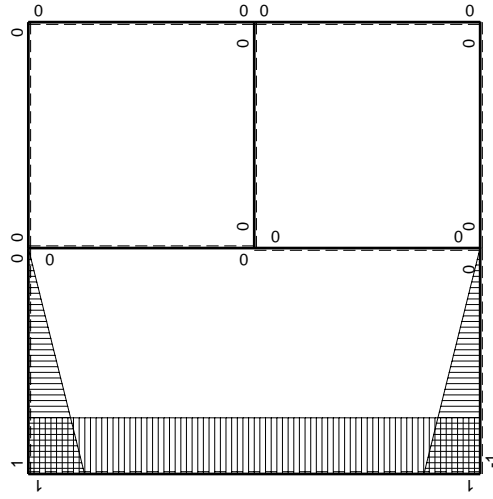


Schema di calcolo iperstatico

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	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

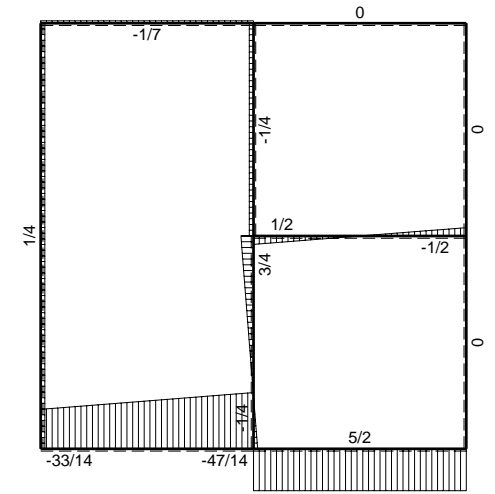
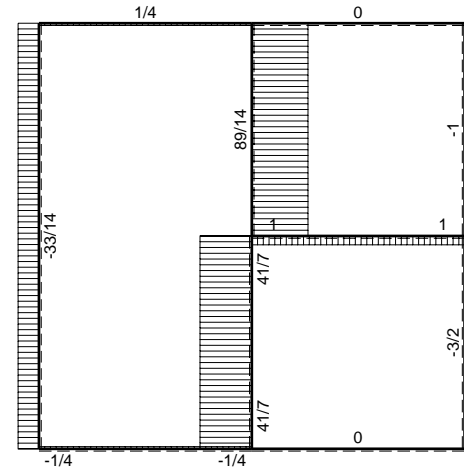
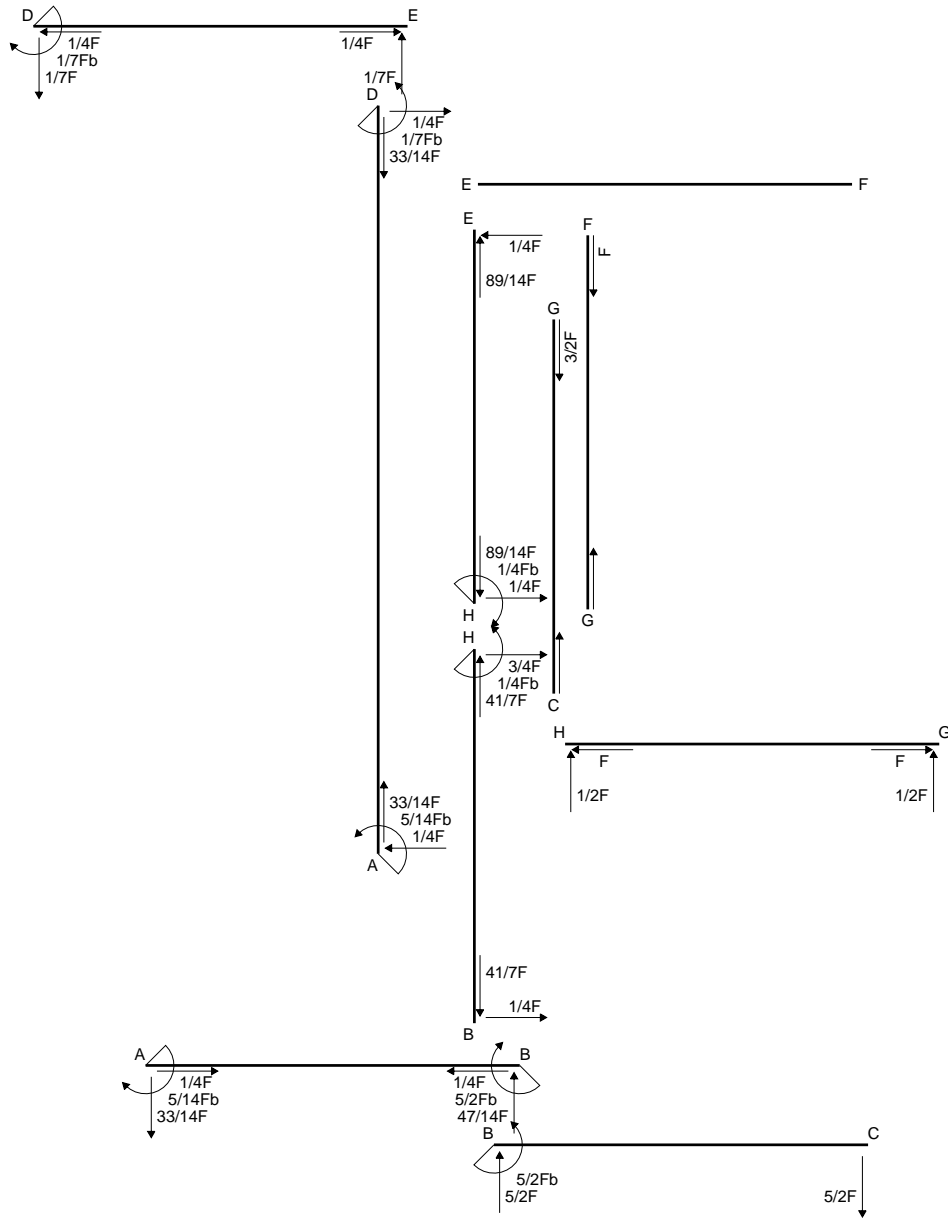
$$= (b - 5/2 b + 4/3 b) Fb \frac{1}{EJ} = -1/6 \frac{Fb^2}{EJ}$$

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

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

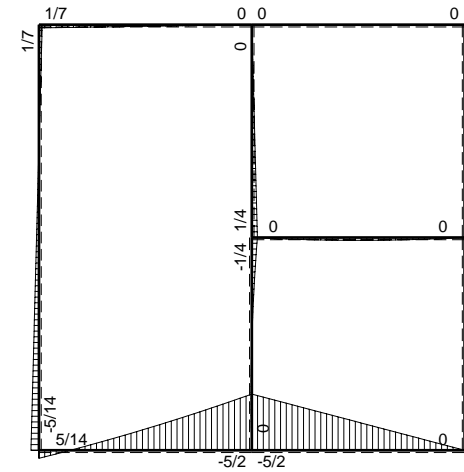
$$L_{ED}^{xo} = \int_0^b (1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

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

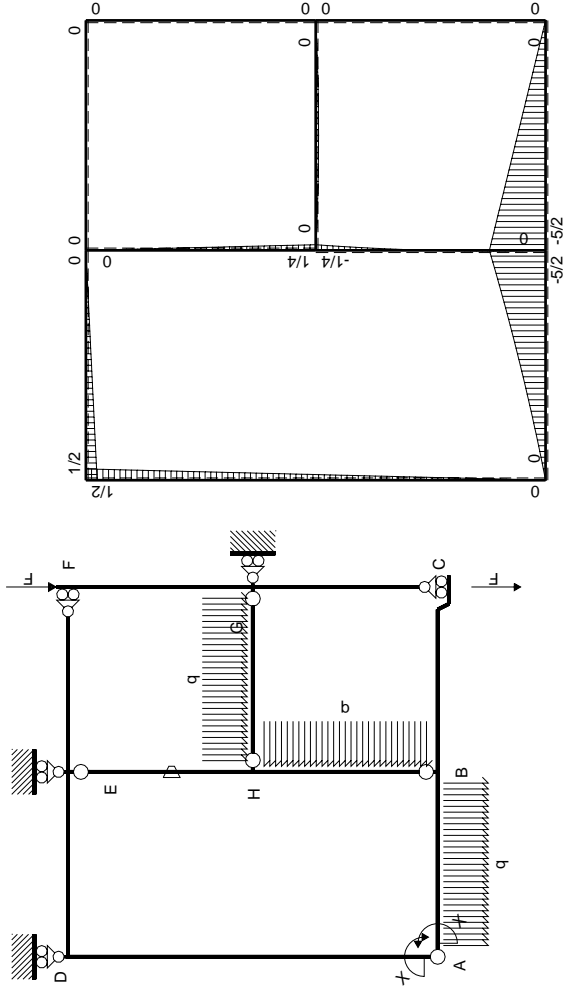


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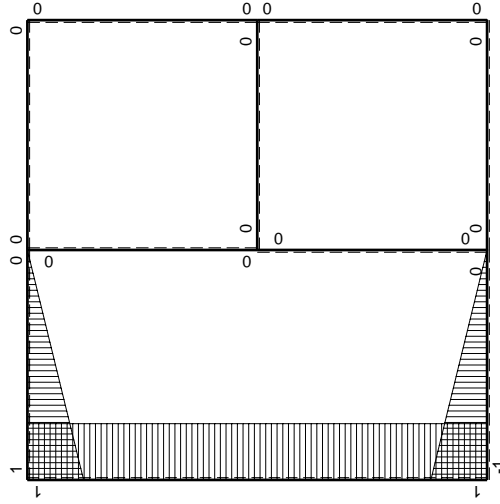


⊕ ⊖ Fb



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	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
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

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

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

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

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

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

$$= (2b) \cdot 1/EJ = 2 \cdot b/EJ$$

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

$$= (2b) \cdot 1/EJ = 2 \cdot b/EJ$$

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

$$= (b - b + 1/3 b) \cdot 1/EJ = 1/3 \cdot b/EJ$$

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

$$= (1/3 b) \cdot 1/EJ = 1/3 \cdot b/EJ$$

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

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

$$= (b - 1/2 b - 1/8 b) \cdot Fb \cdot 1/EJ + 1 \cdot 0 \cdot 1/4 \cdot Fb^2/EJ = 3/8 \cdot Fb^2/EJ$$

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

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

$$= (5/4 b - b + 1/8 b) \cdot Fb \cdot 1/EJ + 1 \cdot 0 \cdot 1/4 \cdot Fb^2/EJ = 3/8 \cdot Fb^2/EJ$$

$$L_{AD}^{xo} = \int_0^{2b} (1/4 x/b) \cdot Fb \cdot 1/EJ \, dx = \left[1/8 x^2/b \right]_0^{2b} \cdot Fb \cdot 1/EJ$$

$$= (1/2 b) \cdot Fb \cdot 1/EJ = 1/2 \cdot Fb^2/EJ$$

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

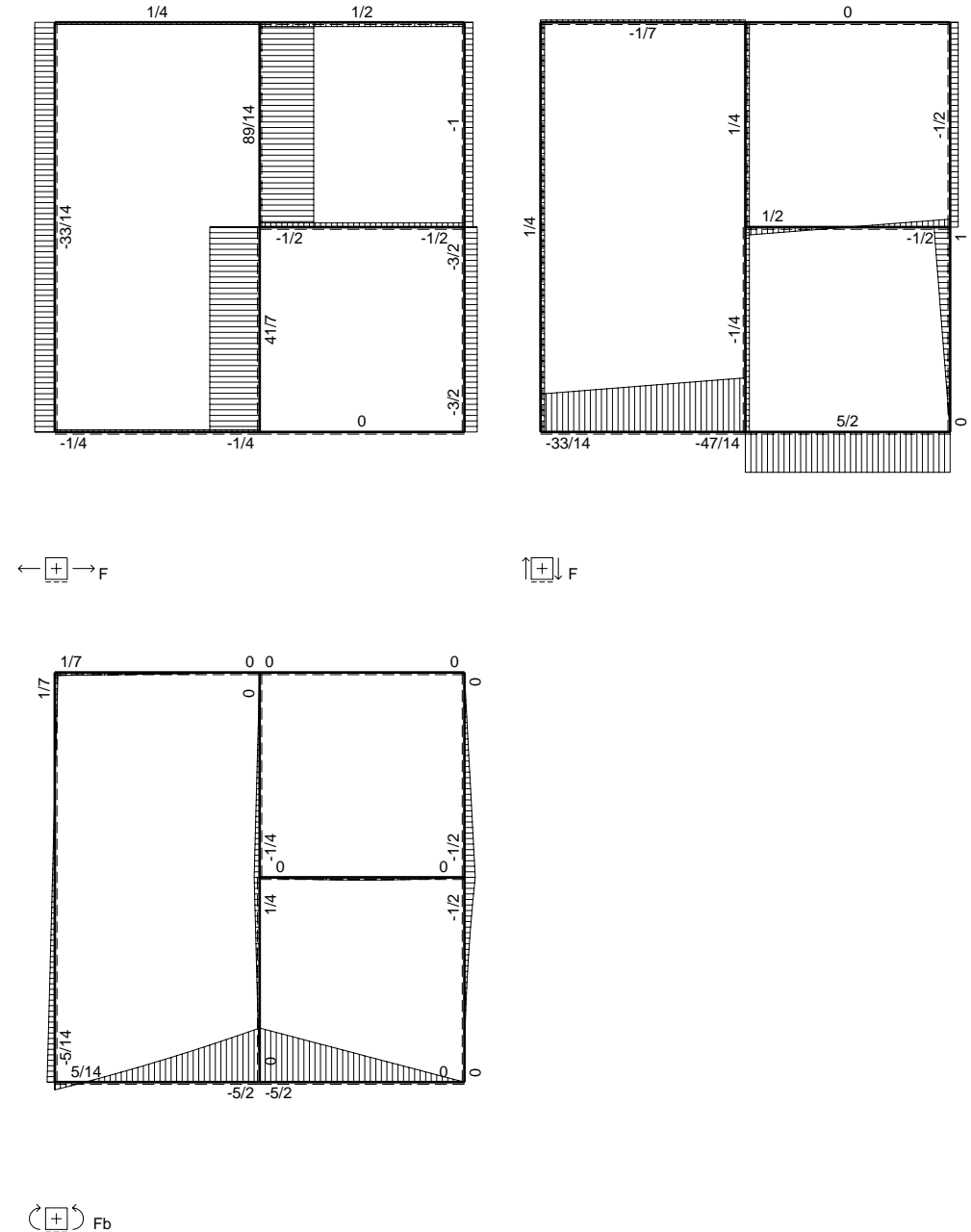
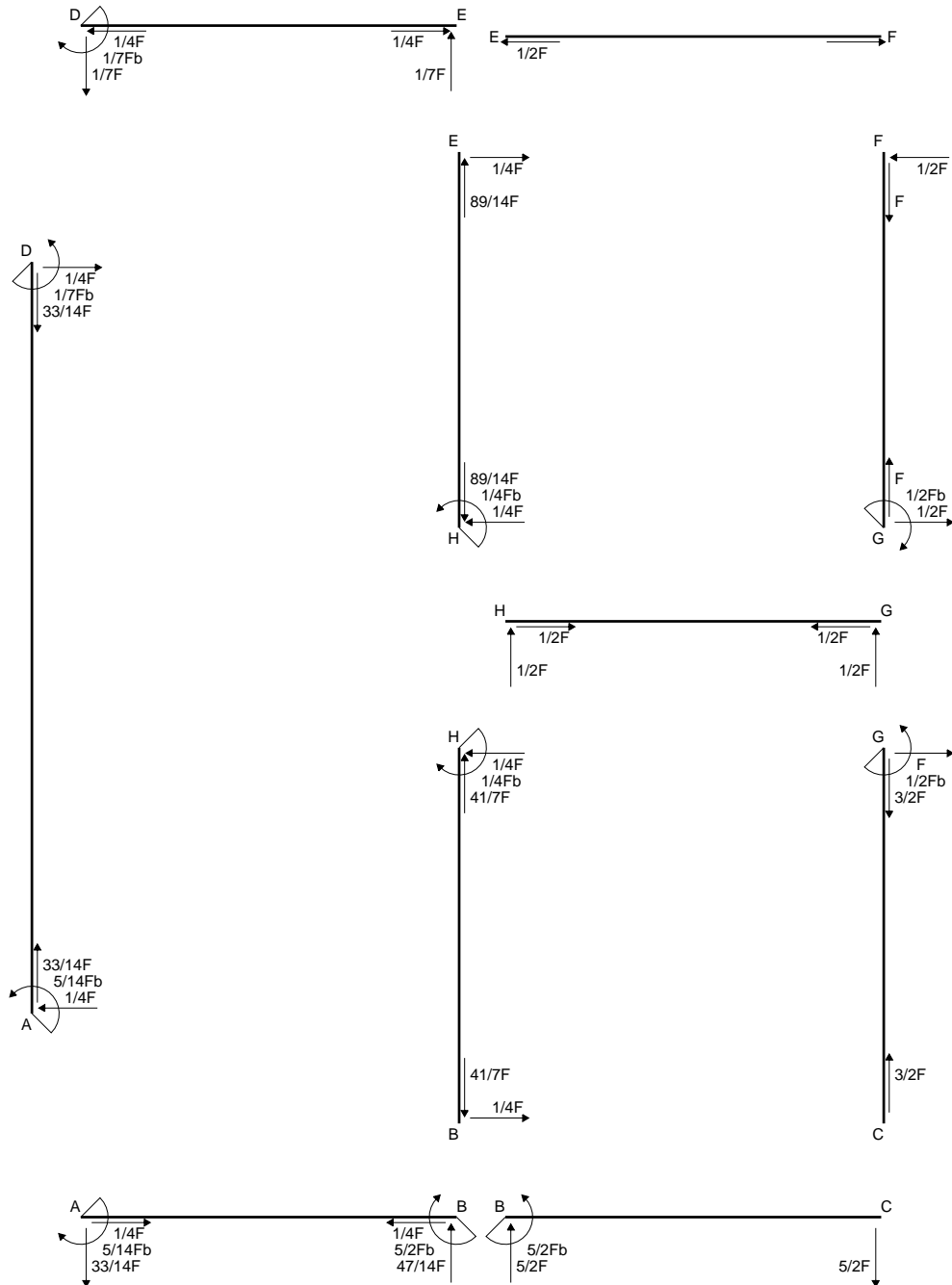
$$= (b - 1/2 b) \cdot Fb \cdot 1/EJ = 1/2 \cdot Fb^2/EJ$$

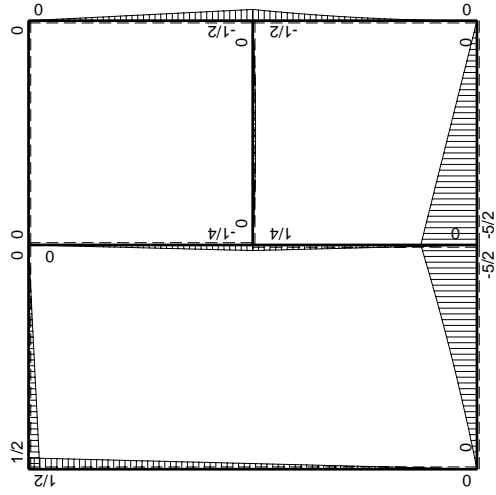
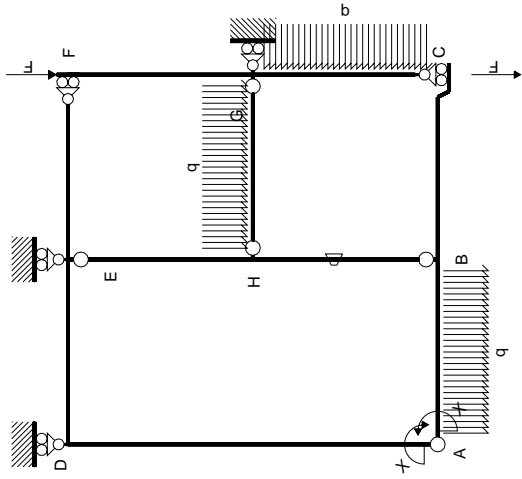
$$L_{DE}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) \cdot Fb \cdot 1/EJ \, dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b \cdot Fb \cdot 1/EJ$$

$$= (1/2 b - 1/2 b + 1/6 b) \cdot Fb \cdot 1/EJ = 1/6 \cdot Fb^2/EJ$$

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

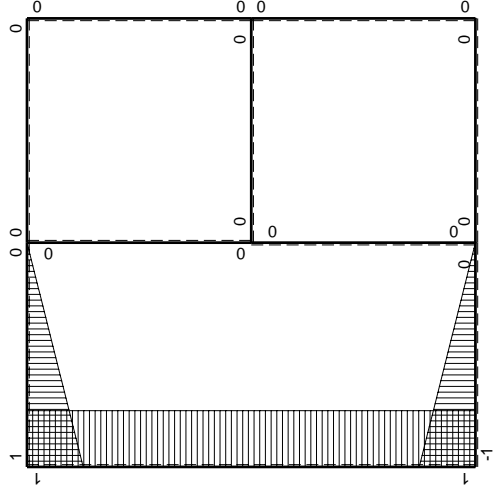
$$= (1/6 b) \cdot Fb \cdot 1/EJ = 1/6 \cdot Fb^2/EJ$$





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	$-1/2Fb+Fx-1/2qx^2$	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

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

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

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

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

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

$$= (2b) \cdot 1/EJ = 2 \cdot b/EJ$$

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

$$= (2b) \cdot 1/EJ = 2 \cdot b/EJ$$

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

$$= (b - b + 1/3 b) \cdot 1/EJ = 1/3 \cdot b/EJ$$

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

$$= (1/3 b) \cdot 1/EJ = 1/3 \cdot b/EJ$$

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

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

$$= (b - 1/2 b - 1/8 b) \cdot Fb \cdot 1/EJ + 1 \cdot 0 \cdot 1/4 \cdot Fb^2/EJ = 3/8 \cdot Fb^2/EJ$$

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

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

$$= (5/4 b - b + 1/8 b) \cdot Fb \cdot 1/EJ + 1 \cdot 0 \cdot 1/4 \cdot Fb^2/EJ = 3/8 \cdot Fb^2/EJ$$

$$L_{AD}^{xo} = \int_0^{2b} (1/4 x/b) \cdot Fb \cdot 1/EJ \, dx = \left[1/8 x^2/b \right]_0^{2b} \cdot Fb \cdot 1/EJ$$

$$= (1/2 b) \cdot Fb \cdot 1/EJ = 1/2 \cdot Fb^2/EJ$$

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

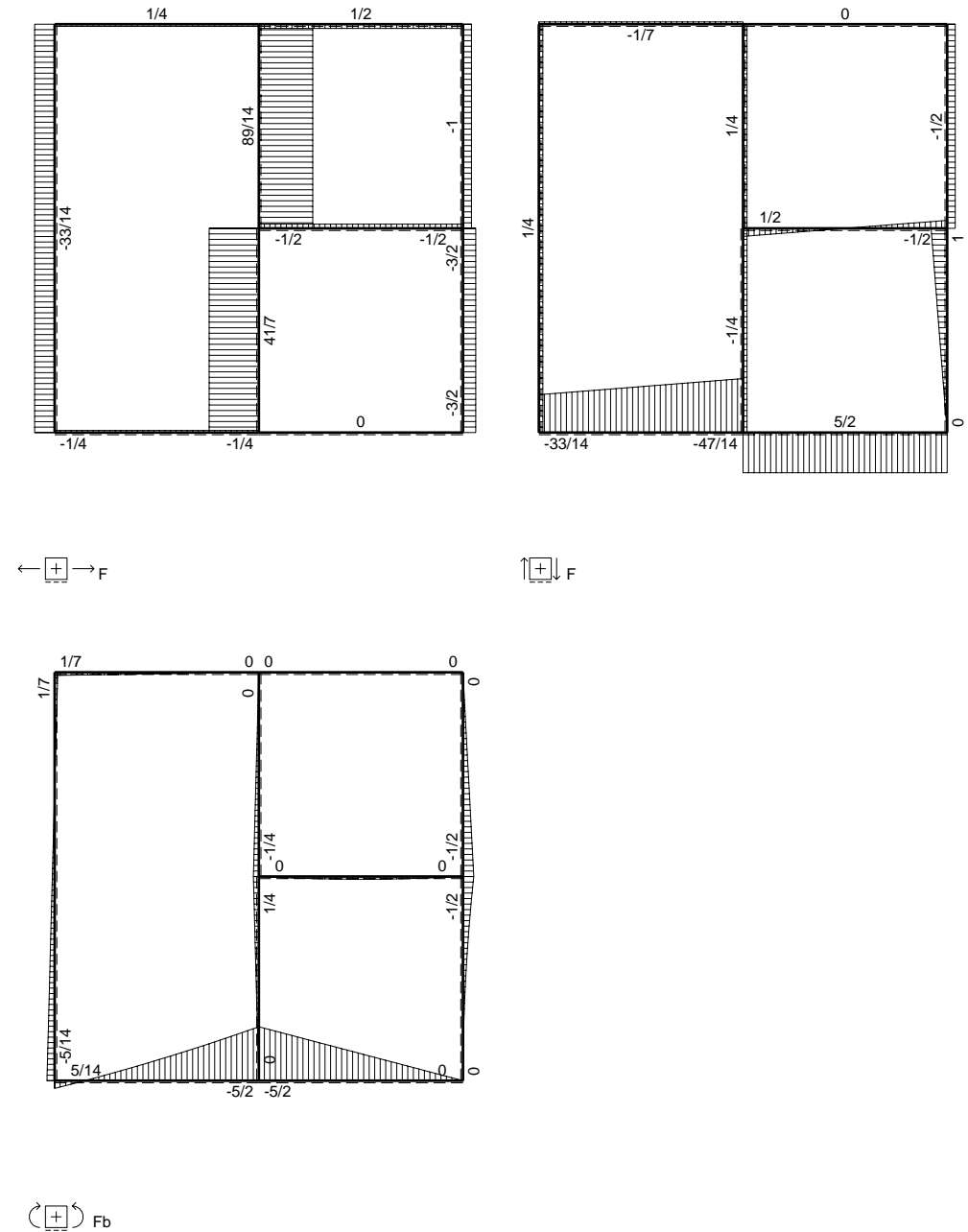
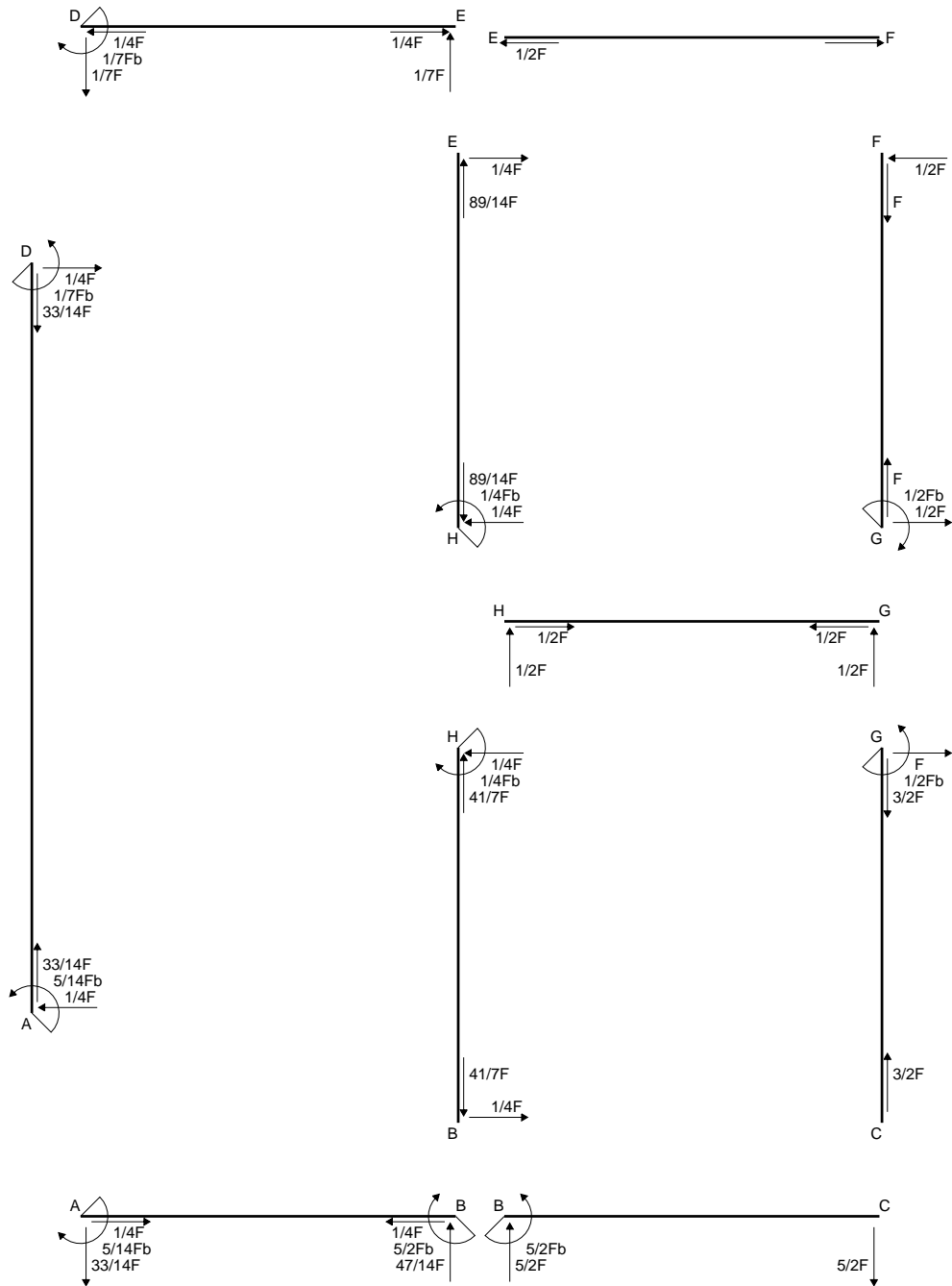
$$= (b - 1/2 b) \cdot Fb \cdot 1/EJ = 1/2 \cdot Fb^2/EJ$$

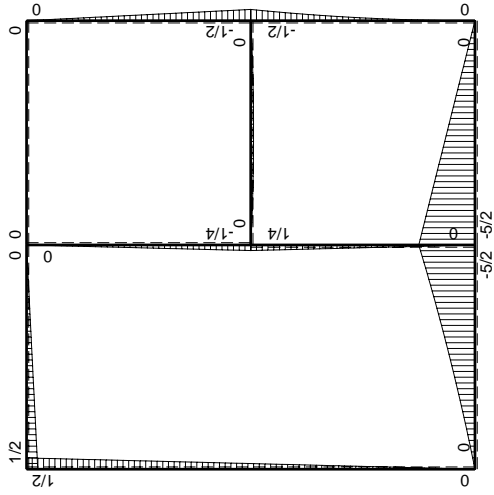
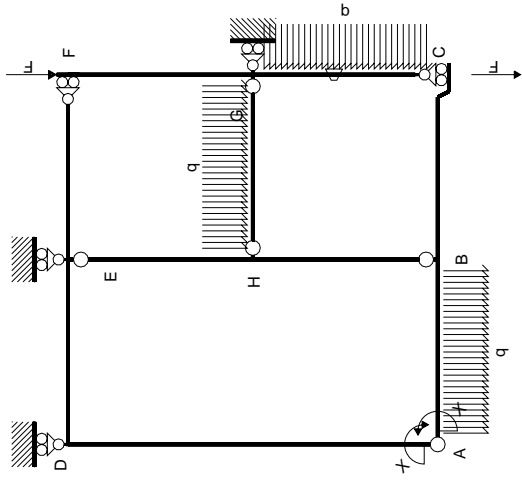
$$L_{DE}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) \cdot Fb \cdot 1/EJ \, dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b \cdot Fb \cdot 1/EJ$$

$$= (1/2 b - 1/2 b + 1/6 b) \cdot Fb \cdot 1/EJ = 1/6 \cdot Fb^2/EJ$$

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

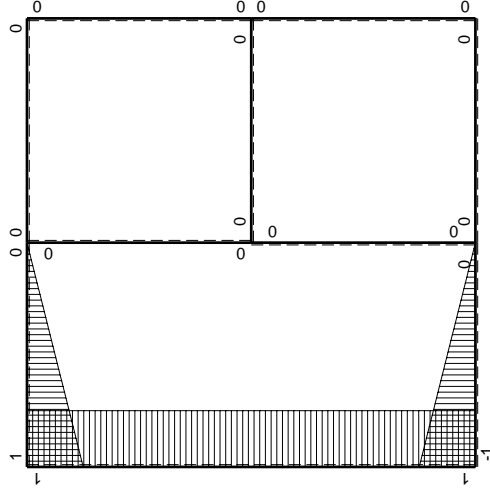
$$= (1/6 b) \cdot Fb \cdot 1/EJ = 1/6 \cdot Fb^2/EJ$$





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

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

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

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

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

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

$$= (2b) \cdot 1/EJ = 2 \cdot b/EJ$$

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

$$= (2b) \cdot 1/EJ = 2 \cdot b/EJ$$

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

$$= (b - b + 1/3 b) \cdot 1/EJ = 1/3 \cdot b/EJ$$

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

$$= (1/3 b) \cdot 1/EJ = 1/3 \cdot b/EJ$$

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

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

$$= (b - 1/2 b - 1/8 b) \cdot Fb \cdot 1/EJ + 1 \cdot 0 \cdot 1/4 \cdot Fb^2/EJ = 3/8 \cdot Fb^2/EJ$$

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

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

$$= (5/4 b - b + 1/8 b) \cdot Fb \cdot 1/EJ + 1 \cdot 0 \cdot 1/4 \cdot Fb^2/EJ = 3/8 \cdot Fb^2/EJ$$

$$L_{AD}^{xo} = \int_0^{2b} (1/4 x/b) \cdot Fb \cdot 1/EJ \, dx = \left[1/8 x^2/b \right]_0^{2b} \cdot Fb \cdot 1/EJ$$

$$= (1/2 b) \cdot Fb \cdot 1/EJ = 1/2 \cdot Fb^2/EJ$$

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

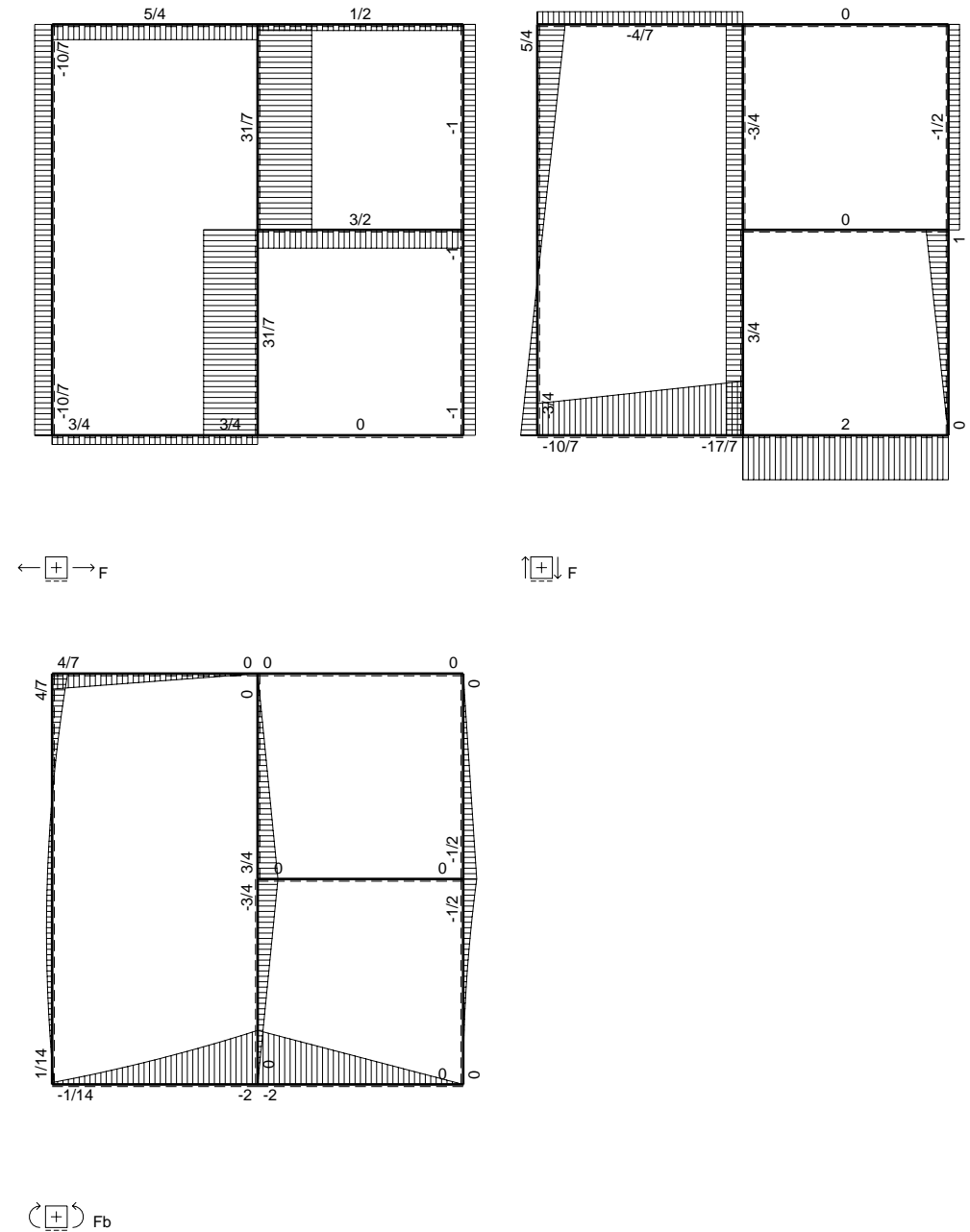
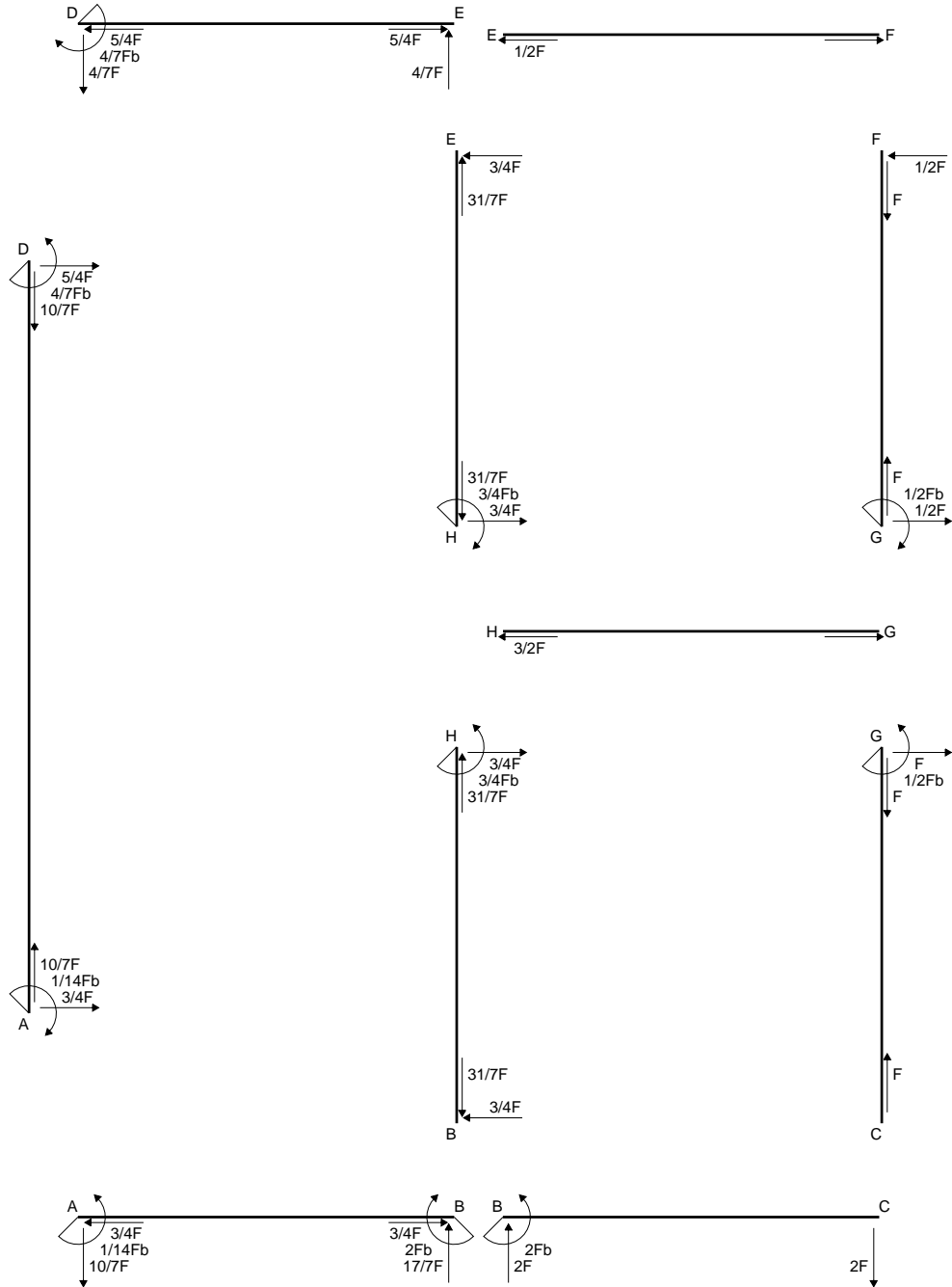
$$= (b - 1/2 b) \cdot Fb \cdot 1/EJ = 1/2 \cdot Fb^2/EJ$$

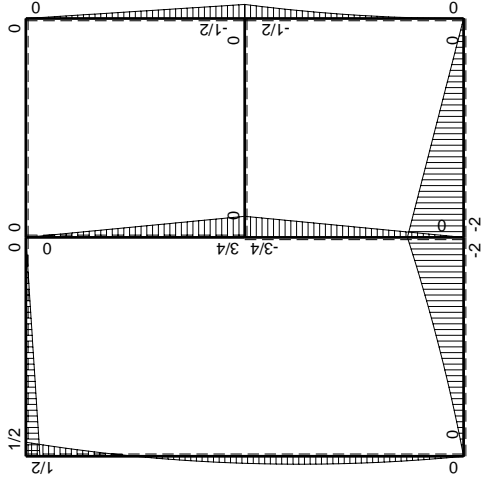
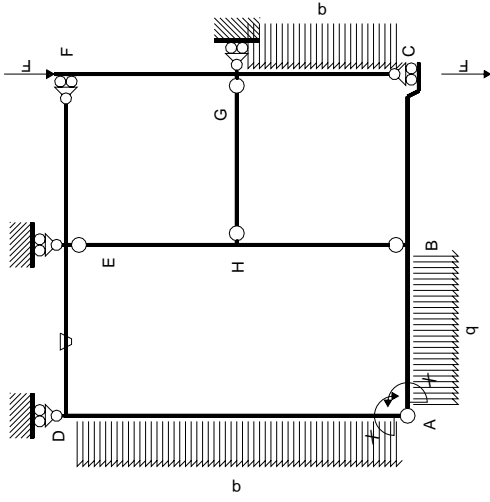
$$L_{DE}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) \cdot Fb \cdot 1/EJ \, dx = \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b \cdot Fb \cdot 1/EJ$$

$$= (1/2 b - 1/2 b + 1/6 b) \cdot Fb \cdot 1/EJ = 1/6 \cdot Fb^2/EJ$$

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

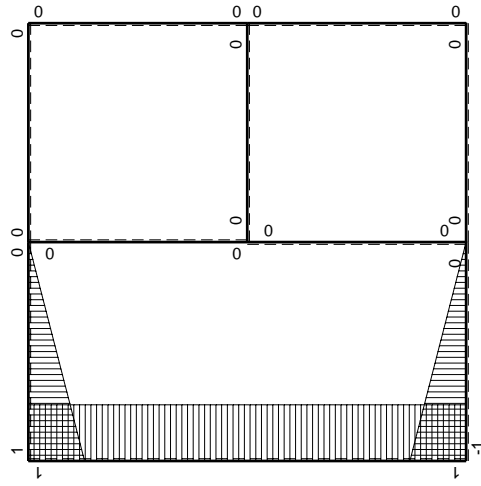
$$= (1/6 b) \cdot Fb \cdot 1/EJ = 1/6 \cdot Fb^2/EJ$$





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	$-3/4Fx+1/2qx^2$	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

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

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

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

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

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

$$= (2b) \cdot 1/EJ = 2 \cdot b/EJ$$

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

$$= (2b) \cdot 1/EJ = 2 \cdot b/EJ$$

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

$$= (b - b + 1/3 b) \cdot 1/EJ = 1/3 \cdot b/EJ$$

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

$$= (1/3 b) \cdot 1/EJ = 1/3 \cdot b/EJ$$

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

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

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

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

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

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

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

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

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

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

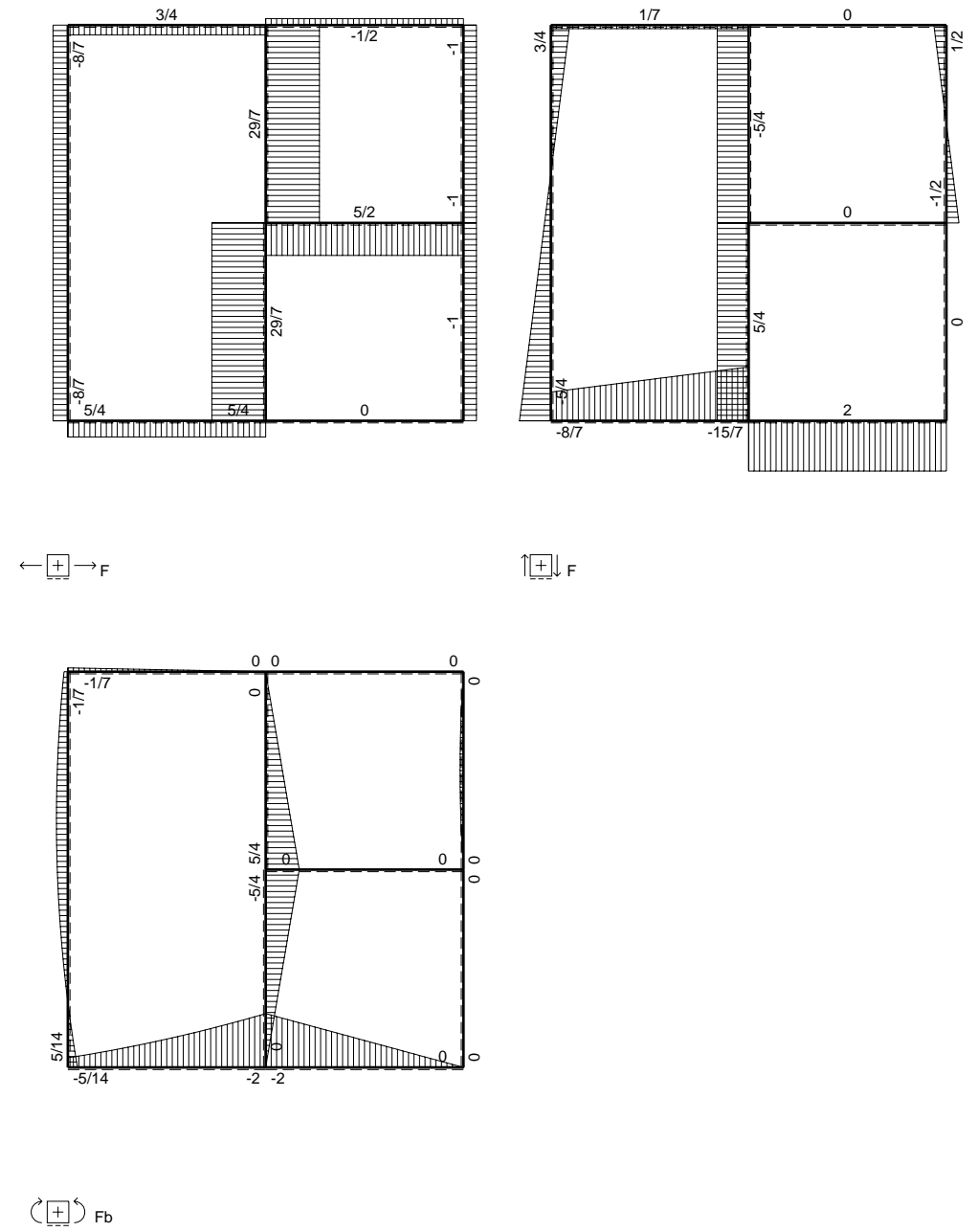
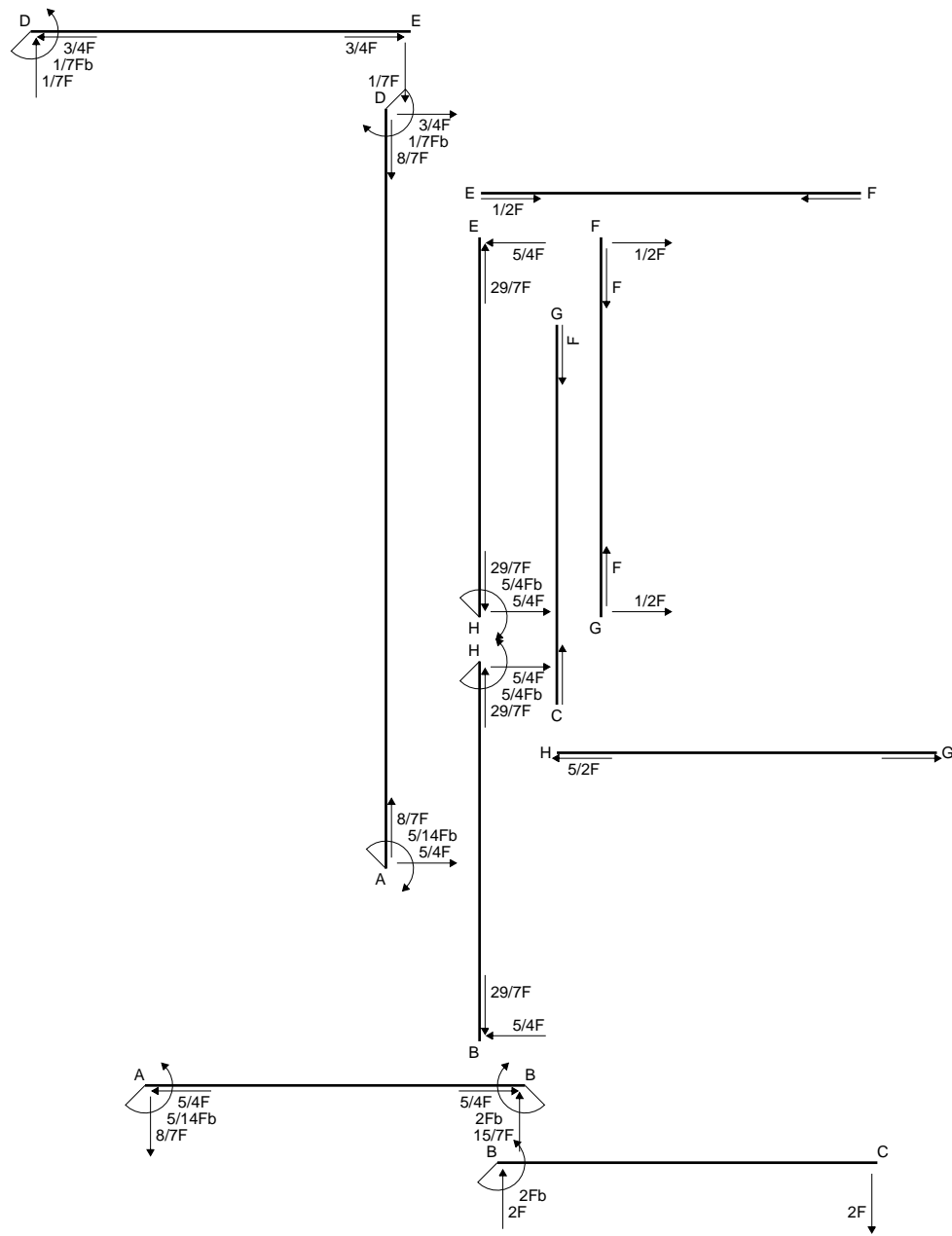
$$L_{DE}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) \cdot Fb \cdot 1/EJ \, dx + \int_0^b (-1 + x/b) \cdot \theta \, dx$$

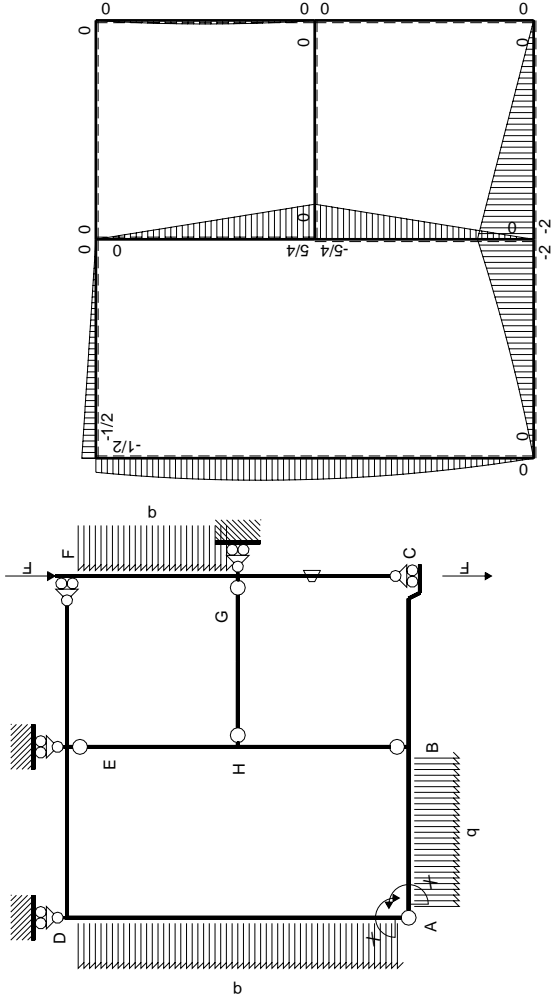
$$= \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b \cdot Fb \cdot 1/EJ + \left[-x + 1/2 x^2/b \right]_0^b \cdot \theta$$

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

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

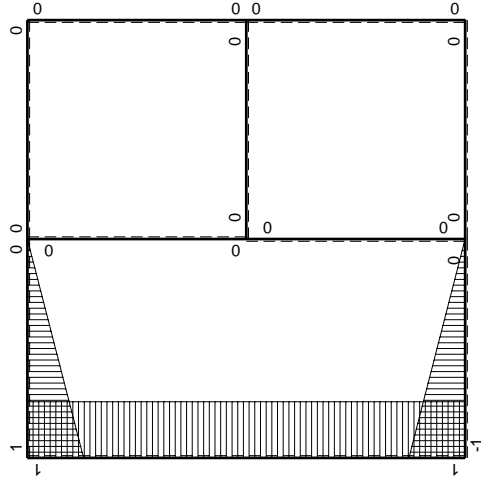
$$= (1/6 b) \cdot Fb \cdot 1/EJ + (1/2 b) \cdot \theta = -1/3 \cdot Fb^2/EJ$$





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	$1/2Fx-1/2qx^2$	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

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

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

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

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

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

$$= (2b) \cdot 1/EJ = 2 \cdot b/EJ$$

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

$$= (2b) \cdot 1/EJ = 2 \cdot b/EJ$$

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

$$= (b - b + 1/3 b) \cdot 1/EJ = 1/3 \cdot b/EJ$$

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

$$= (1/3 b) \cdot 1/EJ = 1/3 \cdot b/EJ$$

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

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

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

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

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

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

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

$$= (-5/2 b + 4/3 b) \cdot Fb \cdot 1/EJ = -7/6 \cdot Fb^2/EJ$$

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

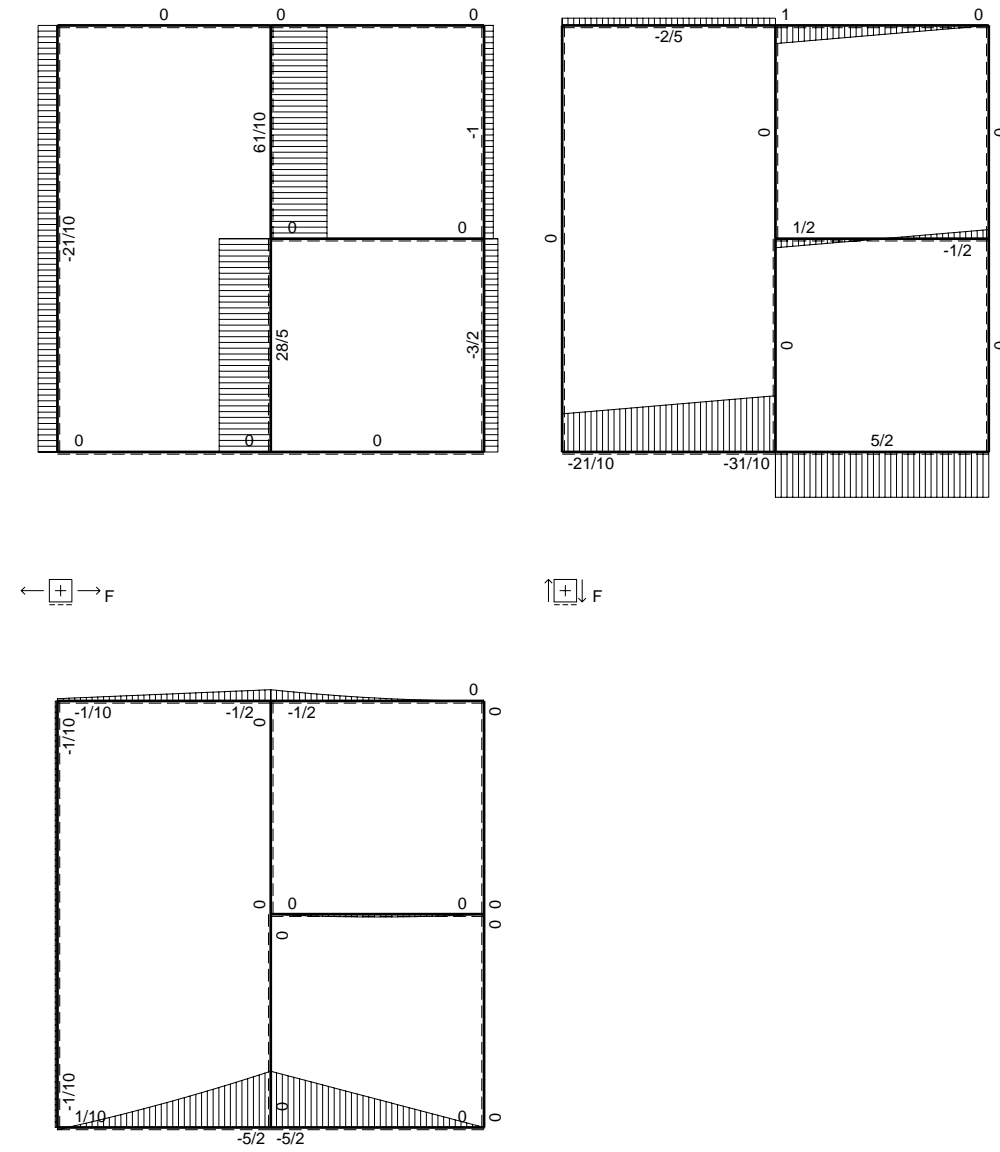
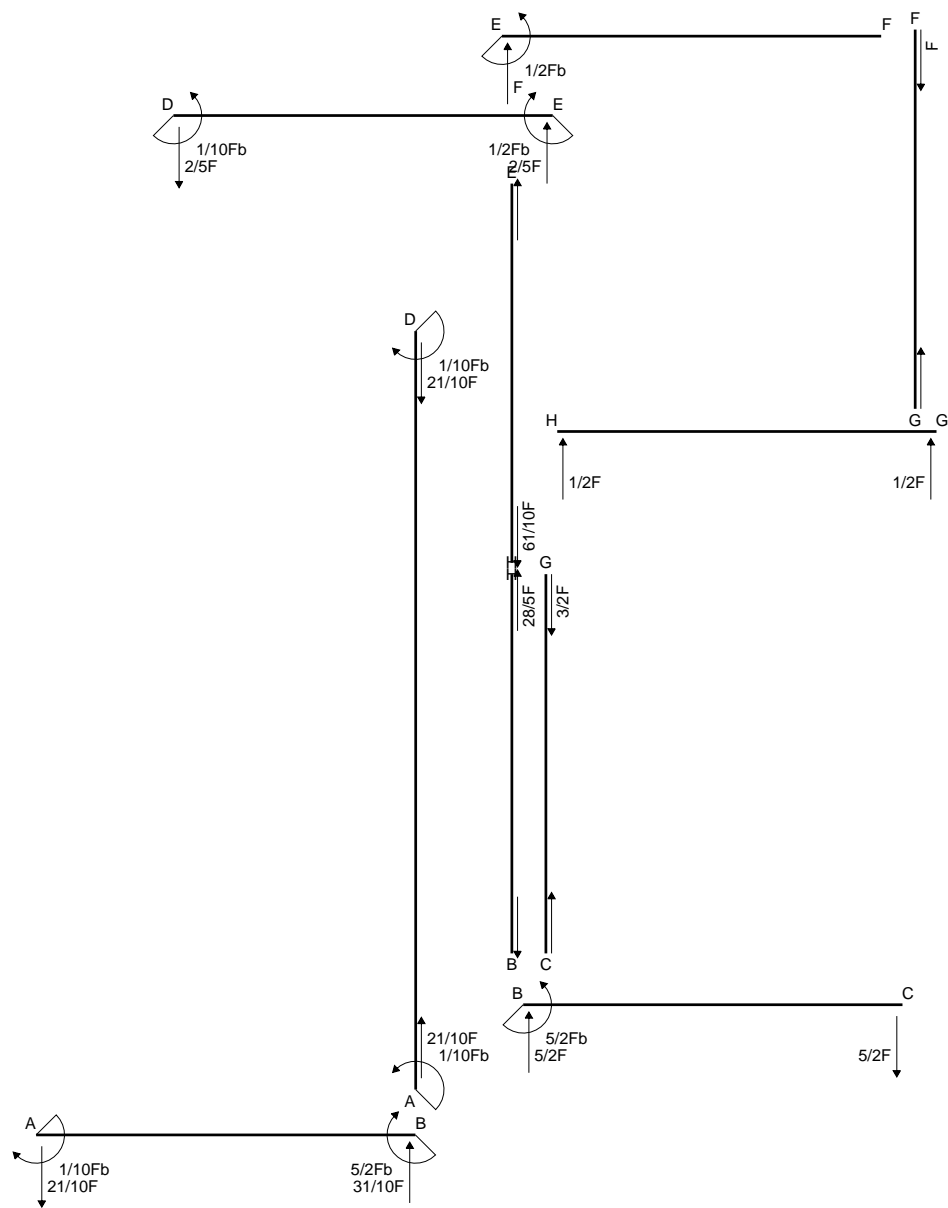
$$= (-b - 3/2 b + 4/3 b) \cdot Fb \cdot 1/EJ = -7/6 \cdot Fb^2/EJ$$

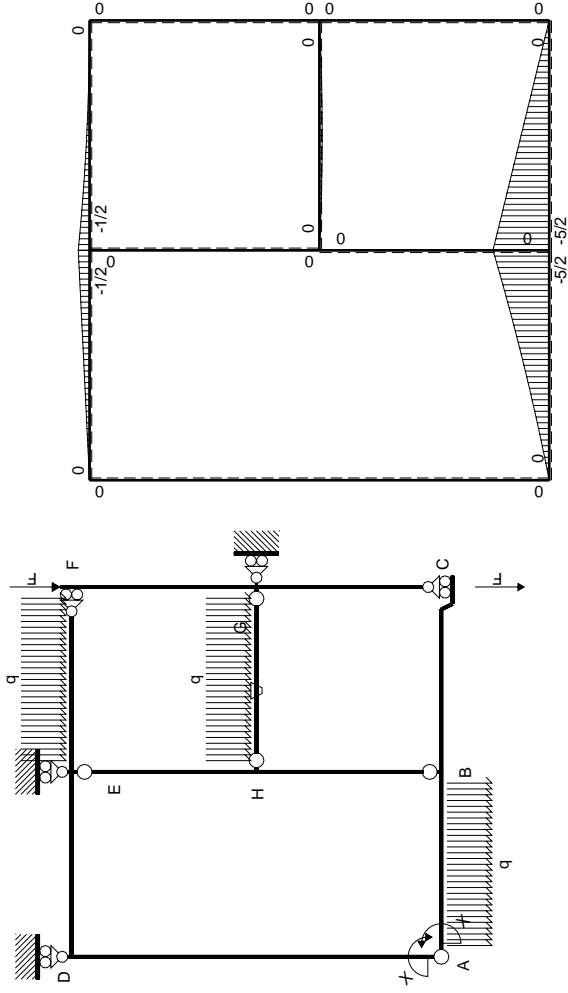
$$L_{DE}^{xo} = \int_0^b (-1/2 + x/b - 1/2 x^2/b^2) \cdot Fb \cdot 1/EJ \, dx = \left[-1/2 x + 1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b \cdot Fb \cdot 1/EJ$$

$$= (-1/2 b + 1/2 b - 1/6 b) \cdot Fb \cdot 1/EJ = -1/6 \cdot Fb^2/EJ$$

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

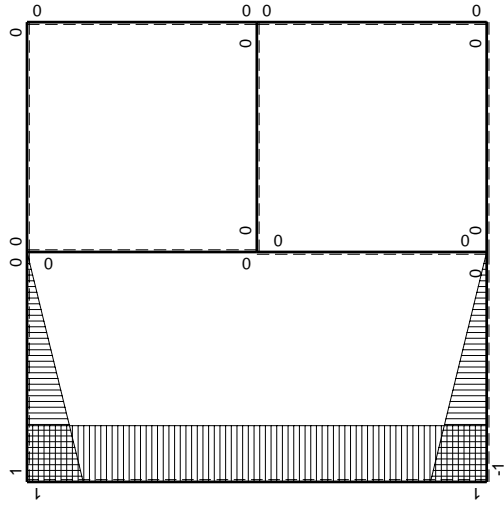
$$= (-1/6 b) \cdot Fb \cdot 1/EJ = -1/6 \cdot Fb^2/EJ$$





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	$1/2Fx-1/2qx^2$	$-Fb/EJ$	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

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

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

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

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

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

$$= (2b) \cdot 1/EJ = 2 \cdot b/EJ$$

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

$$= (2b) \cdot 1/EJ = 2 \cdot b/EJ$$

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

$$= (b - b + 1/3 b) \cdot 1/EJ = 1/3 \cdot b/EJ$$

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

$$= (1/3 b) \cdot 1/EJ = 1/3 \cdot b/EJ$$

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

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

$$= (b - 1/2 b - 1/8 b) \cdot Fb \cdot 1/EJ + 1 \cdot 0 \cdot 1/4 \cdot Fb^2/EJ = 3/8 \cdot Fb^2/EJ$$

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

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

$$= (5/4 b - b + 1/8 b) \cdot Fb \cdot 1/EJ + 1 \cdot 0 \cdot 1/4 \cdot Fb^2/EJ = 3/8 \cdot Fb^2/EJ$$

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

$$= (-1/4 b + 1/6 b) \cdot Fb \cdot 1/EJ = -1/12 \cdot Fb^2/EJ$$

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

$$= (-1/4 b + 1/6 b) \cdot Fb \cdot 1/EJ = -1/12 \cdot Fb^2/EJ$$