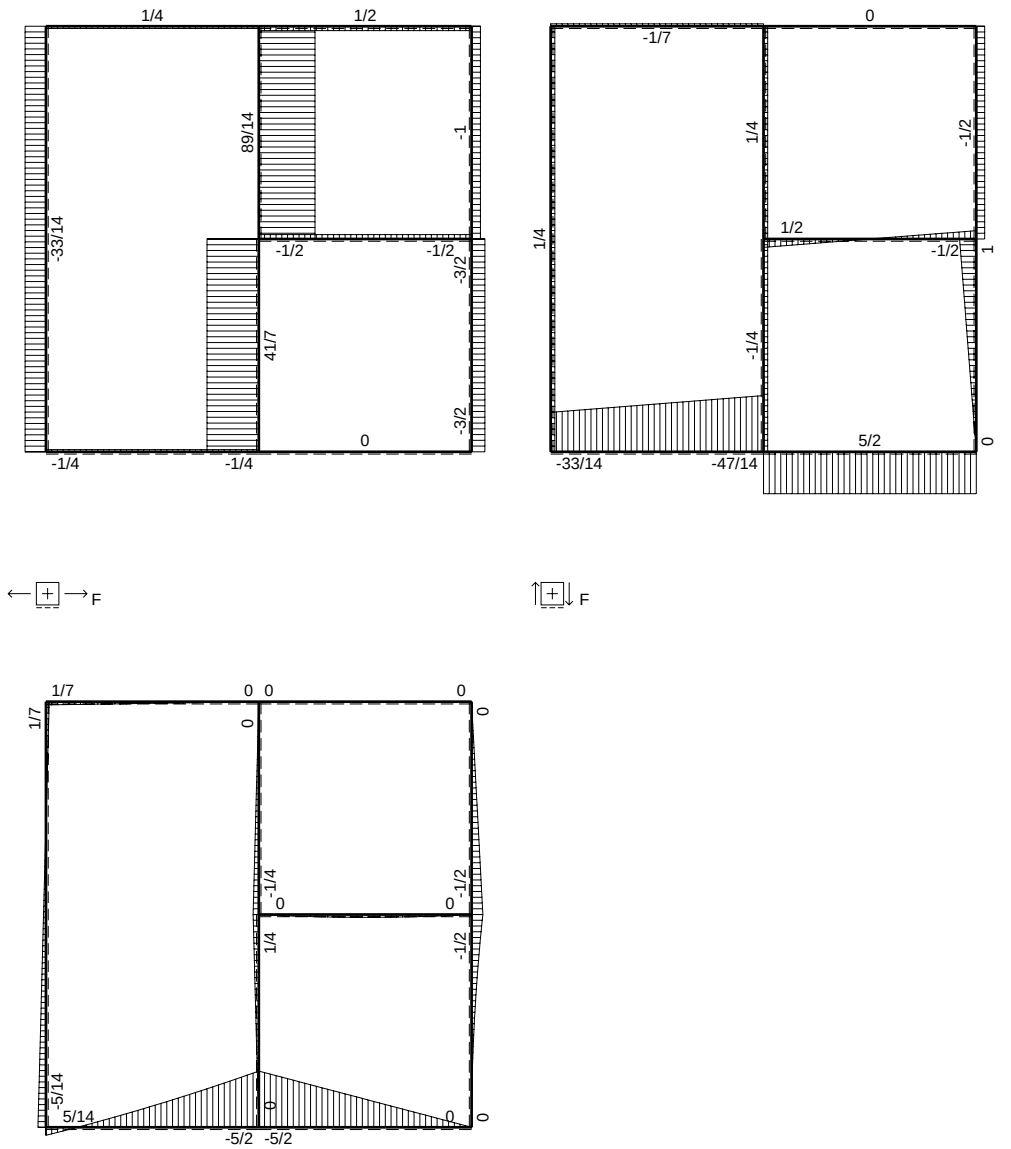
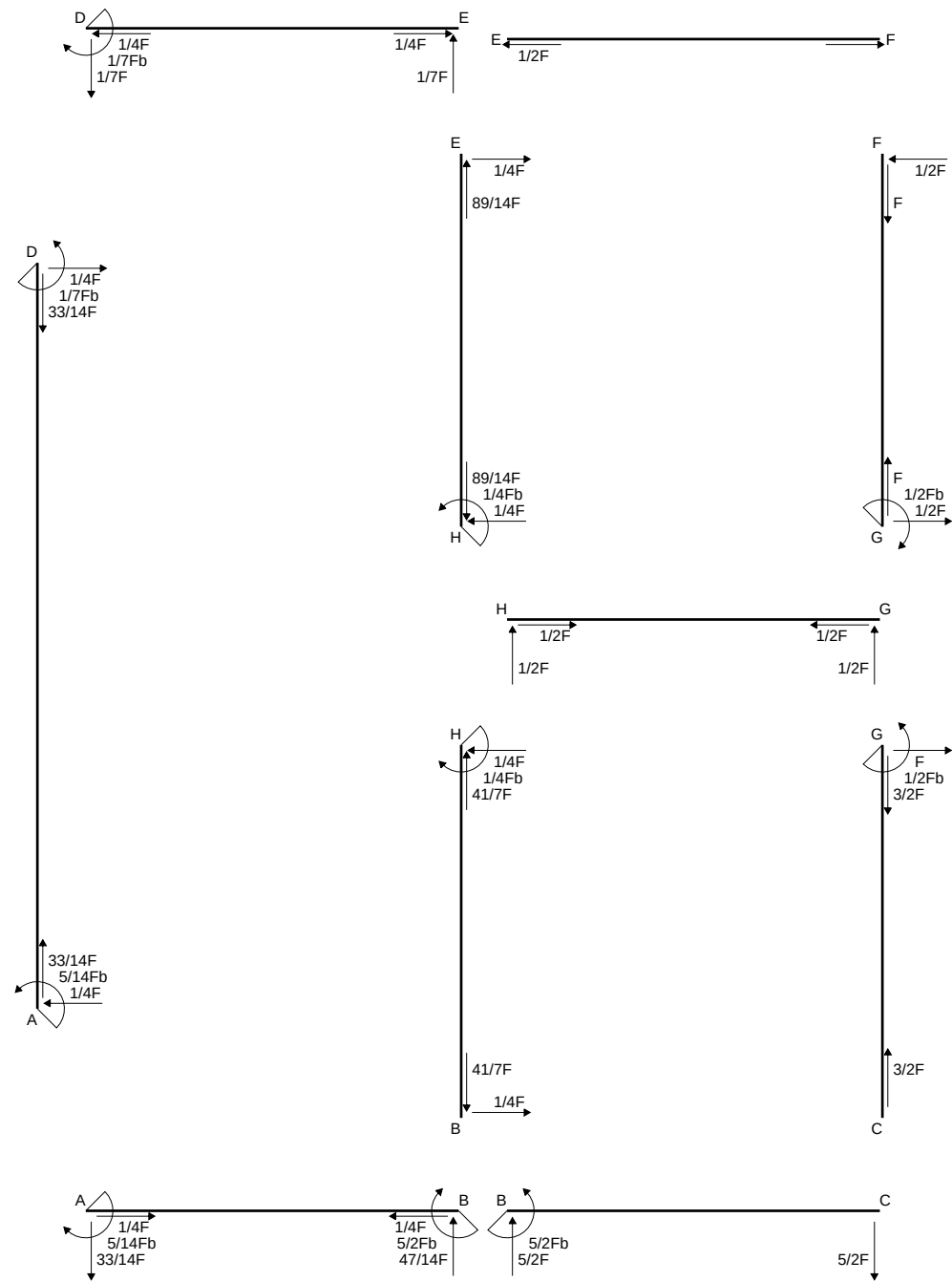
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$5/2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2xb - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 1020. \text{ mm}^2 \\
J_u &= 346417. \text{ mm}^4 \\
J_v &= 75312. \text{ mm}^4 \\
y_g &= 25.05 \text{ mm} \\
T_y &= 4525. \text{ N} \\
M_x &= -2624500. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 28.95 \text{ mm} \\
\sigma_m &= -Mv/J_u = 219.3 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 7. \text{ mm} \\
v_c &= -18.05 \text{ mm} \\
\sigma_c &= -Mv/J_u = -136.8 \text{ N/mm}^2 \\
\tau_c &= 7.156 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 137.3 \text{ N/mm}^2 \\
S &= 6574. \text{ mm}^3
\end{aligned}$$



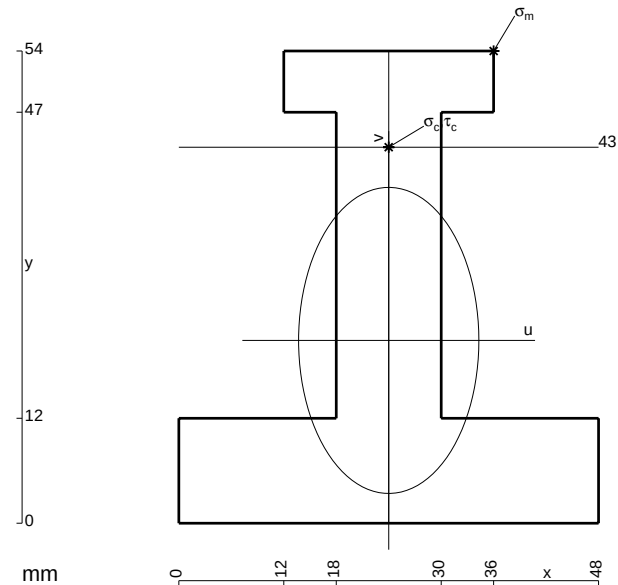
$\left[\begin{matrix} + \\ - \end{matrix} \right] F_b$

Quadro contributi PLV per iperstatica $X=W_{AB}$

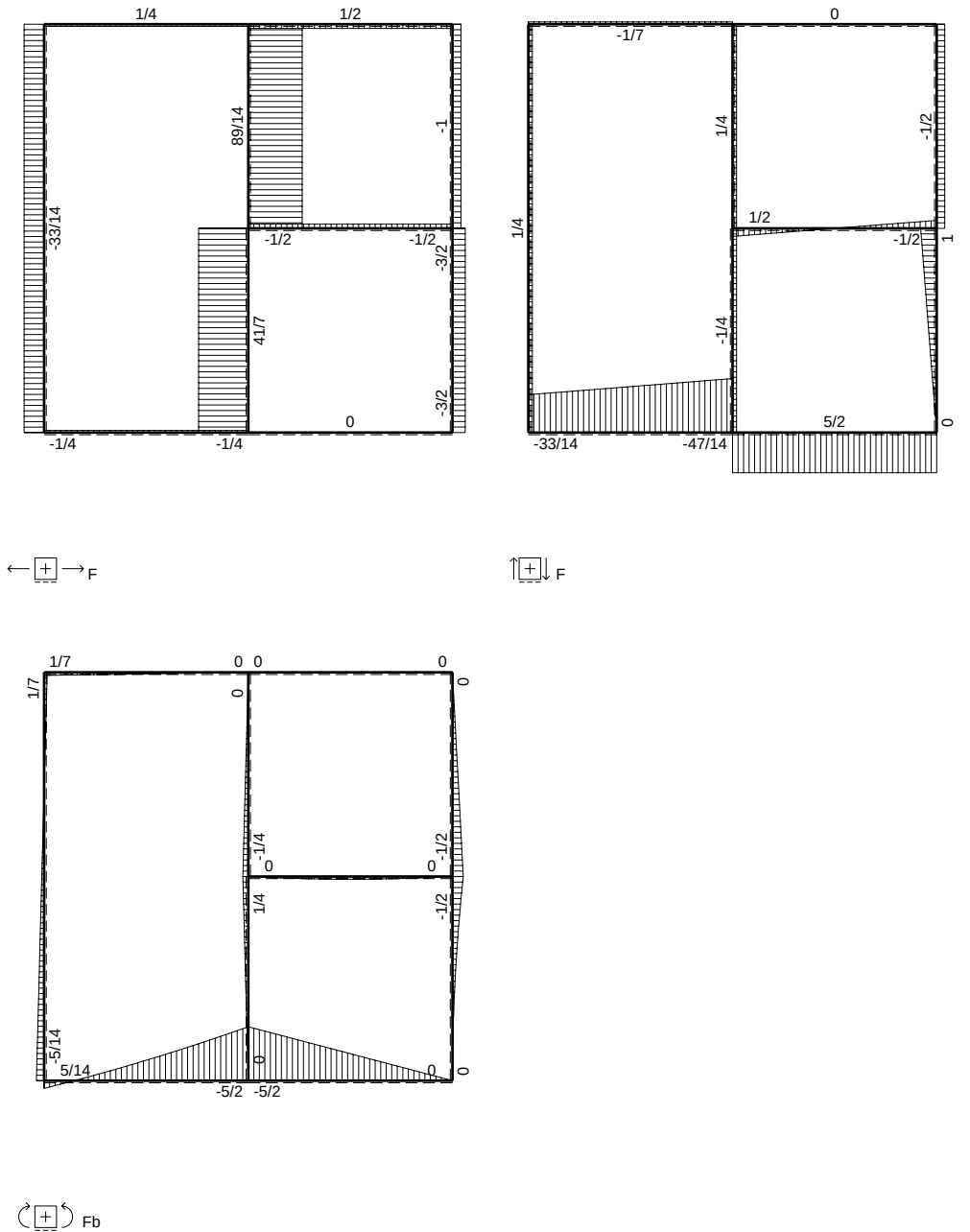
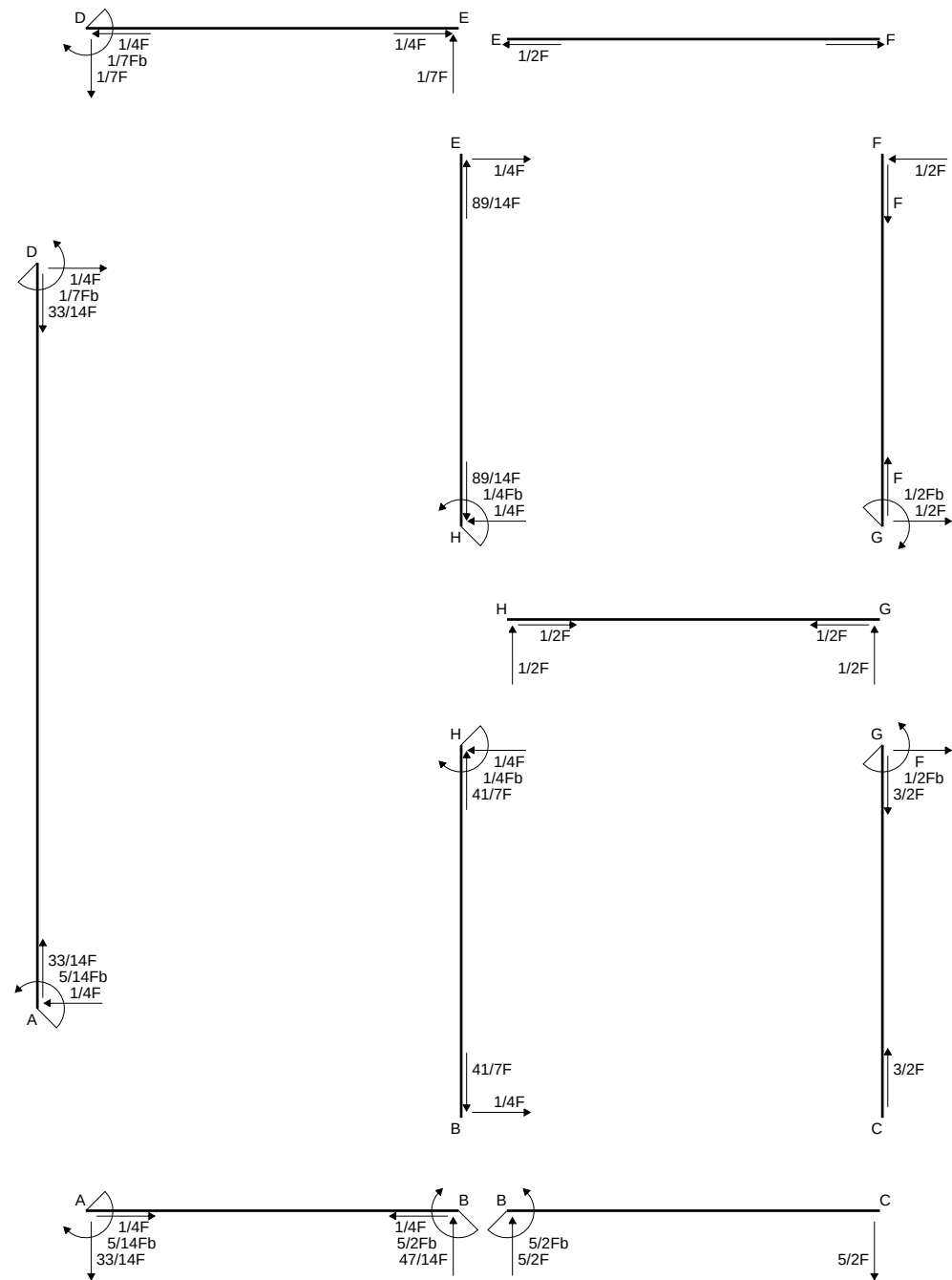
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$1/4Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
 L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
 &= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
 L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
 &= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
 L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
 &= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
 L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
 &= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
 L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
 &= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
 L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
 &= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
 L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
 &= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
 &= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
 L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
 &= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
 &= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
 L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
 &= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
 L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
 &= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
 L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
 &= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
 L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
 &= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
 \end{aligned}$$



$$\begin{aligned}
 A &= 1164. \text{ mm}^2 \\
 J_u &= 356609. \text{ mm}^4 \\
 J_v &= 123696. \text{ mm}^4 \\
 y_g &= 20.9 \text{ mm} \\
 T_y &= 3925. \text{ N} \\
 M_x &= -2472750. \text{ Nmm} \\
 x_m &= 36. \text{ mm} \\
 y_m &= 54. \text{ mm} \\
 u_m &= 12. \text{ mm} \\
 v_m &= 33.1 \text{ mm} \\
 \sigma_m &= -Mv/J_u = 229.5 \text{ N/mm}^2 \\
 x_c &= 24. \text{ mm} \\
 y_c &= 43. \text{ mm} \\
 v_c &= 22.1 \text{ mm} \\
 \sigma_c &= -Mv/J_u = 153.2 \text{ N/mm}^2 \\
 \tau_c &= 5.622 \text{ N/mm}^2 \\
 \sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 153.5 \text{ N/mm}^2 \\
 S &= 6129. \text{ mm}^3
 \end{aligned}$$

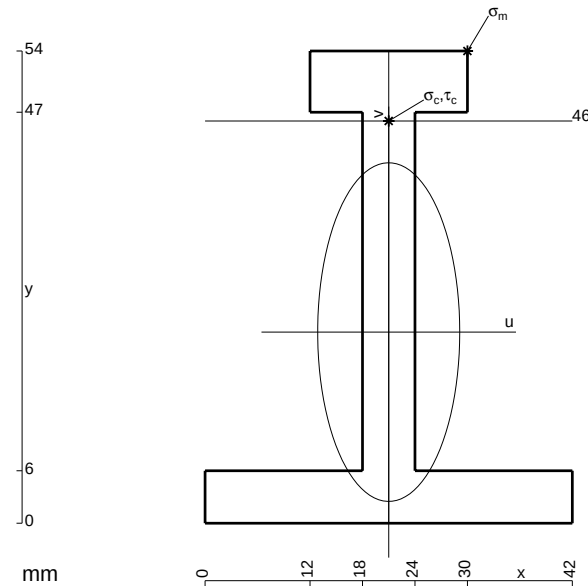


Quadro contributi PLV per iperstatica $X=W_{AB}$

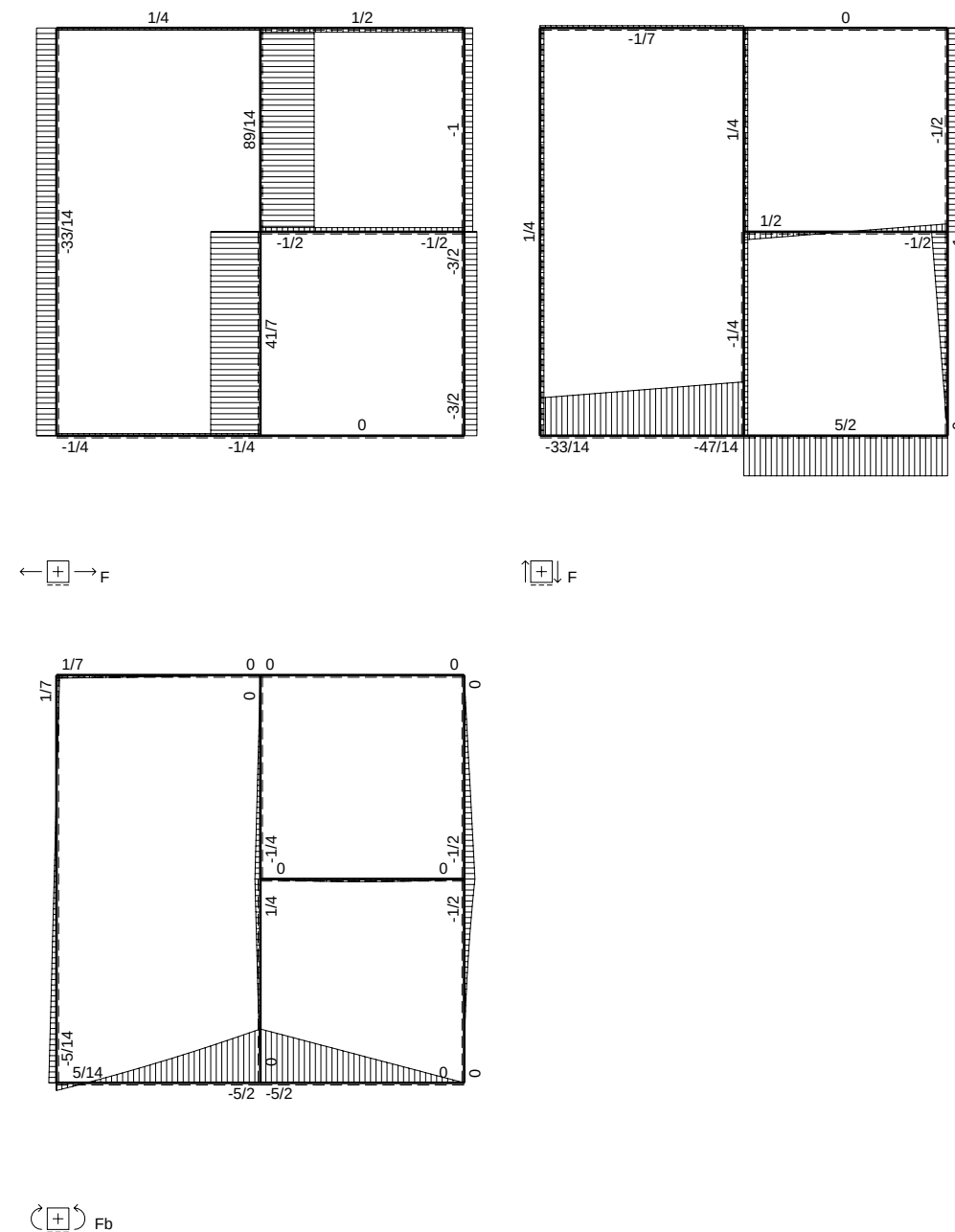
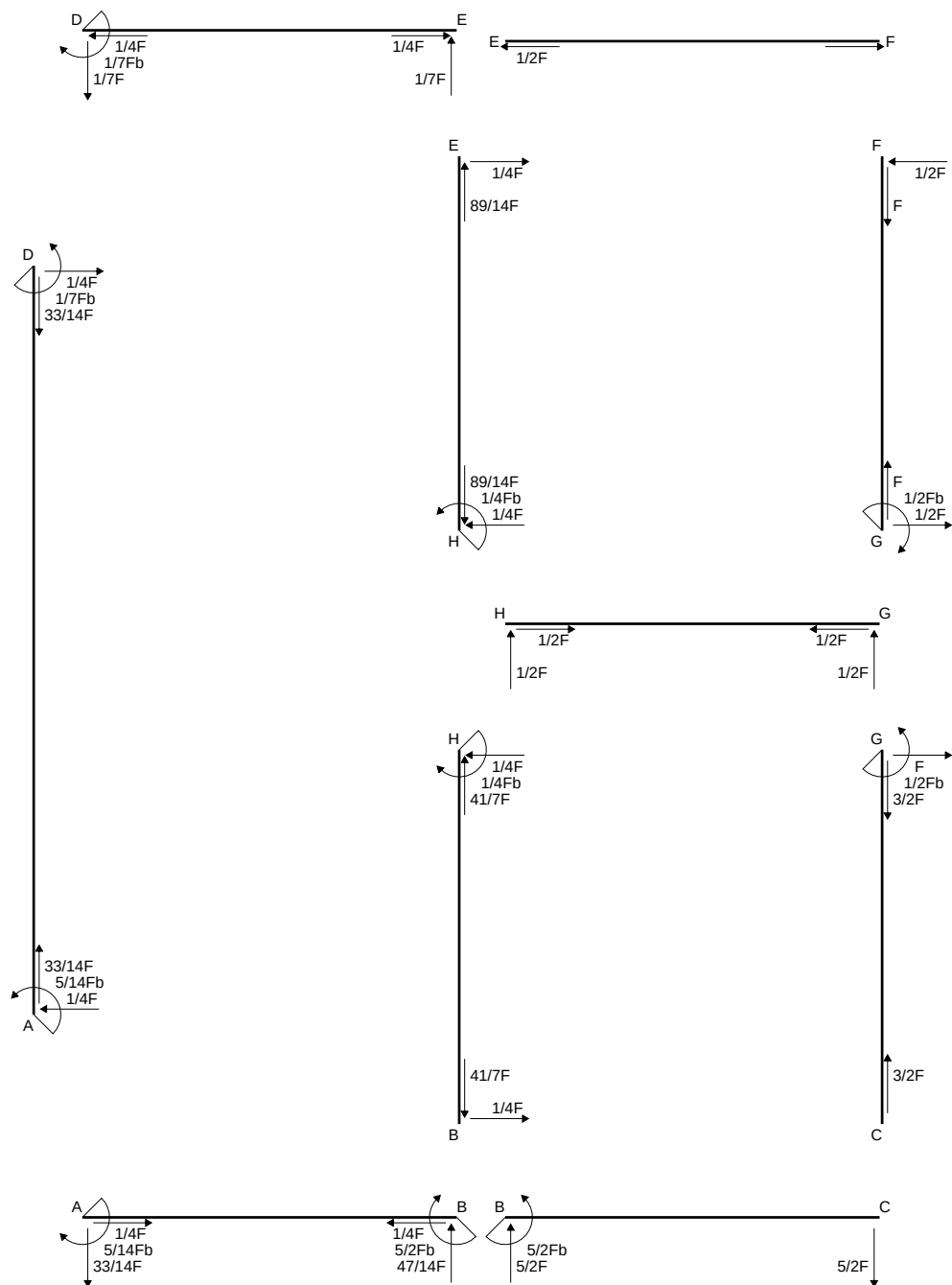
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	Fb/EJ	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2xb - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 xb - 3x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 624. \text{ mm}^2 \\
J_u &= 234015. \text{ mm}^4 \\
J_v &= 41184. \text{ mm}^4 \\
y_g &= 21.86 \text{ mm} \\
T_y &= 2550. \text{ N} \\
M_x &= -1734000. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 32.14 \text{ mm} \\
\sigma_m &= -Mv/J_u = 238.2 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 46. \text{ mm} \\
v_c &= 24.14 \text{ mm} \\
\sigma_c &= -Mv/J_u = 178.9 \text{ N/mm}^2 \\
\tau_c &= 6.823 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 179.3 \text{ N/mm}^2 \\
S &= 3757. \text{ mm}^3
\end{aligned}$$

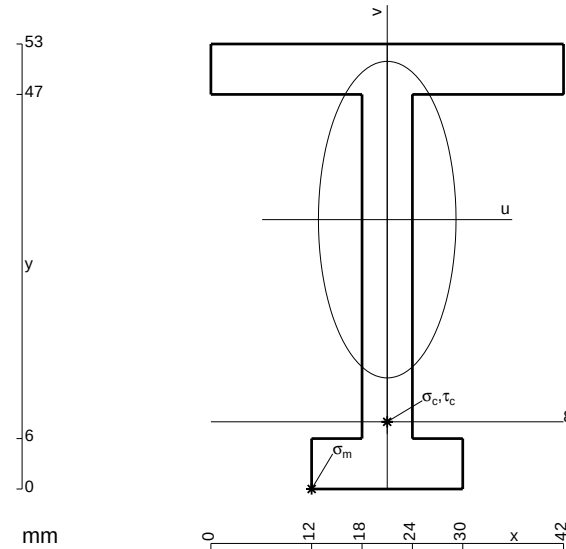


Quadro contributi PLV per iperstatica $X=W_{AB}$

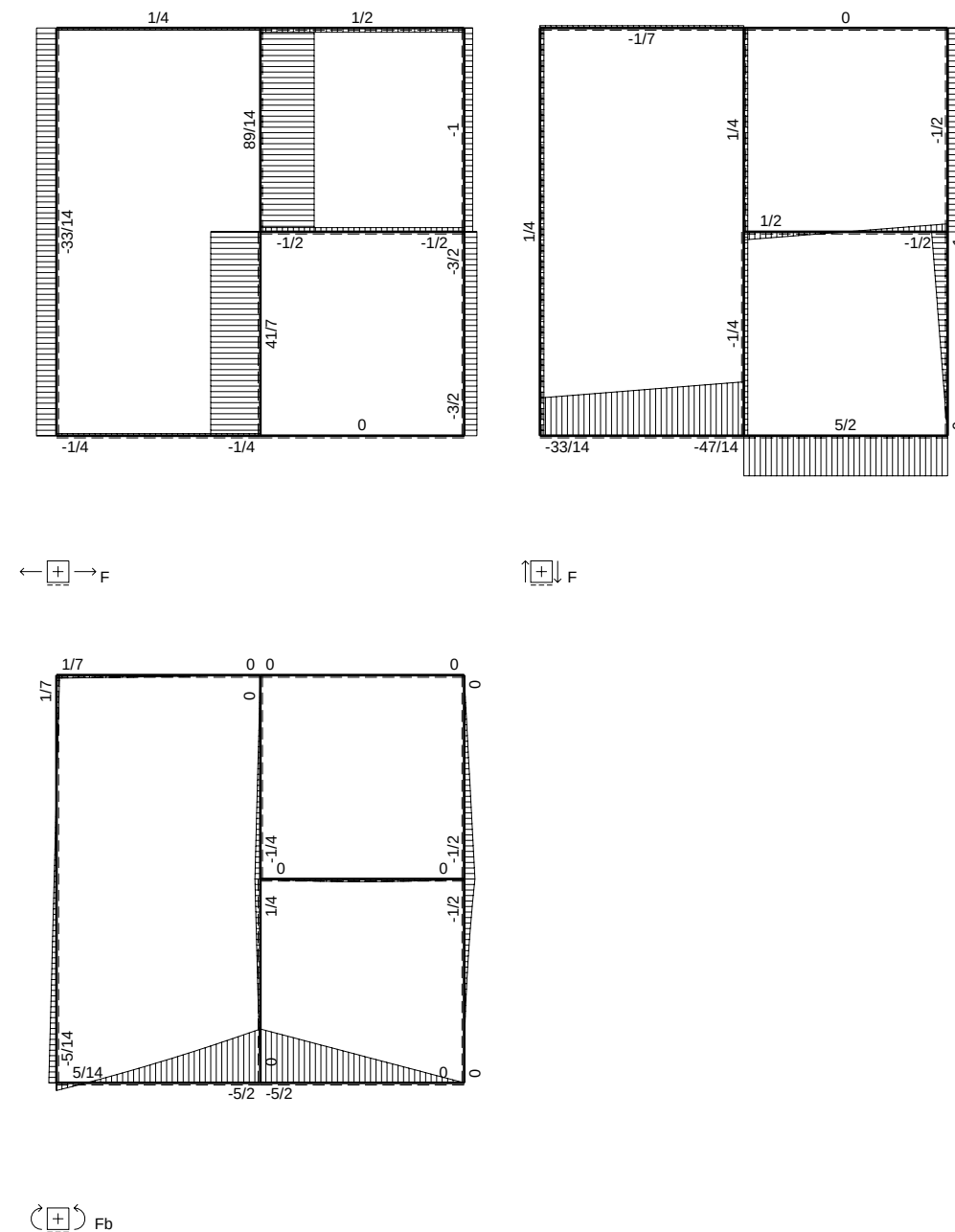
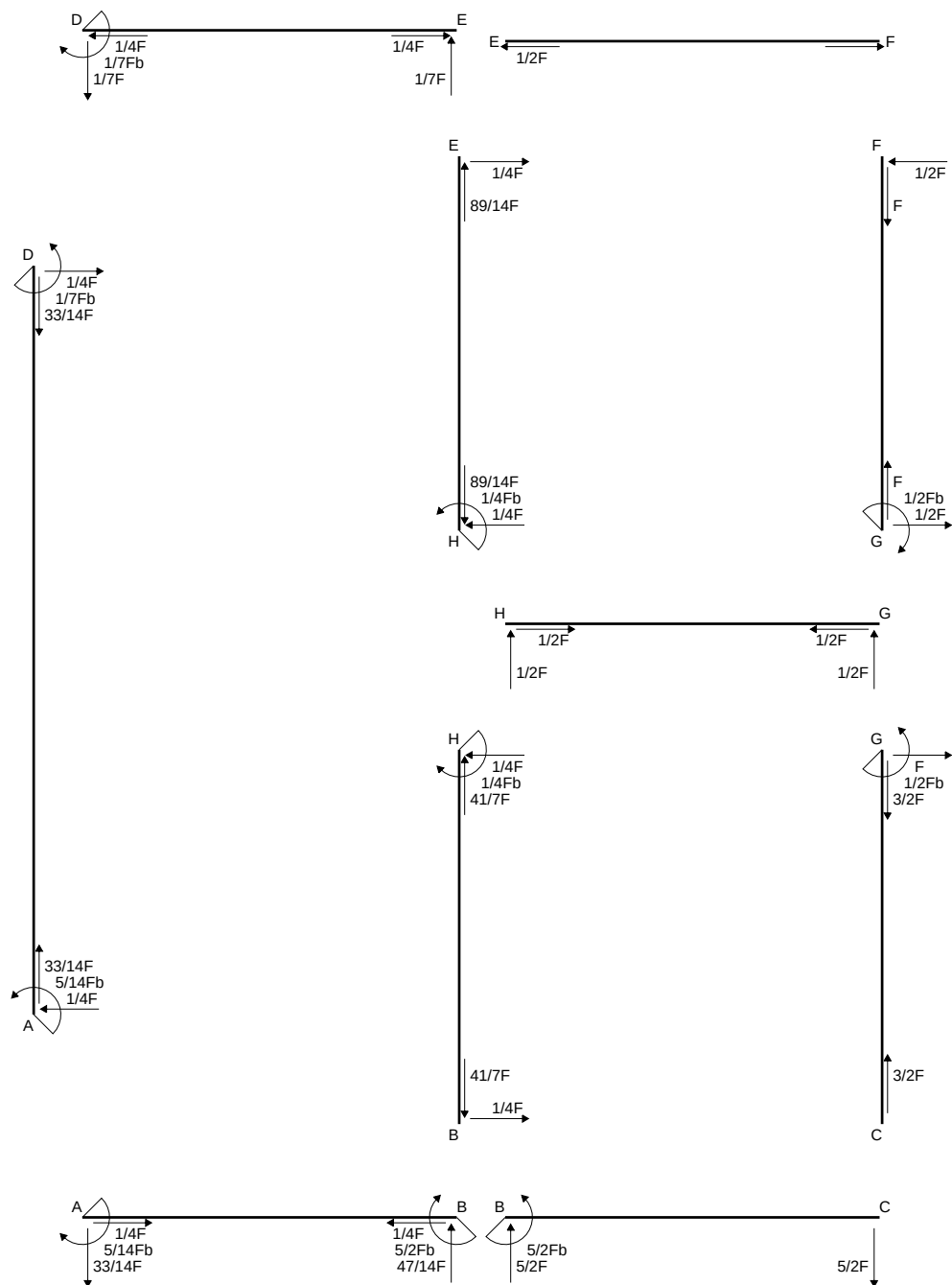
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	Fb/EJ	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 606. \text{ mm}^2 \\
J_u &= 215454. \text{ mm}^4 \\
J_v &= 40698. \text{ mm}^4 \\
y_g &= 32.08 \text{ mm} \\
T_y &= 1850. \text{ N} \\
M_x &= -1332000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -32.08 \text{ mm} \\
\sigma_m &= -Mv/J_u = -198.4 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 8. \text{ mm} \\
v_c &= -24.08 \text{ mm} \\
\sigma_c &= -Mv/J_u = -148.9 \text{ N/mm}^2 \\
\tau_c &= 4.926 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 149.1 \text{ N/mm}^2 \\
S &= 3442. \text{ mm}^3
\end{aligned}$$

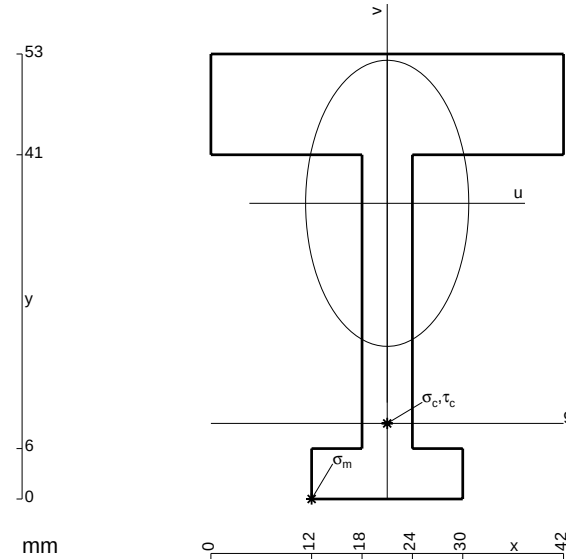


Quadro contributi PLV per iperstatica $X=W_{AB}$

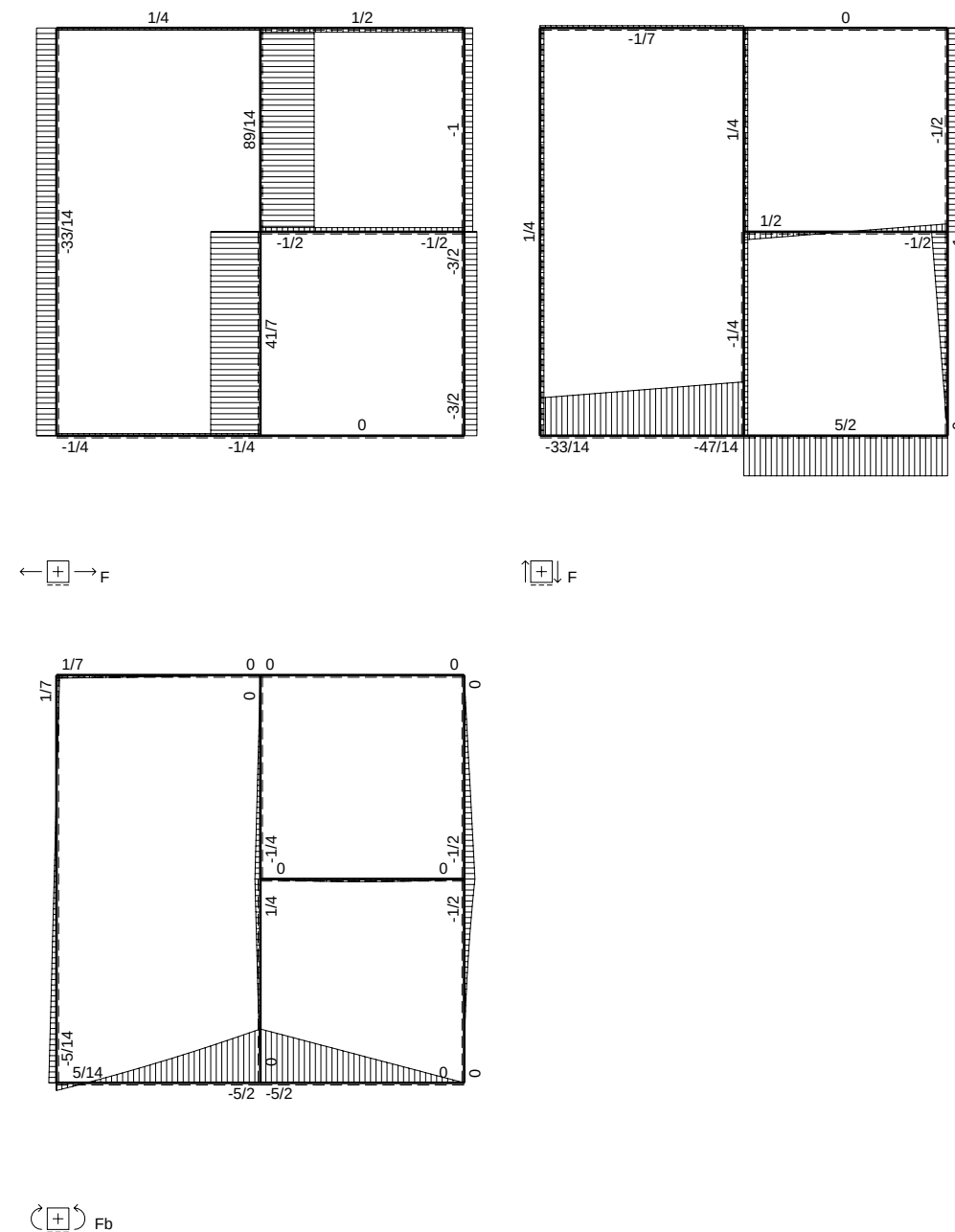
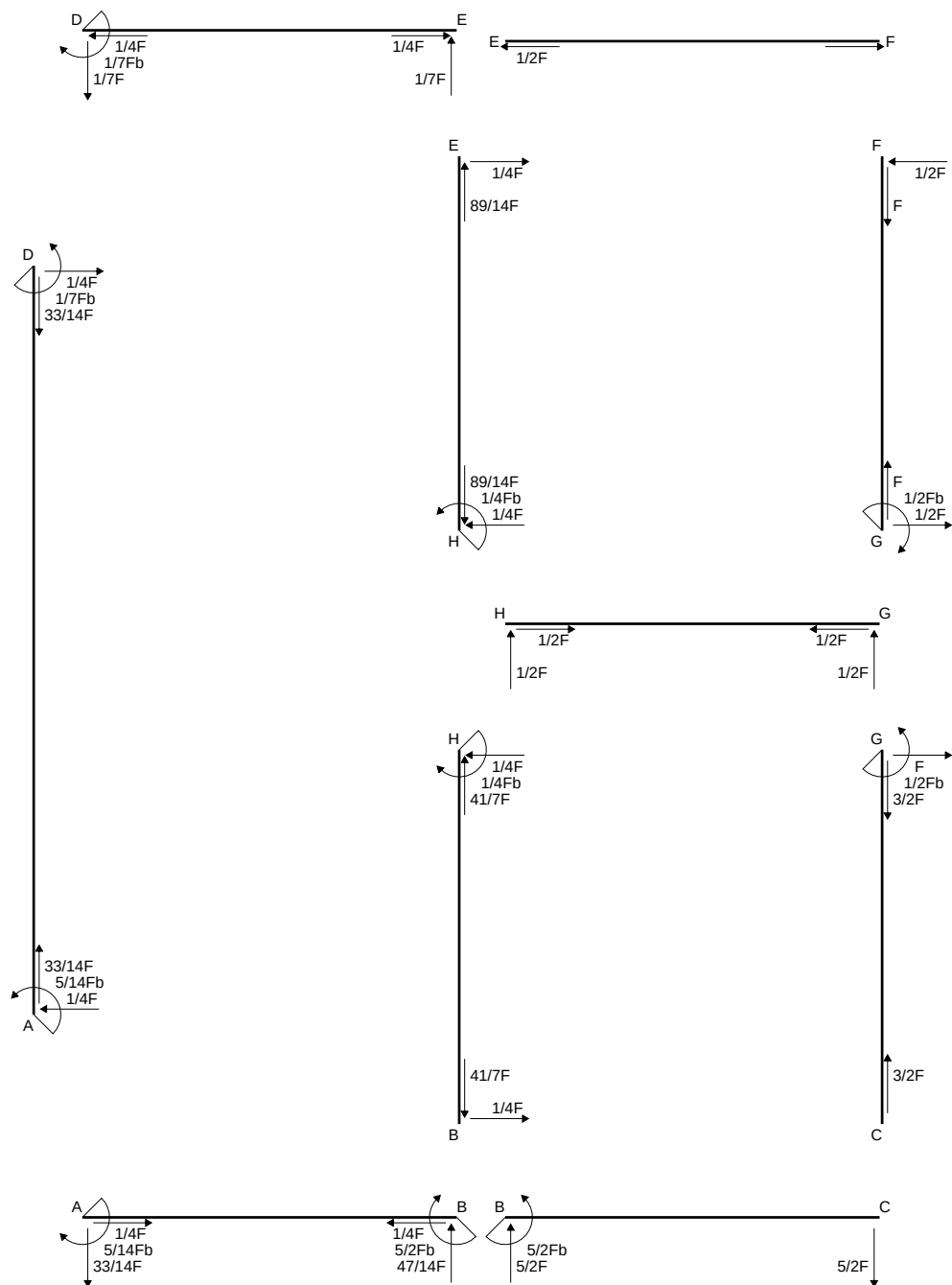
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$-1/4Fx$	Fb/EJ	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

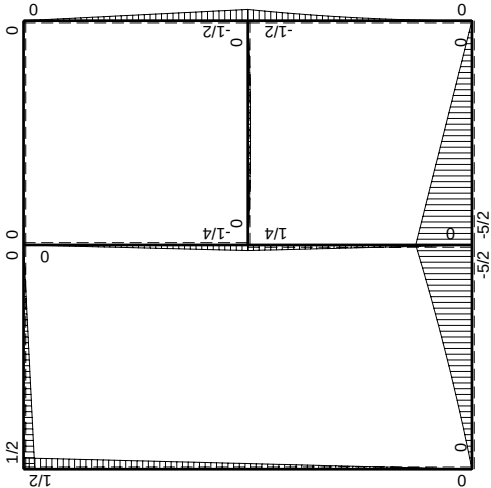
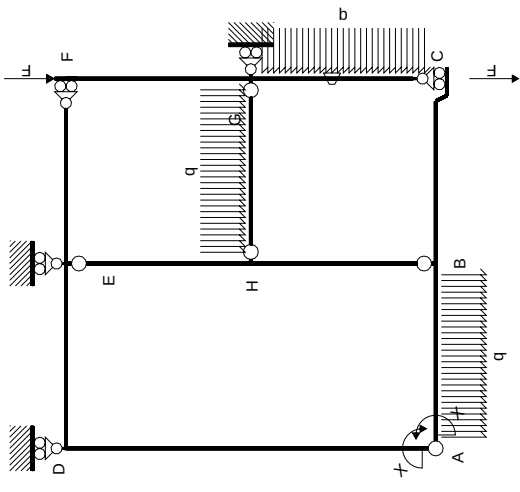
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2xb - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 xb - 3x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



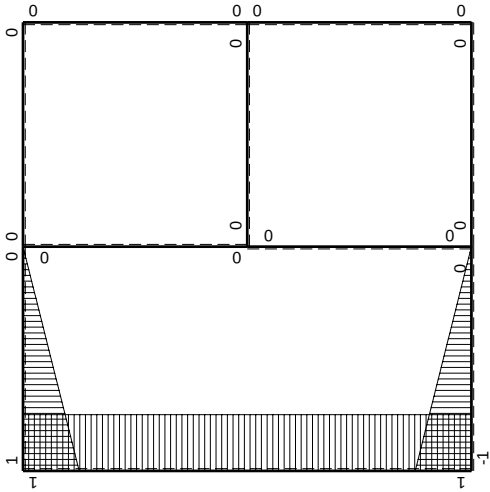
$$\begin{aligned}
A &= 822. \text{ mm}^2 \\
J_u &= 238712. \text{ mm}^4 \\
J_v &= 77634. \text{ mm}^4 \\
y_g &= 35.22 \text{ mm} \\
T_y &= 1850. \text{ N} \\
M_x &= -1406000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -35.22 \text{ mm} \\
\sigma_m &= -Mv/J_u = -207.4 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 9. \text{ mm} \\
v_c &= -26.22 \text{ mm} \\
\sigma_c &= -Mv/J_u = -154.4 \text{ N/mm}^2 \\
\tau_c &= 5.138 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 154.7 \text{ N/mm}^2 \\
S &= 3978. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



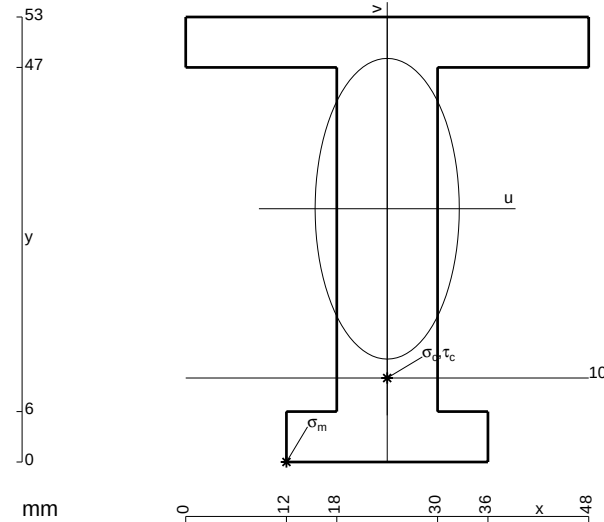
M_X flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

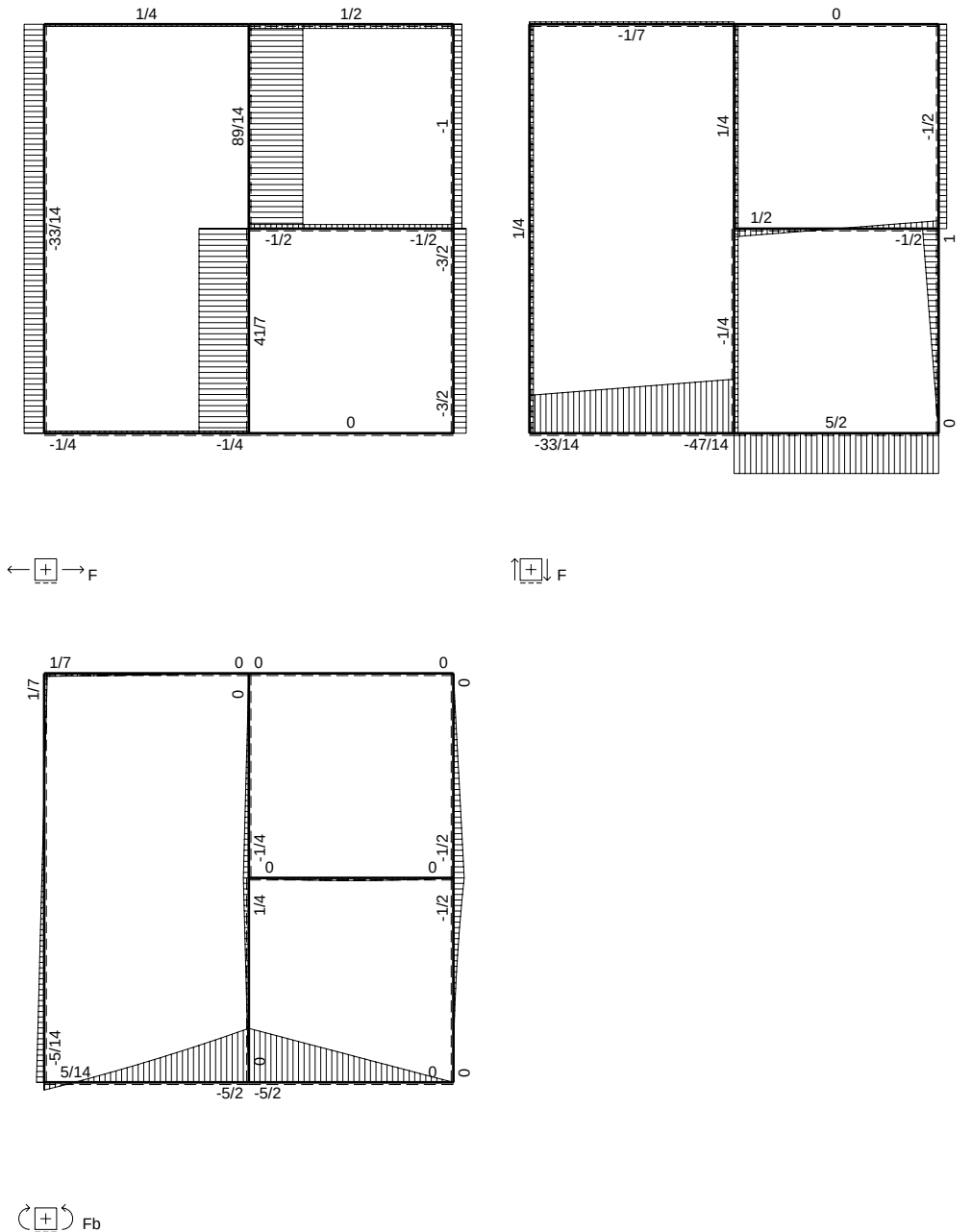
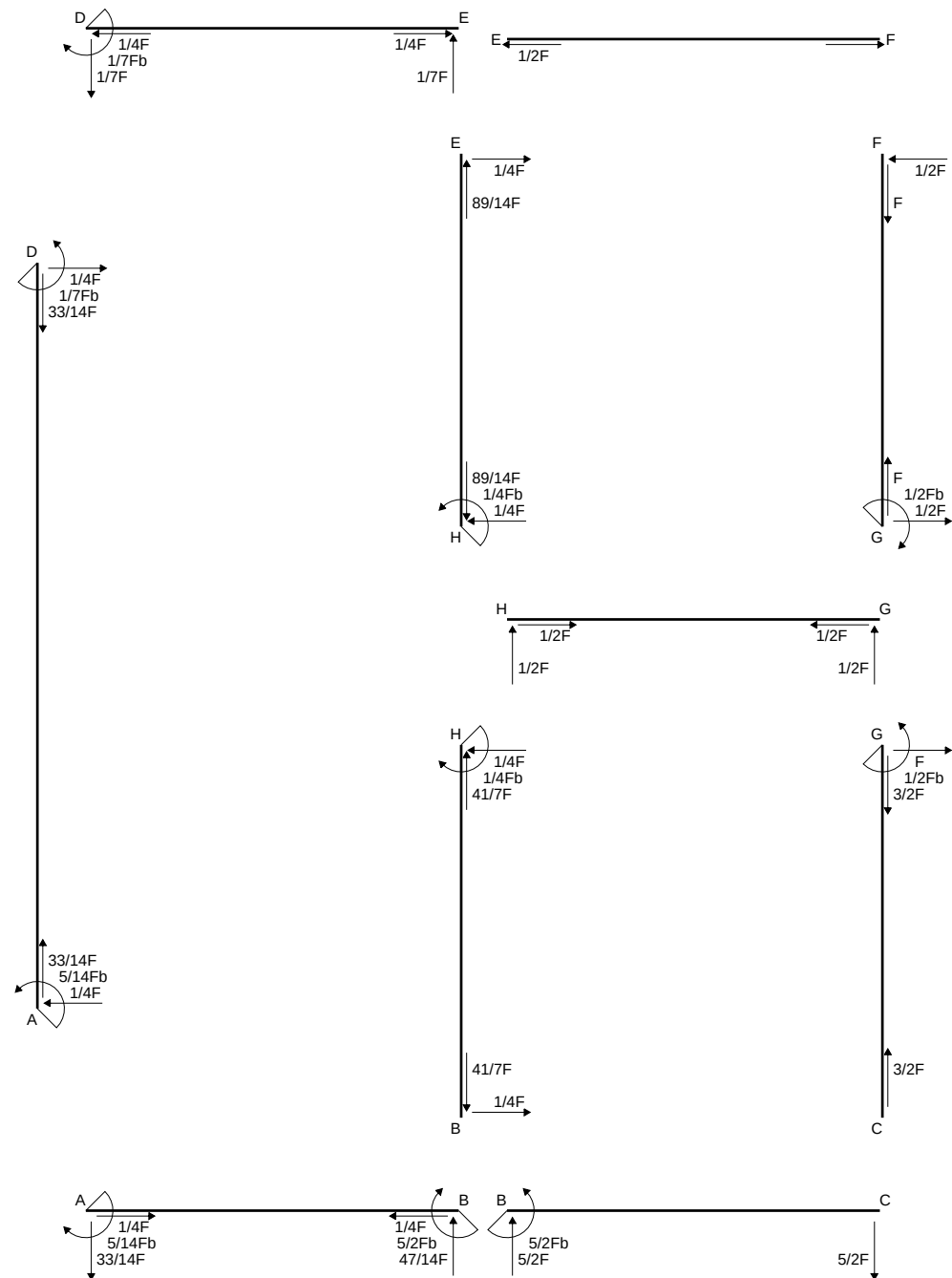
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	$1/2qx^2$	Fb/EJ	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 924. \text{ mm}^2 \\
J_u &= 296396. \text{ mm}^4 \\
J_v &= 68112. \text{ mm}^4 \\
y_g &= 30.16 \text{ mm} \\
T_y &= 2650. \text{ N} \\
M_x &= -2146500. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -30.16 \text{ mm} \\
\sigma_m &= -Mv/J_u = -218.4 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 10. \text{ mm} \\
v_c &= -20.16 \text{ mm} \\
\sigma_c &= -Mv/J_u = -146. \text{ N/mm}^2 \\
\tau_c &= 3.707 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 146.2 \text{ N/mm}^2 \\
S &= 4975. \text{ mm}^3
\end{aligned}$$

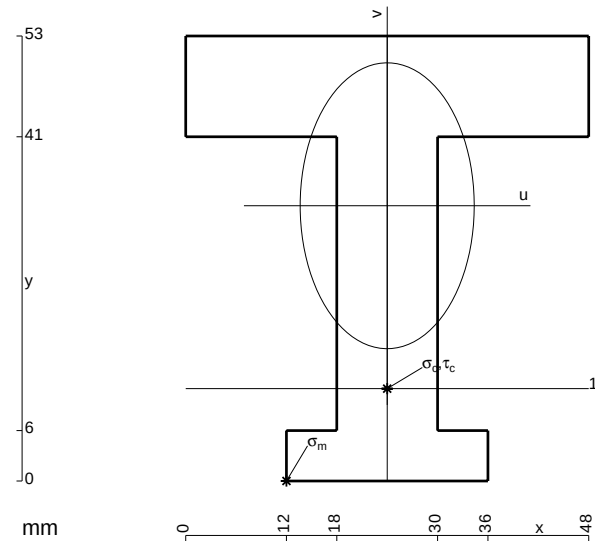


Quadro contributi PLV per iperstatica $X=W_{AB}$

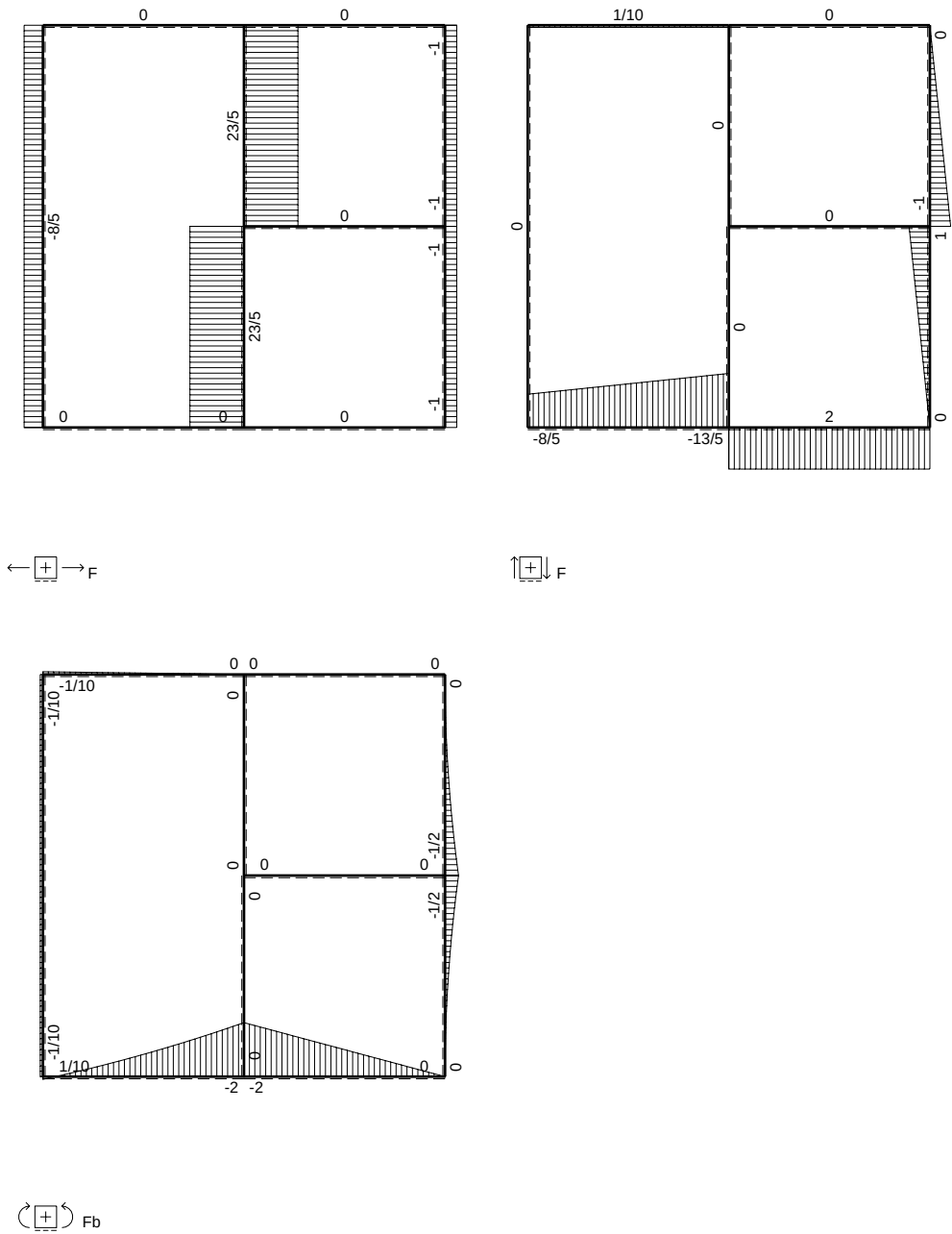
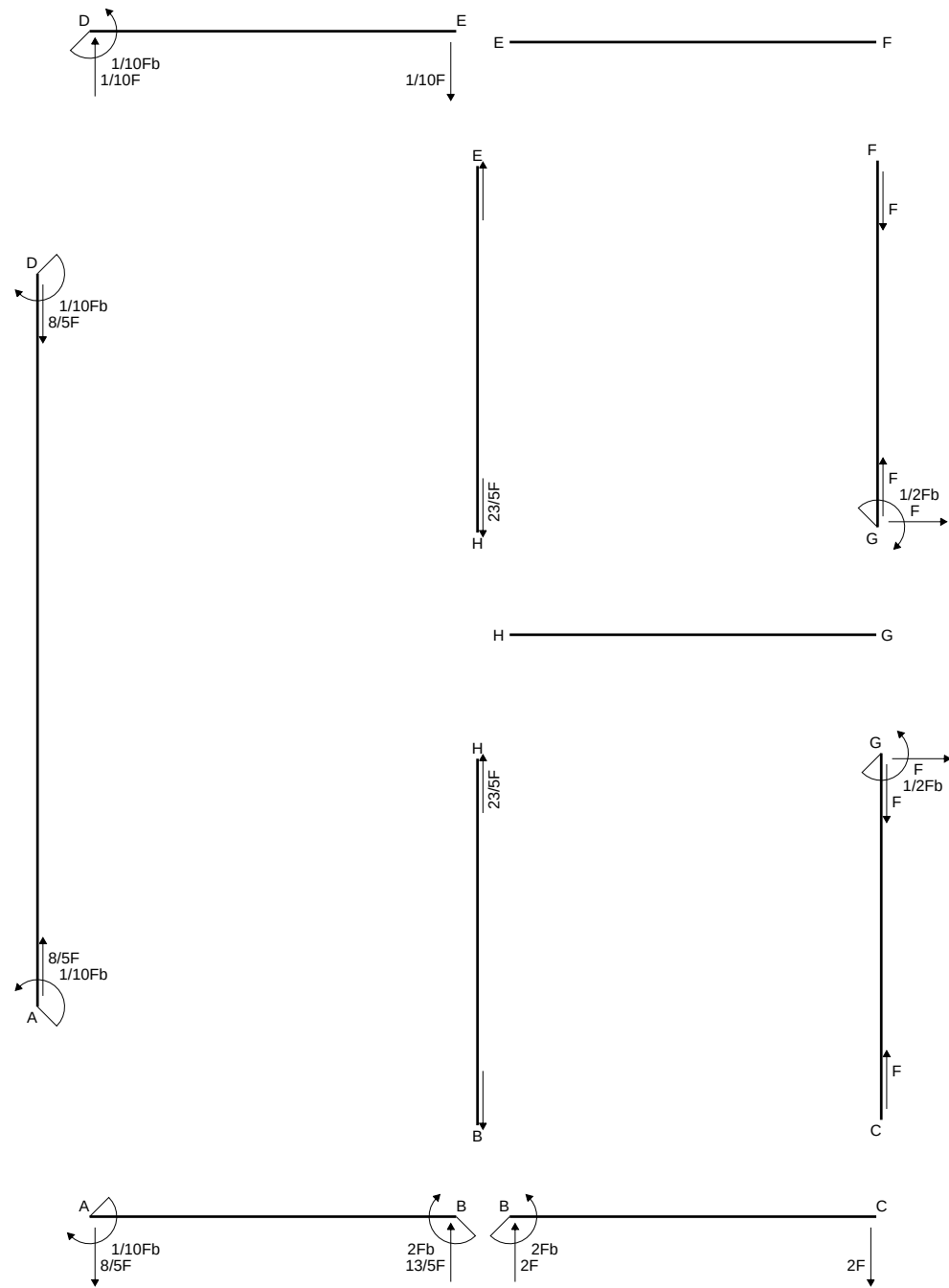
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

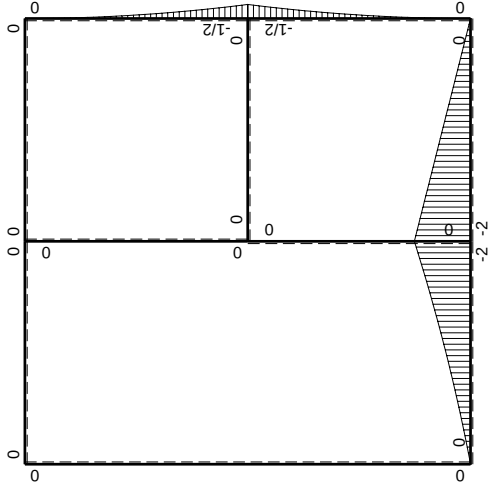
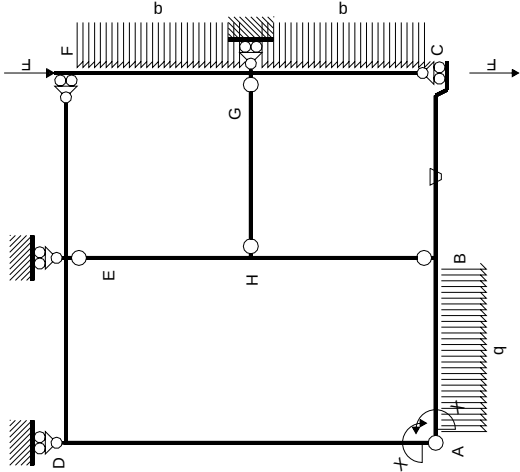
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2xb - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 xb - 3x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 xb) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 xb) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

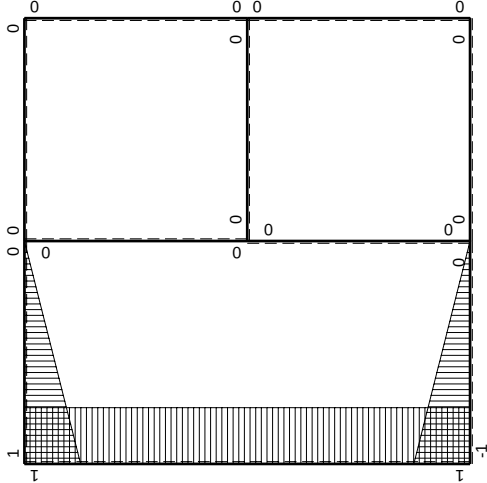


$$\begin{aligned}
A &= 1140. \text{ mm}^2 \\
J_u &= 330567. \text{ mm}^4 \\
J_v &= 122544. \text{ mm}^4 \\
y_g &= 32.78 \text{ mm} \\
T_y &= 2675. \text{ N} \\
M_x &= -2300500. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -32.78 \text{ mm} \\
\sigma_m &= -Mv/J_u = -228.2 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 11. \text{ mm} \\
v_c &= -21.78 \text{ mm} \\
\sigma_c &= -Mv/J_u = -151.6 \text{ N/mm}^2 \\
\tau_c &= 3.875 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 151.8 \text{ N/mm}^2 \\
S &= 5746. \text{ mm}^3
\end{aligned}$$





 M_0 flessione da carichi assegnati



 M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

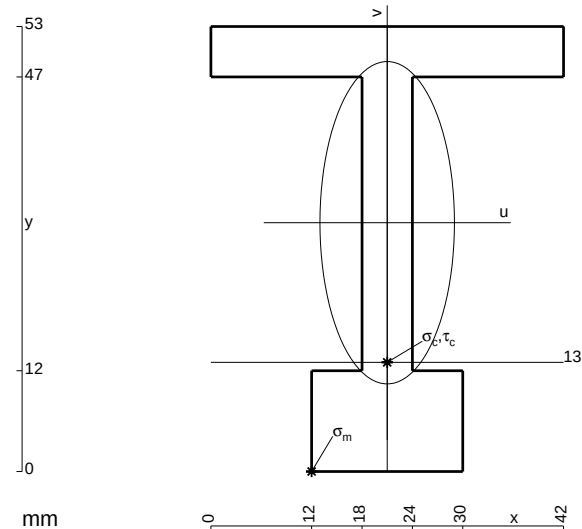
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 678. \text{ mm}^2$$

$$J_u = 249963. \text{ mm}^4$$

$$J_v = 43506. \text{ mm}^4$$

$$y_g = 29.63 \text{ mm}$$

$$T_y = 2220. \text{ N}$$

$$M_x = -2020200. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -29.63 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -134.4 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

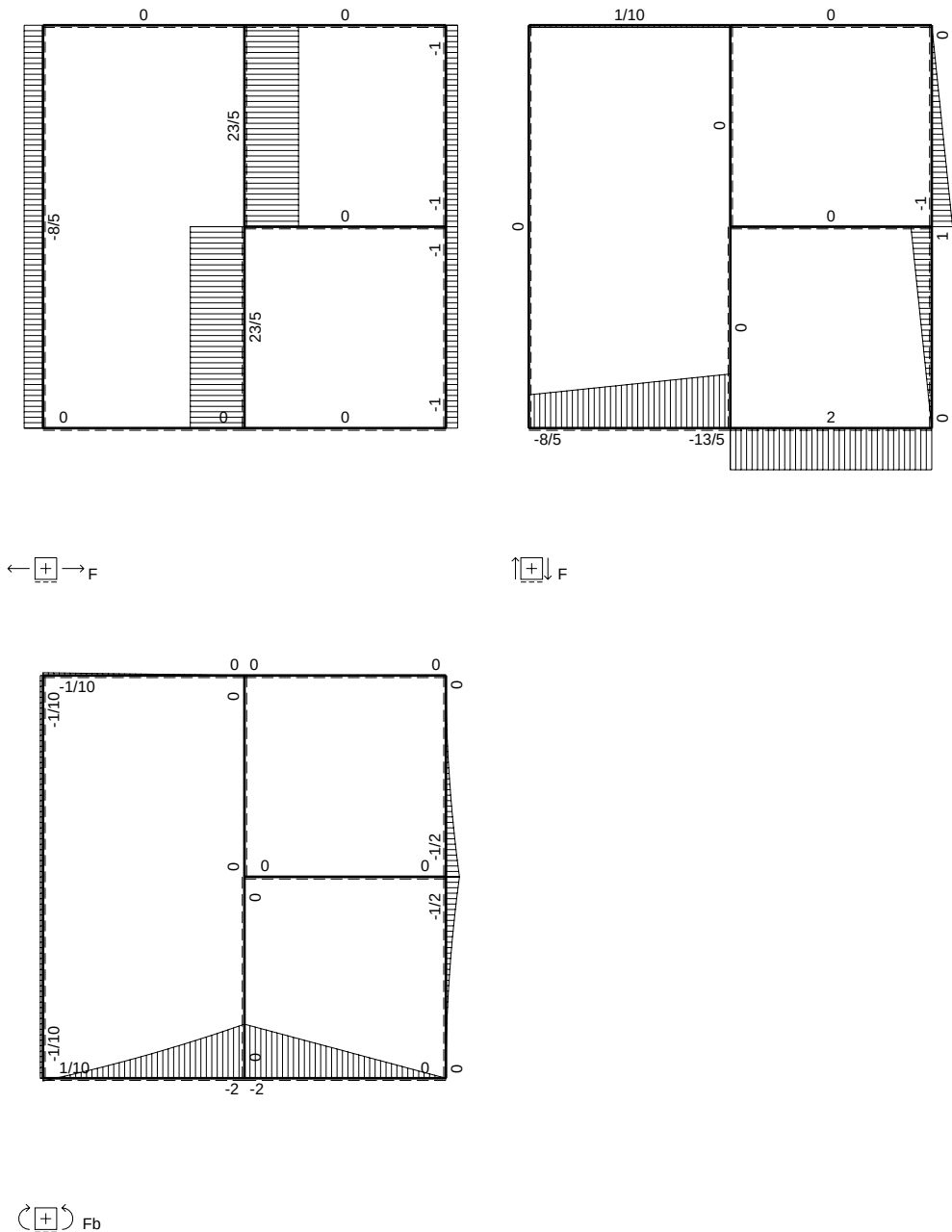
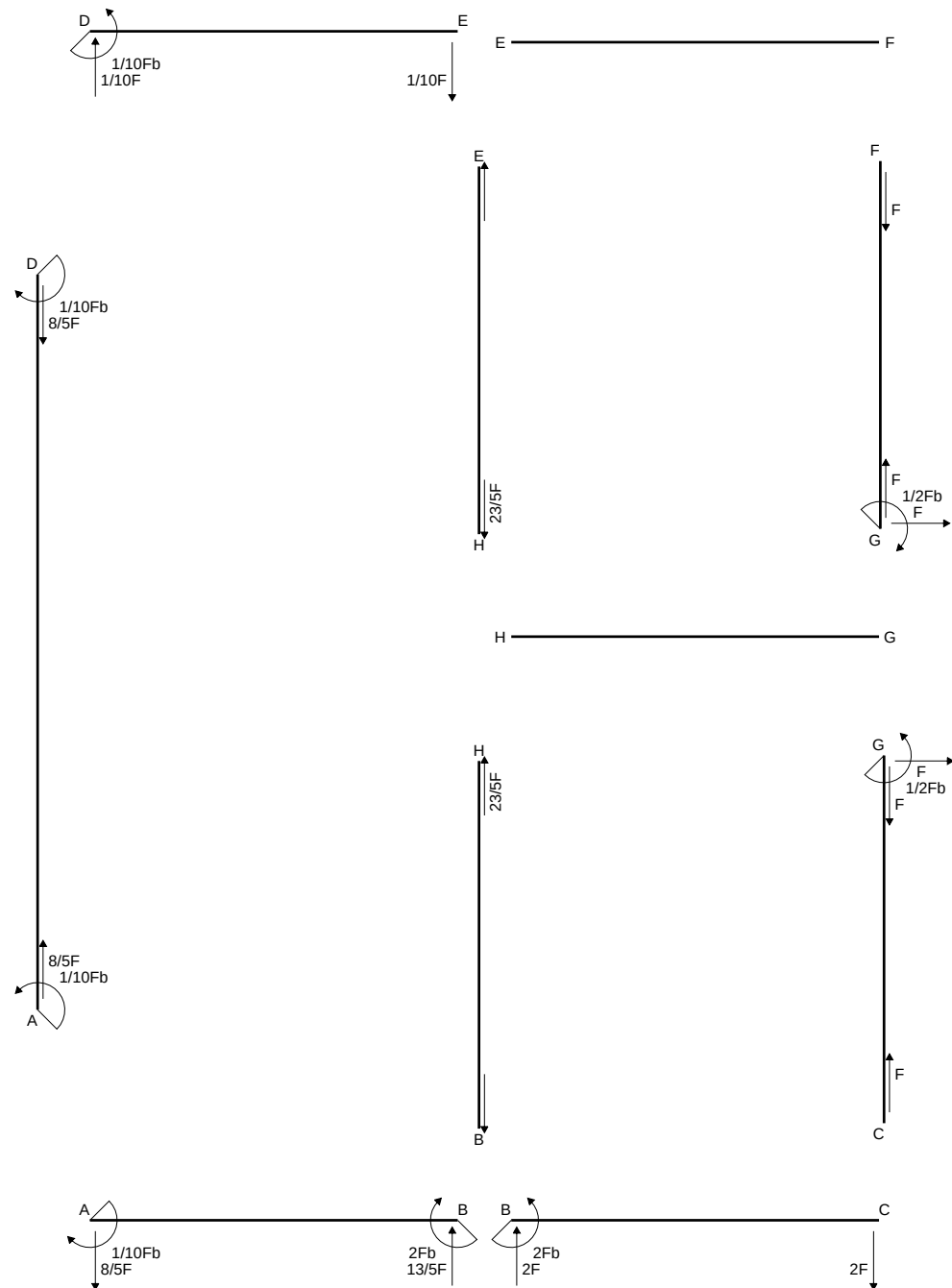
$$v_c = -16.63 \text{ mm}$$

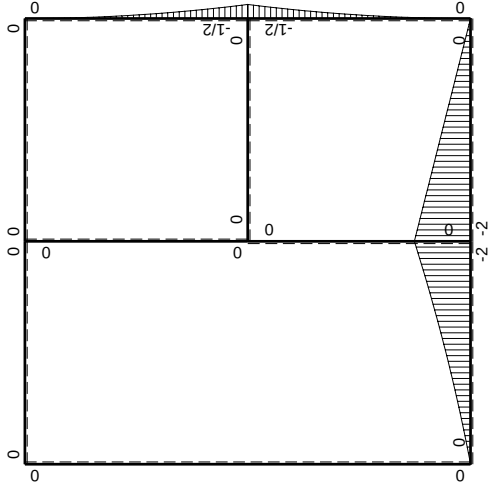
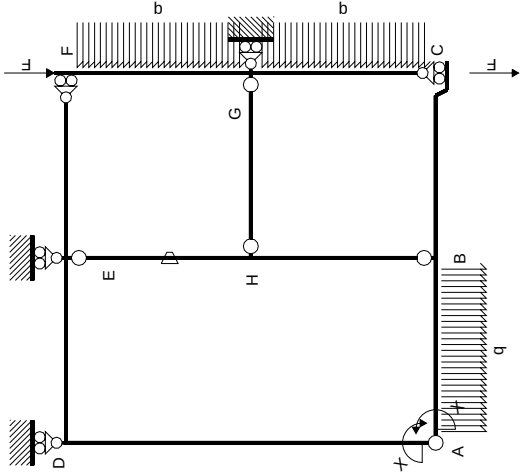
$$\sigma_c = -Mv/J_u = -134.4 \text{ N/mm}^2$$

$$\tau_c = 7.708 \text{ N/mm}^2$$

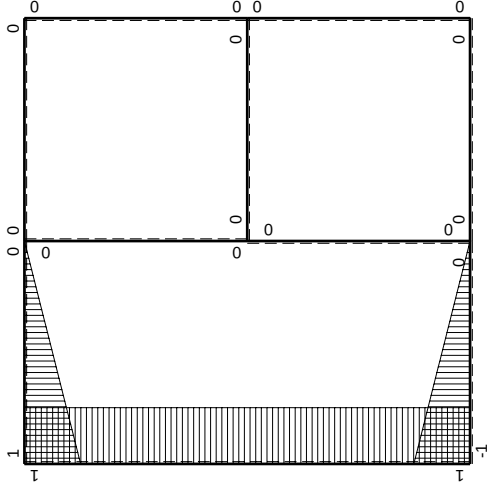
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 135.1 \text{ N/mm}^2$$

$$S = 5207. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	0	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

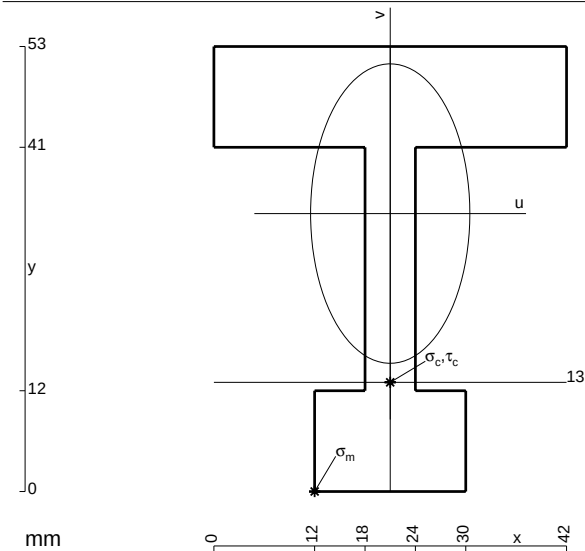
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 894. \text{ mm}^2$$

$$J_u = 284424. \text{ mm}^4$$

$$J_v = 80442. \text{ mm}^4$$

$$y_g = 33.1 \text{ mm}$$

$$T_y = 3560. \text{ N}$$

$$M_x = -1708800. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -33.1 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -198.9 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

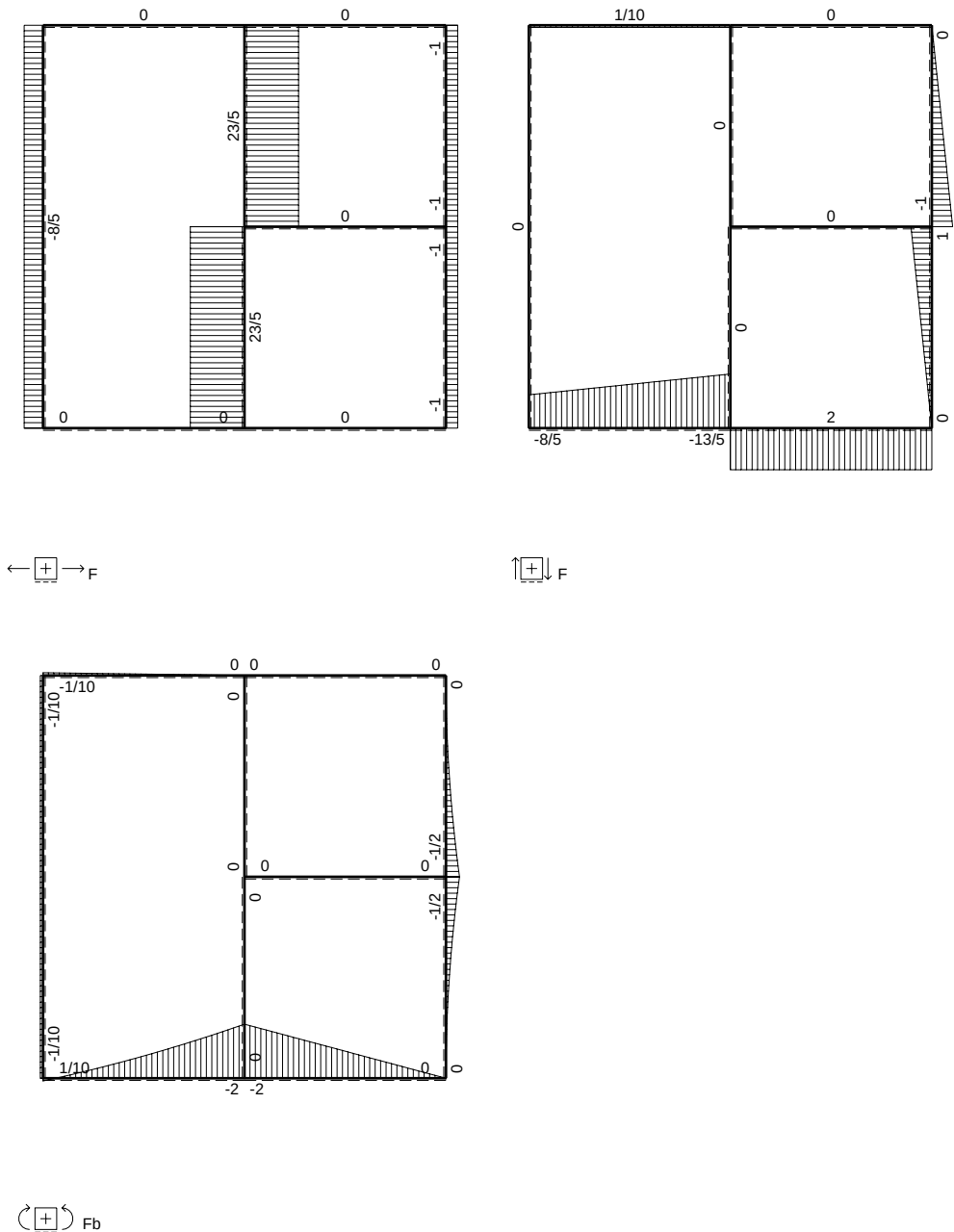
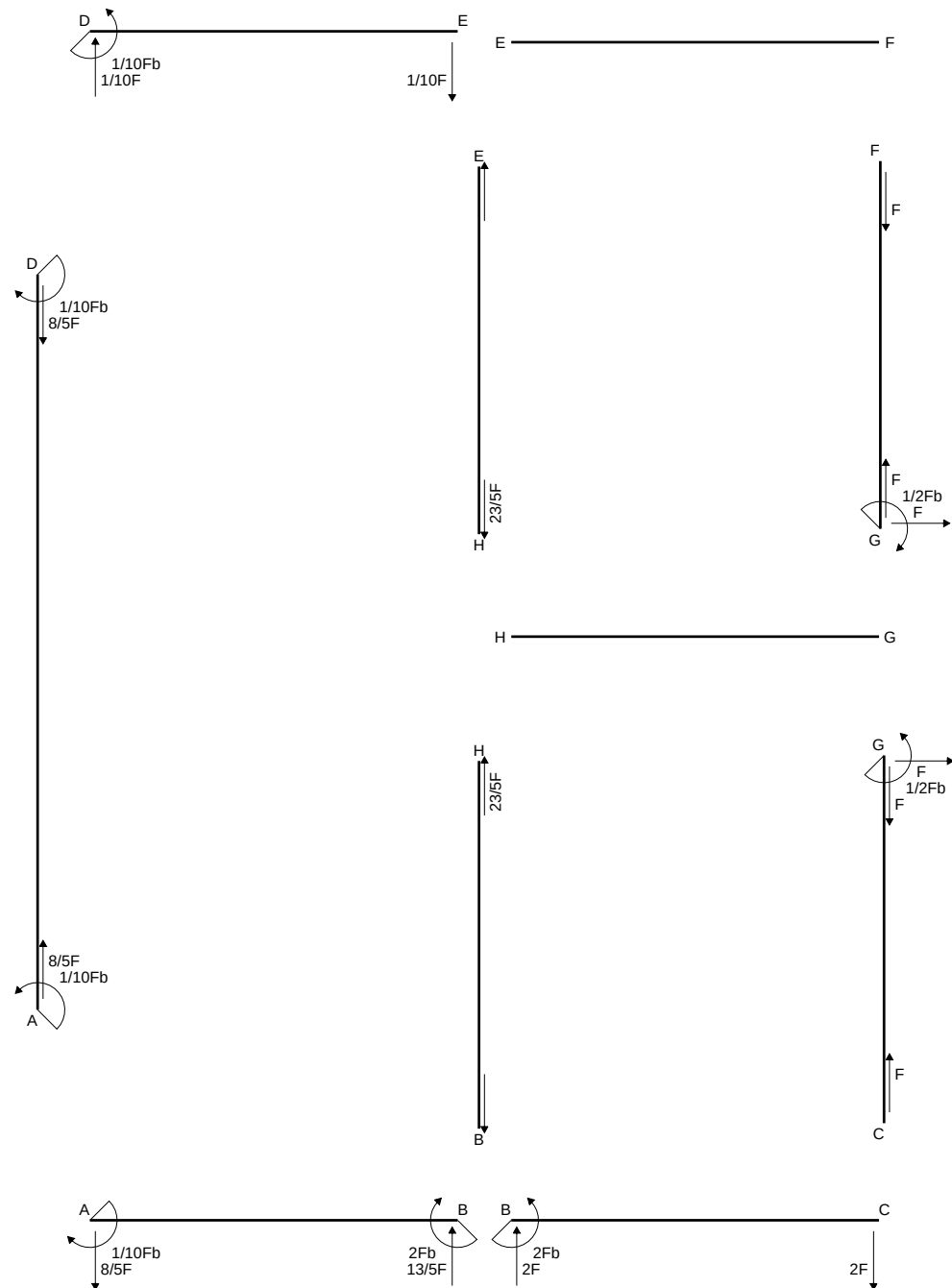
$$v_c = -20.1 \text{ mm}$$

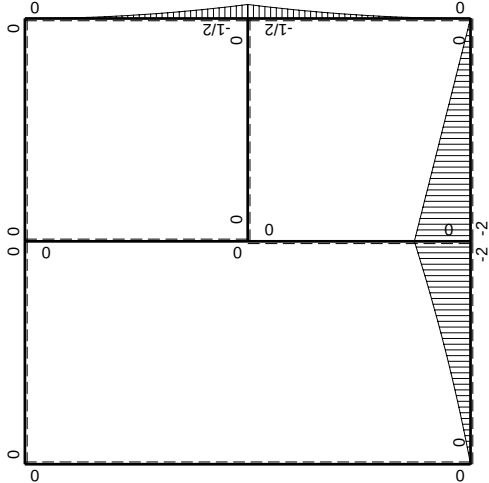
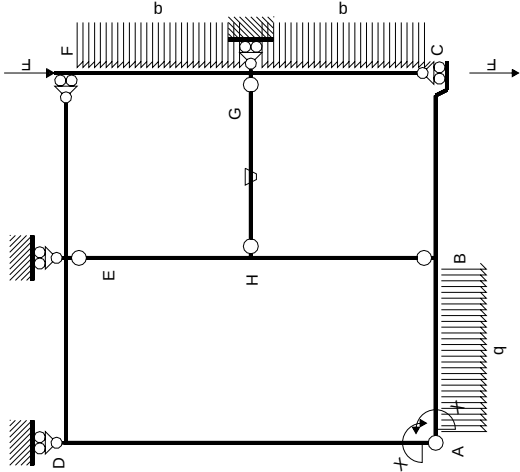
$$\sigma_c = -Mv/J_u = -120.8 \text{ N/mm}^2$$

$$\tau_c = 12.47 \text{ N/mm}^2$$

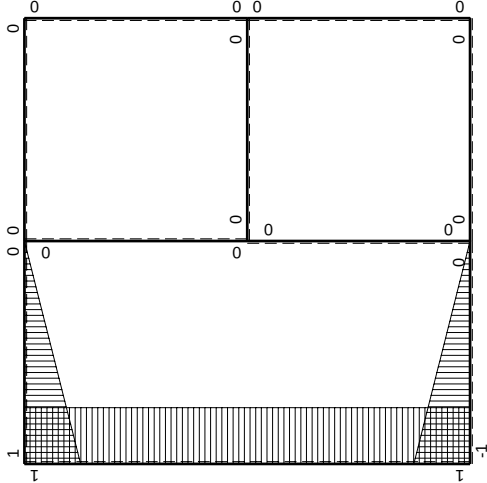
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 122.7 \text{ N/mm}^2$$

$$S = 5978. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} Fb^2/EJ$$

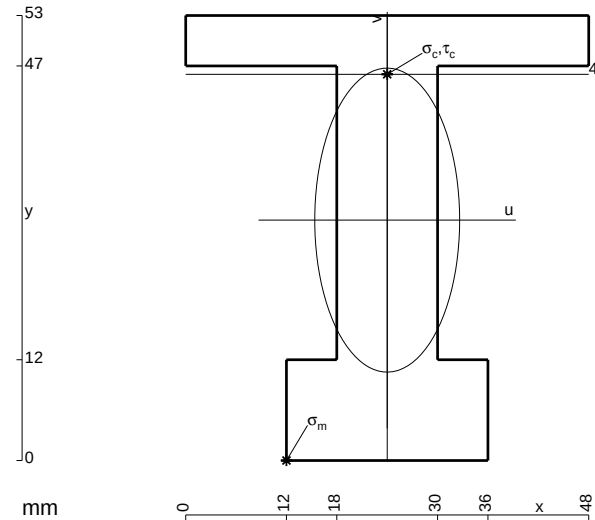
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} Fb^2/EJ$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} Fb^2/EJ = 7/24 Fb^2/EJ$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} Fb^2/EJ$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} Fb^2/EJ$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} Fb^2/EJ = 7/24 Fb^2/EJ$$



$$A = 996. \text{ mm}^2$$

$$J_u = 326526. \text{ mm}^4$$

$$J_v = 74160. \text{ mm}^4$$

$$y_g = 28.63 \text{ mm}$$

$$T_y = 4600. \text{ N}$$

$$M_x = -2392000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -28.63 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -209.8 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 46. \text{ mm}$$

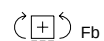
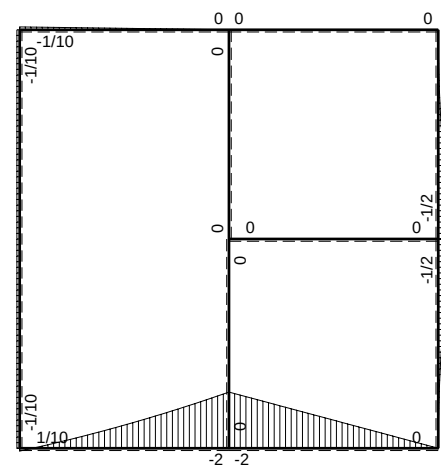
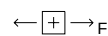
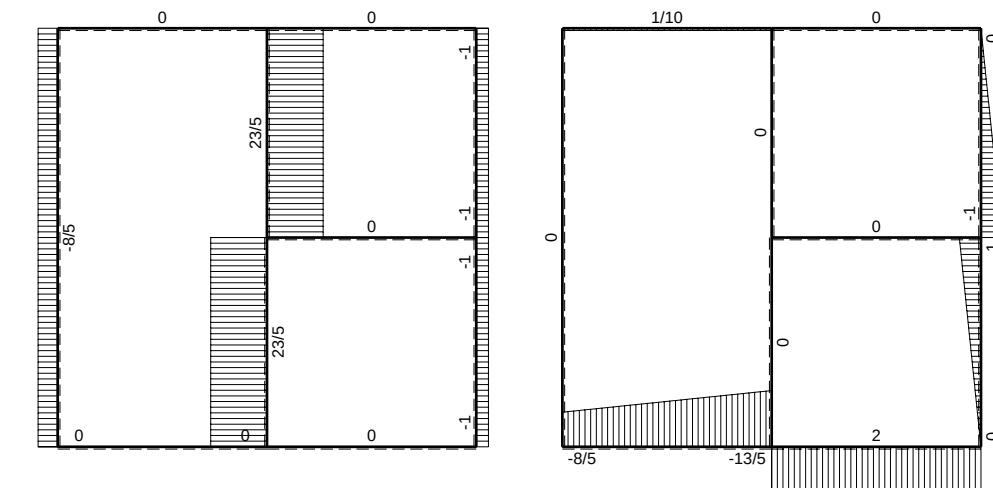
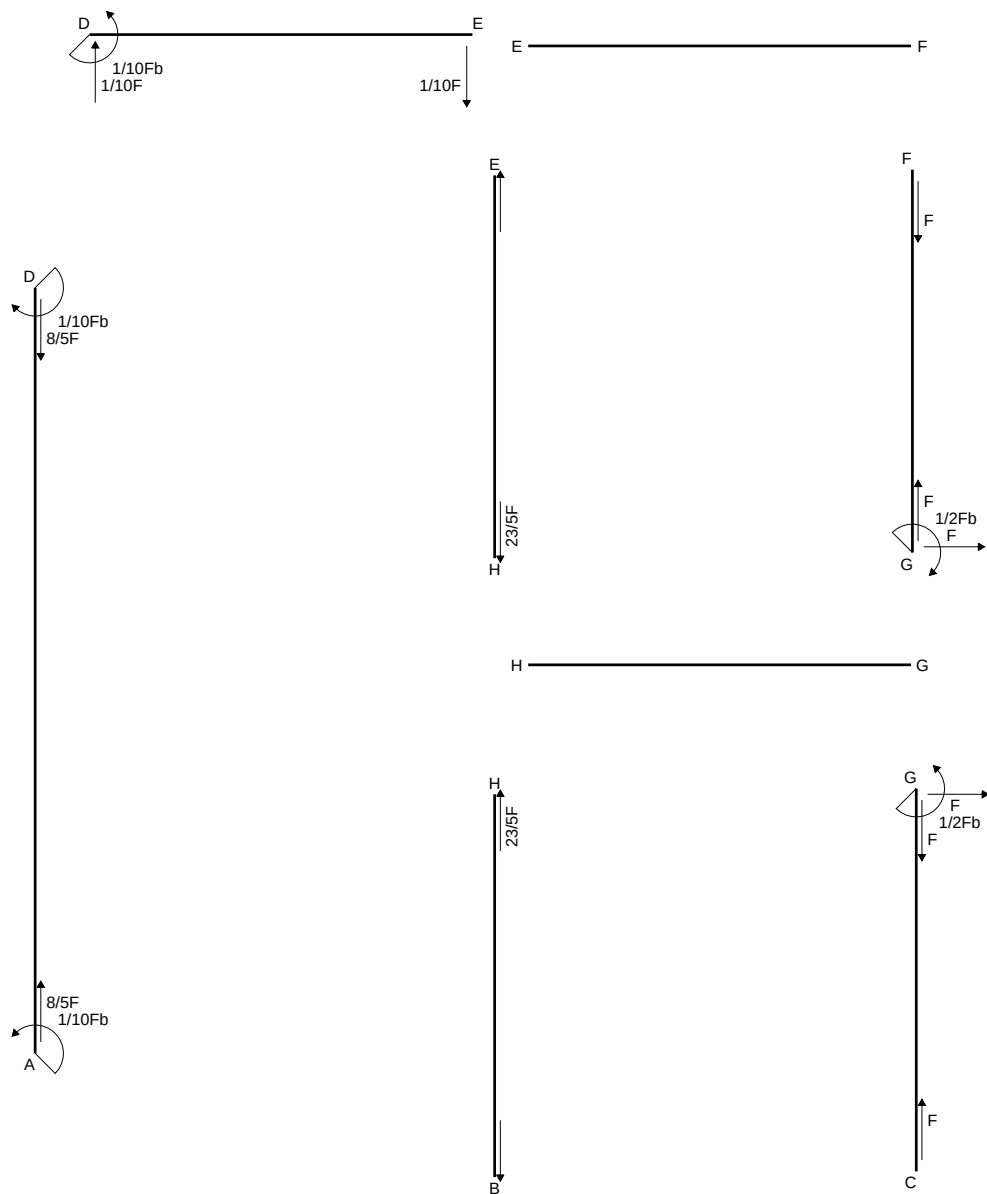
$$v_c = 17.37 \text{ mm}$$

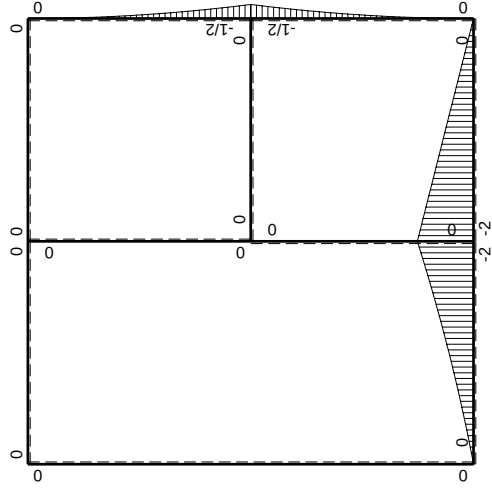
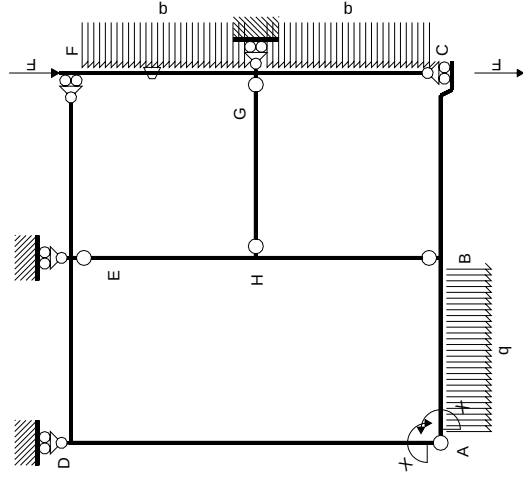
$$\sigma_c = -Mv/J_u = 127.2 \text{ N/mm}^2$$

$$\tau_c = 7.476 \text{ N/mm}^2$$

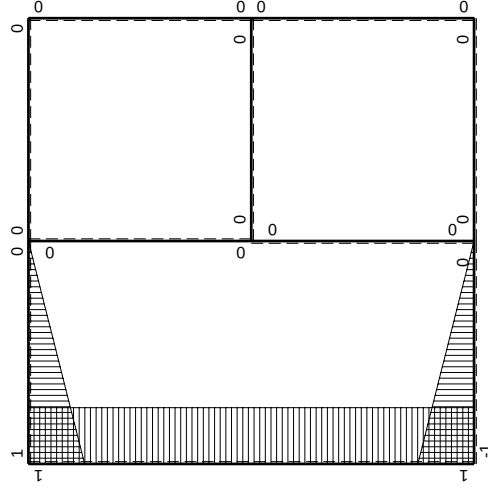
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 127.9 \text{ N/mm}^2$$

$$S = 6368. \text{ mm}^3$$





 M_o flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	$1/2Fb-Fx+1/2qx^2$	Fb/EJ	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

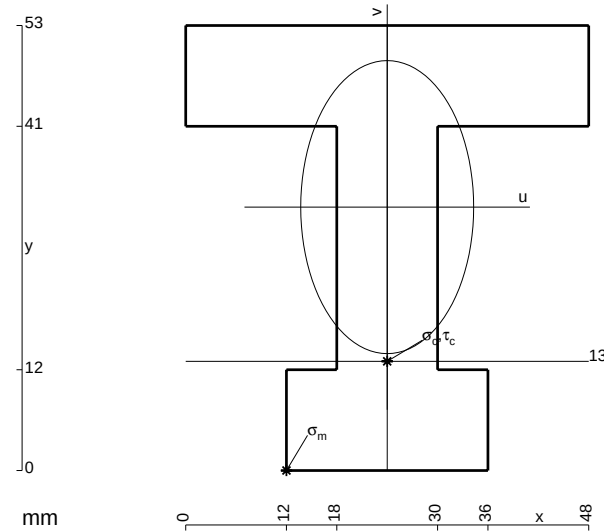
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 1212. \text{ mm}^2$$

$$J_u = 369093. \text{ mm}^4$$

$$J_v = 128592. \text{ mm}^4$$

$$y_g = 31.37 \text{ mm}$$

$$T_y = 4540. \text{ N}$$

$$M_x = -2587800. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -31.37 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -220. \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

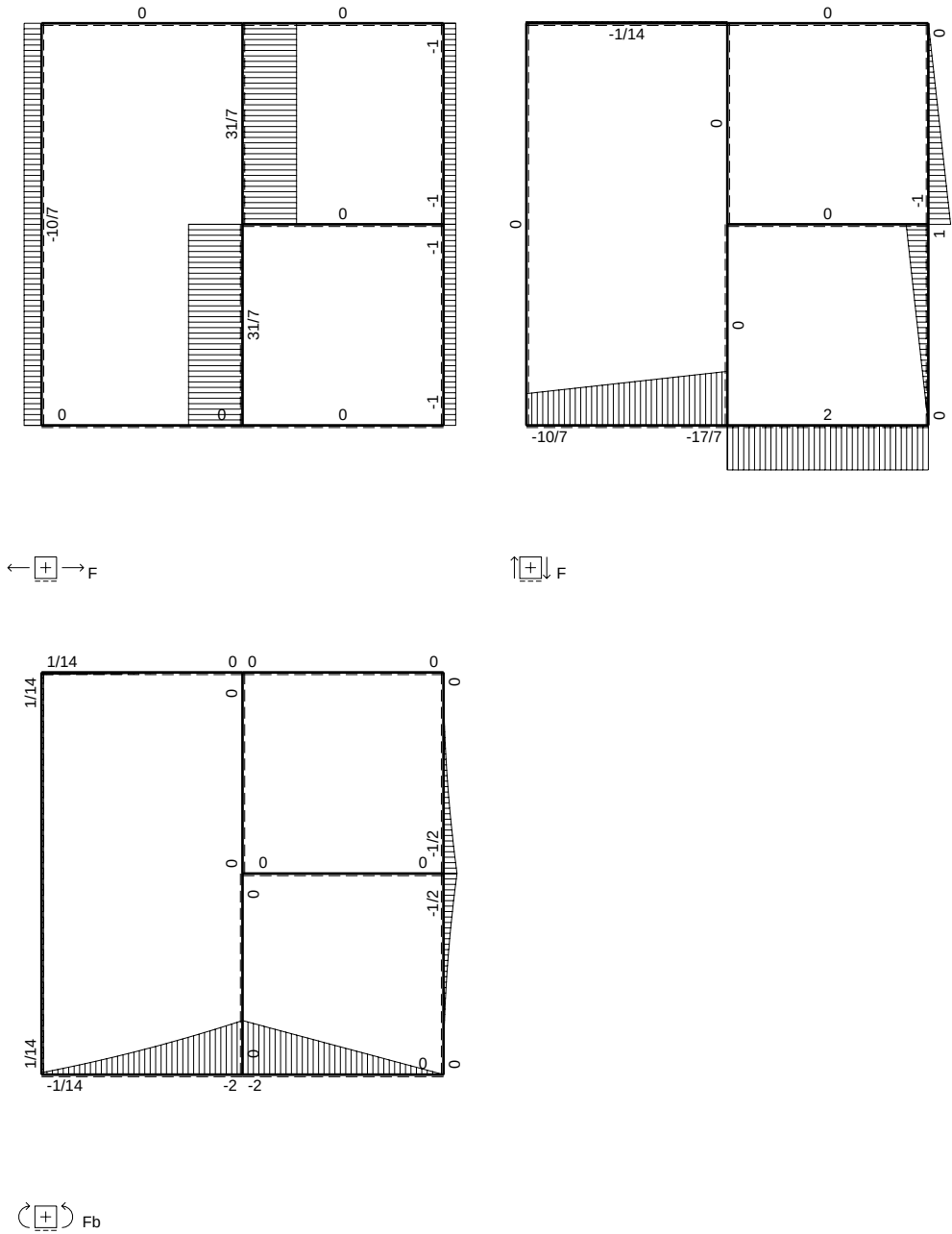
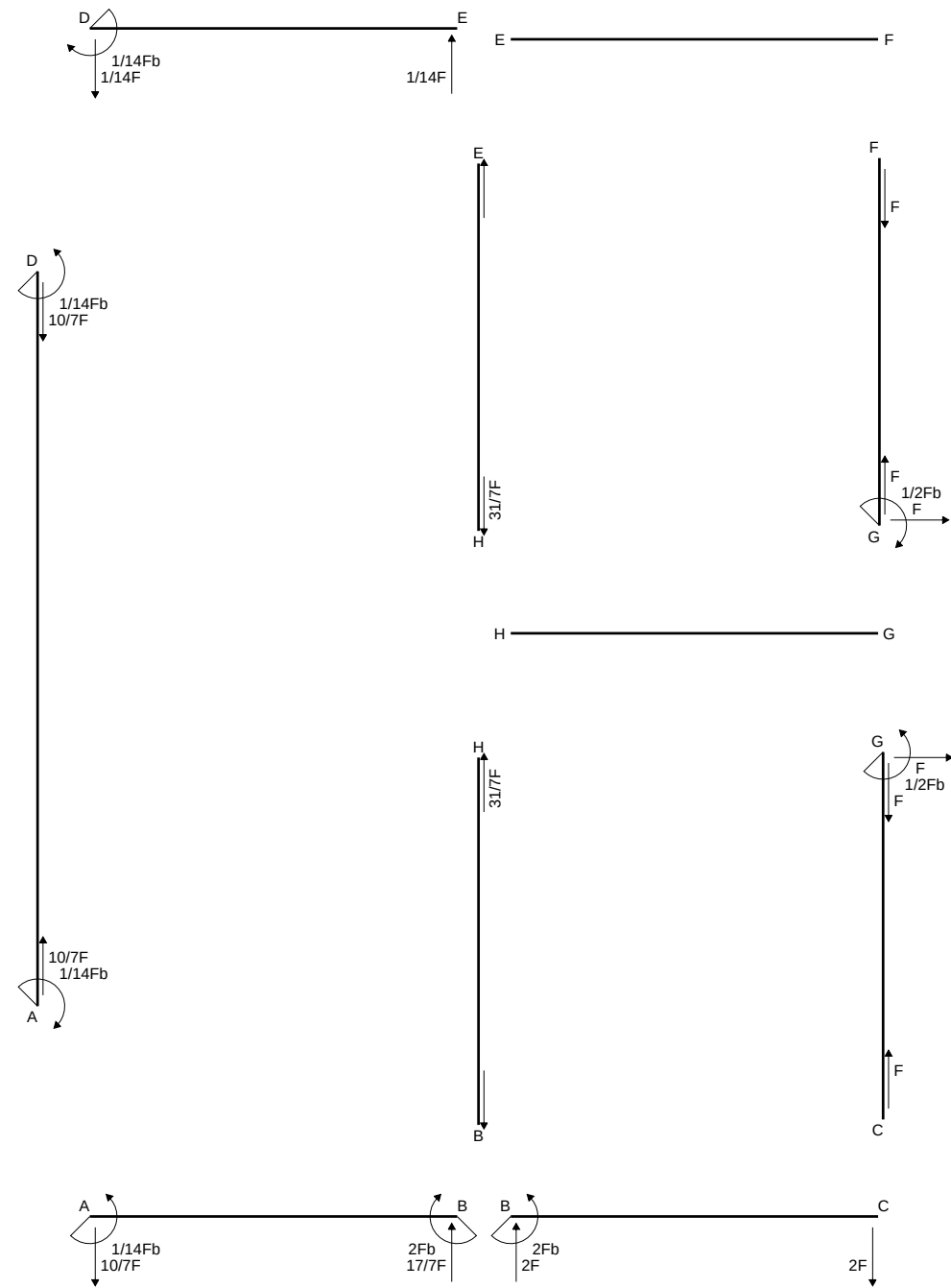
$$v_c = -18.37 \text{ mm}$$

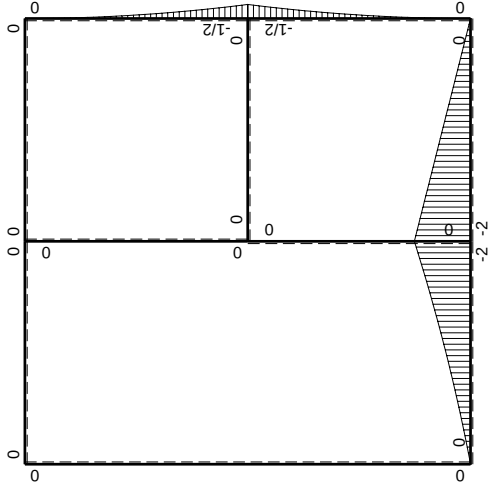
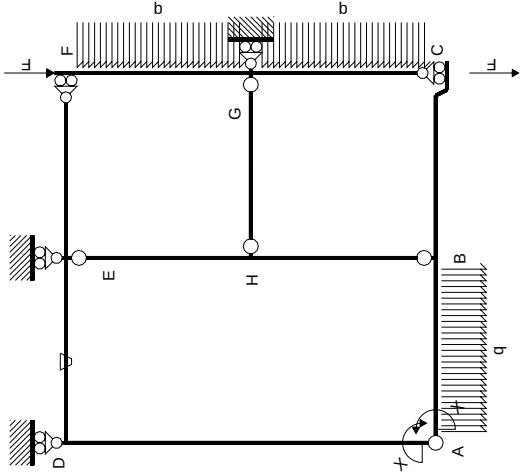
$$\sigma_c = -Mv/J_u = -128.8 \text{ N/mm}^2$$

$$\tau_c = 7.722 \text{ N/mm}^2$$

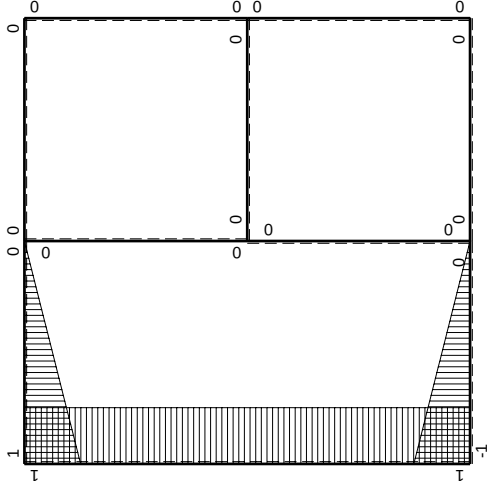
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 129.5 \text{ N/mm}^2$$

$$S = 7533. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	$-Fb/EJ$	0	$-Fb/EJ+Fx/EJ$	$1-2x/b+x^2/b^2$	$(0-1/2)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	0	Fb/EJ	0	$-Fx/EJ$	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/14Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

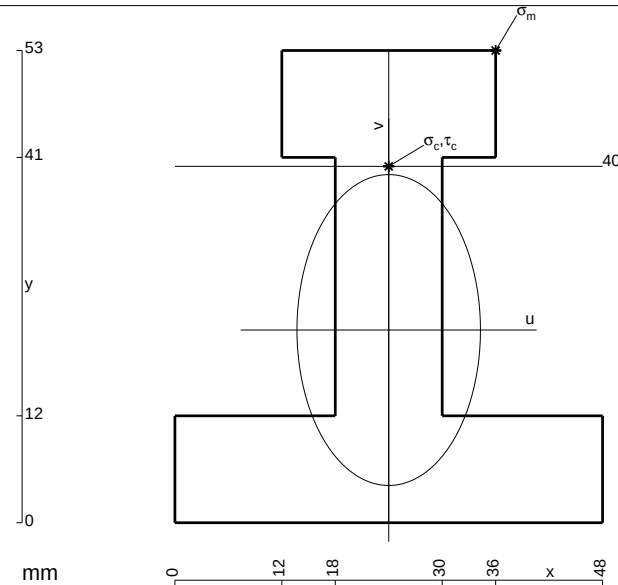
$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{DE}^{xo} = \int_0^b (-1 + x/b) \theta dx = \left[-x + 1/2 x^2/b \right]_0^b \theta$$

$$= (-b + 1/2 b) \theta = -1/2 \frac{Fb^2}{EJ}$$

$$L_{ED}^{xo} = \int_0^b (x/b) \theta dx = \left[1/2 x^2/b \right]_0^b \theta$$

$$= (1/2 b) \theta = -1/2 \frac{Fb^2}{EJ}$$



$$A = 1212. \text{ mm}^2$$

$$J_u = 369093. \text{ mm}^4$$

$$J_v = 128592. \text{ mm}^4$$

$$y_g = 21.63 \text{ mm}$$

$$T_y = 4360. \text{ N}$$

$$M_x = -2703200. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 31.37 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 229.8 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

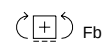
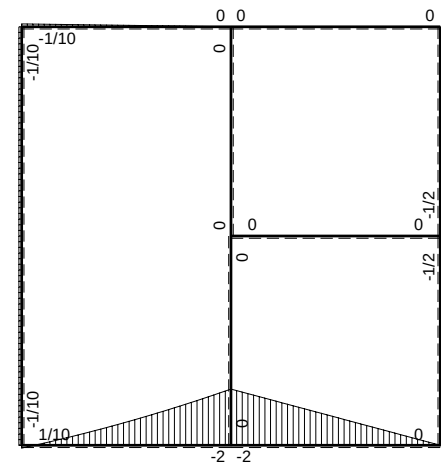
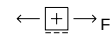
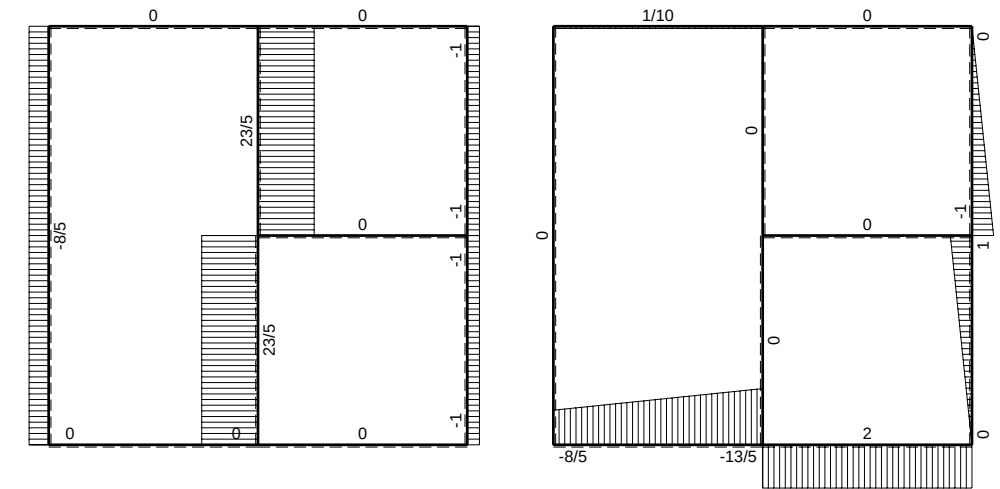
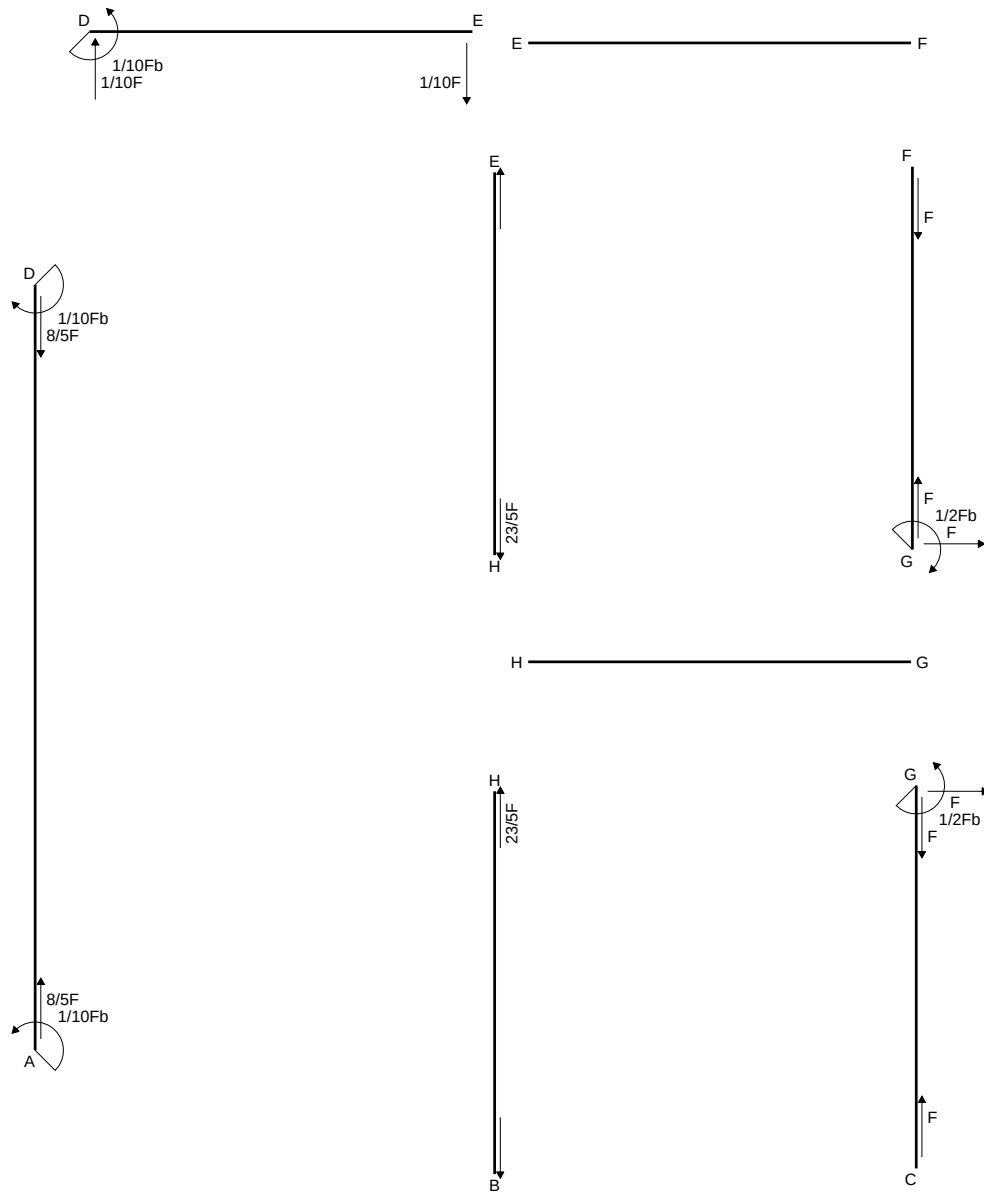
$$v_c = 18.37 \text{ mm}$$

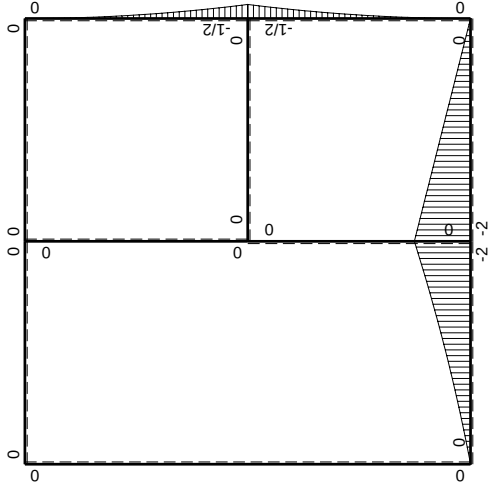
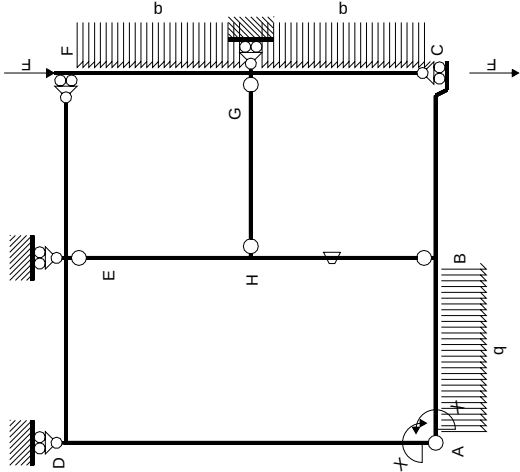
$$\sigma_c = -Mv/J_u = 134.5 \text{ N/mm}^2$$

$$\tau_c = 7.416 \text{ N/mm}^2$$

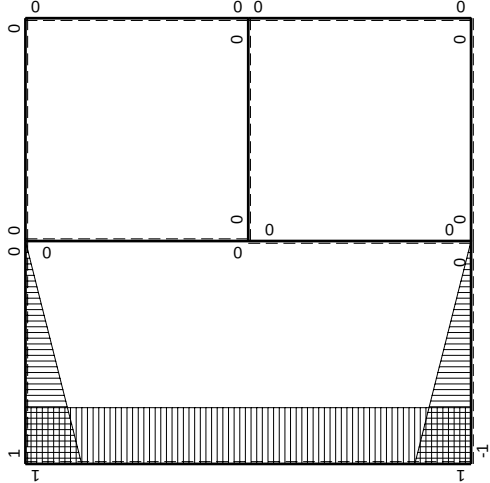
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 135.2 \text{ N/mm}^2$$

$$S = 7533. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	0	Fb/EJ	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

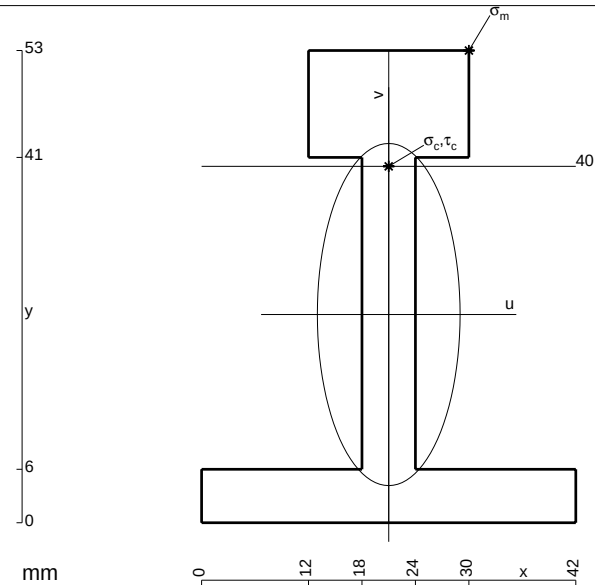
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 678. \text{ mm}^2$$

$$J_u = 249963. \text{ mm}^4$$

$$J_v = 43506. \text{ mm}^4$$

$$y_g = 23.37 \text{ mm}$$

$$T_y = 3020. \text{ N}$$

$$M_x = -2023400. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 29.63 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 239.9 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

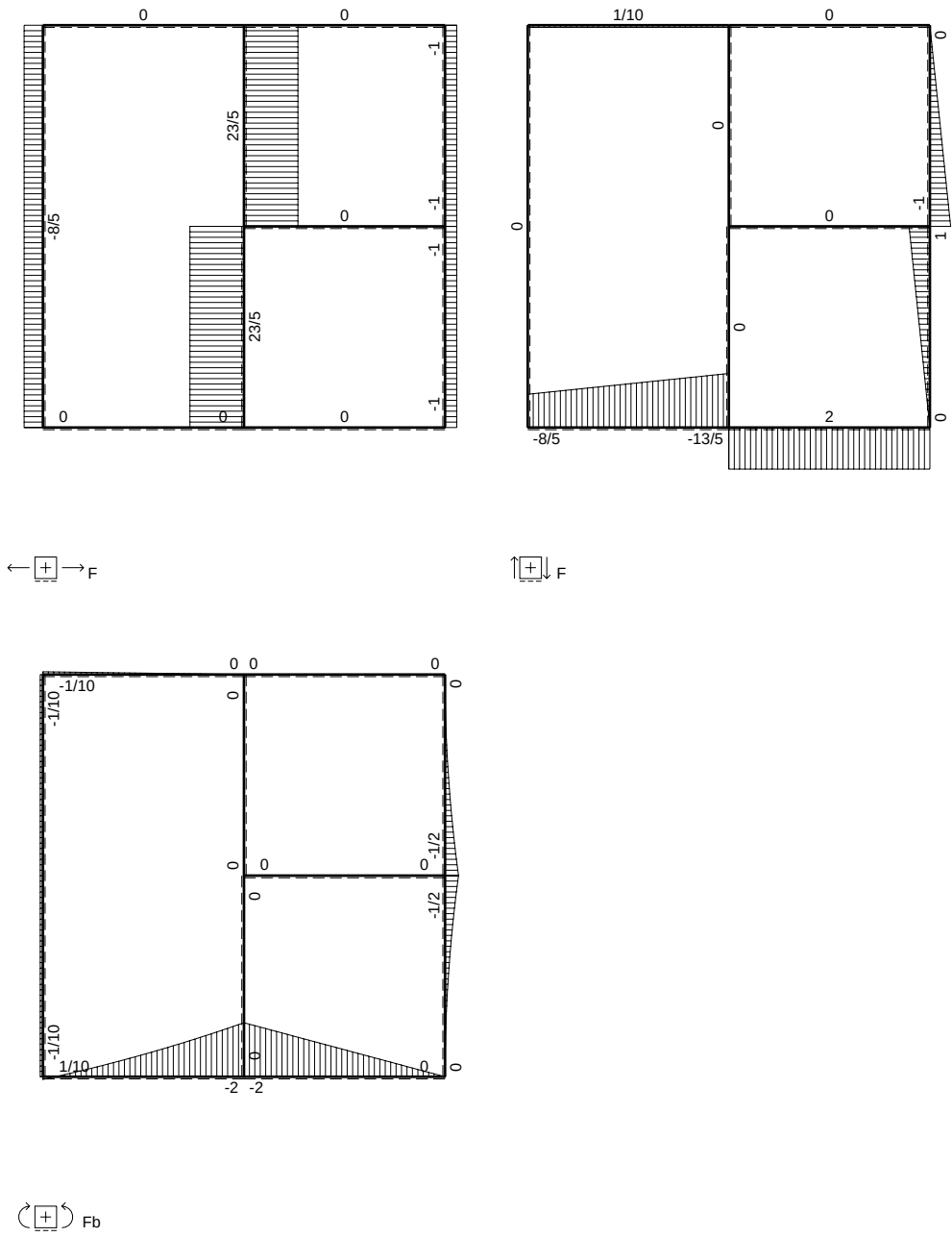
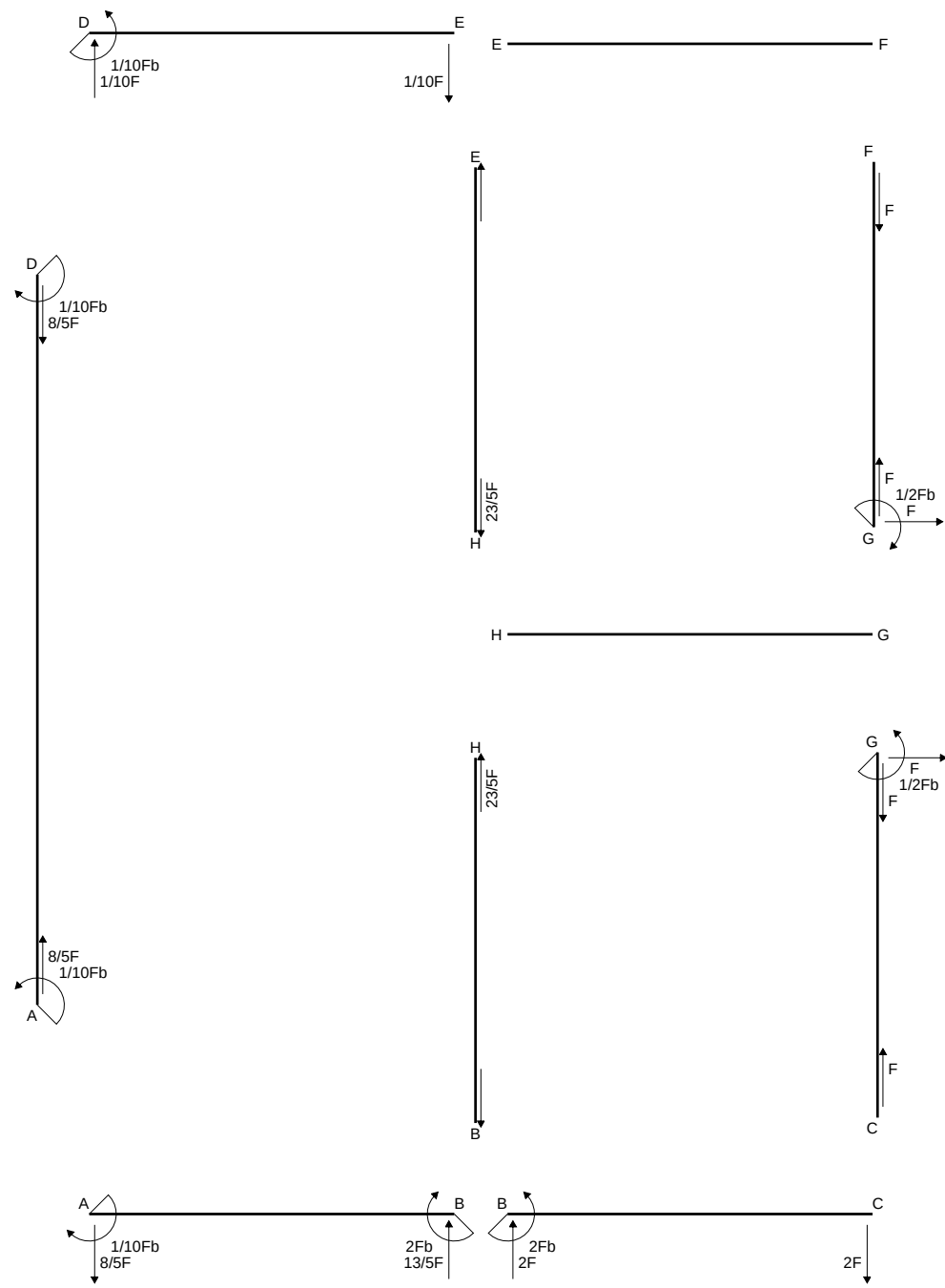
$$v_c = 16.63 \text{ mm}$$

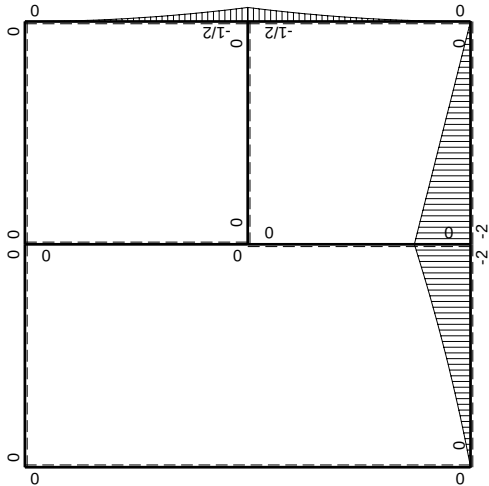
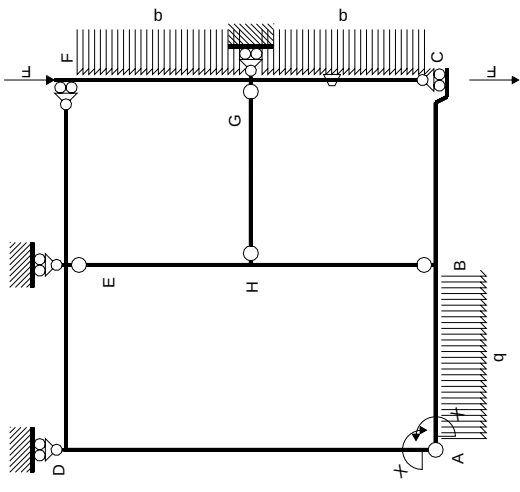
$$\sigma_c = -Mv/J_u = 134.6 \text{ N/mm}^2$$

$$\tau_c = 10.49 \text{ N/mm}^2$$

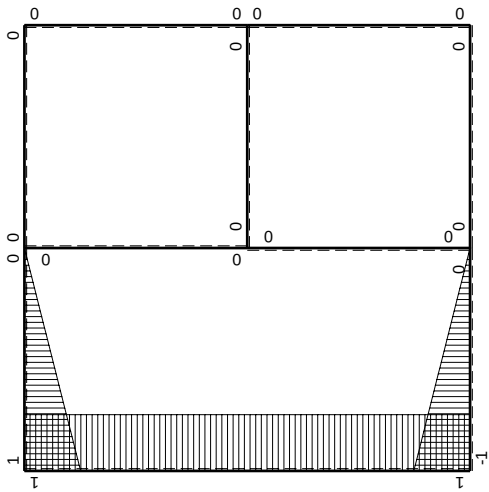
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 135.9 \text{ N/mm}^2$$

$$S = 5207. \text{ mm}^3$$





 M_0 flessione da carichi assegnati



 M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	$1/2qx^2$	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

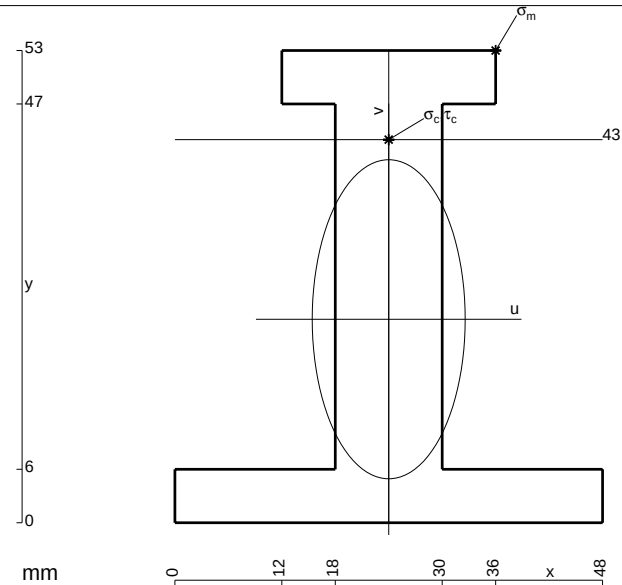
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 924. \text{ mm}^2$$

$$J_u = 296396. \text{ mm}^4$$

$$J_v = 68112. \text{ mm}^4$$

$$y_g = 22.84 \text{ mm}$$

$$T_y = 2720. \text{ N}$$

$$M_x = -1958400. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 30.16 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 199.3 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 43. \text{ mm}$$

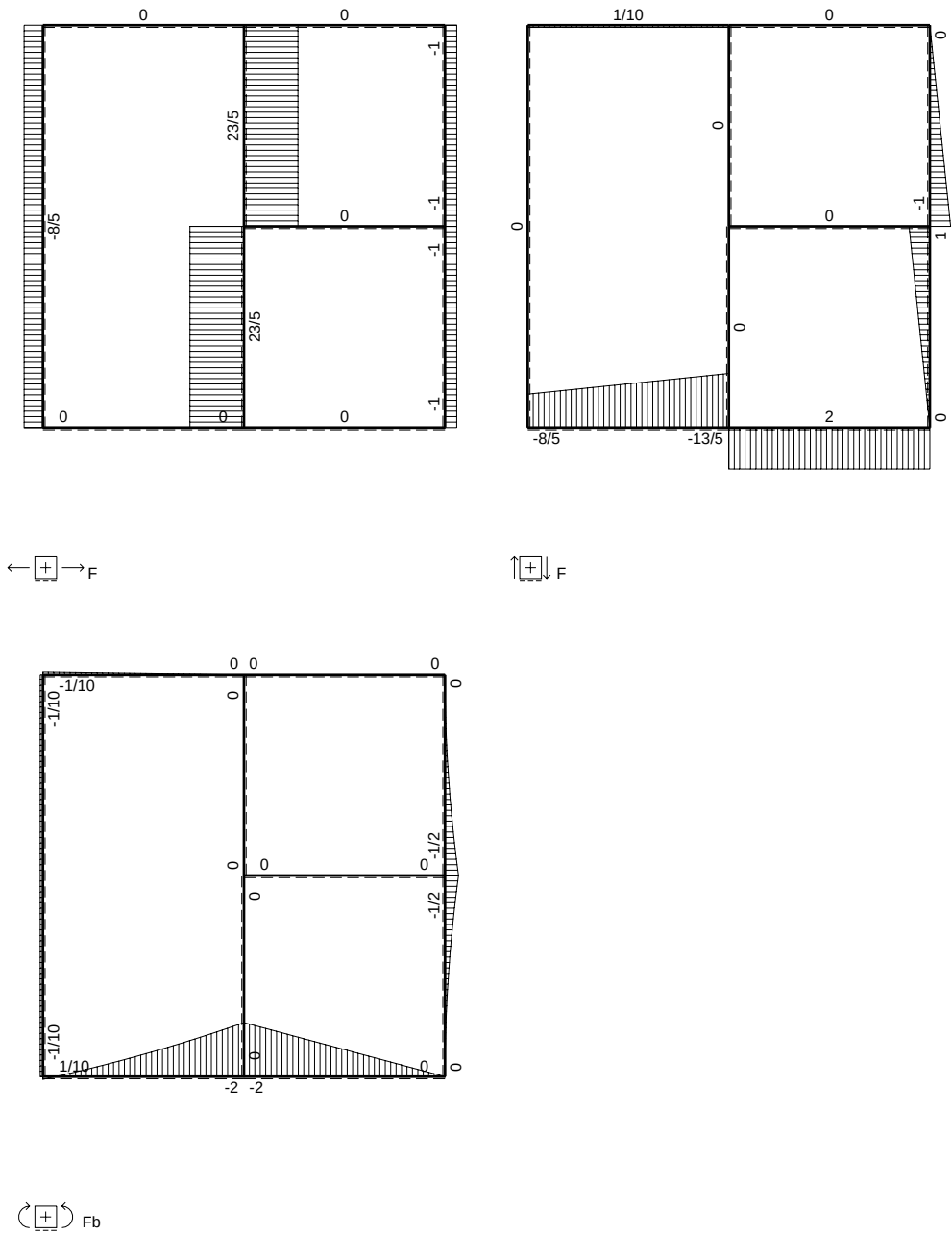
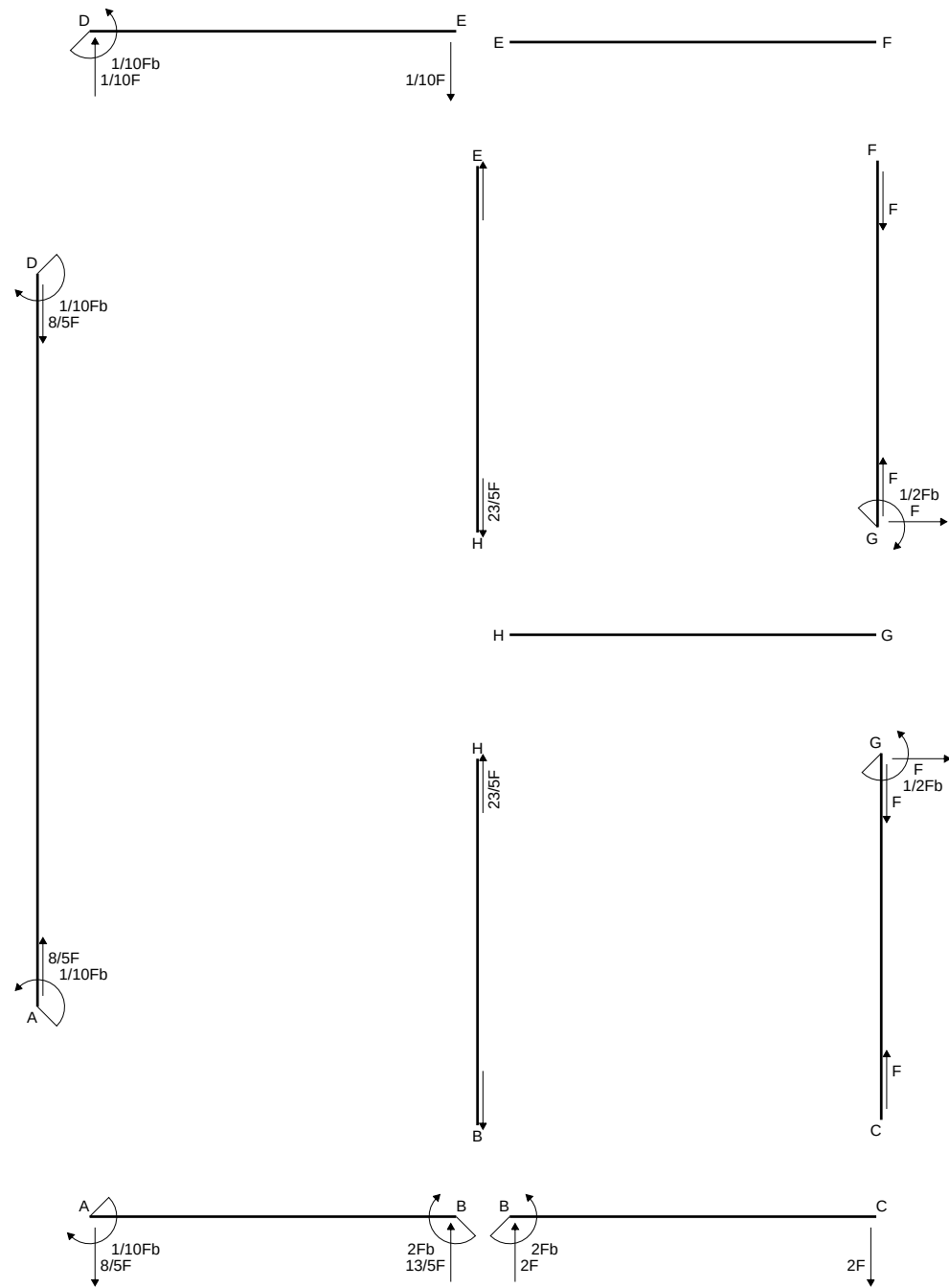
$$v_c = 20.16 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 133.2 \text{ N/mm}^2$$

$$\tau_c = 3.805 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 133.4 \text{ N/mm}^2$$

$$S = 4975. \text{ mm}^3$$



Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	$-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

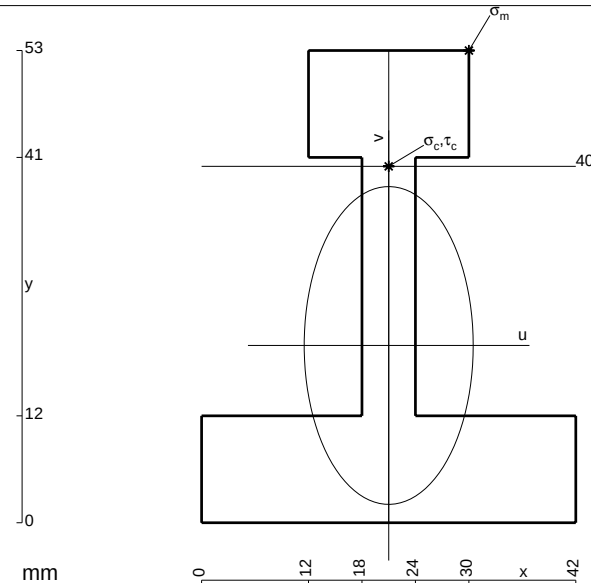
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 894. \text{ mm}^2$$

$$J_u = 284424. \text{ mm}^4$$

$$J_v = 80442. \text{ mm}^4$$

$$y_g = 19.9 \text{ mm}$$

$$T_y = 2360. \text{ N}$$

$$M_x = -1793600. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 33.1 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 208.8 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

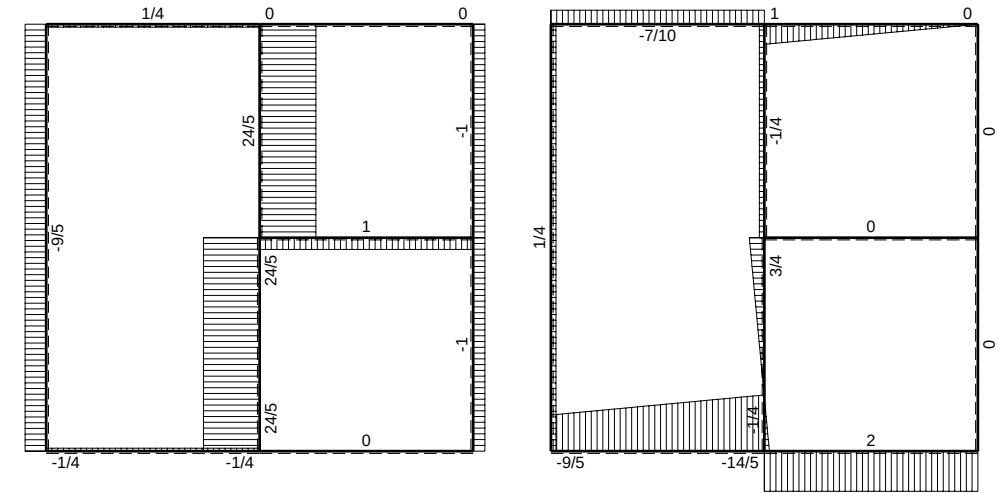
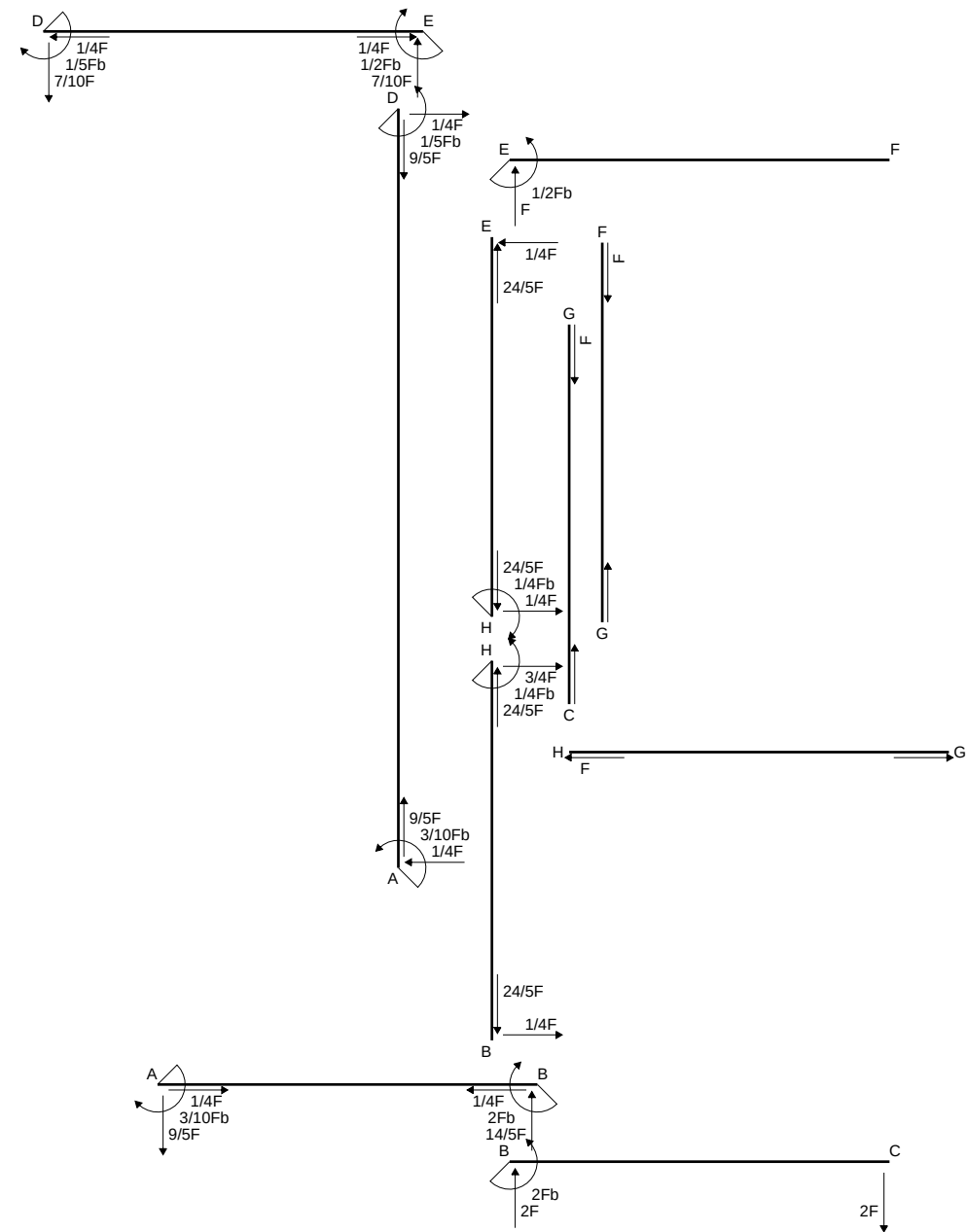
$$v_c = 20.1 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 126.8 \text{ N/mm}^2$$

$$\tau_c = 8.267 \text{ N/mm}^2$$

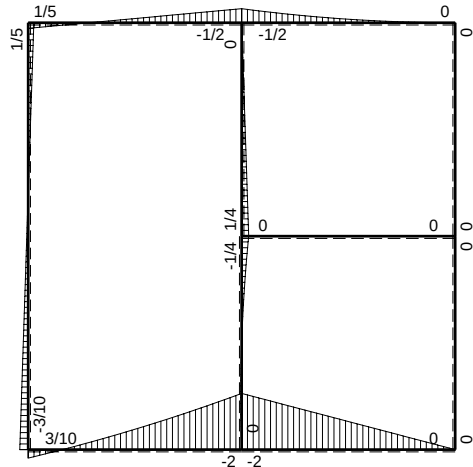
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 127.6 \text{ N/mm}^2$$

$$S = 5978. \text{ mm}^3$$



← ⊕ → F

↑ ⊕ ↓ F



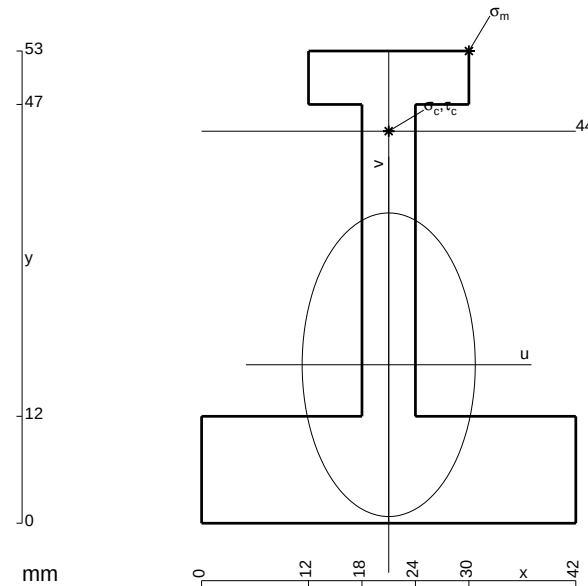
⊕ ⊕ Fb

Quadro contributi PLV per iperstatica $X=W_{AB}$

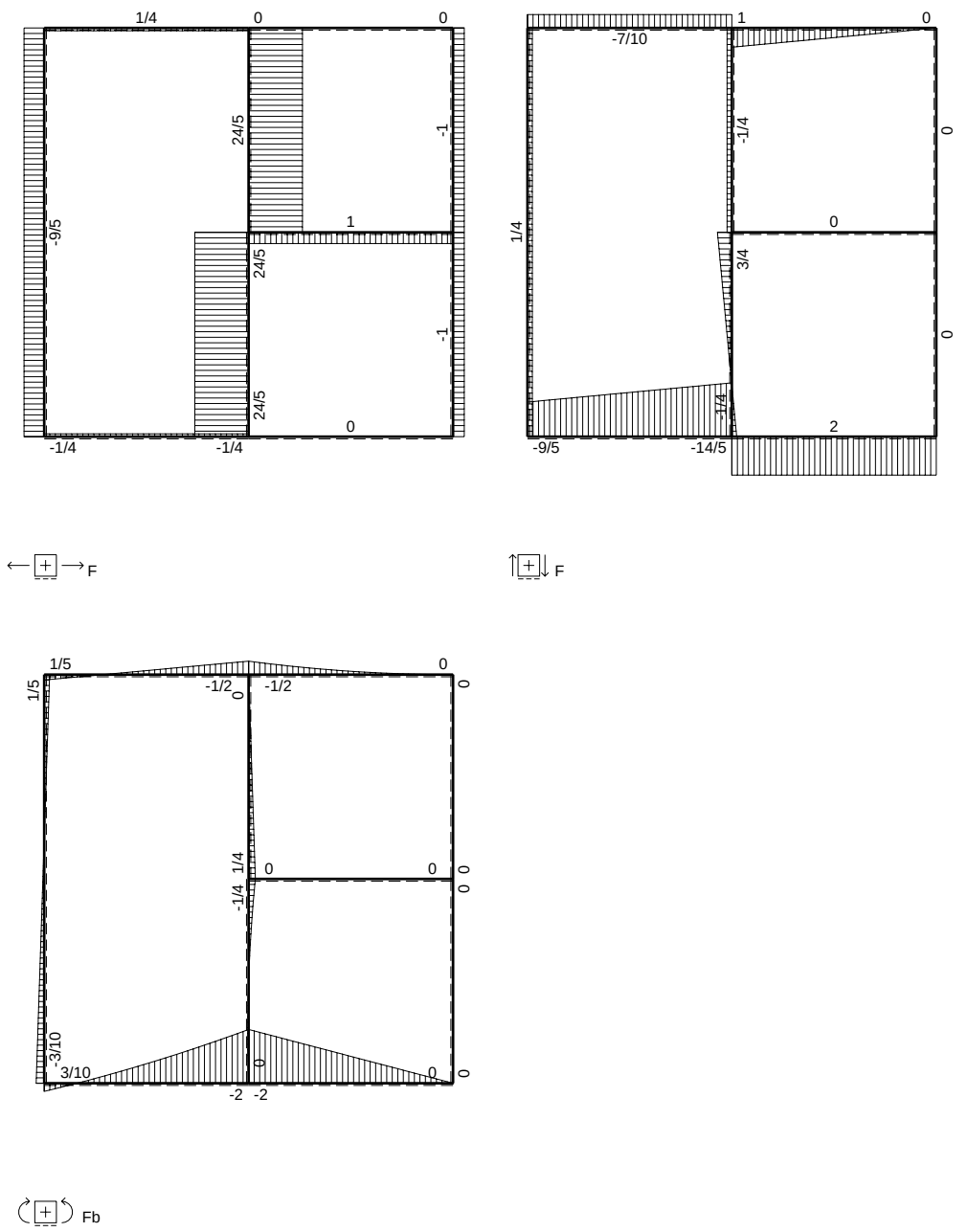
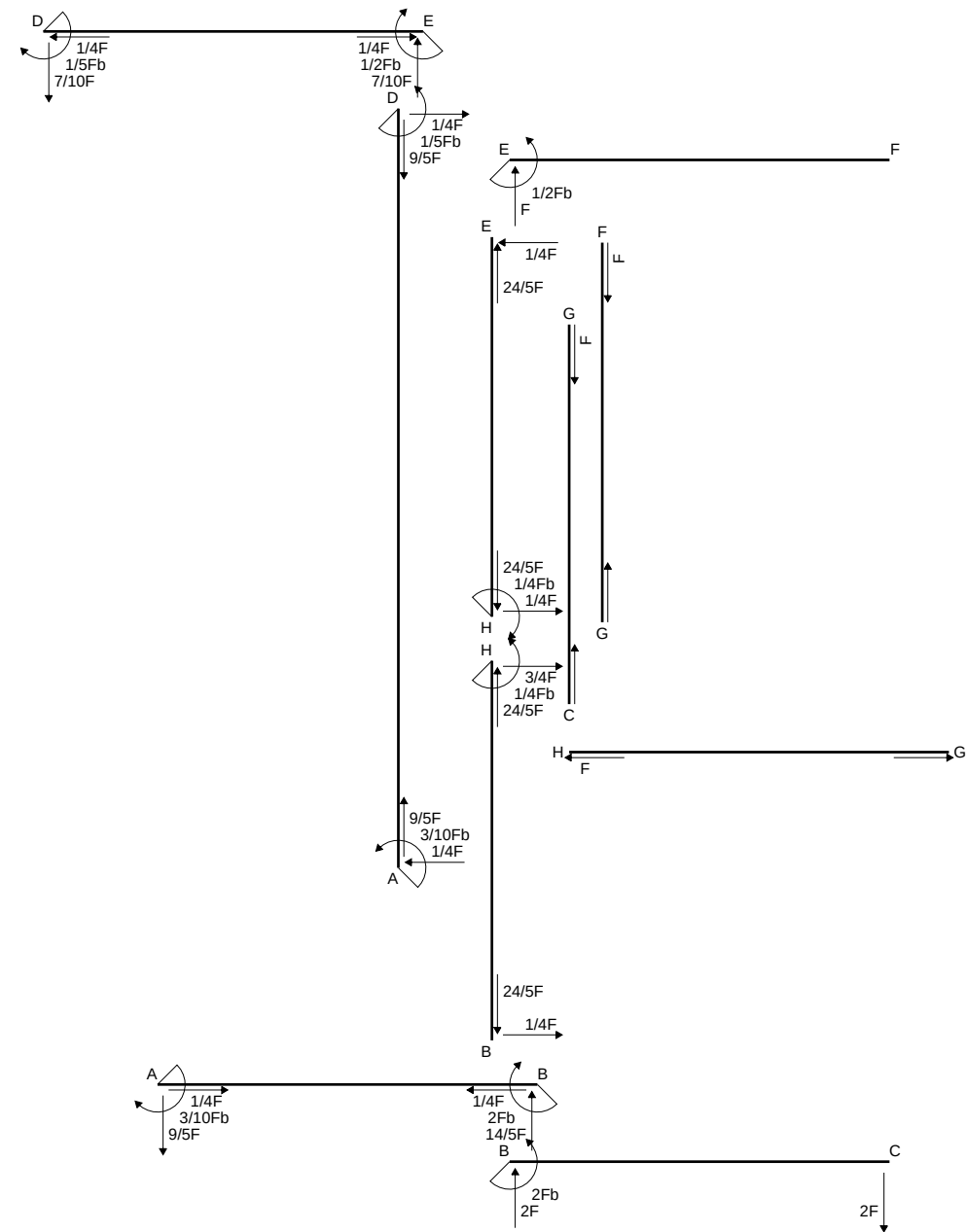
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

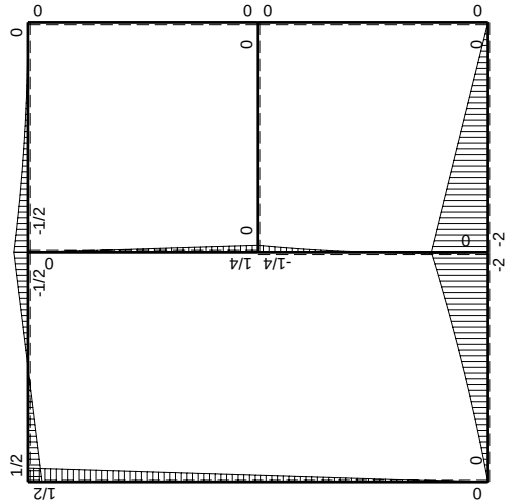
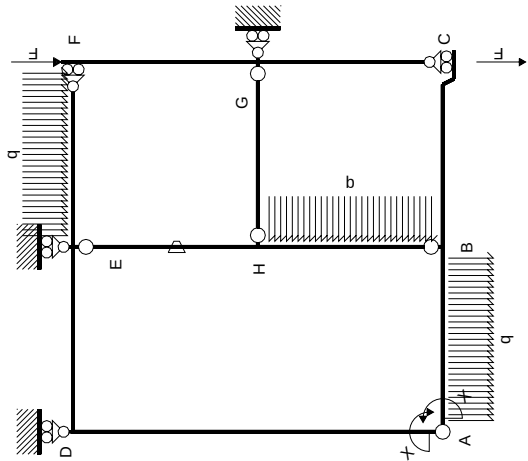
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



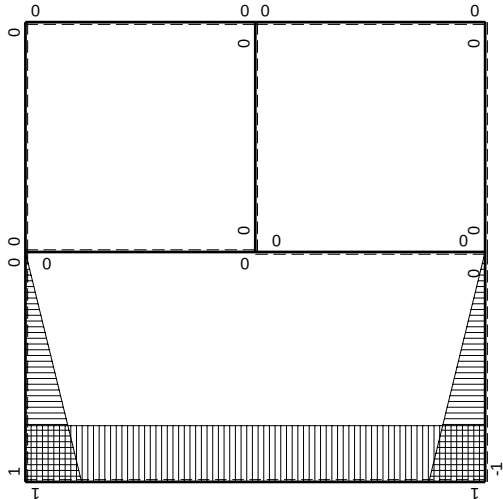
$$\begin{aligned}
A &= 822. \text{ mm}^2 \\
J_u &= 238712. \text{ mm}^4 \\
J_v &= 77634. \text{ mm}^4 \\
y_g &= 17.78 \text{ mm} \\
T_y &= 1840. \text{ N} \\
M_x &= -1490400. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 35.22 \text{ mm} \\
\sigma_m &= -Mv/J_u = 219.9 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 44. \text{ mm} \\
v_c &= 26.22 \text{ mm} \\
\sigma_c &= -Mv/J_u = 163.7 \text{ N/mm}^2 \\
\tau_c &= 5.111 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 163.9 \text{ N/mm}^2 \\
S &= 3978. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



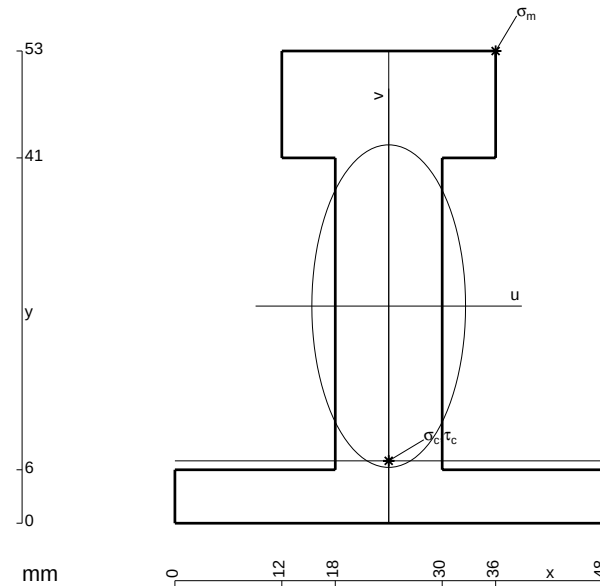
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

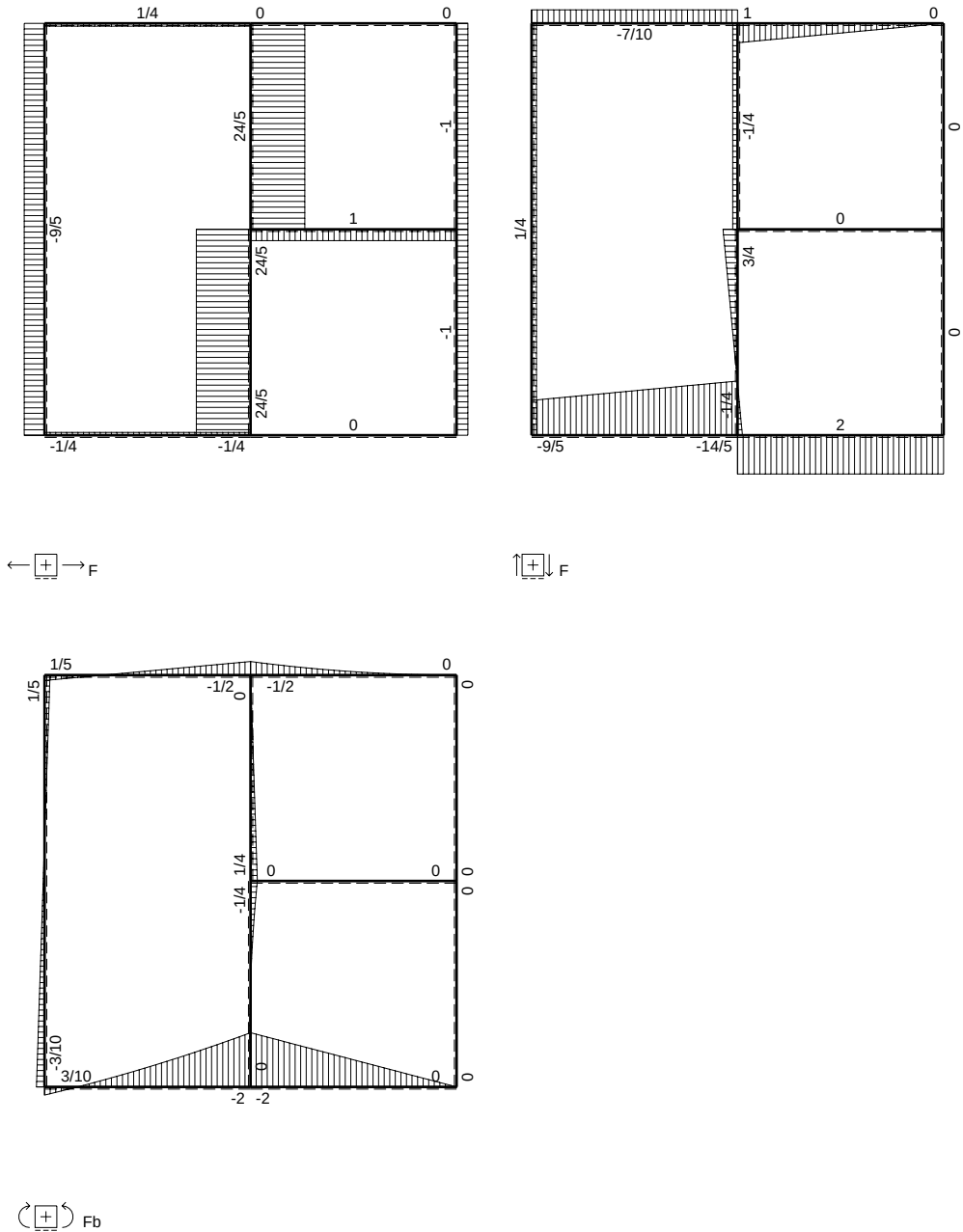
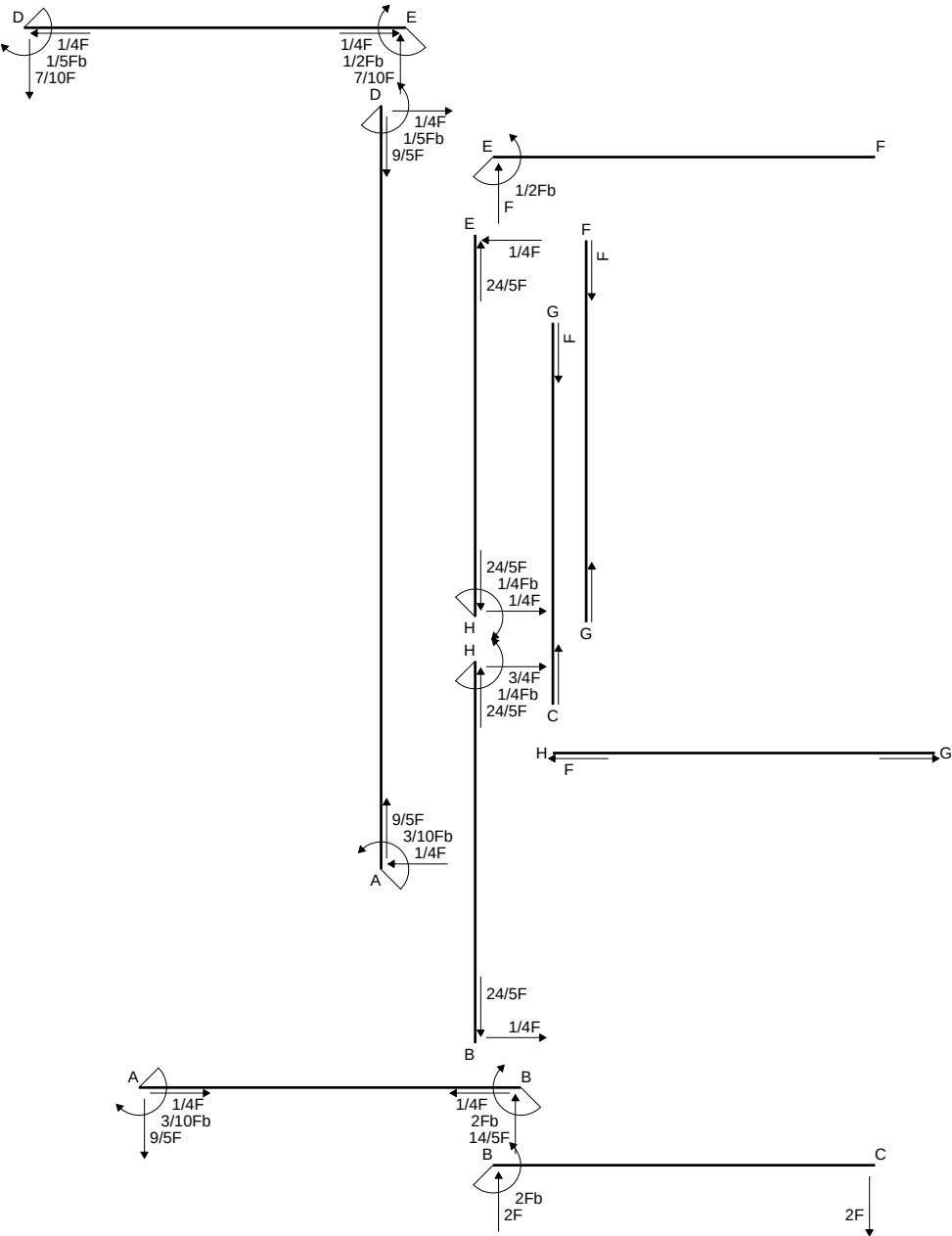
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-1/4Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

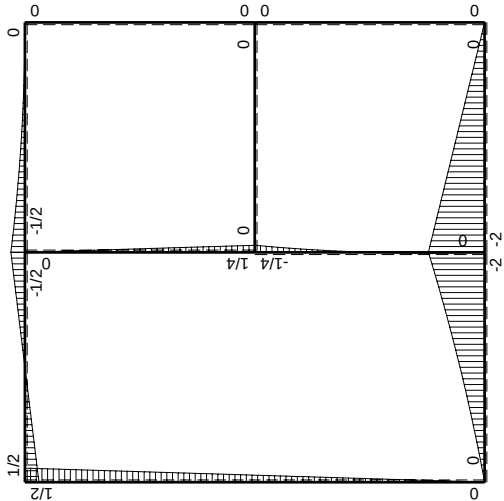
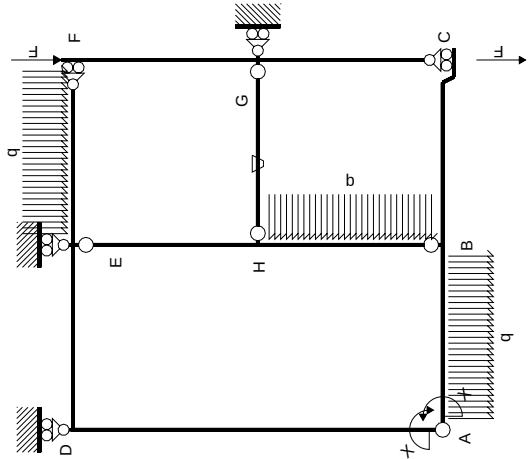
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



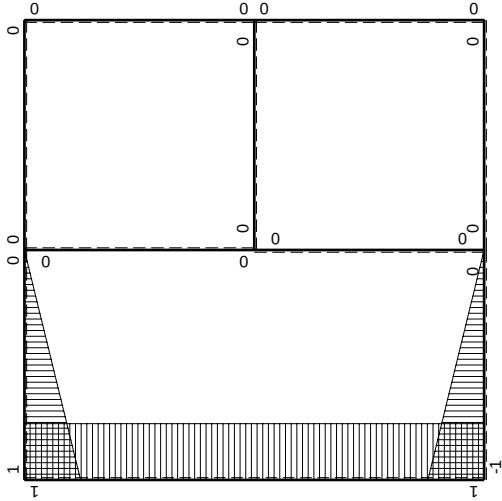
$$\begin{aligned}
A &= 996. \text{ mm}^2 \\
J_u &= 326526. \text{ mm}^4 \\
J_v &= 74160. \text{ mm}^4 \\
y_g &= 24.37 \text{ mm} \\
T_y &= 3040. \text{ N} \\
M_x &= -2614400. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 28.63 \text{ mm} \\
\sigma_m &= -Mv/J_u = 229.3 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 7. \text{ mm} \\
v_c &= -17.37 \text{ mm} \\
\sigma_c &= -Mv/J_u = -139.1 \text{ N/mm}^2 \\
\tau_c &= 4.941 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 139.3 \text{ N/mm}^2 \\
S &= 6368. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



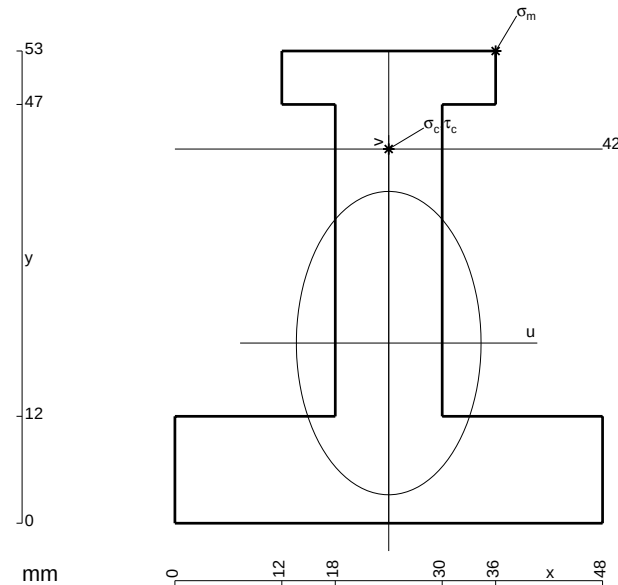
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

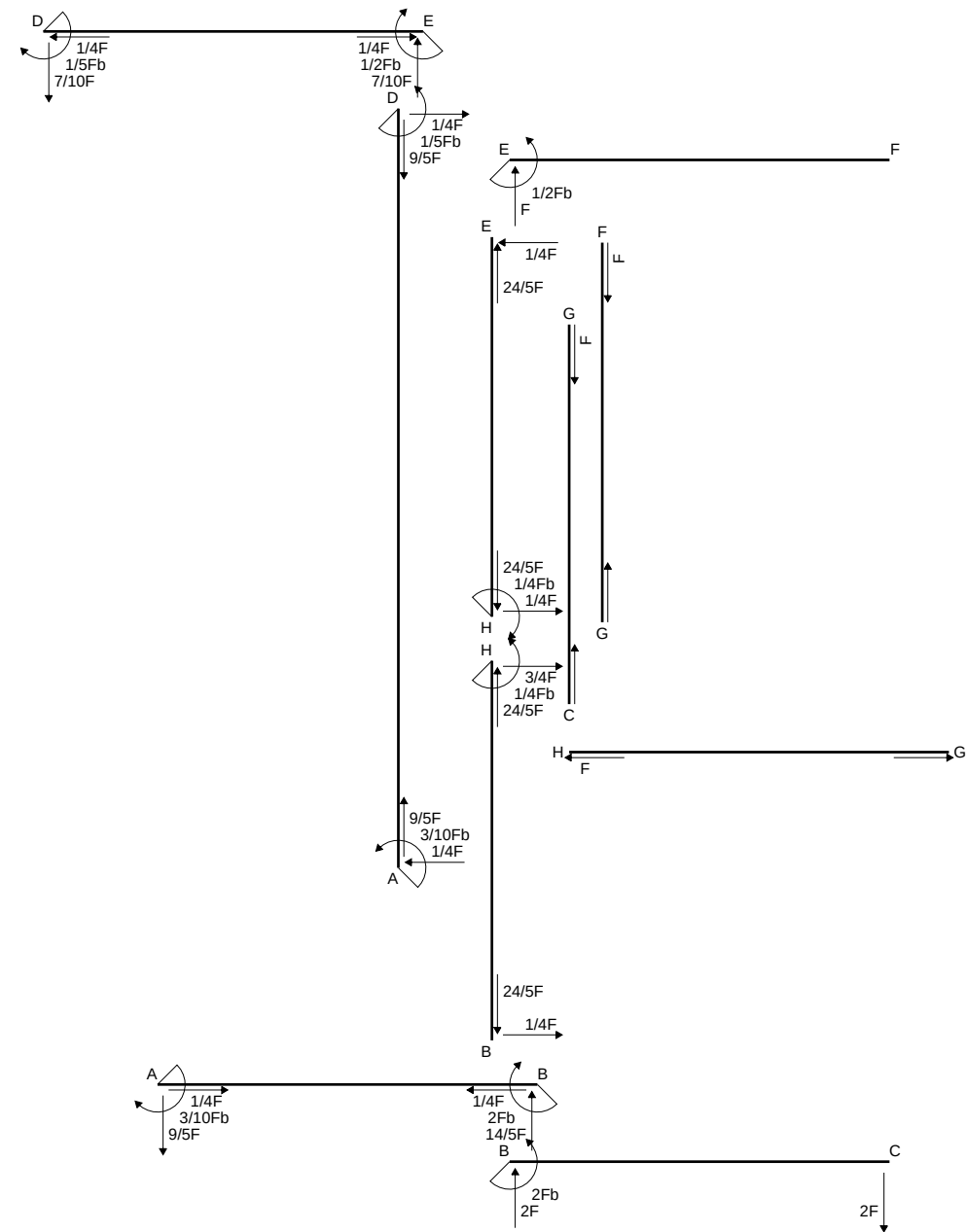
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 1140. \text{ mm}^2 \\
J_u &= 330567. \text{ mm}^4 \\
J_v &= 122544. \text{ mm}^4 \\
y_g &= 20.22 \text{ mm} \\
T_y &= 2640. \text{ N} \\
M_x &= -2402400. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 32.78 \text{ mm} \\
\sigma_m &= -Mv/J_u = 238.3 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 42. \text{ mm} \\
v_c &= 21.78 \text{ mm} \\
\sigma_c &= -Mv/J_u = 158.3 \text{ N/mm}^2 \\
\tau_c &= 3.824 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 158.5 \text{ N/mm}^2 \\
S &= 5746. \text{ mm}^3
\end{aligned}$$

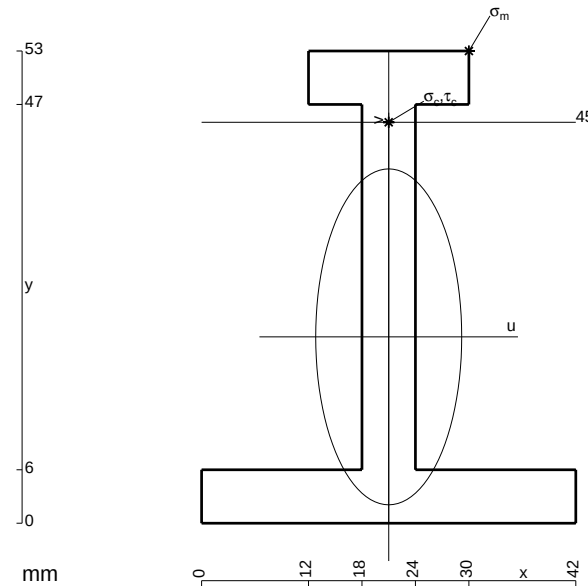


Quadro contributi PLV per iperstatica $X=W_{AB}$

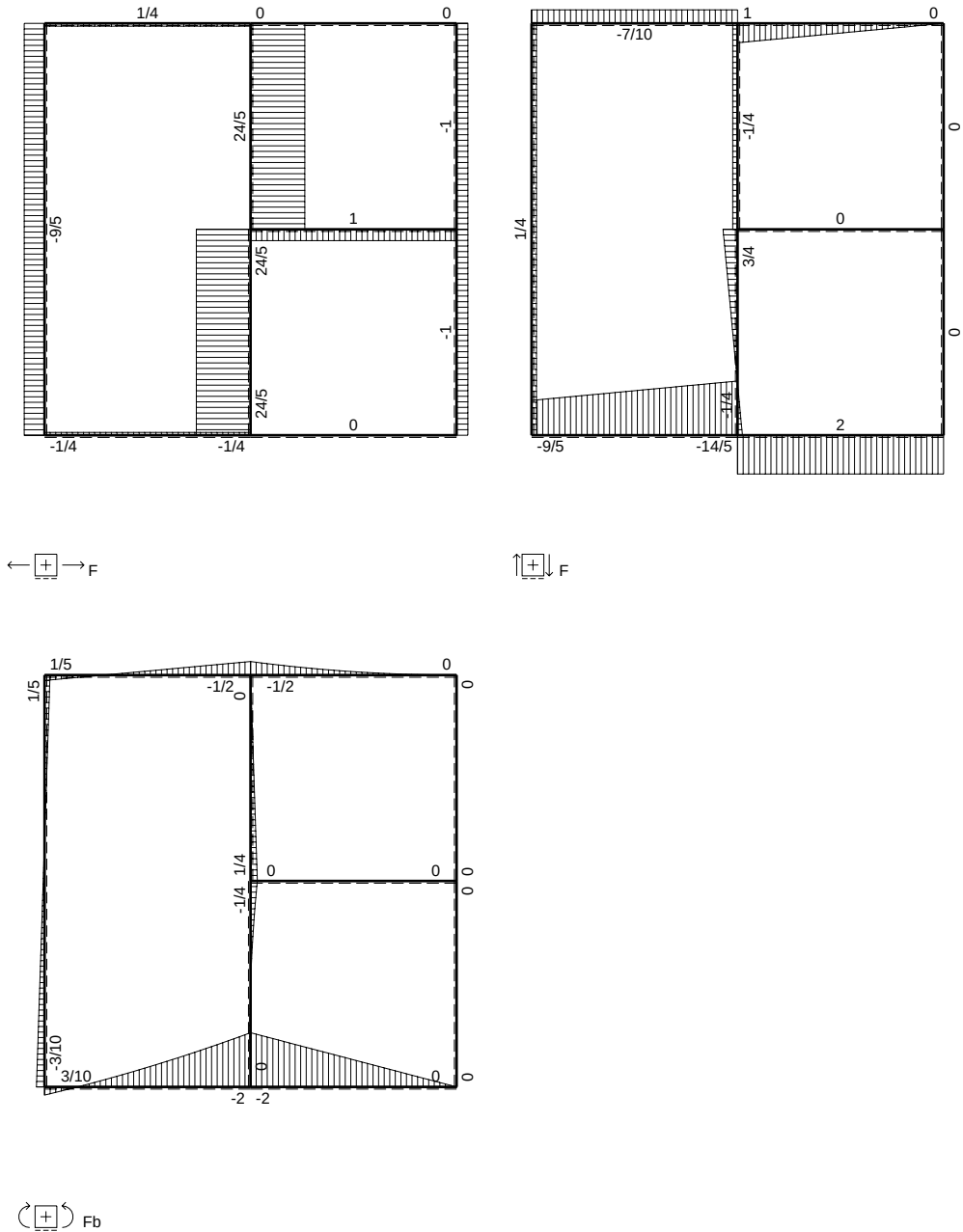
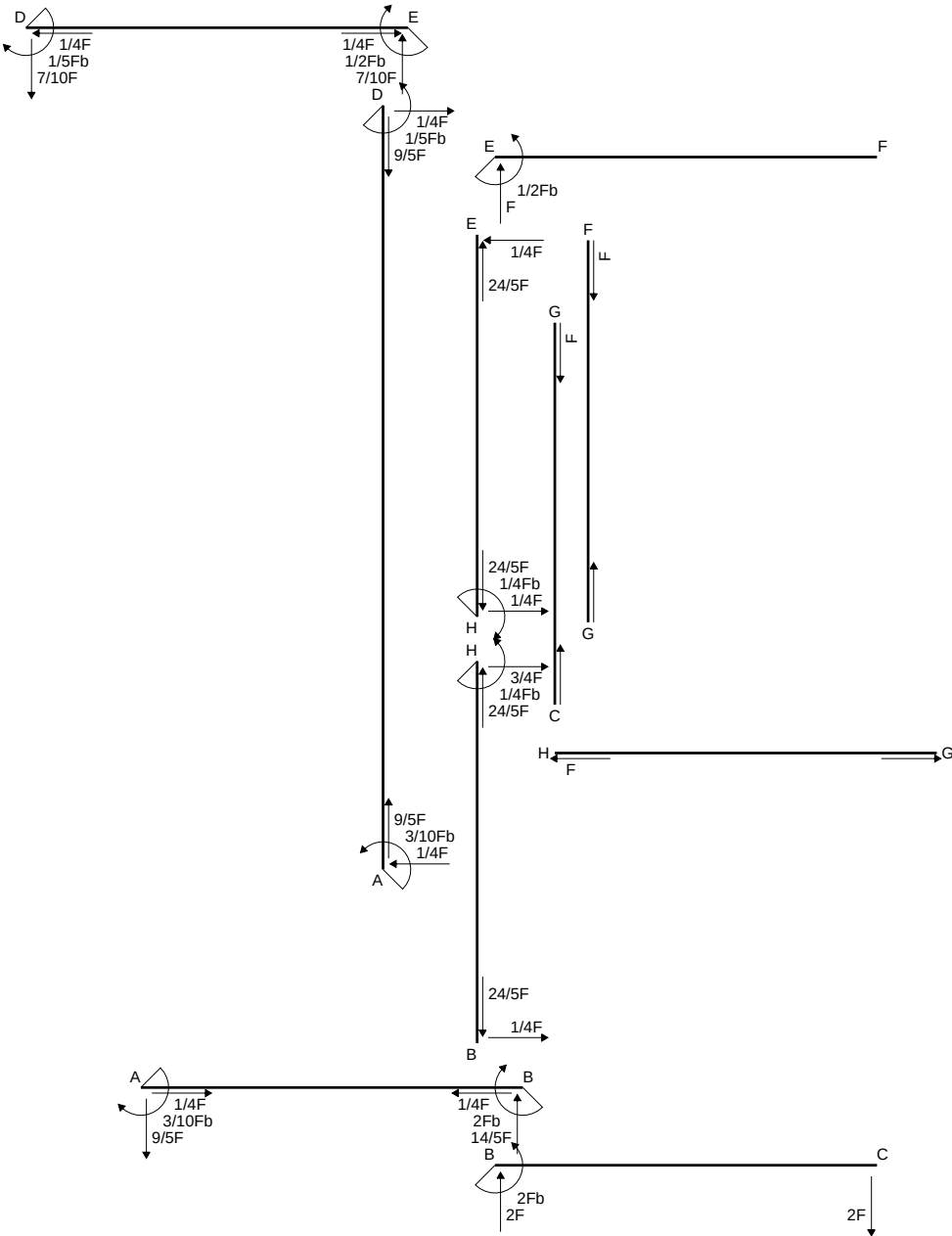
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 606. \text{ mm}^2 \\
J_u &= 215454. \text{ mm}^4 \\
J_v &= 40698. \text{ mm}^4 \\
y_g &= 20.92 \text{ mm} \\
T_y &= 2780. \text{ N} \\
M_x &= -1334400. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 32.08 \text{ mm} \\
\sigma_m &= -Mv/J_u = 198.7 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 45. \text{ mm} \\
v_c &= 24.08 \text{ mm} \\
\sigma_c &= -Mv/J_u = 149.2 \text{ N/mm}^2 \\
\tau_c &= 7.402 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 149.7 \text{ N/mm}^2 \\
S &= 3442. \text{ mm}^3
\end{aligned}$$

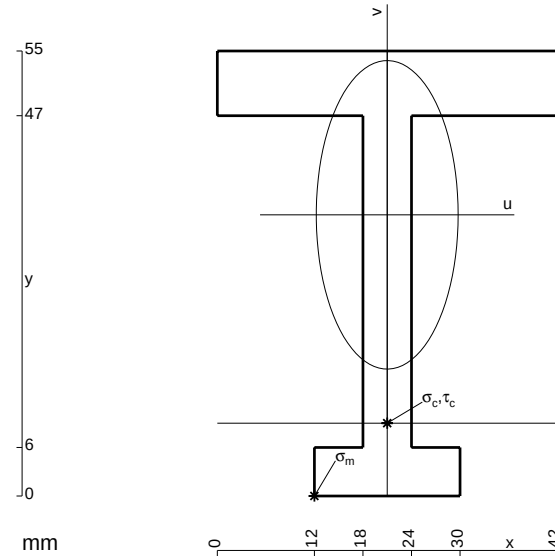


Quadro contributi PLV per iperstatica $X=W_{AB}$

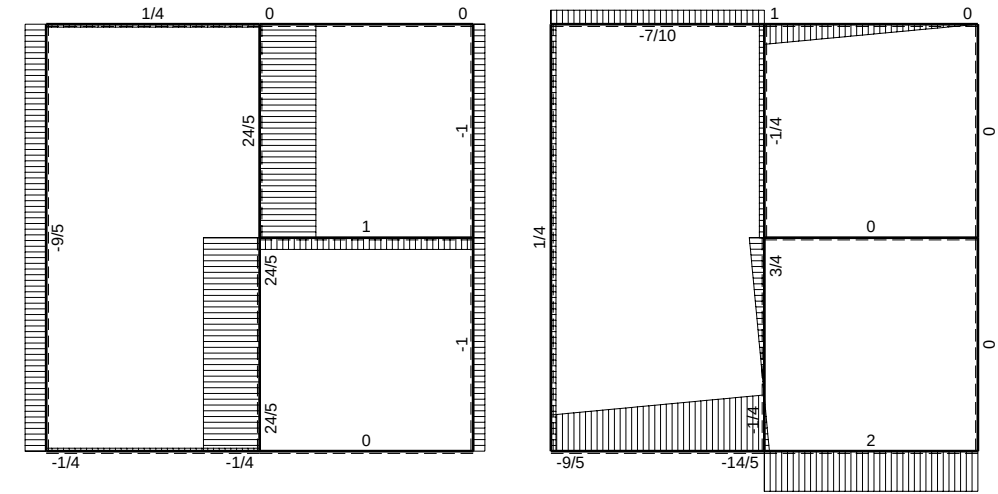
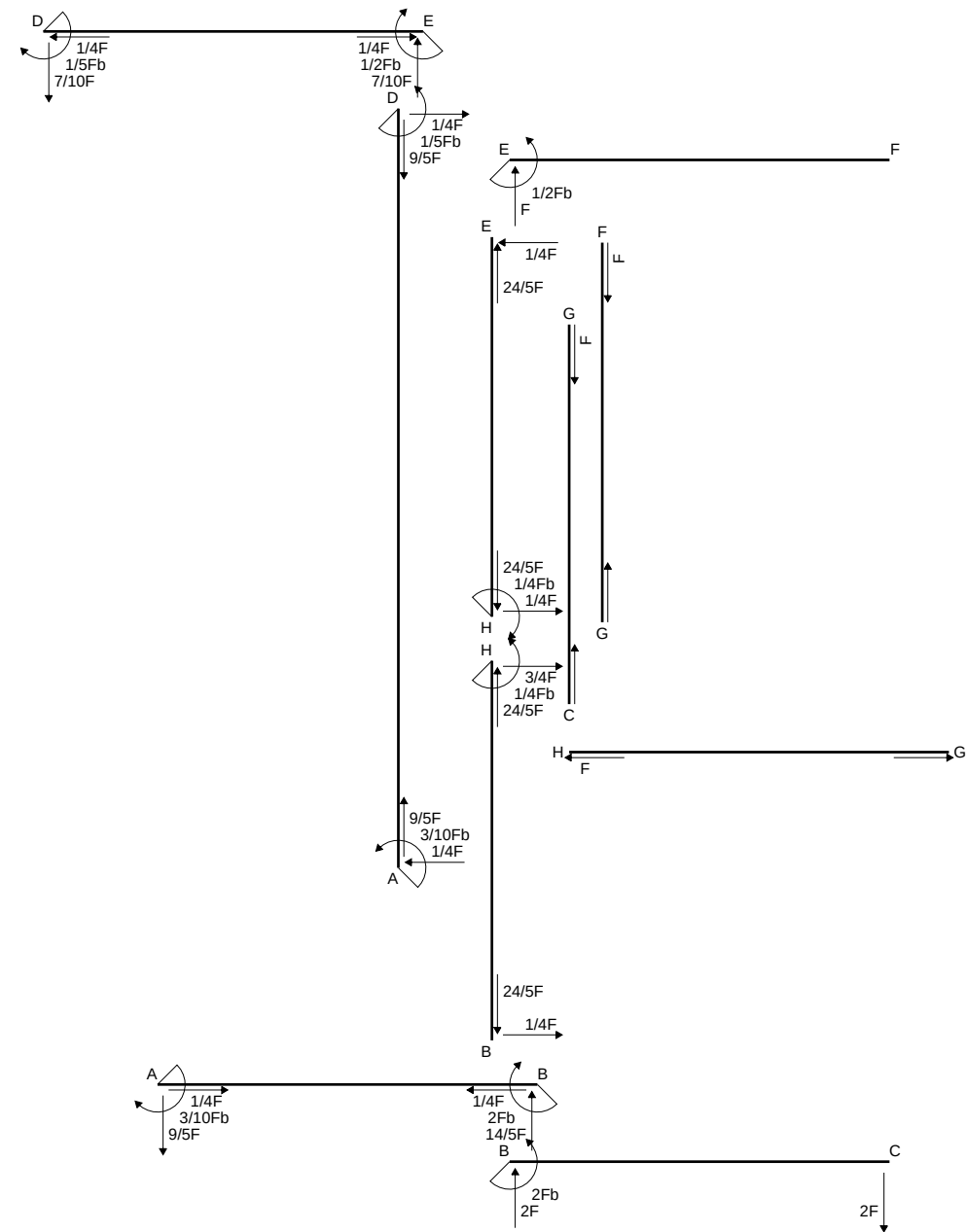
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	Fb/EJ	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{XX} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{XX} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{XX} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{XX} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{XX} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{XX} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{X_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) F_b \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{F_b^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b F_b \frac{1}{EJ} + 1 \frac{0}{4} \frac{F_b^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) F_b \frac{1}{EJ} + 1 \frac{0}{4} \frac{F_b^2}{EJ} = 7/24 \frac{F_b^2}{EJ} \\
L_{BA}^{X_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) F_b \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{F_b^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b F_b \frac{1}{EJ} + 1 \frac{0}{4} \frac{F_b^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) F_b \frac{1}{EJ} + 1 \frac{0}{4} \frac{F_b^2}{EJ} = 7/24 \frac{F_b^2}{EJ} \\
L_{AD}^{X_0} &= \int_0^{2b} (1/4 x/b) F_b \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} F_b \frac{1}{EJ} \\
&= (1/2 b) F_b \frac{1}{EJ} = 1/2 \frac{F_b^2}{EJ} \\
L_{DA}^{X_0} &= \int_0^{2b} (1/2 - 1/4 x/b) F_b \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} F_b \frac{1}{EJ} \\
&= (b - 1/2 b) F_b \frac{1}{EJ} = 1/2 \frac{F_b^2}{EJ} \\
L_{DE}^{X_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) F_b \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b F_b \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) F_b \frac{1}{EJ} = 1/12 \frac{F_b^2}{EJ} \\
L_{ED}^{X_0} &= \int_0^b (-1/2 x/b + x^2/b^2) F_b \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b F_b \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) F_b \frac{1}{EJ} = 1/12 \frac{F_b^2}{EJ}
\end{aligned}$$

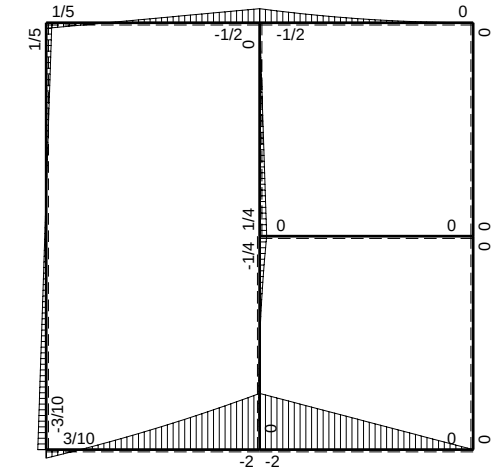


$$\begin{aligned} A &= 690. \text{ mm}^2 \\ J_u &= 250916. \text{ mm}^4 \\ J_v &= 53046. \text{ mm}^4 \\ y_g &= 34.75 \text{ mm} \\ T_y &= 2740. \text{ N} \\ M_x &= -1507000. \text{ Nmm} \\ x_m &= 12. \text{ mm} \\ u_m &= -9. \text{ mm} \\ v_m &= -34.75 \text{ mm} \\ \sigma_m &= -Mv/J_u = -208.7 \text{ N/mm}^2 \\ x_c &= 21. \text{ mm} \\ y_c &= 9. \text{ mm} \\ v_c &= -25.75 \text{ mm} \\ \sigma_c &= -Mv/J_u = -154.7 \text{ N/mm}^2 \\ \tau_c &= 7.134 \text{ N/mm}^2 \\ \sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 155.2 \text{ N/mm}^2 \\ S^* &= 3920. \text{ mm}^3 \end{aligned}$$



← ⊕ → F

↑ ⊕ ↓ F



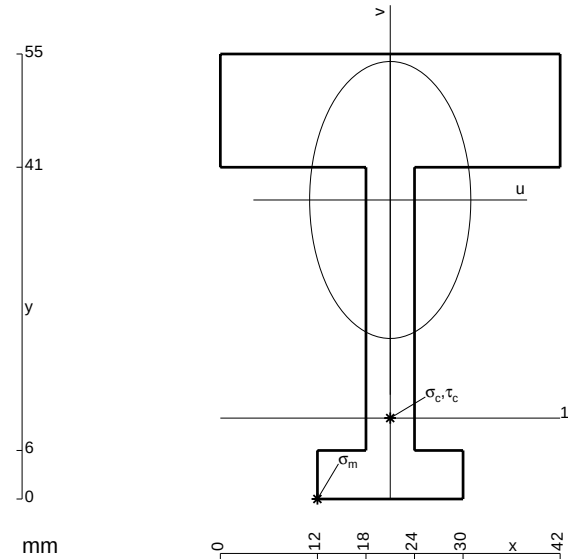
⊕ ⊕ F_b

Quadro contributi PLV per iperstatica $X=W_{AB}$

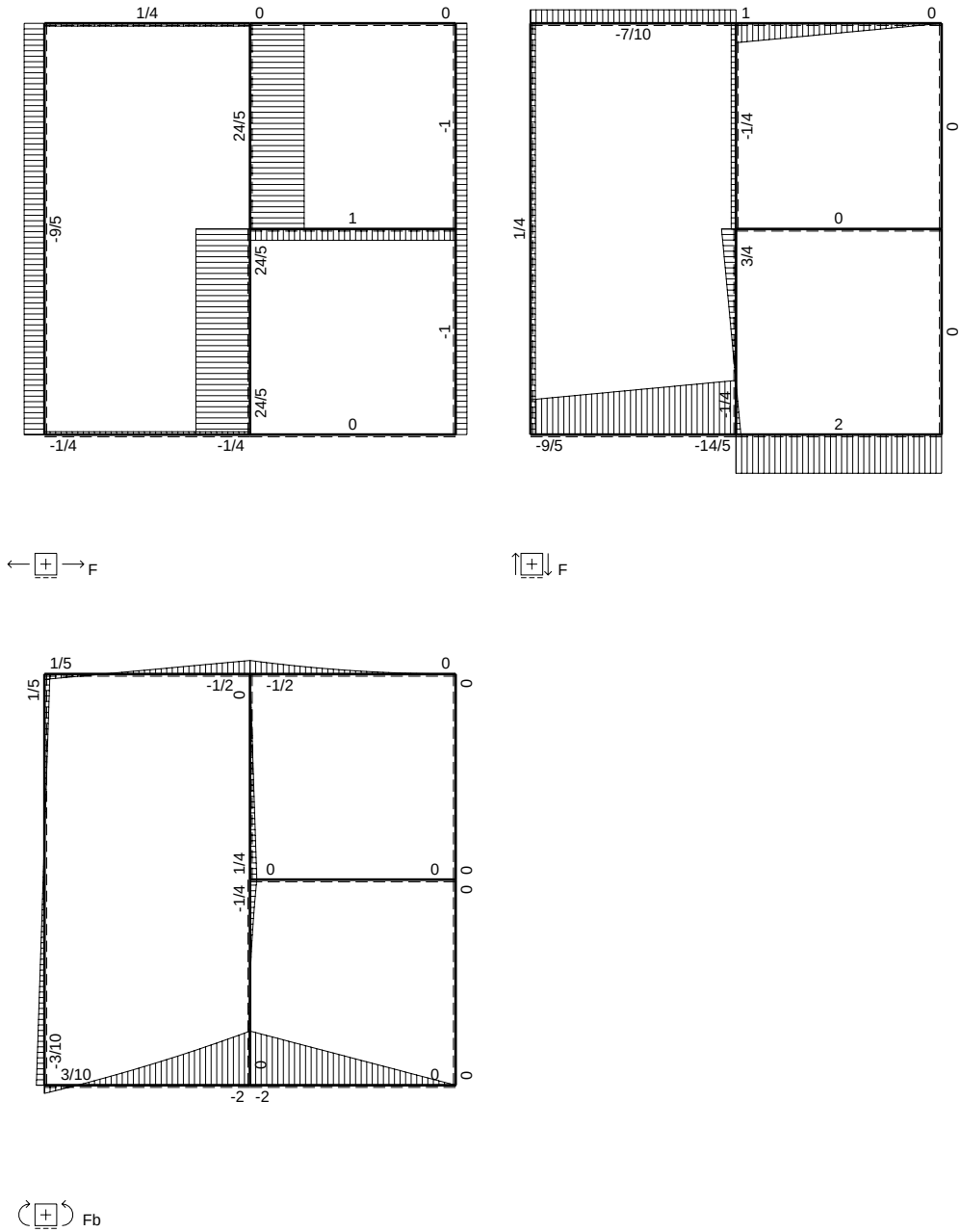
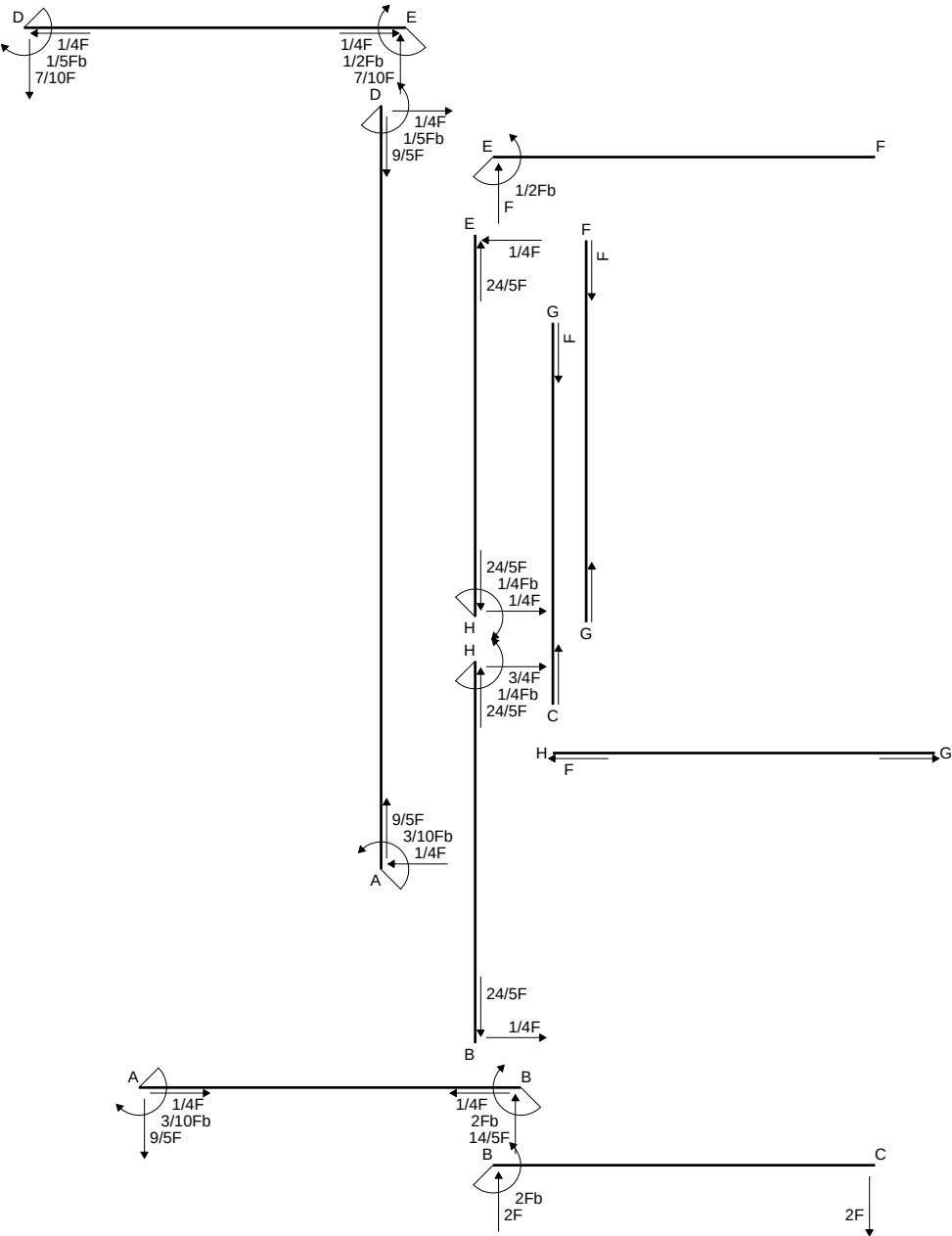
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 906. \text{ mm}^2 \\
J_u &= 265632. \text{ mm}^4 \\
J_v &= 89982. \text{ mm}^4 \\
y_g &= 36.96 \text{ mm} \\
T_y &= 2620. \text{ N} \\
M_x &= -1572000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -36.96 \text{ mm} \\
\sigma_m &= -Mv/J_u = -218.7 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 10. \text{ mm} \\
v_c &= -26.96 \text{ mm} \\
\sigma_c &= -Mv/J_u = -159.5 \text{ N/mm}^2 \\
\tau_c &= 7.171 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 160. \text{ N/mm}^2 \\
S &= 4362. \text{ mm}^3
\end{aligned}$$

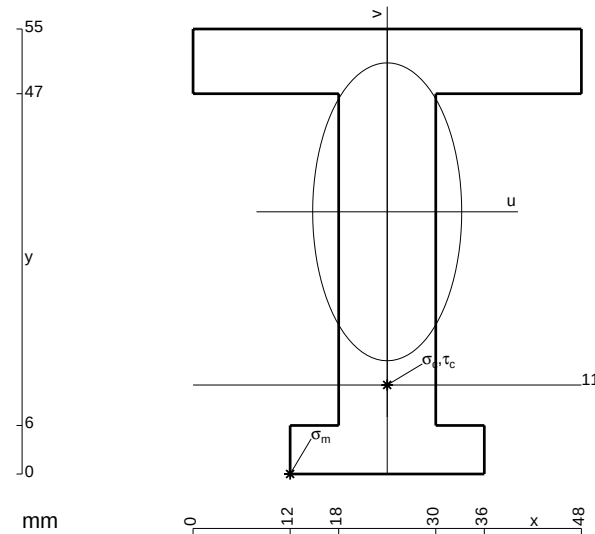


Quadro contributi PLV per iperstatica $X=W_{AB}$

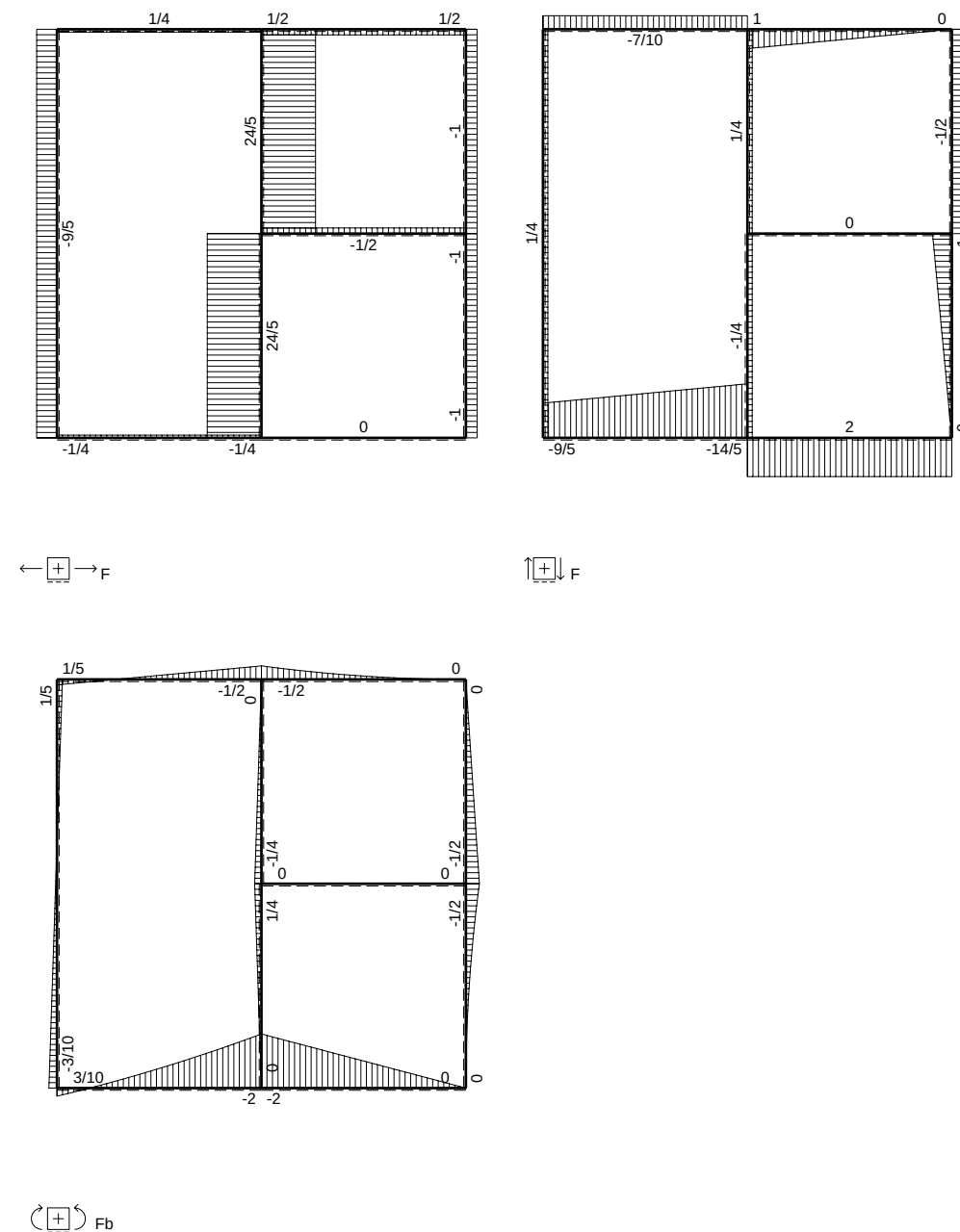
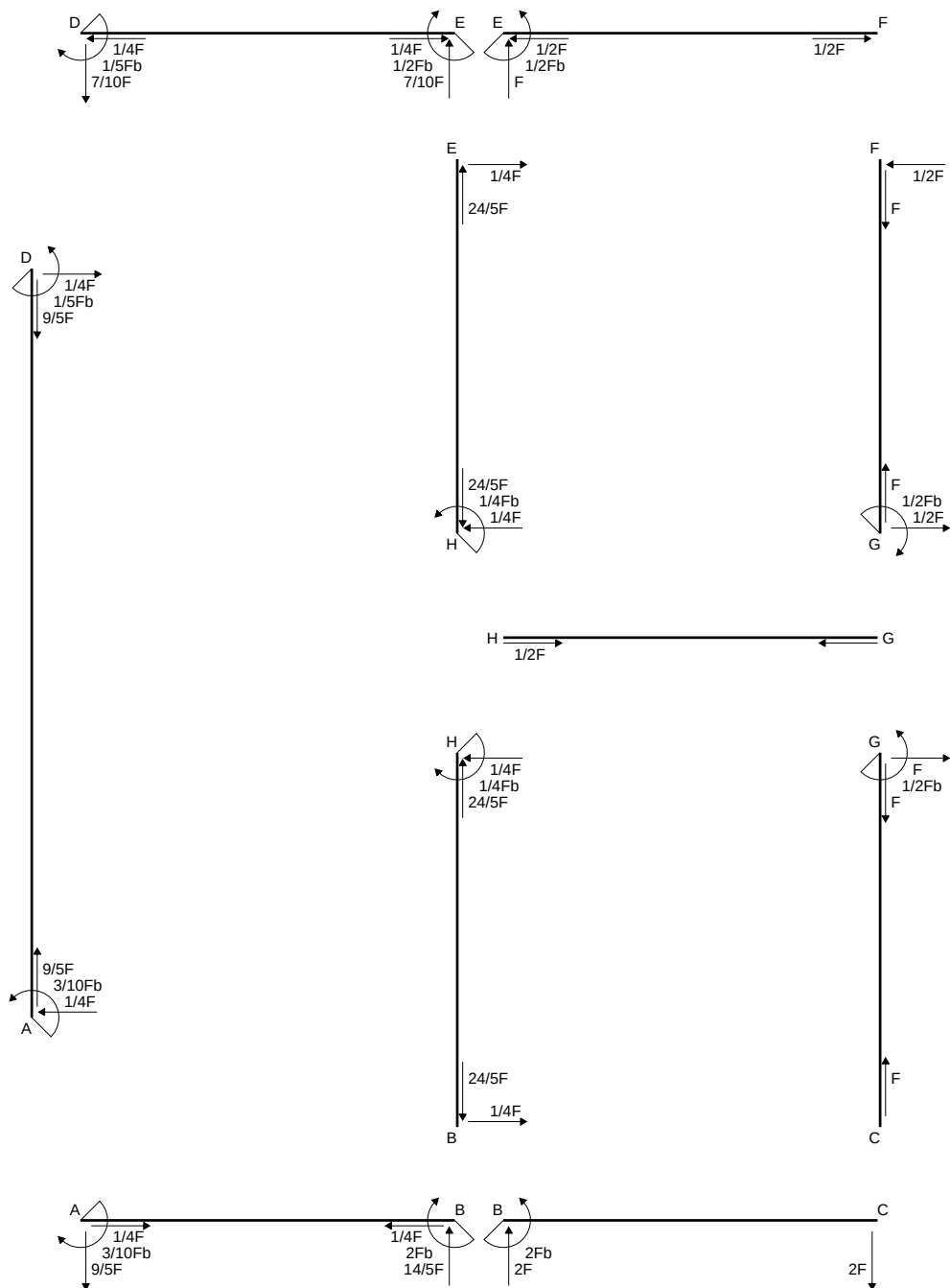
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	$1/2qx^2$	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

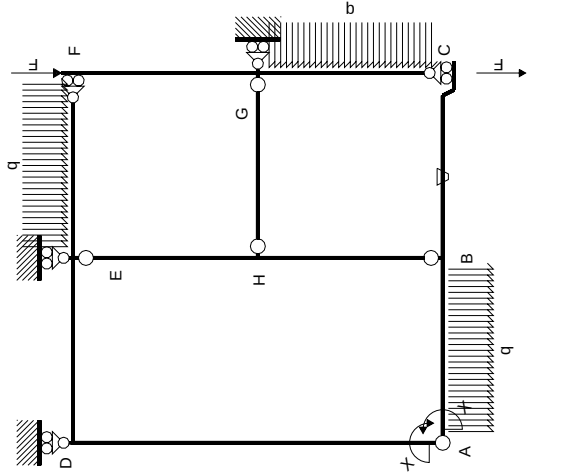
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$

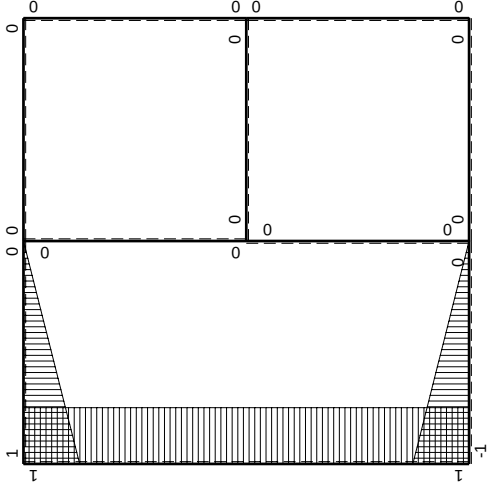


$$\begin{aligned}
A &= 1020. \text{ mm}^2 \\
J_u &= 345844. \text{ mm}^4 \\
J_v &= 86544. \text{ mm}^4 \\
y_g &= 32.41 \text{ mm} \\
T_y &= 3760. \text{ N} \\
M_x &= -2444000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -32.41 \text{ mm} \\
\sigma_m &= -Mv/J_u = -229. \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 11. \text{ mm} \\
v_c &= -21.41 \text{ mm} \\
\sigma_c &= -Mv/J_u = -151.3 \text{ N/mm}^2 \\
\tau_c &= 5.136 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 151.5 \text{ N/mm}^2 \\
S &= 5669. \text{ mm}^3
\end{aligned}$$





$\left(\begin{smallmatrix} + \\ - \end{smallmatrix} \right) M_0$ flessione da carichi assegnati



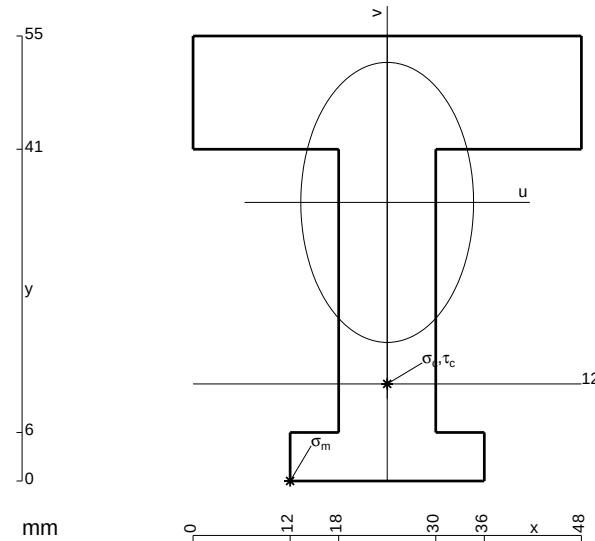
$\left(\begin{smallmatrix} + \\ - \end{smallmatrix} \right) M_x$ flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

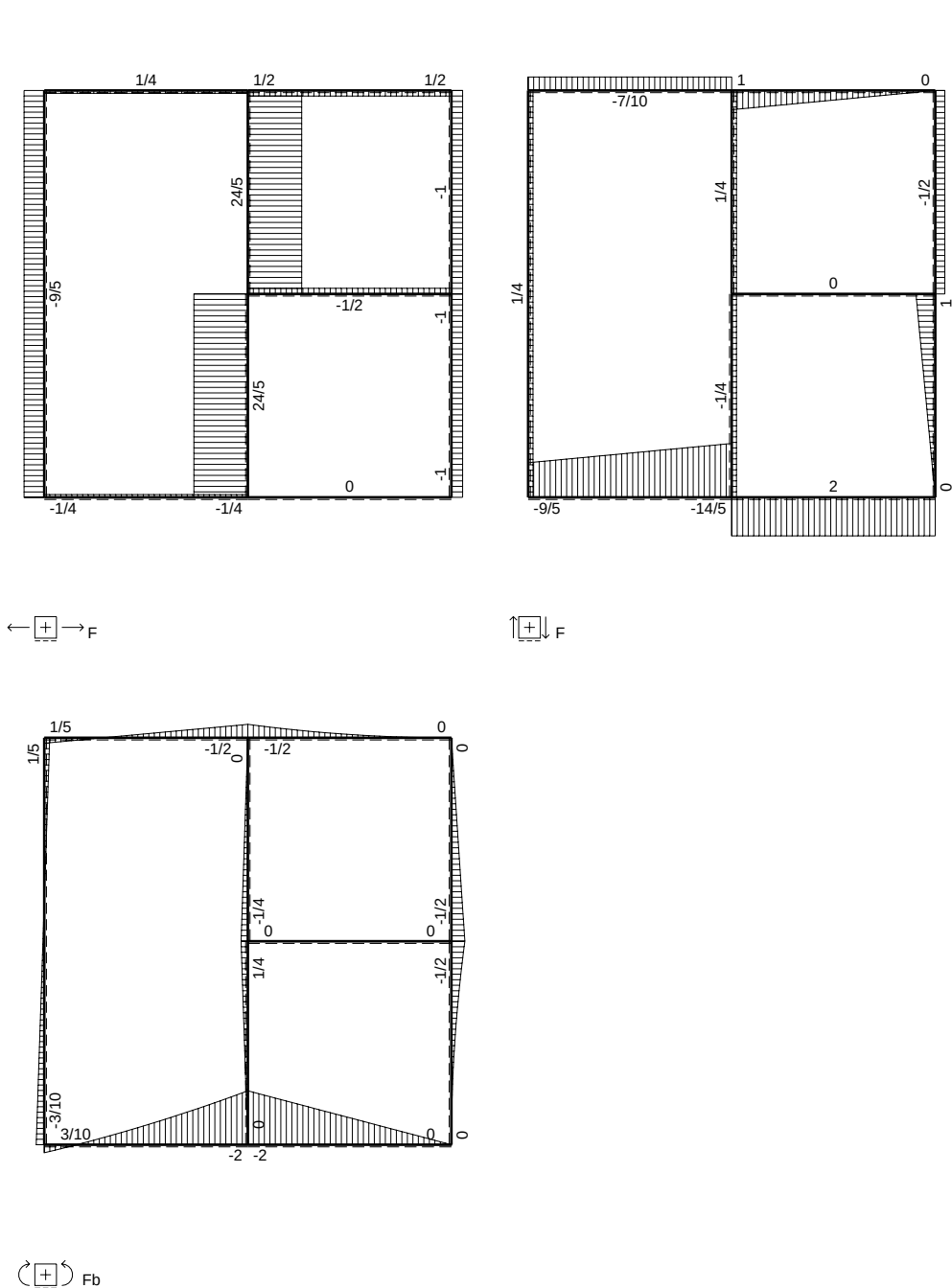
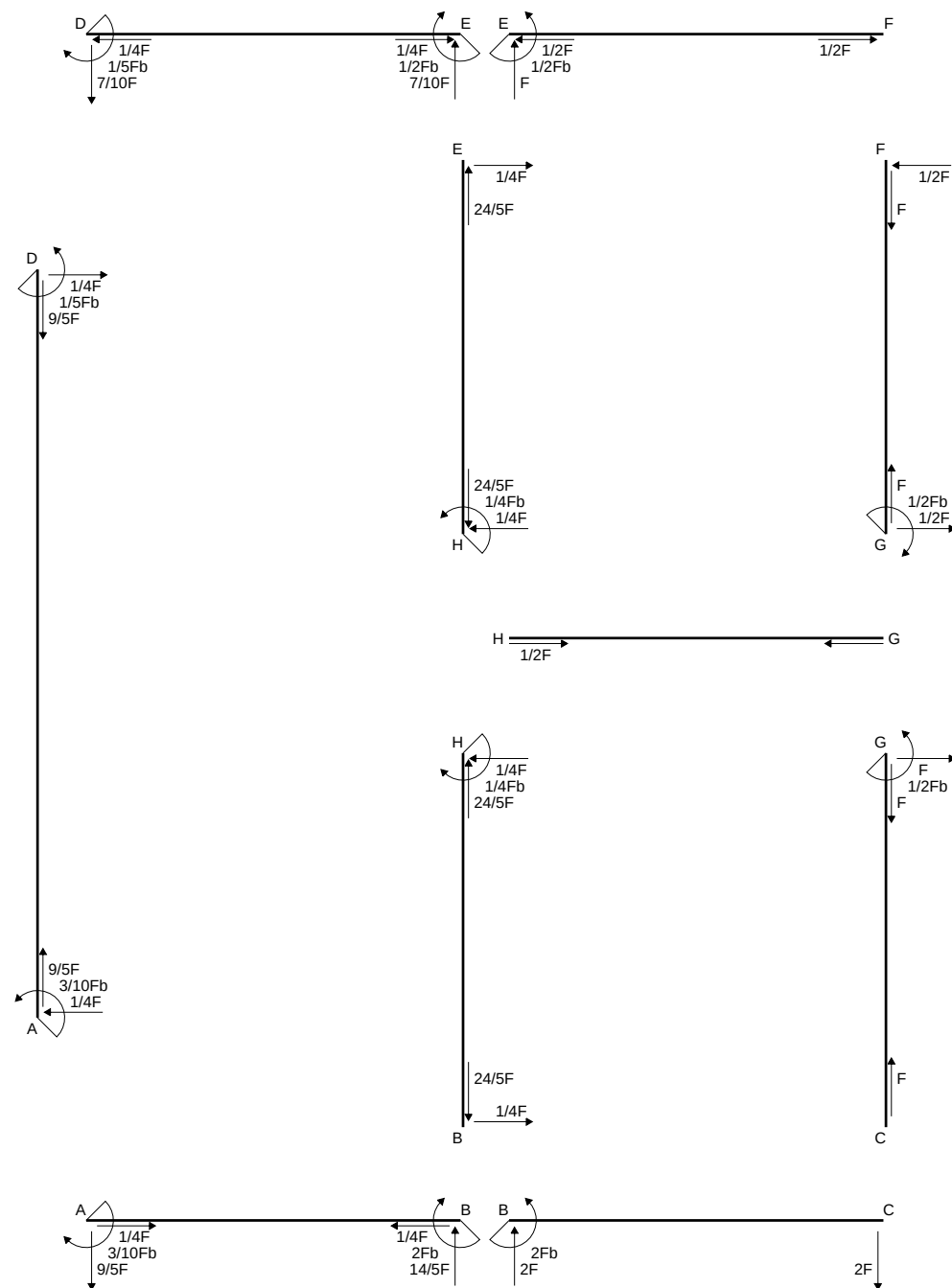
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

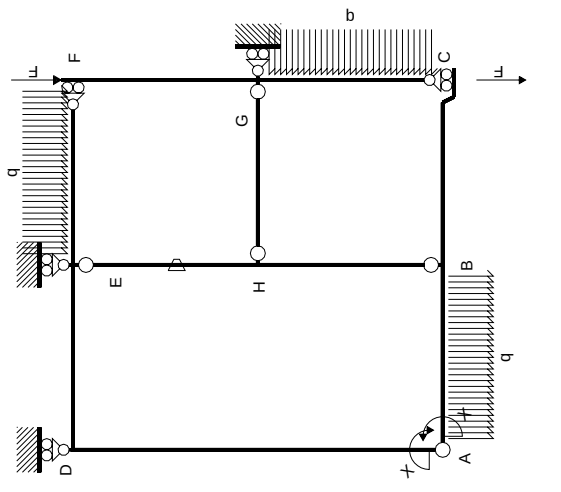
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$

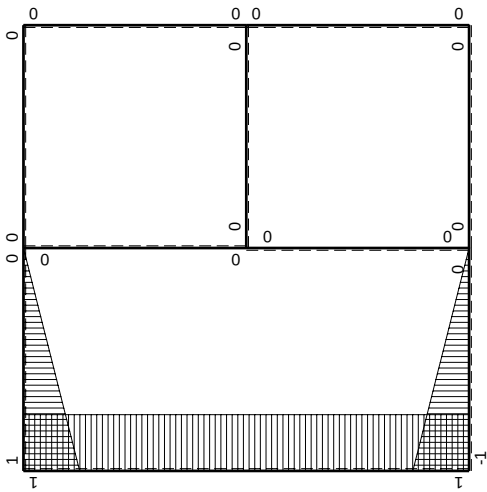


$$\begin{aligned}
A &= 1236. \text{ mm}^2 \\
J_u &= 370453. \text{ mm}^4 \\
J_v &= 140976. \text{ mm}^4 \\
y_g &= 34.43 \text{ mm} \\
T_y &= 3680. \text{ N} \\
M_x &= -2576000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -34.43 \text{ mm} \\
\sigma_m &= -Mv/J_u = -239.4 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 12. \text{ mm} \\
v_c &= -22.43 \text{ mm} \\
\sigma_c &= -Mv/J_u = -156. \text{ N/mm}^2 \\
\tau_c &= 5.263 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 156.3 \text{ N/mm}^2 \\
S &= 6357. \text{ mm}^3
\end{aligned}$$

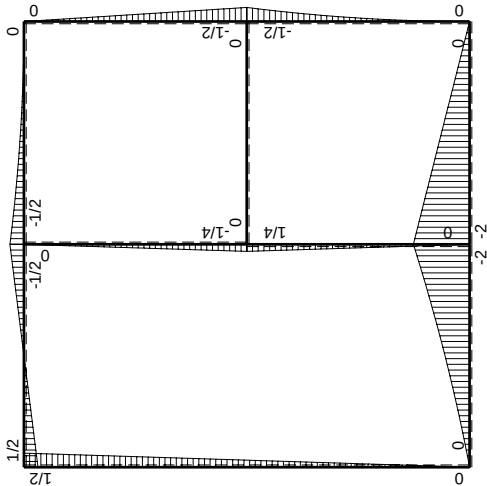




M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

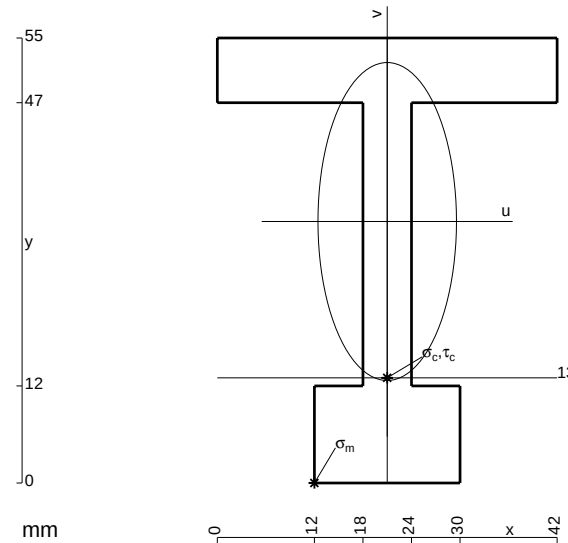


Quadro contributi PLV per iperstatica $X=W_{AB}$

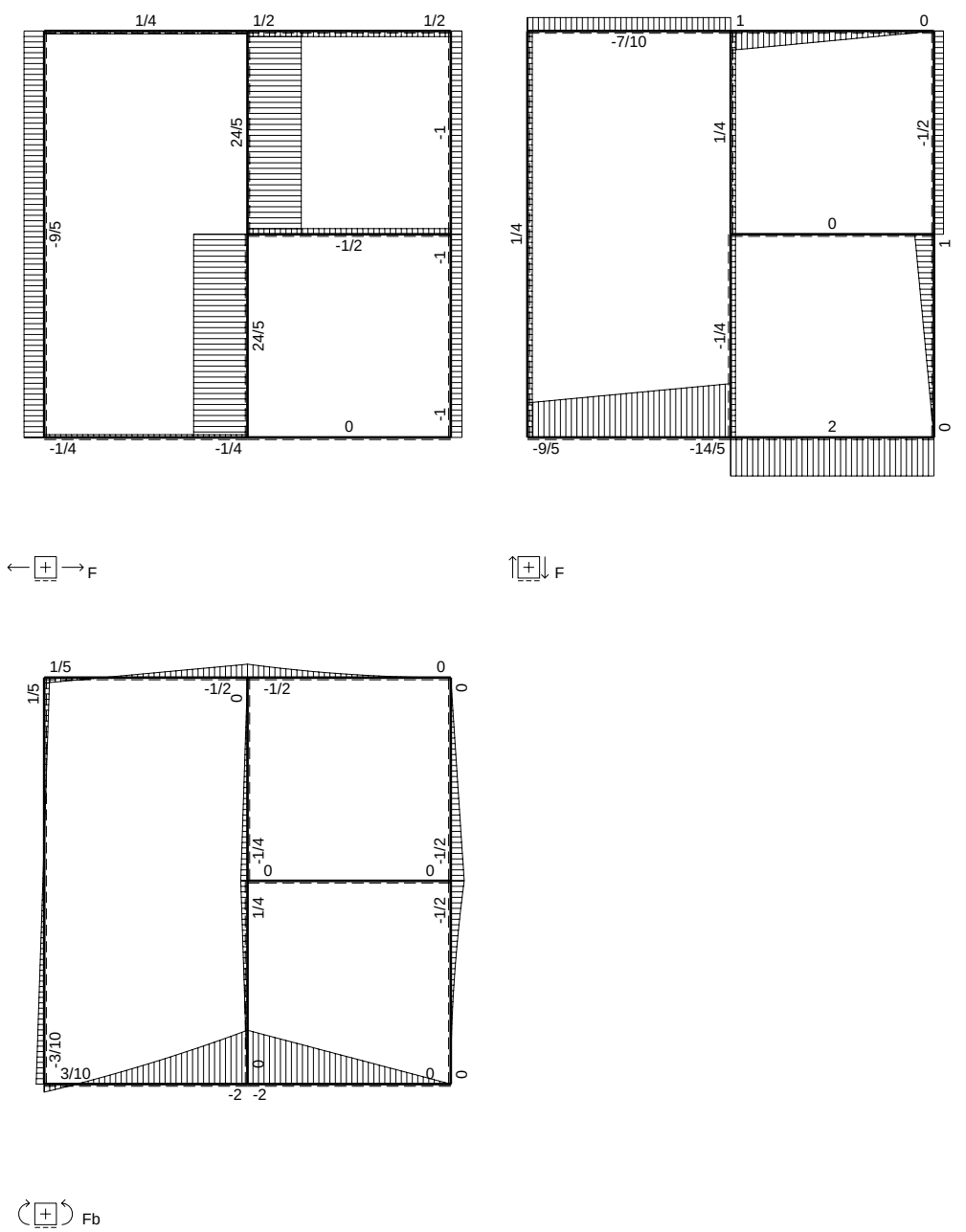
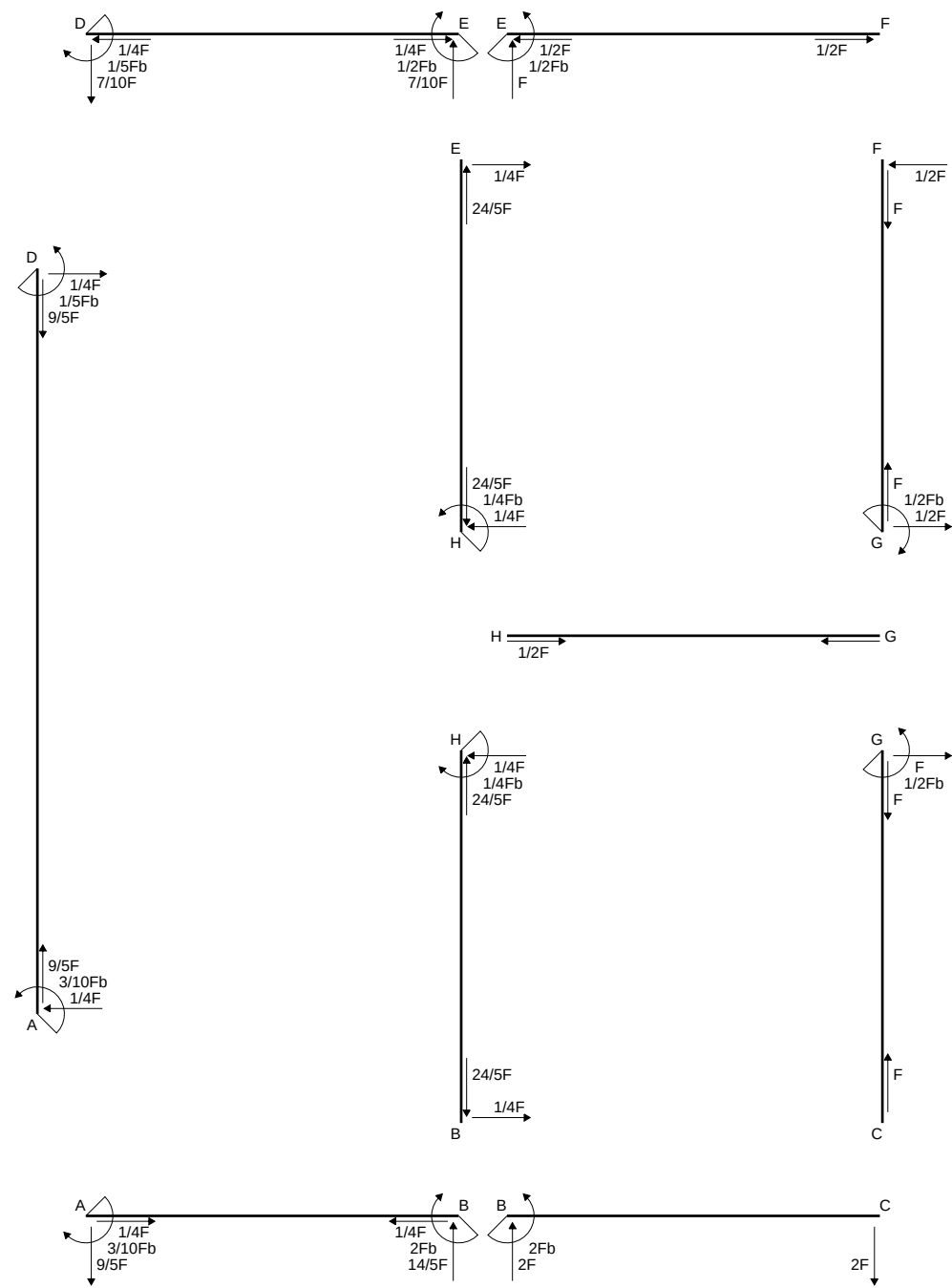
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$1/4Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

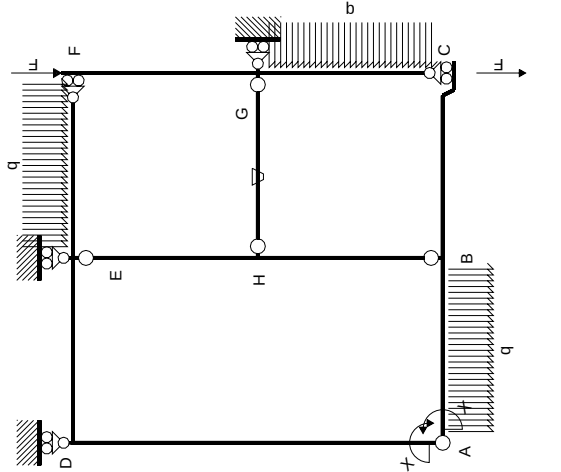
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$

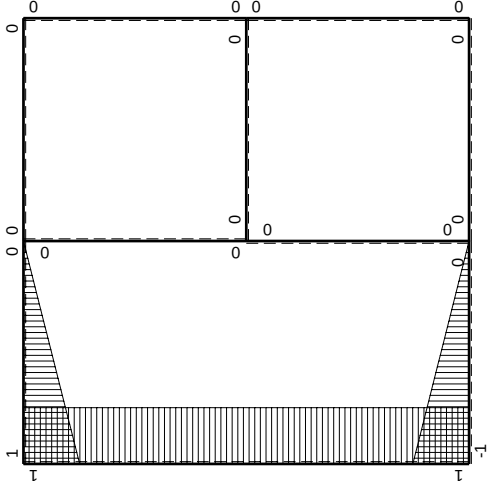


$$\begin{aligned}
A &= 762. \text{ mm}^2 \\
J_u &= 294369. \text{ mm}^4 \\
J_v &= 55854. \text{ mm}^4 \\
y_g &= 32.32 \text{ mm} \\
T_y &= 2420. \text{ N} \\
M_x &= -1815000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -32.32 \text{ mm} \\
\sigma_m &= -Mv/J_u = -199.3 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -19.32 \text{ mm} \\
\sigma_c &= -Mv/J_u = -119.1 \text{ N/mm}^2 \\
\tau_c &= 7.952 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 119.9 \text{ N/mm}^2 \\
S &= 5804. \text{ mm}^3
\end{aligned}$$





$\left(\begin{array}{c} \boxed{+} \\ \boxed{-} \end{array} \right) M_0$ flessione da carichi assegnati



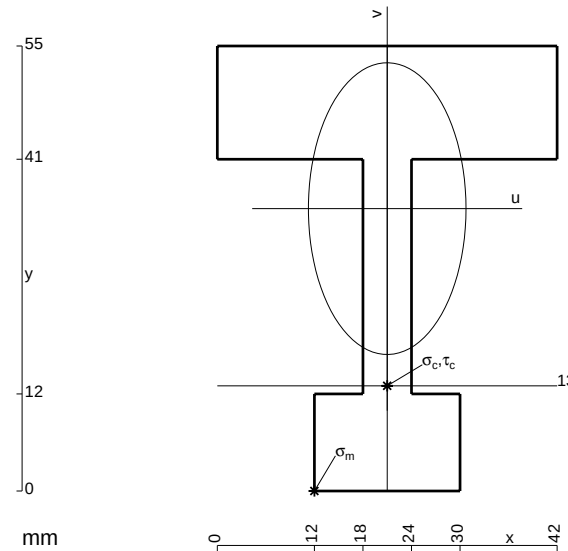
$\left(\begin{array}{c} \boxed{+} \\ \boxed{-} \end{array} \right) M_x$ flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

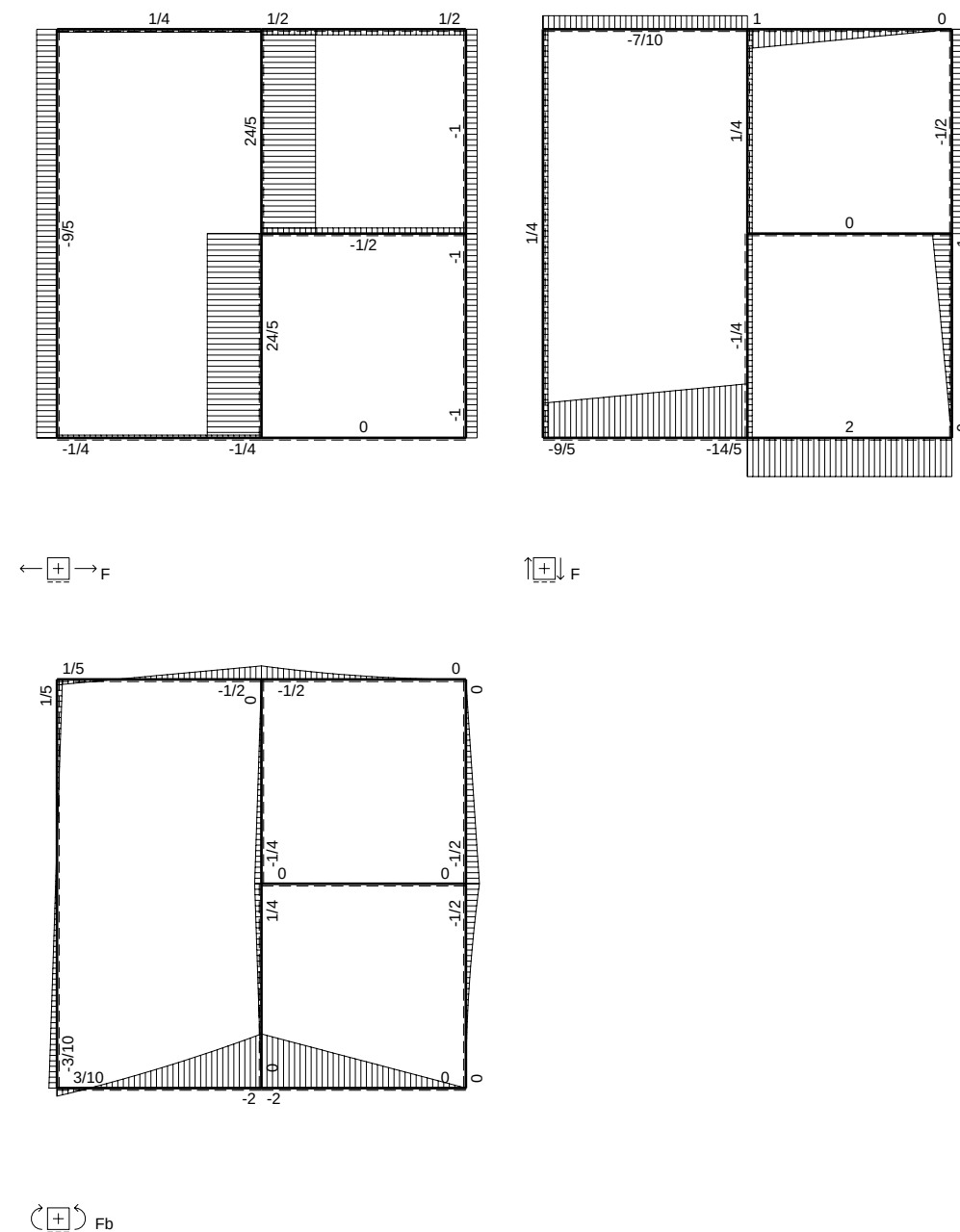
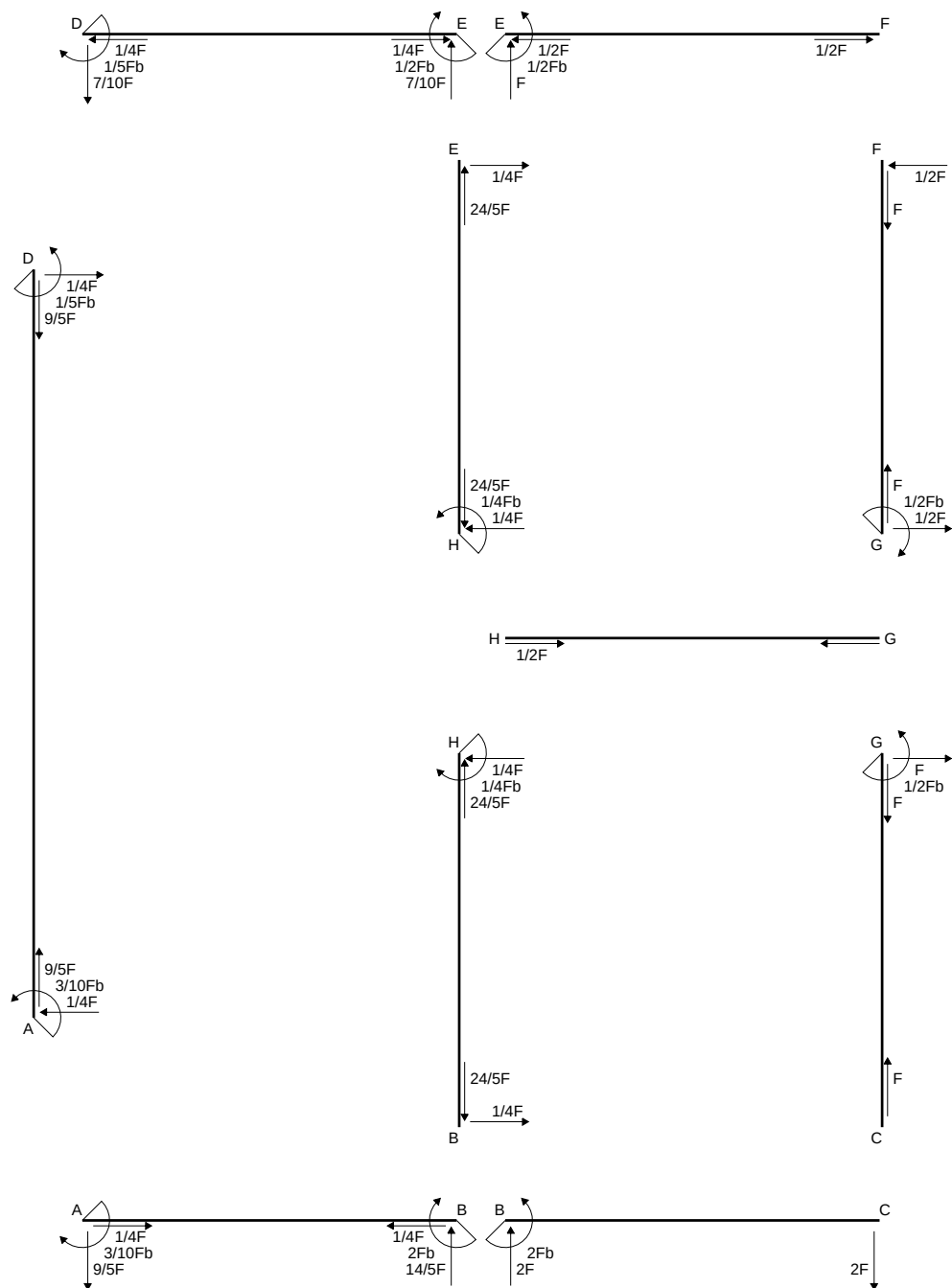
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 978. \text{ mm}^2 \\
J_u &= 317980. \text{ mm}^4 \\
J_v &= 92790. \text{ mm}^4 \\
y_g &= 34.9 \text{ mm} \\
T_y &= 2380. \text{ N} \\
M_x &= -1904000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -34.9 \text{ mm} \\
\sigma_m &= -Mv/J_u = -209. \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -21.9 \text{ mm} \\
\sigma_c &= -Mv/J_u = -131.1 \text{ N/mm}^2 \\
\tau_c &= 7.954 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 131.8 \text{ N/mm}^2 \\
S &= 6377. \text{ mm}^3
\end{aligned}$$

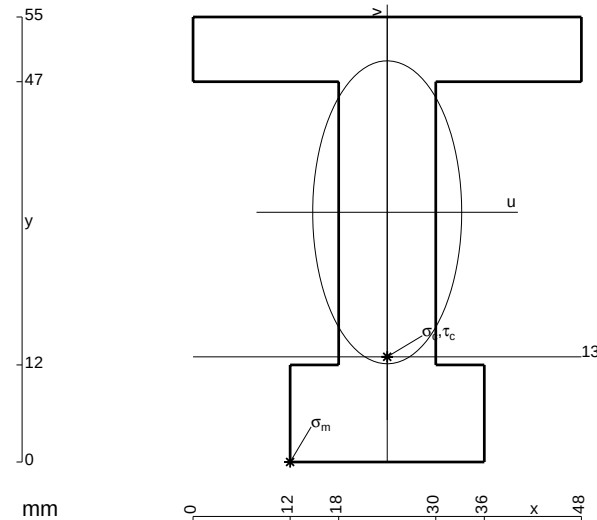


Quadro contributi PLV per iperstatica $X=W_{AB}$

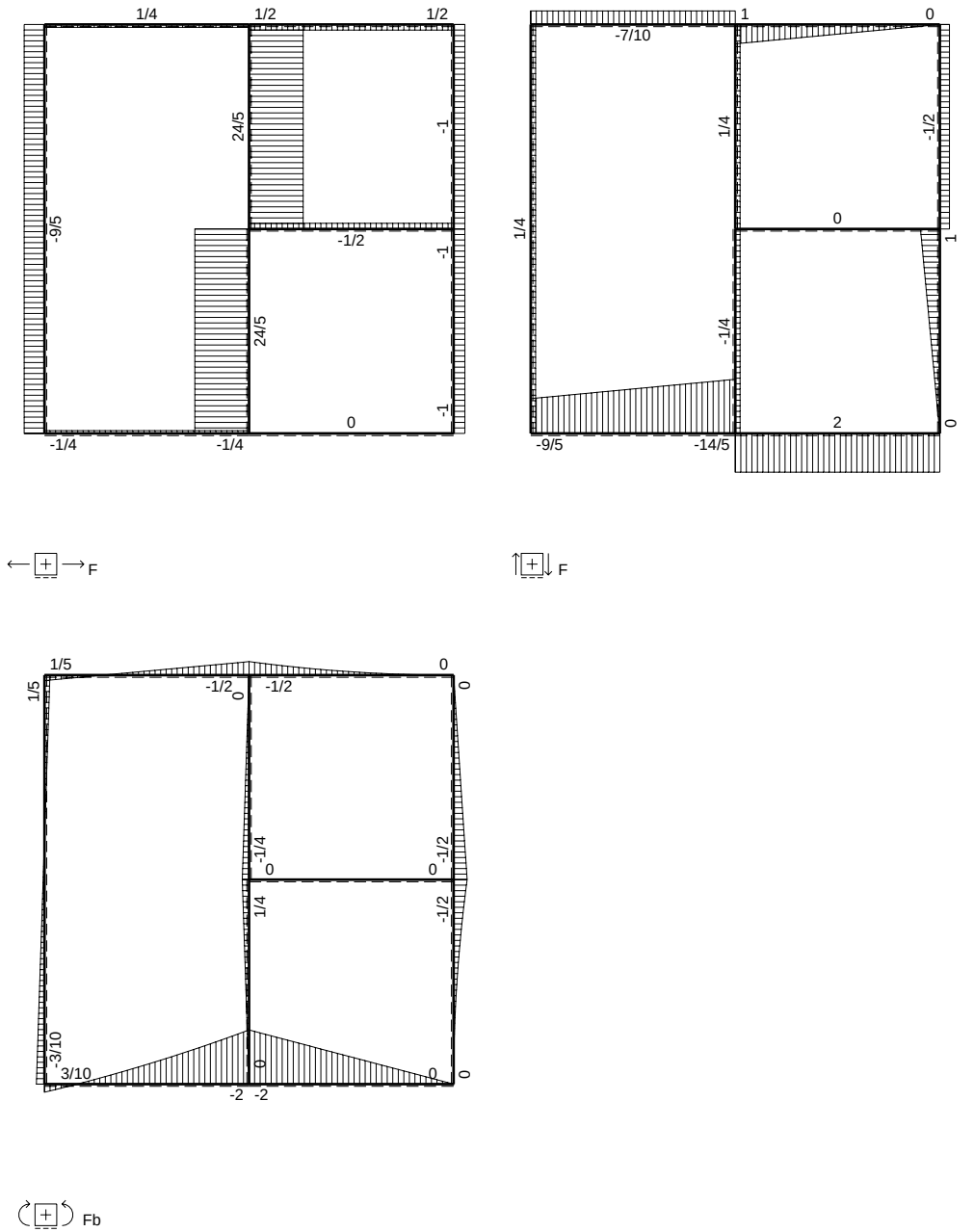
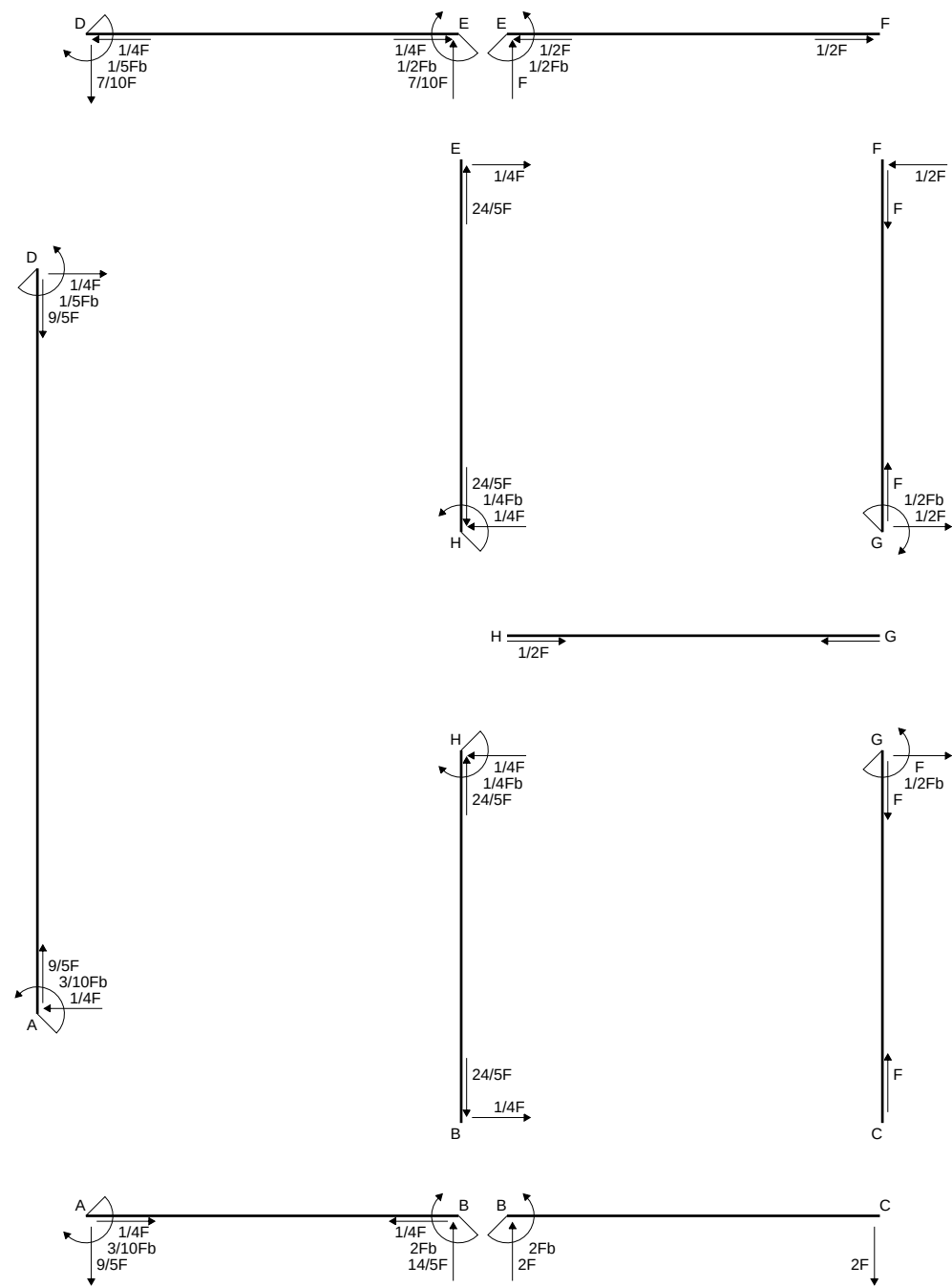
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	$-1/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	Fb/EJ	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

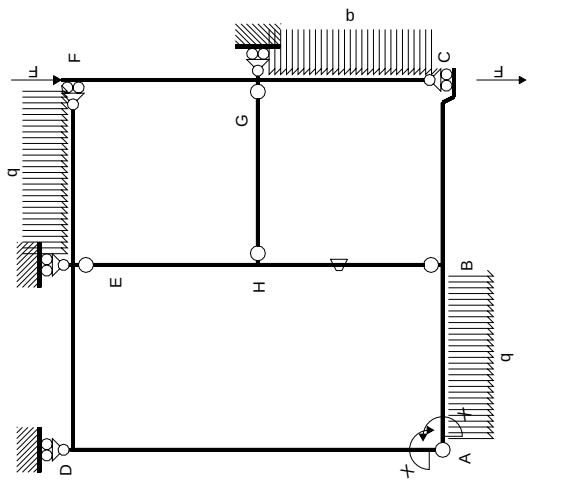
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$

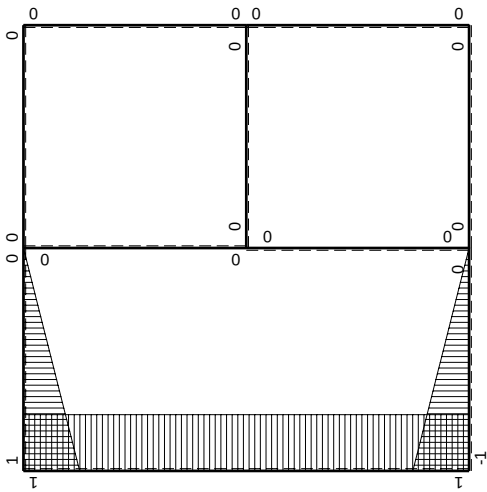


$$\begin{aligned}
A &= 1092. \text{ mm}^2 \\
J_u &= 382903. \text{ mm}^4 \\
J_v &= 92592. \text{ mm}^4 \\
y_g &= 30.86 \text{ mm} \\
T_y &= 3200. \text{ N} \\
M_x &= -2720000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -30.86 \text{ mm} \\
\sigma_m &= -Mv/J_u = -219.2 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -17.86 \text{ mm} \\
\sigma_c &= -Mv/J_u = -126.9 \text{ N/mm}^2 \\
\tau_c &= 5.14 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 127.2 \text{ N/mm}^2 \\
S &= 7381. \text{ mm}^3
\end{aligned}$$





M_0 flessione da carichi assegnati



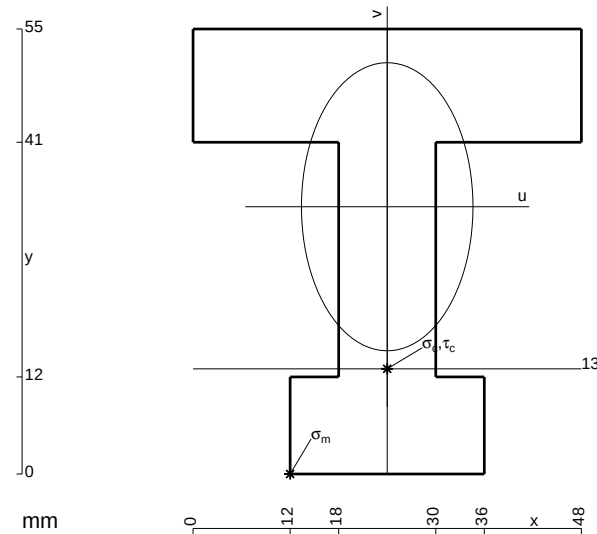
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

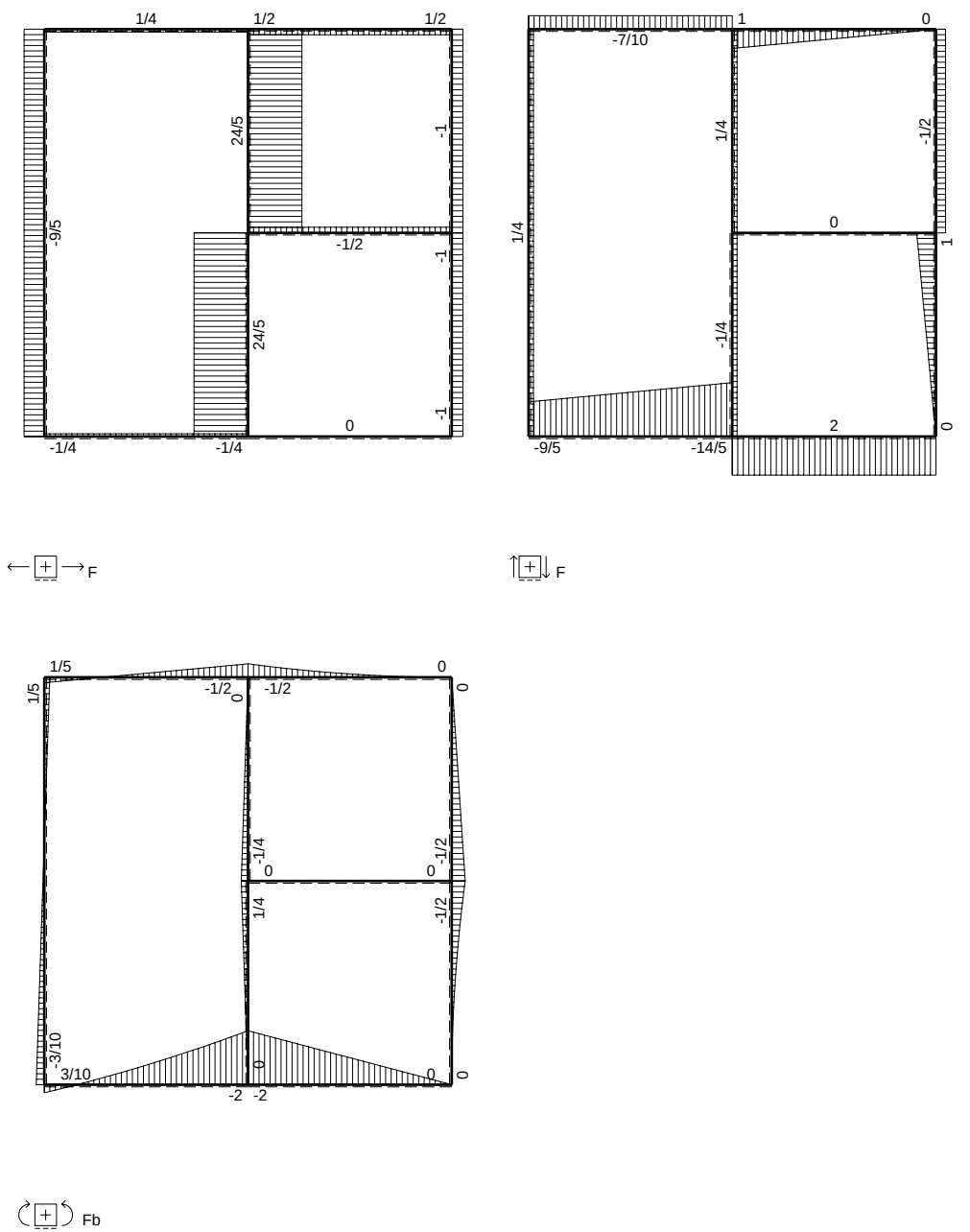
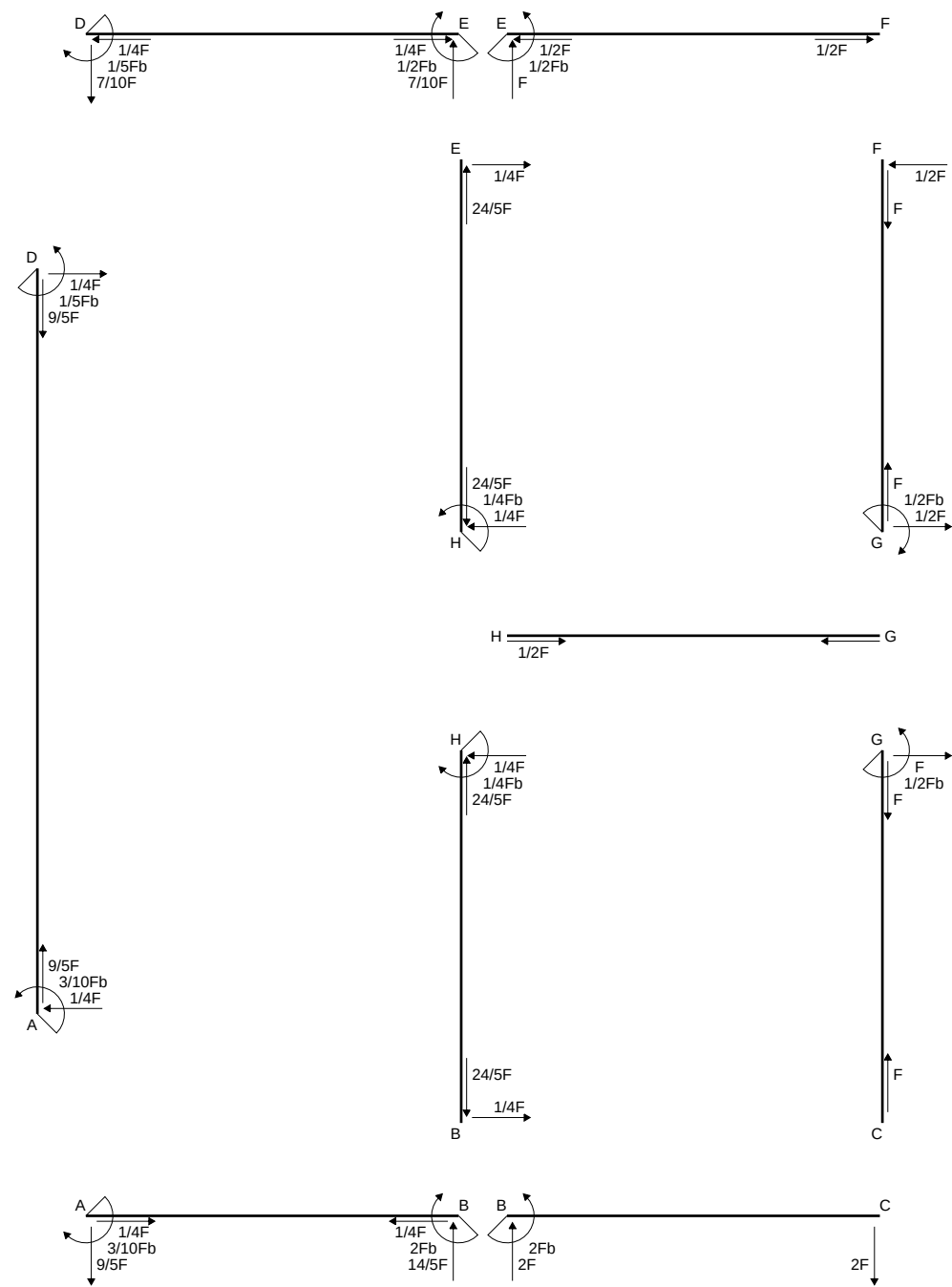
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$-1/4Fx$	Fb/EJ	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 1308. \text{ mm}^2 \\
J_u &= 414675. \text{ mm}^4 \\
J_v &= 147024. \text{ mm}^4 \\
y_g &= 33.03 \text{ mm} \\
T_y &= 3200. \text{ N} \\
M_x &= -2880000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -33.03 \text{ mm} \\
\sigma_m &= -Mv/J_u = -229.4 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -20.03 \text{ mm} \\
\sigma_c &= -Mv/J_u = -139.1 \text{ N/mm}^2 \\
\tau_c &= 5.165 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 139.4 \text{ N/mm}^2 \\
S &= 8032. \text{ mm}^3
\end{aligned}$$

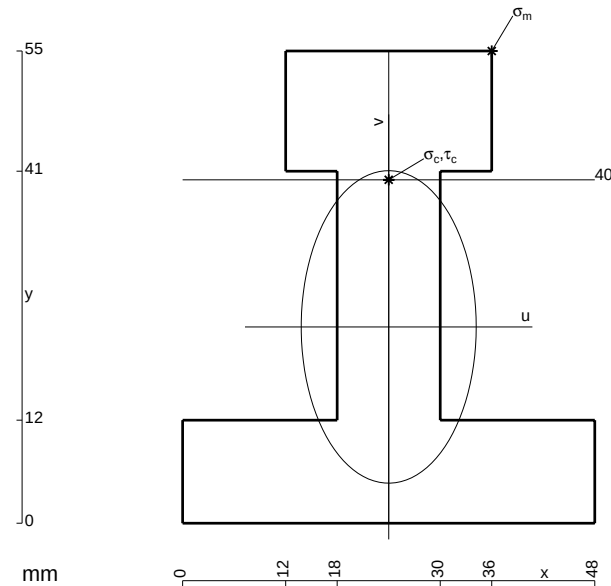


Quadro contributi PLV per iperstatica $X=W_{AB}$

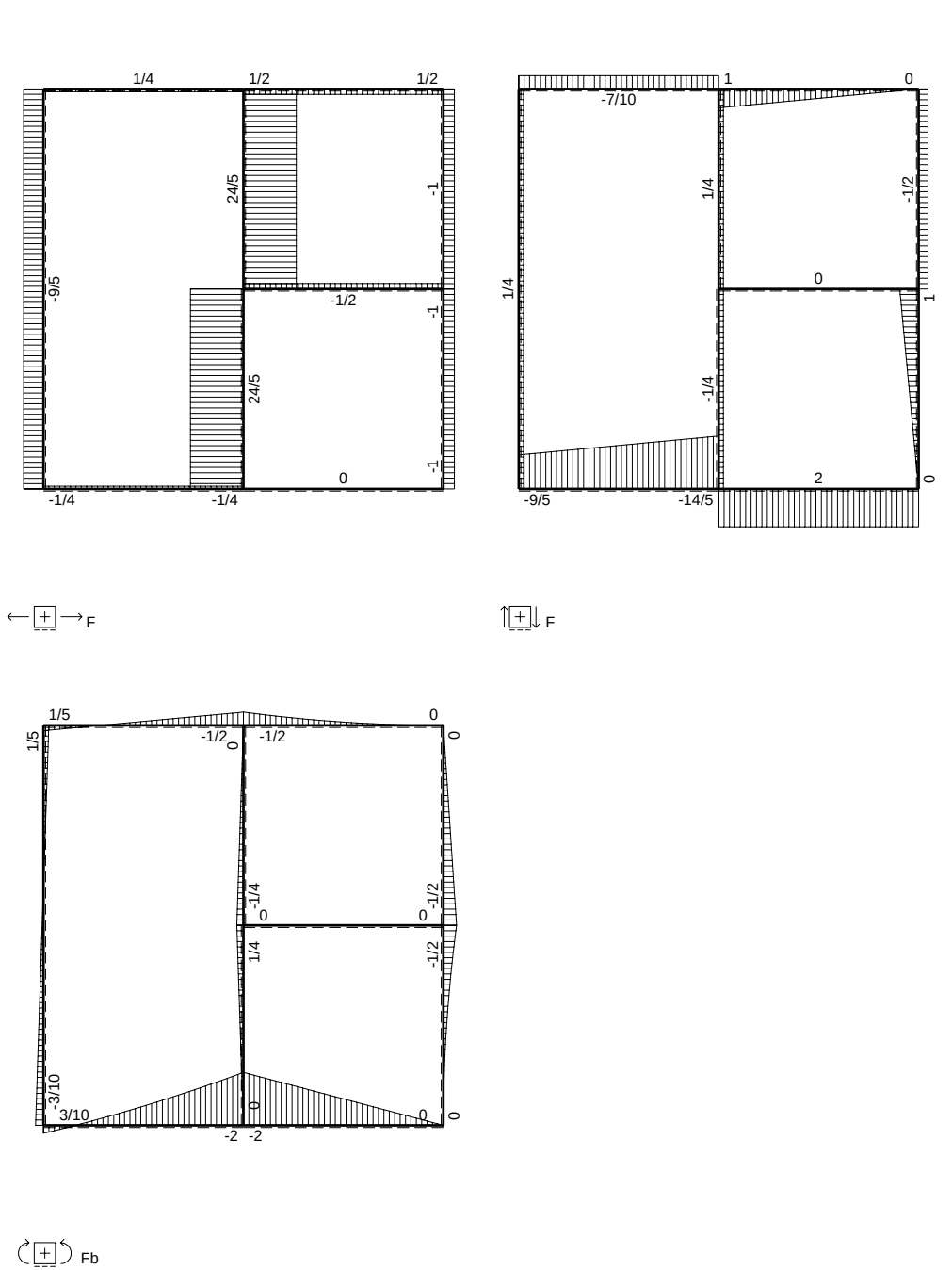
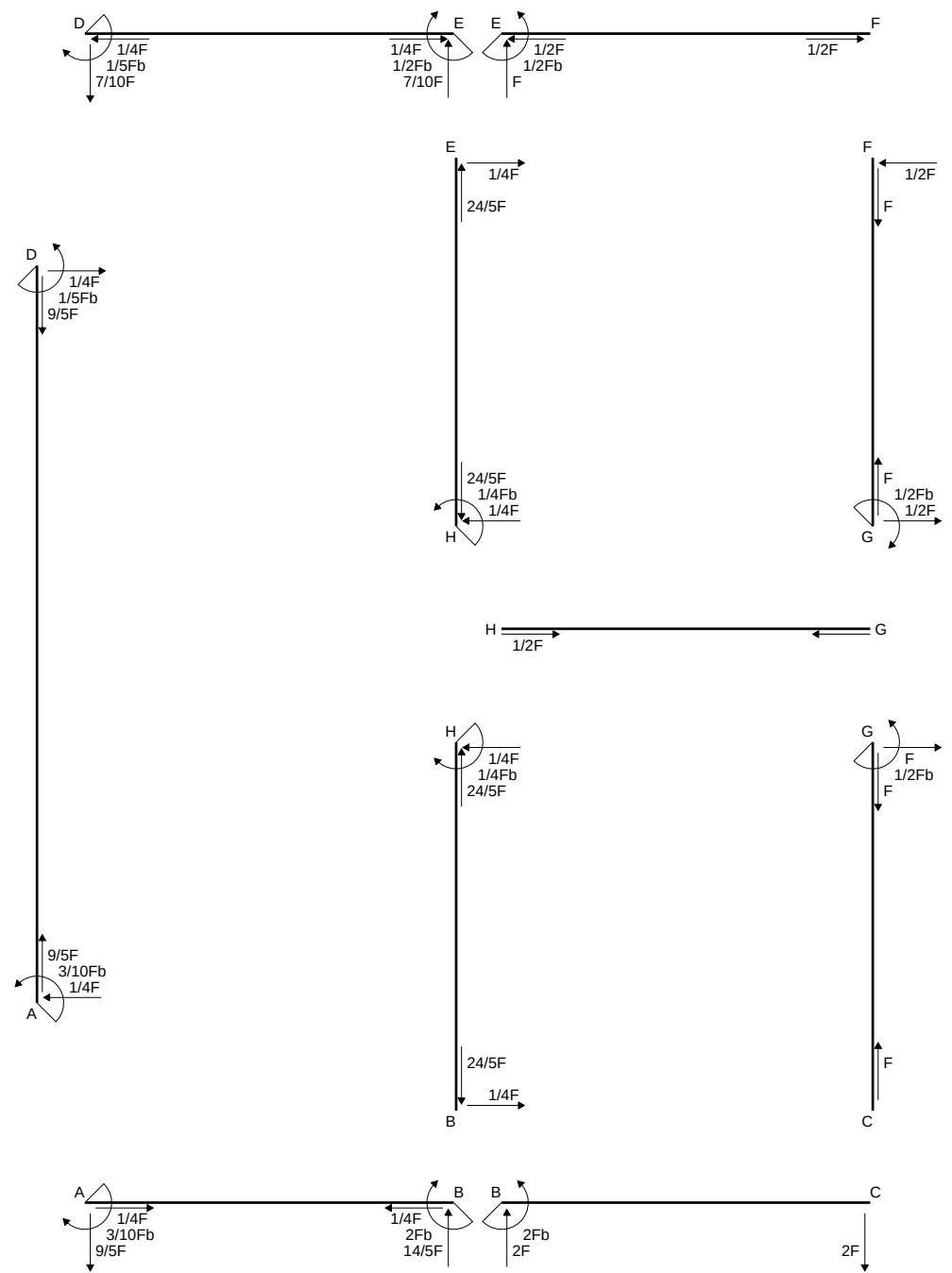
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	$1/2qx^2$	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

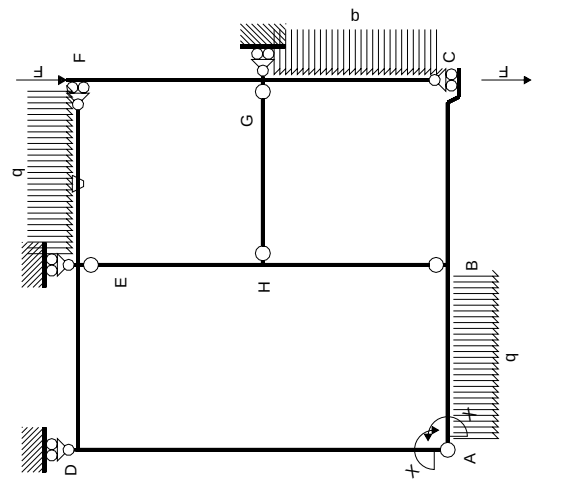
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$

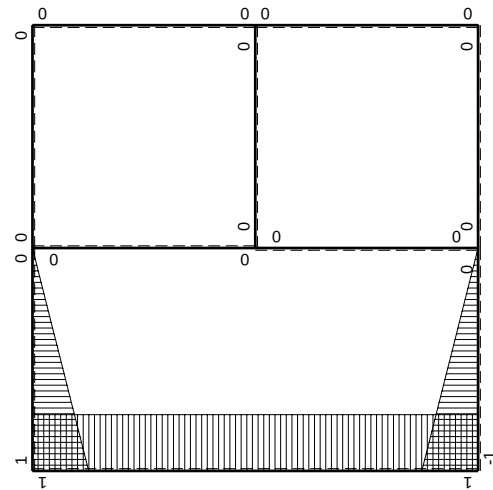


$$\begin{aligned}
A &= 1260. \text{ mm}^2 \\
J_u &= 417492. \text{ mm}^4 \\
J_v &= 130896. \text{ mm}^4 \\
y_g &= 22.86 \text{ mm} \\
T_y &= 3280. \text{ N} \\
M_x &= -3116000. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 32.14 \text{ mm} \\
\sigma_m &= -Mv/J_u = 239.9 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 40. \text{ mm} \\
v_c &= 17.14 \text{ mm} \\
\sigma_c &= -Mv/J_u = 127.9 \text{ N/mm}^2 \\
\tau_c &= 5.668 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 128.3 \text{ N/mm}^2 \\
S &= 8658. \text{ mm}^3
\end{aligned}$$

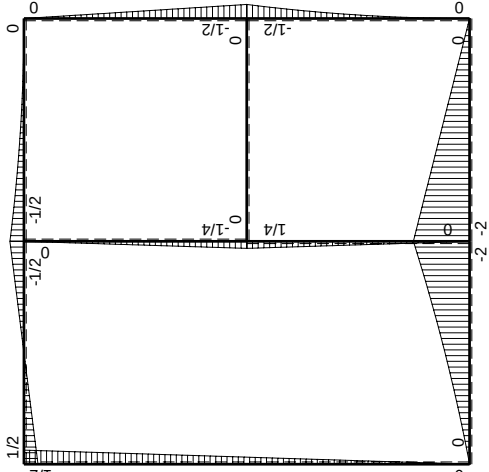




$\left(\begin{smallmatrix} + \\ - \end{smallmatrix} \right) M_0$ flessione da carichi assegnati



$\left(\begin{smallmatrix} + \\ - \end{smallmatrix} \right) M_x$ flessione da iperstatica $X=1$

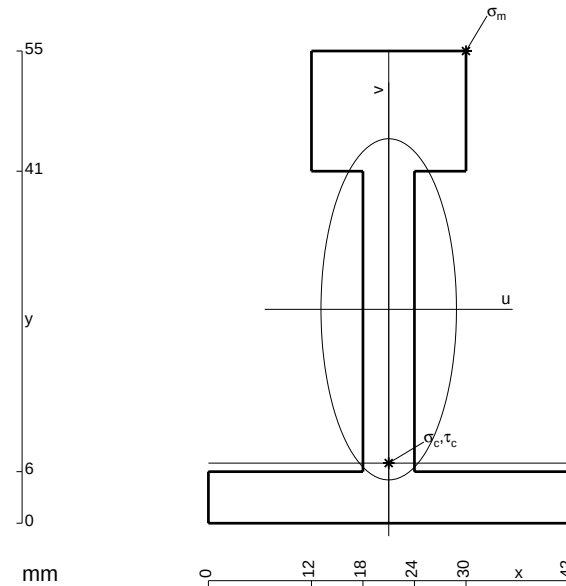


Quadro contributi PLV per iperstatica $X=W_{AB}$

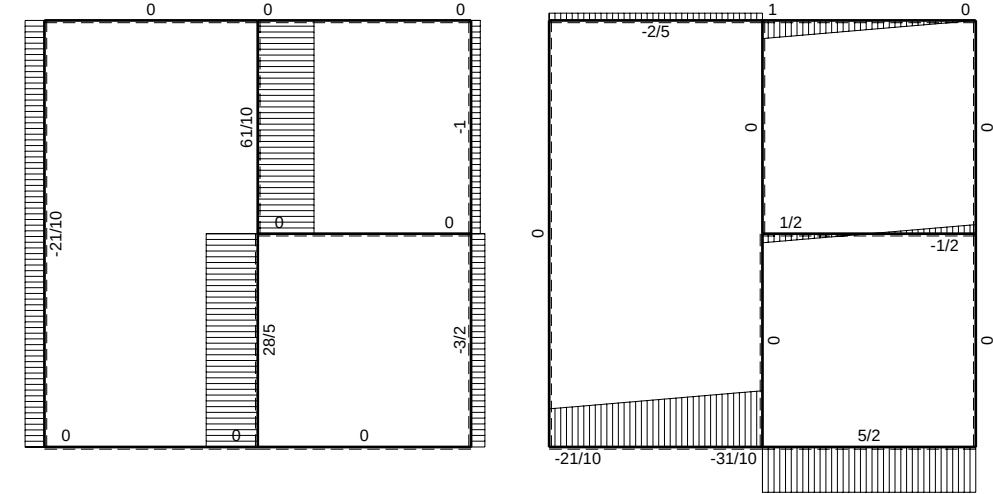
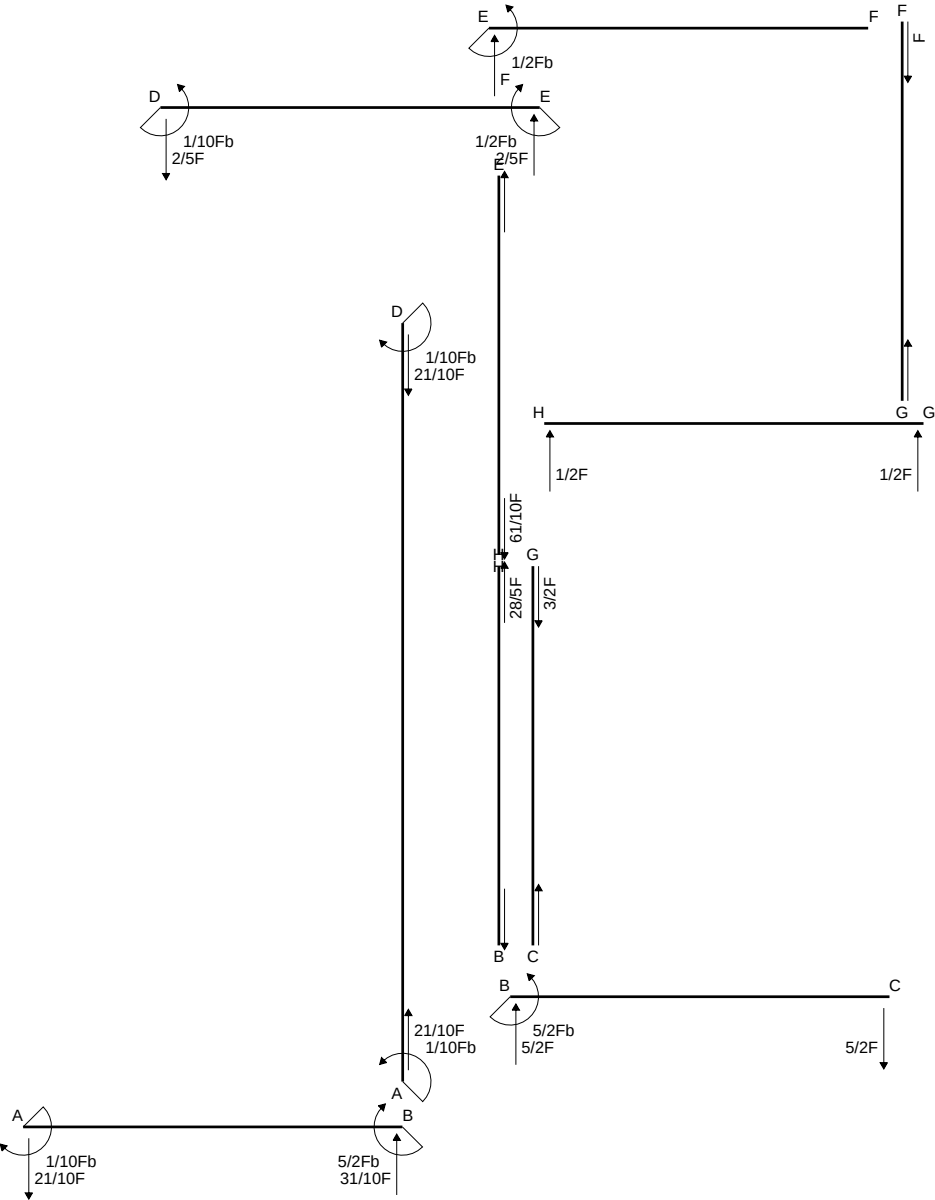
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-Fx$	0	$1/2Fb-3/2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-Fx$	0	$-1/2Fx+Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	$1/2qx^2$	Fb/EJ	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/8Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-3/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - 3/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 3/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 3/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/3 b) Fb \frac{1}{EJ} = 1/12 \frac{Fb^2}{EJ}
\end{aligned}$$

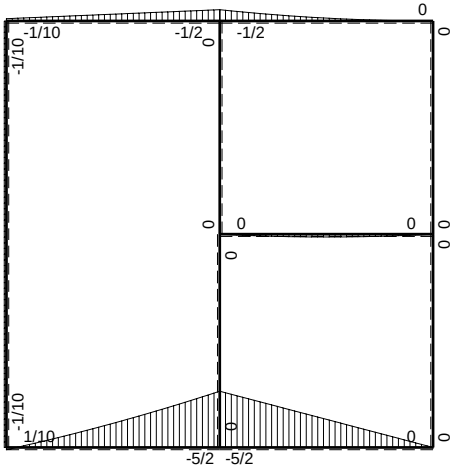


$$\begin{aligned}
A &= 714. \text{ mm}^2 \\
J_u &= 282052. \text{ mm}^4 \\
J_v &= 44478. \text{ mm}^4 \\
y_g &= 24.91 \text{ mm} \\
T_y &= 3740. \text{ N} \\
M_x &= -1870000. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 30.09 \text{ mm} \\
\sigma_m &= -Mv/J_u = 199.5 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 7. \text{ mm} \\
v_c &= -17.91 \text{ mm} \\
\sigma_c &= -Mv/J_u = -118.8 \text{ N/mm}^2 \\
\tau_c &= 12.45 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 120.7 \text{ N/mm}^2 \\
S &= 5632. \text{ mm}^3
\end{aligned}$$

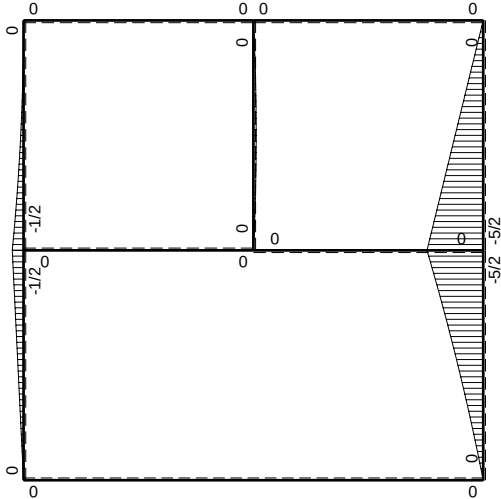
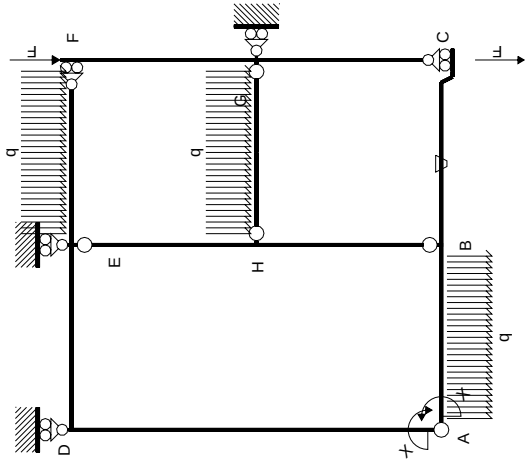


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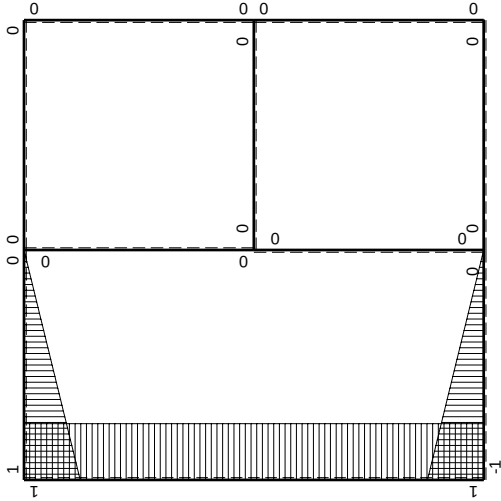


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Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$5/2Fx$	Fb/EJ	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

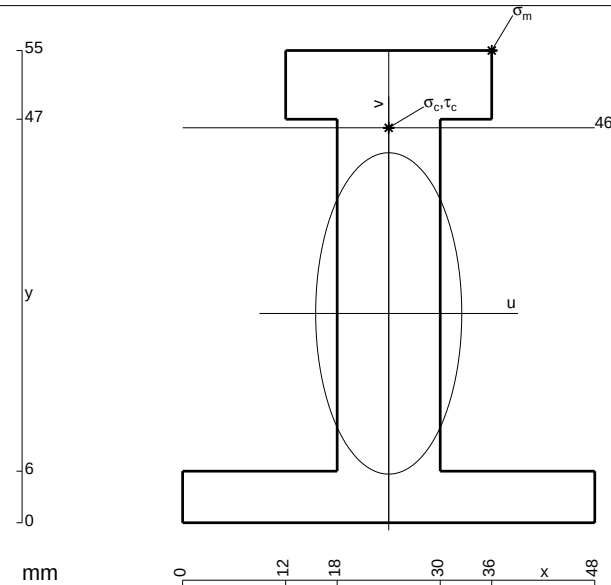
$$= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{DE}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ}$$

$$L_{ED}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ}$$



$$A = 972. \text{ mm}^2$$

$$J_u = 340722. \text{ mm}^4$$

$$J_v = 70416. \text{ mm}^4$$

$$y_g = 24.38 \text{ mm}$$

$$T_y = 4225. \text{ N}$$

$$M_x = -2323750. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 55. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 30.62 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 208.9 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 46. \text{ mm}$$

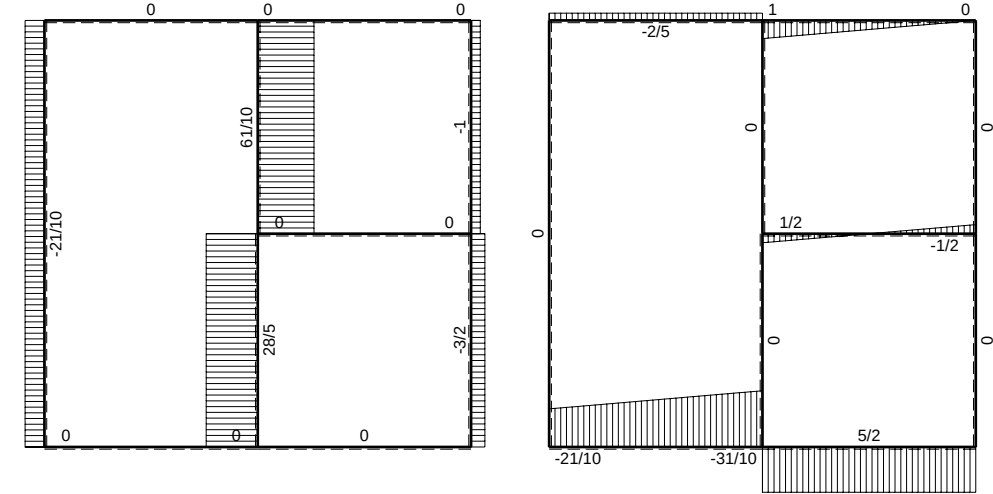
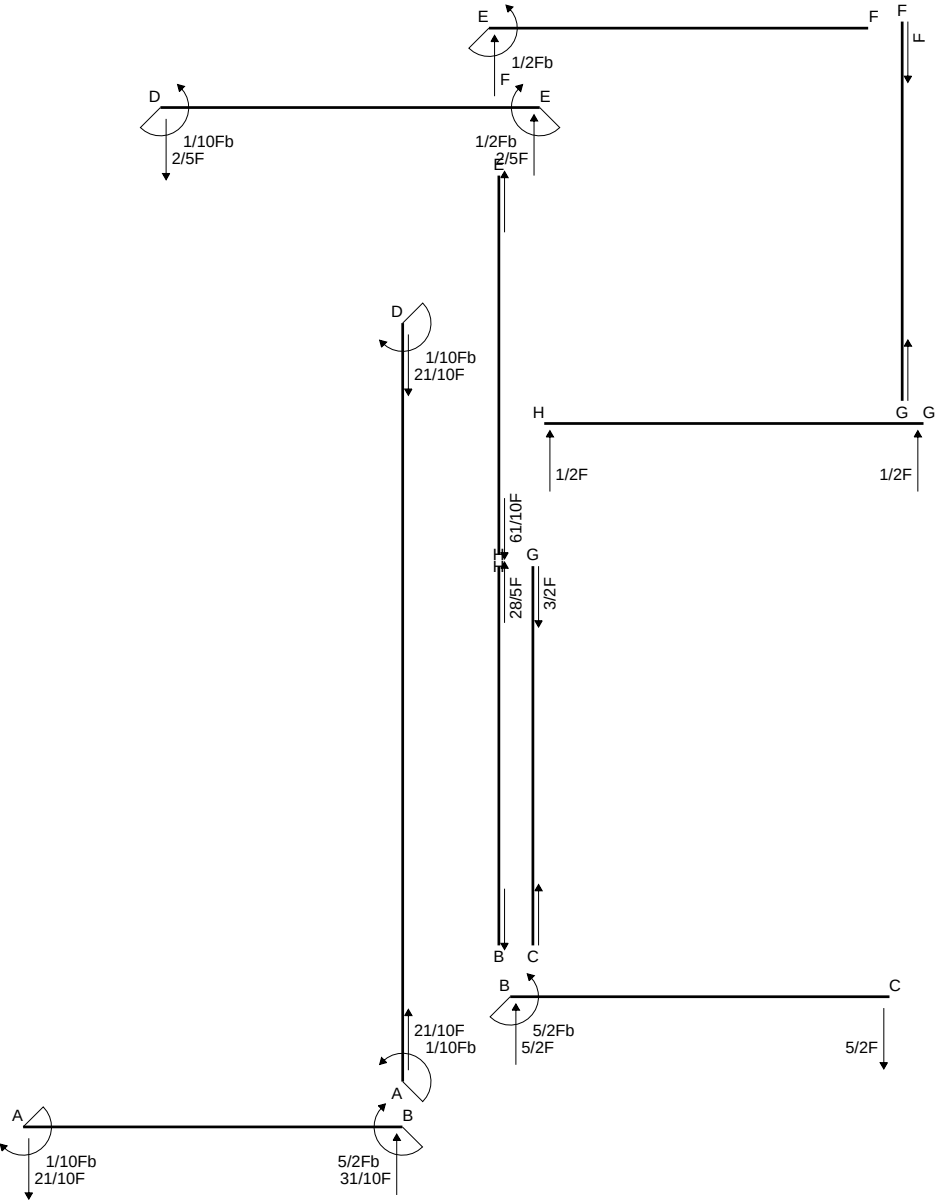
$$v_c = 21.62 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 147.5 \text{ N/mm}^2$$

$$\tau_c = 5.556 \text{ N/mm}^2$$

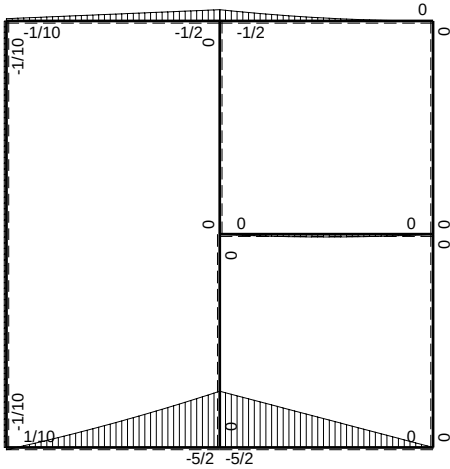
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 147.8 \text{ N/mm}^2$$

$$S = 5377. \text{ mm}^3$$

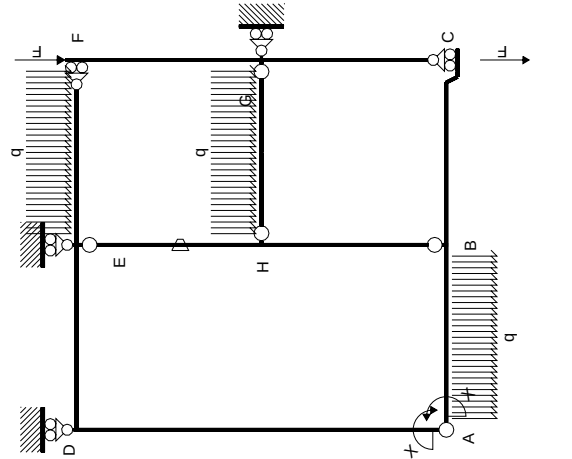


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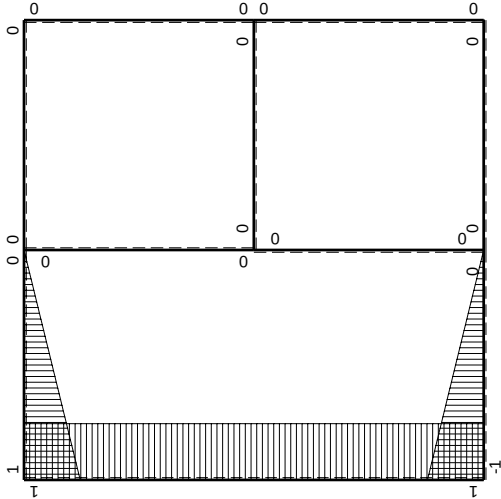


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Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	0	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

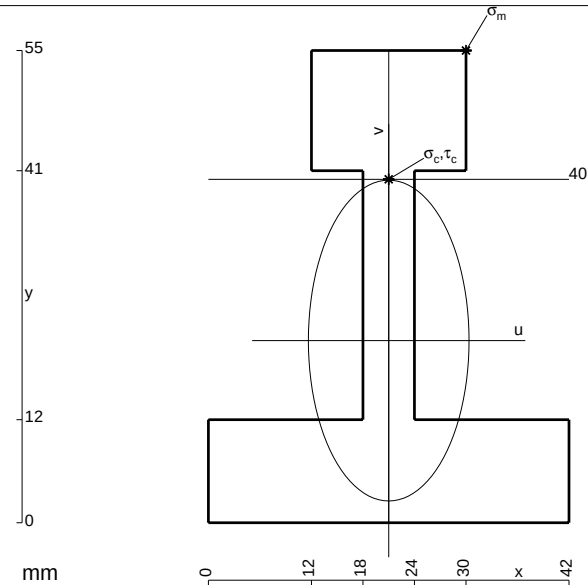
$$= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{DE}^{x_0} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ}$$

$$L_{ED}^{x_0} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ}$$



$$A = 930. \text{ mm}^2$$

$$J_u = 324687. \text{ mm}^4$$

$$J_v = 81414. \text{ mm}^4$$

$$y_g = 21.22 \text{ mm}$$

$$T_y = 3500. \text{ N}$$

$$M_x = -2100000. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 55. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 33.78 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 218.5 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

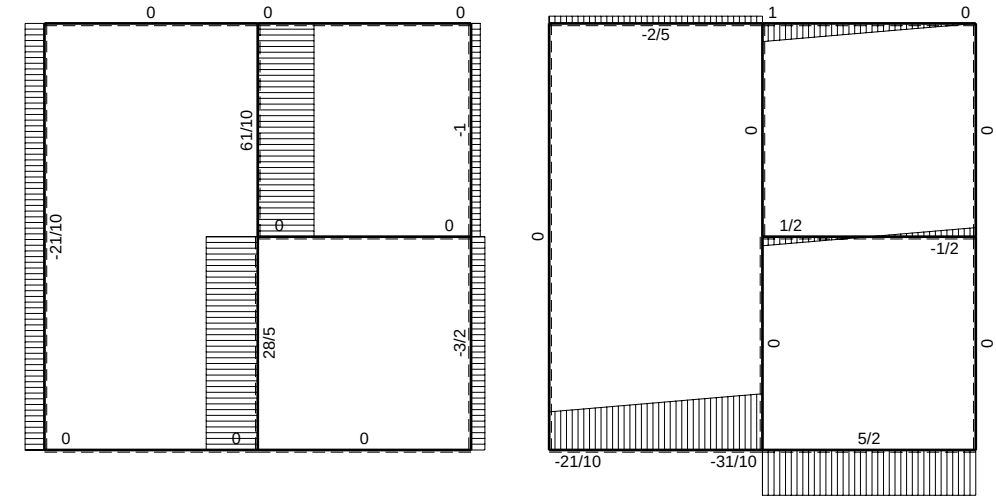
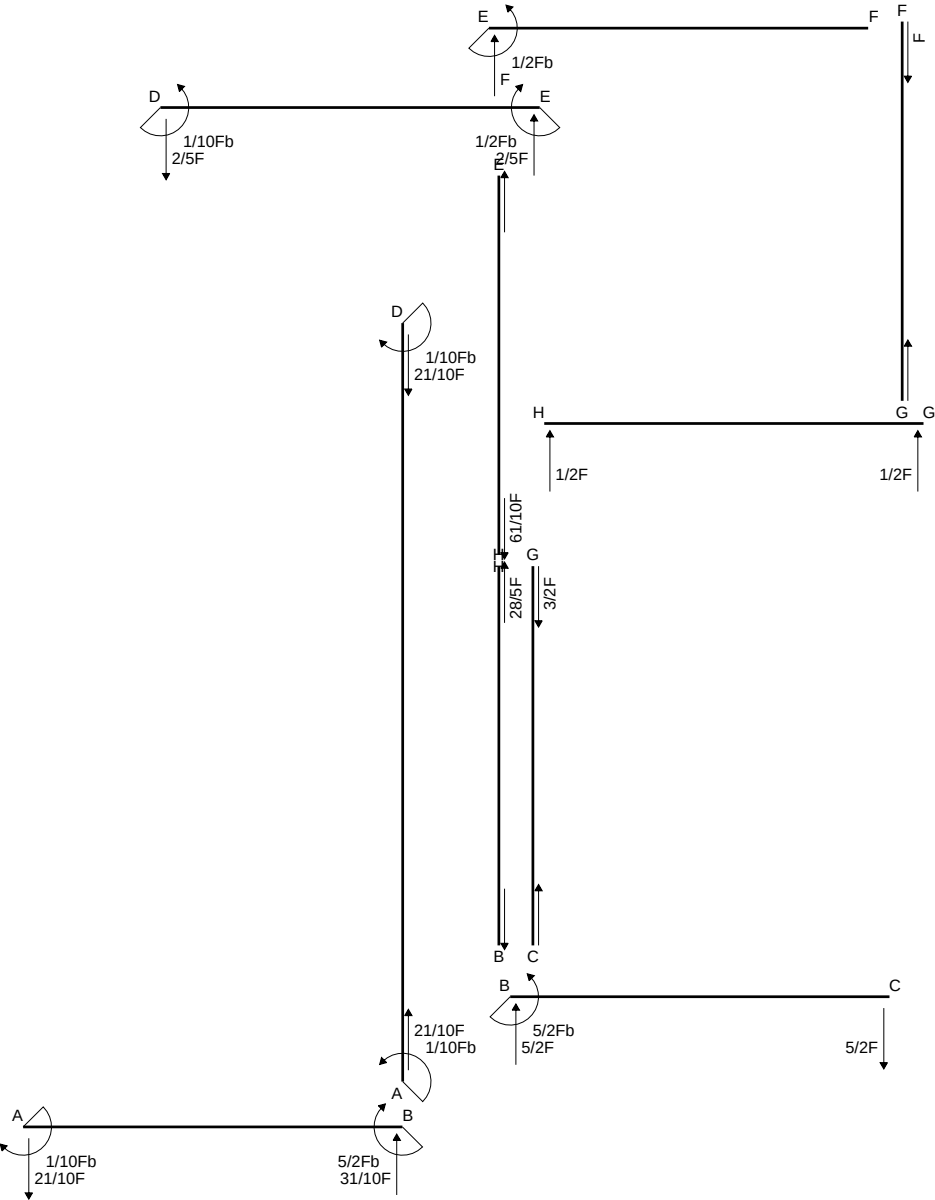
$$v_c = 18.78 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 121.5 \text{ N/mm}^2$$

$$\tau_c = 12.33 \text{ N/mm}^2$$

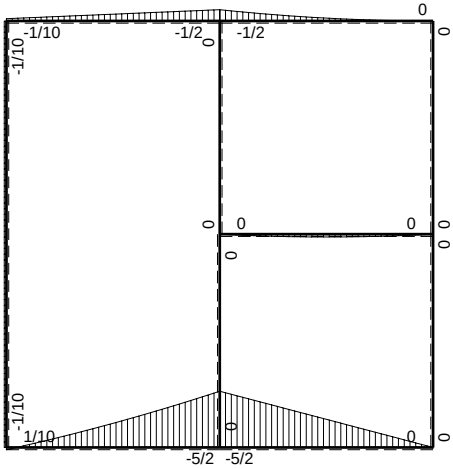
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 123.4 \text{ N/mm}^2$$

$$S = 6865. \text{ mm}^3$$

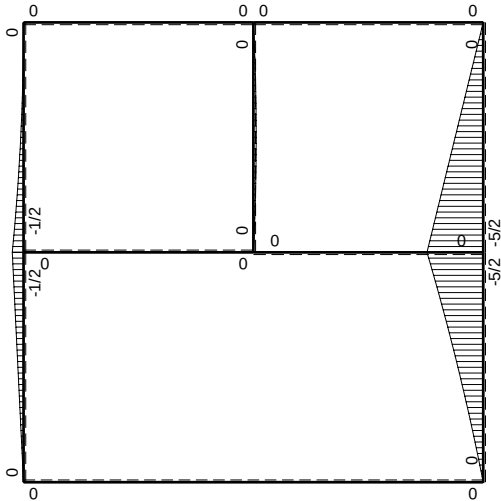
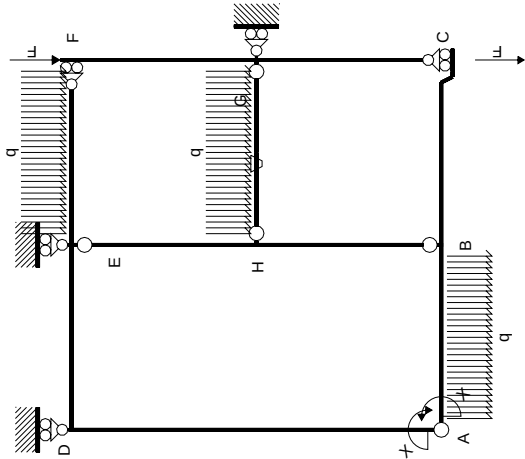


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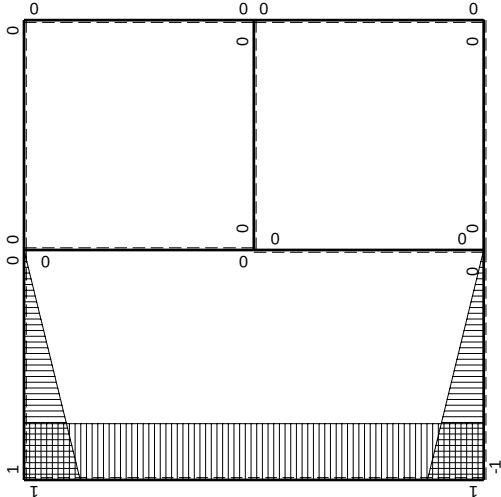


⊕ ⊕ F_b



Schema di calcolo iperstatico

$(\boxed{+}) M_0$ flessione da carichi assegnati



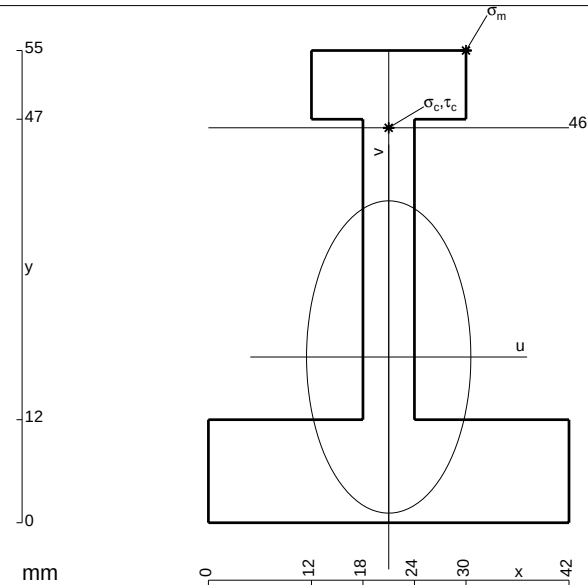
$(\boxed{+}) M_x$ flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

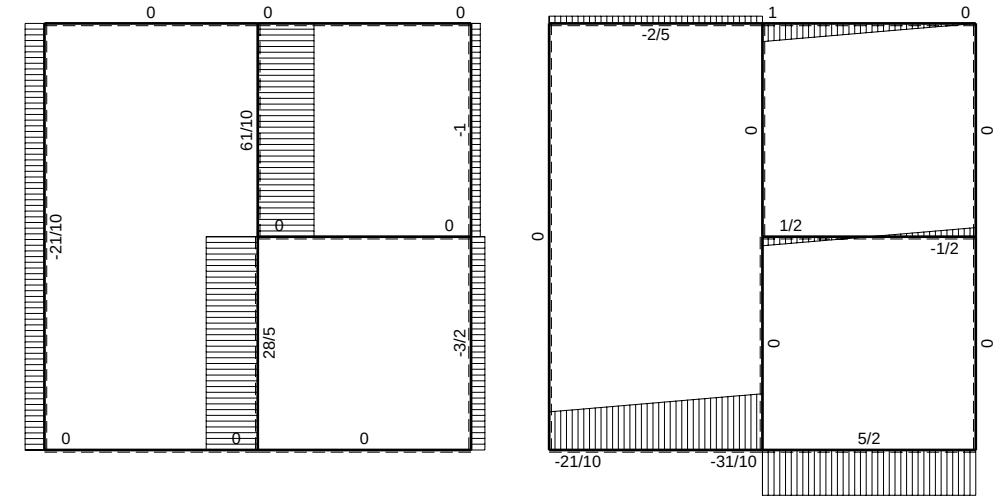
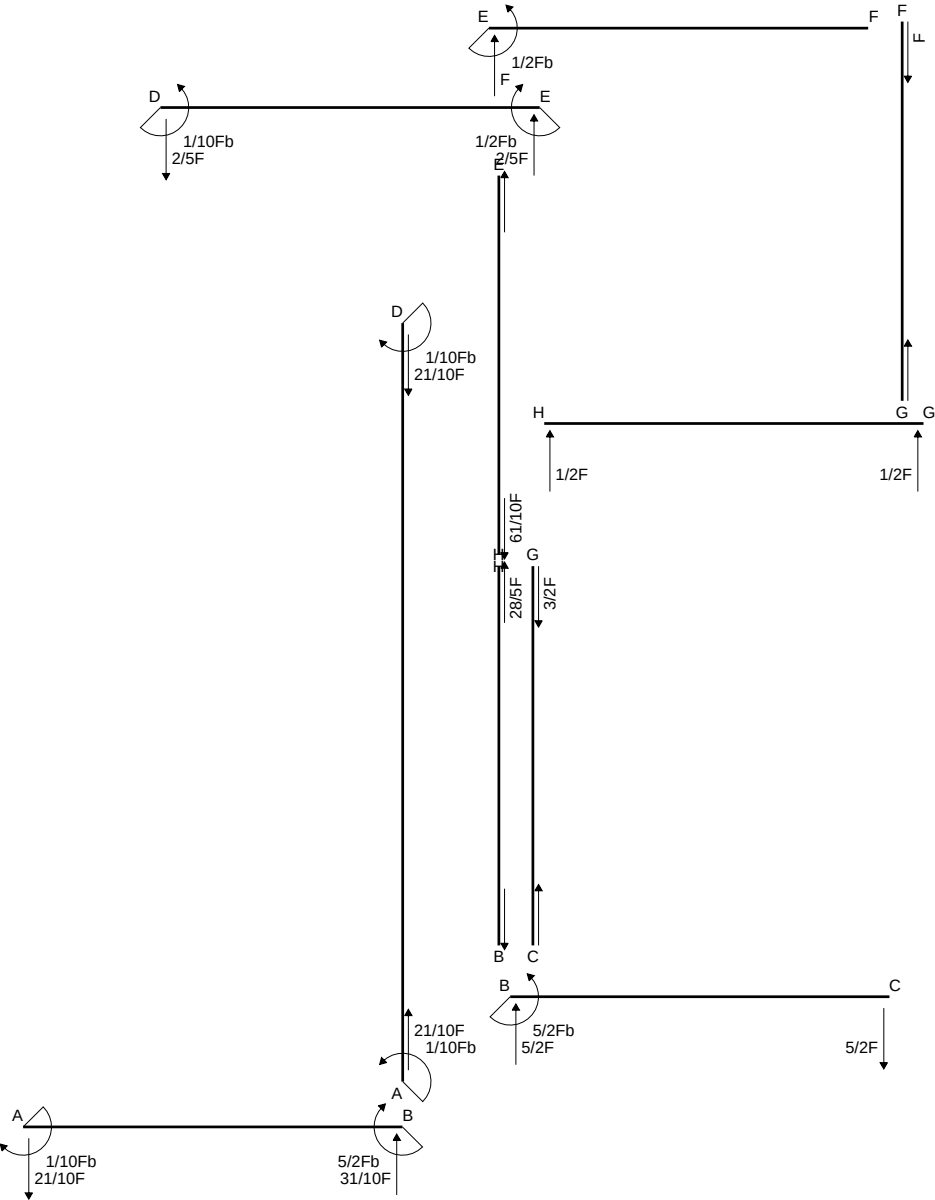
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	Fb/EJ	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ}
\end{aligned}$$

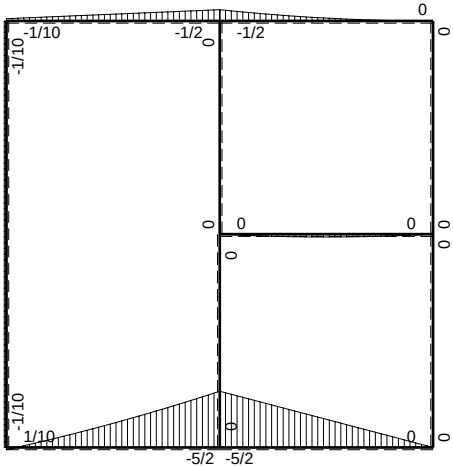


$$\begin{aligned}
A &= 858. \text{ mm}^2 \\
J_u &= 283959. \text{ mm}^4 \\
J_v &= 78606. \text{ mm}^4 \\
y_g &= 19.3 \text{ mm} \\
T_y &= 2800. \text{ N} \\
M_x &= -1820000. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 35.7 \text{ mm} \\
\sigma_m &= -Mv/J_u = 228.8 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 46. \text{ mm} \\
v_c &= 26.7 \text{ mm} \\
\sigma_c &= -Mv/J_u = 171.1 \text{ N/mm}^2 \\
\tau_c &= 7.769 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 171.6 \text{ N/mm}^2 \\
S &= 4727. \text{ mm}^3
\end{aligned}$$

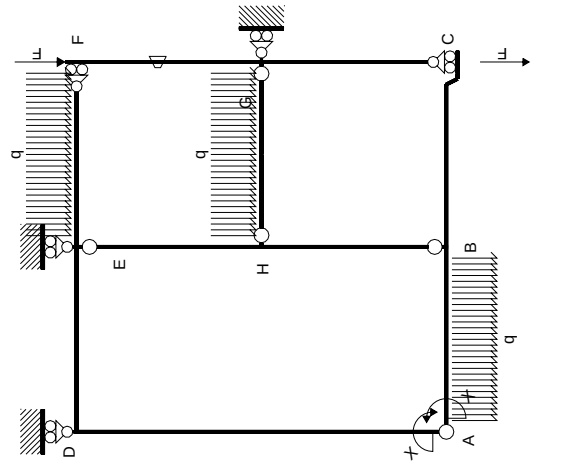


← ⊕ → F

↑ ⊕ ↓ F

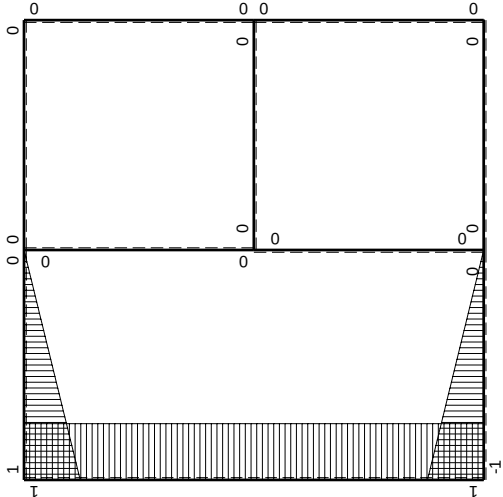


⊕ ⊕ F_b

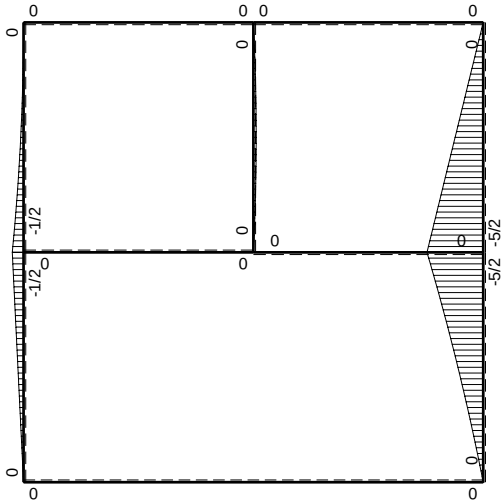


Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$



Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

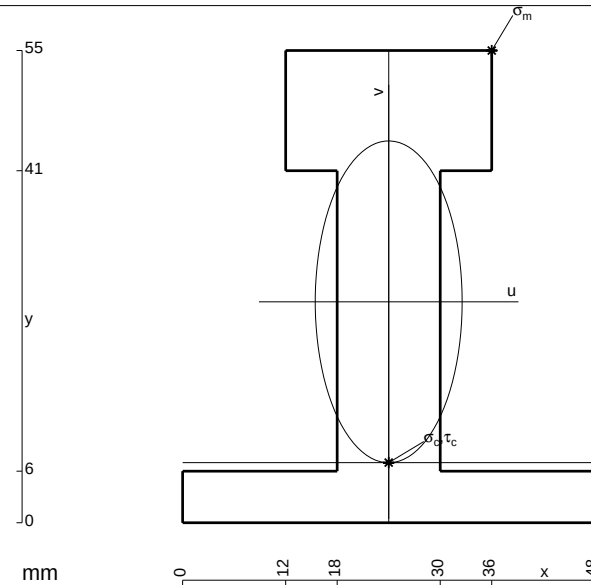
$$= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{DE}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ}$$

$$L_{ED}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ}$$



$$A = 1044. \text{ mm}^2$$

$$J_u = 366752. \text{ mm}^4$$

$$J_v = 76464. \text{ mm}^4$$

$$y_g = 25.73 \text{ mm}$$

$$T_y = 4275. \text{ N}$$

$$M_x = -2992500. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 55. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 29.27 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 238.8 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 7. \text{ mm}$$

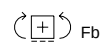
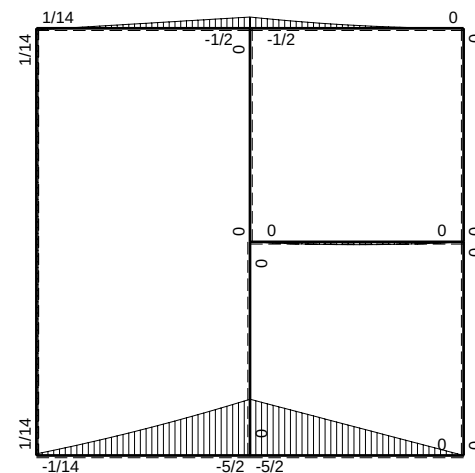
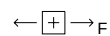
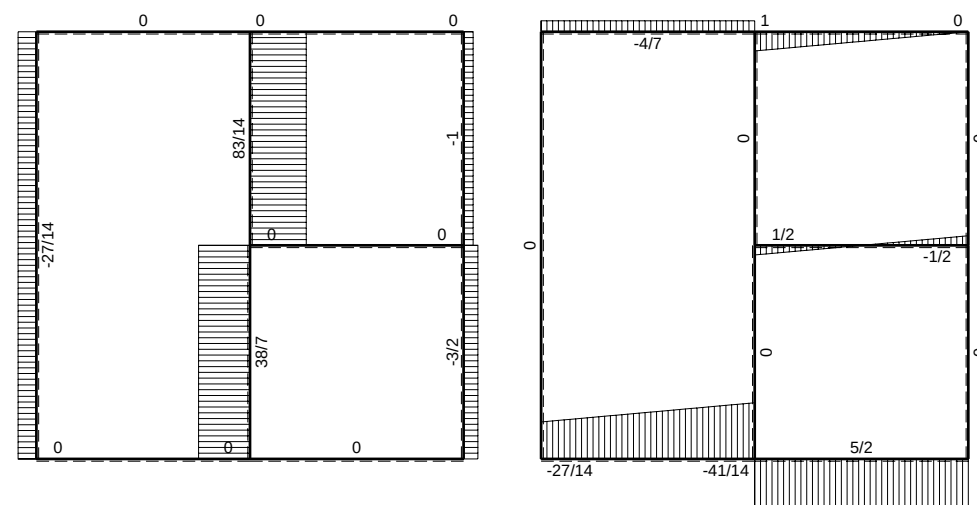
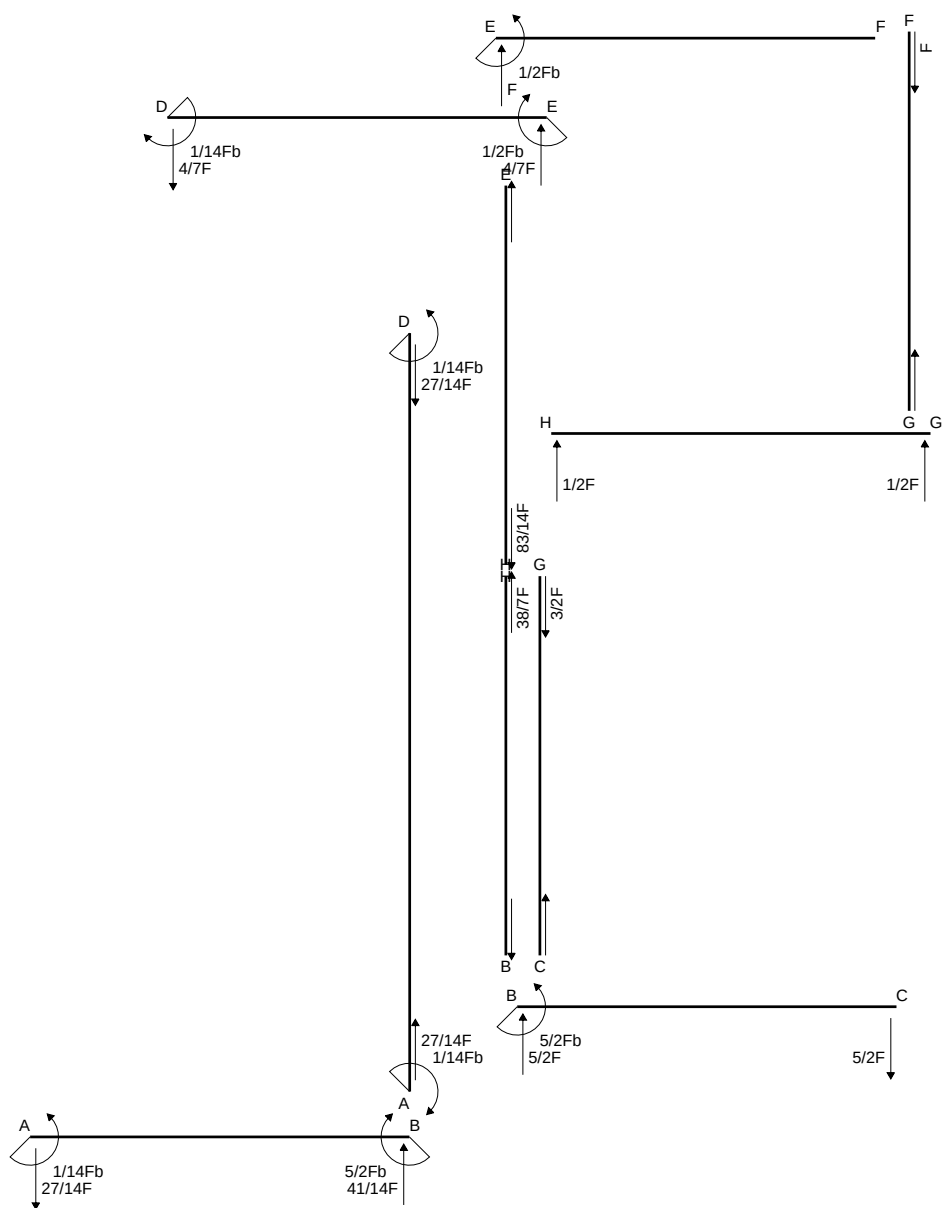
$$v_c = -18.73 \text{ mm}$$

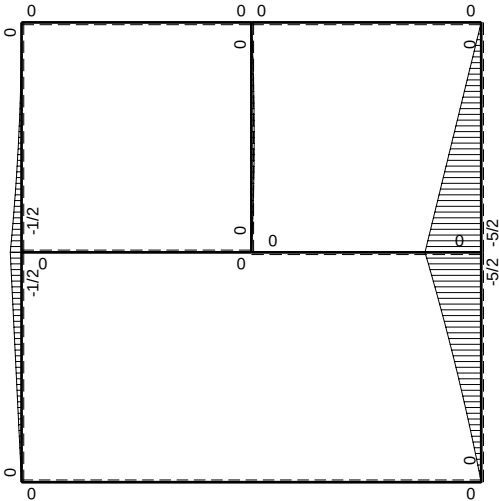
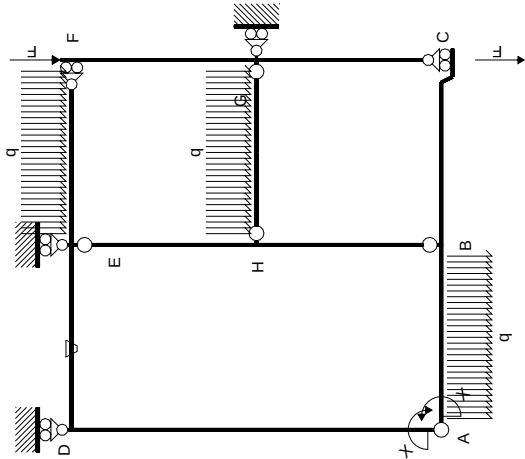
$$\sigma_c = -Mv/J_u = -152.8 \text{ N/mm}^2$$

$$\tau_c = 6.583 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 153.3 \text{ N/mm}^2$$

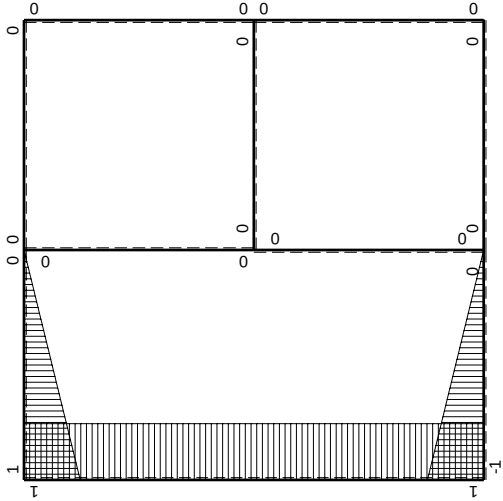
$$S = 6777. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	$-1/2Fx$	$-Fb/EJ$	$-1/2Fx+1/2Fx^2/b$	$-Fb/EJ+Fx/EJ$	$1-2x/b+x^2/b^2$	$(-1/12-1/2)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-1/2Fx$	Fb/EJ	$-1/2Fx+1/2Fx^2/b$	$-Fx/EJ$	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/14Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{DE}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1 + x/b) \theta dx$$

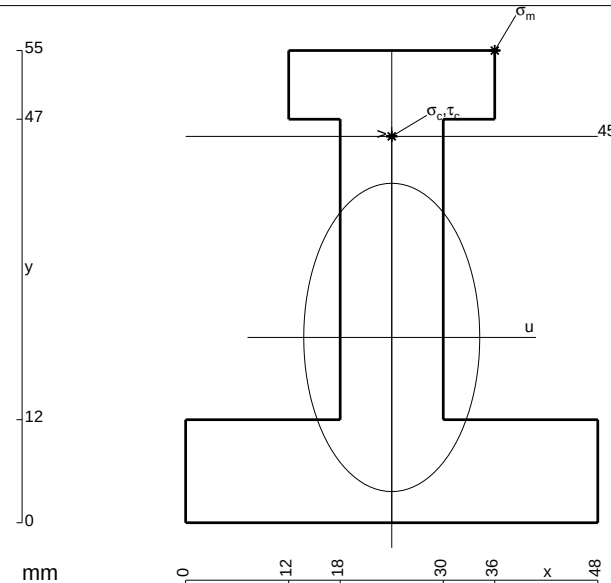
$$= \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} + \left[-x + 1/2 x^2/b \right]_0^b \theta$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} + (-b + 1/2 b) \theta = -7/12 \frac{Fb^2}{EJ}$$

$$L_{ED}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (x/b) \theta dx$$

$$= \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} + \left[1/2 x^2/b \right]_0^b \theta$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} + (1/2 b) \theta = -7/12 \frac{Fb^2}{EJ}$$



$$A = 1188. \text{ mm}^2$$

$$J_u = 383155. \text{ mm}^4$$

$$J_v = 124848. \text{ mm}^4$$

$$y_g = 21.58 \text{ mm}$$

$$T_y = 3050. \text{ N}$$

$$M_x = -2287500. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 55. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 33.42 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 199.5 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 45. \text{ mm}$$

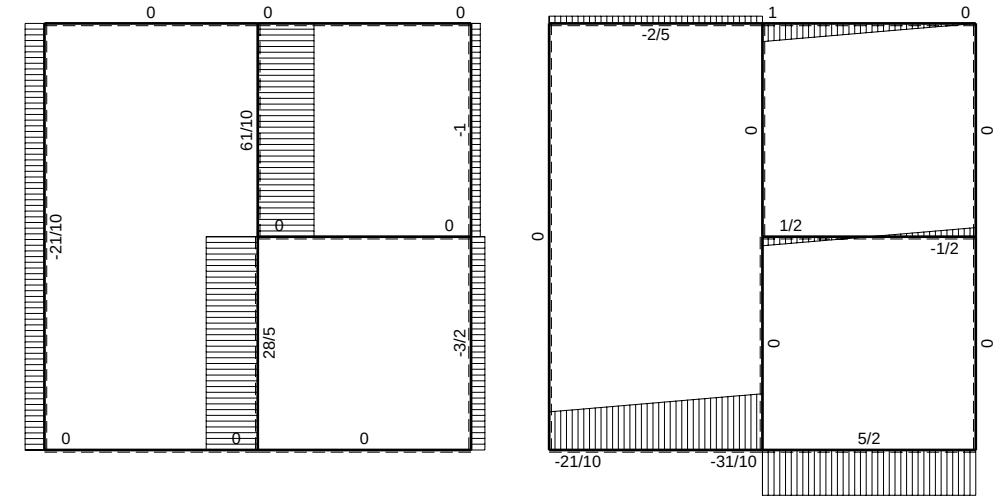
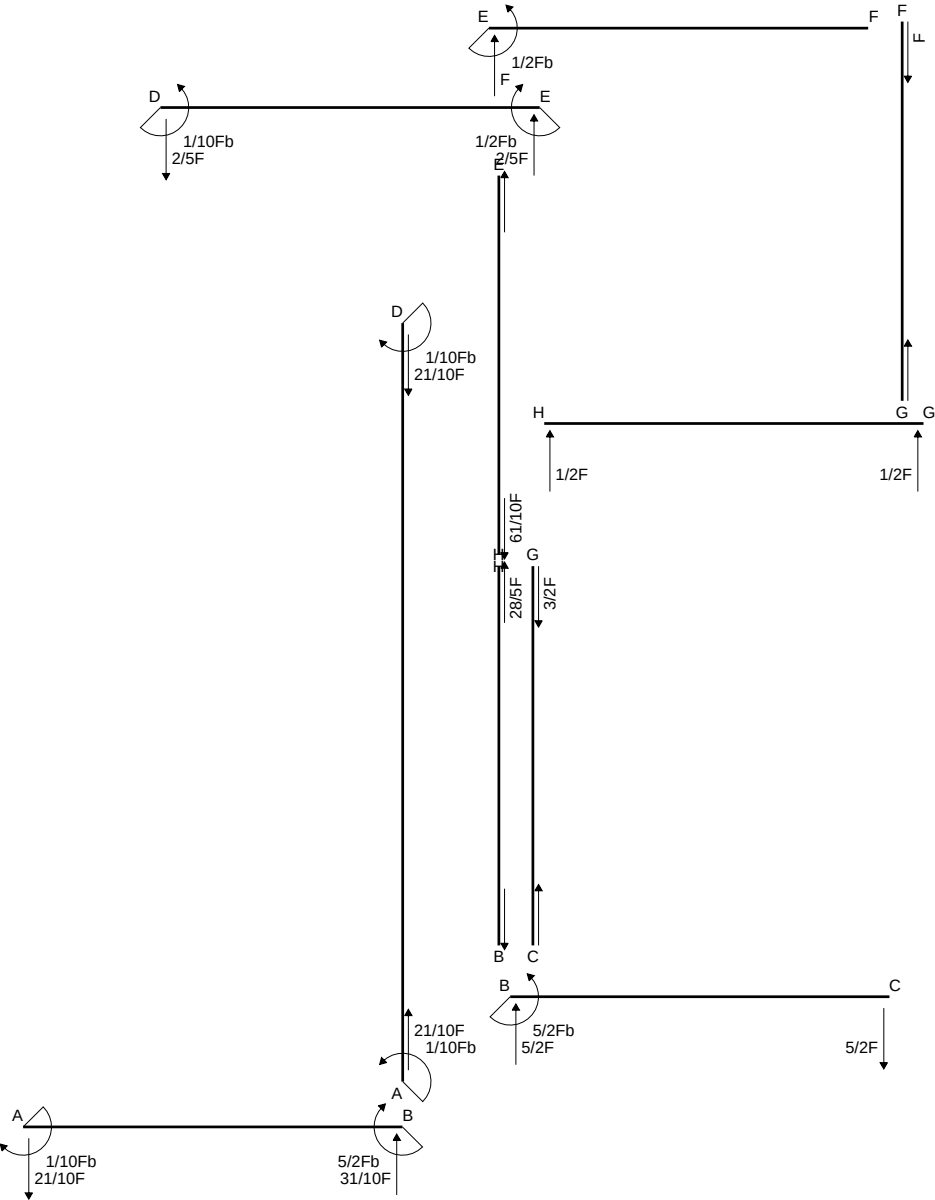
$$v_c = 23.42 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 139.8 \text{ N/mm}^2$$

$$\tau_c = 4.136 \text{ N/mm}^2$$

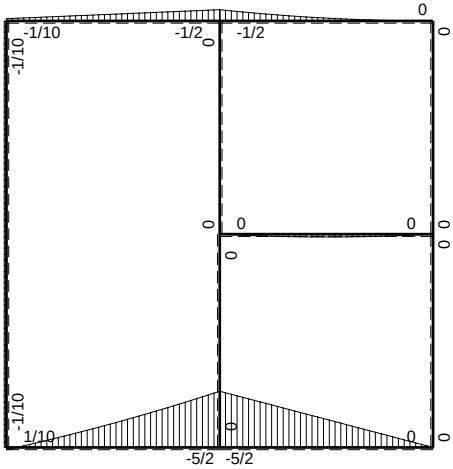
$$\sigma_\varphi = \sqrt{\sigma^2 + 3\tau^2} = 140. \text{ N/mm}^2$$

$$S = 6235. \text{ mm}^3$$

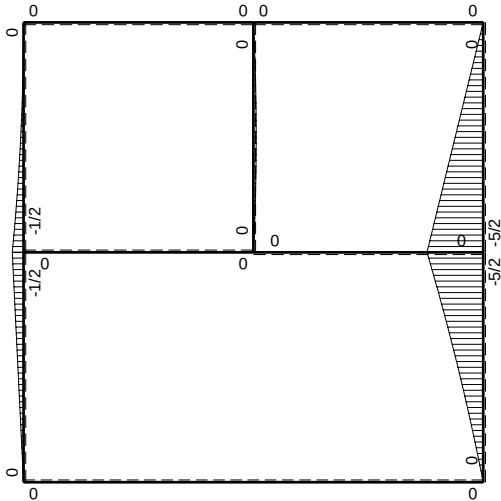
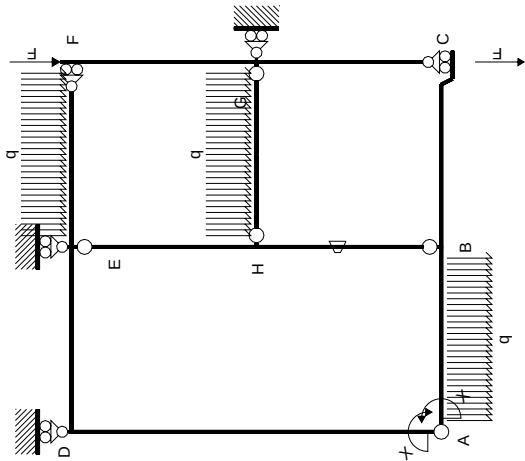


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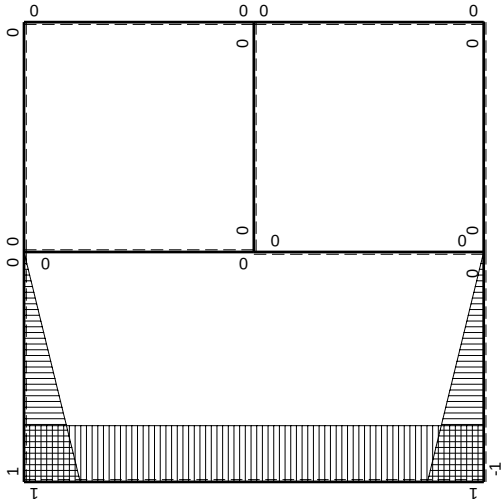


⊕ ⊕ F_b



Schema di calcolo iperstatico

$\curvearrowright \left[\begin{smallmatrix} + \\ - \end{smallmatrix} \right] M_0$ flessione da carichi assegnati



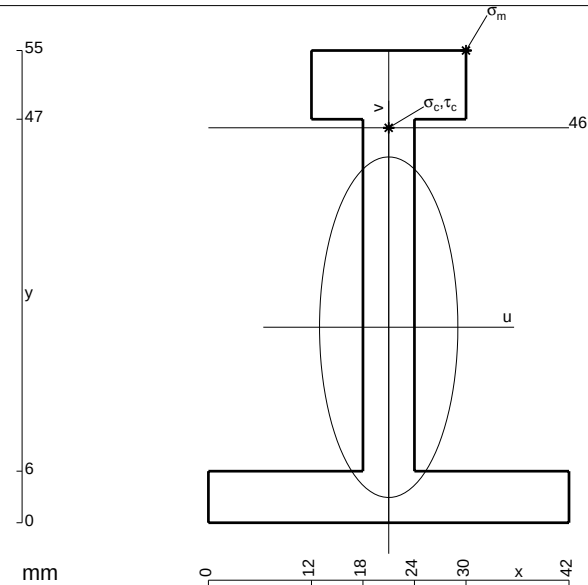
$\curvearrowright \left[\begin{smallmatrix} + \\ - \end{smallmatrix} \right] M_x$ flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

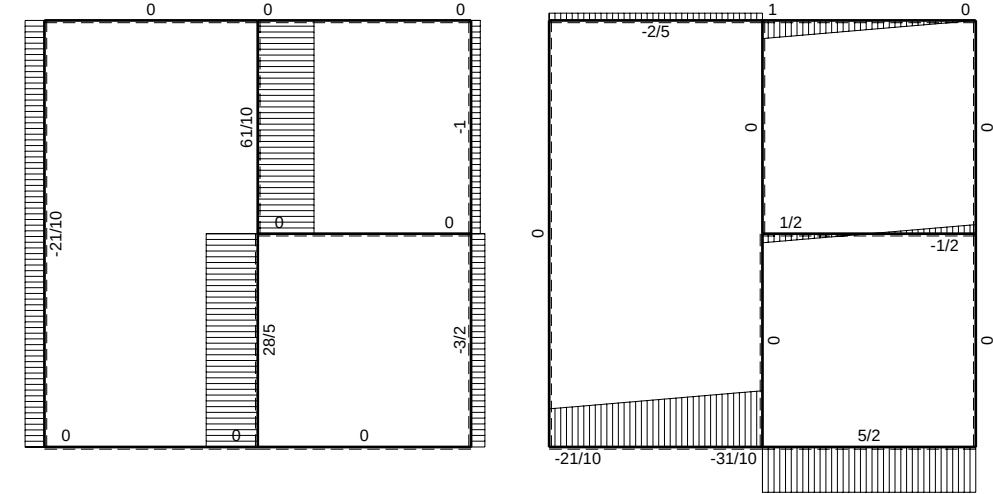
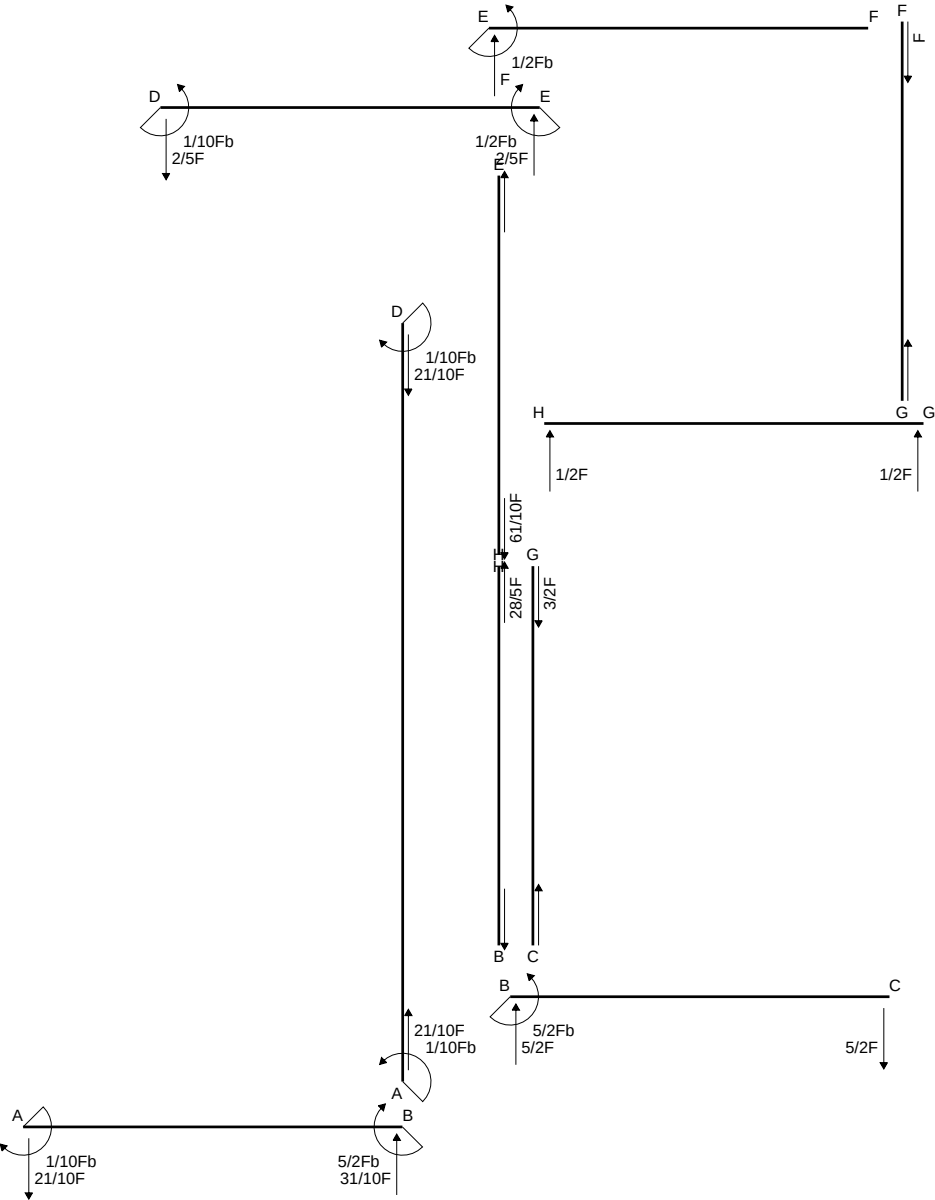
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	0	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	0	Fb/EJ	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ}
\end{aligned}$$

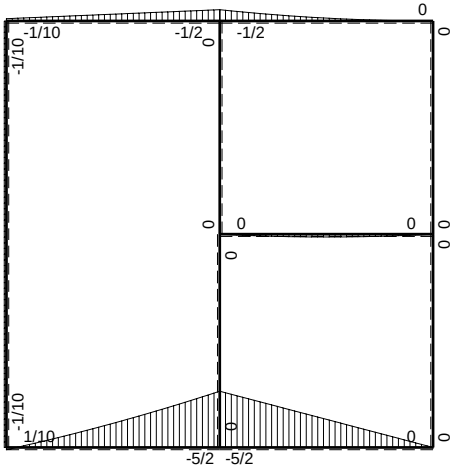


$$\begin{aligned}
A &= 642. \text{ mm}^2 \\
J_u &= 252660. \text{ mm}^4 \\
J_v &= 41670. \text{ mm}^4 \\
y_g &= 22.77 \text{ mm} \\
T_y &= 2050. \text{ N} \\
M_x &= -1640000. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 32.23 \text{ mm} \\
\sigma_m &= -Mv/J_u = 209.2 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 46. \text{ mm} \\
v_c &= 23.23 \text{ mm} \\
\sigma_c &= -Mv/J_u = 150.8 \text{ N/mm}^2 \\
\tau_c &= 5.689 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 151.1 \text{ N/mm}^2 \\
S &= 4207. \text{ mm}^3
\end{aligned}$$

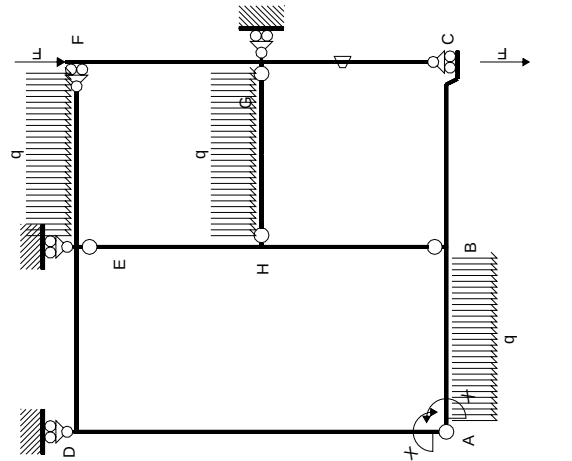


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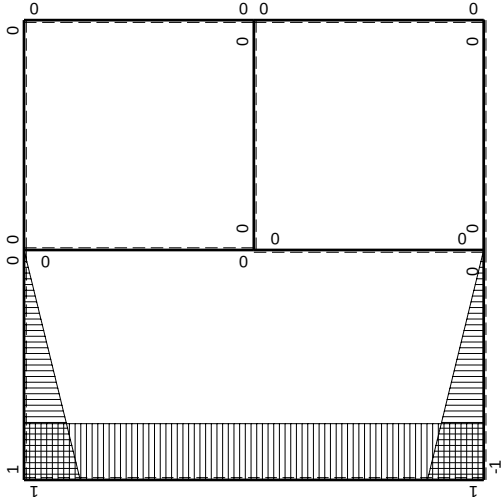


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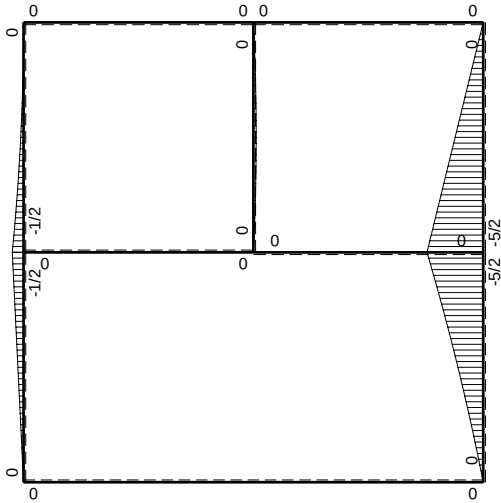


Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$



Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$1/2qx^2$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (5/2 x/b - 3x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

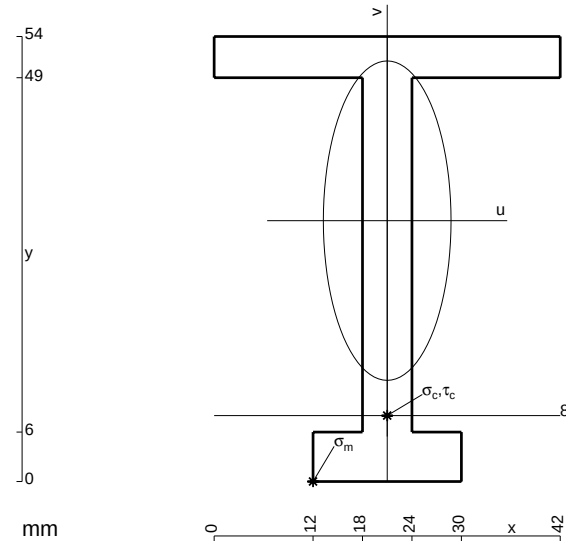
$$= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{DE}^{x_0} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ}$$

$$L_{ED}^{x_0} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ}$$



$$A = 576. \text{ mm}^2$$

$$J_u = 216352. \text{ mm}^4$$

$$J_v = 34560. \text{ mm}^4$$

$$y_g = 31.66 \text{ mm}$$

$$T_y = 1800. \text{ N}$$

$$M_x = -1494000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -31.66 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -163.6 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 8. \text{ mm}$$

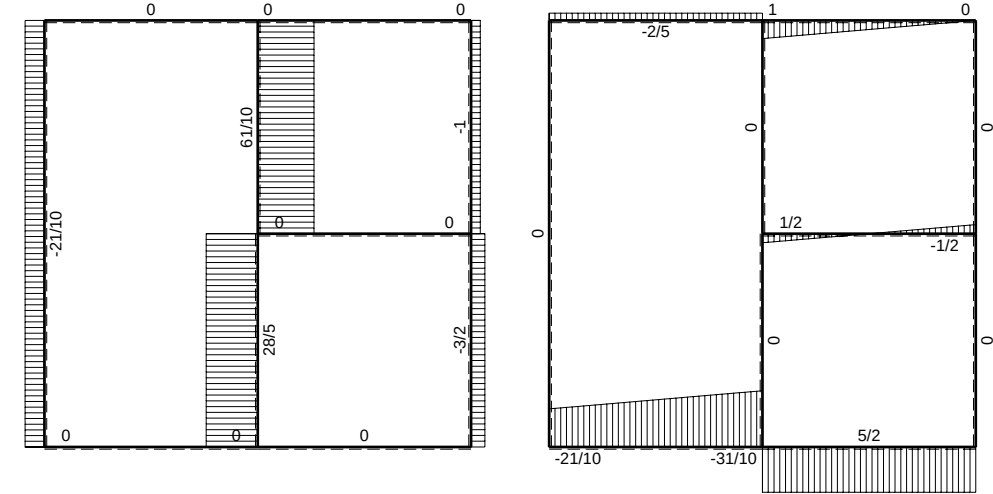
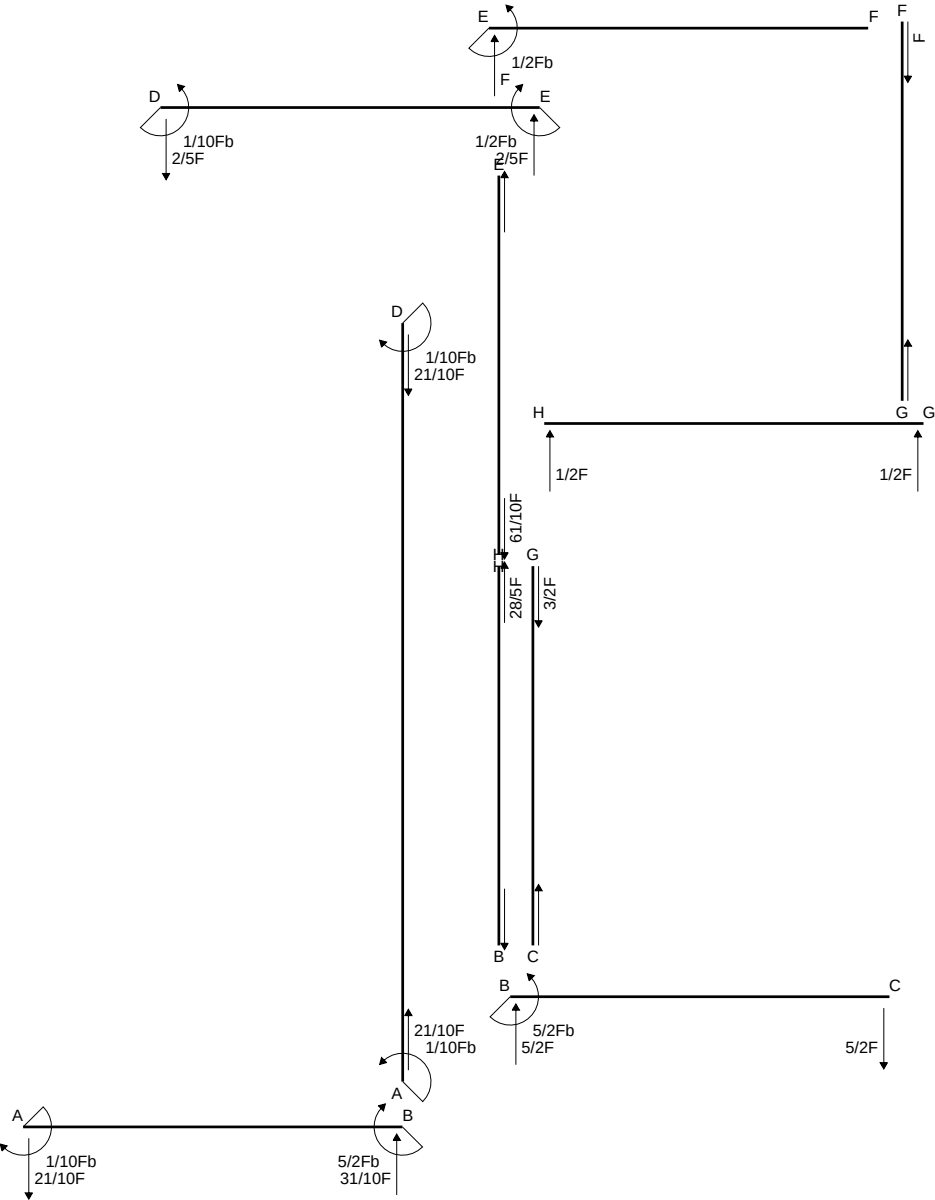
$$v_c = -23.66 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -163.4 \text{ N/mm}^2$$

$$\tau_c = 4.702 \text{ N/mm}^2$$

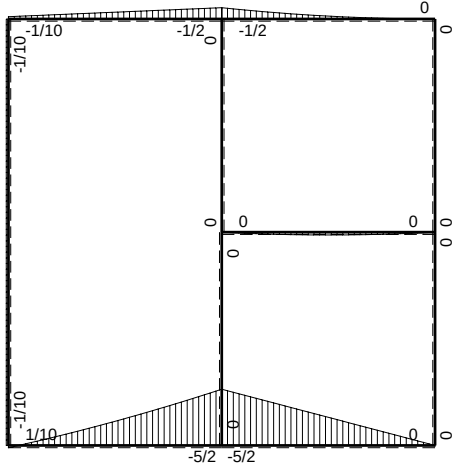
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 163.6 \text{ N/mm}^2$$

$$S = 3391. \text{ mm}^3$$

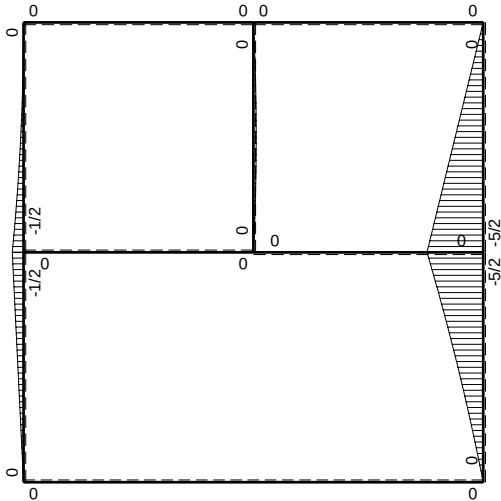
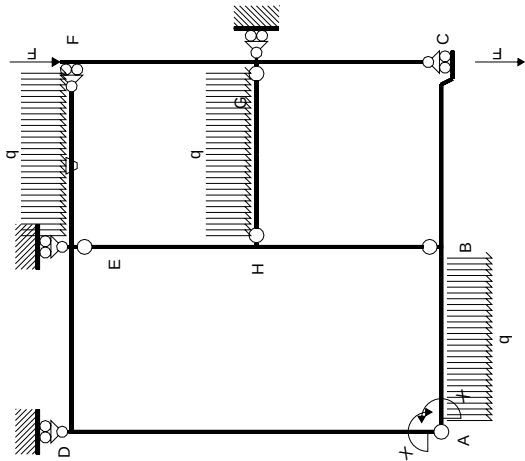


← ⊕ → F

↑ ⊕ ↓ F

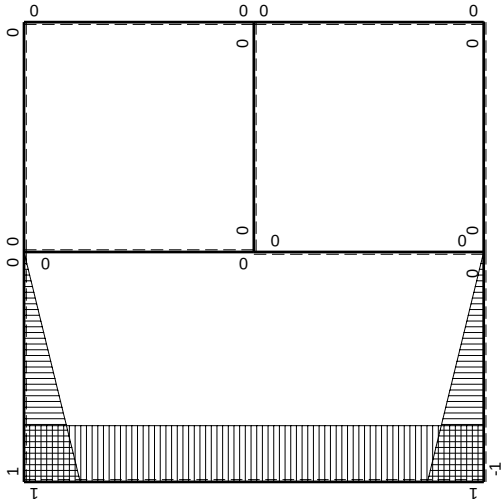


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
EF b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	$1/2qx^2$	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	0	0	0	0	0	0+0	0
EH b	0	0	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (5/2 x/b - 3x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

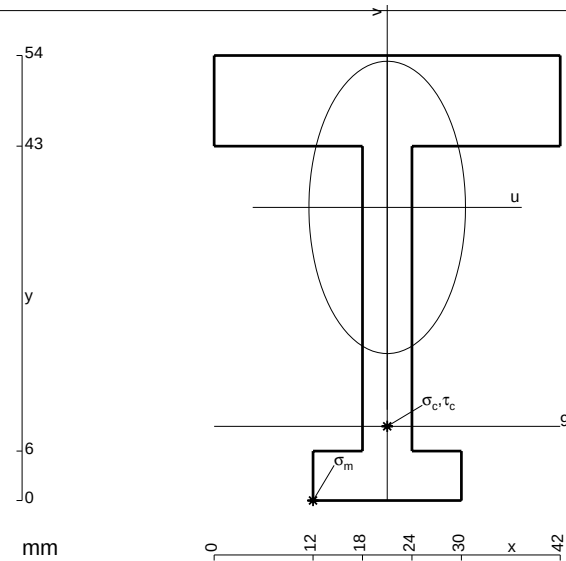
$$= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{DE}^{x_0} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ}$$

$$L_{ED}^{x_0} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 \frac{Fb^2}{EJ}$$



$$A = 792. \text{ mm}^2$$

$$J_u = 249320. \text{ mm}^4$$

$$J_v = 71496. \text{ mm}^4$$

$$y_g = 35.57 \text{ mm}$$

$$T_y = 1825. \text{ N}$$

$$M_x = -1606000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -35.57 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -229.1 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 9. \text{ mm}$$

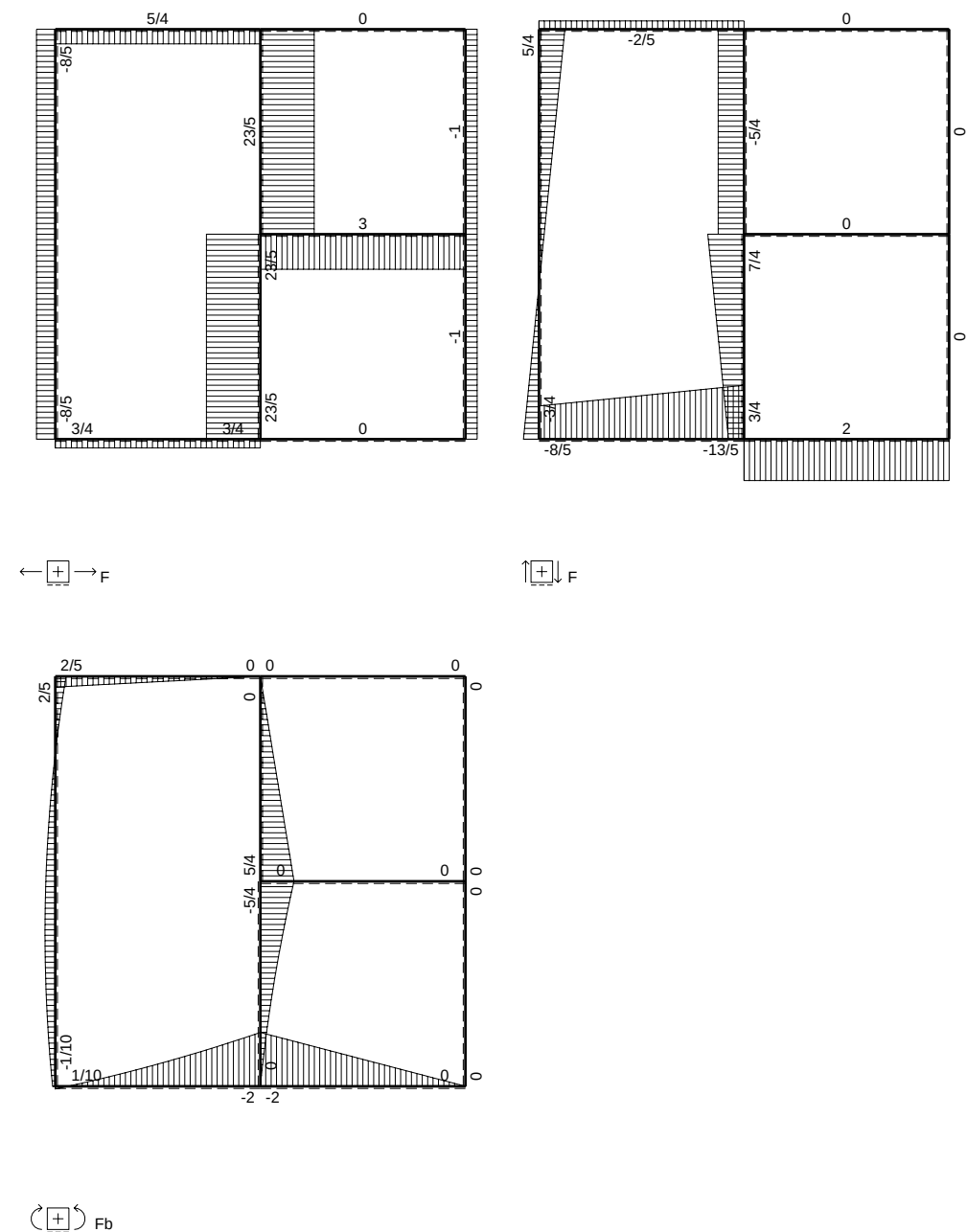
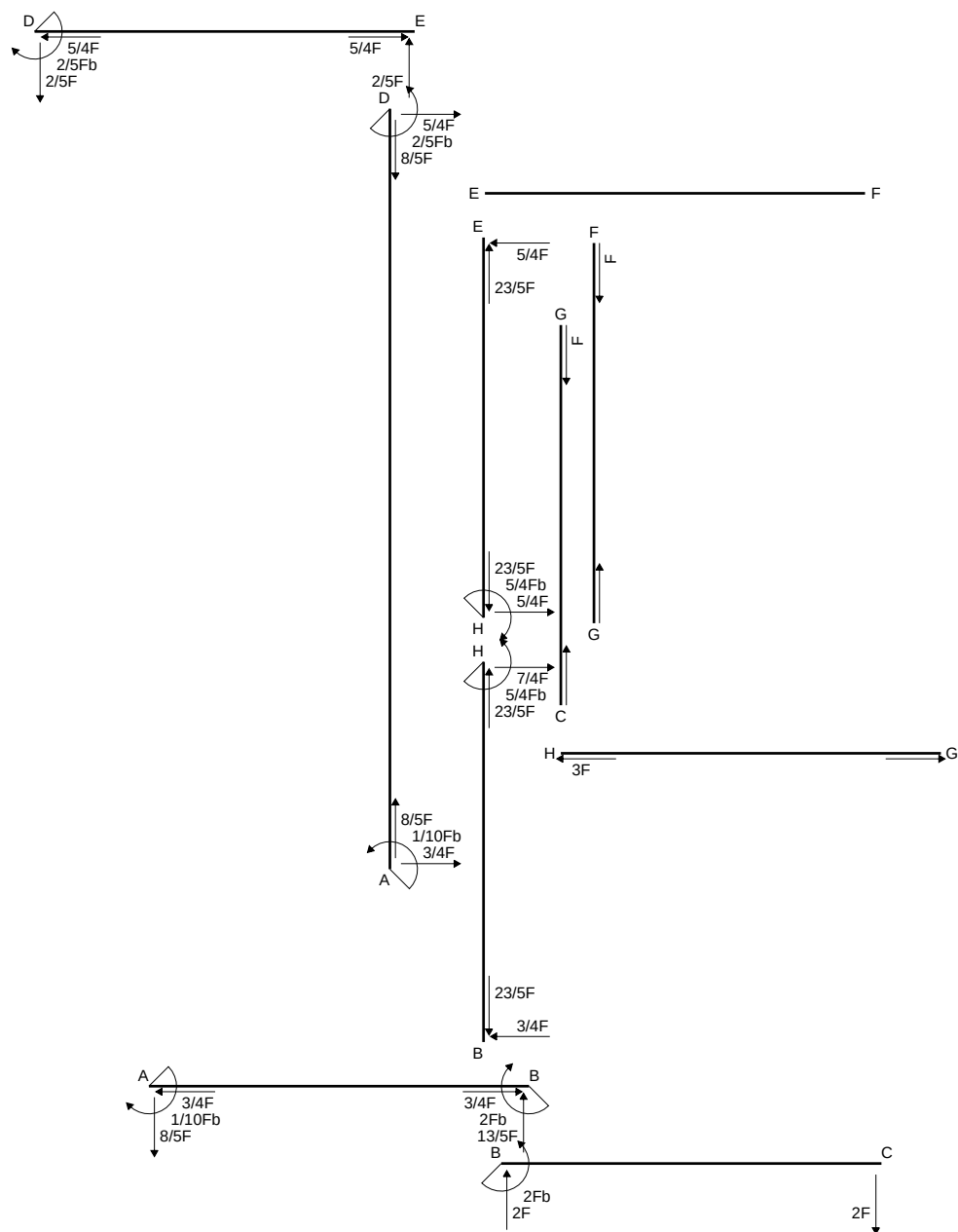
$$v_c = -26.57 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -171.1 \text{ N/mm}^2$$

$$\tau_c = 4.907 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 171.4 \text{ N/mm}^2$$

$$S = 4023. \text{ mm}^3$$

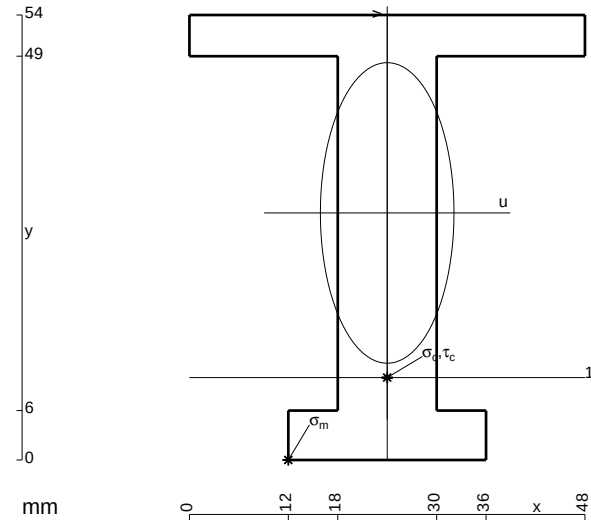


Quadro contributi PLV per iperstatica $X=W_{AB}$

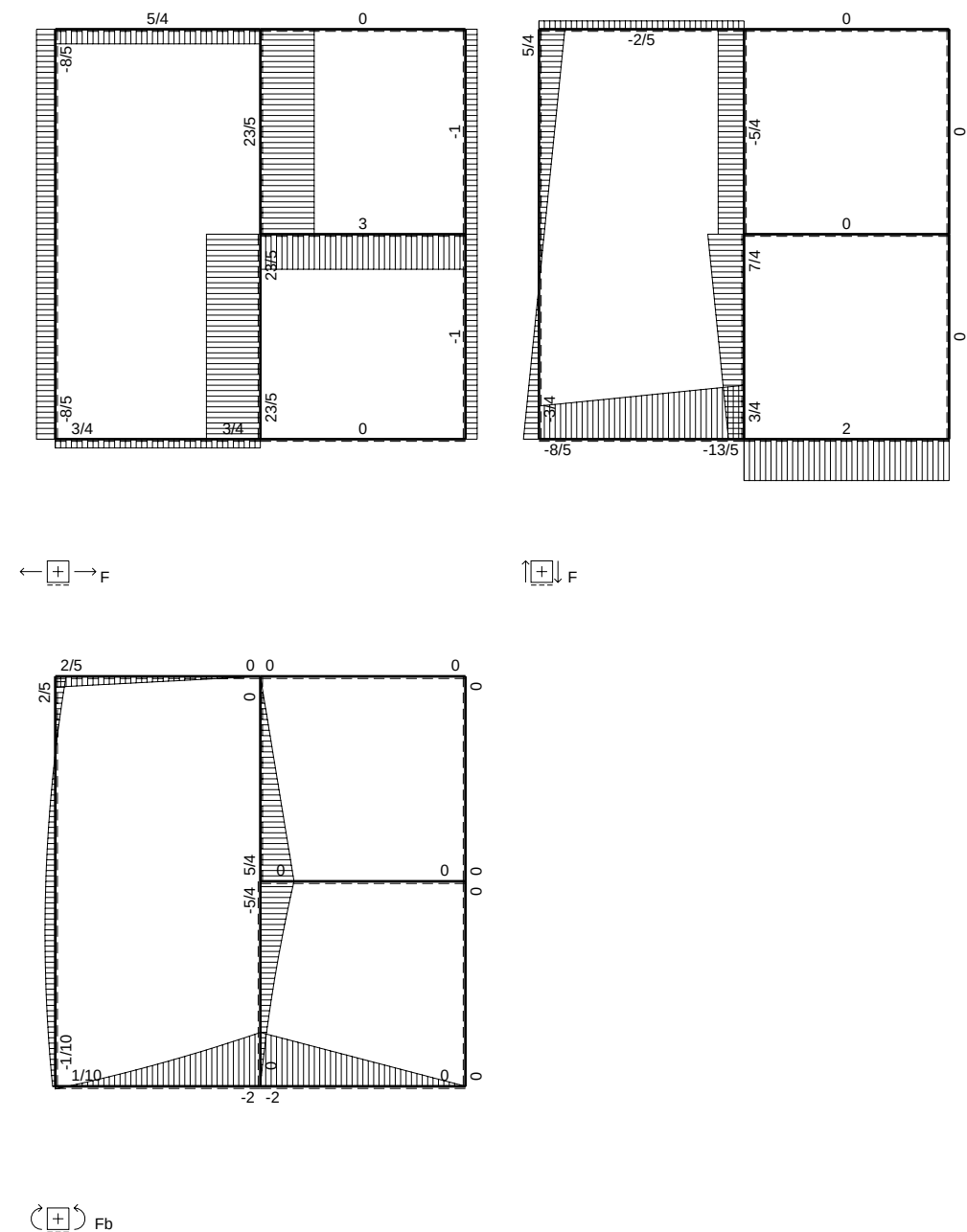
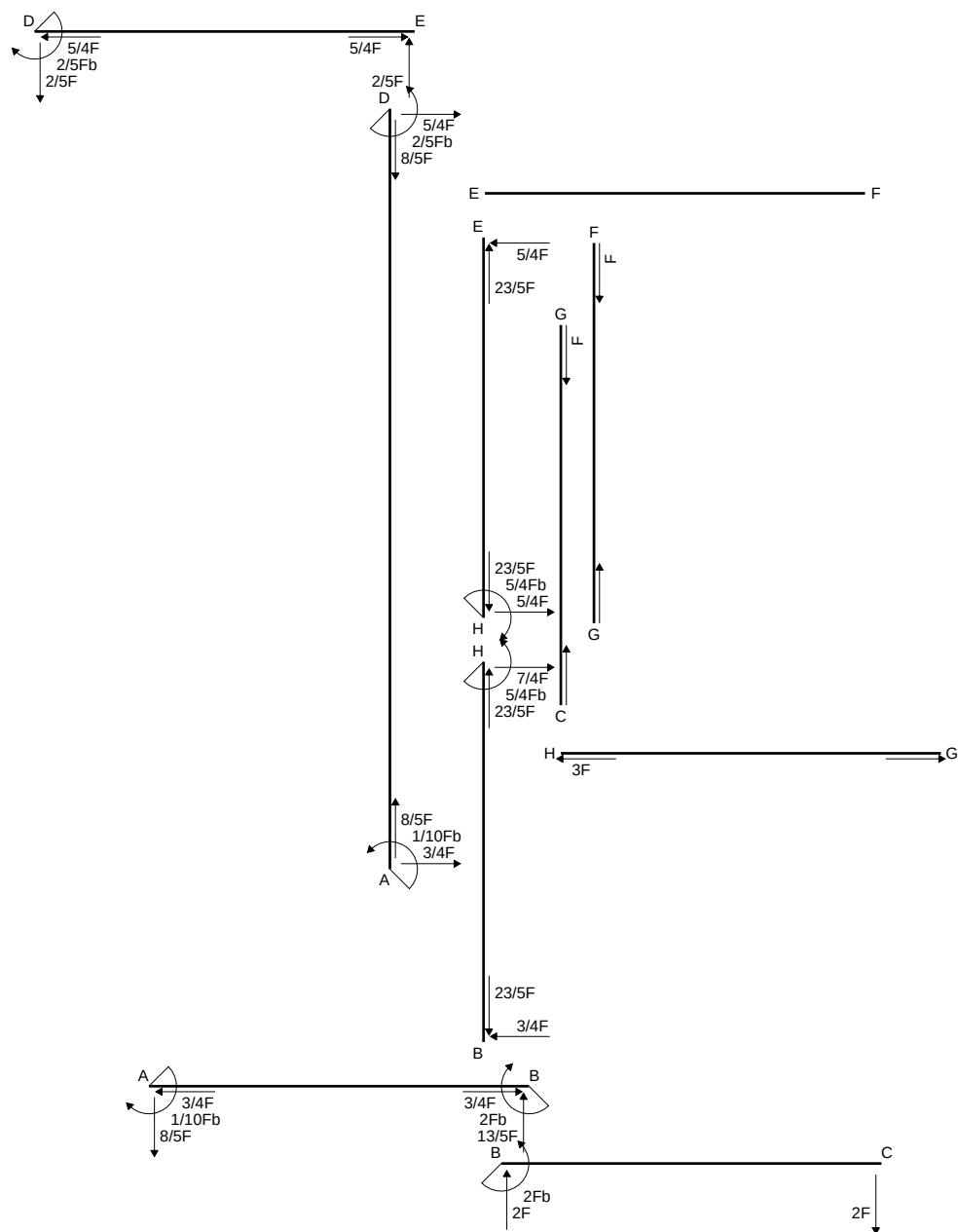
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 900. \text{ mm}^2 \\
J_u &= 299580. \text{ mm}^4 \\
J_v &= 59184. \text{ mm}^4 \\
y_g &= 29.98 \text{ mm} \\
T_y &= 2560. \text{ N} \\
M_x &= -2380800. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -29.98 \text{ mm} \\
\sigma_m &= -Mv/J_u = -238.3 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 10. \text{ mm} \\
v_c &= -19.98 \text{ mm} \\
\sigma_c &= -Mv/J_u = -158.8 \text{ N/mm}^2 \\
\tau_c &= 3.518 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 158.9 \text{ N/mm}^2 \\
S &= 4940. \text{ mm}^3
\end{aligned}$$

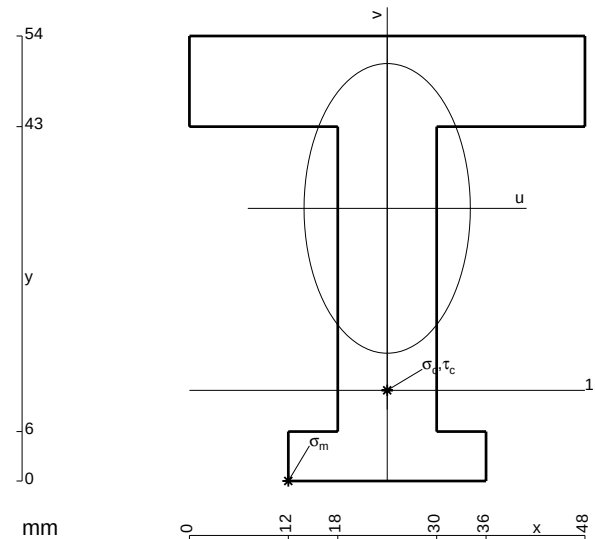


Quadro contributi PLV per iperstatica $X=W_{AB}$

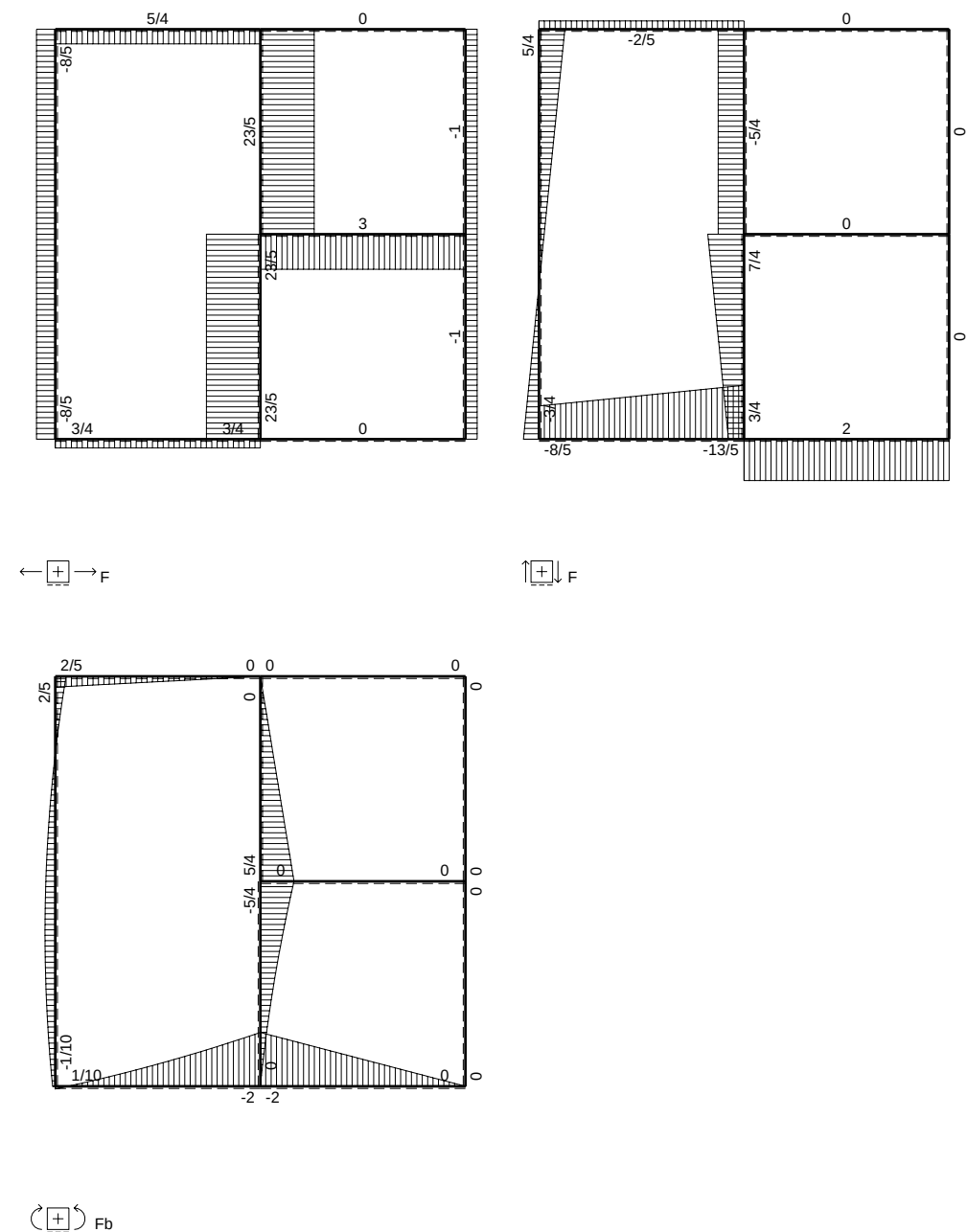
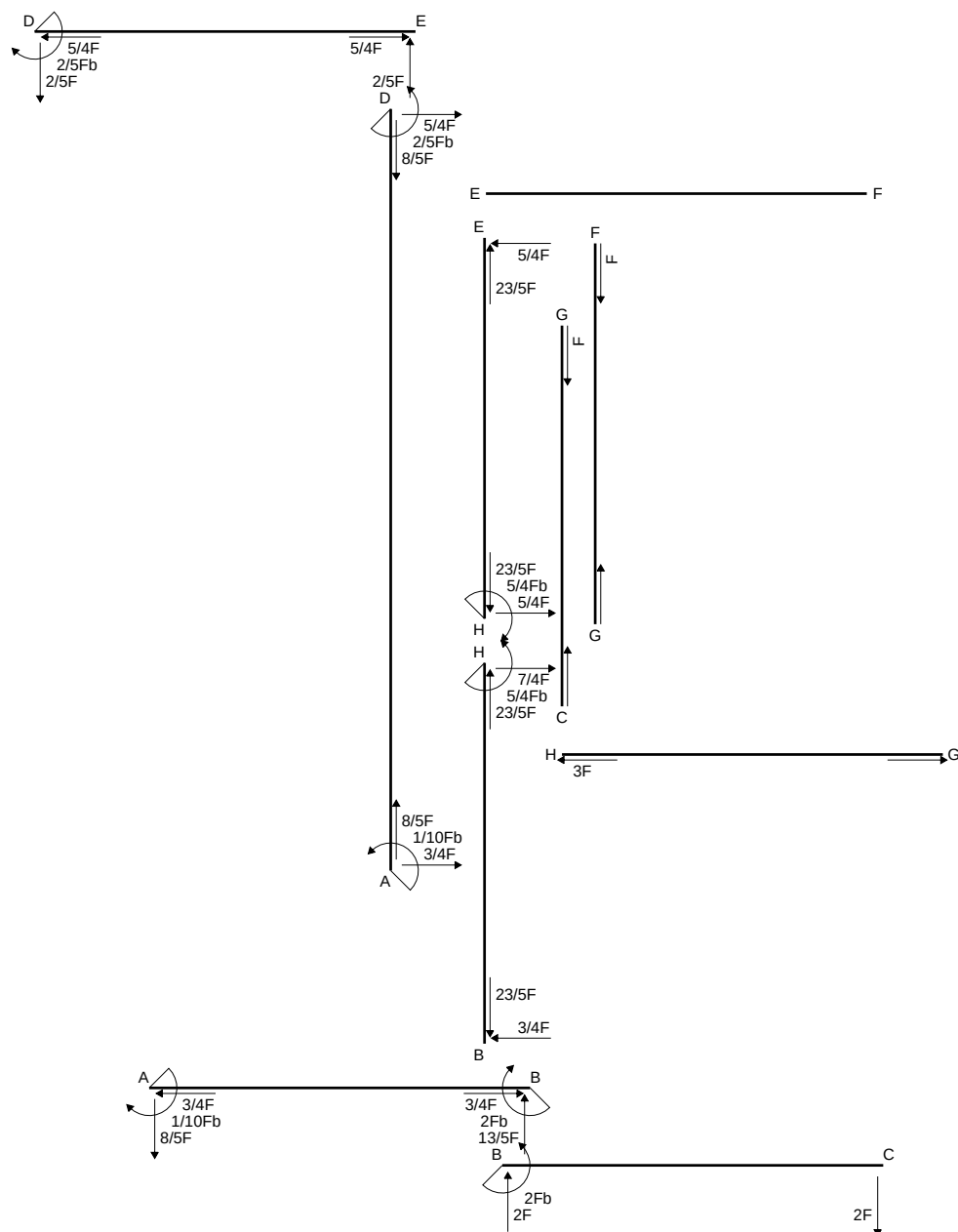
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-5/4Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

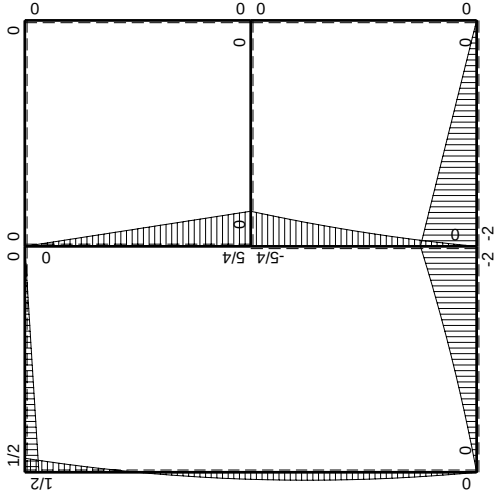
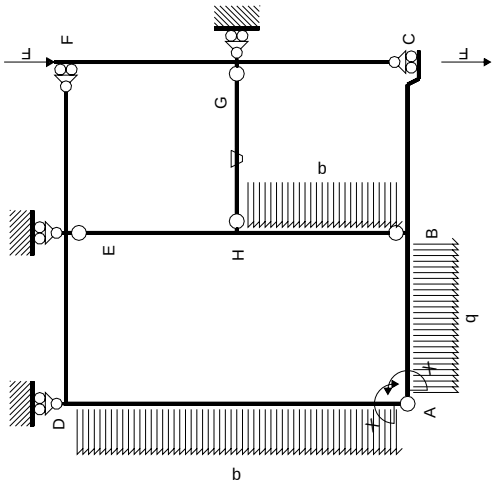
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



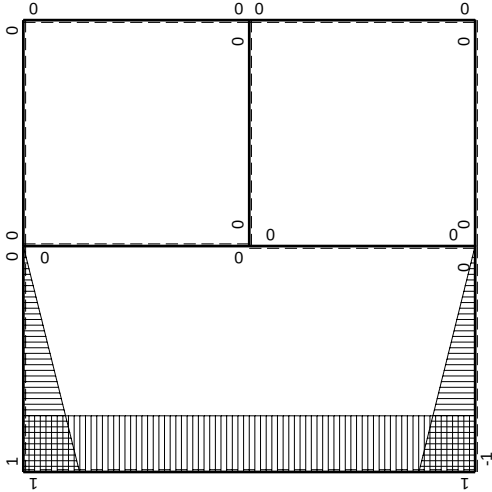
$$\begin{aligned}
A &= 1116. \text{ mm}^2 \\
J_u &= 344933. \text{ mm}^4 \\
J_v &= 113616. \text{ mm}^4 \\
y_g &= 33.08 \text{ mm} \\
T_y &= 4240. \text{ N} \\
M_x &= -2077600. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -33.08 \text{ mm} \\
\sigma_m &= -Mv/J_u = -199.3 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 11. \text{ mm} \\
v_c &= -22.08 \text{ mm} \\
\sigma_c &= -Mv/J_u = -133. \text{ N/mm}^2 \\
\tau_c &= 5.948 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 133.4 \text{ N/mm}^2 \\
S &= 5806. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



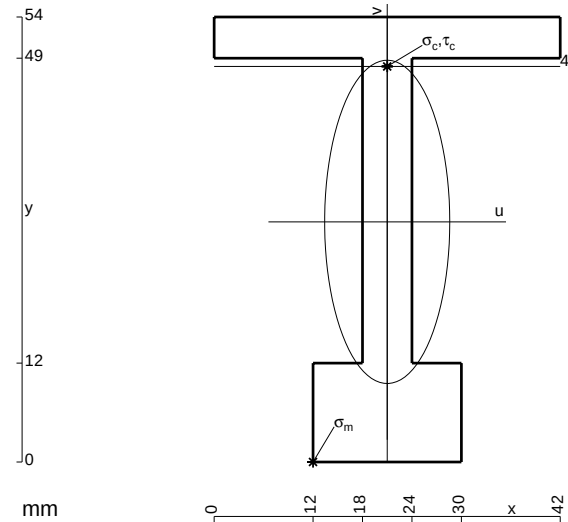
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

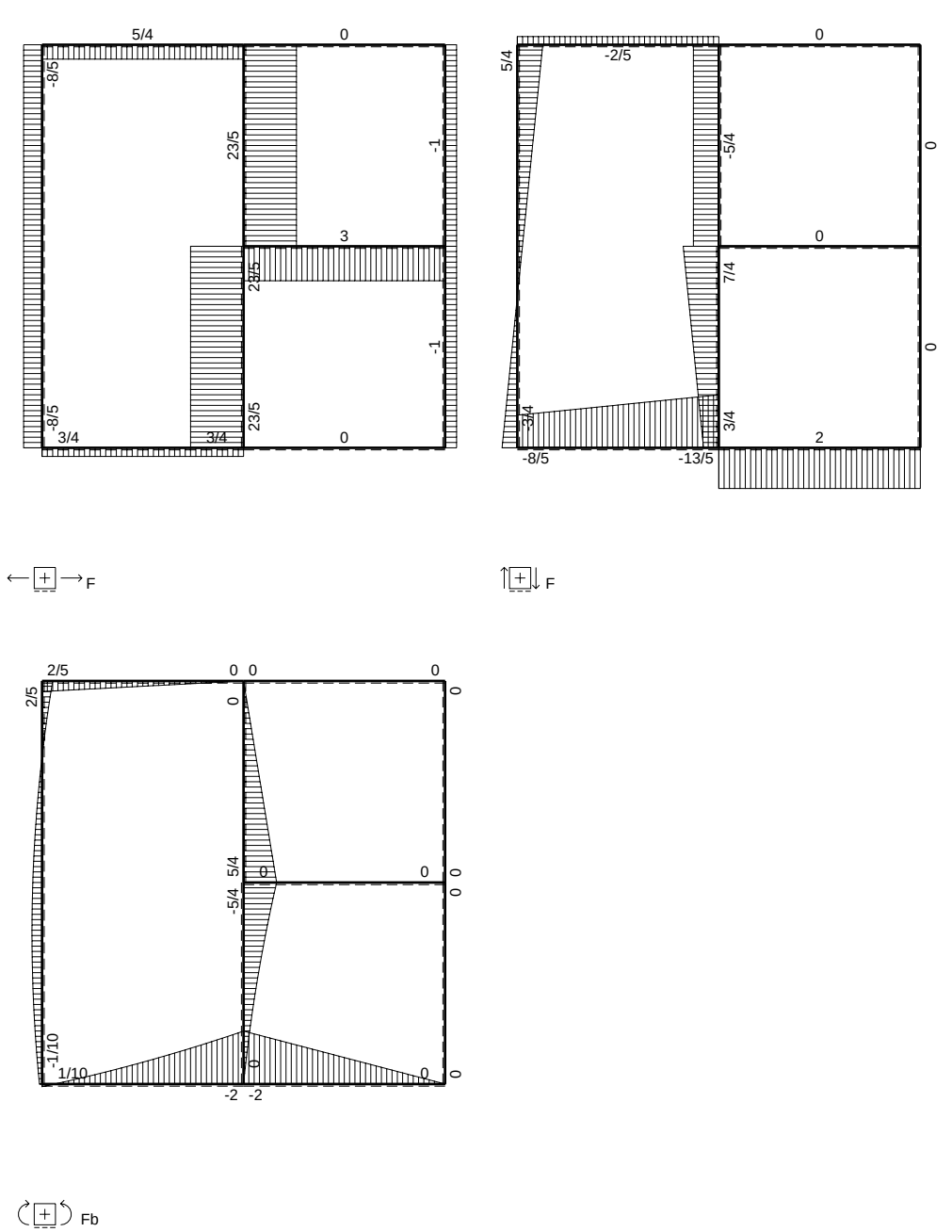
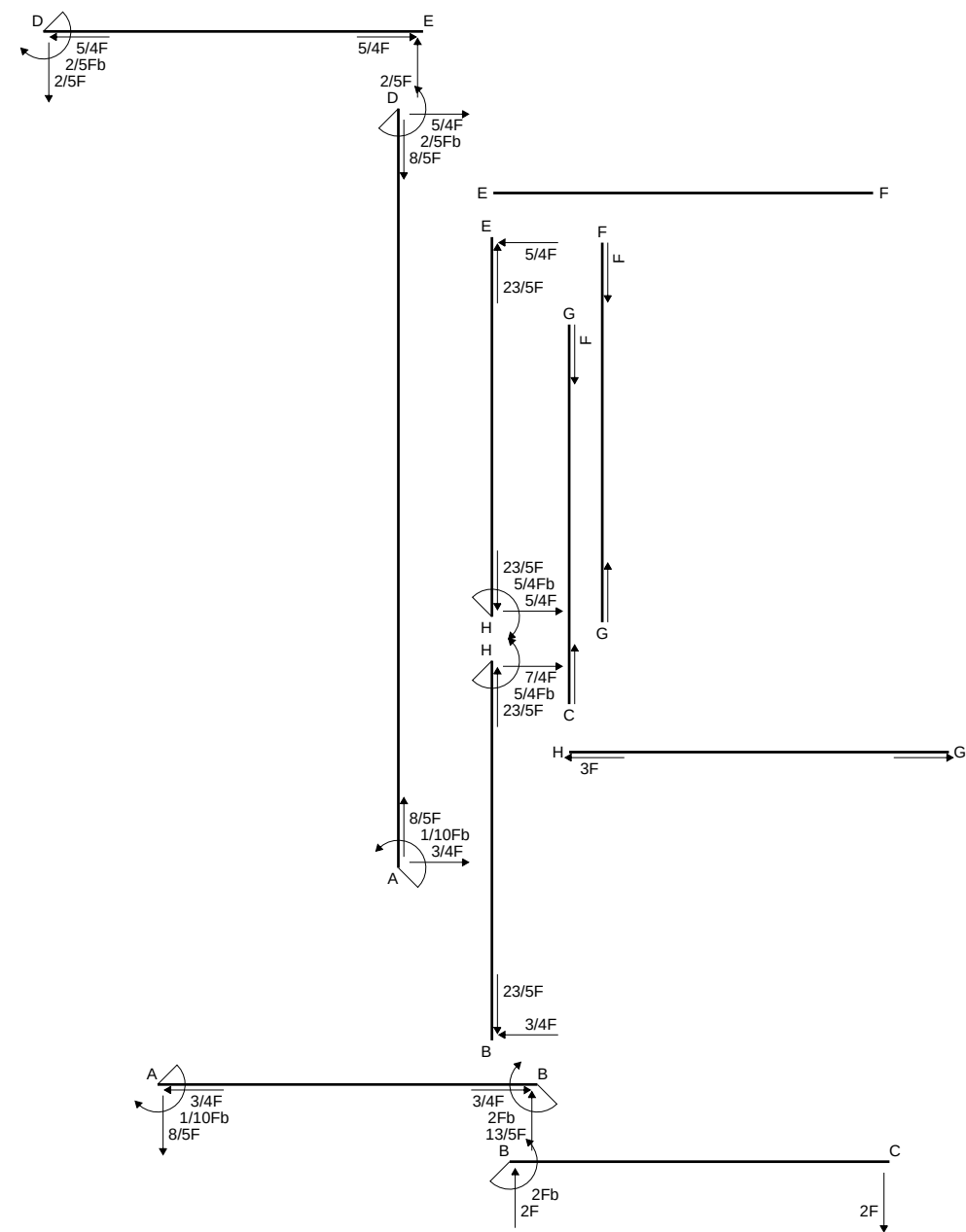
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

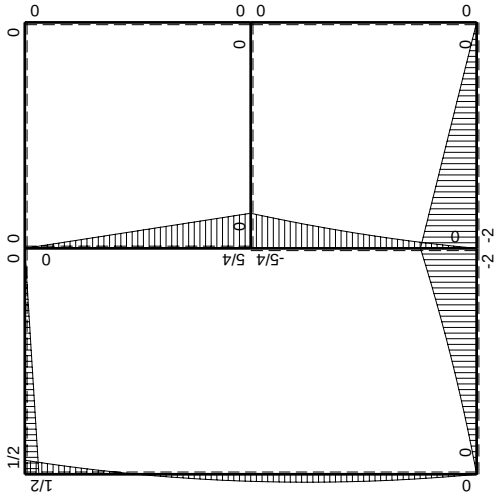
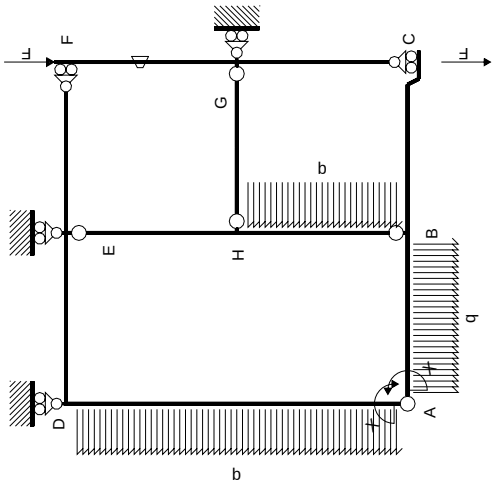
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



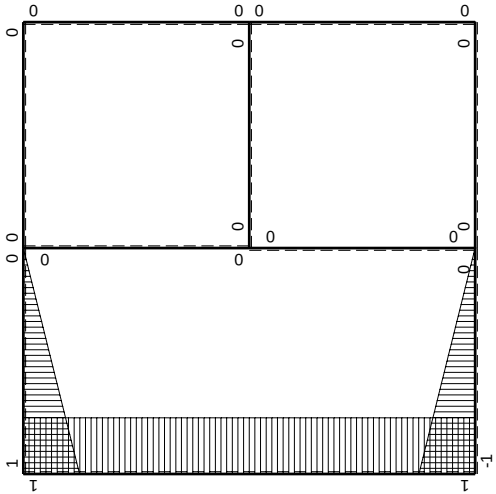
$$\begin{aligned}
A &= 648. \text{ mm}^2 \\
J_u &= 249419. \text{ mm}^4 \\
J_v &= 37368. \text{ mm}^4 \\
y_g &= 29.14 \text{ mm} \\
T_y &= 3380. \text{ N} \\
M_x &= -1791400. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -29.14 \text{ mm} \\
\sigma_m &= -Mv/J_u = -209.3 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 48. \text{ mm} \\
v_c &= 18.86 \text{ mm} \\
\sigma_c &= -Mv/J_u = 135.5 \text{ N/mm}^2 \\
\tau_c &= 10.87 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 136.8 \text{ N/mm}^2 \\
S &= 4812. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_k flessione da carichi assegnati



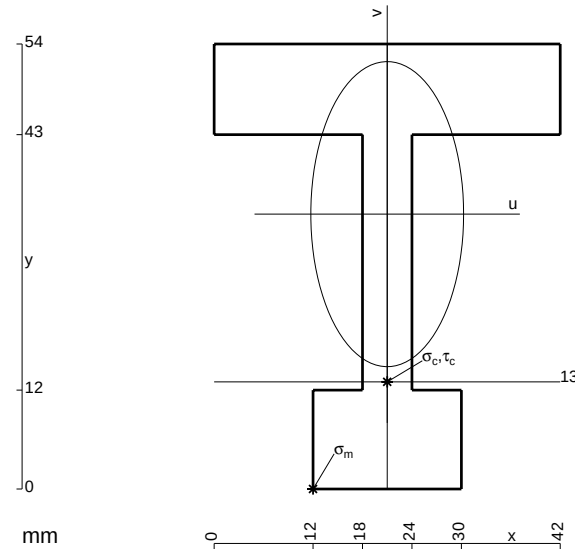
M_k flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

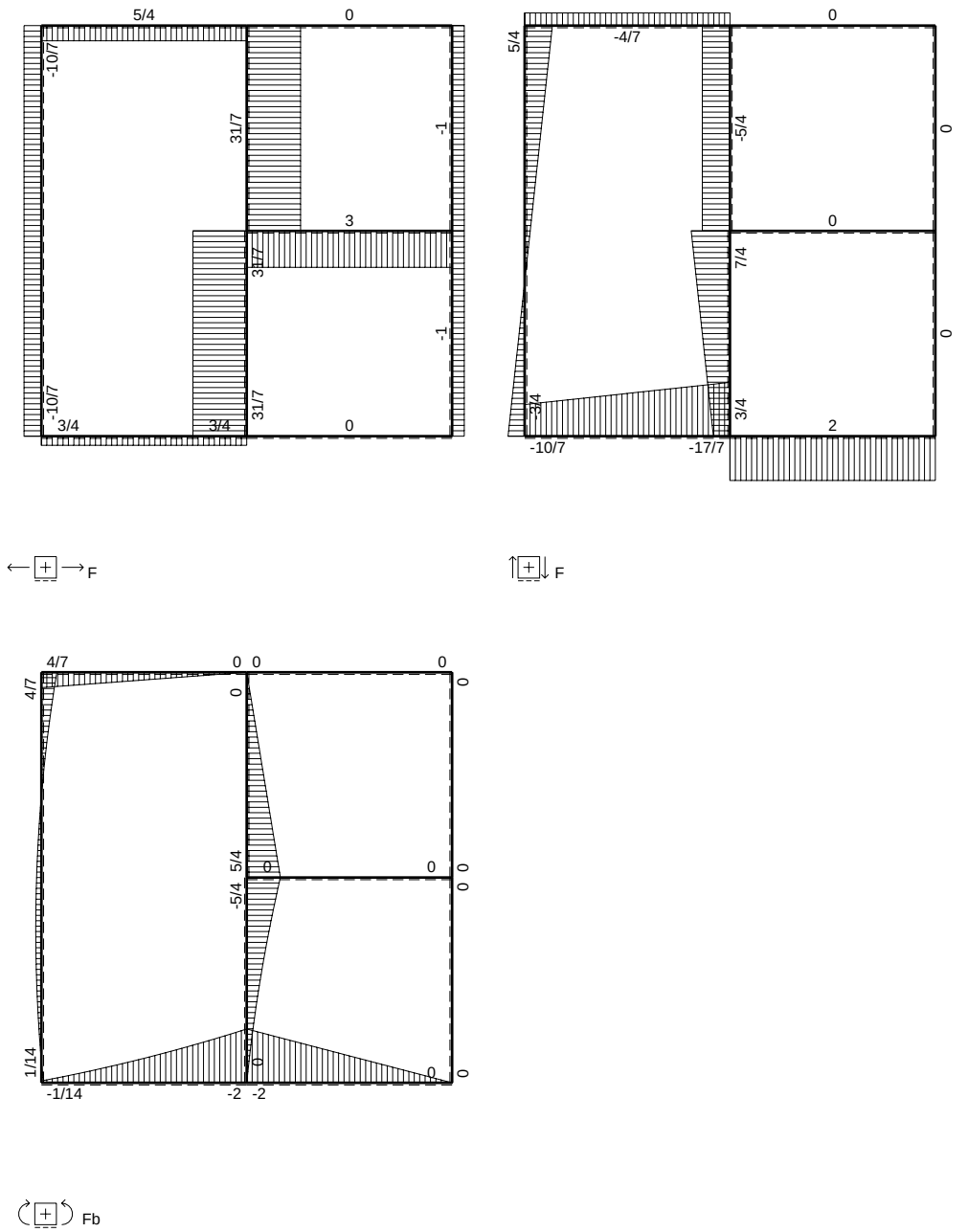
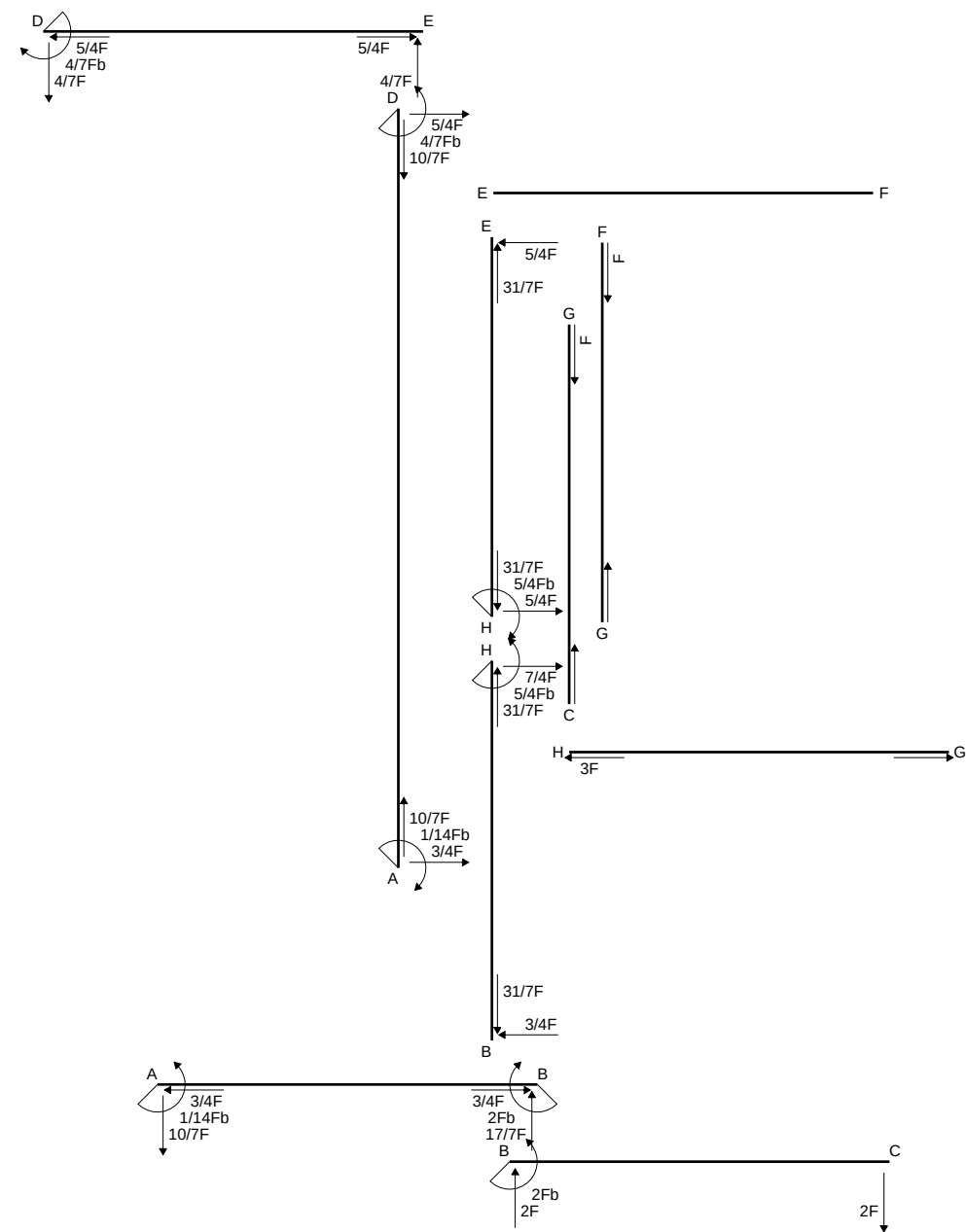
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

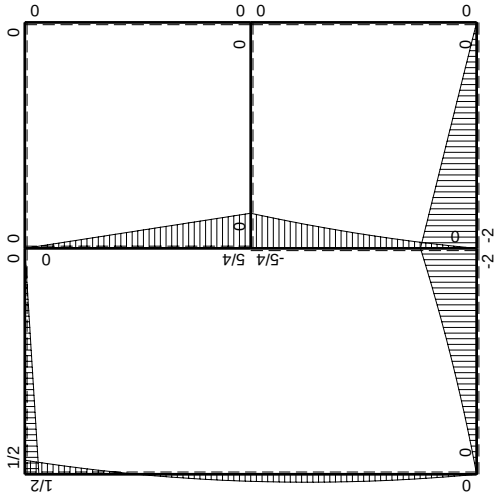
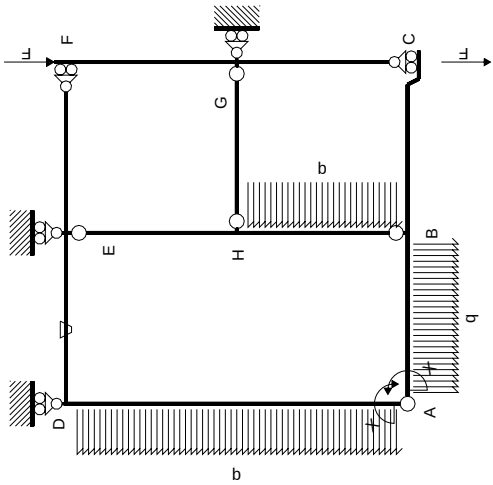
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



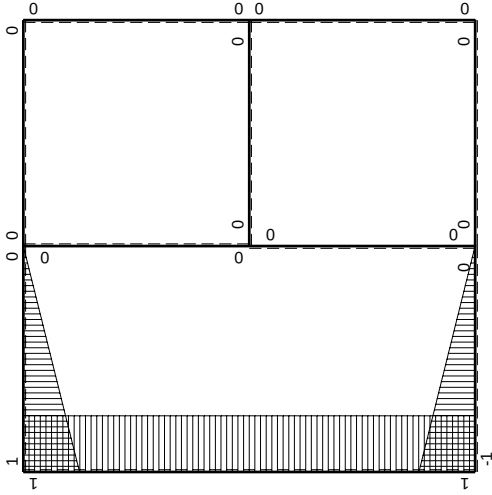
$$\begin{aligned}
A &= 864. \text{ mm}^2 \\
J_u &= 296124. \text{ mm}^4 \\
J_v &= 74304. \text{ mm}^4 \\
y_g &= 33.35 \text{ mm} \\
T_y &= 3360. \text{ N} \\
M_x &= -1948800. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -33.35 \text{ mm} \\
\sigma_m &= -Mv/J_u = -219.5 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -20.35 \text{ mm} \\
\sigma_c &= -Mv/J_u = -134. \text{ N/mm}^2 \\
\tau_c &= 11.41 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 135.4 \text{ N/mm}^2 \\
S &= 6034. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$-Fb/EJ+Fx/EJ$	$1-2x/b+x^2/b^2$	$(1/6-1/2)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	Fb/EJ	$1/2Fx^2/b$	$-Fx/EJ$	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/14Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ}$$

$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{AD}^{x_0} = \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}$$

$$L_{DA}^{x_0} = \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}$$

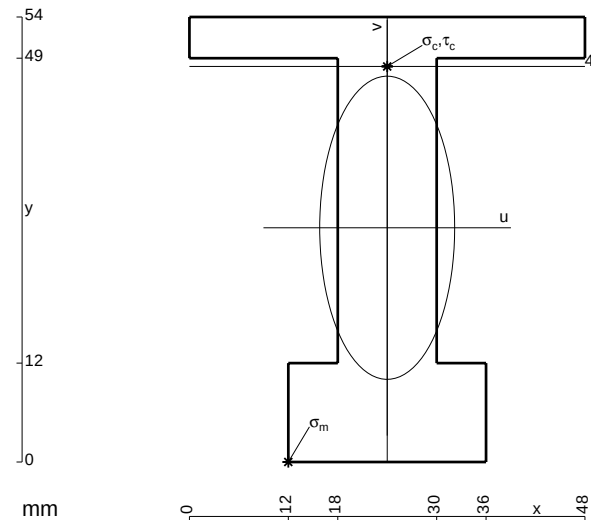
$$L_{DE}^{x_0} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1 + x/b) \theta \, dx$$

$$= \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} + \left[-x + 1/2 x^2/b \right]_0^b \theta$$

$$= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b + 1/2 b) \theta = -1/3 \frac{Fb^2}{EJ}$$

$$L_{ED}^{x_0} = \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (x/b) \theta \, dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} + \left[1/2 x^2/b \right]_0^b \theta$$

$$= (1/6 b) Fb \frac{1}{EJ} + (1/2 b) \theta = -1/3 \frac{Fb^2}{EJ}$$



$$A = 972. \text{ mm}^2$$

$$J_u = 329140. \text{ mm}^4$$

$$J_v = 65232. \text{ mm}^4$$

$$y_g = 28.43 \text{ mm}$$

$$T_y = 4220. \text{ N}$$

$$M_x = -2658600. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -28.43 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -229.6 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 48. \text{ mm}$$

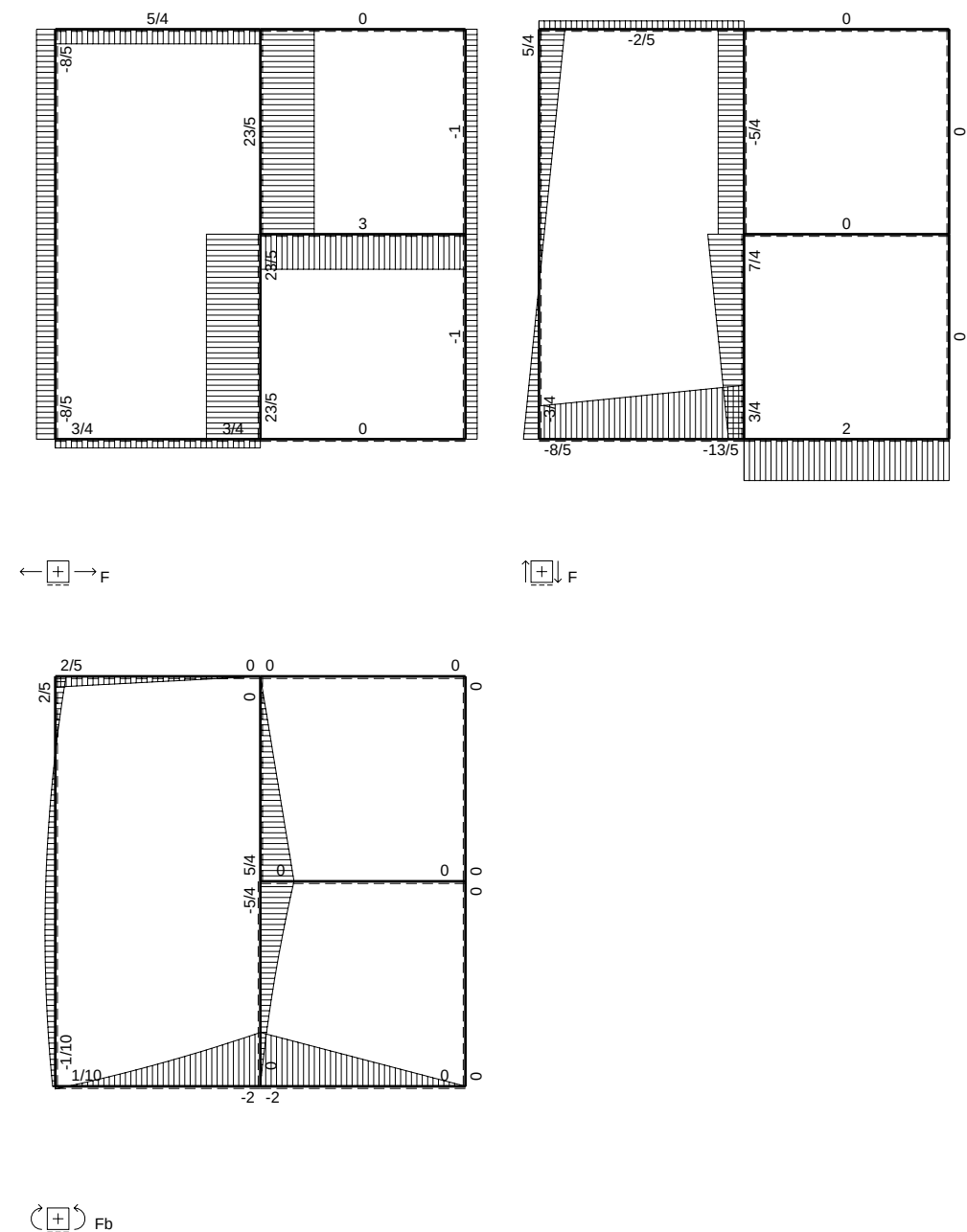
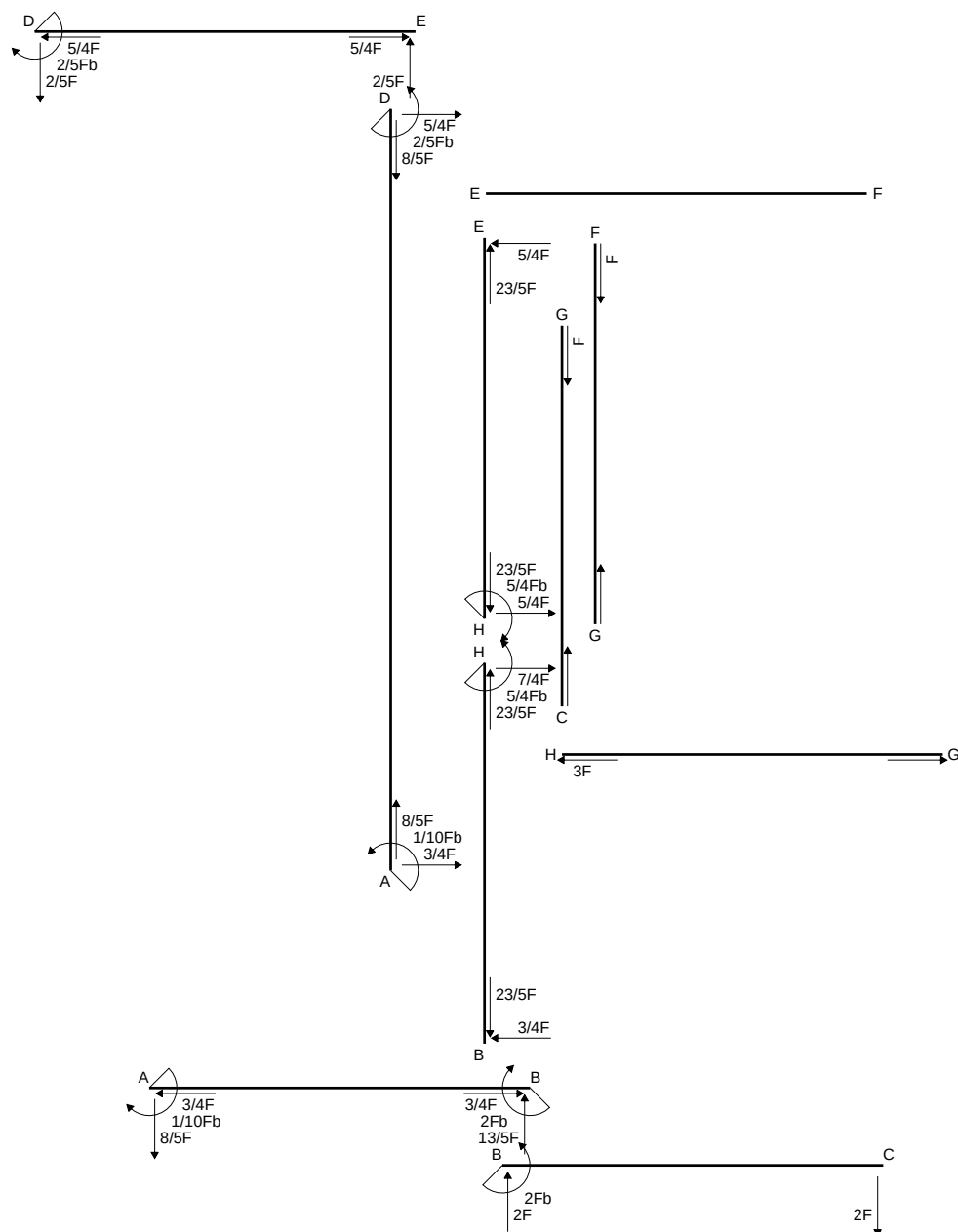
$$v_c = 19.57 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 158.1 \text{ N/mm}^2$$

$$\tau_c = 6.174 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 158.5 \text{ N/mm}^2$$

$$S = 5779. \text{ mm}^3$$

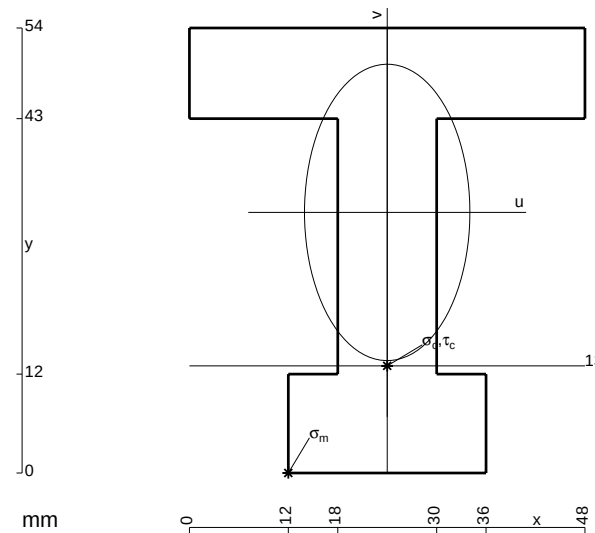


Quadro contributi PLV per iperstatica $X=W_{AB}$

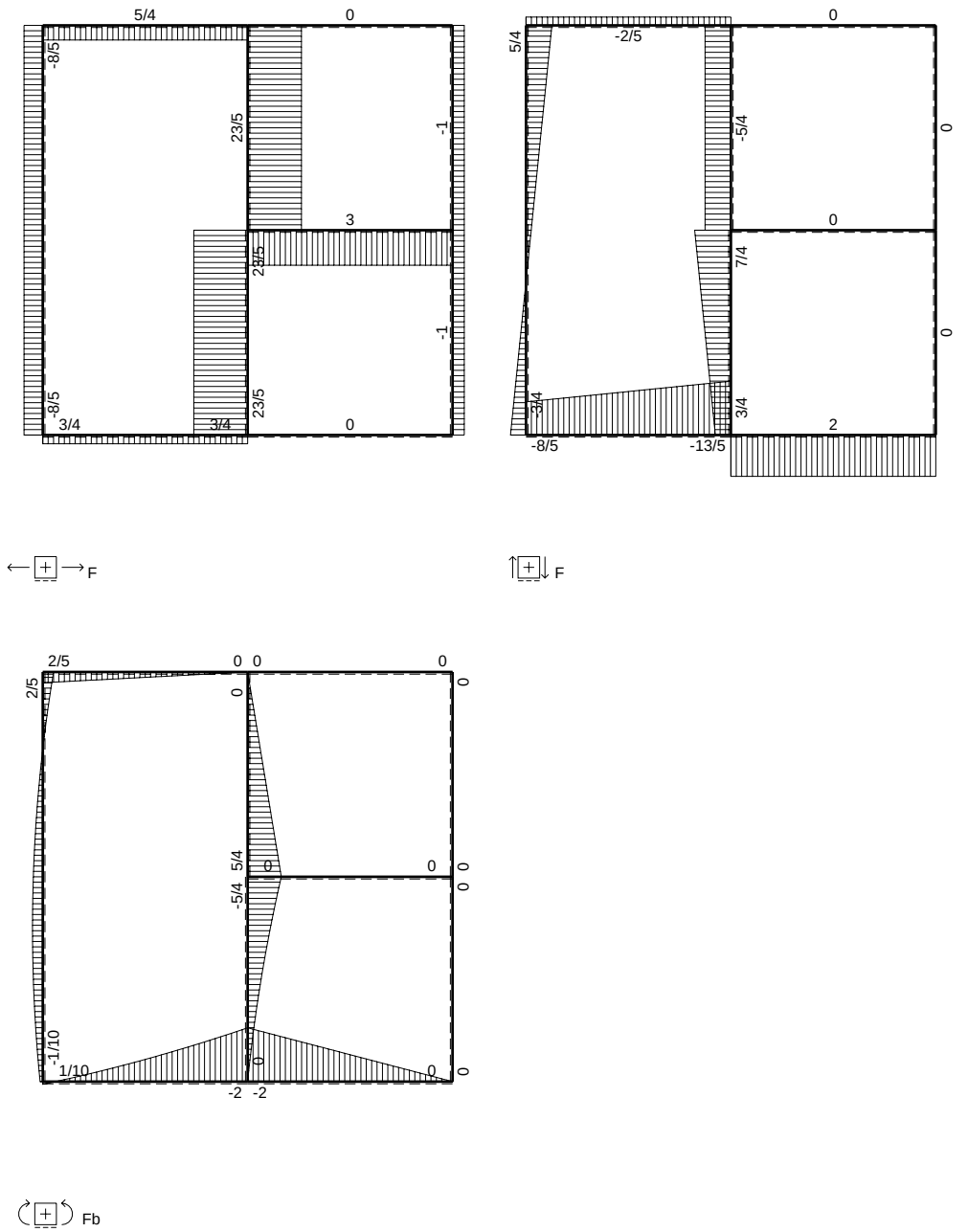
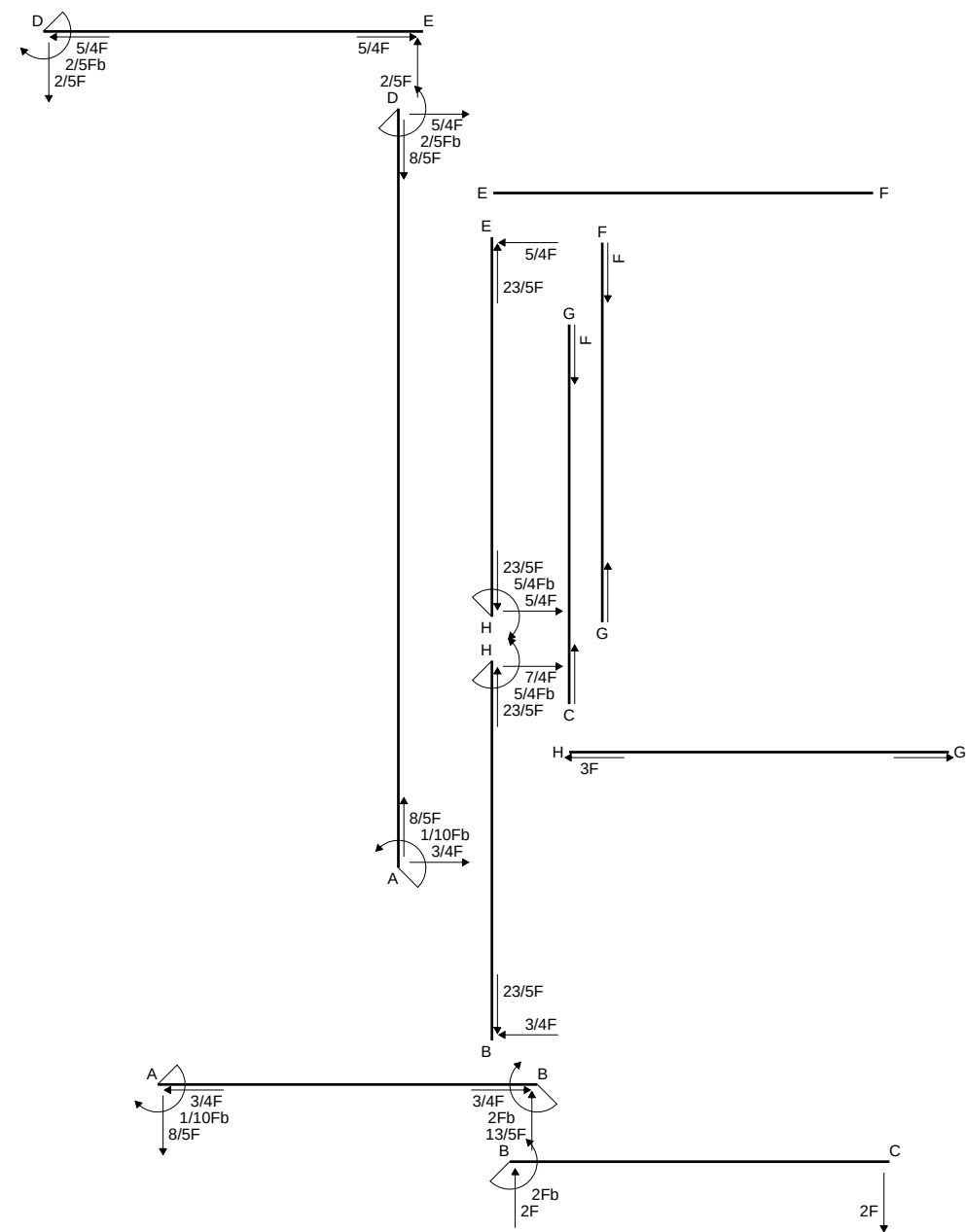
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	Fb/EJ	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

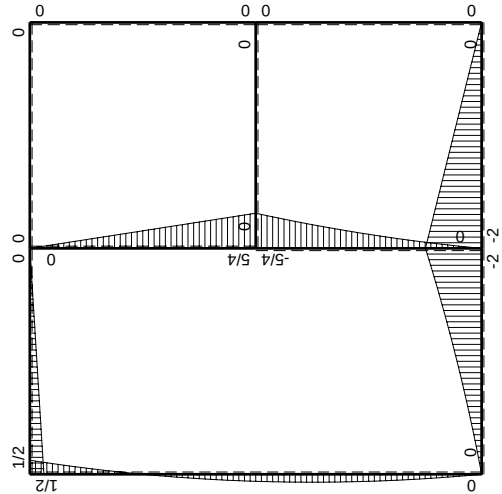
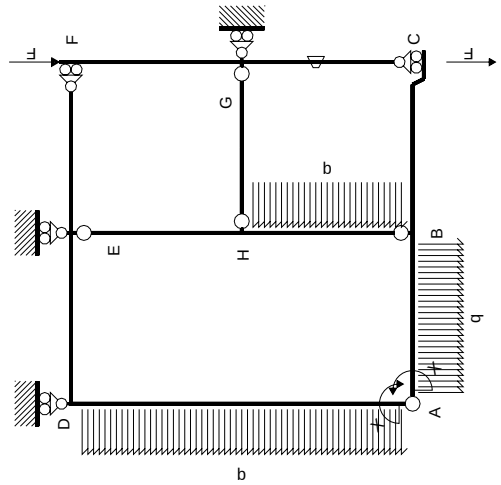
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



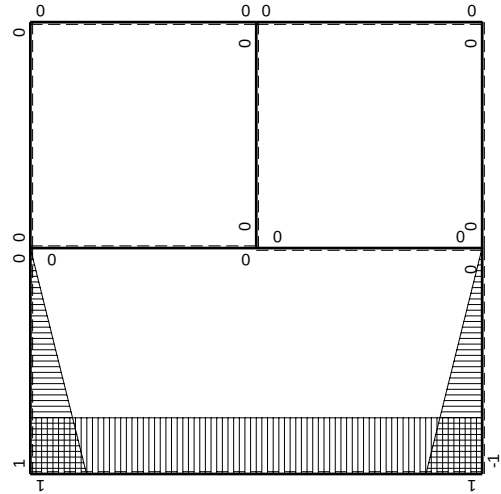
$$\begin{aligned}
A &= 1188. \text{ mm}^2 \\
J_u &= 384370. \text{ mm}^4 \\
J_v &= 119664. \text{ mm}^4 \\
y_g &= 31.62 \text{ mm} \\
T_y &= 4280. \text{ N} \\
M_x &= -2910400. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -31.62 \text{ mm} \\
\sigma_m &= -Mv/J_u = -239.4 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -18.62 \text{ mm} \\
\sigma_c &= -Mv/J_u = -141. \text{ N/mm}^2 \\
\tau_c &= 7.06 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 141.5 \text{ N/mm}^2 \\
S &= 7608. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_k flessione da carichi assegnati



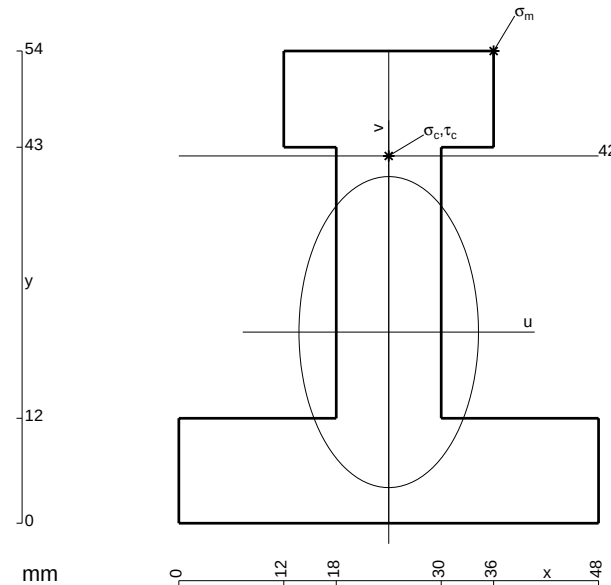
M_k flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

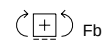
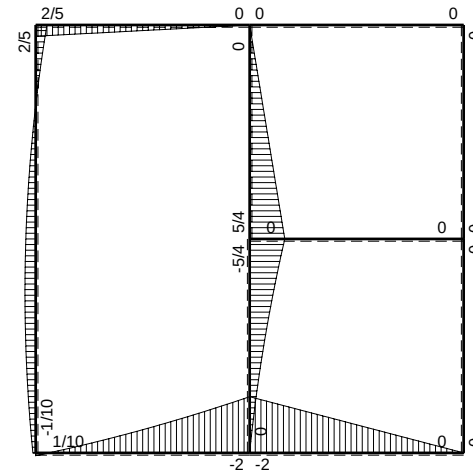
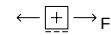
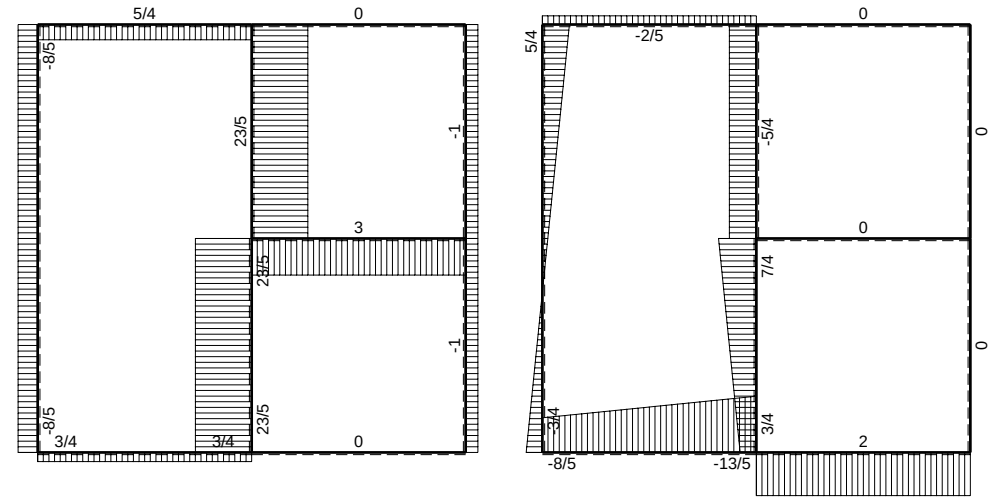
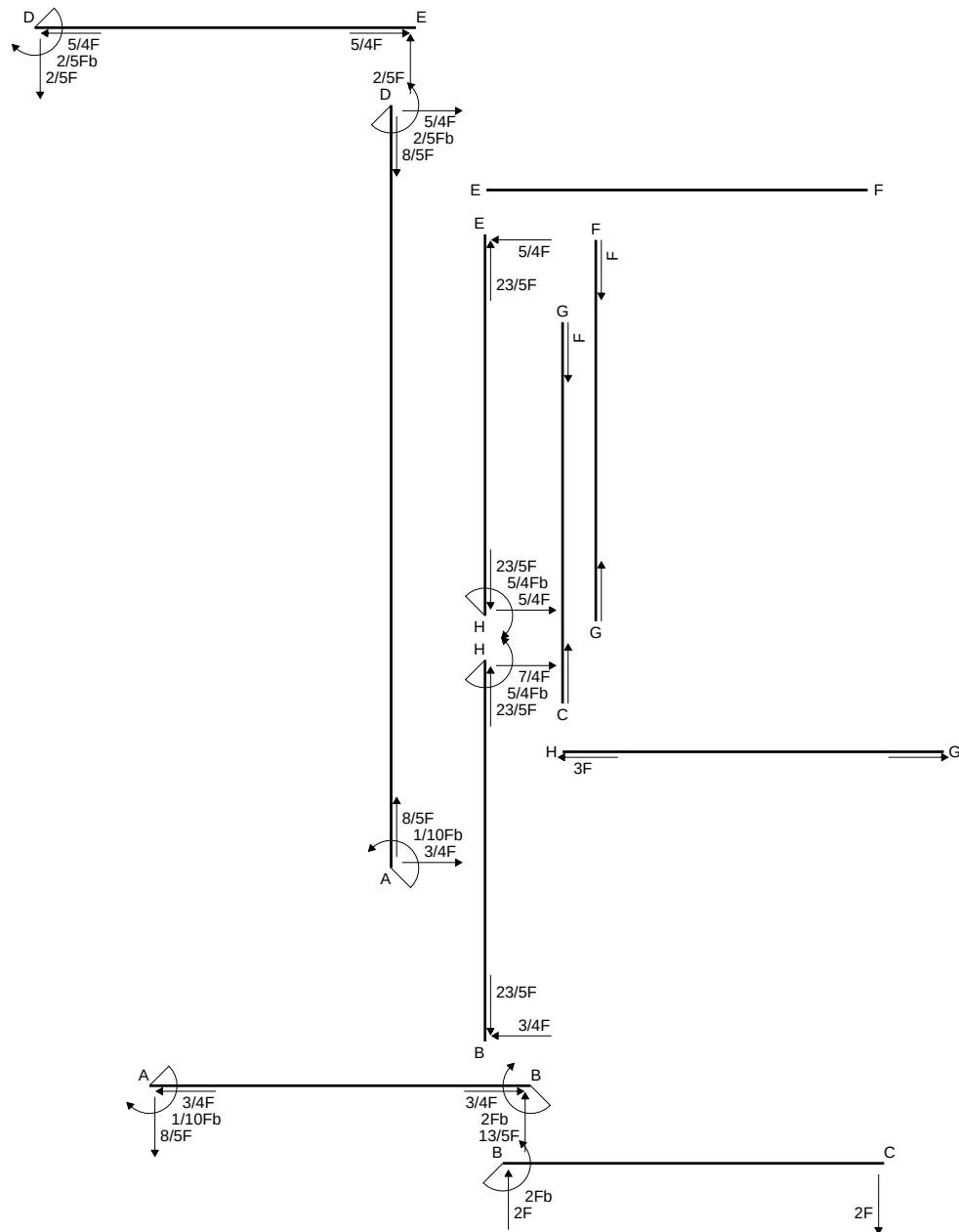
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

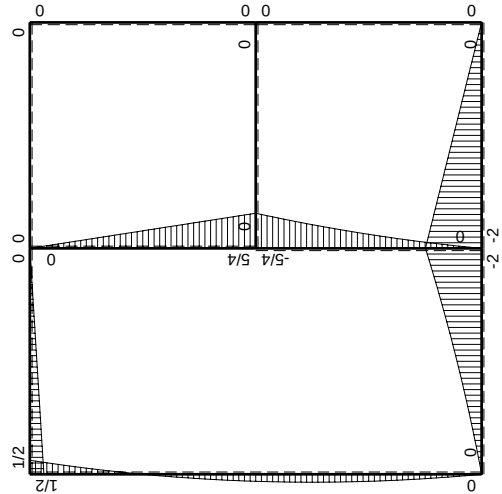
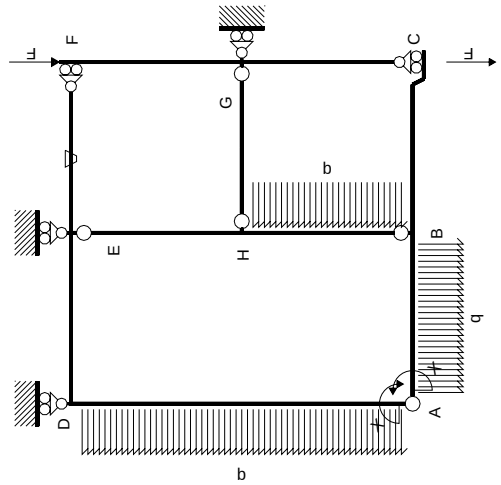
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



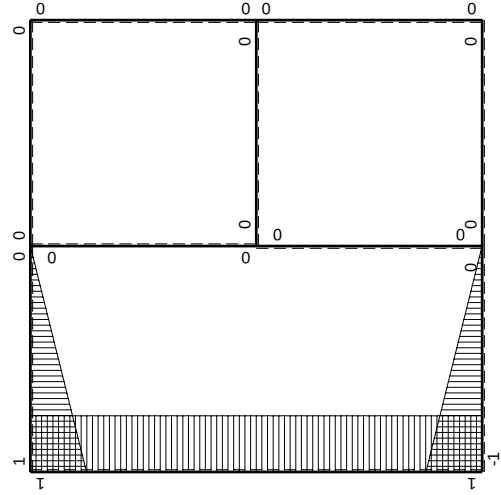
$$\begin{aligned}
A &= 1212. \text{ mm}^2 \\
J_u &= 383443. \text{ mm}^4 \\
J_v &= 127728. \text{ mm}^4 \\
y_g &= 21.86 \text{ mm} \\
T_y &= 3260. \text{ N} \\
M_x &= -2379800. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 32.14 \text{ mm} \\
\sigma_m &= -Mv/J_u = 199.5 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 42. \text{ mm} \\
v_c &= 20.14 \text{ mm} \\
\sigma_c &= -Mv/J_u = 125. \text{ N/mm}^2 \\
\tau_c &= 5.159 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 125.3 \text{ N/mm}^2 \\
S &= 7282. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



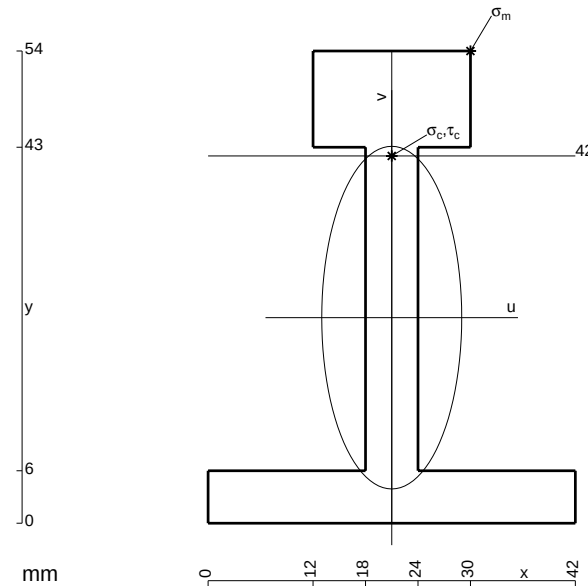
M_X flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

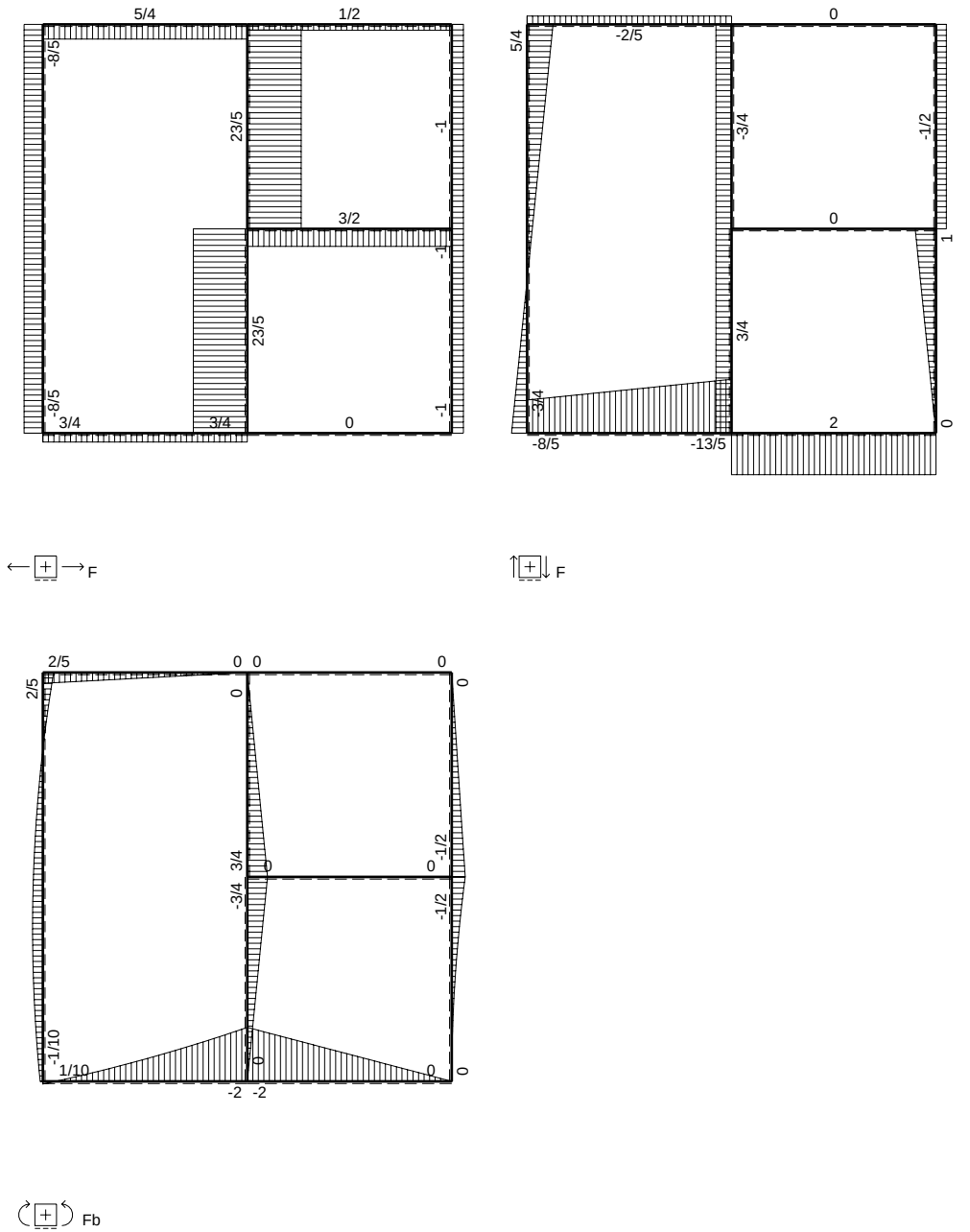
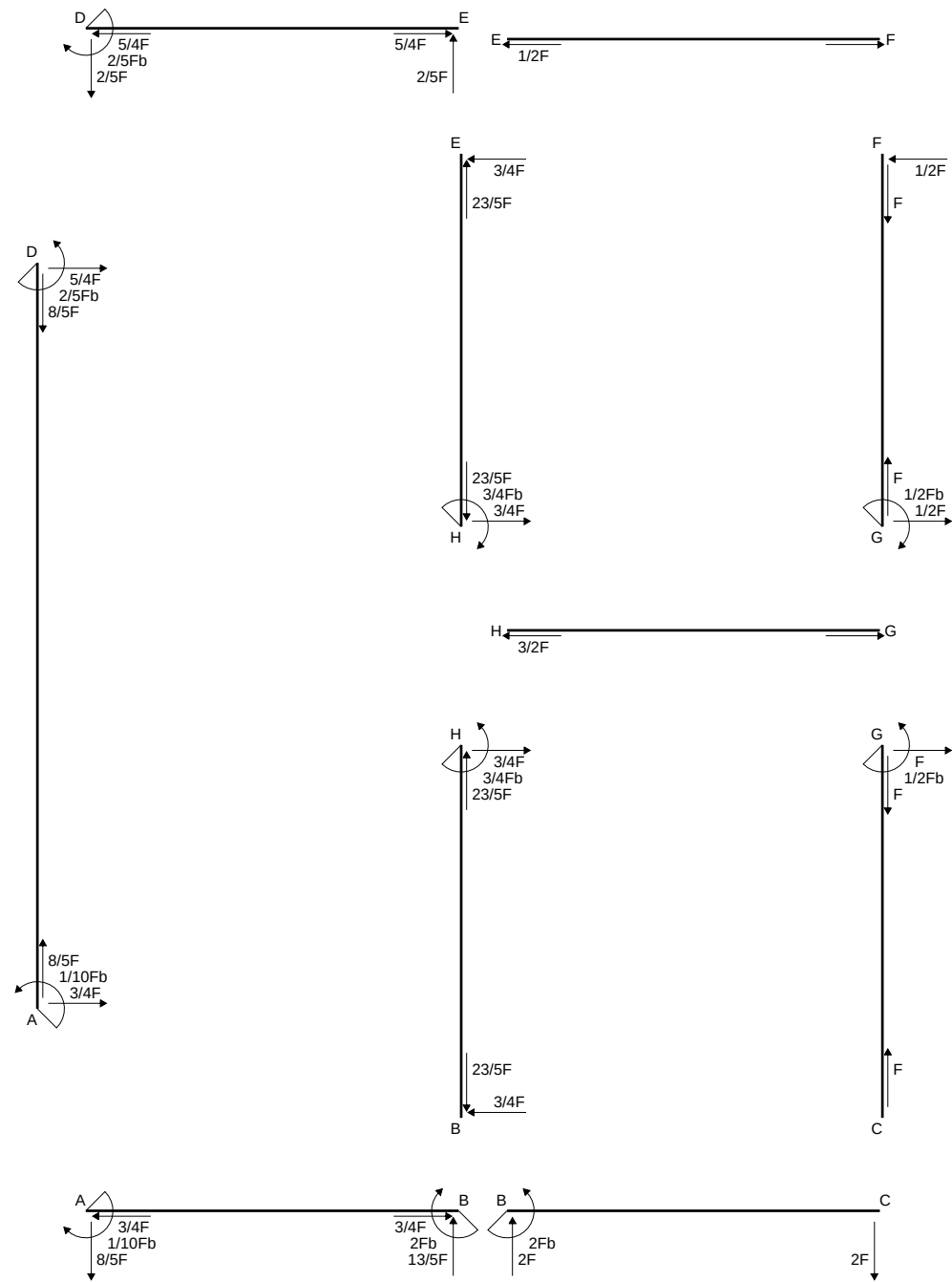
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+7/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$3/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

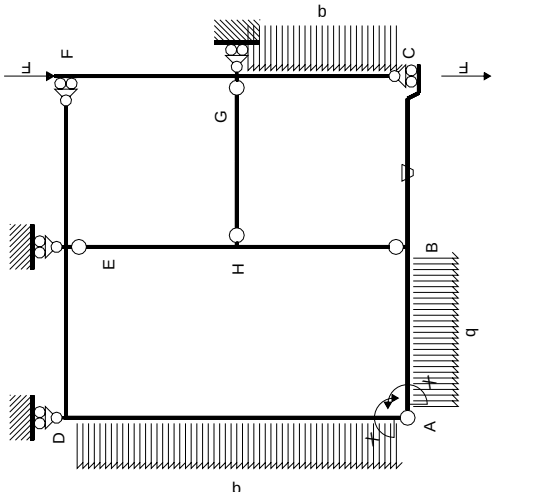
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



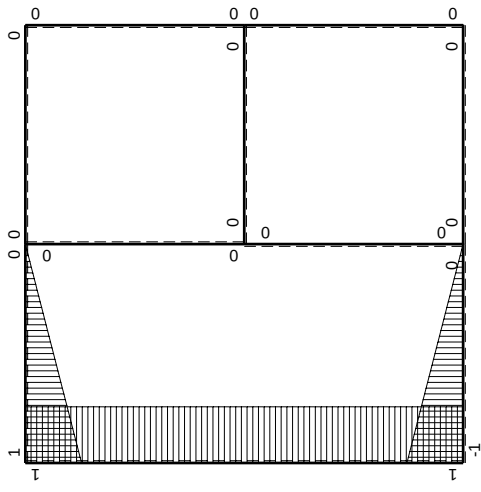
$$\begin{aligned}
A &= 672. \text{ mm}^2 \\
J_u &= 257954. \text{ mm}^4 \\
J_v &= 43056. \text{ mm}^4 \\
y_g &= 23.51 \text{ mm} \\
T_y &= 2260. \text{ N} \\
M_x &= -1762800. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 30.49 \text{ mm} \\
\sigma_m &= -Mv/J_u = 208.4 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 42. \text{ mm} \\
v_c &= 18.49 \text{ mm} \\
\sigma_c &= -Mv/J_u = 126.4 \text{ N/mm}^2 \\
\tau_c &= 7.392 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 127. \text{ N/mm}^2 \\
S &= 5062. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



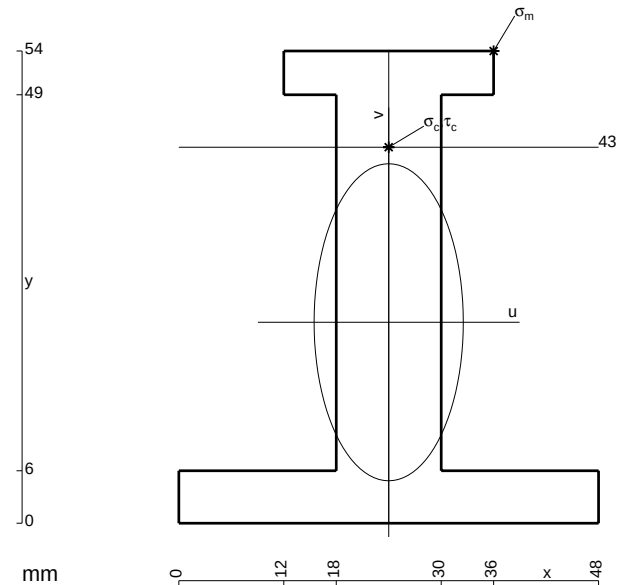
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

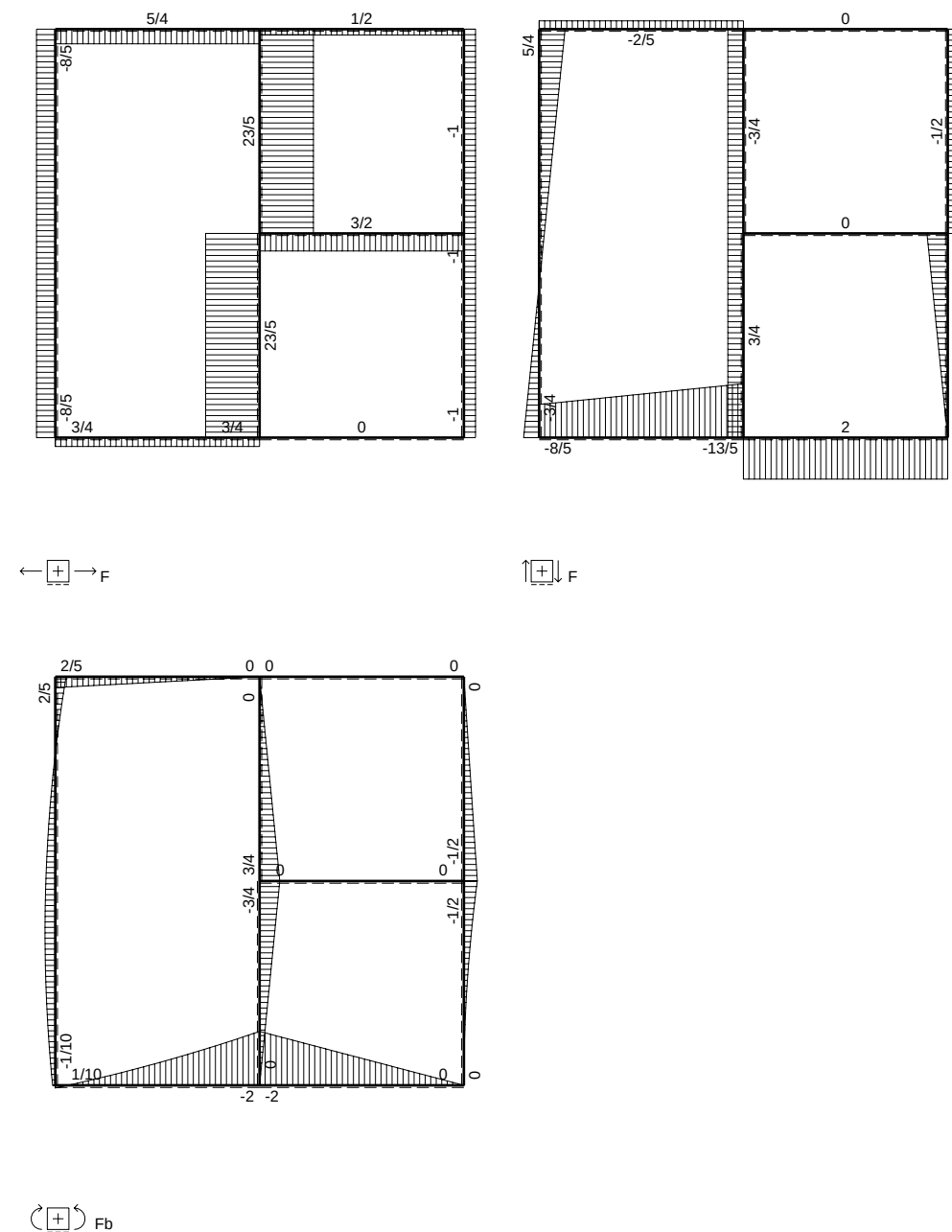
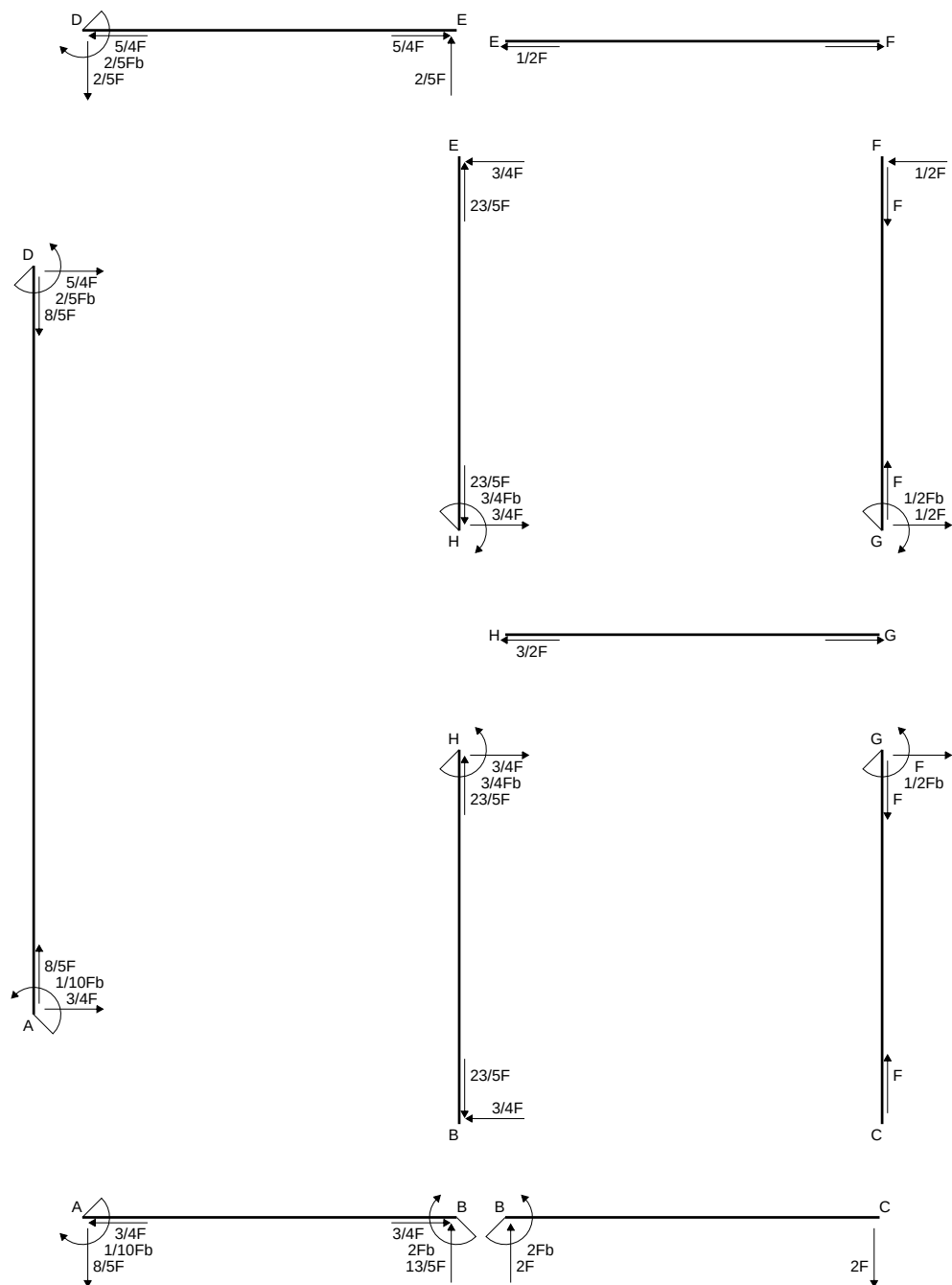
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

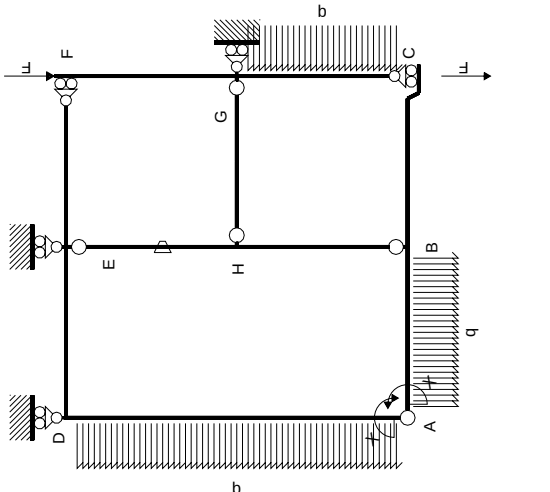
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



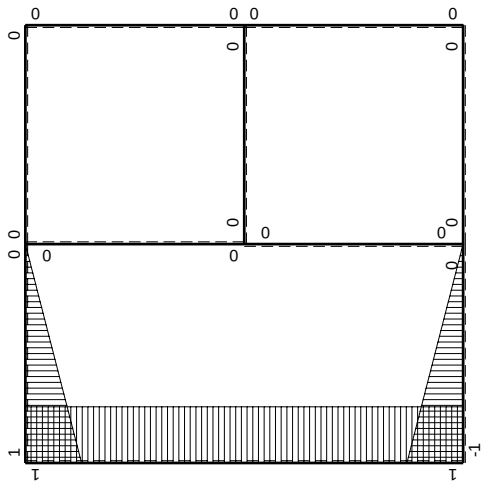
$$\begin{aligned}
A &= 924. \text{ mm}^2 \\
J_u &= 303740. \text{ mm}^4 \\
J_v &= 67248. \text{ mm}^4 \\
y_g &= 22.98 \text{ mm} \\
T_y &= 2580. \text{ N} \\
M_x &= -2141400. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 31.02 \text{ mm} \\
\sigma_m &= -Mv/J_u = 218.7 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 43. \text{ mm} \\
v_c &= 20.02 \text{ mm} \\
\sigma_c &= -Mv/J_u = 141.1 \text{ N/mm}^2 \\
\tau_c &= 3.596 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 141.3 \text{ N/mm}^2 \\
S &= 5080. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



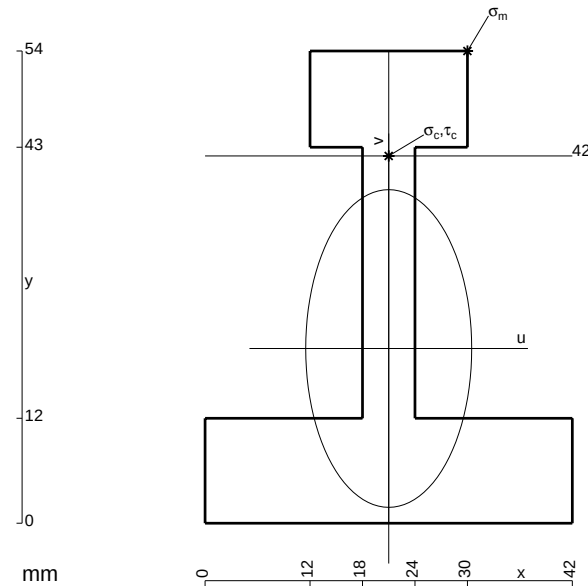
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

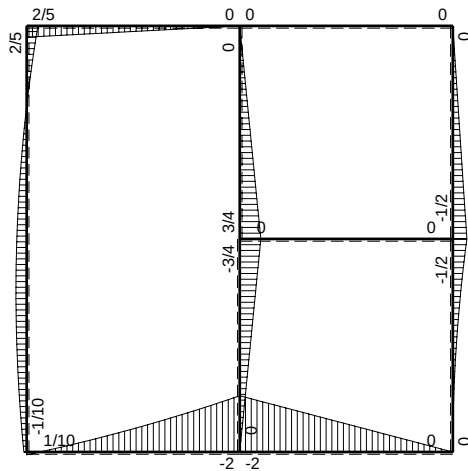
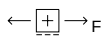
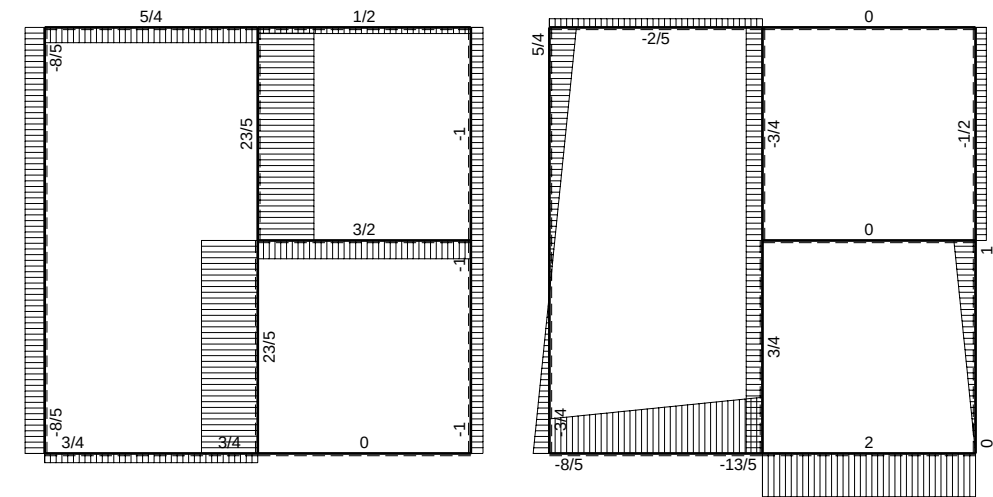
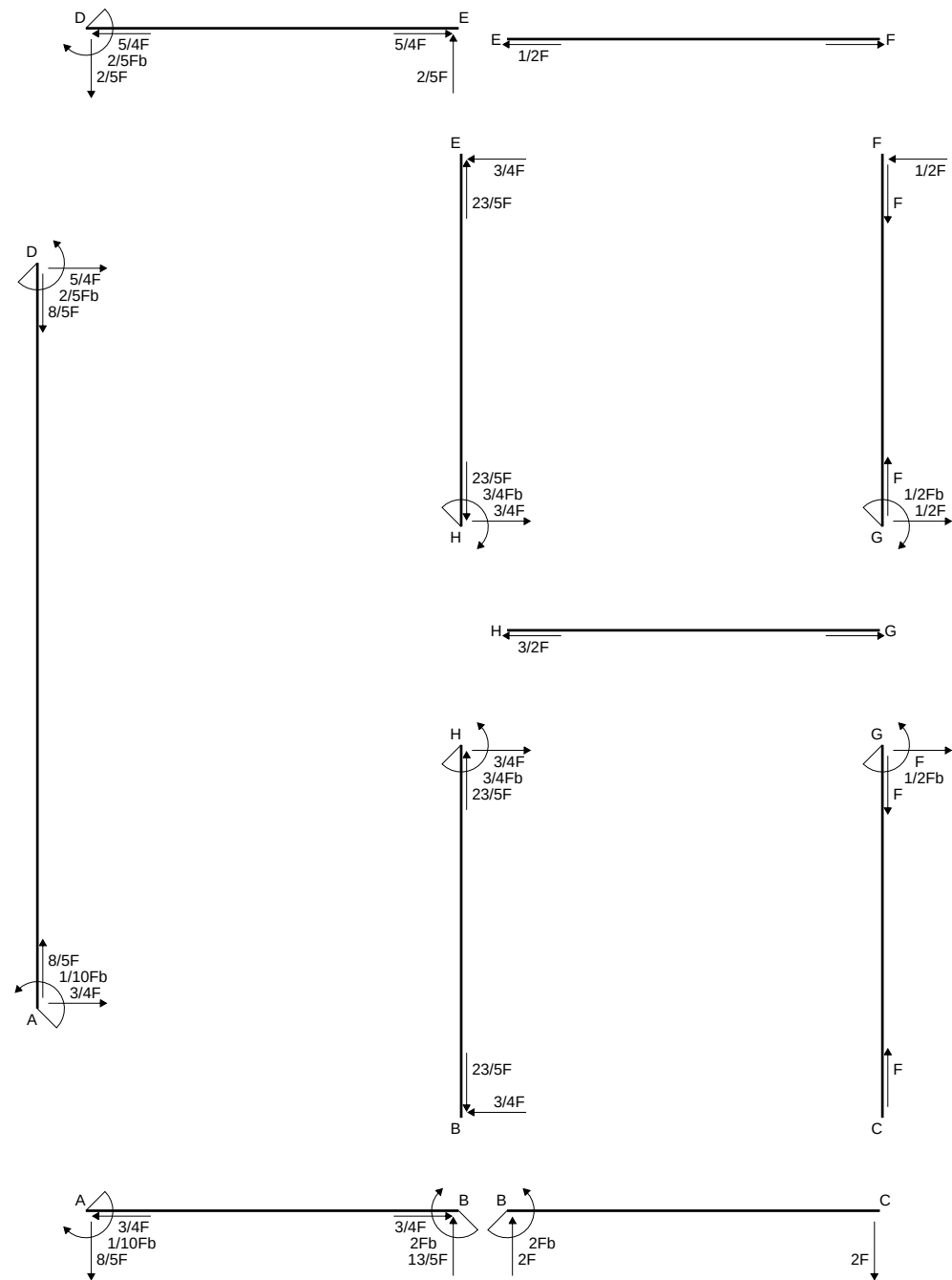
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-3/4Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

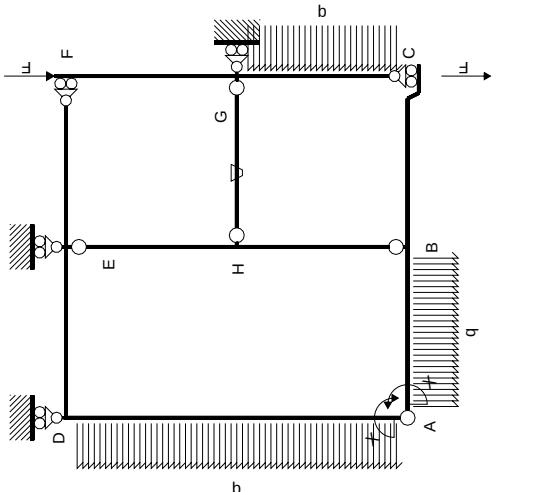
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



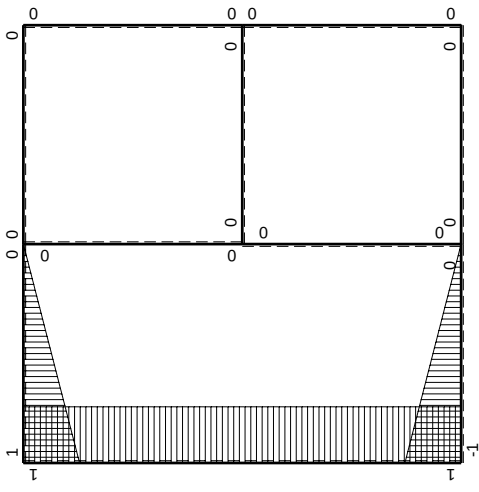
$$\begin{aligned}
A &= 888. \text{ mm}^2 \\
J_u &= 293012. \text{ mm}^4 \\
J_v &= 79992. \text{ mm}^4 \\
y_g &= 19.98 \text{ mm} \\
T_y &= 2240. \text{ N} \\
M_x &= -1971200. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 34.02 \text{ mm} \\
\sigma_m &= -Mv/J_u = 228.9 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 42. \text{ mm} \\
v_c &= 22.02 \text{ mm} \\
\sigma_c &= -Mv/J_u = 148.1 \text{ N/mm}^2 \\
\tau_c &= 7.367 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 148.7 \text{ N/mm}^2 \\
S &= 5782. \text{ mm}^3
\end{aligned}$$



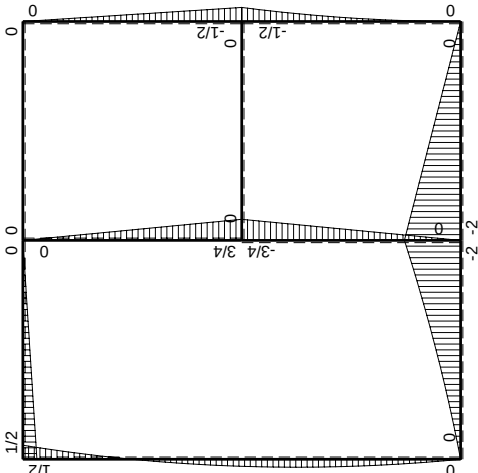


Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

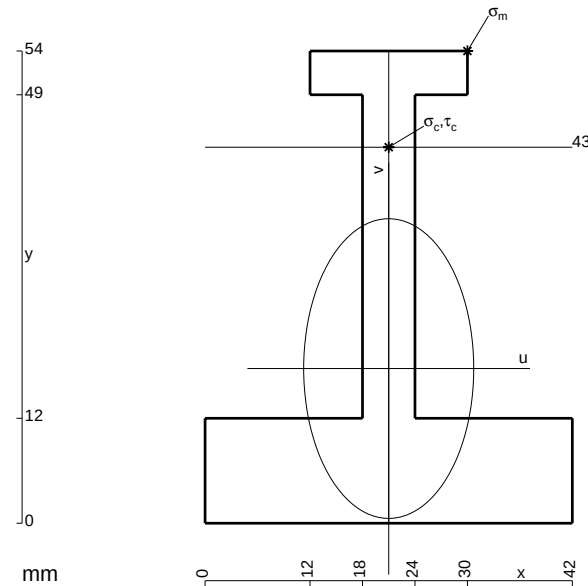


Quadro contributi PLV per iperstatica $X=W_{AB}$

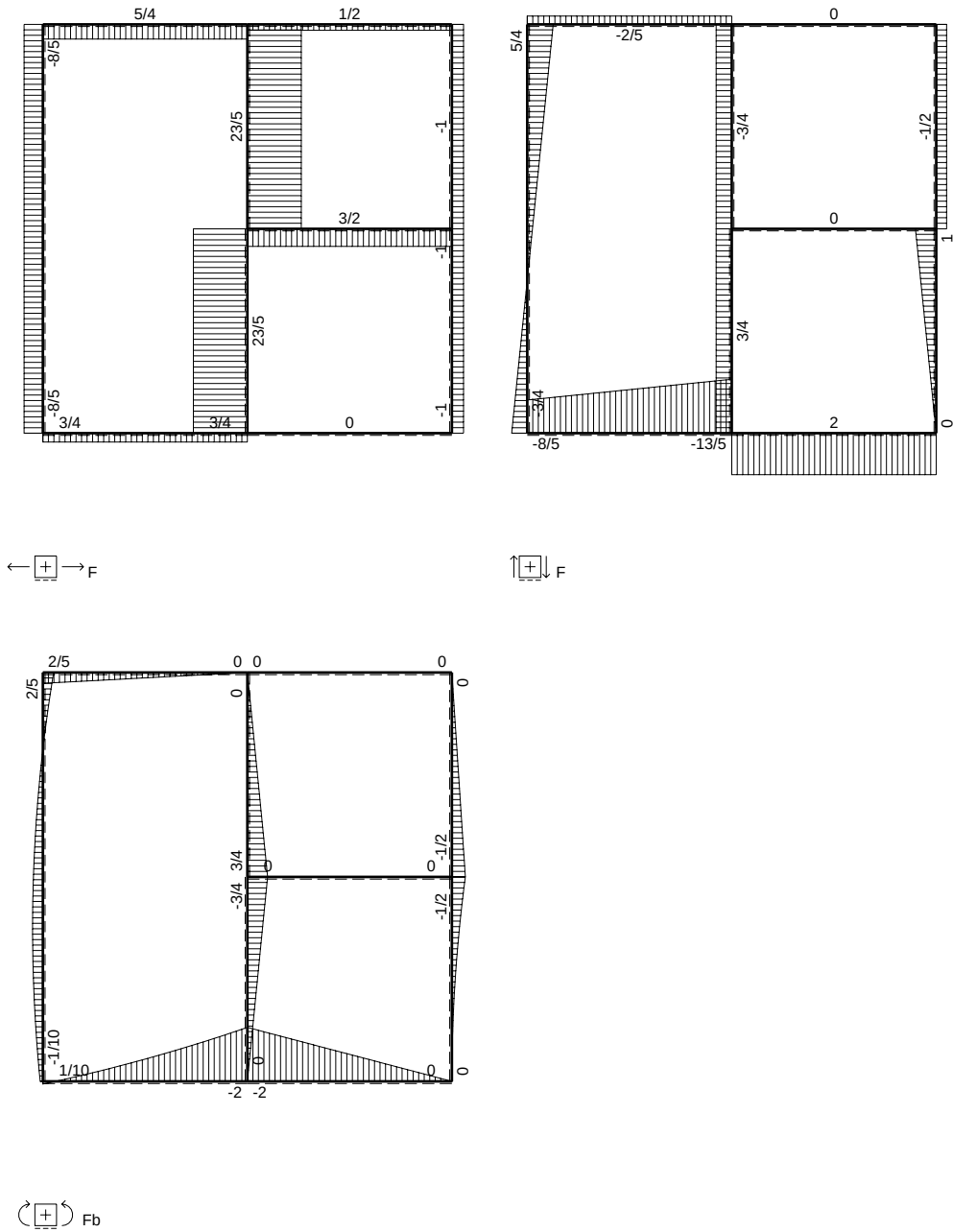
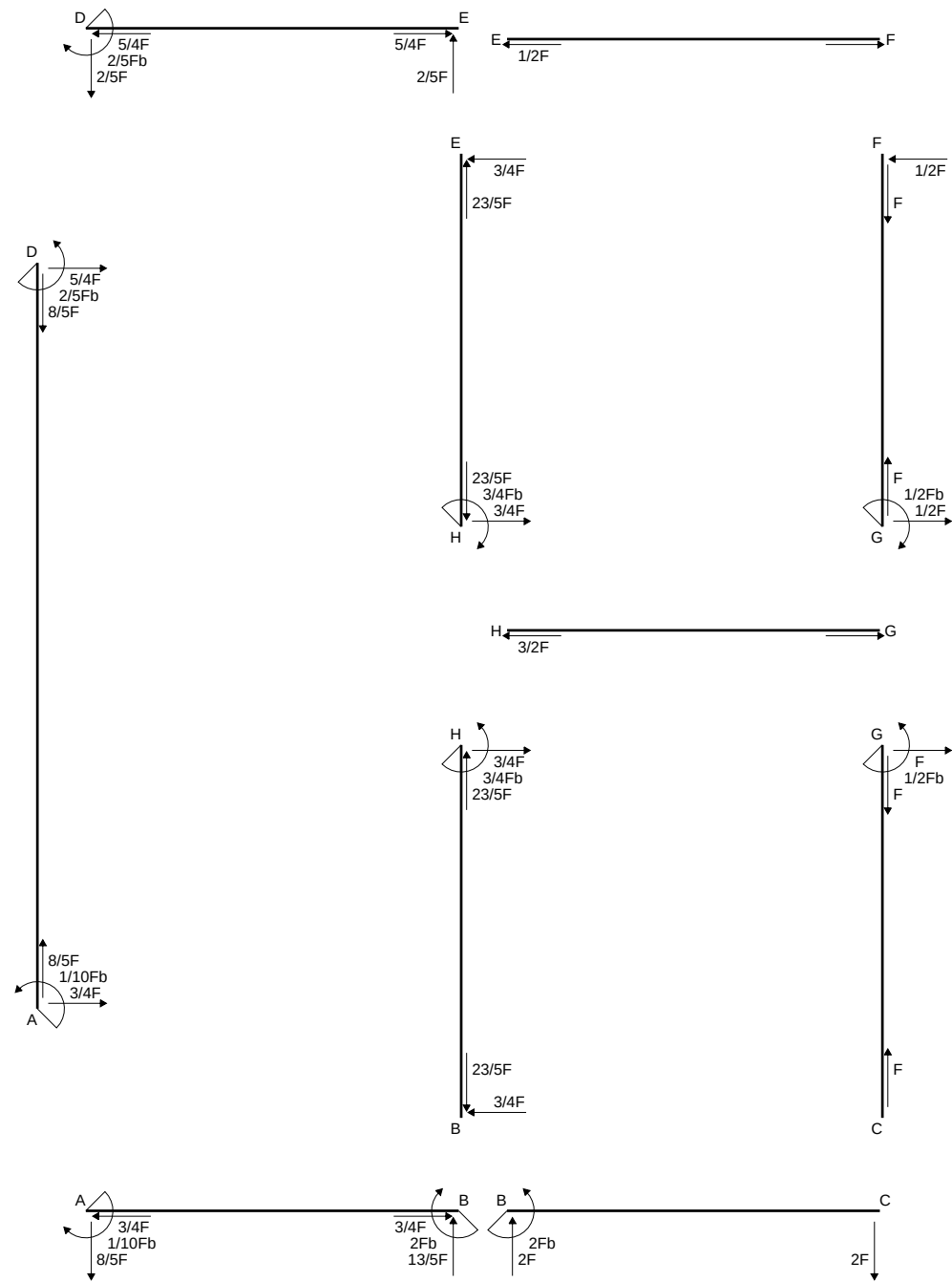
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

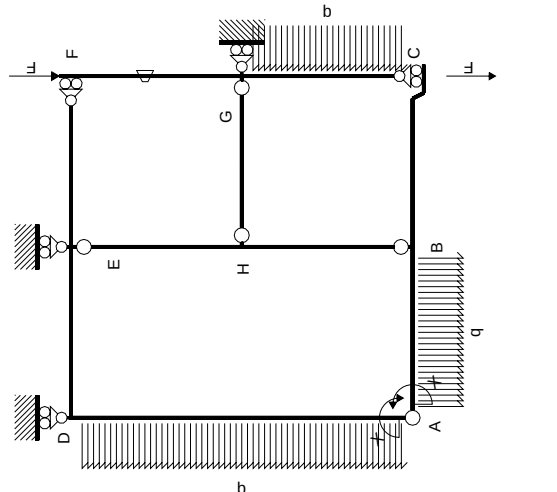
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



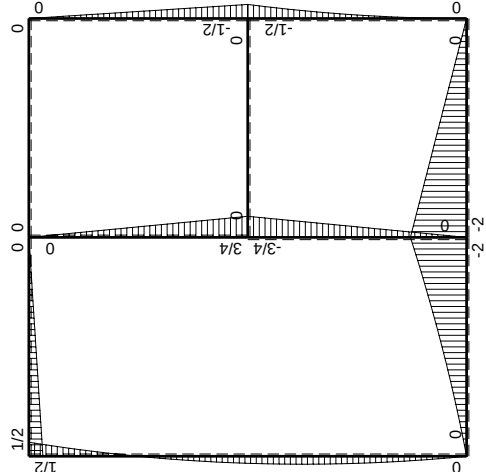
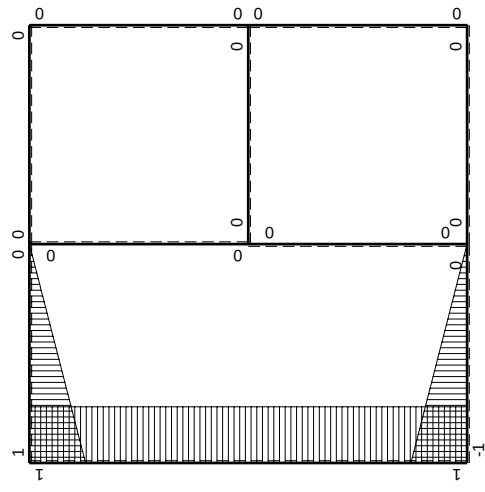
$$\begin{aligned}
A &= 816. \text{ mm}^2 \\
J_u &= 239746. \text{ mm}^4 \\
J_v &= 77184. \text{ mm}^4 \\
y_g &= 17.68 \text{ mm} \\
T_y &= 1700. \text{ N} \\
M_x &= -1581000. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 36.32 \text{ mm} \\
\sigma_m &= -Mv/J_u = 239.5 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 43. \text{ mm} \\
v_c &= 25.32 \text{ mm} \\
\sigma_c &= -Mv/J_u = 166.9 \text{ N/mm}^2 \\
\tau_c &= 4.801 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 167.2 \text{ N/mm}^2 \\
S &= 4063. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



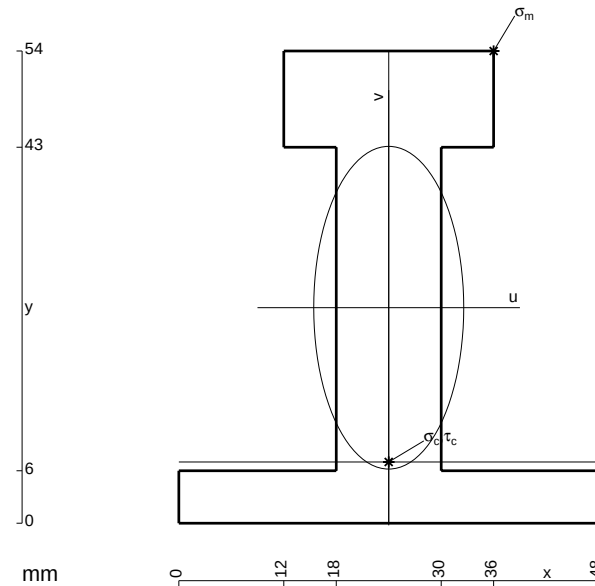
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

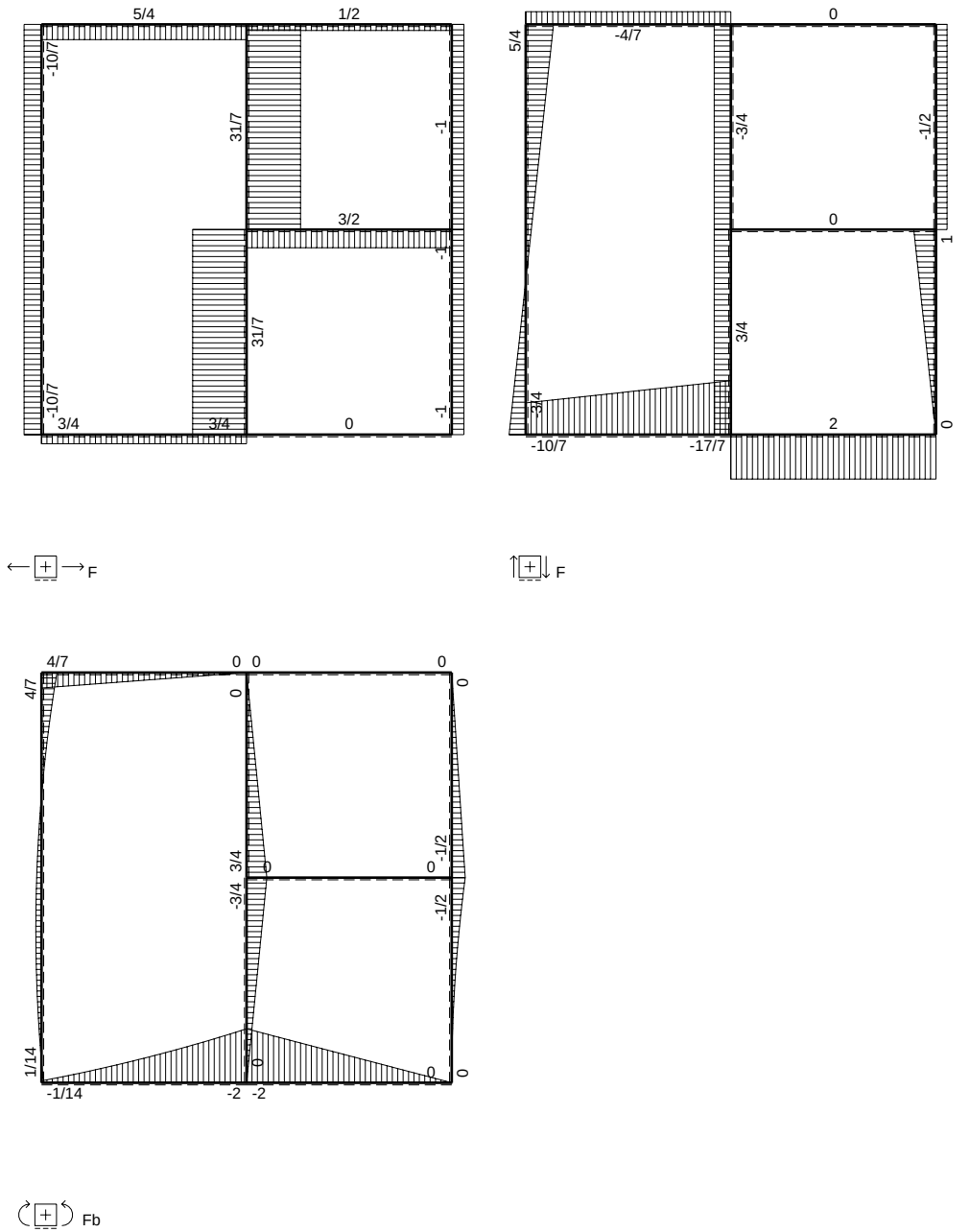
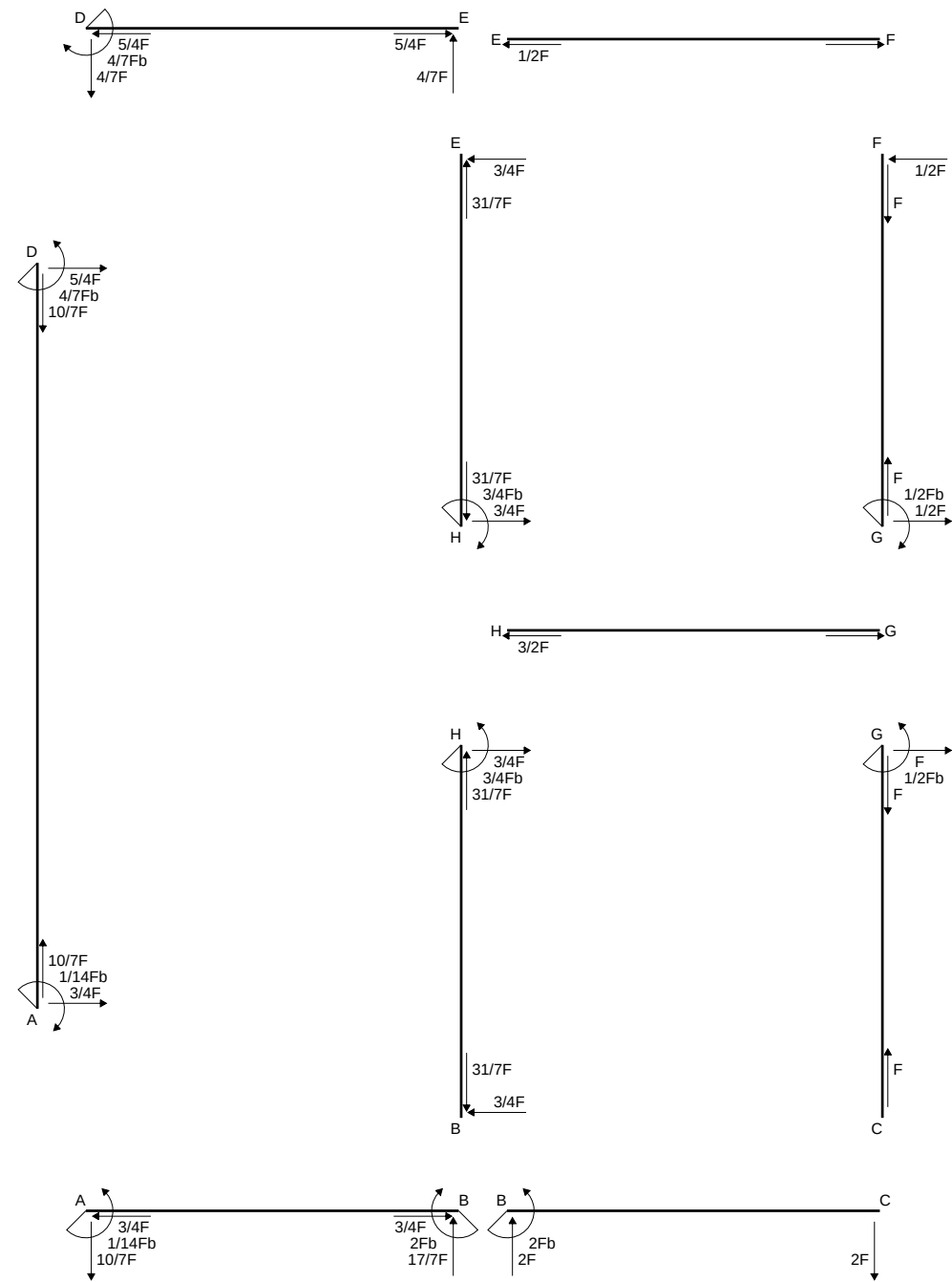
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	Fb/EJ	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

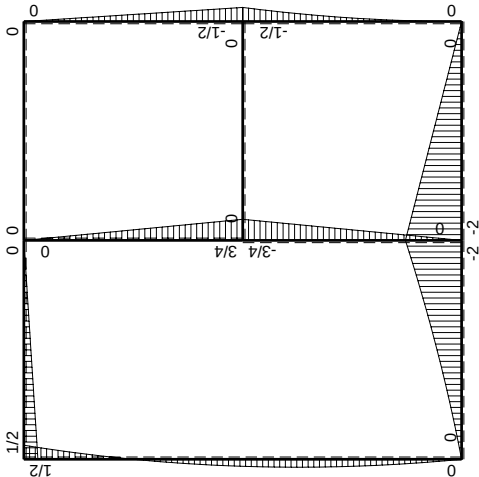
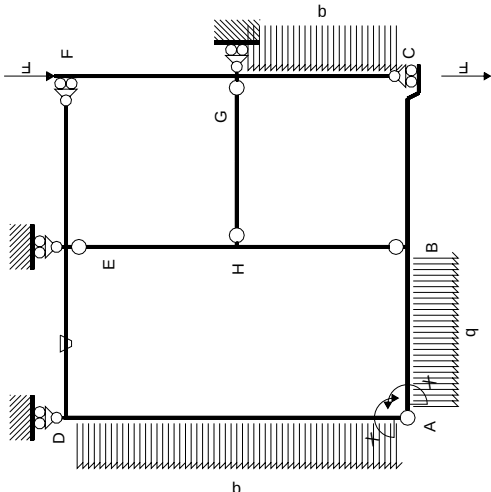
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{xo} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{xo} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{xo} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{xo} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{xo} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{xo} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



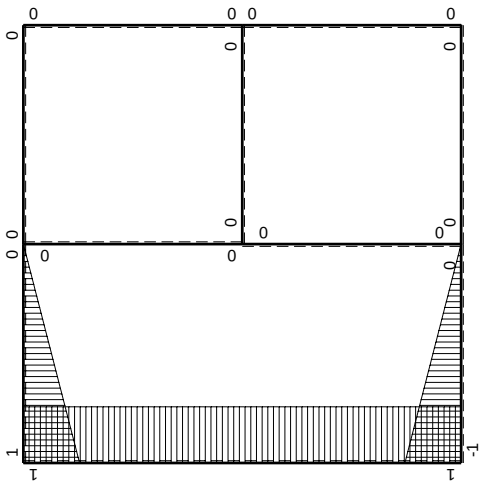
$$\begin{aligned}
A &= 996. \text{ mm}^2 \\
J_u &= 339350. \text{ mm}^4 \\
J_v &= 73296. \text{ mm}^4 \\
y_g &= 24.64 \text{ mm} \\
T_y &= 4700. \text{ N} \\
M_x &= -2303000. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 29.36 \text{ mm} \\
\sigma_m &= -Mv/J_u = 199.2 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 7. \text{ mm} \\
v_c &= -17.64 \text{ mm} \\
\sigma_c &= -Mv/J_u = -119.7 \text{ N/mm}^2 \\
\tau_c &= 7.446 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 120.4 \text{ N/mm}^2 \\
S &= 6451. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



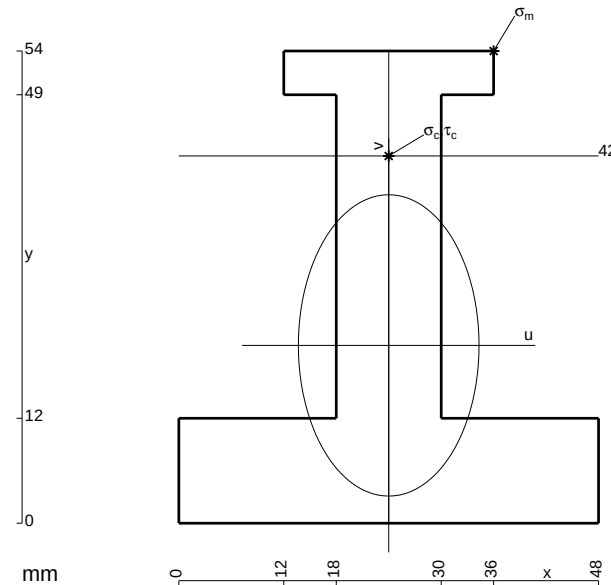
M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

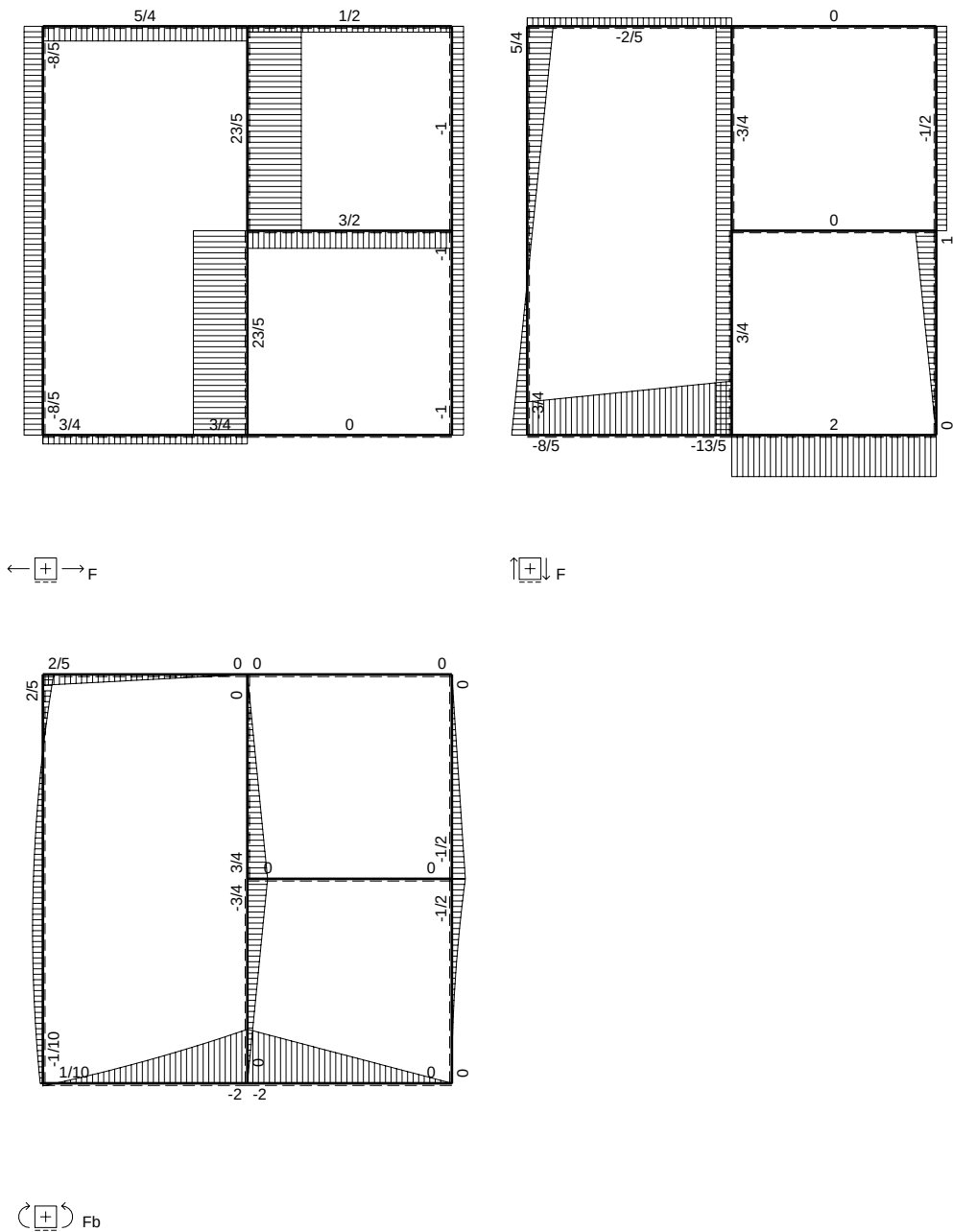
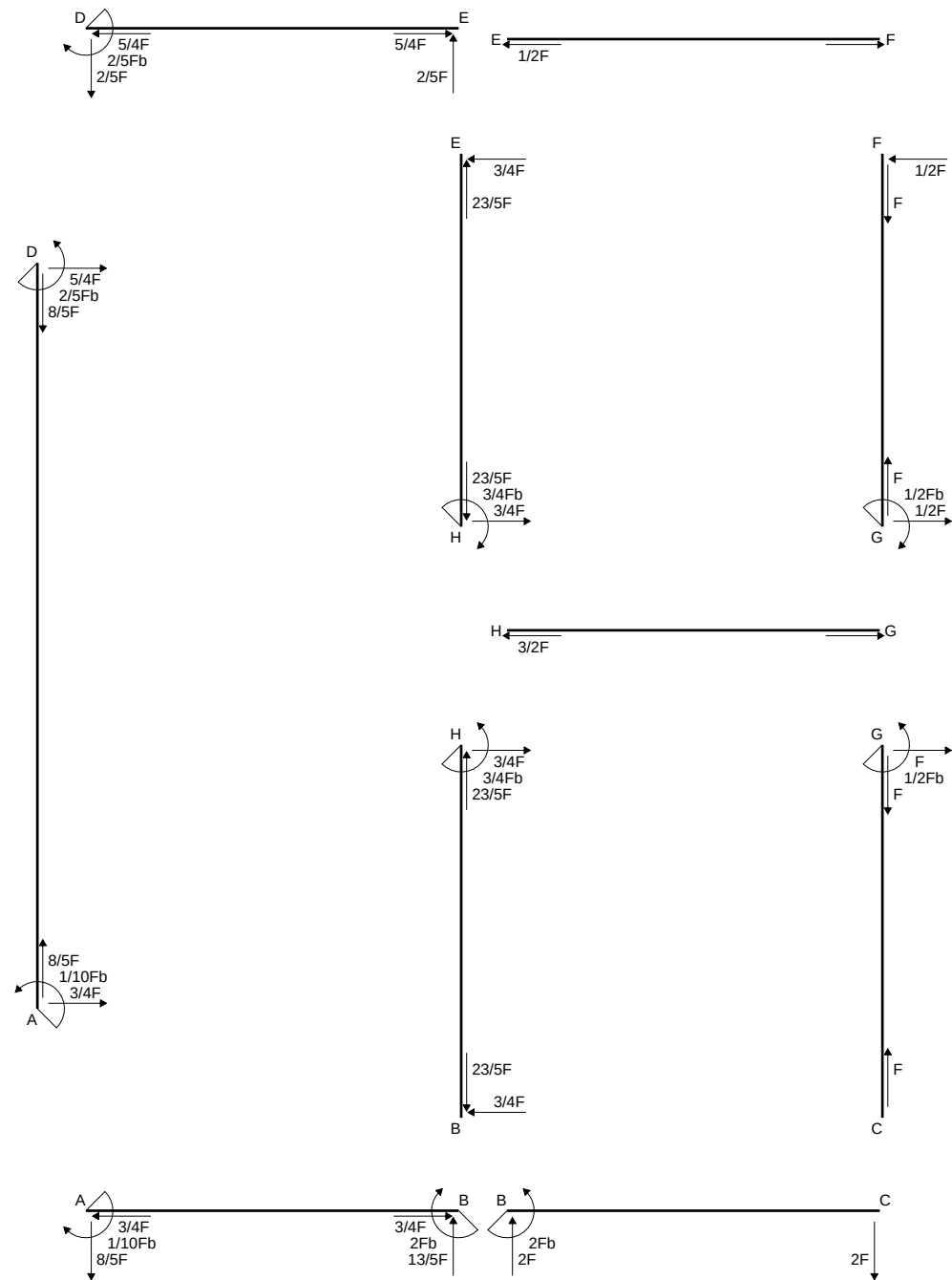
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$-Fb/EJ+Fx/EJ$	$1-2x/b+x^2/b^2$	$(1/6-1/2)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	Fb/EJ	$1/2Fx^2/b$	$-Fx/EJ$	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/14Fb$	

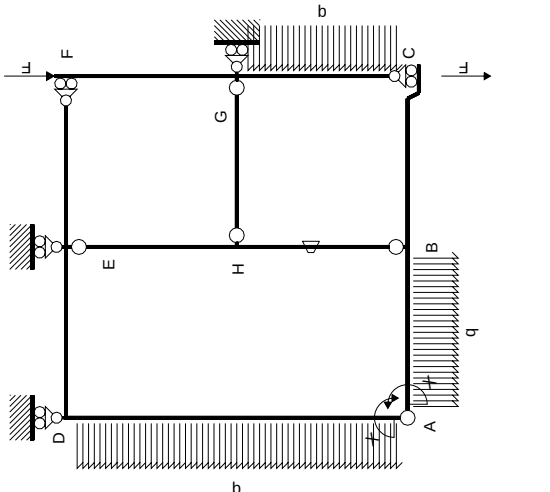
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1 + x/b) \theta \, dx \\
&= \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} + \left[-x + 1/2 x^2/b \right]_0^b \theta \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b + 1/2 b) \theta = -1/3 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (x/b) \theta \, dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} + \left[1/2 x^2/b \right]_0^b \theta \\
&= (1/6 b) Fb \frac{1}{EJ} + (1/2 b) \theta = -1/3 \frac{Fb^2}{EJ}
\end{aligned}$$



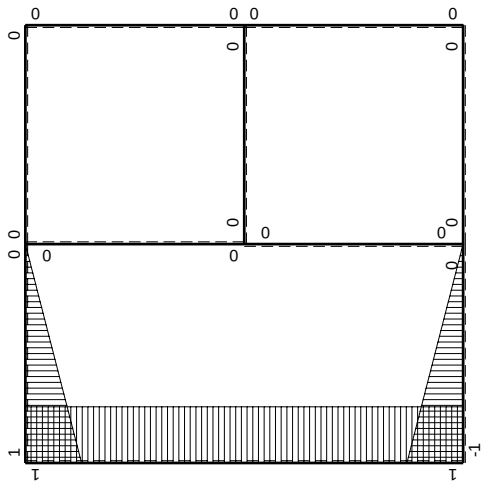
$$\begin{aligned}
A &= 1140. \text{ mm}^2 \\
J_u &= 338607. \text{ mm}^4 \\
J_v &= 121680. \text{ mm}^4 \\
y_g &= 20.33 \text{ mm} \\
T_y &= 3980. \text{ N} \\
M_x &= -2109400. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 33.67 \text{ mm} \\
\sigma_m &= -Mv/J_u = 209.7 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 42. \text{ mm} \\
v_c &= 21.67 \text{ mm} \\
\sigma_c &= -Mv/J_u = 135. \text{ N/mm}^2 \\
\tau_c &= 5.734 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 135.4 \text{ N/mm}^2 \\
S &= 5854. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



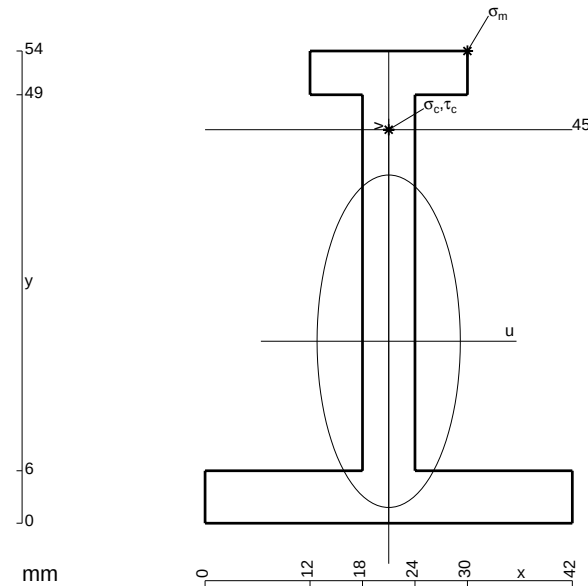
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

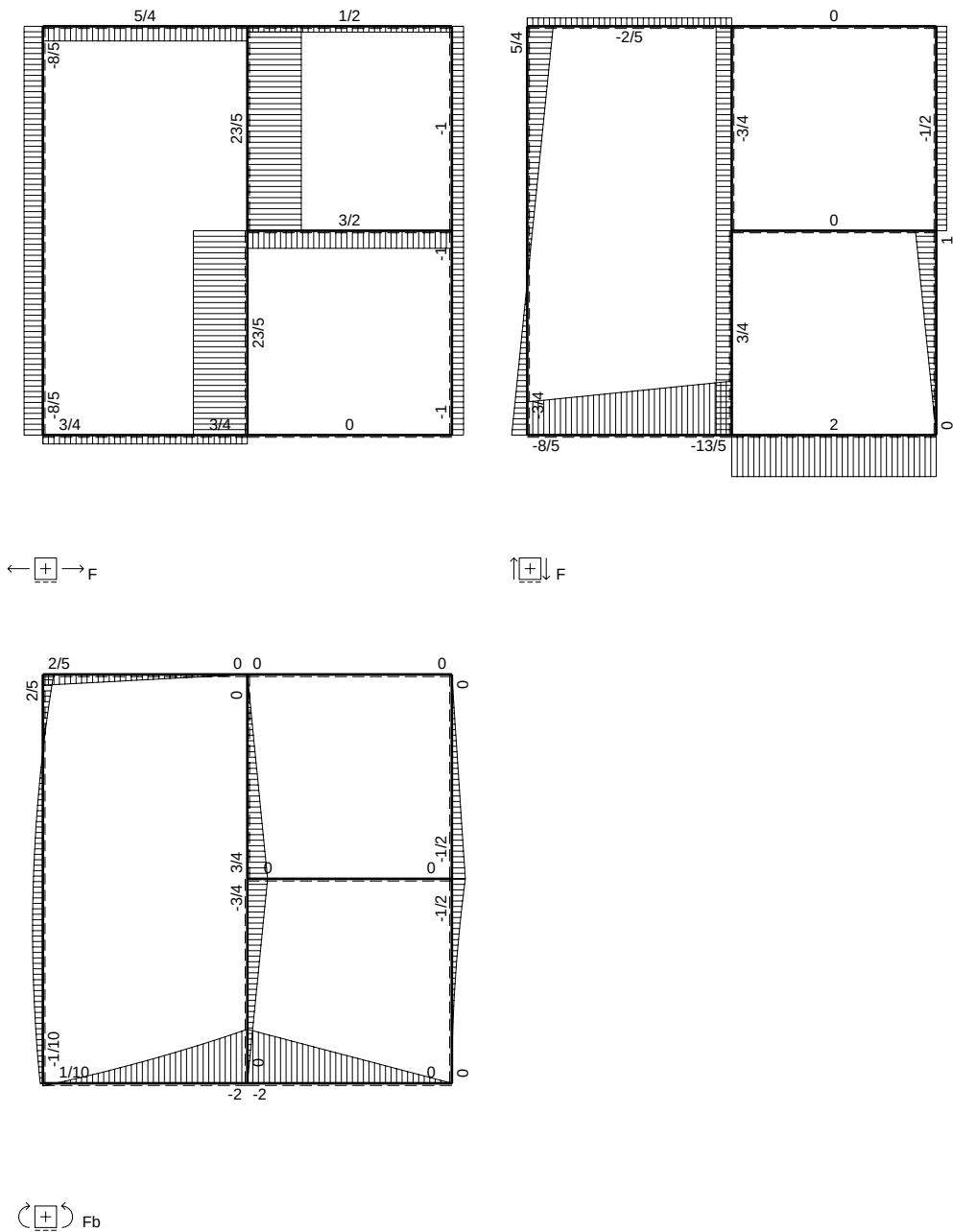
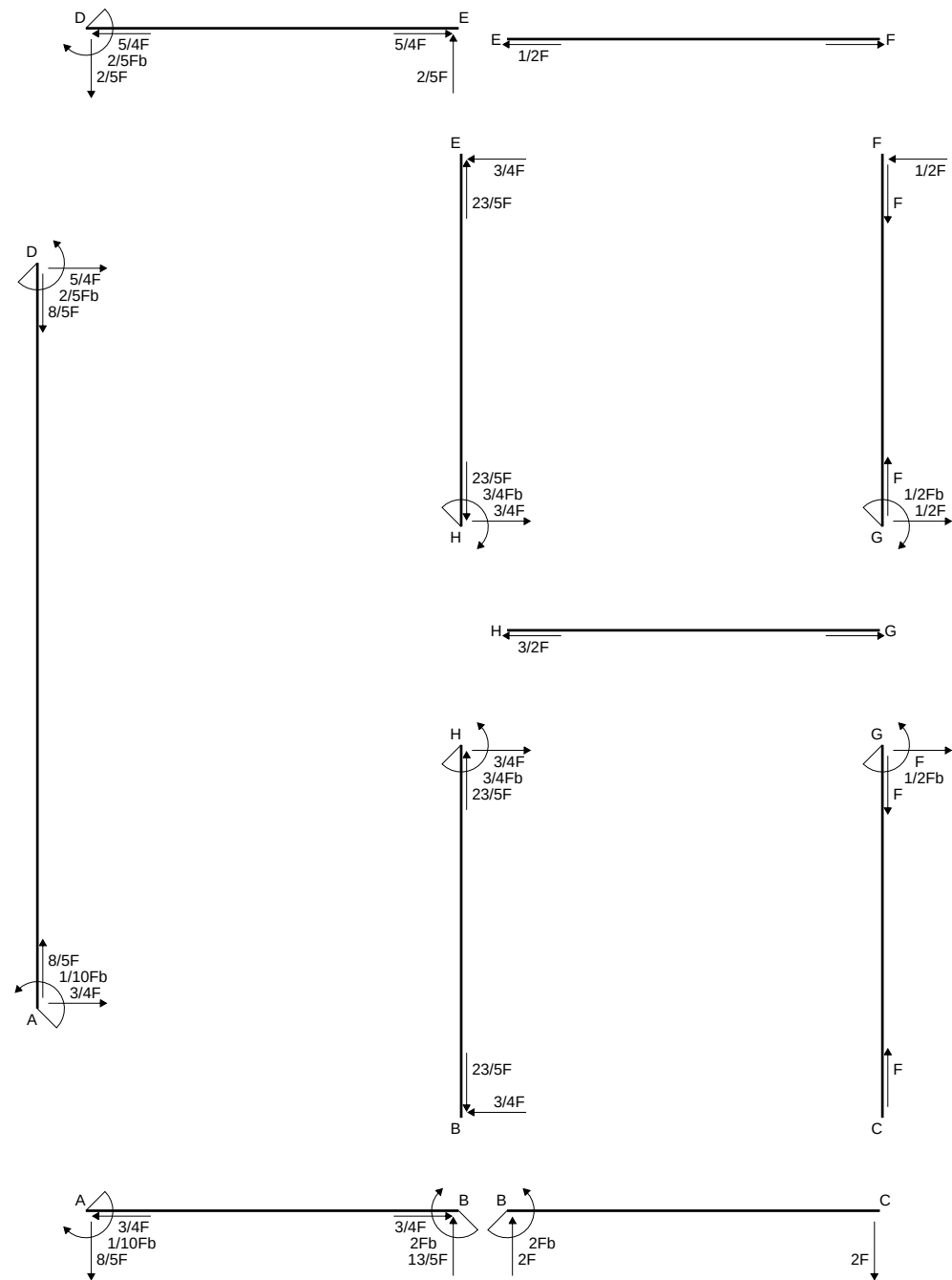
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$3/4Fx$	Fb/EJ	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

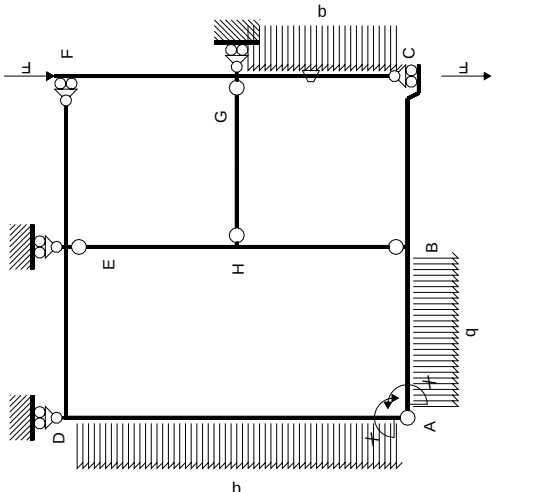
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



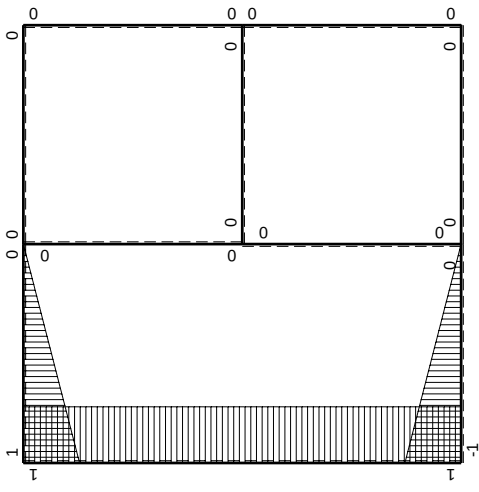
$$\begin{aligned}
A &= 600. \text{ mm}^2 \\
J_u &= 216946. \text{ mm}^4 \\
J_v &= 40248. \text{ mm}^4 \\
y_g &= 20.81 \text{ mm} \\
T_y &= 2460. \text{ N} \\
M_x &= -1426800. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 33.19 \text{ mm} \\
\sigma_m &= -Mv/J_u = 218.3 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 45. \text{ mm} \\
v_c &= 24.19 \text{ mm} \\
\sigma_c &= -Mv/J_u = 159.1 \text{ N/mm}^2 \\
\tau_c &= 6.408 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 159.5 \text{ N/mm}^2 \\
S &= 3391. \text{ mm}^3
\end{aligned}$$



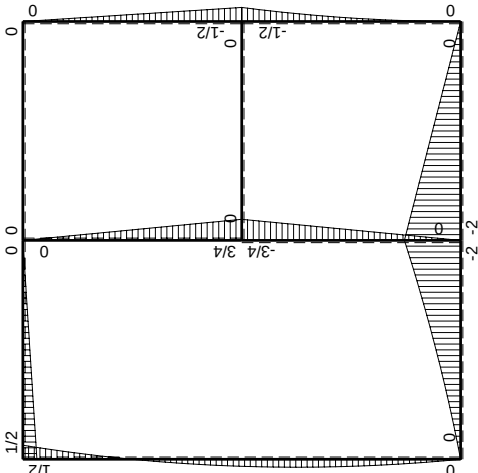


Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

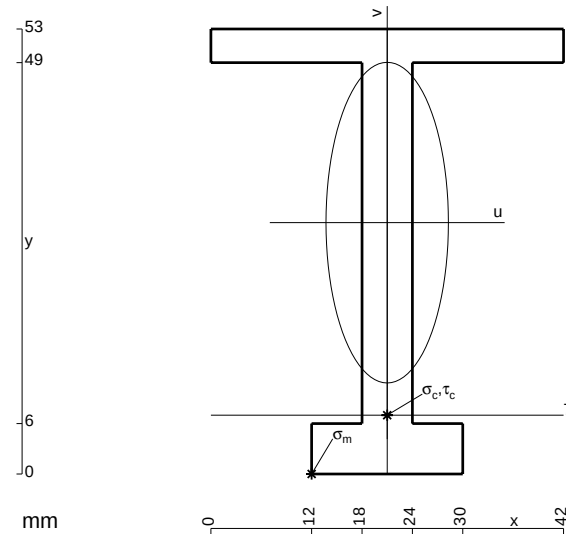


Quadro contributi PLV per iperstatica $X=W_{AB}$

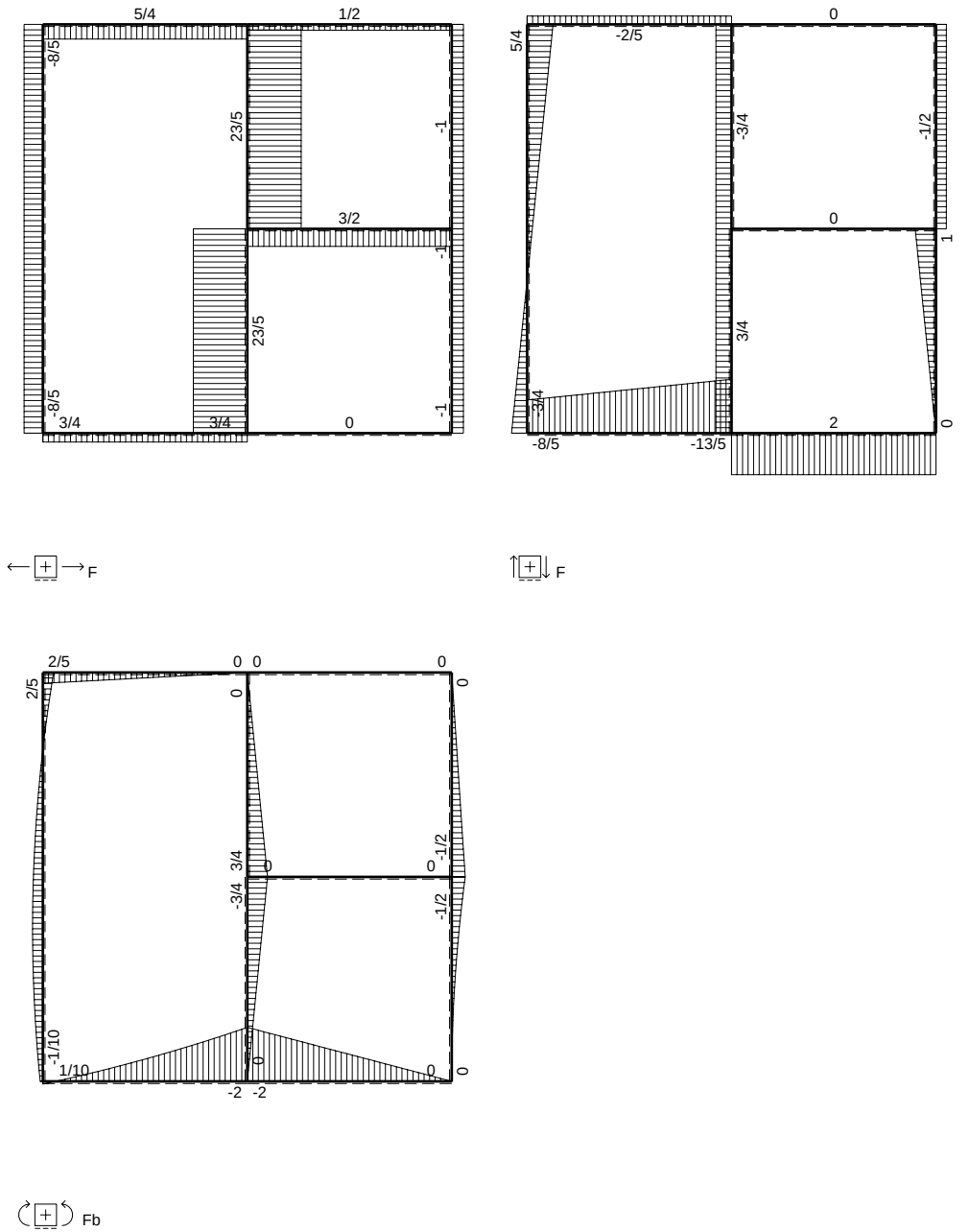
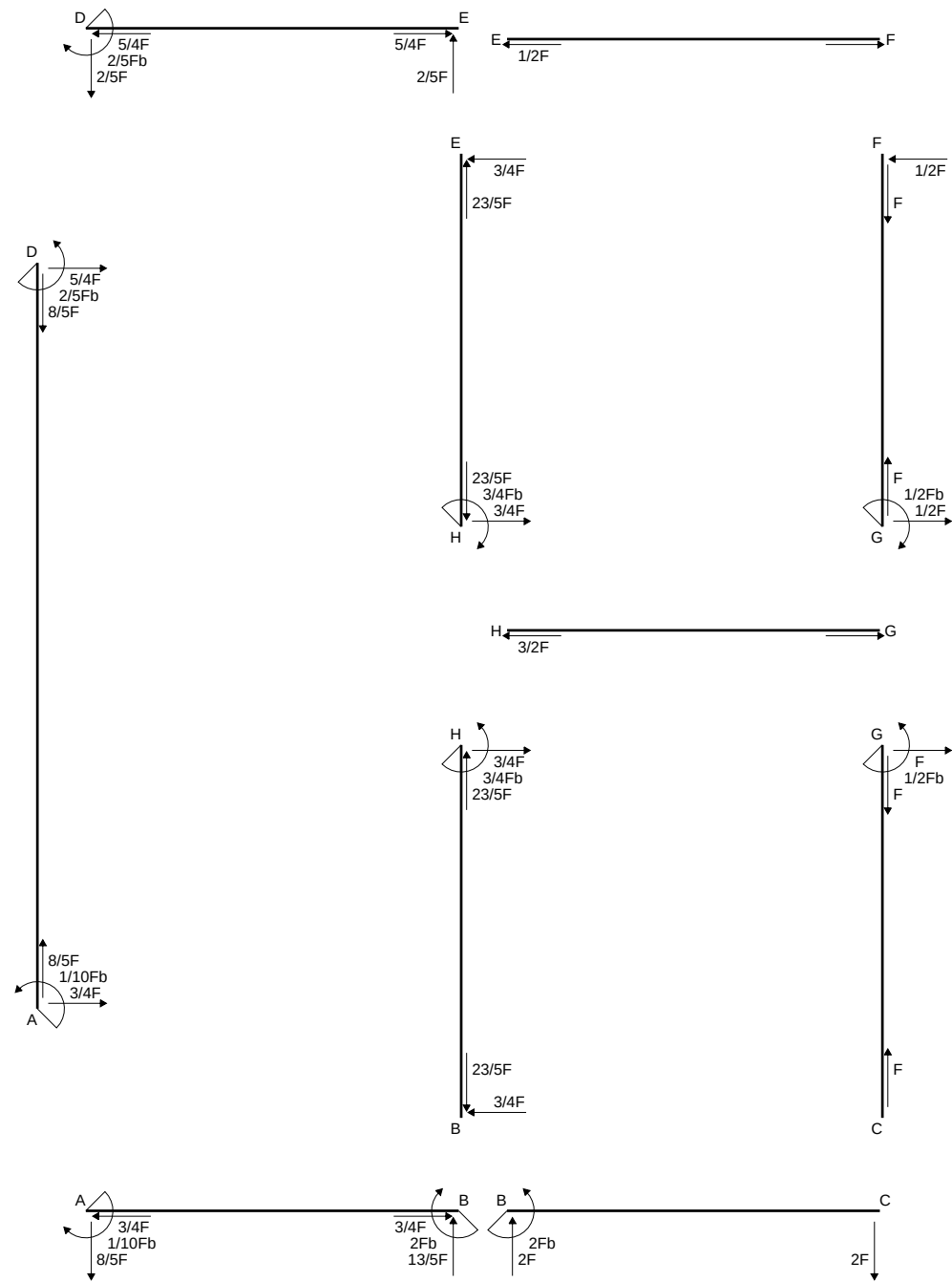
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	$1/2qx^2$	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

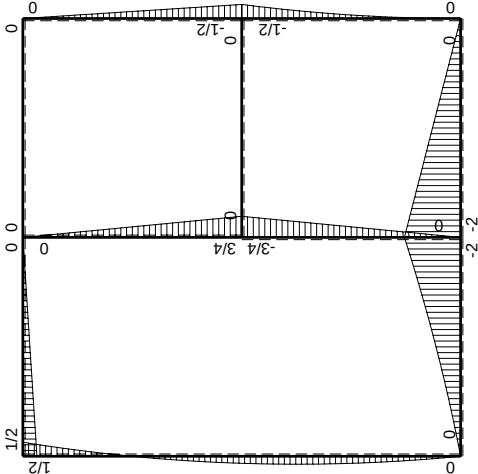
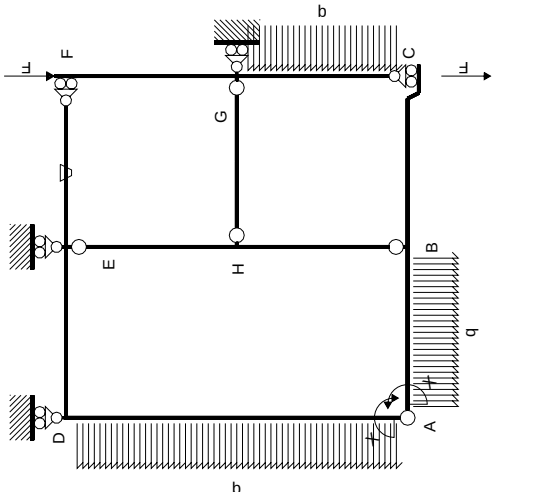
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



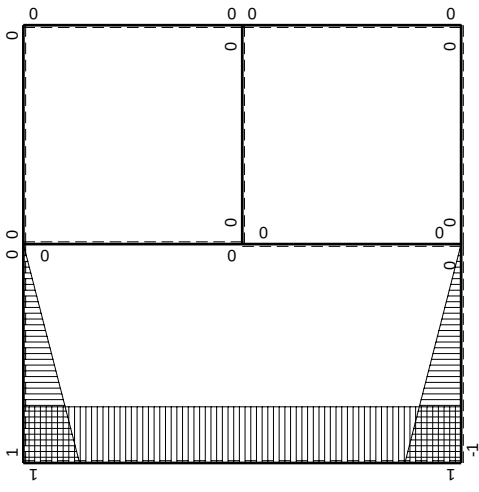
$$\begin{aligned}
A &= 534. \text{ mm}^2 \\
J_u &= 194732. \text{ mm}^4 \\
J_v &= 28386. \text{ mm}^4 \\
y_g &= 29.94 \text{ mm} \\
T_y &= 2400. \text{ N} \\
M_x &= -1488000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -29.94 \text{ mm} \\
\sigma_m &= -Mv/J_u = -228.8 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 7. \text{ mm} \\
v_c &= -22.94 \text{ mm} \\
\sigma_c &= -Mv/J_u = -175.3 \text{ N/mm}^2 \\
\tau_c &= 6.265 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 175.6 \text{ N/mm}^2 \\
S &= 3050. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



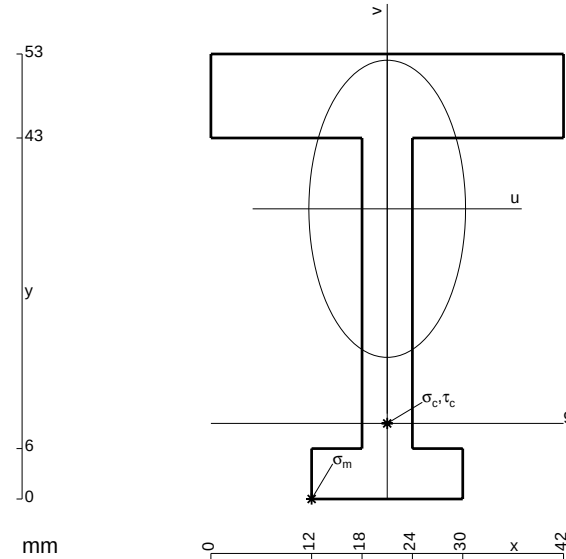
M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

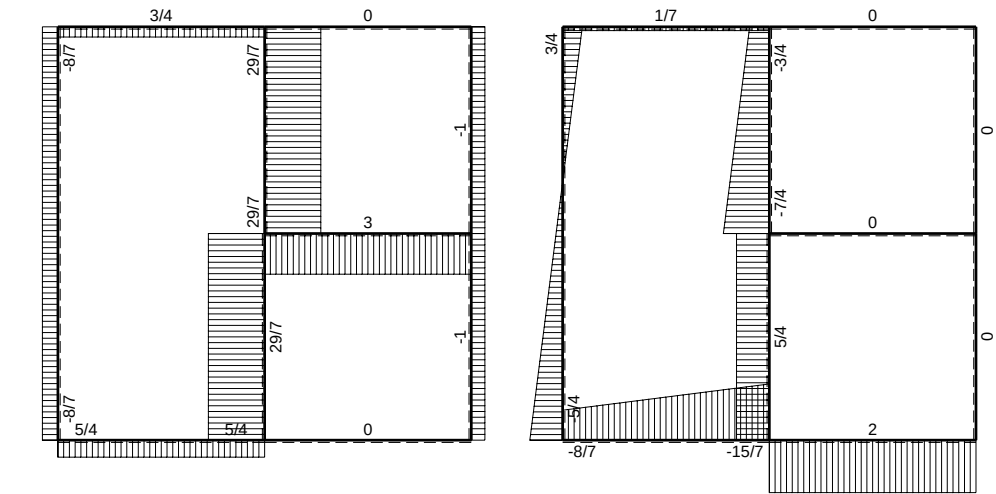
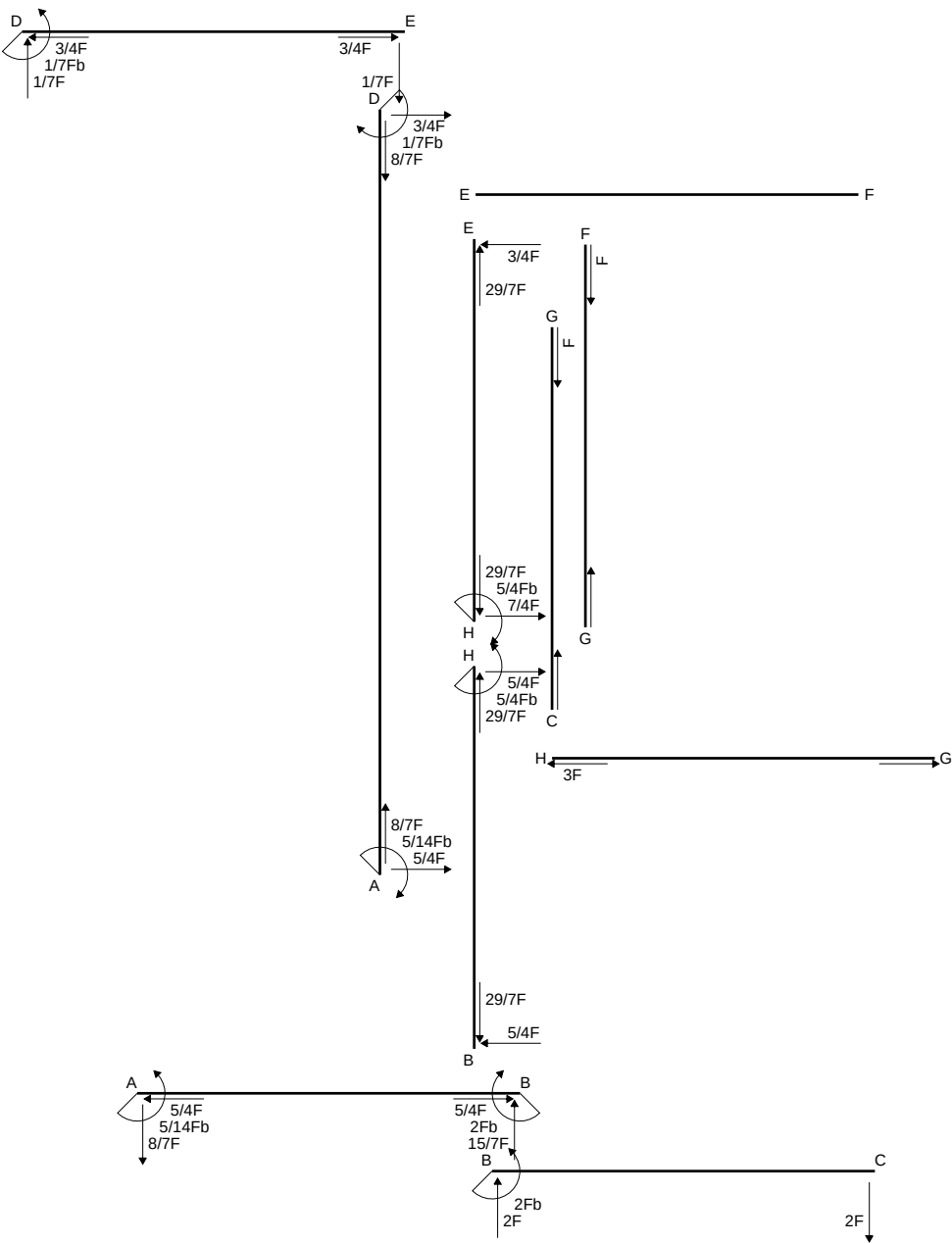
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-3/4Fx+1/2qx^2$	0	$-3/4Fx+1/2Fx^2/b$	0	1	$(-1/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+5/4Fx-1/2qx^2$	0	$1/2Fb-5/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-3/4Fb+3/4Fx$	0	0	0	0	0+0	0
BH b	0	$3/4Fx$	0	0	0	0		
HE b	0	$3/4Fb-3/4Fx$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-3/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

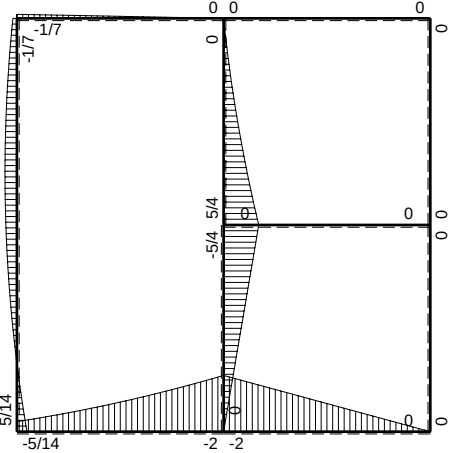


$$\begin{aligned}
A &= 750. \text{ mm}^2 \\
J_u &= 235055. \text{ mm}^4 \\
J_v &= 65322. \text{ mm}^4 \\
y_g &= 34.56 \text{ mm} \\
T_y &= 2420. \text{ N} \\
M_x &= -1621400. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -34.56 \text{ mm} \\
\sigma_m &= -Mv/J_u = -238.4 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 9. \text{ mm} \\
v_c &= -25.56 \text{ mm} \\
\sigma_c &= -Mv/J_u = -176.3 \text{ N/mm}^2 \\
\tau_c &= 6.685 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 176.7 \text{ N/mm}^2 \\
S &= 3896. \text{ mm}^3
\end{aligned}$$

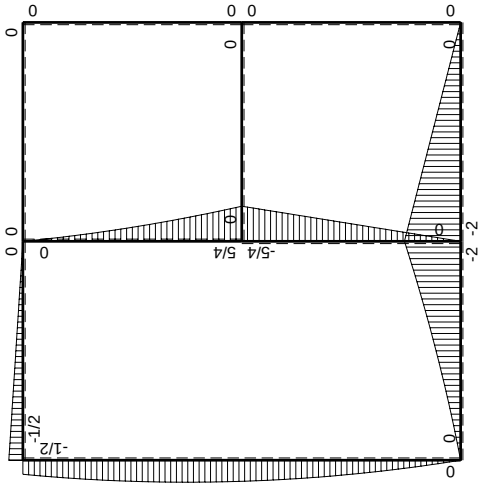
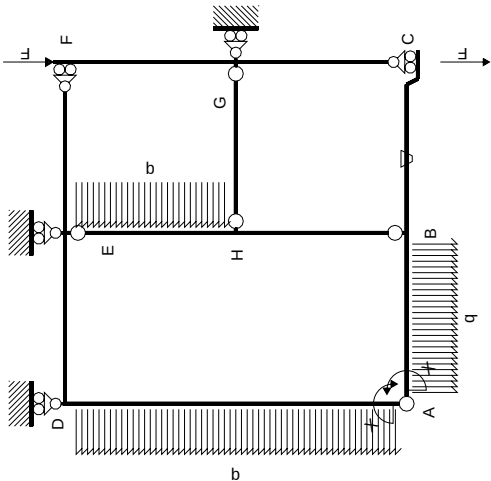


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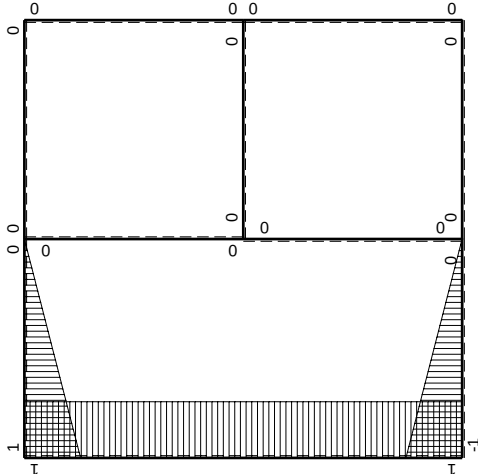


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



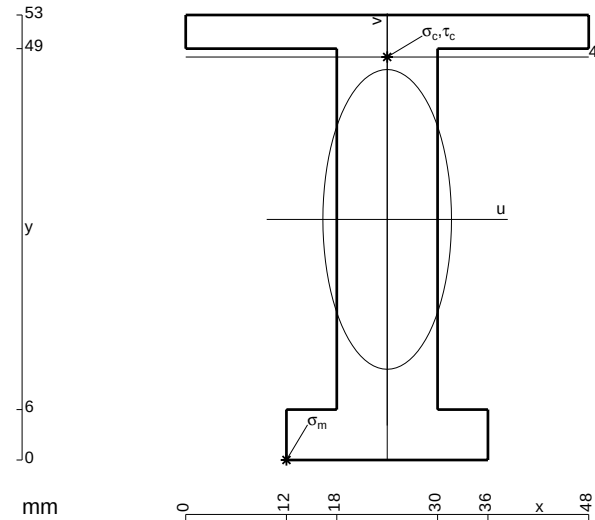
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

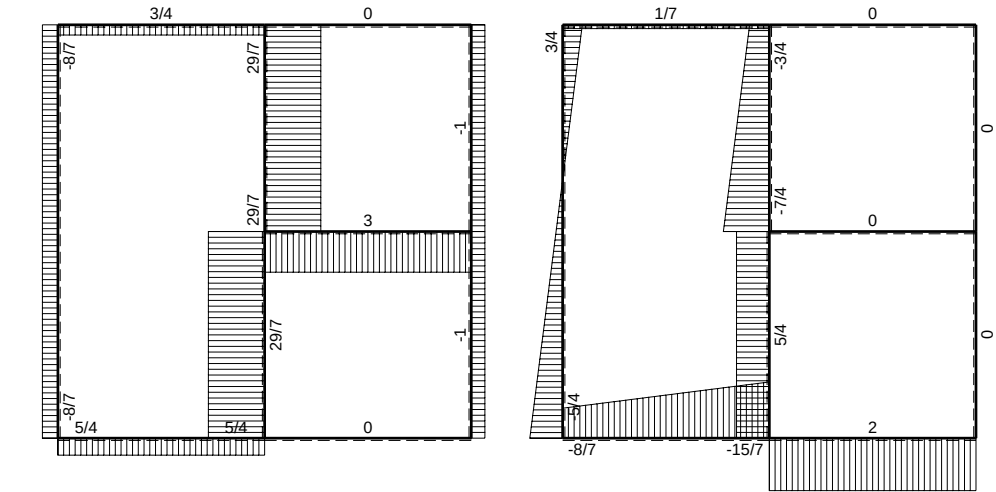
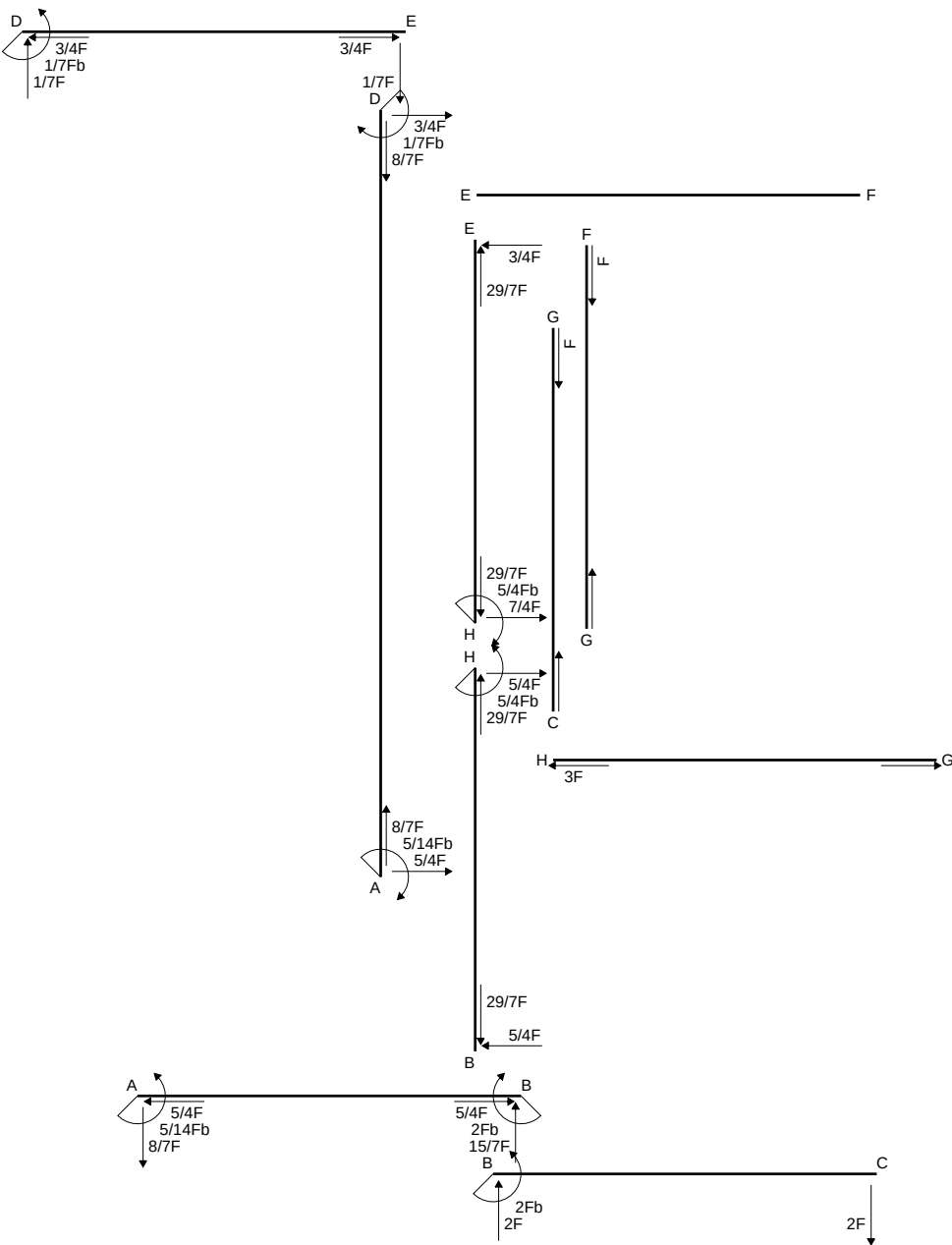
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

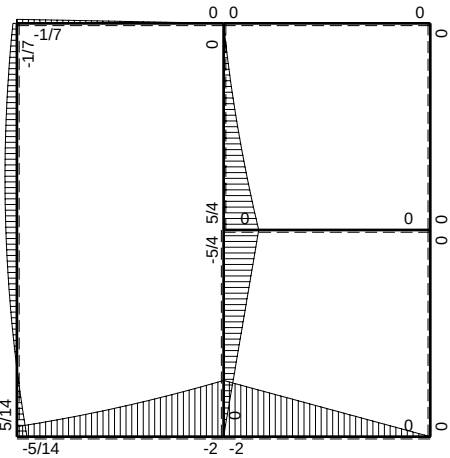


$$\begin{aligned}
A &= 852. \text{ mm}^2 \\
J_u &= 271527. \text{ mm}^4 \\
J_v &= 49968. \text{ mm}^4 \\
y_g &= 28.65 \text{ mm} \\
T_y &= 2620. \text{ N} \\
M_x &= -1886400. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -28.65 \text{ mm} \\
\sigma_m &= -Mv/J_u = -199.1 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 48. \text{ mm} \\
v_c &= 19.35 \text{ mm} \\
\sigma_c &= -Mv/J_u = 134.4 \text{ N/mm}^2 \\
\tau_c &= 3.641 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 134.5 \text{ N/mm}^2 \\
S &= 4528. \text{ mm}^3
\end{aligned}$$

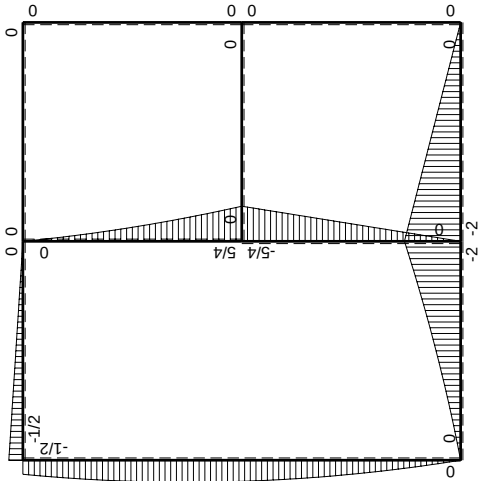
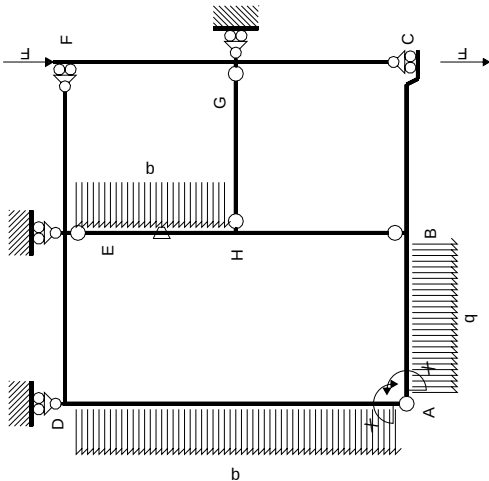


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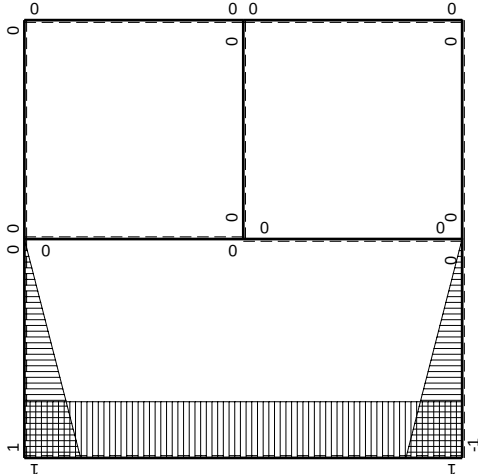


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



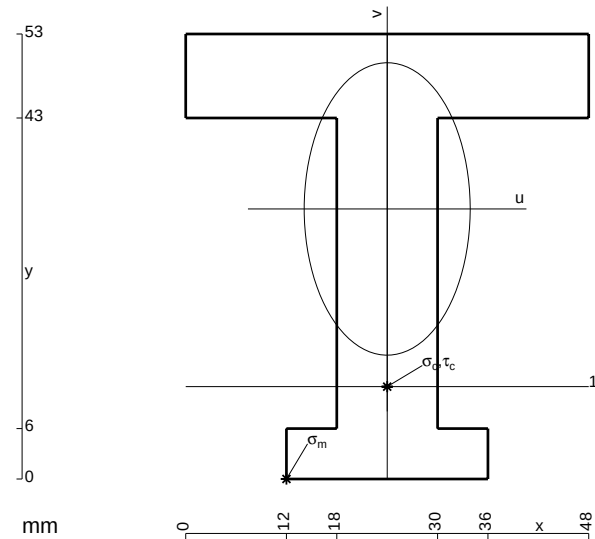
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

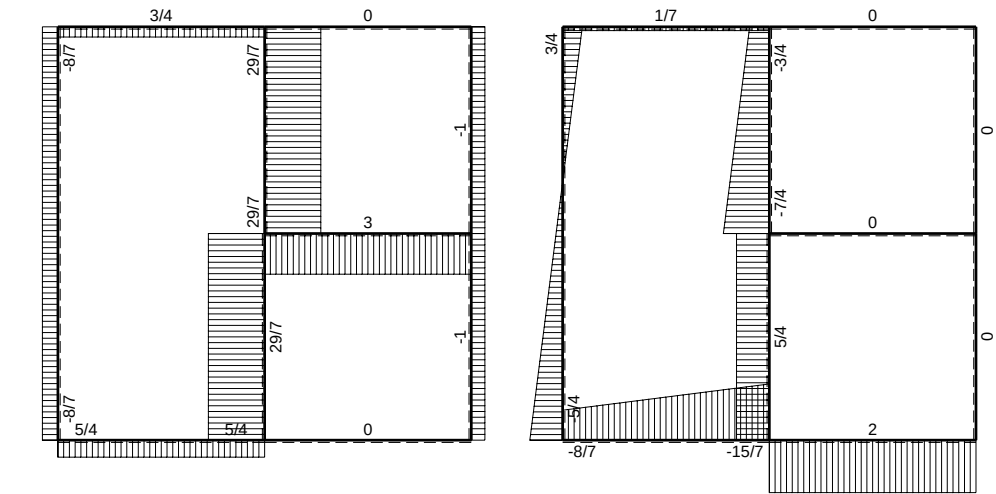
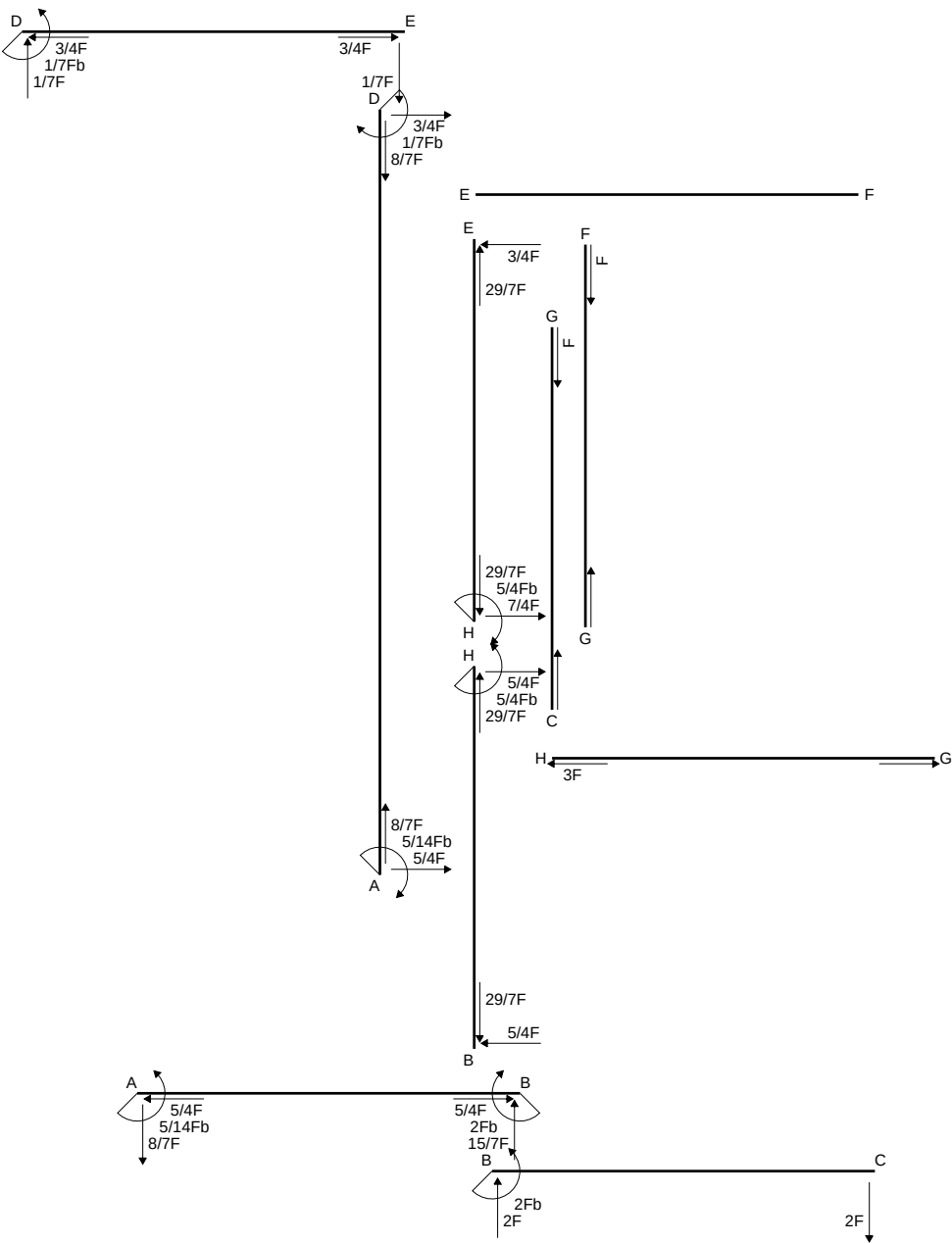
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{xo} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{xo} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{xo} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{xo} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{xo} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{xo} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

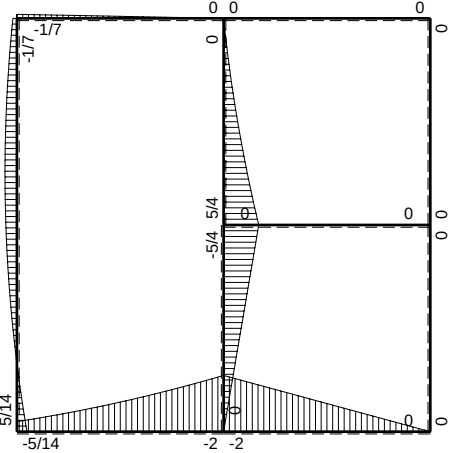


$$\begin{aligned}
A &= 1068. \text{ mm}^2 \\
J_u &= 324016. \text{ mm}^4 \\
J_v &= 104400. \text{ mm}^4 \\
y_g &= 32.16 \text{ mm} \\
T_y &= 2780. \text{ N} \\
M_x &= -2112800. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -32.16 \text{ mm} \\
\sigma_m &= -Mv/J_u = -209.7 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 11. \text{ mm} \\
v_c &= -21.16 \text{ mm} \\
\sigma_c &= -Mv/J_u = -138. \text{ N/mm}^2 \\
\tau_c &= 4.018 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 138.2 \text{ N/mm}^2 \\
S &= 5619. \text{ mm}^3
\end{aligned}$$



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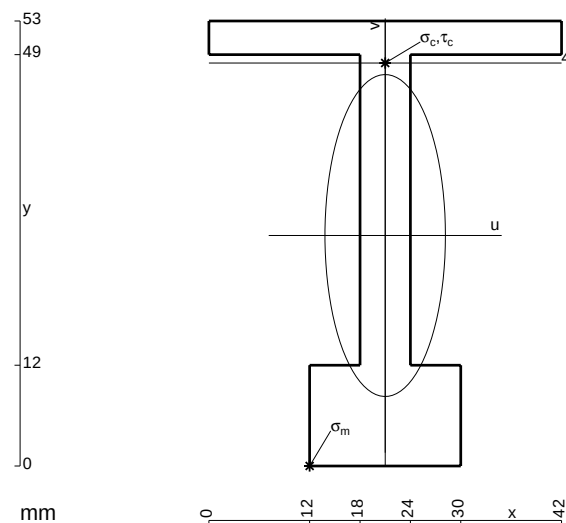
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Quadro contributi PLV per iperstatica $X=W_{AB}$

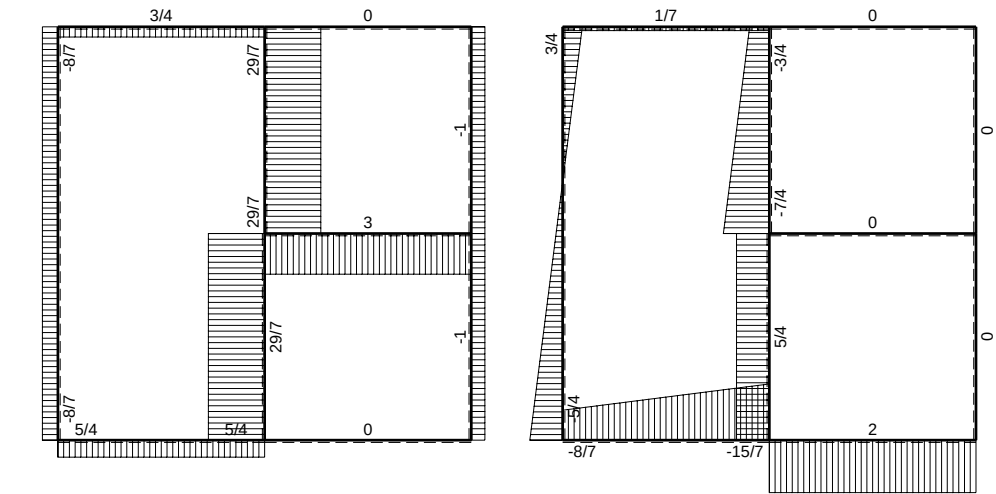
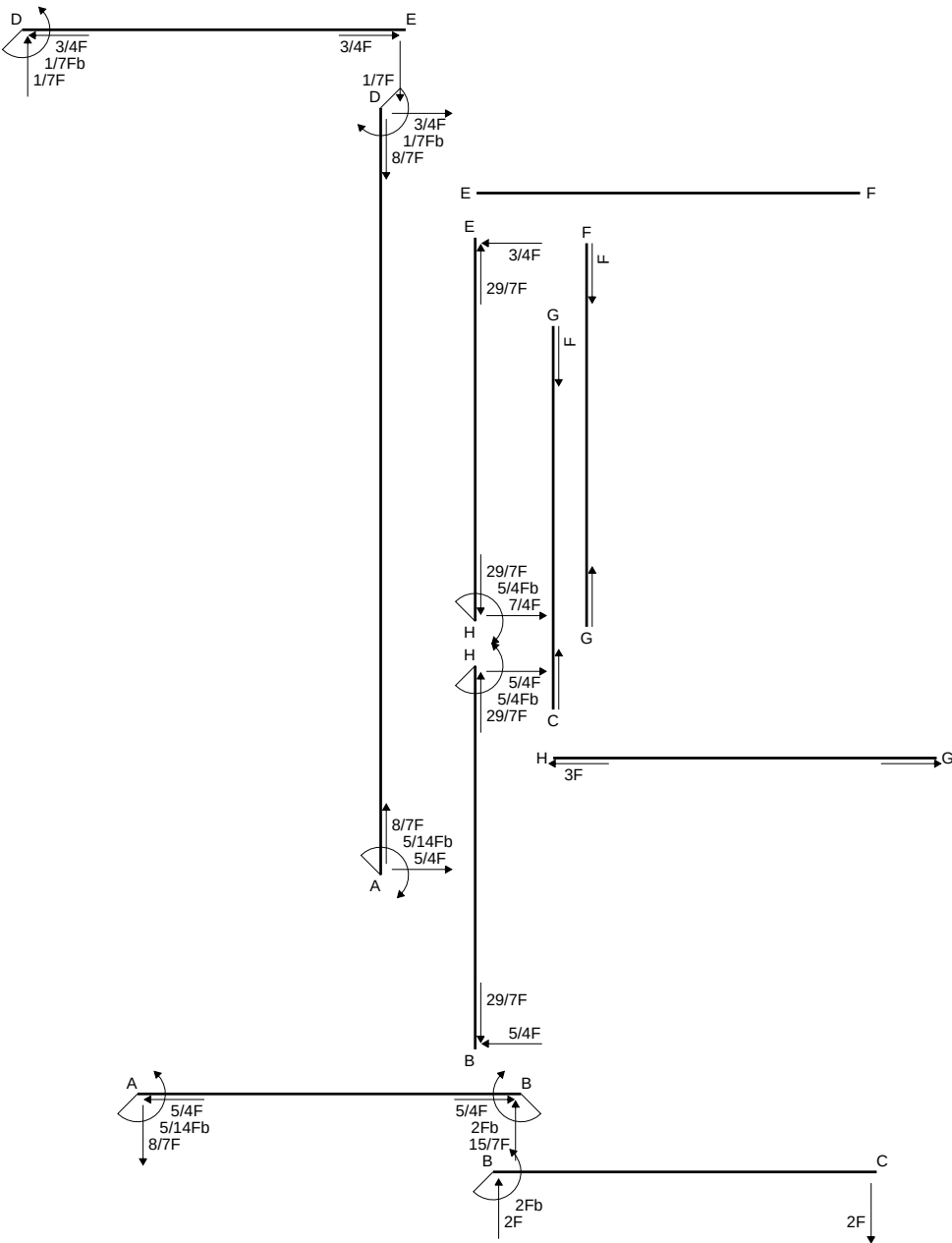
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

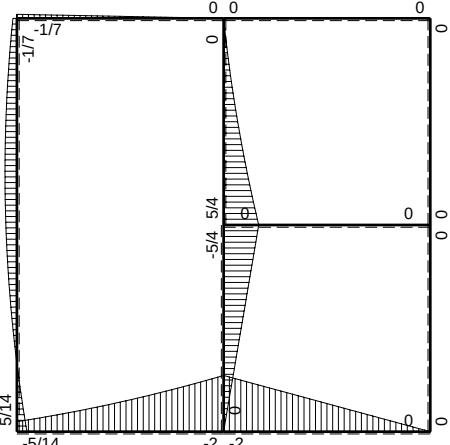


$$\begin{aligned} A &= 606. \text{ mm}^2 \\ J_u &= 222763. \text{ mm}^4 \\ J_v &= 31194. \text{ mm}^4 \\ y_g &= 27.45 \text{ mm} \\ T_y &= 2200. \text{ N} \\ M_x &= -1782000. \text{ Nmm} \\ x_m &= 12. \text{ mm} \\ u_m &= -9. \text{ mm} \\ v_m &= -27.45 \text{ mm} \\ \sigma_m &= -Mv/J_u = -219.6 \text{ N/mm}^2 \\ x_c &= 21. \text{ mm} \\ y_c &= 48. \text{ mm} \\ v_c &= 20.55 \text{ mm} \\ \sigma_c &= -Mv/J_u = 164.4 \text{ N/mm}^2 \\ \tau_c &= 6.72 \text{ N/mm}^2 \\ \sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 164.8 \text{ N/mm}^2 \\ S &= 4083. \text{ mm}^3 \end{aligned}$$

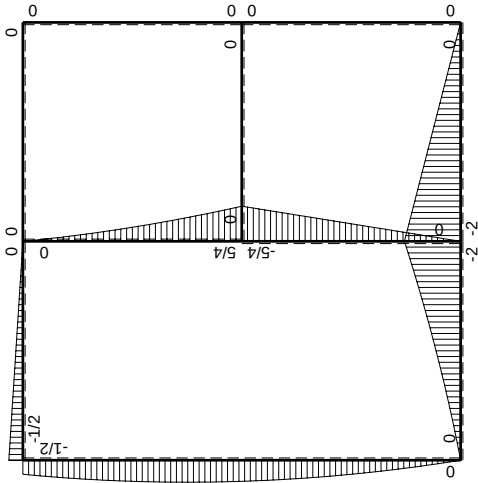
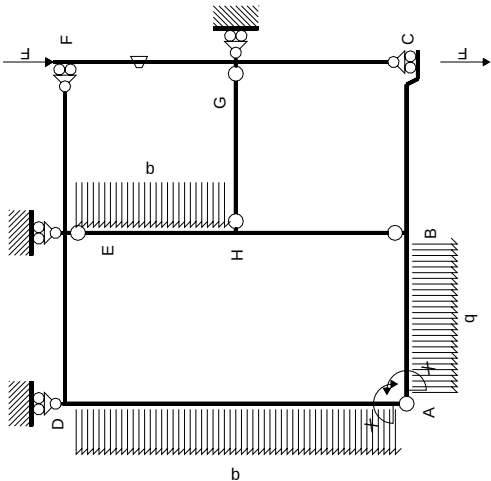


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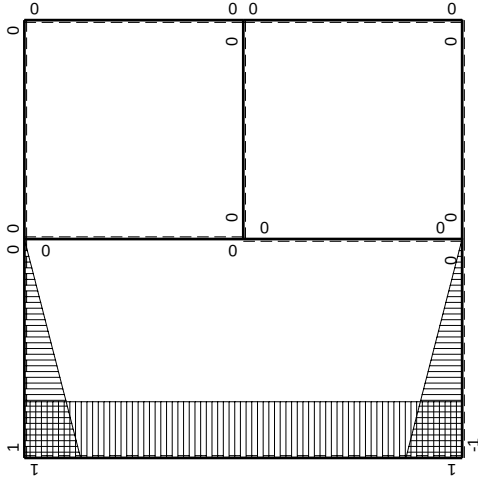


⊕ ⊕ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



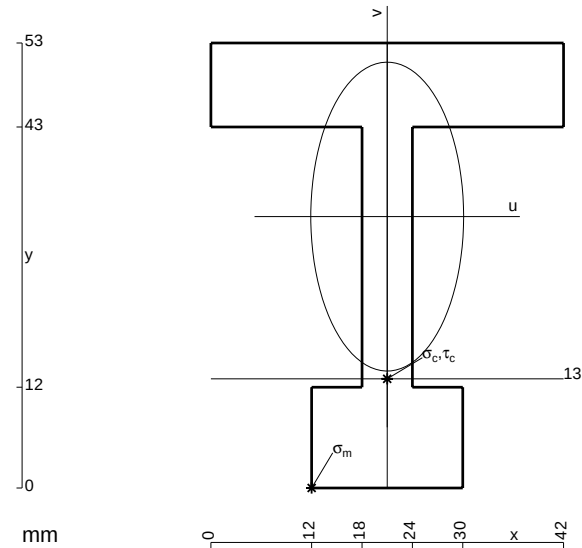
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

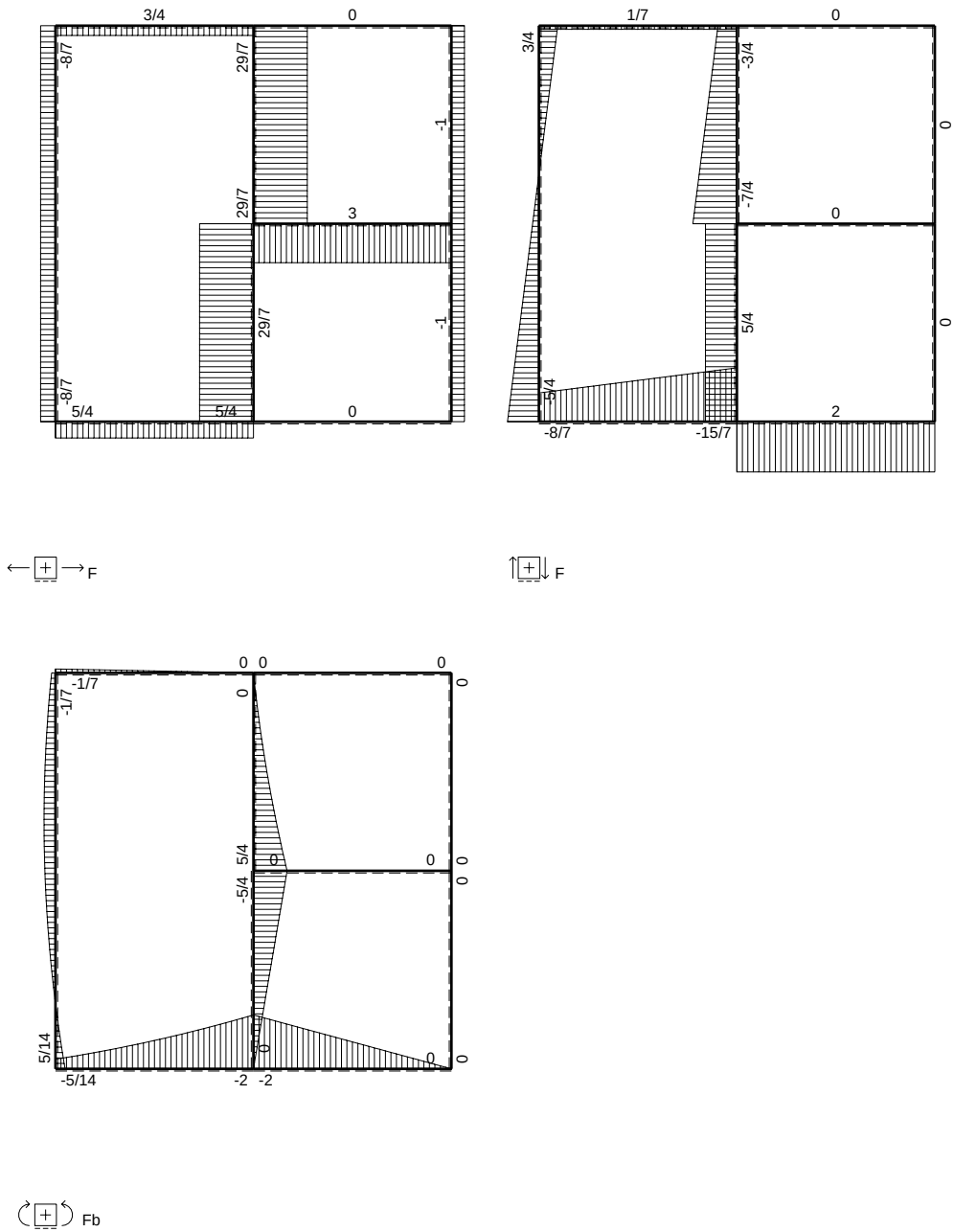
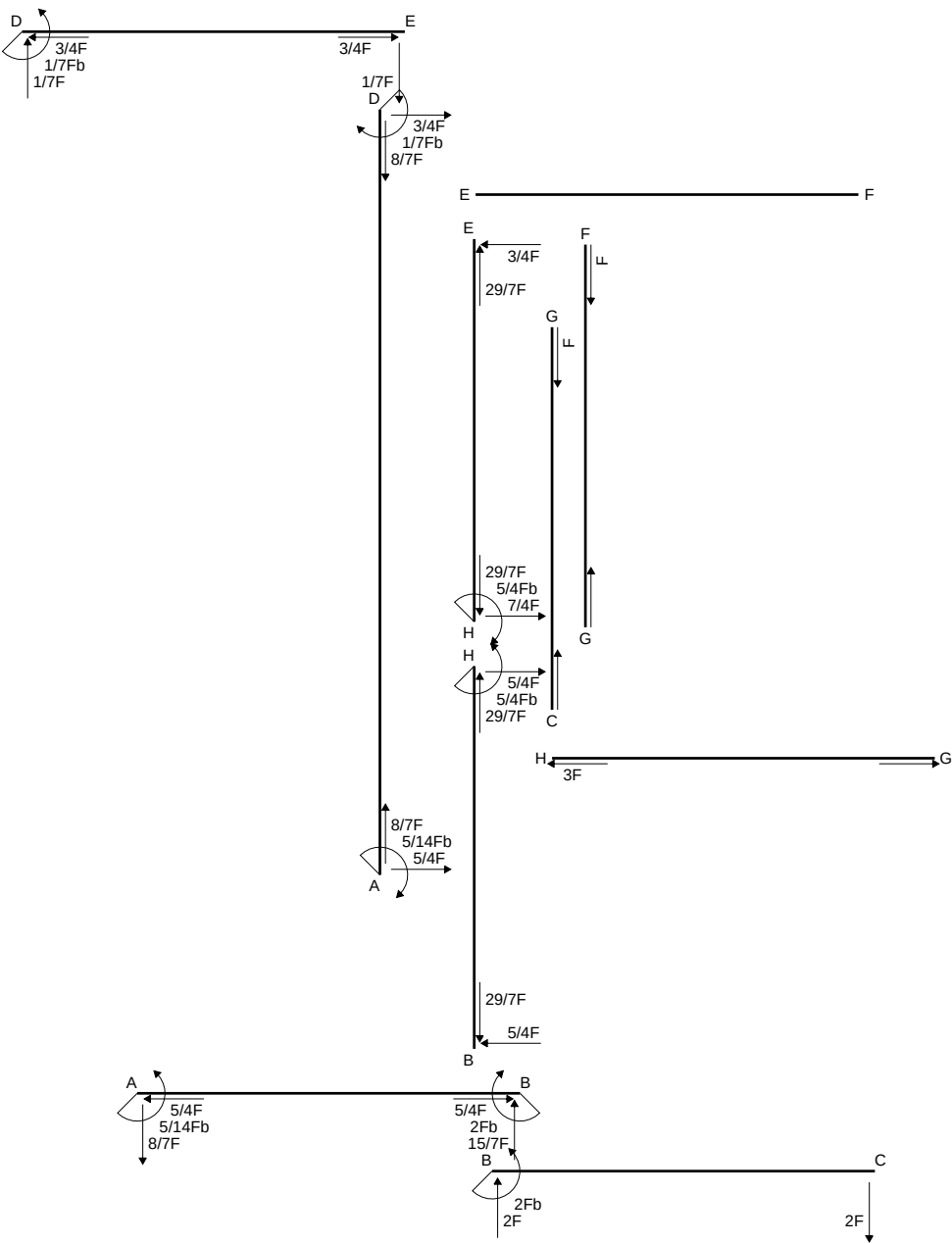
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

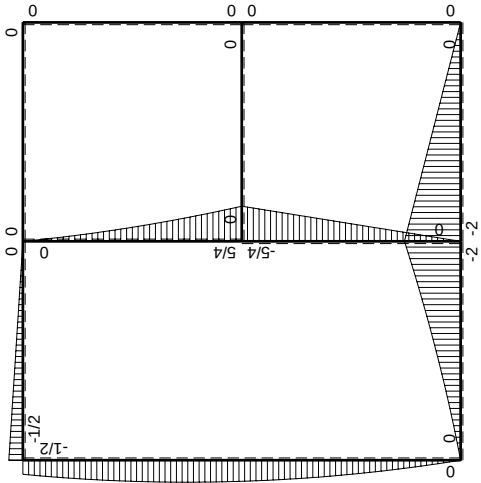
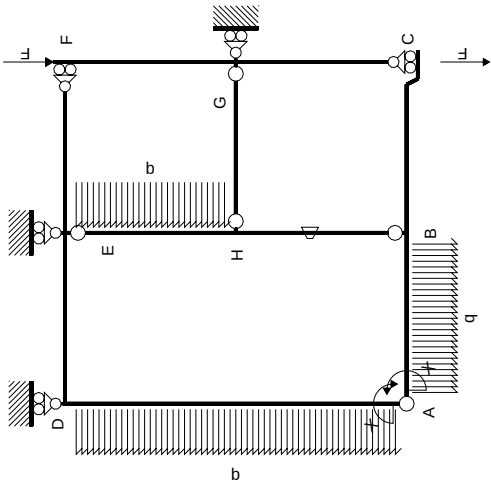
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



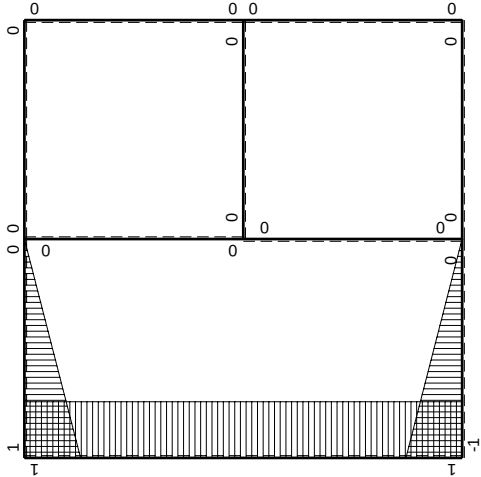
$$\begin{aligned}
A &= 822. \text{ mm}^2 \\
J_u &= 278203. \text{ mm}^4 \\
J_v &= 68130. \text{ mm}^4 \\
y_g &= 32.32 \text{ mm} \\
T_y &= 2300. \text{ N} \\
M_x &= -1978000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -32.32 \text{ mm} \\
\sigma_m &= -Mv/J_u = -229.8 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -19.32 \text{ mm} \\
\sigma_c &= -Mv/J_u = -137.4 \text{ N/mm}^2 \\
\tau_c &= 7.999 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 138.1 \text{ N/mm}^2 \\
S &= 5805. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



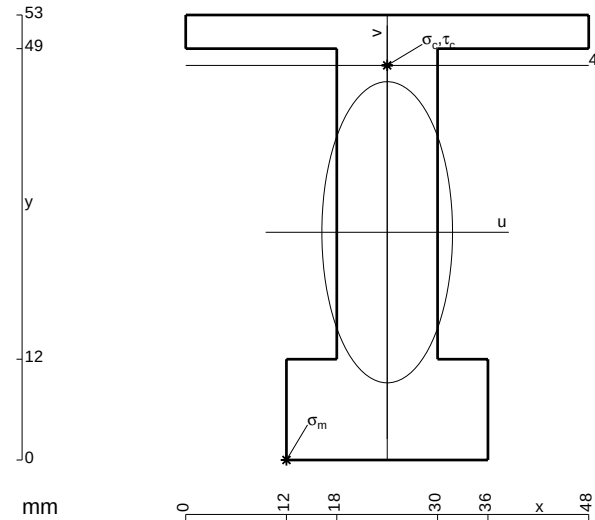
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

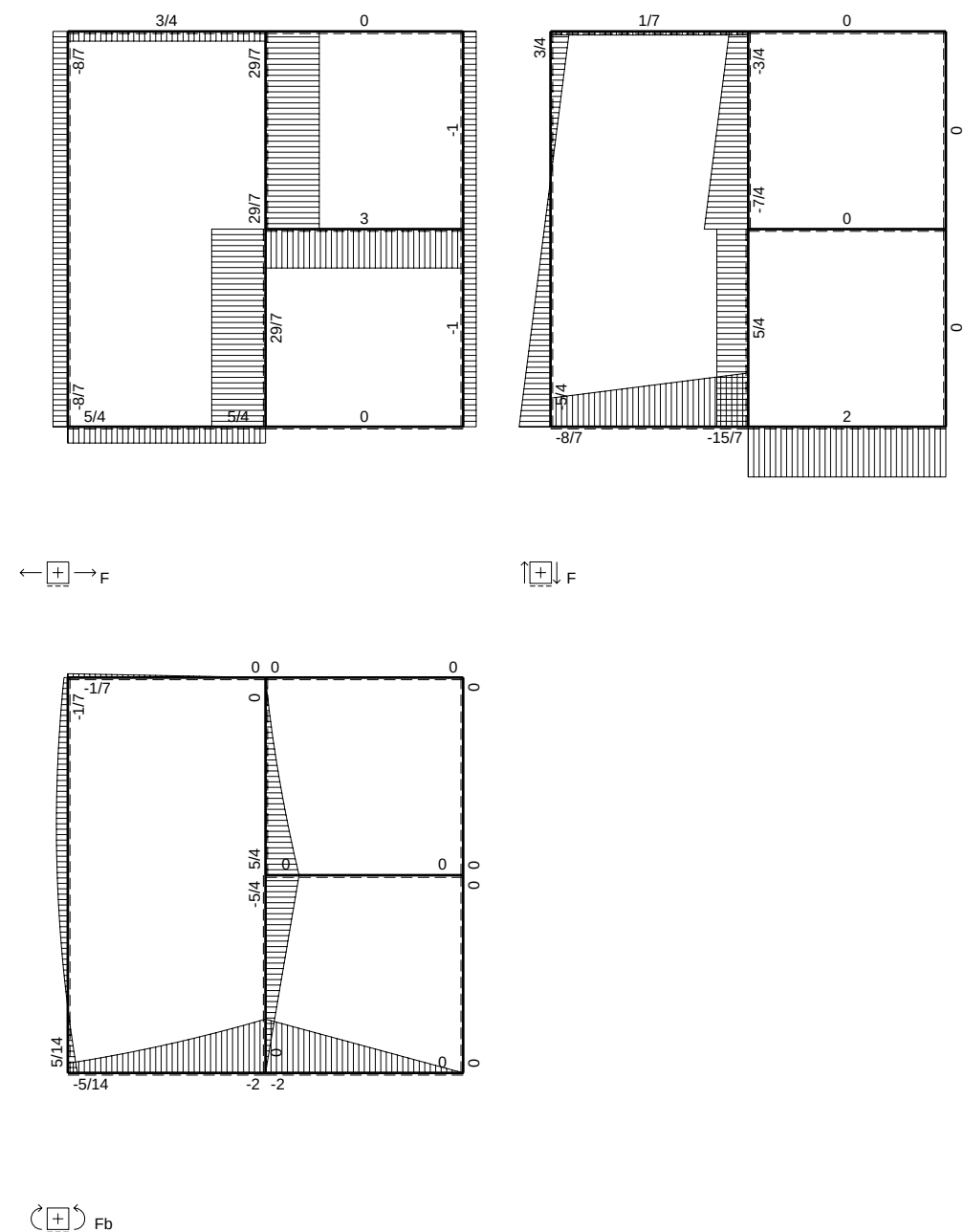
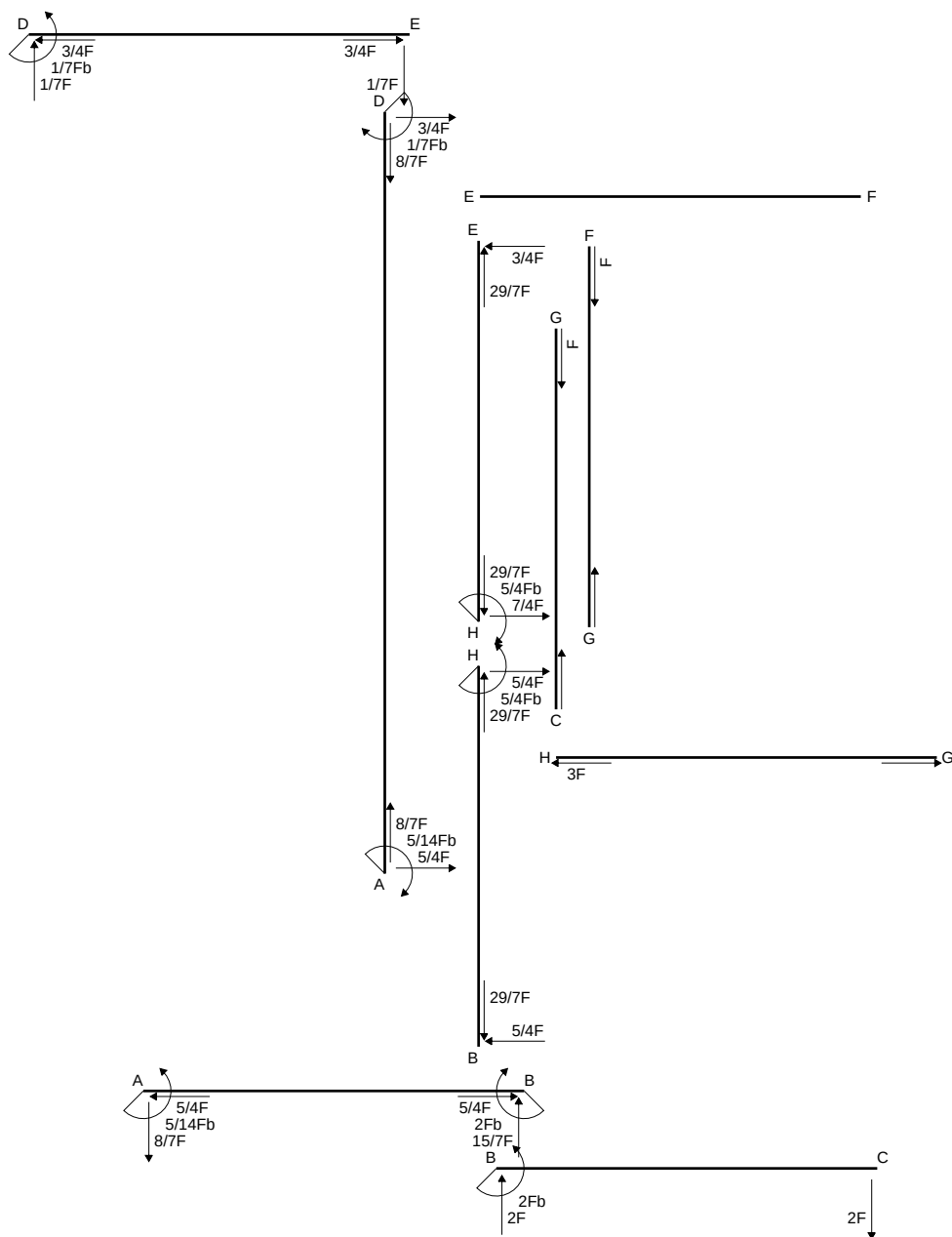
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$5/4Fx$	Fb/EJ	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

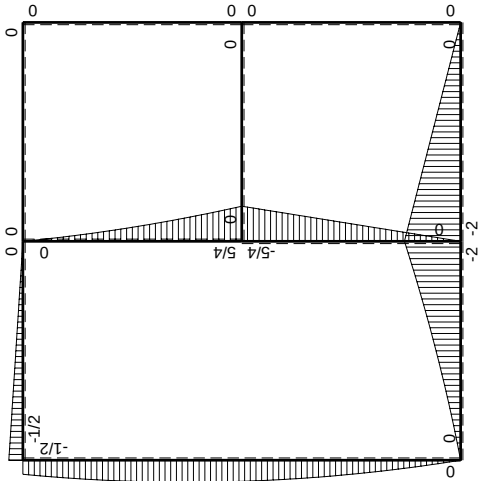
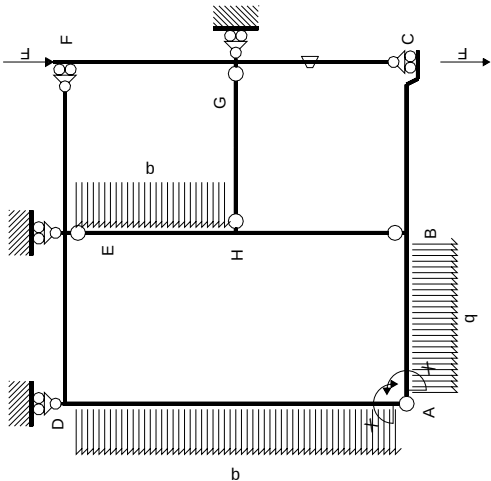
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



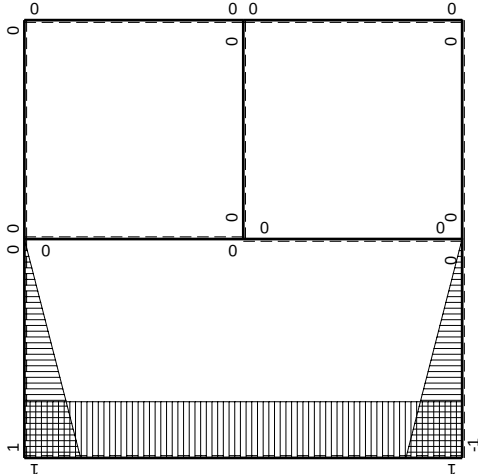
$$\begin{aligned}
A &= 924. \text{ mm}^2 \\
J_u &= 297390. \text{ mm}^4 \\
J_v &= 56016. \text{ mm}^4 \\
y_g &= 27.12 \text{ mm} \\
T_y &= 2880. \text{ N} \\
M_x &= -2620800. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -27.12 \text{ mm} \\
\sigma_m &= -Mv/J_u = -239. \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 47. \text{ mm} \\
v_c &= 19.88 \text{ mm} \\
\sigma_c &= -Mv/J_u = 175.2 \text{ N/mm}^2 \\
\tau_c &= 4.104 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 175.3 \text{ N/mm}^2 \\
S &= 5085. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



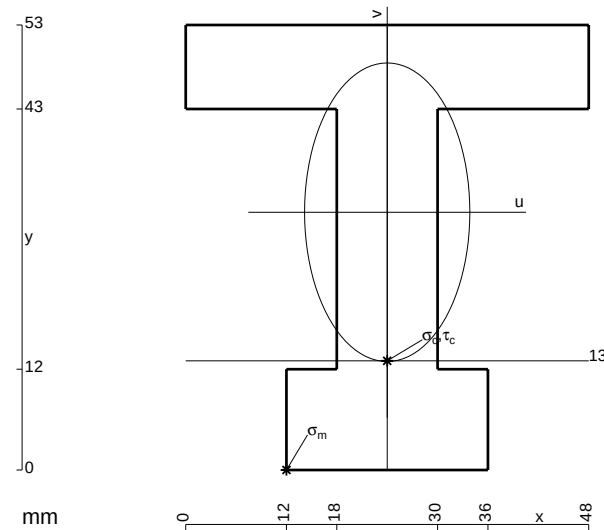
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

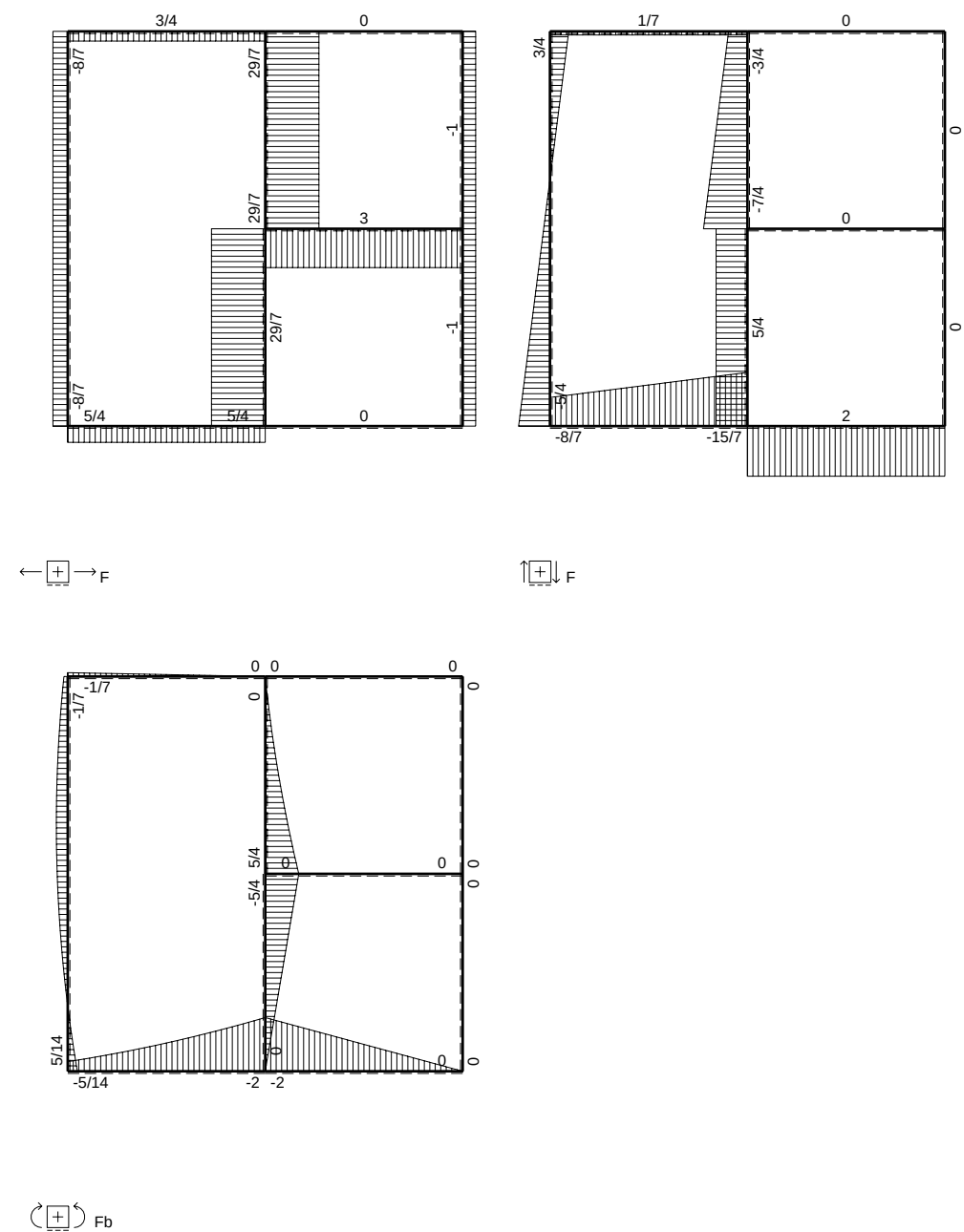
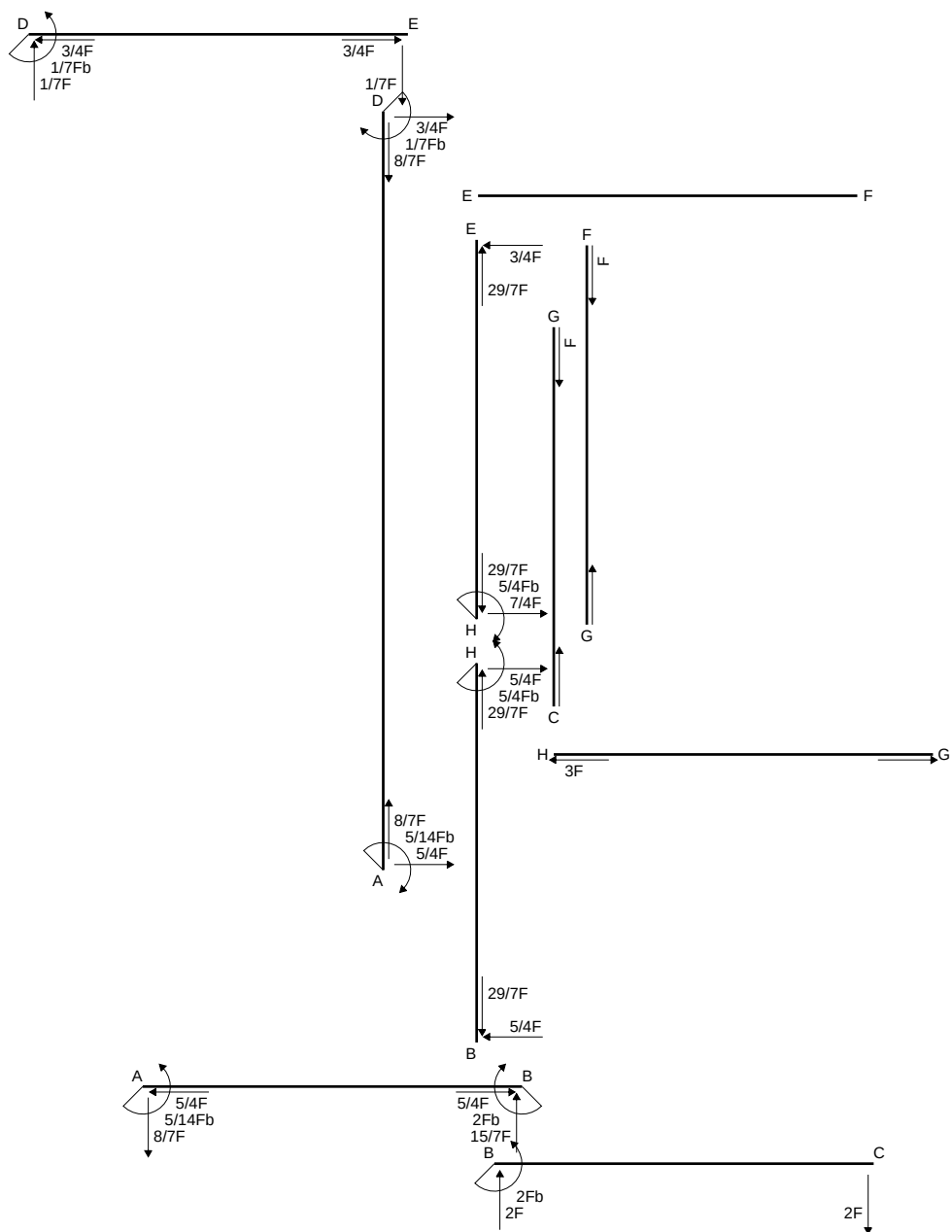
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

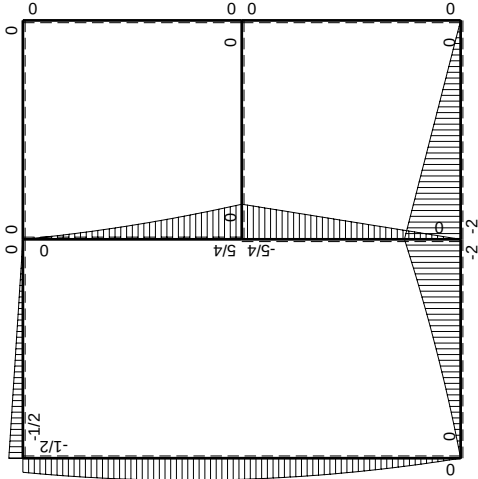
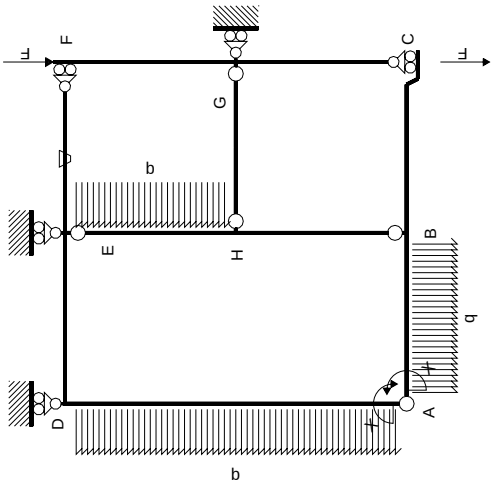
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



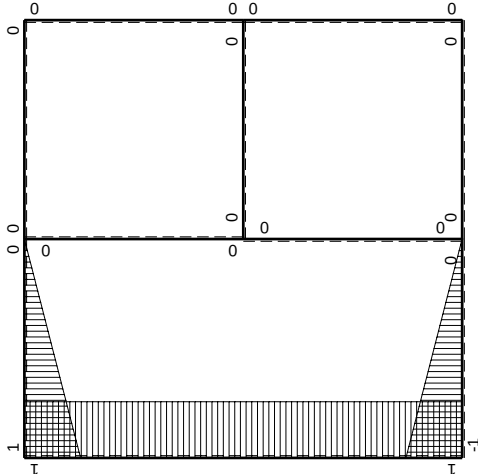
$$\begin{aligned}
A &= 1140. \text{ mm}^2 \\
J_u &= 360421. \text{ mm}^4 \\
J_v &= 110448. \text{ mm}^4 \\
y_g &= 30.7 \text{ mm} \\
T_y &= 4880. \text{ N} \\
M_x &= -2342400. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -30.7 \text{ mm} \\
\sigma_m &= -Mv/J_u = -199.5 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -17.7 \text{ mm} \\
\sigma_c &= -Mv/J_u = -115. \text{ N/mm}^2 \\
\tau_c &= 8.273 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 115.9 \text{ N/mm}^2 \\
S &= 7332. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



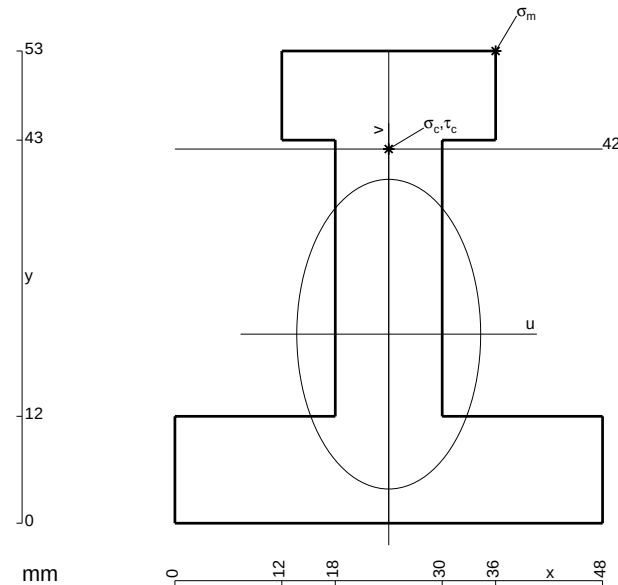
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

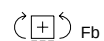
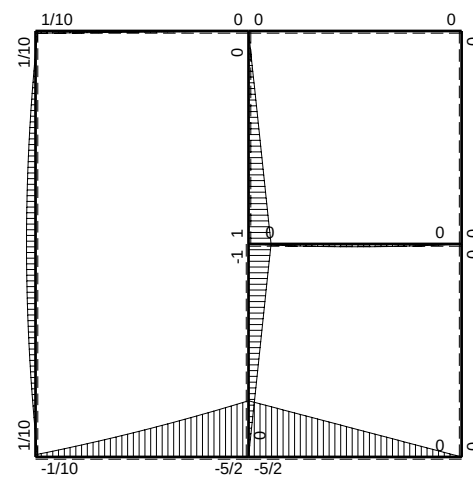
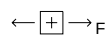
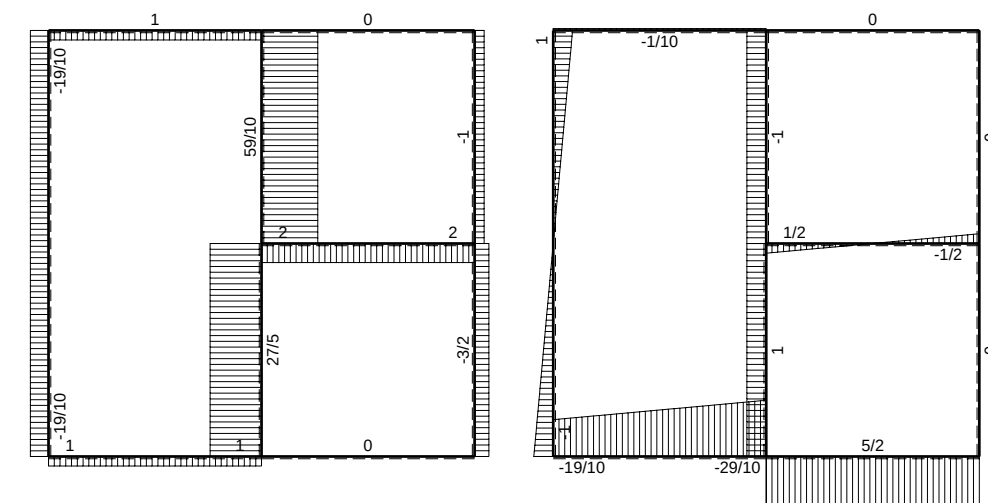
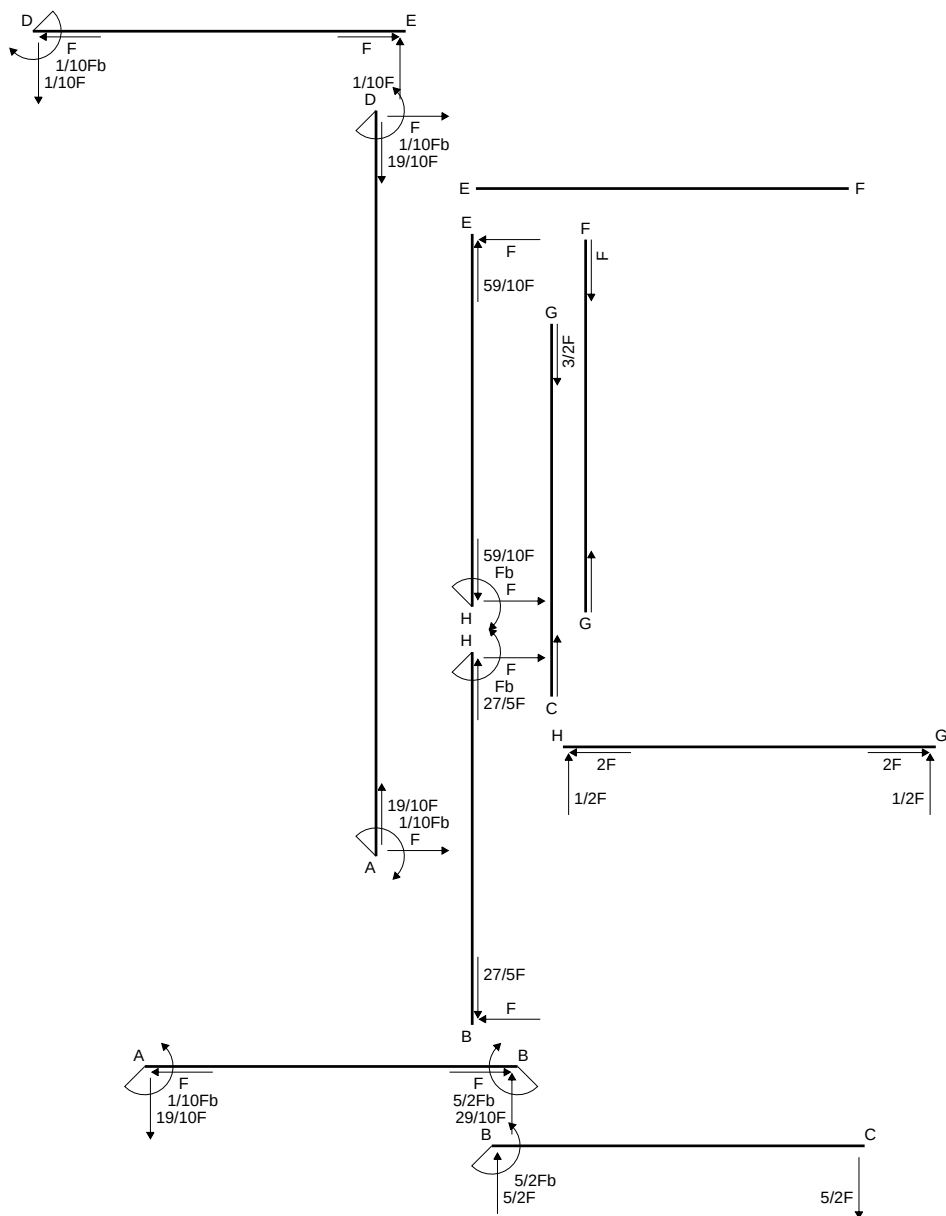
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

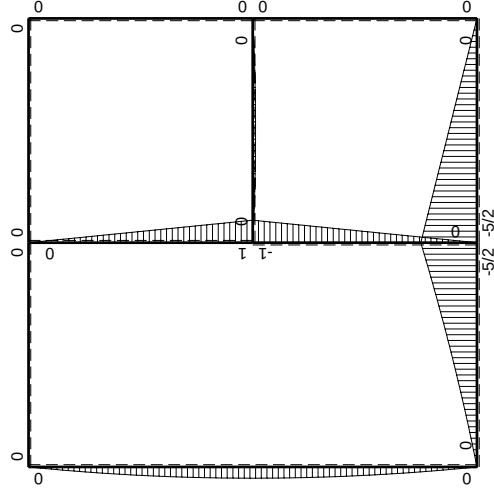
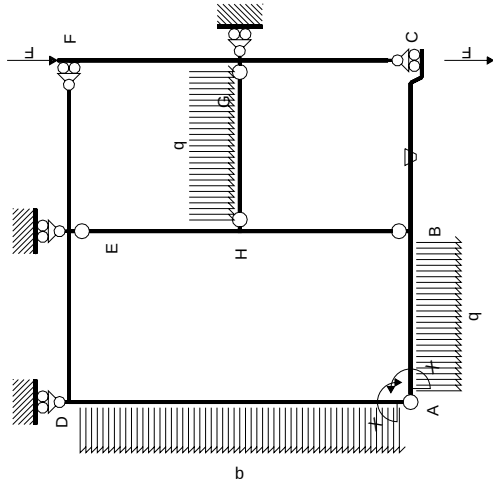
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



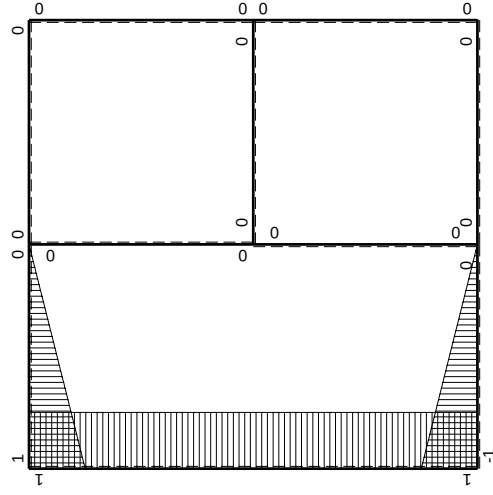
$$\begin{aligned}
A &= 1188. \text{ mm}^2 \\
J_u &= 358924. \text{ mm}^4 \\
J_v &= 126576. \text{ mm}^4 \\
y_g &= 21.22 \text{ mm} \\
T_y &= 4560. \text{ N} \\
M_x &= -2371200. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 31.78 \text{ mm} \\
\sigma_m &= -Mv/J_u = 210. \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 42. \text{ mm} \\
v_c &= 20.78 \text{ mm} \\
\sigma_c &= -Mv/J_u = 137.3 \text{ N/mm}^2 \\
\tau_c &= 7.076 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 137.8 \text{ N/mm}^2 \\
S &= 6683. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_o flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$5/2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$-Fx+1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1	$(-2/3+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fx-1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-Fb+Fx$	0	0	0	0	0+0	0
BH b	0	Fx	0	0	0	0		
HE b	0	$Fb-Fx$	0	0	0	0	0+0	0
EH b	0	$-Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

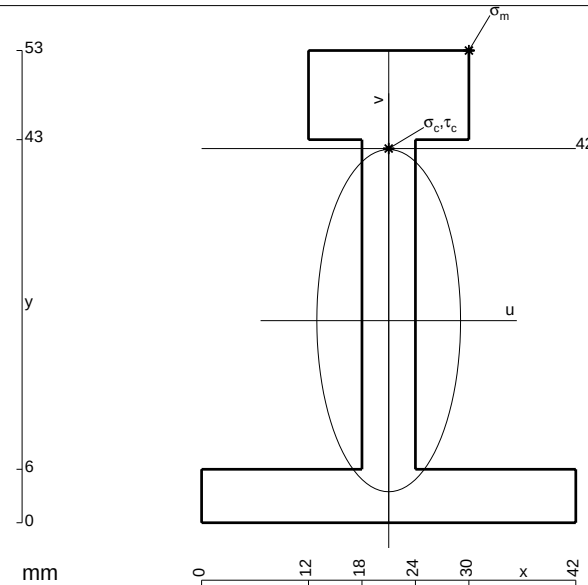
$$= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{AD}^{x_0} = \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ}$$

$$L_{DA}^{x_0} = \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ}$$



$$A = 654. \text{ mm}^2$$

$$J_u = 241316. \text{ mm}^4$$

$$J_v = 42570. \text{ mm}^4$$

$$y_g = 22.68 \text{ mm}$$

$$T_y = 3050. \text{ N}$$

$$M_x = -1738500. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 30.32 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 218.4 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 42. \text{ mm}$$

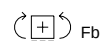
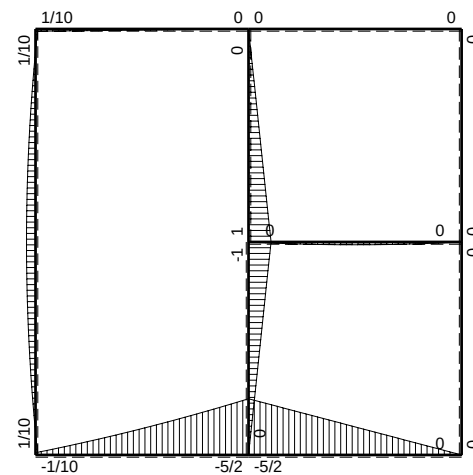
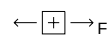
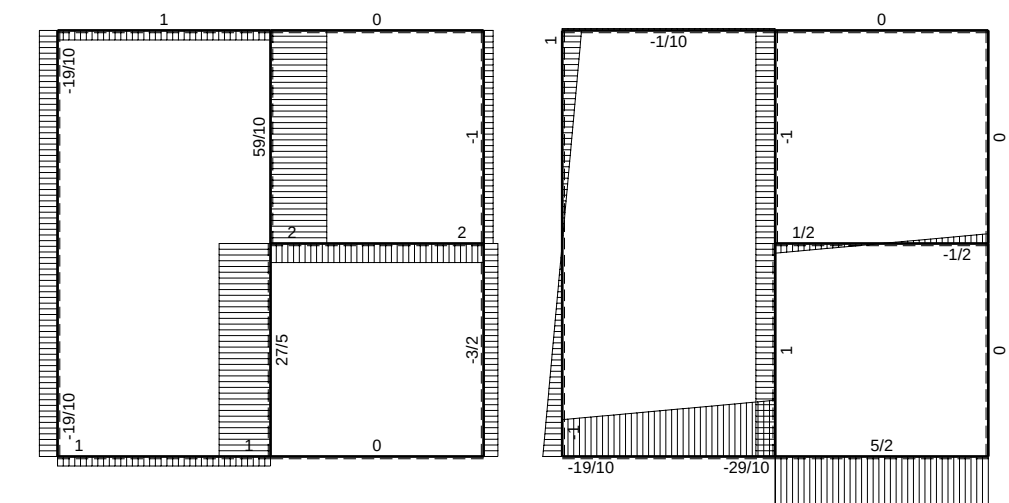
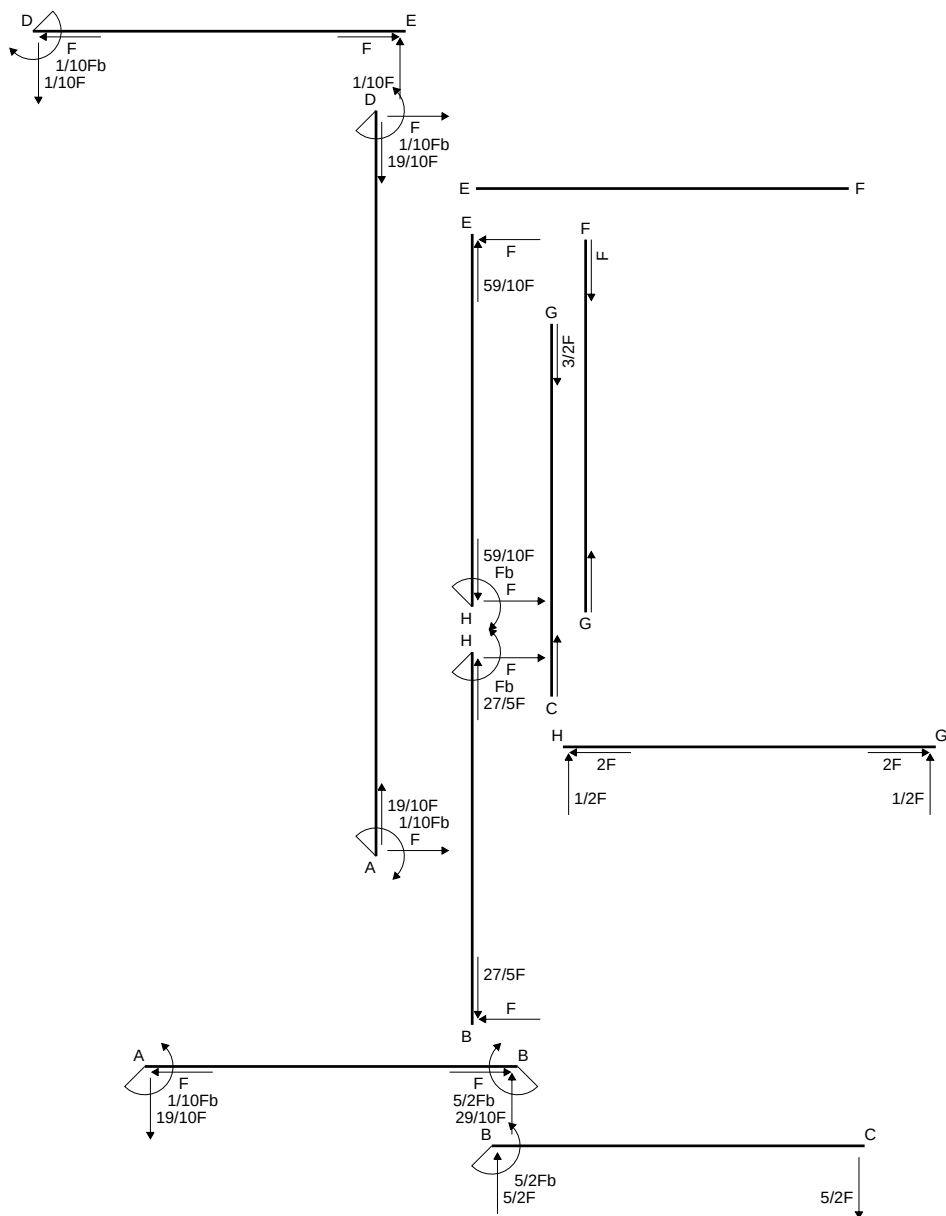
$$v_c = 19.32 \text{ mm}$$

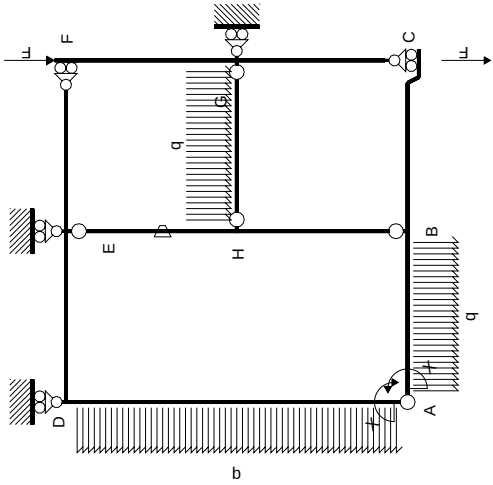
$$\sigma_c = -Mv/J_u = 139.2 \text{ N/mm}^2$$

$$\tau_c = 9.85 \text{ N/mm}^2$$

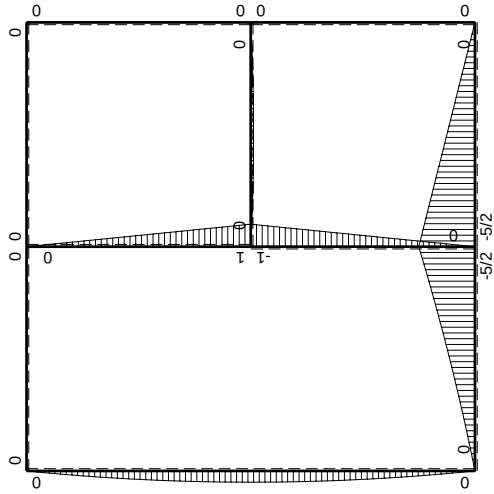
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 140.2 \text{ N/mm}^2$$

$$S = 4676. \text{ mm}^3$$



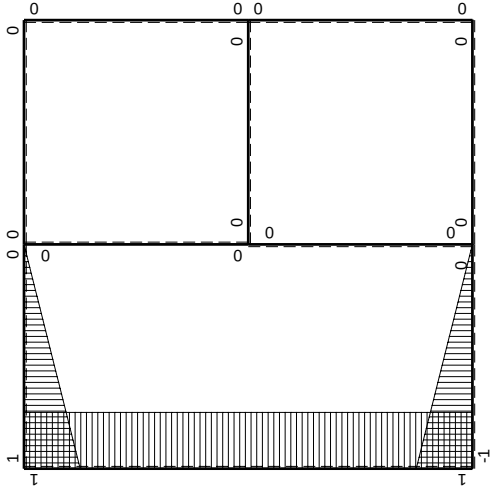


b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-Fx+1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1	$(-2/3+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fx-1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-Fb+Fx$	0	0	0	0	0+0	0
BH b	0	Fx	0	0	0	0		
HE b	0	$Fb-Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

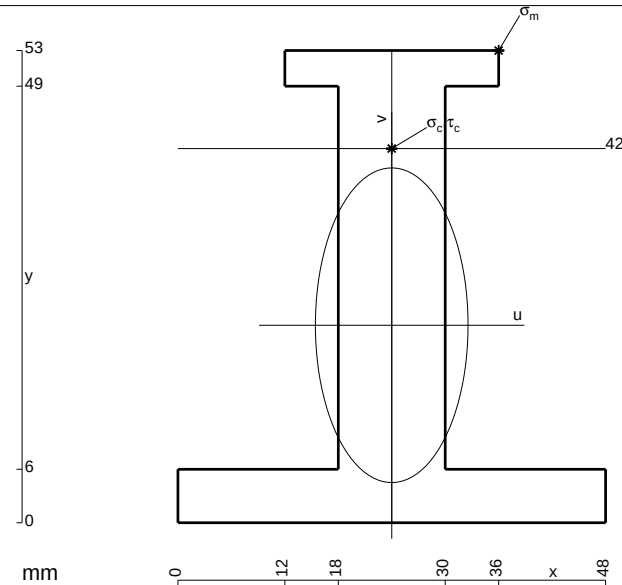
$$= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{AD}^{xo} = \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ}$$

$$L_{DA}^{xo} = \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ}$$



$$A = 900. \text{ mm}^2$$

$$J_u = 280787. \text{ mm}^4$$

$$J_v = 66096. \text{ mm}^4$$

$$y_g = 22.17 \text{ mm}$$

$$T_y = 3375. \text{ N}$$

$$M_x = -2092500. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 30.83 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 229.8 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 42. \text{ mm}$$

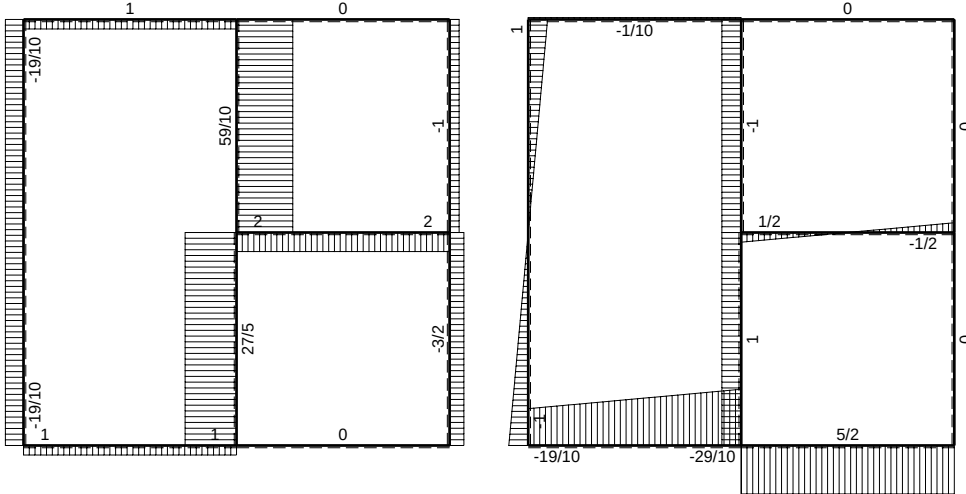
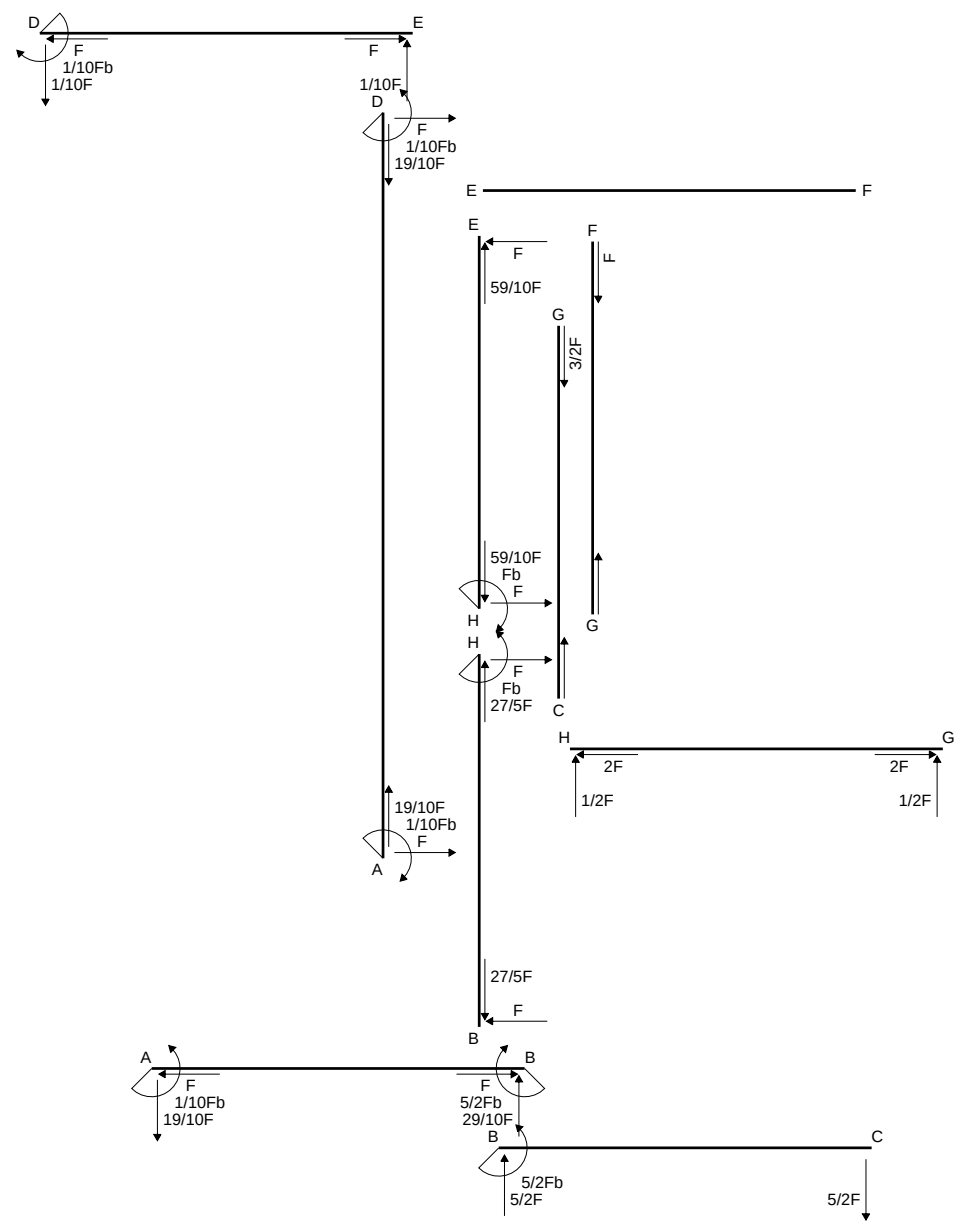
$$v_c = 19.83 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 147.8 \text{ N/mm}^2$$

$$\tau_c = 4.736 \text{ N/mm}^2$$

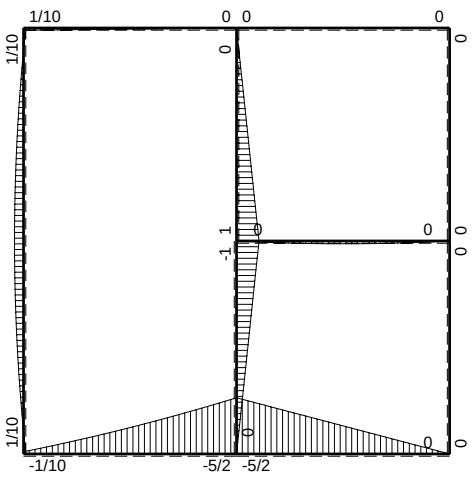
$$\sigma_\varphi = \sqrt{\sigma^2 + 3\tau^2} = 148. \text{ N/mm}^2$$

$$S = 4728. \text{ mm}^3$$

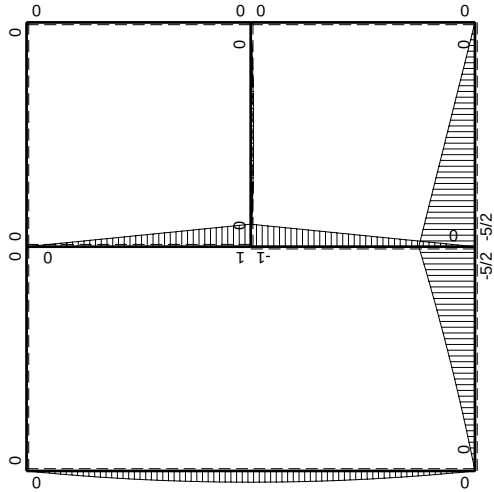
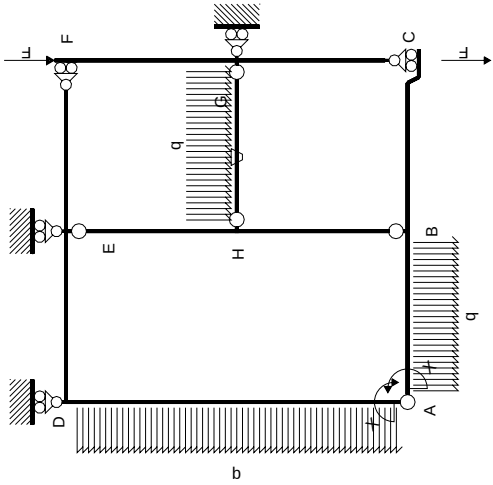


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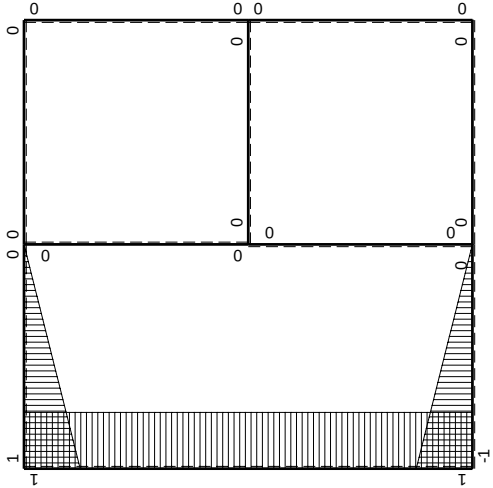


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Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



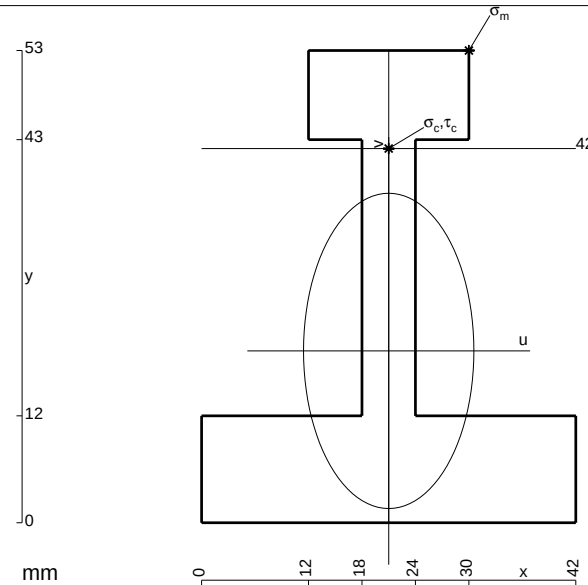
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

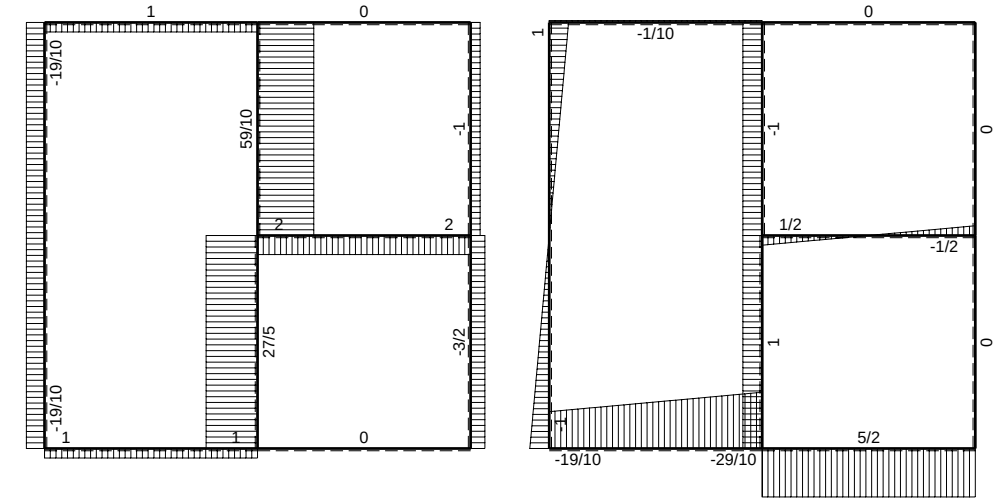
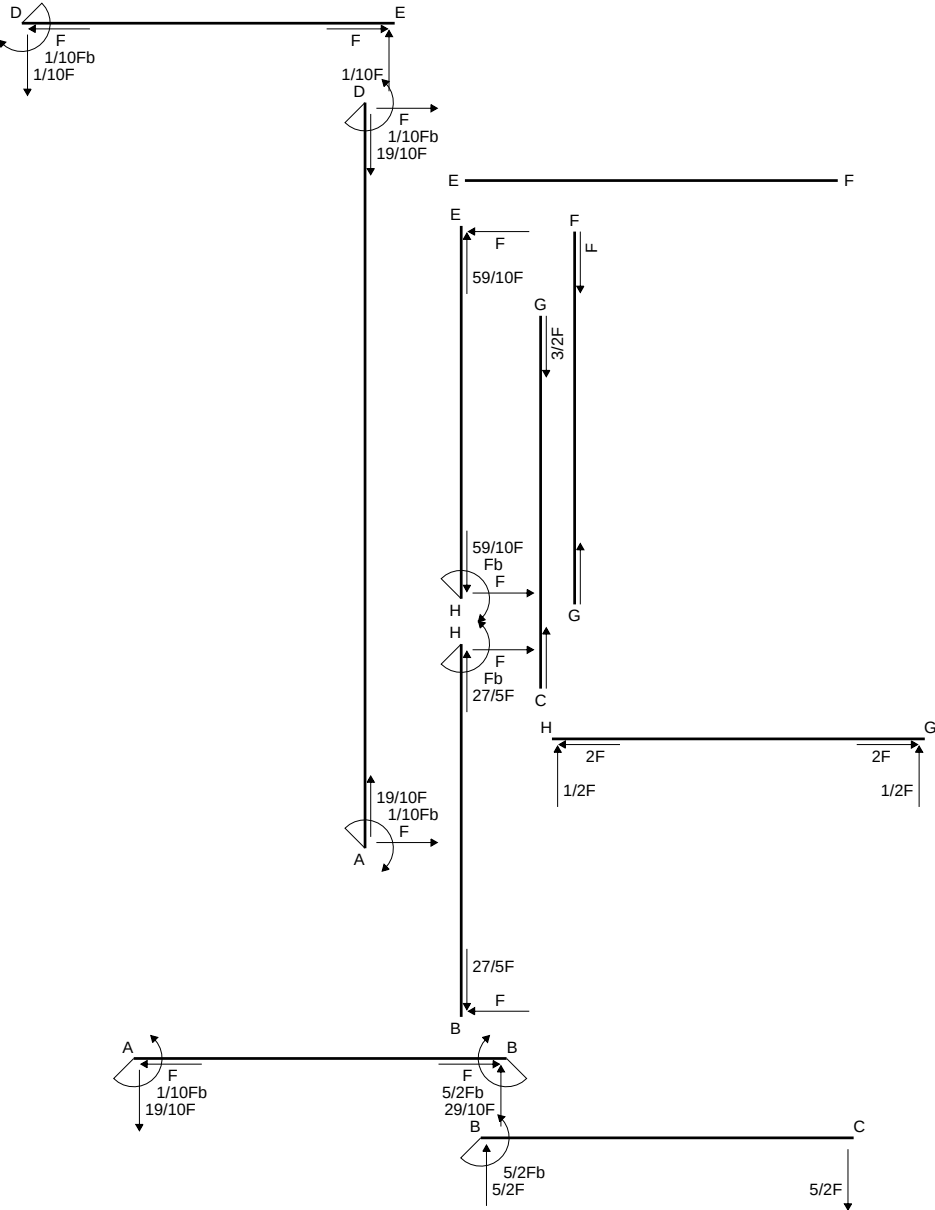
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-Fx+1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1	$(-2/3+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fx-1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	Fb/EJ	0	0	0		
HB b	0	$-Fb+Fx$	0	0	0	0	0+0	0
BH b	0	Fx	0	0	0	0		
HE b	0	$Fb-Fx$	0	0	0	0	0+0	0
EH b	0	$-Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
 L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
 &= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
 L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
 &= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
 L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
 &= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
 L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
 &= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
 L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
 &= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
 L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
 &= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
 L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
 L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
 L_{AD}^{x_0} &= \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
 &= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ} \\
 L_{DA}^{x_0} &= \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
 &= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ}
 \end{aligned}$$

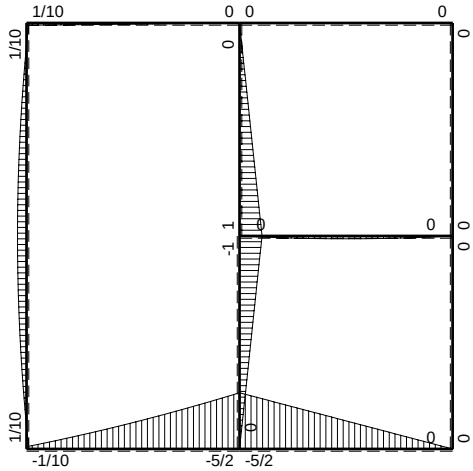


$$\begin{aligned}
 A &= 870. \text{ mm}^2 \\
 J_u &= 272367. \text{ mm}^4 \\
 J_v &= 79506. \text{ mm}^4 \\
 y_g &= 19.29 \text{ mm} \\
 T_y &= 2875. \text{ N} \\
 M_x &= -1926250. \text{ Nmm} \\
 x_m &= 30. \text{ mm} \\
 y_m &= 53. \text{ mm} \\
 u_m &= 9. \text{ mm} \\
 v_m &= 33.71 \text{ mm} \\
 \sigma_m &= -Mv/J_u = 238.4 \text{ N/mm}^2 \\
 x_c &= 21. \text{ mm} \\
 y_c &= 42. \text{ mm} \\
 v_c &= 22.71 \text{ mm} \\
 \sigma_c &= -Mv/J_u = 160.6 \text{ N/mm}^2 \\
 \tau_c &= 9.338 \text{ N/mm}^2 \\
 \sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 161.4 \text{ N/mm}^2 \\
 S &= 5308. \text{ mm}^3
 \end{aligned}$$

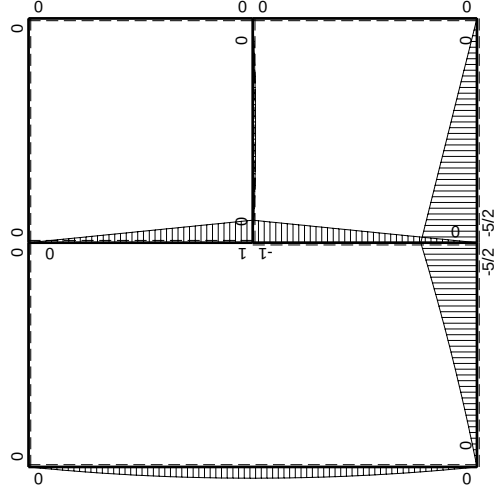
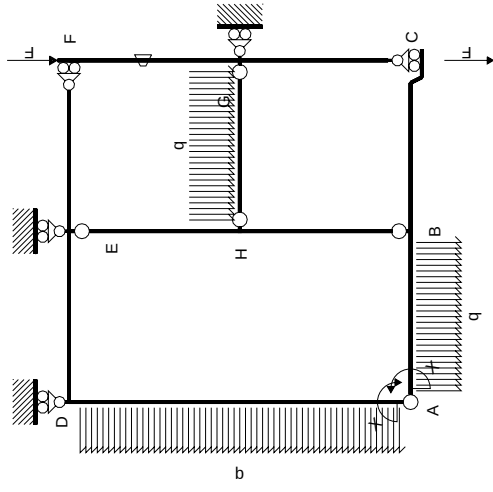


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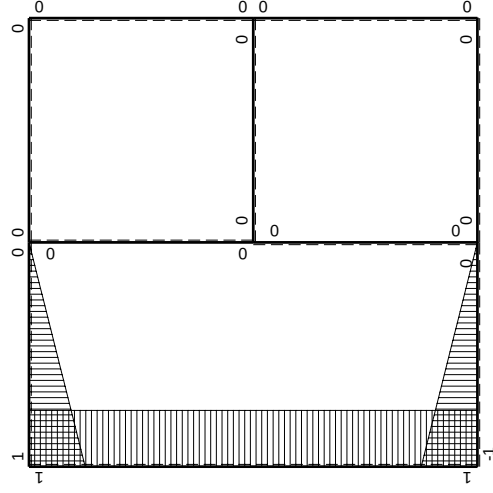
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Schema di calcolo iperstatico



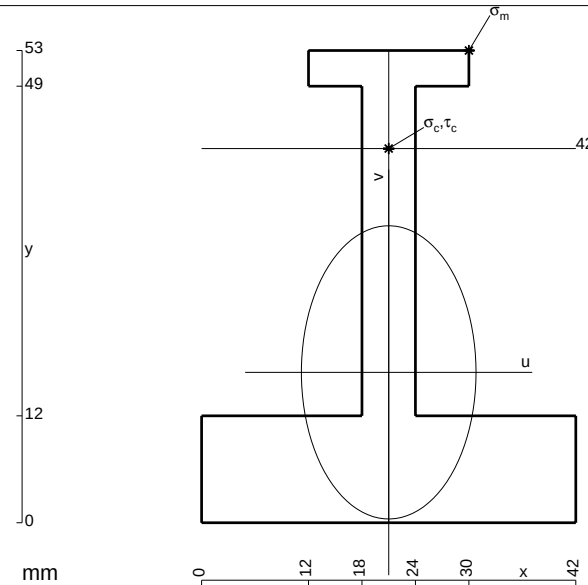
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

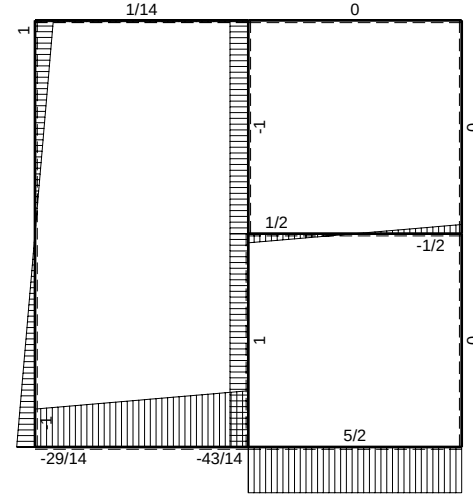
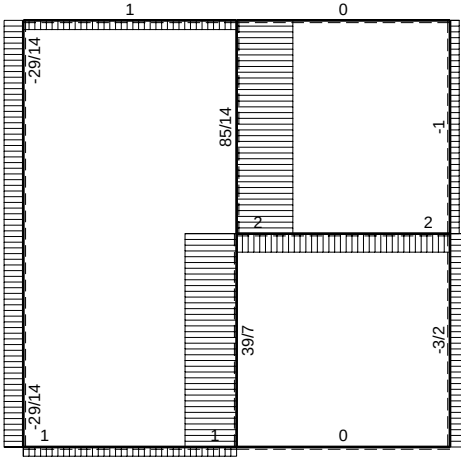
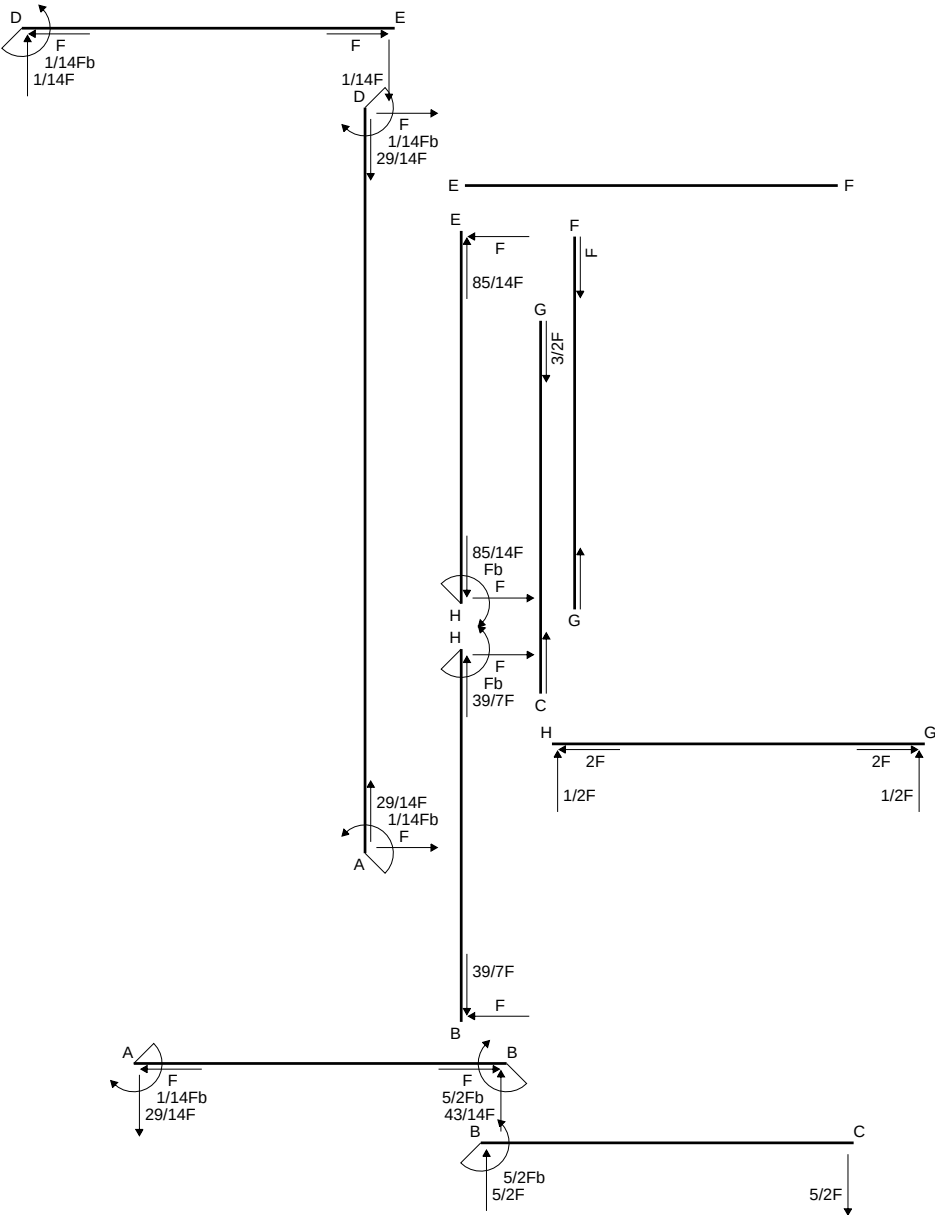
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-Fx+1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1	$(-2/3+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fx-1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-Fb+Fx$	0	0	0	0	0+0	0
BH b	0	Fx	0	0	0	0		
HE b	0	$Fb-Fx$	0	0	0	0	0+0	0
EH b	0	$-Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ}
\end{aligned}$$

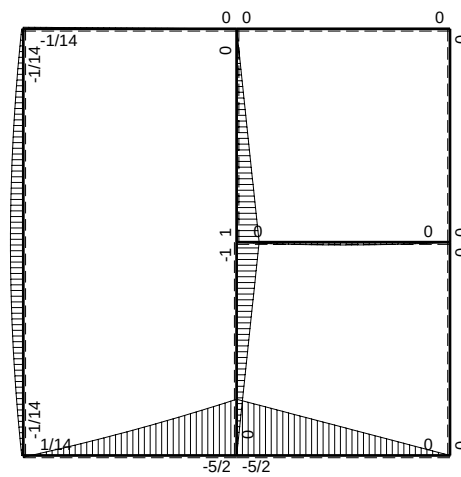


$$\begin{aligned}
A &= 798. \text{ mm}^2 \\
J_u &= 216134. \text{ mm}^4 \\
J_v &= 76698. \text{ mm}^4 \\
y_g &= 16.88 \text{ mm} \\
T_y &= 1650. \text{ N} \\
M_x &= -1188000. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 36.12 \text{ mm} \\
\sigma_m &= -Mv/J_u = 198.6 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 42. \text{ mm} \\
v_c &= 25.12 \text{ mm} \\
\sigma_c &= -Mv/J_u = 138.1 \text{ N/mm}^2 \\
\tau_c &= 4.656 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 138.3 \text{ N/mm}^2 \\
S &= 3659. \text{ mm}^3
\end{aligned}$$

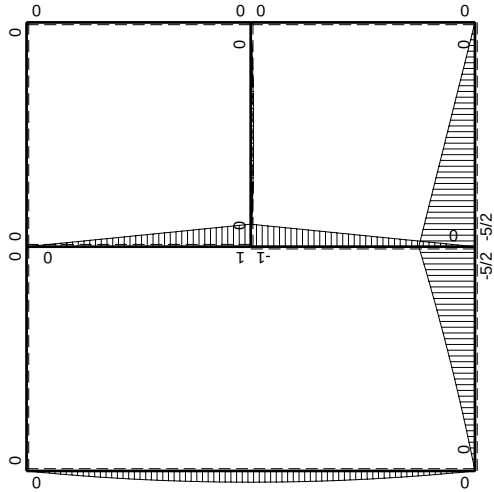
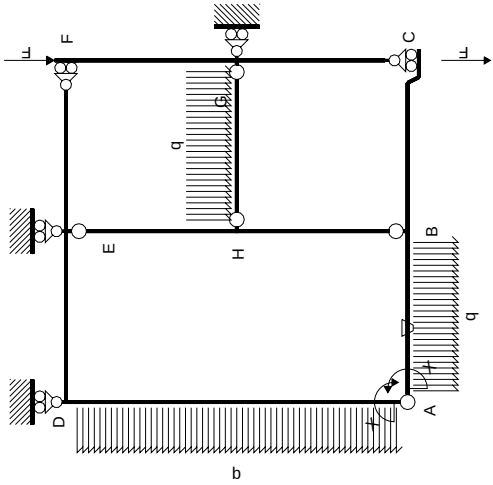


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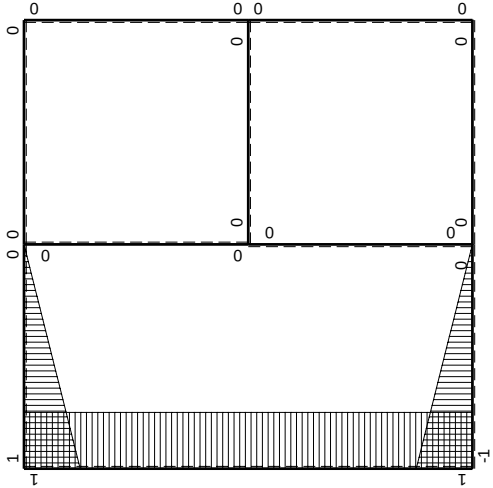


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	$-Fb/EJ$	$2Fx-3/2Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$	$(3/8+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	Fb/EJ	$5/2Fx-3Fx^2/b+1/2qx^3/b$	Fx/EJ	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-Fx+1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1	$(-2/3+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fx-1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-Fb+Fx$	0	0	0	0	0+0	0
BH b	0	Fx	0	0	0	0		
HE b	0	$Fb-Fx$	0	0	0	0	0+0	0
EH b	0	$-Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/14Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + \int_0^b (1 - x/b) \theta dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + \left[x - 1/2 x^2/b \right]_0^b \theta + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + (b - 1/2 b) \theta + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/8 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + \int_0^b (-x/b) \theta dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + \left[-1/2 x^2/b \right]_0^b \theta + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

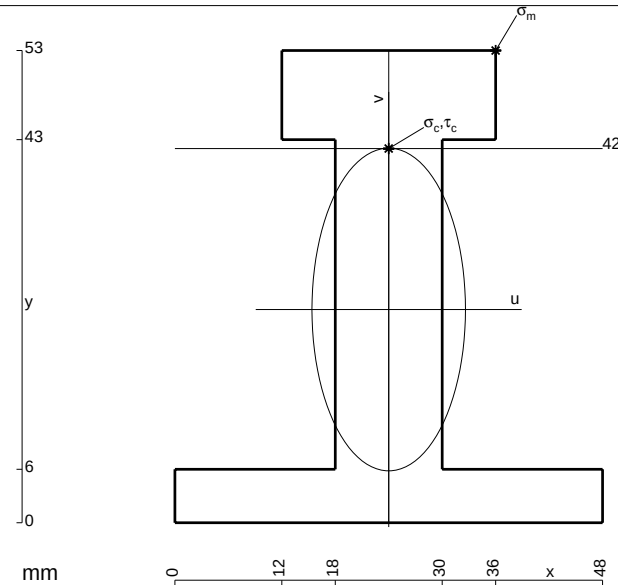
$$= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + (-1/2 b) \theta + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/8 \frac{Fb^2}{EJ}$$

$$L_{AD}^{x_0} = \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ}$$

$$L_{DA}^{x_0} = \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ}$$



$$A = 972. \text{ mm}^2$$

$$J_u = 318872. \text{ mm}^4$$

$$J_v = 72144. \text{ mm}^4$$

$$y_g = 23.93 \text{ mm}$$

$$T_y = 3025. \text{ N}$$

$$M_x = -2299000. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 29.07 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 209.6 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 42. \text{ mm}$$

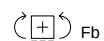
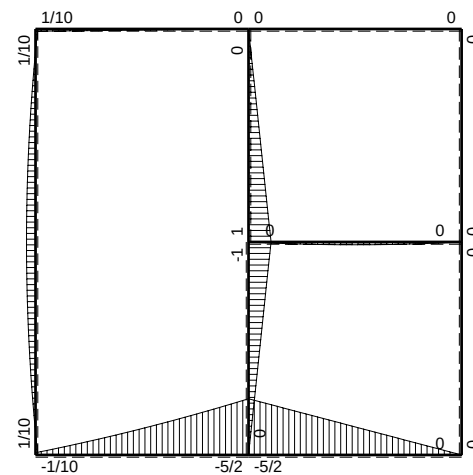
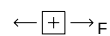
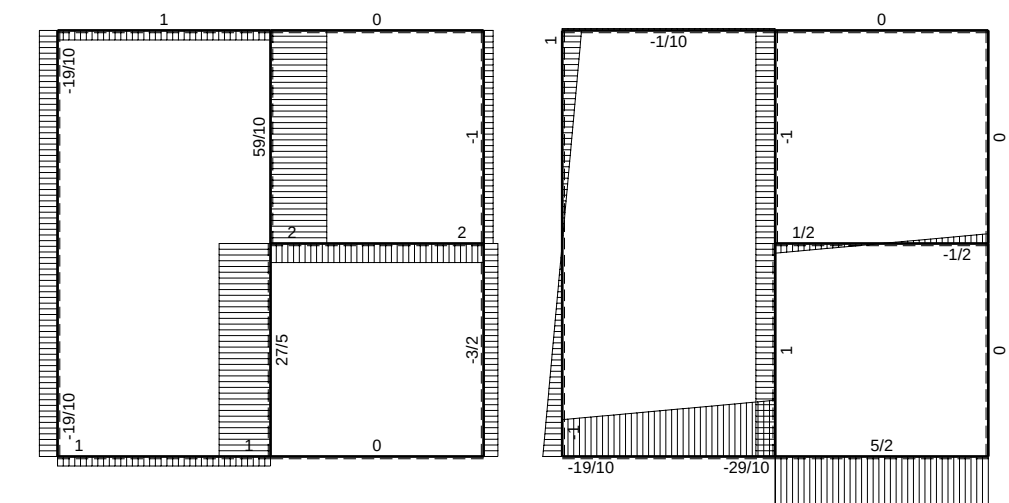
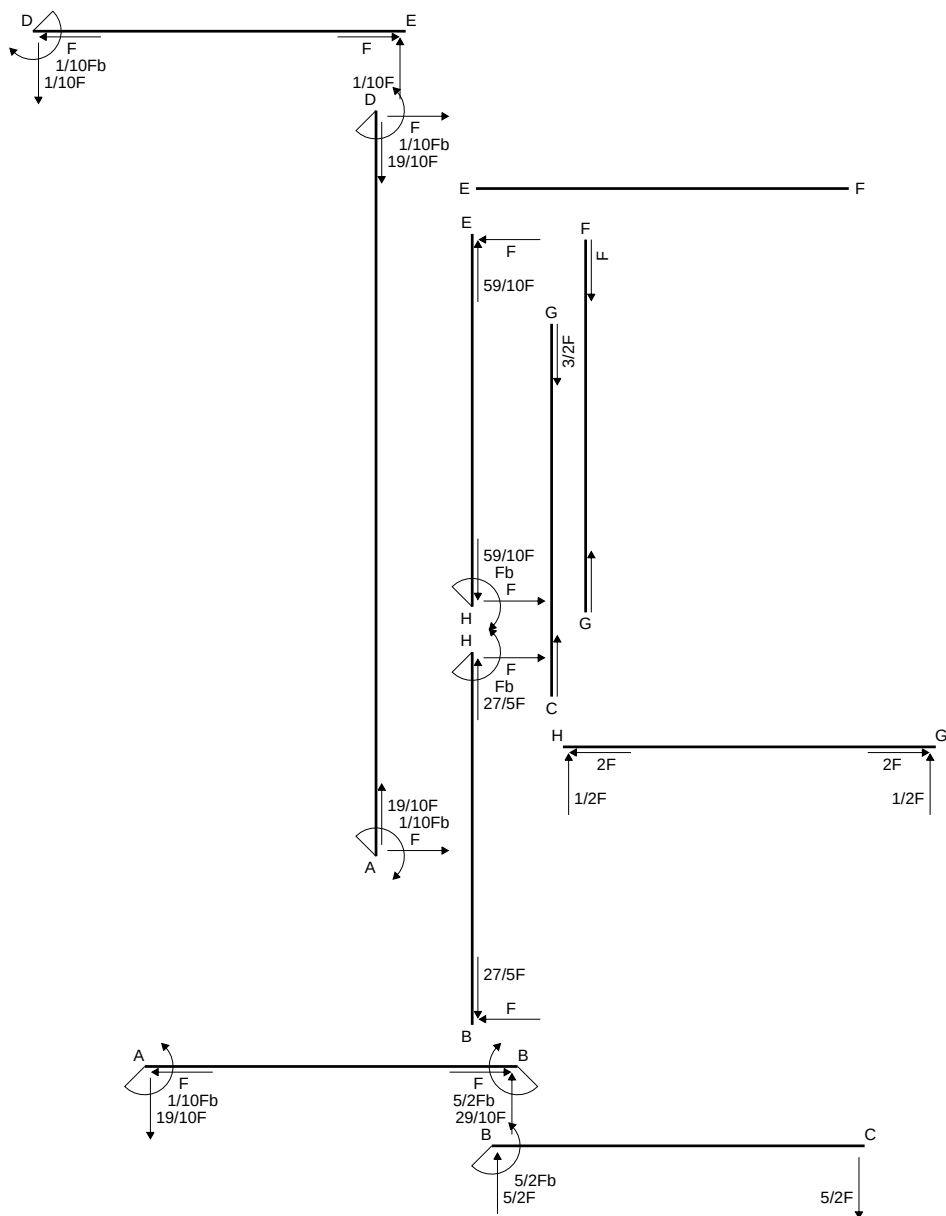
$$v_c = 18.07 \text{ mm}$$

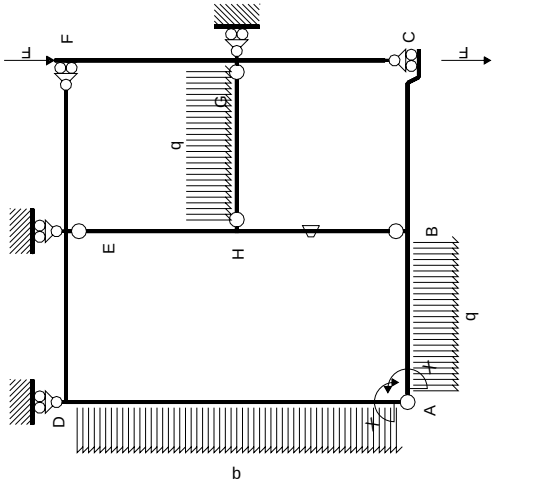
$$\sigma_c = -Mv/J_u = 130.3 \text{ N/mm}^2$$

$$\tau_c = 4.743 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 130.5 \text{ N/mm}^2$$

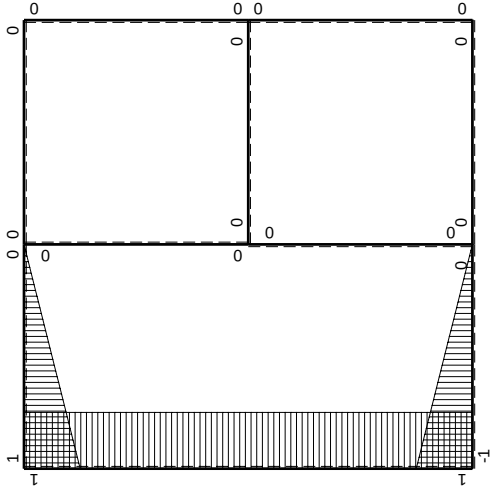
$$S = 5999. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



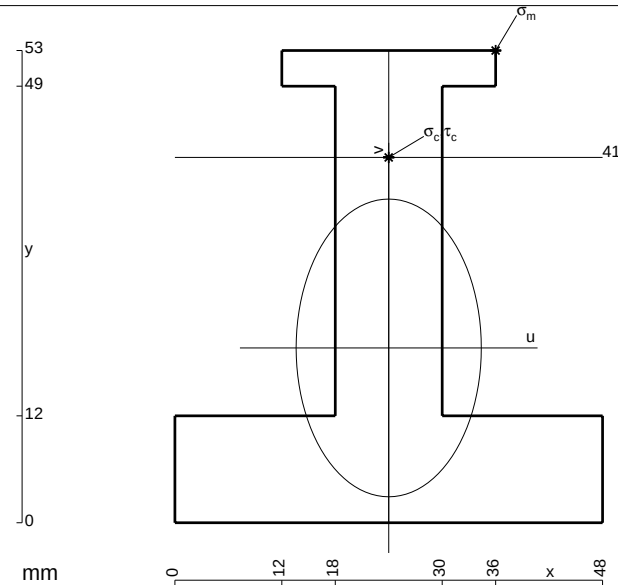
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

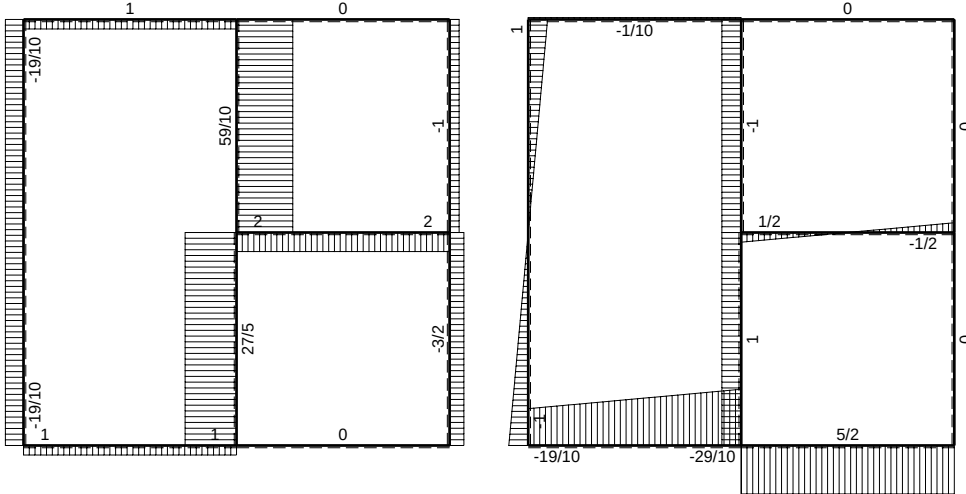
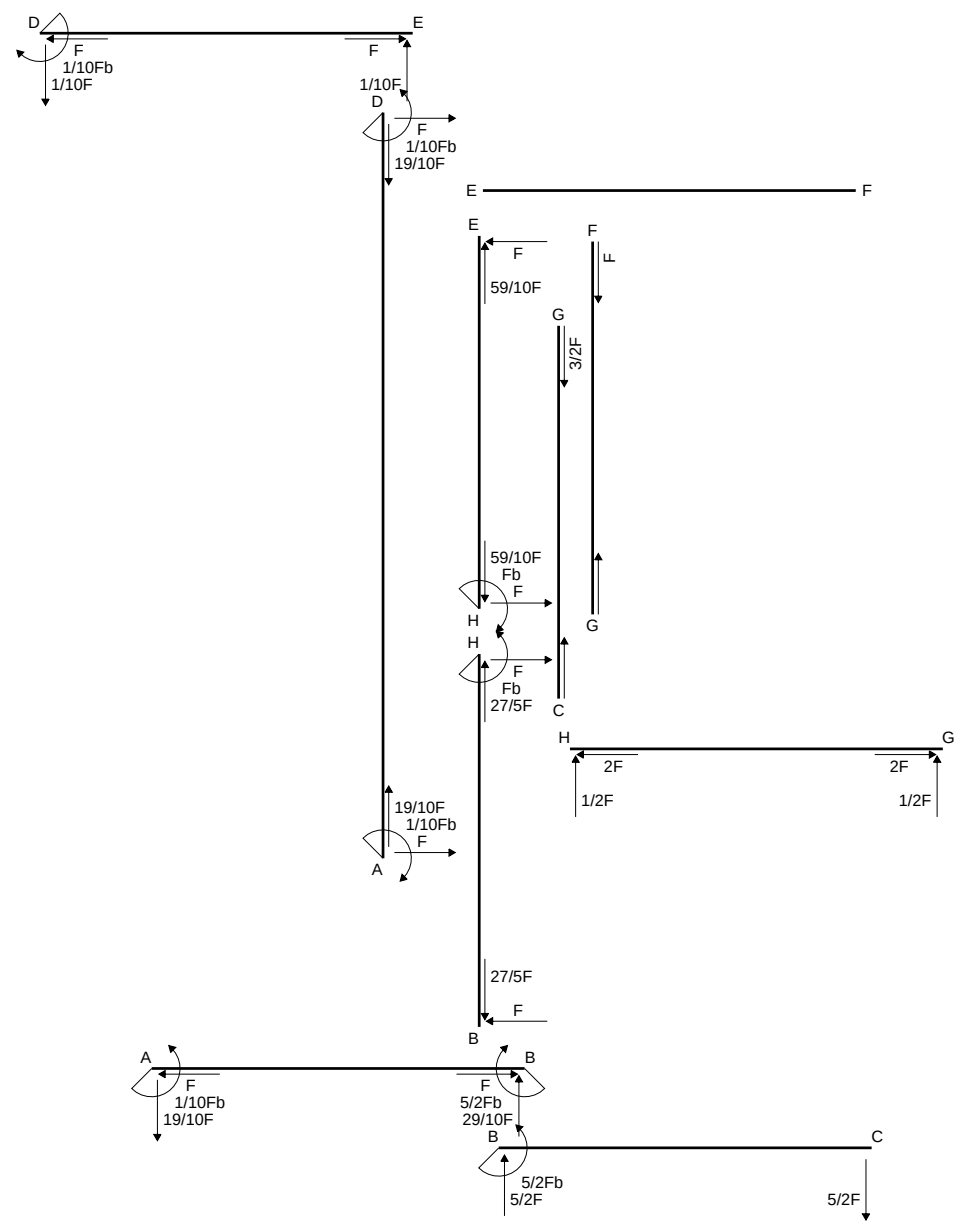
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-Fx+1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1	$(-2/3+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fx-1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-Fb+Fx$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	Fx	Fb/EJ	0	0	0		
HE b	0	$Fb-Fx$	0	0	0	0	0+0	0
EH b	0	$-Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ}
\end{aligned}$$

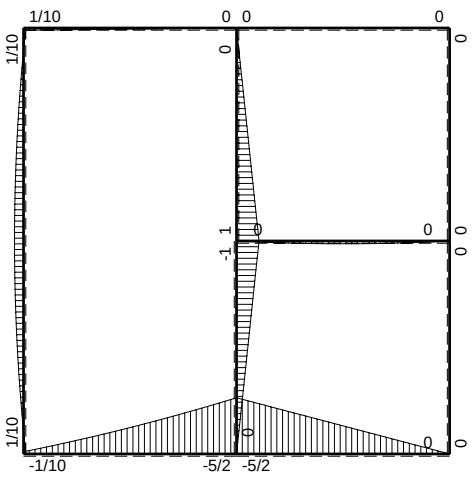


$$\begin{aligned}
A &= 1116. \text{ mm}^2 \\
J_u &= 311633. \text{ mm}^4 \\
J_v &= 120528. \text{ mm}^4 \\
y_g &= 19.62 \text{ mm} \\
T_y &= 2525. \text{ N} \\
M_x &= -2045250. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 33.38 \text{ mm} \\
\sigma_m &= -Mv/J_u = 219.1 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 41. \text{ mm} \\
v_c &= 21.38 \text{ mm} \\
\sigma_c &= -Mv/J_u = 140.3 \text{ N/mm}^2 \\
\tau_c &= 3.679 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 140.5 \text{ N/mm}^2 \\
S &= 5449. \text{ mm}^3
\end{aligned}$$

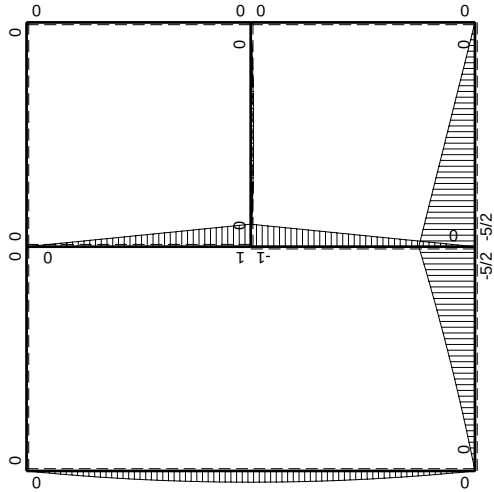
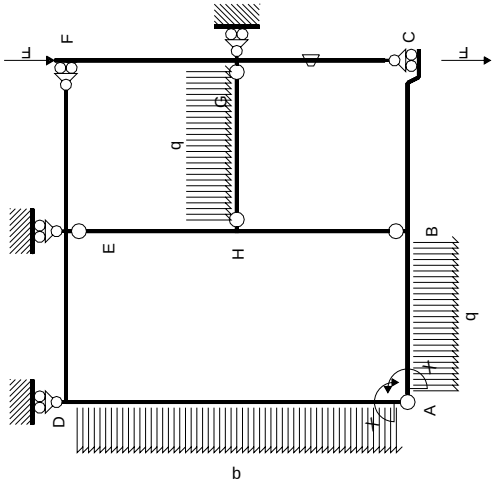


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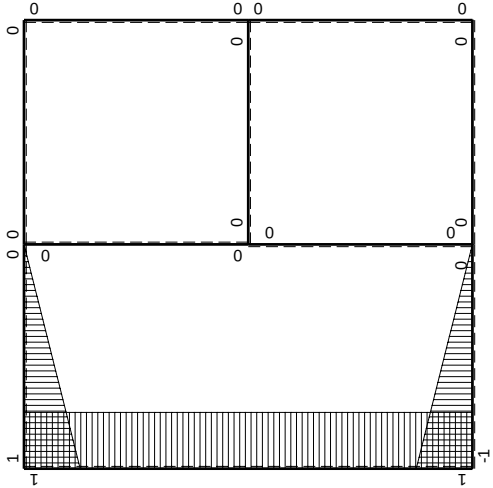


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



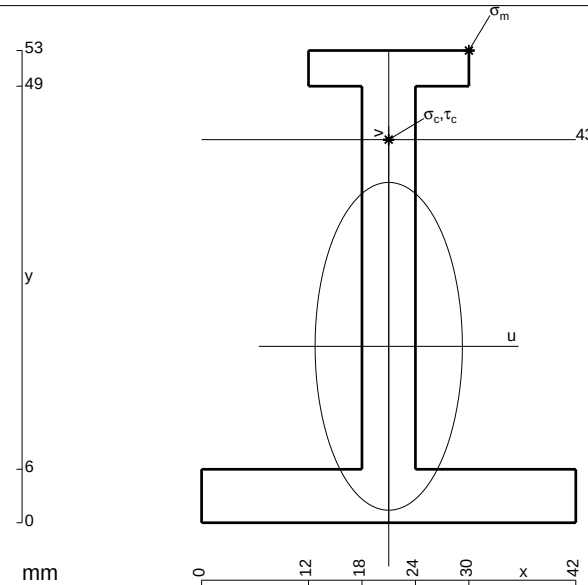
M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

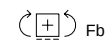
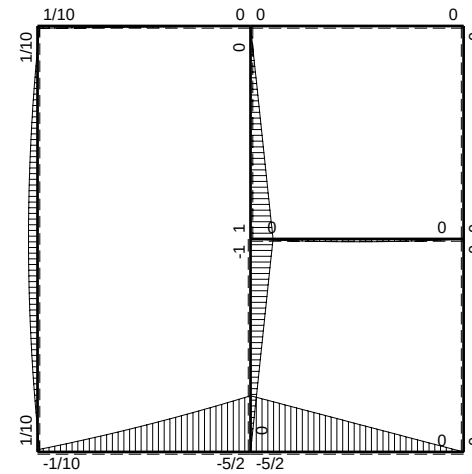
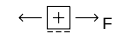
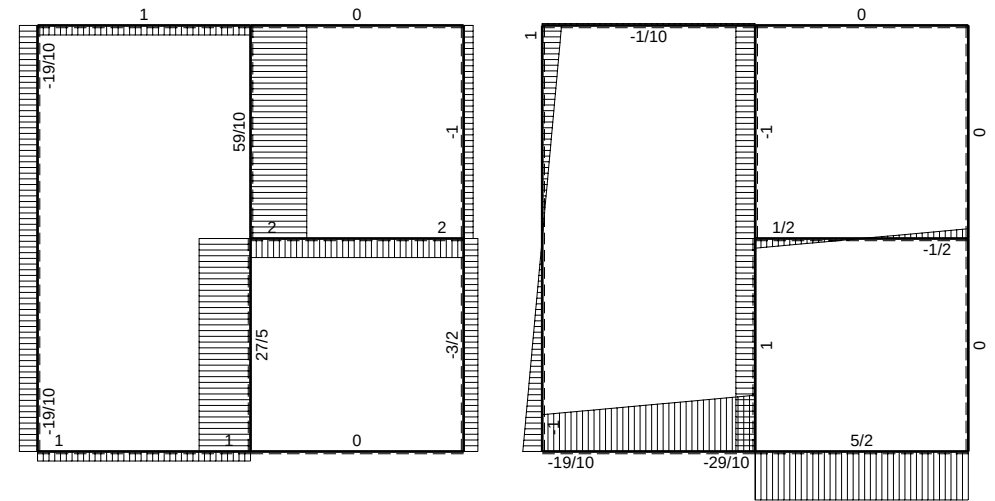
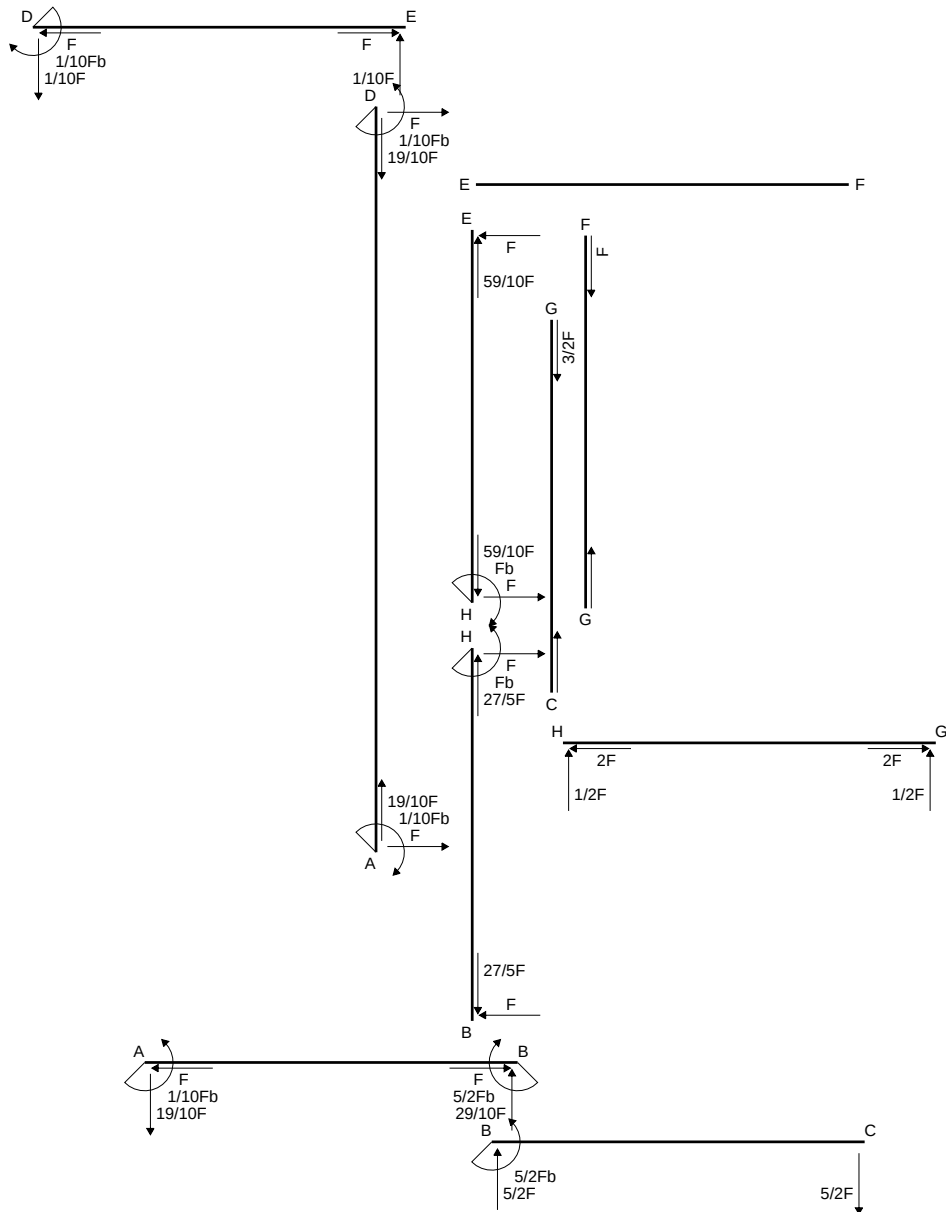
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-Fx+1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1	$(-2/3+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fx-1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-Fb+Fx$	0	0	0	0	0+0	0
BH b	0	Fx	0	0	0	0		
HE b	0	$Fb-Fx$	0	0	0	0	0+0	0
EH b	0	$-Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/10Fb$	

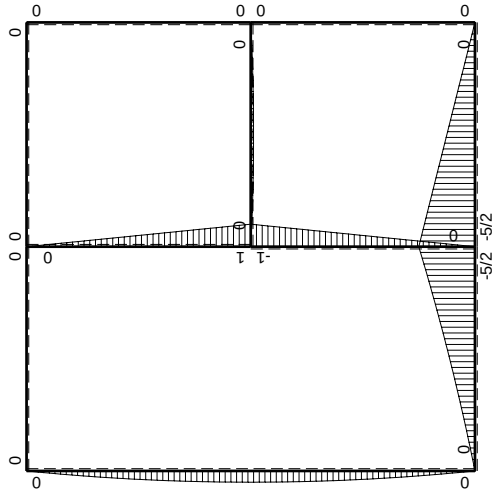
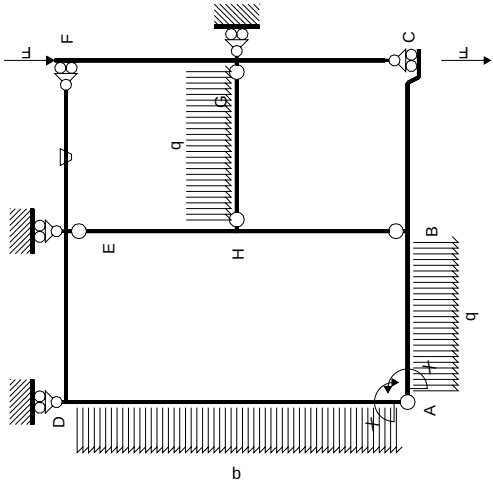
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ}
\end{aligned}$$



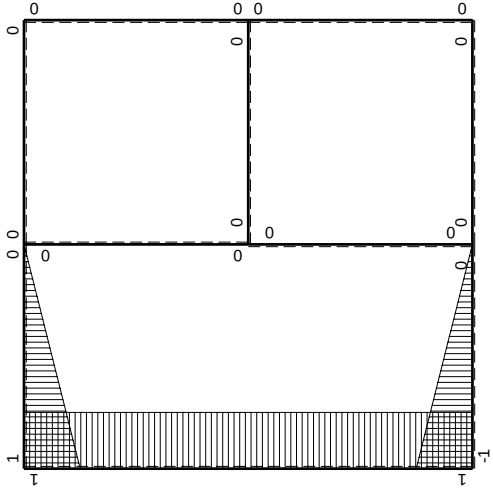
$$\begin{aligned}
A &= 582. \text{ mm}^2 \\
J_u &= 197114. \text{ mm}^4 \\
J_v &= 39762. \text{ mm}^4 \\
y_g &= 19.8 \text{ mm} \\
T_y &= 1575. \text{ N} \\
M_x &= -1354500. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 33.2 \text{ mm} \\
\sigma_m &= -Mv/J_u = 228.1 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 43. \text{ mm} \\
v_c &= 23.2 \text{ mm} \\
\sigma_c &= -Mv/J_u = 159.4 \text{ N/mm}^2 \\
\tau_c &= 4.248 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 159.6 \text{ N/mm}^2 \\
S &= 3190. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-Fx+1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1	$(-2/3+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fx-1/2qx^2$	0	$-Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-Fb+Fx$	0	0	0	0	0+0	0
BH b	0	Fx	0	0	0	0		
HE b	0	$Fb-Fx$	0	0	0	0	0+0	0
EH b	0	$-Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ}$$

$$= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (5/2 x/b - 3x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ}$$

$$= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ}$$

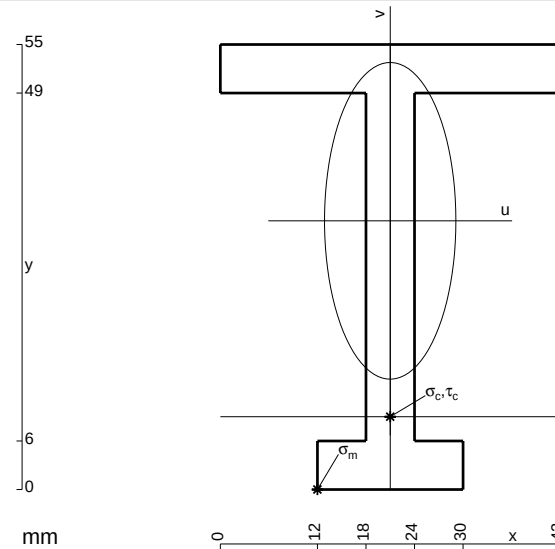
$$= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ}$$

$$L_{AD}^{x_0} = \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ}$$

$$L_{DA}^{x_0} = \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ}$$

$$= (-2b + 4/3 b) Fb \frac{1}{EJ} = -2/3 \frac{Fb^2}{EJ}$$



$$A = 618. \text{ mm}^2$$

$$J_u = 236783. \text{ mm}^4$$

$$J_v = 40734. \text{ mm}^4$$

$$y_g = 33.21 \text{ mm}$$

$$T_y = 1800. \text{ N}$$

$$M_x = -1710000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -33.21 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -239.8 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 9. \text{ mm}$$

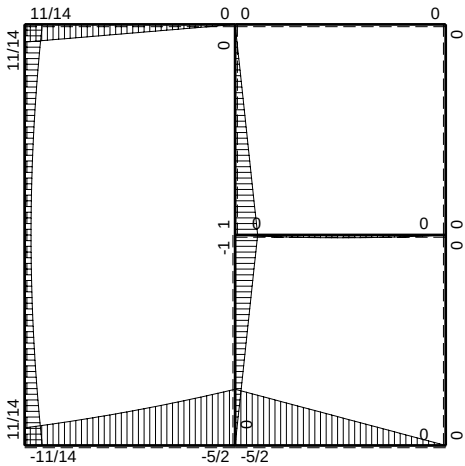
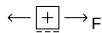
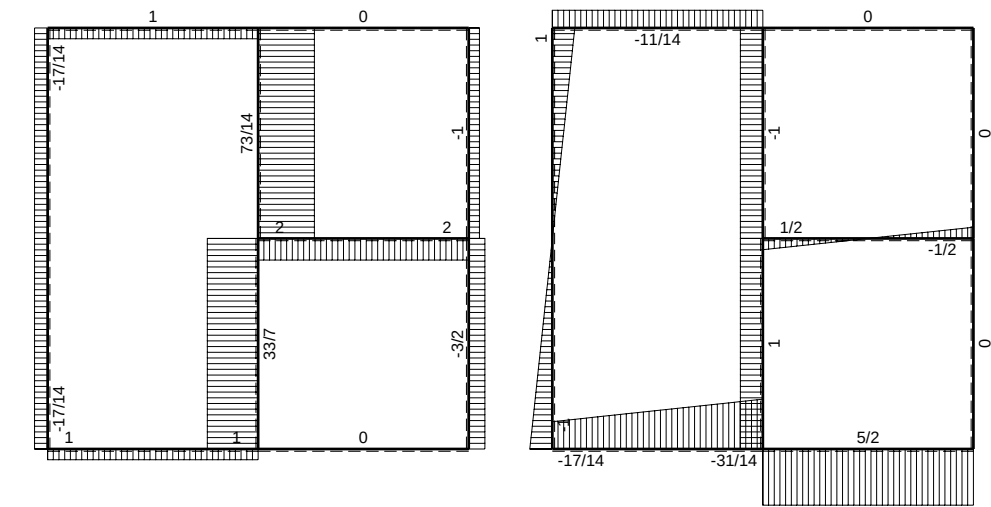
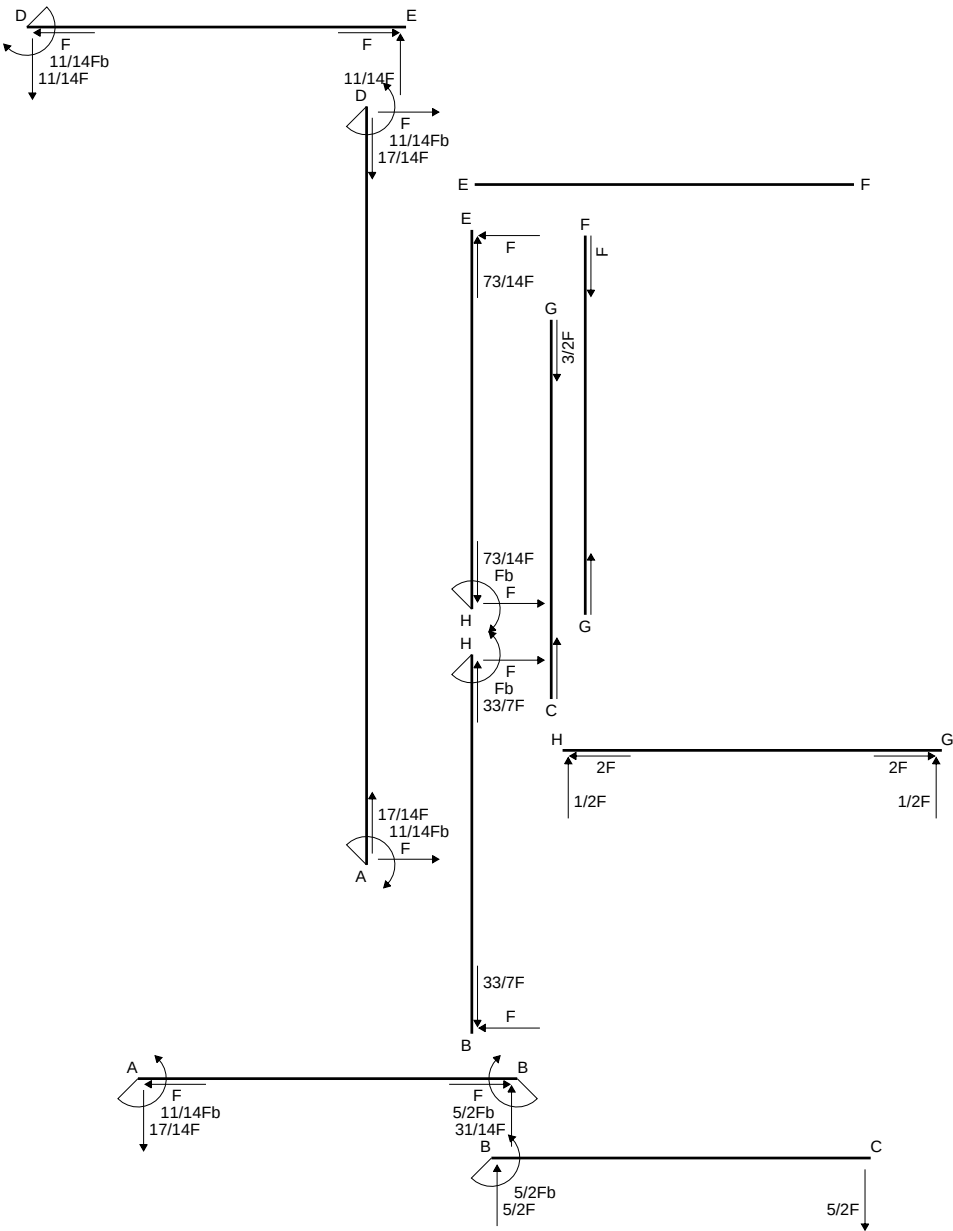
$$v_c = -24.21 \text{ mm}$$

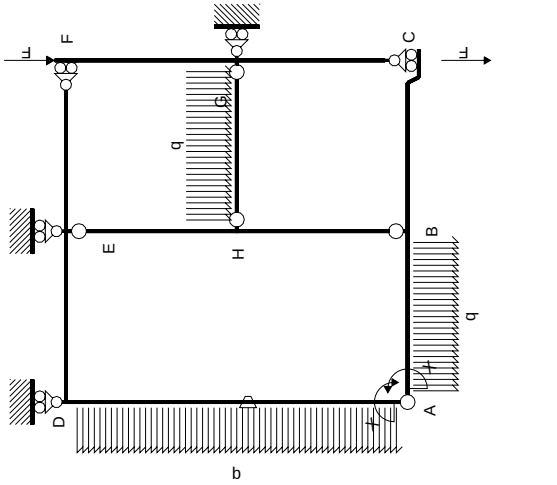
$$\sigma_c = -Mv/J_u = -174.8 \text{ N/mm}^2$$

$$\tau_c = 4.72 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 175. \text{ N/mm}^2$$

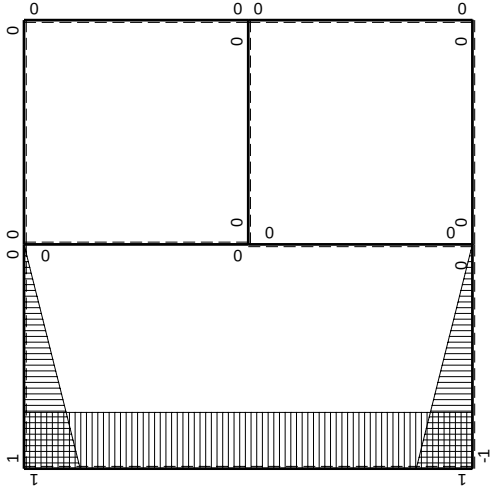
$$S^* = 3725. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



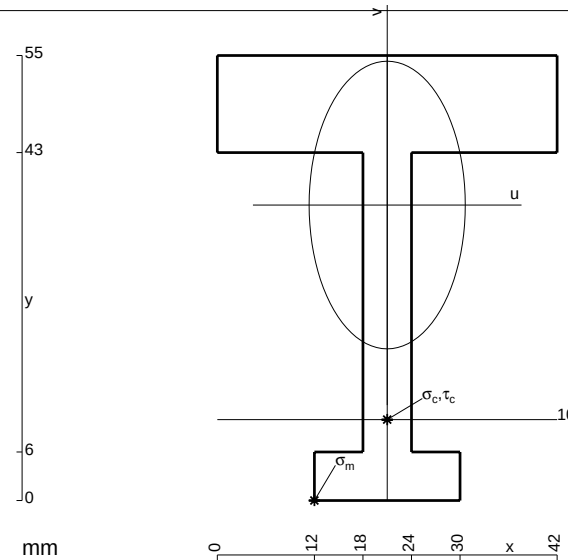
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

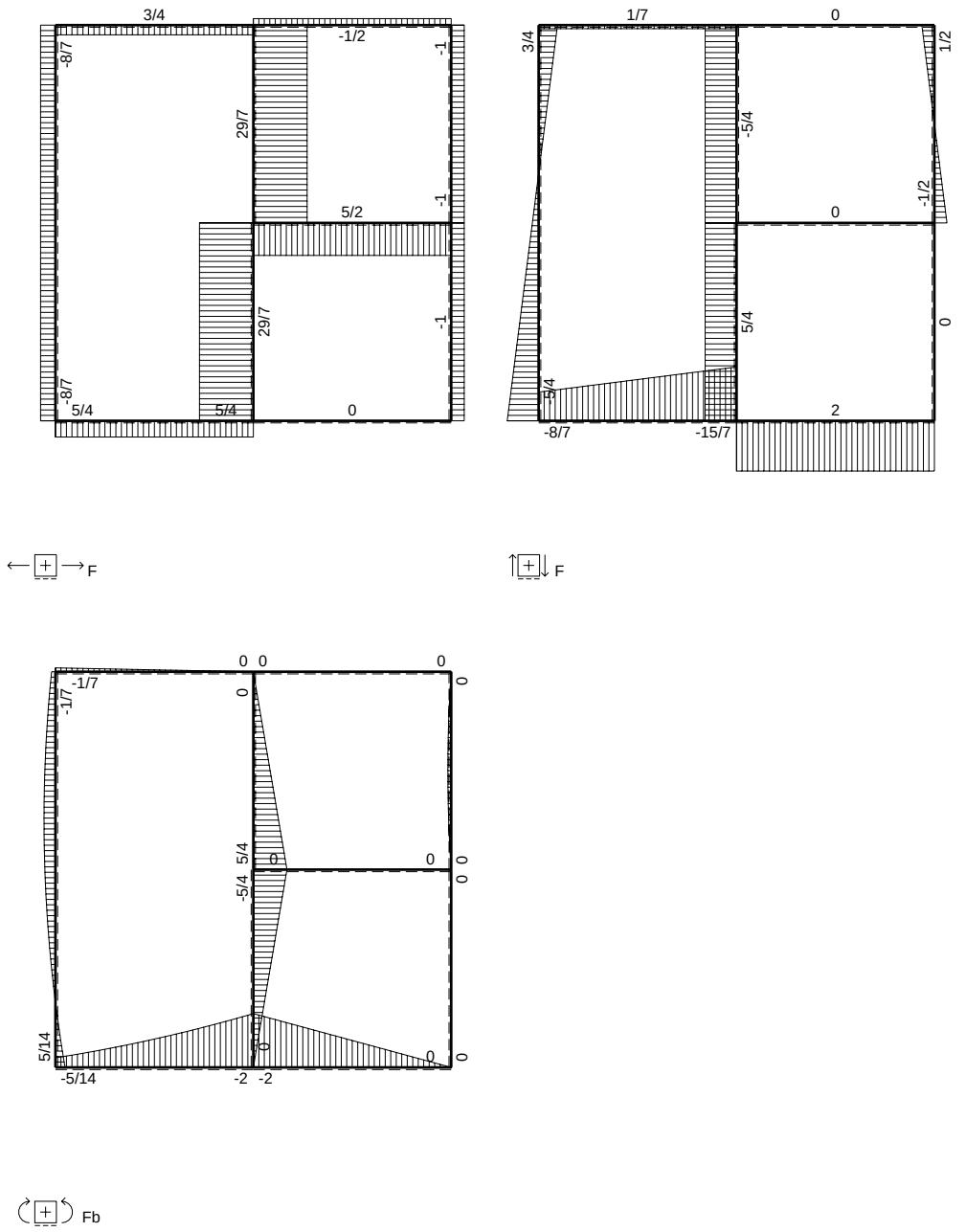
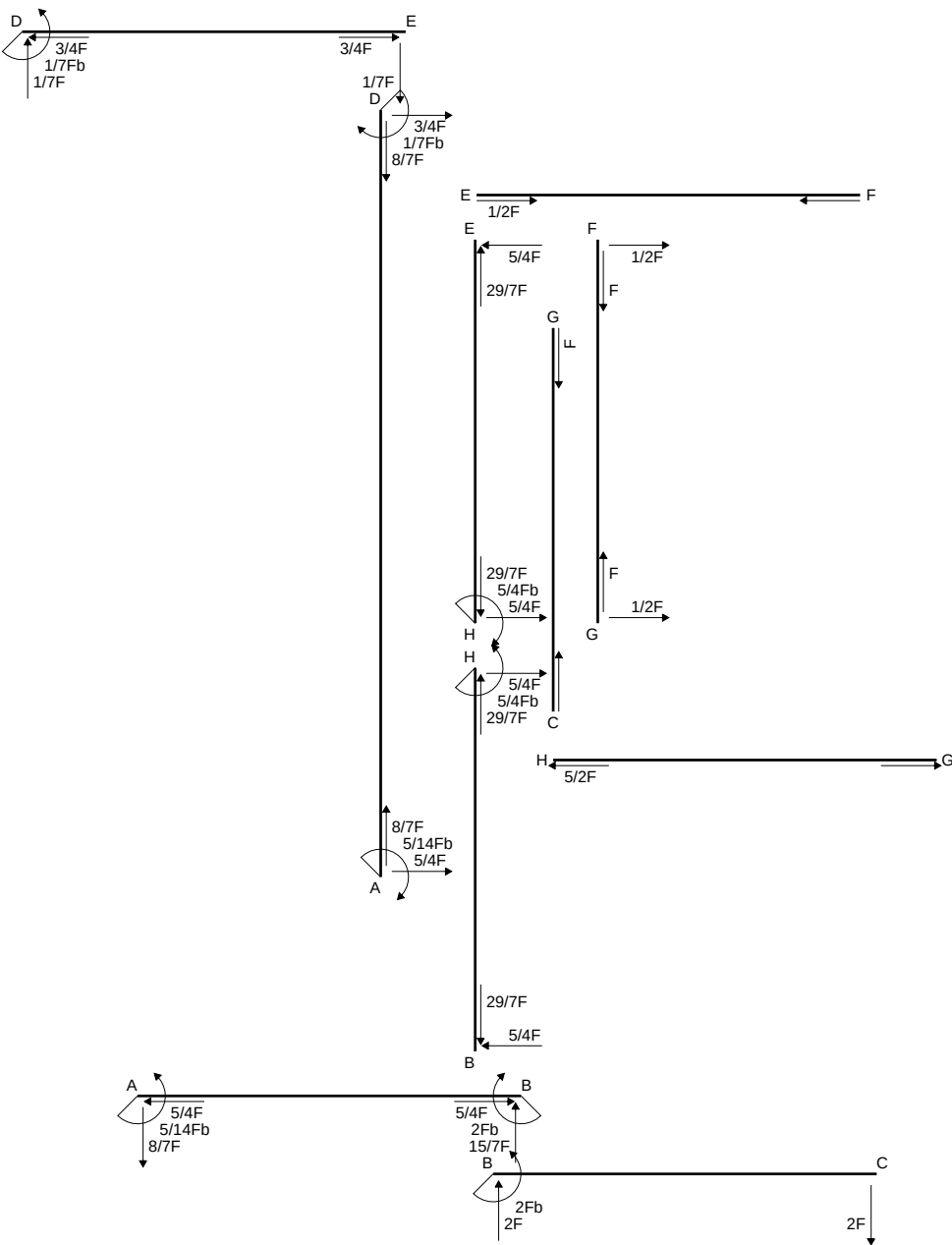
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-Fx+1/2qx^2$	$-Fb/EJ$	$-Fx+1/2Fx^2/b$	$-Fb/EJ$	1	$(-2/3-2)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fx-1/2qx^2$	Fb/EJ	$-Fx+1/2Fx^2/b$	$-Fb/EJ$	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-Fb+Fx$	0	0	0	0	0+0	0
BH b	0	Fx	0	0	0	0		
HE b	0	$Fb-Fx$	0	0	0	0	0+0	0
EH b	0	$-Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-55/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$11/14Fb$	

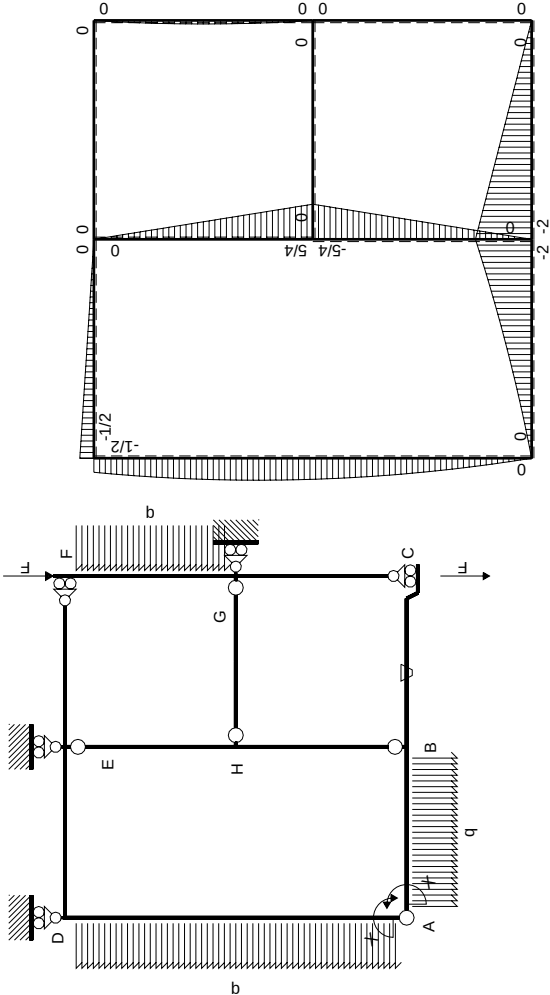
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^{2b} (-1) \theta dx \\
&= \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} + \left[-x \right]_0^{2b} \theta \\
&= (-2b + 4/3 b) Fb \frac{1}{EJ} + (-2b) \theta = -8/3 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^{2b} (1) \theta dx \\
&= \left[-1/2 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} + \left[x \right]_0^{2b} \theta \\
&= (-2b + 4/3 b) Fb \frac{1}{EJ} + (2b) \theta = -8/3 \frac{Fb^2}{EJ}
\end{aligned}$$



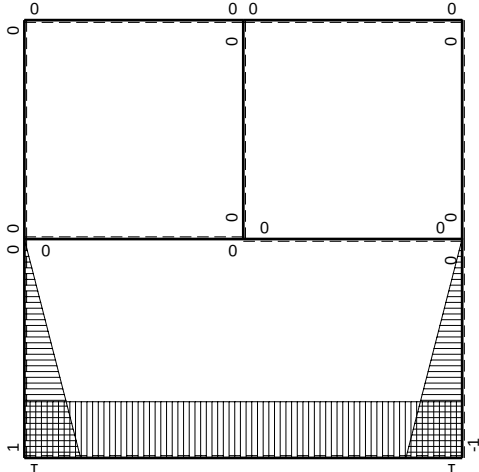
$$\begin{aligned}
A &= 834. \text{ mm}^2 \\
J_u &= 263619. \text{ mm}^4 \\
J_v &= 77670. \text{ mm}^4 \\
y_g &= 36.52 \text{ mm} \\
T_y &= 2875. \text{ N} \\
M_x &= -1437500. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -36.52 \text{ mm} \\
\sigma_m &= -Mv/J_u = -199.1 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 10. \text{ mm} \\
v_c &= -26.52 \text{ mm} \\
\sigma_c &= -Mv/J_u = -144.6 \text{ N/mm}^2 \\
\tau_c &= 7.825 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 145.3 \text{ N/mm}^2 \\
S &= 4305. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



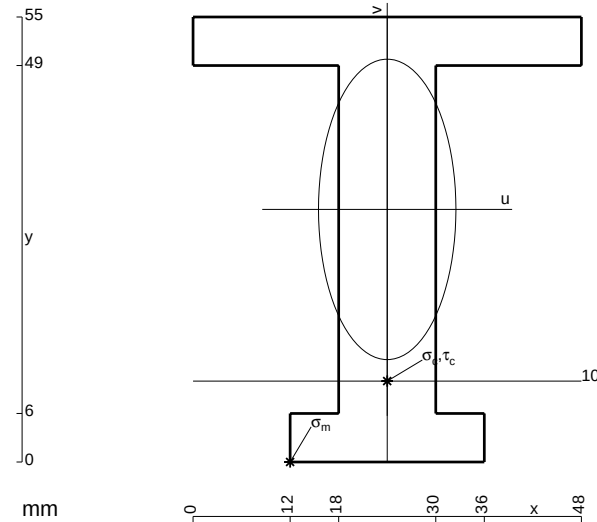
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

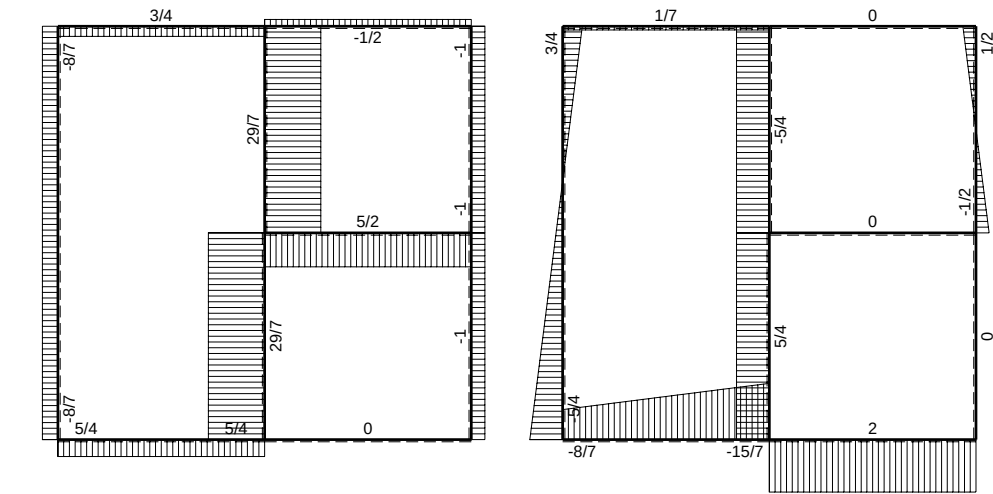
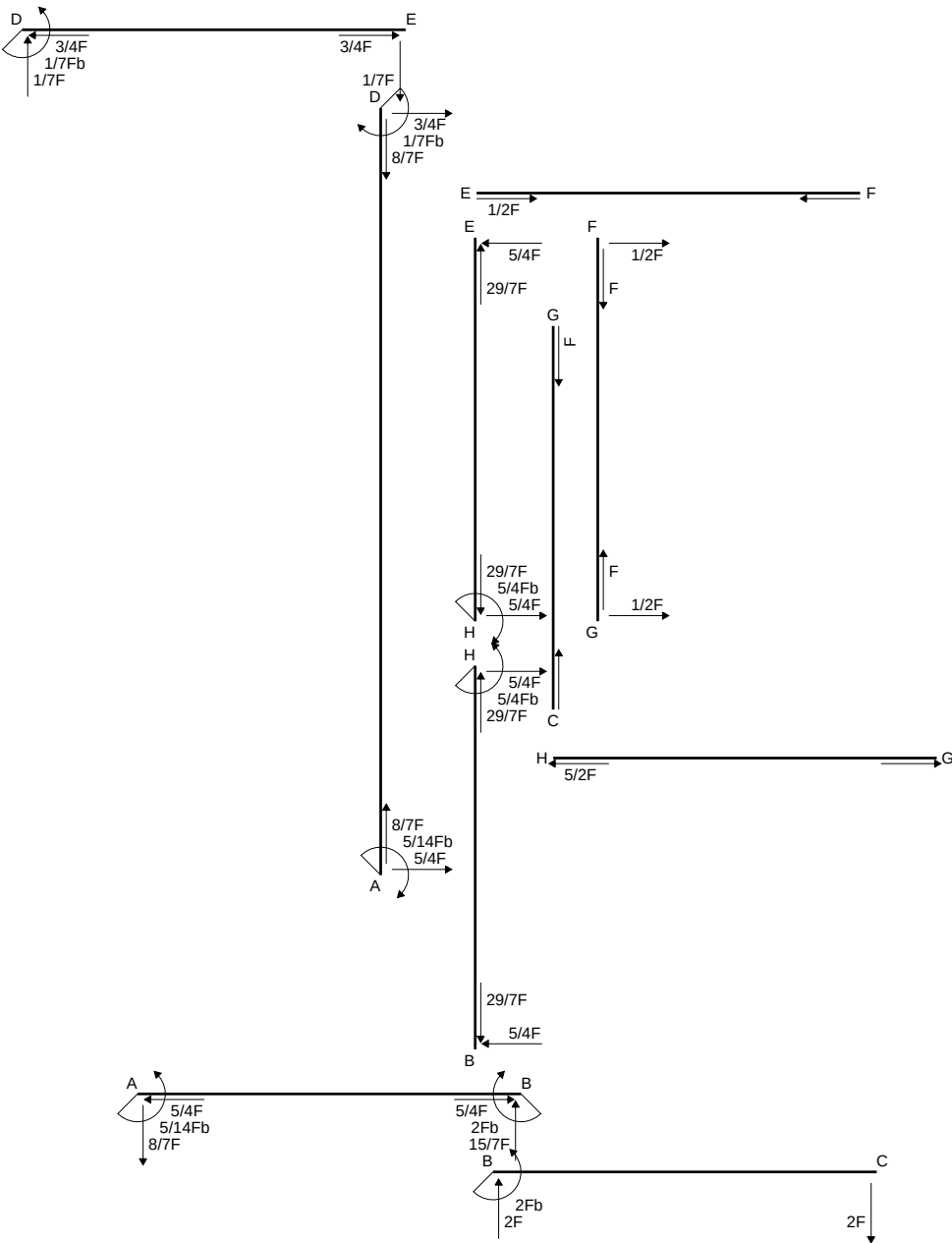
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int x M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

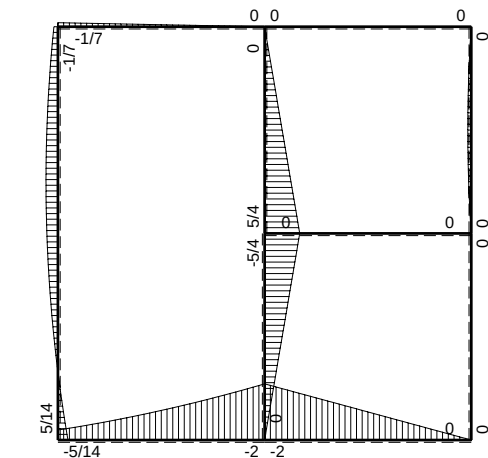


$$\begin{aligned}
A &= 948. \text{ mm}^2 \\
J_u &= 326981. \text{ mm}^4 \\
J_v &= 68400. \text{ mm}^4 \\
y_g &= 31.22 \text{ mm} \\
T_y &= 3980. \text{ N} \\
M_x &= -2189000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -31.22 \text{ mm} \\
\sigma_m &= -Mv/J_u = -209. \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 10. \text{ mm} \\
v_c &= -21.22 \text{ mm} \\
\sigma_c &= -Mv/J_u = -142.1 \text{ N/mm}^2 \\
\tau_c &= 5.253 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 142.4 \text{ N/mm}^2 \\
S &= 5179. \text{ mm}^3
\end{aligned}$$

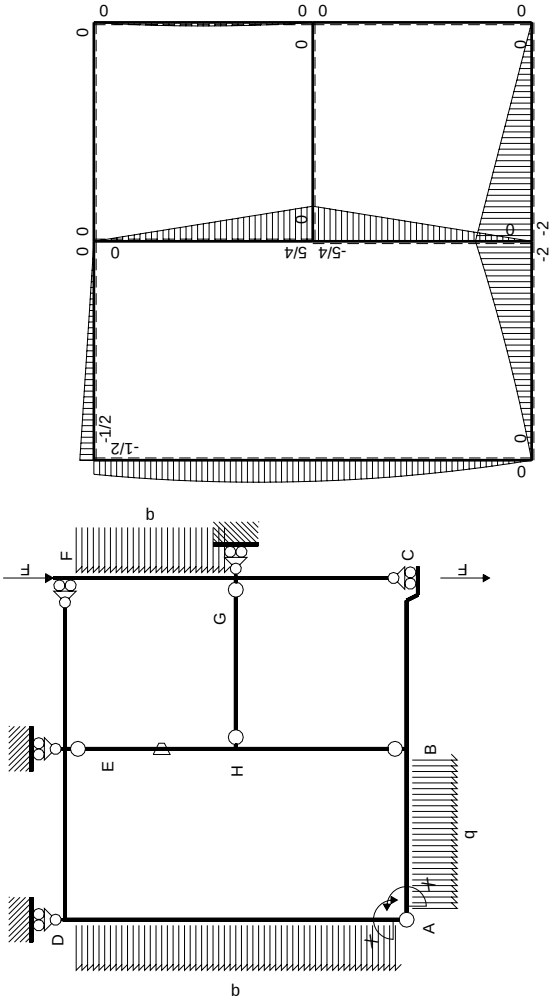


← ⊕ → F

↑ ⊕ ↓ F

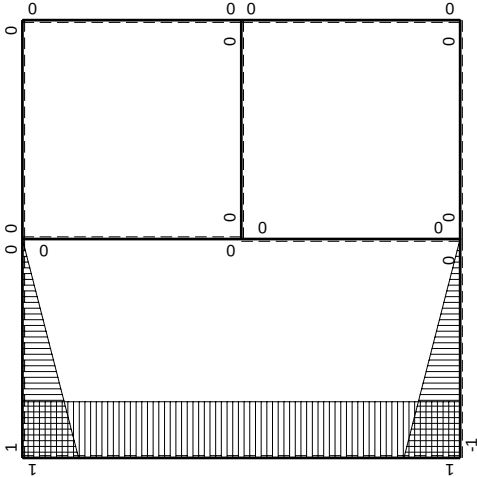


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



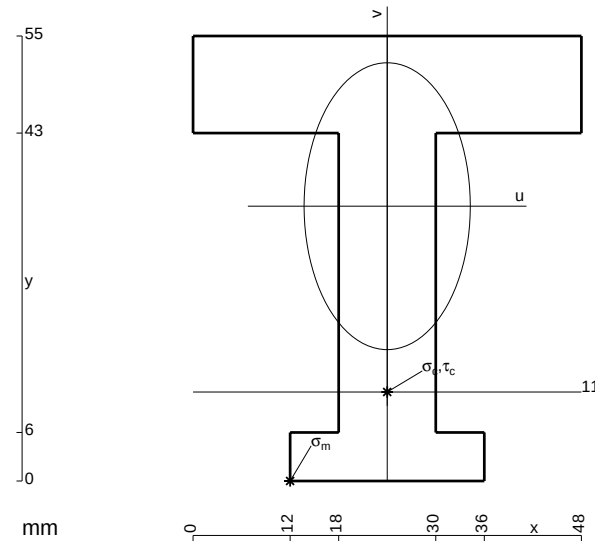
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

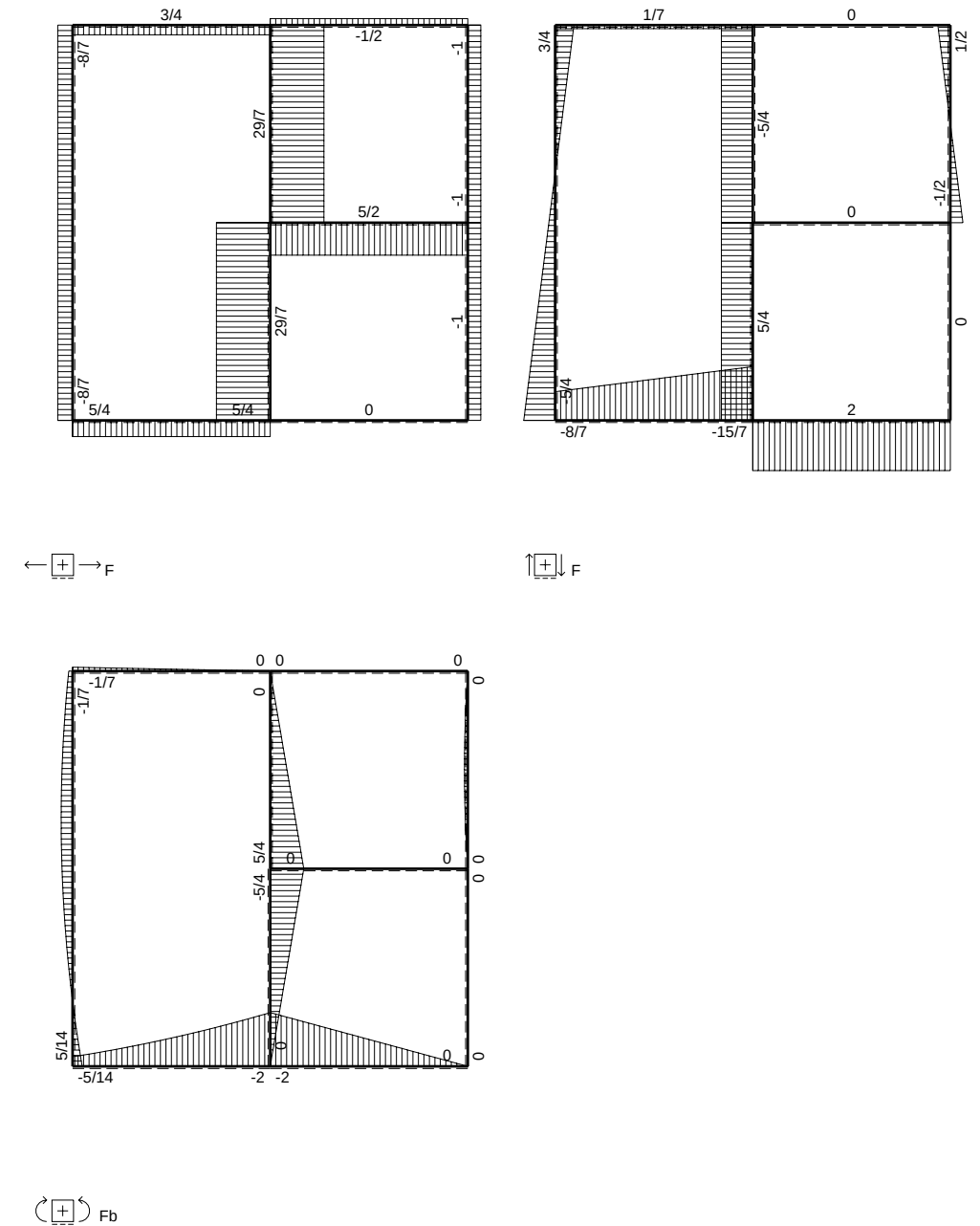
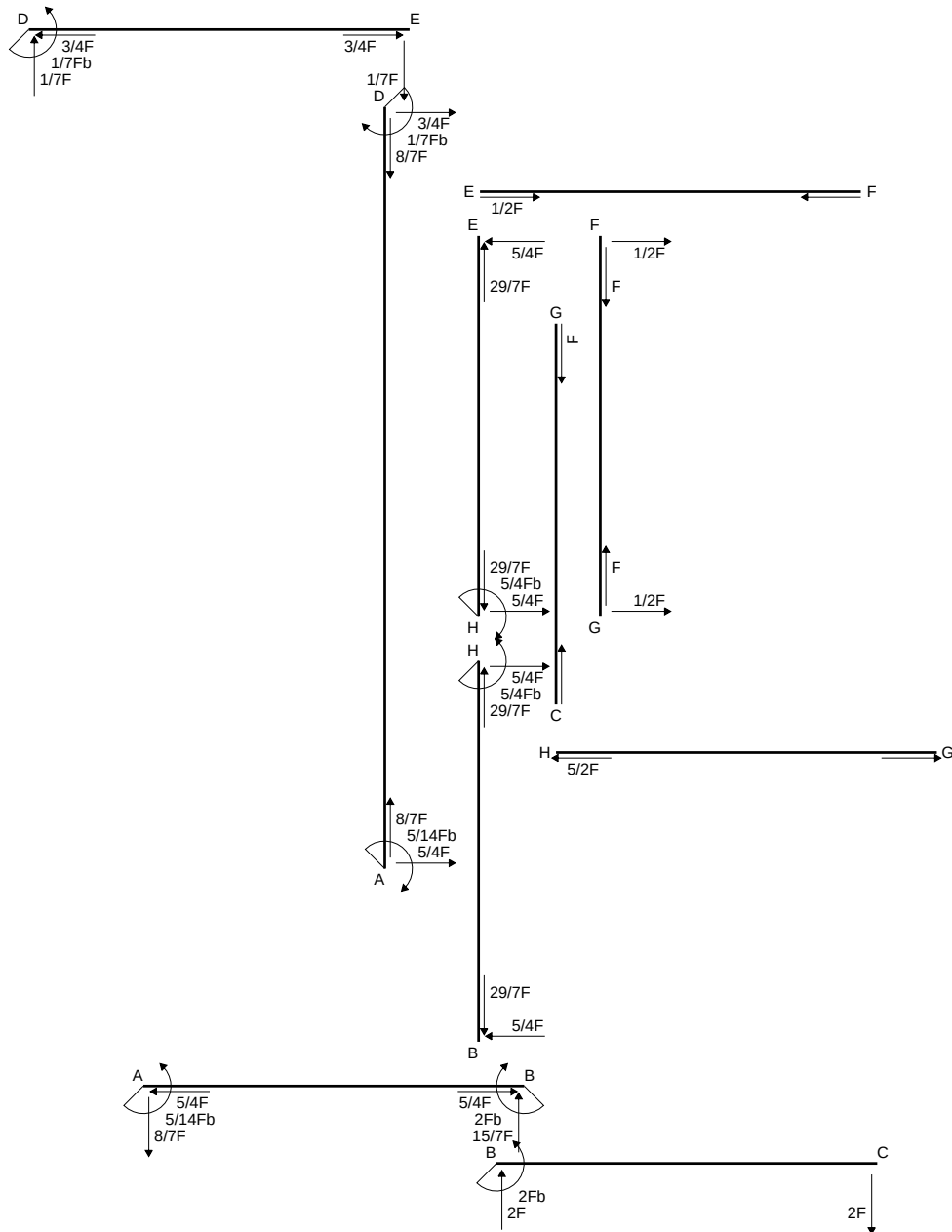
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int x M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-5/4Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

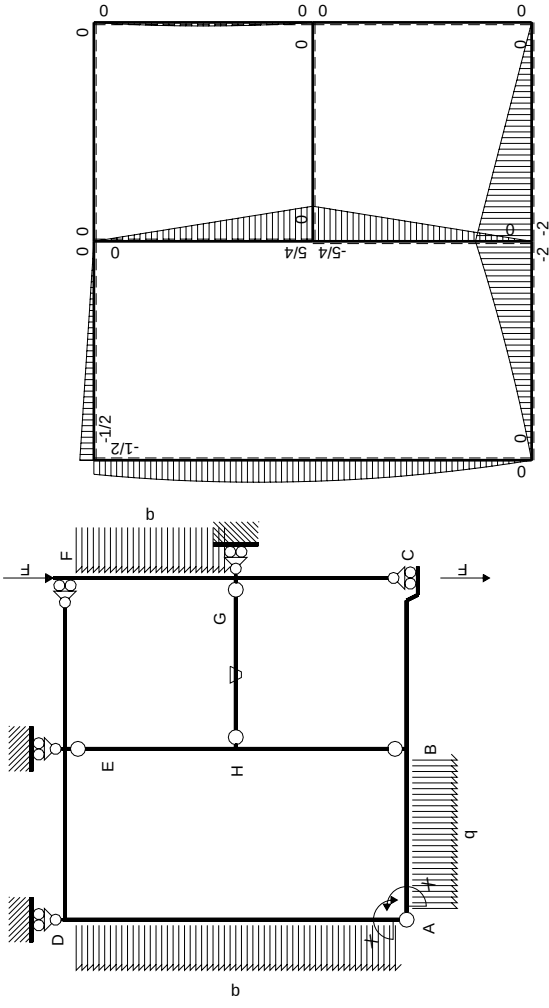
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



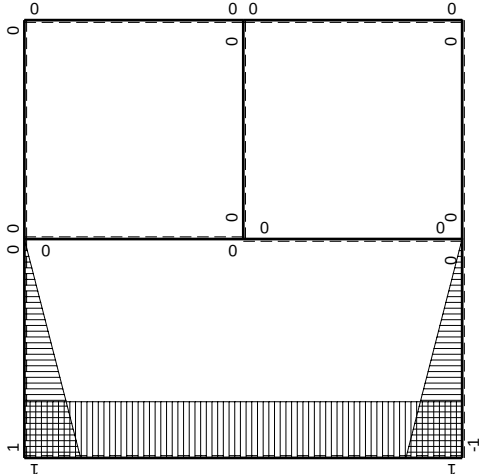
$$\begin{aligned}
A &= 1164. \text{ mm}^2 \\
J_u &= 366051. \text{ mm}^4 \\
J_v &= 122832. \text{ mm}^4 \\
y_g &= 33.96 \text{ mm} \\
T_y &= 3940. \text{ N} \\
M_x &= -2364000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -33.96 \text{ mm} \\
\sigma_m &= -Mv/J_u = -219.3 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 11. \text{ mm} \\
v_c &= -22.96 \text{ mm} \\
\sigma_c &= -Mv/J_u = -148.3 \text{ N/mm}^2 \\
\tau_c &= 5.37 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 148.6 \text{ N/mm}^2 \\
S &= 5987. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



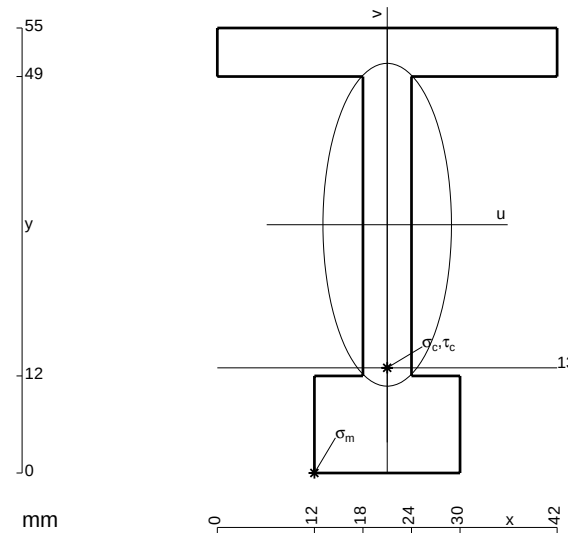
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

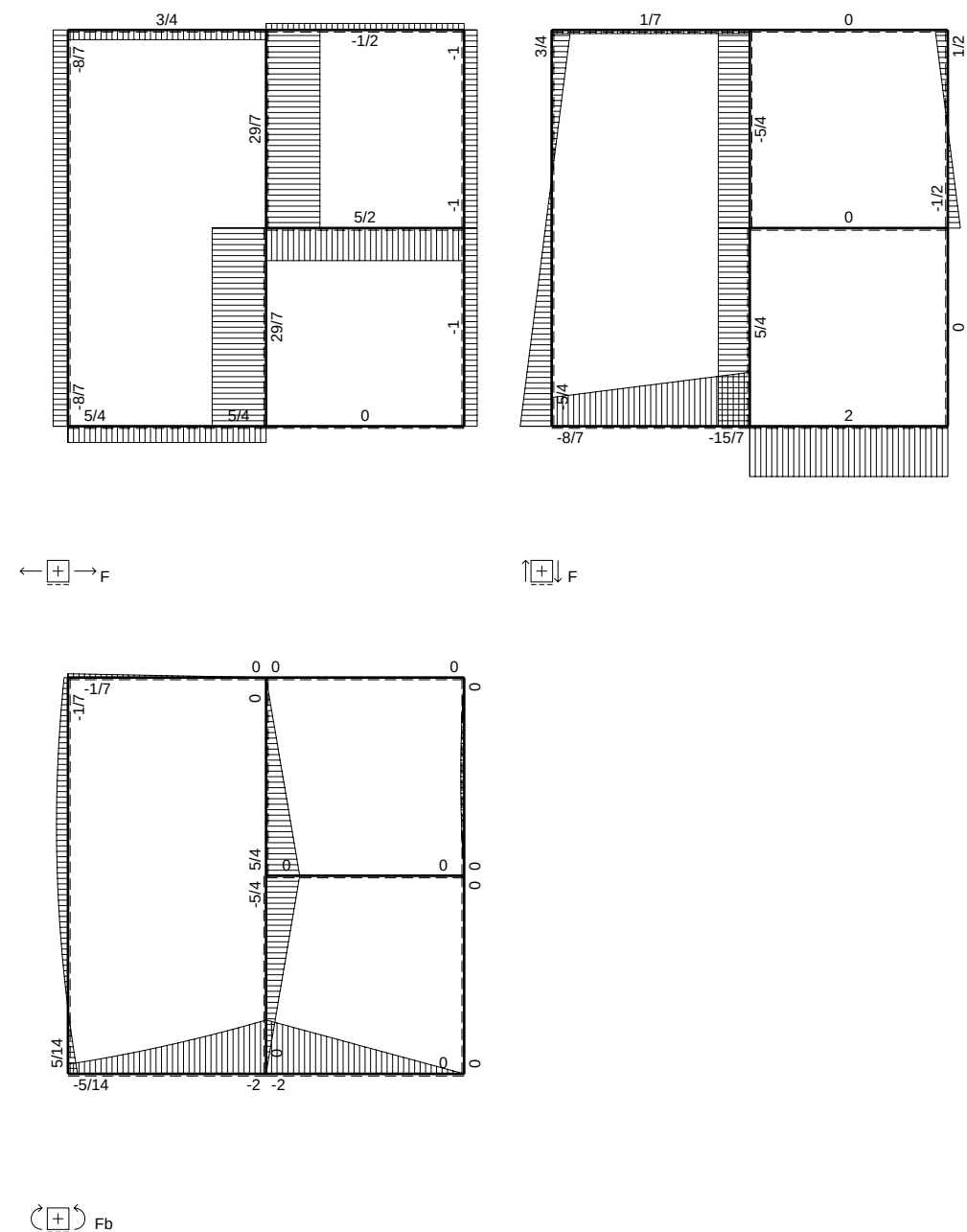
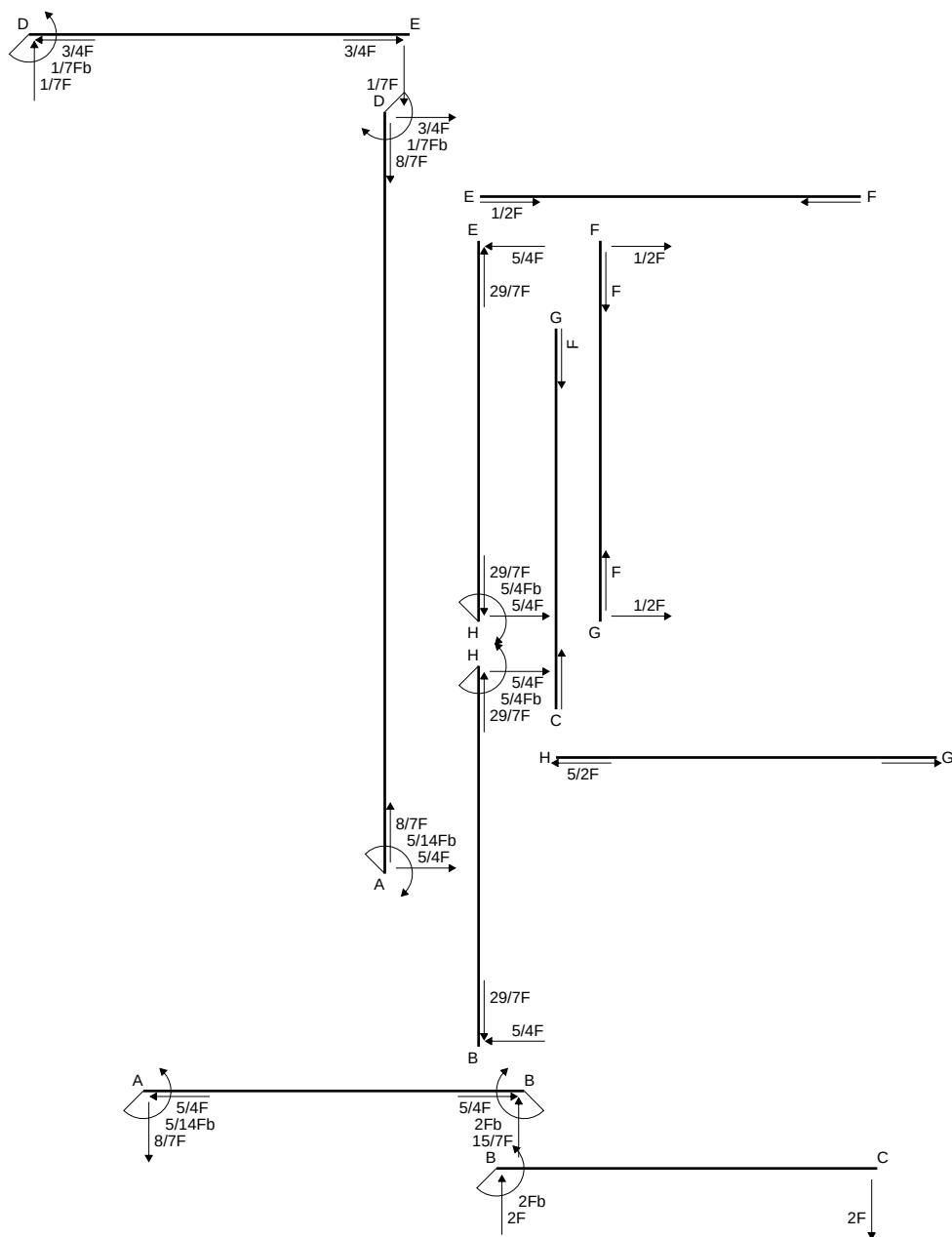
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

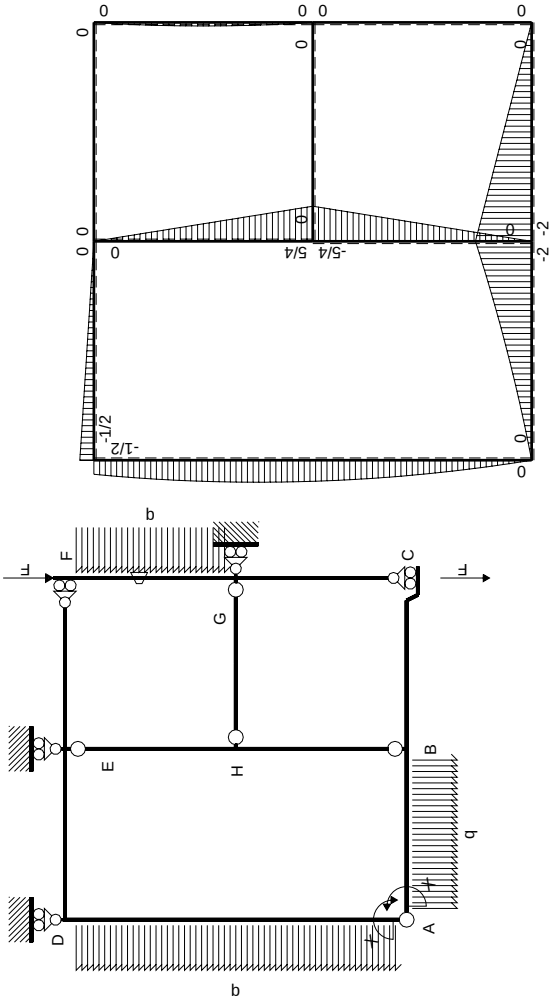
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



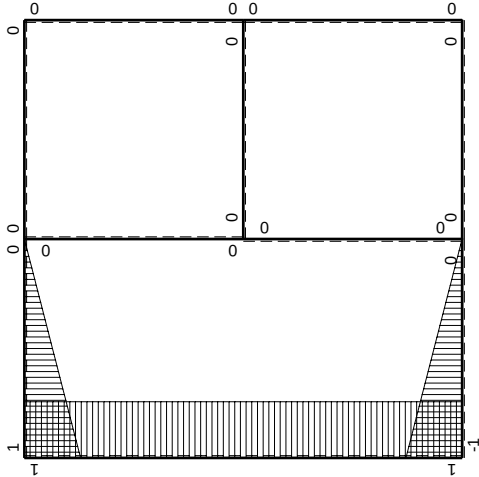
$$\begin{aligned}
A &= 690. \text{ mm}^2 \\
J_u &= 274792. \text{ mm}^4 \\
J_v &= 43542. \text{ mm}^4 \\
y_g &= 30.68 \text{ mm} \\
T_y &= 3160. \text{ N} \\
M_x &= -2054000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -30.68 \text{ mm} \\
\sigma_m &= -Mv/J_u = -229.3 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -17.68 \text{ mm} \\
\sigma_c &= -Mv/J_u = -132.2 \text{ N/mm}^2 \\
\tau_c &= 10.43 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 133.4 \text{ N/mm}^2 \\
S &= 5441. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



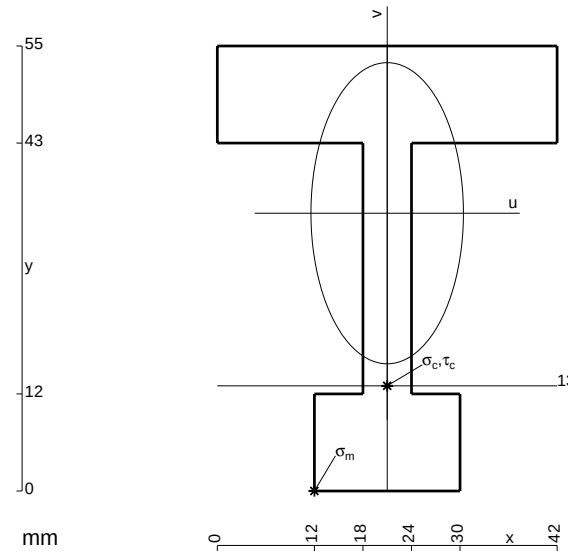
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

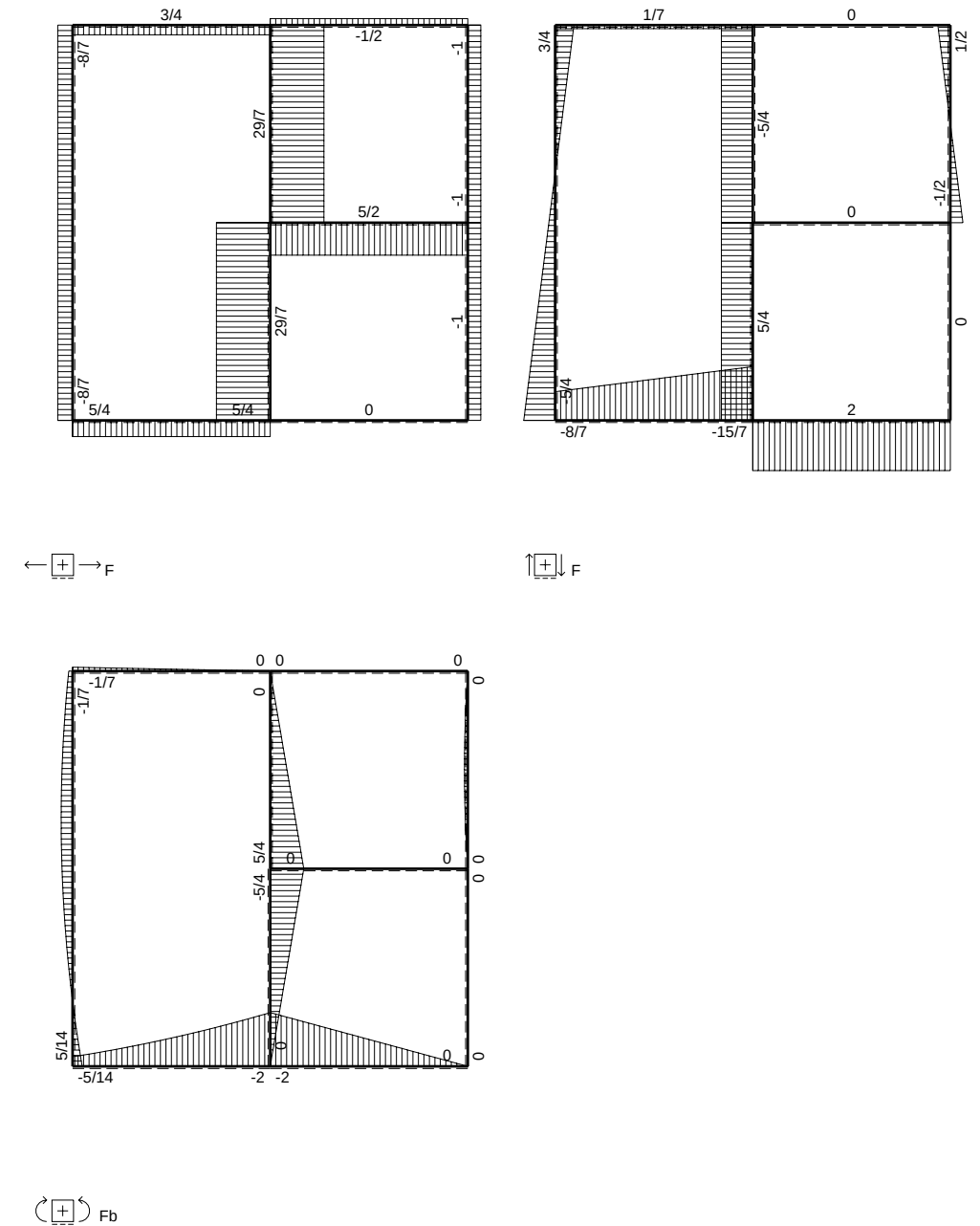
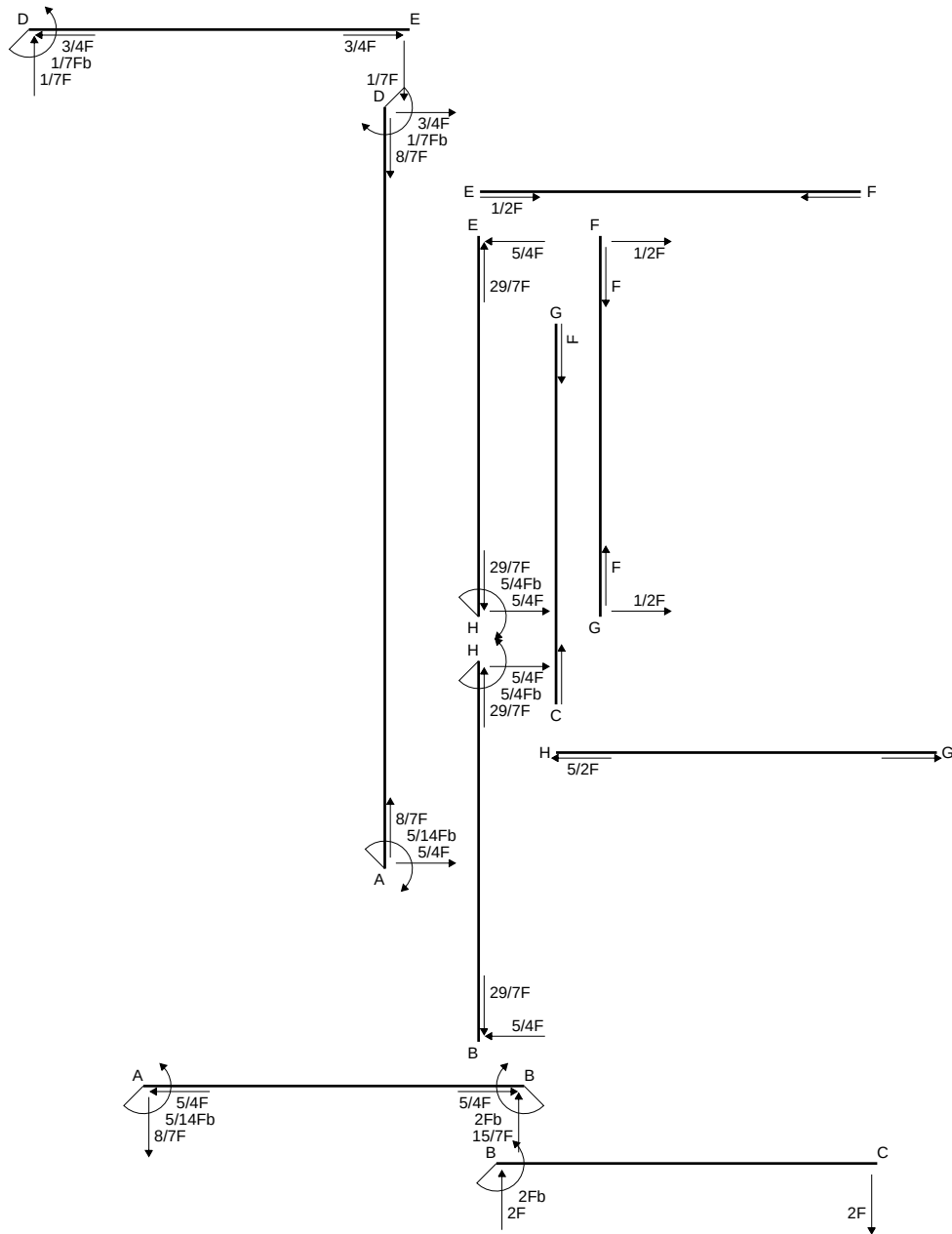
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

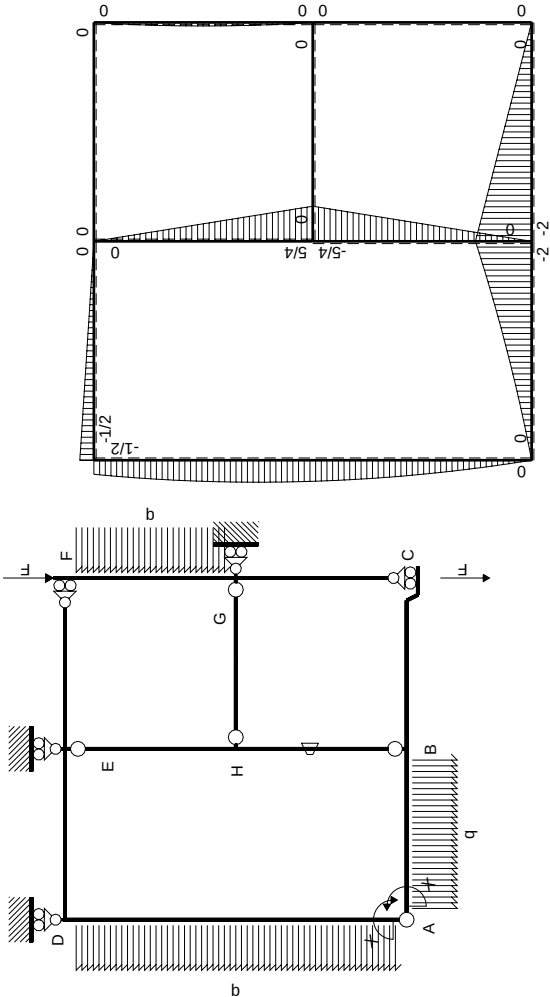
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



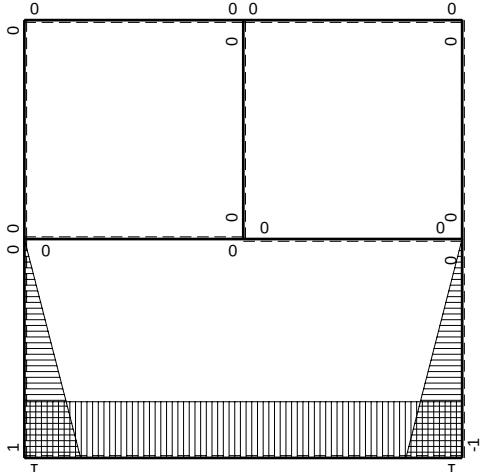
$$\begin{aligned}
A &= 906. \text{ mm}^2 \\
J_u &= 314037. \text{ mm}^4 \\
J_v &= 80478. \text{ mm}^4 \\
y_g &= 34.33 \text{ mm} \\
T_y &= 3120. \text{ N} \\
M_x &= -2184000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -34.33 \text{ mm} \\
\sigma_m &= -Mv/J_u = -238.8 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -21.33 \text{ mm} \\
\sigma_c &= -Mv/J_u = -148.4 \text{ N/mm}^2 \\
\tau_c &= 10.35 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 149.5 \text{ N/mm}^2 \\
S &= 6251. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



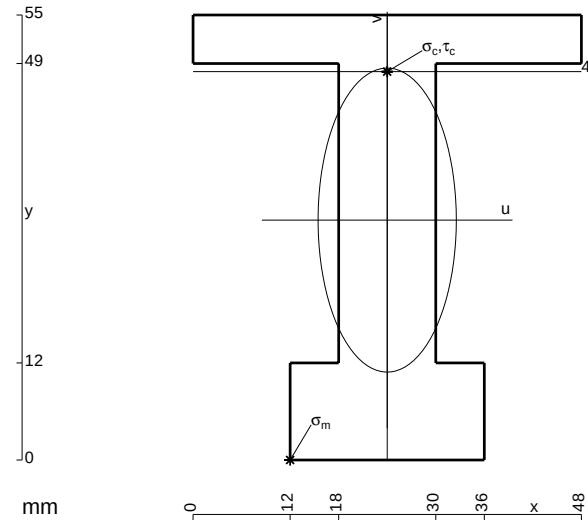
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

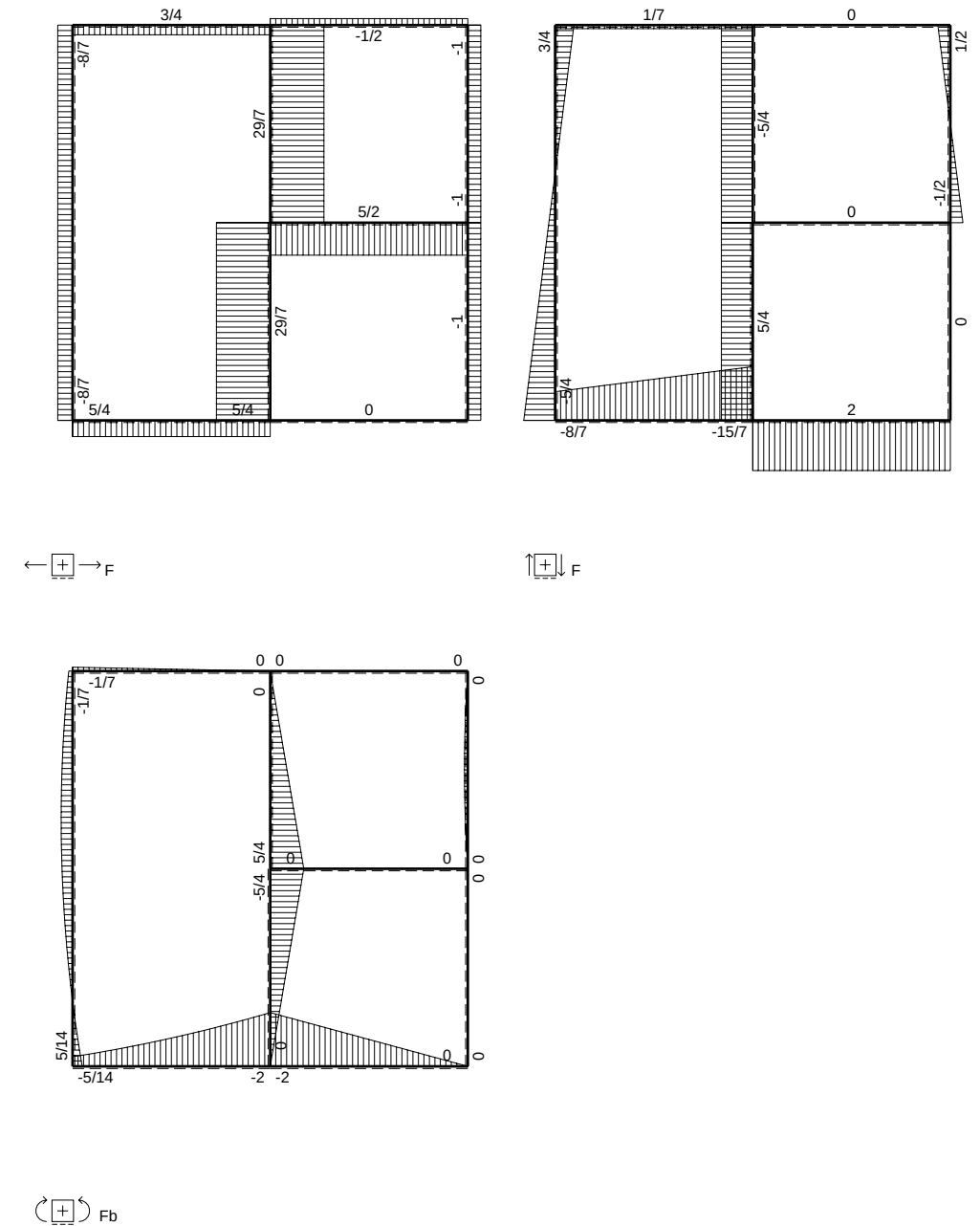
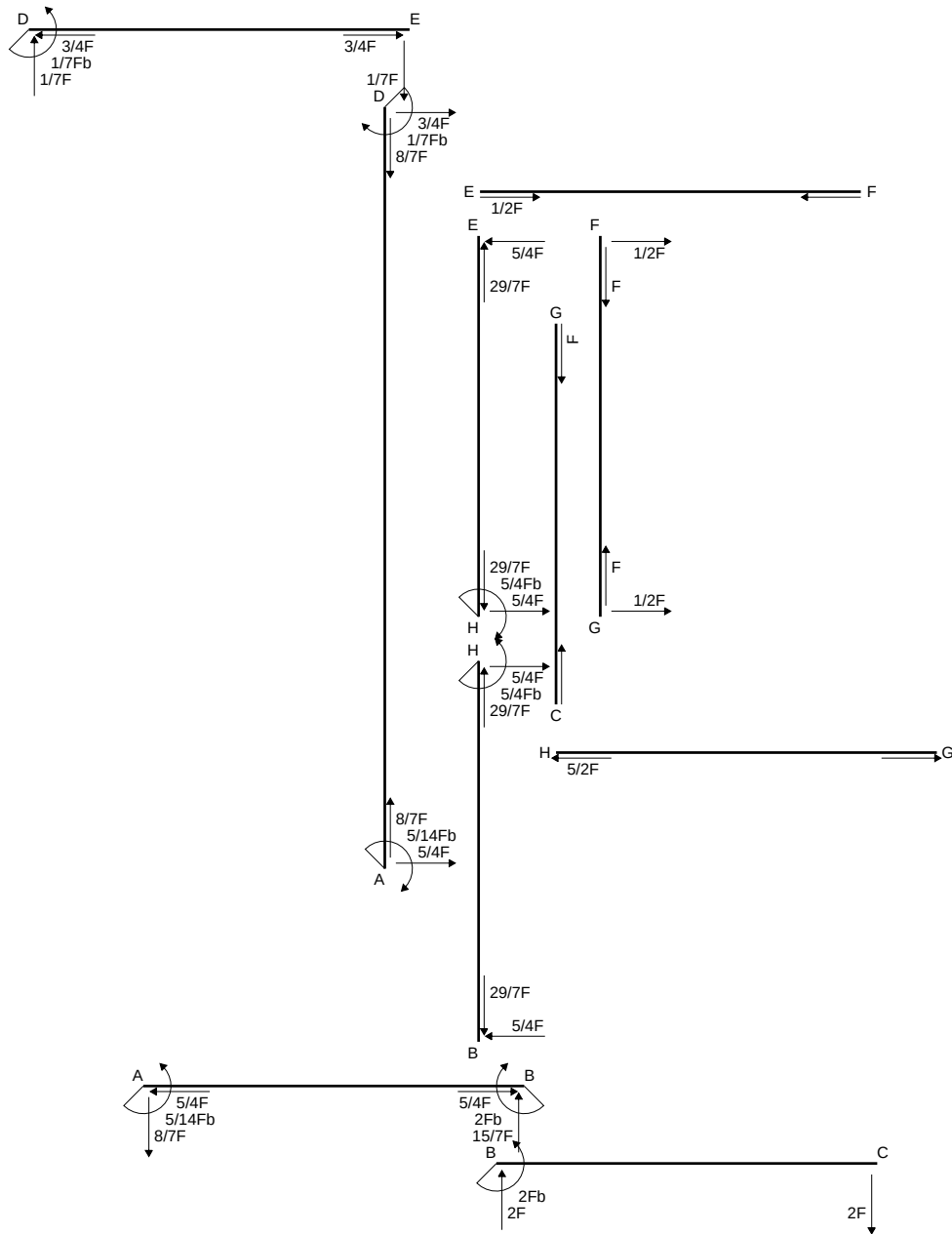
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$5/4Fx$	Fb/EJ	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

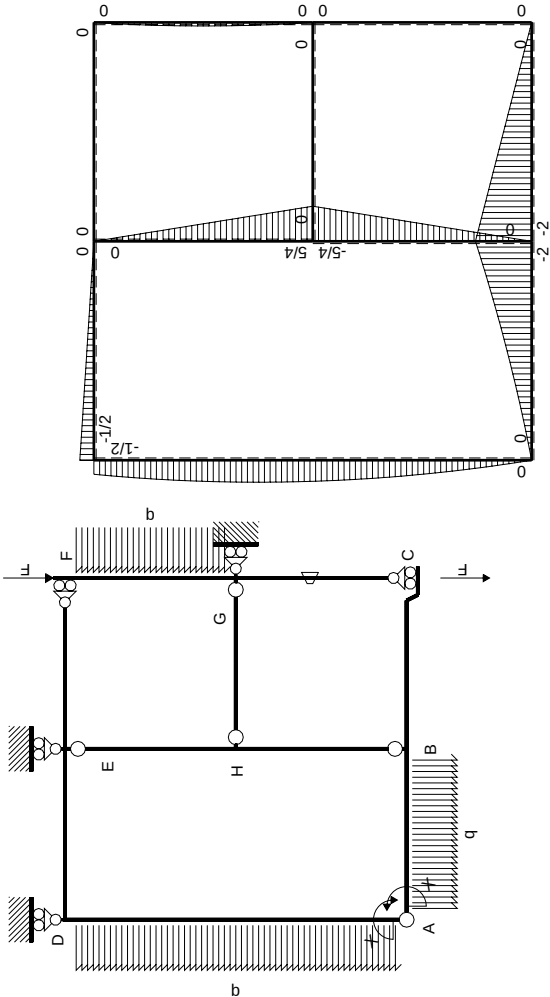
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



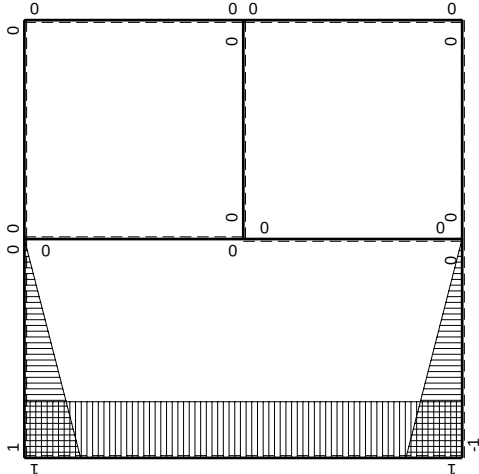
$$\begin{aligned}
A &= 1020. \text{ mm}^2 \\
J_u &= 360241. \text{ mm}^4 \\
J_v &= 74448. \text{ mm}^4 \\
y_g &= 29.65 \text{ mm} \\
T_y &= 3220. \text{ N} \\
M_x &= -2415000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -29.65 \text{ mm} \\
\sigma_m &= -Mv/J_u = -198.8 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 48. \text{ mm} \\
v_c &= 18.35 \text{ mm} \\
\sigma_c &= -Mv/J_u = 123. \text{ N/mm}^2 \\
\tau_c &= 4.962 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 123.3 \text{ N/mm}^2 \\
S &= 6662. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



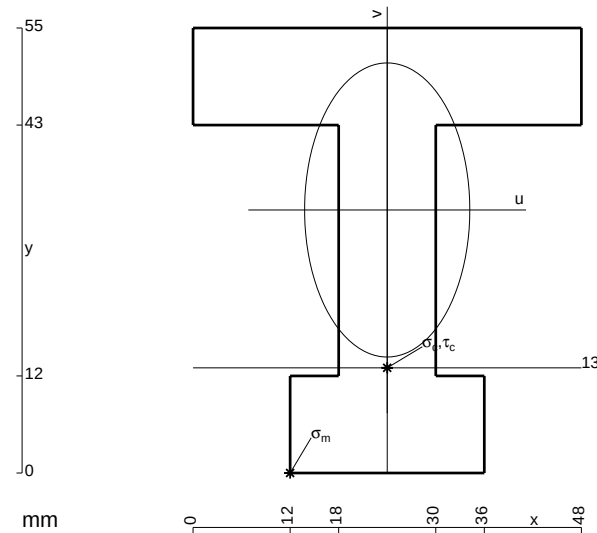
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

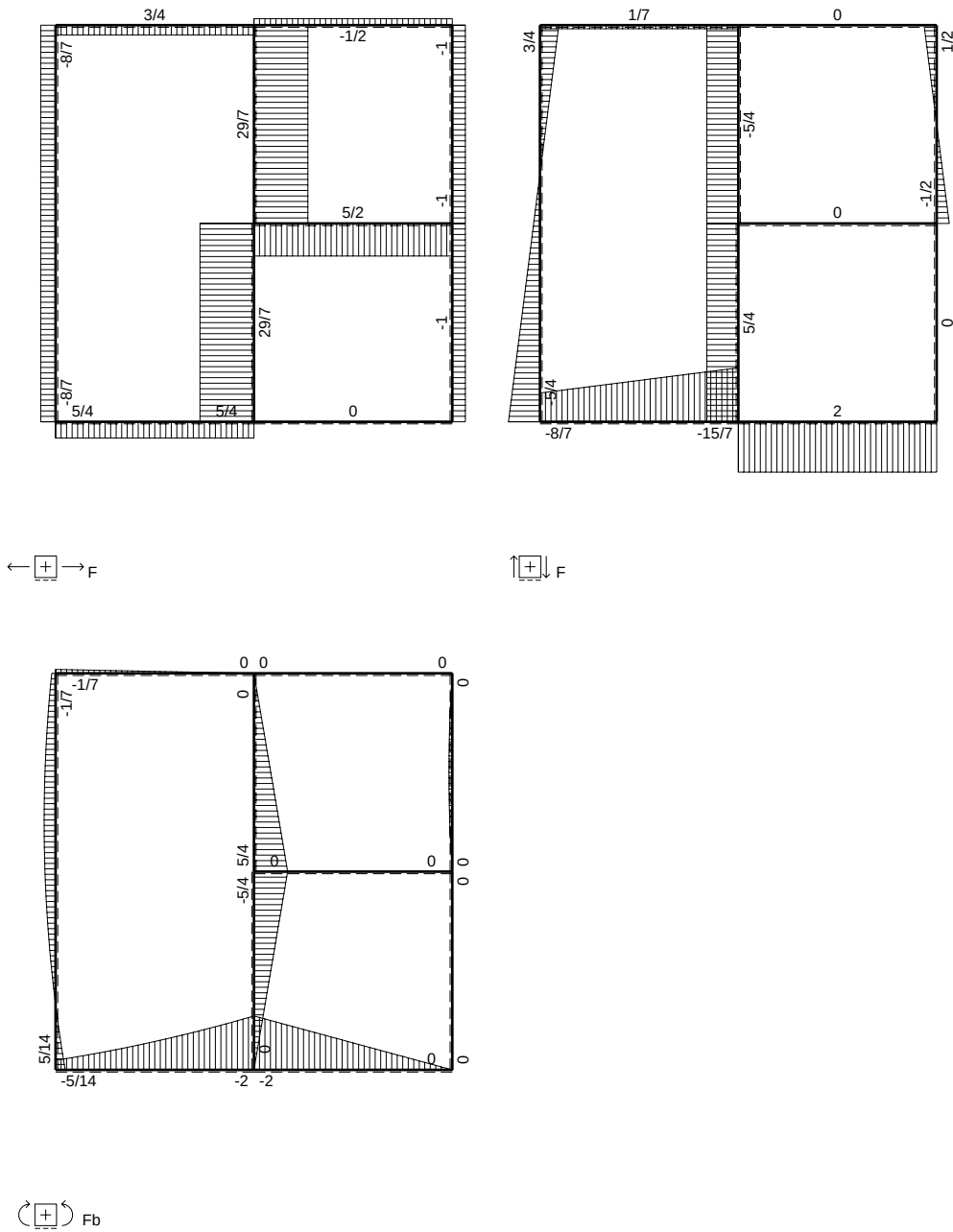
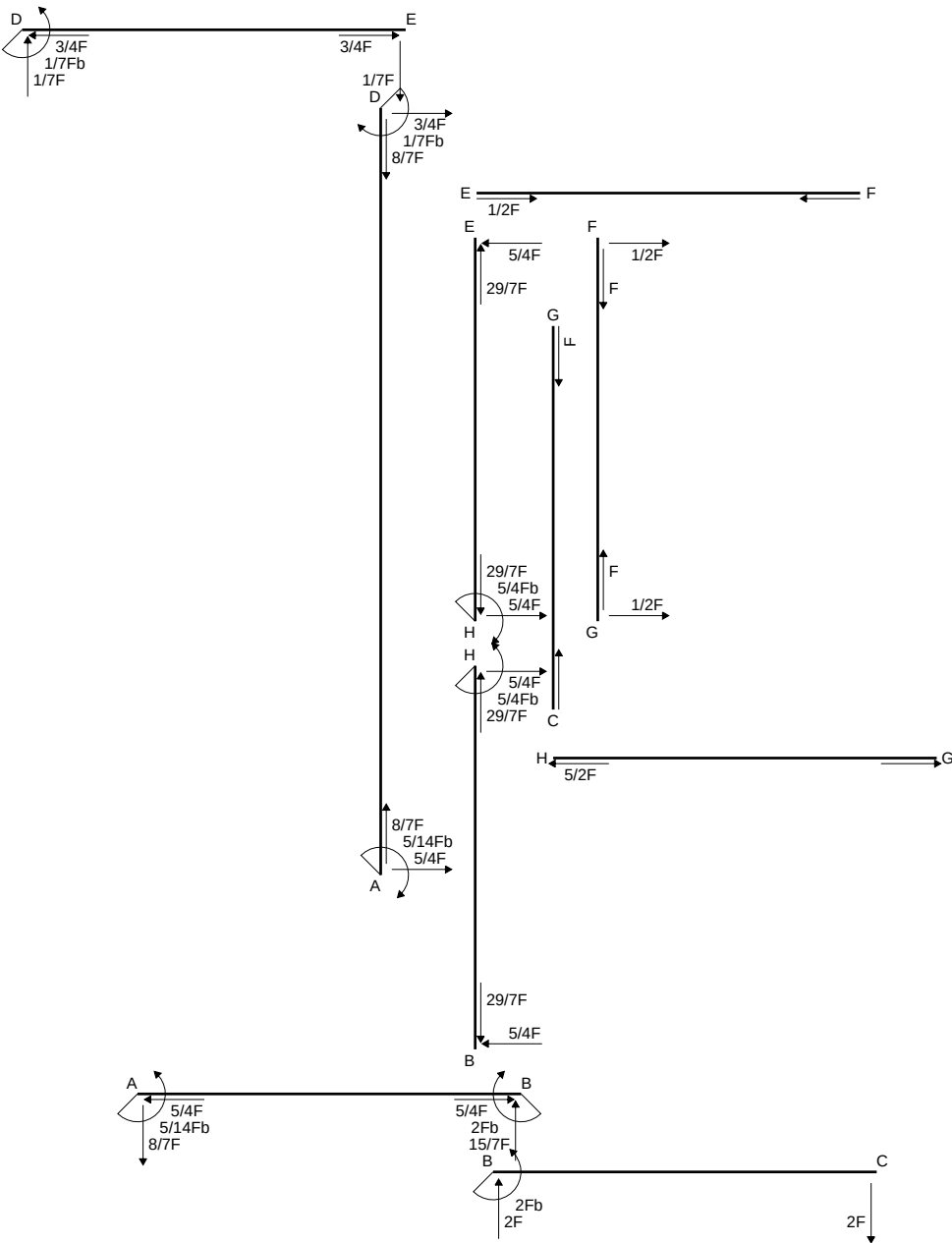
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 1236. \text{ mm}^2 \\
J_u &= 408523. \text{ mm}^4 \\
J_v &= 128880. \text{ mm}^4 \\
y_g &= 32.51 \text{ mm} \\
T_y &= 3280. \text{ N} \\
M_x &= -2624000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -32.51 \text{ mm} \\
\sigma_m &= -Mv/J_u = -208.8 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 13. \text{ mm} \\
v_c &= -19.51 \text{ mm} \\
\sigma_c &= -Mv/J_u = -125.3 \text{ N/mm}^2 \\
\tau_c &= 5.269 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 125.6 \text{ N/mm}^2 \\
S &= 7875. \text{ mm}^3
\end{aligned}$$

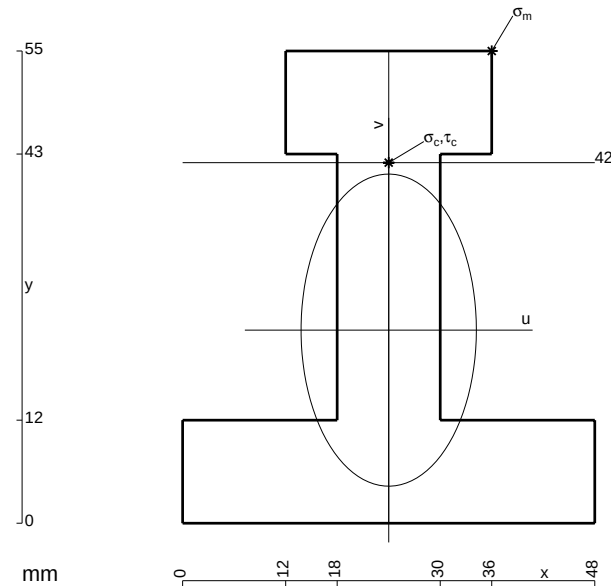


Quadro contributi PLV per iperstatica $X=W_{AB}$

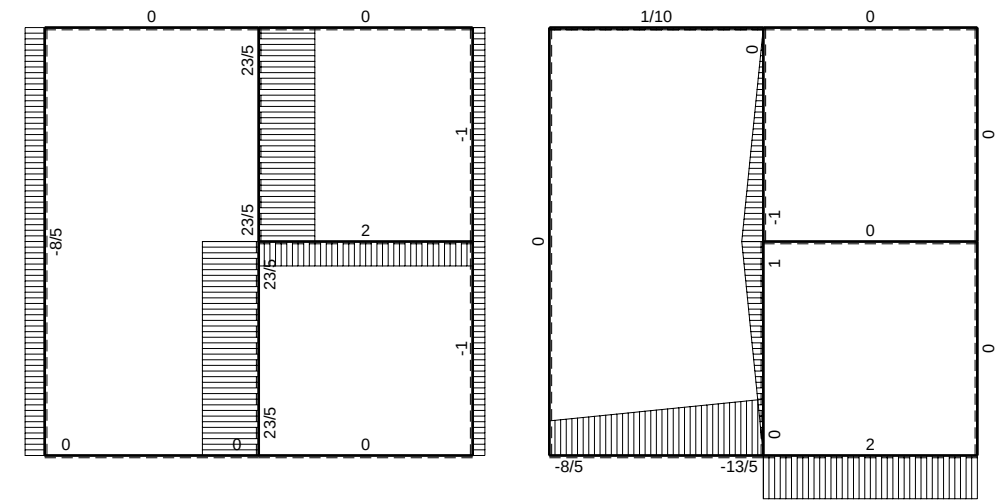
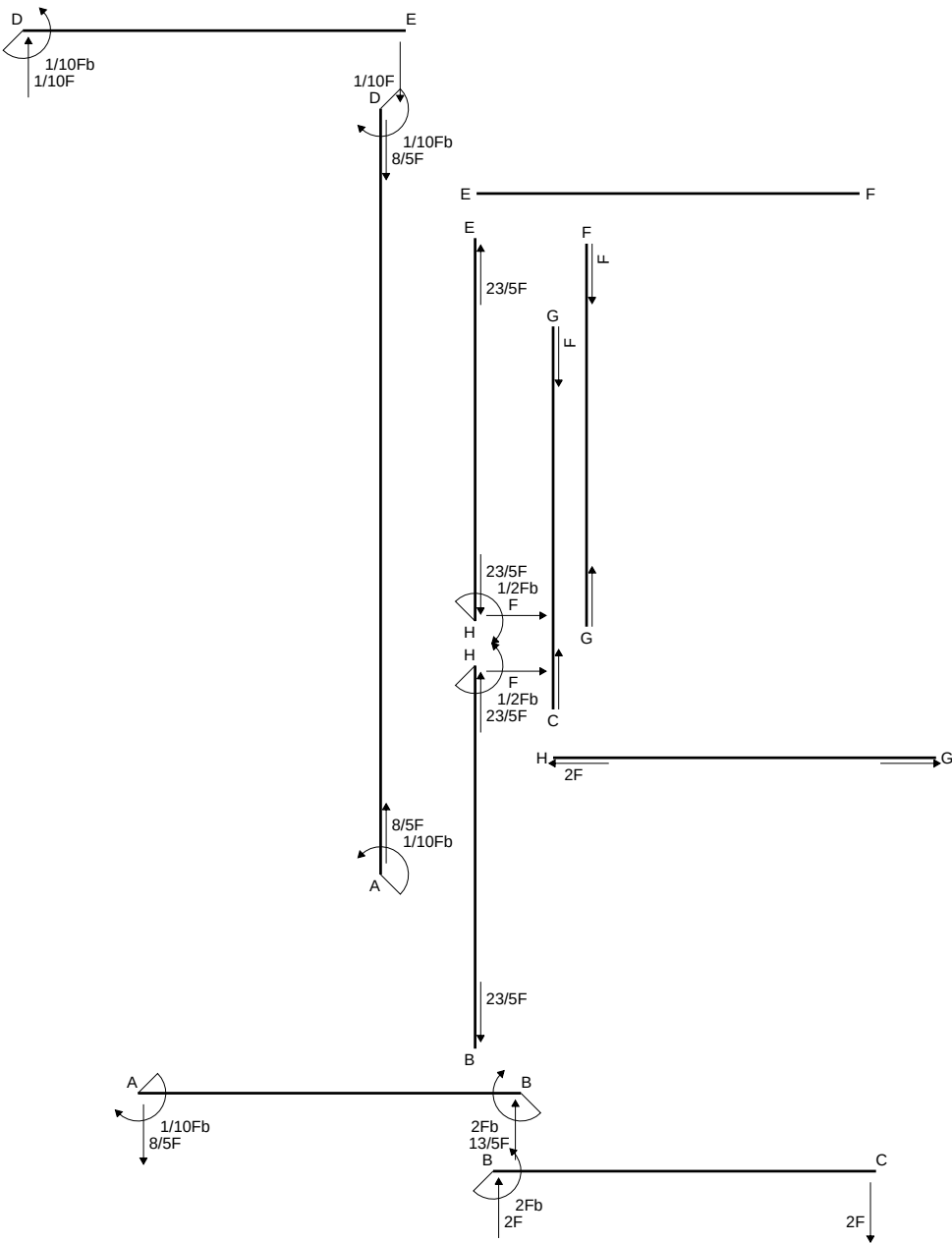
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-5/4Fx$	0	0	0	0	0+0	0
EH b	0	$-5/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

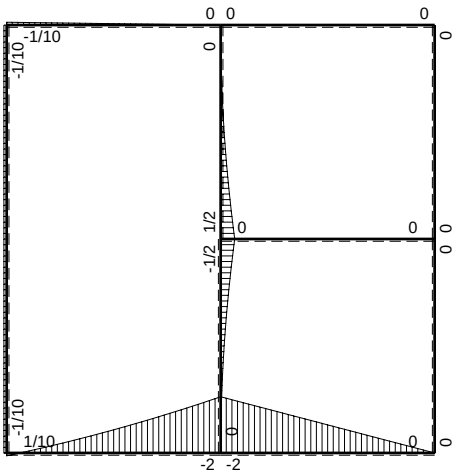


$$\begin{aligned}
A &= 1236. \text{ mm}^2 \\
J_u &= 408523. \text{ mm}^4 \\
J_v &= 128880. \text{ mm}^4 \\
y_g &= 22.49 \text{ mm} \\
T_y &= 3240. \text{ N} \\
M_x &= -2754000. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 55. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 32.51 \text{ mm} \\
\sigma_m &= -Mv/J_u = 219.2 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 42. \text{ mm} \\
v_c &= 19.51 \text{ mm} \\
\sigma_c &= -Mv/J_u = 131.5 \text{ N/mm}^2 \\
\tau_c &= 5.205 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 131.8 \text{ N/mm}^2 \\
S &= 7875. \text{ mm}^3
\end{aligned}$$

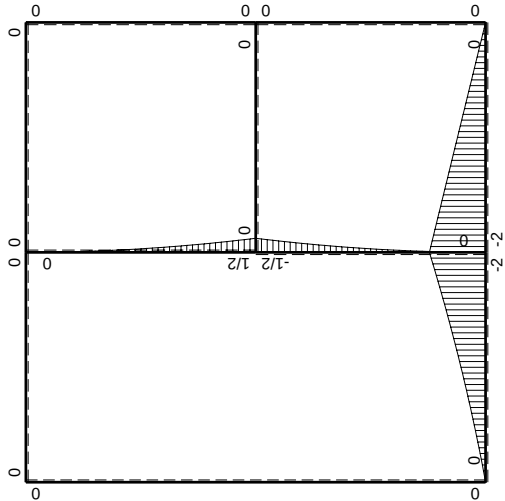
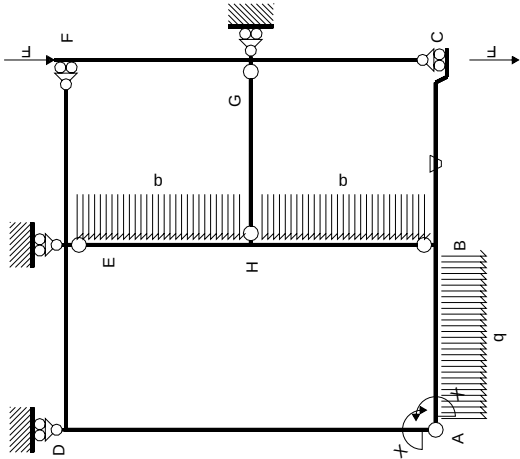


← ⊕ → F

↑ ⊕ ↓ F

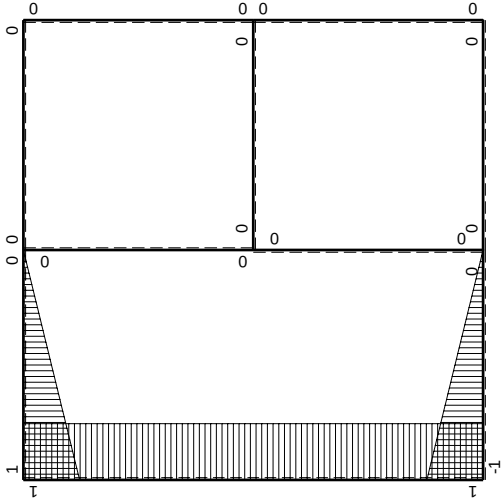


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

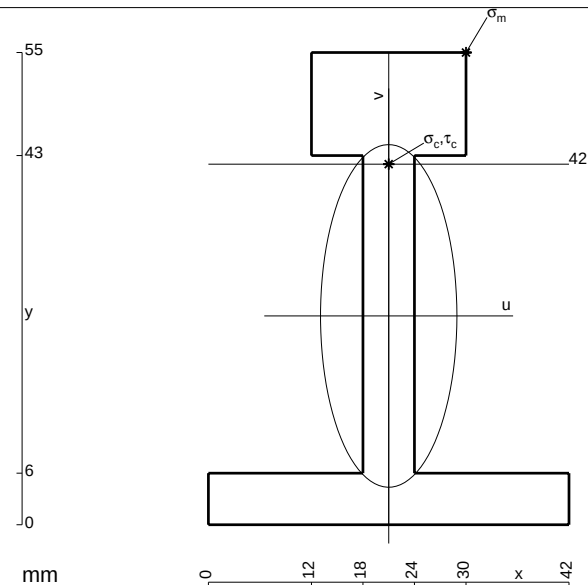
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

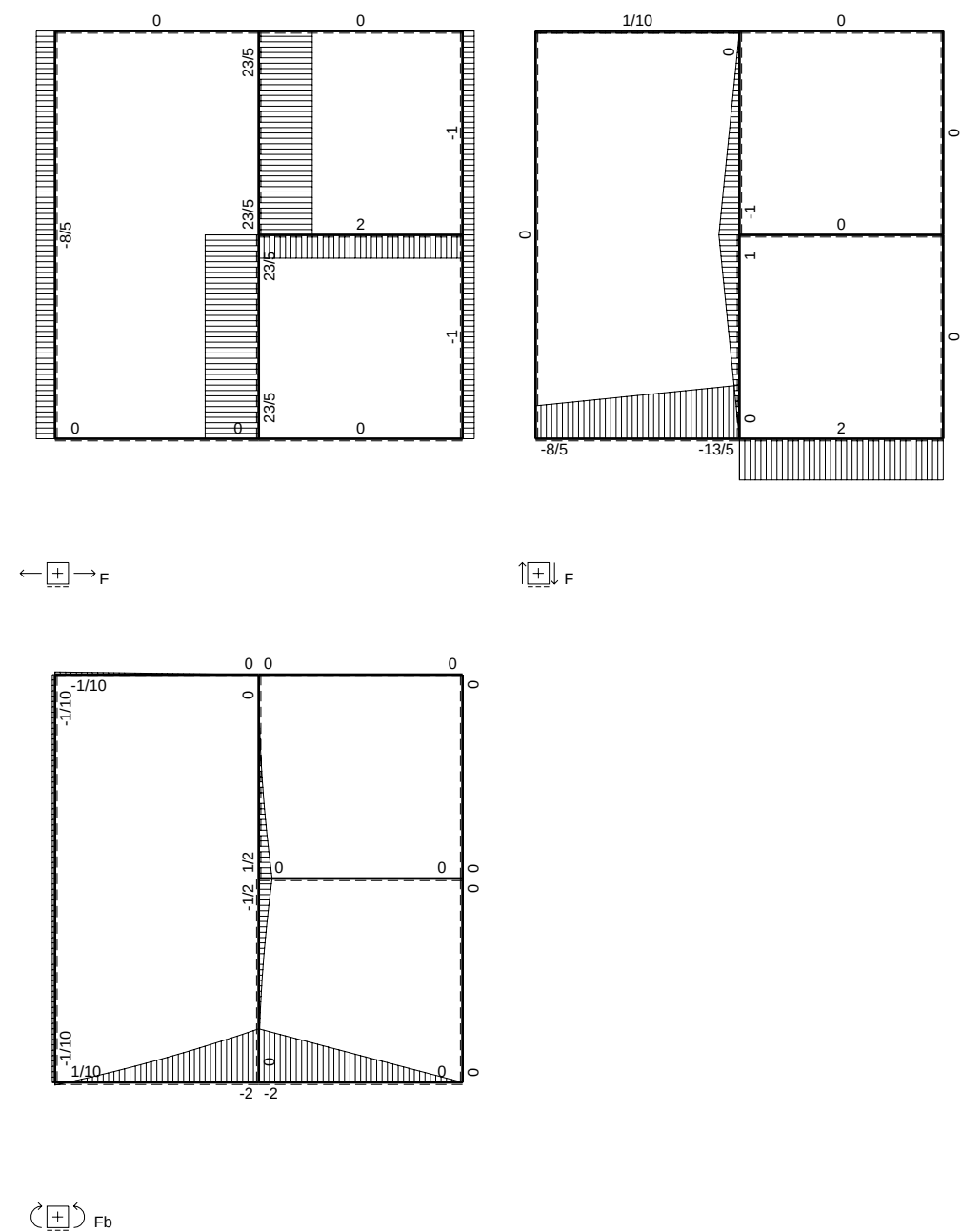
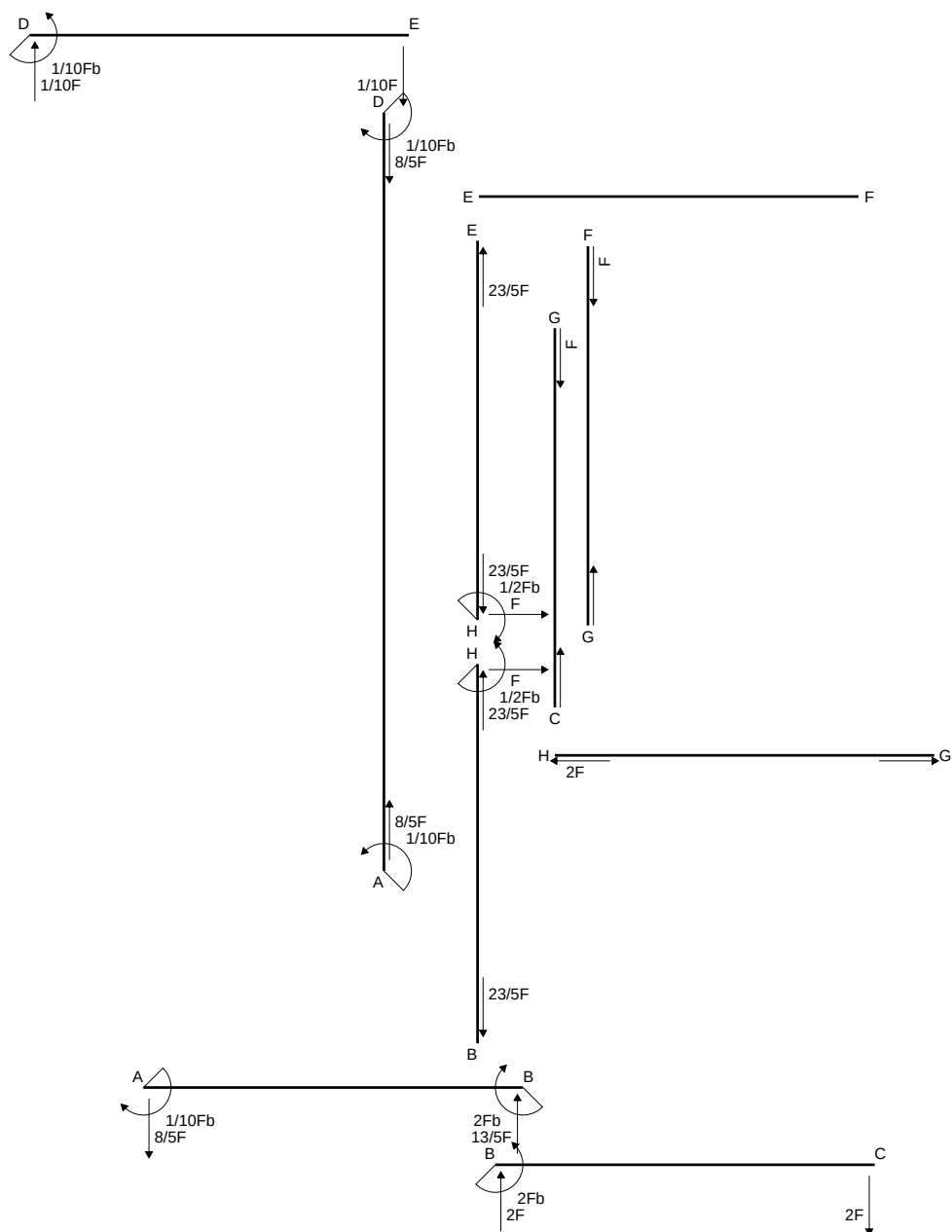
$$L_{BA}^{x_0} = \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

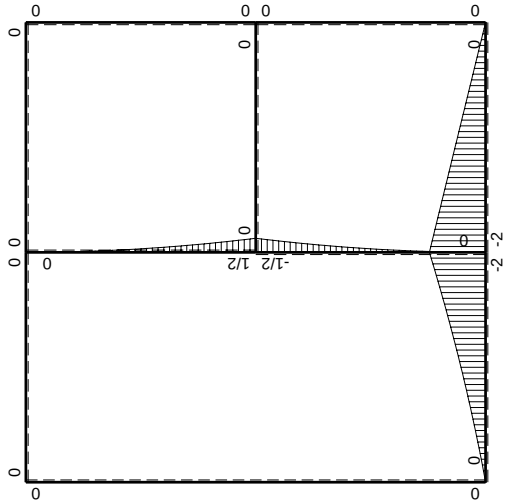
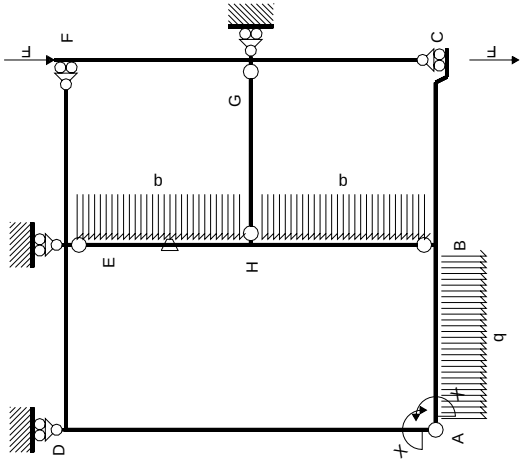
$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



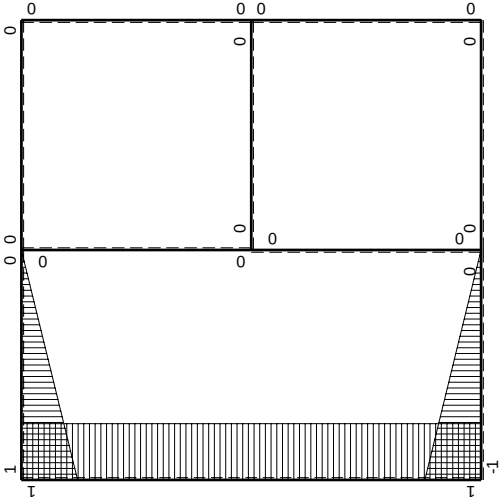
$$\begin{aligned} A &= 690. \text{ mm}^2 \\ J_u &= 274793. \text{ mm}^4 \\ J_v &= 43542. \text{ mm}^4 \\ y_g &= 24.32 \text{ mm} \\ T_y &= 2280. \text{ N} \\ M_x &= -2052000. \text{ Nmm} \\ x_m &= 30. \text{ mm} \\ y_m &= 55. \text{ mm} \\ u_m &= 9. \text{ mm} \\ v_m &= 30.68 \text{ mm} \\ \sigma_m &= -Mv/J_u = 229.1 \text{ N/mm}^2 \\ x_c &= 21. \text{ mm} \\ y_c &= 42. \text{ mm} \\ v_c &= 17.68 \text{ mm} \\ \sigma_c &= -Mv/J_u = 132. \text{ N/mm}^2 \\ \tau_c &= 7.524 \text{ N/mm}^2 \\ \sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 132.7 \text{ N/mm}^2 \\ S &= 5441. \text{ mm}^3 \end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

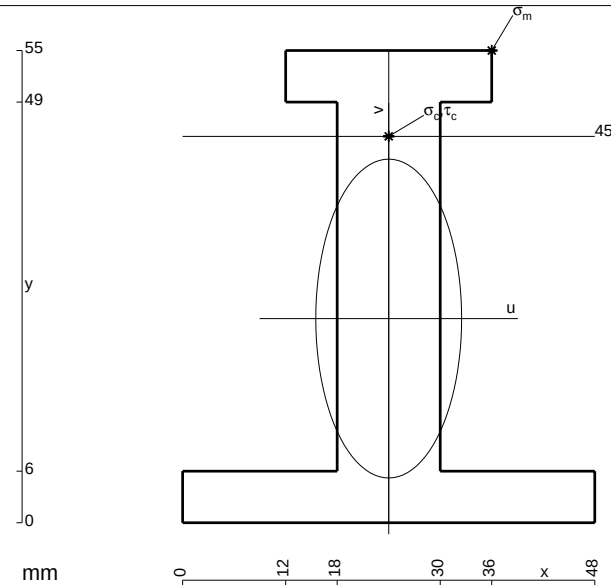
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 948. \text{ mm}^2$$

$$J_u = 326982. \text{ mm}^4$$

$$J_v = 68400. \text{ mm}^4$$

$$y_g = 23.78 \text{ mm}$$

$$T_y = 2640. \text{ N}$$

$$M_x = -2508000. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 55. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 31.22 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 239.5 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 45. \text{ mm}$$

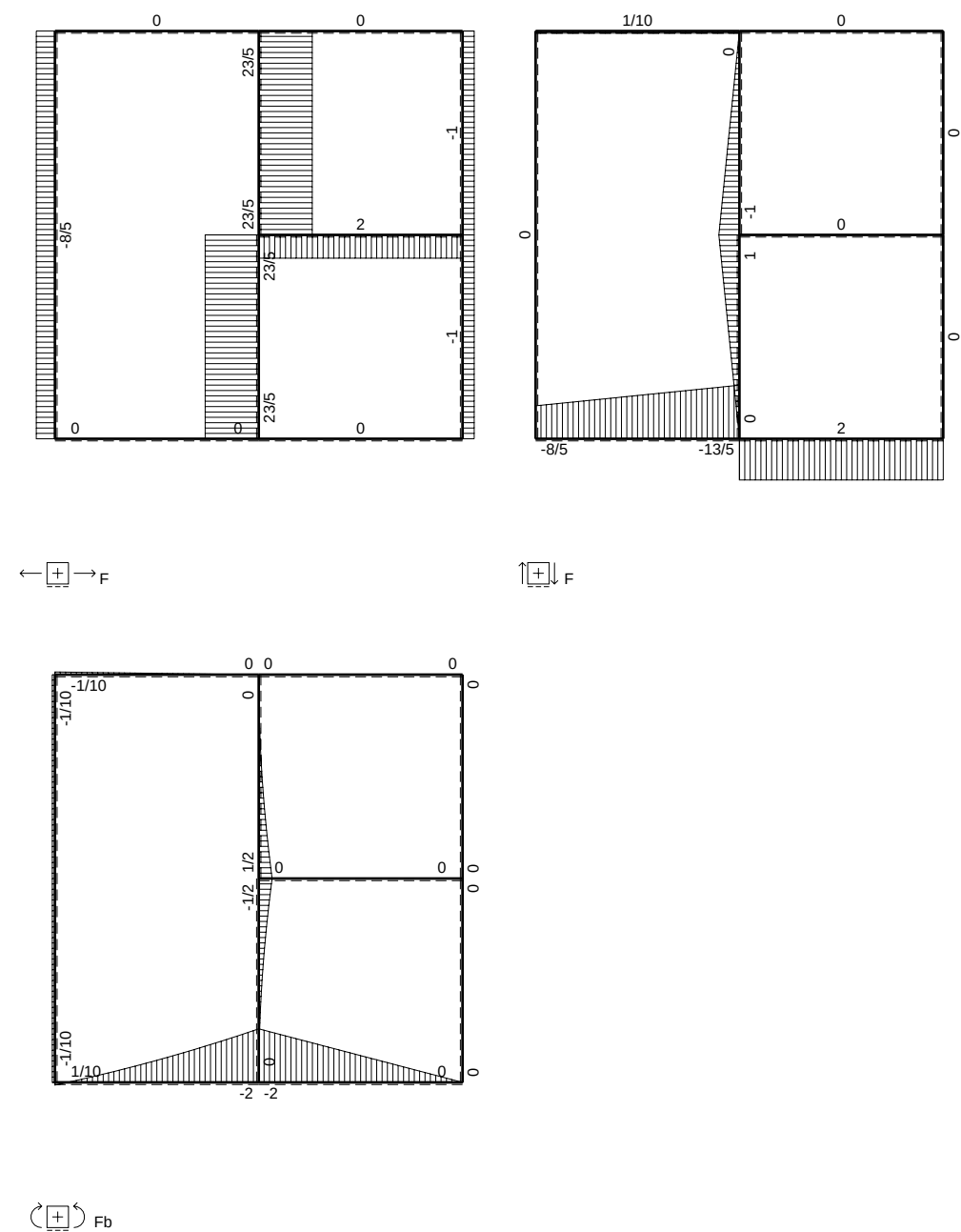
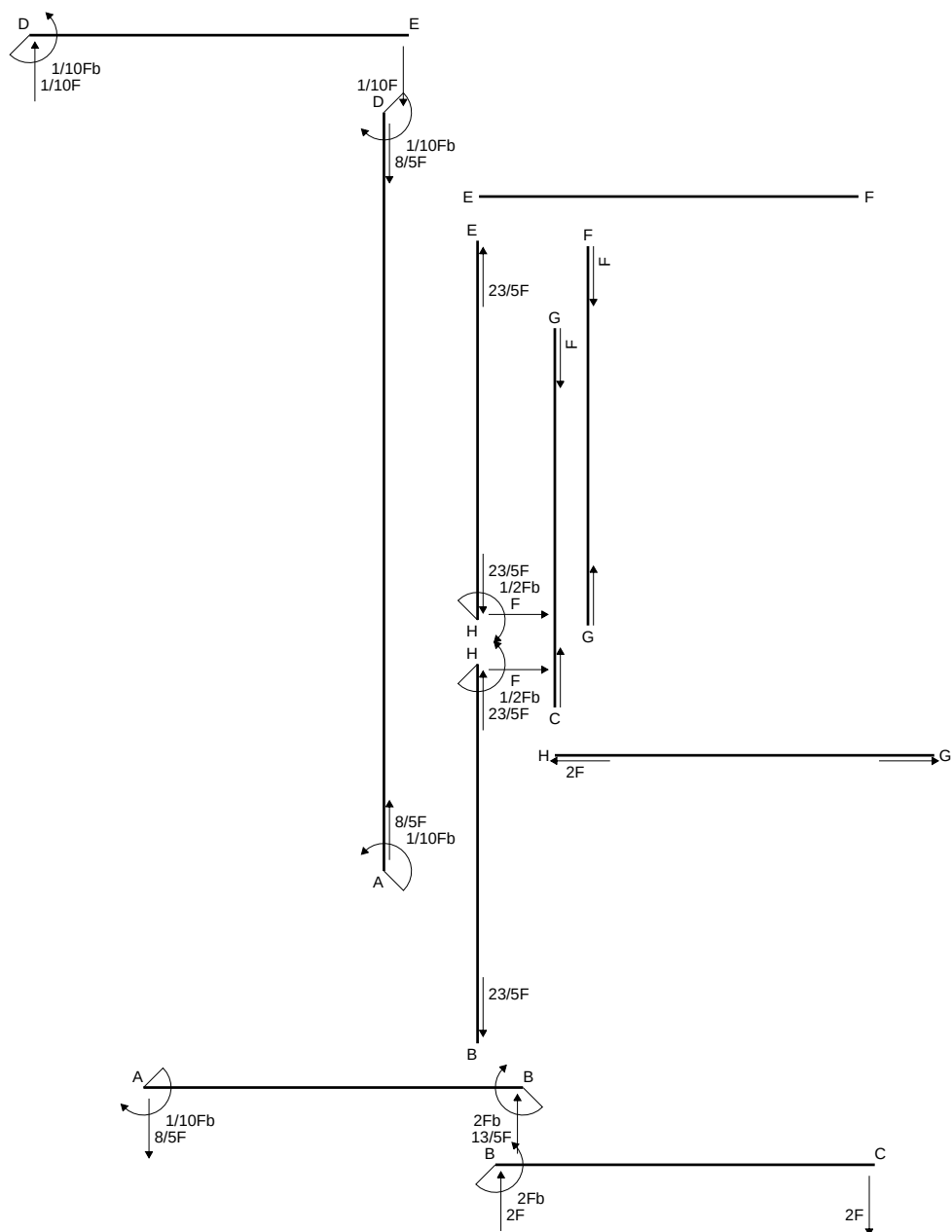
$$v_c = 21.22 \text{ mm}$$

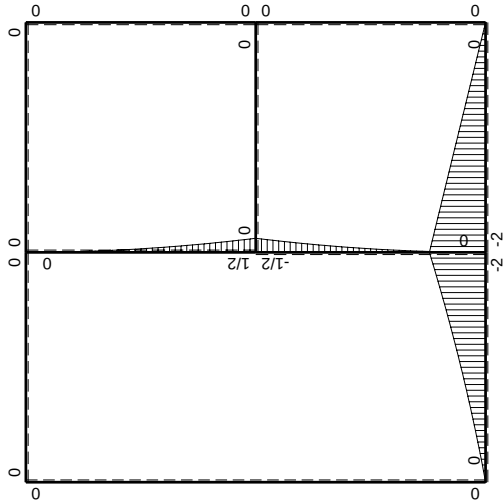
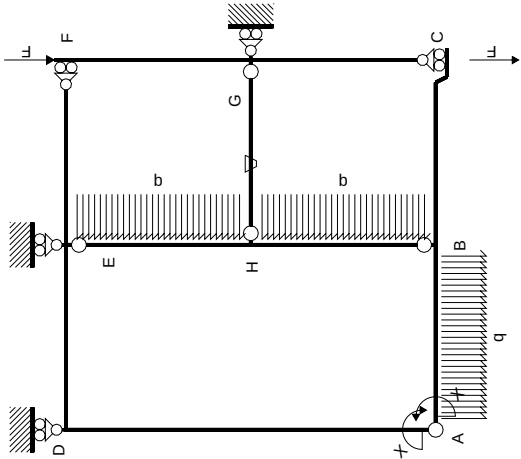
$$\sigma_c = -Mv/J_u = 162.8 \text{ N/mm}^2$$

$$\tau_c = 3.484 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 162.9 \text{ N/mm}^2$$

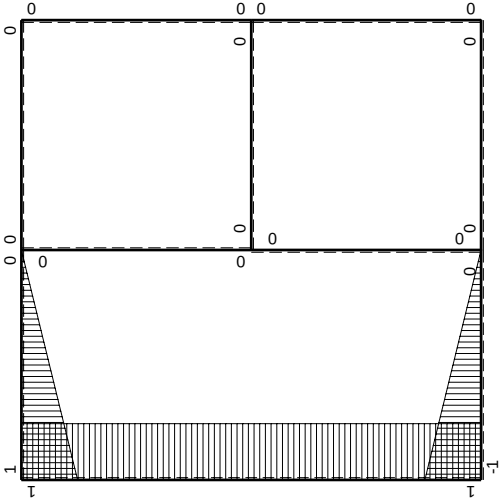
$$S = 5179. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

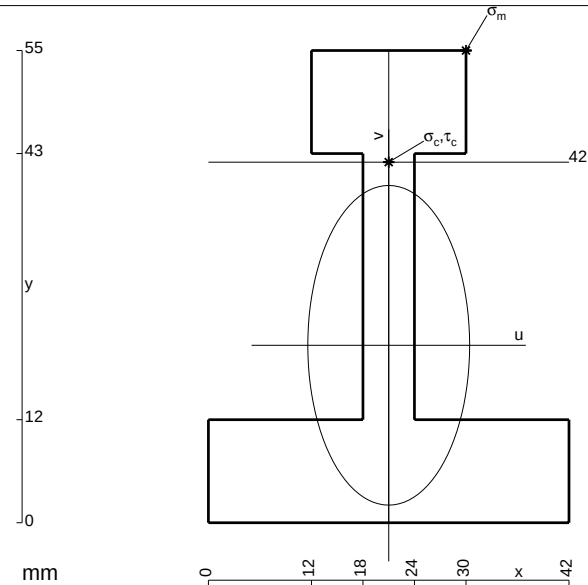
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 906. \text{ mm}^2$$

$$J_u = 314037. \text{ mm}^4$$

$$J_v = 80478. \text{ mm}^4$$

$$y_g = 20.67 \text{ mm}$$

$$T_y = 3640. \text{ N}$$

$$M_x = -1820000. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 55. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 34.33 \text{ mm}$$

$$\sigma_m = -M_v/J_u = 199. \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 42. \text{ mm}$$

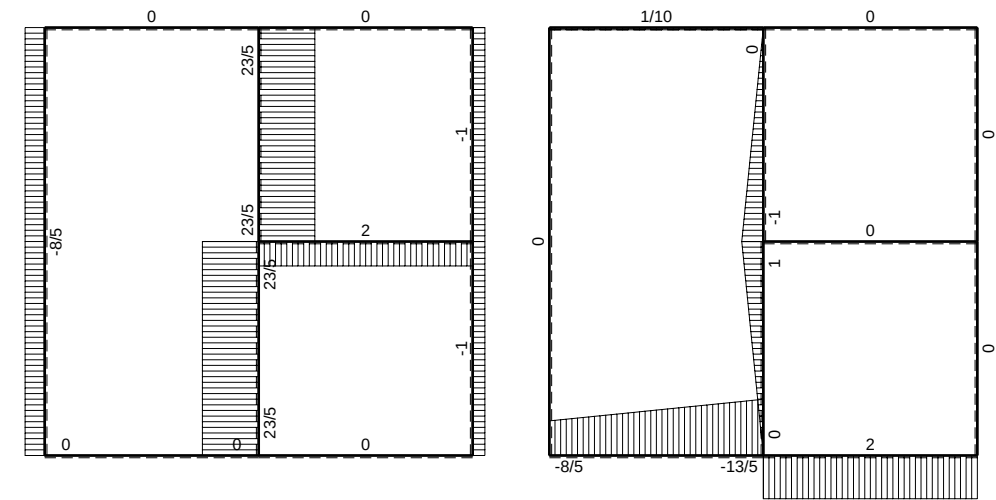
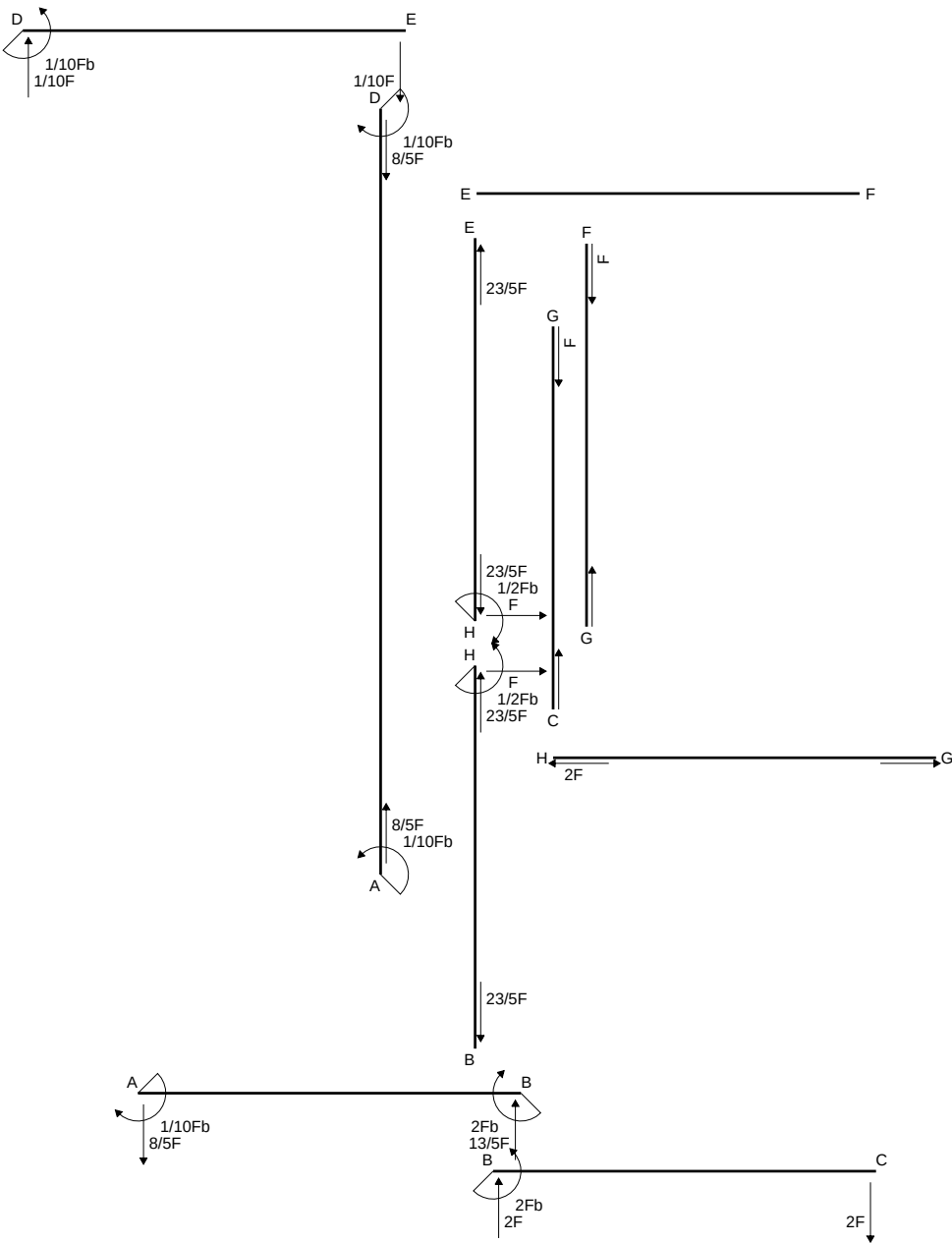
$$v_c = 21.33 \text{ mm}$$

$$\sigma_c = -M_v/J_u = 123.6 \text{ N/mm}^2$$

$$\tau_c = 12.08 \text{ N/mm}^2$$

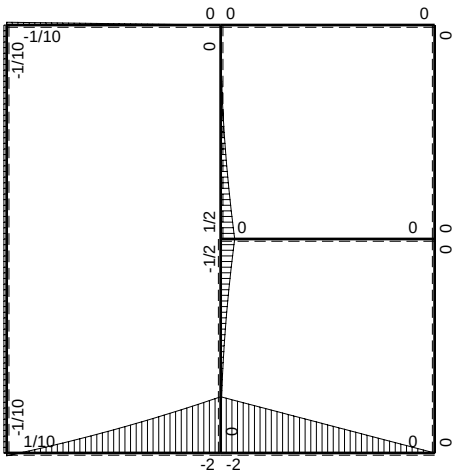
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 125.4 \text{ N/mm}^2$$

$$S = 6251. \text{ mm}^3$$

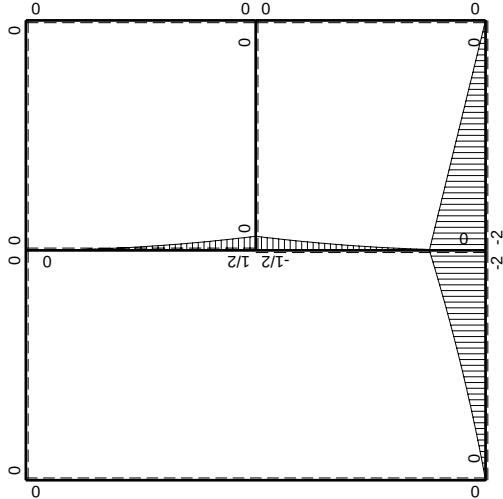
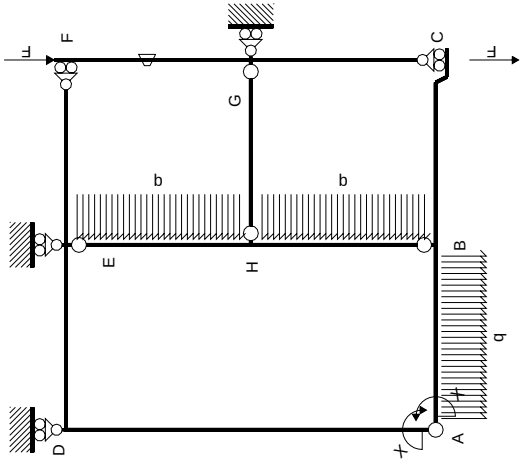


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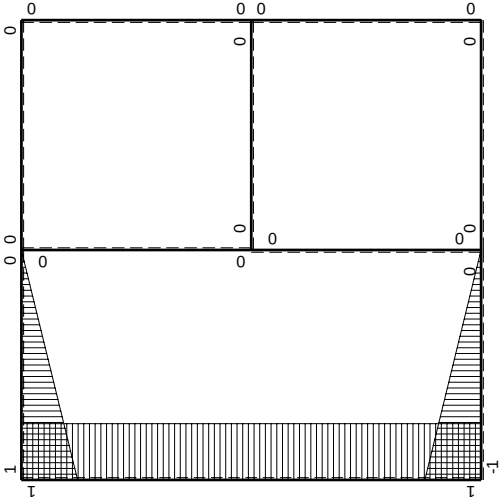


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Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

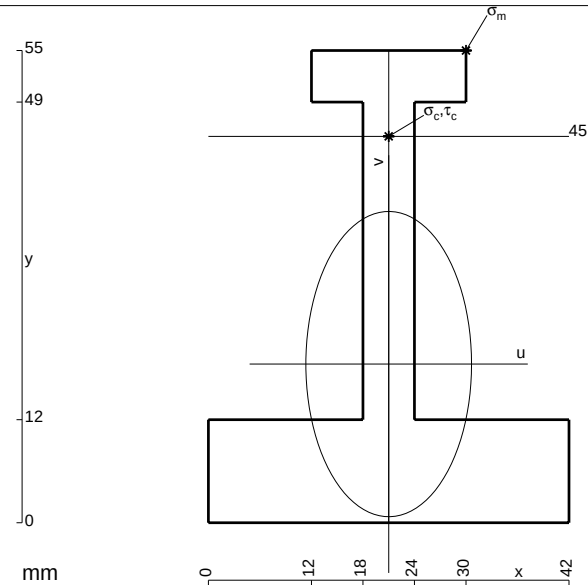
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 834. \text{ mm}^2$$

$$J_u = 263619. \text{ mm}^4$$

$$J_v = 77670. \text{ mm}^4$$

$$y_g = 18.48 \text{ mm}$$

$$T_y = 2740. \text{ N}$$

$$M_x = -1507000. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 55. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 36.52 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 208.8 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 45. \text{ mm}$$

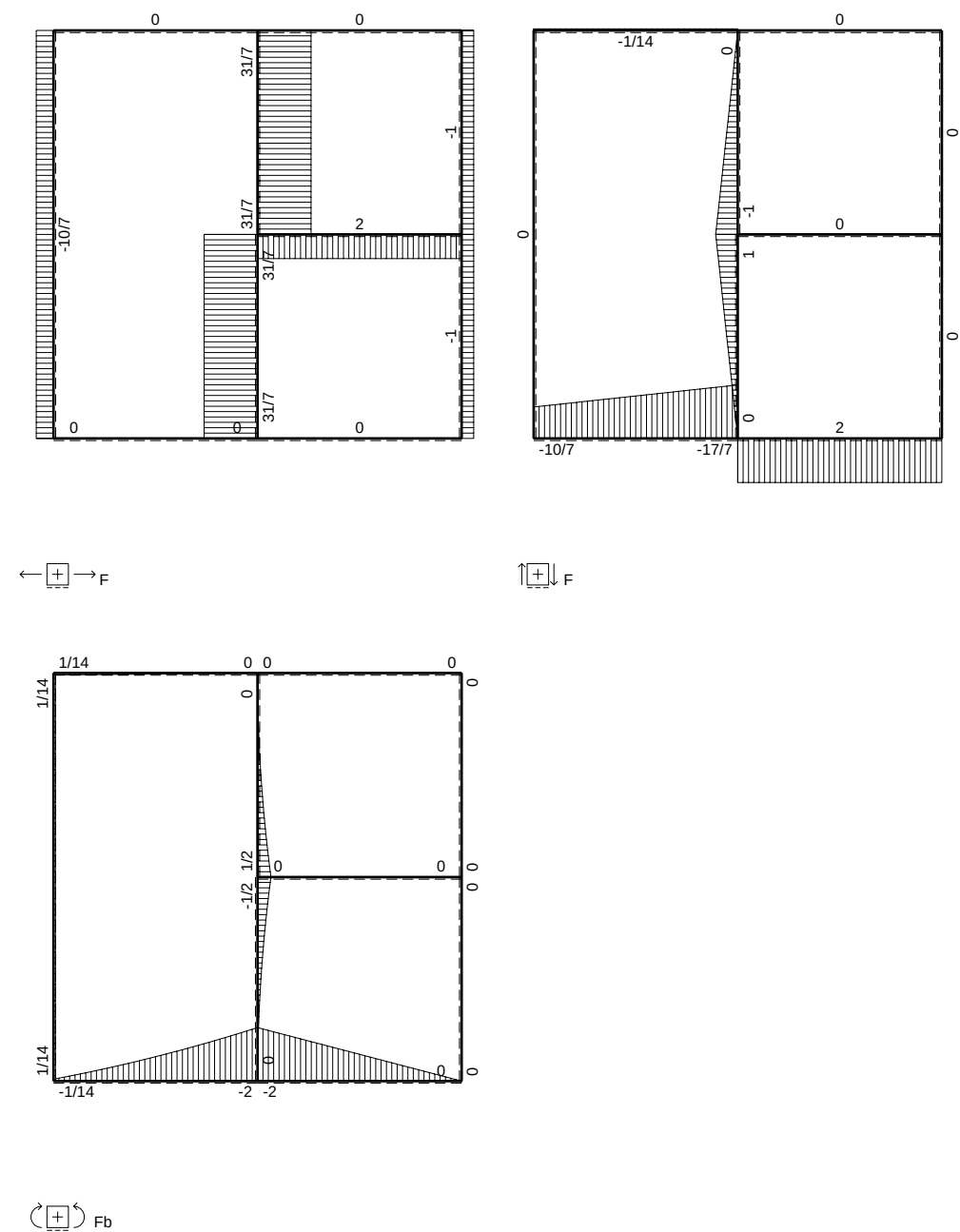
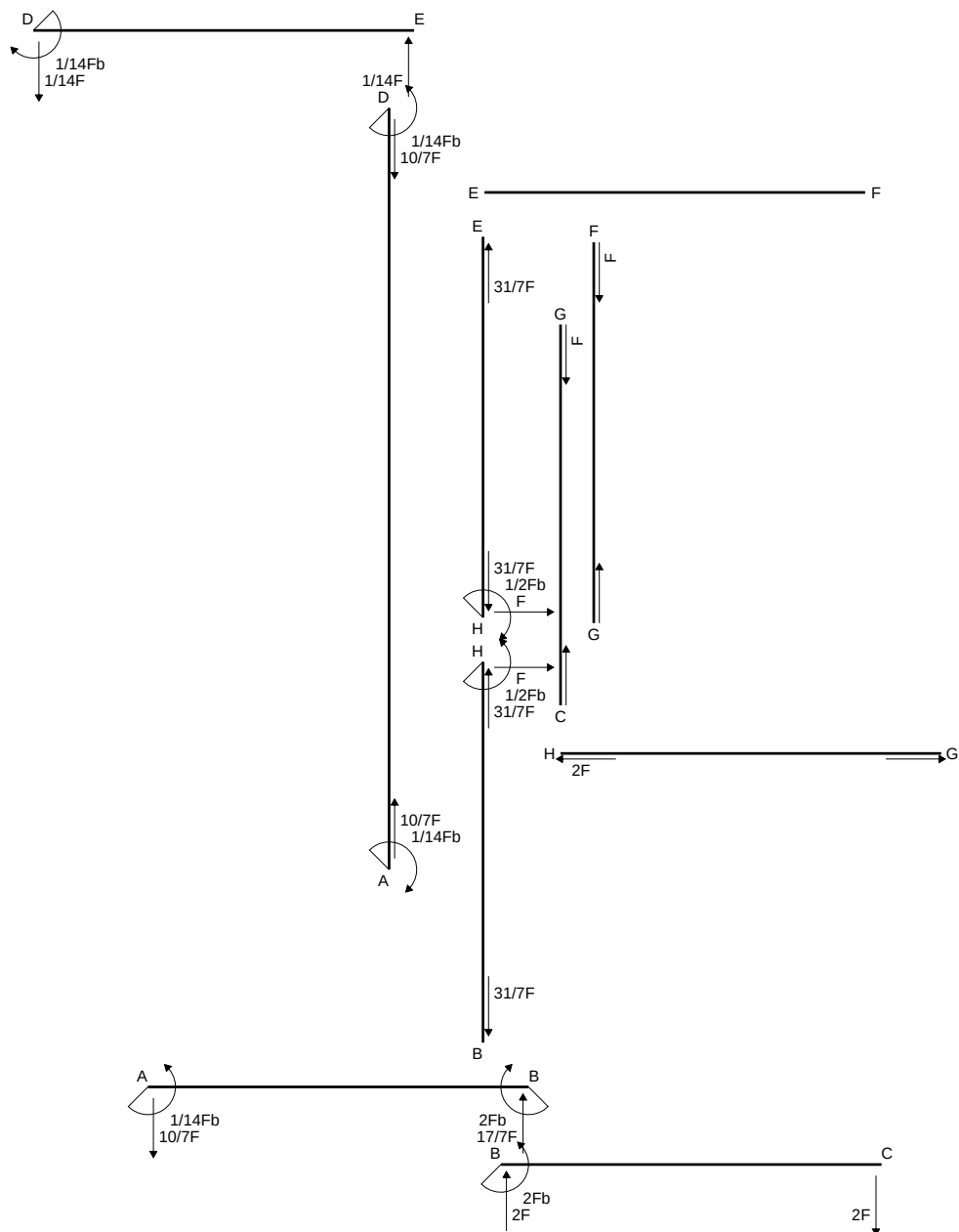
$$v_c = 26.52 \text{ mm}$$

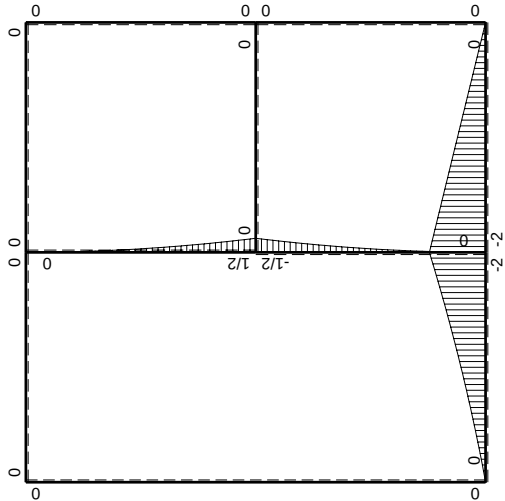
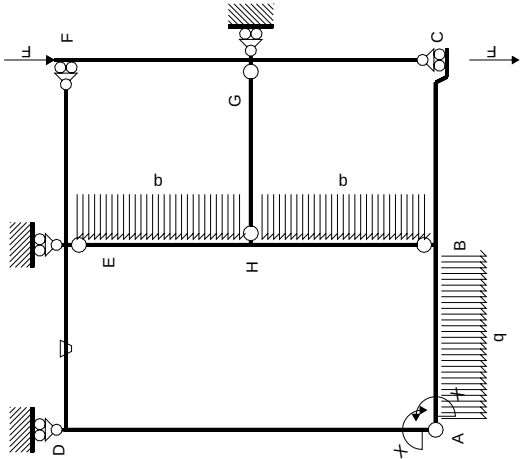
$$\sigma_c = -Mv/J_u = 151.6 \text{ N/mm}^2$$

$$\tau_c = 7.457 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 152.2 \text{ N/mm}^2$$

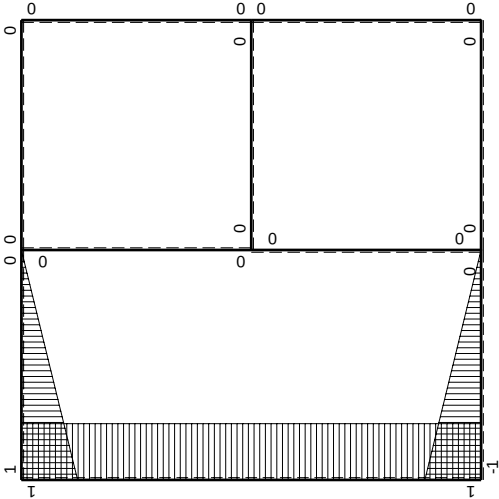
$$S = 4305. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	$-Fb/EJ$	0	$-Fb/EJ+Fx/EJ$	$1-2x/b+x^2/b^2$	$(0-1/2)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	0	Fb/EJ	0	$-Fx/EJ$	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/14Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

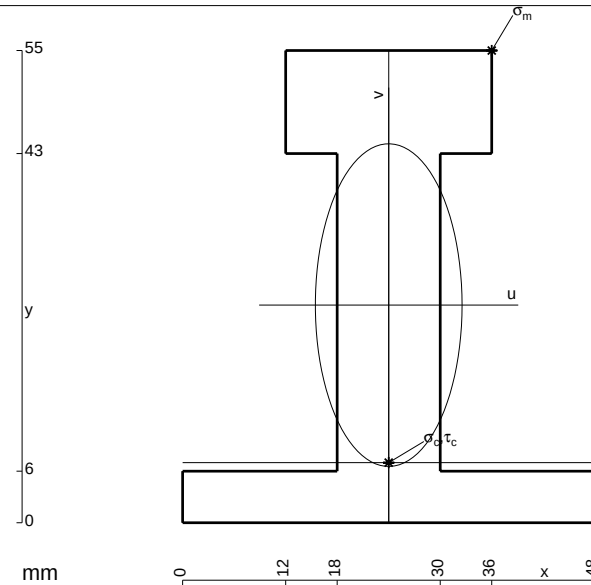
$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{DE}^{xo} = \int_0^b (-1 + x/b) \theta dx = \left[-x + 1/2 x^2/b \right]_0^b \theta$$

$$= (-b + 1/2 b) \theta = -1/2 \frac{Fb^2}{EJ}$$

$$L_{ED}^{xo} = \int_0^b (x/b) \theta dx = \left[1/2 x^2/b \right]_0^b \theta$$

$$= (1/2 b) \theta = -1/2 \frac{Fb^2}{EJ}$$



$$A = 1020. \text{ mm}^2$$

$$J_u = 360241. \text{ mm}^4$$

$$J_v = 74448. \text{ mm}^4$$

$$y_g = 25.35 \text{ mm}$$

$$T_y = 4440. \text{ N}$$

$$M_x = -2664000. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 55. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 29.65 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 219.3 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 7. \text{ mm}$$

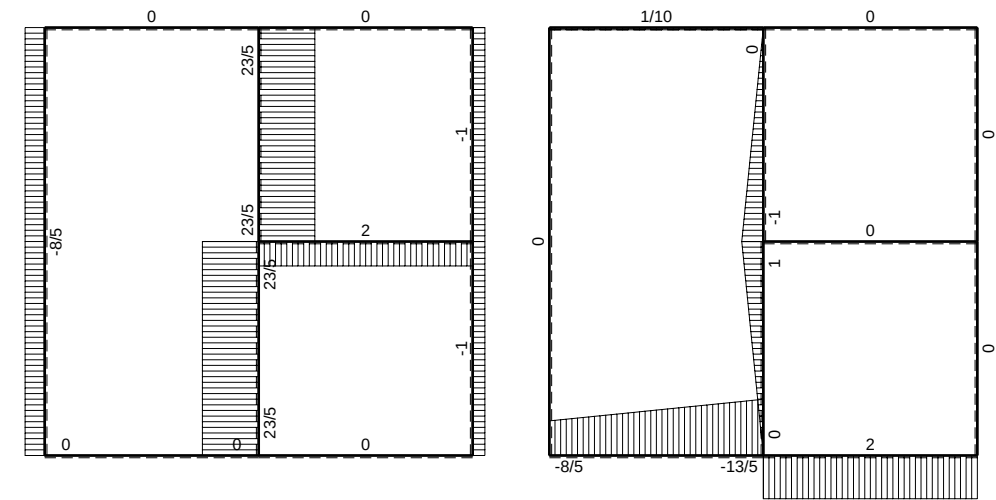
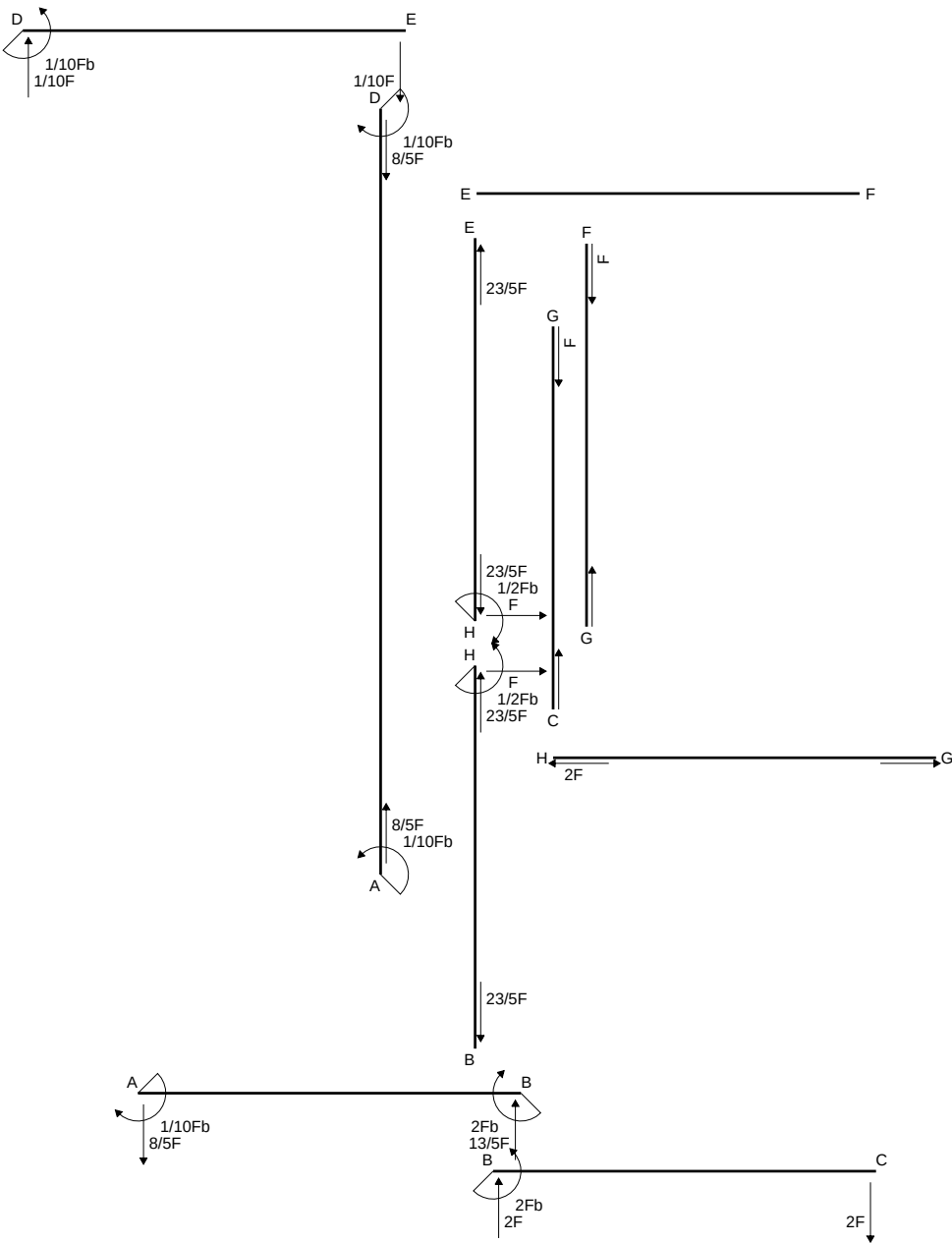
$$v_c = -18.35 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -135.7 \text{ N/mm}^2$$

$$\tau_c = 6.843 \text{ N/mm}^2$$

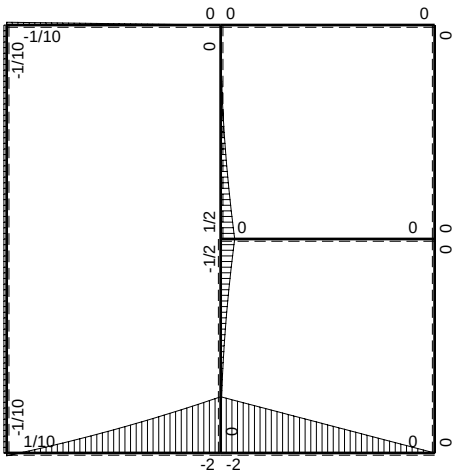
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 136.2 \text{ N/mm}^2$$

$$S = 6662. \text{ mm}^3$$

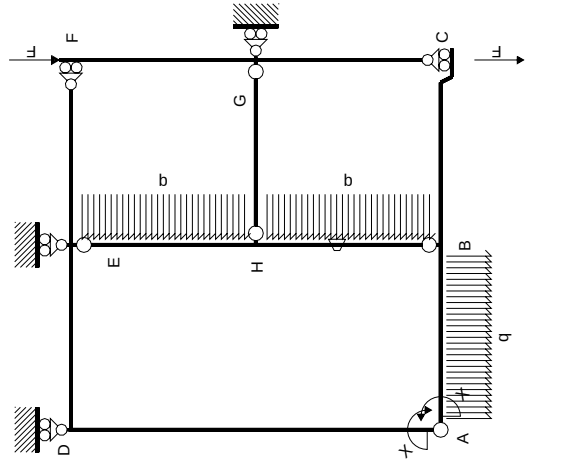


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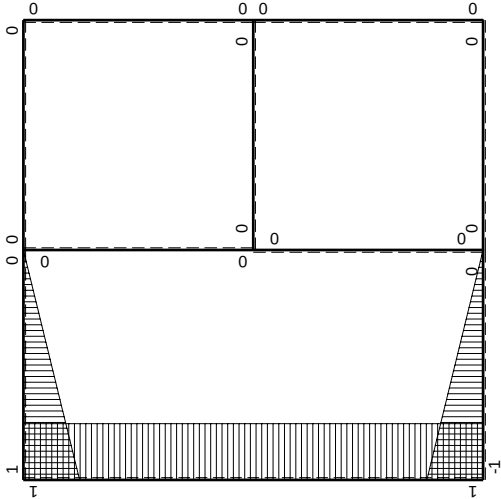


⊕ ⊖ F_b

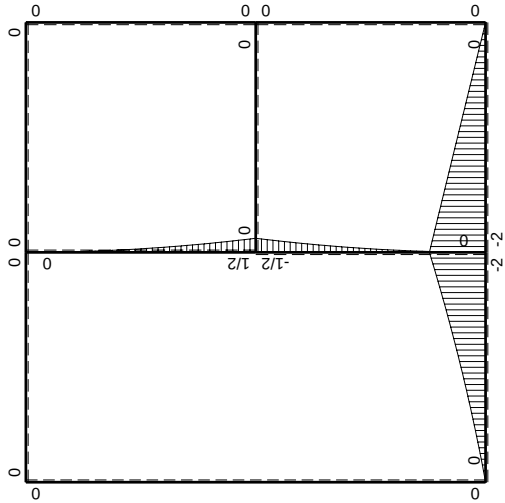


Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$



Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$1/2qx^2$	Fb/EJ	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

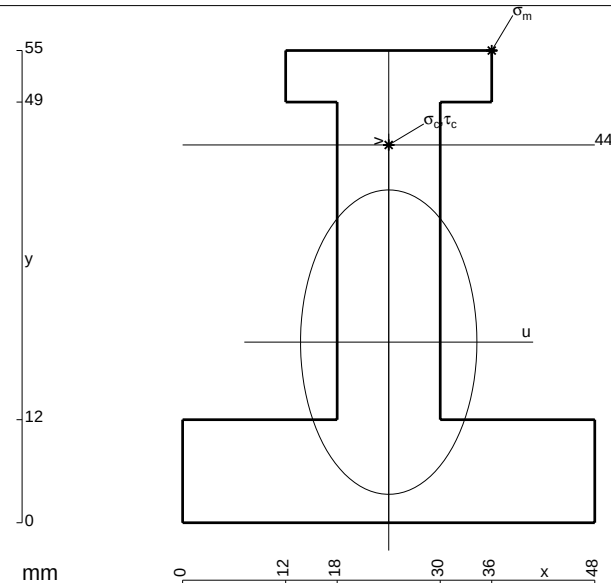
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 1164. \text{ mm}^2$$

$$J_u = 366050. \text{ mm}^4$$

$$J_v = 122832. \text{ mm}^4$$

$$y_g = 21.04 \text{ mm}$$

$$T_y = 3800. \text{ N}$$

$$M_x = -2470000. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 55. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 33.96 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 229.2 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 44. \text{ mm}$$

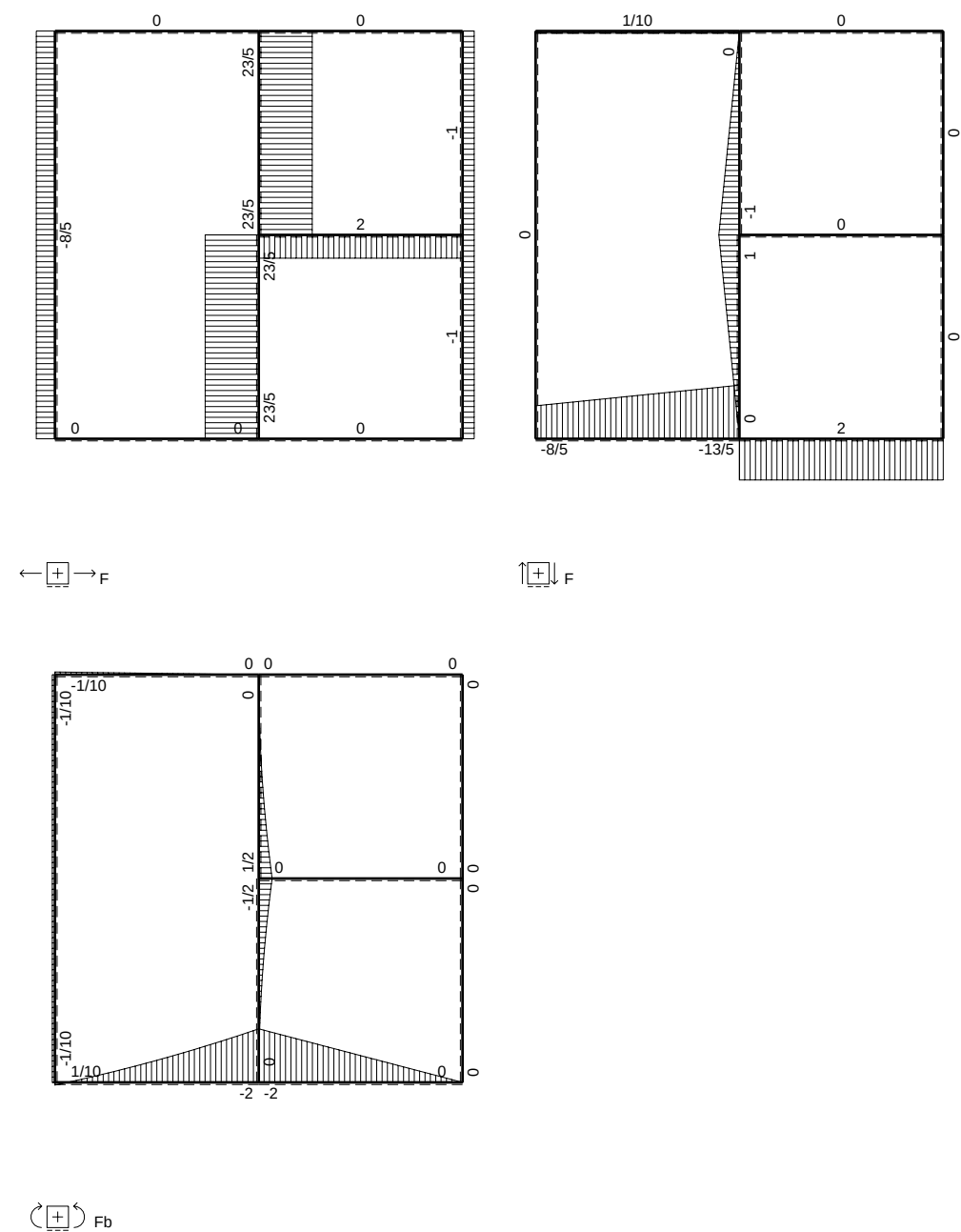
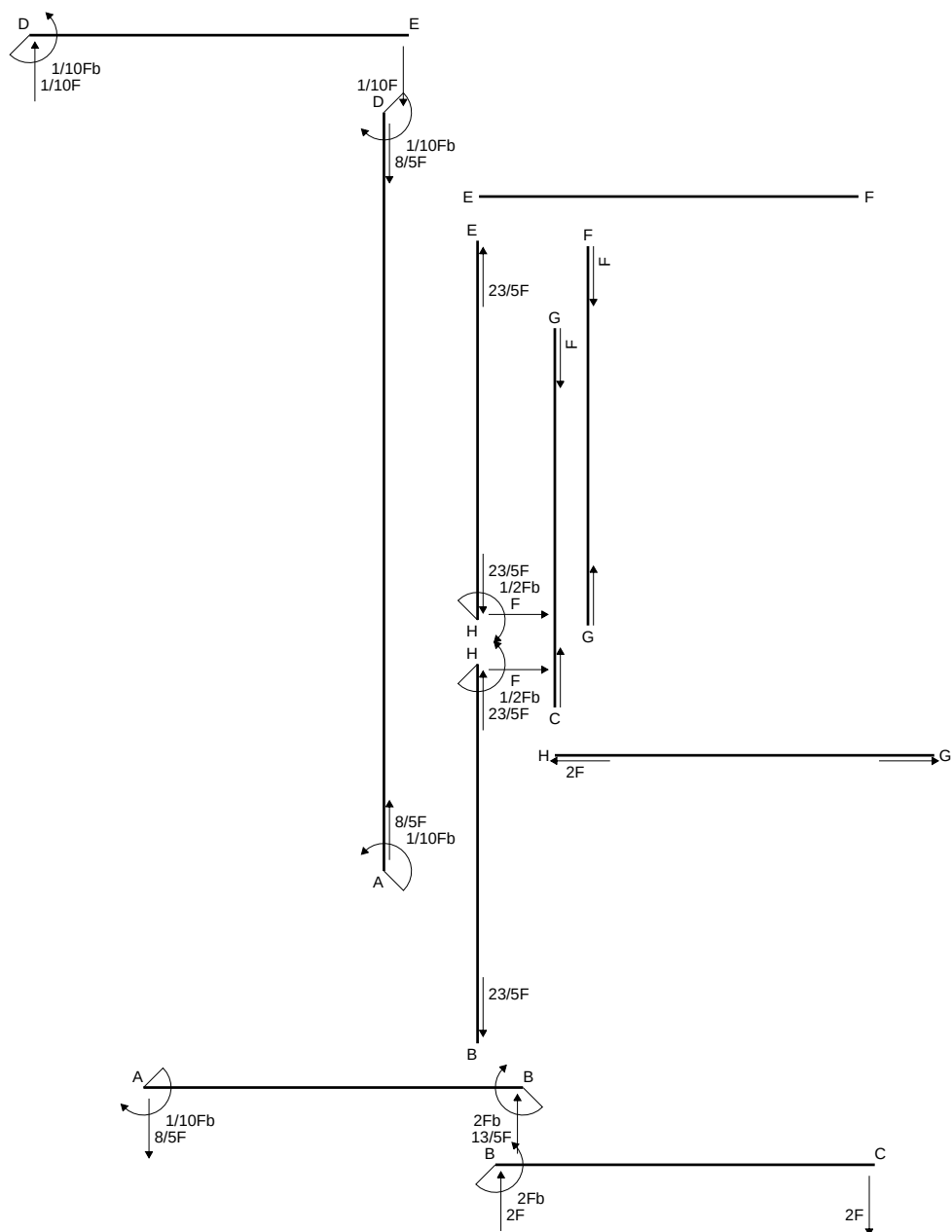
$$v_c = 22.96 \text{ mm}$$

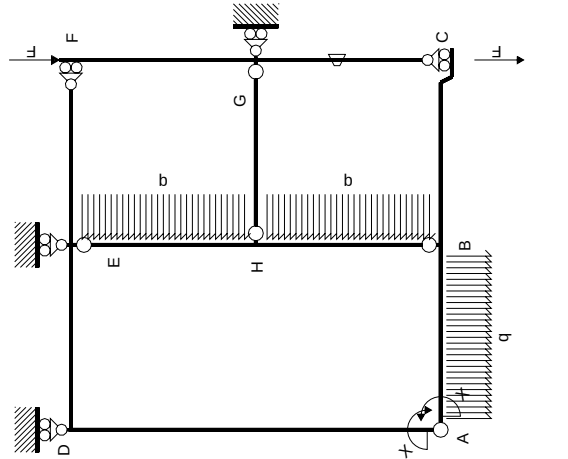
$$\sigma_c = -Mv/J_u = 155. \text{ N/mm}^2$$

$$\tau_c = 5.179 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 155.2 \text{ N/mm}^2$$

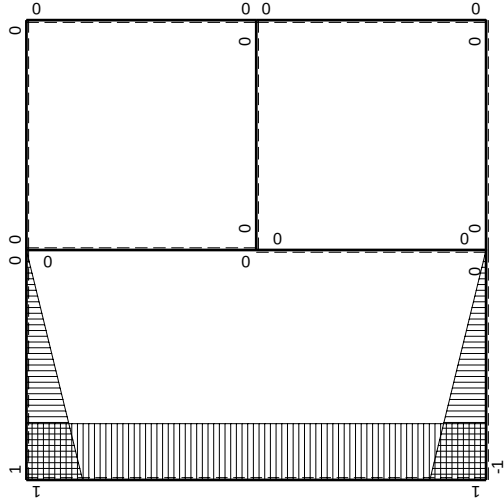
$$S = 5987. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



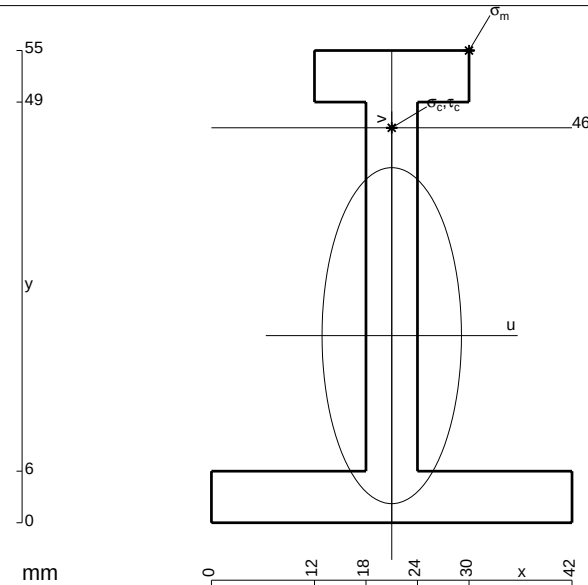
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

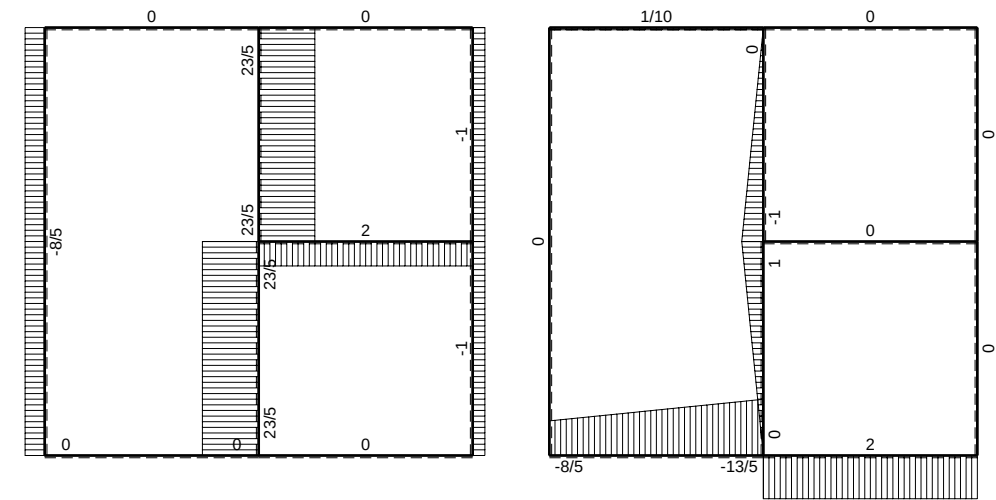
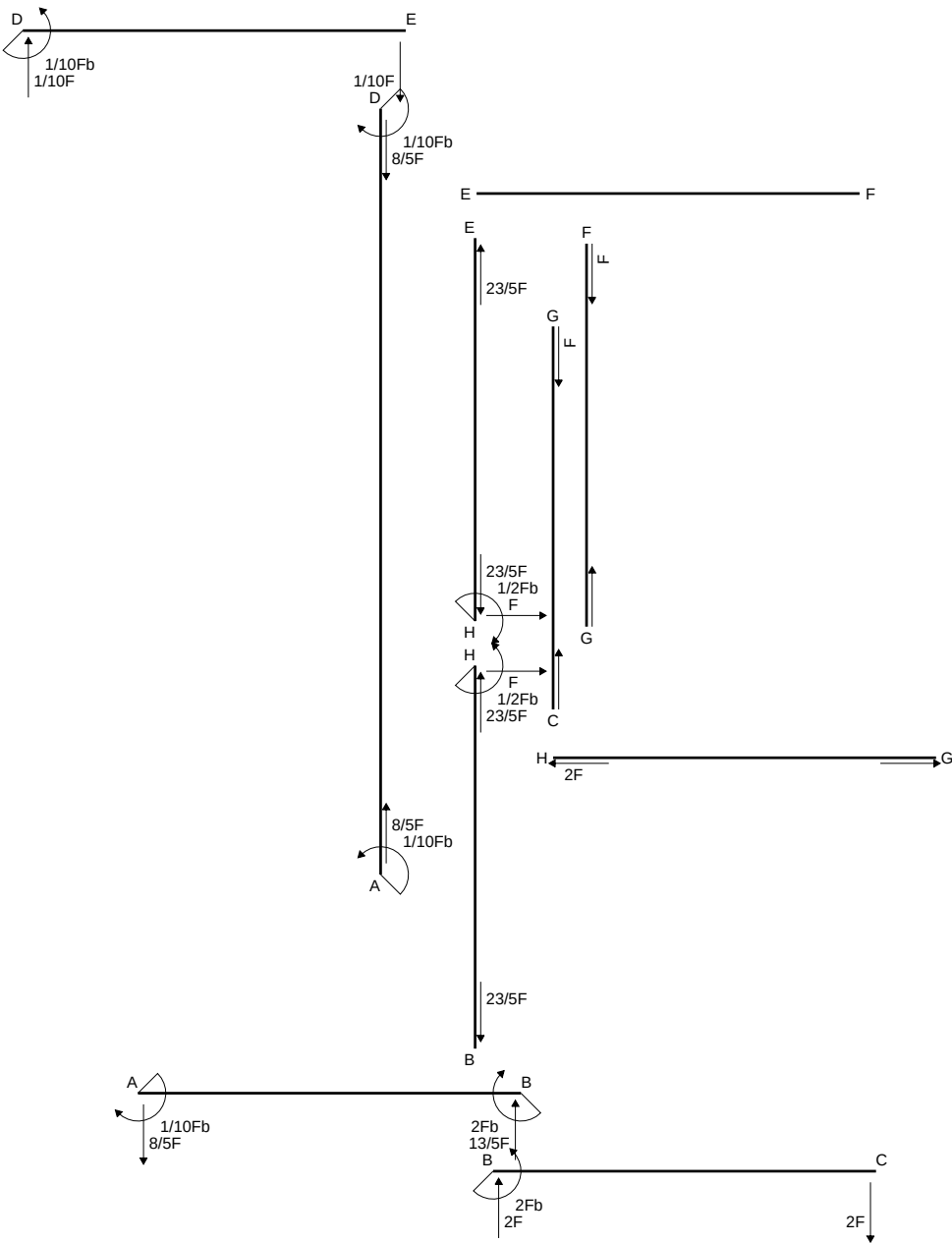
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
 L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
 &= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
 L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
 &= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
 L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
 &= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
 L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
 &= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
 L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
 &= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
 L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
 &= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
 L_{AB}^{xo} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
 L_{BA}^{xo} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}
 \end{aligned}$$

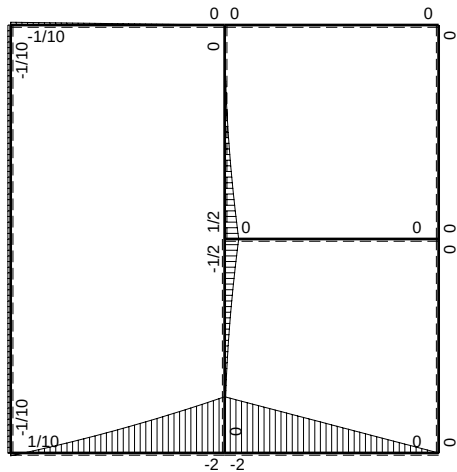


$$\begin{aligned}
 A &= 618. \text{ mm}^2 \\
 J_u &= 236783. \text{ mm}^4 \\
 J_v &= 40734. \text{ mm}^4 \\
 y_g &= 21.79 \text{ mm} \\
 T_y &= 2440. \text{ N} \\
 M_x &= -1708000. \text{ Nmm} \\
 x_m &= 30. \text{ mm} \\
 y_m &= 55. \text{ mm} \\
 u_m &= 9. \text{ mm} \\
 v_m &= 33.21 \text{ mm} \\
 \sigma_m &= -Mv/J_u = 239.5 \text{ N/mm}^2 \\
 x_c &= 21. \text{ mm} \\
 y_c &= 46. \text{ mm} \\
 v_c &= 24.21 \text{ mm} \\
 \sigma_c &= -Mv/J_u = 174.6 \text{ N/mm}^2 \\
 \tau_c &= 6.398 \text{ N/mm}^2 \\
 \sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 175. \text{ N/mm}^2 \\
 S &= 3725. \text{ mm}^3
 \end{aligned}$$

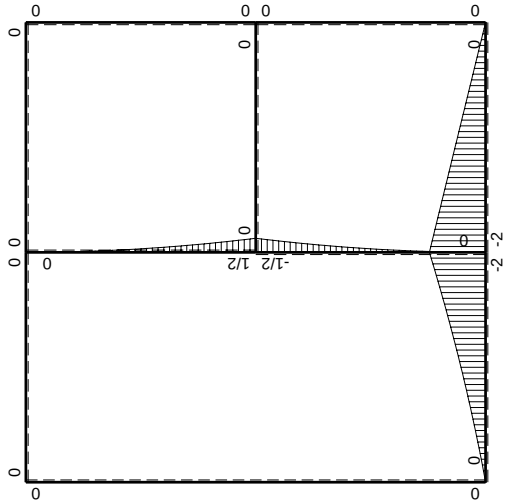
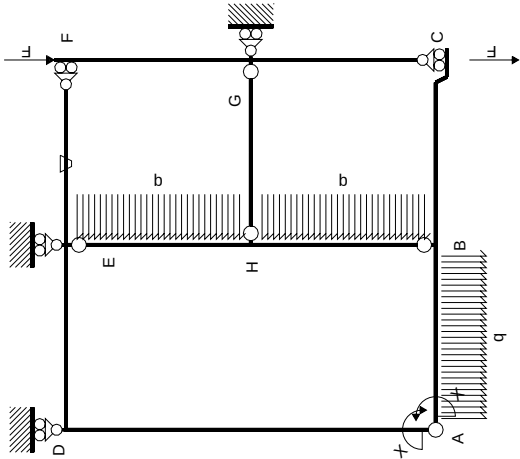


← ⊕ → F

↑ ⊕ ↓ F

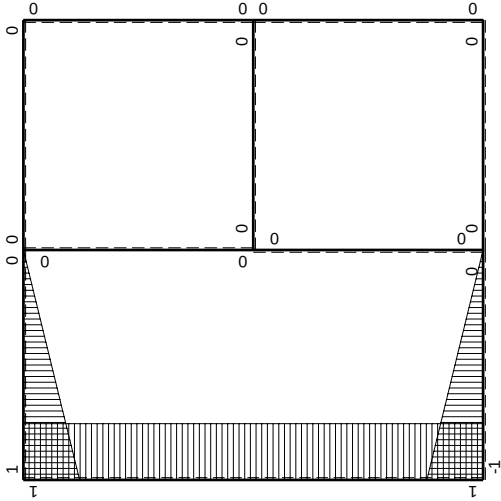


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$1/2qx^2$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

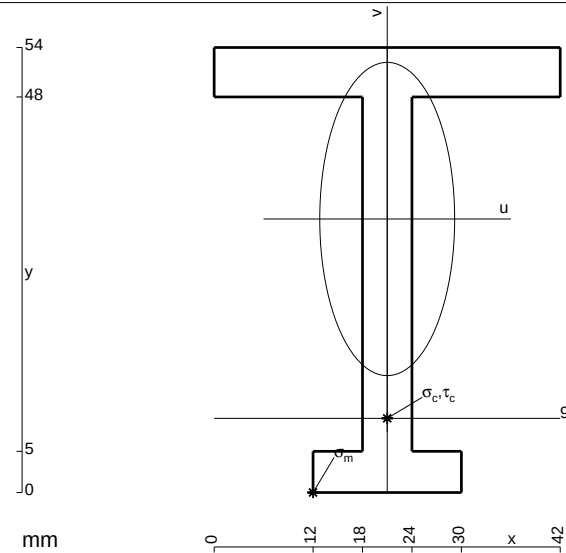
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 600. \text{ mm}^2$$

$$J_u = 216946. \text{ mm}^4$$

$$J_v = 40248. \text{ mm}^4$$

$$y_g = 33.19 \text{ mm}$$

$$T_y = 1780. \text{ N}$$

$$M_x = -1299400. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -33.19 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -198.8 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 9. \text{ mm}$$

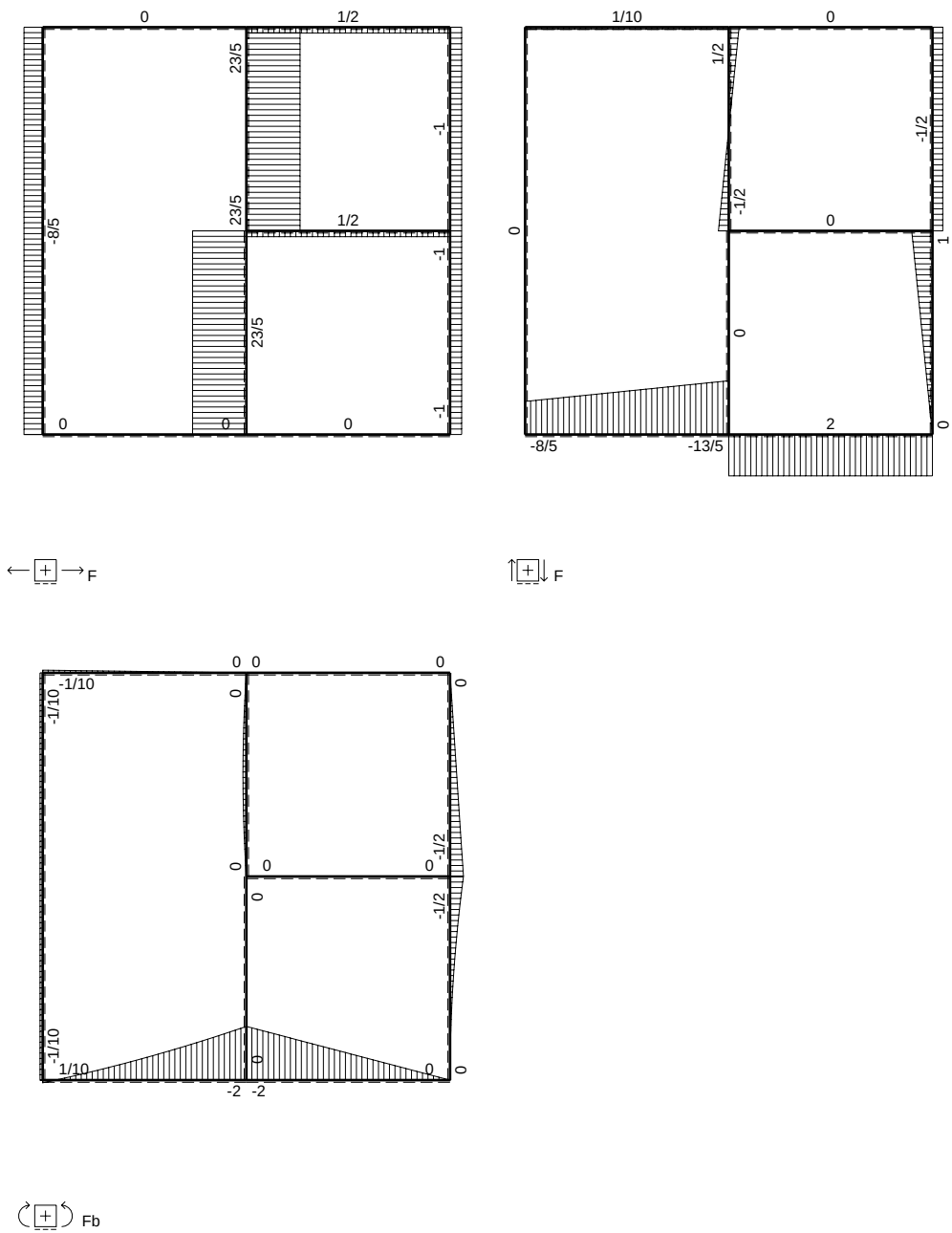
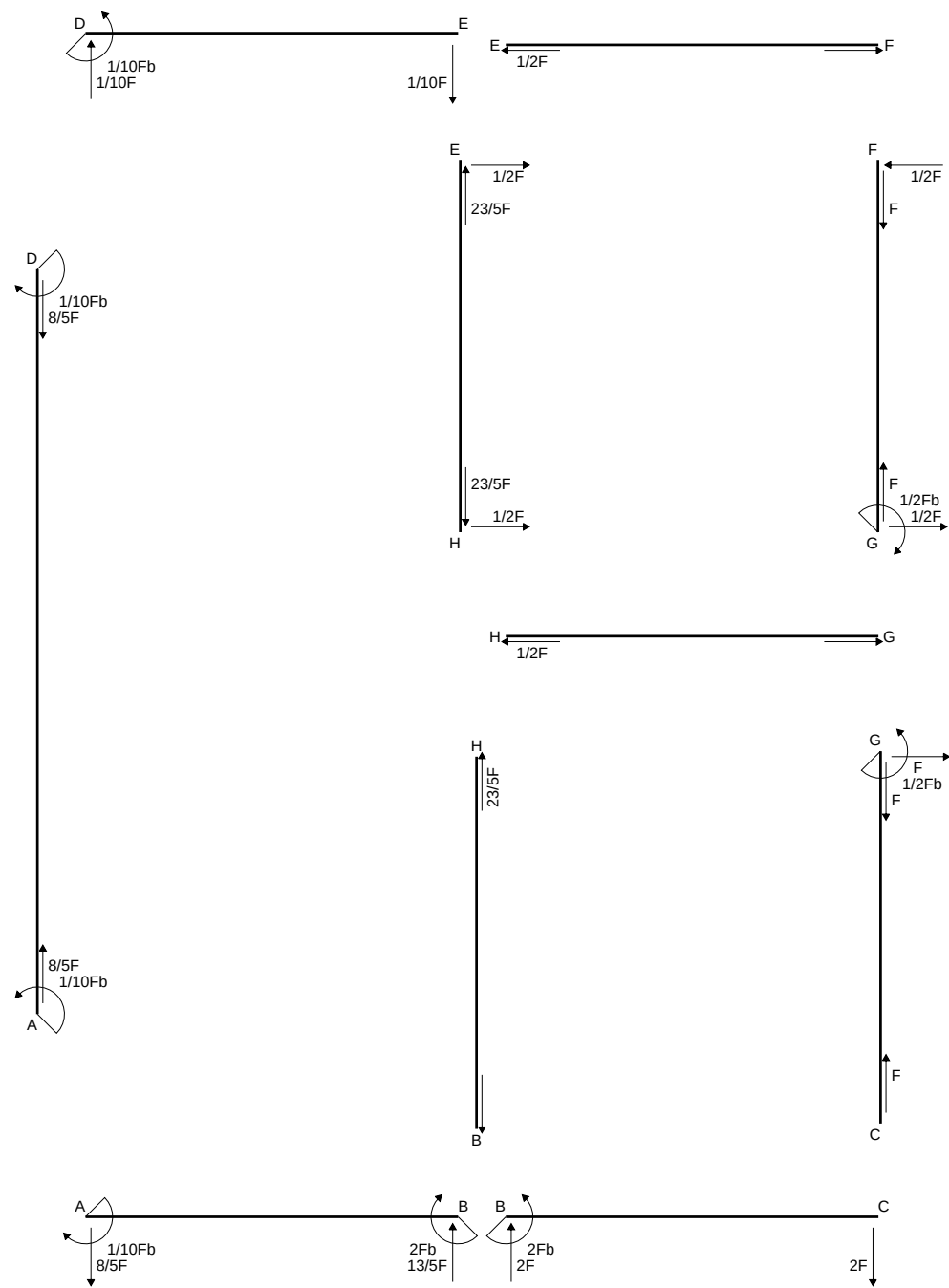
$$v_c = -24.19 \text{ mm}$$

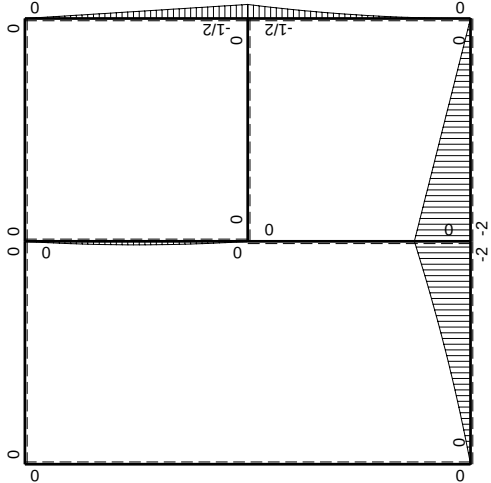
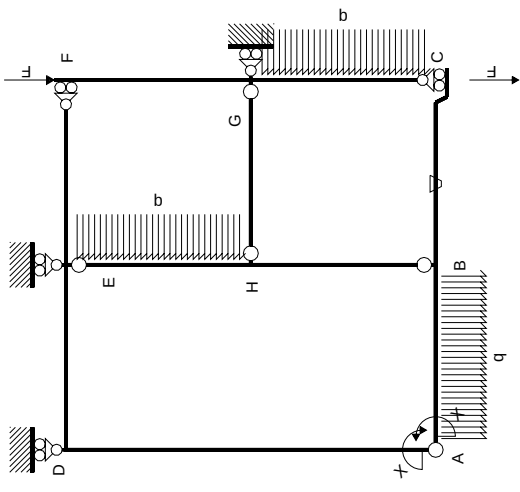
$$\sigma_c = -Mv/J_u = -144.9 \text{ N/mm}^2$$

$$\tau_c = 4.637 \text{ N/mm}^2$$

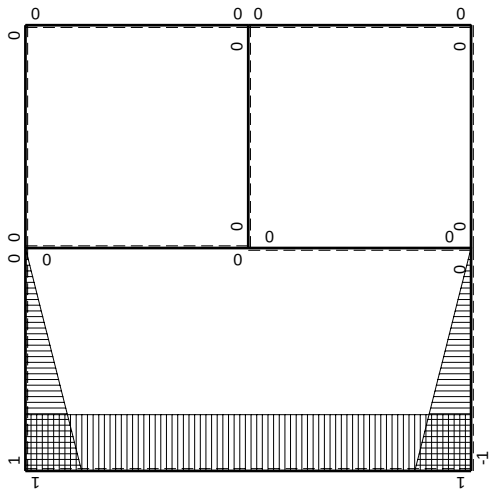
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 145.1 \text{ N/mm}^2$$

$$S = 3391. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} Fb^2/EJ$$

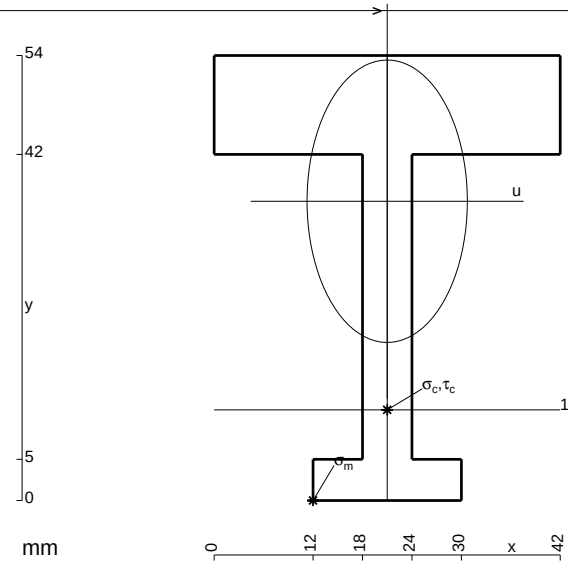
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} Fb^2/EJ$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} Fb^2/EJ = 7/24 Fb^2/EJ$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} Fb^2/EJ$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} Fb^2/EJ$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} Fb^2/EJ = 7/24 Fb^2/EJ$$



$$A = 816. \text{ mm}^2$$

$$J_u = 239746. \text{ mm}^4$$

$$J_v = 77184. \text{ mm}^4$$

$$y_g = 36.32 \text{ mm}$$

$$T_y = 1760. \text{ N}$$

$$M_x = -1372800. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -36.32 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -207.9 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 11. \text{ mm}$$

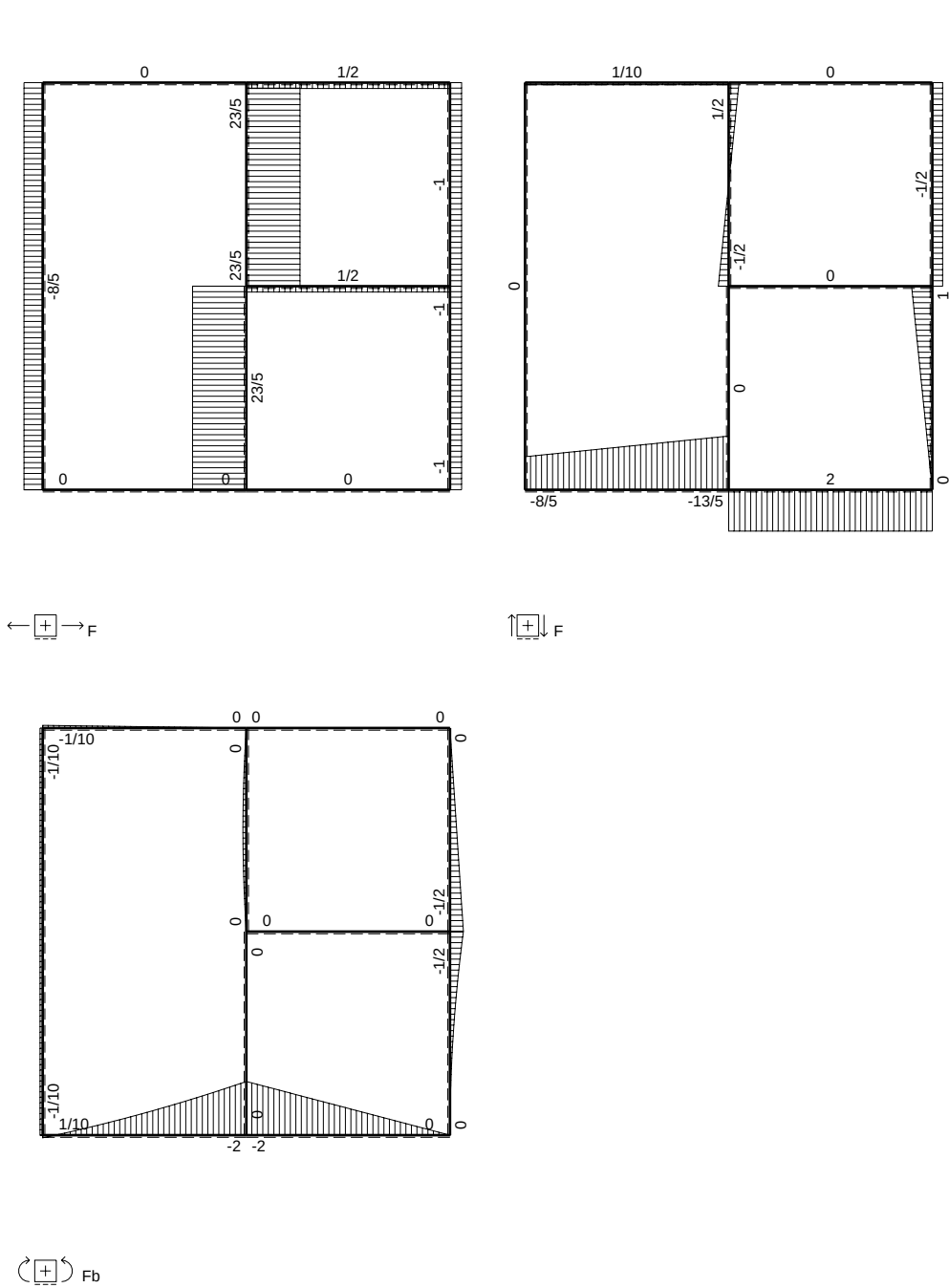
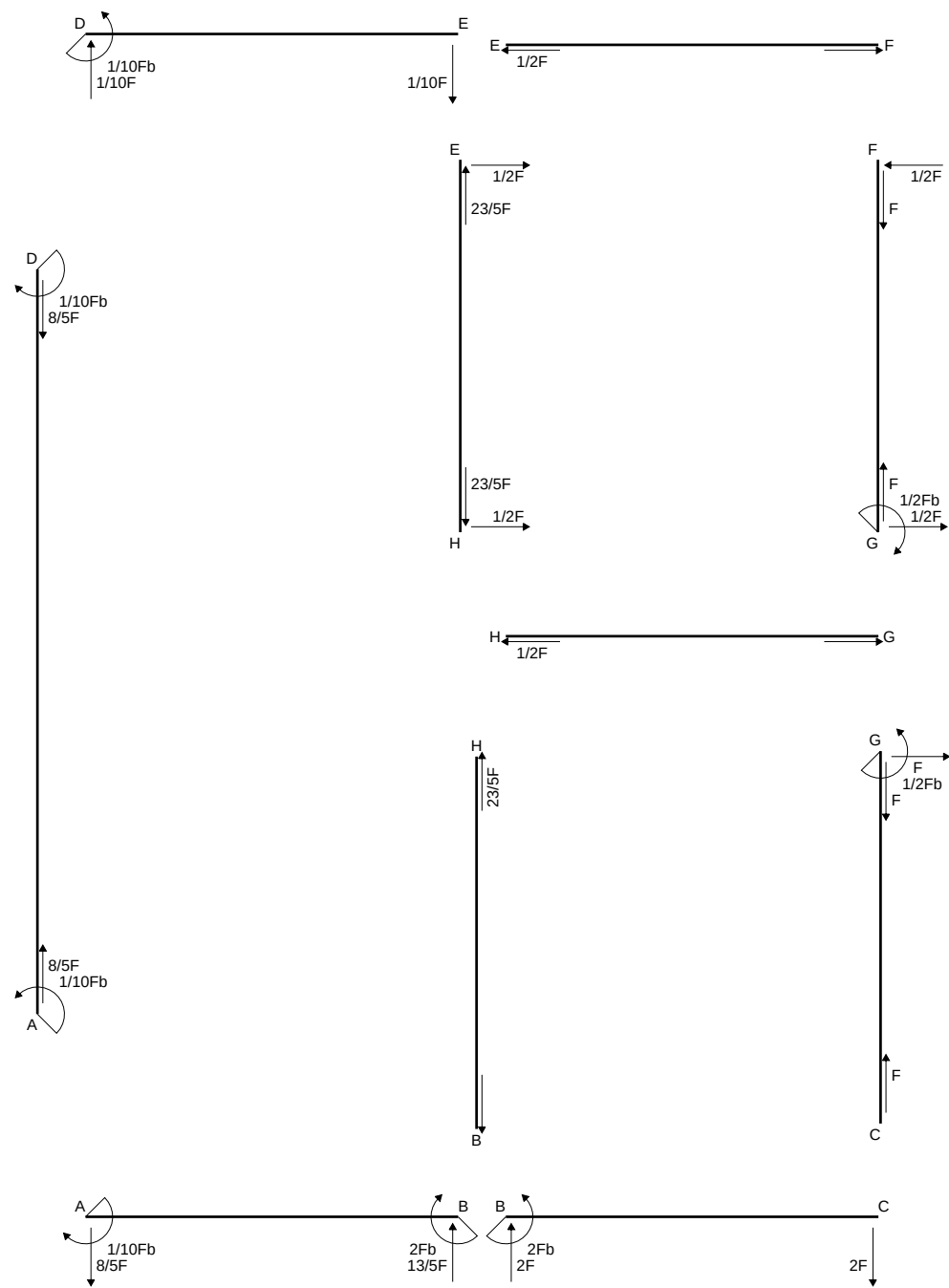
$$v_c = -25.32 \text{ mm}$$

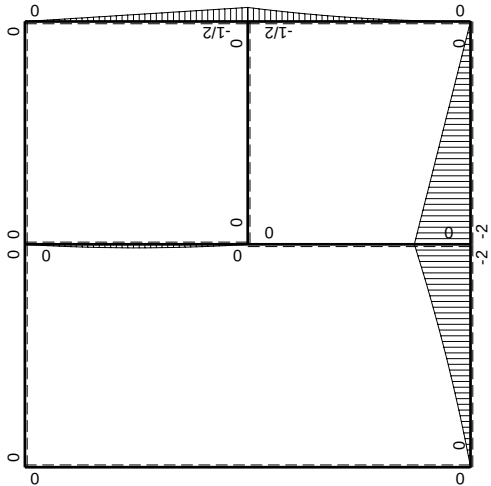
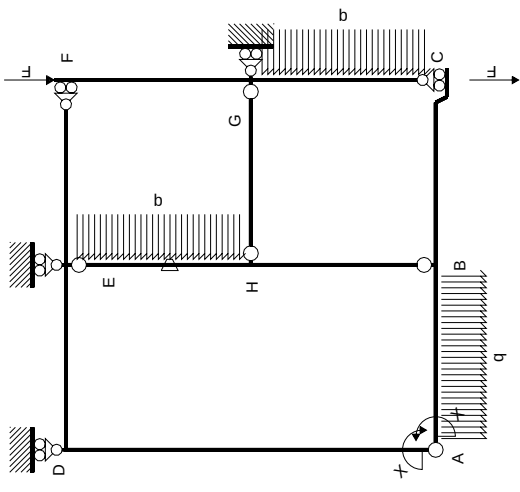
$$\sigma_c = -Mv/J_u = -145. \text{ N/mm}^2$$

$$\tau_c = 4.971 \text{ N/mm}^2$$

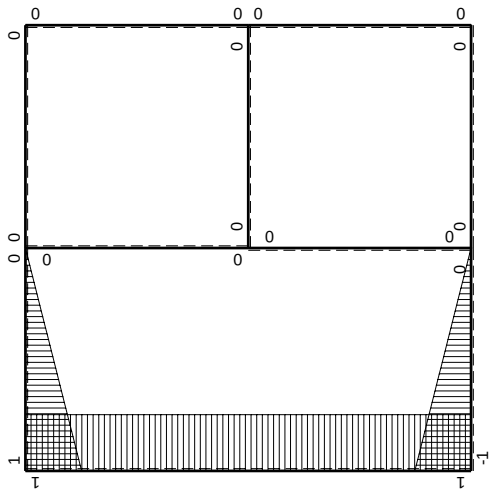
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 145.2 \text{ N/mm}^2$$

$$S = 4063. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

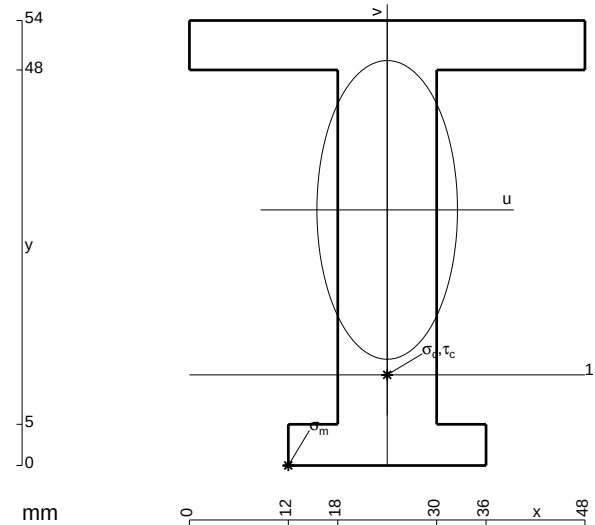
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 924. \text{ mm}^2$$

$$J_u = 303740. \text{ mm}^4$$

$$J_v = 67248. \text{ mm}^4$$

$$y_g = 31.02 \text{ mm}$$

$$T_y = 2580. \text{ N}$$

$$M_x = -2141400. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -31.02 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -218.7 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 11. \text{ mm}$$

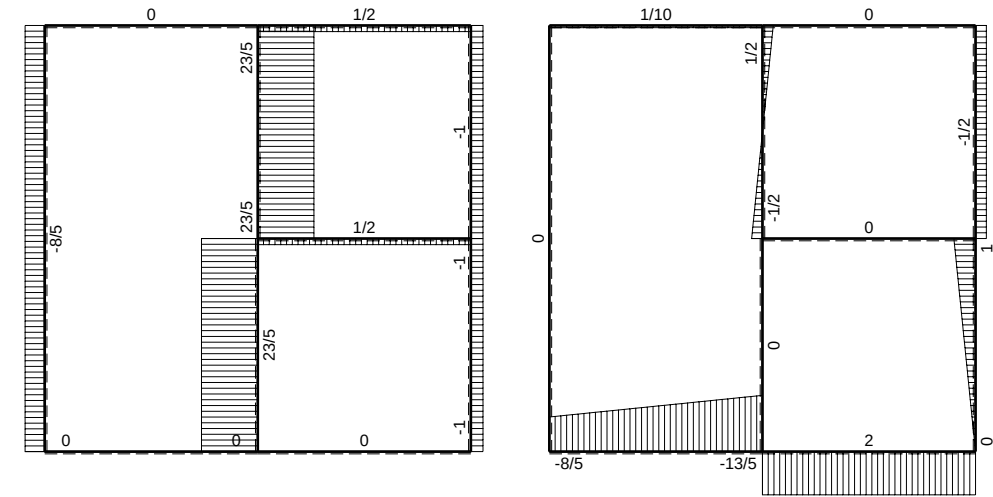
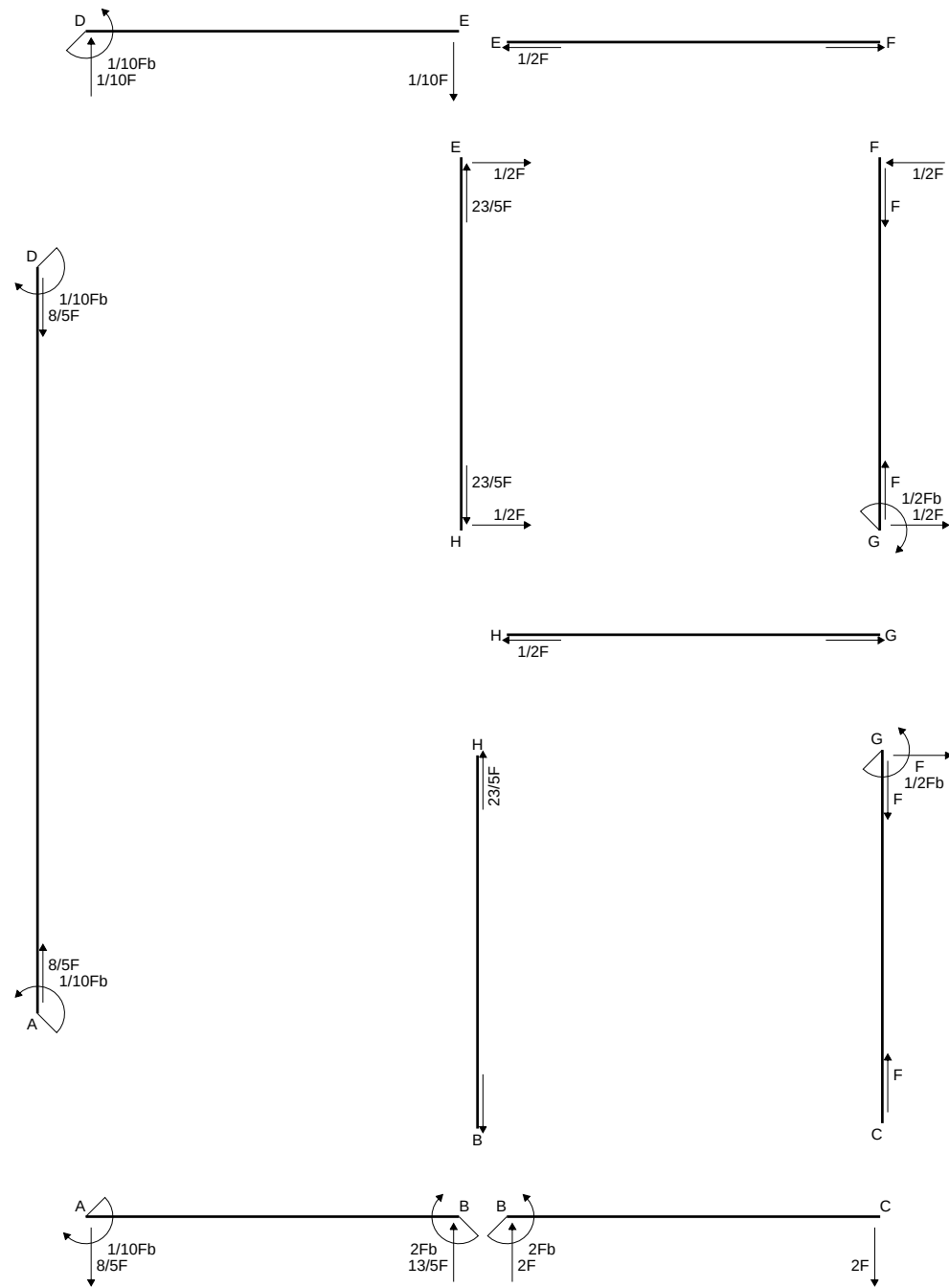
$$v_c = -20.02 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -141.1 \text{ N/mm}^2$$

$$\tau_c = 3.596 \text{ N/mm}^2$$

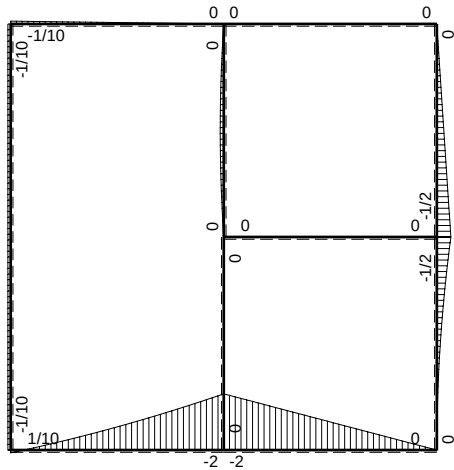
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 141.3 \text{ N/mm}^2$$

$$S = 5080. \text{ mm}^3$$

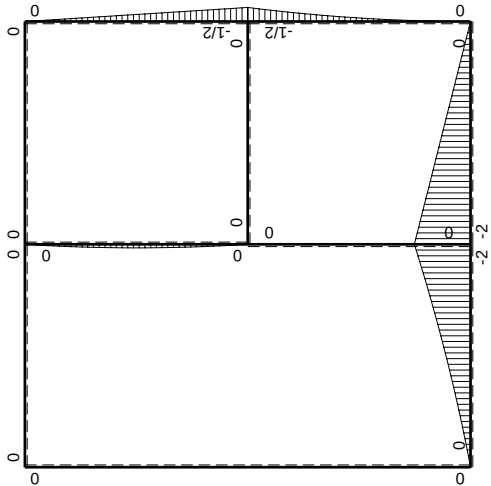
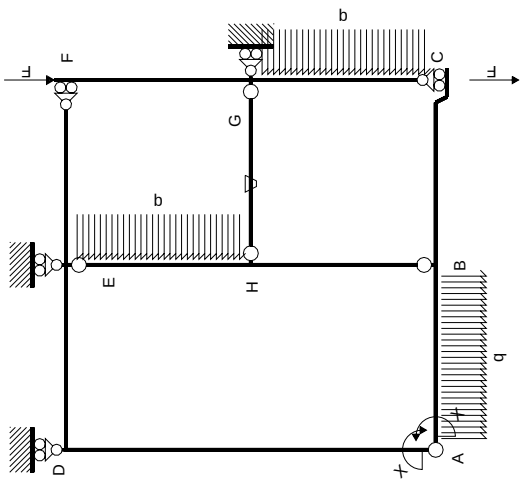


← ⊕ → F

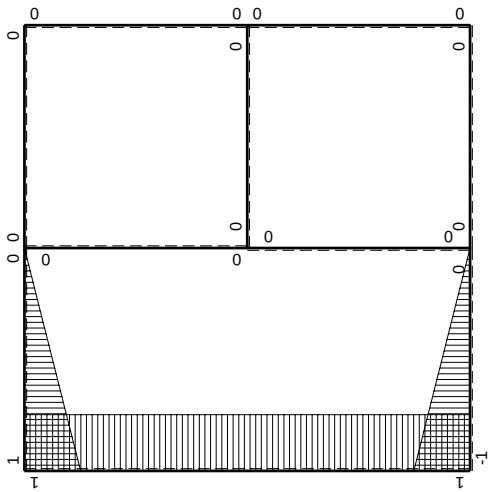
↑ ⊕ ↓ F



⊕ ⊖ Fb



M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

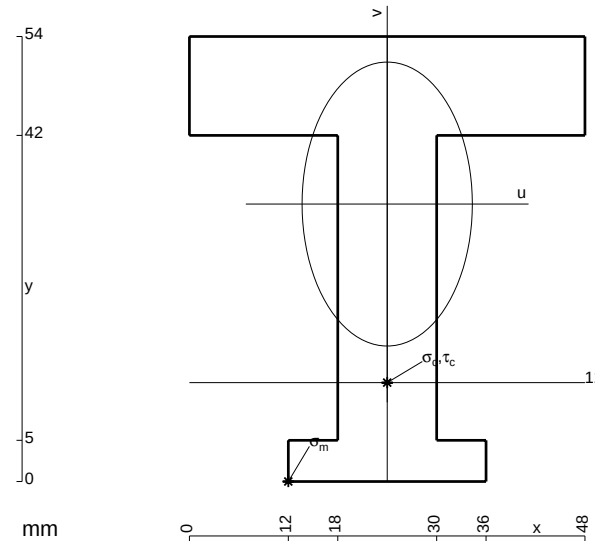
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 1140. \text{ mm}^2$$

$$J_u = 338607. \text{ mm}^4$$

$$J_v = 121680. \text{ mm}^4$$

$$y_g = 33.67 \text{ mm}$$

$$T_y = 2620. \text{ N}$$

$$M_x = -2305600. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -33.67 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -229.3 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 12. \text{ mm}$$

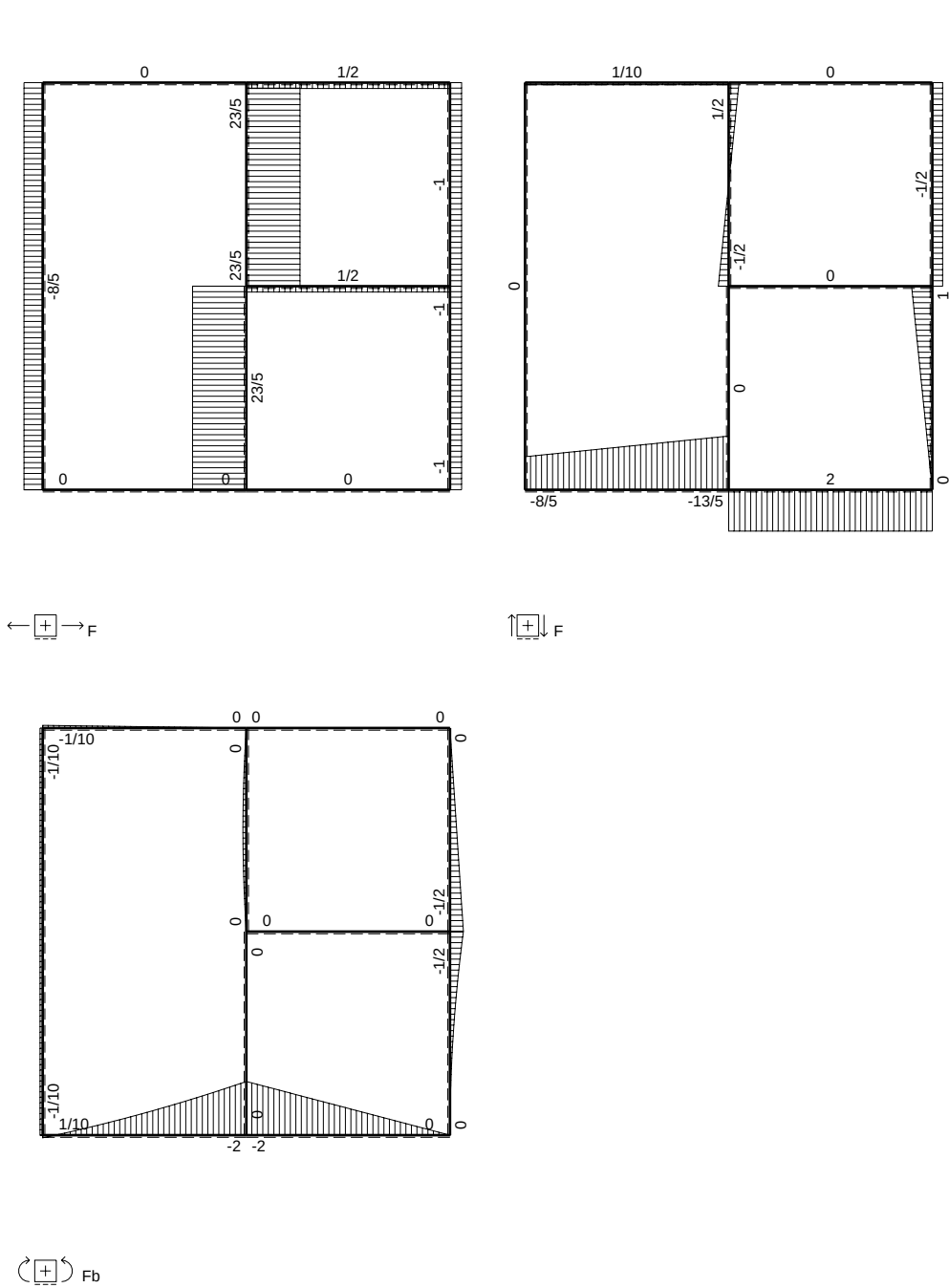
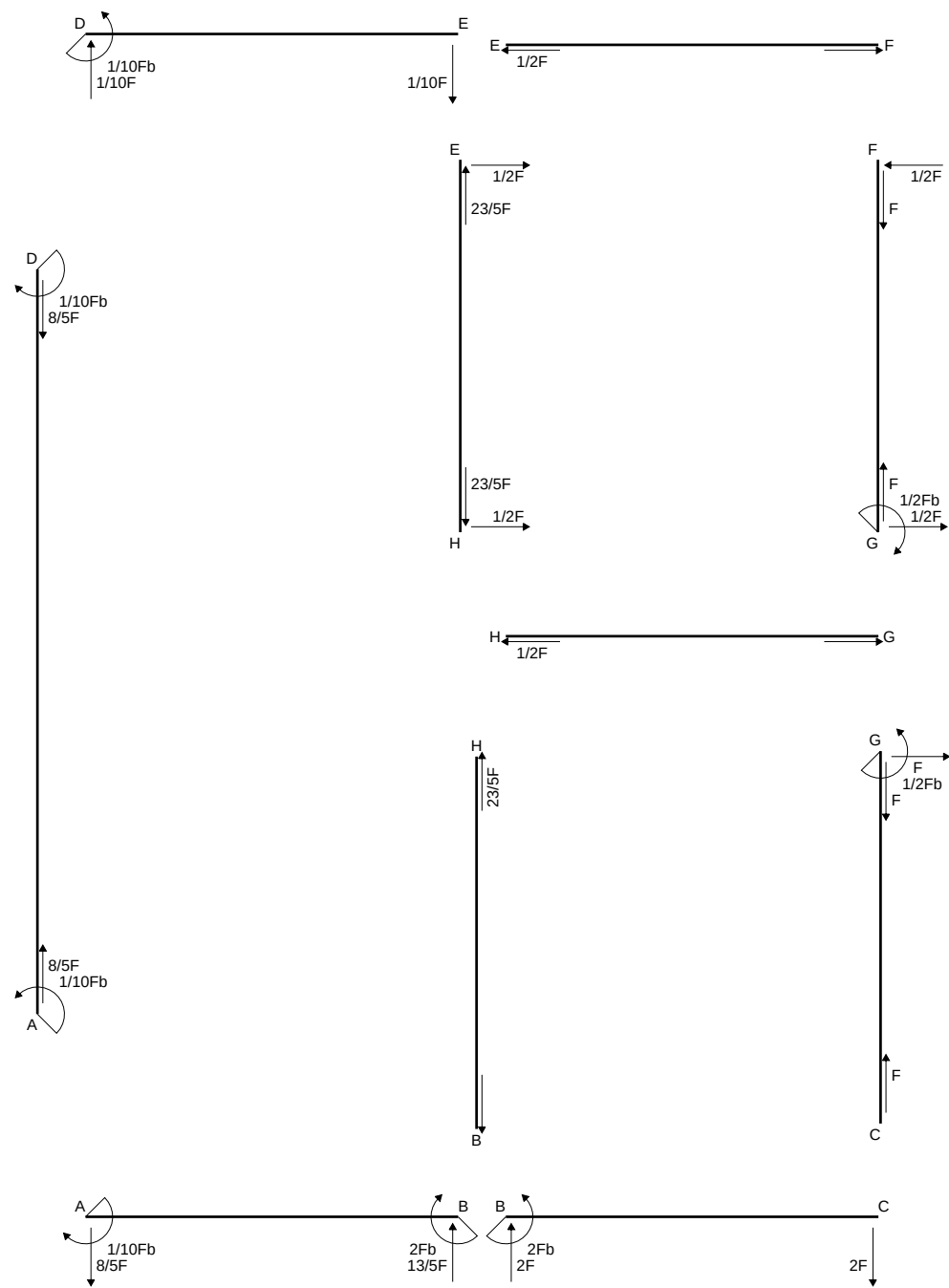
$$v_c = -21.67 \text{ mm}$$

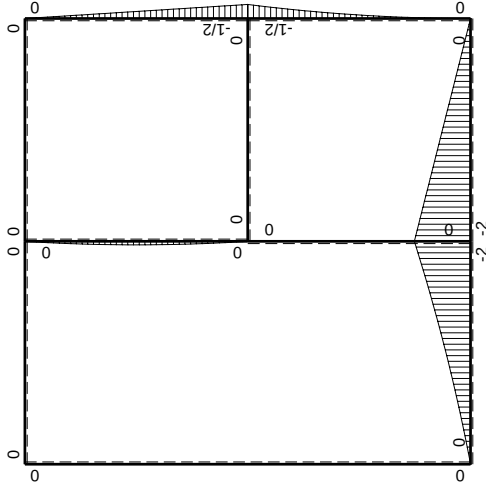
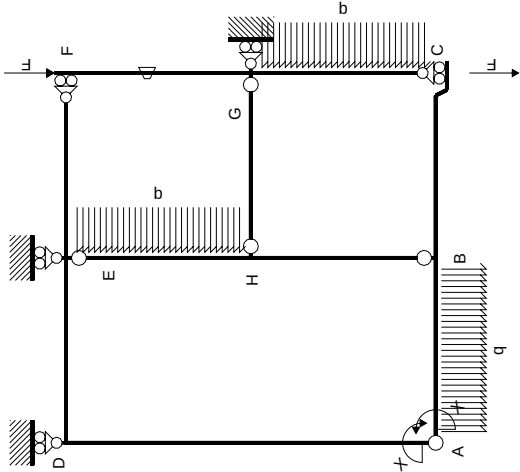
$$\sigma_c = -Mv/J_u = -147.5 \text{ N/mm}^2$$

$$\tau_c = 3.775 \text{ N/mm}^2$$

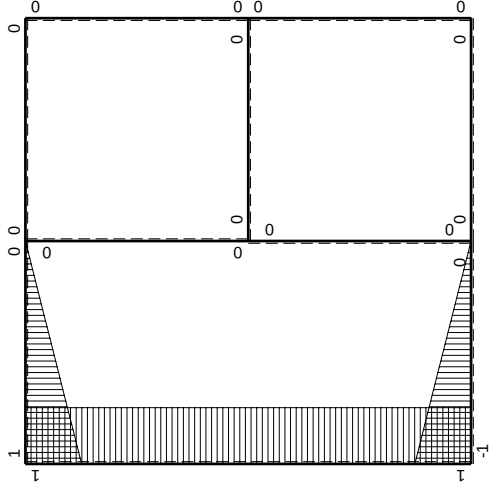
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 147.7 \text{ N/mm}^2$$

$$S = 5854. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	Fb/EJ	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

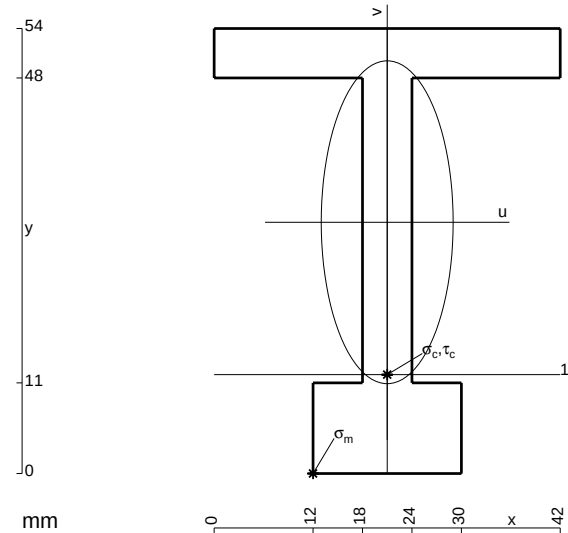
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 672. \text{ mm}^2$$

$$J_u = 257954. \text{ mm}^4$$

$$J_v = 43056. \text{ mm}^4$$

$$y_g = 30.49 \text{ mm}$$

$$T_y = 2180. \text{ N}$$

$$M_x = -2027400. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -30.49 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -239.6 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 12. \text{ mm}$$

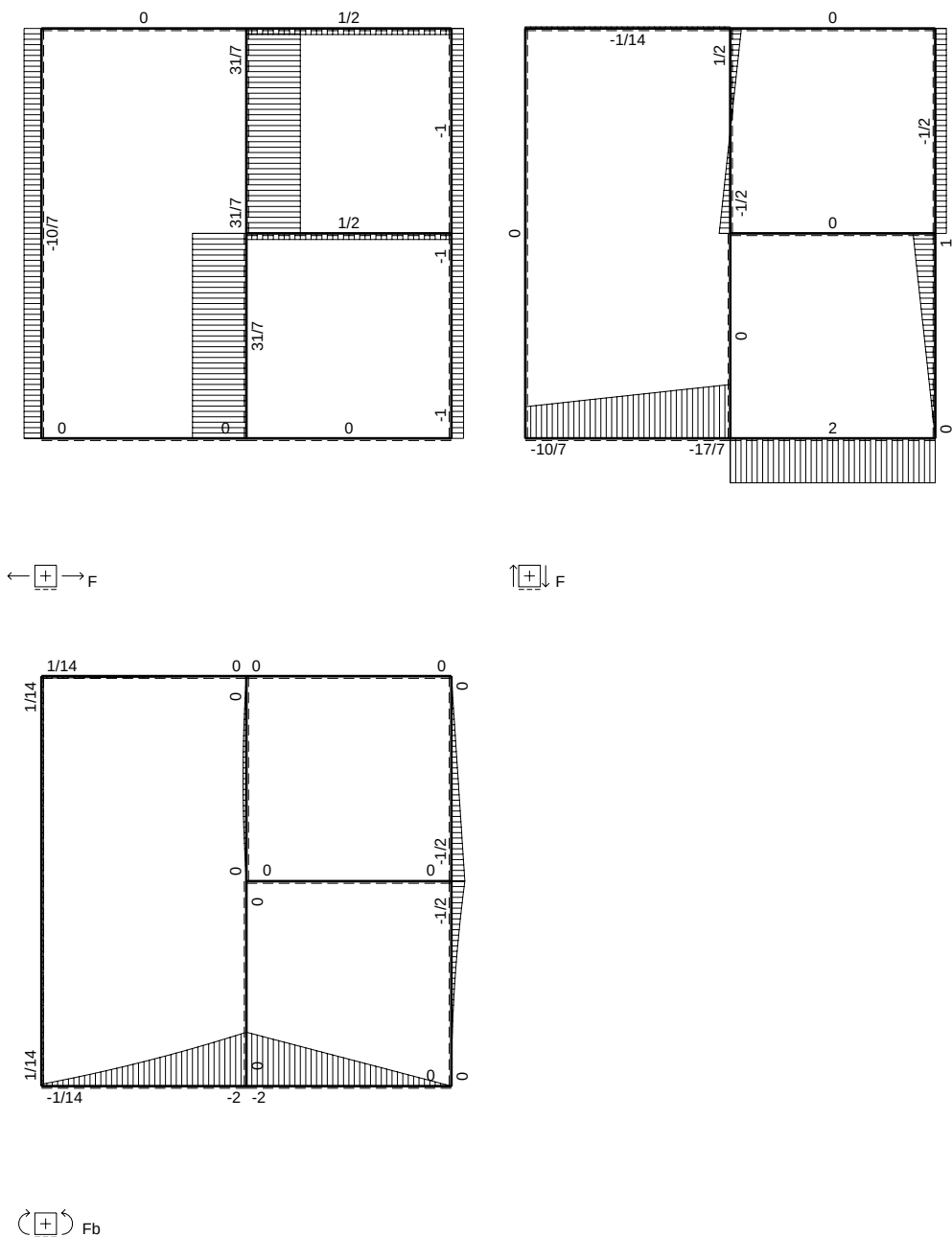
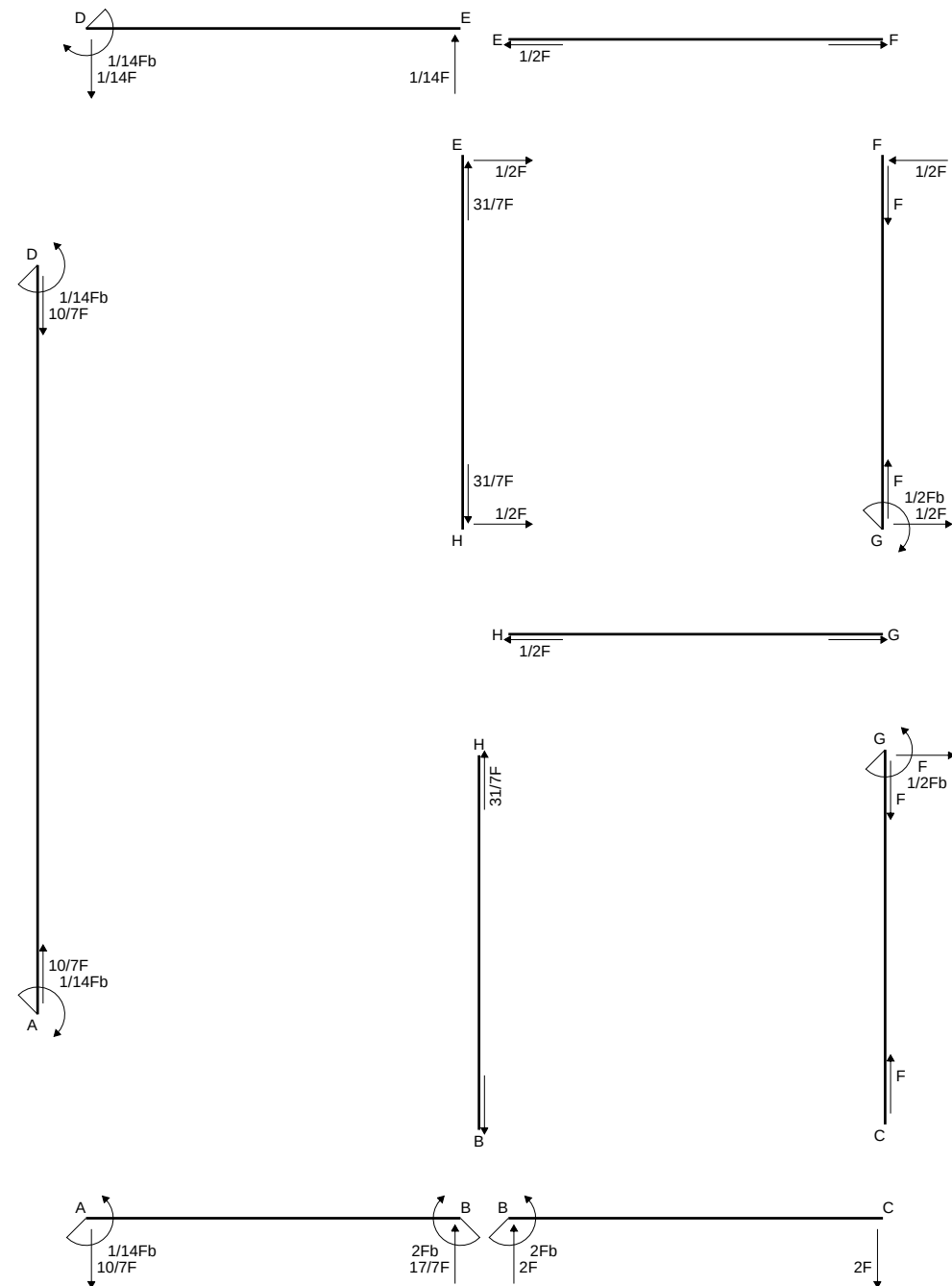
$$v_c = -18.49 \text{ mm}$$

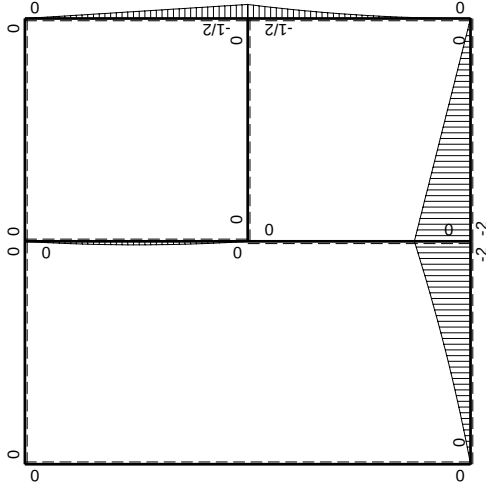
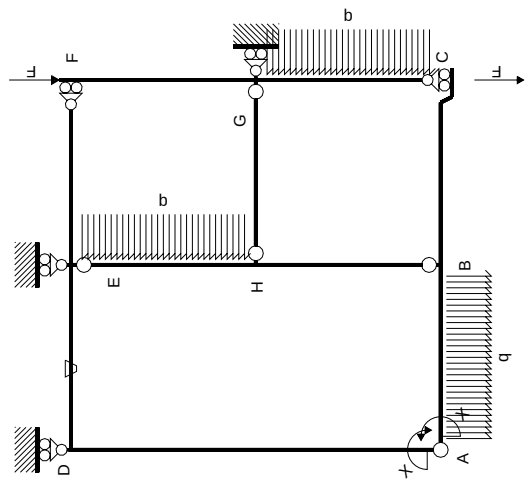
$$\sigma_c = -Mv/J_u = -145.3 \text{ N/mm}^2$$

$$\tau_c = 7.13 \text{ N/mm}^2$$

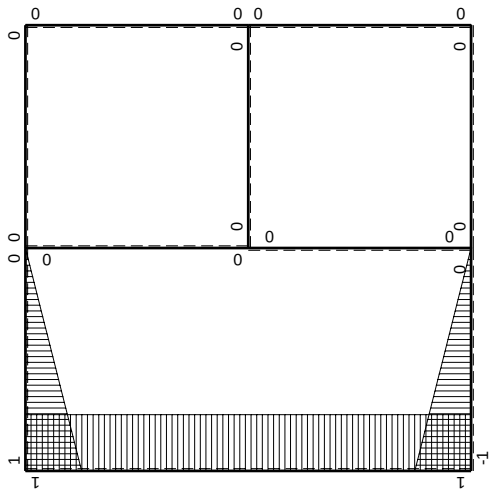
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 145.9 \text{ N/mm}^2$$

$$S = 5062. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	$-Fb/EJ$	0	$-Fb/EJ+Fx/EJ$	$1-2x/b+x^2/b^2$	$(0-1/2)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	0	Fb/EJ	0	$-Fx/EJ$	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/14Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{xo} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{xo} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

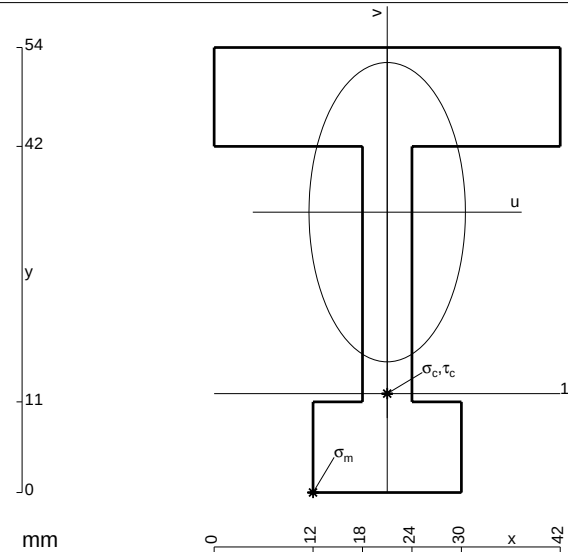
$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{DE}^{xo} = \int_0^b (-1 + x/b) \theta dx = \left[-x + 1/2 x^2/b \right]_0^b \theta$$

$$= (-b + 1/2 b) \theta = -1/2 \frac{Fb^2}{EJ}$$

$$L_{ED}^{xo} = \int_0^b (x/b) \theta dx = \left[1/2 x^2/b \right]_0^b \theta$$

$$= (1/2 b) \theta = -1/2 \frac{Fb^2}{EJ}$$



$$A = 888. \text{ mm}^2$$

$$J_u = 293012. \text{ mm}^4$$

$$J_v = 79992. \text{ mm}^4$$

$$y_g = 34.02 \text{ mm}$$

$$T_y = 3500. \text{ N}$$

$$M_x = -1715000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -34.02 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -199.1 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 12. \text{ mm}$$

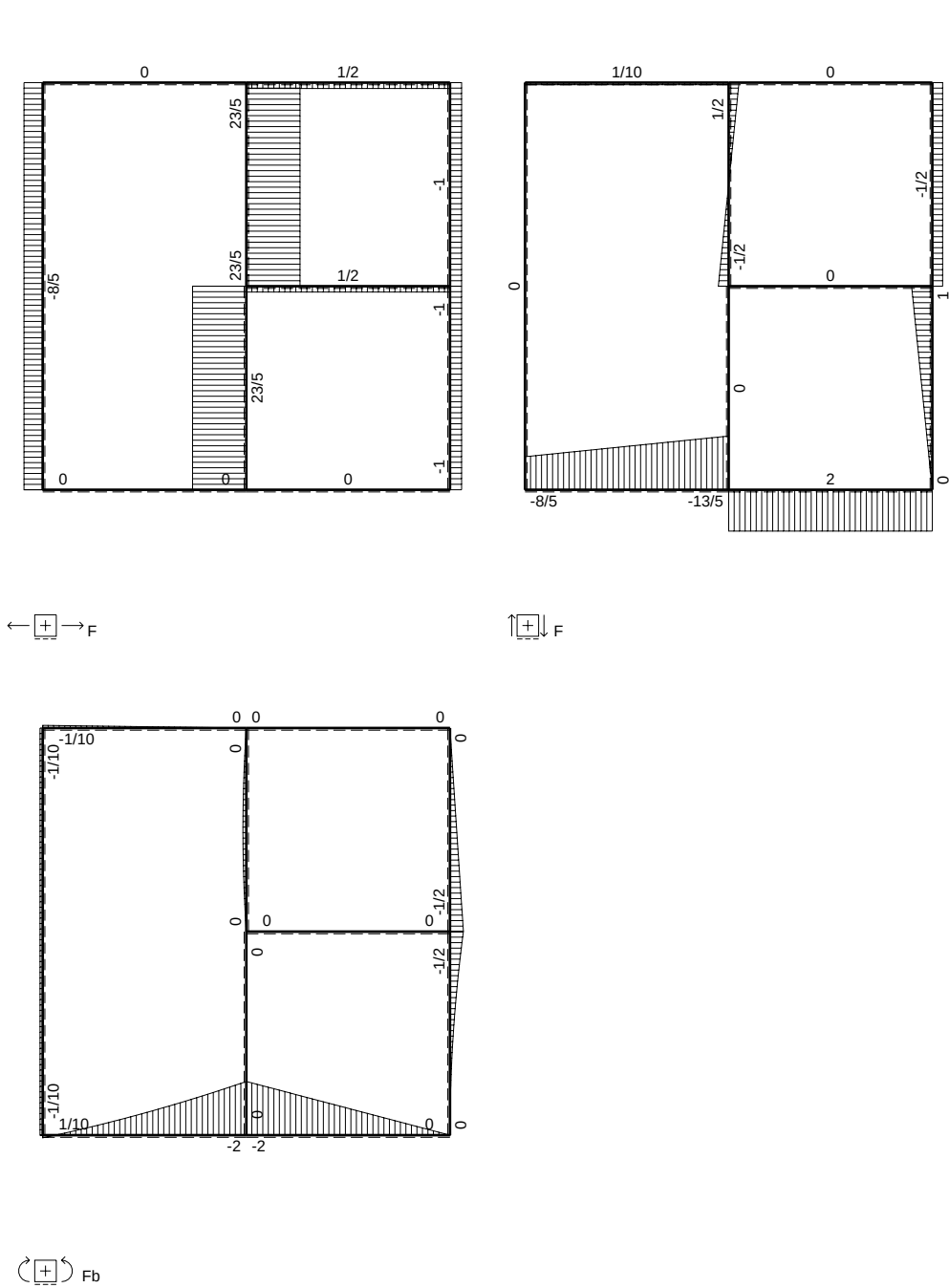
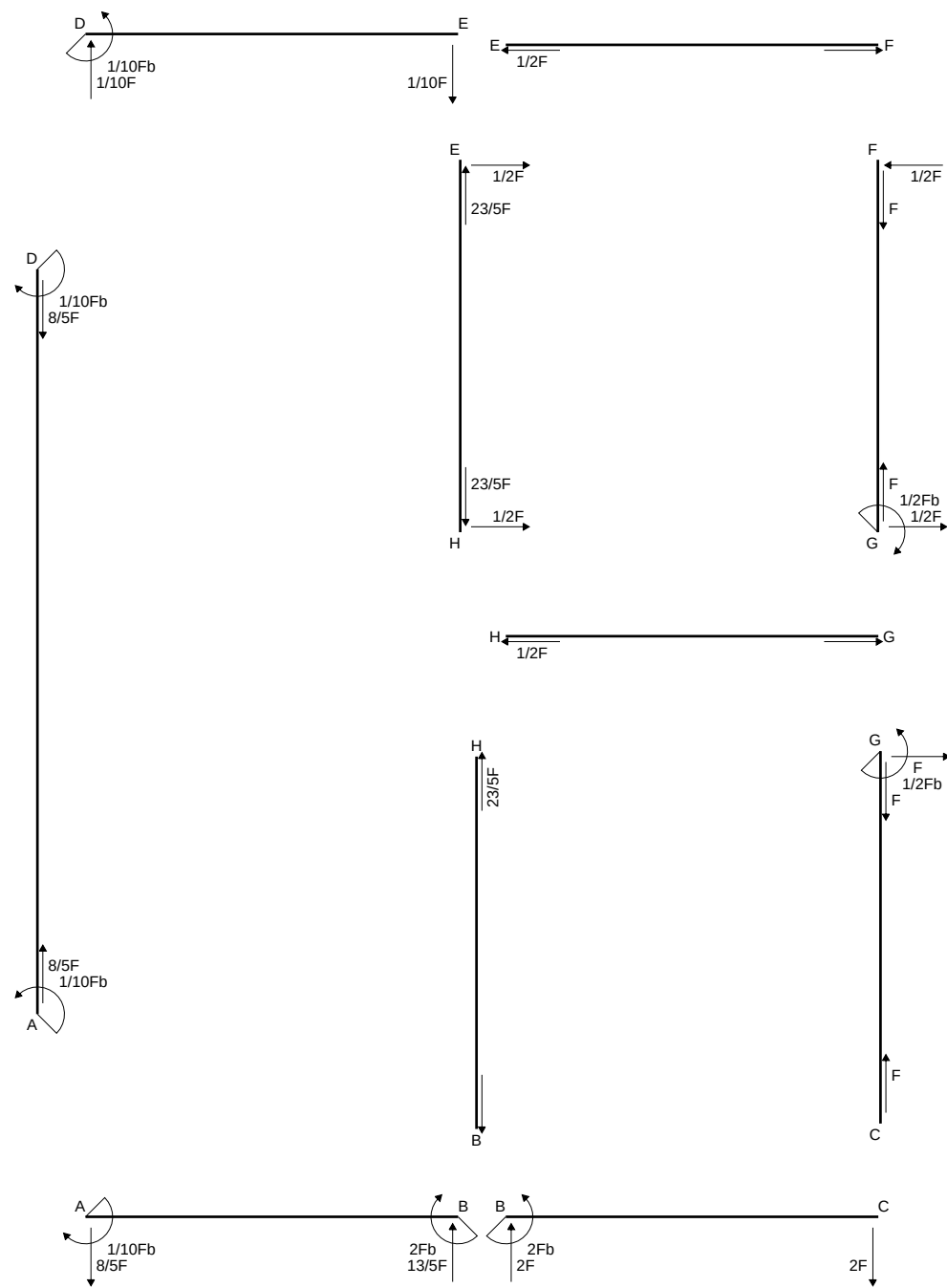
$$v_c = -22.02 \text{ mm}$$

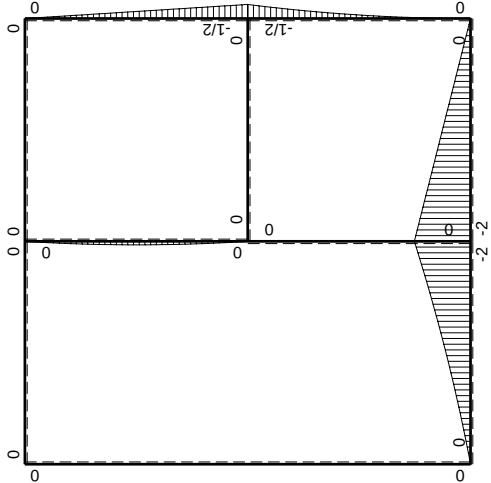
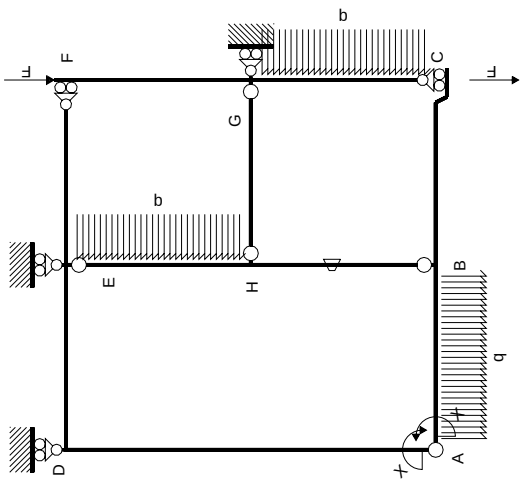
$$\sigma_c = -Mv/J_u = -128.9 \text{ N/mm}^2$$

$$\tau_c = 11.51 \text{ N/mm}^2$$

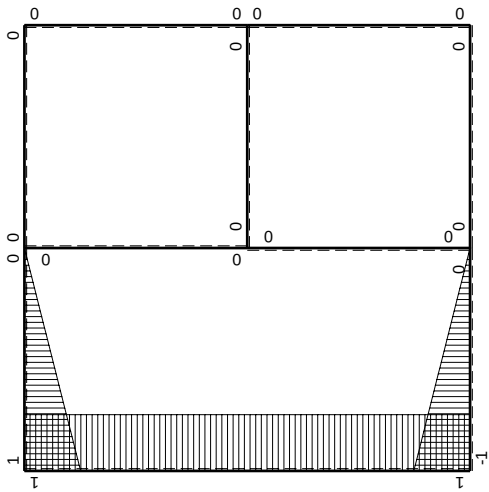
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 130.4 \text{ N/mm}^2$$

$$S = 5782. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	0	Fb/EJ	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

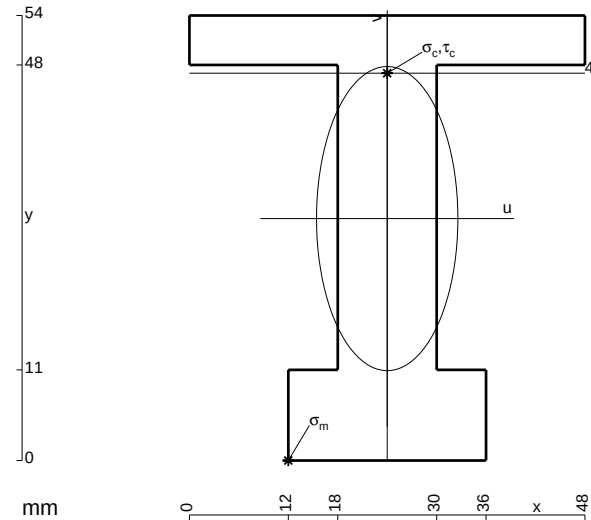
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 996. \text{ mm}^2$$

$$J_u = 339350. \text{ mm}^4$$

$$J_v = 73296. \text{ mm}^4$$

$$y_g = 29.36 \text{ mm}$$

$$T_y = 4580. \text{ N}$$

$$M_x = -2427400. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -29.36 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -210. \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 47. \text{ mm}$$

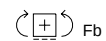
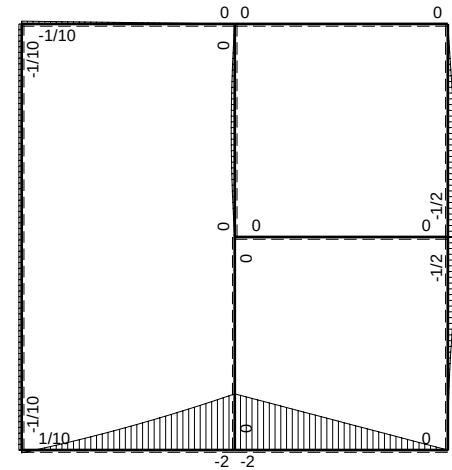
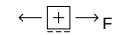
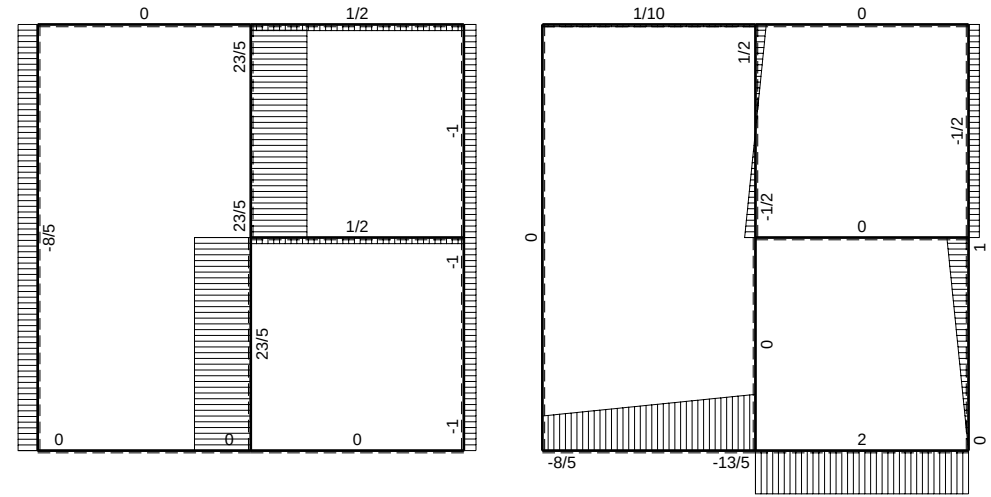
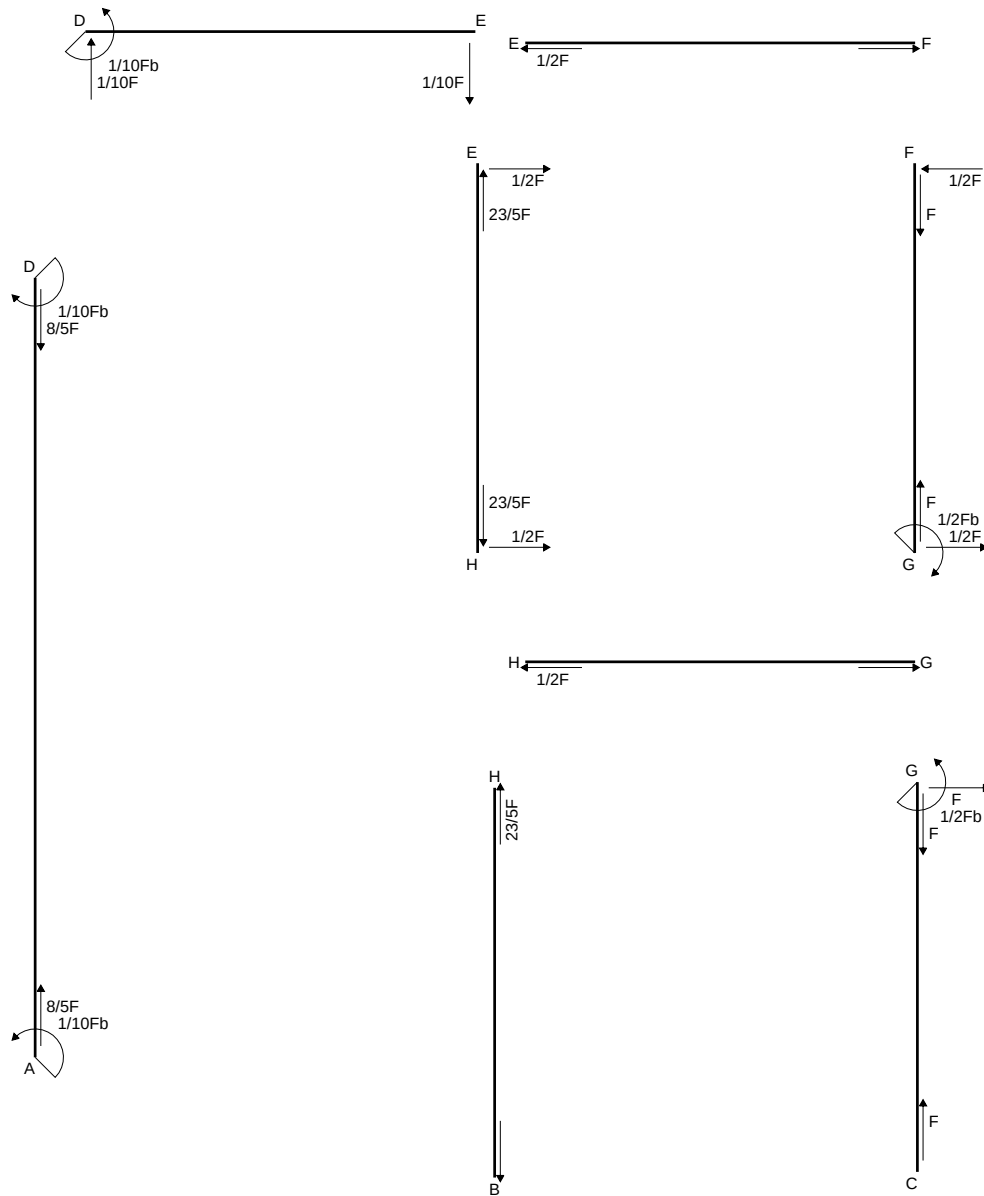
$$v_c = 17.64 \text{ mm}$$

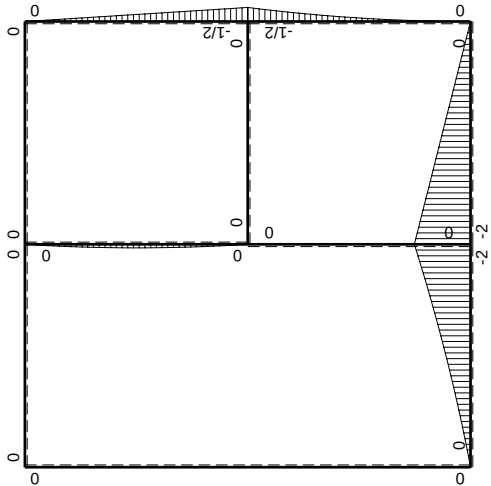
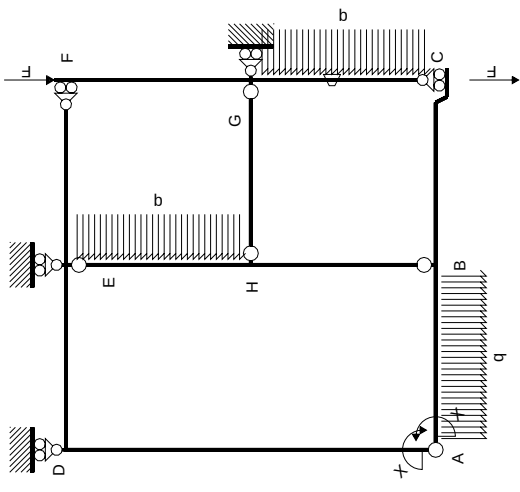
$$\sigma_c = -Mv/J_u = 126.2 \text{ N/mm}^2$$

$$\tau_c = 7.256 \text{ N/mm}^2$$

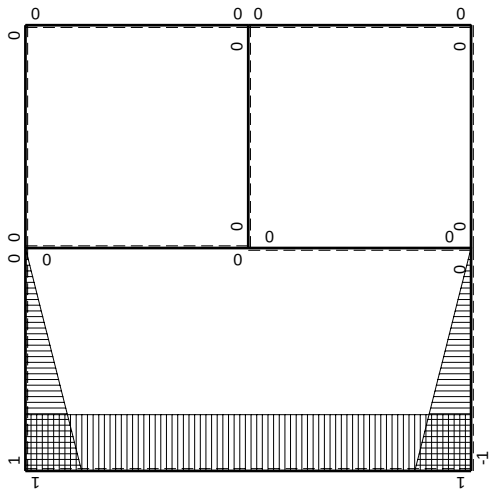
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 126.8 \text{ N/mm}^2$$

$$S = 6451. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	$1/2qx^2$	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

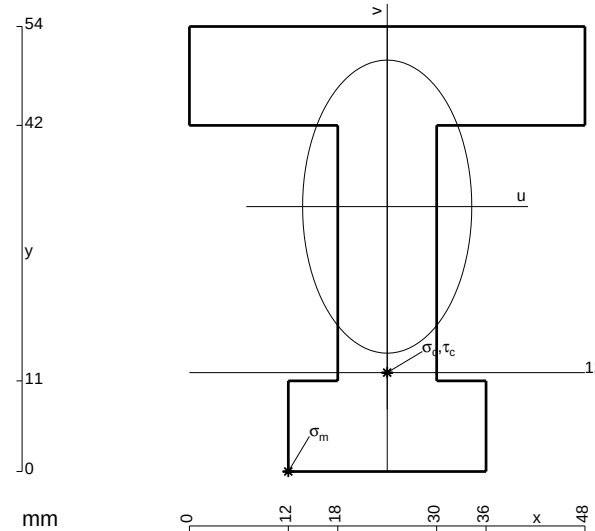
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 1212. \text{ mm}^2$$

$$J_u = 383443. \text{ mm}^4$$

$$J_v = 127728. \text{ mm}^4$$

$$y_g = 32.14 \text{ mm}$$

$$T_y = 4520. \text{ N}$$

$$M_x = -2621600. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -32.14 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -219.8 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 12. \text{ mm}$$

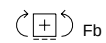
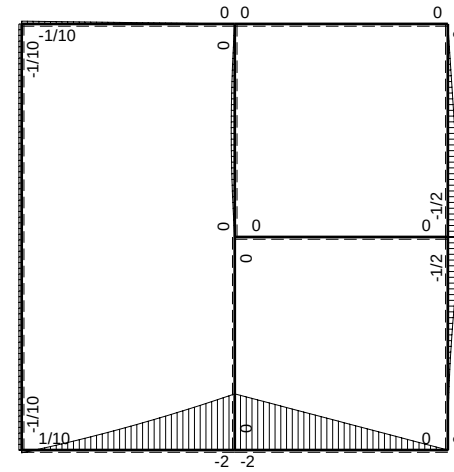
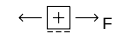
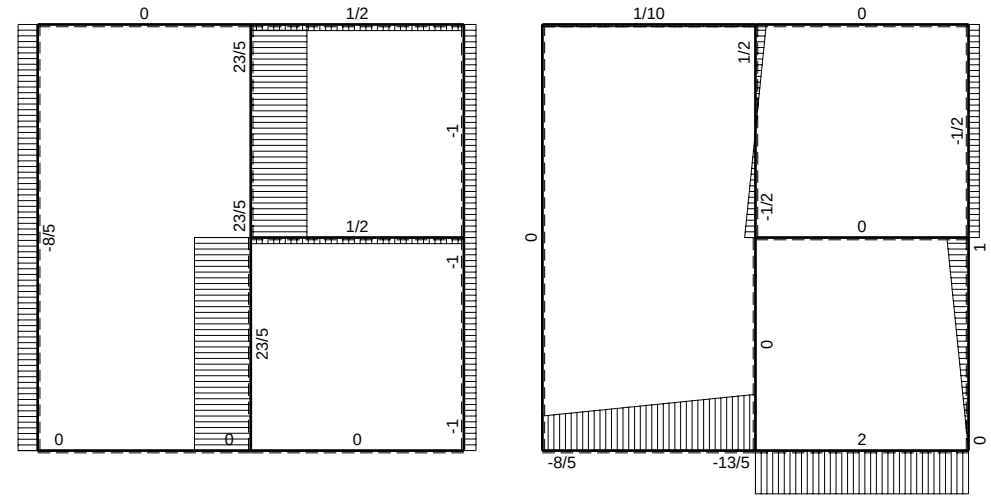
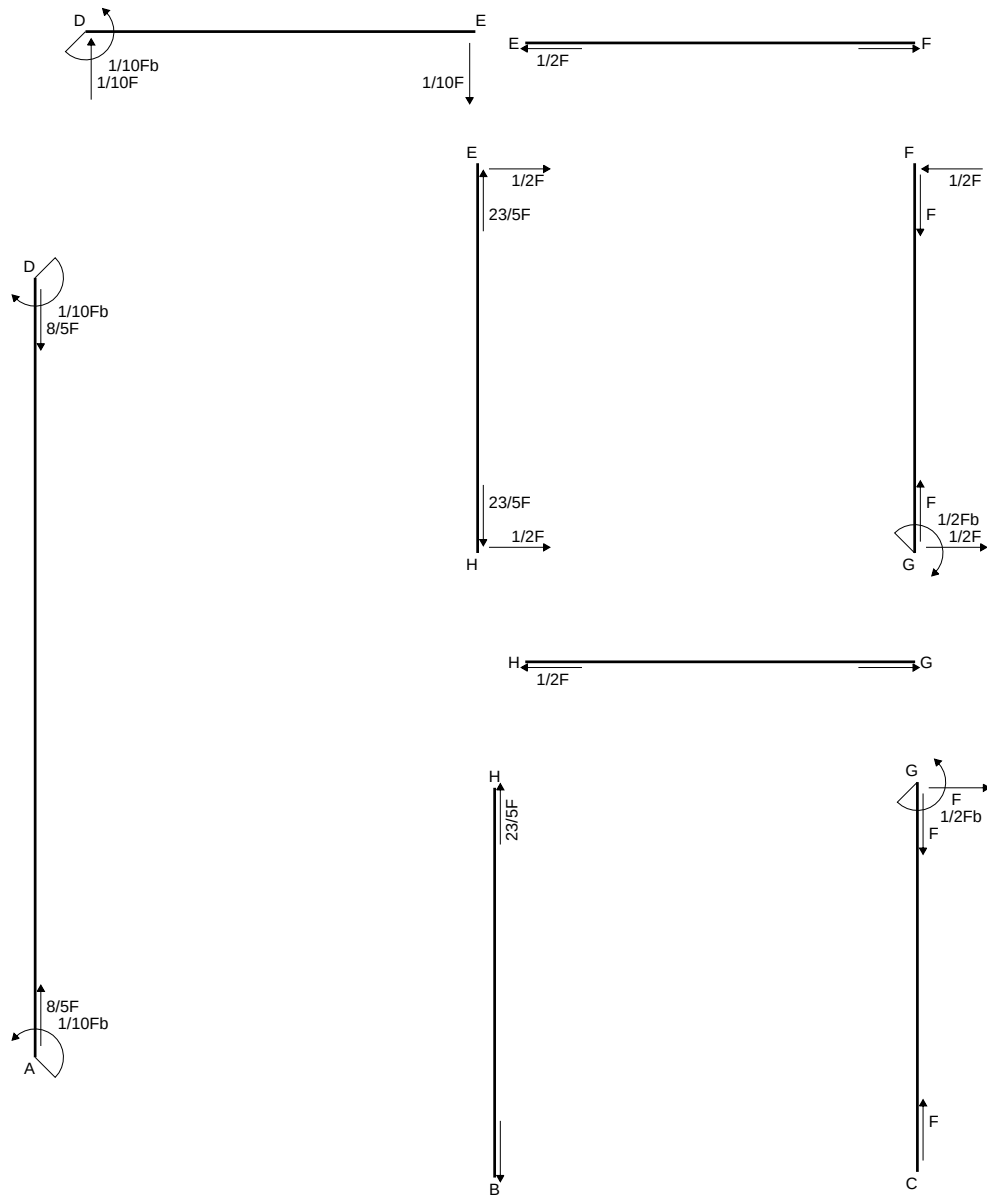
$$v_c = -20.14 \text{ mm}$$

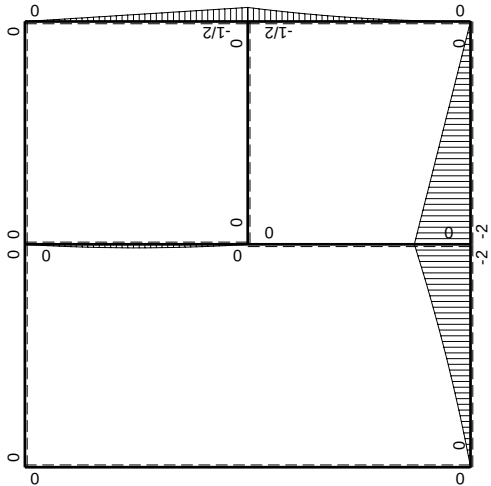
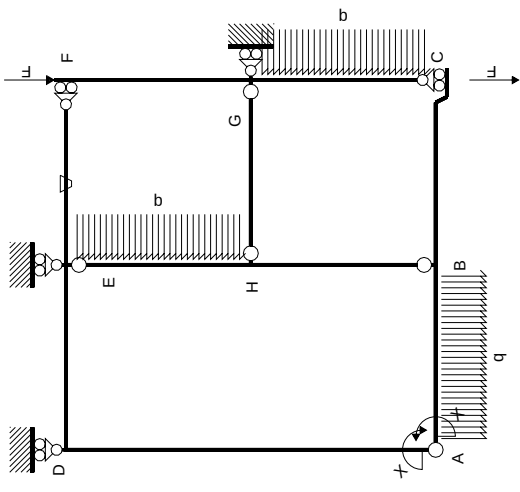
$$\sigma_c = -Mv/J_u = -137.7 \text{ N/mm}^2$$

$$\tau_c = 7.153 \text{ N/mm}^2$$

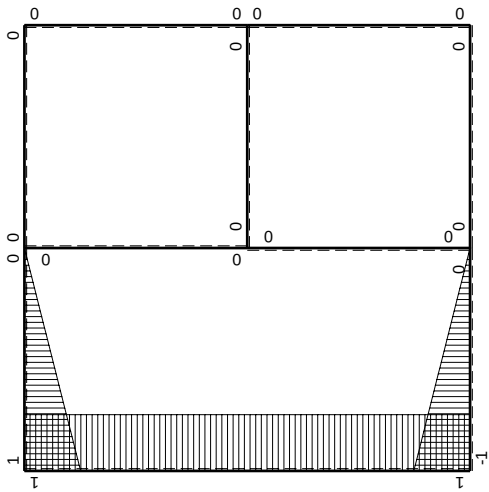
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 138.3 \text{ N/mm}^2$$

$$S = 7282. \text{ mm}^3$$





M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	0	0	0	0	1	0+0	$2Xb/EJ$
DA 2b	-1	0	0	0	0	1		
DE b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
ED b	$-x/b$	0	0	0	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	0	0	0	0	0	0+0	0
BH b	0	0	0	0	0	0		
HE b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{BA}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ}$$

$$L_{AD}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DA}^{xx} = \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ}$$

$$= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ}$$

$$L_{DE}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{ED}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ}$$

$$L_{AB}^{x_0} = \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

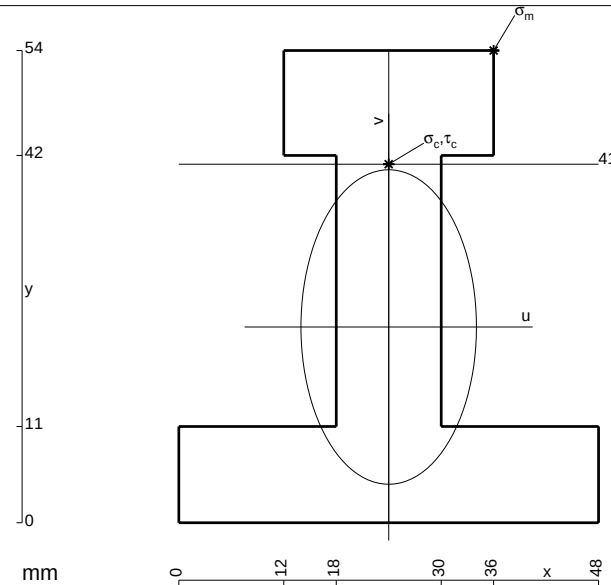
$$= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$

$$L_{BA}^{x_0} = \int_0^b (2x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ}$$

$$= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ}$$



$$A = 1188. \text{ mm}^2$$

$$J_u = 384370. \text{ mm}^4$$

$$J_v = 119664. \text{ mm}^4$$

$$y_g = 22.38 \text{ mm}$$

$$T_y = 4420. \text{ N}$$

$$M_x = -2784600. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 54. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 31.62 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 229.1 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 41. \text{ mm}$$

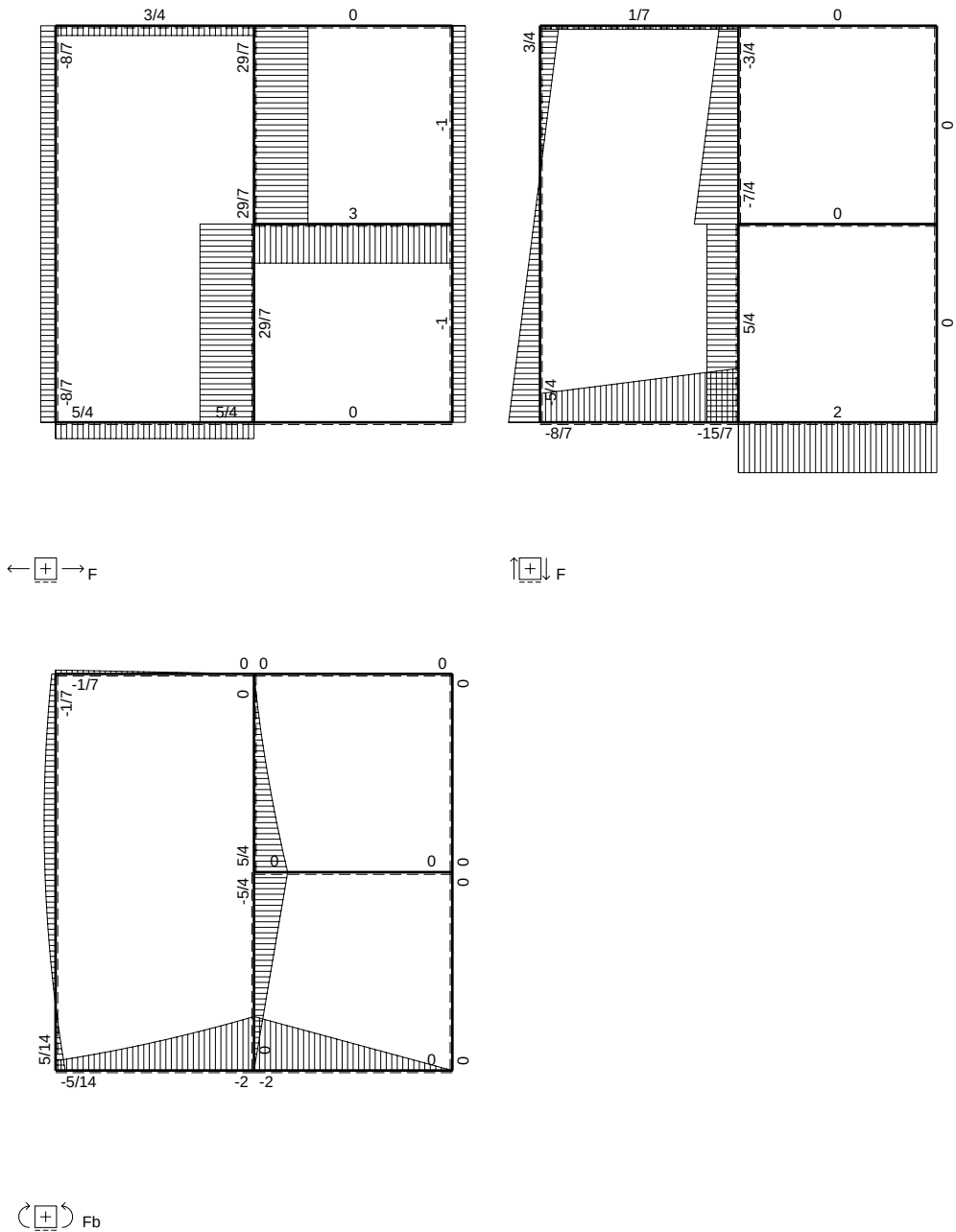
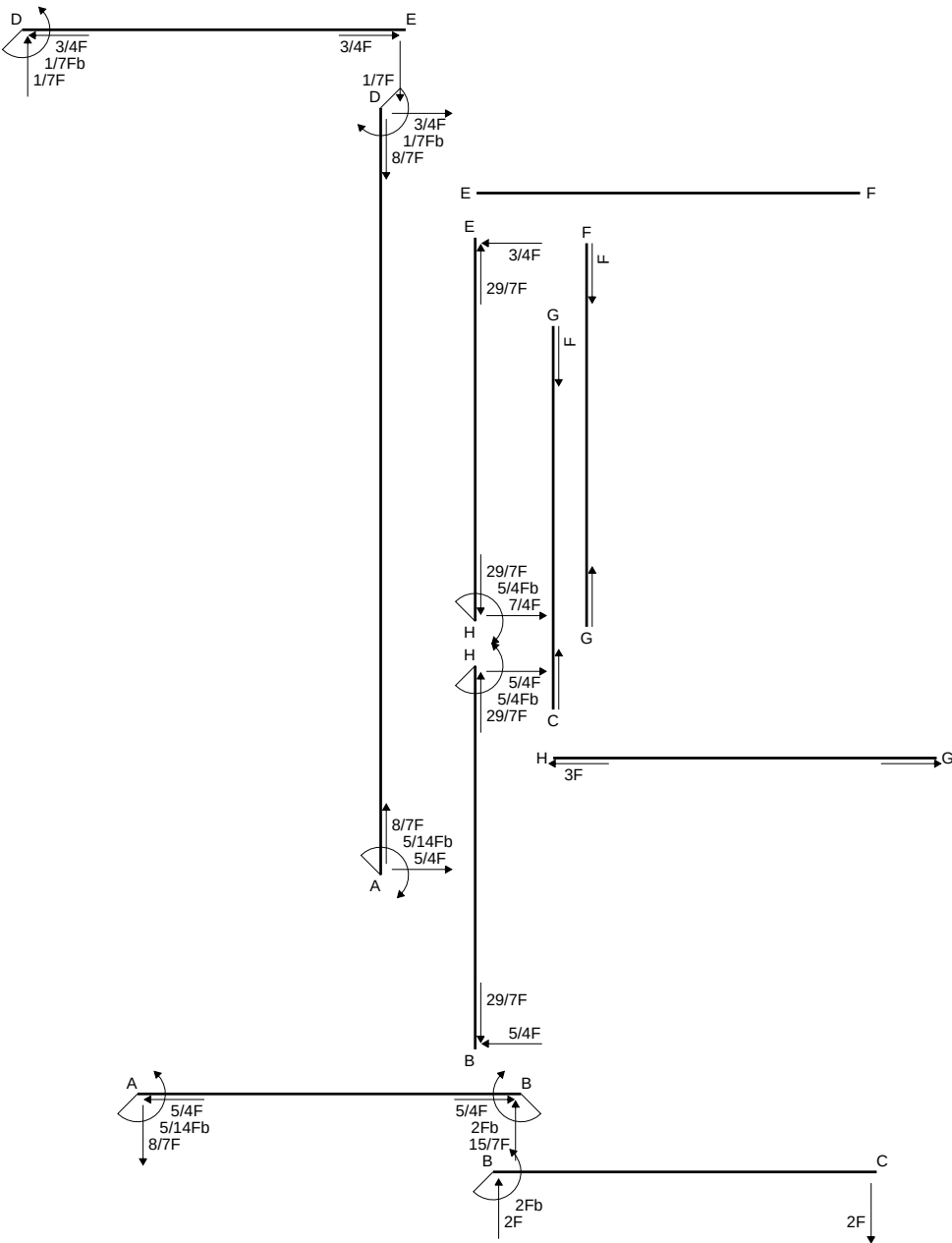
$$v_c = 18.62 \text{ mm}$$

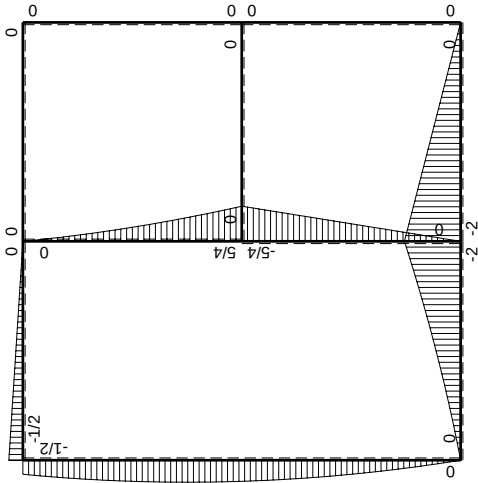
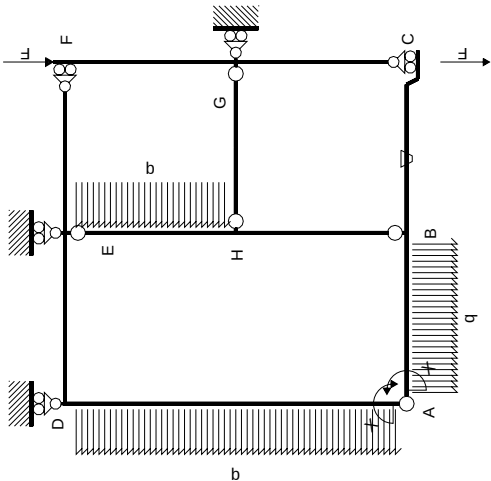
$$\sigma_c = -Mv/J_u = 134.9 \text{ N/mm}^2$$

$$\tau_c = 7.291 \text{ N/mm}^2$$

$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 135.5 \text{ N/mm}^2$$

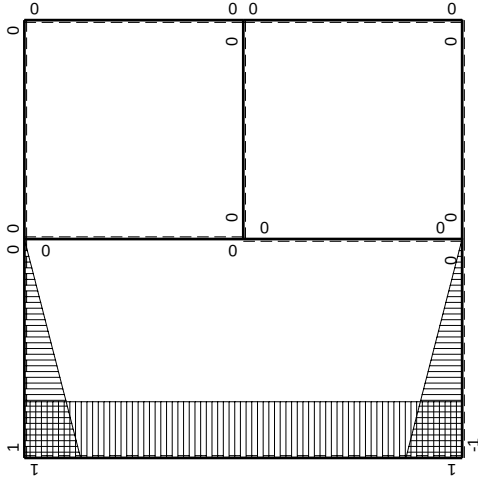
$$S = 7608. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



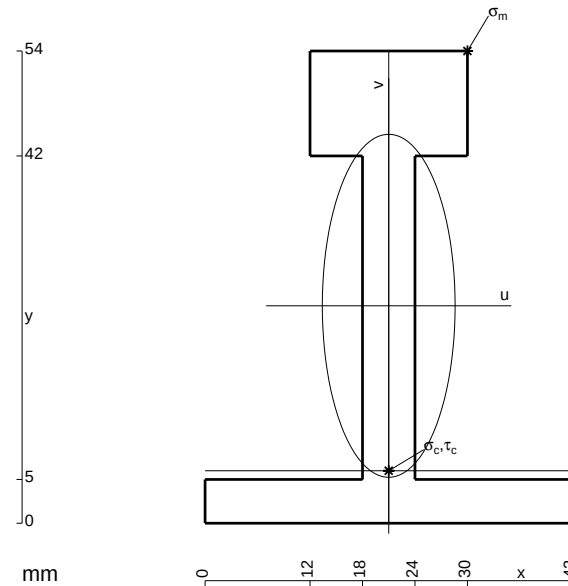
M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

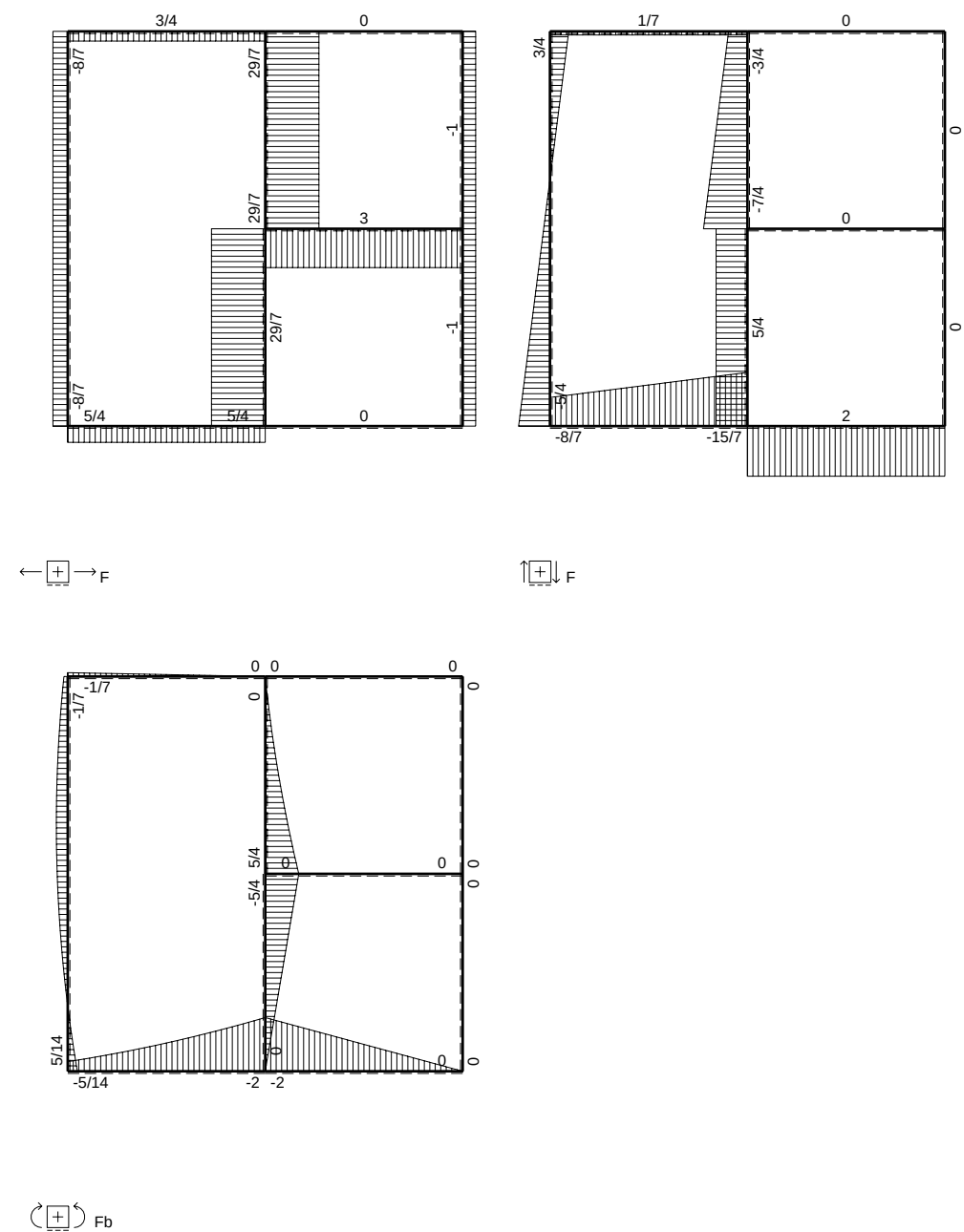
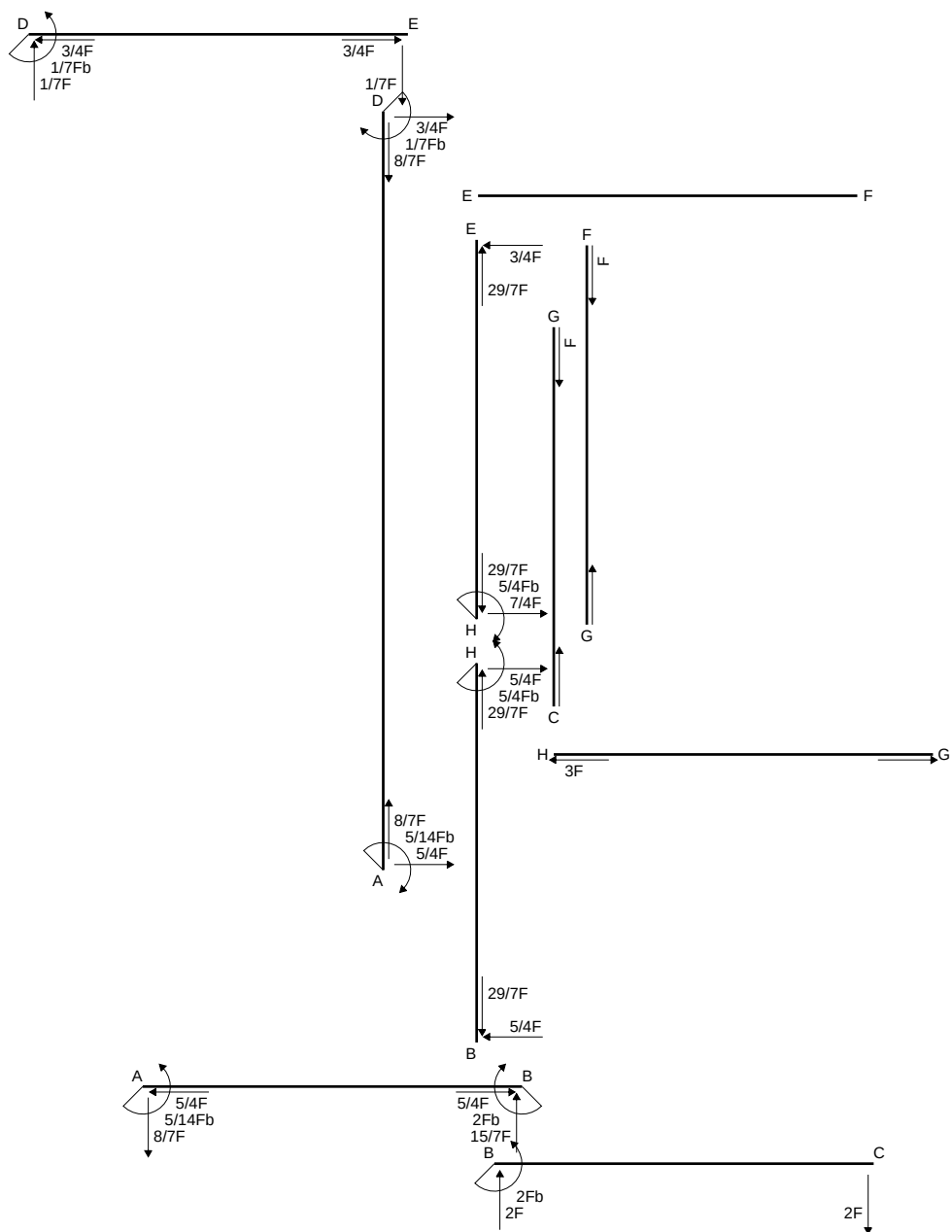
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

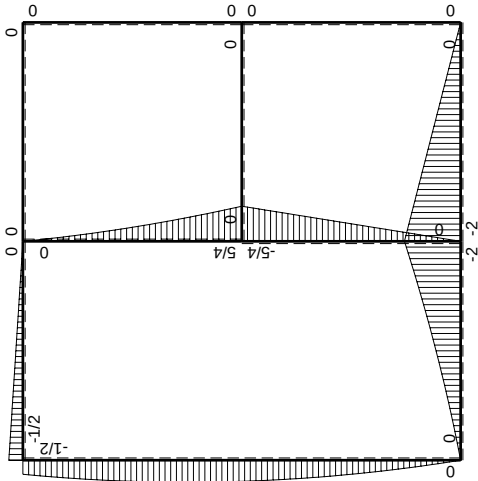
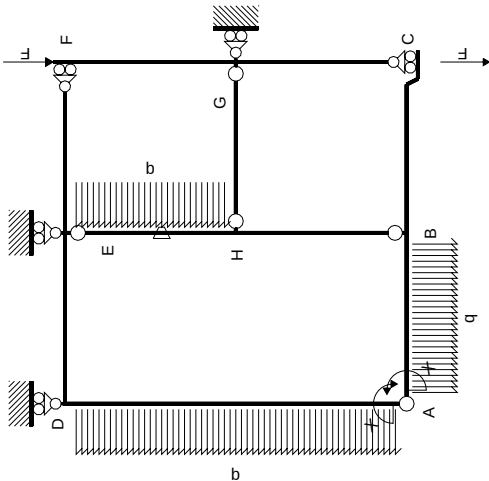
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



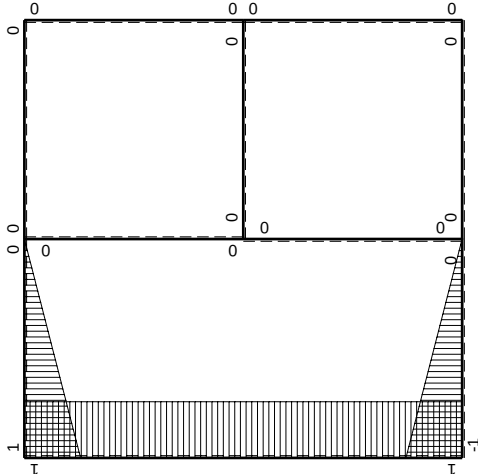
$$\begin{aligned}
A &= 648. \text{ mm}^2 \\
J_u &= 249420. \text{ mm}^4 \\
J_v &= 37368. \text{ mm}^4 \\
y_g &= 24.86 \text{ mm} \\
T_y &= 3020. \text{ N} \\
M_x &= -2053600. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 29.14 \text{ mm} \\
\sigma_m &= -Mv/J_u = 239.9 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 6. \text{ mm} \\
v_c &= -18.86 \text{ mm} \\
\sigma_c &= -Mv/J_u = -155.3 \text{ N/mm}^2 \\
\tau_c &= 9.711 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 156.2 \text{ N/mm}^2 \\
S &= 4812. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



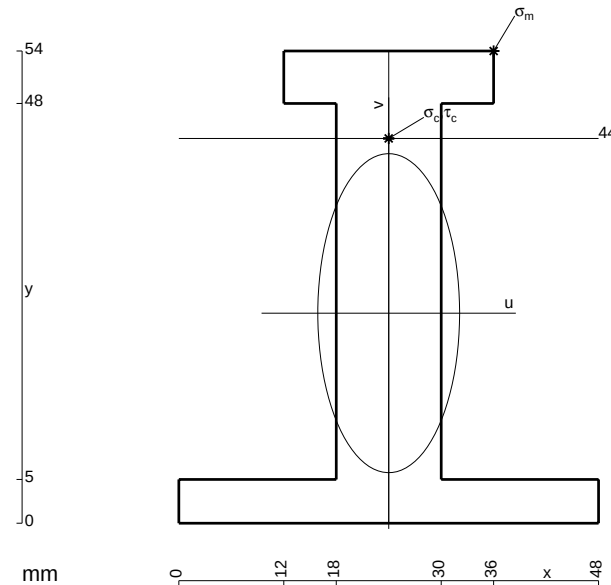
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

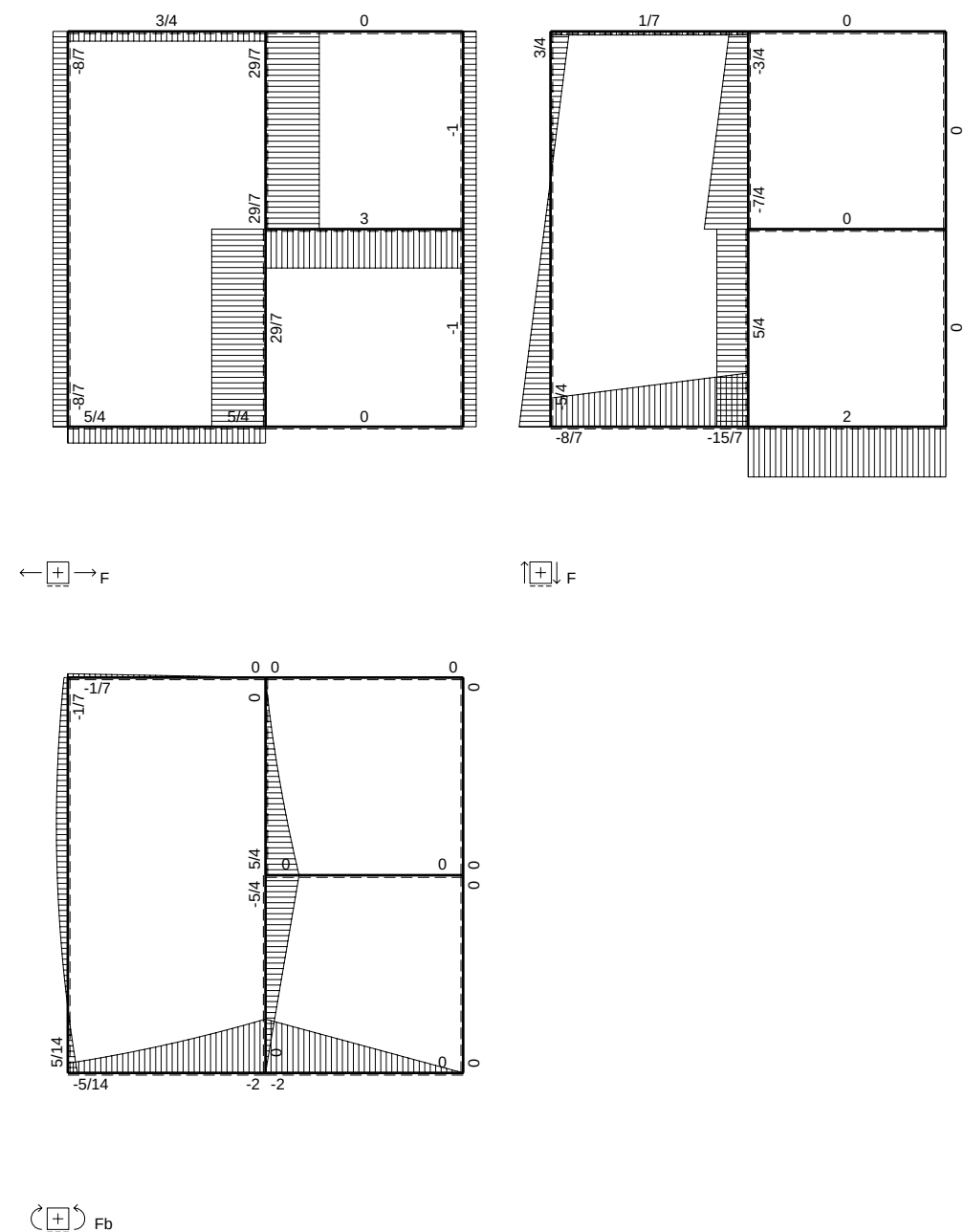
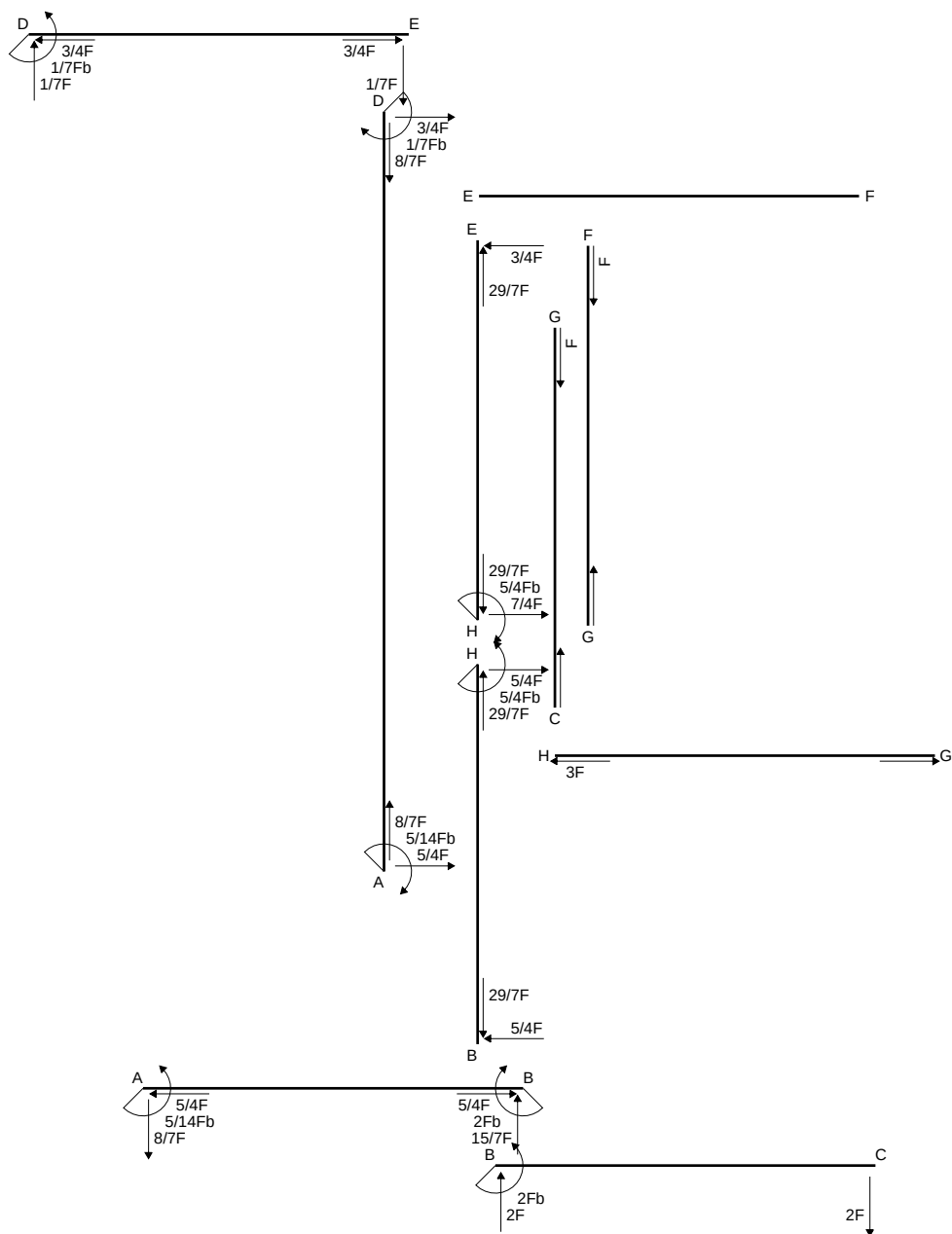
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

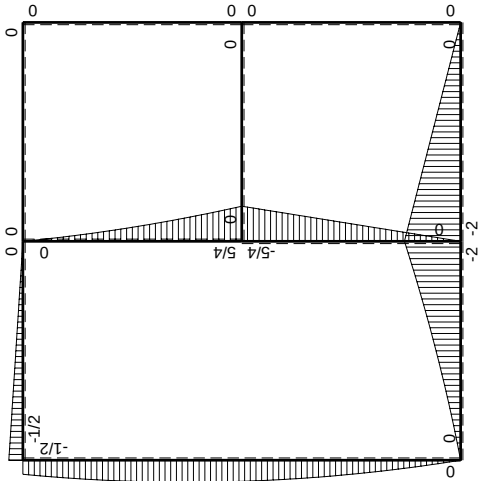
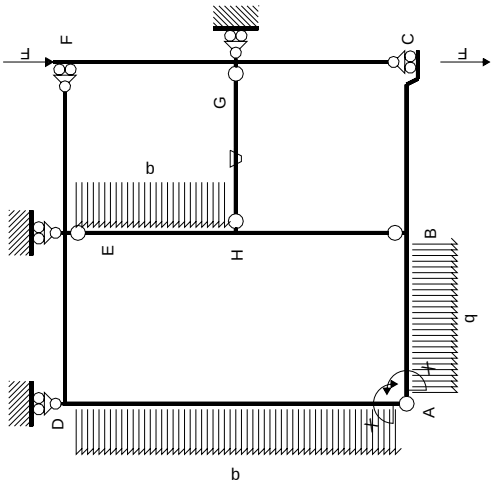
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



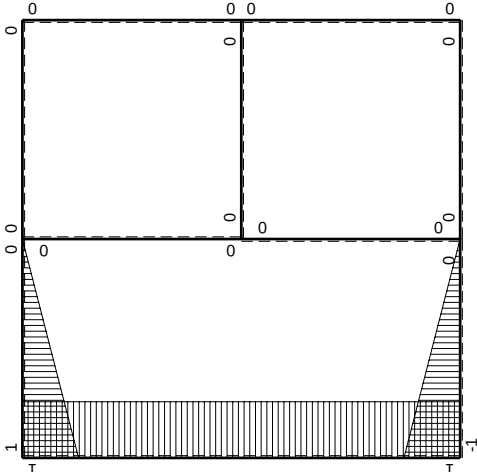
$$\begin{aligned}
A &= 900. \text{ mm}^2 \\
J_u &= 299580. \text{ mm}^4 \\
J_v &= 59184. \text{ mm}^4 \\
y_g &= 24.02 \text{ mm} \\
T_y &= 2720. \text{ N} \\
M_x &= -1985600. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 29.98 \text{ mm} \\
\sigma_m &= -Mv/J_u = 198.7 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 44. \text{ mm} \\
v_c &= 19.98 \text{ mm} \\
\sigma_c &= -Mv/J_u = 132.4 \text{ N/mm}^2 \\
\tau_c &= 3.738 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 132.6 \text{ N/mm}^2 \\
S &= 4940. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



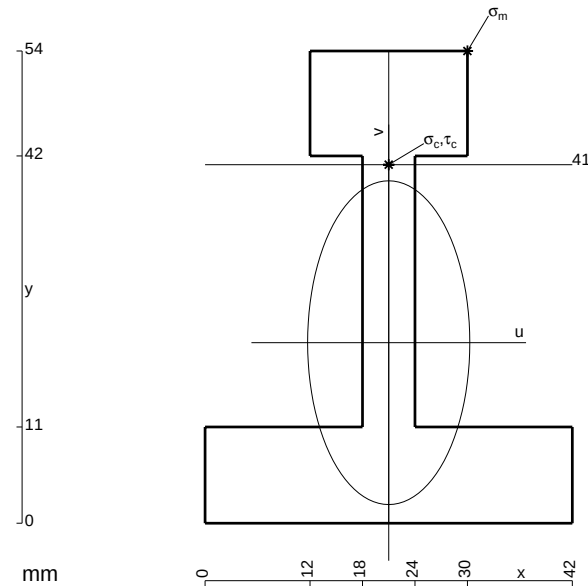
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

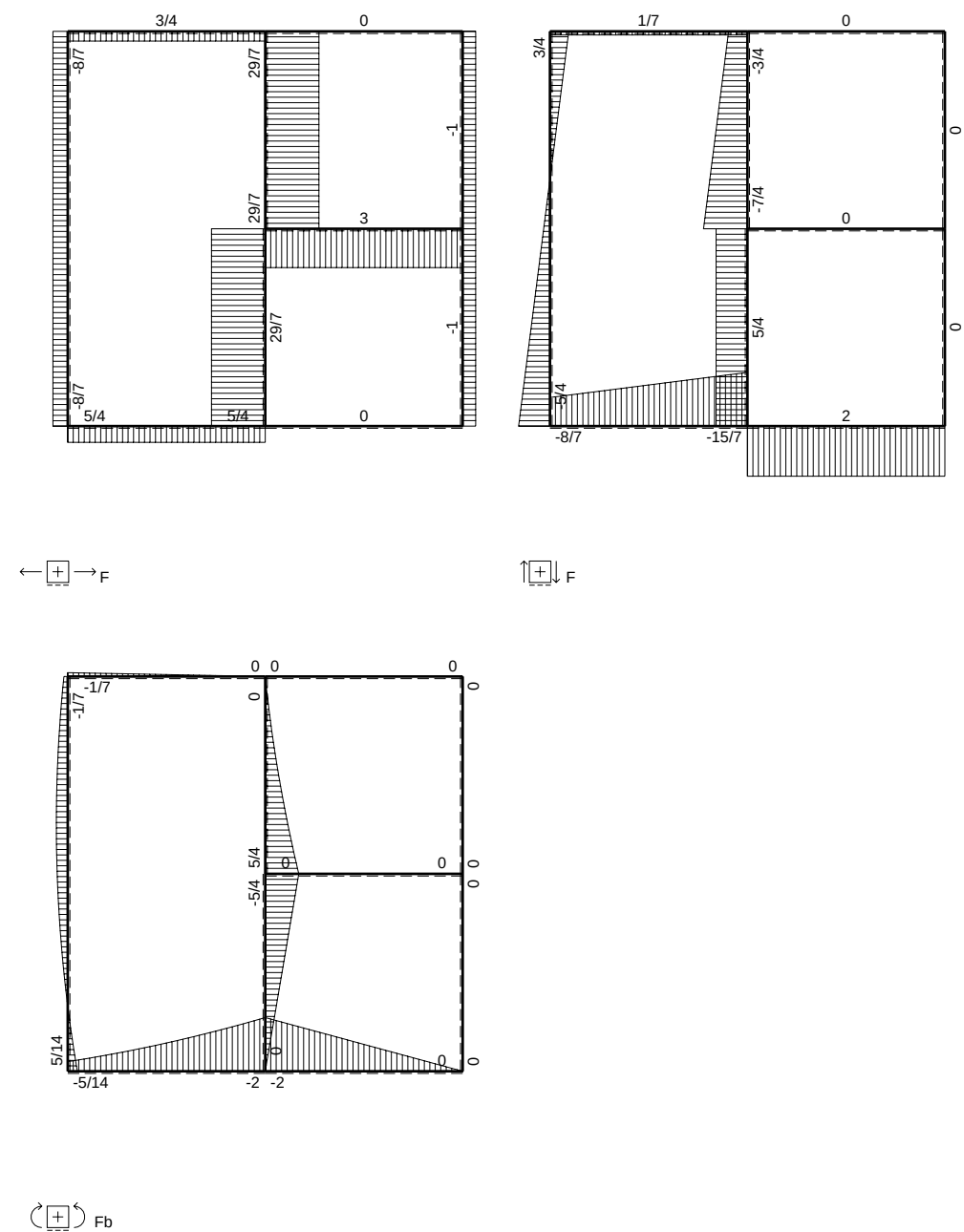
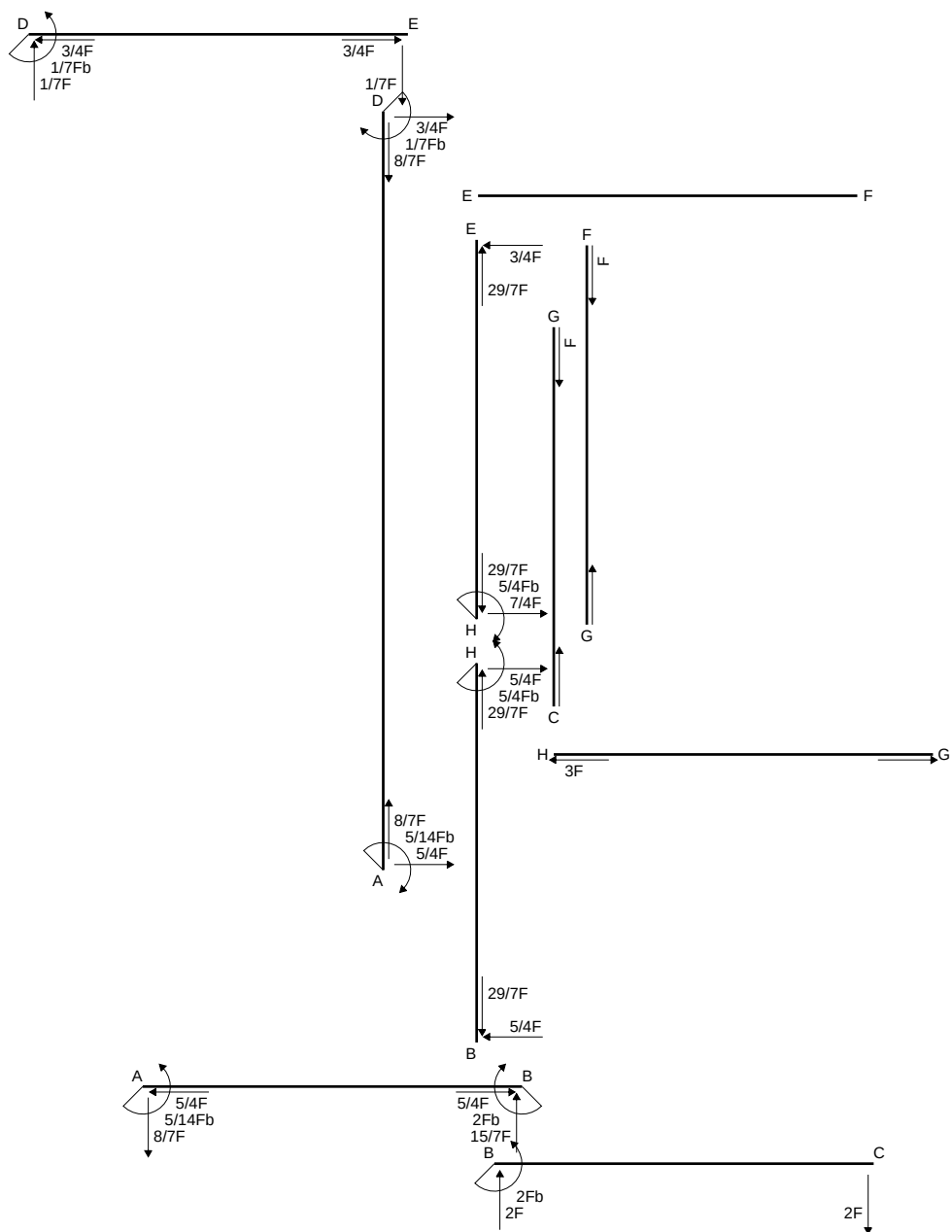
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

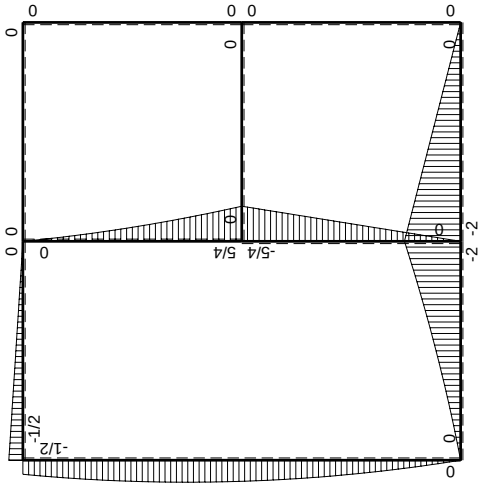
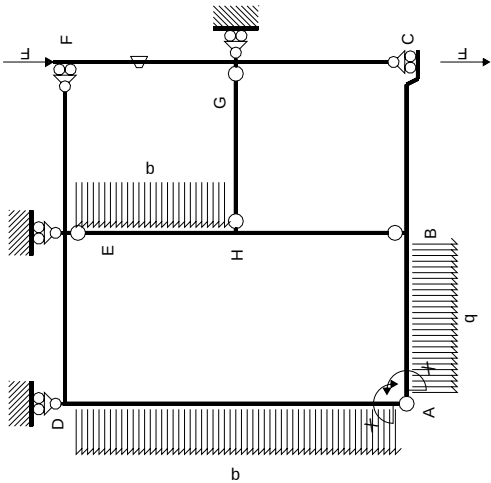
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + \frac{1}{2} \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + \frac{1}{2} \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



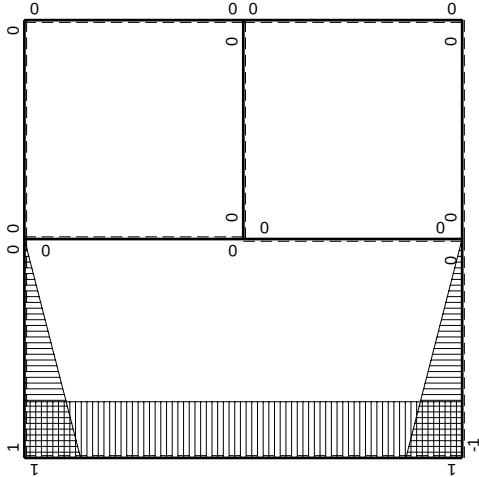
$$\begin{aligned} A &= 864. \text{ mm}^2 \\ J_u &= 296124. \text{ mm}^4 \\ J_v &= 74304. \text{ mm}^4 \\ y_g &= 20.65 \text{ mm} \\ T_y &= 2380. \text{ N} \\ M_x &= -1856400. \text{ Nmm} \\ x_m &= 30. \text{ mm} \\ y_m &= 54. \text{ mm} \\ u_m &= 9. \text{ mm} \\ v_m &= 33.35 \text{ mm} \\ \sigma_m &= -M_v/J_u = 209.1 \text{ N/mm}^2 \\ x_c &= 21. \text{ mm} \\ y_c &= 41. \text{ mm} \\ v_c &= 20.35 \text{ mm} \\ \sigma_c &= -M_v/J_u = 127.6 \text{ N/mm}^2 \\ \tau_c &= 8.082 \text{ N/mm}^2 \\ \sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 128.4 \text{ N/mm}^2 \\ S^* &= 6034. \text{ mm}^3 \end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



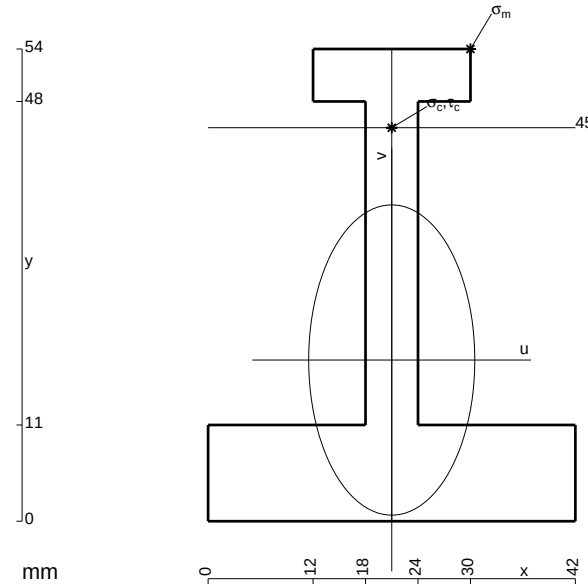
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

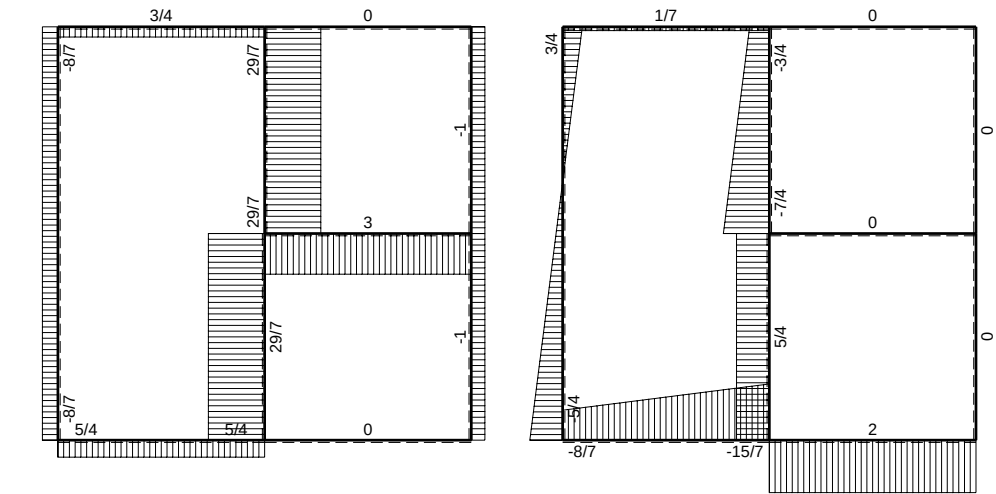
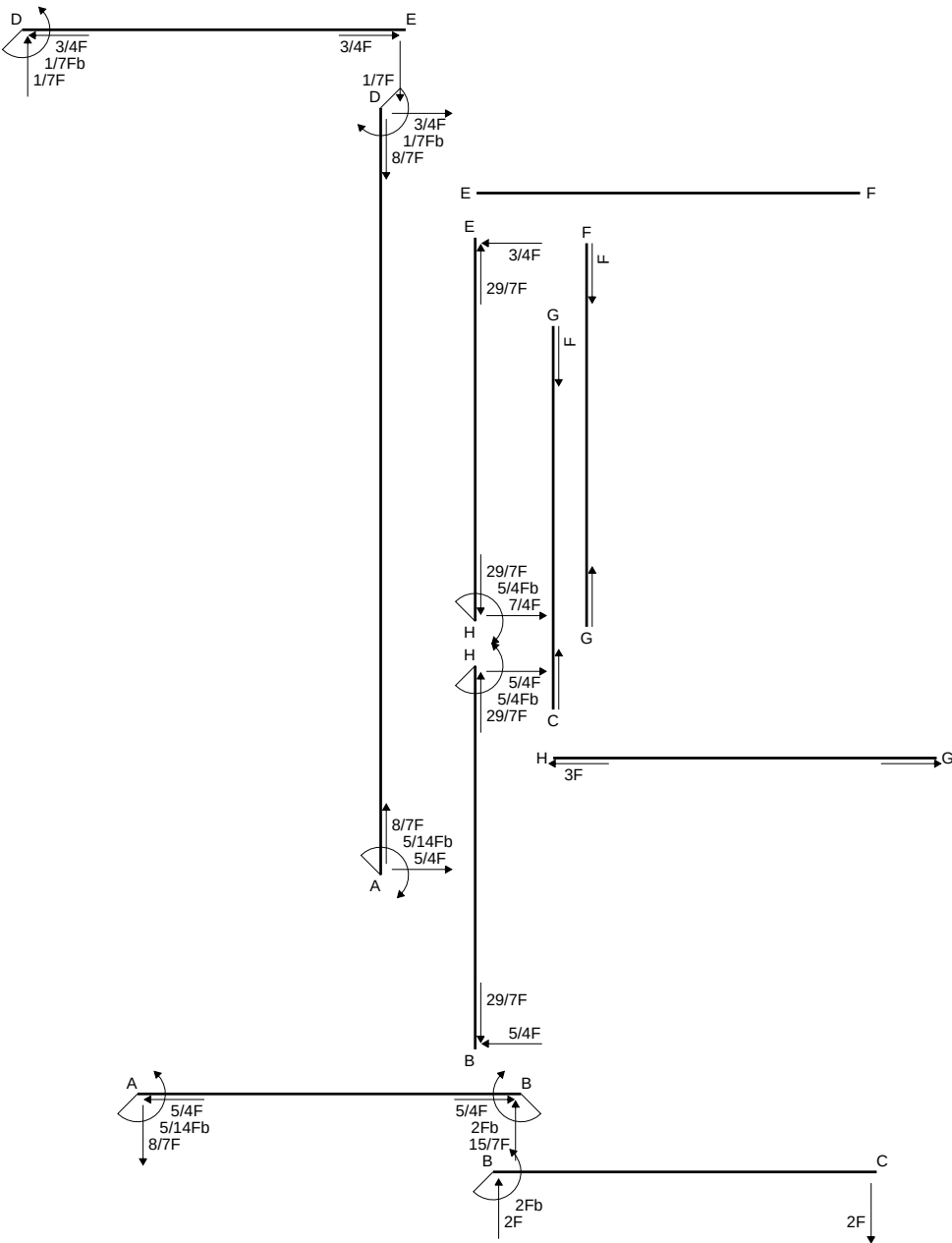
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{xo} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{xo} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{xo} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{xo} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{xo} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{xo} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

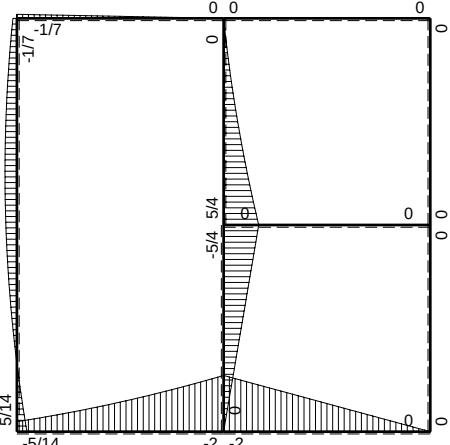


$$\begin{aligned}
A &= 792. \text{ mm}^2 \\
J_u &= 249320. \text{ mm}^4 \\
J_v &= 71496. \text{ mm}^4 \\
y_g &= 18.43 \text{ mm} \\
T_y &= 1840. \text{ N} \\
M_x &= -1527200. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 35.57 \text{ mm} \\
\sigma_m &= -Mv/J_u = 217.9 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 45. \text{ mm} \\
v_c &= 26.57 \text{ mm} \\
\sigma_c &= -Mv/J_u = 162.7 \text{ N/mm}^2 \\
\tau_c &= 4.948 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 163. \text{ N/mm}^2 \\
S &= 4023. \text{ mm}^3
\end{aligned}$$

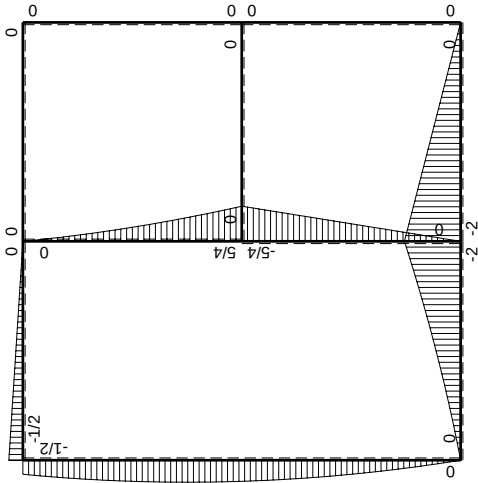
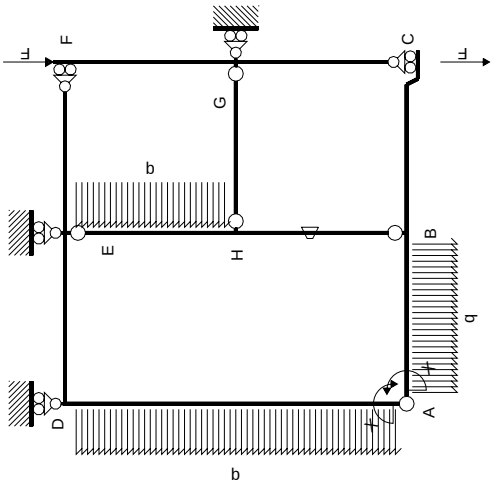


← ⊕ → F

↑ ⊕ ↓ F

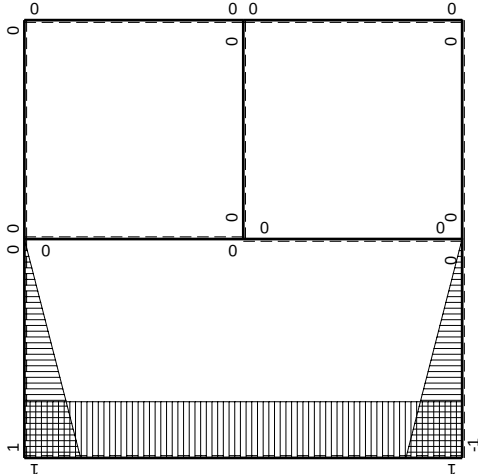


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



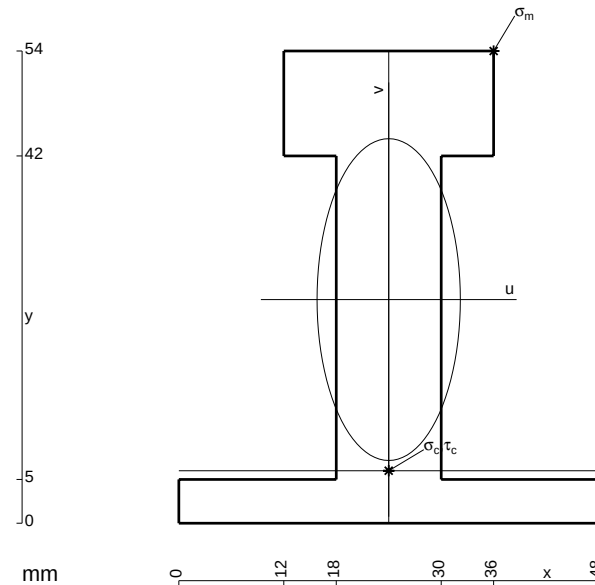
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

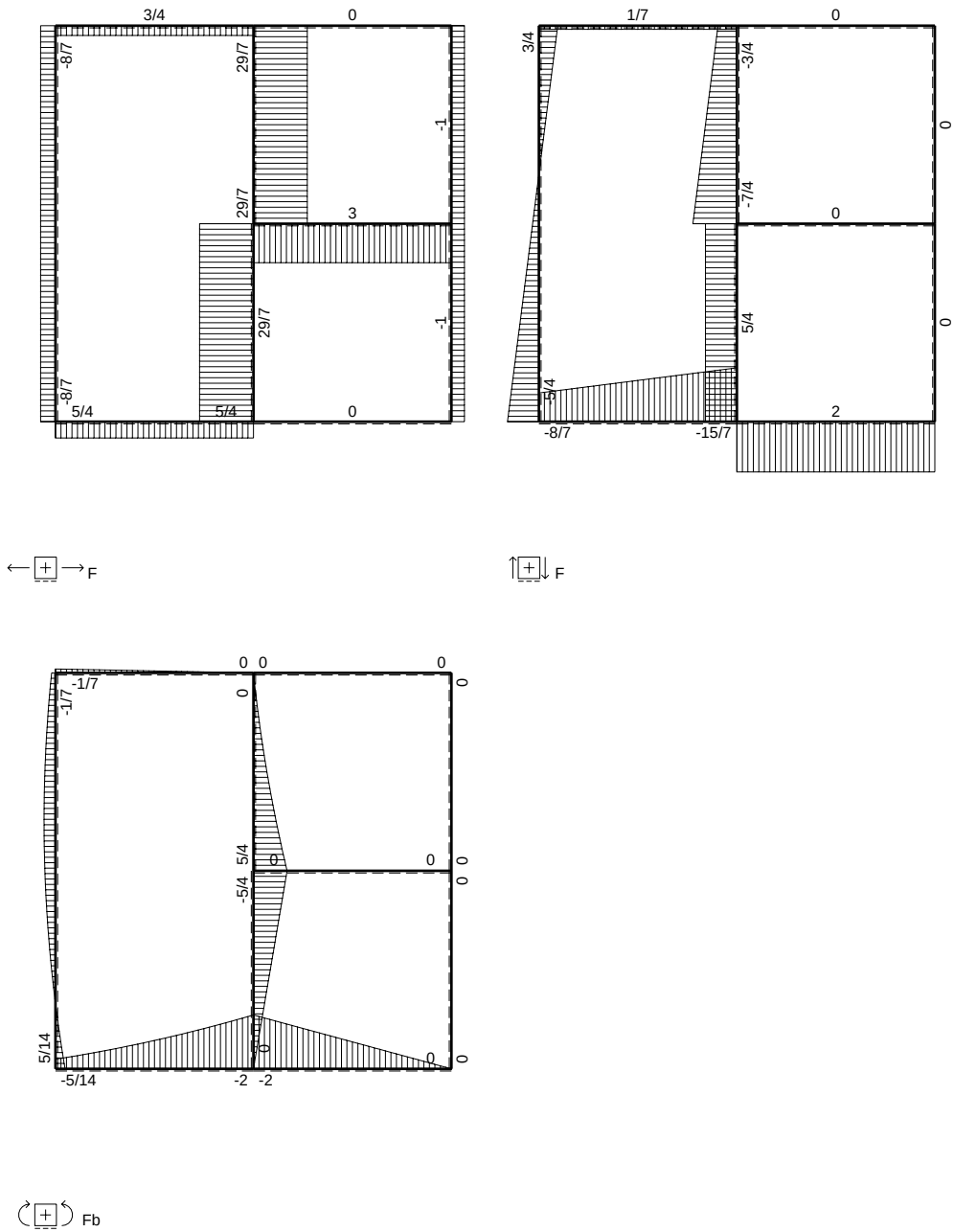
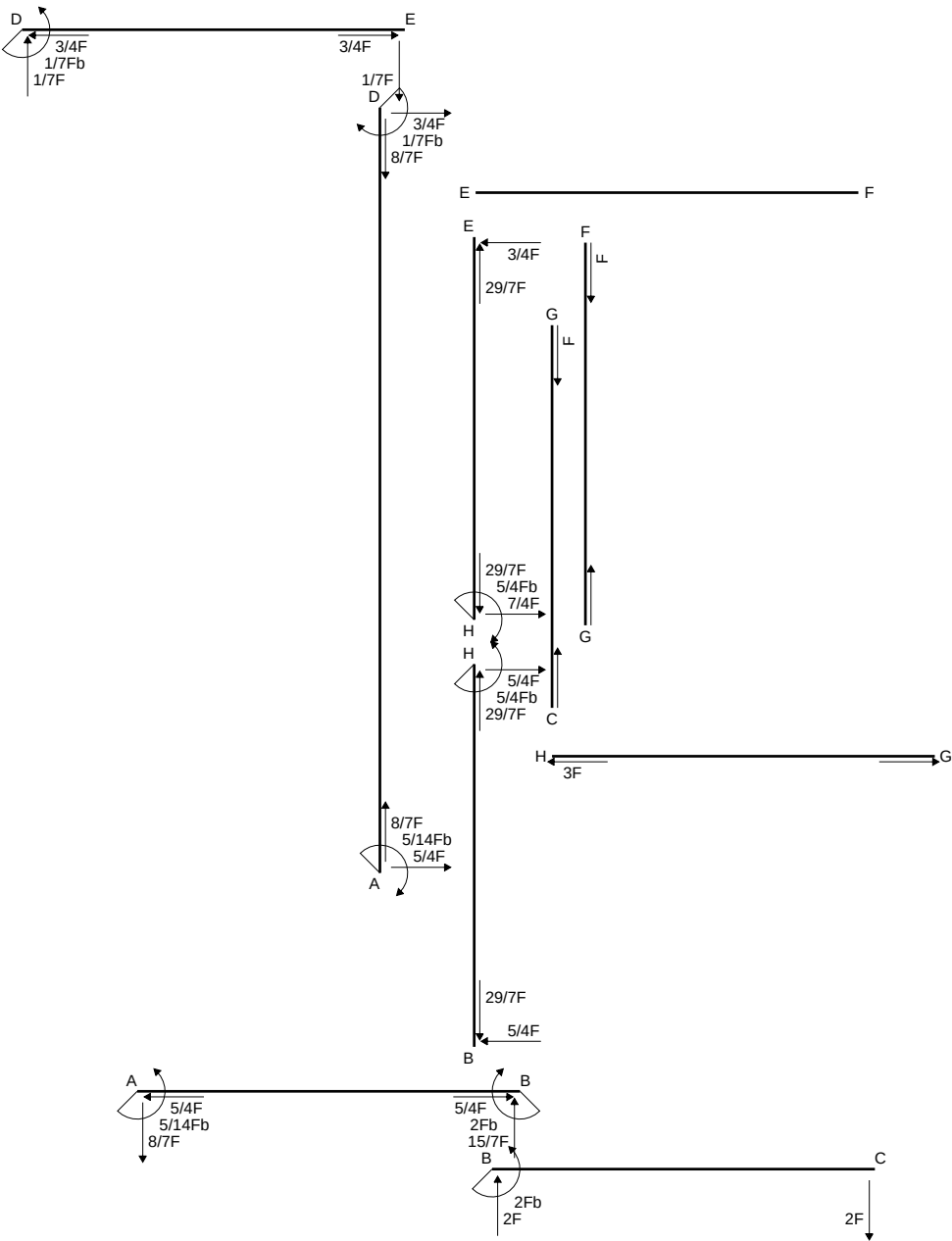
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$5/4Fx$	Fb/EJ	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

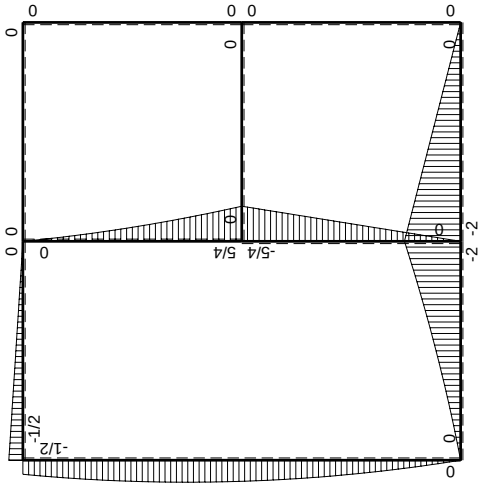
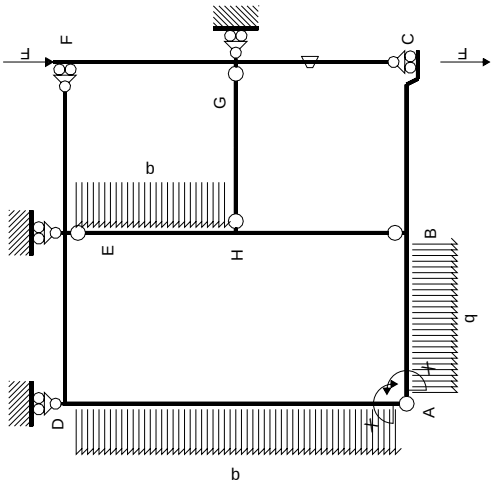
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{xo} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{xo} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{xo} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{xo} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{xo} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{xo} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



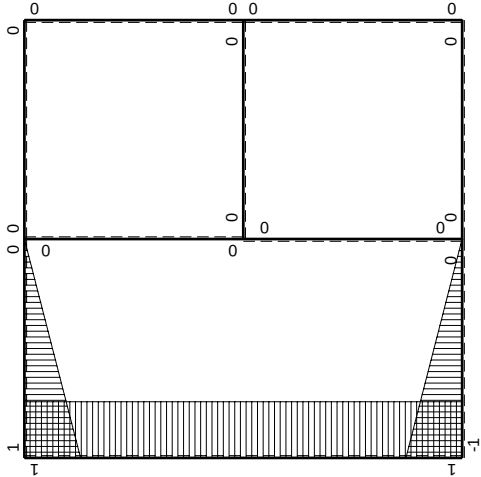
$$\begin{aligned}
A &= 972. \text{ mm}^2 \\
J_u &= 329140. \text{ mm}^4 \\
J_v &= 65232. \text{ mm}^4 \\
y_g &= 25.57 \text{ mm} \\
T_y &= 3020. \text{ N} \\
M_x &= -2657600. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 28.43 \text{ mm} \\
\sigma_m &= -Mv/J_u = 229.5 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 6. \text{ mm} \\
v_c &= -19.57 \text{ mm} \\
\sigma_c &= -Mv/J_u = -158. \text{ N/mm}^2 \\
\tau_c &= 4.418 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 158.2 \text{ N/mm}^2 \\
S &= 5779. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



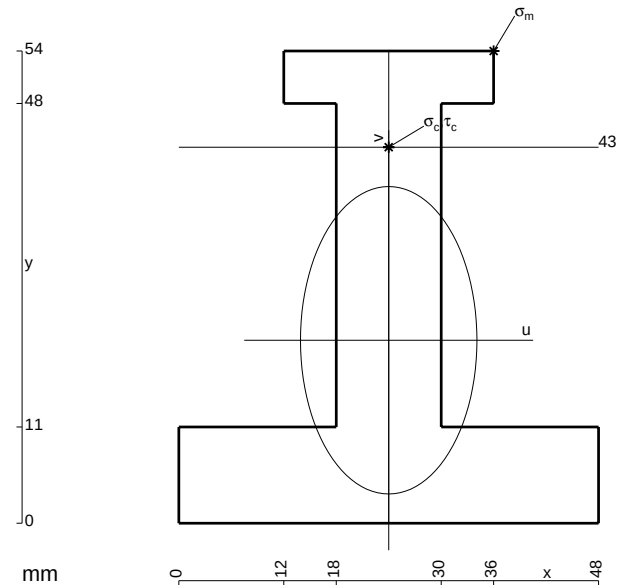
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

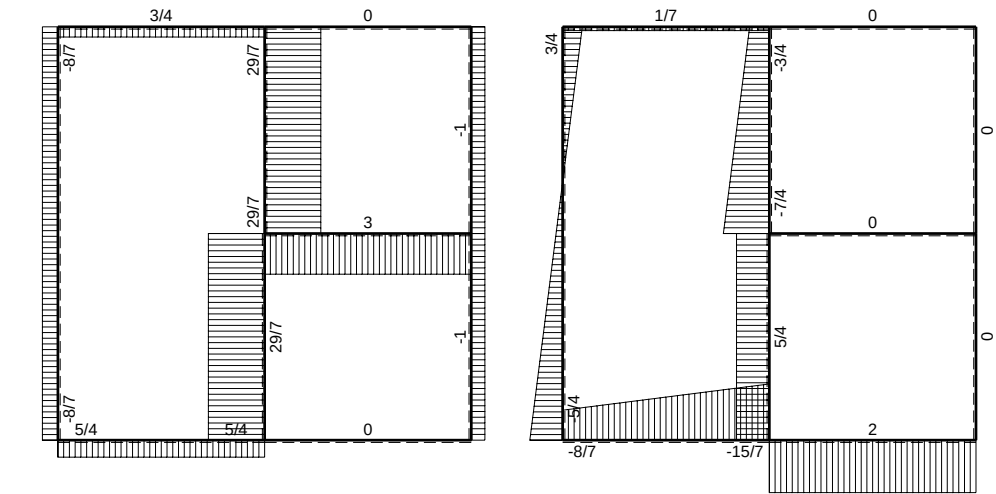
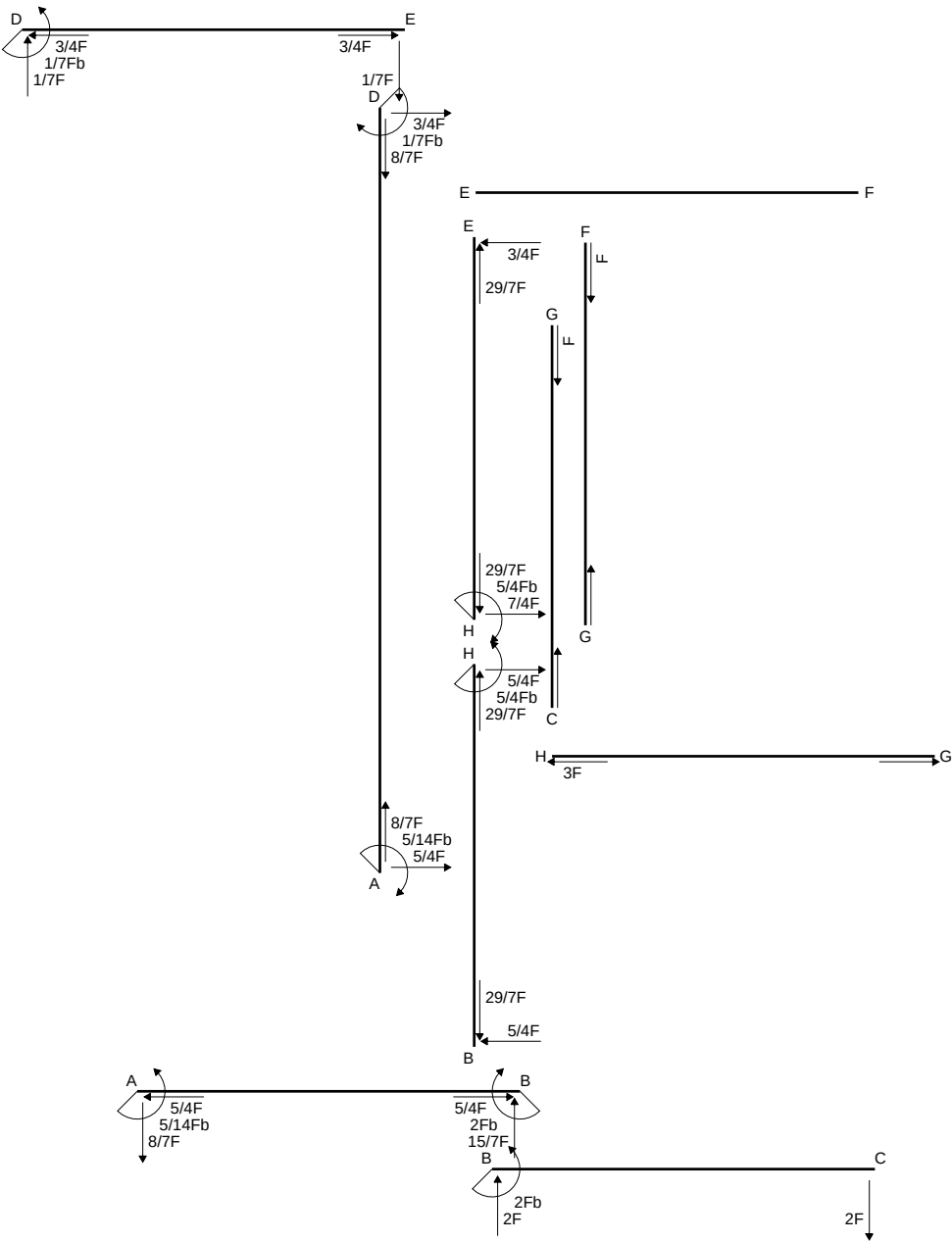
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
 L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
 &= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
 L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
 &= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
 L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
 &= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
 L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
 &= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
 L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
 &= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
 L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
 &= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
 L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
 L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
 &= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
 L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
 &= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
 L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
 &= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
 L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
 &= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
 L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
 &= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
 \end{aligned}$$

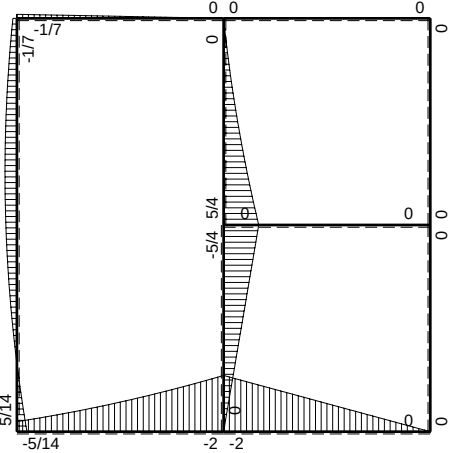


$$\begin{aligned}
 A &= 1116. \text{ mm}^2 \\
 J_u &= 344933. \text{ mm}^4 \\
 J_v &= 113616. \text{ mm}^4 \\
 y_g &= 20.92 \text{ mm} \\
 T_y &= 2680. \text{ N} \\
 M_x &= -2492400. \text{ Nmm} \\
 x_m &= 36. \text{ mm} \\
 y_m &= 54. \text{ mm} \\
 u_m &= 12. \text{ mm} \\
 v_m &= 33.08 \text{ mm} \\
 \sigma_m &= -Mv/J_u = 239. \text{ N/mm}^2 \\
 x_c &= 24. \text{ mm} \\
 y_c &= 43. \text{ mm} \\
 v_c &= 22.08 \text{ mm} \\
 \sigma_c &= -Mv/J_u = 159.5 \text{ N/mm}^2 \\
 \tau_c &= 3.76 \text{ N/mm}^2 \\
 \sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 159.7 \text{ N/mm}^2 \\
 S &= 5806. \text{ mm}^3
 \end{aligned}$$

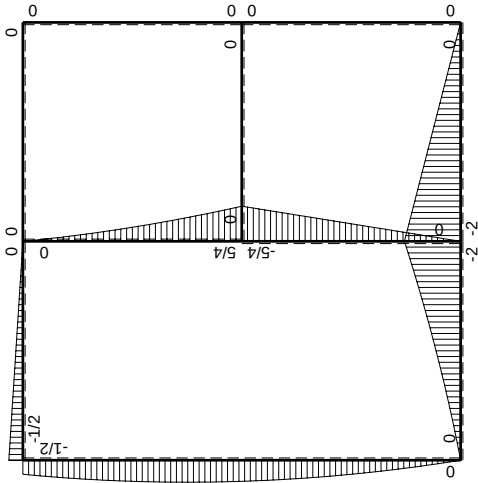
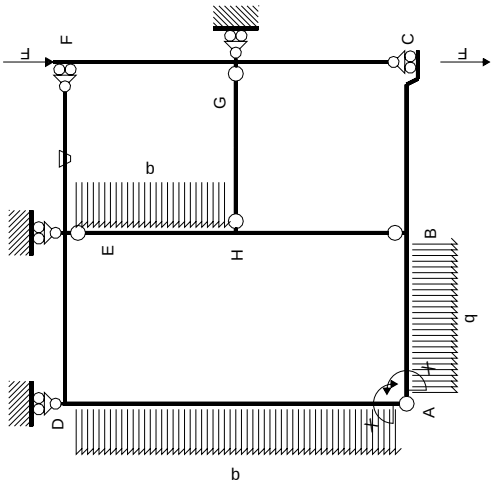


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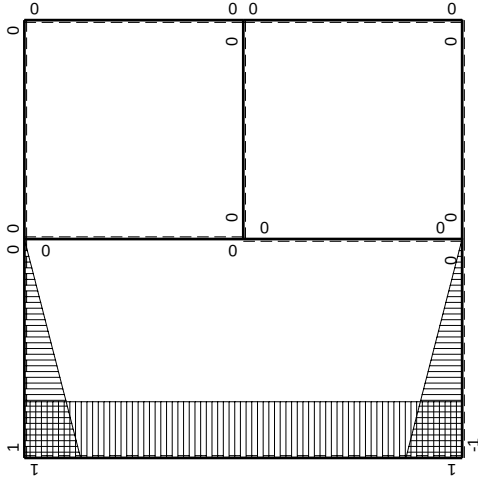


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



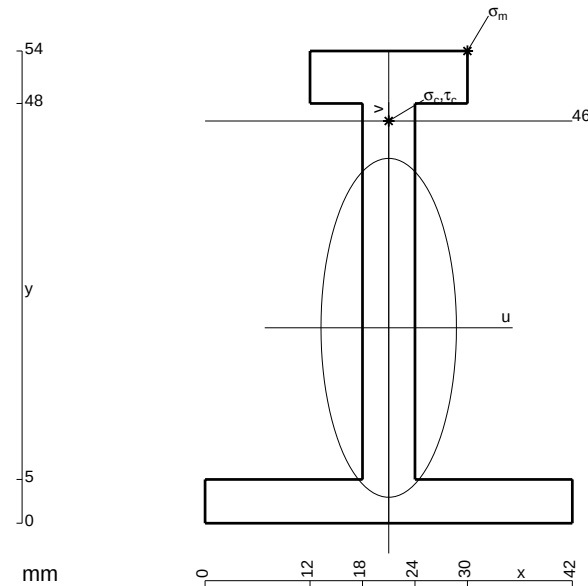
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

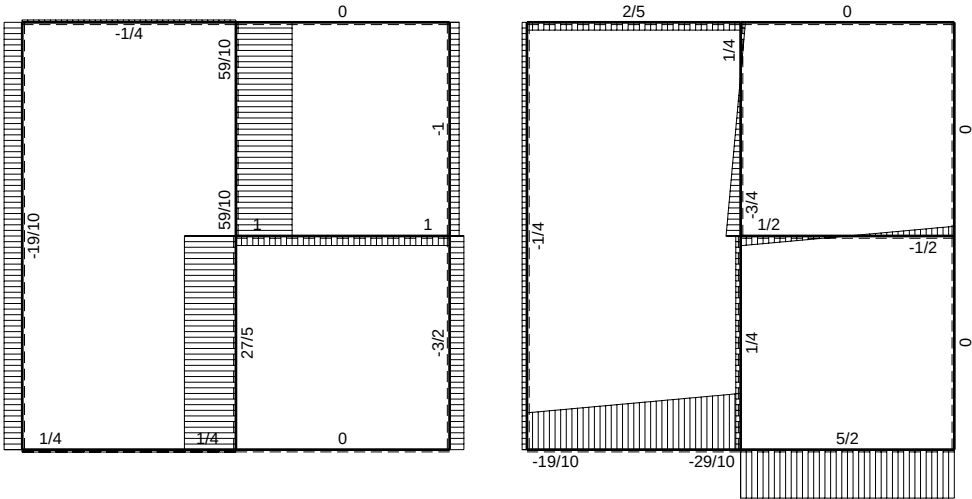
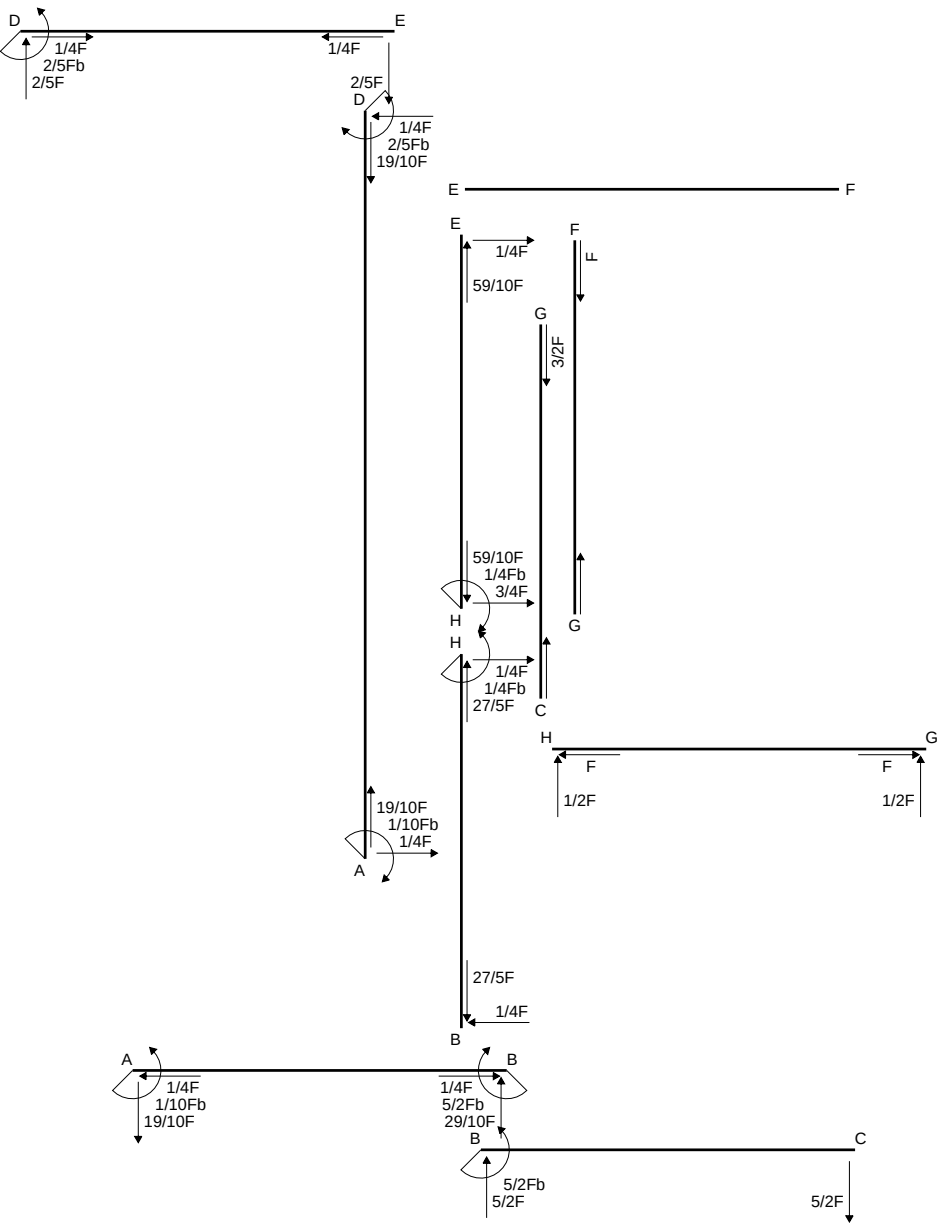
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-5/4Fx+1/2qx^2$	0	$-5/4Fx+1/2Fx^2/b$	0	1	$(-7/6+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb+3/4Fx-1/2qx^2$	0	$-1/2Fb-3/4Fx+1/2Fx^2/b$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-5/4Fb+5/4Fx$	0	0	0	0	0+0	0
BH b	0	$5/4Fx$	0	0	0	0		
HE b	0	$5/4Fb-7/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-3/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-5/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-5/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 - 3/4 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x - 3/8 x^2/b + 1/6 x^3/b^2 \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b - 3/2 b + 4/3 b) Fb \frac{1}{EJ} = -7/6 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

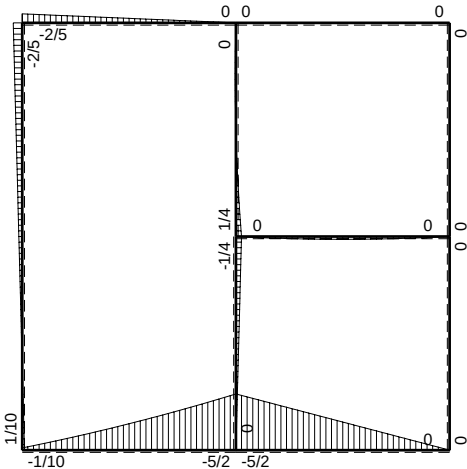


$$\begin{aligned}
A &= 576. \text{ mm}^2 \\
J_u &= 216352. \text{ mm}^4 \\
J_v &= 34560. \text{ mm}^4 \\
y_g &= 22.34 \text{ mm} \\
T_y &= 2780. \text{ N} \\
M_x &= -1362200. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 54. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 31.66 \text{ mm} \\
\sigma_m &= -Mv/J_u = 199.3 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 46. \text{ mm} \\
v_c &= 23.66 \text{ mm} \\
\sigma_c &= -Mv/J_u = 148.9 \text{ N/mm}^2 \\
\tau_c &= 7.262 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 149.5 \text{ N/mm}^2 \\
S &= 3391. \text{ mm}^3
\end{aligned}$$

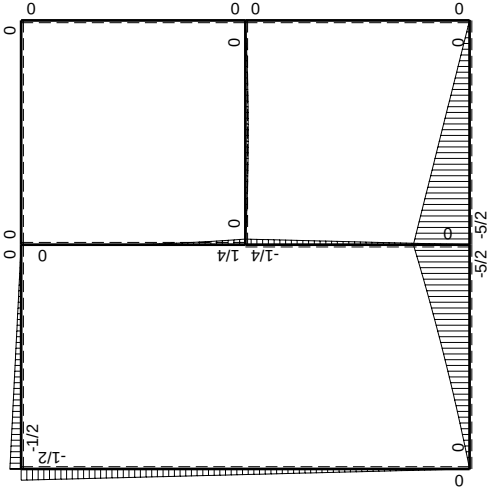
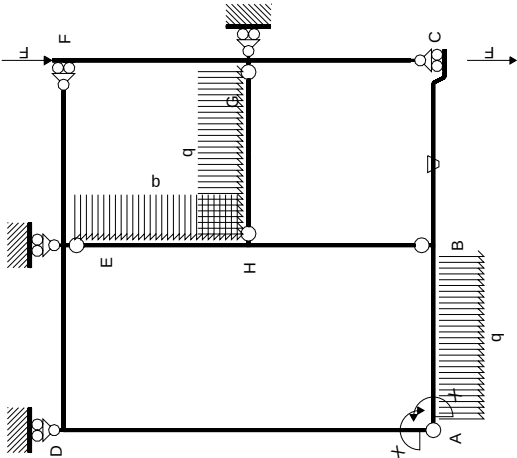


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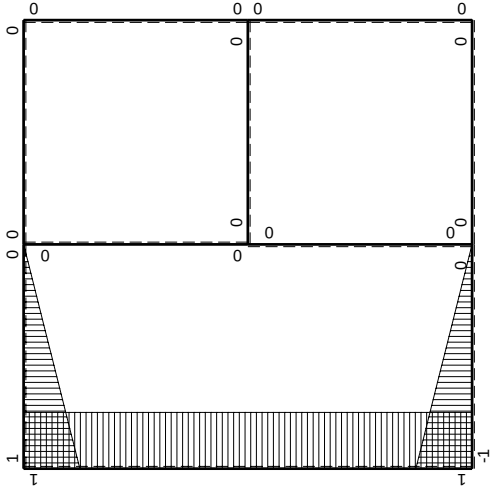


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati

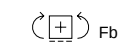
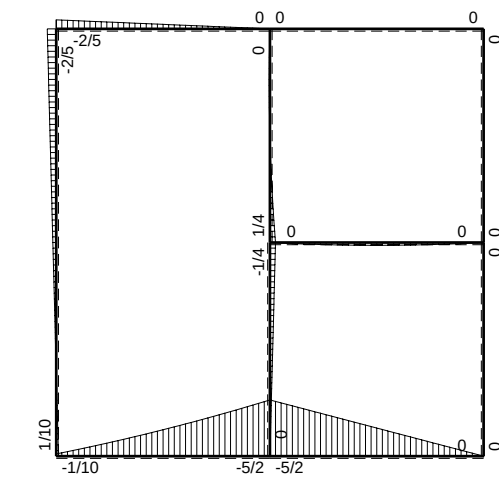
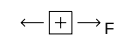
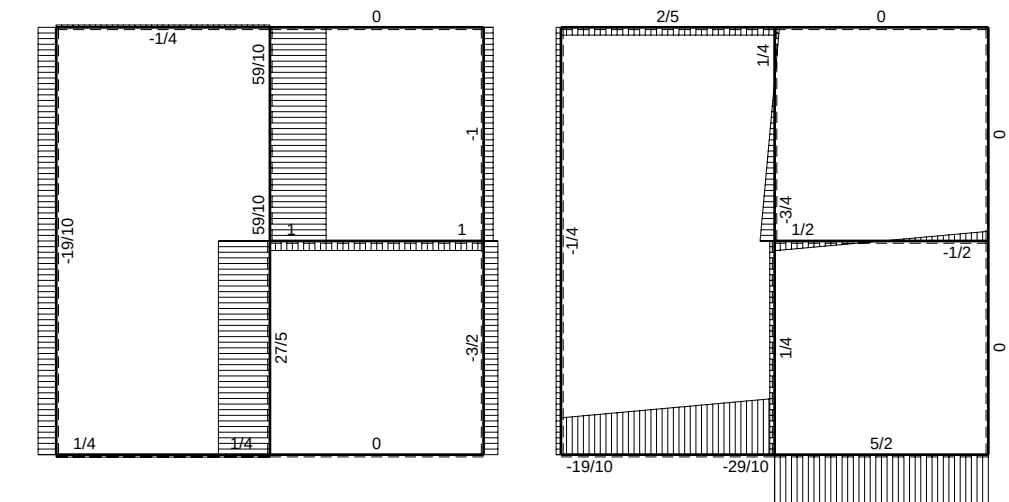
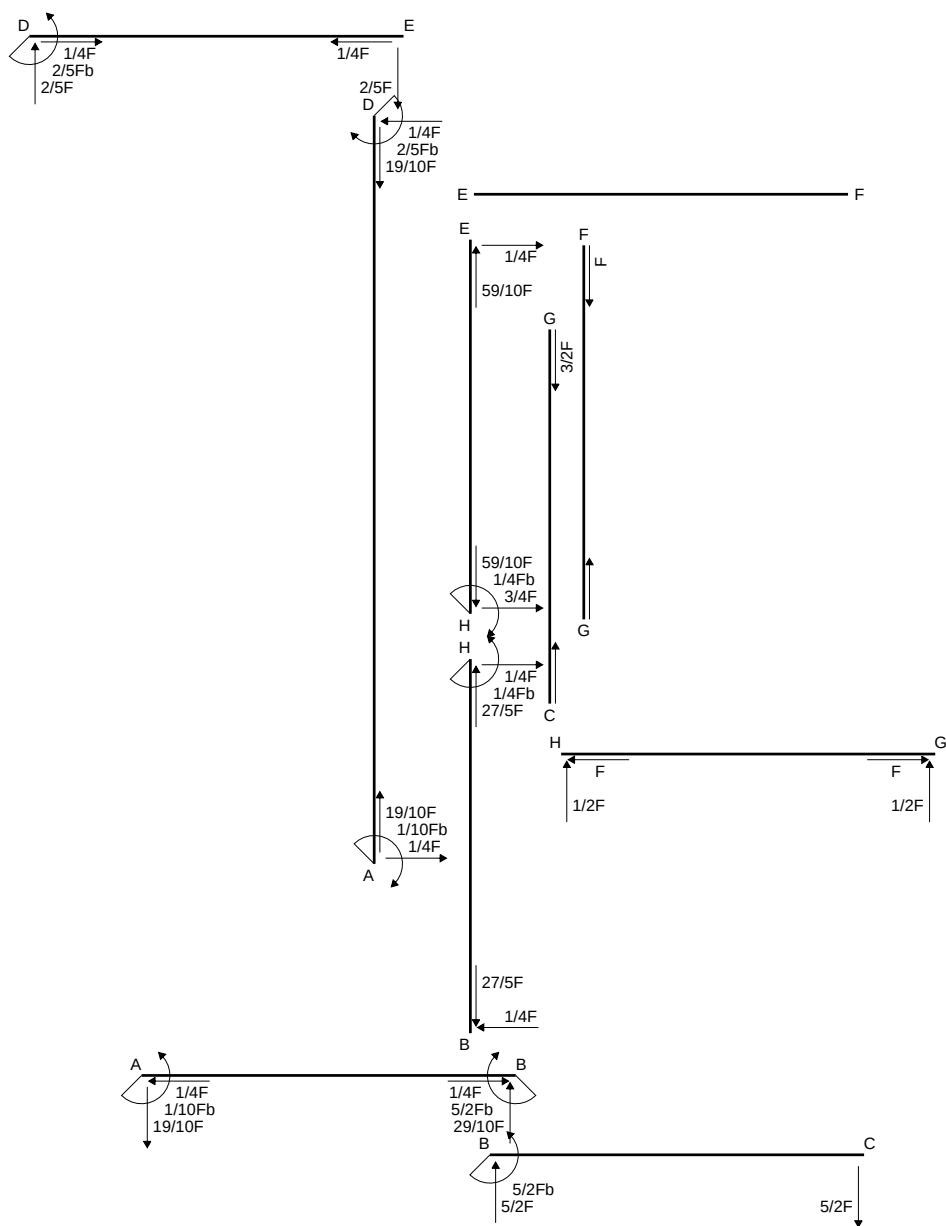


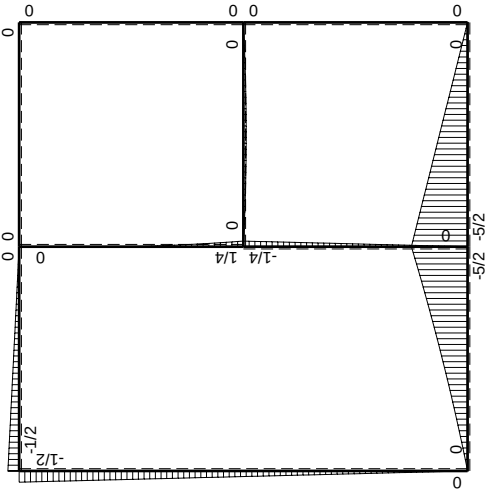
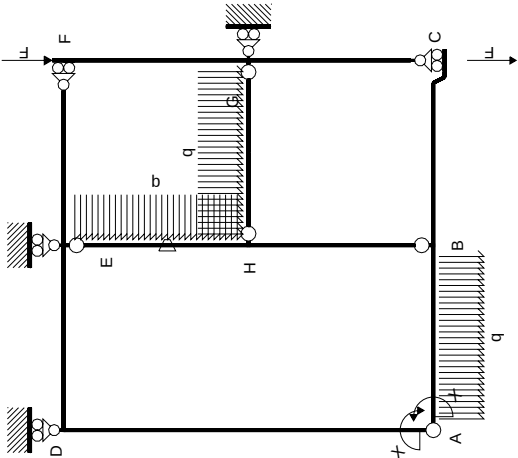
M_X flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$5/2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$-1/4Fx$	0	$-1/4Fx$	0	1	$(-1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb-1/4Fx$	0	$-1/2Fb+1/4Fx$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
BH b	0	$1/4Fx$	0	0	0	0		
HE b	0	$1/4Fb-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/10Fb$	

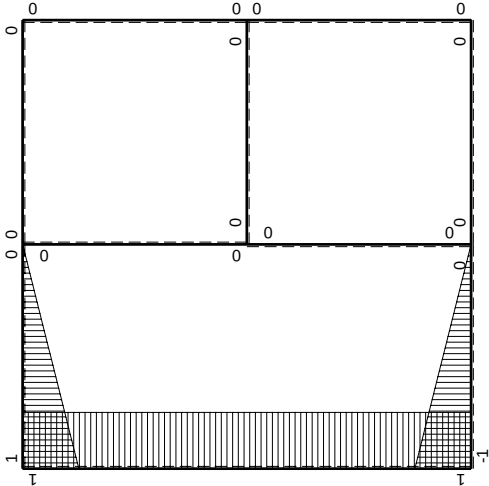
Sviluppi di calcolo iperstatica





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



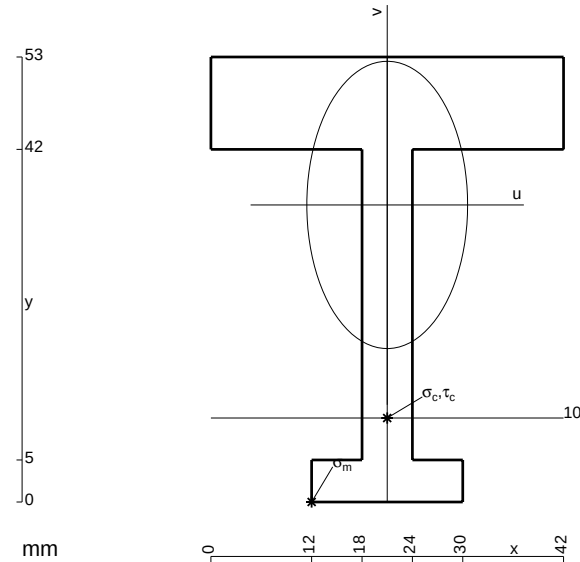
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

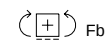
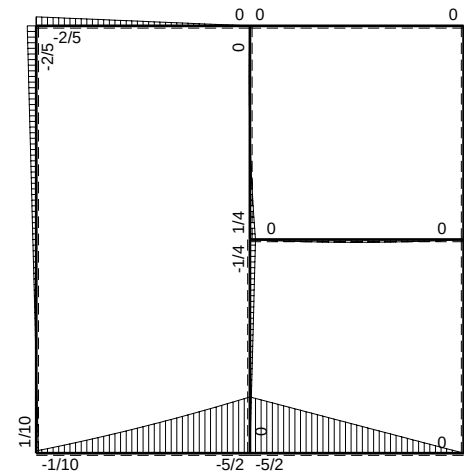
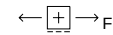
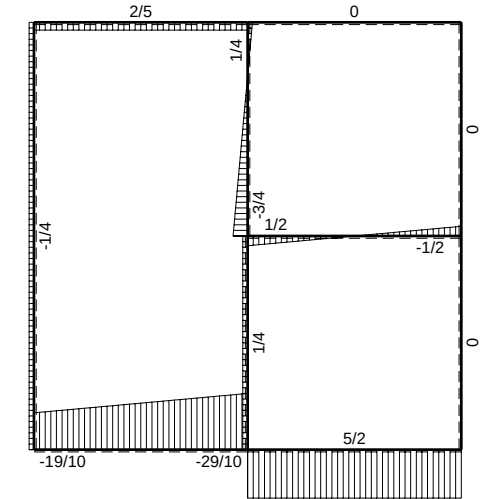
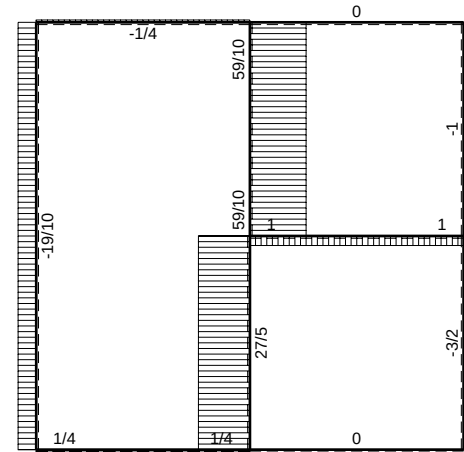
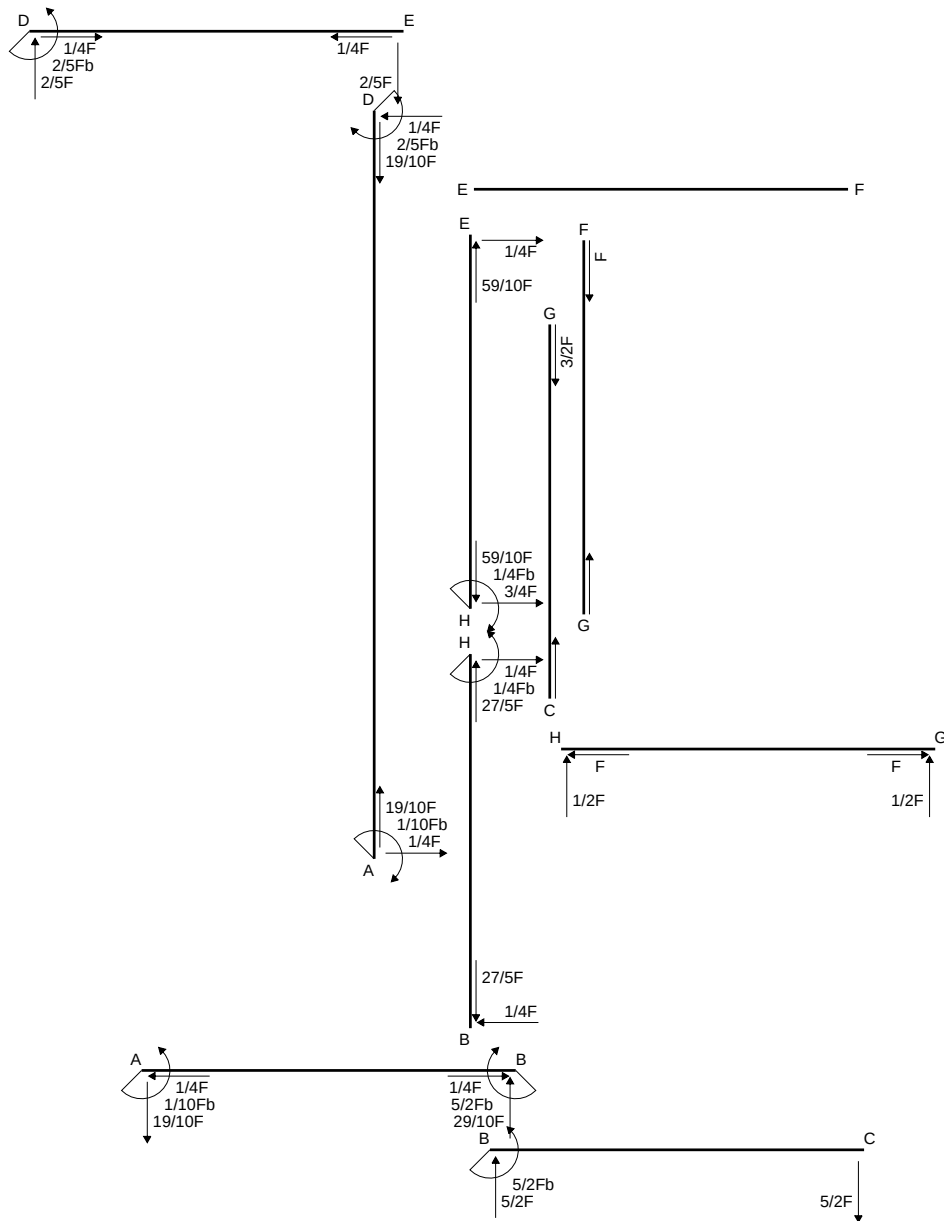
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-1/4Fx$	0	$-1/4Fx$	0	1	$(-1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb-1/4Fx$	0	$-1/2Fb+1/4Fx$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
BH b	0	$1/4Fx$	0	0	0	0		
HE b	0	$1/4Fb-3/4Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$1/4Fx-1/2qx^2$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/10Fb$	

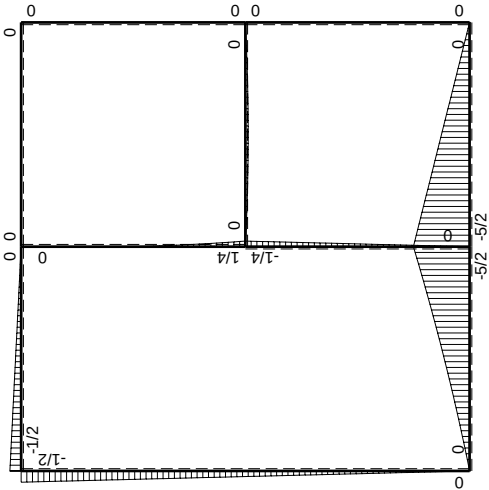
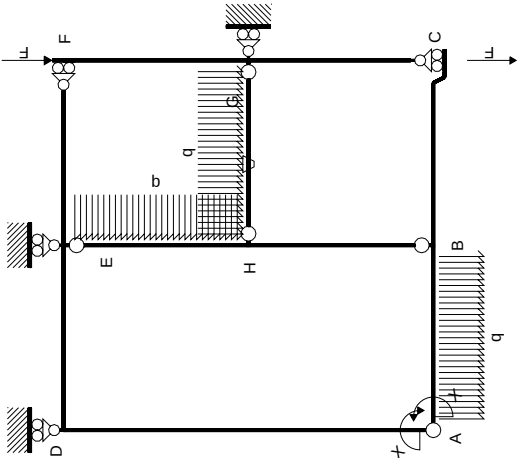
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 + 1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b + 1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



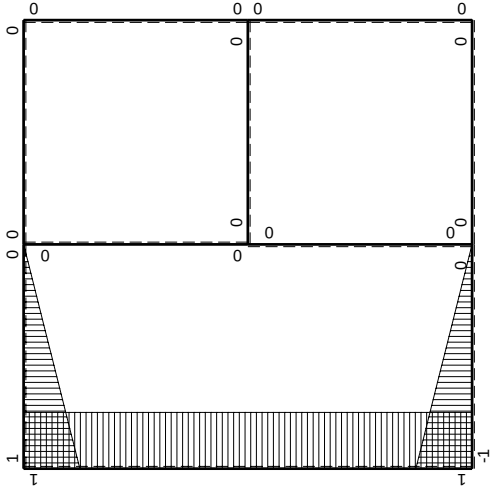
$$\begin{aligned}
A &= 774. \text{ mm}^2 \\
J_u &= 226668. \text{ mm}^4 \\
J_v &= 71010. \text{ mm}^4 \\
y_g &= 35.38 \text{ mm} \\
T_y &= 2450. \text{ N} \\
M_x &= -1396500. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -35.38 \text{ mm} \\
\sigma_m &= -Mv/J_u = -218. \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 10. \text{ mm} \\
v_c &= -25.38 \text{ mm} \\
\sigma_c &= -Mv/J_u = -156.4 \text{ N/mm}^2 \\
\tau_c &= 6.838 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 156.8 \text{ N/mm}^2 \\
S &= 3796. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



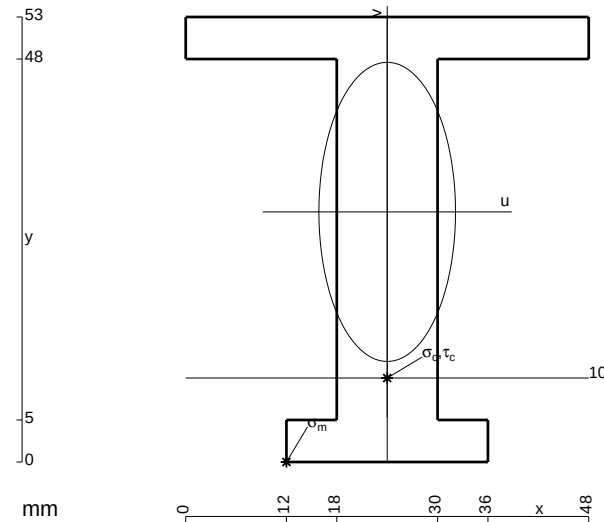
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

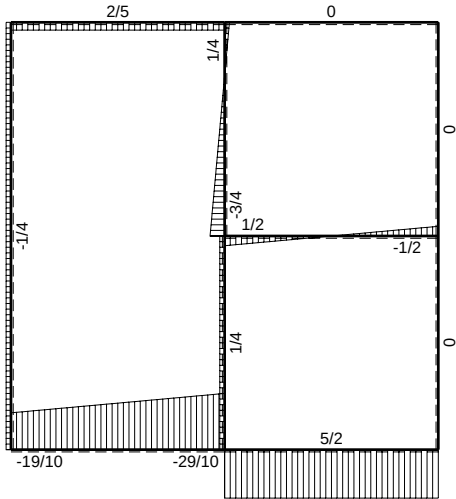
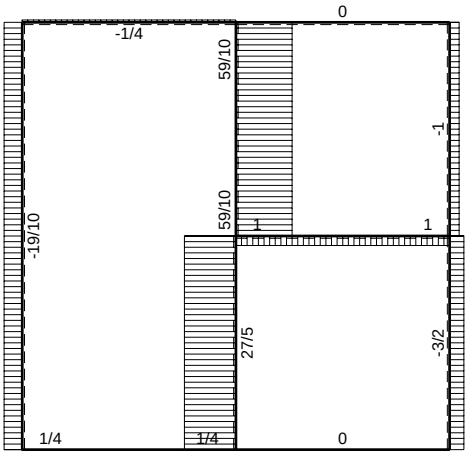
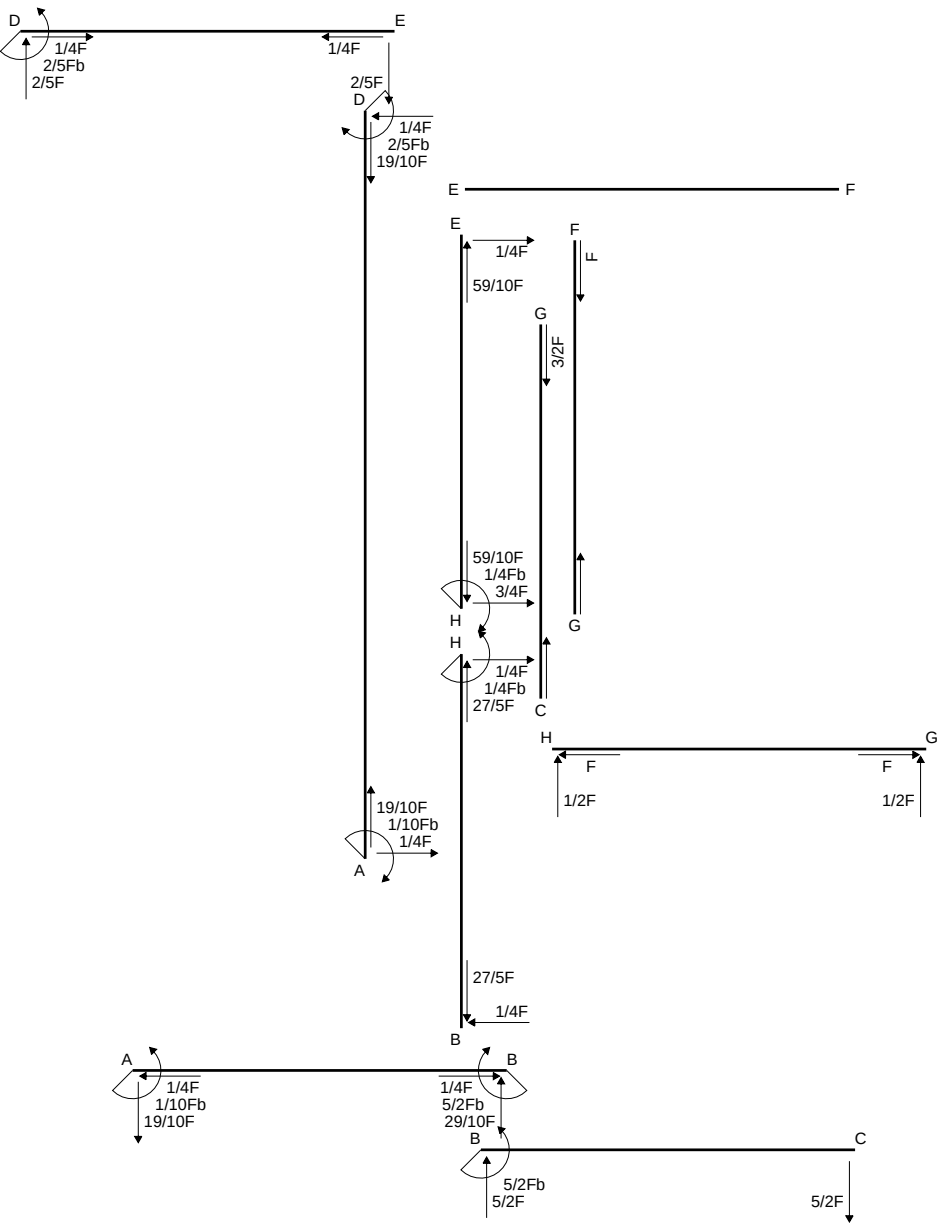
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-1/4Fx$	0	$-1/4Fx$	0	1	$(-1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb-1/4Fx$	0	$-1/2Fb+1/4Fx$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	Fb/EJ	0	0	0		
HB b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
BH b	0	$1/4Fx$	0	0	0	0		
HE b	0	$1/4Fb-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						1/10Fb	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 + 1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b + 1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

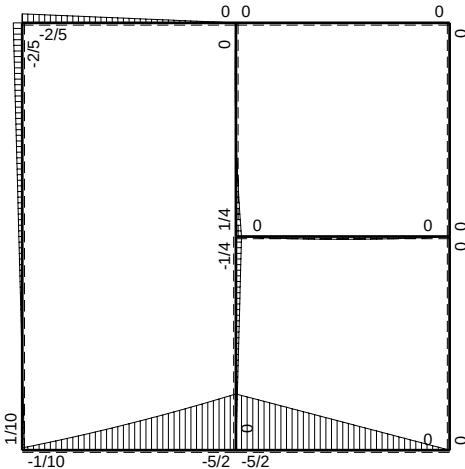


$$\begin{aligned}
A &= 876. \text{ mm}^2 \\
J_u &= 278148. \text{ mm}^4 \\
J_v &= 58032. \text{ mm}^4 \\
y_g &= 29.79 \text{ mm} \\
T_y &= 3450. \text{ N} \\
M_x &= -2139000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -29.79 \text{ mm} \\
\sigma_m &= -Mv/J_u = -229.1 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 10. \text{ mm} \\
v_c &= -19.79 \text{ mm} \\
\sigma_c &= -Mv/J_u = -152.2 \text{ N/mm}^2 \\
\tau_c &= 4.767 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 152.4 \text{ N/mm}^2 \\
S &= 4612. \text{ mm}^3
\end{aligned}$$



← ⊕ → F

↑ ⊕ ↓ F



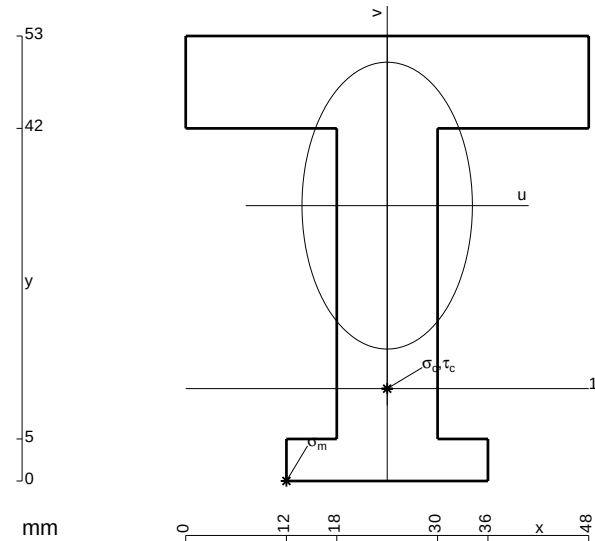
⊕ ⊖ F_b

Quadro contributi PLV per iperstatica $X=W_{AB}$

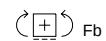
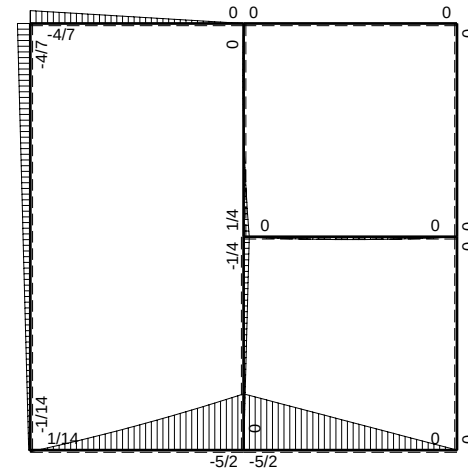
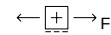
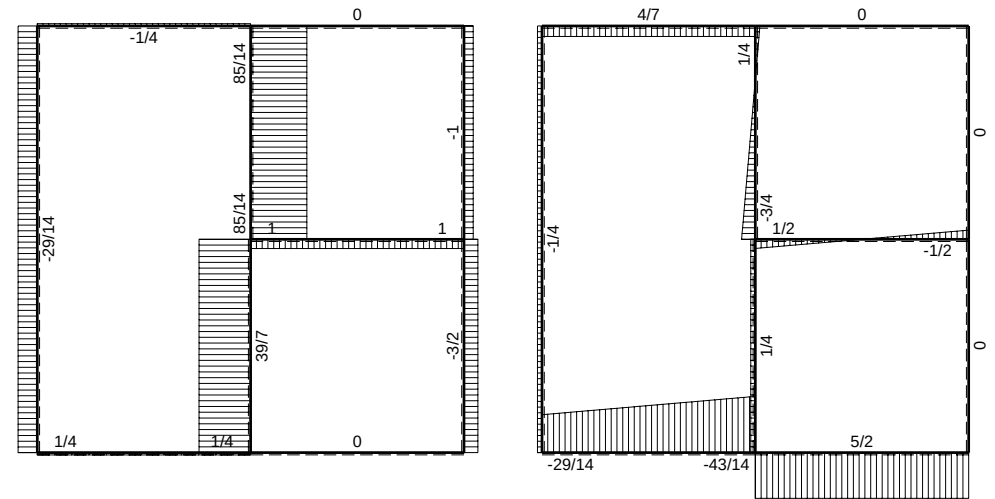
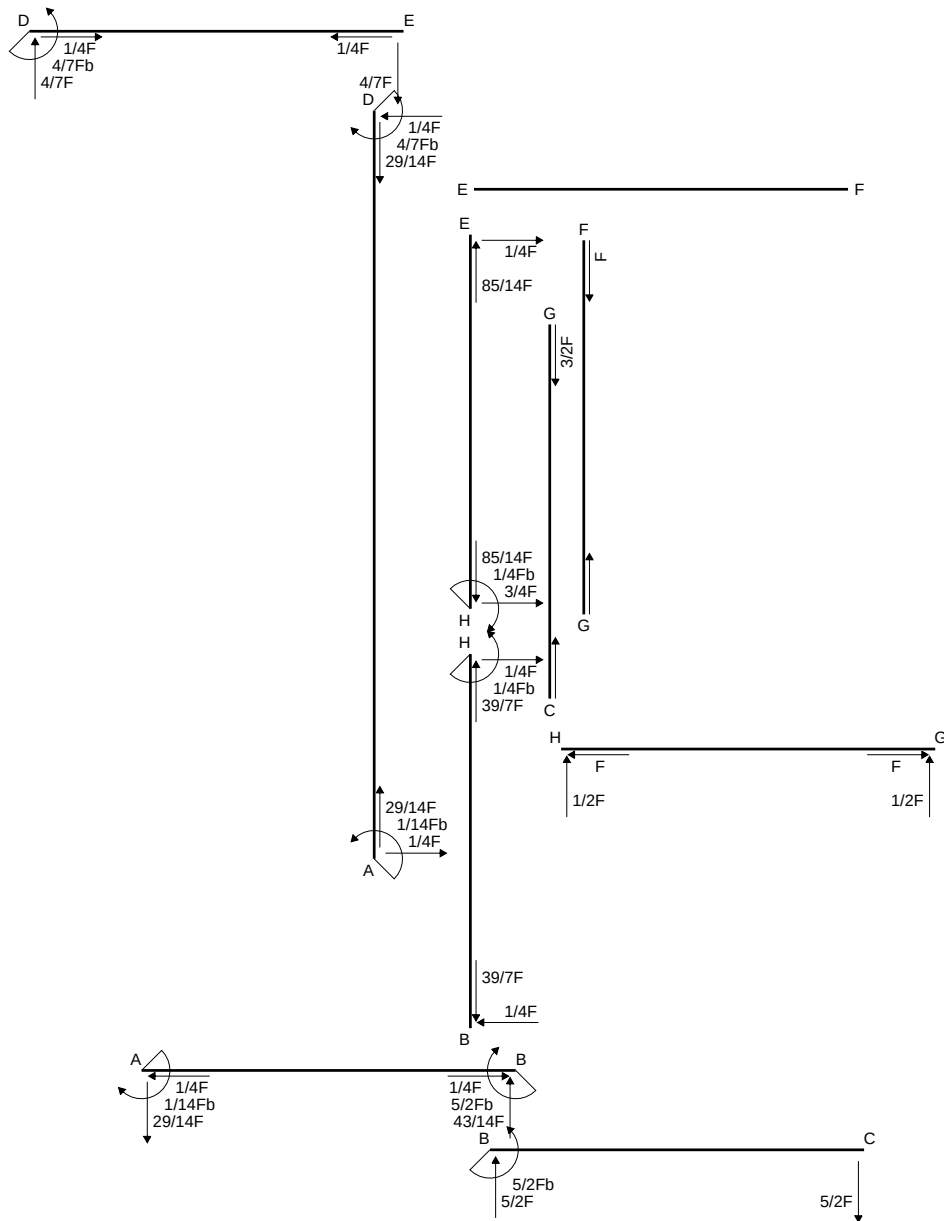
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-1/4Fx$	0	$-1/4Fx$	0	1	$(-1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb-1/4Fx$	0	$-1/2Fb+1/4Fx$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
BH b	0	$1/4Fx$	0	0	0	0		
HE b	0	$1/4Fb-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/10Fb$	

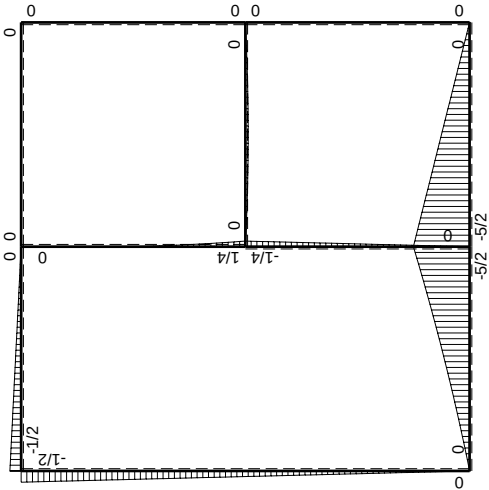
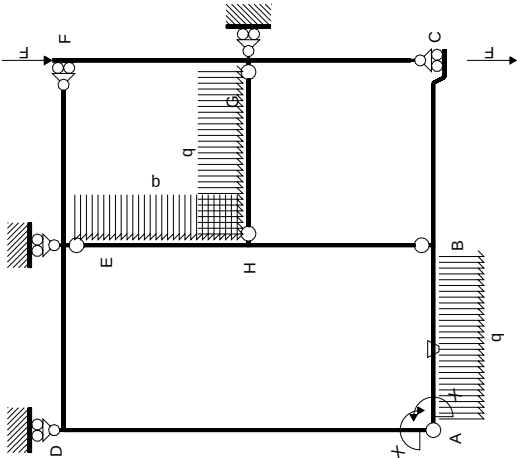
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 + 1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b + 1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



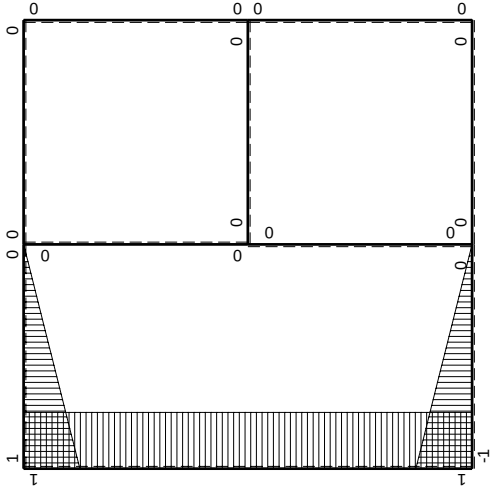
$$\begin{aligned}
A &= 1092. \text{ mm}^2 \\
J_u &= 318895. \text{ mm}^4 \\
J_v &= 112464. \text{ mm}^4 \\
y_g &= 32.8 \text{ mm} \\
T_y &= 3475. \text{ N} \\
M_x &= -2328250. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -32.8 \text{ mm} \\
\sigma_m &= -Mv/J_u = -239.4 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 11. \text{ mm} \\
v_c &= -21.8 \text{ mm} \\
\sigma_c &= -Mv/J_u = -159.1 \text{ N/mm}^2 \\
\tau_c &= 4.923 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 159.4 \text{ N/mm}^2 \\
S &= 5421. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



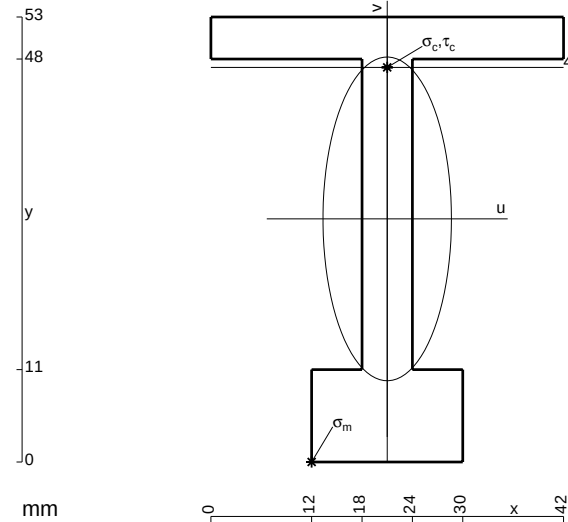
M_X flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

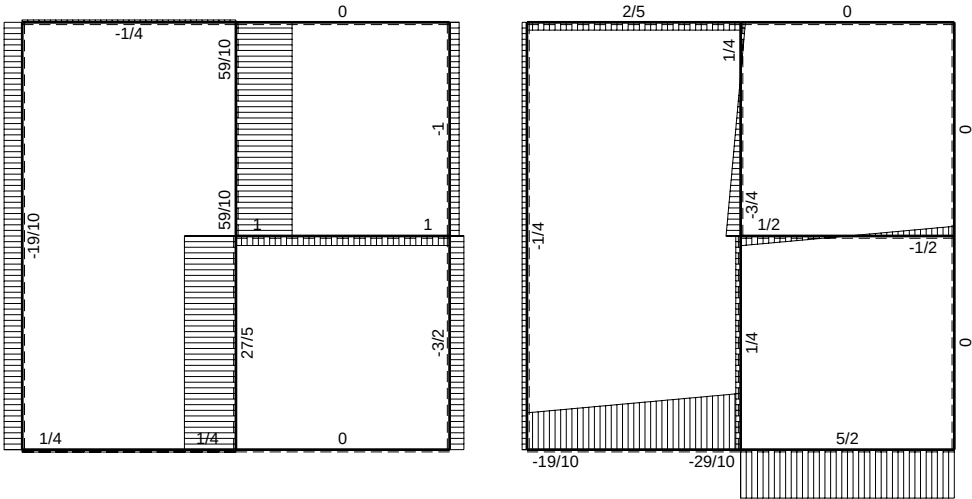
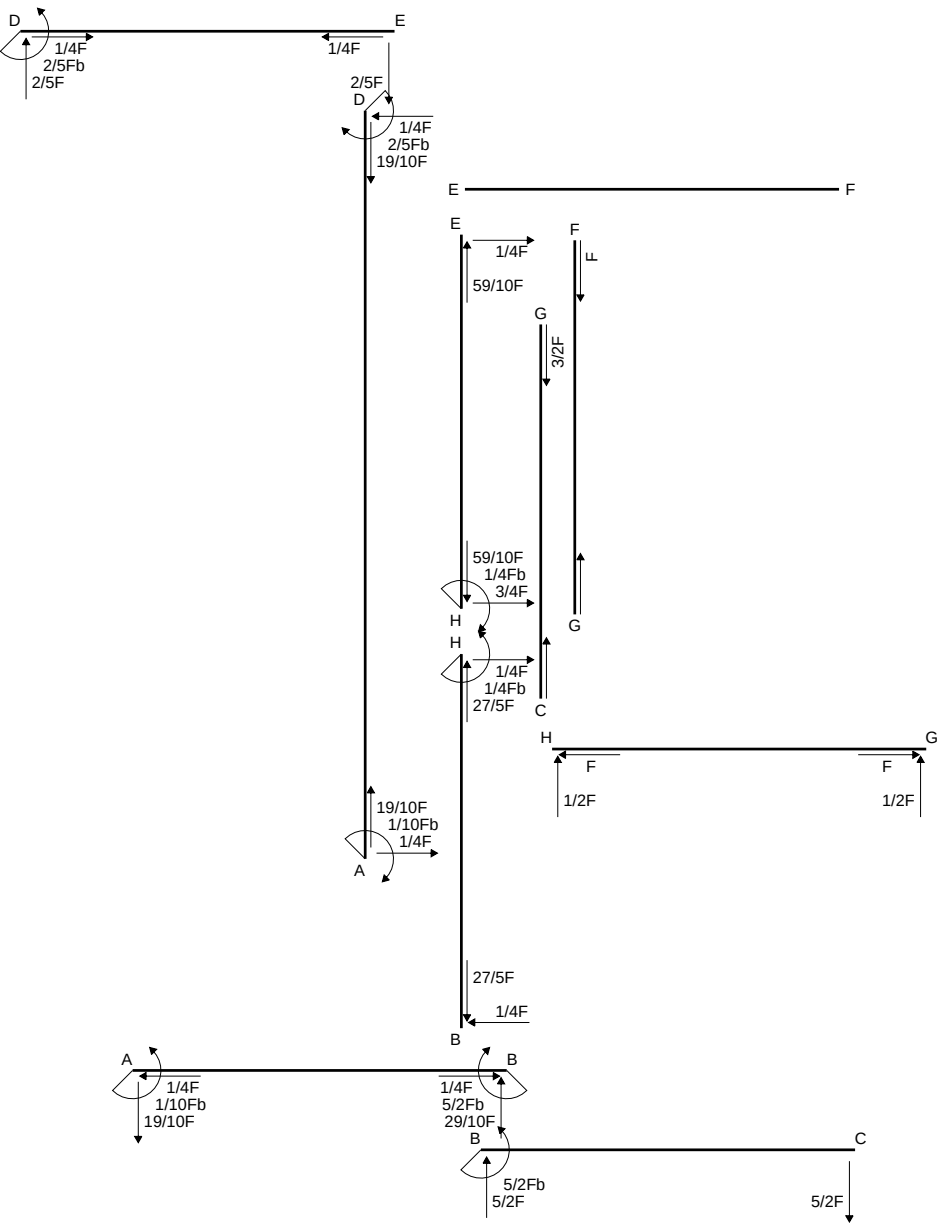
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int x M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	$-Fb/EJ$	$2Fx-3/2Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$	$(3/8+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	Fb/EJ	$5/2Fx-3Fx^2/b+1/2qx^3/b$	Fx/EJ	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-1/4Fx$	0	$-1/4Fx$	0	1	$(-1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb-1/4Fx$	0	$-1/2Fb+1/4Fx$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
BH b	0	$1/4Fx$	0	0	0	0		
HE b	0	$1/4Fb-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$5/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-1/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2xb - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + \int_0^b (1 - x/b) \theta dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + \left[x - 1/2 x^2/b \right]_0^b \theta + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + (b - 1/2 b) \theta + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 xb - 3x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + \int_0^b (-x/b) \theta dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + \left[-1/2 x^2/b \right]_0^b \theta + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + (-1/2 b) \theta + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 + 1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b + 1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

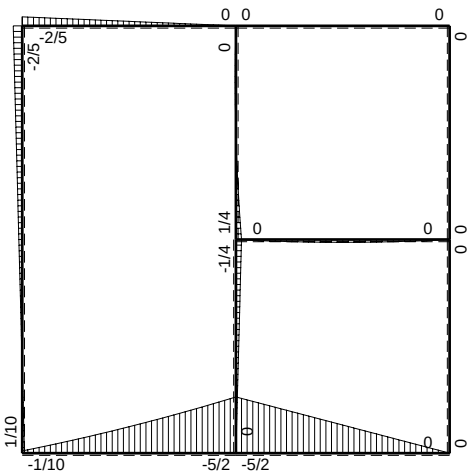


$$\begin{aligned}
A &= 630. \text{ mm}^2 \\
J_u &= 234233. \text{ mm}^4 \\
J_v &= 36882. \text{ mm}^4 \\
y_g &= 28.96 \text{ mm} \\
T_y &= 2225. \text{ N} \\
M_x &= -1602000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -28.96 \text{ mm} \\
\sigma_m &= -Mv/J_u = -198. \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 47. \text{ mm} \\
v_c &= 18.04 \text{ mm} \\
\sigma_c &= -Mv/J_u = 123.4 \text{ N/mm}^2 \\
\tau_c &= 7.338 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 124.1 \text{ N/mm}^2 \\
S &= 4635. \text{ mm}^3
\end{aligned}$$

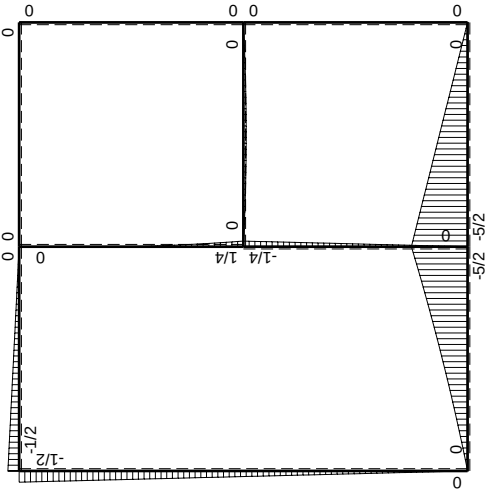
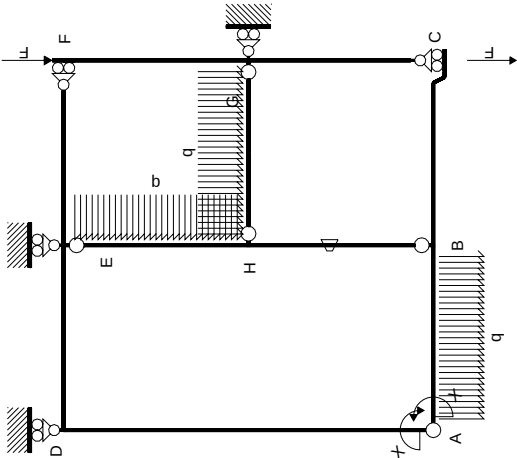


← ⊕ → F

↑ ⊕ ↓ F

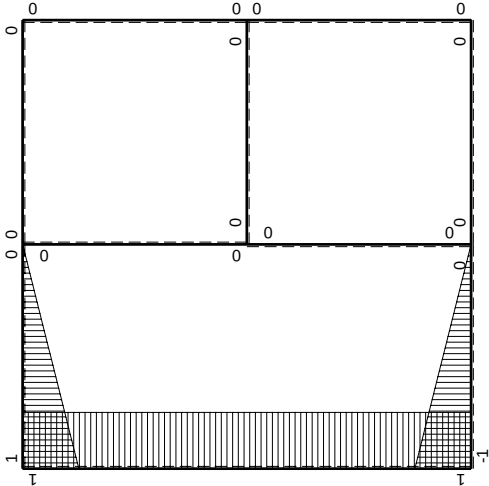


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



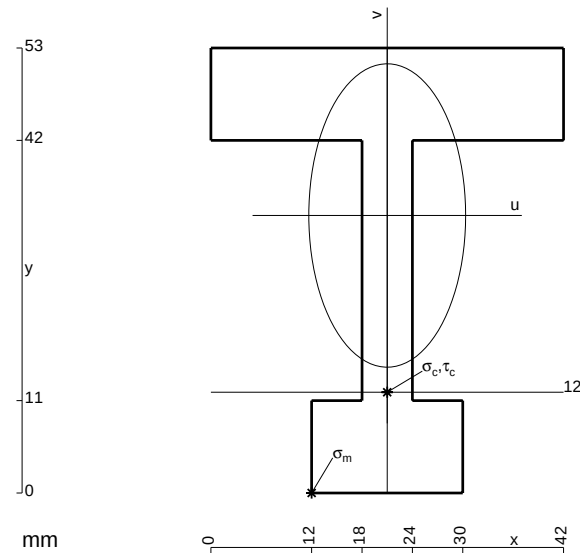
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

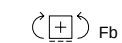
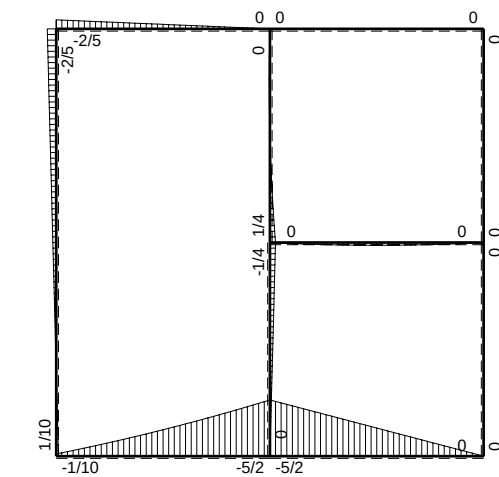
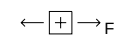
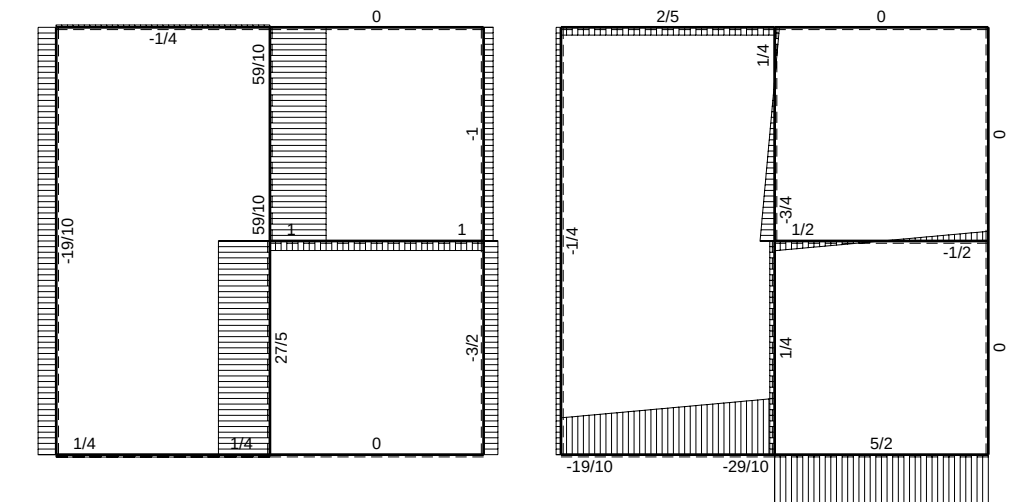
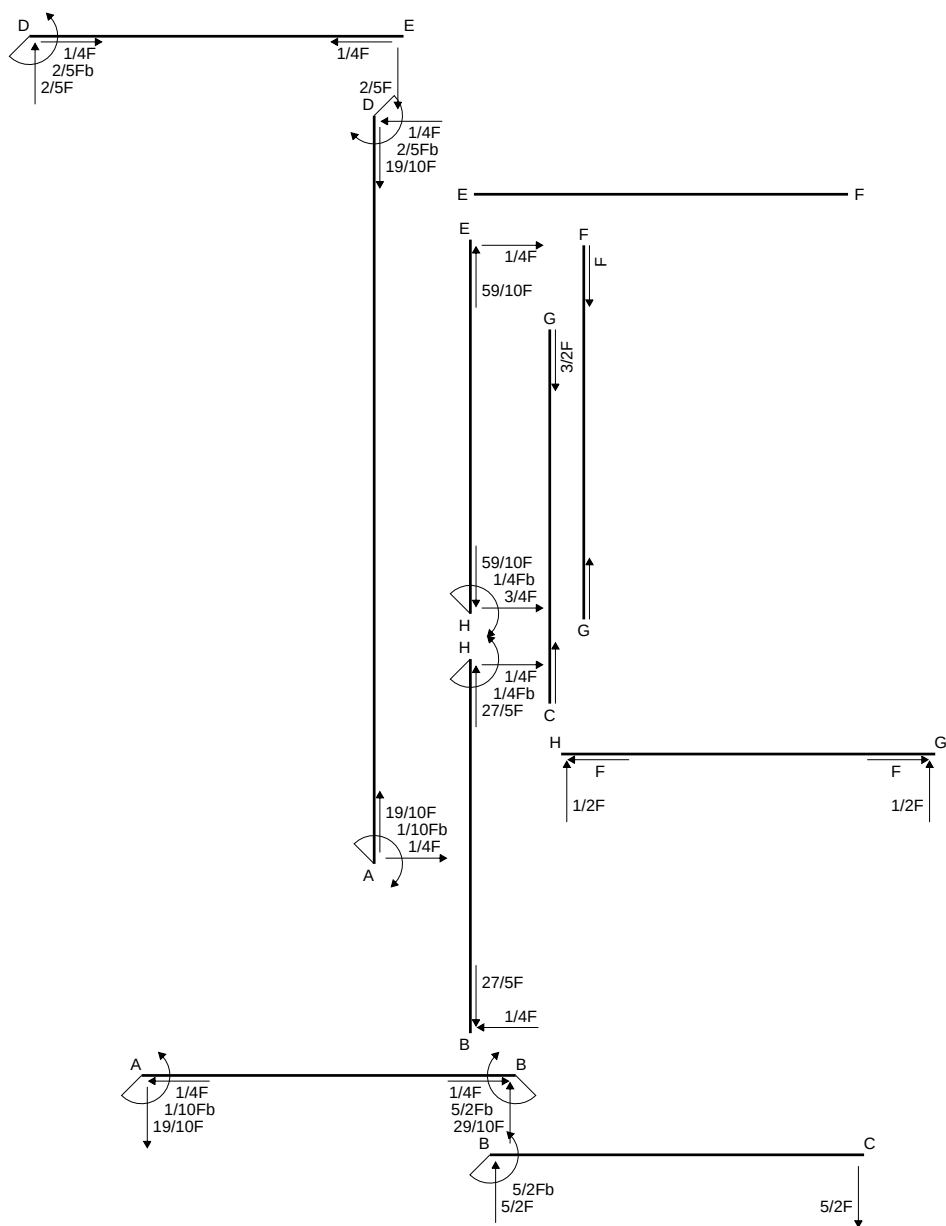
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-1/4Fx$	0	$-1/4Fx$	0	1	$(-1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb-1/4Fx$	0	$-1/2Fb+1/4Fx$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$1/4Fx$	Fb/EJ	0	0	0		
HE b	0	$1/4Fb-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						1/10Fb	

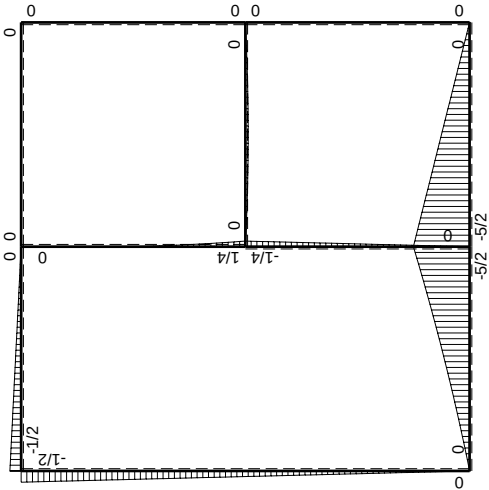
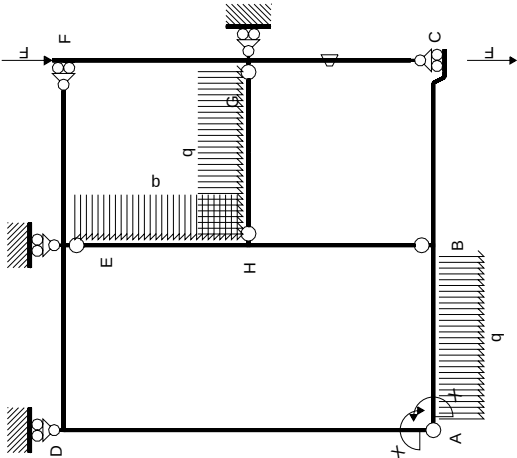
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 + 1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b + 1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



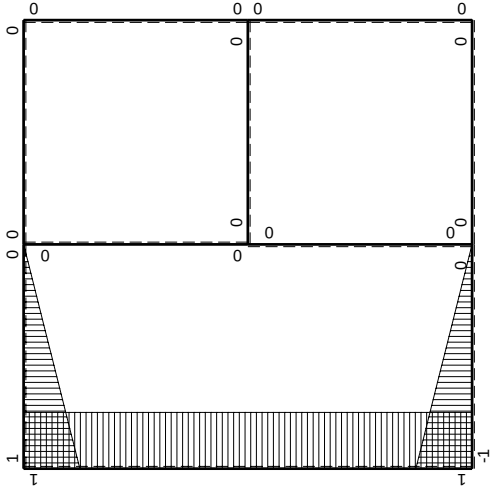
$$\begin{aligned}
A &= 846. \text{ mm}^2 \\
J_u &= 276280. \text{ mm}^4 \\
J_v &= 73818. \text{ mm}^4 \\
y_g &= 33.05 \text{ mm} \\
T_y &= 2300. \text{ N} \\
M_x &= -1748000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -33.05 \text{ mm} \\
\sigma_m &= -Mv/J_u = -209.1 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 12. \text{ mm} \\
v_c &= -21.05 \text{ mm} \\
\sigma_c &= -Mv/J_u = -133.2 \text{ N/mm}^2 \\
\tau_c &= 7.749 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 133.9 \text{ N/mm}^2 \\
S &= 5585. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



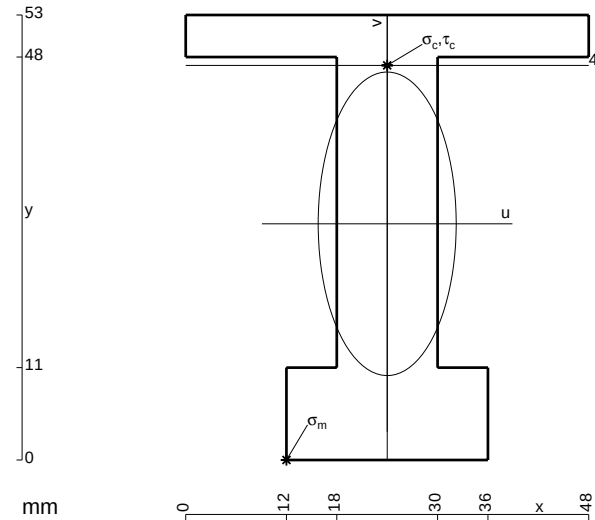
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

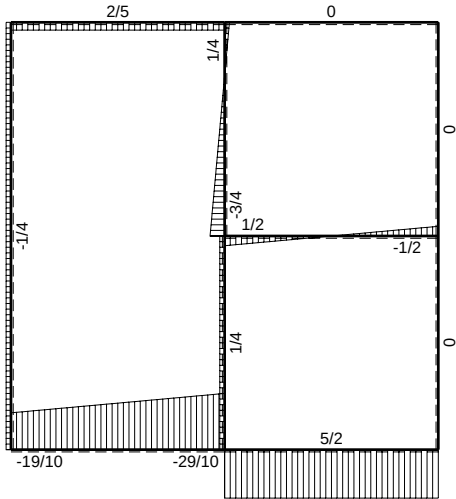
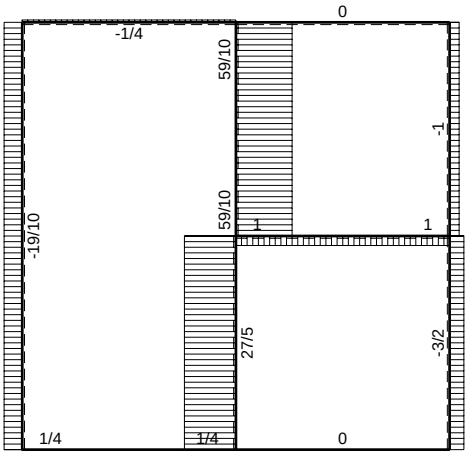
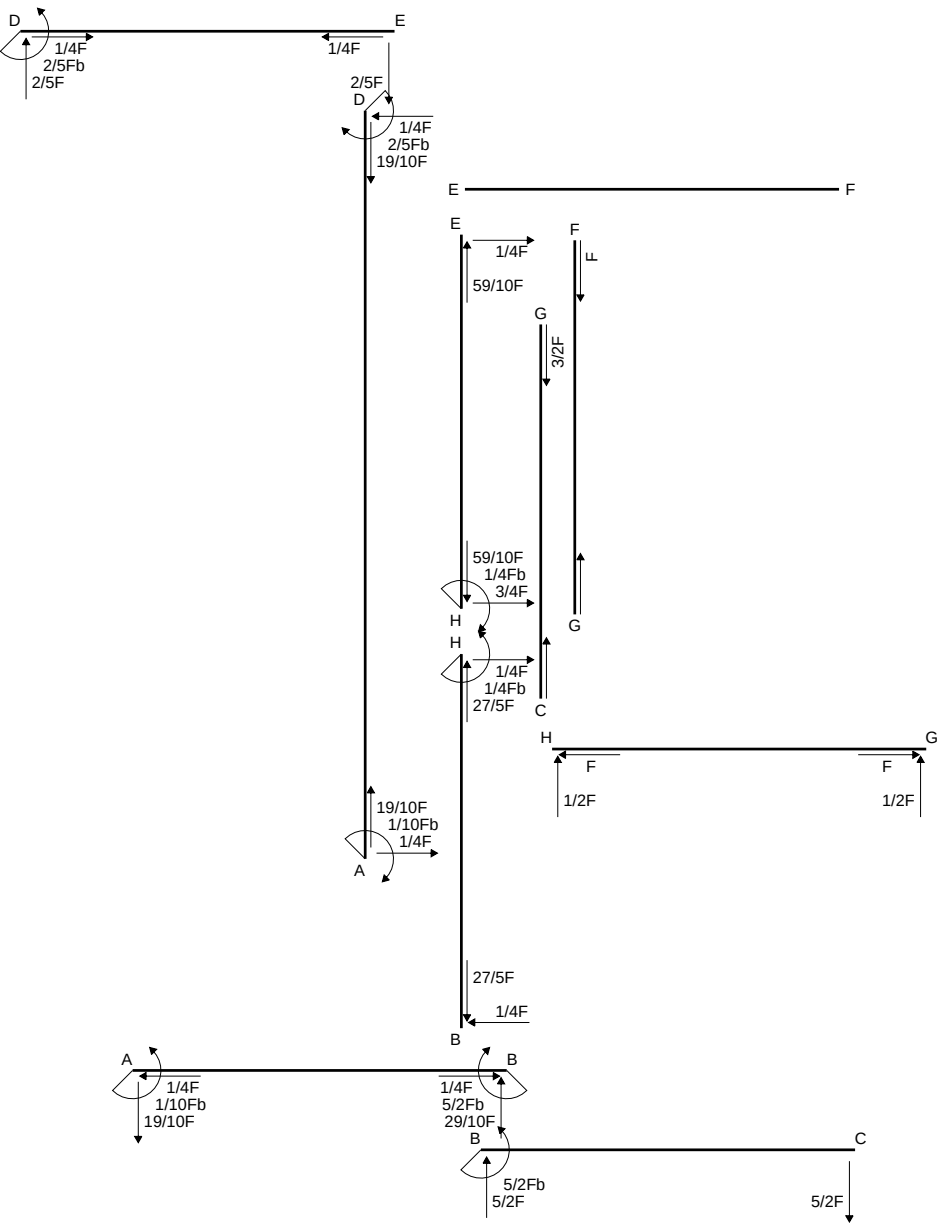
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-1/4Fx$	0	$-1/4Fx$	0	1	$(-1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb-1/4Fx$	0	$-1/2Fb+1/4Fx$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
BH b	0	$1/4Fx$	0	0	0	0		
HE b	0	$1/4Fb-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 + 1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b + 1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

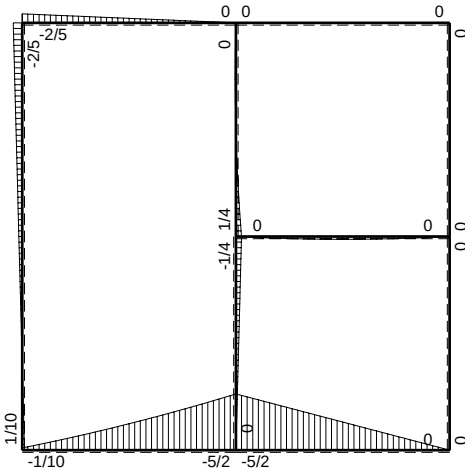


$$\begin{aligned}
A &= 948. \text{ mm}^2 \\
J_u &= 309947. \text{ mm}^4 \\
J_v &= 64080. \text{ mm}^4 \\
y_g &= 28.13 \text{ mm} \\
T_y &= 2975. \text{ N} \\
M_x &= -2409750. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -28.13 \text{ mm} \\
\sigma_m &= -Mv/J_u = -218.7 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 47. \text{ mm} \\
v_c &= 18.87 \text{ mm} \\
\sigma_c &= -Mv/J_u = 146.7 \text{ N/mm}^2 \\
\tau_c &= 4.48 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 146.9 \text{ N/mm}^2 \\
S &= 5601. \text{ mm}^3
\end{aligned}$$

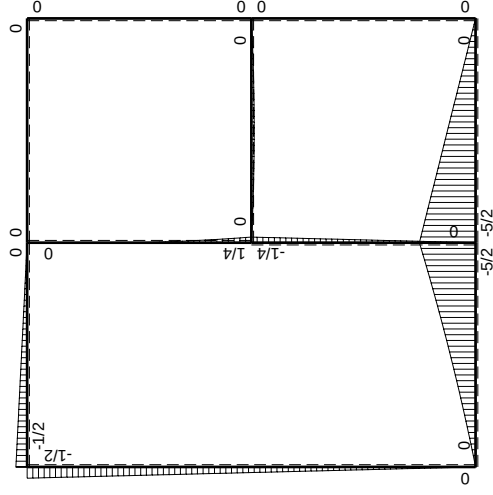
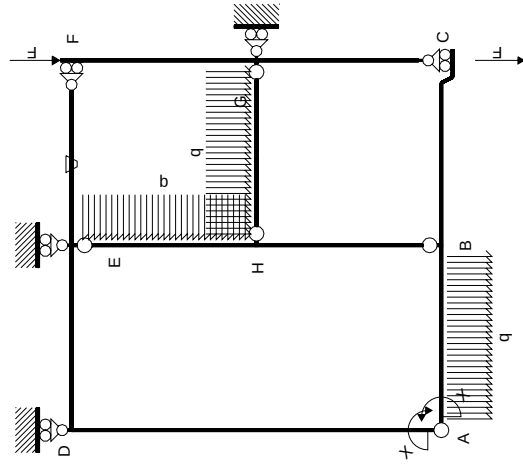


← ⊕ → F

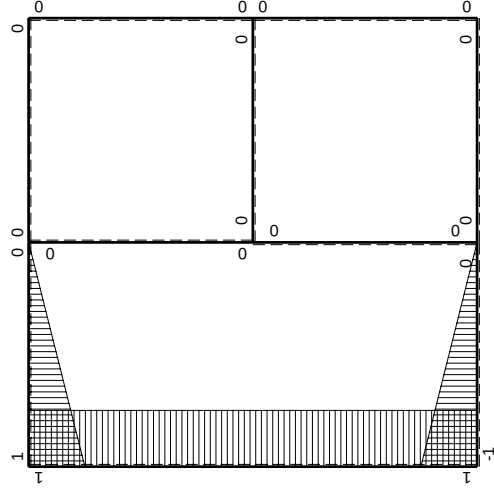
↑ ⊕ ↓ F



⊕ ⊖ F_b



Schema di calcolo iperstatico



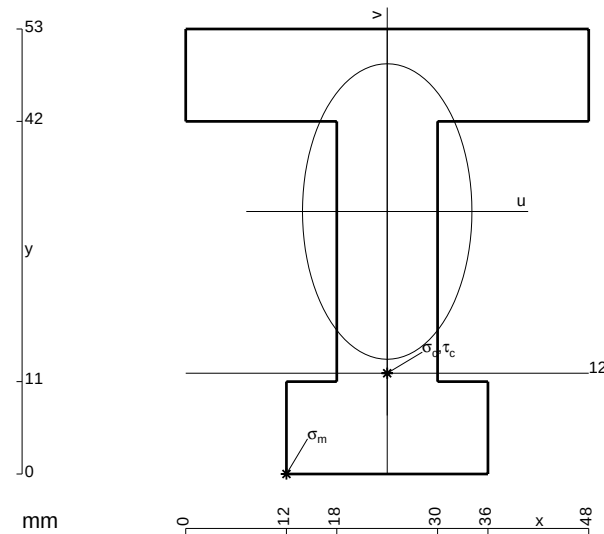
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

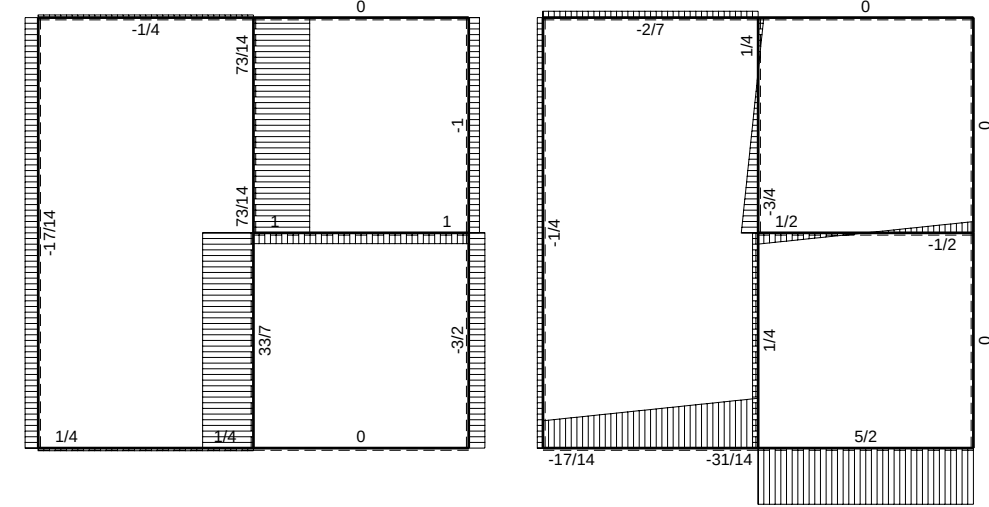
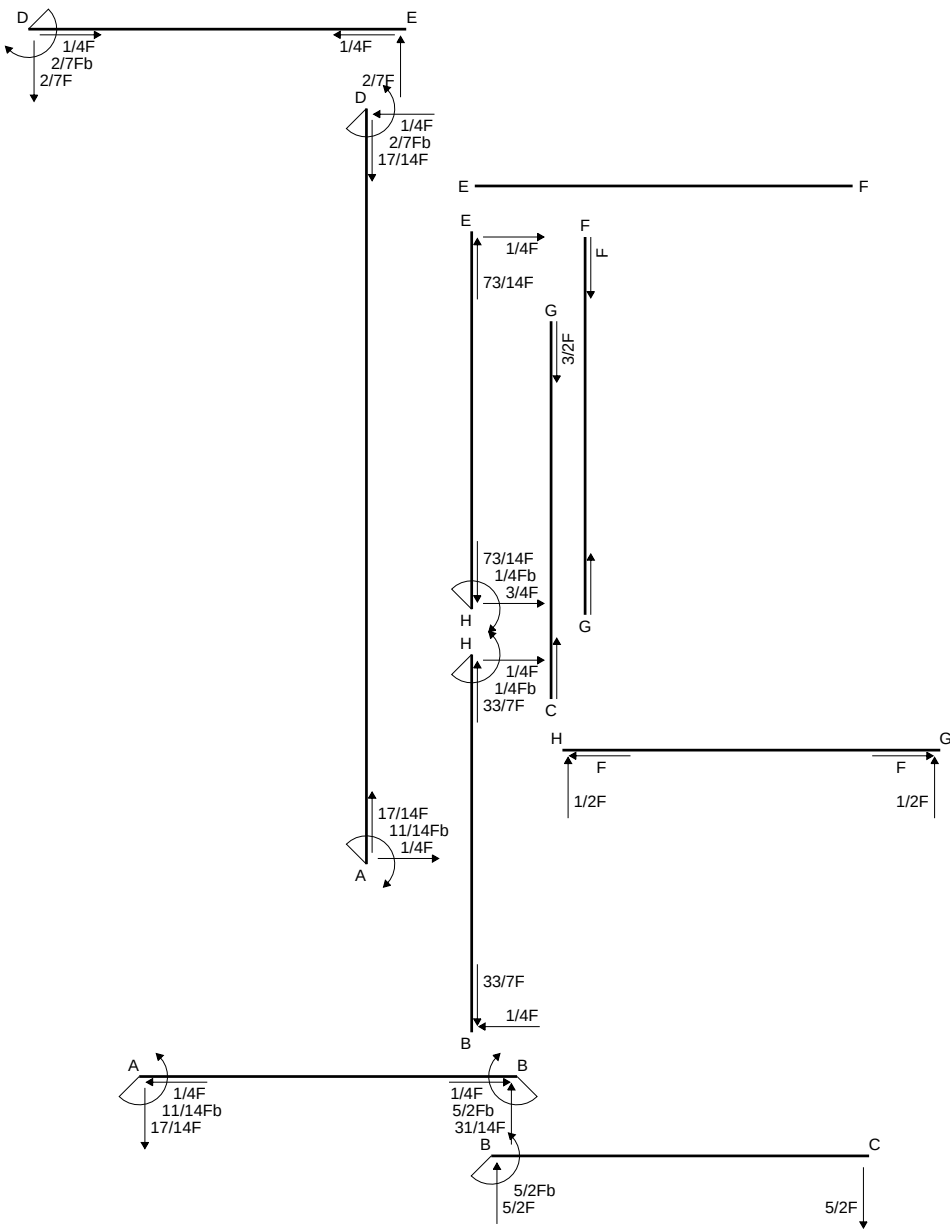
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-1/4Fx$	0	$-1/4Fx$	0	1	$(-1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb-1/4Fx$	0	$-1/2Fb+1/4Fx$	0	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
BH b	0	$1/4Fx$	0	0	0	0		
HE b	0	$1/4Fb-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-7/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$1/10Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 + 1/4 x/b) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b + 1/2 b) Fb \frac{1}{EJ} = -1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

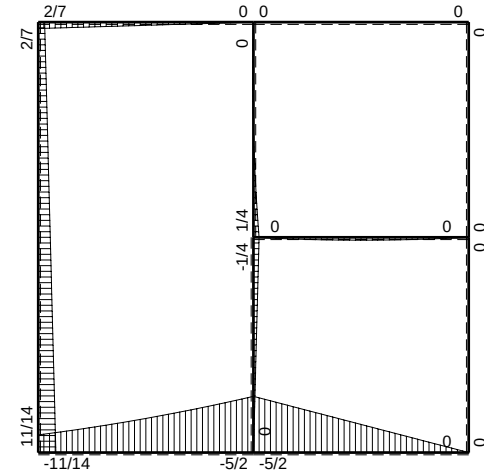


$$\begin{aligned}
A &= 1164. \text{ mm}^2 \\
J_u &= 360644. \text{ mm}^4 \\
J_v &= 118512. \text{ mm}^4 \\
y_g &= 31.26 \text{ mm} \\
T_y &= 3075. \text{ N} \\
M_x &= -2644500. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -31.26 \text{ mm} \\
\sigma_m &= -Mv/J_u = -229.2 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 12. \text{ mm} \\
v_c &= -19.26 \text{ mm} \\
\sigma_c &= -Mv/J_u = -141.2 \text{ N/mm}^2 \\
\tau_c &= 5.001 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 141.5 \text{ N/mm}^2 \\
S &= 7039. \text{ mm}^3
\end{aligned}$$

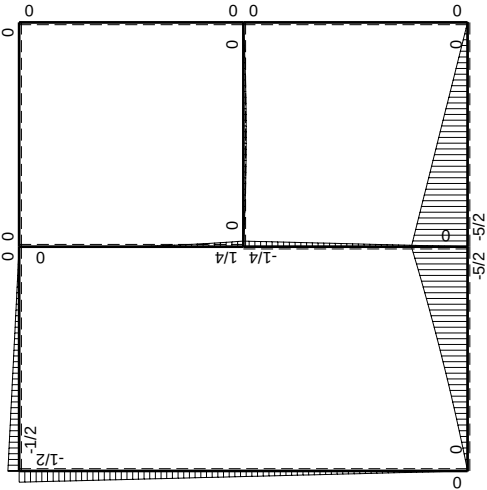
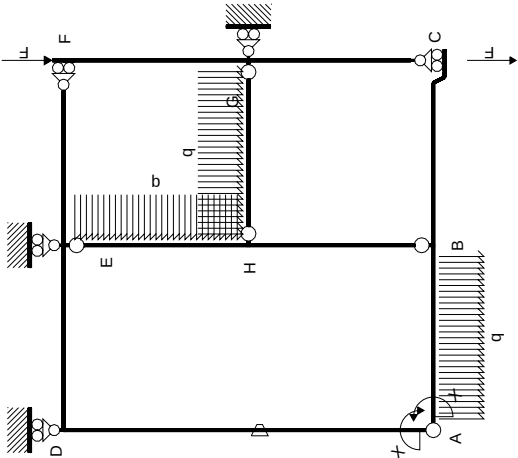


← ⊕ → F

↑ ⊕ ↓ F

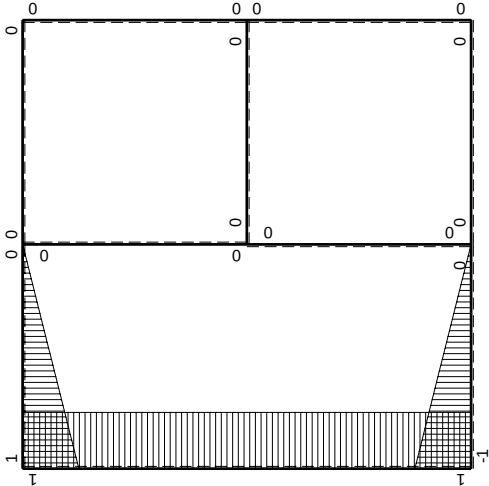


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



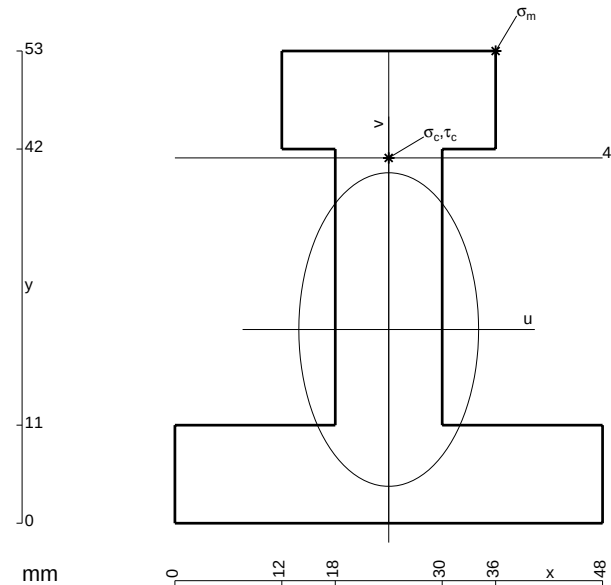
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

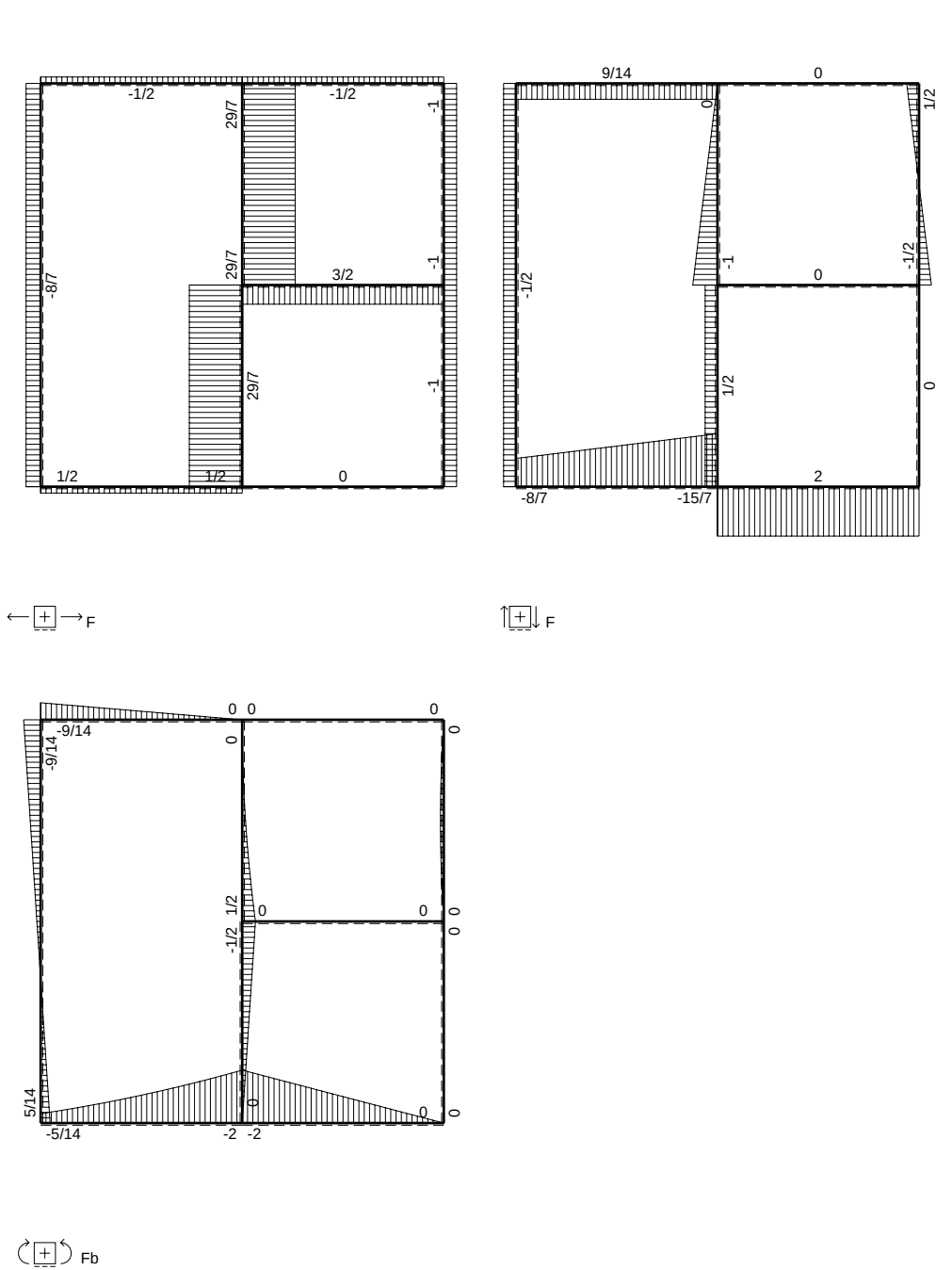
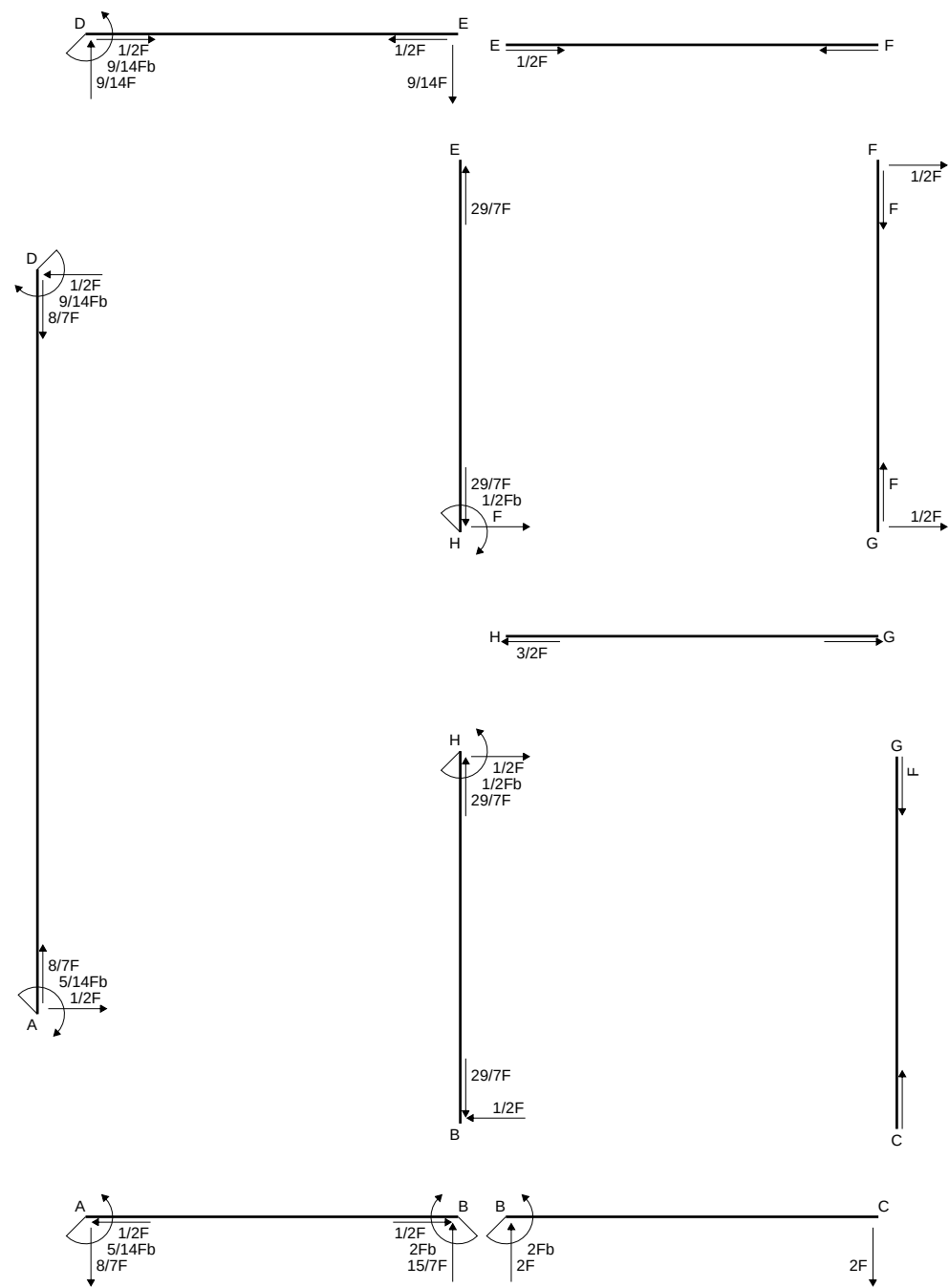
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$-1/4Fx$	$-Fb/EJ$	$-1/4Fx$	$-Fb/EJ$	1	$(-1/2-2)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$1/2Fb-1/4Fx$	Fb/EJ	$-1/2Fb+1/4Fx$	$-Fb/EJ$	1		
DE b	$1-x/b$	$-1/2Fb+1/2Fx$	0	$-1/2Fb+Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$1/2Fx$	0	$-1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
BH b	0	$1/4Fx$	0	0	0	0		
HE b	0	$1/4Fb-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$1/4Fx-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-55/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$11/14Fb$	

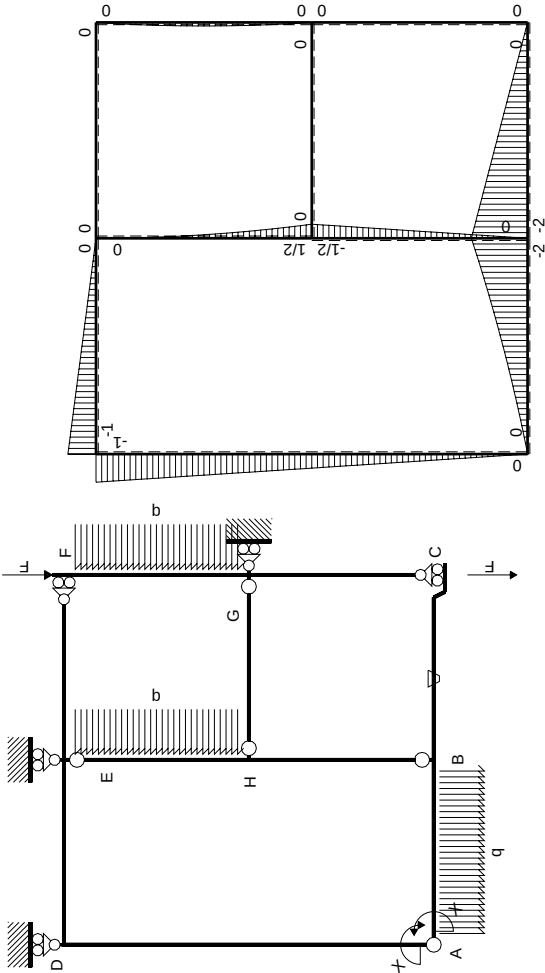
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/4 x/b) Fb \frac{1}{EJ} dx + \int_0^{2b} (-1) \theta dx = \left[-1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} + \left[-x \right]_0^{2b} \theta \\
&= (-1/2 b) Fb \frac{1}{EJ} + (-2b) \theta = -5/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1/2 + 1/4 x/b) Fb \frac{1}{EJ} dx + \int_0^{2b} (1) \theta dx = \left[-1/2 x + 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} + \left[x \right]_0^{2b} \theta \\
&= (-b + 1/2 b) Fb \frac{1}{EJ} + (2b) \theta = -5/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/2 b + 1/2 b - 1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/6 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



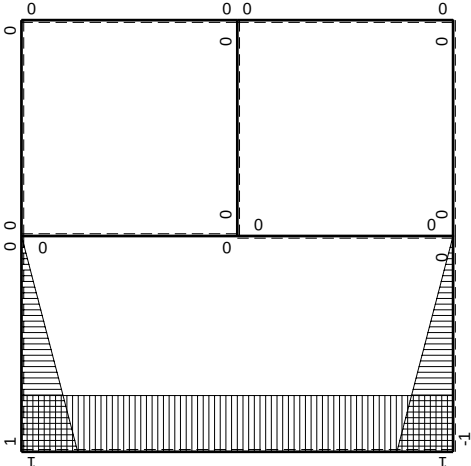
$$\begin{aligned}
A &= 1164. \text{ mm}^2 \\
J_u &= 360644. \text{ mm}^4 \\
J_v &= 118512. \text{ mm}^4 \\
y_g &= 21.74 \text{ mm} \\
T_y &= 3025. \text{ N} \\
M_x &= -2752750. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 31.26 \text{ mm} \\
\sigma_m &= -Mv/J_u = 238.6 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 41. \text{ mm} \\
v_c &= 19.26 \text{ mm} \\
\sigma_c &= -Mv/J_u = 147. \text{ N/mm}^2 \\
\tau_c &= 4.92 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 147.3 \text{ N/mm}^2 \\
S &= 7039. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



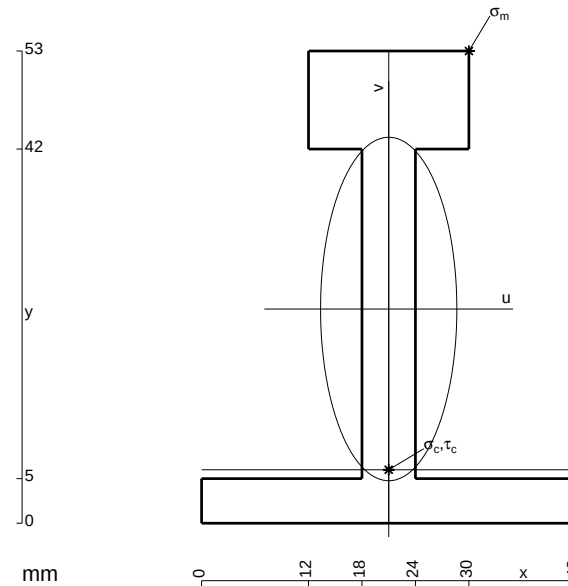
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

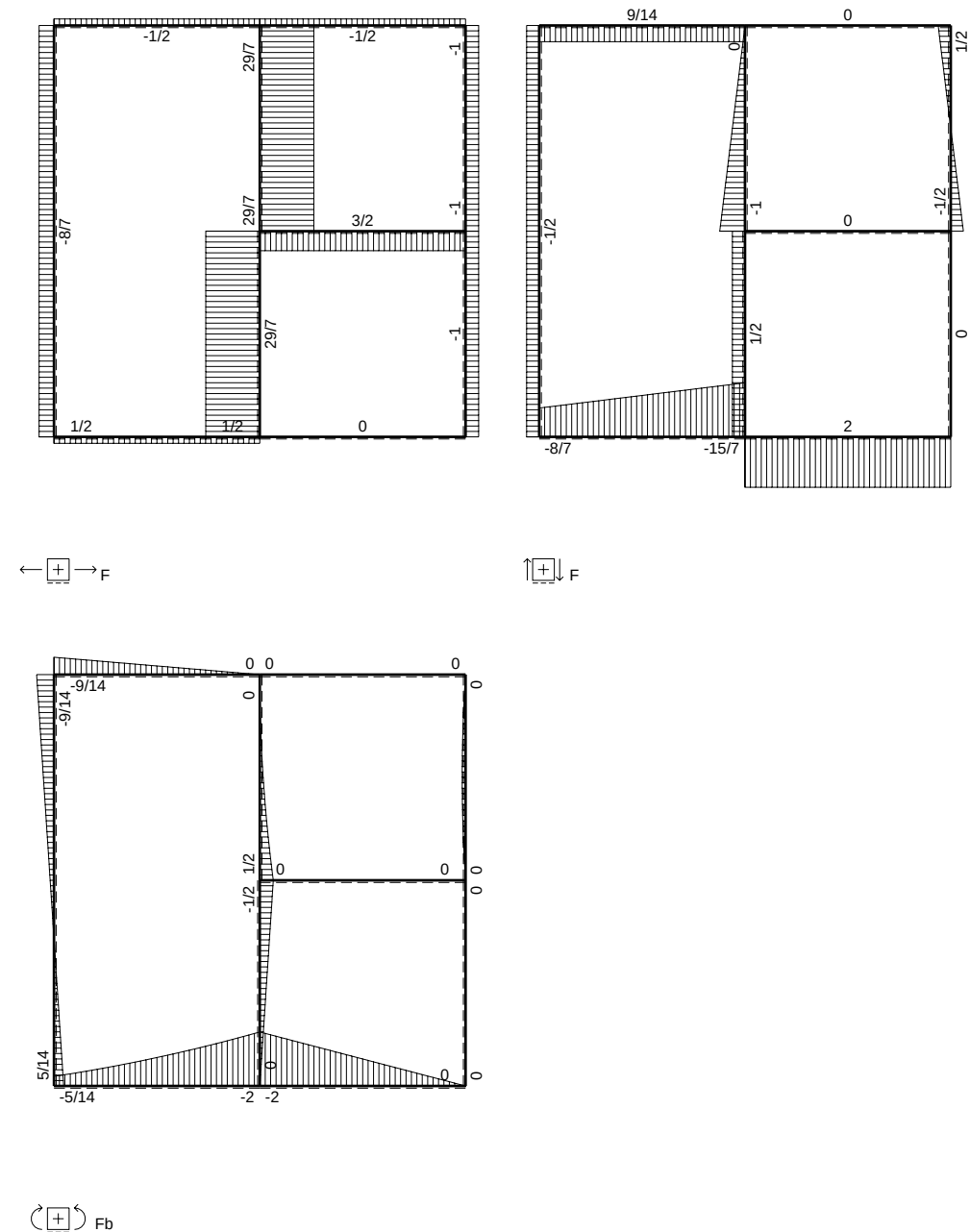
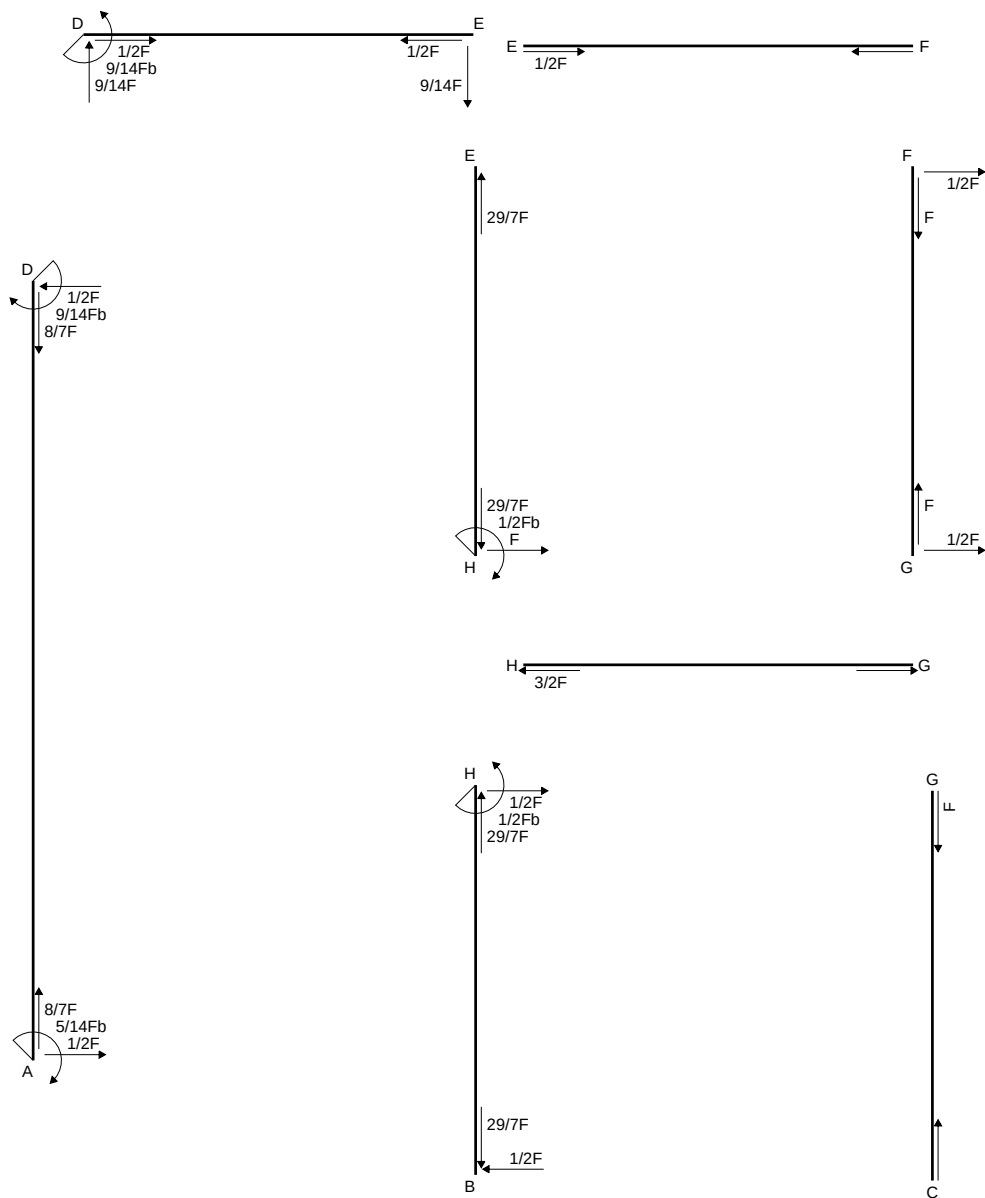
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$-1/2Fx$	0	$-1/2Fx$	0	1	$(-1+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fb-1/2Fx$	0	$-Fb+1/2Fx$	0	1		
DE b	$1-x/b$	$-Fb+Fx$	0	$-Fb+2Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	Fx	0	$-Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BH b	0	$1/2Fx$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

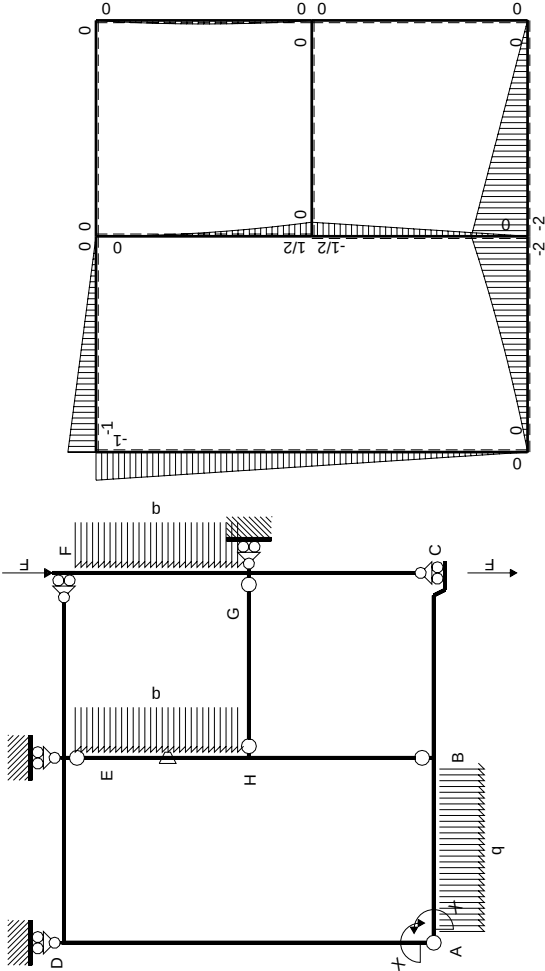
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{xo} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{xo} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{xo} &= \int_0^{2b} (-1/2 x/b) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b) Fb \frac{1}{EJ} = - \frac{Fb^2}{EJ} \\
L_{DA}^{xo} &= \int_0^{2b} (-1 + 1/2 x/b) Fb \frac{1}{EJ} dx = \left[-x + 1/4 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-2b + b) Fb \frac{1}{EJ} = - \frac{Fb^2}{EJ} \\
L_{DE}^{xo} &= \int_0^b (-1 + 2x/b - x^2/b^2) Fb \frac{1}{EJ} dx = \left[-x + x^2/b - 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-b + b - 1/3 b) Fb \frac{1}{EJ} = -1/3 \frac{Fb^2}{EJ} \\
L_{ED}^{xo} &= \int_0^b (-x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/3 b) Fb \frac{1}{EJ} = -1/3 \frac{Fb^2}{EJ}
\end{aligned}$$



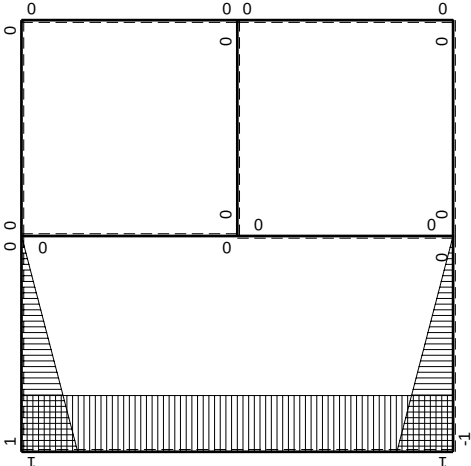
$$\begin{aligned}
A &= 630. \text{ mm}^2 \\
J_u &= 234233. \text{ mm}^4 \\
J_v &= 36882. \text{ mm}^4 \\
y_g &= 24.04 \text{ mm} \\
T_y &= 3360. \text{ N} \\
M_x &= -1612800. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 28.96 \text{ mm} \\
\sigma_m &= -Mv/J_u = 199.4 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 6. \text{ mm} \\
v_c &= -18.04 \text{ mm} \\
\sigma_c &= -Mv/J_u = -124.2 \text{ N/mm}^2 \\
\tau_c &= 11.08 \text{ N/mm}^2 \\
\sigma_o &= \sqrt{\sigma^2 + 3\tau^2} = 125.7 \text{ N/mm}^2 \\
S &= 4635. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati

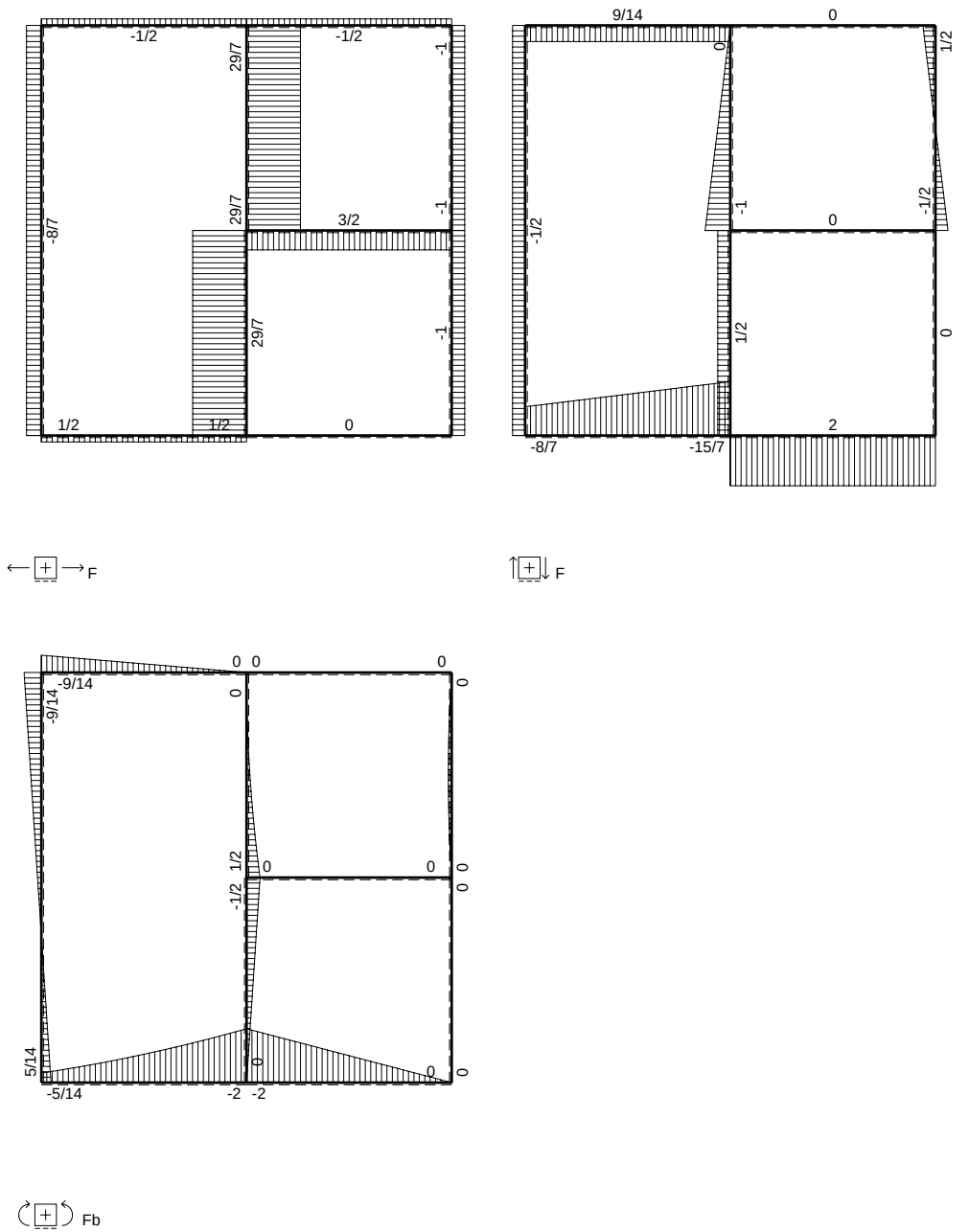
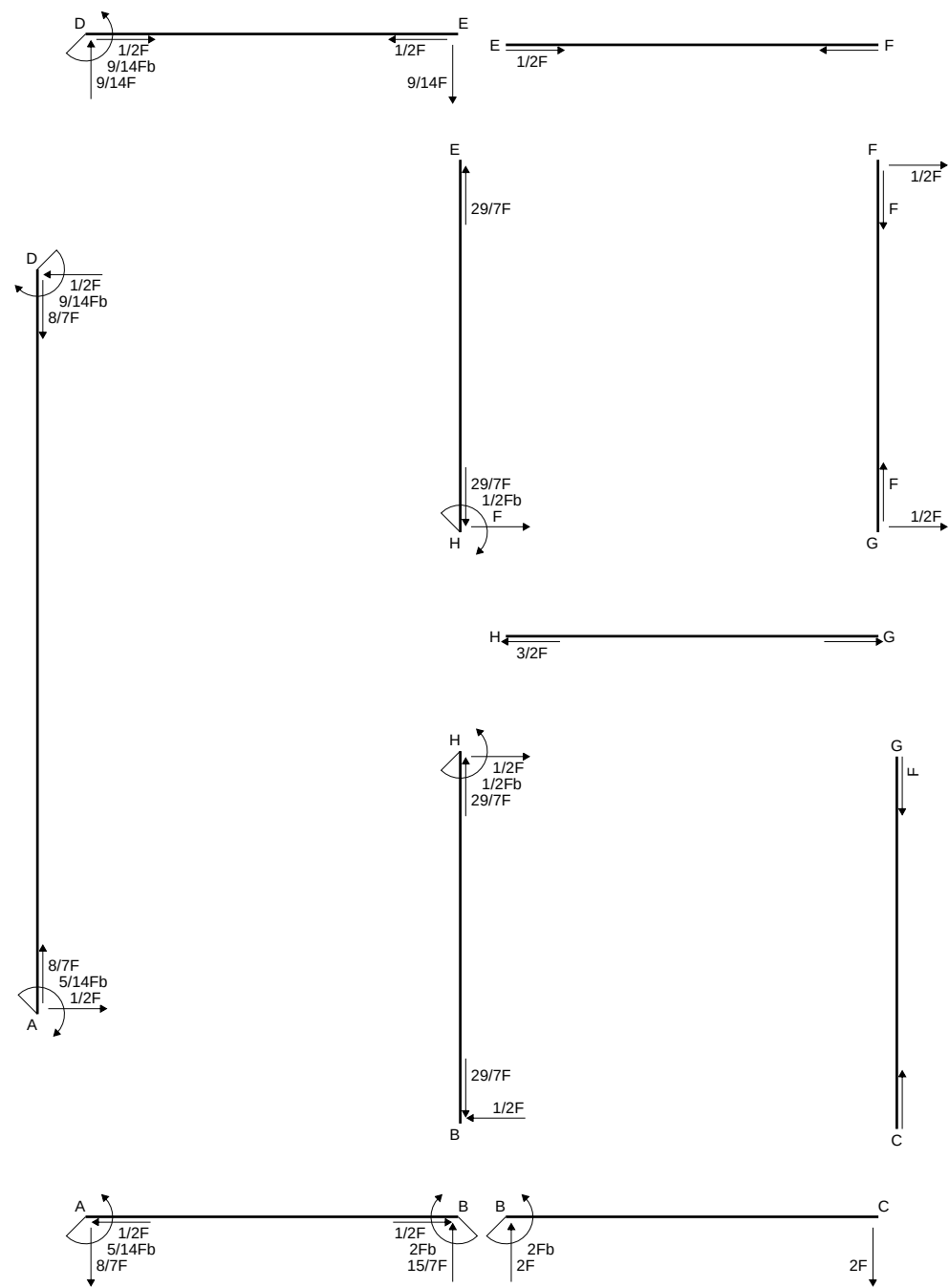


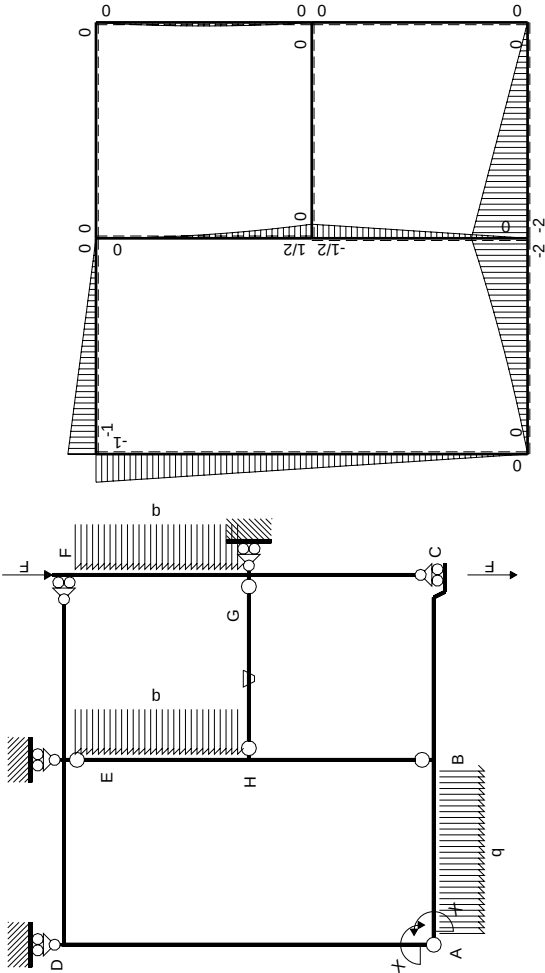
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-1/2Fx$	0	$-1/2Fx$	0	1	$(-1+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fb-1/2Fx$	0	$-Fb+1/2Fx$	0	1		
DE b	$1-x/b$	$-Fb+Fx$	0	$-Fb+2Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	Fx	0	$-Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BH b	0	$1/2Fx$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

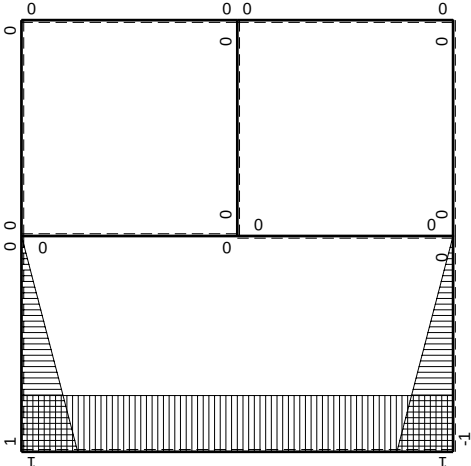
Sviluppi di calcolo iperstatica





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



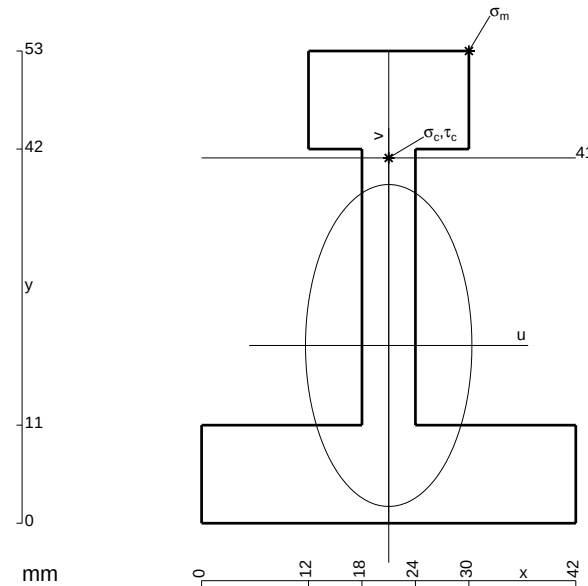
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

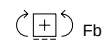
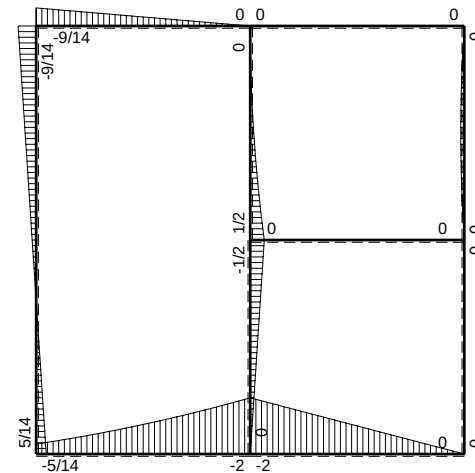
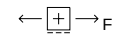
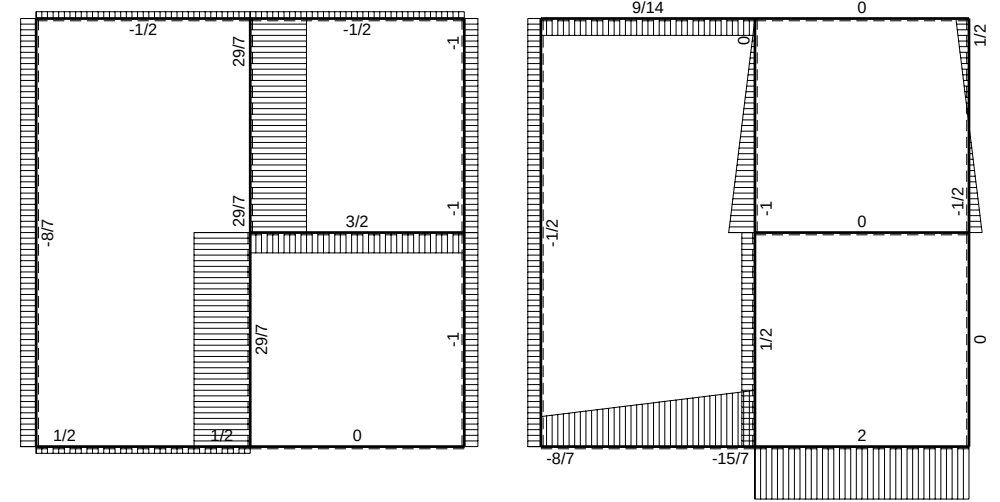
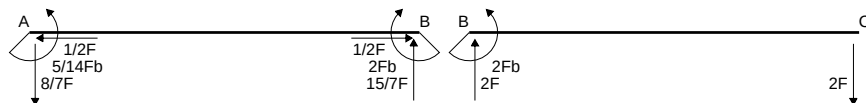
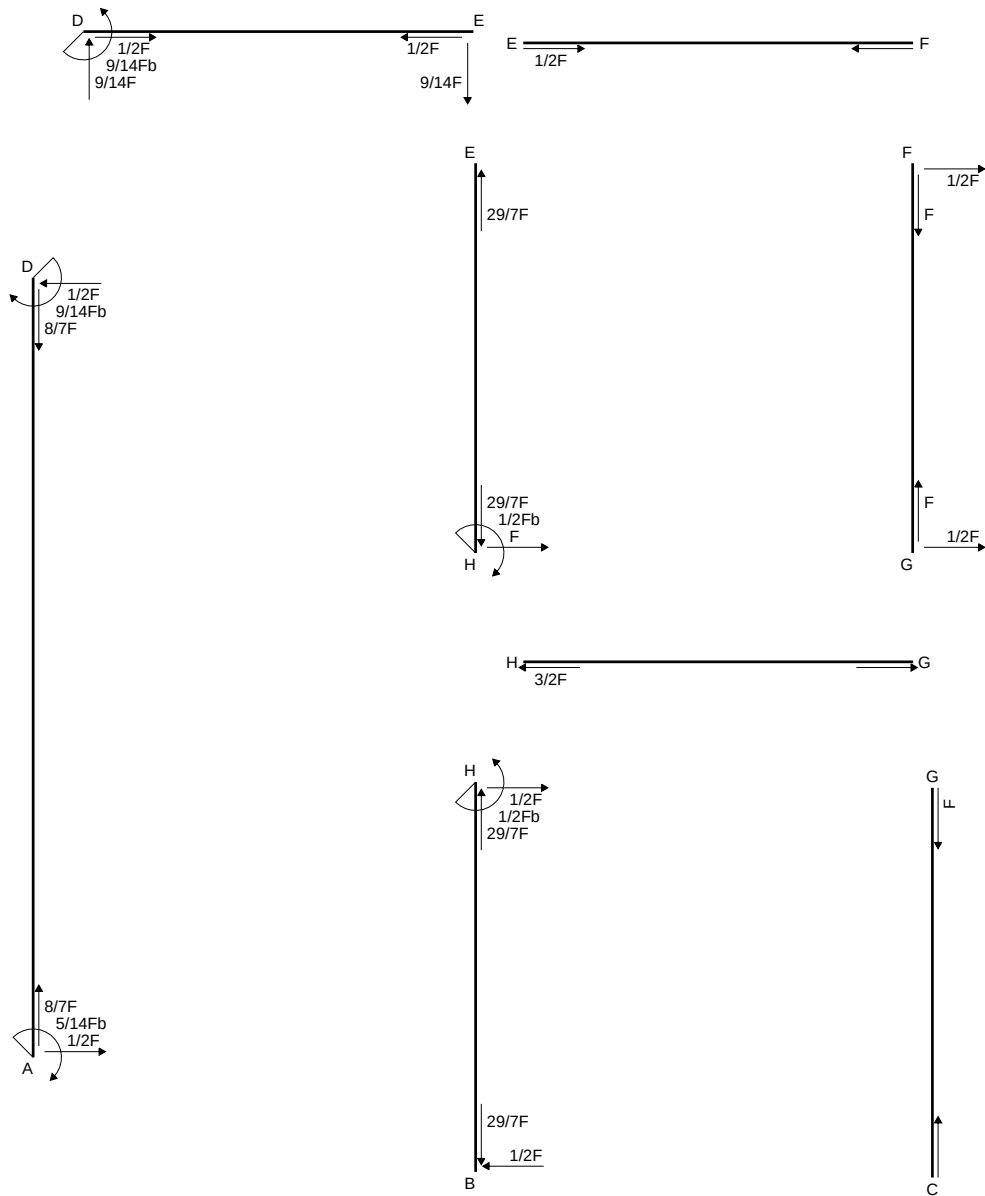
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-1/2Fx$	0	$-1/2Fx$	0	1	$(-1+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fb-1/2Fx$	0	$-Fb+1/2Fx$	0	1		
DE b	$1-x/b$	$-Fb+Fx$	0	$-Fb+2Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	Fx	0	$-Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	0	Fb/EJ	0	0	0		
HB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BH b	0	$1/2Fx$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

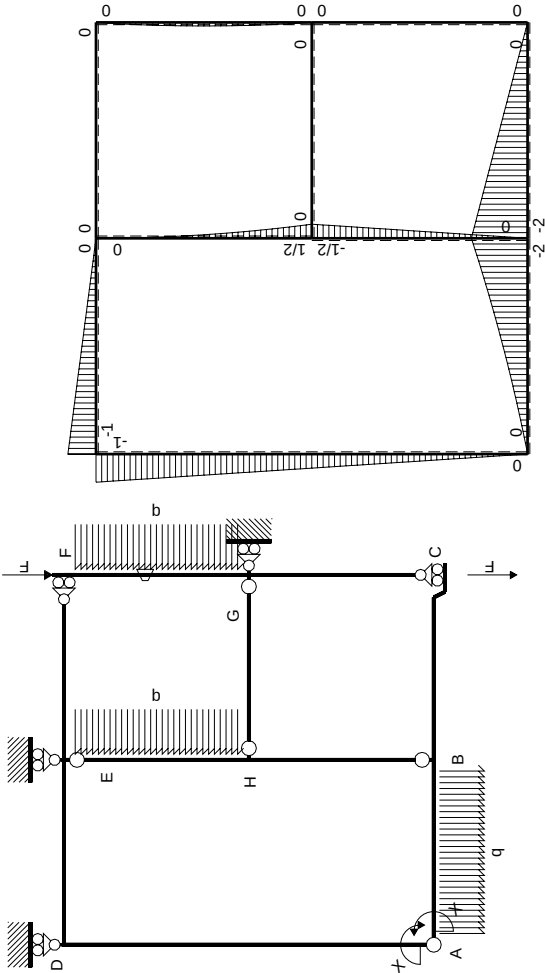
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/2 x/b) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b) Fb \frac{1}{EJ} = - \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1 + 1/2 x/b) Fb \frac{1}{EJ} dx = \left[-x + 1/4 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-2b + b) Fb \frac{1}{EJ} = - \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1 + 2x/b - x^2/b^2) Fb \frac{1}{EJ} dx = \left[-x + x^2/b - 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-b + b - 1/3 b) Fb \frac{1}{EJ} = -1/3 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/3 b) Fb \frac{1}{EJ} = -1/3 \frac{Fb^2}{EJ}
\end{aligned}$$



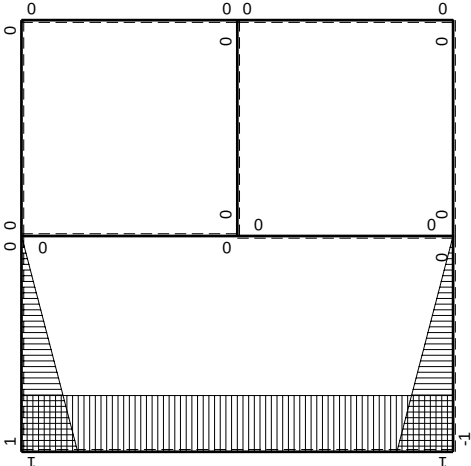
$$\begin{aligned}
A &= 846. \text{ mm}^2 \\
J_u &= 276280. \text{ mm}^4 \\
J_v &= 73818. \text{ mm}^4 \\
y_g &= 19.95 \text{ mm} \\
T_y &= 3220. \text{ N} \\
M_x &= -1835400. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 33.05 \text{ mm} \\
\sigma_m &= -Mv/J_u = 219.6 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 41. \text{ mm} \\
v_c &= 21.05 \text{ mm} \\
\sigma_c &= -Mv/J_u = 139.9 \text{ N/mm}^2 \\
\tau_c &= 10.85 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 141.1 \text{ N/mm}^2 \\
S &= 5585. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



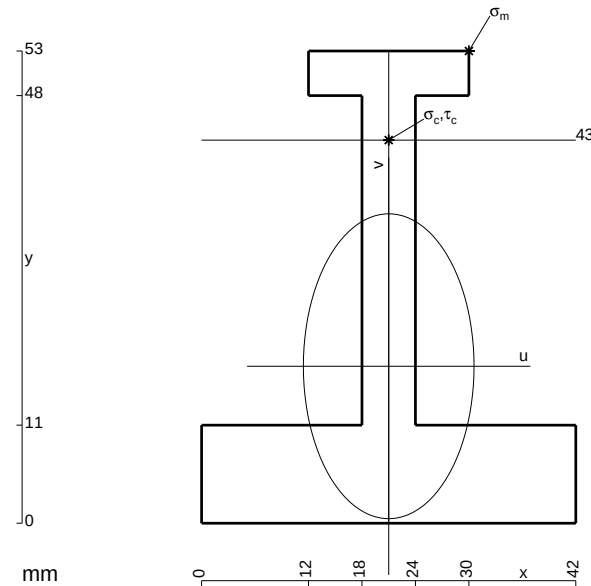
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

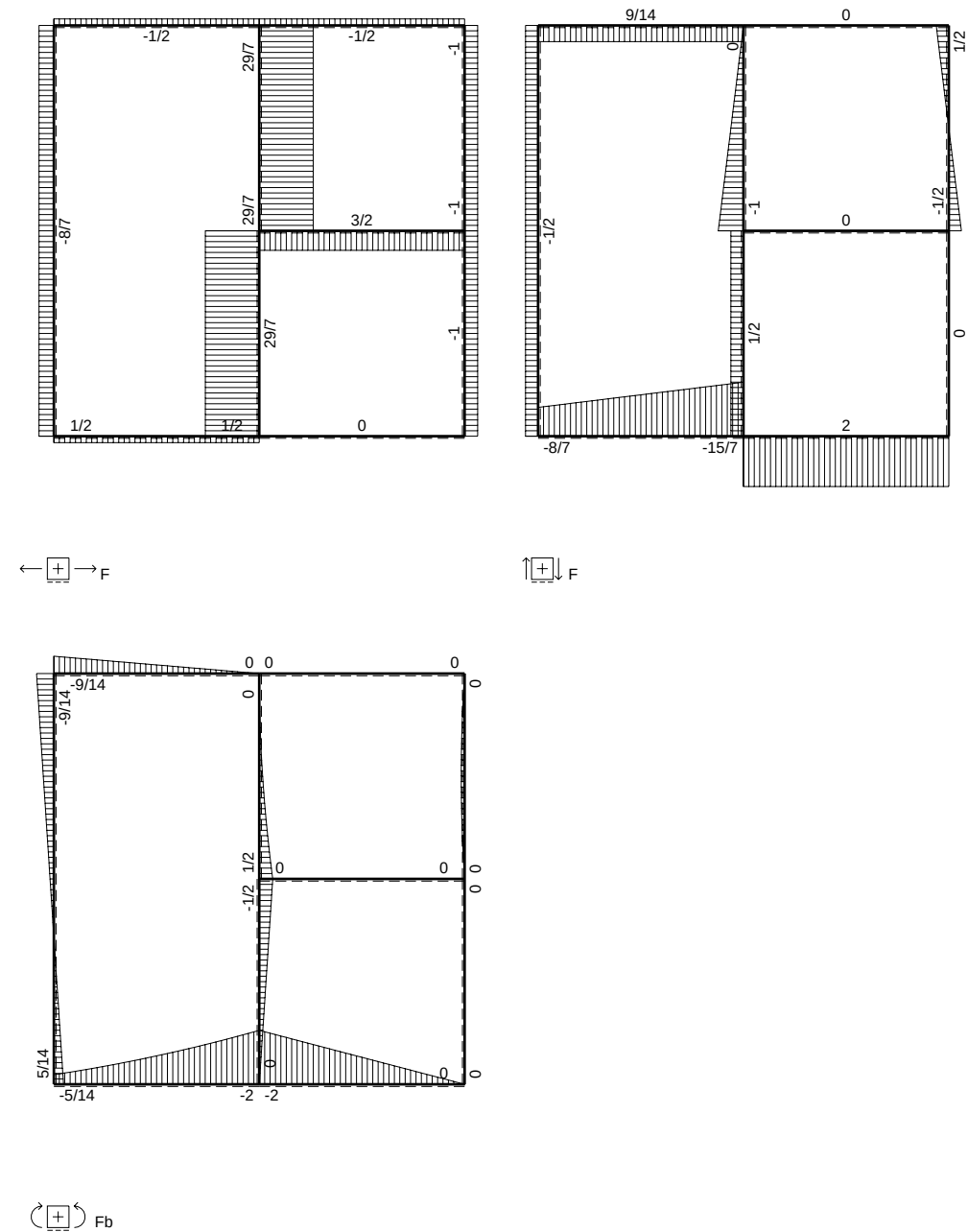
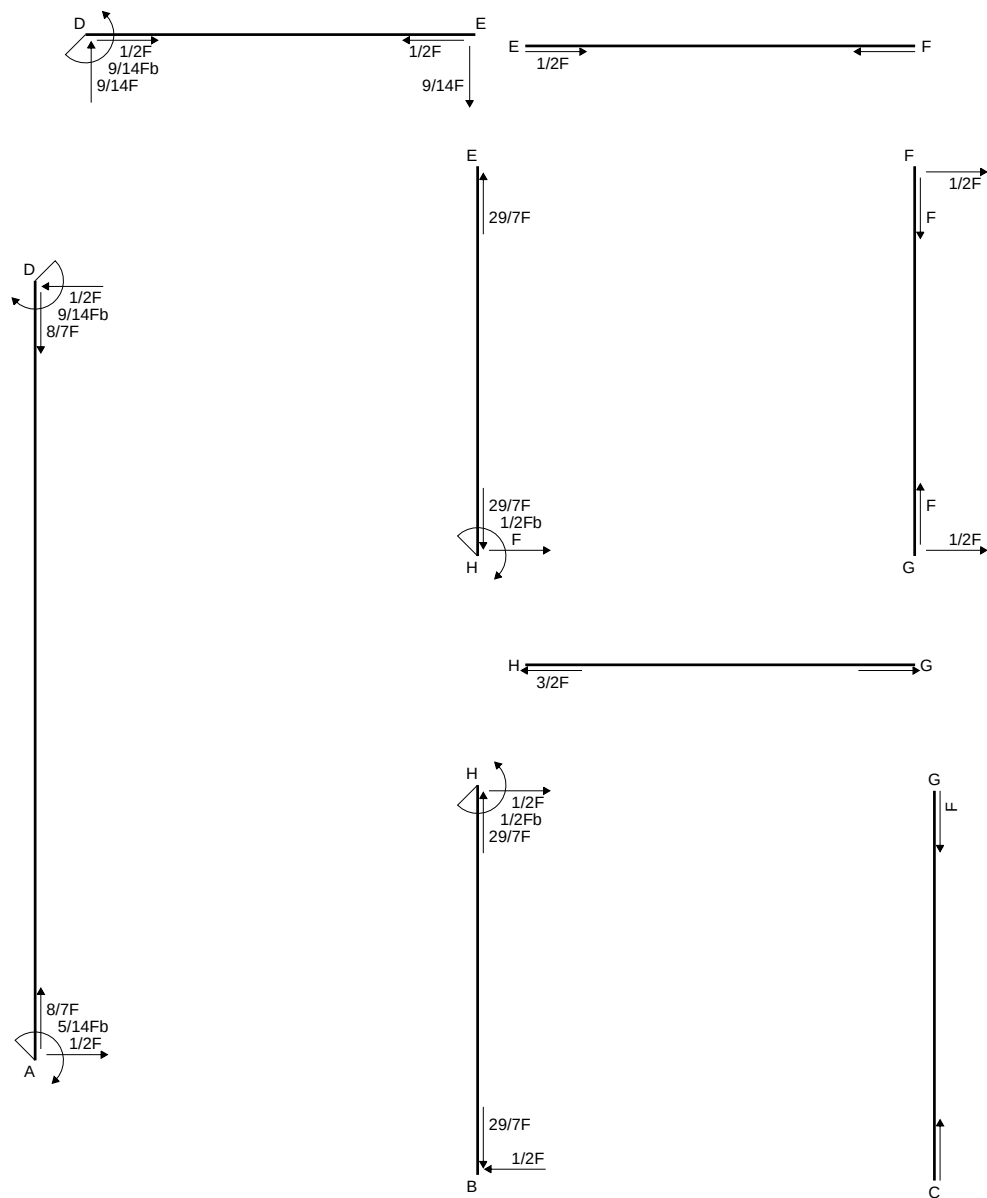
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-1/2Fx$	0	$-1/2Fx$	0	1	$(-1+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fb-1/2Fx$	0	$-Fb+1/2Fx$	0	1		
DE b	$1-x/b$	$-Fb+Fx$	0	$-Fb+2Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	Fx	0	$-Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BH b	0	$1/2Fx$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

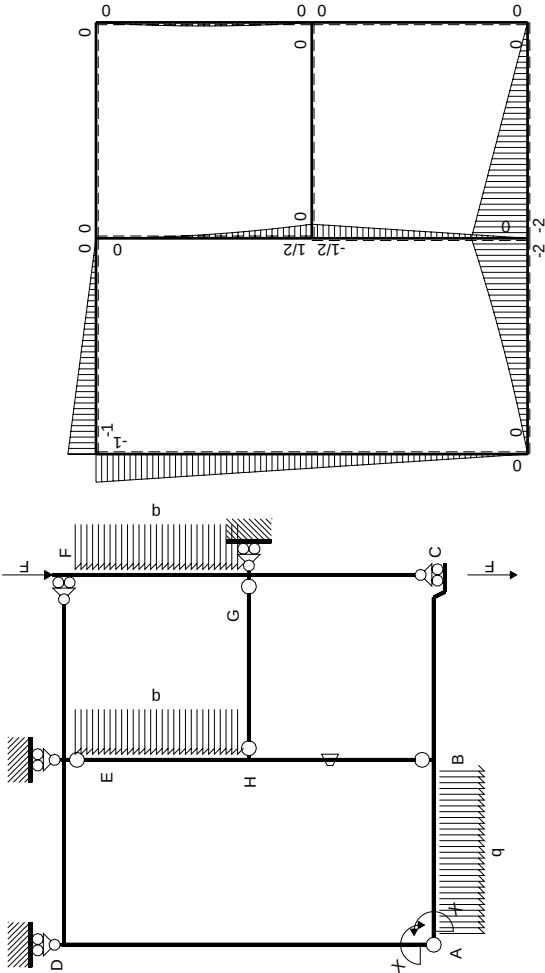
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/2 x/b) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b) Fb \frac{1}{EJ} = - \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1 + 1/2 x/b) Fb \frac{1}{EJ} dx = \left[-x + 1/4 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-2b + b) Fb \frac{1}{EJ} = - \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1 + 2x/b - x^2/b^2) Fb \frac{1}{EJ} dx = \left[-x + x^2/b - 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-b + b - 1/3 b) Fb \frac{1}{EJ} = -1/3 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/3 b) Fb \frac{1}{EJ} = -1/3 \frac{Fb^2}{EJ}
\end{aligned}$$



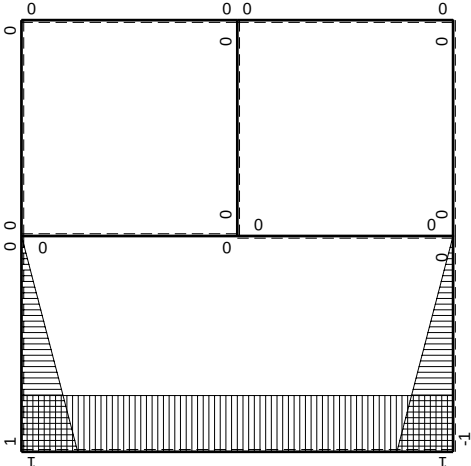
$$\begin{aligned}
A &= 774. \text{ mm}^2 \\
J_u &= 226668. \text{ mm}^4 \\
J_v &= 71010. \text{ mm}^4 \\
y_g &= 17.62 \text{ mm} \\
T_y &= 2360. \text{ N} \\
M_x &= -1463200. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 35.38 \text{ mm} \\
\sigma_m &= -Mv/J_u = 228.4 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 43. \text{ mm} \\
v_c &= 25.38 \text{ mm} \\
\sigma_c &= -Mv/J_u = 163.9 \text{ N/mm}^2 \\
\tau_c &= 6.587 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 164.3 \text{ N/mm}^2 \\
S &= 3796. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



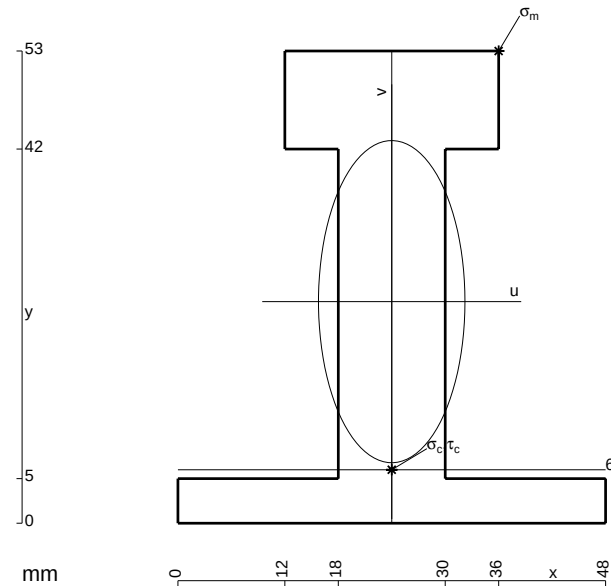
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

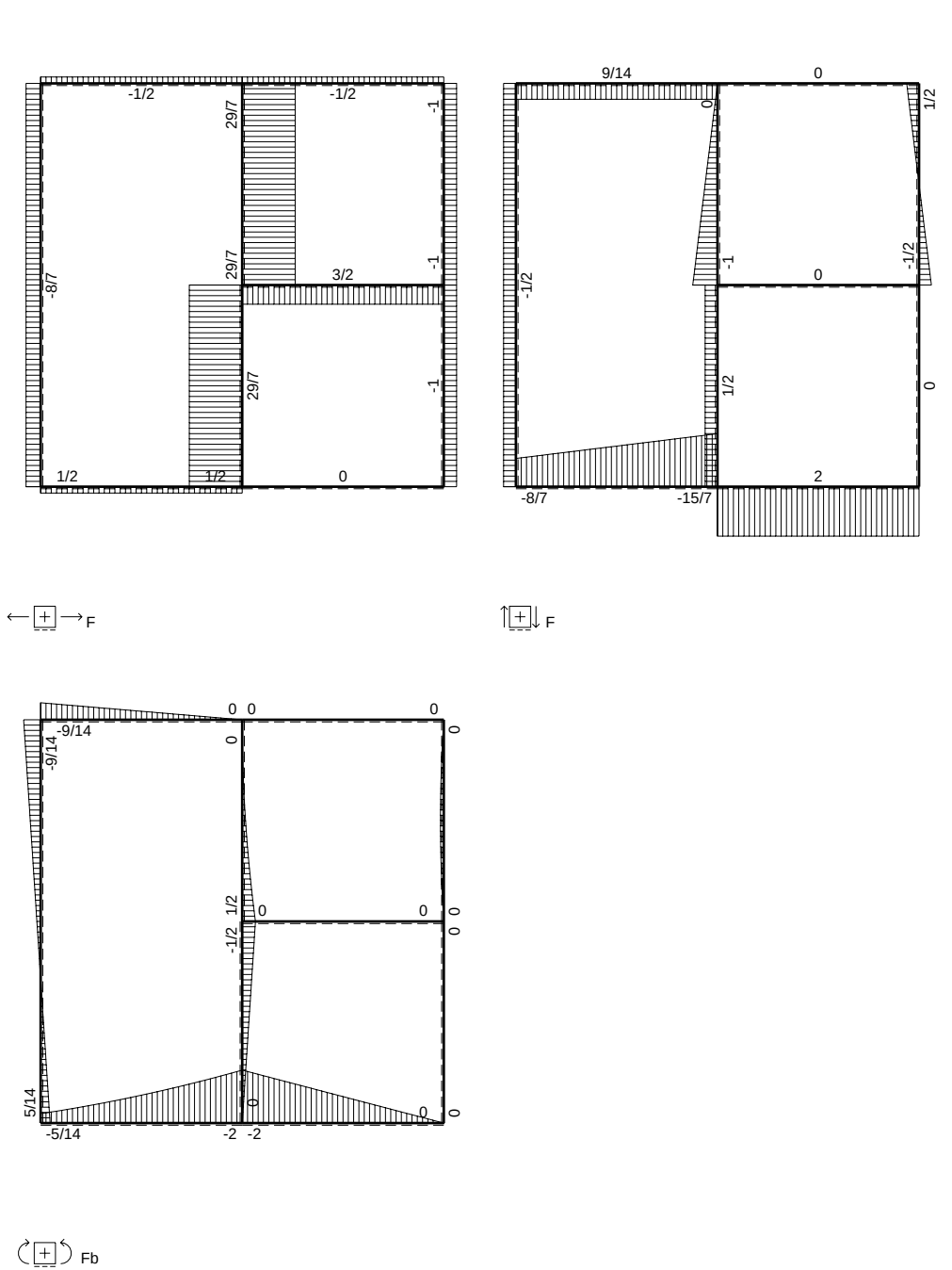
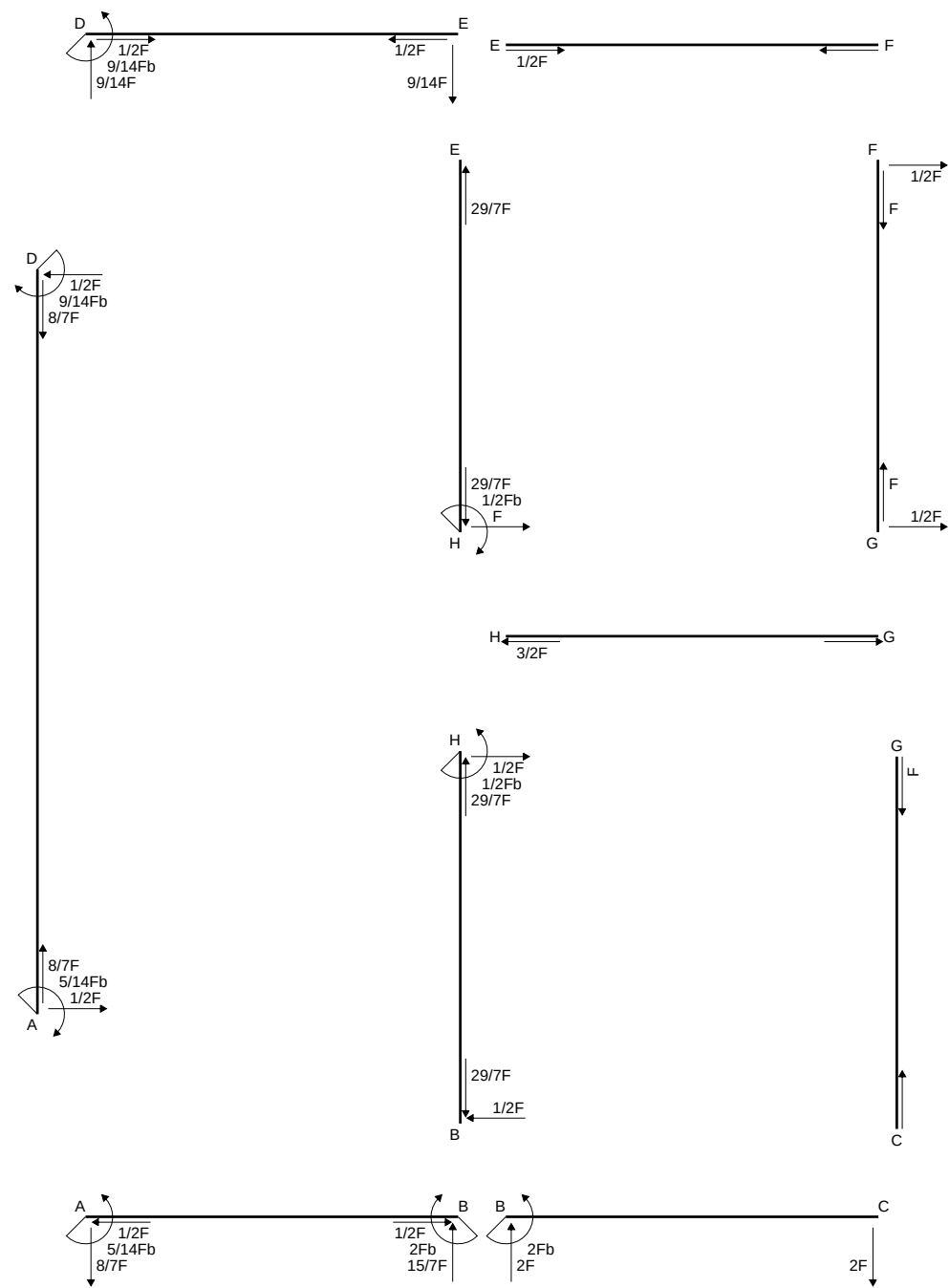
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-1/2Fx$	0	$-1/2Fx$	0	1	$(-1+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fb-1/2Fx$	0	$-Fb+1/2Fx$	0	1		
DE b	$1-x/b$	$-Fb+Fx$	0	$-Fb+2Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	Fx	0	$-Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+1/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$1/2Fx$	Fb/EJ	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

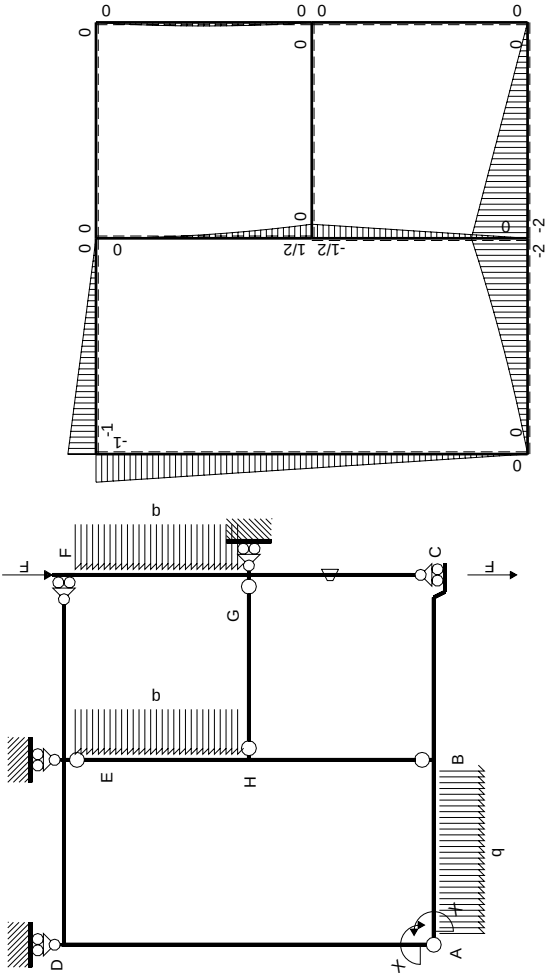
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/2 x/b) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b) Fb \frac{1}{EJ} = - \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1 + 1/2 x/b) Fb \frac{1}{EJ} dx = \left[-x + 1/4 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-2b + b) Fb \frac{1}{EJ} = - \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1 + 2x/b - x^2/b^2) Fb \frac{1}{EJ} dx = \left[-x + x^2/b - 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-b + b - 1/3 b) Fb \frac{1}{EJ} = -1/3 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/3 b) Fb \frac{1}{EJ} = -1/3 \frac{Fb^2}{EJ}
\end{aligned}$$



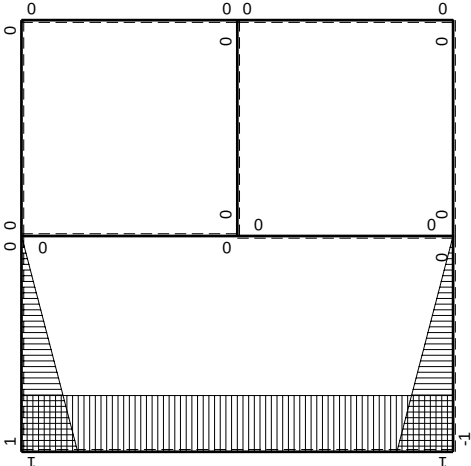
$$\begin{aligned}
A &= 948. \text{ mm}^2 \\
J_u &= 309947. \text{ mm}^4 \\
J_v &= 64080. \text{ mm}^4 \\
y_g &= 24.87 \text{ mm} \\
T_y &= 3940. \text{ N} \\
M_x &= -2639800. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 28.13 \text{ mm} \\
\sigma_m &= -Mv/J_u = 239.6 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 6. \text{ mm} \\
v_c &= -18.87 \text{ mm} \\
\sigma_c &= -Mv/J_u = -160.7 \text{ N/mm}^2 \\
\tau_c &= 5.933 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 161. \text{ N/mm}^2 \\
S &= 5601. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



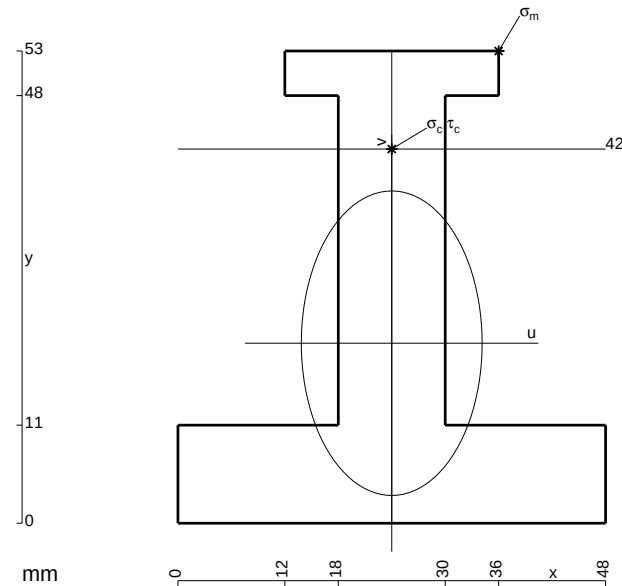
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

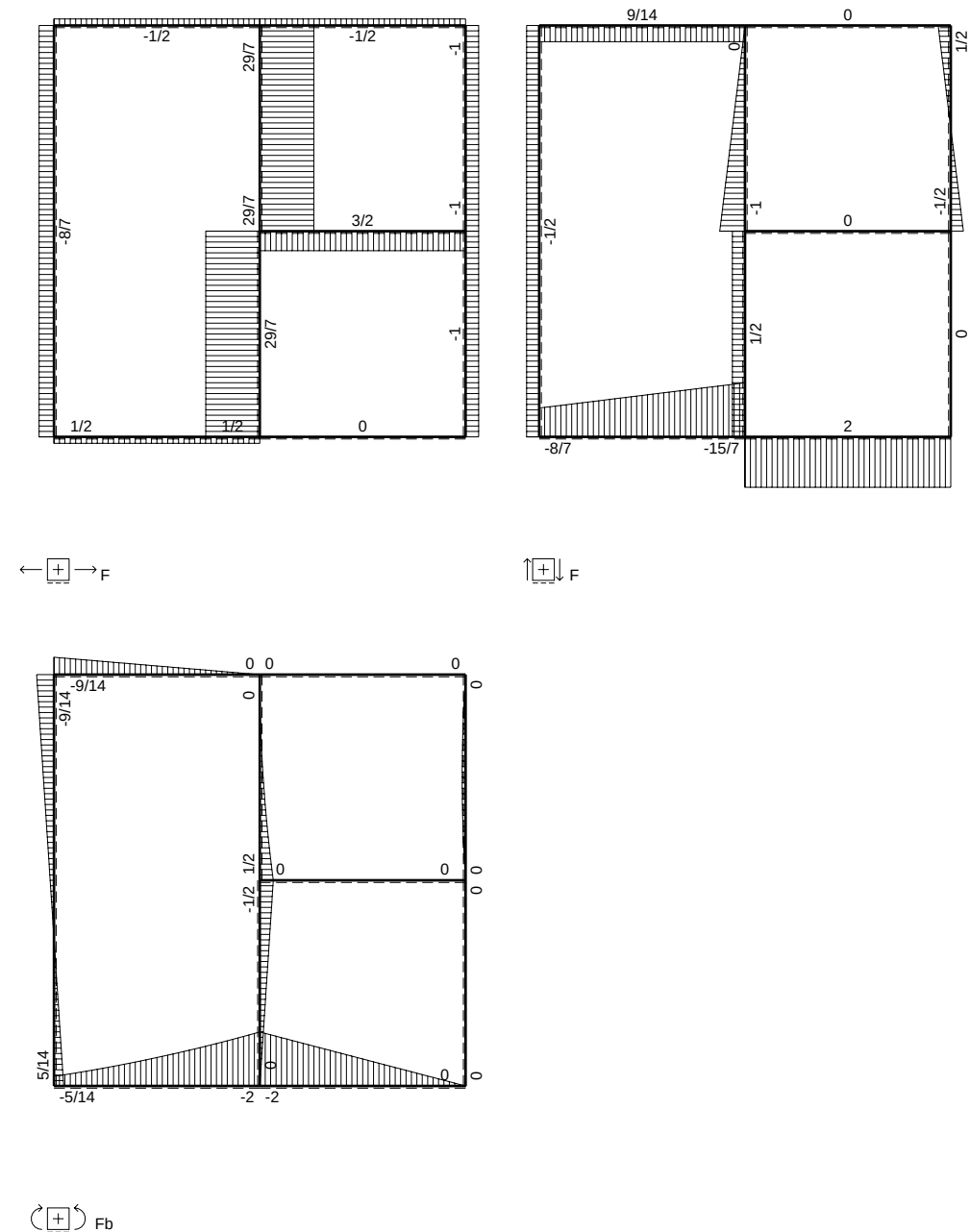
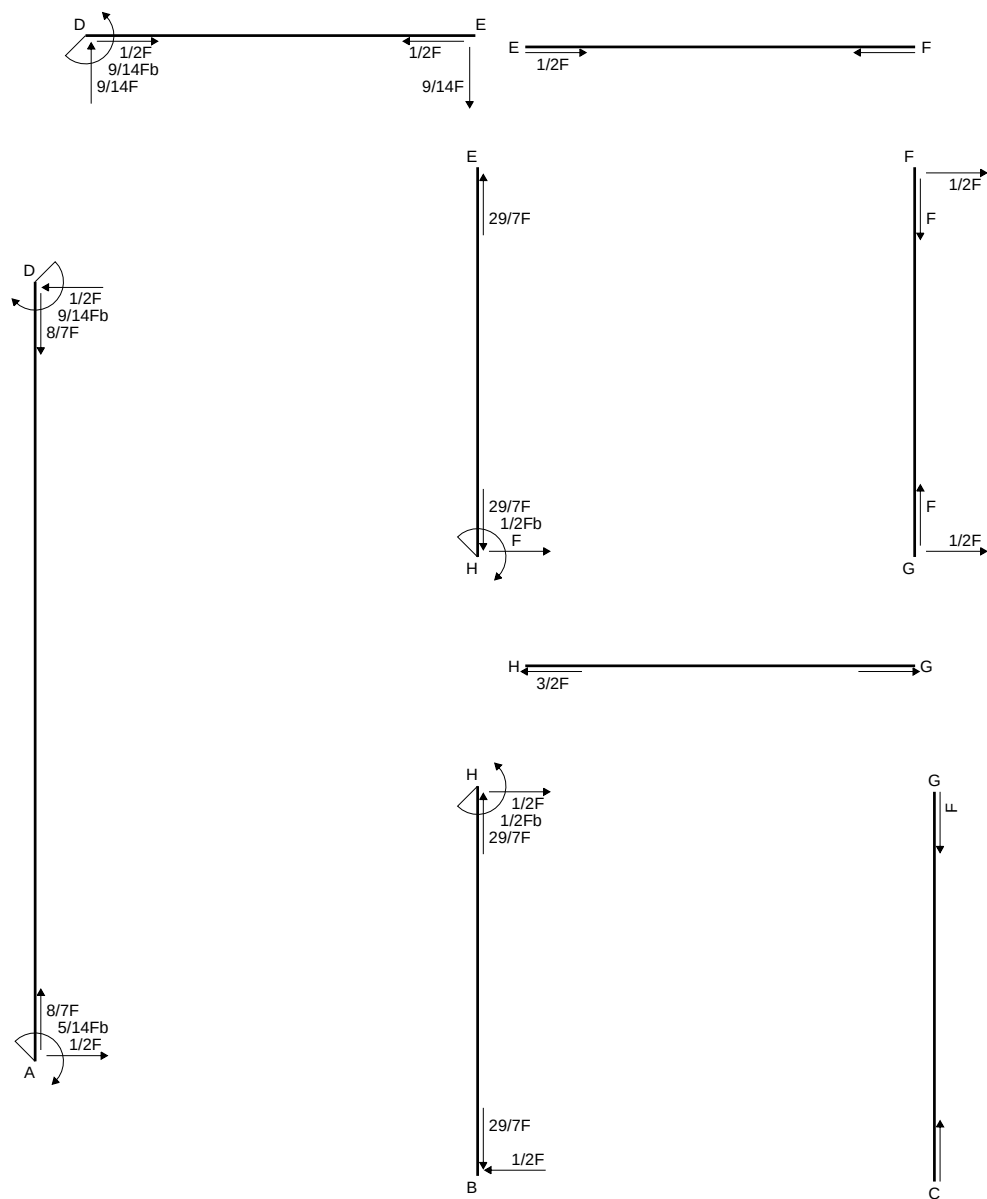
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-1/2Fx$	0	$-1/2Fx$	0	1	$(-1+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fb-1/2Fx$	0	$-Fb+1/2Fx$	0	1		
DE b	$1-x/b$	$-Fb+Fx$	0	$-Fb+2Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	Fx	0	$-Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BH b	0	$1/2Fx$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

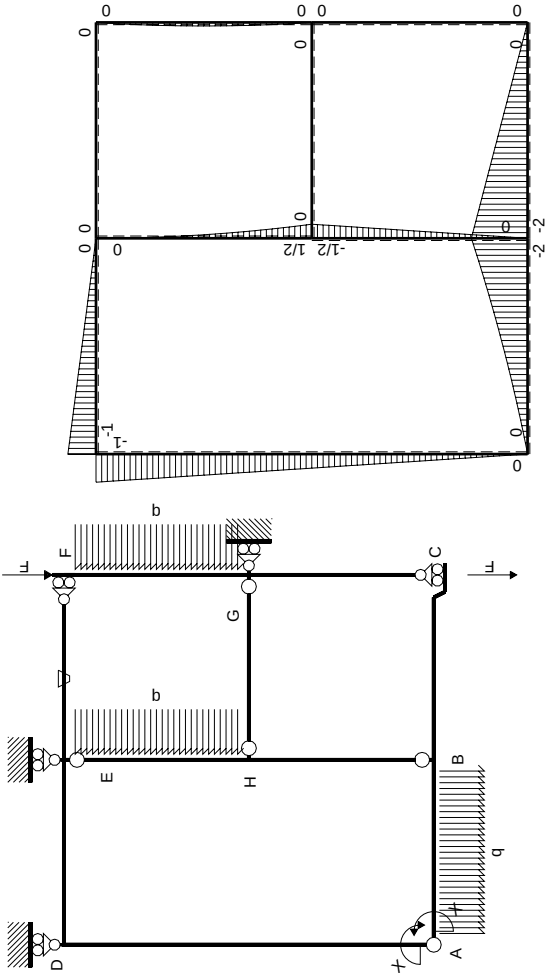
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/2 x/b) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b) Fb \frac{1}{EJ} = - \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1 + 1/2 x/b) Fb \frac{1}{EJ} dx = \left[-x + 1/4 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-2b + b) Fb \frac{1}{EJ} = - \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1 + 2x/b - x^2/b^2) Fb \frac{1}{EJ} dx = \left[-x + x^2/b - 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-b + b - 1/3 b) Fb \frac{1}{EJ} = -1/3 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/3 b) Fb \frac{1}{EJ} = -1/3 \frac{Fb^2}{EJ}
\end{aligned}$$



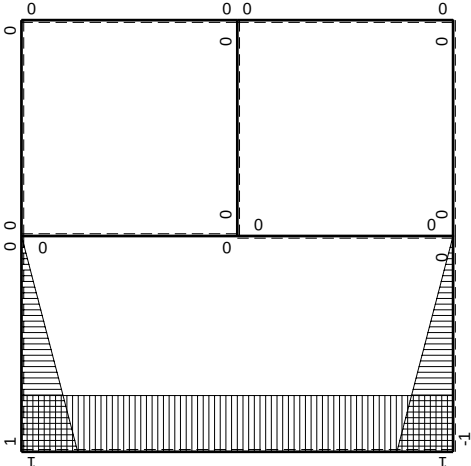
$$\begin{aligned}
A &= 1092. \text{ mm}^2 \\
J_u &= 318895. \text{ mm}^4 \\
J_v &= 112464. \text{ mm}^4 \\
y_g &= 20.2 \text{ mm} \\
T_y &= 2700. \text{ N} \\
M_x &= -1944000. \text{ Nmm} \\
x_m &= 36. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 12. \text{ mm} \\
v_m &= 32.8 \text{ mm} \\
\sigma_m &= -Mv/J_u = 199.9 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 42. \text{ mm} \\
v_c &= 21.8 \text{ mm} \\
\sigma_c &= -Mv/J_u = 132.9 \text{ N/mm}^2 \\
\tau_c &= 3.825 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 133. \text{ N/mm}^2 \\
S &= 5421. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



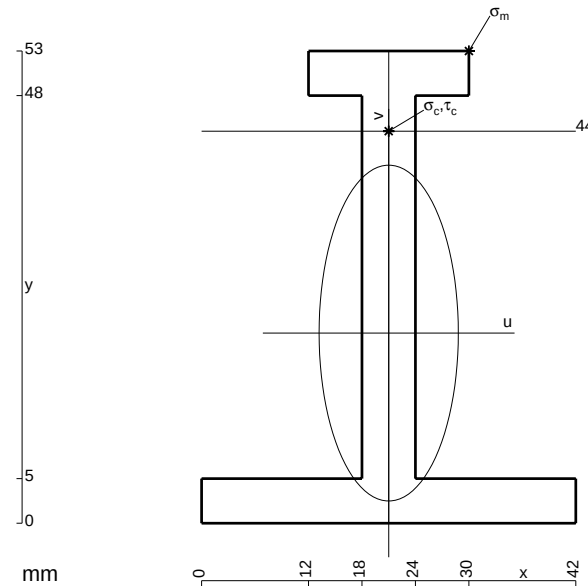
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

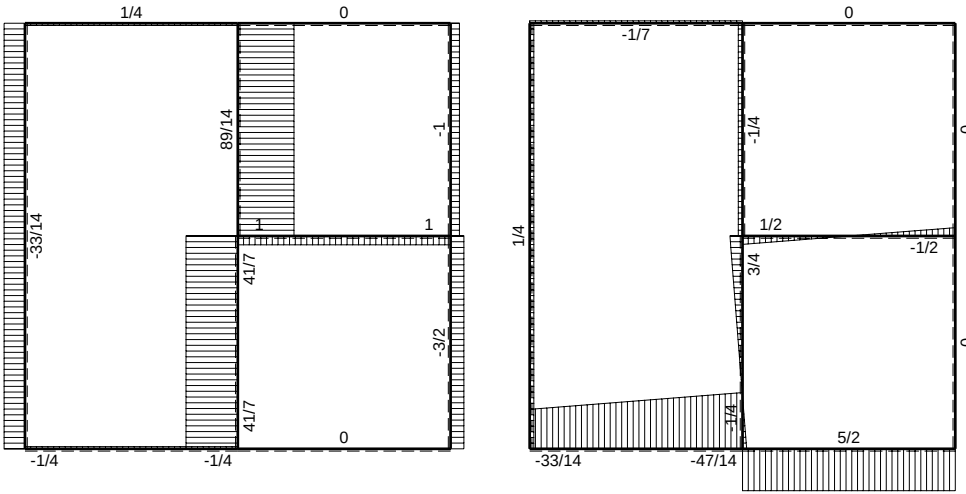
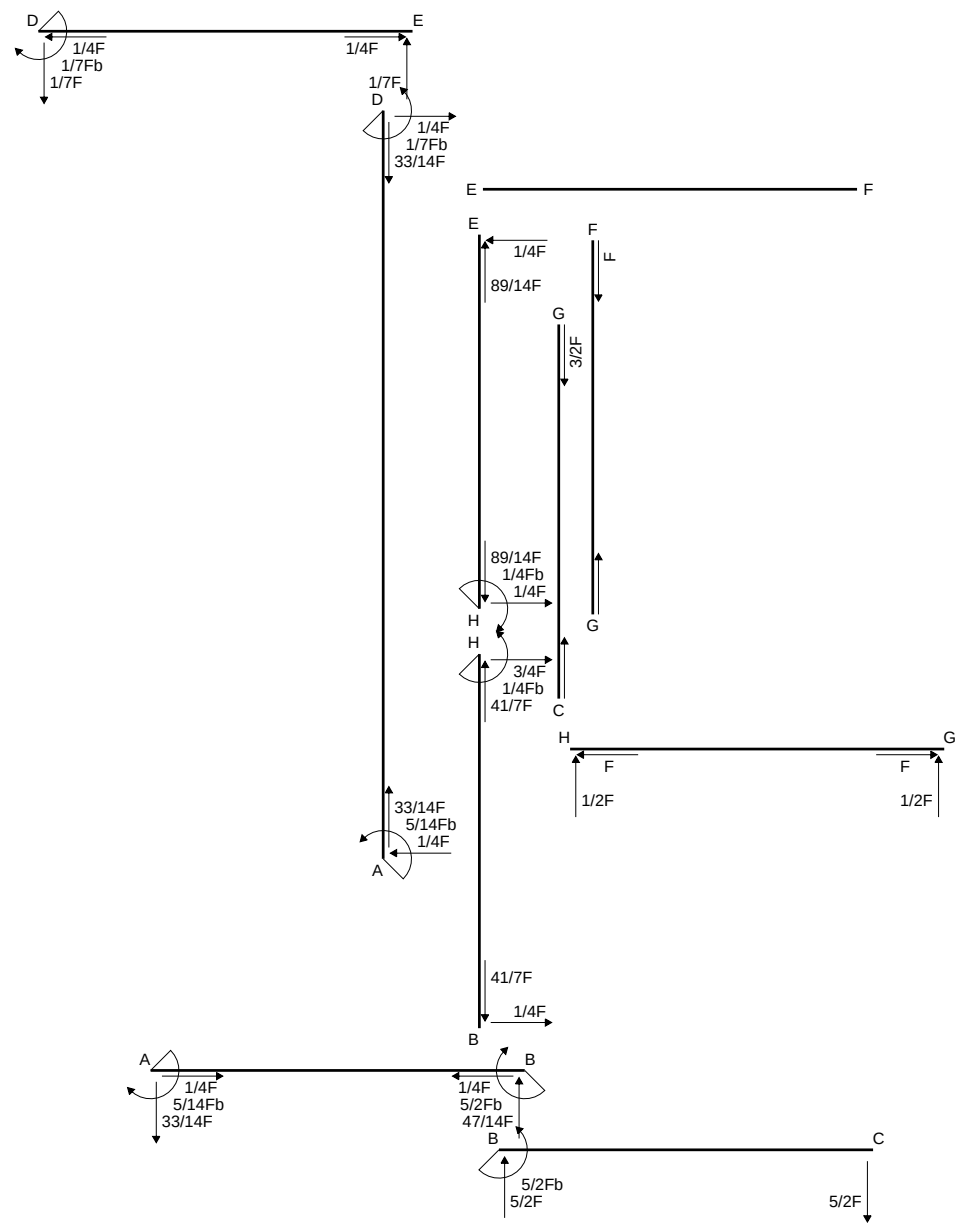
→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-3/2Fx-1/2qx^2$	0	$3/2Fx-Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(7/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$2Fb-5/2Fx+1/2qx^2$	0	$2Fx-5/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
CB b	0	$2Fx$	0	0	0	0		
AD 2b	1	$-1/2Fx$	0	$-1/2Fx$	0	1	$(-1+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$Fb-1/2Fx$	0	$-Fb+1/2Fx$	0	1		
DE b	$1-x/b$	$-Fb+Fx$	0	$-Fb+2Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	Fx	0	$-Fx^2/b$	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	0	0	0	0	0	0+0	0
GH b	0	0	0	0	0	0		
HB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BH b	0	$1/2Fx$	0	0	0	0		
HE b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
EH b	0	$-1/2qx^2$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$-25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (3/2 x/b - x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[3/4 x^2/b - 1/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (3/4 b - 1/3 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (2 x/b - 5/2 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 5/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 5/6 b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 7/24 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (-1/2 x/b) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-b) Fb \frac{1}{EJ} = - \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (-1 + 1/2 x/b) Fb \frac{1}{EJ} dx = \left[-x + 1/4 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (-2b + b) Fb \frac{1}{EJ} = - \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (-1 + 2x/b - x^2/b^2) Fb \frac{1}{EJ} dx = \left[-x + x^2/b - 1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-b + b - 1/3 b) Fb \frac{1}{EJ} = -1/3 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (-x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/3 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (-1/3 b) Fb \frac{1}{EJ} = -1/3 \frac{Fb^2}{EJ}
\end{aligned}$$

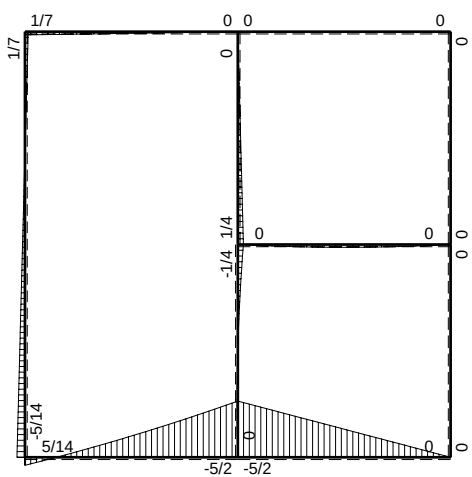


$$\begin{aligned}
A &= 558. \text{ mm}^2 \\
J_u &= 198314. \text{ mm}^4 \\
J_v &= 34074. \text{ mm}^4 \\
y_g &= 21.34 \text{ mm} \\
T_y &= 1720. \text{ N} \\
M_x &= -1307200. \text{ Nmm} \\
x_m &= 30. \text{ mm} \\
y_m &= 53. \text{ mm} \\
u_m &= 9. \text{ mm} \\
v_m &= 31.66 \text{ mm} \\
\sigma_m &= -Mv/J_u = 208.7 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 44. \text{ mm} \\
v_c &= 22.66 \text{ mm} \\
\sigma_c &= -Mv/J_u = 149.4 \text{ N/mm}^2 \\
\tau_c &= 4.649 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 149.6 \text{ N/mm}^2 \\
S &= 3216. \text{ mm}^3
\end{aligned}$$



← ⊕ → F

↑ ⊕ ↓ F



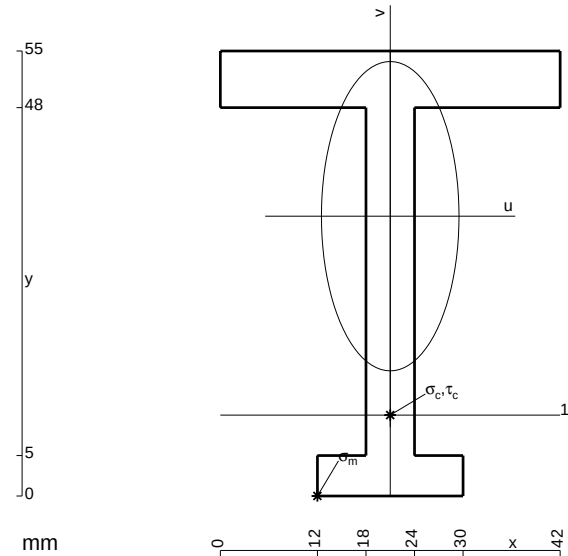
⊕ ⊖ F_b

Quadro contributi PLV per iperstatica $X=W_{AB}$

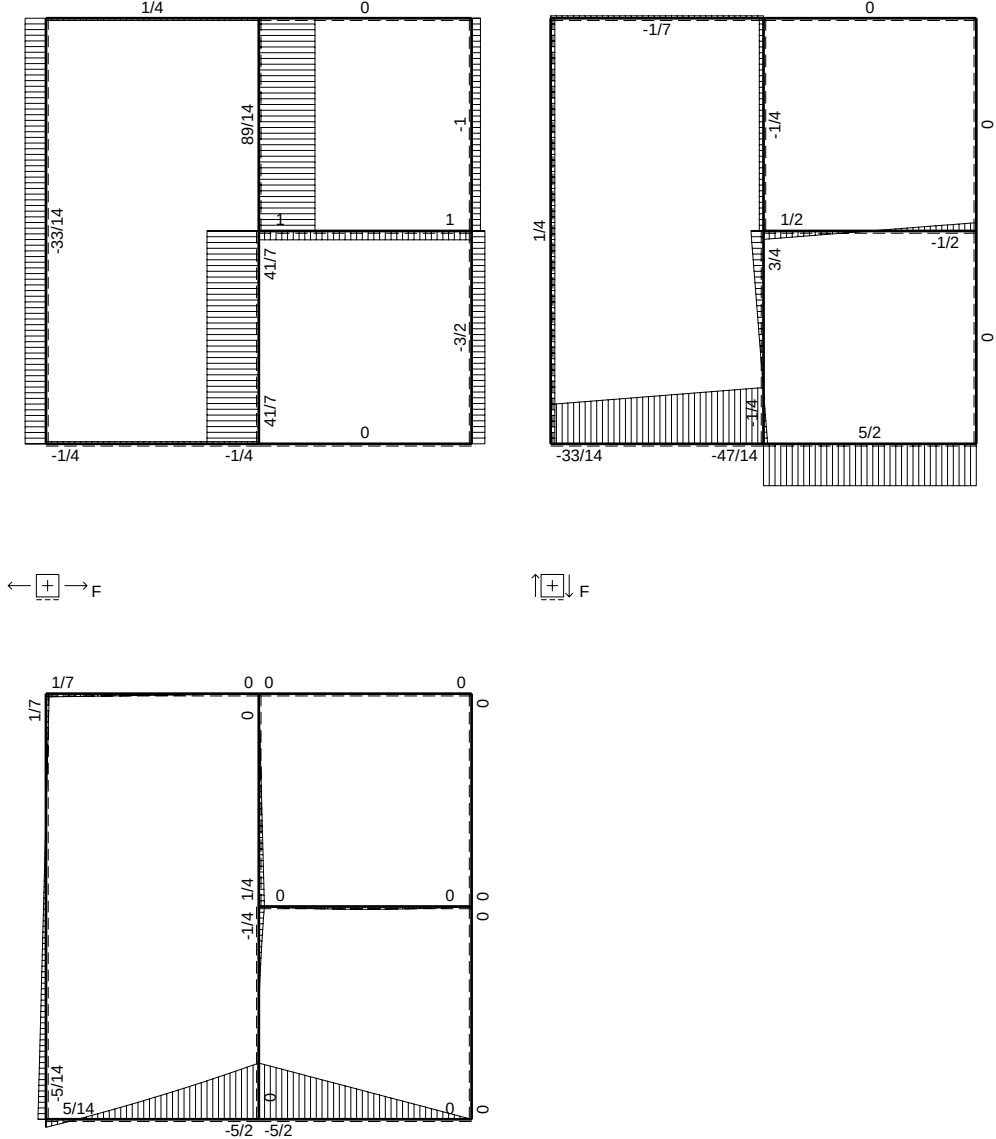
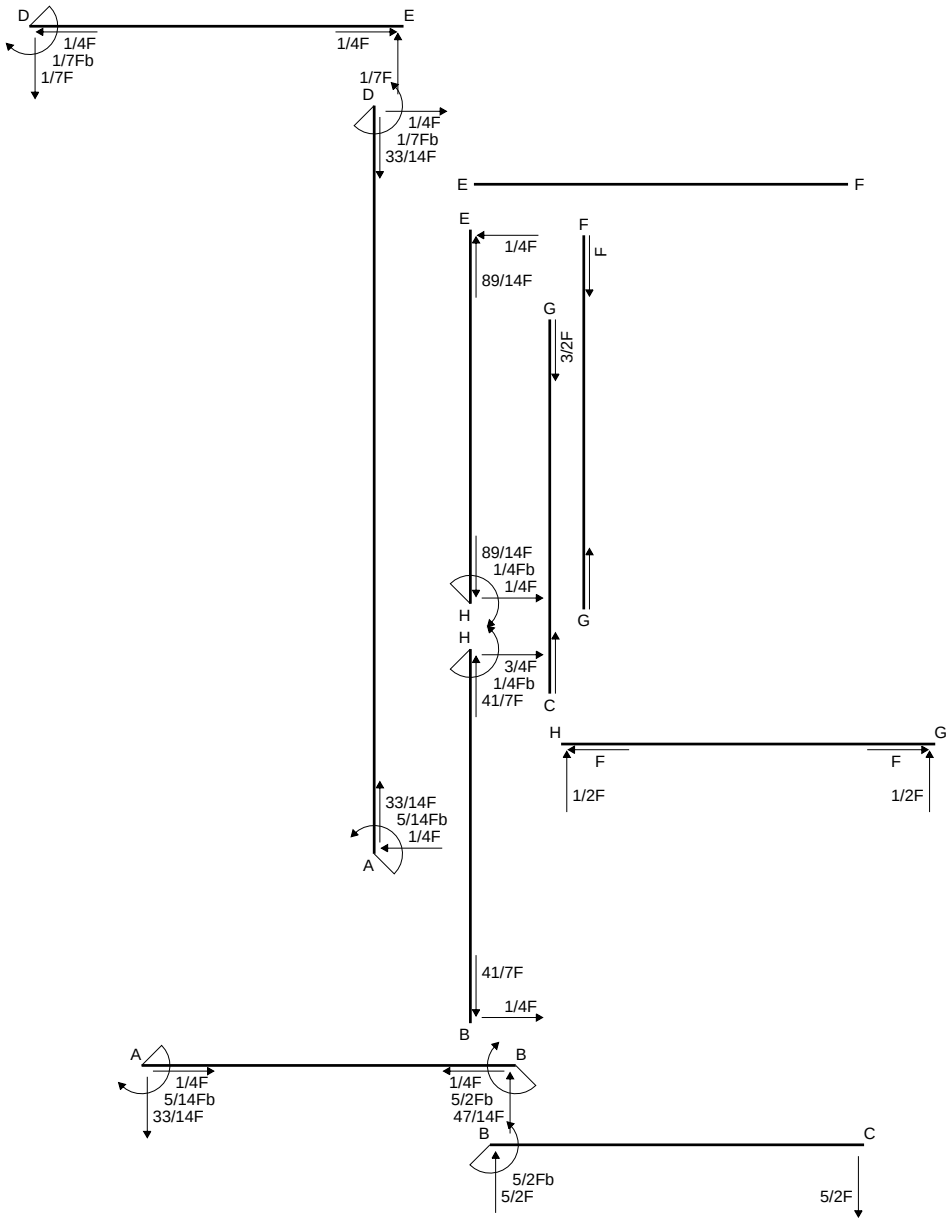
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$5/2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 642. \text{ mm}^2 \\
J_u &= 234775. \text{ mm}^4 \\
J_v &= 46422. \text{ mm}^4 \\
y_g &= 34.58 \text{ mm} \\
T_y &= 1750. \text{ N} \\
M_x &= -1487500. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -34.58 \text{ mm} \\
\sigma_m &= -Mv/J_u = -219.1 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 10. \text{ mm} \\
v_c &= -24.58 \text{ mm} \\
\sigma_c &= -Mv/J_u = -155.8 \text{ N/mm}^2 \\
\tau_c &= 4.597 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 156. \text{ N/mm}^2 \\
S &= 3700. \text{ mm}^3
\end{aligned}$$

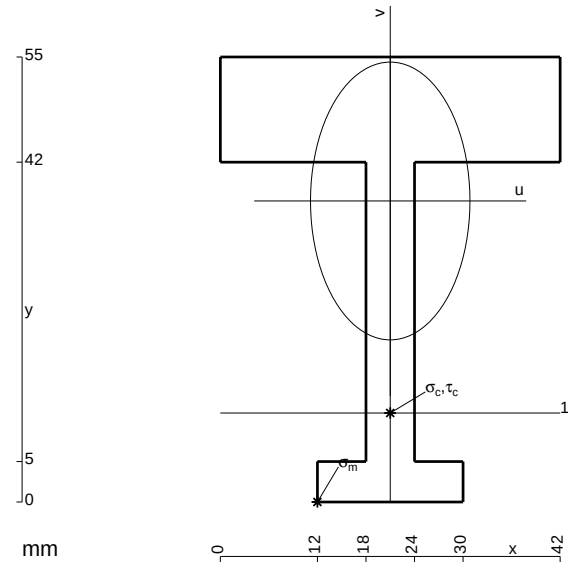


Quadro contributi PLV per iperstatica $X=W_{AB}$

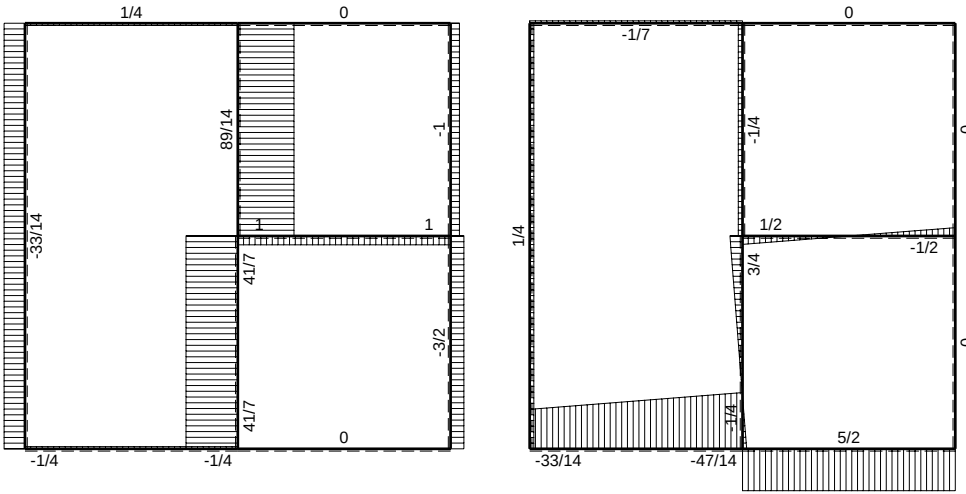
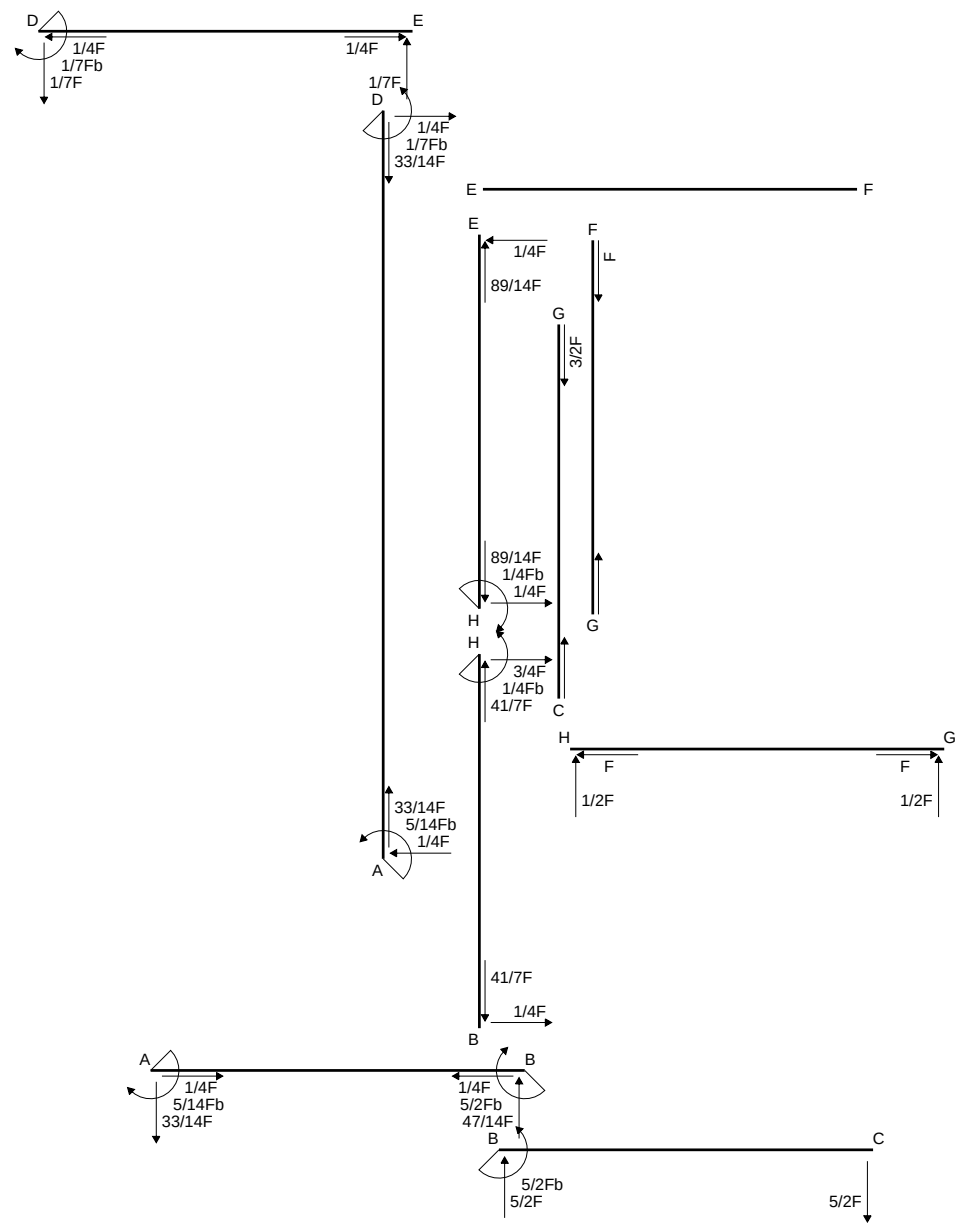
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0
EH b	0	$-1/4Fx$	Fb/EJ	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

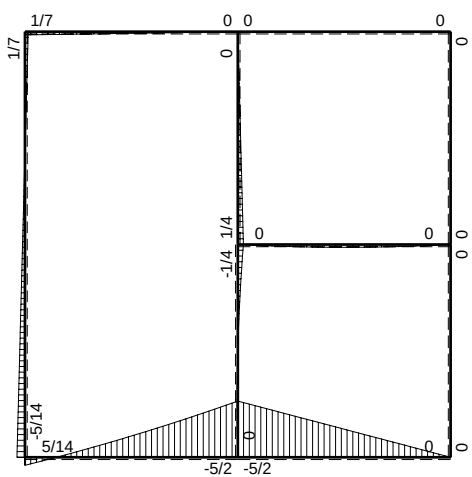


$$\begin{aligned}
A &= 858. \text{ mm}^2 \\
J_u &= 252957. \text{ mm}^4 \\
J_v &= 83358. \text{ mm}^4 \\
y_g &= 37.21 \text{ mm} \\
T_y &= 1725. \text{ N} \\
M_x &= -1552500. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -37.21 \text{ mm} \\
\sigma_m &= -Mv/J_u = -228.4 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 11. \text{ mm} \\
v_c &= -26.21 \text{ mm} \\
\sigma_c &= -Mv/J_u = -160.8 \text{ N/mm}^2 \\
\tau_c &= 4.745 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 161. \text{ N/mm}^2 \\
S &= 4175. \text{ mm}^3
\end{aligned}$$

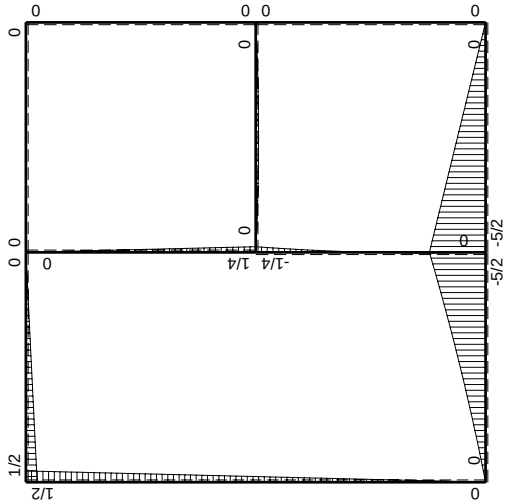
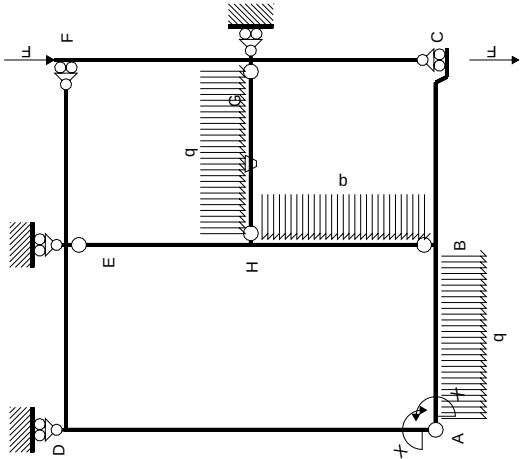


← ⊕ → F

↑ ⊕ ↓ F

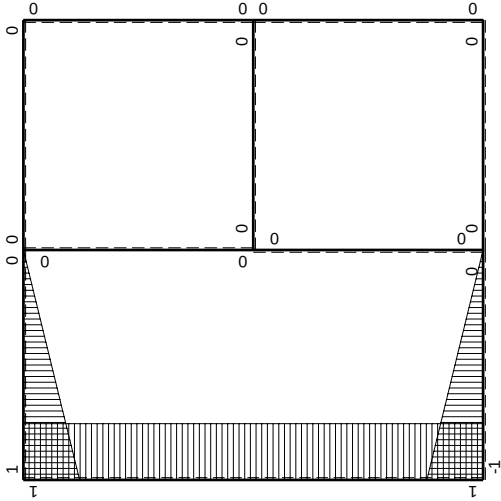


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



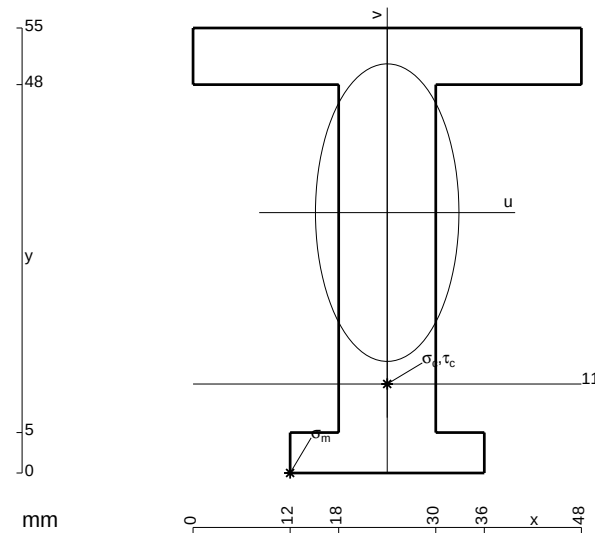
M_X flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

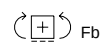
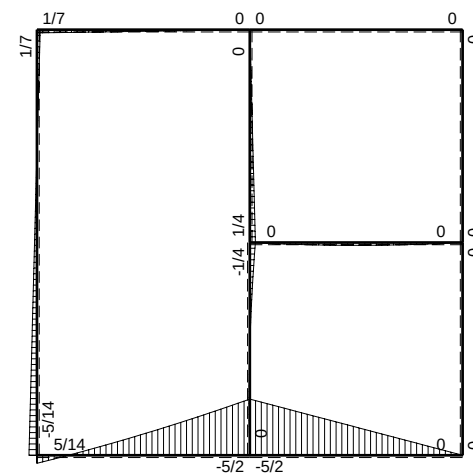
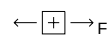
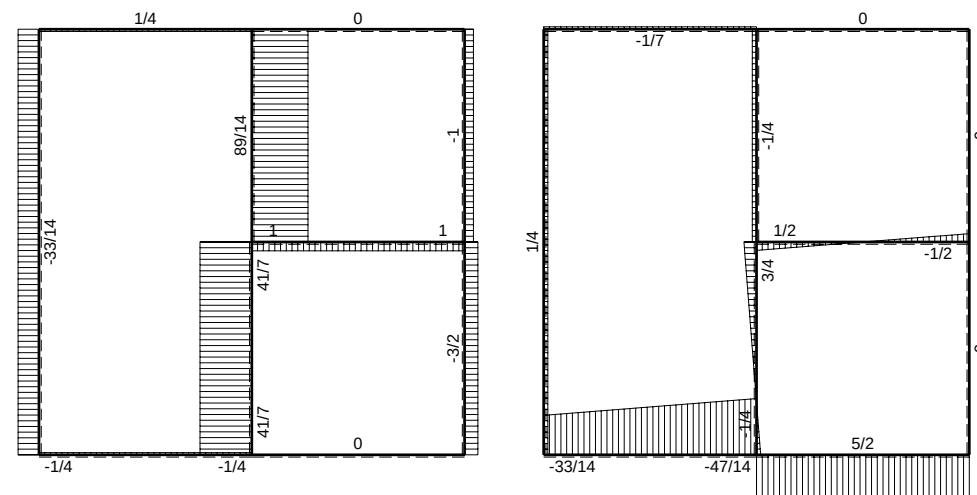
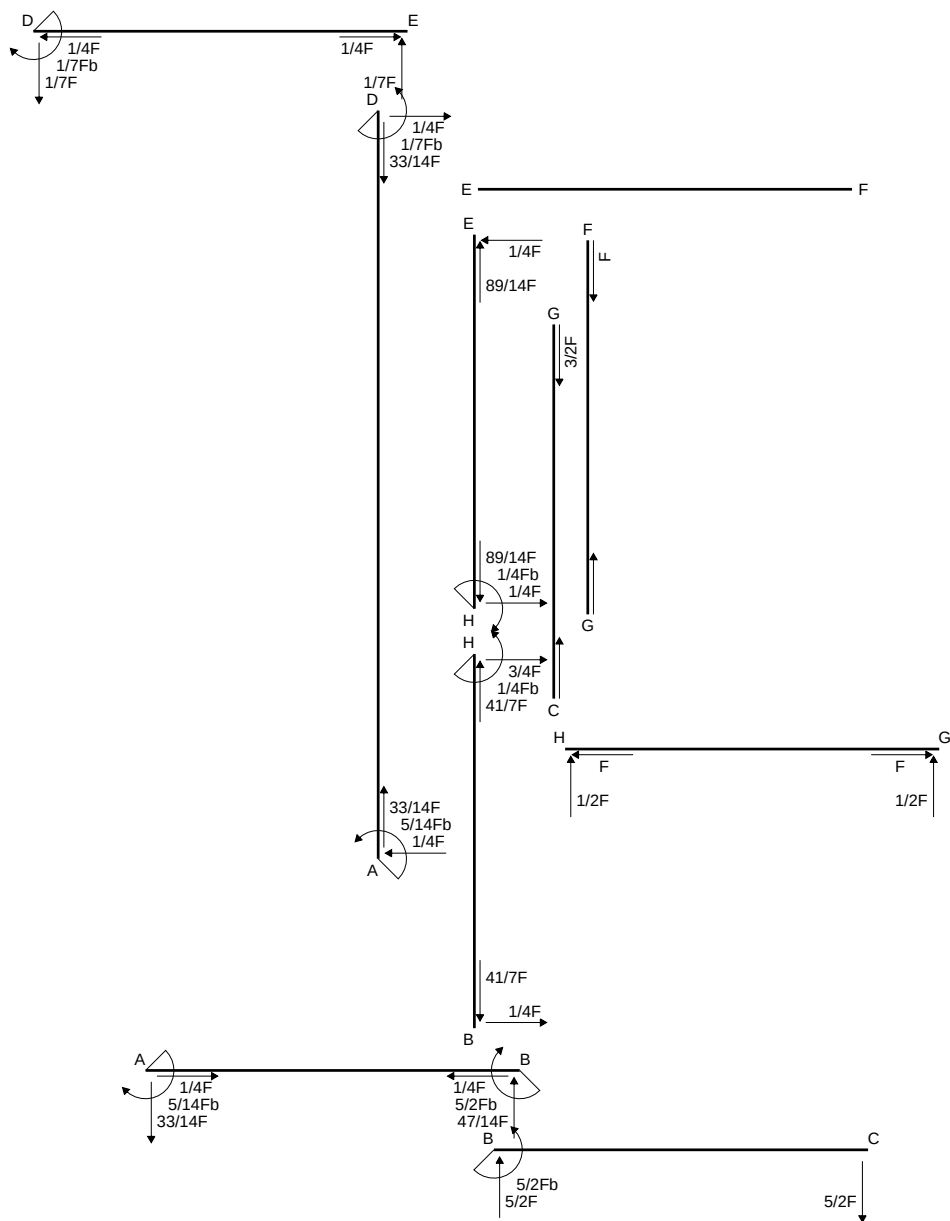
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	Fb/EJ	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

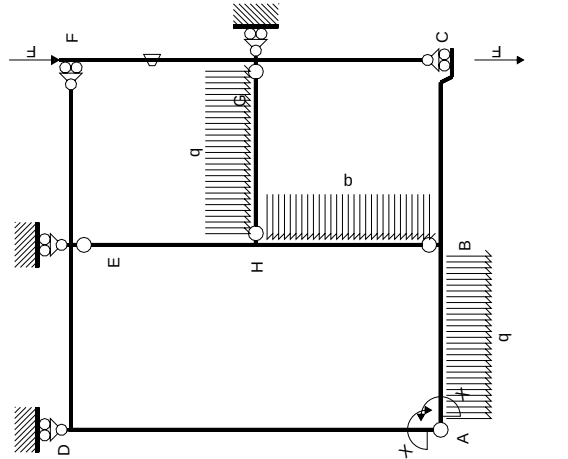
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



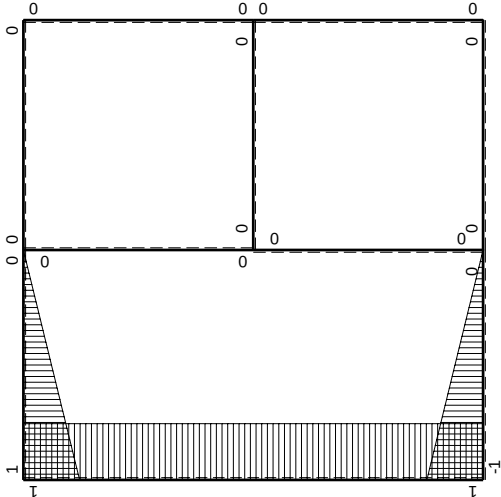
$$\begin{aligned}
A &= 972. \text{ mm}^2 \\
J_u &= 328901. \text{ mm}^4 \\
J_v &= 76464. \text{ mm}^4 \\
y_g &= 32.18 \text{ mm} \\
T_y &= 2575. \text{ N} \\
M_x &= -2446250. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -32.18 \text{ mm} \\
\sigma_m &= -Mv/J_u = -239.3 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 11. \text{ mm} \\
v_c &= -21.18 \text{ mm} \\
\sigma_c &= -Mv/J_u = -157.5 \text{ N/mm}^2 \\
\tau_c &= 3.459 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 157.6 \text{ N/mm}^2 \\
S &= 5302. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



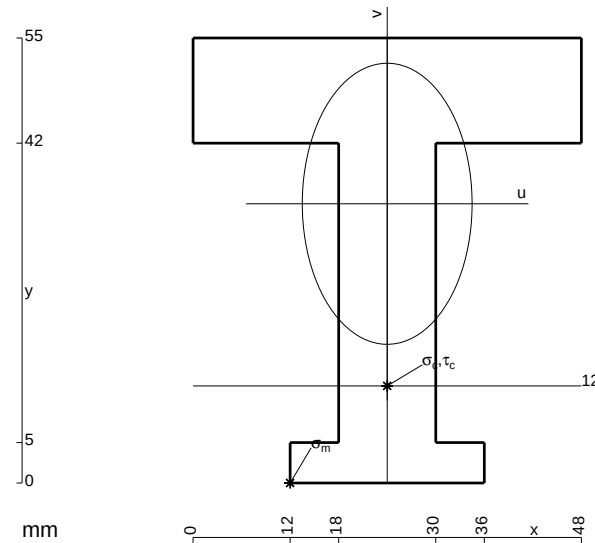
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

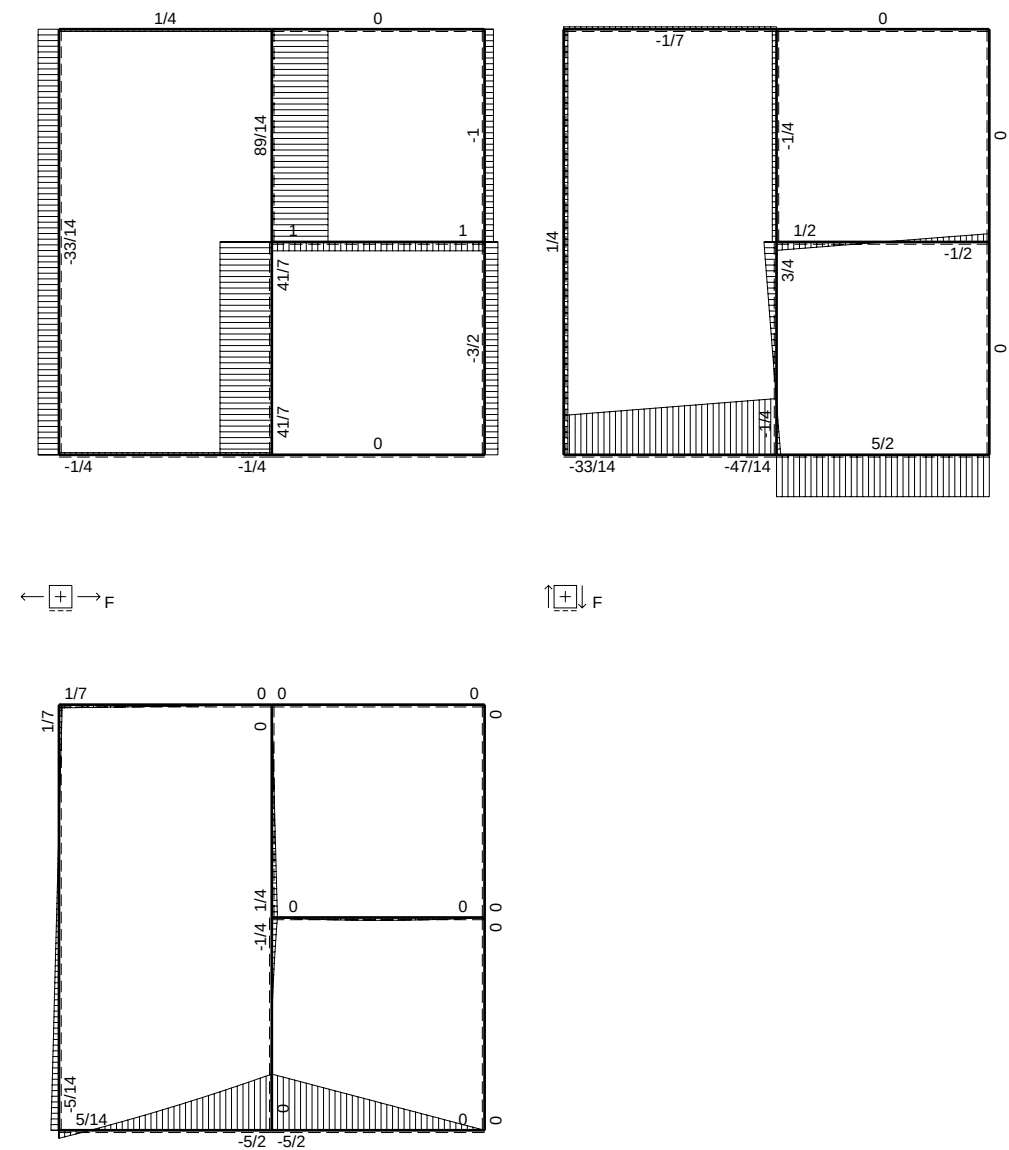
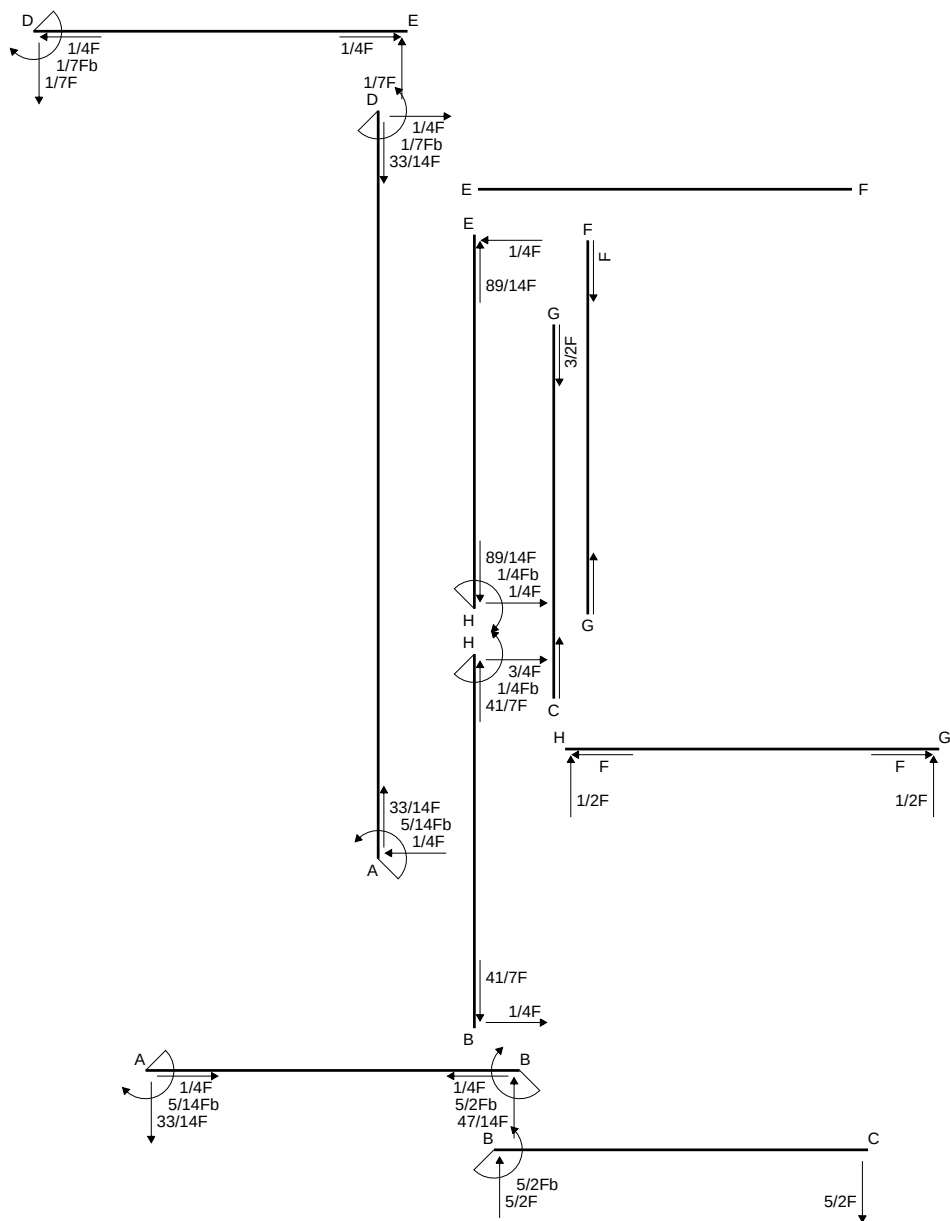
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0
GF b	0	0	Fb/EJ	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 1188. \text{ mm}^2 \\
J_u &= 358599. \text{ mm}^4 \\
J_v &= 130896. \text{ mm}^4 \\
y_g &= 34.51 \text{ mm} \\
T_y &= 4150. \text{ N} \\
M_x &= -2075000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -34.51 \text{ mm} \\
\sigma_m &= -Mv/J_u = -199.7 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 12. \text{ mm} \\
v_c &= -22.51 \text{ mm} \\
\sigma_c &= -Mv/J_u = -130.3 \text{ N/mm}^2 \\
\tau_c &= 5.812 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 130.6 \text{ N/mm}^2 \\
S &= 6026. \text{ mm}^3
\end{aligned}$$

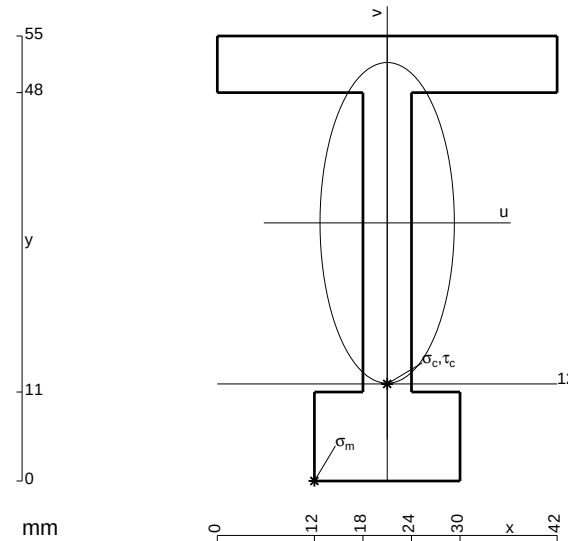


Quadro contributi PLV per iperstatica $X=W_{AB}$

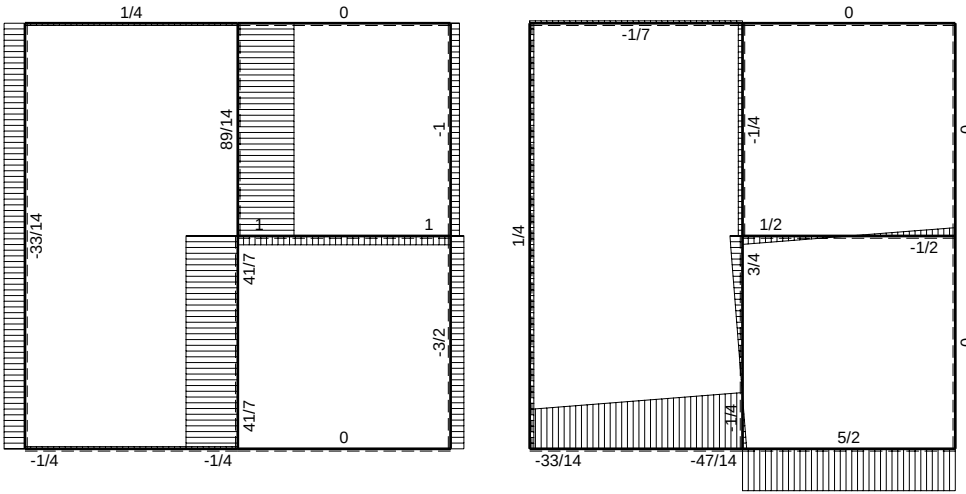
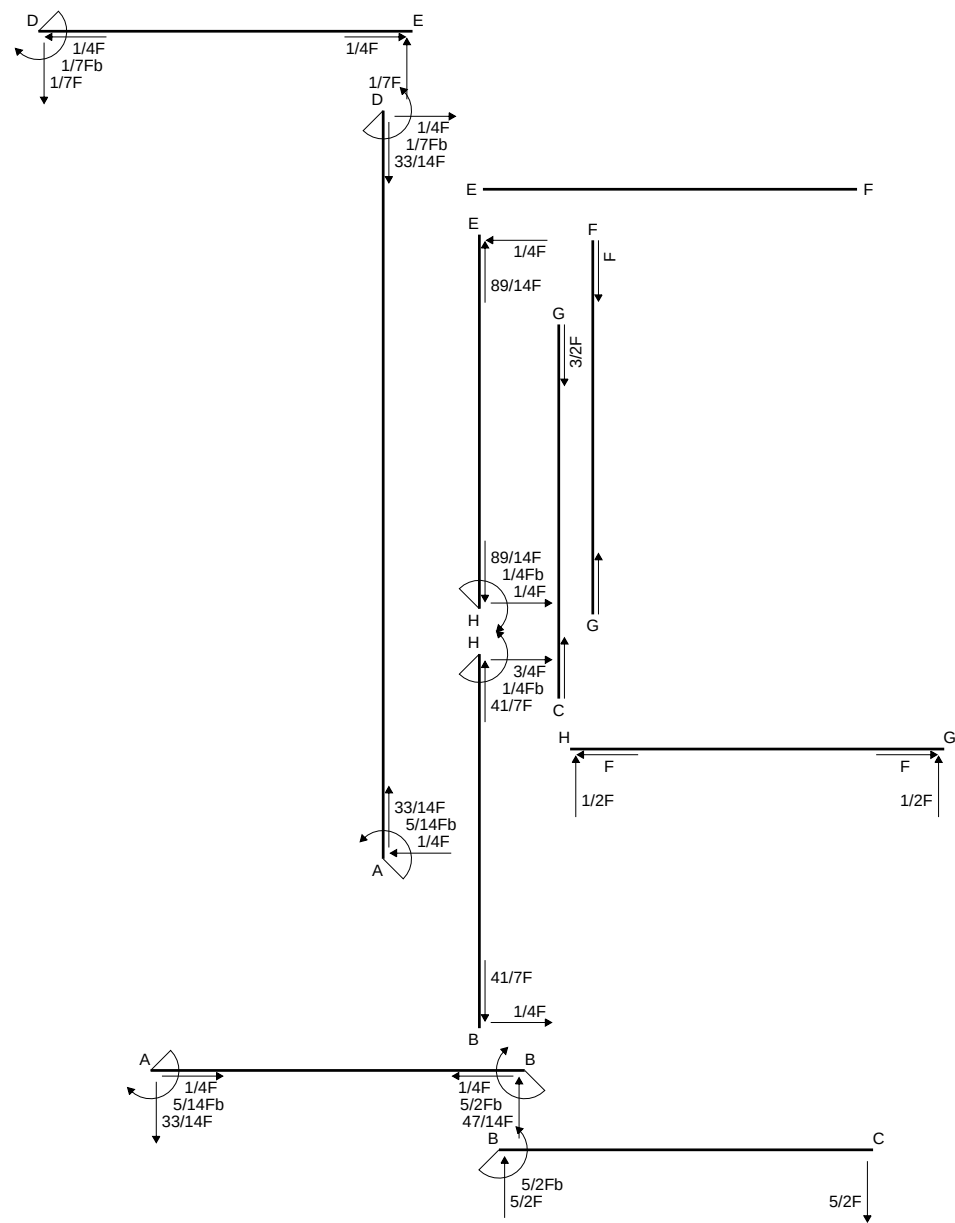
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	Fb/EJ	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \cdot \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \cdot \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \cdot 0 \cdot \frac{1}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$

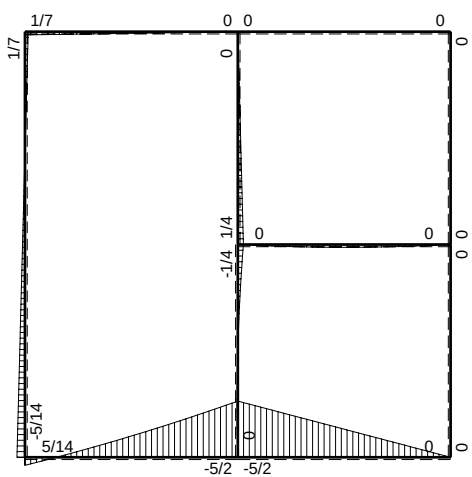


$$\begin{aligned}
A &= 714. \text{ mm}^2 \\
J_u &= 280743. \text{ mm}^4 \\
J_v &= 49230. \text{ mm}^4 \\
y_g &= 31.9 \text{ mm} \\
T_y &= 3350. \text{ N} \\
M_x &= -1842500. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -31.9 \text{ mm} \\
\sigma_m &= -Mv/J_u = -209.4 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 12. \text{ mm} \\
v_c &= -19.9 \text{ mm} \\
\sigma_c &= -Mv/J_u = -130.6 \text{ N/mm}^2 \\
\tau_c &= 10.64 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 131.9 \text{ N/mm}^2 \\
S &= 5350. \text{ mm}^3
\end{aligned}$$

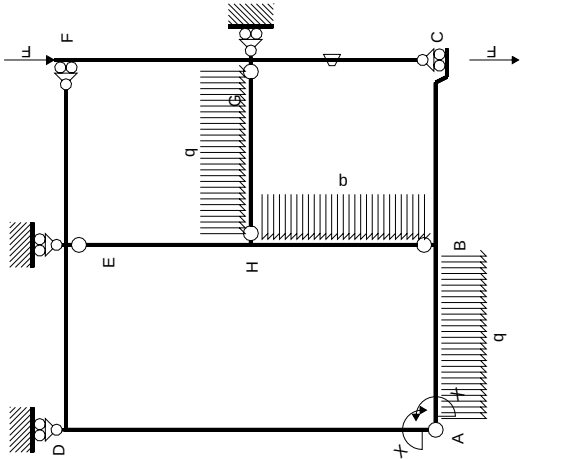


← ⊕ → F

↑ ⊕ ↓ F

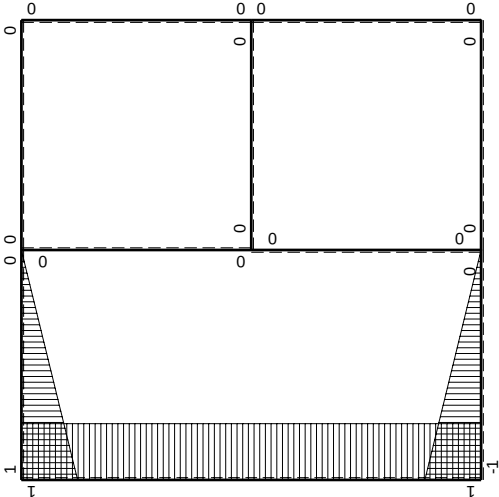


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



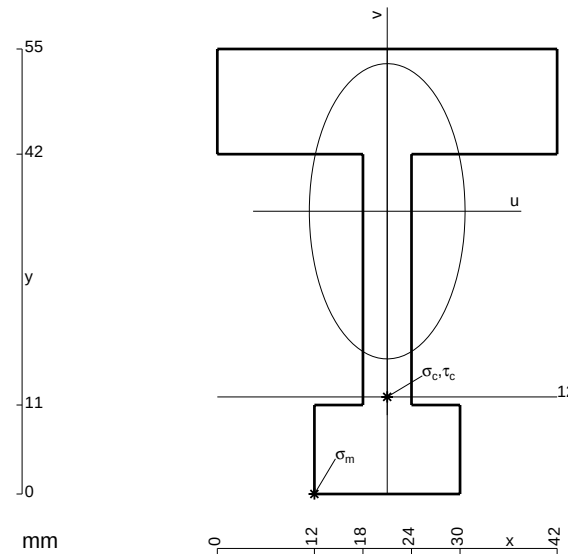
M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{AB}$

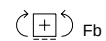
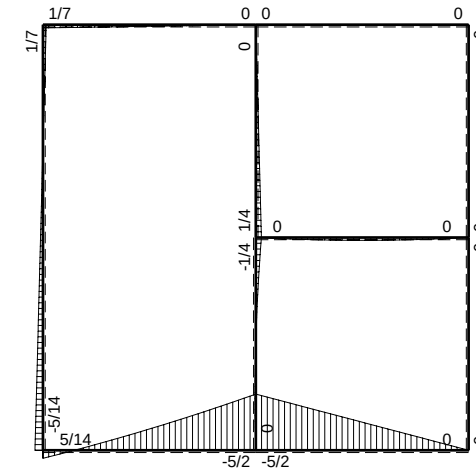
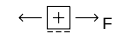
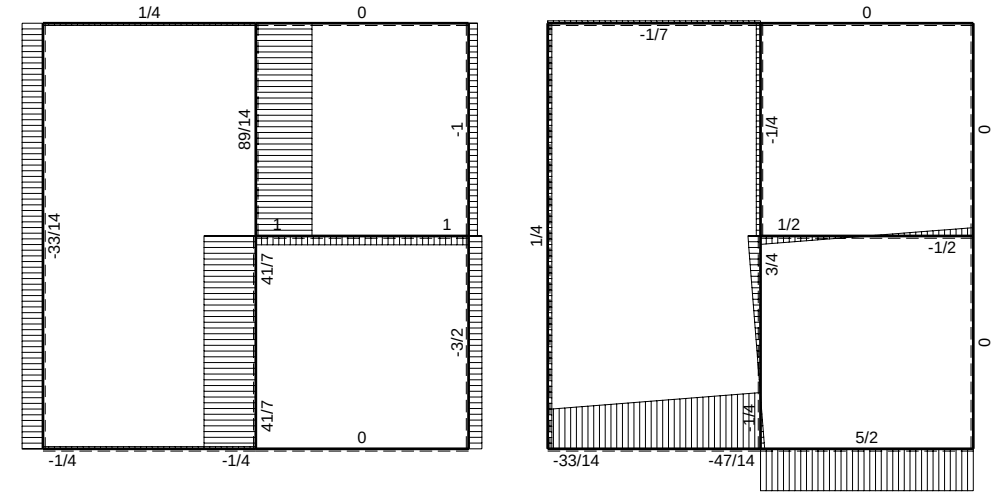
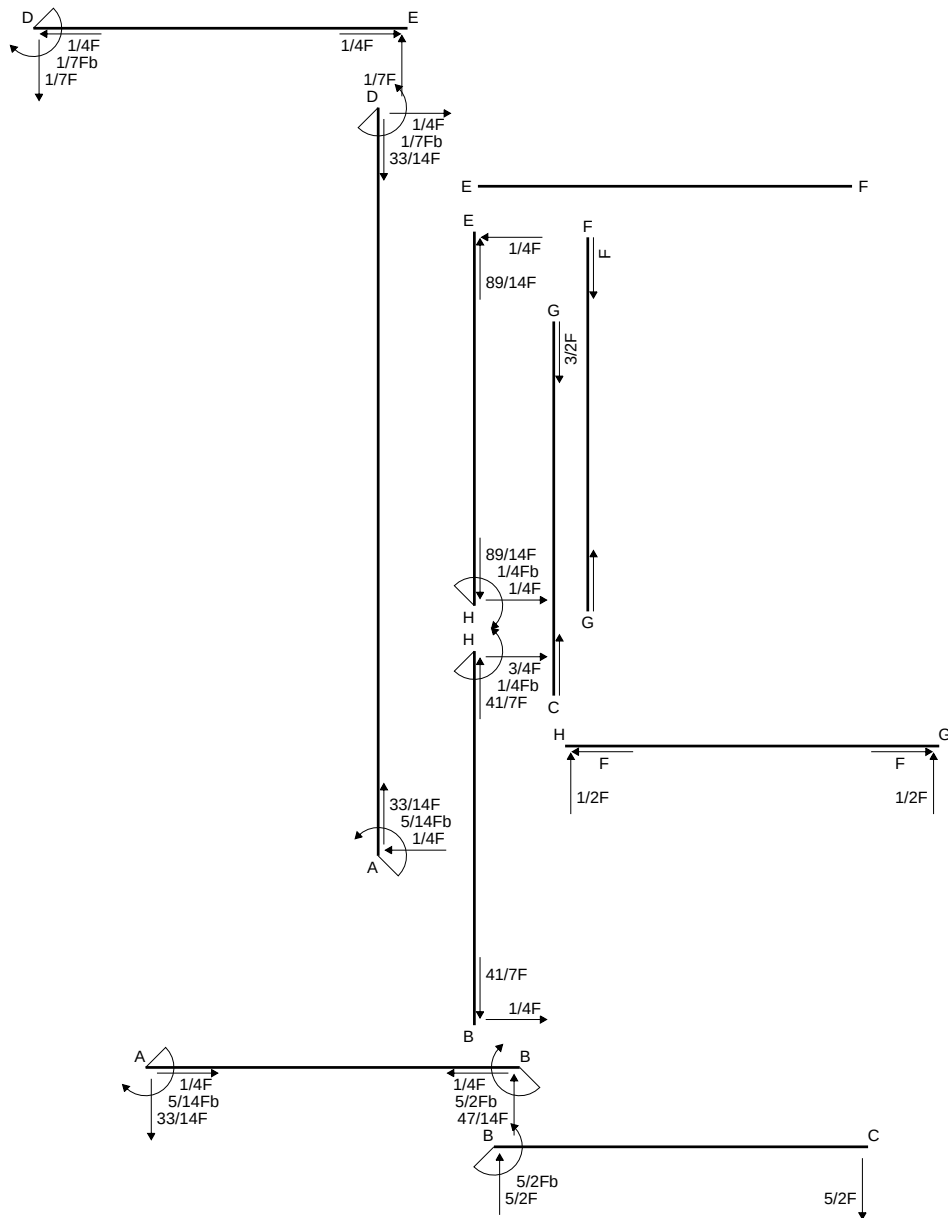
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	$-Fb/EJ$	0	0	0	0+0	0
CG b	0	0	Fb/EJ	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

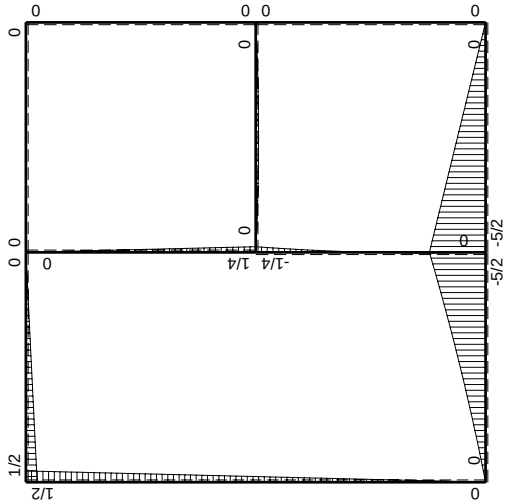
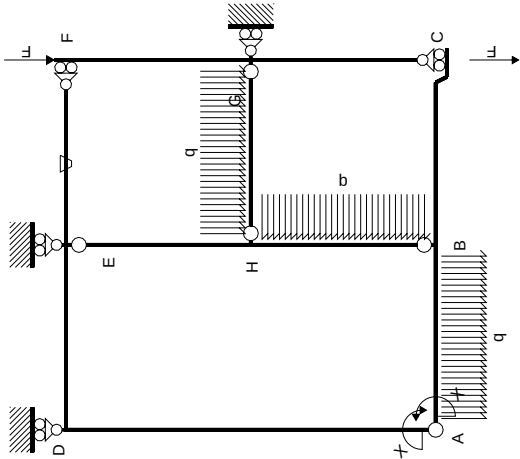
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2xb - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 xb - 3x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 xb) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



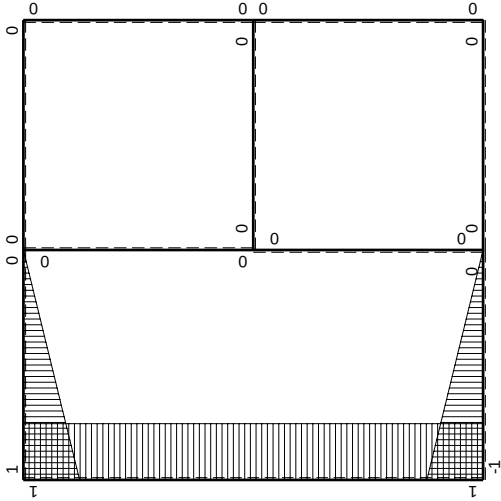
$$\begin{aligned}
A &= 930. \text{ mm}^2 \\
J_u &= 309835. \text{ mm}^4 \\
J_v &= 86166. \text{ mm}^4 \\
y_g &= 34.95 \text{ mm} \\
T_y &= 3250. \text{ N} \\
M_x &= -1950000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -9. \text{ mm} \\
v_m &= -34.95 \text{ mm} \\
\sigma_m &= -Mv/J_u = -219.9 \text{ N/mm}^2 \\
x_c &= 21. \text{ mm} \\
y_c &= 12. \text{ mm} \\
v_c &= -22.95 \text{ mm} \\
\sigma_c &= -Mv/J_u = -144.4 \text{ N/mm}^2 \\
\tau_c &= 10.44 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 145.5 \text{ N/mm}^2 \\
S &= 5971. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



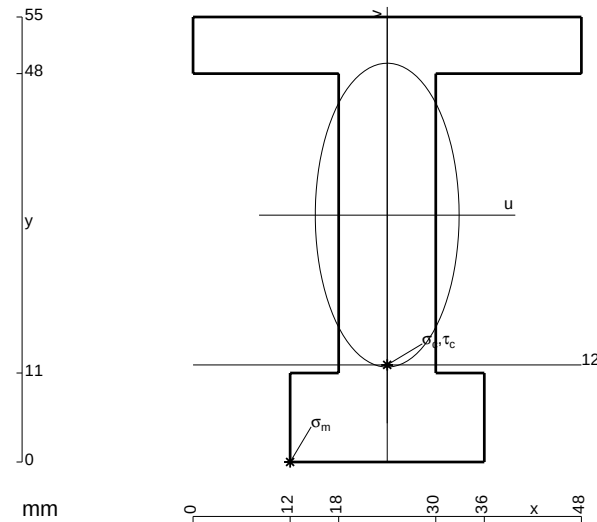
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

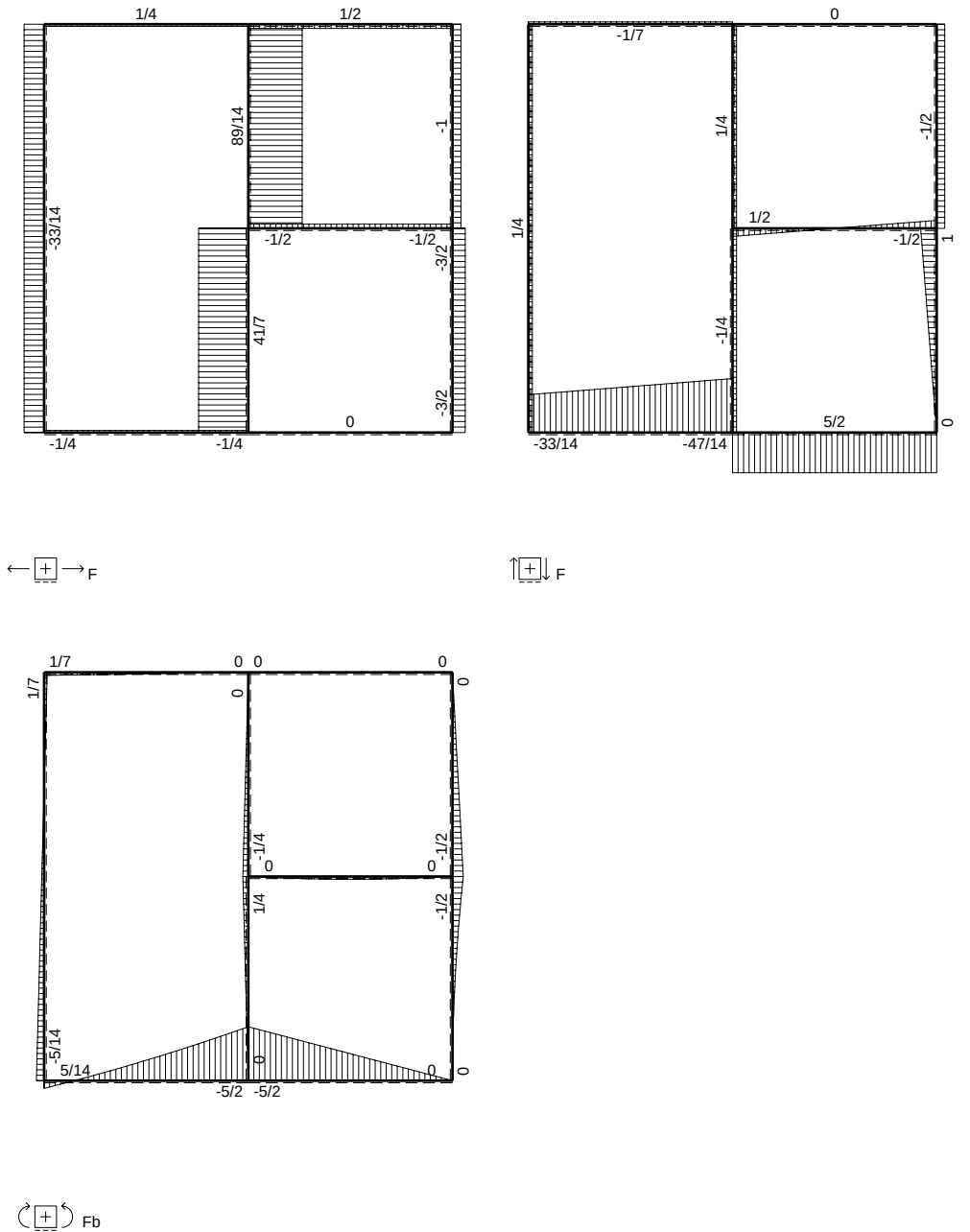
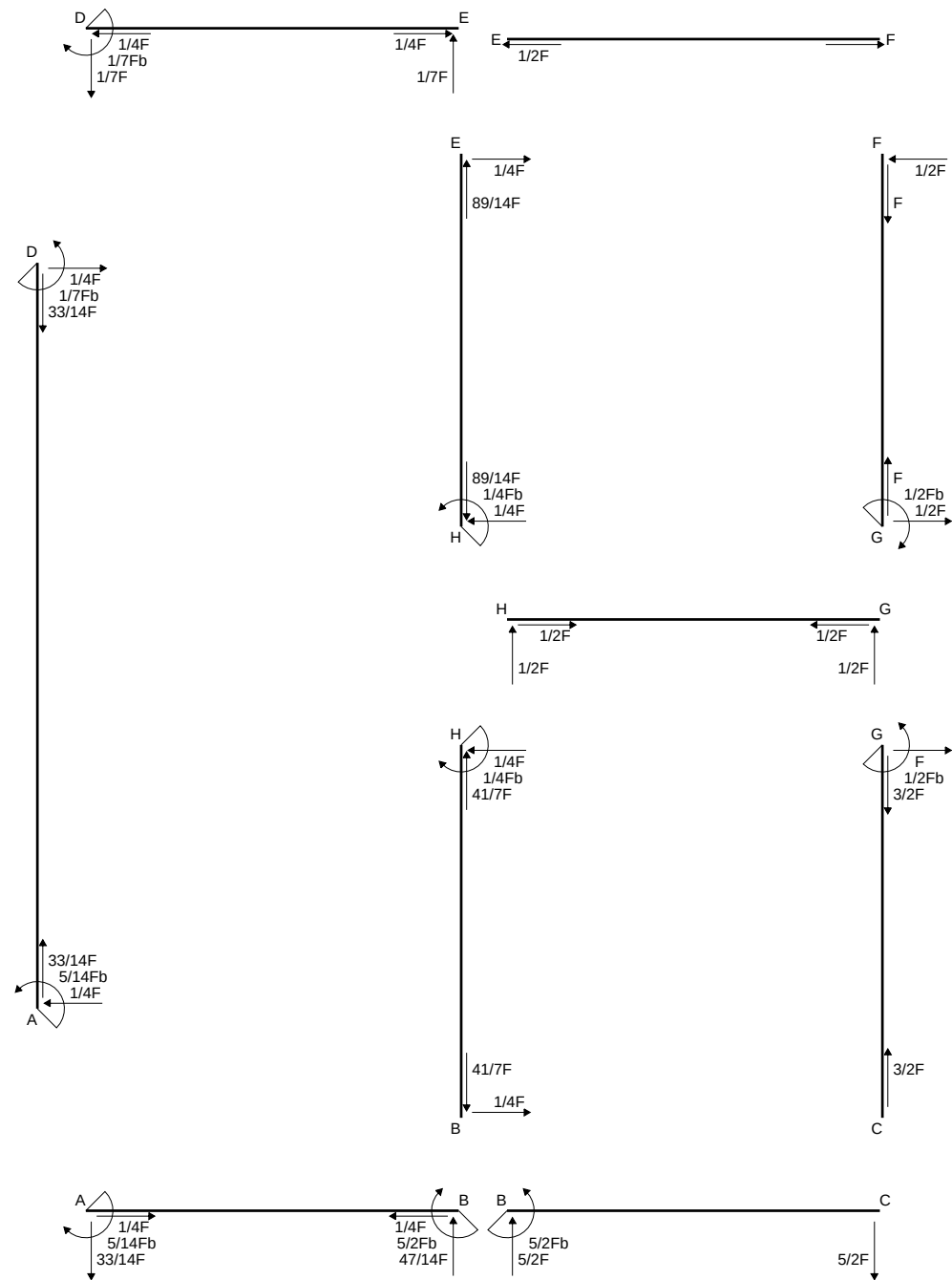
→	$M_x(x)$	$M_0(x)$	θ	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	0	0	0	0	0+0	0
CB b	0	$5/2Fx$	0	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	$-Fb/EJ$	0	0	0	0+0	0
FE b	0	0	Fb/EJ	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GC b	0	0	0	0	0	0	0+0	0
CG b	0	0	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$-1/4Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx+1/2qx^2$	0	0	0	0		
HE b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
EH b	0	$-1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

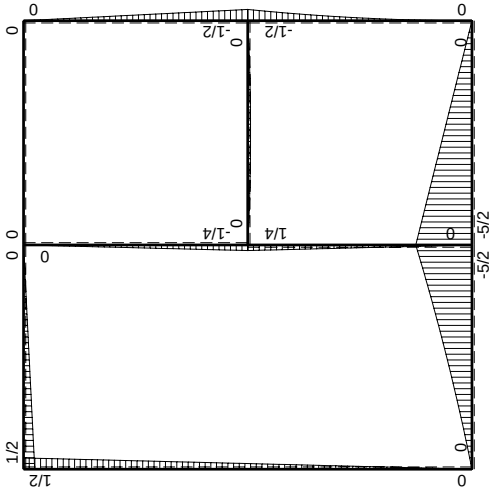
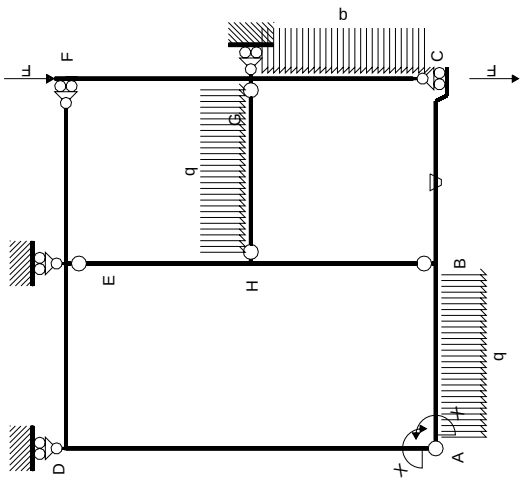
Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



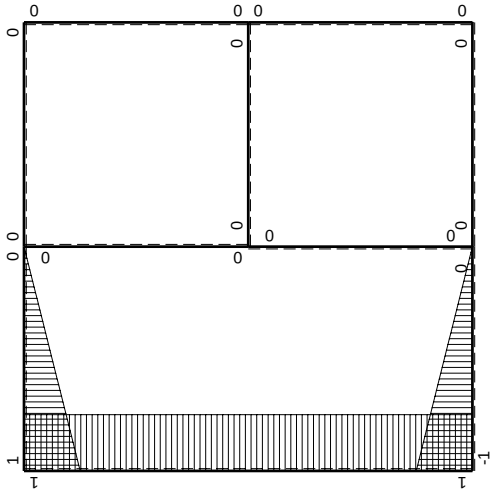
$$\begin{aligned}
A &= 1044. \text{ mm}^2 \\
J_u &= 368307. \text{ mm}^4 \\
J_v &= 82512. \text{ mm}^4 \\
y_g &= 30.51 \text{ mm} \\
T_y &= 4250. \text{ N} \\
M_x &= -2762500. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -30.51 \text{ mm} \\
\sigma_m &= -Mv/J_u = -228.9 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 12. \text{ mm} \\
v_c &= -18.51 \text{ mm} \\
\sigma_c &= -Mv/J_u = -138.8 \text{ N/mm}^2 \\
\tau_c &= 6.569 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 139.3 \text{ N/mm}^2 \\
S &= 6831. \text{ mm}^3
\end{aligned}$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



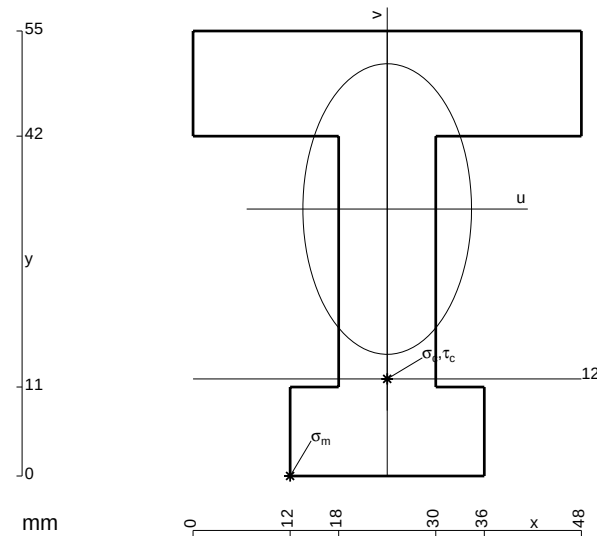
M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+x/b$	$-2Fx-1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	x/b	$5/2Fb-3Fx+1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
BC b	0	$-5/2Fb+5/2Fx$	$-Fb/EJ$	0	0	0	0+0	0
CB b	0	$5/2Fx$	Fb/EJ	0	0	0		
AD 2b	1	$1/4Fx$	0	$1/4Fx$	0	1	$(1/2+0)Fb^2/EJ$	$2Xb/EJ$
DA 2b	-1	$-1/2Fb+1/4Fx$	0	$1/2Fb-1/4Fx$	0	1		
DE b	$1-x/b$	$1/2Fb-1/2Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
ED b	$-x/b$	$-1/2Fx$	0	$1/2Fx^2/b$	0	x^2/b^2		
EF b	0	0	0	0	0	0	0+0	0
FE b	0	0	0	0	0	0		
FG b	0	$-1/2Fx$	0	0	0	0	0+0	0
GF b	0	$1/2Fb-1/2Fx$	0	0	0	0		
GC b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
CG b	0	$1/2qx^2$	0	0	0	0		
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HB b	0	$1/4Fb-1/4Fx$	0	0	0	0	0+0	0
BH b	0	$-1/4Fx$	0	0	0	0		
HE b	0	$-1/4Fb+1/4Fx$	0	0	0	0	0+0	0
EH b	0	$1/4Fx$	0	0	0	0		
AB	molla asta $-W_{1AB}(W_{0AB}+XW_{1AB})/k_{AB}$							$1/4Xb/EJ$
	totali						$25/24Fb^2/EJ$	$35/12Xb/EJ$
	iperstatica $X=W_{AB}$						$-5/14Fb$	

Sviluppi di calcolo iperstatica

$$\begin{aligned}
L_{AB}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{BA}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx + 1 \frac{1}{4} \frac{b}{EJ} = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} \\
&= (1/3 b) \frac{1}{EJ} + 1 \frac{1}{4} \frac{b}{EJ} = 7/12 \frac{b}{EJ} \\
L_{AD}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DA}^{xx} &= \int_0^{2b} (1) \frac{1}{EJ} dx = \left[x \right]_0^{2b} \frac{1}{EJ} \\
&= (2b) \frac{1}{EJ} = 2 \frac{b}{EJ} \\
L_{DE}^{xx} &= \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{ED}^{xx} &= \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ} \\
&= (1/3 b) \frac{1}{EJ} = 1/3 \frac{b}{EJ} \\
L_{AB}^{x_0} &= \int_0^b (2x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (b - 1/2 b - 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{BA}^{x_0} &= \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= \left[5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} \\
&= (5/4 b - b + 1/8 b) Fb \frac{1}{EJ} + 1 \frac{0}{4} \frac{Fb^2}{EJ} = 3/8 \frac{Fb^2}{EJ} \\
L_{AD}^{x_0} &= \int_0^{2b} (1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DA}^{x_0} &= \int_0^{2b} (1/2 - 1/4 x/b) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/8 x^2/b \right]_0^{2b} Fb \frac{1}{EJ} \\
&= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 \frac{Fb^2}{EJ} \\
L_{DE}^{x_0} &= \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/2 b - 1/2 b + 1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ} \\
L_{ED}^{x_0} &= \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ} \\
&= (1/6 b) Fb \frac{1}{EJ} = 1/6 \frac{Fb^2}{EJ}
\end{aligned}$$



$$\begin{aligned}
A &= 1260. \text{ mm}^2 \\
J_u &= 406524. \text{ mm}^4 \\
J_v &= 136944. \text{ mm}^4 \\
y_g &= 33. \text{ mm} \\
T_y &= 4200. \text{ N} \\
M_x &= -2940000. \text{ Nmm} \\
x_m &= 12. \text{ mm} \\
u_m &= -12. \text{ mm} \\
v_m &= -33. \text{ mm} \\
\sigma_m &= -Mv/J_u = -238.6 \text{ N/mm}^2 \\
x_c &= 24. \text{ mm} \\
y_c &= 12. \text{ mm} \\
v_c &= -21. \text{ mm} \\
\sigma_c &= -Mv/J_u = -151.8 \text{ N/mm}^2 \\
\tau_c &= 6.472 \text{ N/mm}^2 \\
\sigma_0 &= \sqrt{\sigma^2 + 3\tau^2} = 152.3 \text{ N/mm}^2 \\
S &= 7517. \text{ mm}^3
\end{aligned}$$