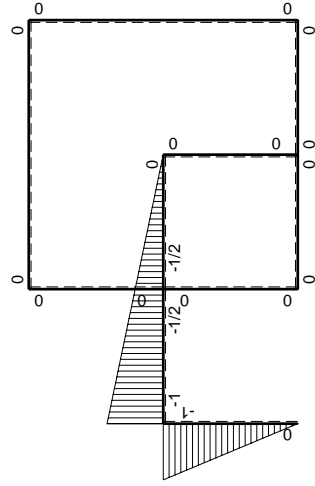


Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-7/2Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$7/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-7/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

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

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

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

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

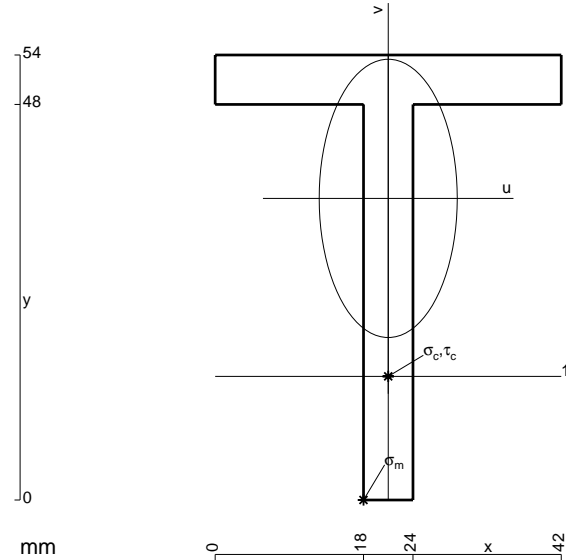
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{x_0} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

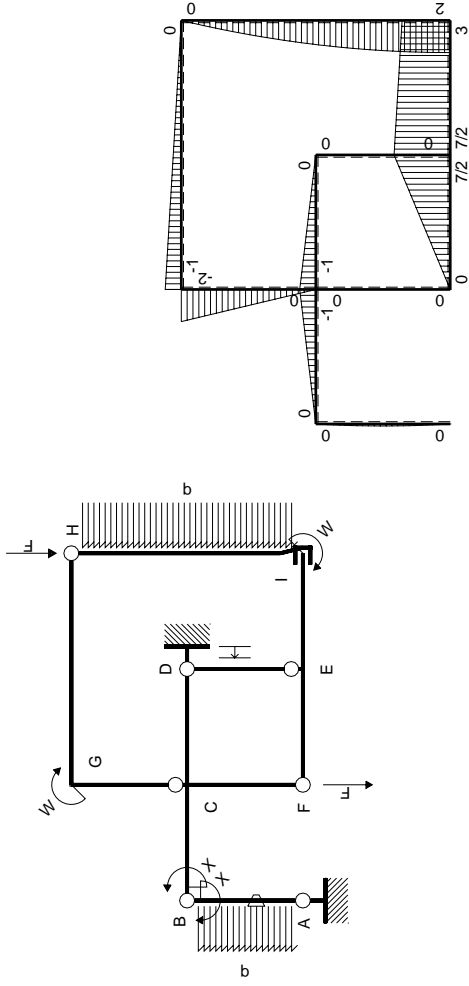
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{DC}^{x_0} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

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

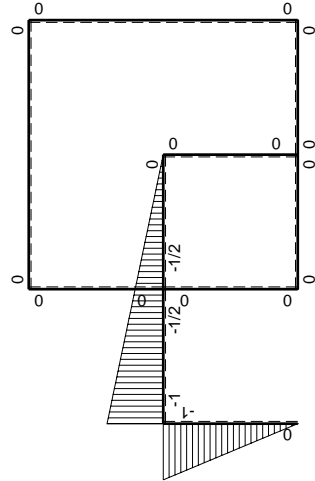


- A = 540. mm²
- J_u = 154030. mm⁴
- J_v = 37908. mm⁴
- y_g = 36.6 mm
- T_y = -1785. N
- M_x = 874650. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -36.6 mm
- $\sigma_m = -Mv/J_u = 207.8$ N/mm²
- x_c = 21. mm
- y_c = 15. mm
- v_c = -21.6 mm
- $\sigma_c = -Mv/J_u = 122.7$ N/mm²
- $\tau_c = 5.058$ N/mm²
- $\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 123.$ N/mm²
- S = 2619. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-7/2Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$		
	totali						$1/24Fb^2/EJ$	Xb/EJ	
	iperstatica $X=W_{BC}$						$-1/24Fb$		

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

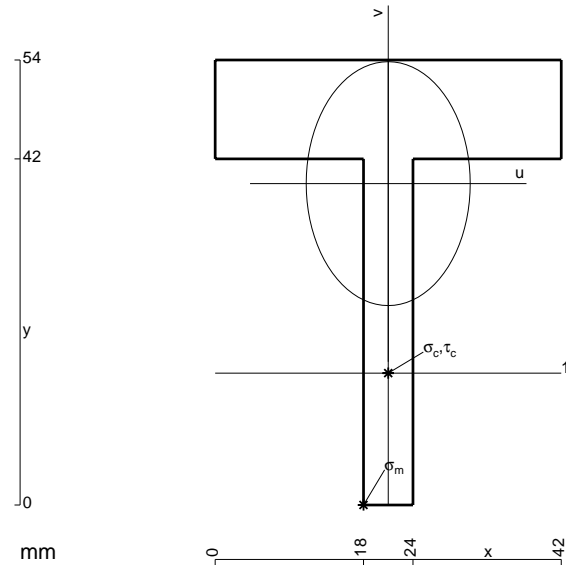
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

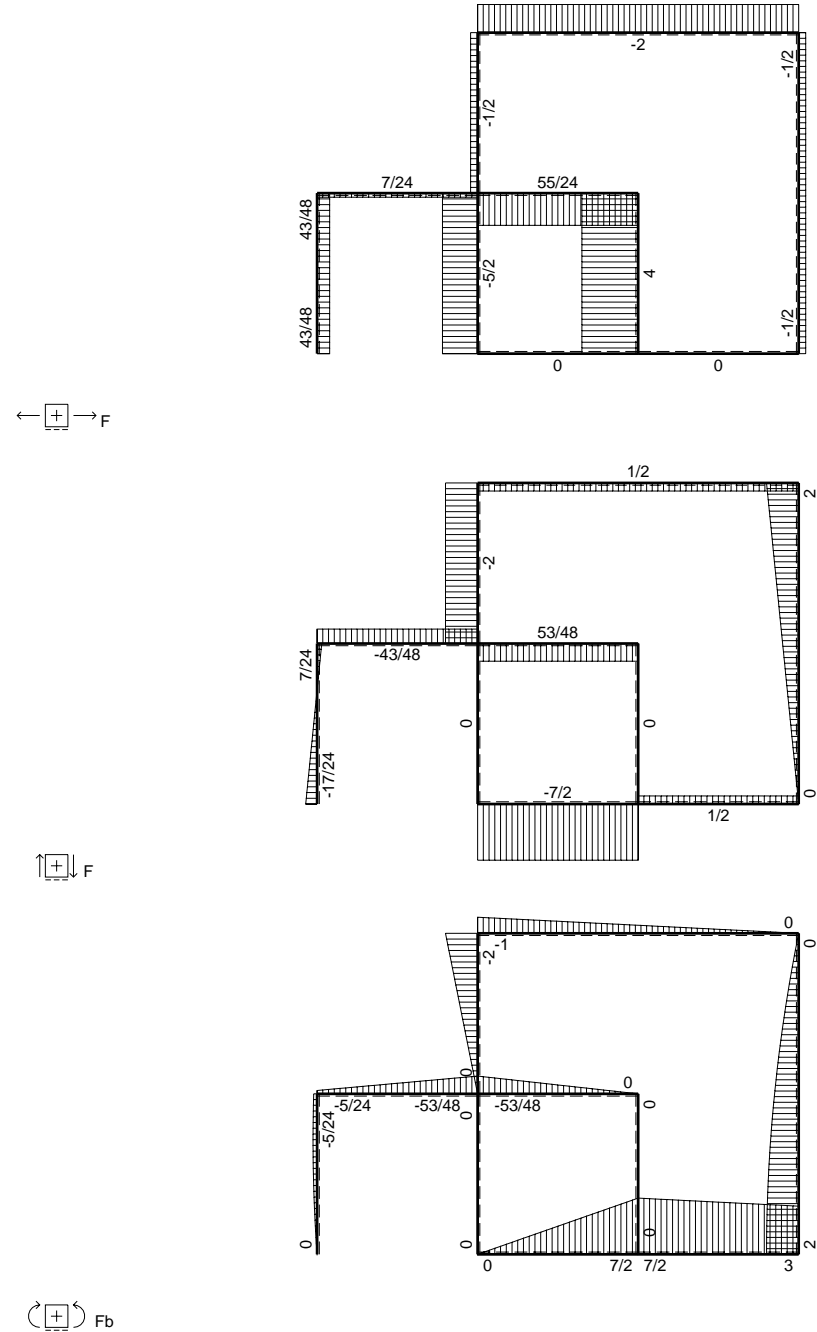
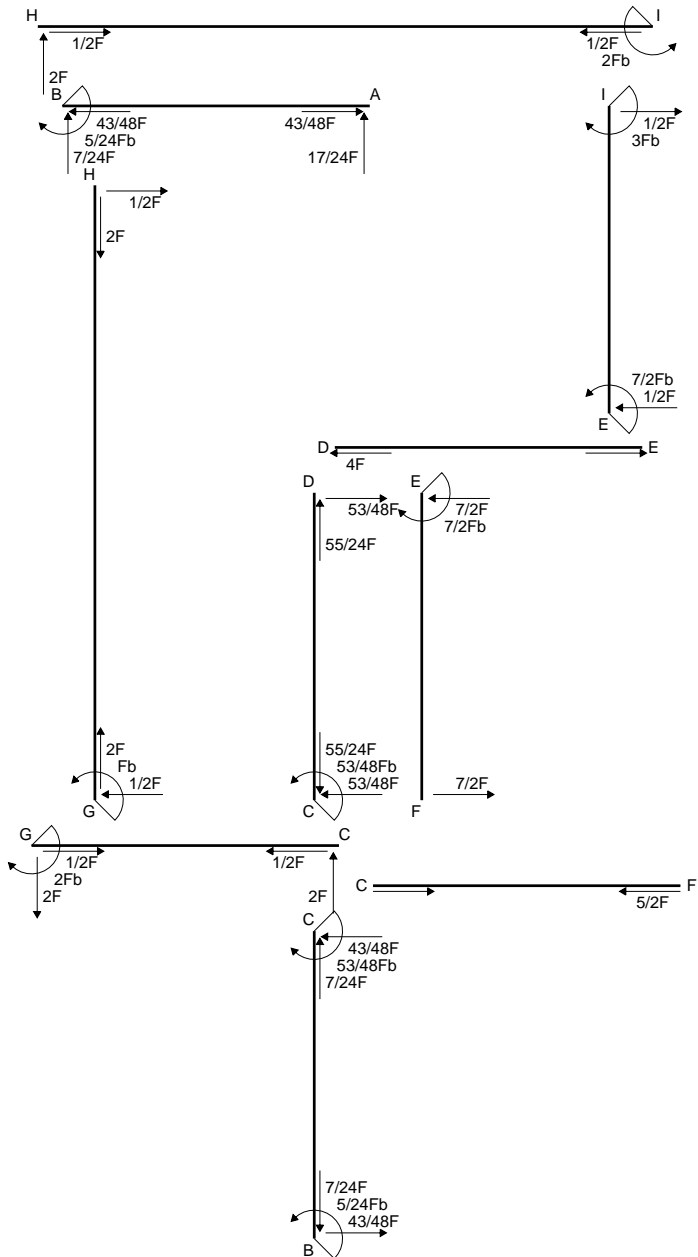
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

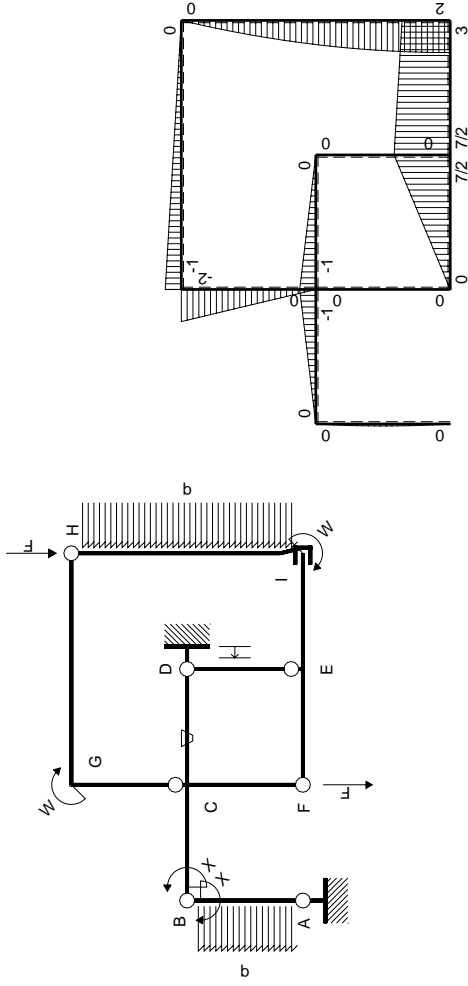
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

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



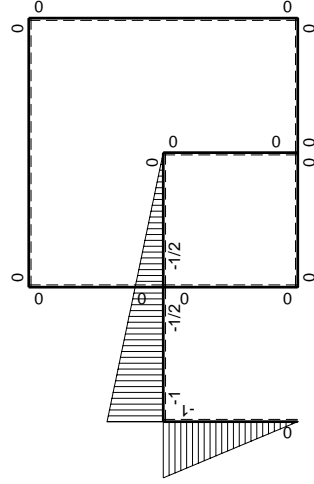
$A = 756. \text{ mm}^2$
 $J_u = 165564. \text{ mm}^4$
 $J_v = 74844. \text{ mm}^4$
 $y_g = 39. \text{ mm}$
 $T_y = -1715. \text{ N}$
 $M_x = 926100. \text{ Nmm}$
 $x_m = 18. \text{ mm}$
 $u_m = -3. \text{ mm}$
 $v_m = -39. \text{ mm}$
 $\sigma_m = -Mv/J_u = 218.2 \text{ N/mm}^2$
 $x_c = 21. \text{ mm}$
 $y_c = 16. \text{ mm}$
 $v_c = -23. \text{ mm}$
 $\sigma_c = -Mv/J_u = 128.7 \text{ N/mm}^2$
 $\tau_c = 5.138 \text{ N/mm}^2$
 $\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 129. \text{ N/mm}^2$
 $S = 2976. \text{ mm}^3$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	Fb/EJ	$1/2Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-7/2Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-5/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$5/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

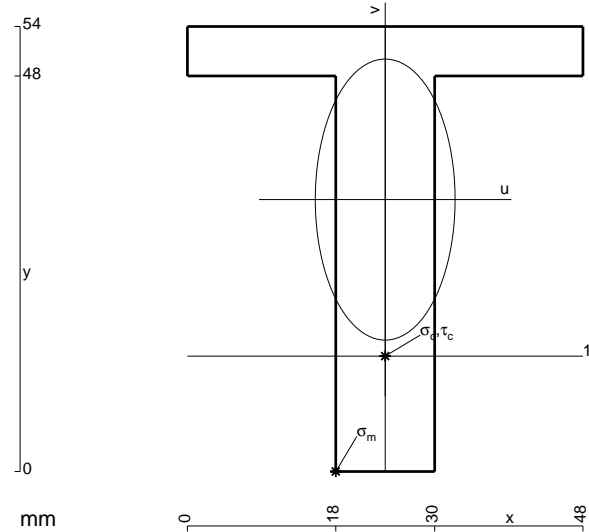
$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

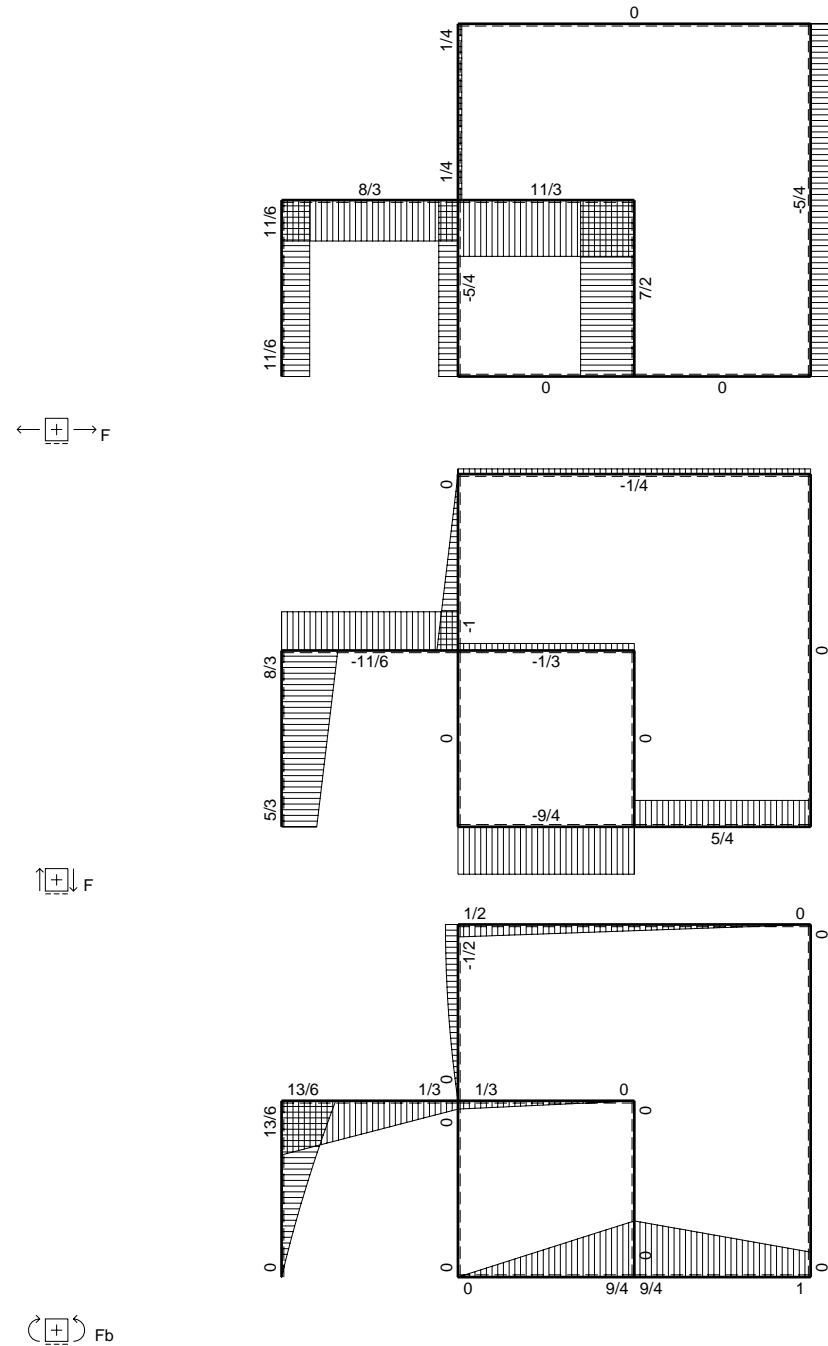
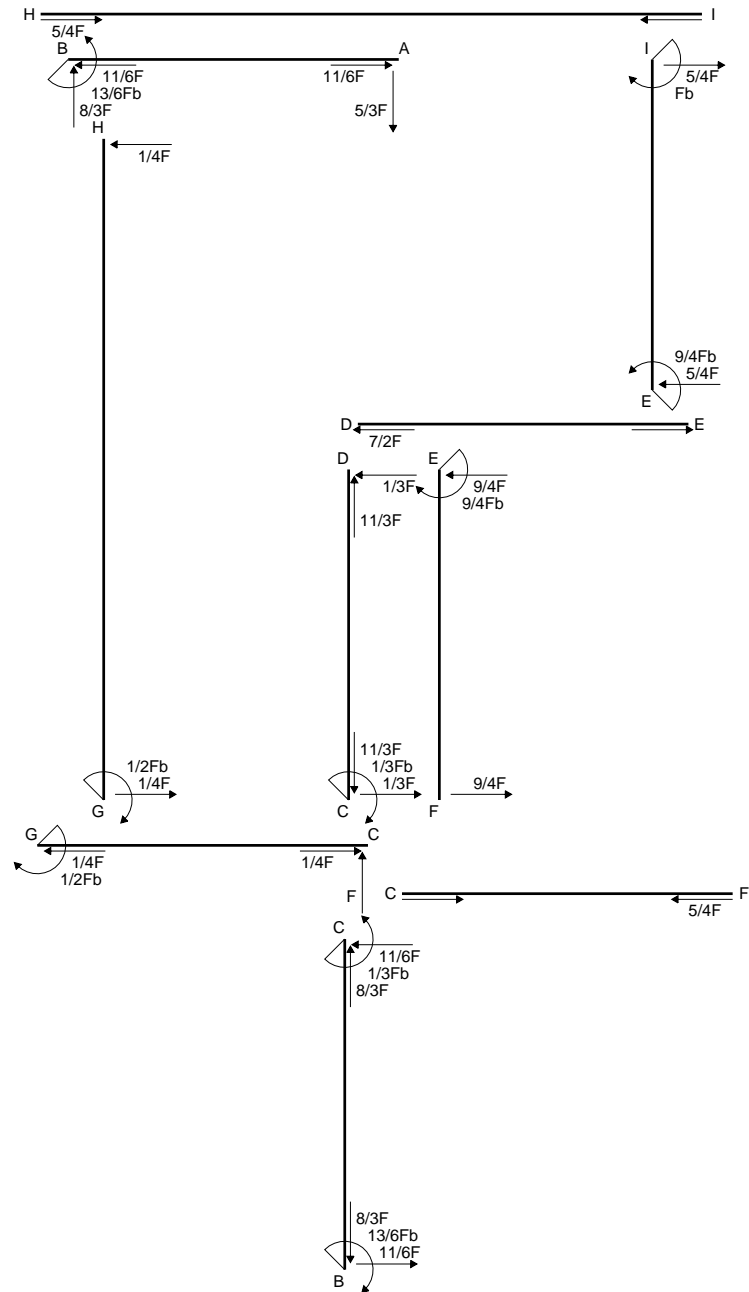
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 5/12 Fb^2/EJ$$

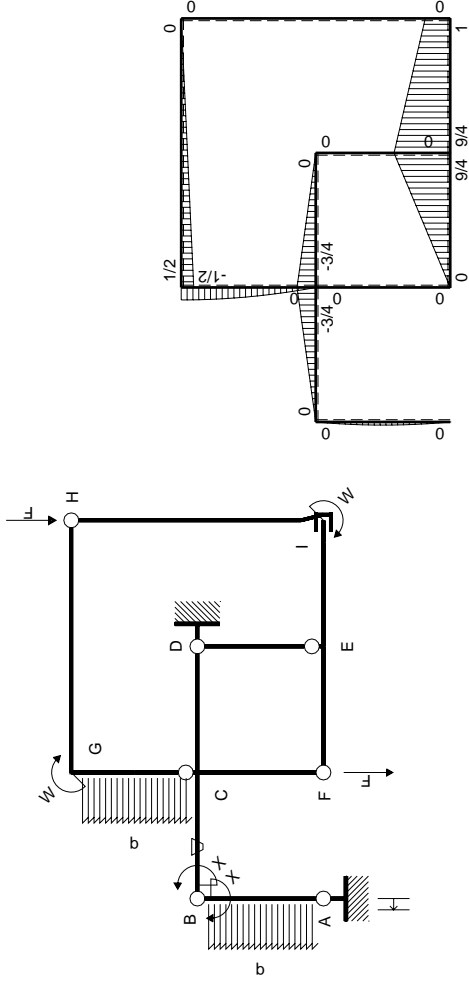
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/6 b) Fb 1/EJ + (-1/4 b) \theta = 5/12 Fb^2/EJ$$



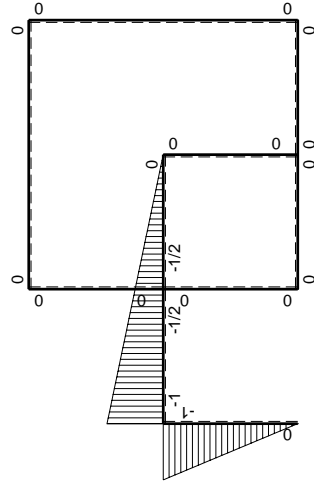
- A = 864. mm²
- J_u = 251424. mm⁴
- J_v = 62208. mm⁴
- y_g = 33. mm
- T_y = -3010. N
- M_x = 1745800. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -33. mm
- σ_m = -Mv/J_u = 229.1 N/mm²
- x_c = 24. mm
- y_c = 14. mm
- v_c = -19. mm
- σ_c = -Mv/J_u = 131.9 N/mm²
- τ_c = 4.358 N/mm²
- σ_ρ = √σ²+3τ² = 132.1 N/mm²
- S = 4368. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0
FE b	0	$-9/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$13/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-13/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

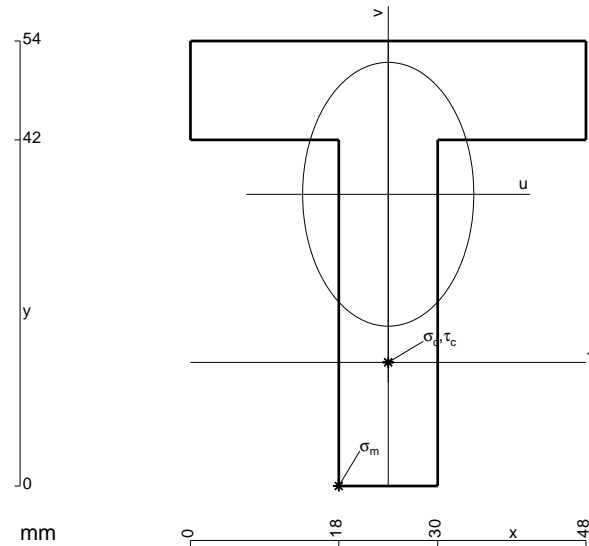
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

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

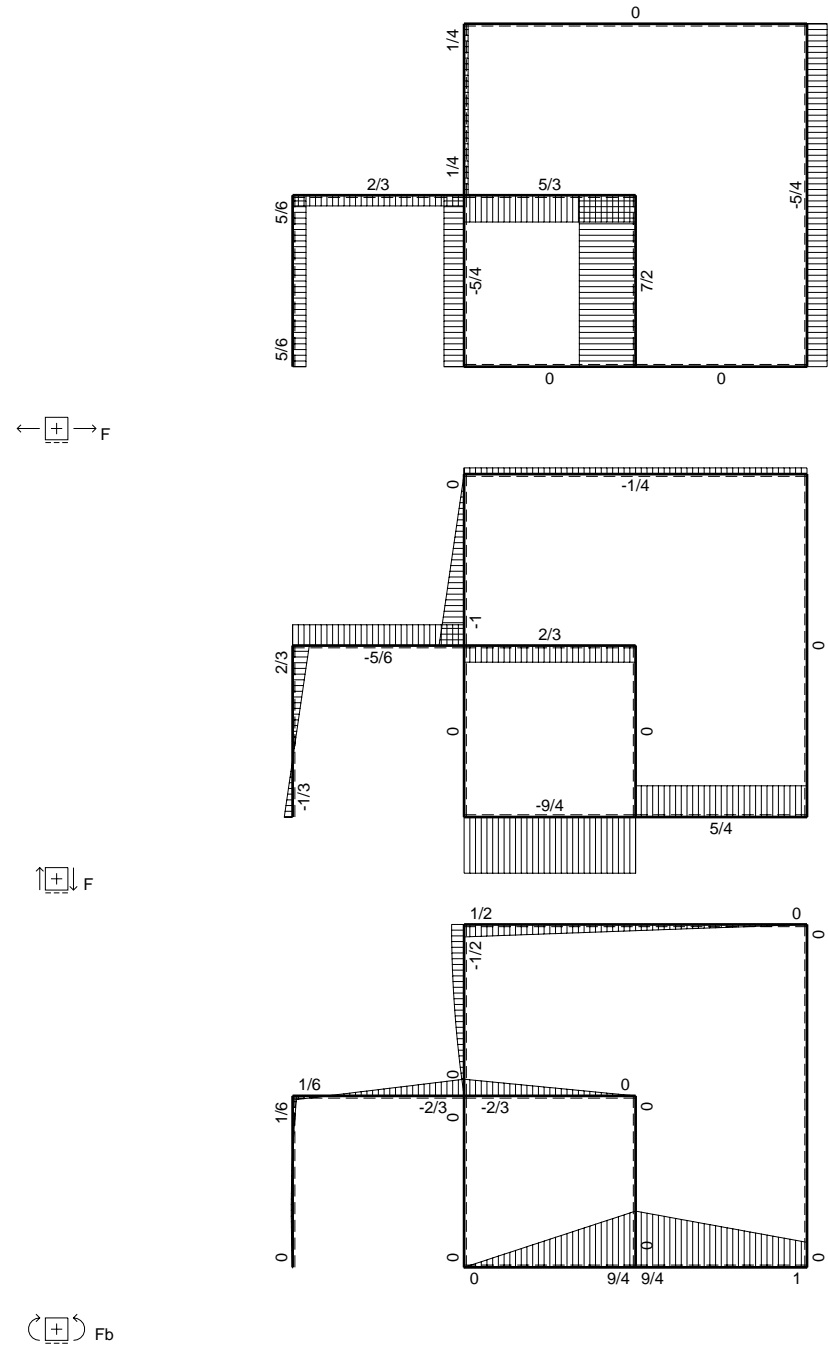
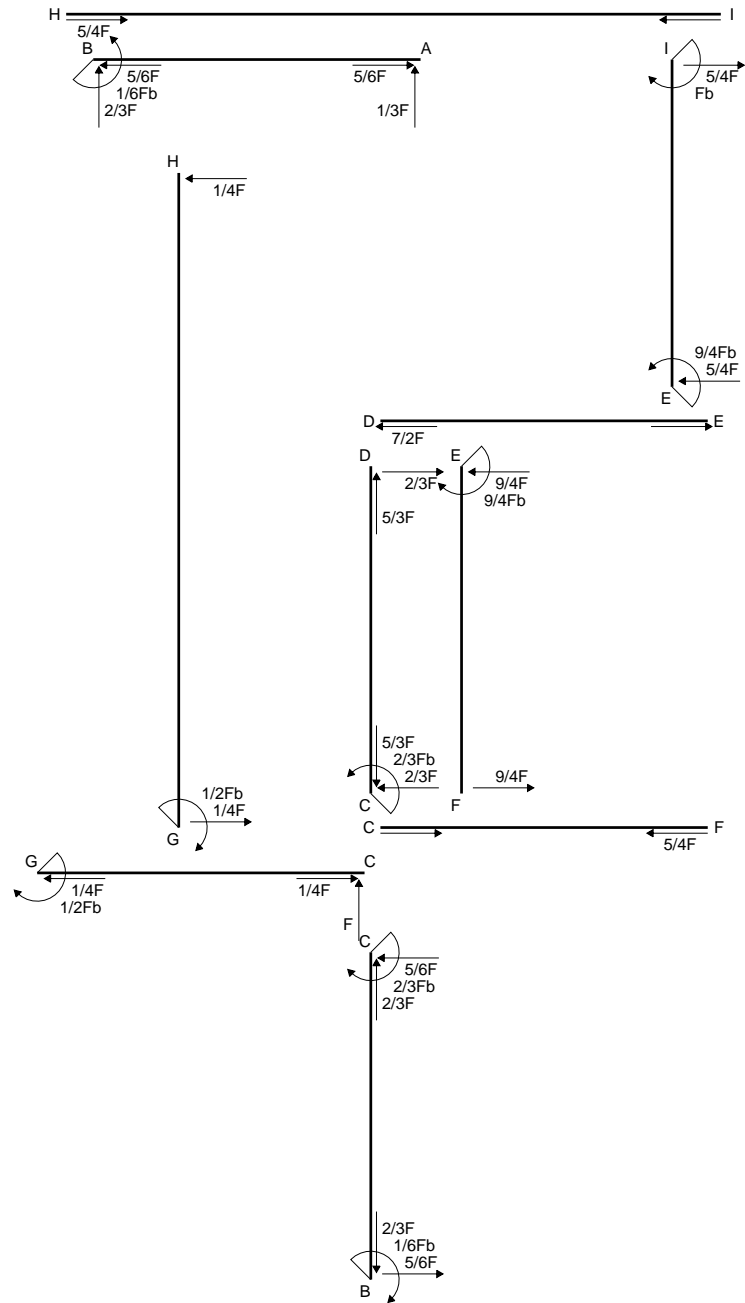
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

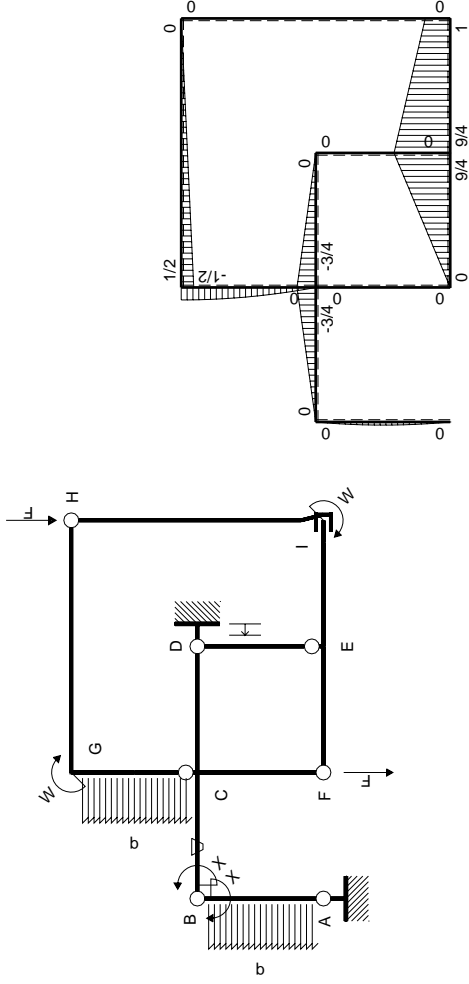
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 1080. mm²
- J_u = 276955. mm⁴
- J_v = 116640. mm⁴
- y_g = 35.4 mm
- T_y = -2970. N
- M_x = 1871100. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -35.4 mm
- σ_m = -Mv/J_u = 239.2 N/mm²
- x_c = 24. mm
- y_c = 15. mm
- v_c = -20.4 mm
- σ_c = -Mv/J_u = 137.8 N/mm²
- τ_c = 4.488 N/mm²
- σ_o = √σ² + 3τ² = 138. N/mm²
- S = 5022. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0
FE b	0	$-9/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$1/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-1/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

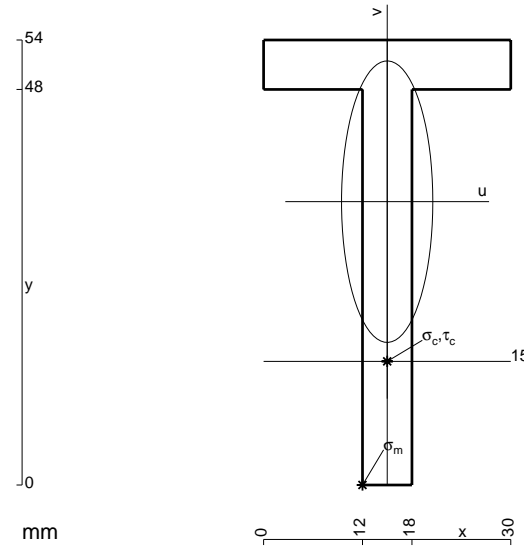
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

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

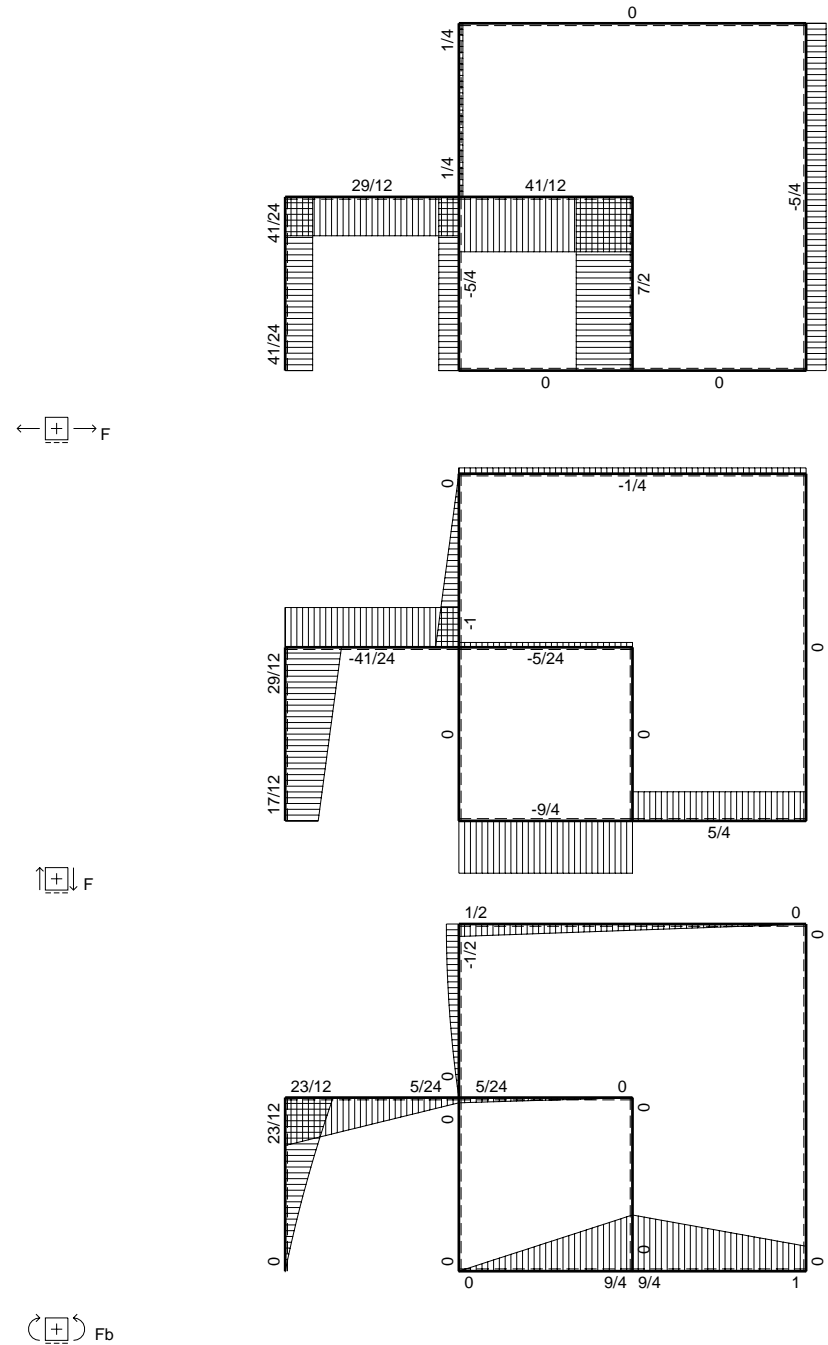
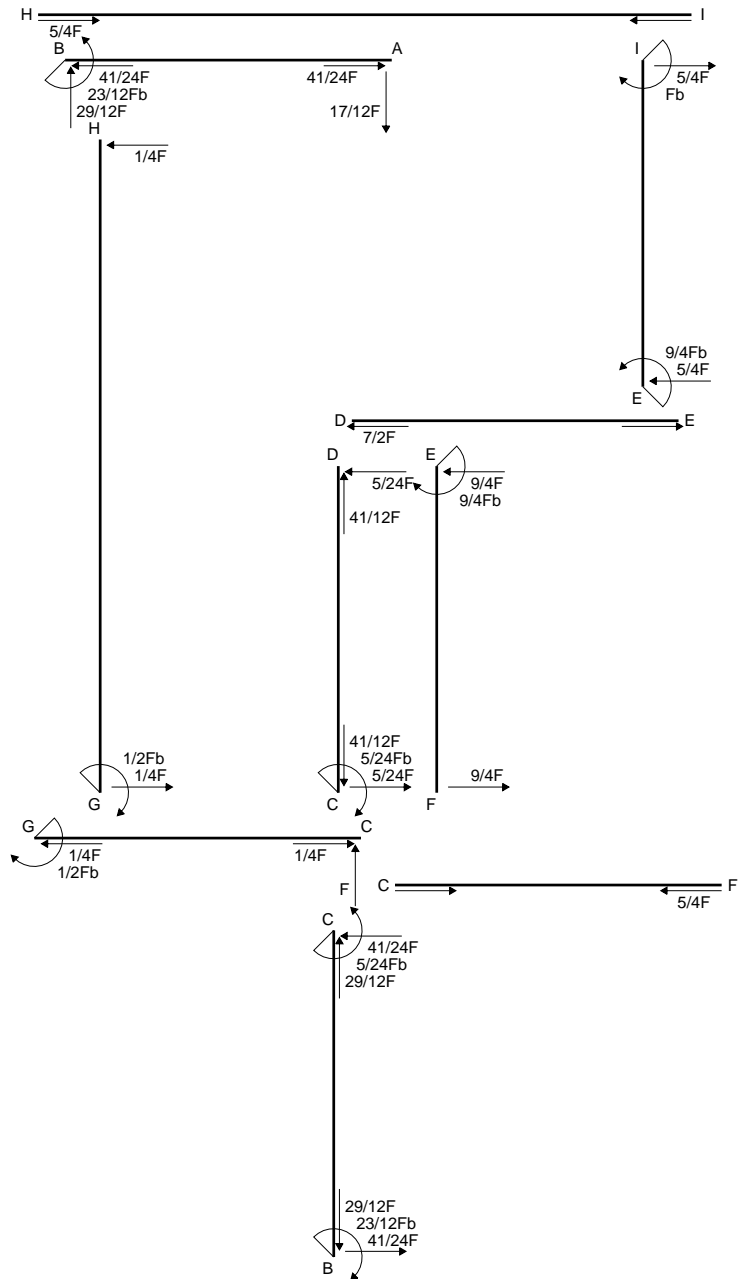
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

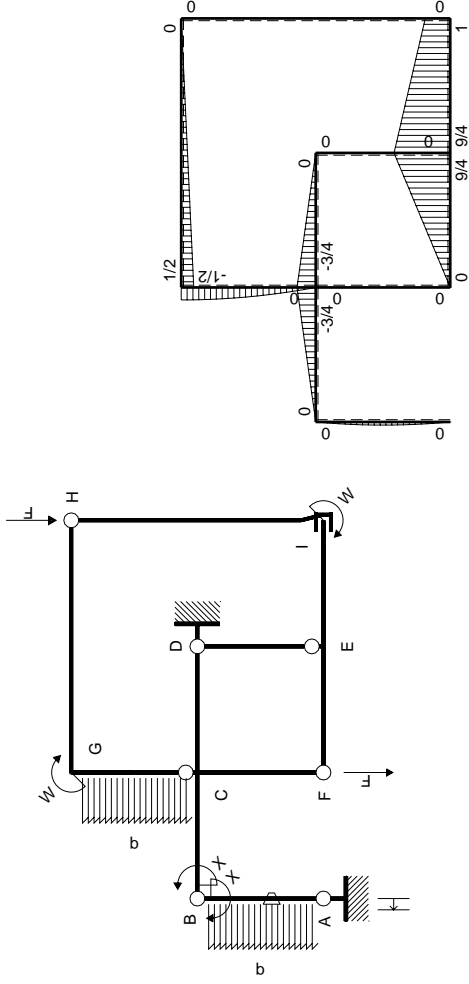
$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 468. mm²
- J_u = 136587. mm⁴
- J_v = 14364. mm⁴
- y_g = 34.38 mm
- T_y = -1170. N
- M_x = 783900. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -34.38 mm
- σ_m = -Mv/J_u = 197.3 N/mm²
- x_c = 15. mm
- y_c = 15. mm
- v_c = -19.38 mm
- σ_c = -Mv/J_u = 111.3 N/mm²
- τ_c = 3.454 N/mm²
- σ_q = √σ²+3τ² = 111.4 N/mm²
- S = 2420. mm³

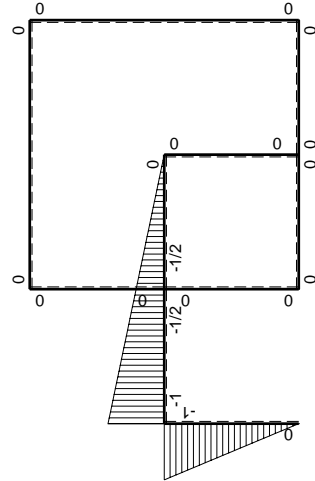


\oplus \ominus F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0
FE b	0	$-9/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$23/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-23/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

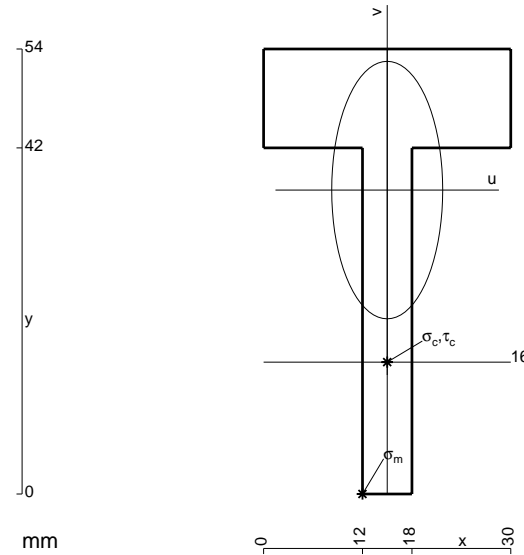
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



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

$$J_u = 149427. \text{ mm}^4$$

$$J_v = 27756. \text{ mm}^4$$

$$y_g = 36.88 \text{ mm}$$

$$T_y = -1170. \text{ N}$$

$$M_x = 842400. \text{ Nmm}$$

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

$$u_m = -3. \text{ mm}$$

$$v_m = -36.88 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 207.9 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 16. \text{ mm}$$

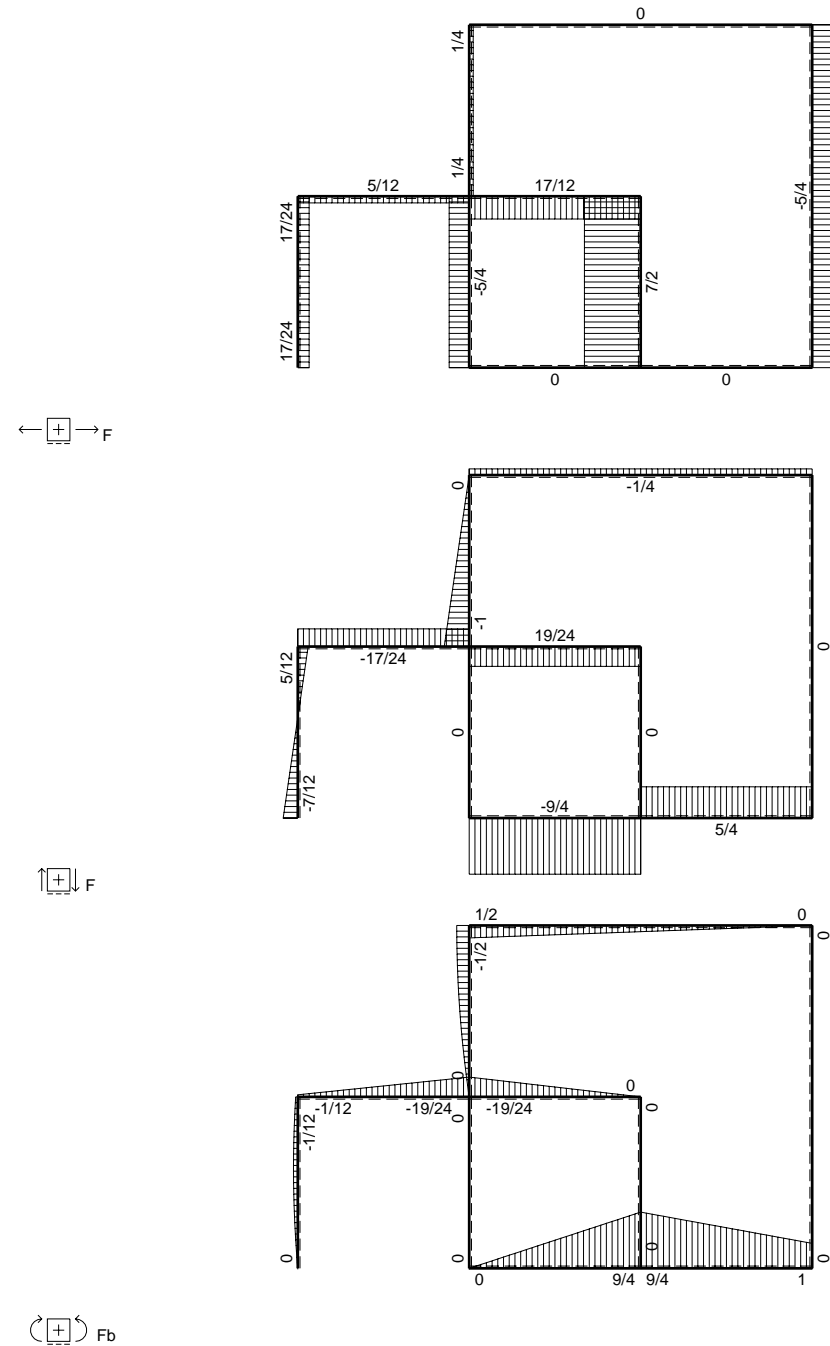
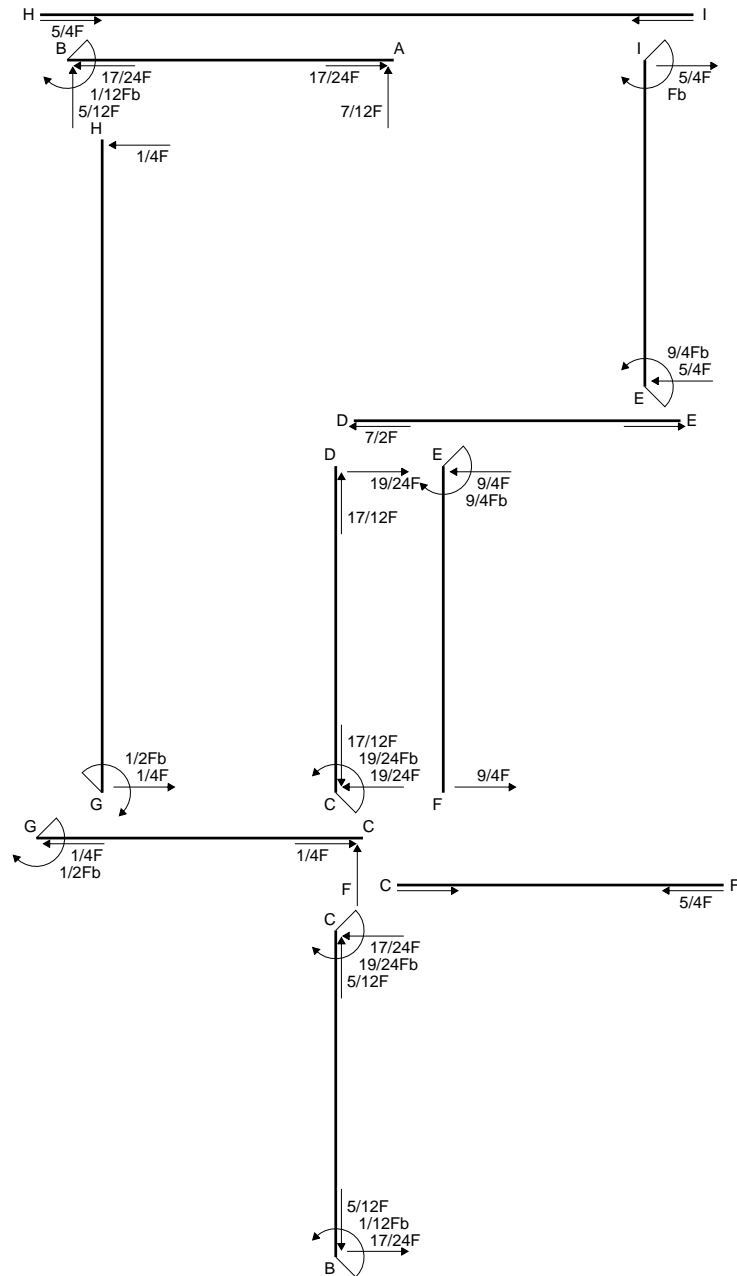
$$v_c = -20.88 \text{ mm}$$

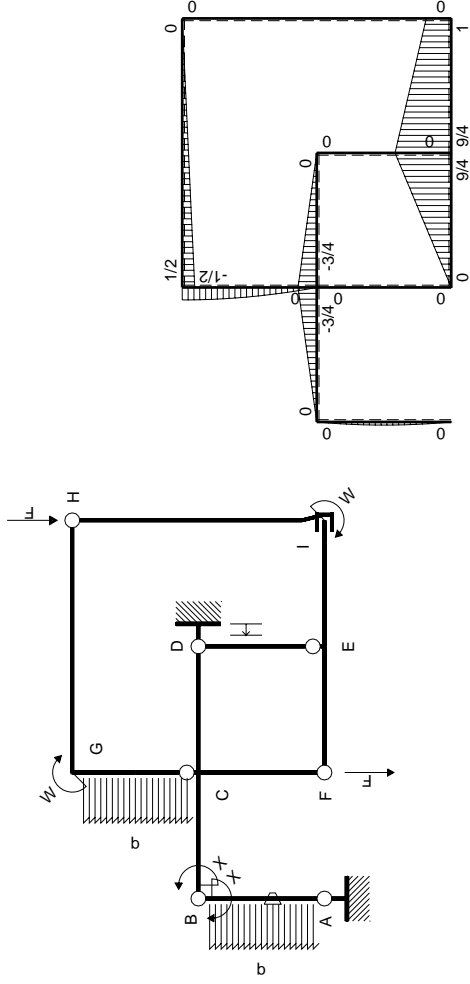
$$\sigma_c = -Mv/J_u = 117.7 \text{ N/mm}^2$$

$$\tau_c = 3.618 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 117.9 \text{ N/mm}^2$$

$$S = 2773. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0
FE b	0	$-9/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$-1/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$1/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{x\theta} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{x\theta} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{x\theta} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

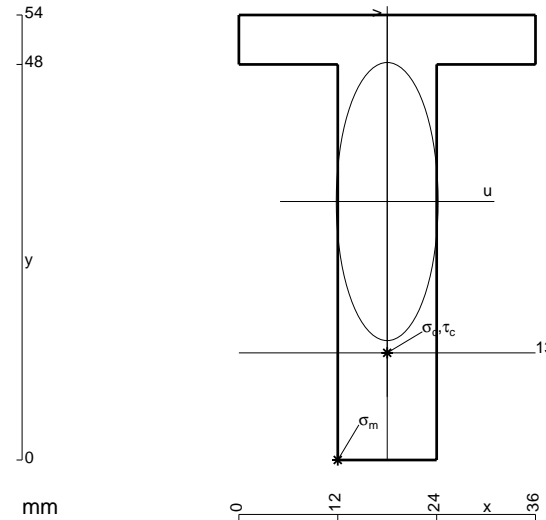
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CD}^{x\theta} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

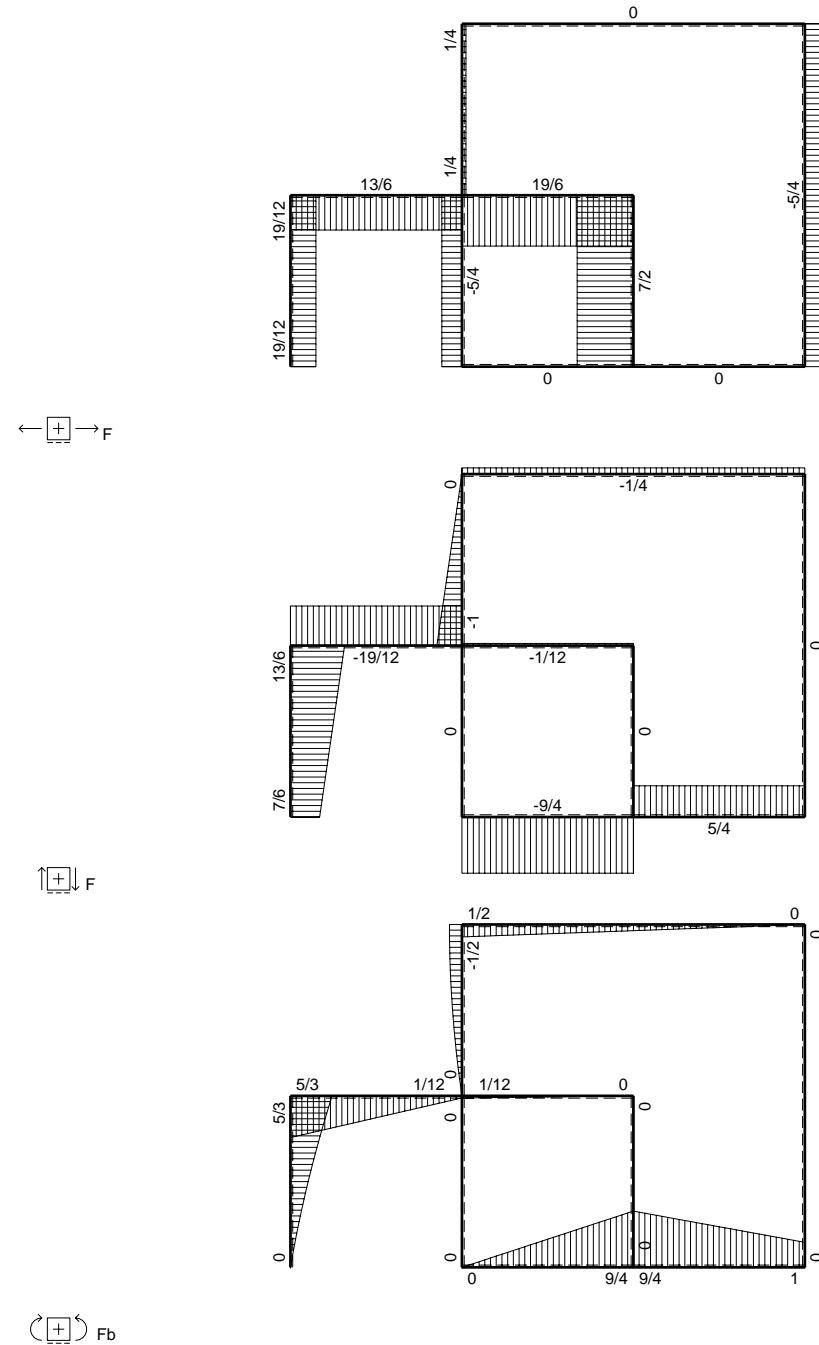
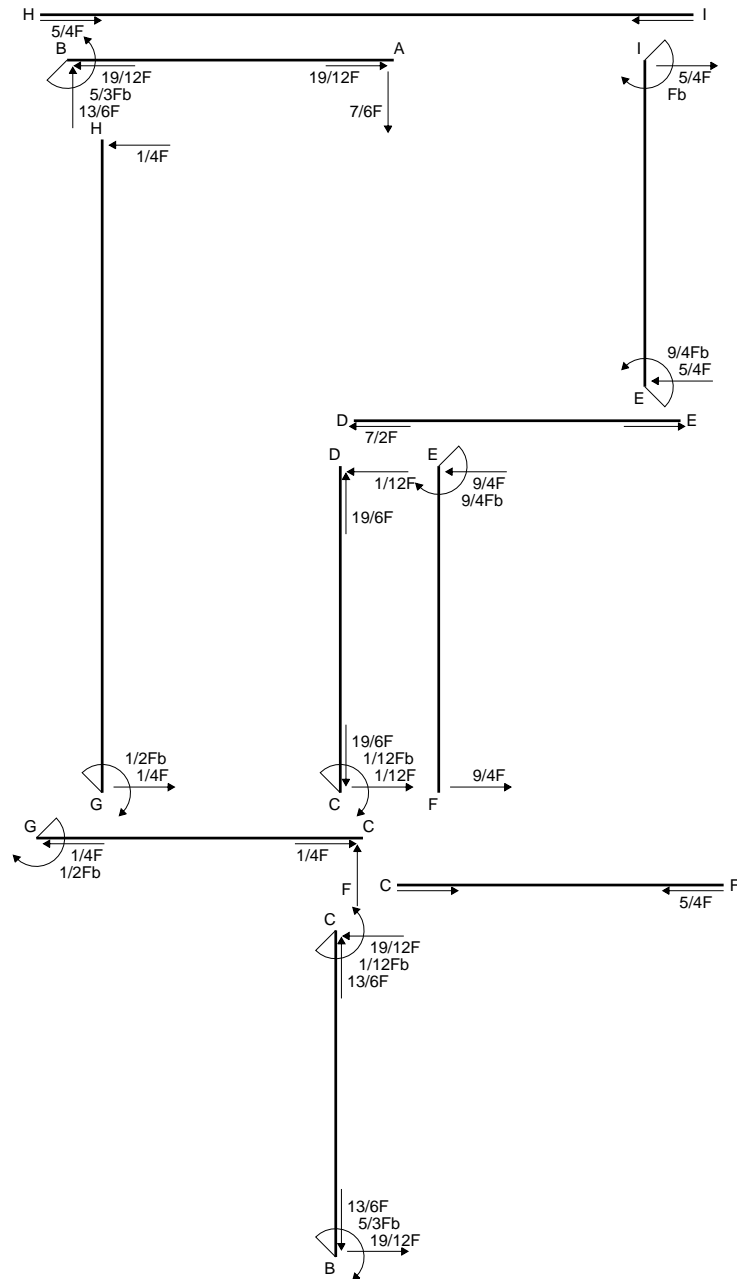
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

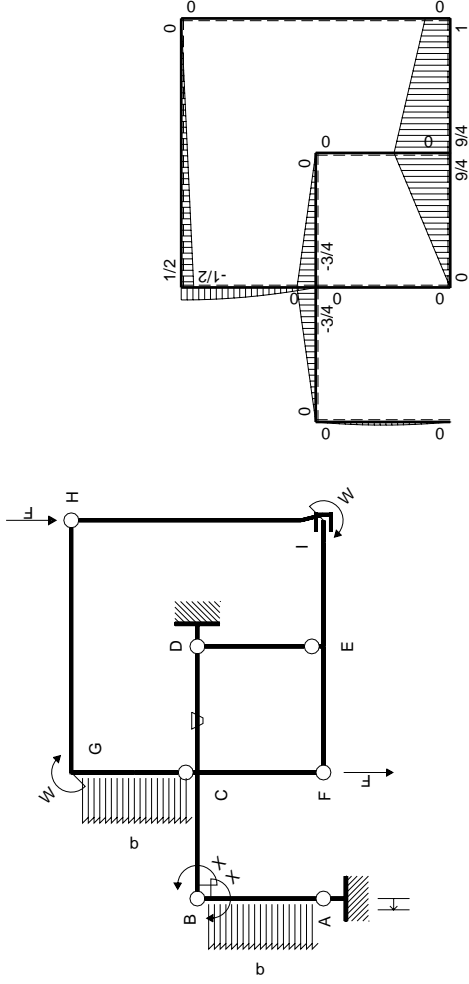
$$L_{DC}^{x\theta} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 792. mm²
- J_u = 225759. mm⁴
- J_v = 30240. mm⁴
- y_g = 31.36 mm
- T_y = -2070. N
- M_x = 1573200. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -31.36 mm
- σ_m = -Mv/J_u = 218.6 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -18.36 mm
- σ_c = -Mv/J_u = 128. N/mm²
- τ_c = 2.964 N/mm²
- σ_q = √σ² + 3τ² = 128.1 N/mm²
- S = 3879. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$							Fb^2/EJ	
	totali							$5/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-5/3Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

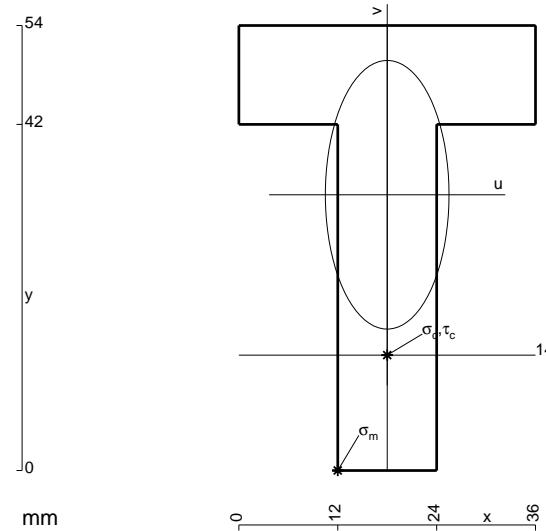
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



$$A = 936. \text{ mm}^2$$

$$J_u = 248849. \text{ mm}^4$$

$$J_v = 52704. \text{ mm}^4$$

$$y_g = 33.46 \text{ mm}$$

$$T_y = -2093. \text{ N}$$

$$M_x = 1694930. \text{ Nmm}$$

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

$$u_m = -6. \text{ mm}$$

$$v_m = -33.46 \text{ mm}$$

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

$$x_c = 18. \text{ mm}$$

$$y_c = 14. \text{ mm}$$

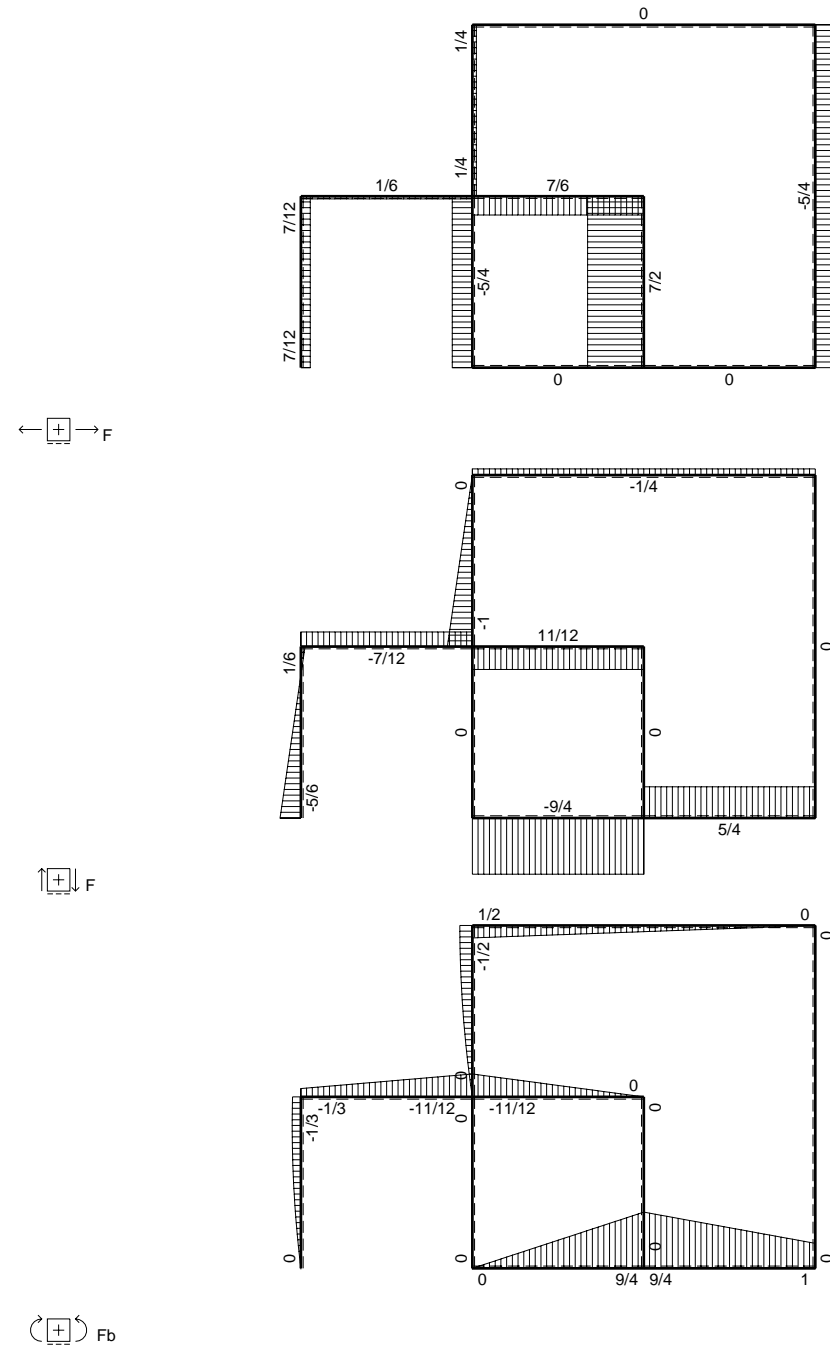
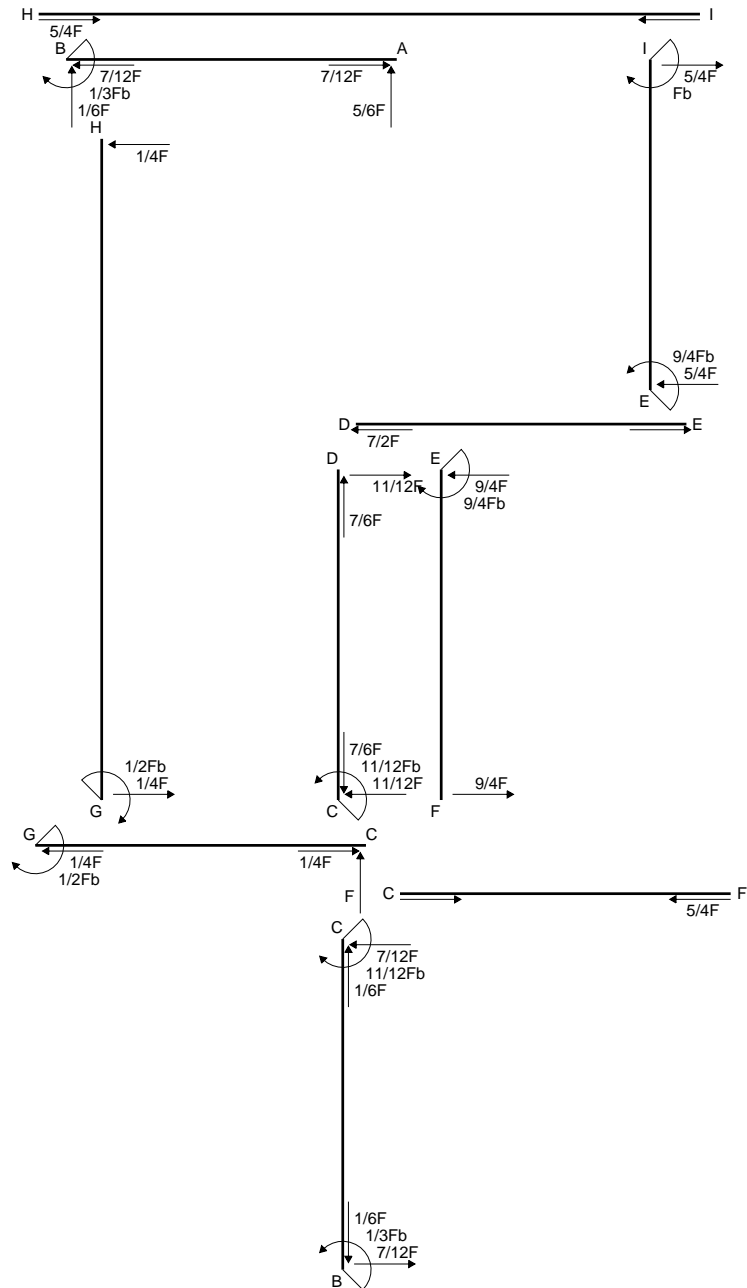
$$v_c = -19.46 \text{ mm}$$

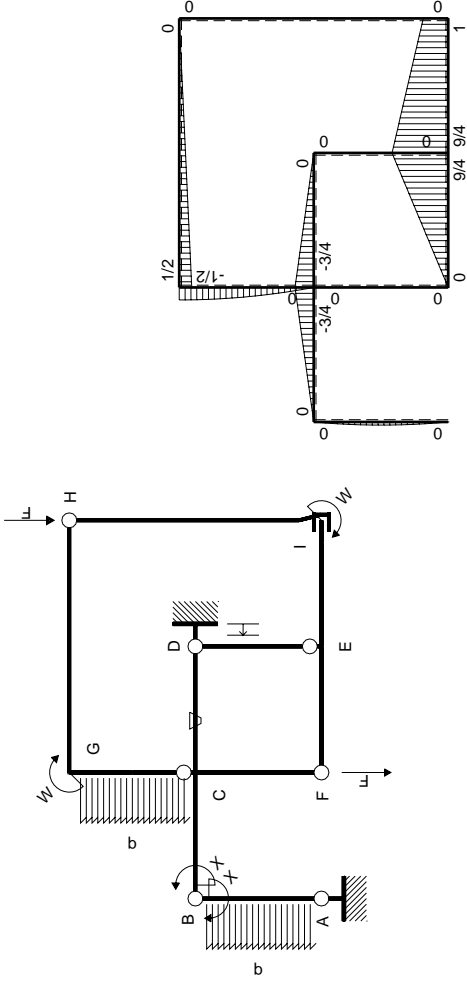
$$\sigma_c = -Mv/J_u = 132.6 \text{ N/mm}^2$$

$$\tau_c = 3.115 \text{ N/mm}^2$$

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

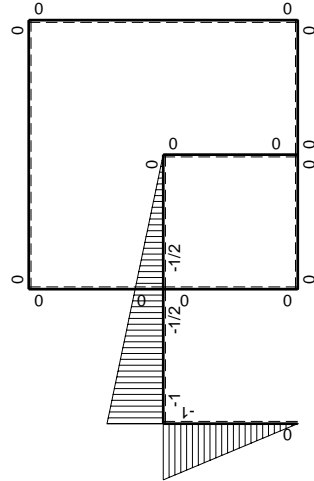
$$S = 4446. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/3Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

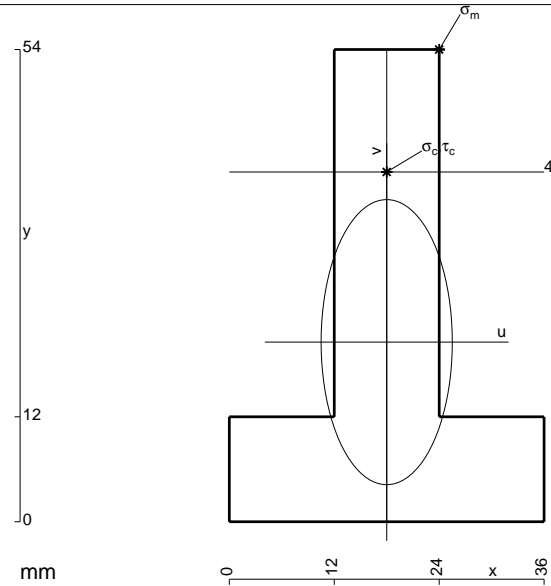
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

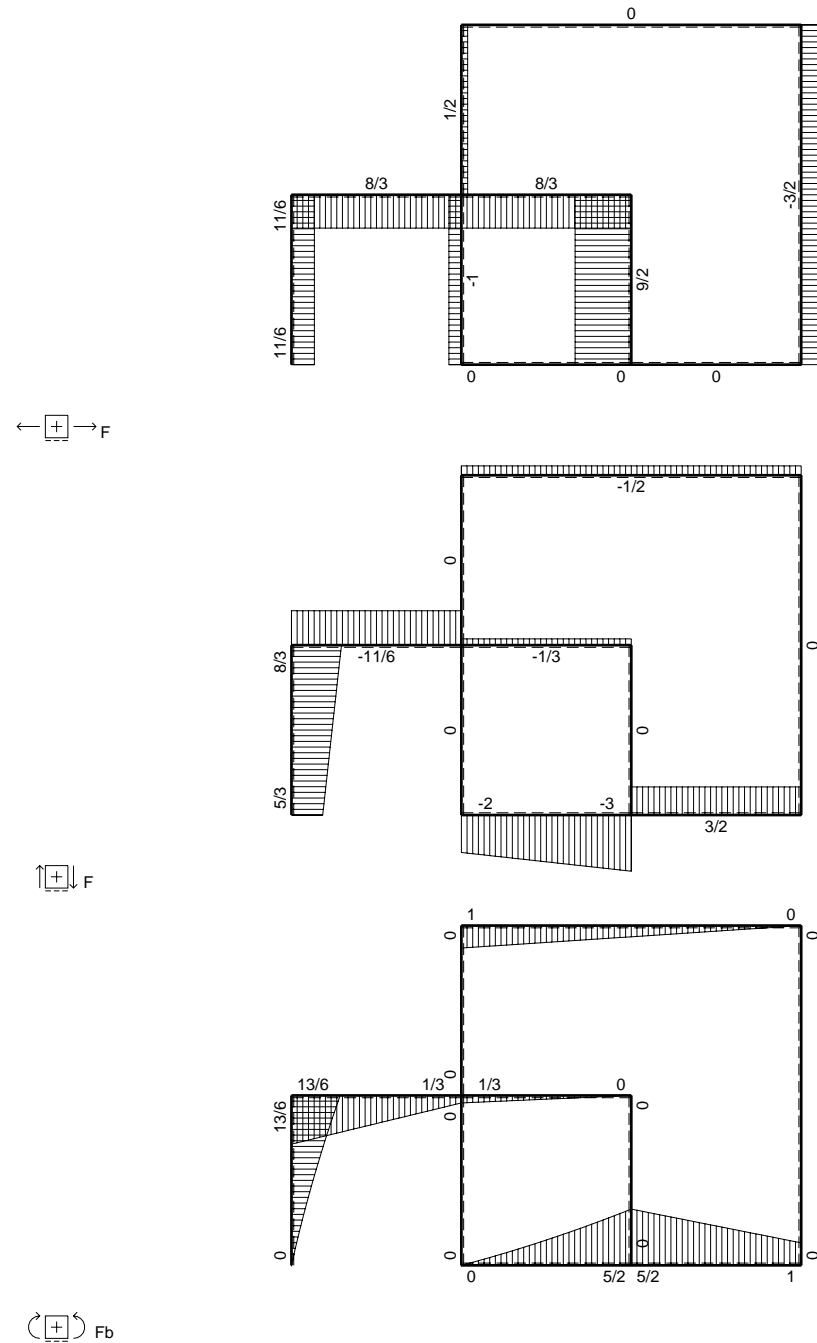
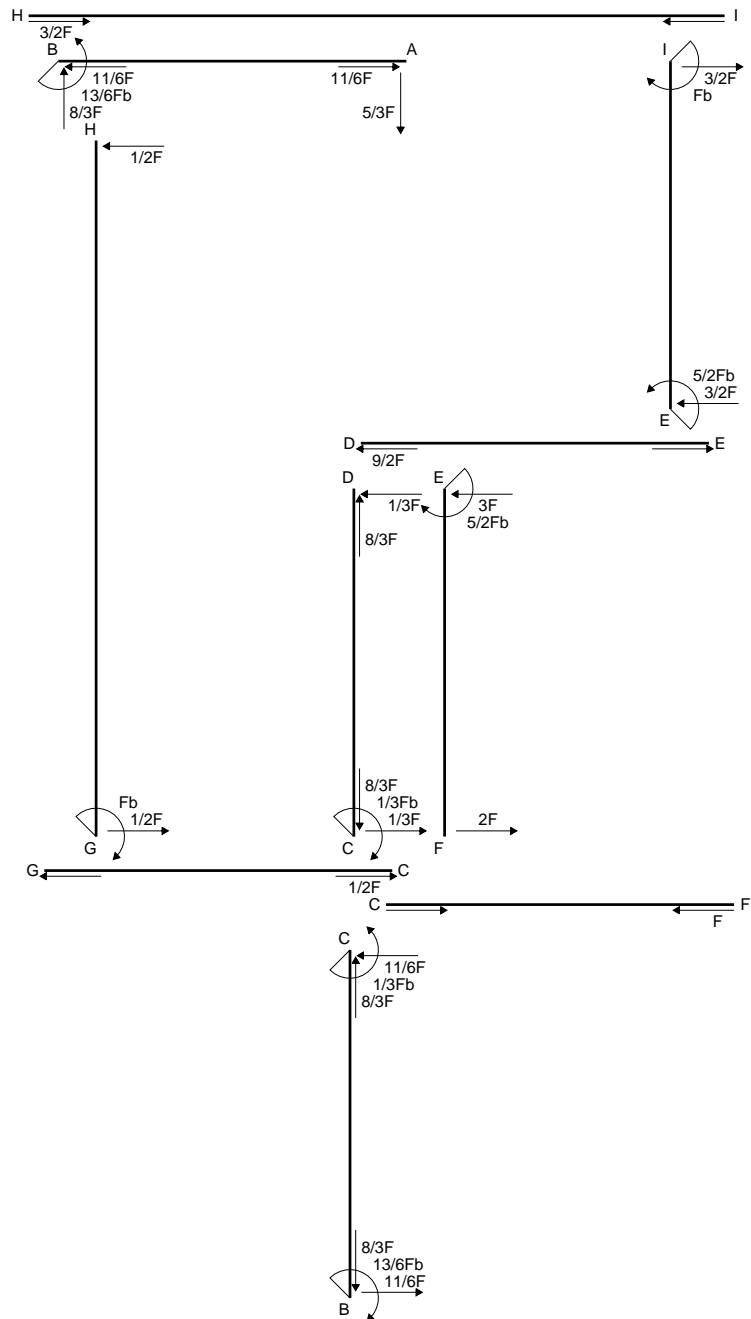
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

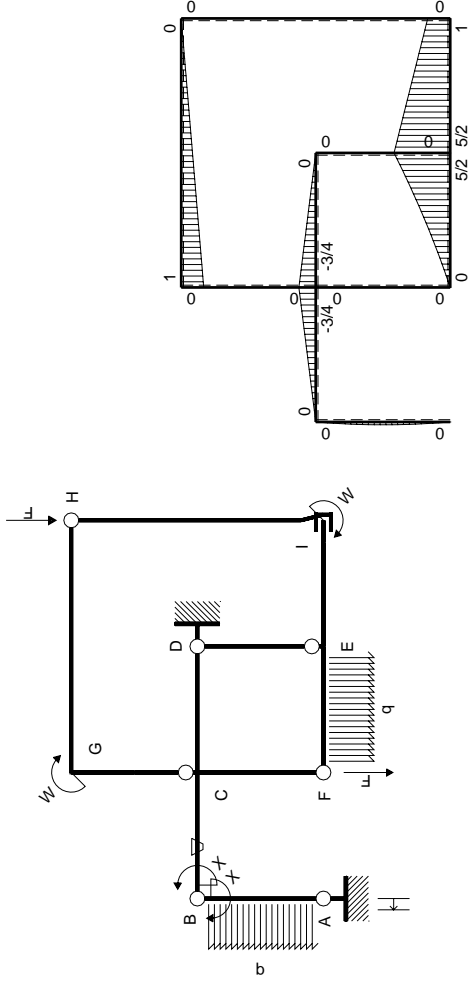
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



- A = 936. mm²
- J_u = 248849. mm⁴
- J_v = 52704. mm⁴
- y_g = 20.54 mm
- T_y = -2093. N
- M_x = 1778630. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 6. mm
- v_m = 33.46 mm
- σ_m = -Mv/J_u = -239.2 N/mm²
- x_c = 18. mm
- y_c = 40. mm
- v_c = 19.46 mm
- σ_c = -Mv/J_u = -139.1 N/mm²
- τ_c = 3.115 N/mm²
- σ_q = √σ²+3τ² = 139.2 N/mm²
- S = 4446. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$13/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-13/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

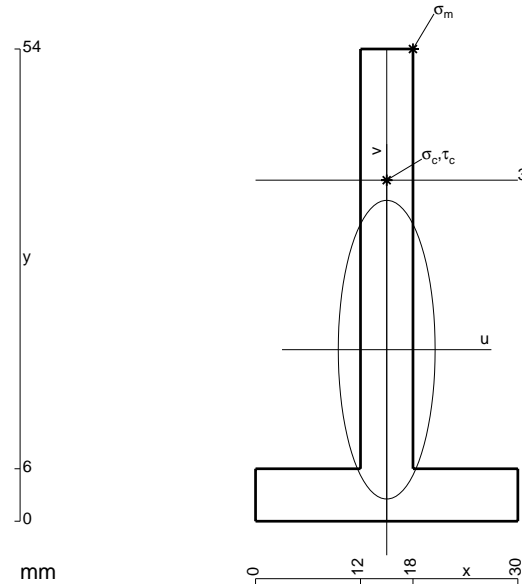
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

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

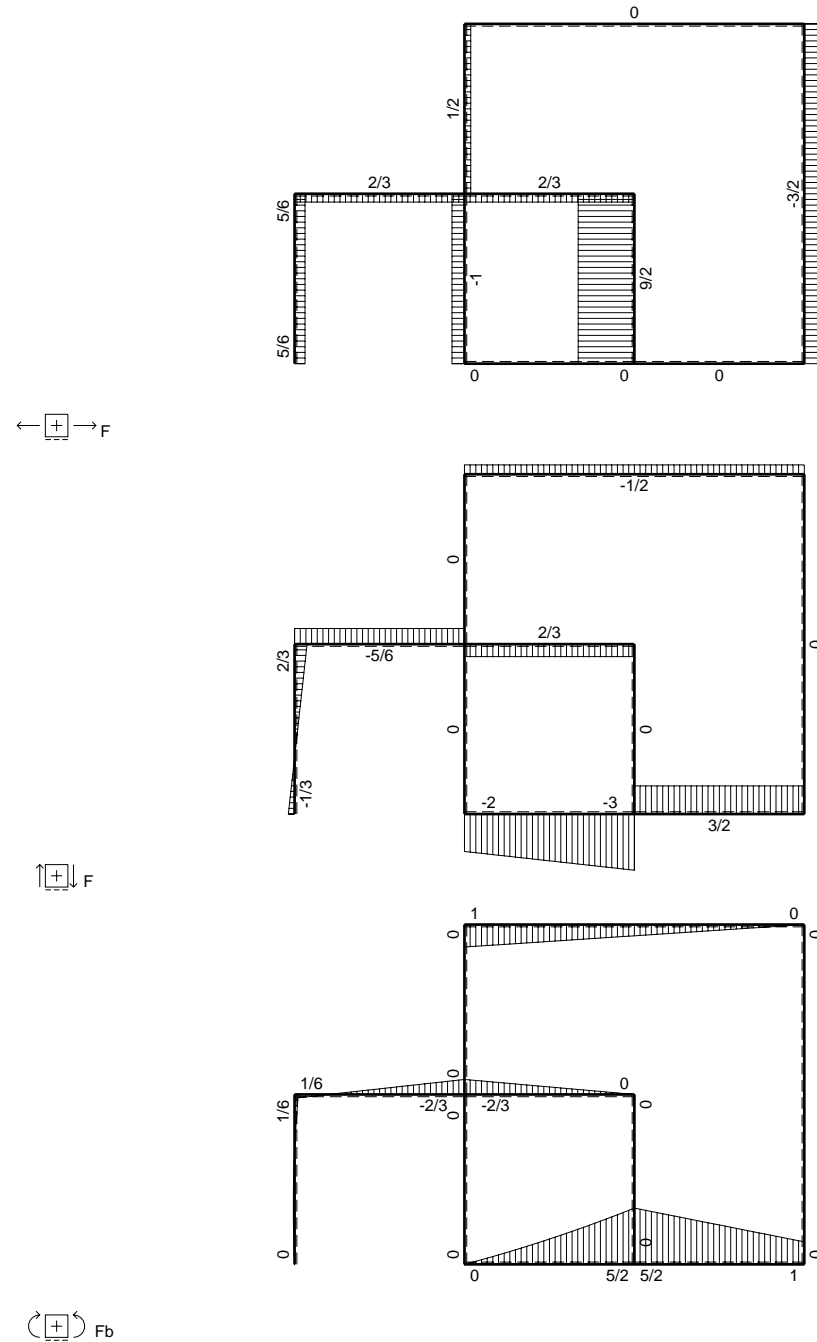
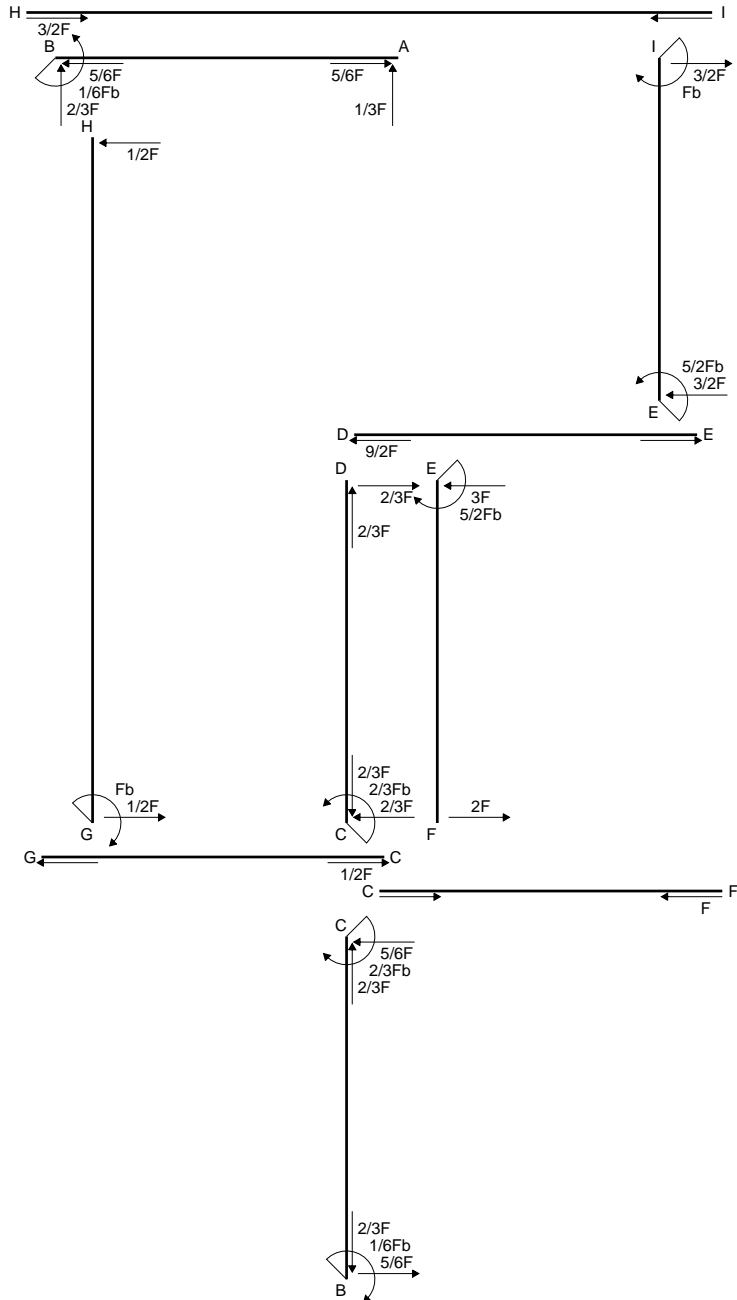
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

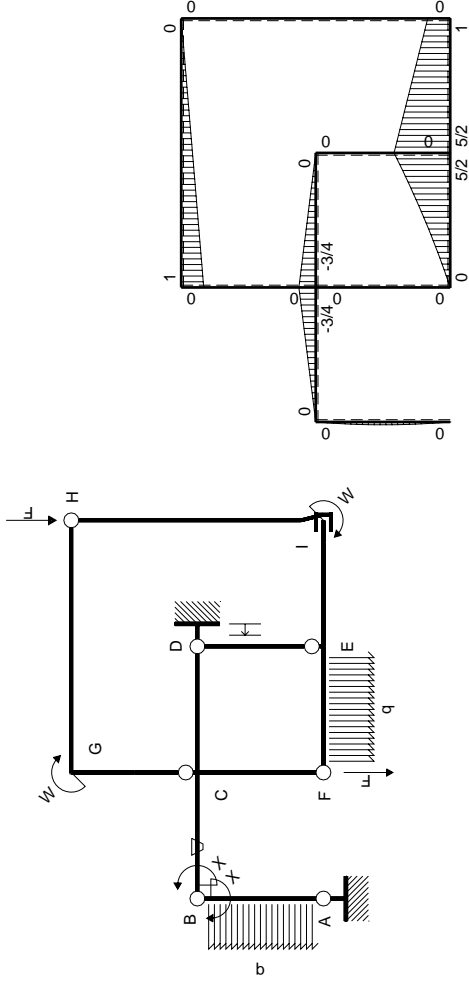
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



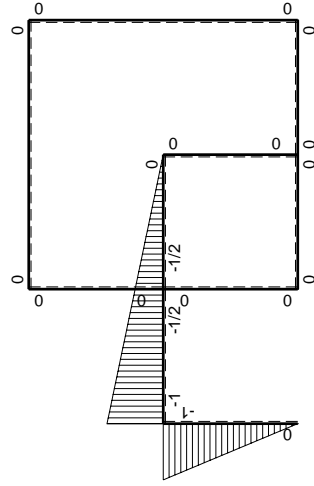
- A = 468. mm²
- J_u = 136587. mm⁴
- J_v = 14364. mm⁴
- y_g = 19.62 mm
- T_y = -2100. N
- M_x = 787500. Nmm
- x_m = 18. mm
- y_m = 54. mm
- u_m = 3. mm
- v_m = 34.38 mm
- σ_m = -M_v/J_u = -198.2 N/mm²
- x_c = 15. mm
- y_c = 39. mm
- v_c = 19.38 mm
- σ_c = -M_v/J_u = -111.8 N/mm²
- τ_c = 6.2 N/mm²
- σ_σ = √σ²+3τ² = 112.3 N/mm²
- S = 2420. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{x_0} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{x_0} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

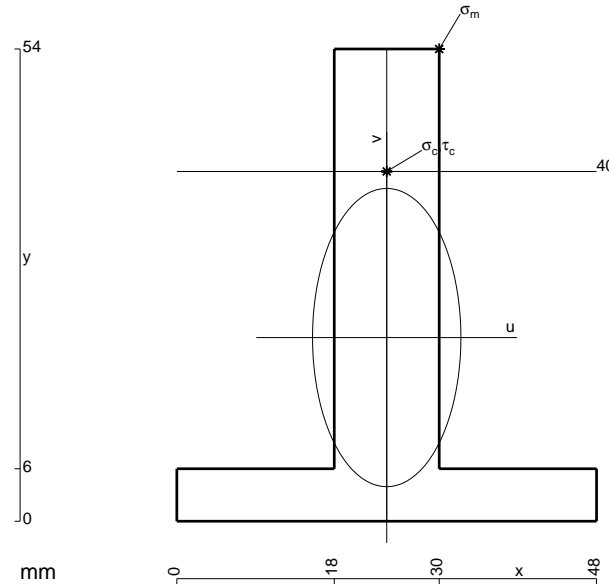
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

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

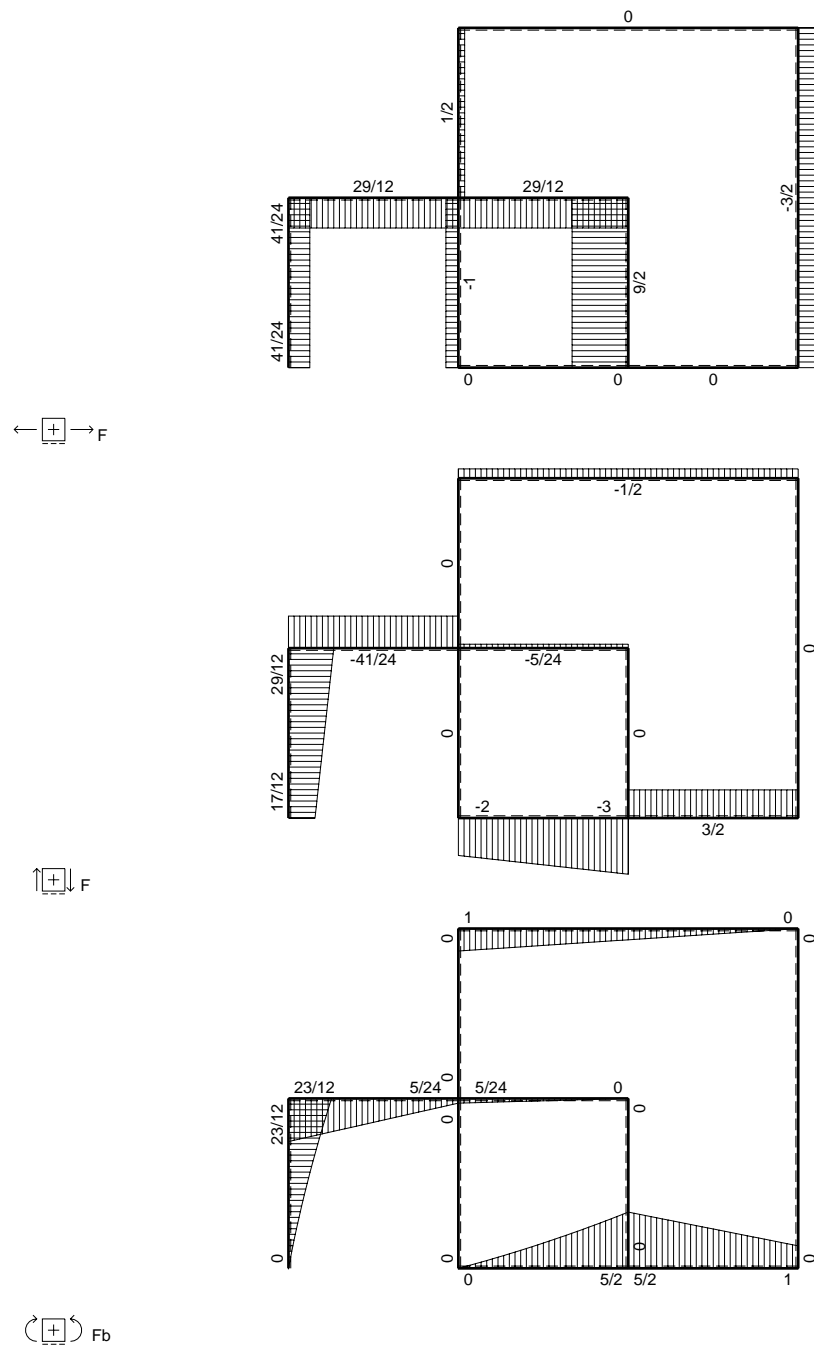
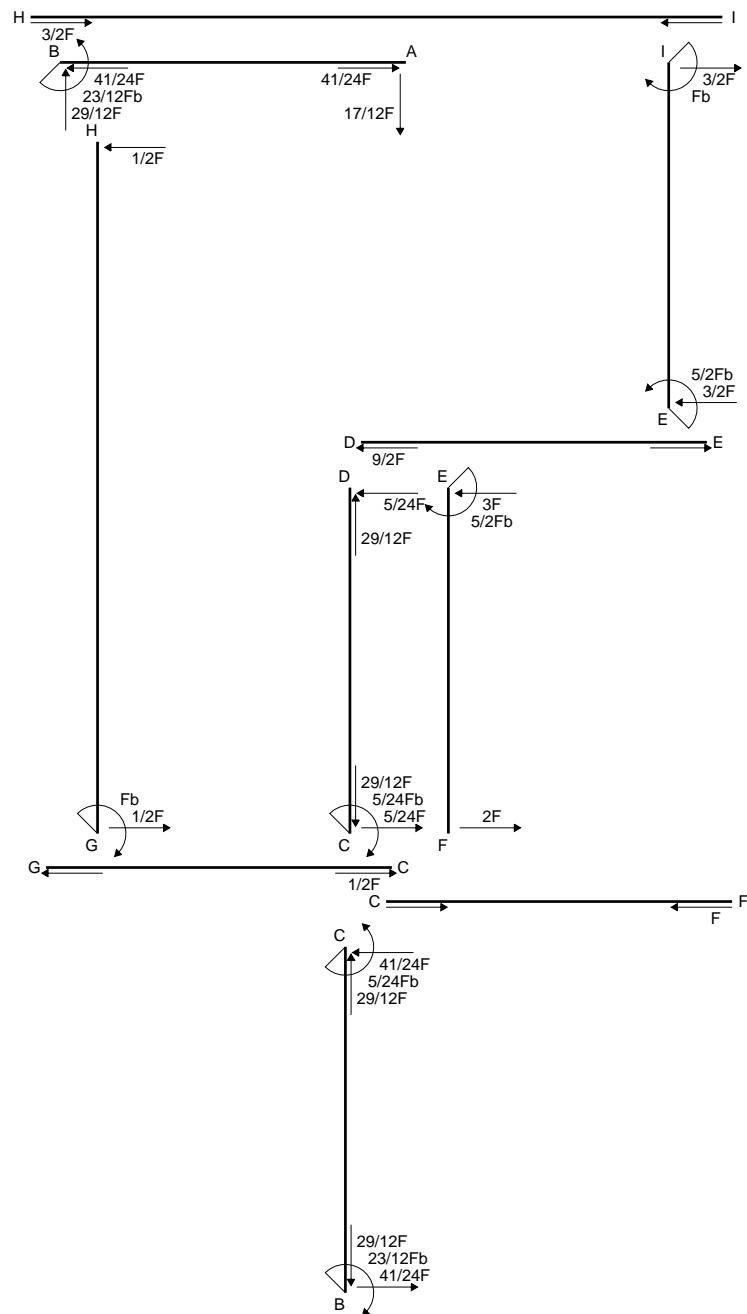
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

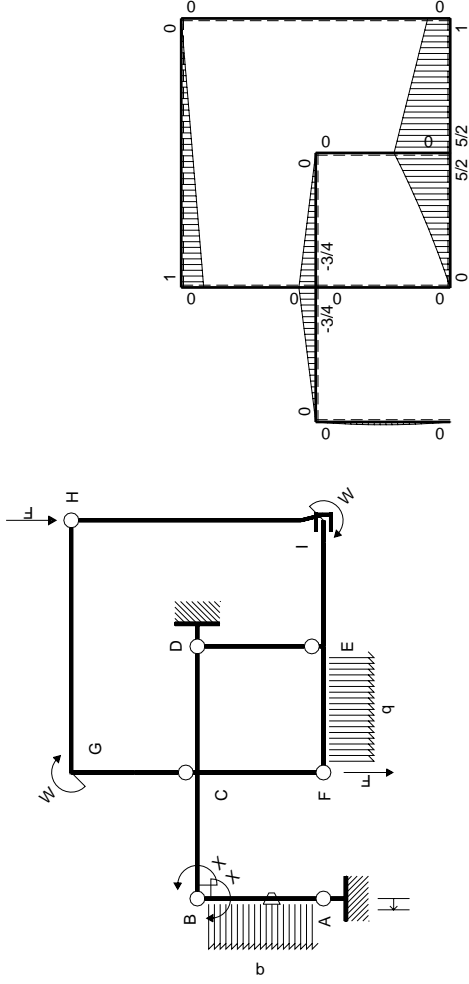
$$L_{DC}^{x_0} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 864. mm²
- J_u = 251424. mm⁴
- J_v = 62208. mm⁴
- y_g = 21. mm
- T_y = -3900. N
- M_x = 1592500. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 6. mm
- v_m = 33. mm
- σ_m = -Mv/J_u = -209. N/mm²
- x_c = 24. mm
- y_c = 40. mm
- v_c = 19. mm
- σ_c = -Mv/J_u = -120.3 N/mm²
- τ_c = 5.646 N/mm²
- σ_σ = √σ²+3τ² = 120.7 N/mm²
- S = 4368. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$23/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-23/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

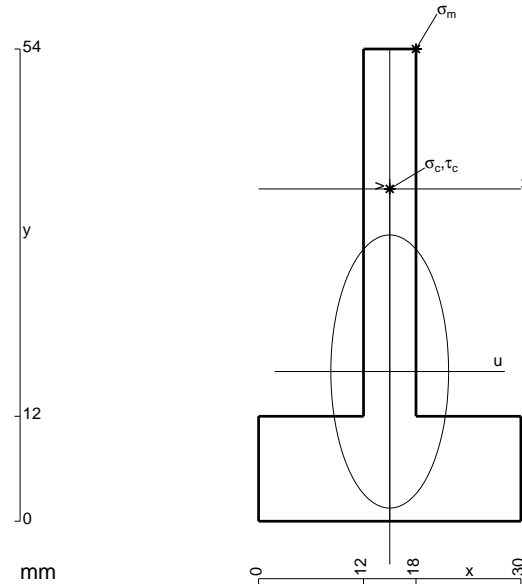
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

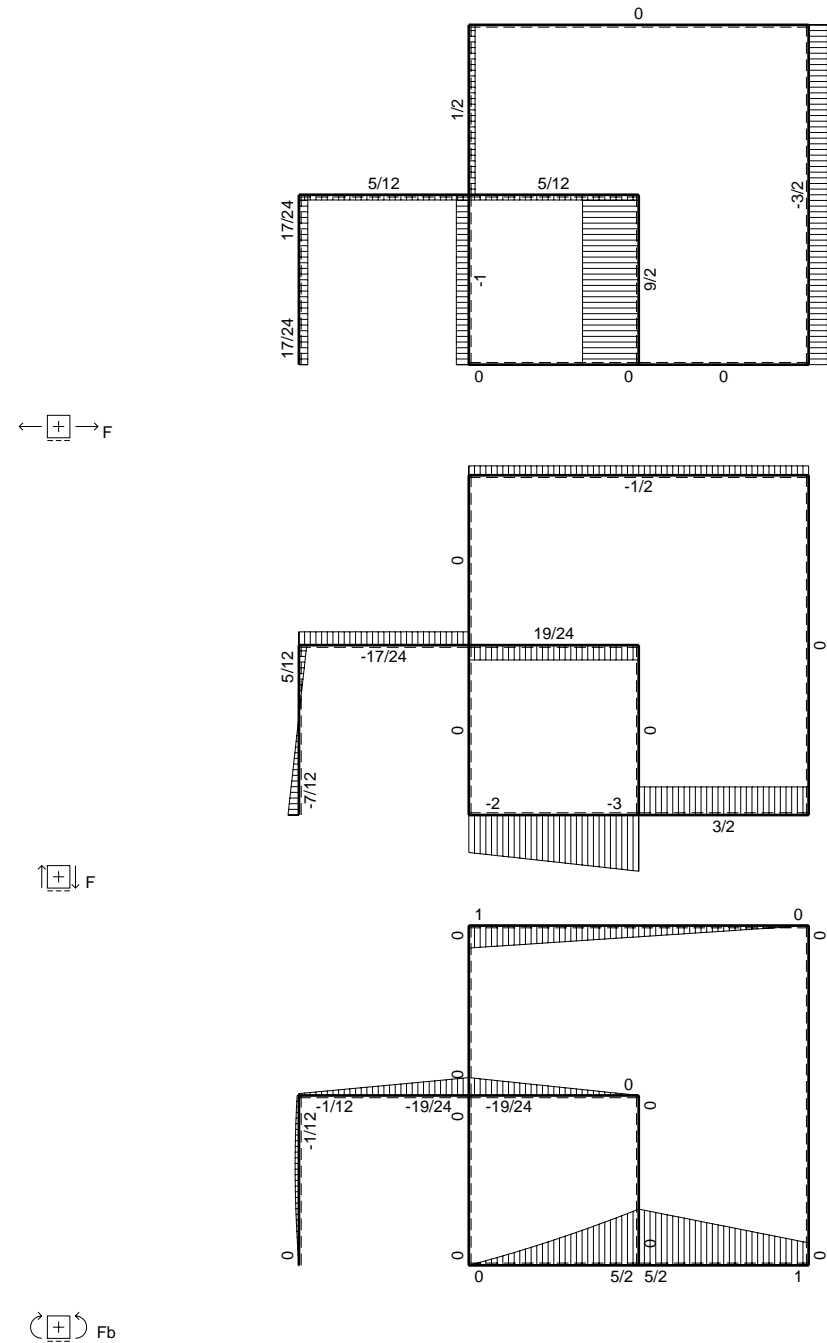
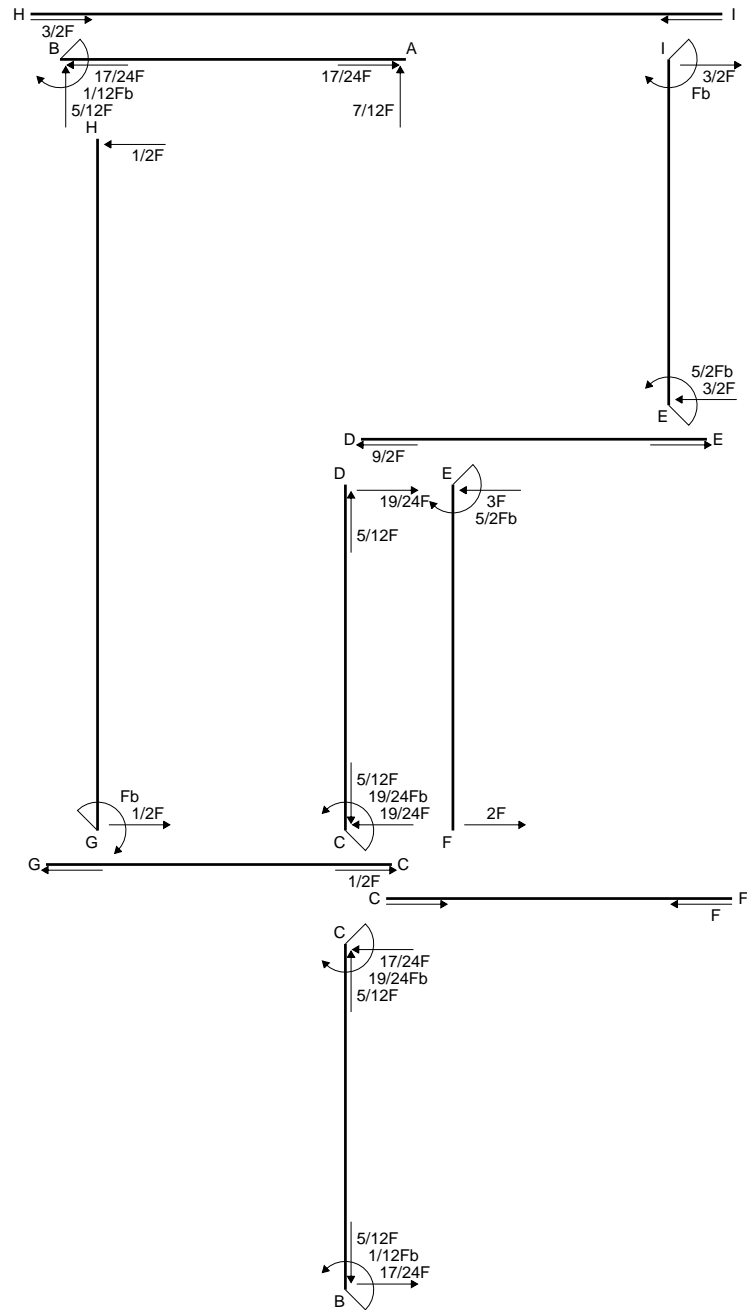
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

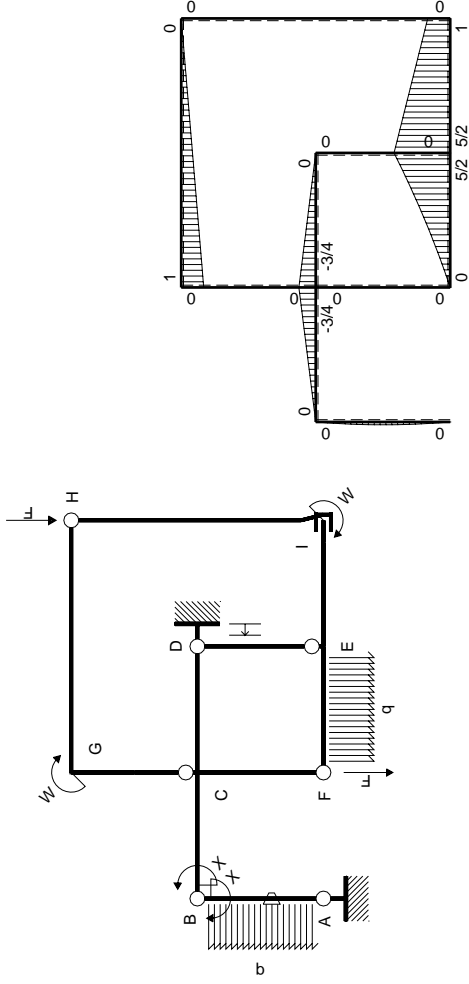
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 612. mm²
- J_u = 149428. mm⁴
- J_v = 27756. mm⁴
- y_g = 17.12 mm
- T_y = -1980. N
- M_x = 891000. Nmm
- x_m = 18. mm
- y_m = 54. mm
- u_m = 3. mm
- v_m = 36.88 mm
- σ_m = -Mv/J_u = -219.9 N/mm²
- x_c = 15. mm
- y_c = 38. mm
- v_c = 20.88 mm
- σ_c = -Mv/J_u = -124.5 N/mm²
- τ_c = 6.123 N/mm²
- σ_o = √σ²+3τ² = 125. N/mm²
- S = 2773. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

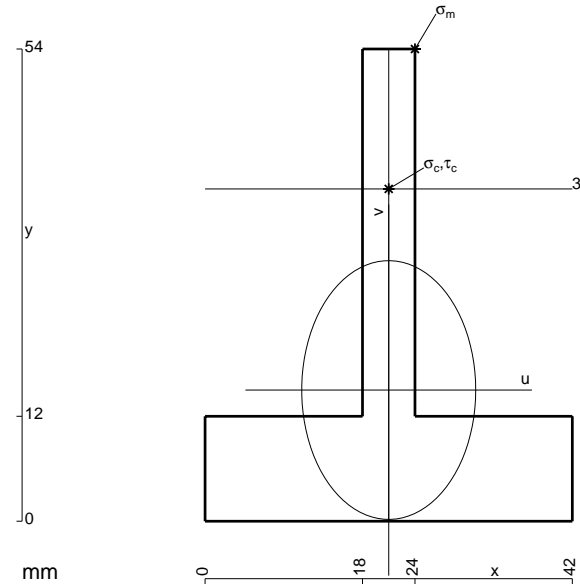
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

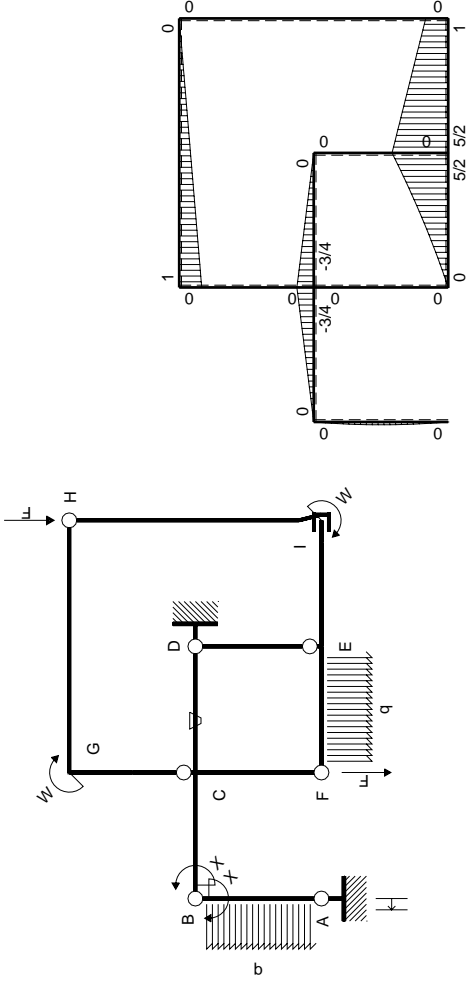
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 756. mm²
- J_u = 165564. mm⁴
- J_v = 74844. mm⁴
- y_g = 15. mm
- T_y = -2010. N
- M_x = 971500. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 3. mm
- v_m = 39. mm
- σ_m = -Mv/J_u = -228.8 N/mm²
- x_c = 21. mm
- y_c = 38. mm
- v_c = 23. mm
- σ_c = -Mv/J_v = -135. N/mm²
- τ_c = 6.022 N/mm²
- σ_o = √σ²+3τ² = 135.4 N/mm²
- S = 2976. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$5/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-5/3Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

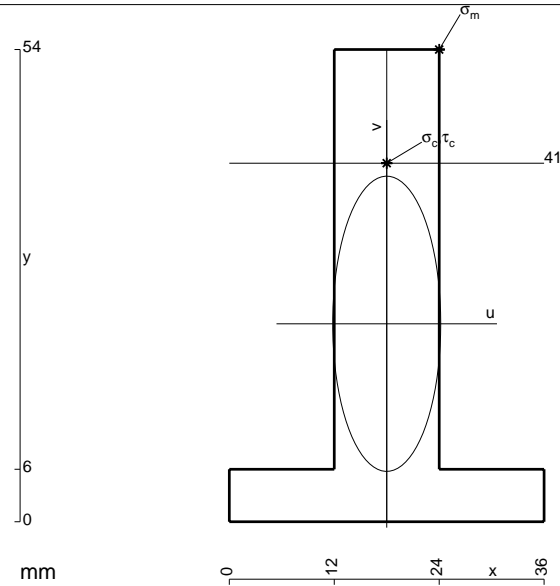
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

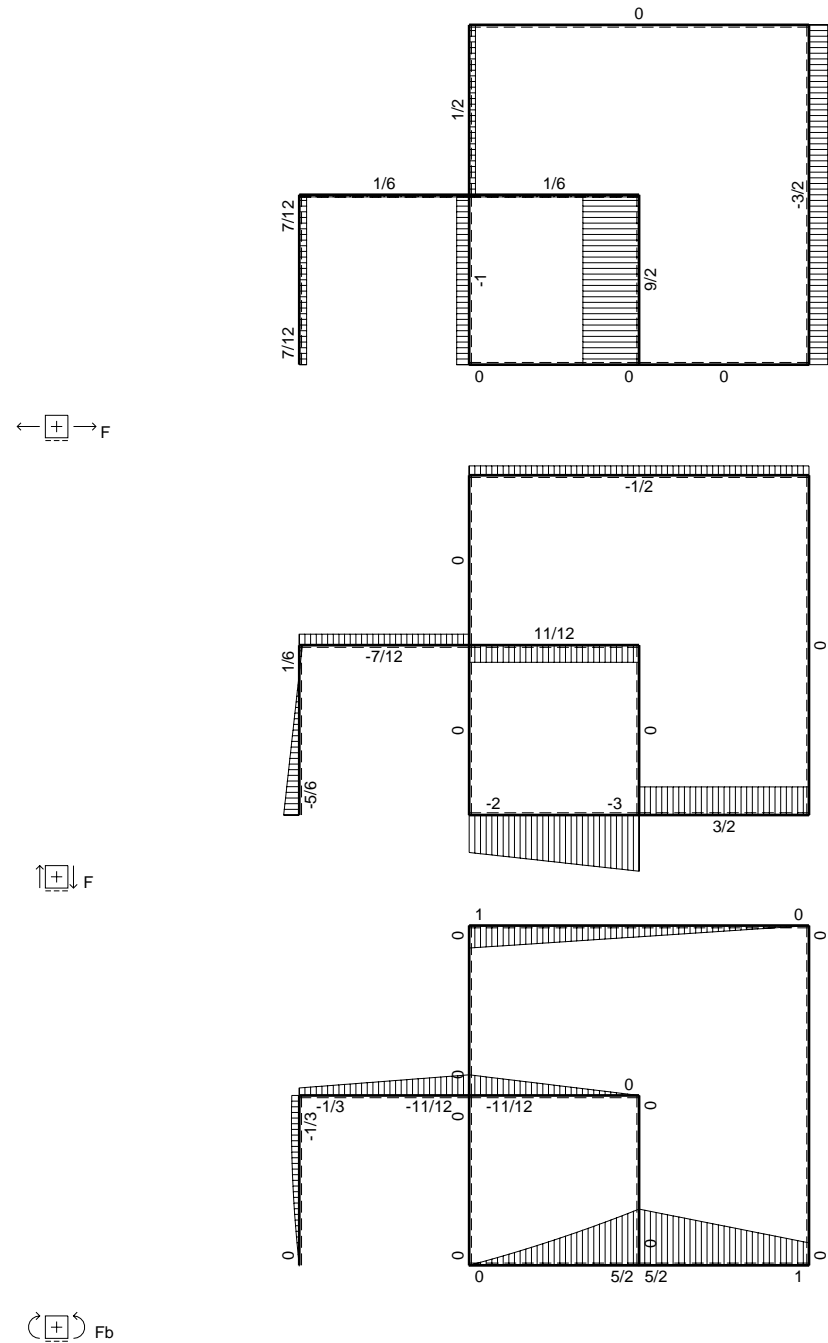
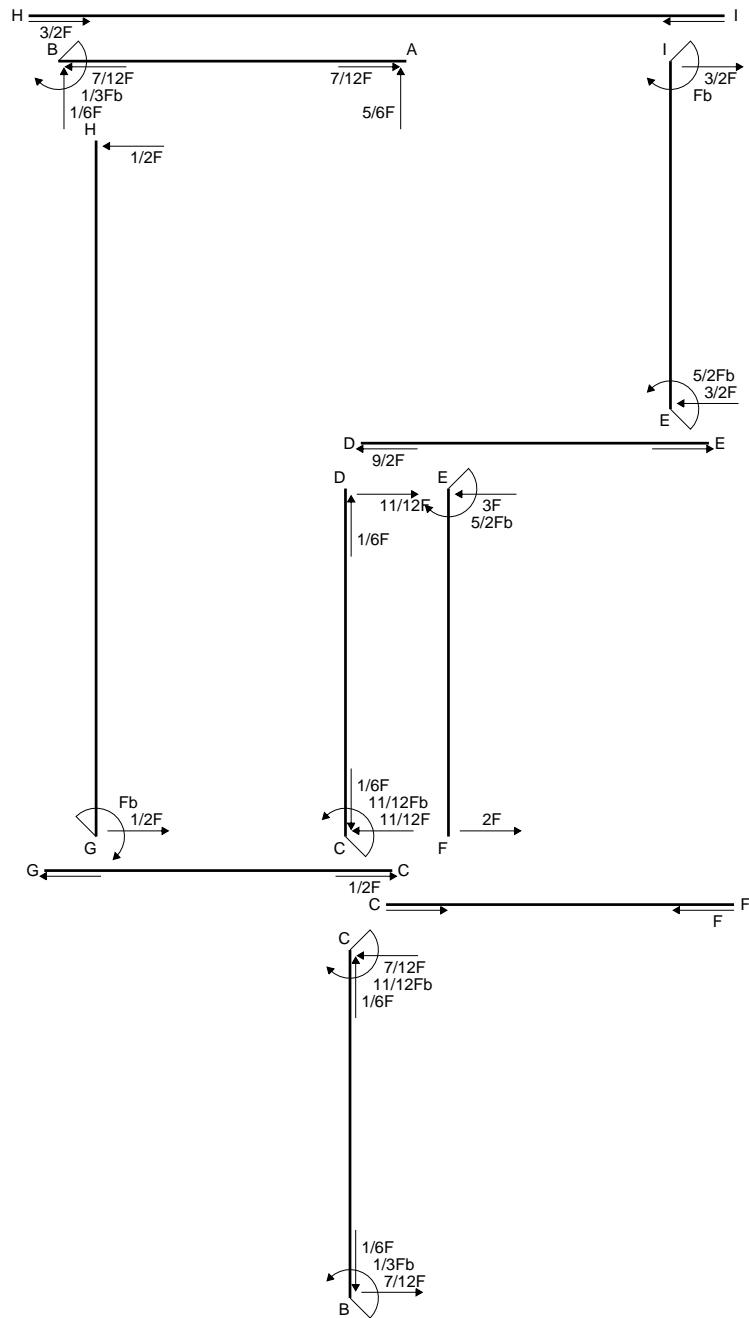
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

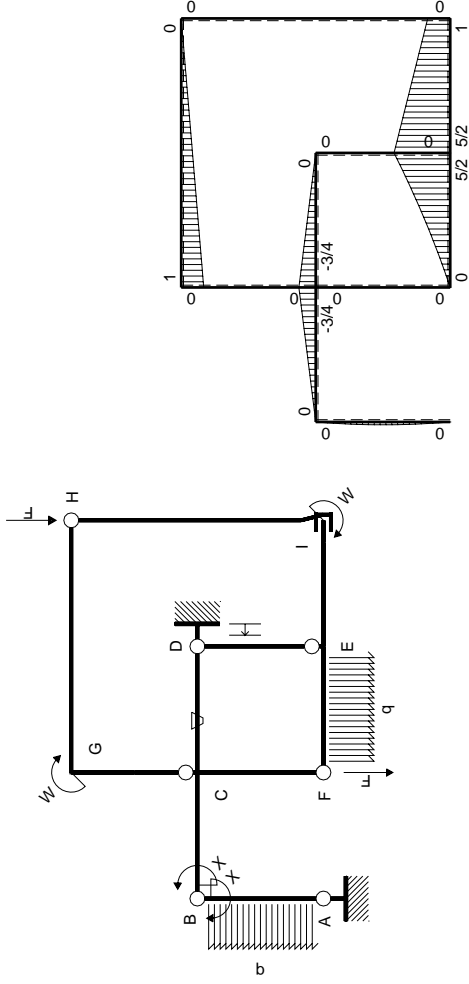
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



- A = 792. mm²
- J_u = 225759. mm⁴
- J_v = 30240. mm⁴
- y_g = 22.64 mm
- T_y = -3270. N
- M_x = 1716750. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 6. mm
- v_m = 31.36 mm
- σ_m = -Mv/J_u = -238.5 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 18.36 mm
- σ_c = -Mv/J_u = -139.6 N/mm²
- τ_c = 4.682 N/mm²
- σ_q = √σ²+3τ² = 139.9 N/mm²
- S = 3879. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$-1/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$1/3Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

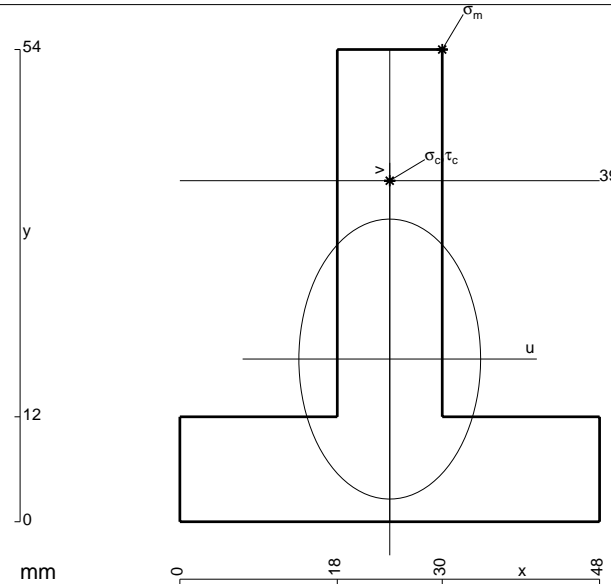
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

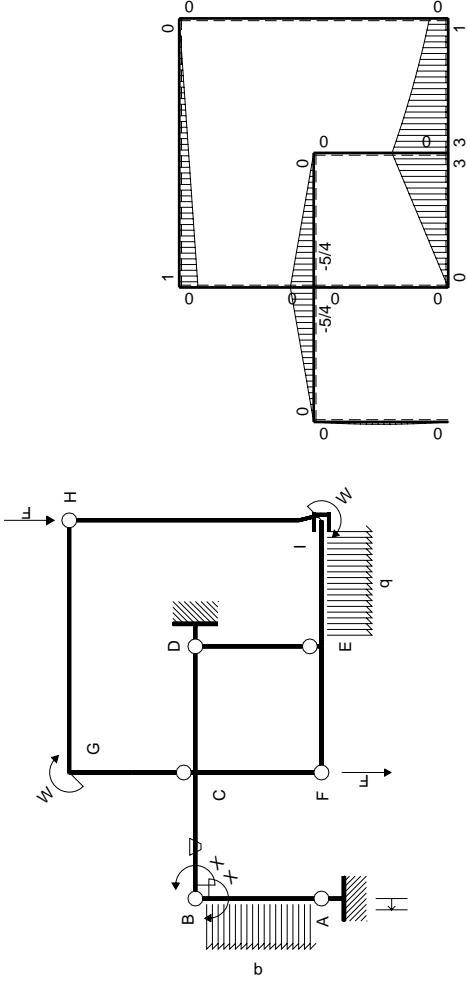
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



- A = 1080. mm²
- J_u = 276955. mm⁴
- J_v = 116640. mm⁴
- y_g = 18.6 mm
- T_y = -2790. N
- M_x = 1557750. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 6. mm
- v_m = 35.4 mm
- σ_m = -Mv/J_u = -199.1 N/mm²
- x_c = 24. mm
- y_c = 39. mm
- v_c = 20.4 mm
- σ_c = -Mv/J_u = -114.7 N/mm²
- τ_c = 4.216 N/mm²
- σ_φ = √(σ²+3τ²) = 115. N/mm²
- S = 5022. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$3Fb-3Fx$	0	0	0	0	0+0	0
FE b	0	$-3Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$29/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-29/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

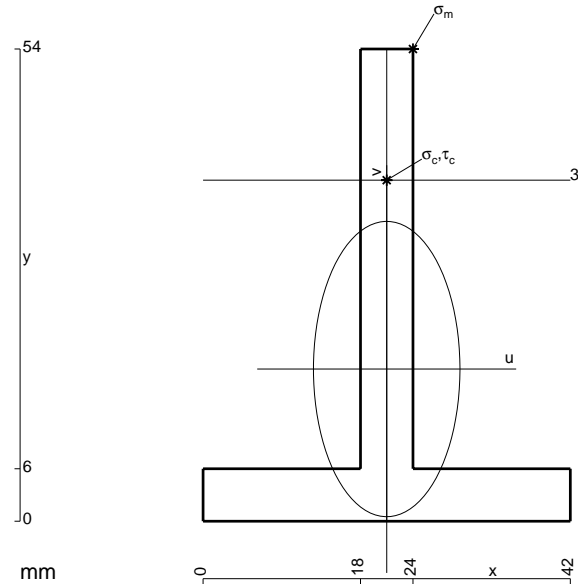
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

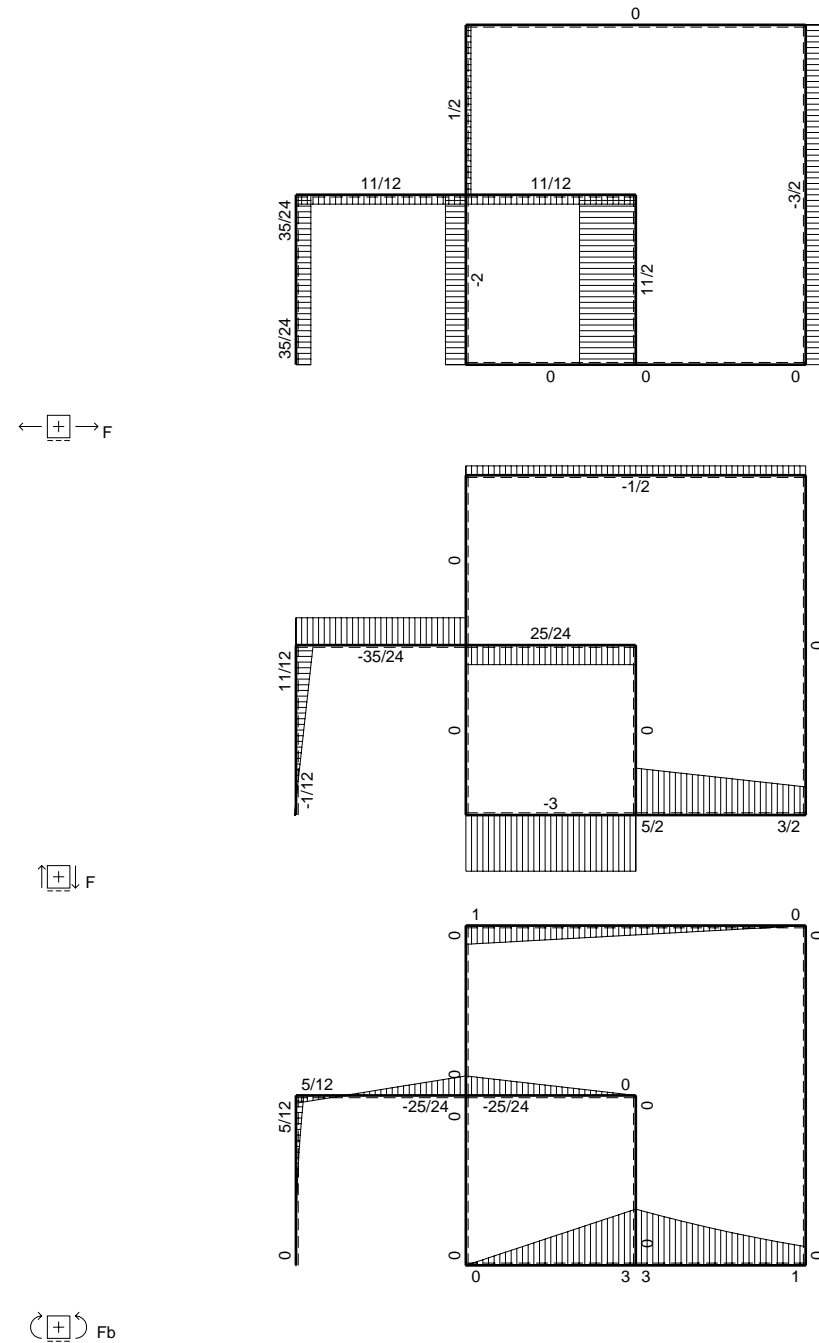
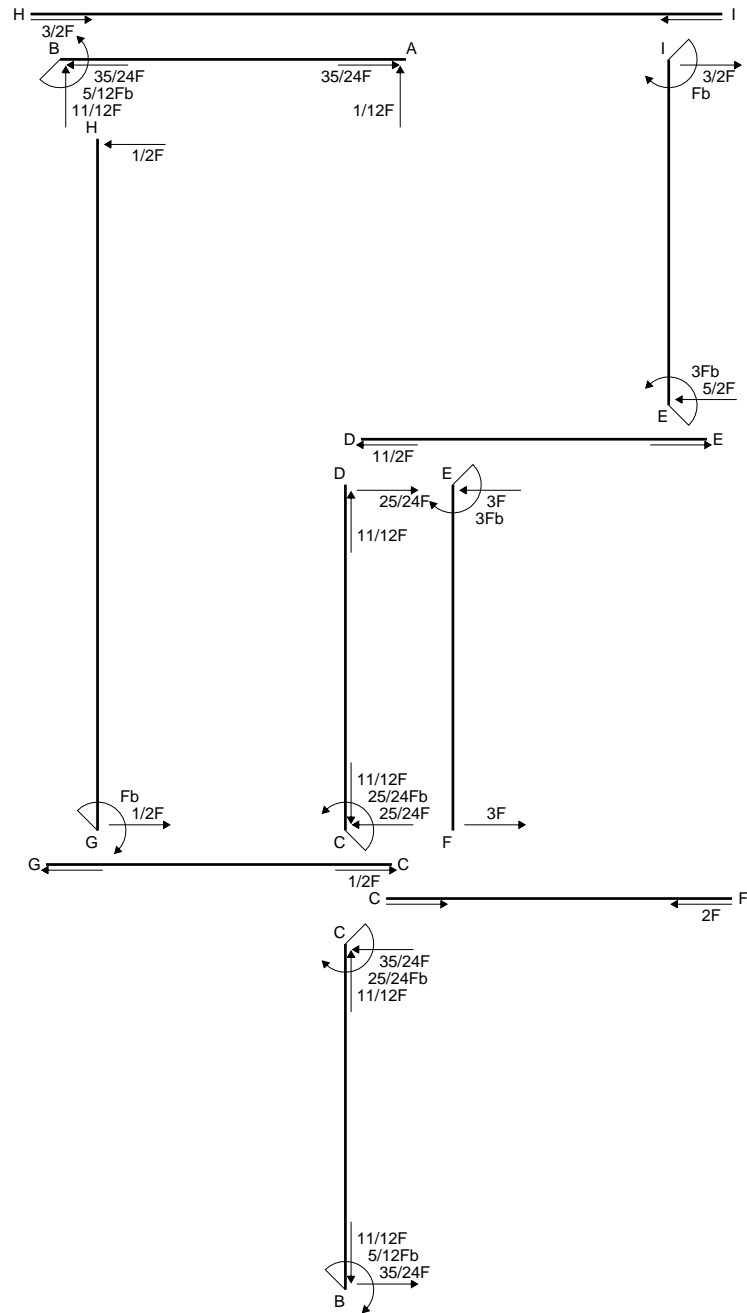
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

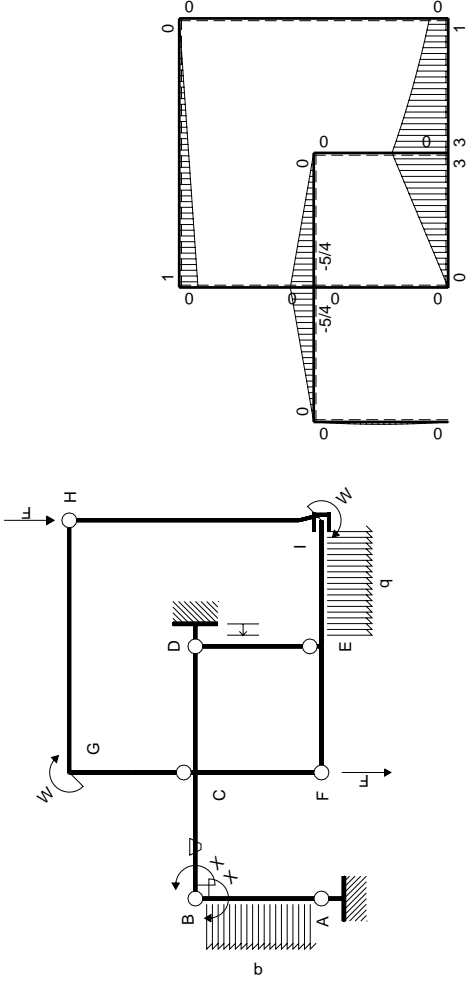
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



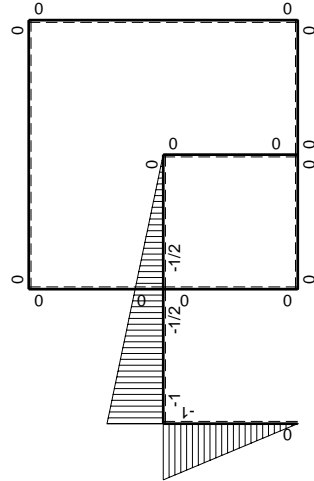
- A = 540. mm²
- J_u = 154030. mm⁴
- J_v = 37908. mm⁴
- y_g = 17.4 mm
- T_y = -1200. N
- M_x = 864000. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 3. mm
- v_m = 36.6 mm
- σ_m = -Mv/J_u = -205.3 N/mm²
- x_c = 21. mm
- y_c = 39. mm
- v_c = 21.6 mm
- σ_c = -Mv/J_u = -121.2 N/mm²
- τ_c = 3.401 N/mm²
- σ_o = √σ²+3τ² = 121.3 N/mm²
- S = 2619. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$3Fb-3Fx$	0	0	0	0	0+0	0
FE b	0	$-3Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$5/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-5/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

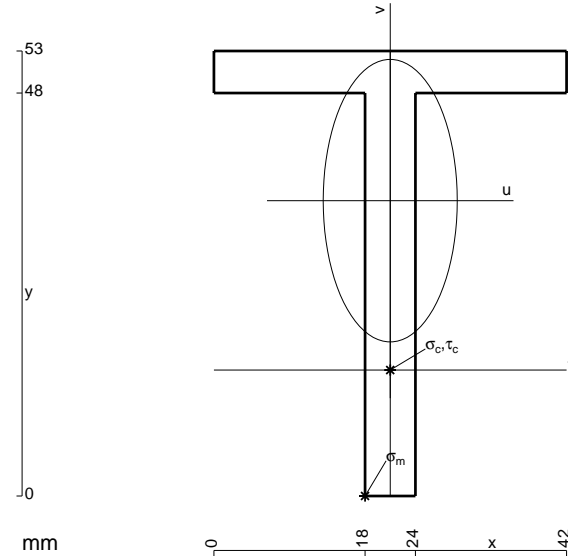
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



$$A = 498. \text{ mm}^2$$

$$J_u = 141019. \text{ mm}^4$$

$$J_v = 31734. \text{ mm}^4$$

$$y_g = 35.17 \text{ mm}$$

$$T_y = -1170. \text{ N}$$

$$M_x = 865800. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$u_m = -3. \text{ mm}$$

$$v_m = -35.17 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 216. \text{ N/mm}^2$$

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

$$y_c = 15. \text{ mm}$$

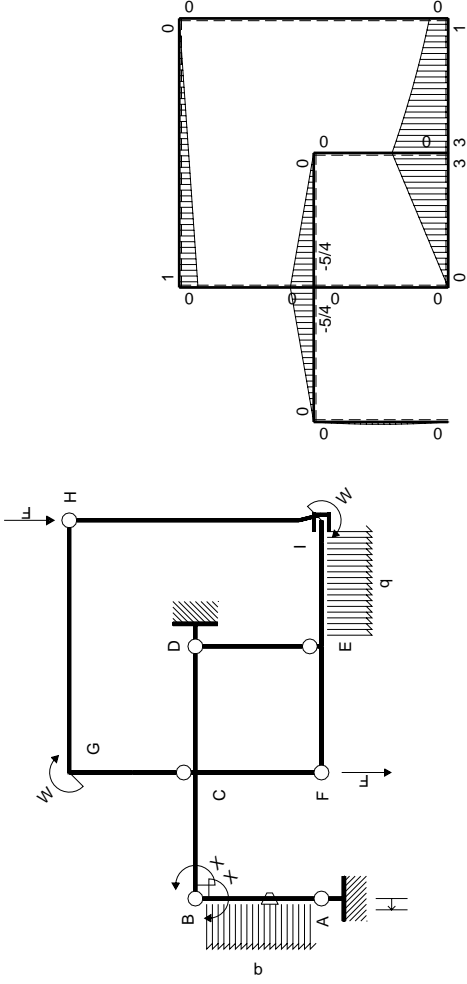
$$v_c = -20.17 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 123.9 \text{ N/mm}^2$$

$$\tau_c = 3.444 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 124. \text{ N/mm}^2$$

$$S = 2491. \text{ mm}^3$$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$3Fb-3Fx$	0	0	0	0	0+0	0
FE b	0	$-3Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$13/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-13/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

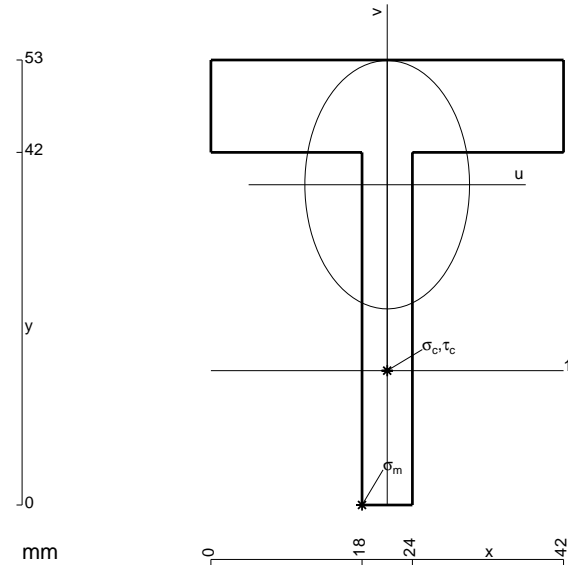
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

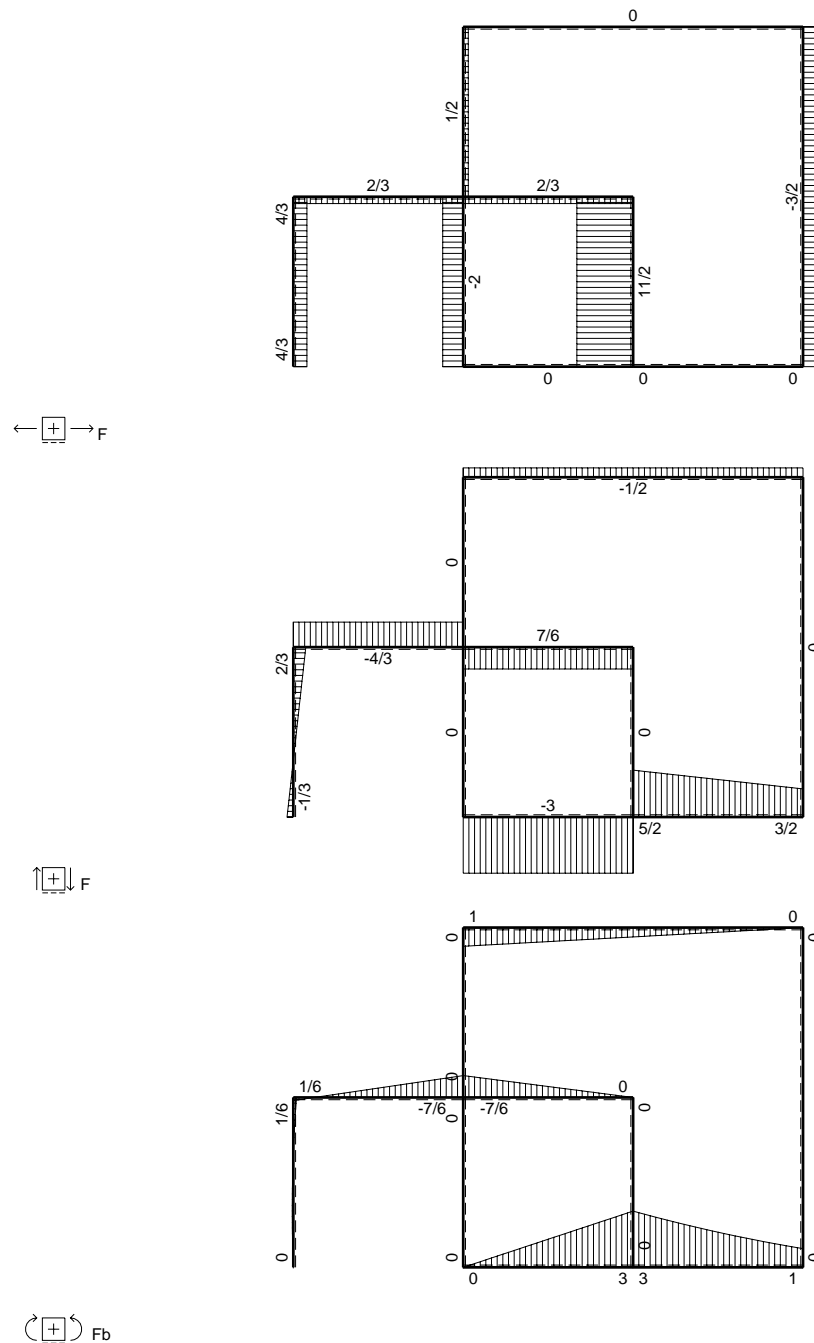
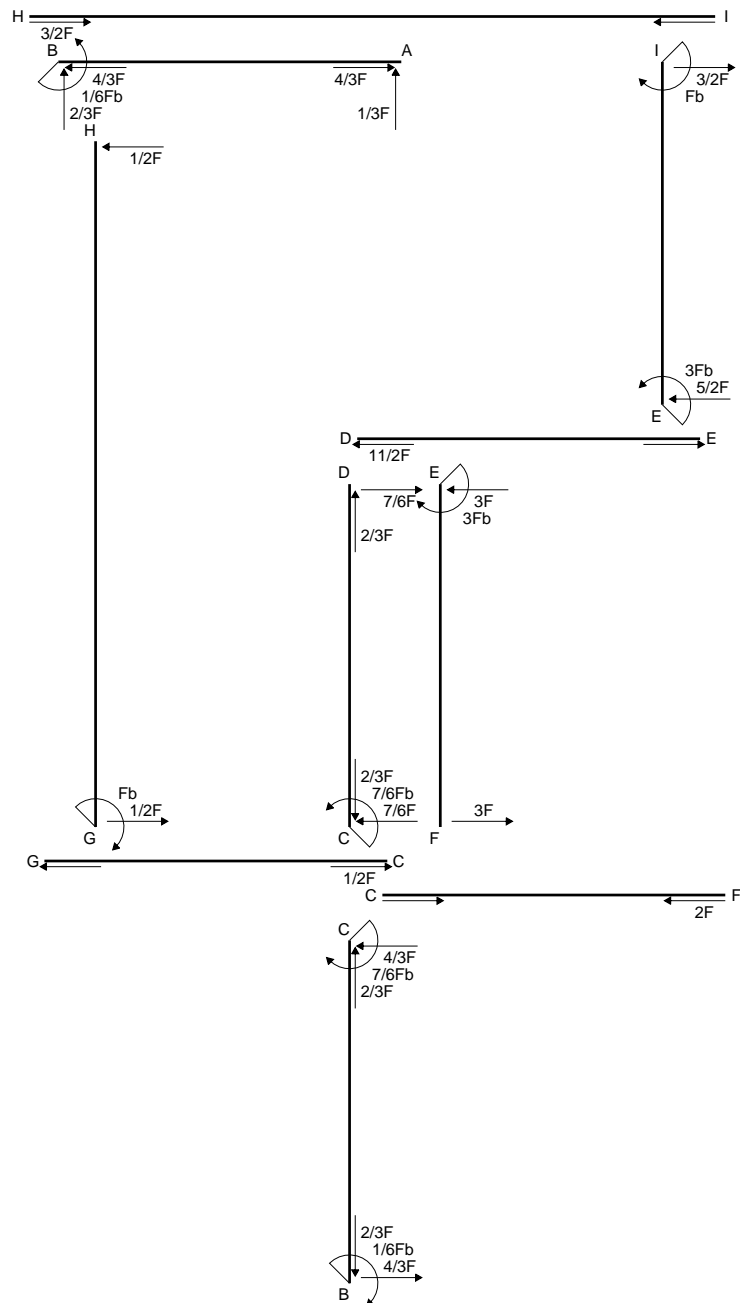
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

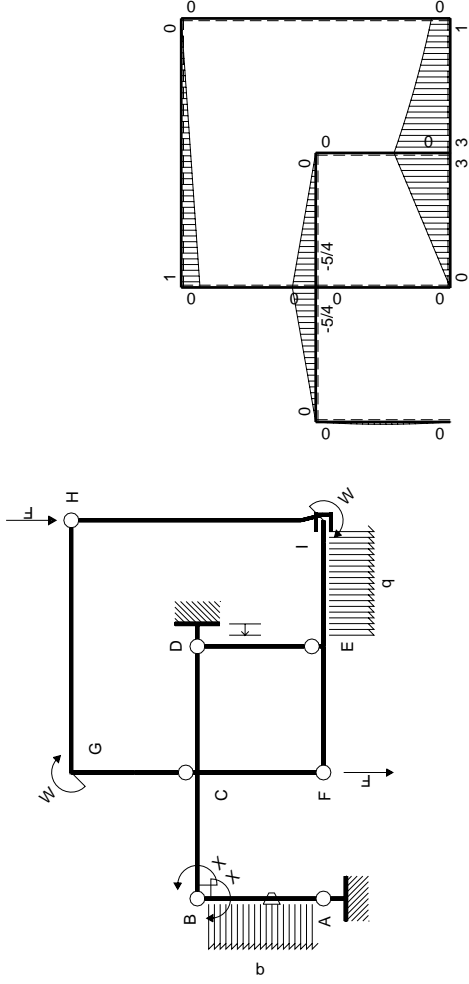
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



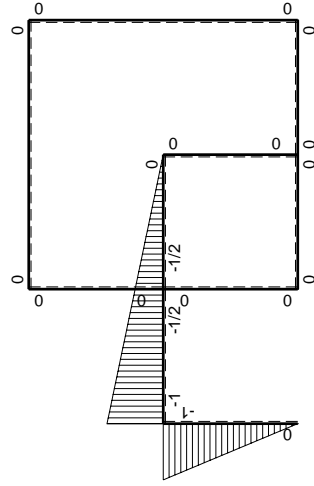
- A = 714. mm²
- J_u = 156210. mm⁴
- J_v = 68670. mm⁴
- y_g = 38.15 mm
- T_y = -1170. N
- M_x = 924300. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -38.15 mm
- σ_m = -Mv/J_u = 225.7 N/mm²
- x_c = 21. mm
- y_c = 16. mm
- v_c = -22.15 mm
- σ_c = -Mv/J_u = 131. N/mm²
- τ_c = 3.613 N/mm²
- σ_q = √σ²+3τ² = 131.2 N/mm²
- S = 2894. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$3Fb-3Fx$	0	0	0	0	0+0	0
FE b	0	$-3Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$1/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-1/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

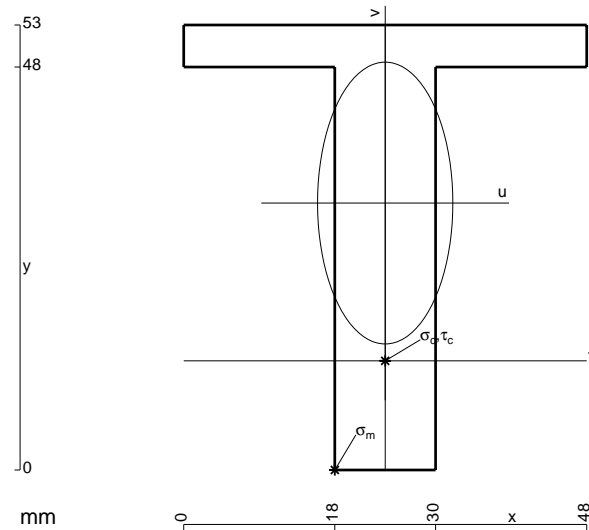
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

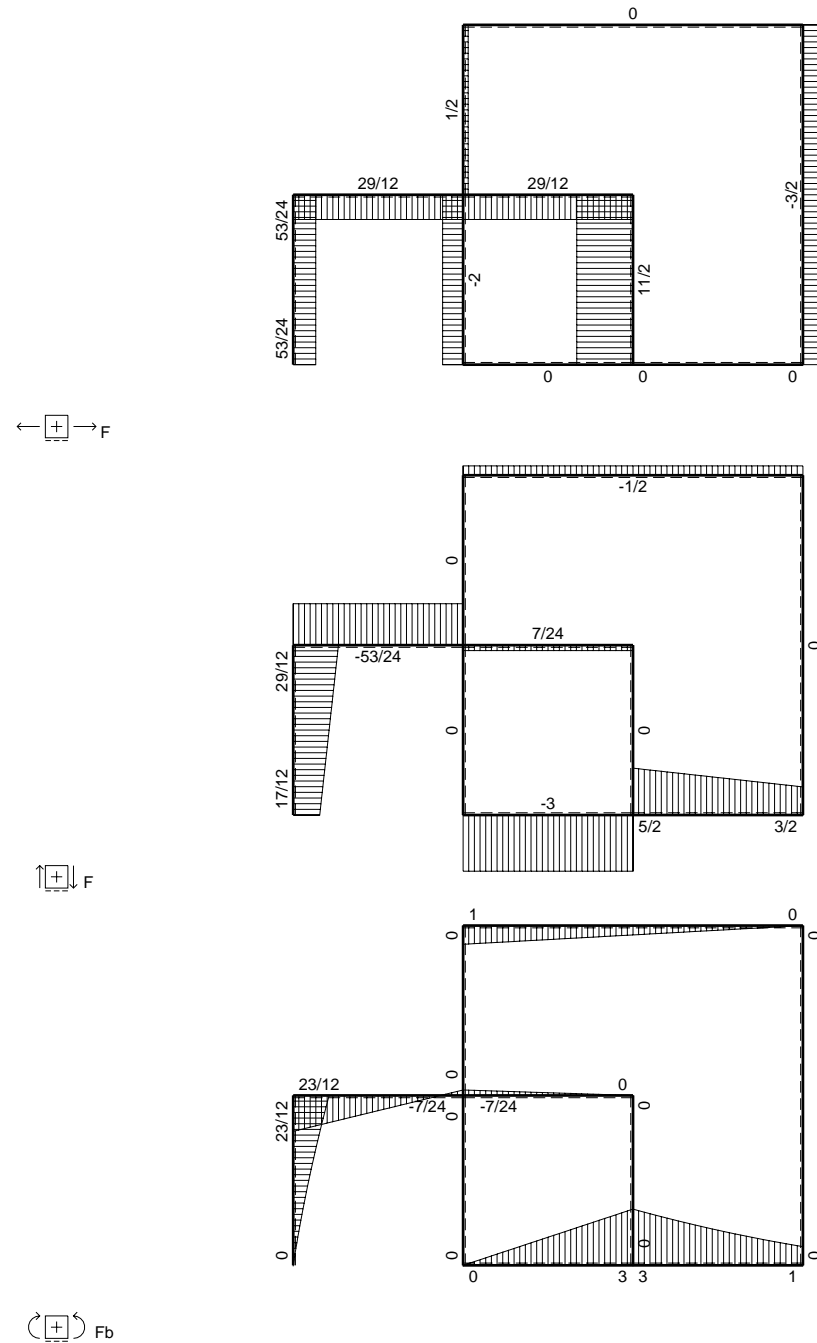
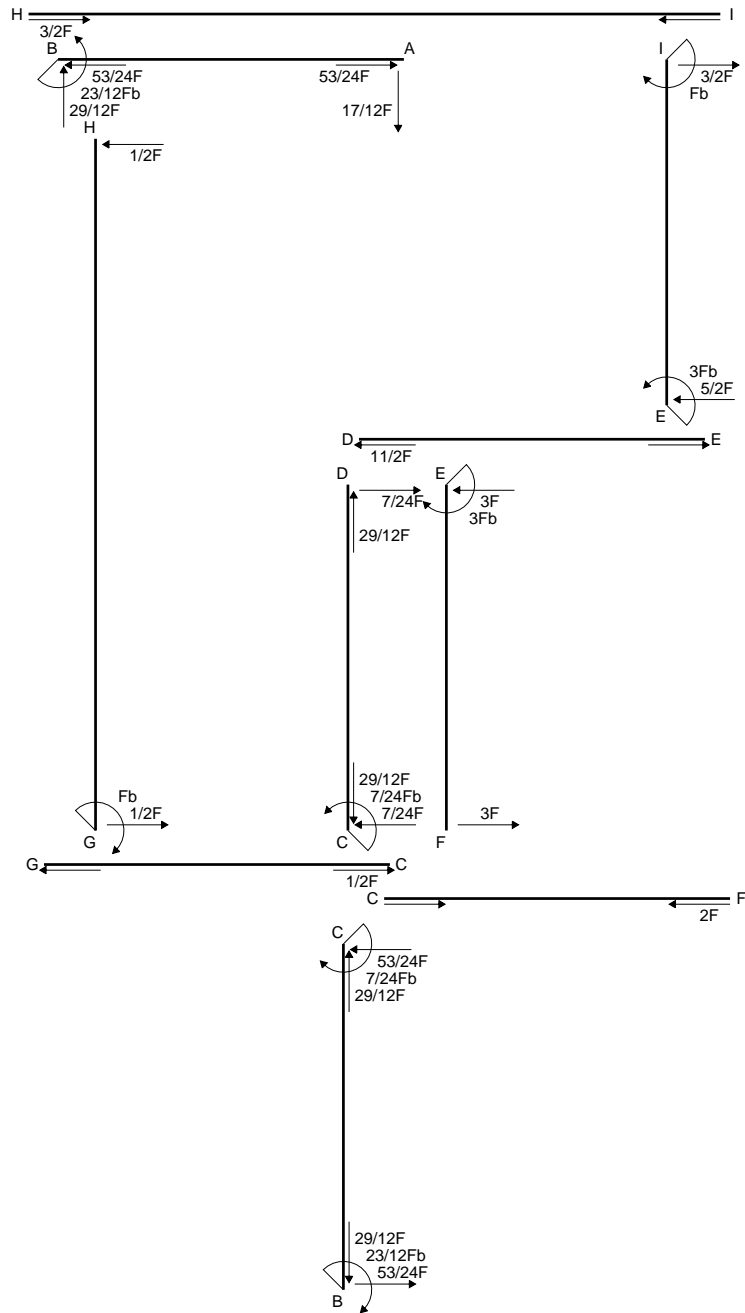
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

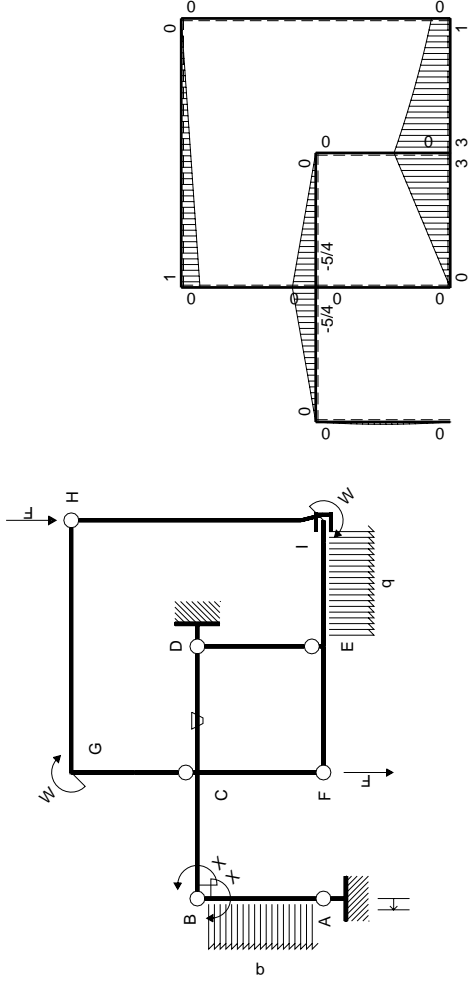
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



- A = 816. mm²
- J_u = 230061. mm⁴
- J_v = 52992. mm⁴
- y_g = 31.79 mm
- T_y = -2070. N
- M_x = 1718100. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -31.79 mm
- σ_m = -Mv/J_u = 237.4 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -18.79 mm
- σ_c = -Mv/J_u = 140.4 N/mm²
- τ_c = 2.959 N/mm²
- σ_q = √σ² + 3τ² = 140.4 N/mm²
- S = 3946. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	$-Fb/EJ$	$5/8Fb-5/4Fx+5/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	Fb/EJ	$5/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$3Fb-3Fx$	0	0	0	0	0+0	0
FE b	0	$-3Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$23/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-23/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

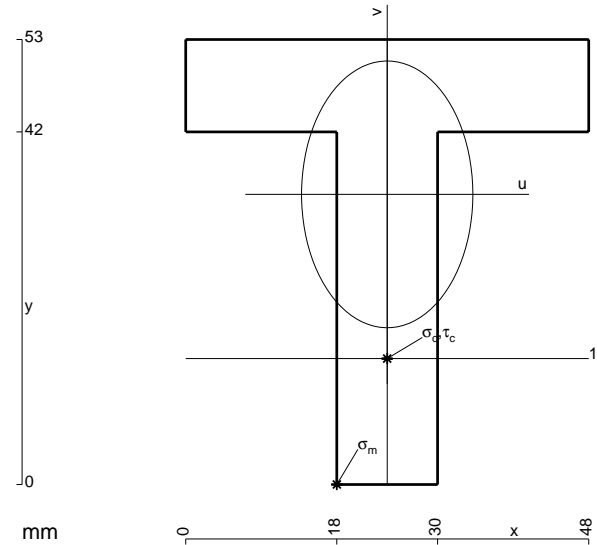
$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

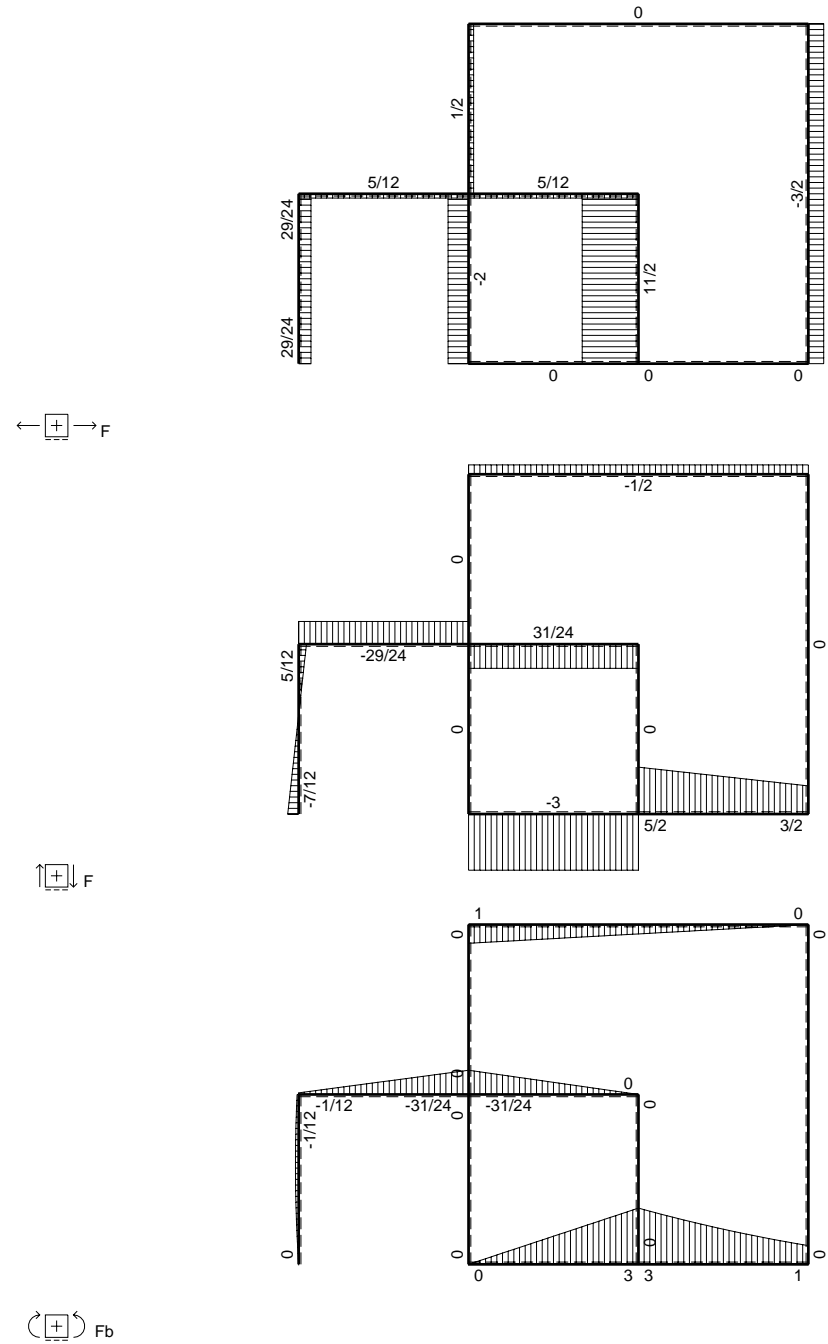
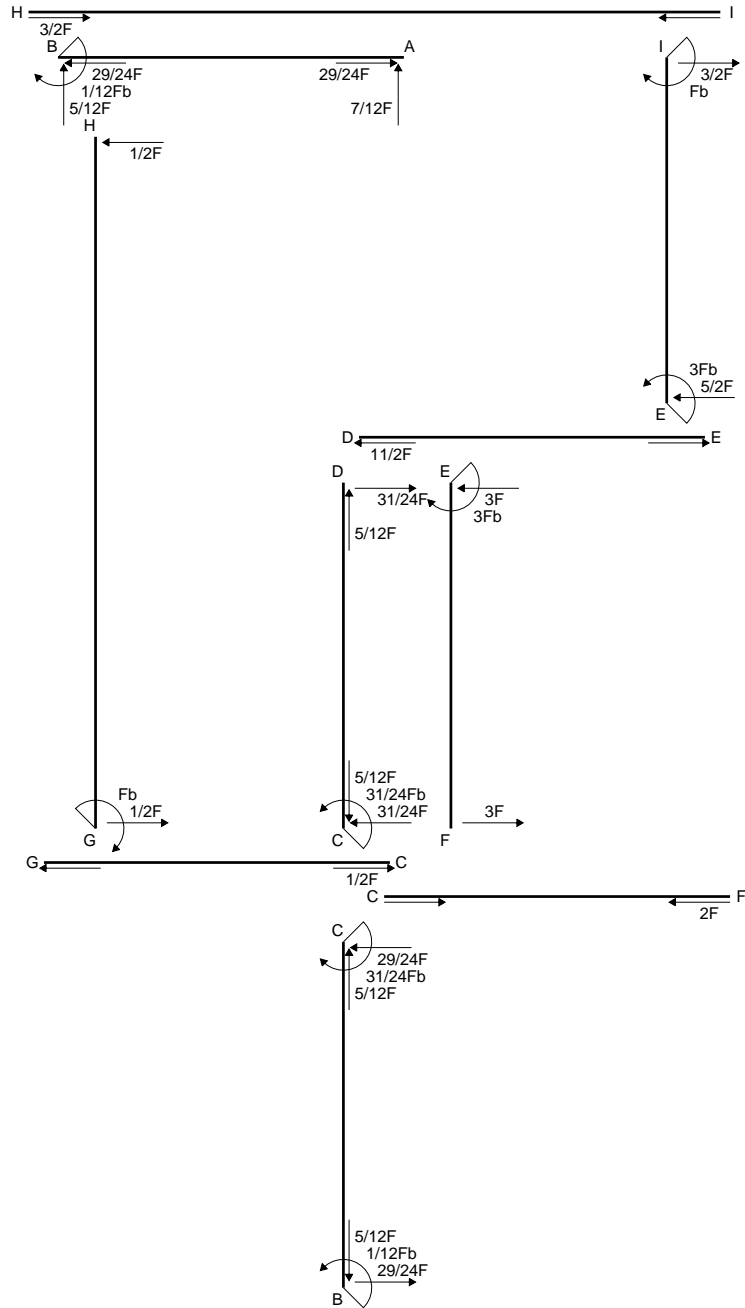
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 11/24 Fb^2/EJ$$

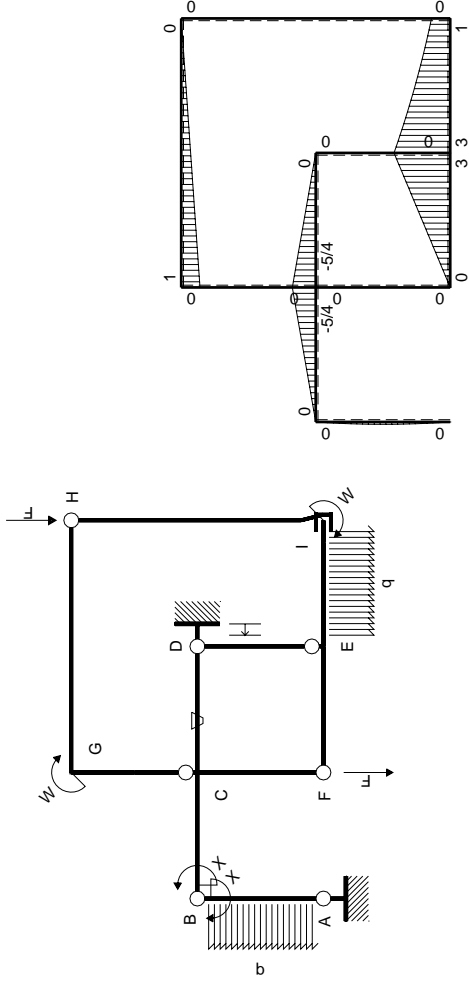
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (5/24 b) Fb 1/EJ + (-1/4 b) \theta = 11/24 Fb^2/EJ$$



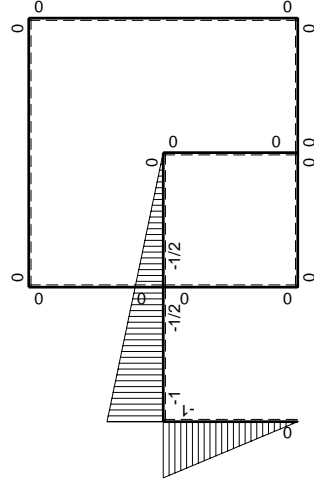
- A = 1032. mm²
- J_u = 260495. mm⁴
- J_v = 107424. mm⁴
- y_g = 34.56 mm
- T_y = -3420. N
- M_x = 1504800. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -34.56 mm
- σ_m = -Mv/J_u = 199.6 N/mm²
- x_c = 24. mm
- y_c = 15. mm
- v_c = -19.56 mm
- σ_c = -Mv/J_u = 113. N/mm²
- τ_c = 5.329 N/mm²
- σ_o = √σ²+3τ² = 113.4 N/mm²
- S = 4870. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	$-Fb/EJ$	$5/8Fb-5/4Fx+5/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$5/4Fx$	Fb/EJ	$5/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$3Fb-3Fx$	0	0	0	0	0+0	0	
FE b	0	$-3Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

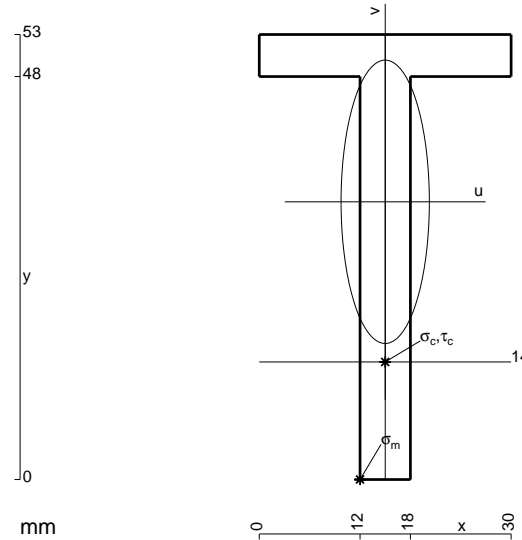
$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

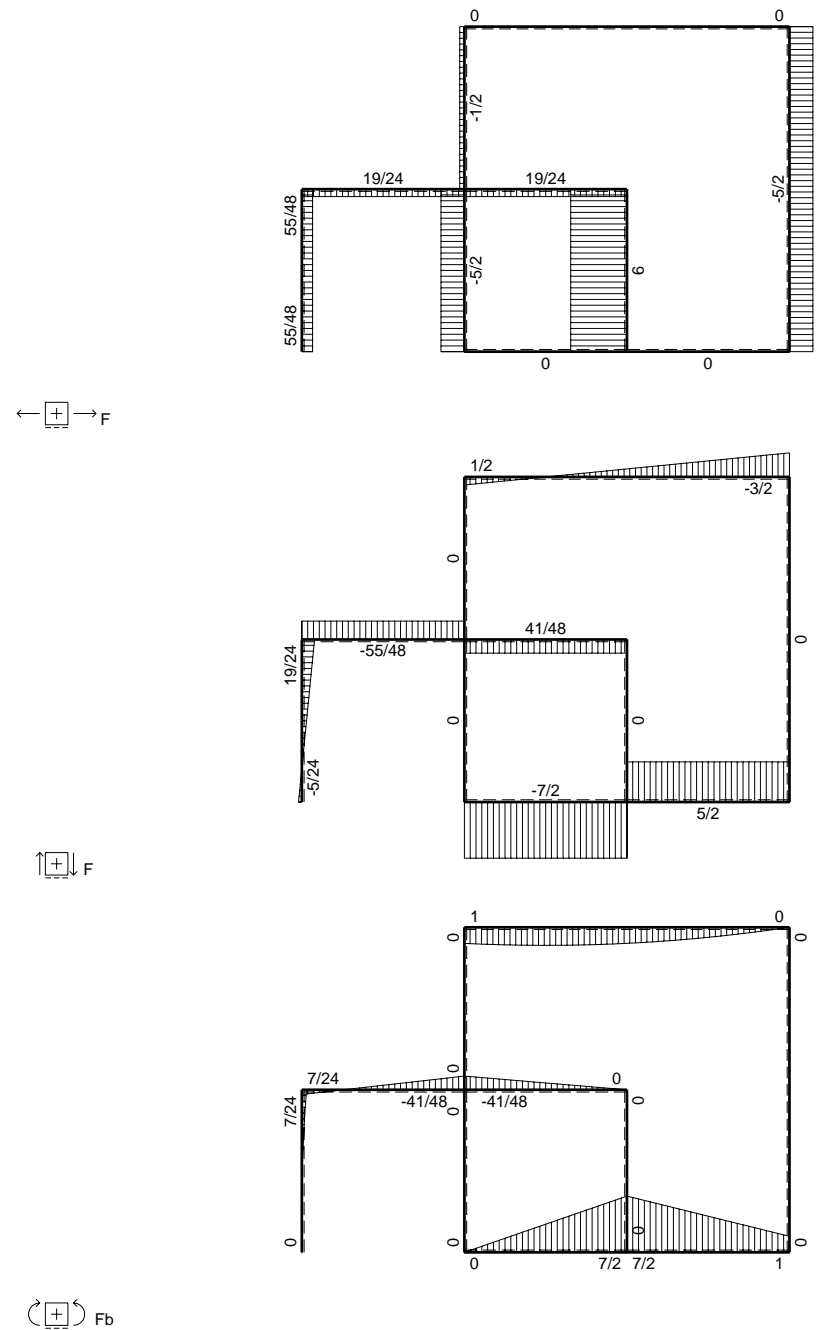
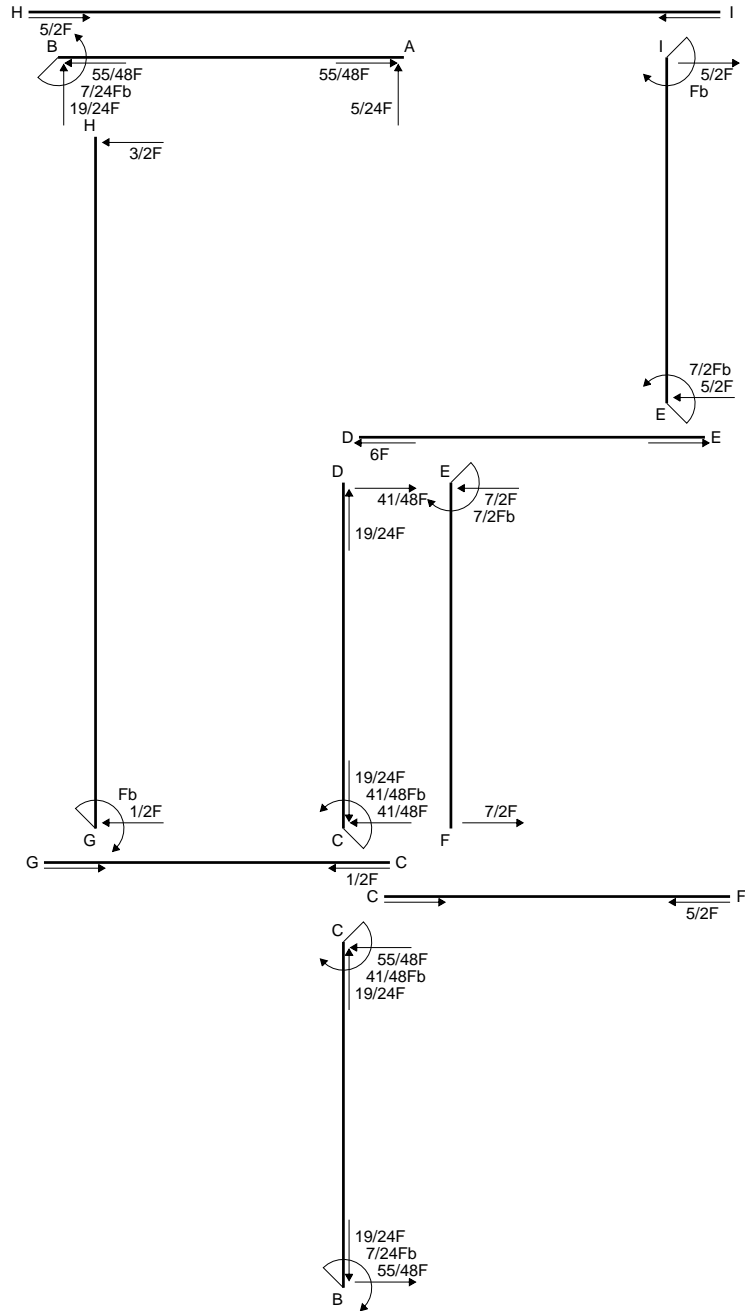
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 11/24 Fb^2/EJ$$

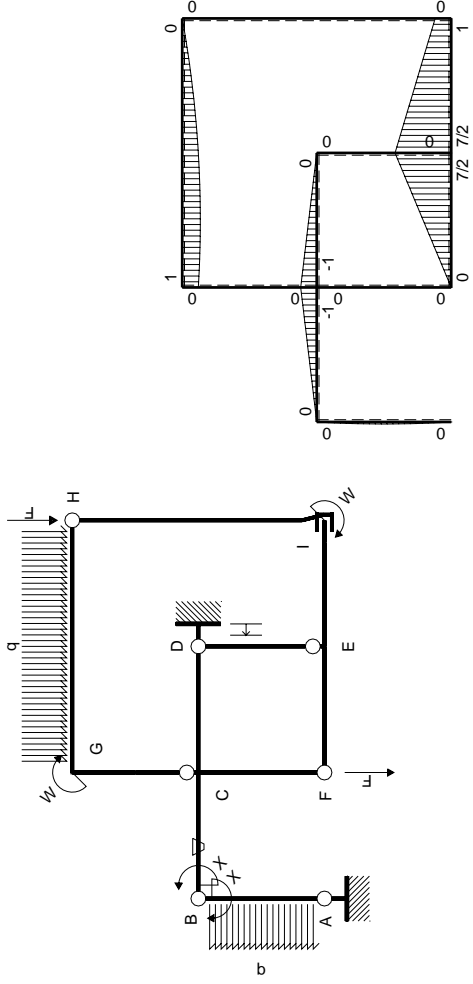
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (5/24 b) Fb 1/EJ + (-1/4 b) \theta = 11/24 Fb^2/EJ$$



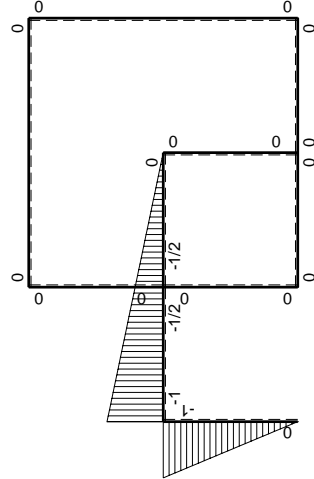
- A = 438. mm²
- J_u = 124871. mm⁴
- J_v = 12114. mm⁴
- y_g = 33.08 mm
- T_y = -1650. N
- M_x = 792000. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -33.08 mm
- σ_m = -Mv/J_u = 209.8 N/mm²
- x_c = 15. mm
- y_c = 14. mm
- v_c = -19.08 mm
- σ_c = -Mv/J_u = 121. N/mm²
- τ_c = 4.824 N/mm²
- σ_o = √σ²+3τ² = 121.3 N/mm²
- S = 2190. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0			
ED b	0	0	0	0	0	0	0+0	0	
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0			
FE b	0	$-7/2Fx$	0	0	0	0	0+0	0	
FC b	0	0	0	0	0	0			
CF b	0	0	0	0	0	0	0+0	0	
CG b	0	0	0	0	0	0			
GC b	0	0	0	0	0	0	0+0	0	
GH 2b	0	$Fb+1/2Fx-1/2qx^2$	0	0	0	0			
HG 2b	0	$-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
HI 2b	0	0	0	0	0	0			
IH 2b	0	0	0	0	0	0	0+0	0	
IE b	0	$Fb+5/2Fx$	0	0	0	0			
EI b	0	$-7/2Fb+5/2Fx$	0	0	0	0	0+0	0	
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$		
	totali						$7/24Fb^2/EJ$	Xb/EJ	
	iperstatica $X=W_{BC}$						$-7/24Fb$		

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

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

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

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

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

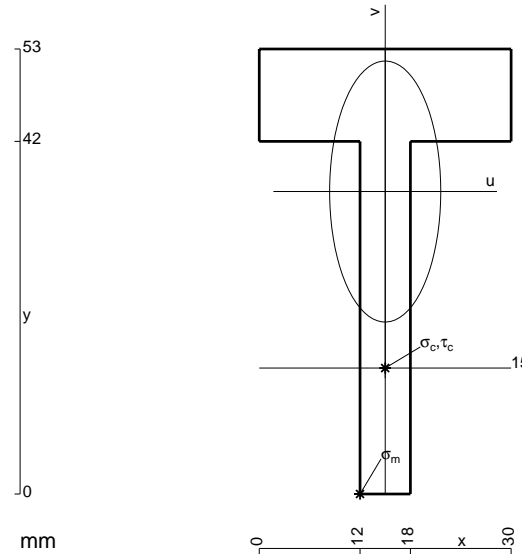
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

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

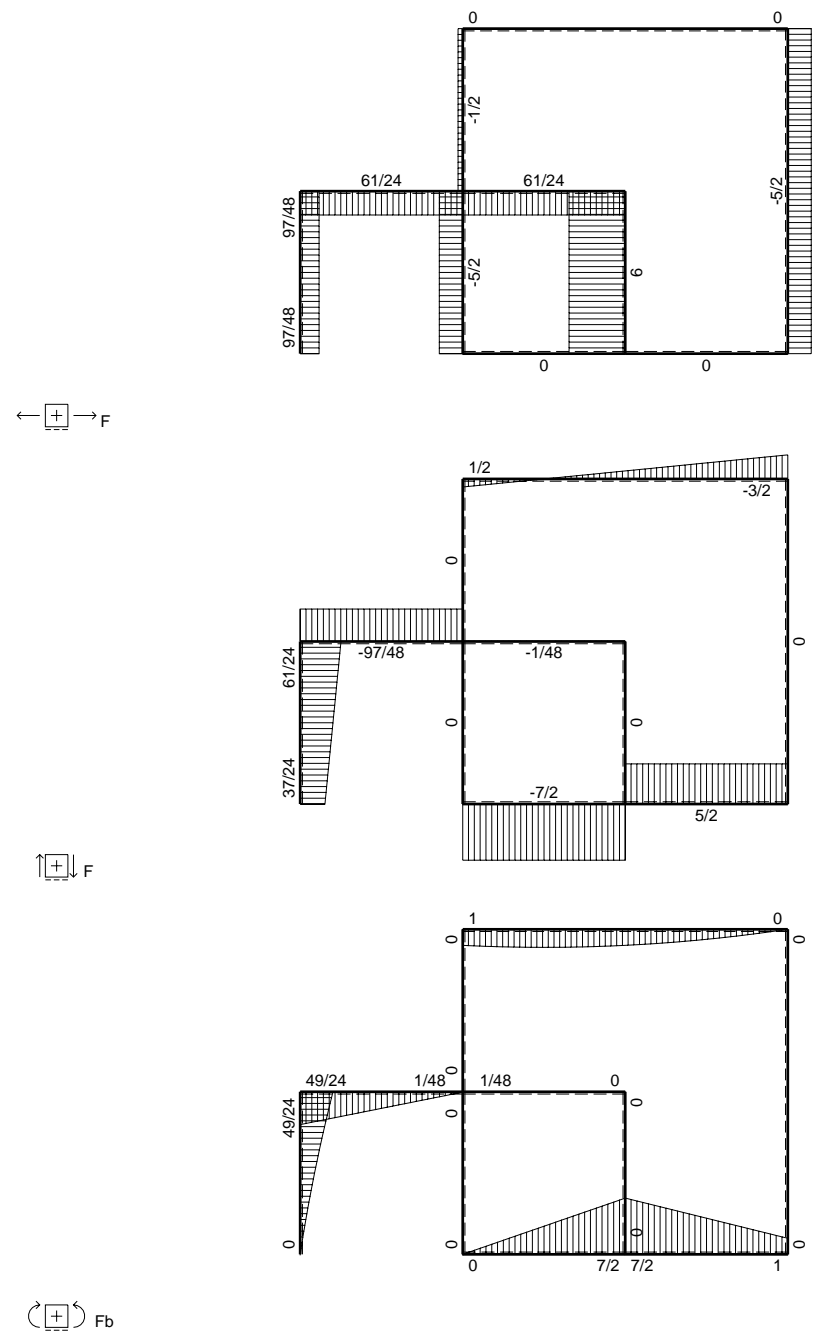
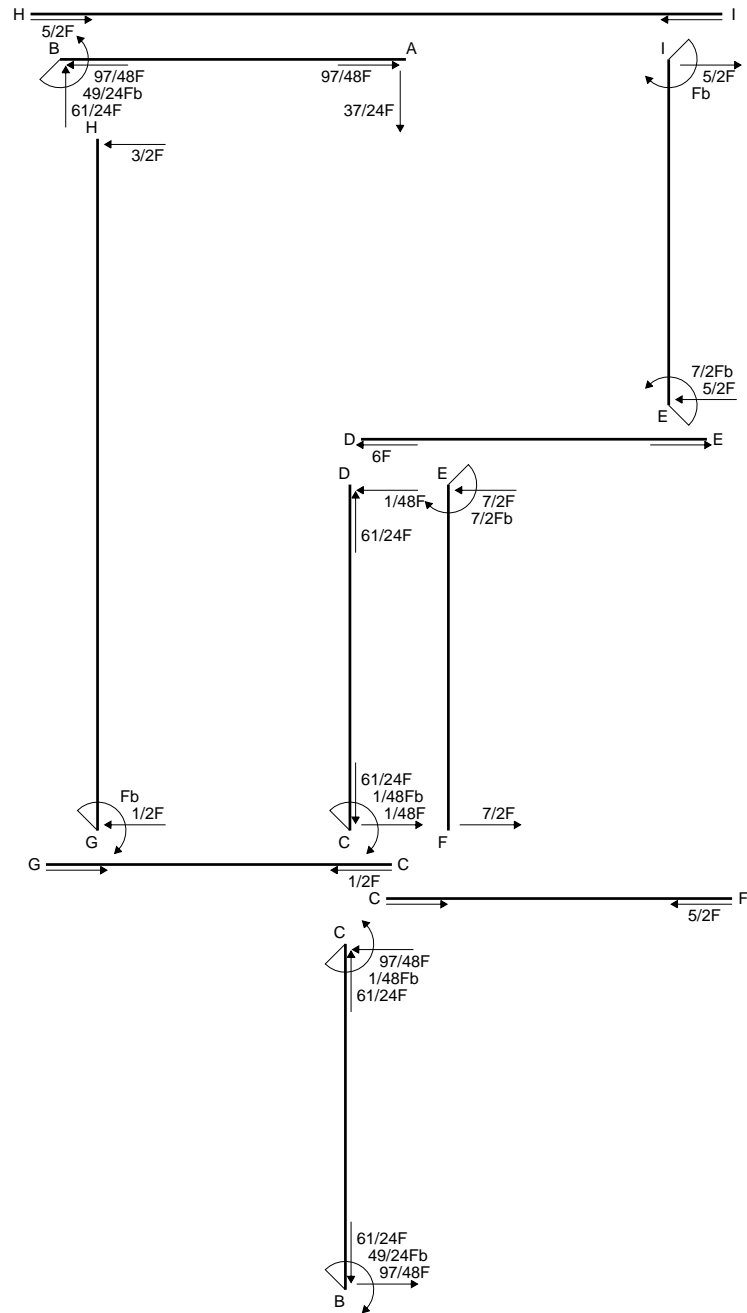
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

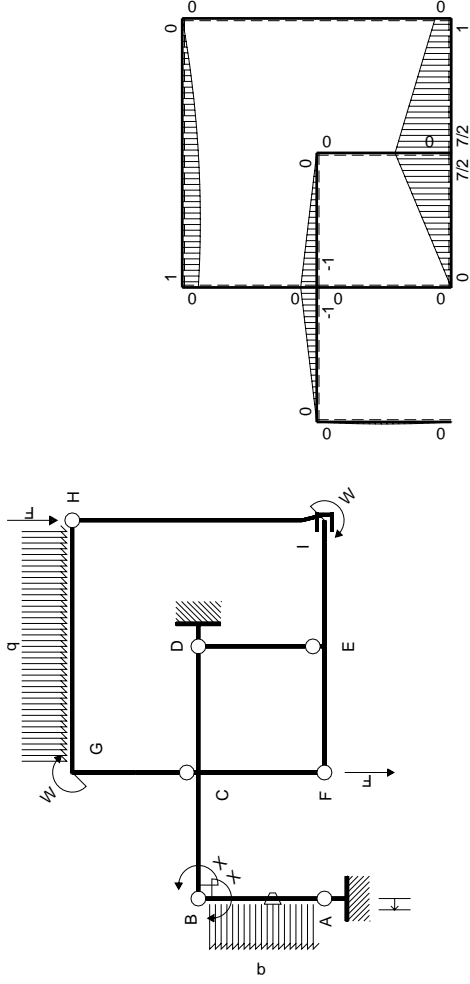
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

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



- A = 582. mm²
- J_u = 140714. mm⁴
- J_v = 25506. mm⁴
- y_g = 36.03 mm
- T_y = -1645. N
- M_x = 855400. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -36.03 mm
- σ_m = -Mv/J_u = 219. N/mm²
- x_c = 15. mm
- y_c = 15. mm
- v_c = -21.03 mm
- σ_c = -Mv/J_u = 127.8 N/mm²
- τ_c = 5.002 N/mm²
- σ_q = √σ²+3τ² = 128.1 N/mm²
- S = 2567. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0
FE b	0	$-7/2Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb+1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
HG 2b	0	$-3/2Fx+1/2qx^2$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+5/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$49/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-49/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

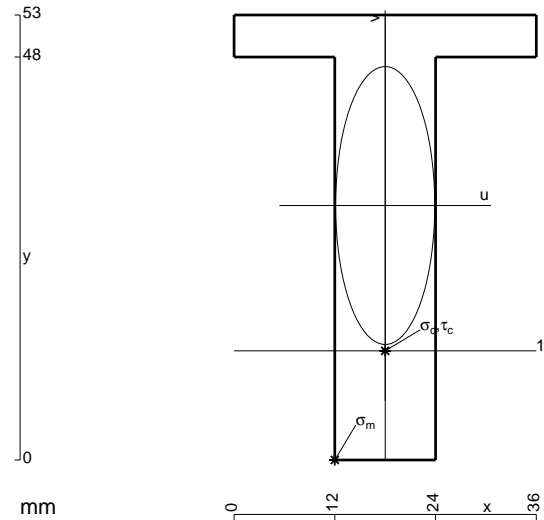
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

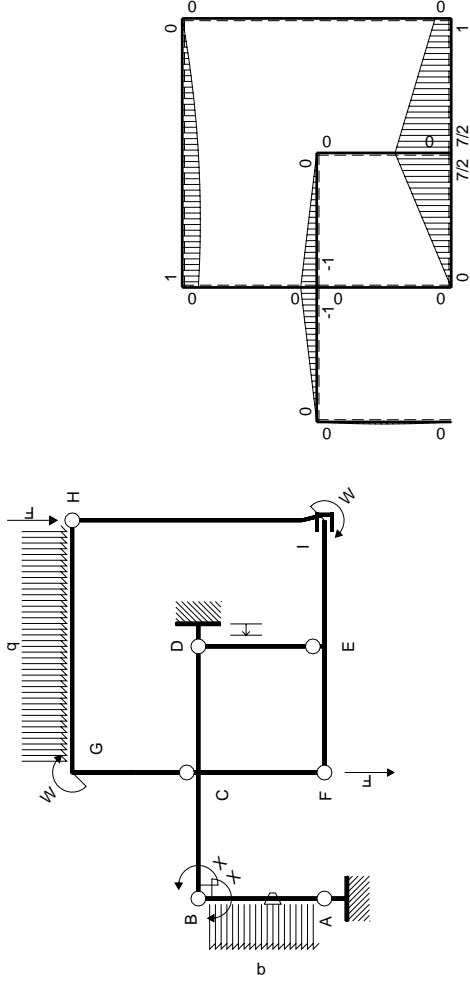
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

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

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



$A = 756. \text{ mm}^2$
 $J_u = 207276. \text{ mm}^4$
 $J_v = 26352. \text{ mm}^4$
 $y_g = 30.31 \text{ mm}$
 $T_y = -2730. \text{ N}$
 $M_x = 1556100. \text{ Nmm}$
 $x_m = 12. \text{ mm}$
 $u_m = -6. \text{ mm}$
 $v_m = -30.31 \text{ mm}$
 $\sigma_m = -Mv/J_u = 227.5 \text{ N/mm}^2$
 $x_c = 18. \text{ mm}$
 $y_c = 13. \text{ mm}$
 $v_c = -17.31 \text{ mm}$
 $\sigma_c = -Mv/J_u = 129.9 \text{ N/mm}^2$
 $\tau_c = 4.077 \text{ N/mm}^2$
 $\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 130.1 \text{ N/mm}^2$
 $S = 3714. \text{ mm}^3$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-7/2Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb+1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG 2b	0	$-3/2Fx+1/2qx^2$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+5/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{x\theta} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{x\theta} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{x\theta} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

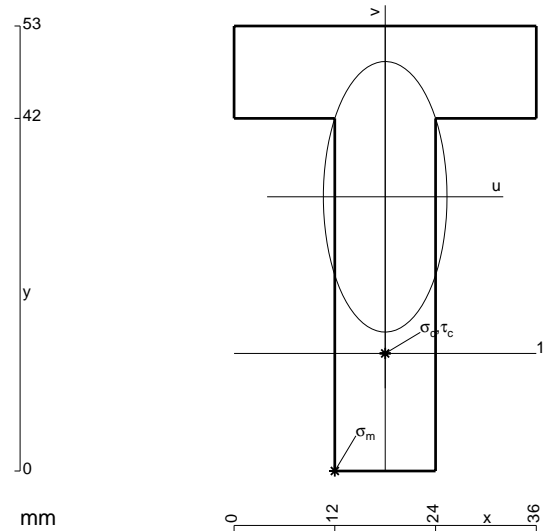
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CD}^{x\theta} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

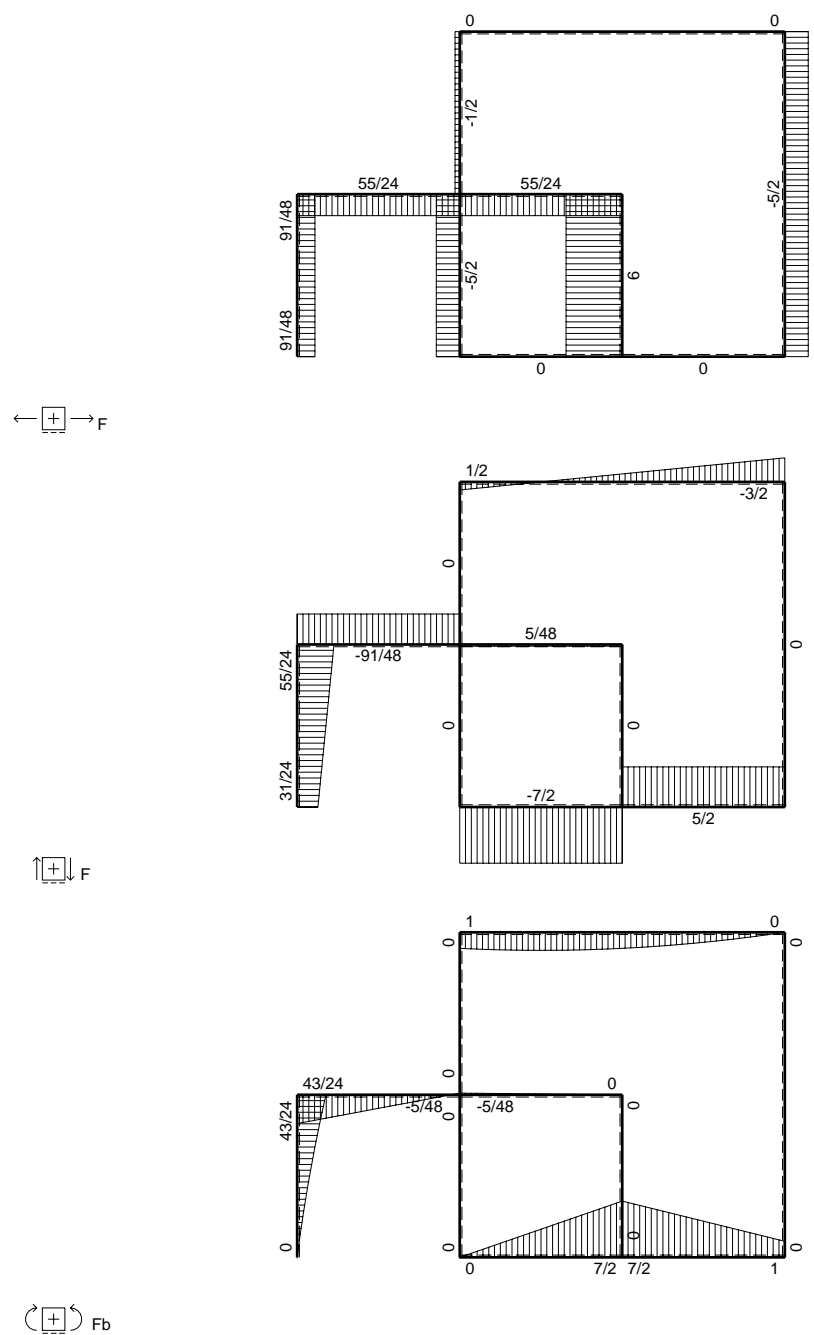
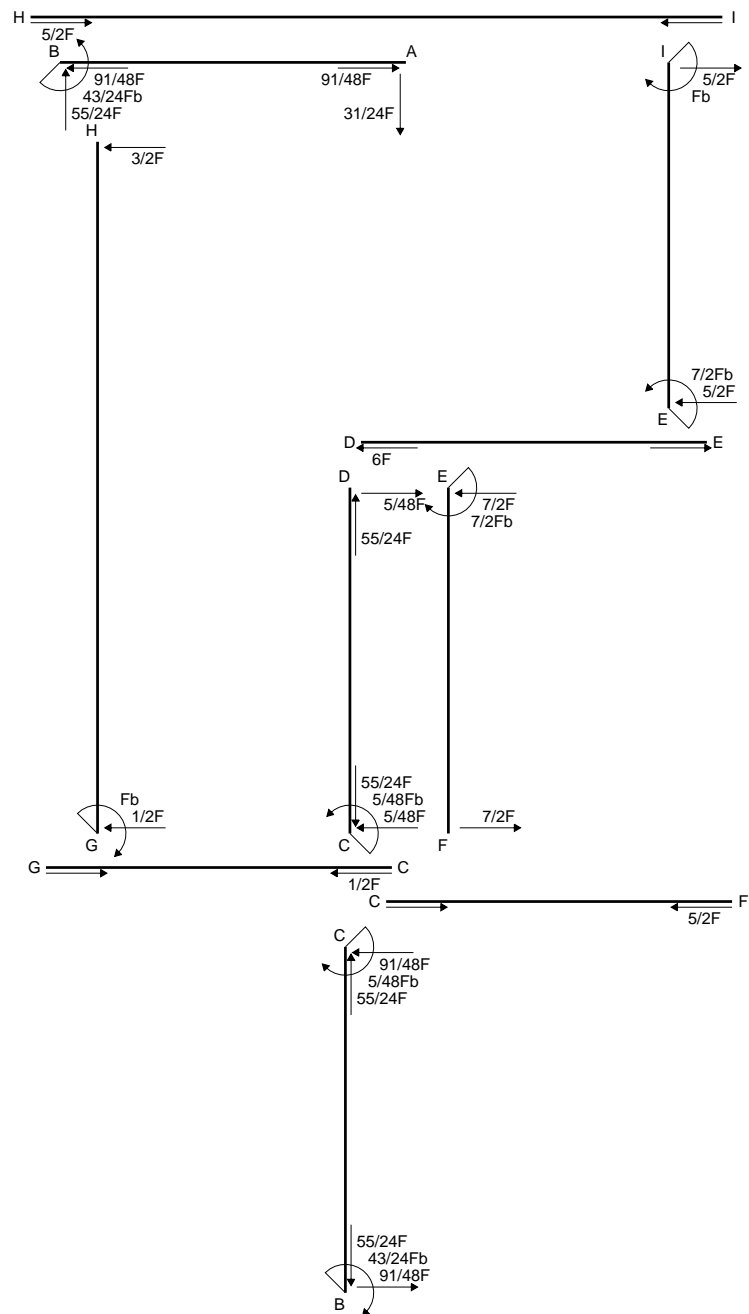
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

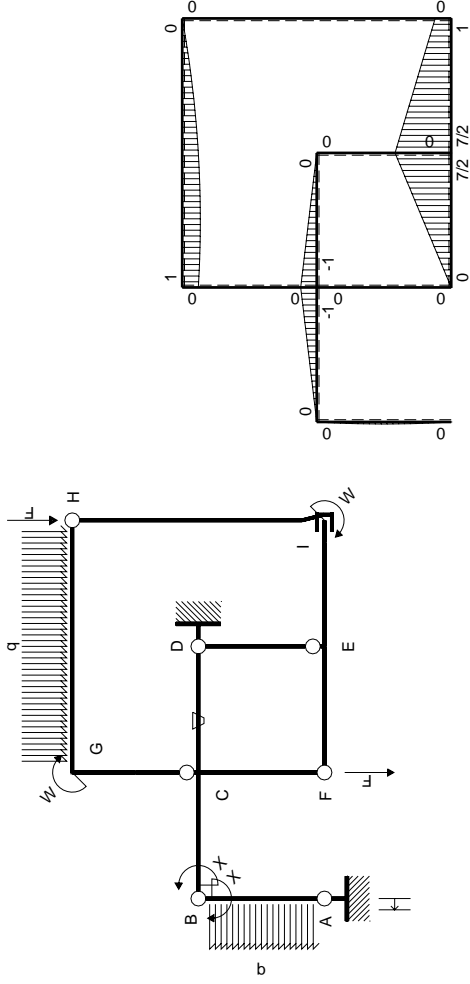
$$L_{DC}^{x\theta} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

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



$A = 900. \text{ mm}^2$
 $J_u = 233812. \text{ mm}^4$
 $J_v = 48816. \text{ mm}^4$
 $y_g = 32.66 \text{ mm}$
 $T_y = -2800. \text{ N}$
 $M_x = 1708000. \text{ Nmm}$
 $x_m = 12. \text{ mm}$
 $u_m = -6. \text{ mm}$
 $v_m = -32.66 \text{ mm}$
 $\sigma_m = -Mv/J_u = 238.6 \text{ N/mm}^2$
 $x_c = 18. \text{ mm}$
 $y_c = 14. \text{ mm}$
 $v_c = -18.66 \text{ mm}$
 $\sigma_c = -Mv/J_u = 136.3 \text{ N/mm}^2$
 $\tau_c = 4.302 \text{ N/mm}^2$
 $\sigma_\theta = \sqrt{\sigma^2 + 3\tau^2} = 136.5 \text{ N/mm}^2$
 $S = 4311. \text{ mm}^3$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	Fx	Fb/EJ	$1/2Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0
FE b	0	$-7/2Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb+1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
HG 2b	0	$-3/2Fx+1/2qx^2$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+5/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$43/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-43/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

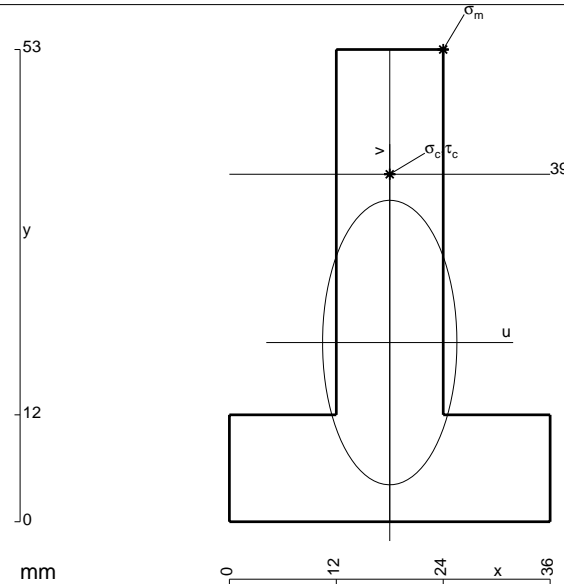
$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

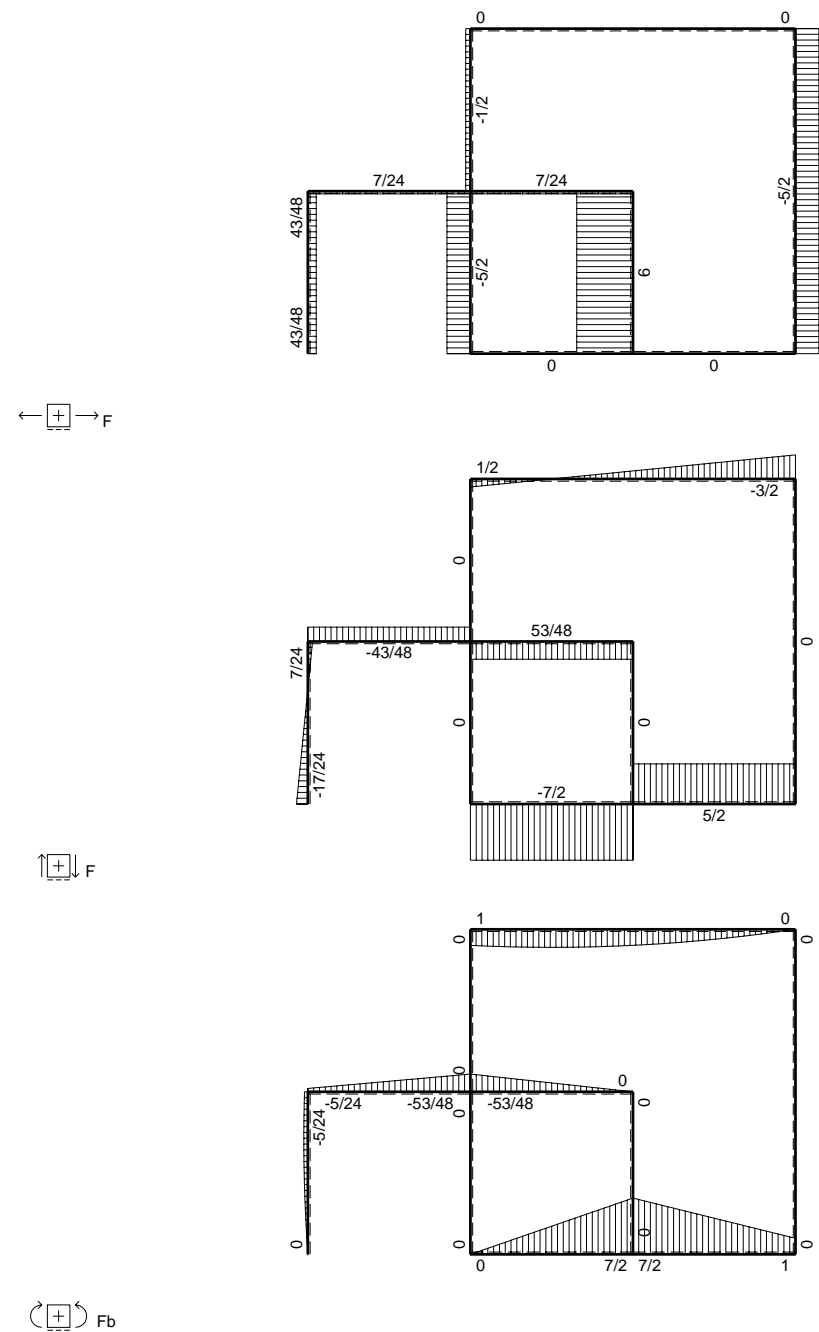
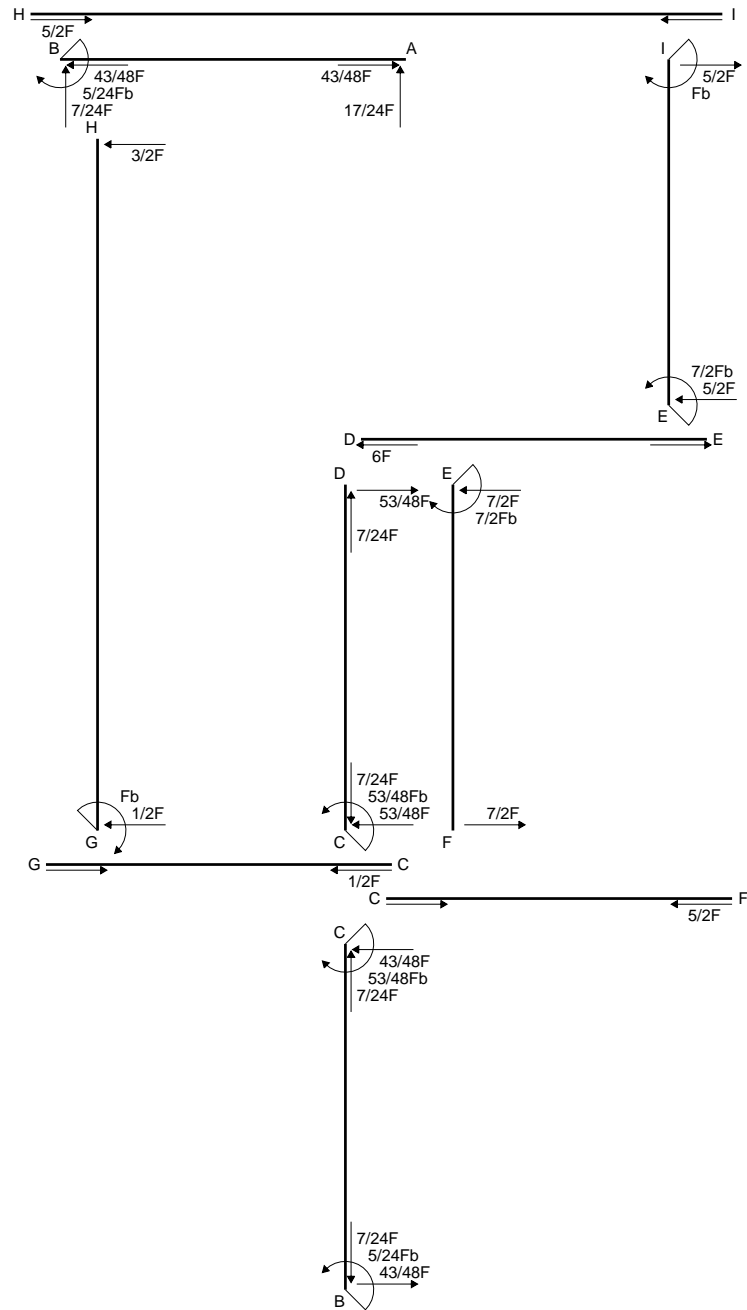
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 5/12 Fb^2/EJ$$

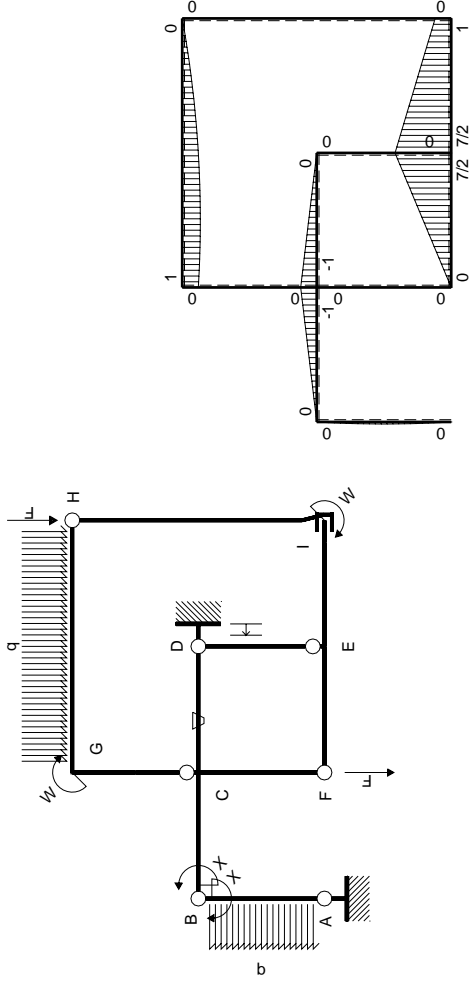
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/6 b) Fb 1/EJ + (-1/4 b) \theta = 5/12 Fb^2/EJ$$



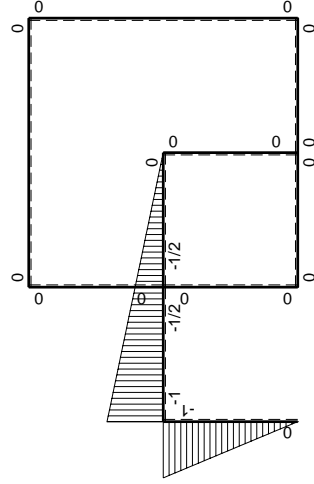
- A = 924. mm²
- J_u = 235641. mm⁴
- J_v = 52560. mm⁴
- y_g = 20.11 mm
- T_y = -2170. N
- M_x = 1432200. Nmm
- x_m = 24. mm
- y_m = 53. mm
- u_m = 6. mm
- v_m = 32.89 mm
- σ_m = -Mv/J_u = -199.9 N/mm²
- x_c = 18. mm
- y_c = 39. mm
- v_c = 18.89 mm
- σ_c = -Mv/J_u = -114.8 N/mm²
- τ_c = 3.338 N/mm²
- σ_φ = √σ²+3τ² = 115. N/mm²
- S = 4349. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	Fb/EJ	$1/2Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-7/2Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb+1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG 2b	0	$-3/2Fx+1/2qx^2$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+5/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-5/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$5/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

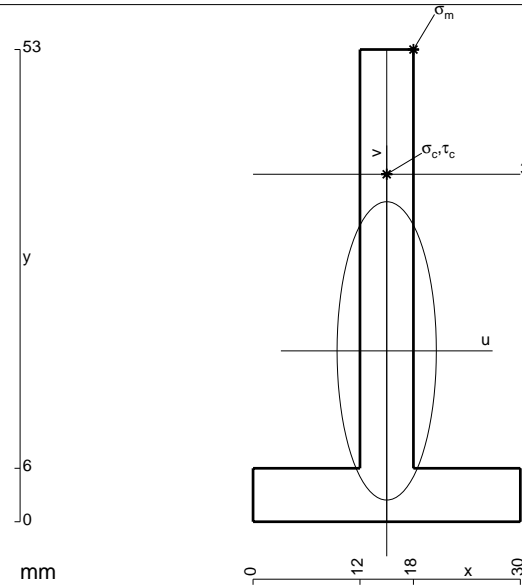
$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 5/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/6 b) Fb 1/EJ + (-1/4 b) \theta = 5/12 Fb^2/EJ$$



- A = 462. mm²
- J_u = 129608. mm⁴
- J_v = 14346. mm⁴
- y_g = 19.18 mm
- T_y = -1120. N
- M_x = 784000. Nmm
- x_m = 18. mm
- y_m = 53. mm
- u_m = 3. mm
- v_m = 33.82 mm
- σ_m = -Mv/J_u = -204.6 N/mm²
- x_c = 15. mm
- y_c = 39. mm
- v_c = 19.82 mm
- σ_c = -Mv/J_u = -119.9 N/mm²
- τ_c = 3.245 N/mm²
- σ_q = √σ²+3τ² = 120.1 N/mm²
- S = 2253. mm³

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-5/2Fx$	0	0	0	0	0+0	0
FE b	0	$-5/2Fx$	0	0	0	0		
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$7/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-7/3Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

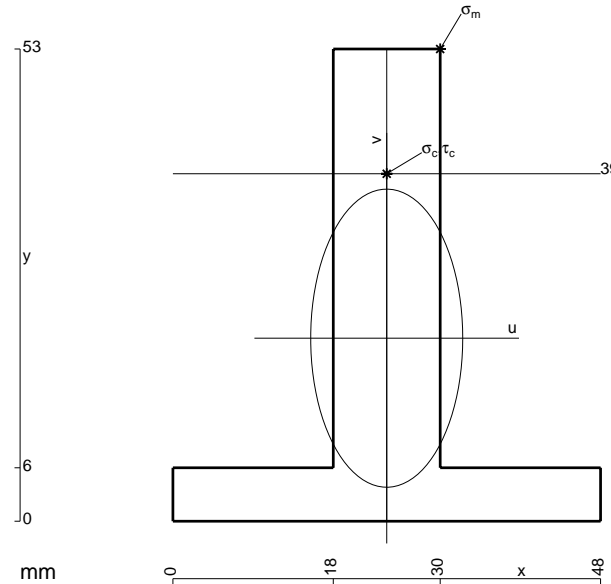
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

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

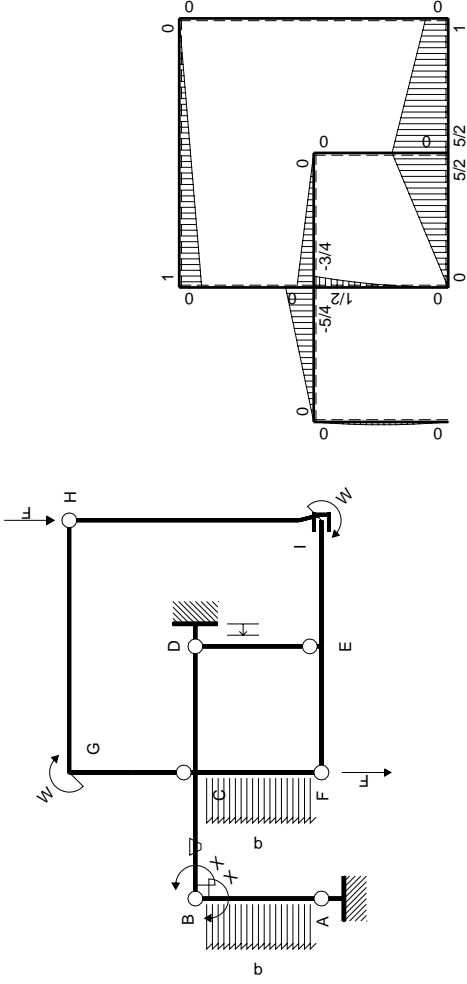
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

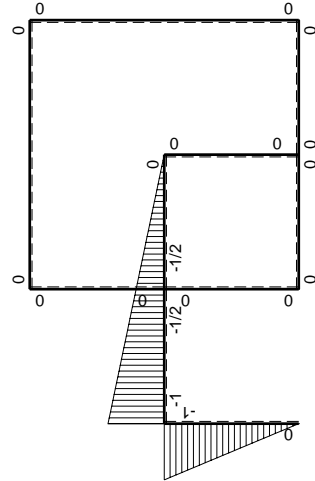


- A = 852. mm²
- J_u = 238569. mm⁴
- J_v = 62064. mm⁴
- y_g = 20.54 mm
- T_y = -2175. N
- M_x = 1609500. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 6. mm
- v_m = 32.46 mm
- σ_m = -Mv/J_u = -219. N/mm²
- x_c = 24. mm
- y_c = 39. mm
- v_c = 18.46 mm
- σ_c = -Mv/J_u = -124.5 N/mm²
- τ_c = 3.249 N/mm²
- σ_o = √σ²+3τ² = 124.7 N/mm²
- S = 4277. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-5/2Fx$	0	0	0	0	0+0	0
FE b	0	$-5/2Fx$	0	0	0	0		
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$1/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-1/3Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{x_0} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{x_0} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

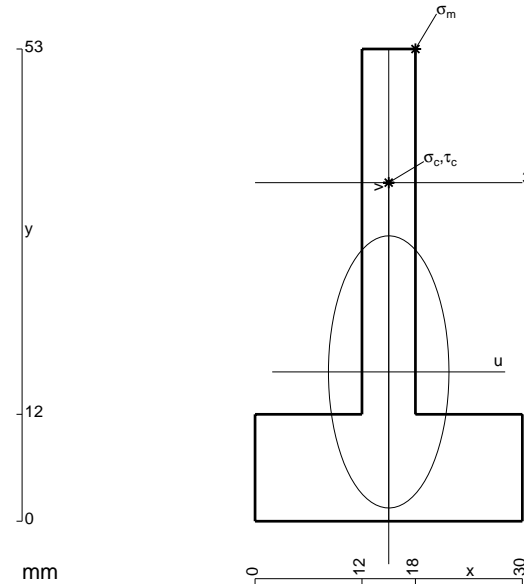
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

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

$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{x_0} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



$$A = 606. \text{ mm}^2$$

$$J_u = 141406. \text{ mm}^4$$

$$J_v = 27738. \text{ mm}^4$$

$$y_g = 16.76 \text{ mm}$$

$$T_y = -1125. \text{ N}$$

$$M_x = 888750. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

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

$$u_m = 3. \text{ mm}$$

$$v_m = 36.24 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -227.8 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 38. \text{ mm}$$

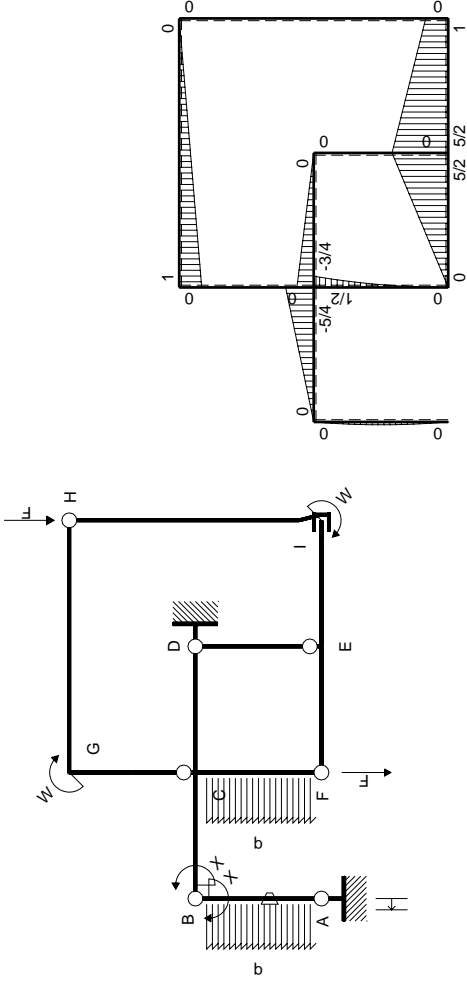
$$v_c = 21.24 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -133.5 \text{ N/mm}^2$$

$$\tau_c = 3.43 \text{ N/mm}^2$$

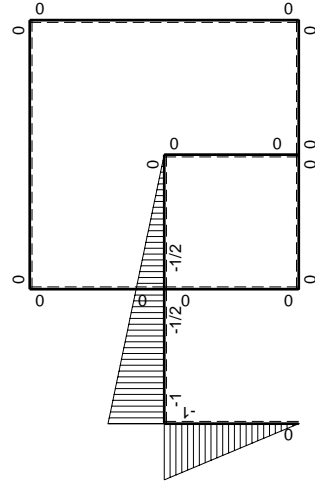
$$\sigma_\varrho = \sqrt{\sigma^2 + 3\tau^2} = 133.6 \text{ N/mm}^2$$

$$S = 2587. \text{ mm}^3$$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-5/2Fx$	0	0	0	0	0+0	0
FE b	0	$-5/2Fx$	0	0	0	0		
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$25/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-25/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

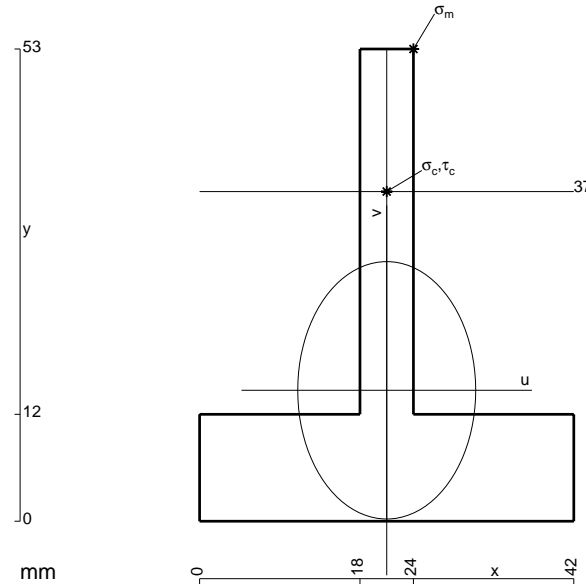
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

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

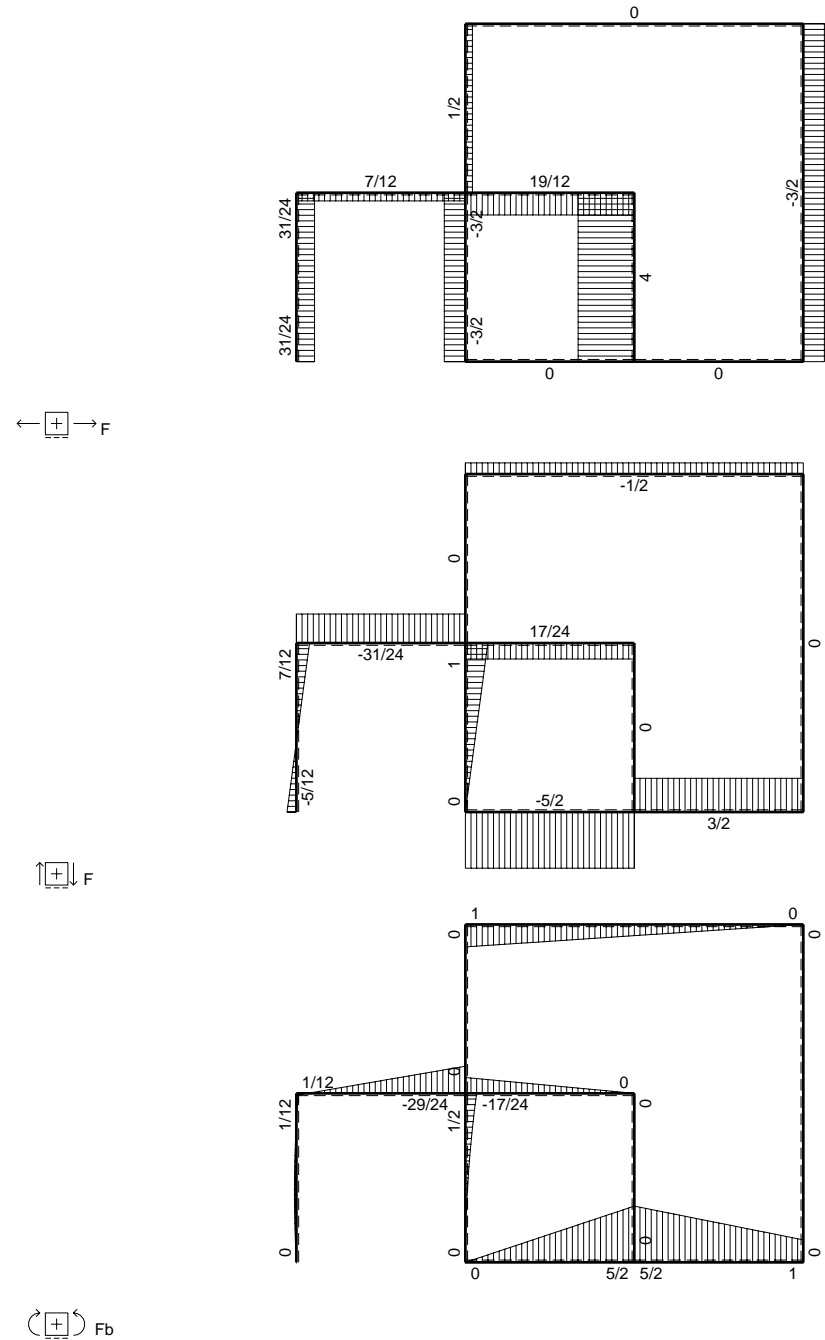
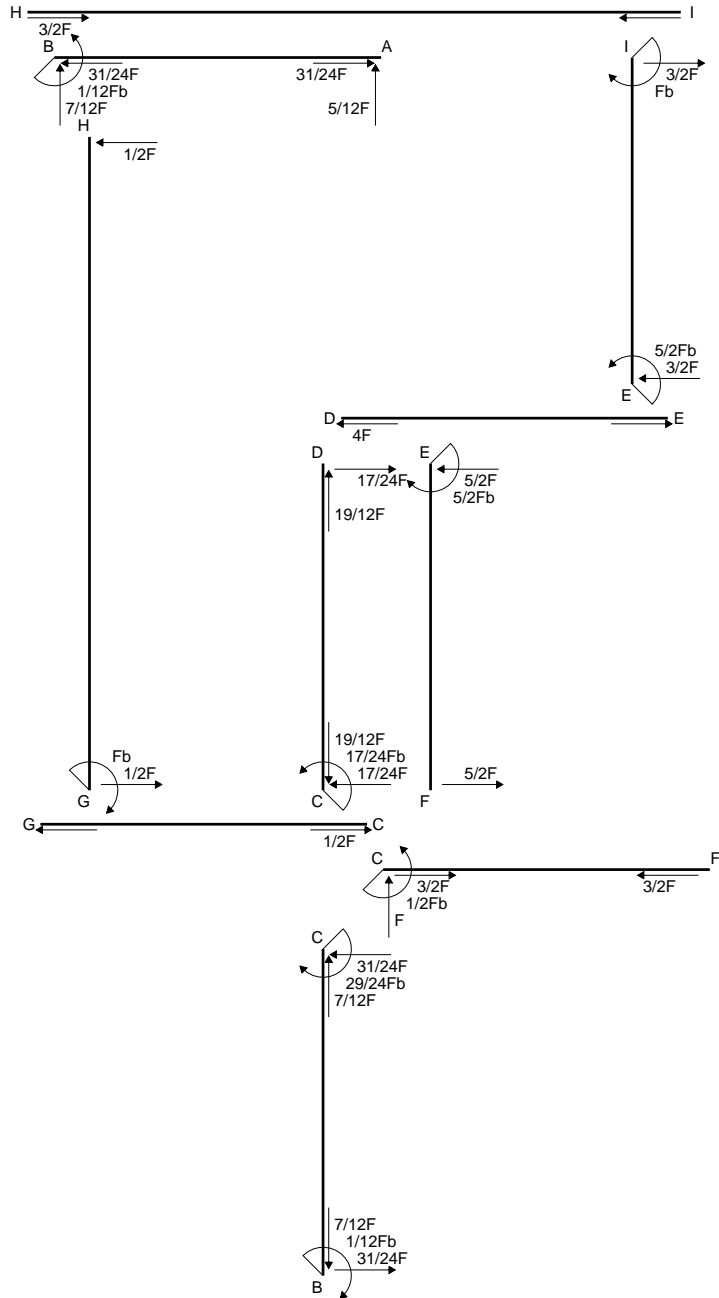
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



$A = 750. \text{ mm}^2$
 $J_u = 156599. \text{ mm}^4$
 $J_v = 74826. \text{ mm}^4$
 $y_g = 14.69 \text{ mm}$
 $T_y = -1175. \text{ N}$
 $M_x = 975250. \text{ Nmm}$
 $x_m = 24. \text{ mm}$
 $y_m = 53. \text{ mm}$
 $u_m = 3. \text{ mm}$
 $v_m = 38.31 \text{ mm}$
 $\sigma_m = -Mv/J_u = -238.6 \text{ N/mm}^2$
 $x_c = 21. \text{ mm}$
 $y_c = 37. \text{ mm}$
 $v_c = 22.31 \text{ mm}$
 $\sigma_c = -Mv/J_u = -138.9 \text{ N/mm}^2$
 $\tau_c = 3.639 \text{ N/mm}^2$
 $\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 139.1 \text{ N/mm}^2$
 $S = 2910. \text{ mm}^3$



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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-5/2Fx$	0	0	0	0	0+0	0
FE b	0	$-5/2Fx$	0	0	0	0		
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$1/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-1/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

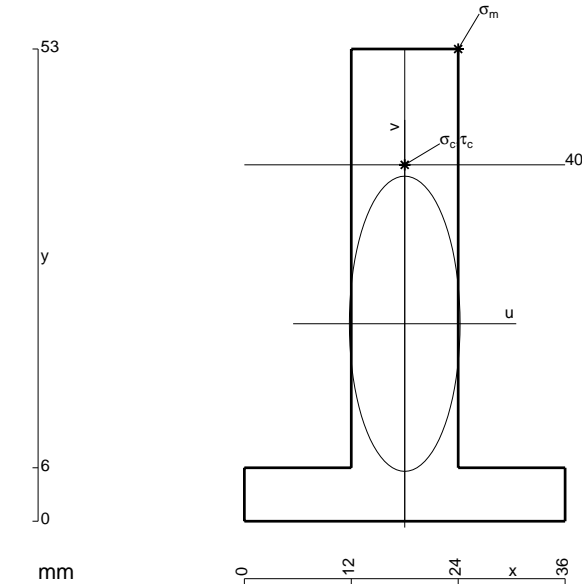
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

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

$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 780. mm²
- J_u = 214152. mm⁴
- J_v = 30096. mm⁴
- y_g = 22.16 mm
- T_y = -3150. N
- M_x = 1386000. Nmm
- x_m = 24. mm
- y_m = 53. mm
- u_m = 6. mm
- v_m = 30.84 mm
- σ_m = -Mv/J_u = -199.6 N/mm²
- x_c = 18. mm
- y_c = 40. mm
- v_c = 17.84 mm
- σ_c = -Mv/J_u = -115.5 N/mm²
- τ_c = 4.654 N/mm²
- σ_o = √σ²+3τ² = 115.7 N/mm²
- S = 3797. mm³

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$5/2Fb-5/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-5/2Fx$	0	0	0	0			
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$							Fb^2/EJ	
	totali							$11/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-11/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

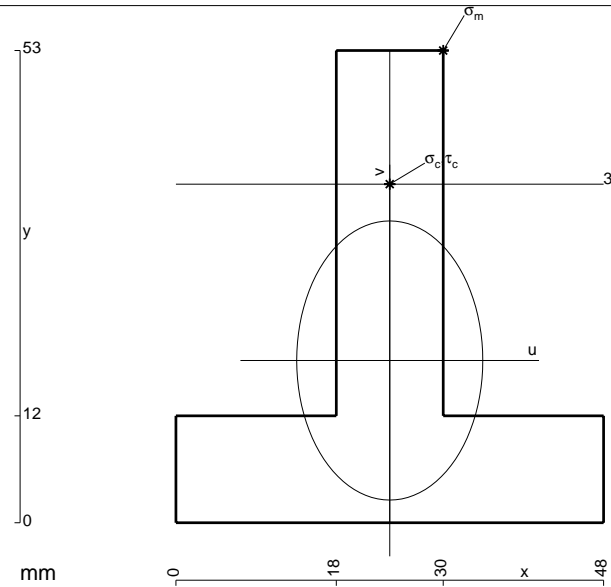
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

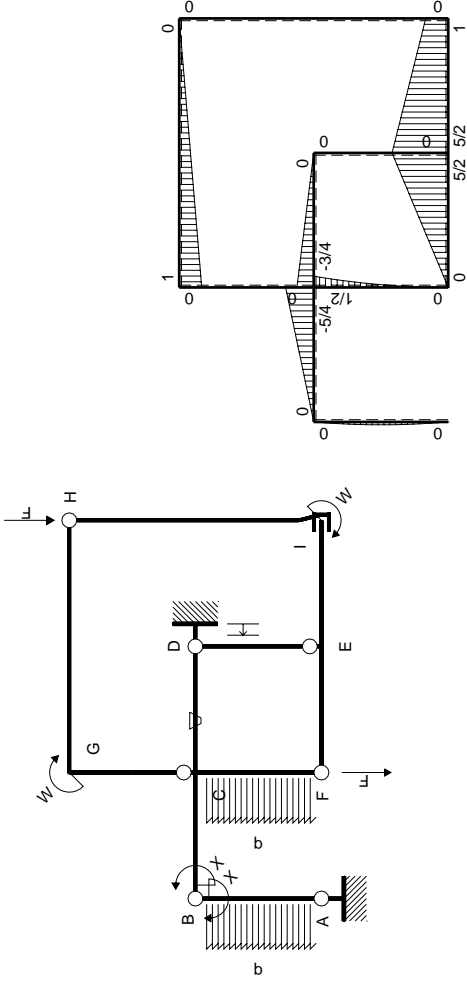
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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

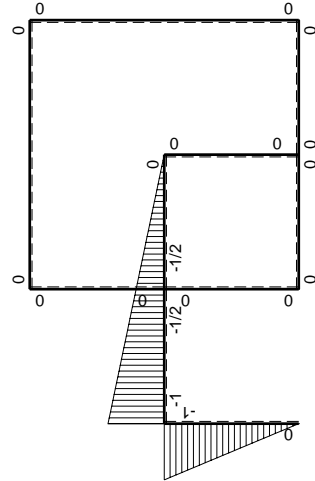


- A = 1068. mm²
- J_u = 262174. mm⁴
- J_v = 116496. mm⁴
- y_g = 18.21 mm
- T_y = -3275. N
- M_x = 1572000. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 6. mm
- v_m = 34.79 mm
- σ_m = -M_v/J_u = -208.6 N/mm²
- x_c = 24. mm
- y_c = 38. mm
- v_c = 19.79 mm
- σ_c = -M_v/J_u = -118.7 N/mm²
- τ_c = 5.114 N/mm²
- σ_φ = √(σ²+3τ²) = 119. N/mm²
- S = 4913. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$5/2Fb-5/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-5/2Fx$	0	0	0	0			
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/6Fb$	

Sviluppi di calcolo iperstatica

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$5/2Fb-5/2Fx$	0	0	0	0	0+0	0
FE b	0	$-5/2Fx$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$7/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-7/3Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{x_0} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{x_0} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

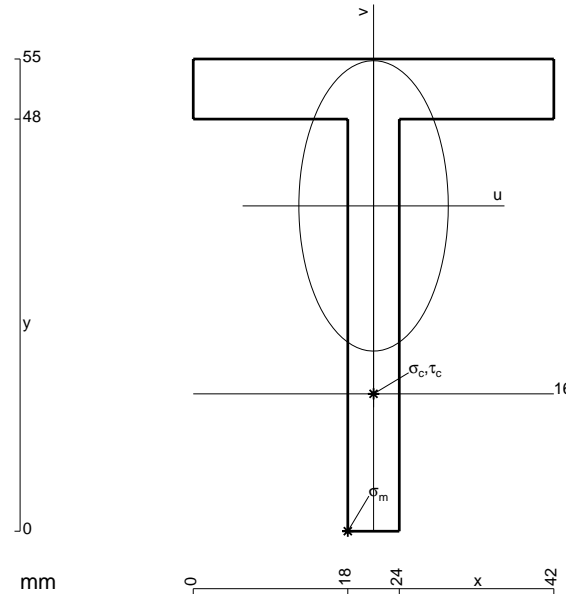
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

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

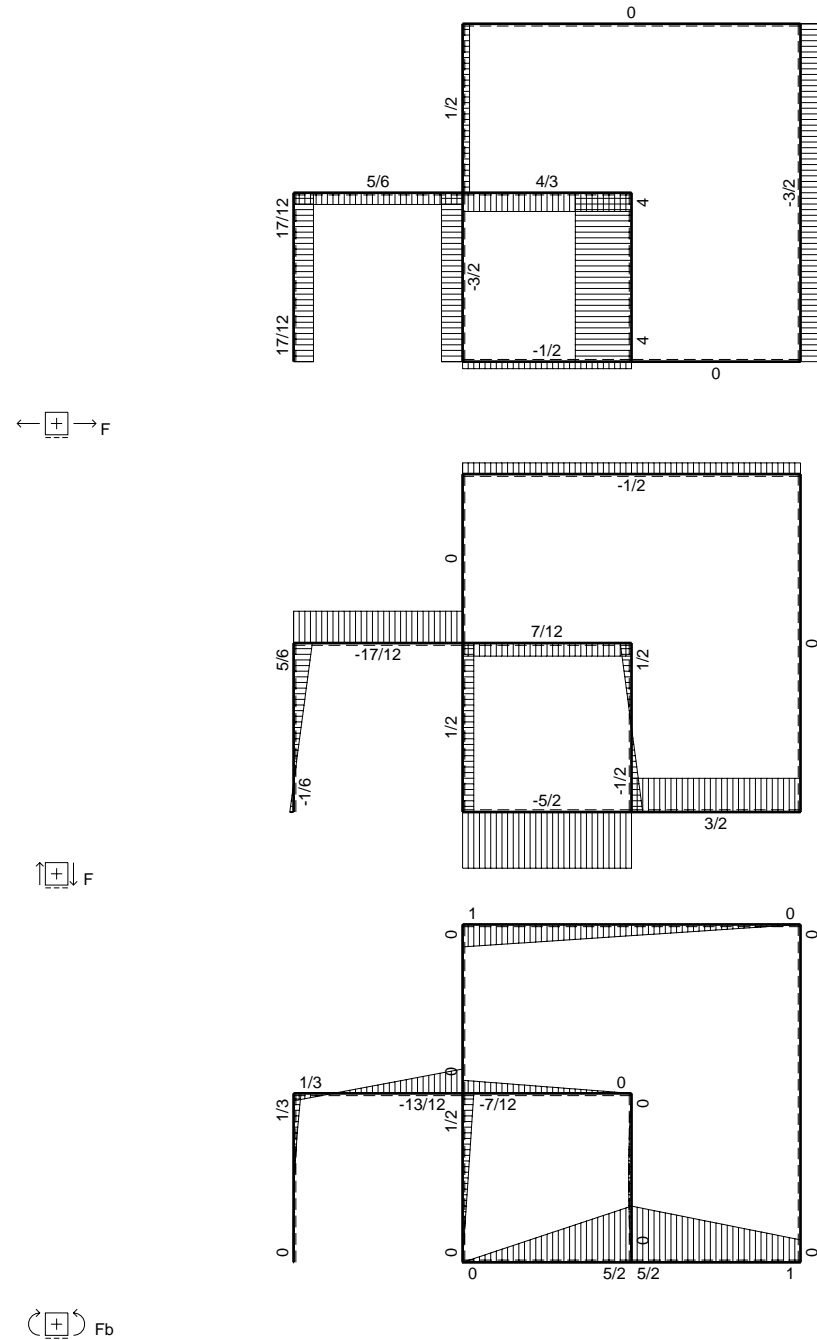
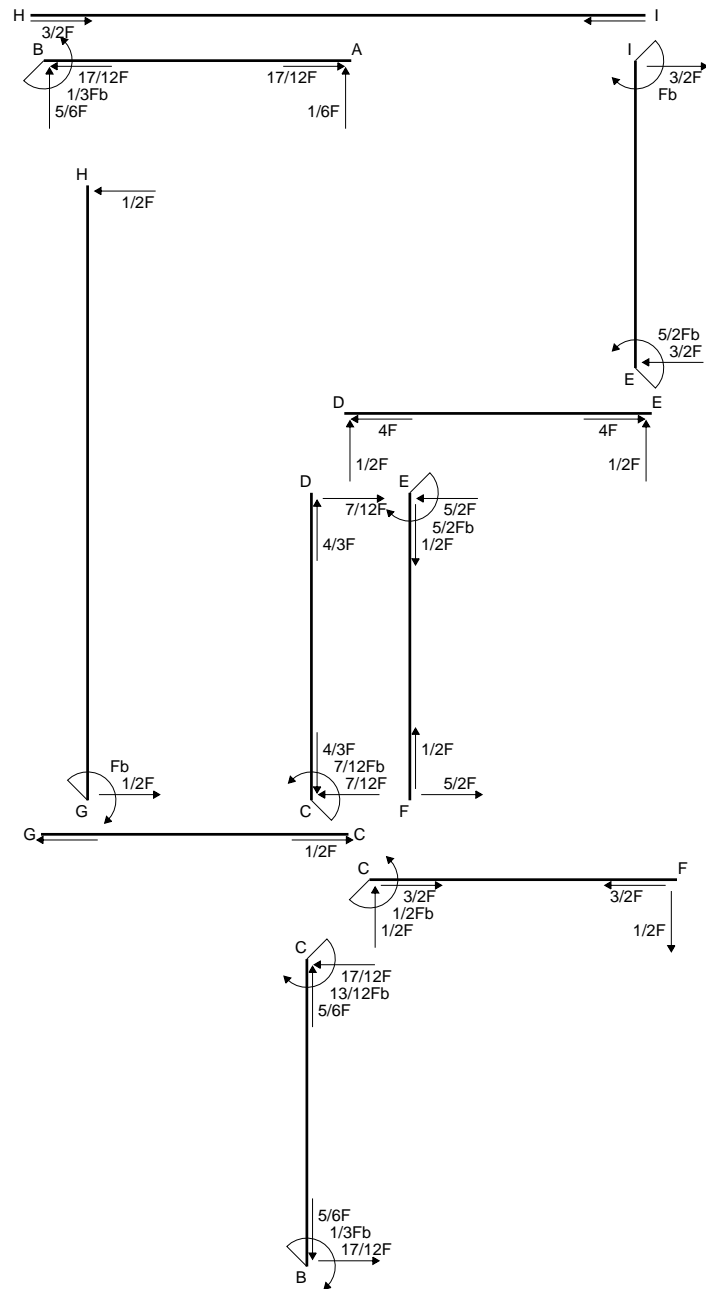
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

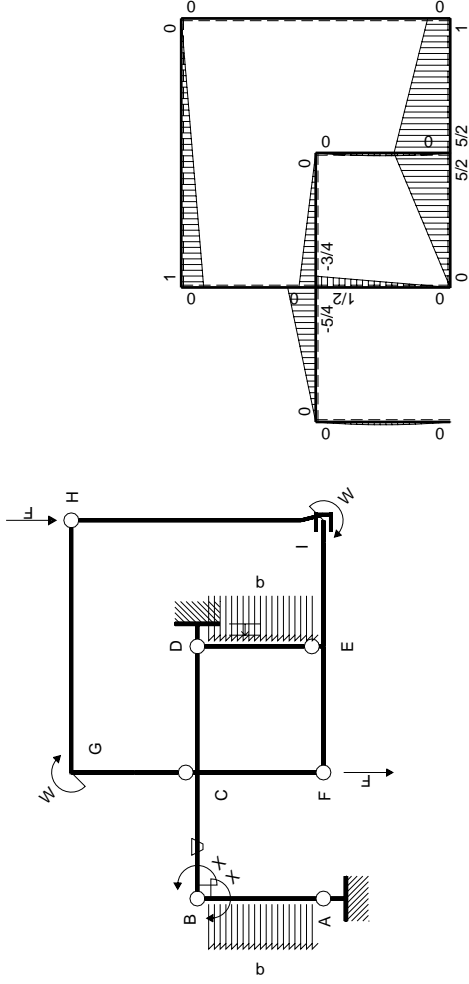
$$L_{DC}^{x_0} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



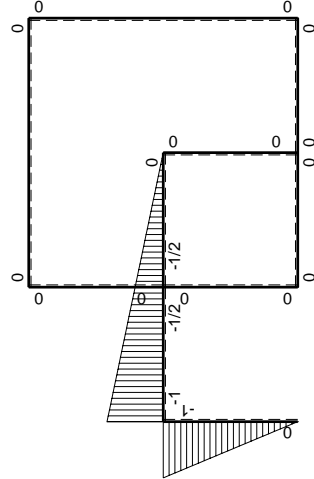
- A = 582. mm²
- J_u = 166519. mm⁴
- J_v = 44082. mm⁴
- y_g = 37.89 mm
- N = -345. N
- T_y = -1725. N
- M_x = 1000500. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -37.89 mm
- $\sigma_m = N/A - Mv/J_u = 227.1 \text{ N/mm}^2$
- x_c = 21. mm
- y_c = 16. mm
- v_c = -21.89 mm
- $\sigma_c = N/A - Mv/J_u = 130.9 \text{ N/mm}^2$
- $\tau_c = 4.954 \text{ N/mm}^2$
- $\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 131.2 \text{ N/mm}^2$
- S = 2870. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0			
EF b	0	$5/2Fb-5/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-5/2Fx$	0	0	0	0			
FC b	0	$1/2Fx$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/3Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

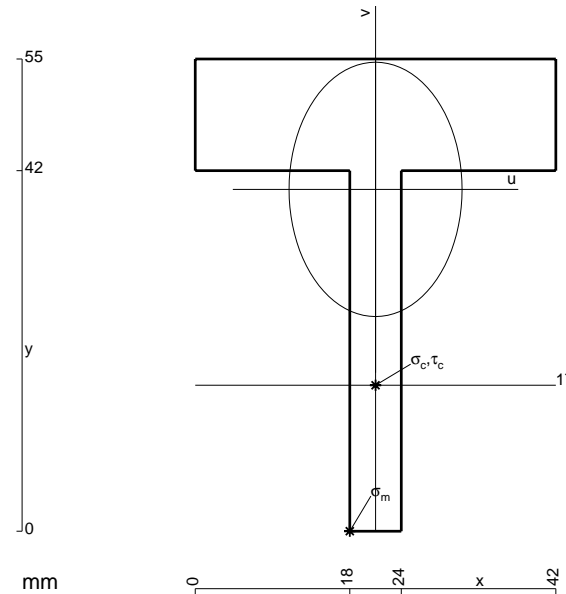
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

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

$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



$$A = 798. \text{ mm}^2$$

$$J_u = 175127. \text{ mm}^4$$

$$J_v = 81018. \text{ mm}^4$$

$$y_g = 39.82 \text{ mm}$$

$$N = -335. \text{ N}$$

$$T_y = -1675. \text{ N}$$

$$M_x = 1055250. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$u_m = -3. \text{ mm}$$

$$v_m = -39.82 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = 239.5 \text{ N/mm}^2$$

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

$$y_c = 17. \text{ mm}$$

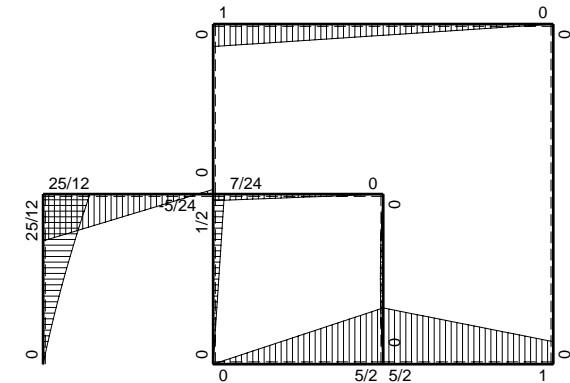
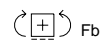
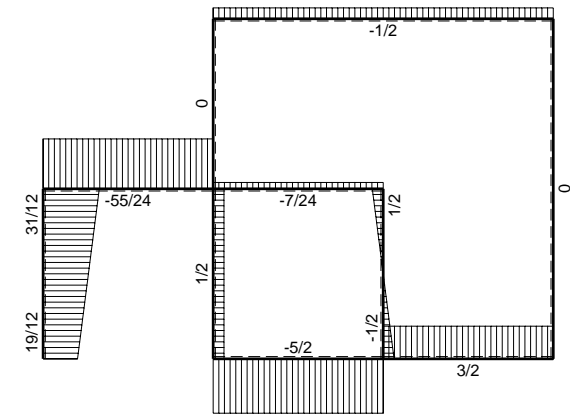
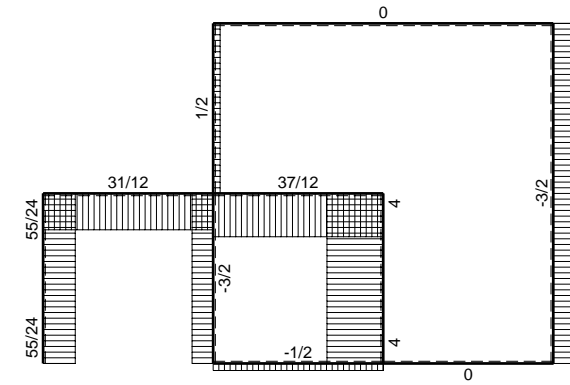
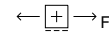
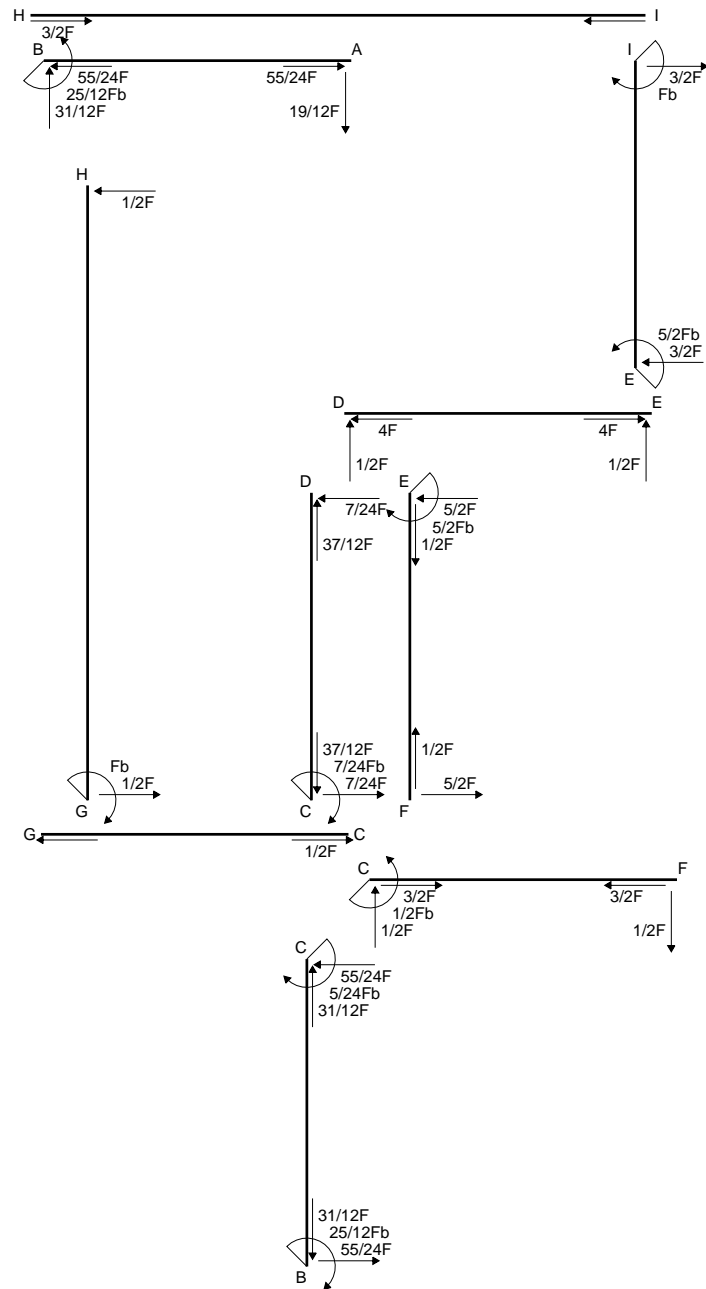
$$v_c = -22.82 \text{ mm}$$

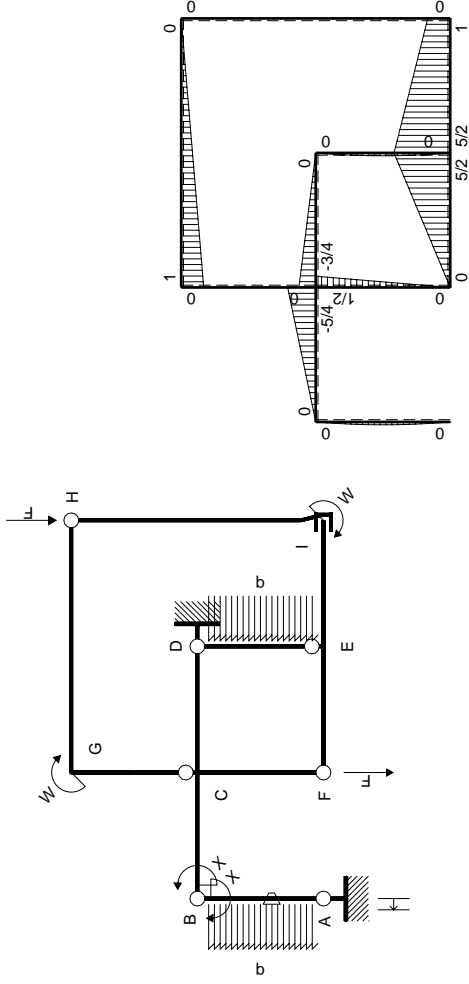
$$\sigma_c = N/A - Mv/J_u = 137.1 \text{ N/mm}^2$$

$$\tau_c = 5.092 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 137.3 \text{ N/mm}^2$$

$$S = 3194. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$5/2Fb-5/2Fx$	0	0	0	0	0+0	0
FE b	0	$-5/2Fx$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$25/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-25/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

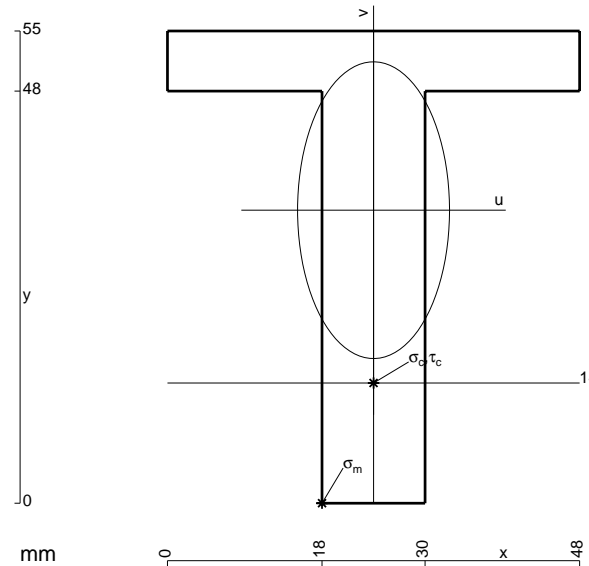
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

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

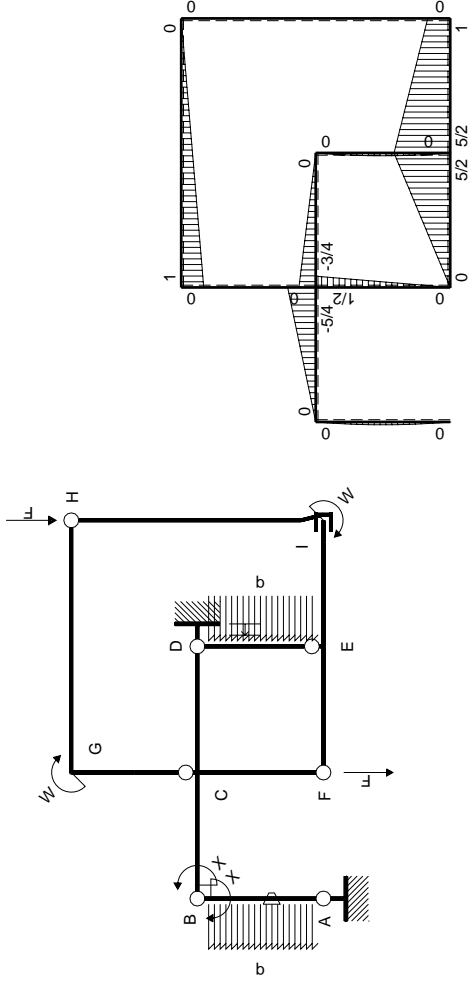
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 912. mm²
- J_u = 272448. mm⁴
- J_v = 71424. mm⁴
- y_g = 34.13 mm
- N = -475. N
- T_y = -2375. N
- M_x = 1591250. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -34.13 mm
- σ_m = N/A-Mv/J_u = 198.8 N/mm²
- x_c = 24. mm
- y_c = 14. mm
- v_c = -20.13 mm
- σ_c = N/A-Mv/J_u = 117.1 N/mm²
- τ_c = 3.311 N/mm²
- σ_o = √σ²+3τ² = 117.2 N/mm²
- S = 4558. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$5/2Fb-5/2Fx$	0	0	0	0	0+0	0
FE b	0	$-5/2Fx$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$1/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-1/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

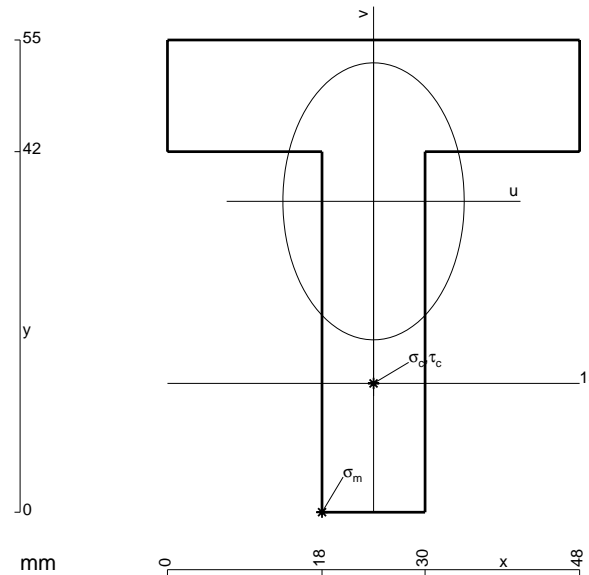
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

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

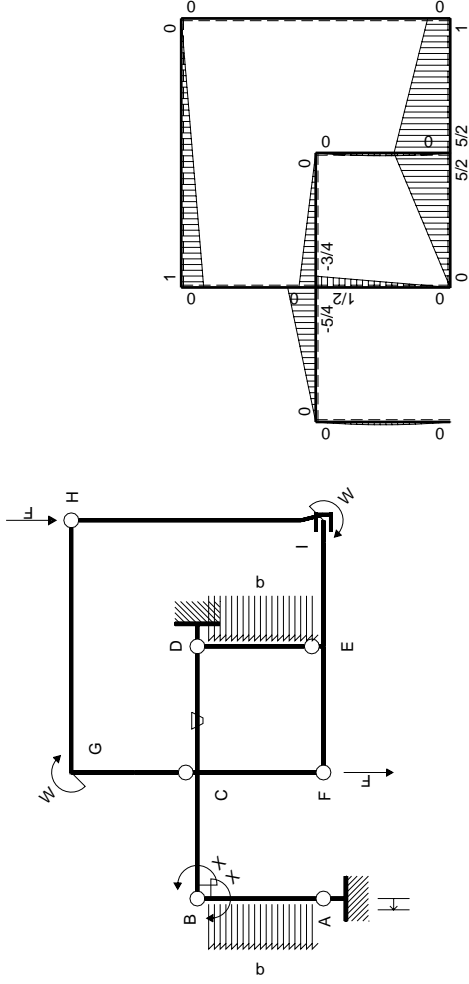
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 1128. mm²
- J_u = 293725. mm⁴
- J_v = 125856. mm⁴
- y_g = 36.21 mm
- N = -470. N
- T_y = -2350. N
- M_x = 1692000. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -36.21 mm
- σ_m = N/A-Mv/J_u = 208.2 N/mm²
- x_c = 24. mm
- y_c = 15. mm
- v_c = -21.21 mm
- σ_c = N/A-Mv/J_u = 121.8 N/mm²
- τ_c = 3.446 N/mm²
- σ_o = √σ²+3τ² = 121.9 N/mm²
- S = 5168. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$5/2Fb-5/2Fx$	0	0	0	0	0+0	0
FE b	0	$-5/2Fx$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$11/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-11/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

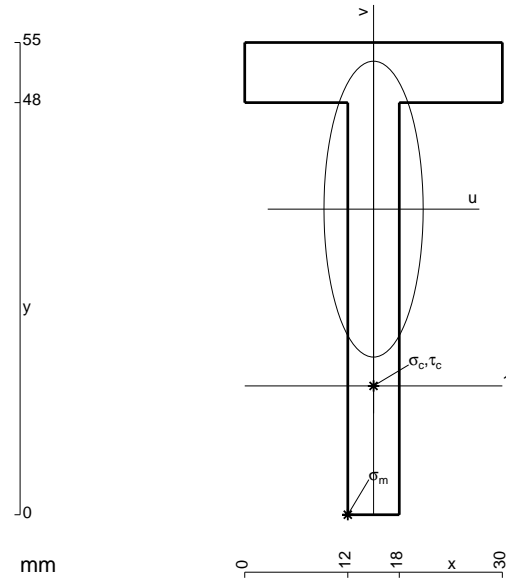
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

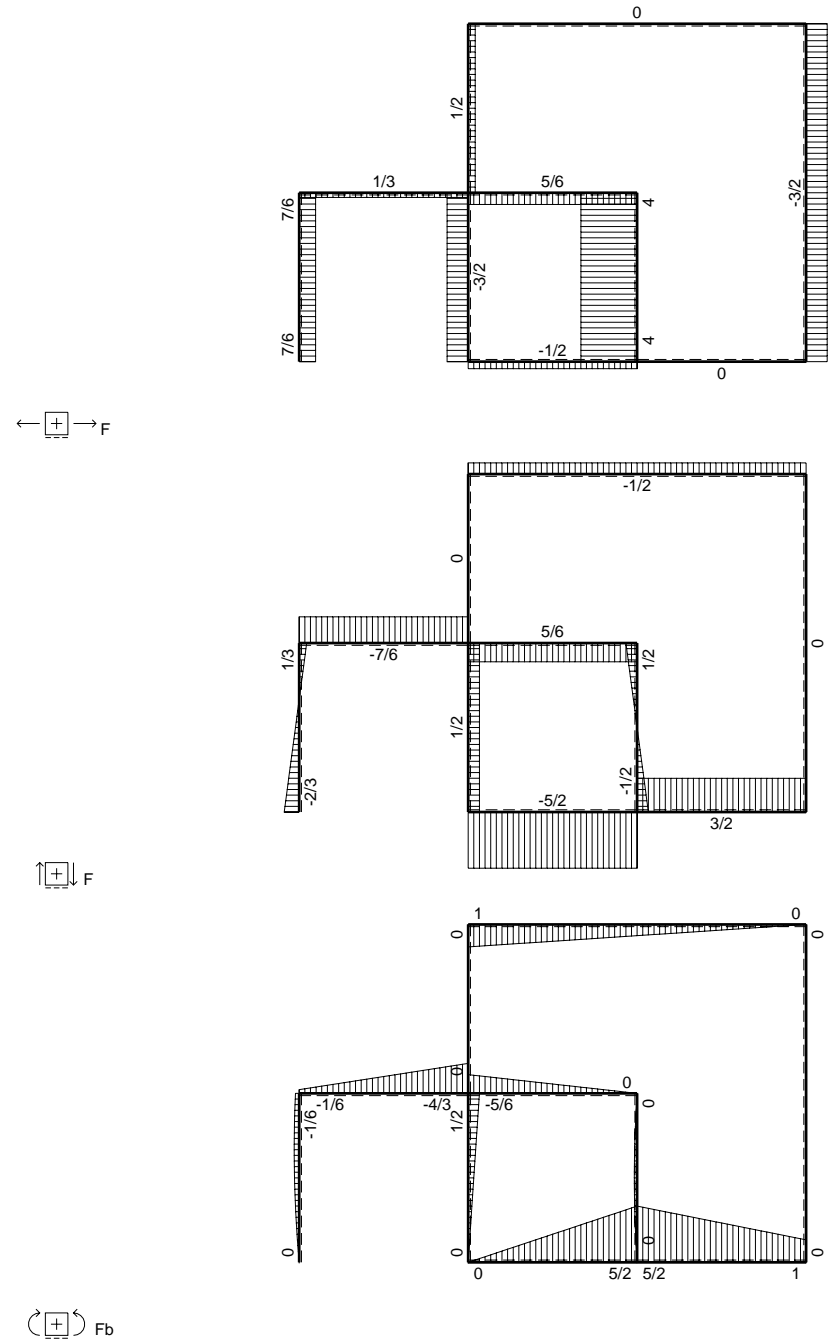
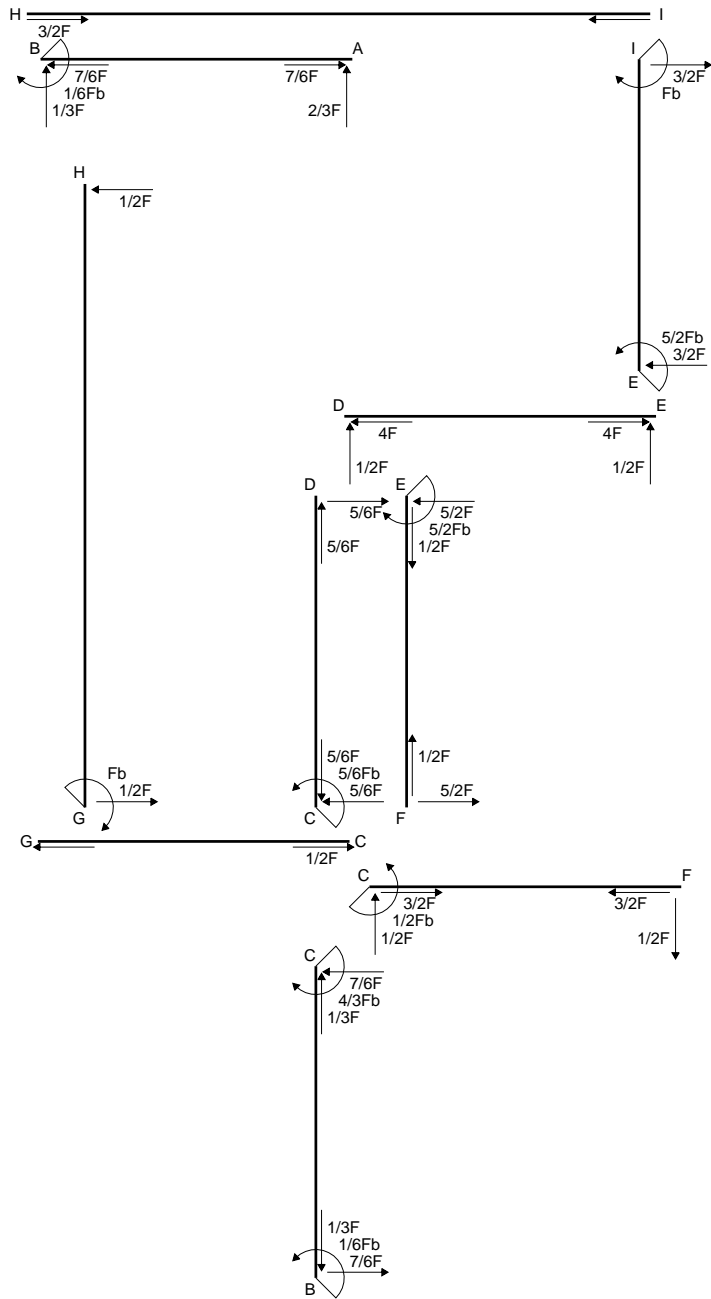
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

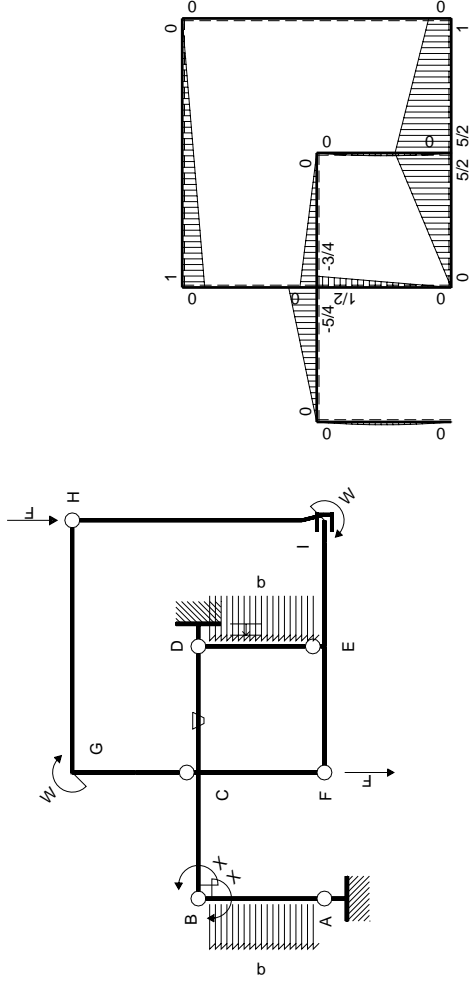
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



- A = 498. mm²
- J_u = 147997. mm⁴
- J_v = 16614. mm⁴
- y_g = 35.6 mm
- N = -240. N
- T_y = -1200. N
- M_x = 912000. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -35.6 mm
- σ_m = N/A - Mv/J_u = 218.9 N/mm²
- x_c = 15. mm
- y_c = 15. mm
- v_c = -20.6 mm
- σ_c = N/A - Mv/J_u = 126.4 N/mm²
- τ_c = 3.417 N/mm²
- σ_φ = √(σ² + 3τ²) = 126.6 N/mm²
- S = 2529. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0			
EF b	0	$5/2Fb-5/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-5/2Fx$	0	0	0	0			
FC b	0	$1/2Fx$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

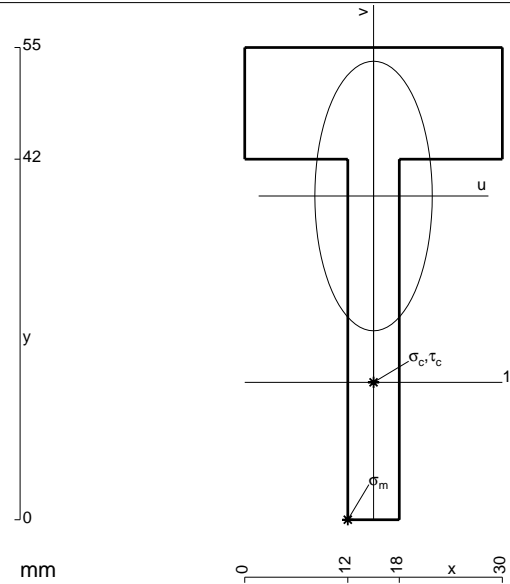
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

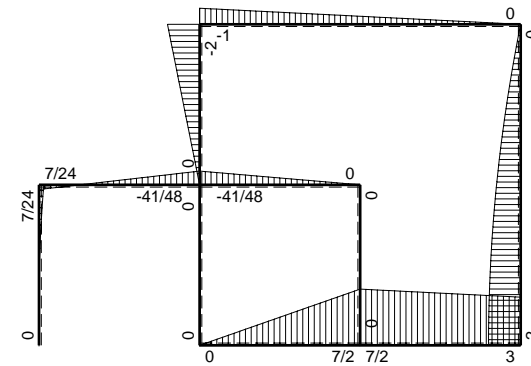
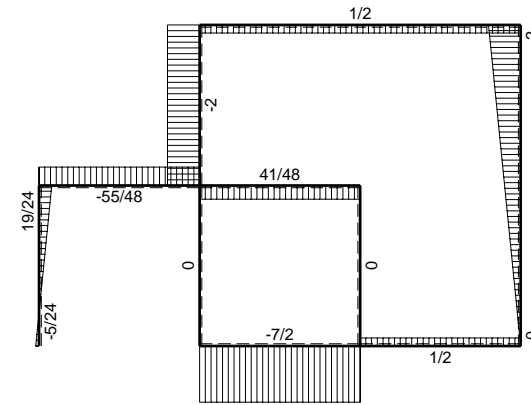
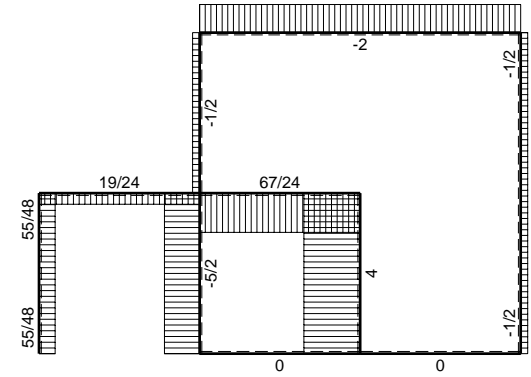
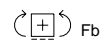
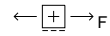
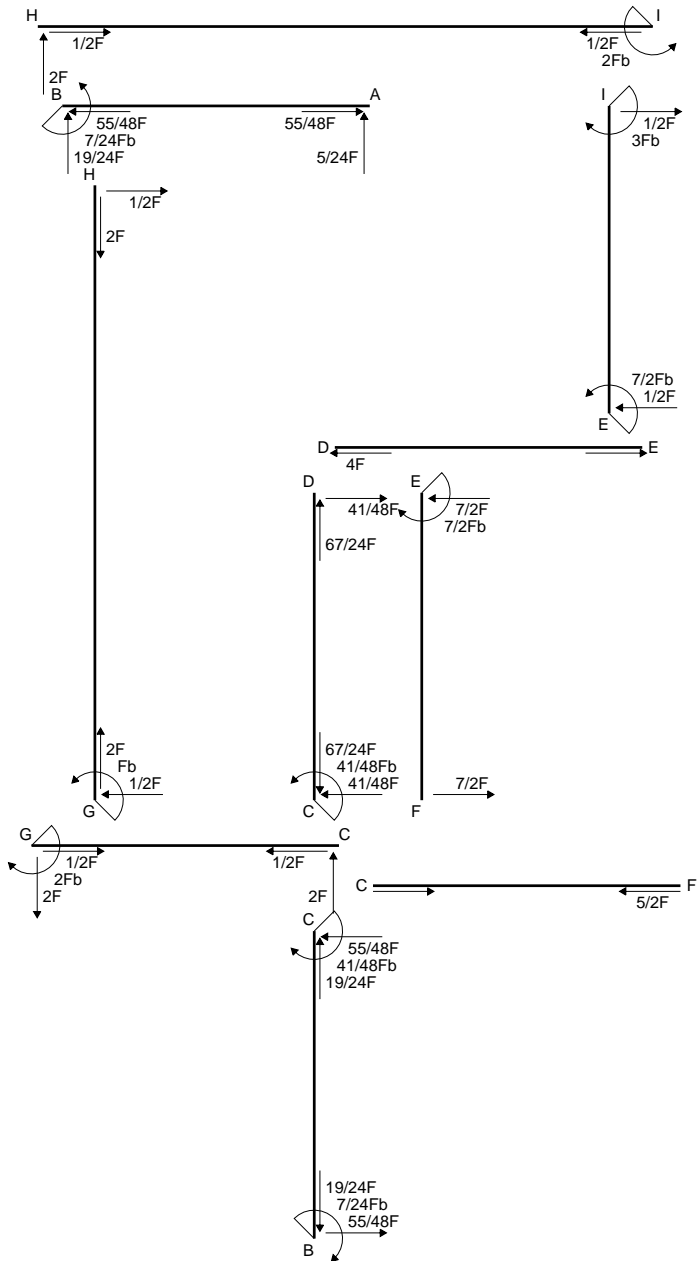
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

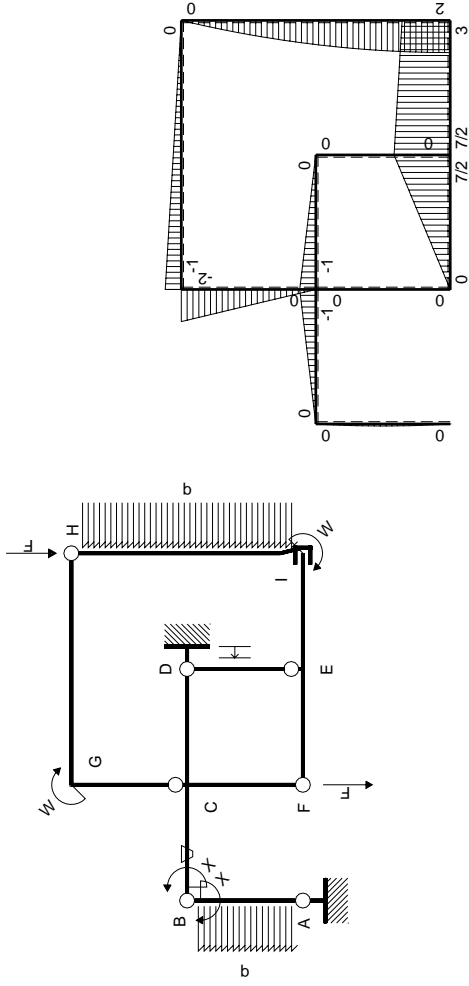
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



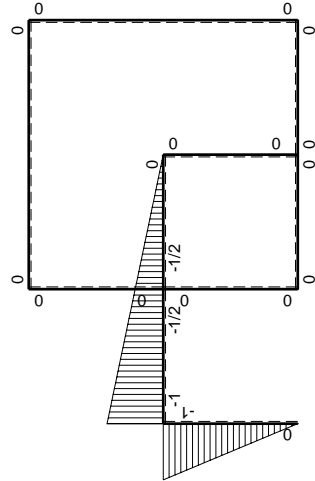
- A = 642. mm²
- J_u = 158306. mm⁴
- J_v = 30006. mm⁴
- y_g = 37.71 mm
- N = -235. N
- T_y = -1175. N
- M_x = 951750. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -37.71 mm
- σ_m = N/A-Mv/J_u = 226.3 N/mm²
- x_c = 15. mm
- y_c = 16. mm
- v_c = -21.71 mm
- σ_c = N/A-Mv/J_u = 130.1 N/mm²
- τ_c = 3.528 N/mm²
- σ_φ = √(σ²+3τ²) = 130.3 N/mm²
- S = 2852. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-7/2Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$7/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-7/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

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

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

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

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

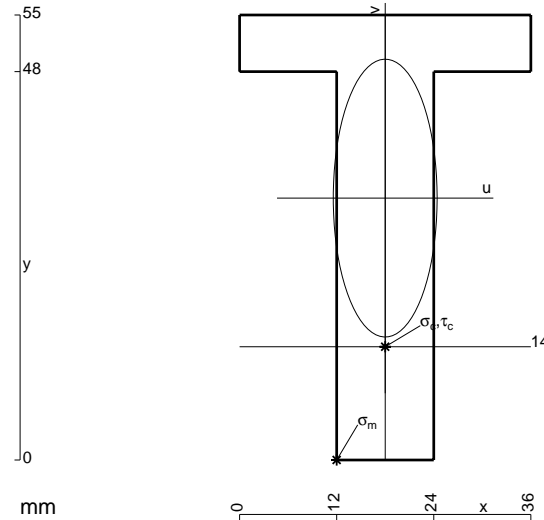
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

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

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

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

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



$$A = 828. \text{ mm}^2$$

$$J_u = 244195. \text{ mm}^4$$

$$J_v = 34128. \text{ mm}^4$$

$$y_g = 32.37 \text{ mm}$$

$$T_y = -2100. \text{ N}$$

$$M_x = 1785000. \text{ Nmm}$$

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

$$u_m = -6. \text{ mm}$$

$$v_m = -32.37 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 236.6 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 14. \text{ mm}$$

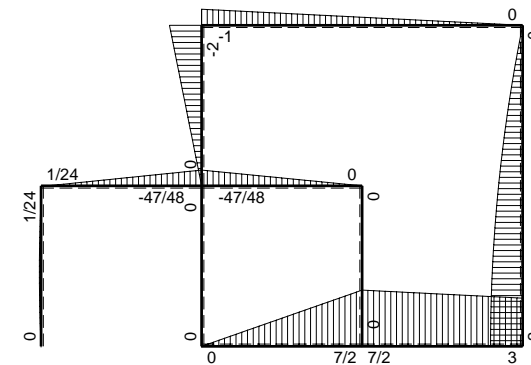
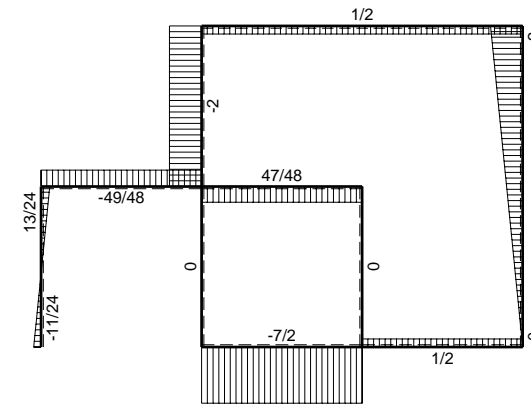
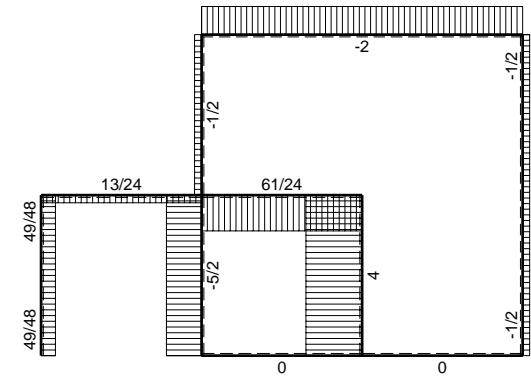
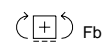
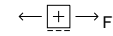
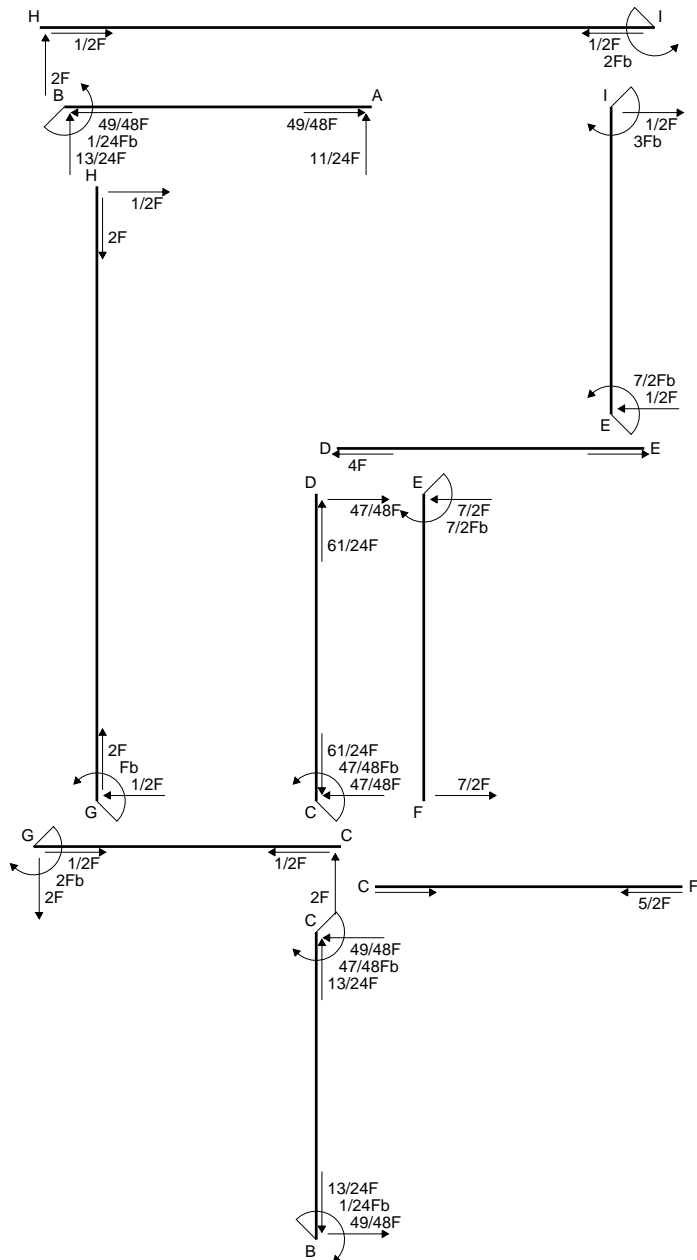
$$v_c = -18.37 \text{ mm}$$

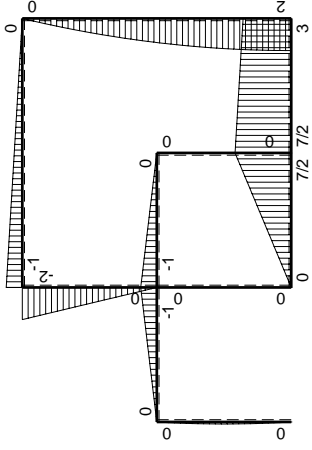
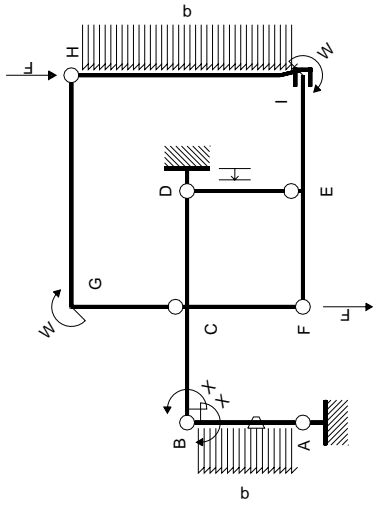
$$\sigma_c = -Mv/J_u = 134.3 \text{ N/mm}^2$$

$$\tau_c = 3.054 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 134.4 \text{ N/mm}^2$$

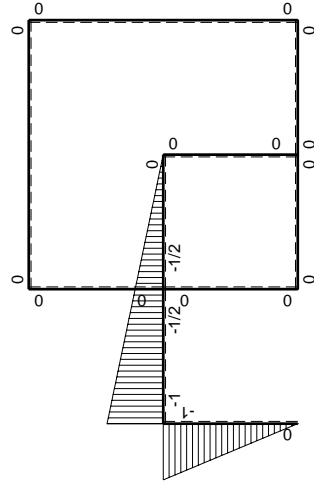
$$S = 4262. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-7/2Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$		
	totali						$1/24Fb^2/EJ$	Xb/EJ	
	iperstatica $X=W_{BC}$						$-1/24Fb$		

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

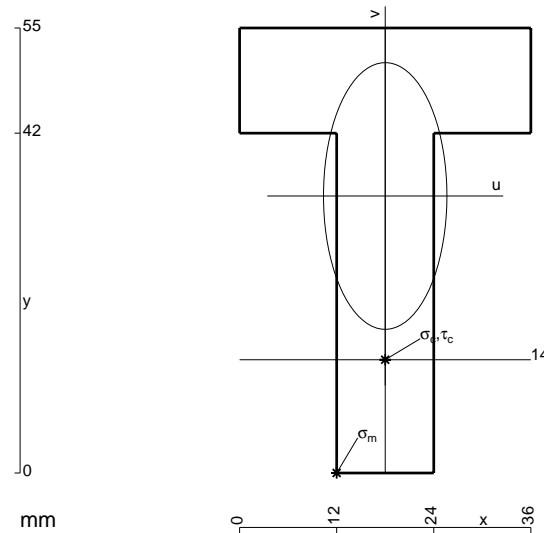
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

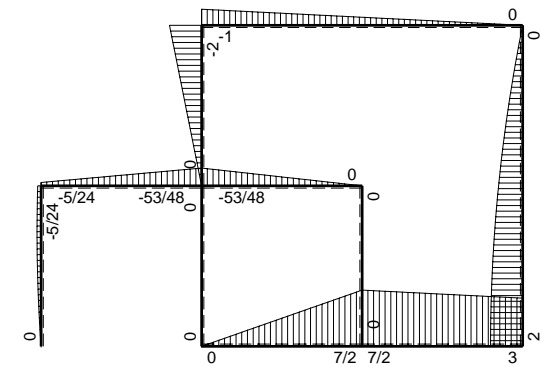
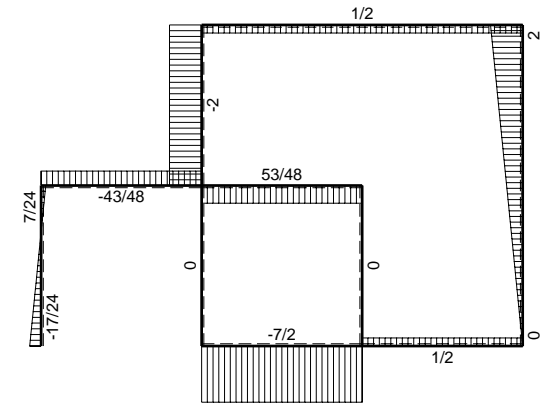
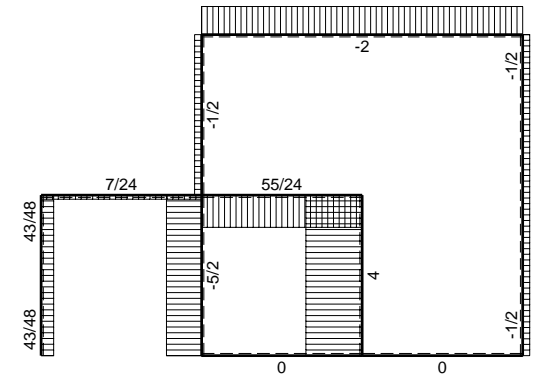
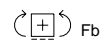
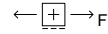
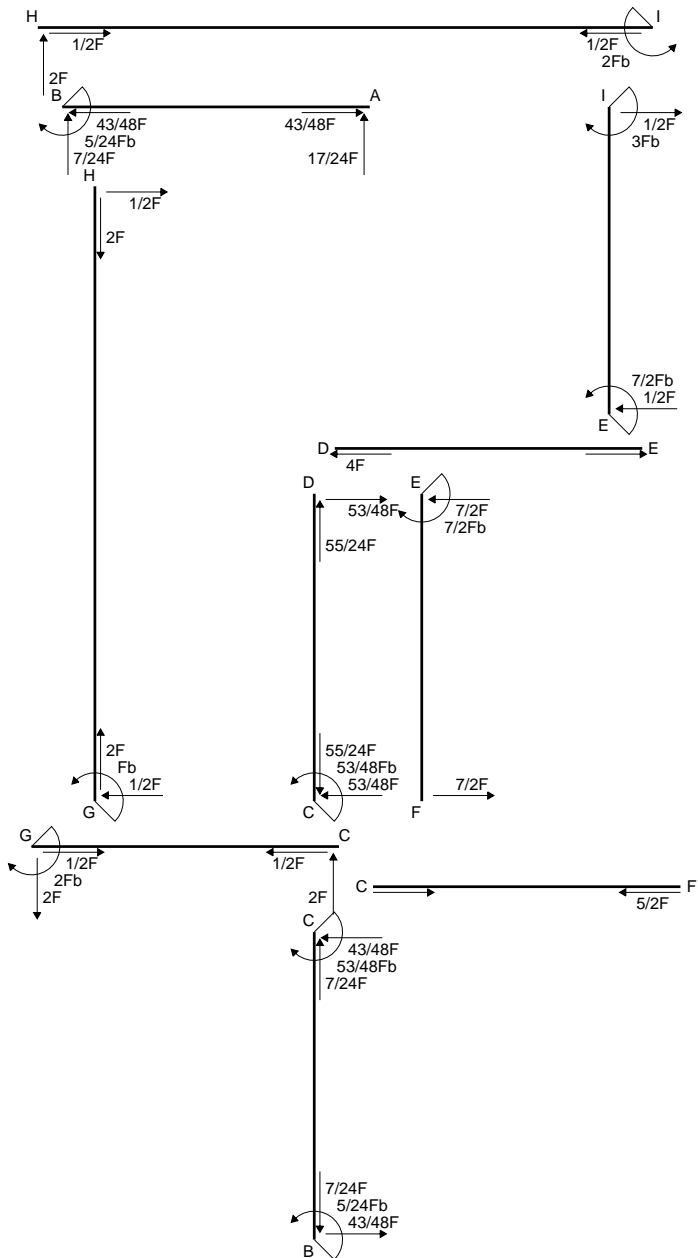
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

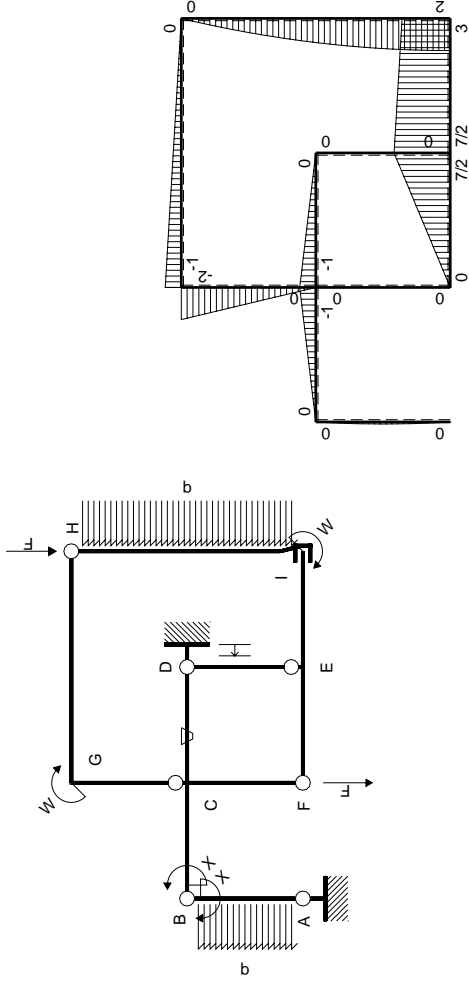
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

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



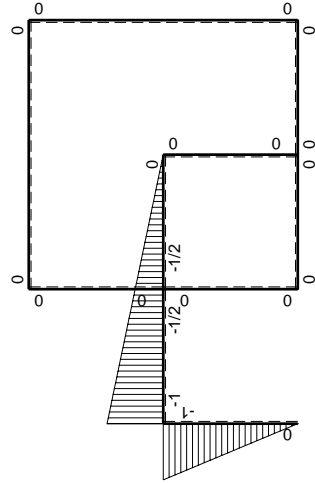
$A = 972. \text{ mm}^2$
 $J_u = 264196. \text{ mm}^4$
 $J_v = 56592. \text{ mm}^4$
 $y_g = 34.24 \text{ mm}$
 $T_y = -3395. \text{ N}$
 $M_x = 1527750. \text{ Nmm}$
 $x_m = 12. \text{ mm}$
 $u_m = -6. \text{ mm}$
 $v_m = -34.24 \text{ mm}$
 $\sigma_m = -Mv/J_u = 198. \text{ N/mm}^2$
 $x_c = 18. \text{ mm}$
 $y_c = 14. \text{ mm}$
 $v_c = -20.24 \text{ mm}$
 $\sigma_c = -Mv/J_u = 117. \text{ N/mm}^2$
 $\tau_c = 4.901 \text{ N/mm}^2$
 $\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 117.4 \text{ N/mm}^2$
 $S = 4576. \text{ mm}^3$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	Fx	Fb/EJ	$1/2Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0
FE b	0	$-7/2Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$-5/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$5/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

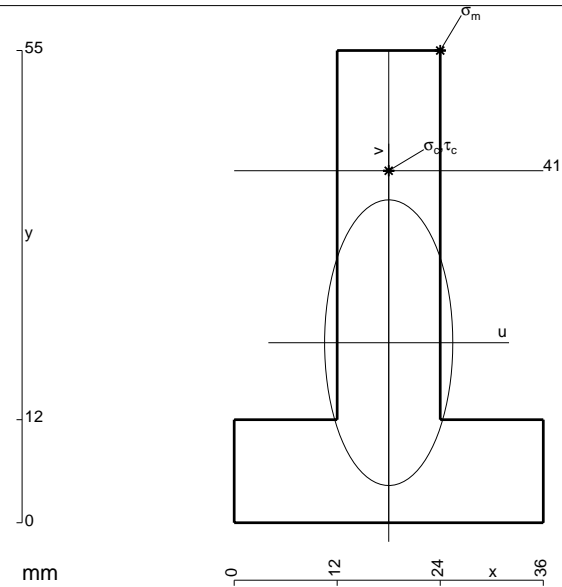
$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 5/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/6 b) Fb 1/EJ + (-1/4 b) \theta = 5/12 Fb^2/EJ$$



$$A = 948. \text{ mm}^2$$

$$J_u = 262515. \text{ mm}^4$$

$$J_v = 52848. \text{ mm}^4$$

$$y_g = 20.97 \text{ mm}$$

$$T_y = -3290. \text{ N}$$

$$M_x = 1612100. \text{ Nmm}$$

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

$$y_m = 55. \text{ mm}$$

$$u_m = 6. \text{ mm}$$

$$v_m = 34.03 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -209. \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

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

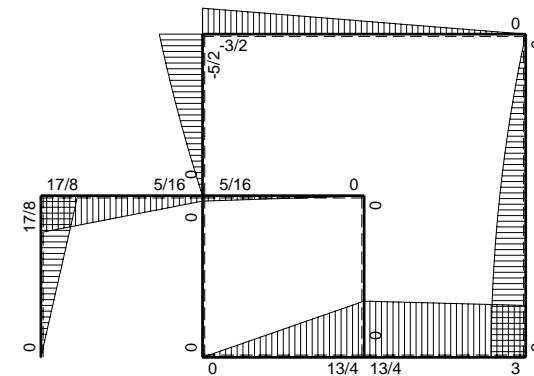
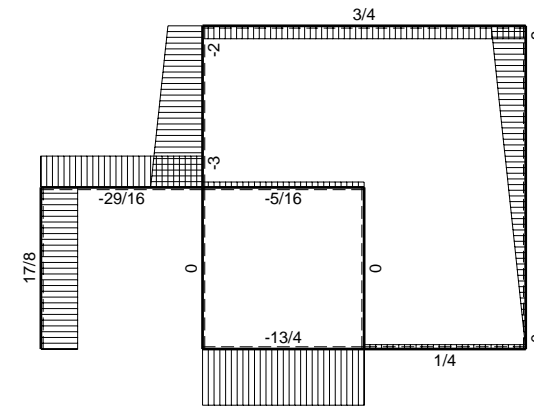
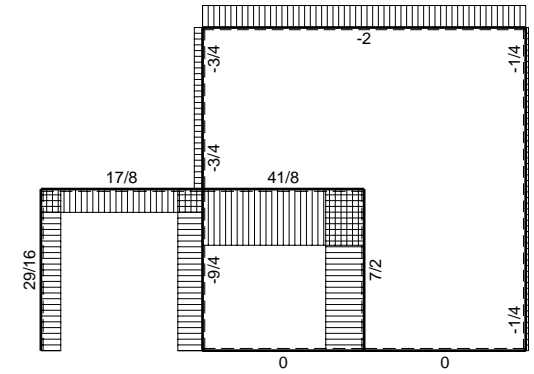
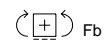
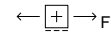
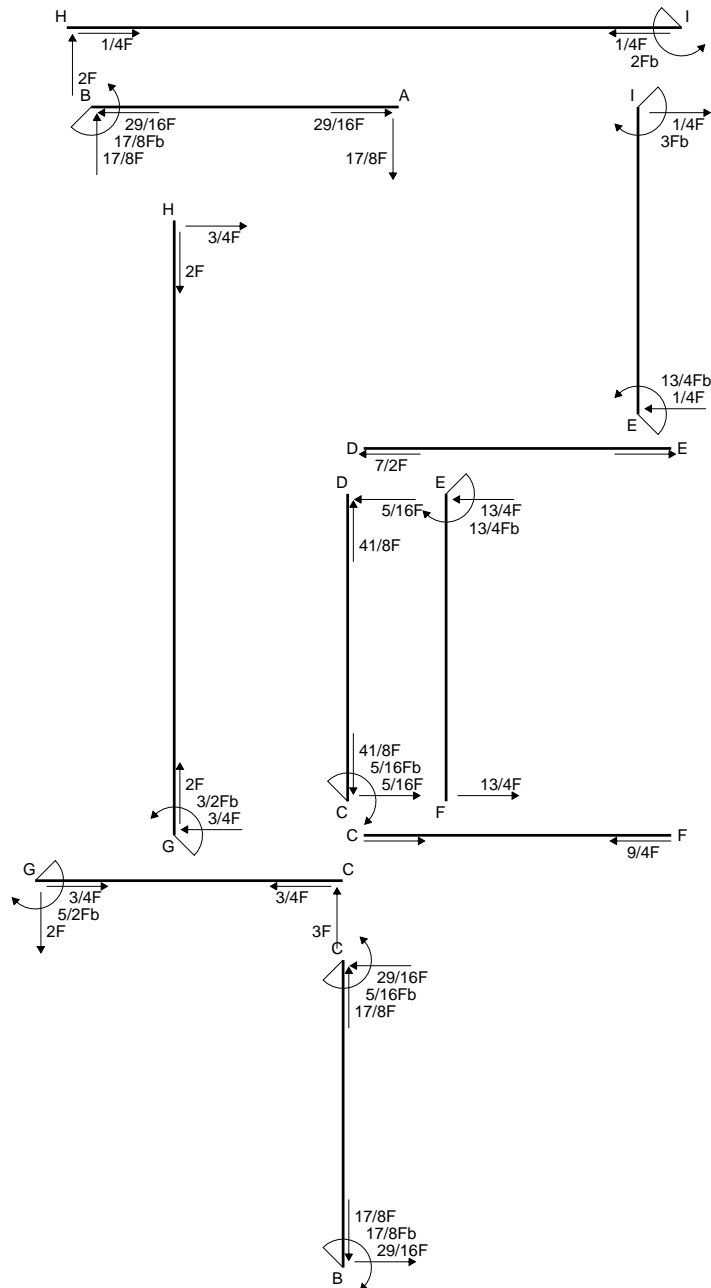
$$v_c = 20.03 \text{ mm}$$

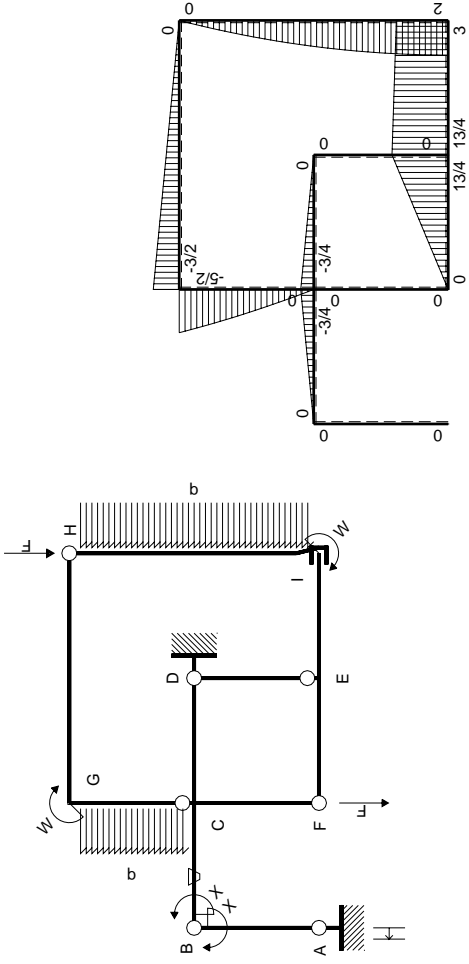
$$\sigma_c = -Mv/J_u = -123. \text{ N/mm}^2$$

$$\tau_c = 4.743 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 123.3 \text{ N/mm}^2$$

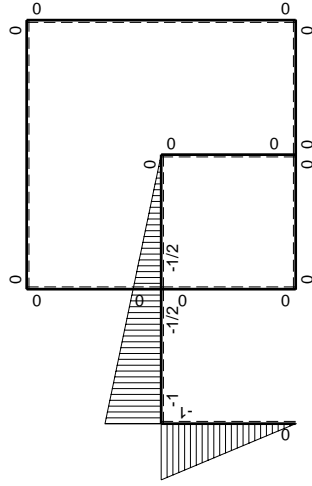
$$S = 4541. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0
FE b	0	$-13/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-3Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$5/2Fb-2Fx-1/2qx^2$	0	0	0	0		
GH 2b	0	$-3/2Fb+3/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$3/4Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/4Fx$	0	0	0	0	0+0	0
EI b	0	$-13/4Fb+1/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$17/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-17/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

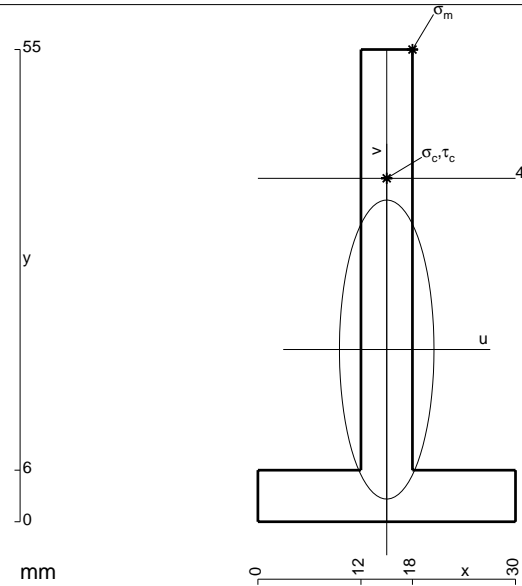
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

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

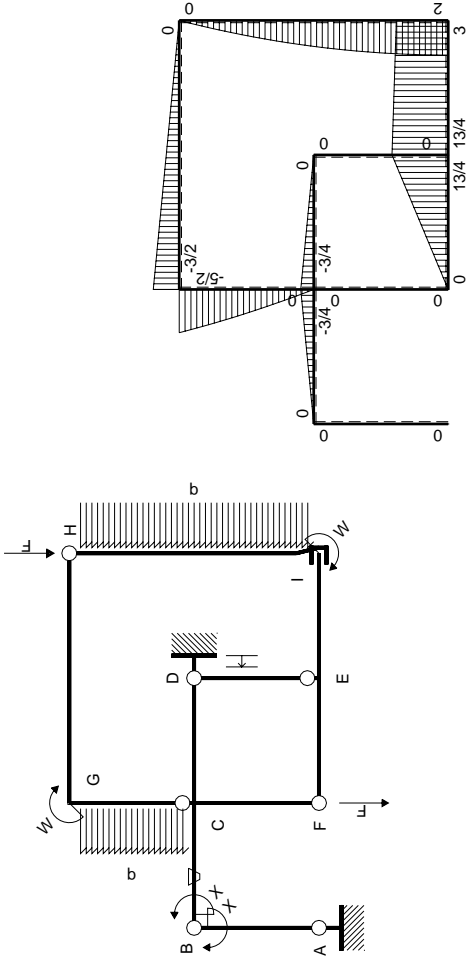
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

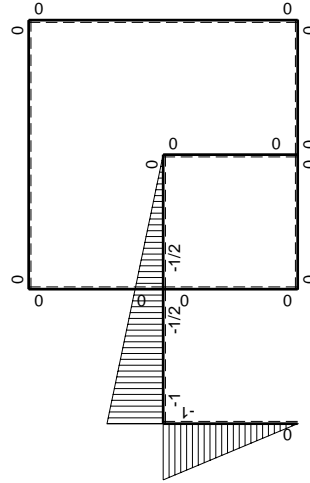


- A = 474. mm²
- J_u = 143796. mm⁴
- J_v = 14382. mm⁴
- y_g = 20.06 mm
- T_y = -1658. N
- M_x = 895050. Nmm
- x_m = 18. mm
- y_m = 55. mm
- u_m = 3. mm
- v_m = 34.94 mm
- σ_m = -Mv/J_u = -217.5 N/mm²
- x_c = 15. mm
- y_c = 40. mm
- v_c = 19.94 mm
- σ_c = -Mv/J_u = -124.1 N/mm²
- τ_c = 4.745 N/mm²
- σ_q = √σ²+3τ² = 124.4 N/mm²
- S = 2470. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-13/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$5/2Fb-2Fx-1/2qx^2$	0	0	0	0			
GH 2b	0	$-3/2Fb+3/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$3/4Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-13/4Fb+1/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

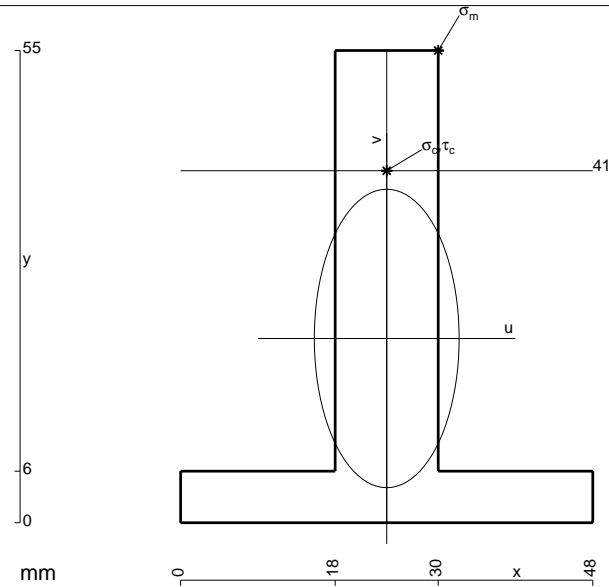
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

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

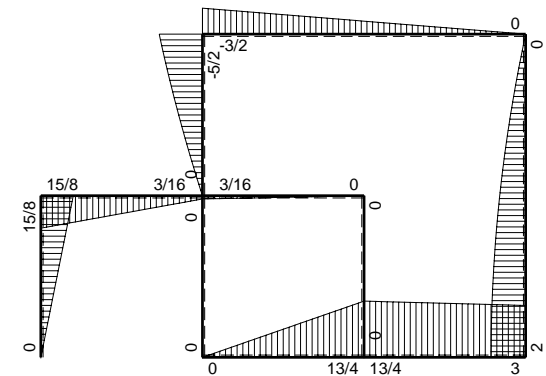
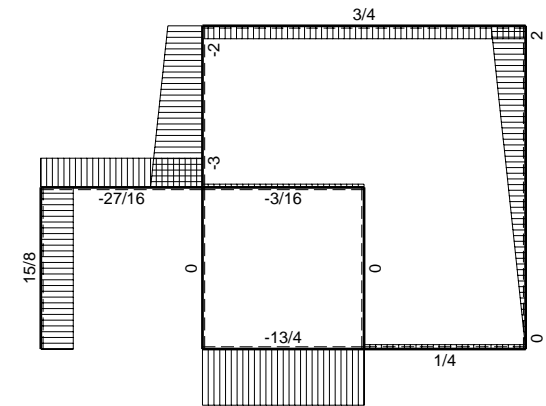
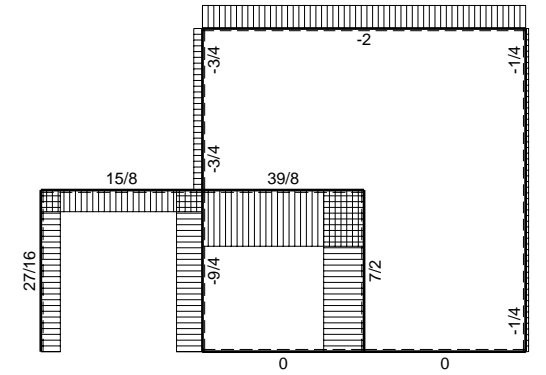
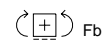
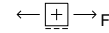
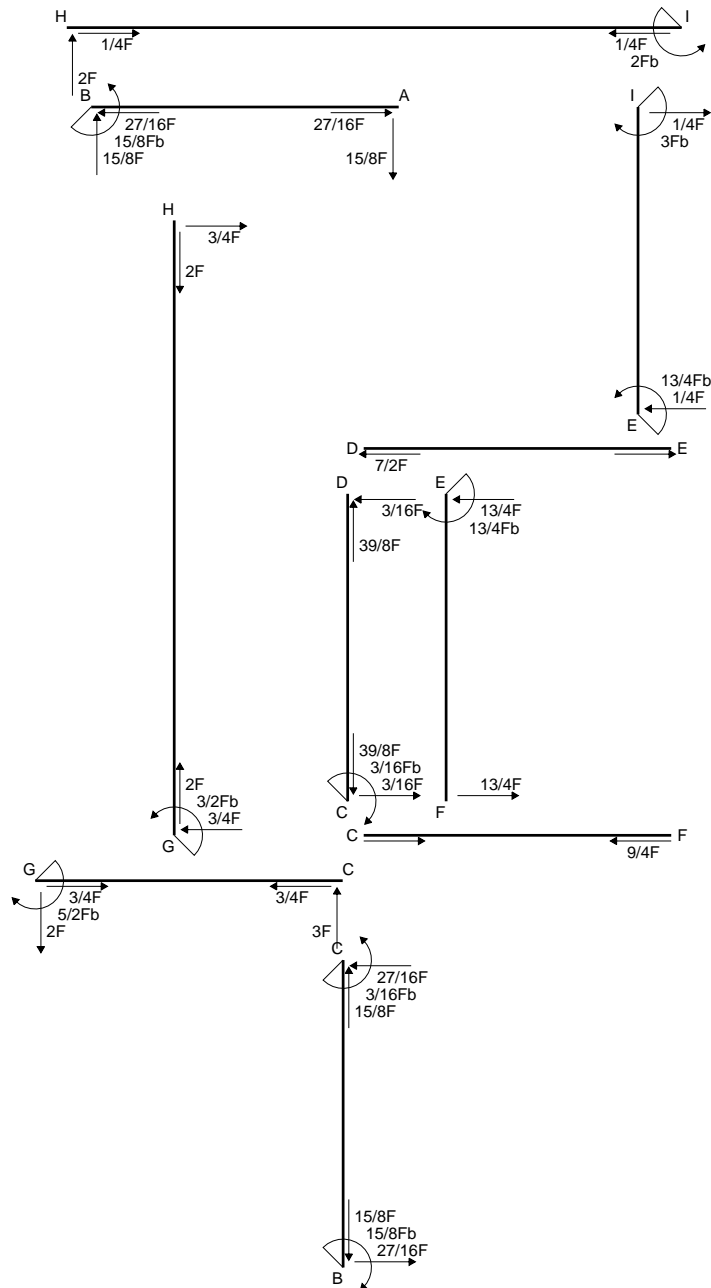
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

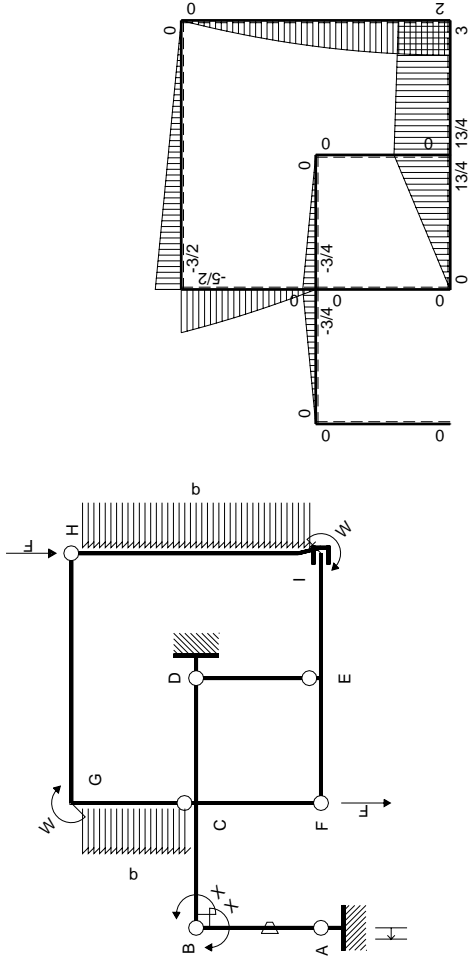
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



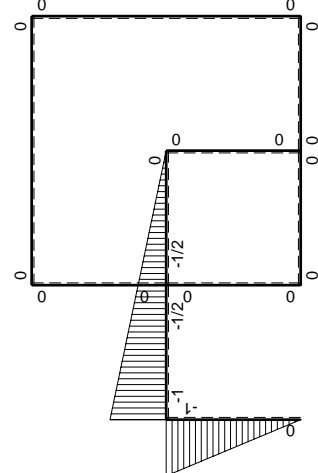
- A = 876. mm²
- J_u = 264708. mm⁴
- J_v = 62352. mm⁴
- y_g = 21.46 mm
- T_y = -3120. N
- M_x = 1809600. Nmm
- x_m = 30. mm
- y_m = 55. mm
- u_m = 6. mm
- v_m = 33.54 mm
- σ_m = -Mv/J_u = -229.3 N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 19.54 mm
- σ_c = -Mv/J_u = -133.6 N/mm²
- τ_c = 4.38 N/mm²
- σ_q = √σ²+3τ² = 133.8 N/mm²
- S = 4459. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0
FE b	0	$-13/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-3Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$5/2Fb-2Fx-1/2qx^2$	0	0	0	0		
GH 2b	0	$-3/2Fb+3/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$3/4Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/4Fx$	0	0	0	0	0+0	0
EI b	0	$-13/4Fb+1/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$15/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-15/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

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

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

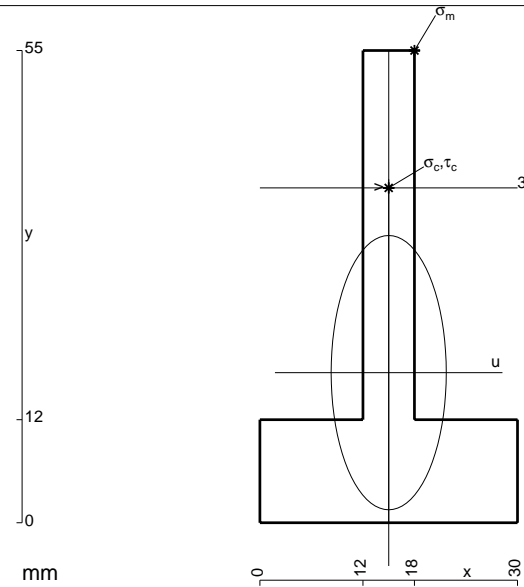
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

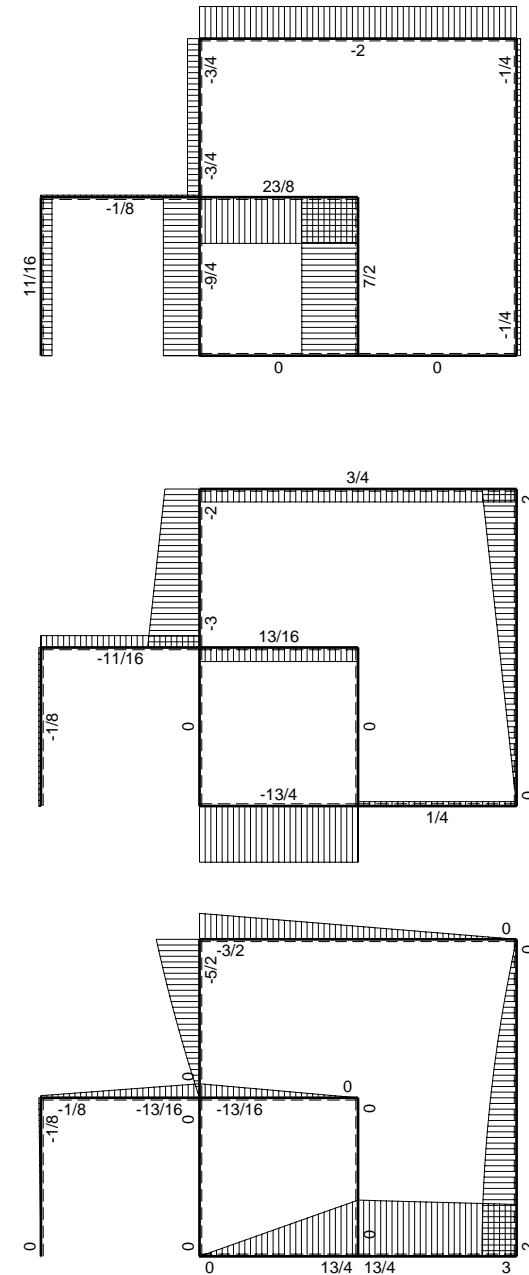
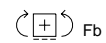
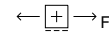
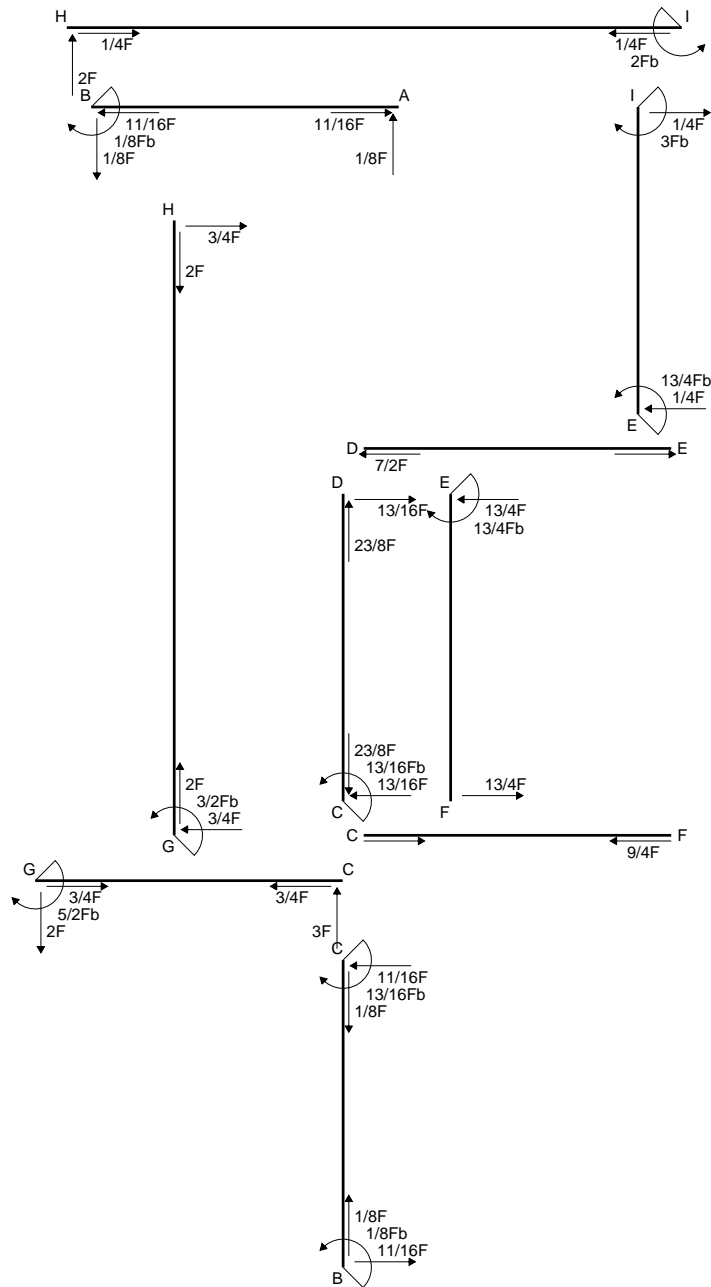
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

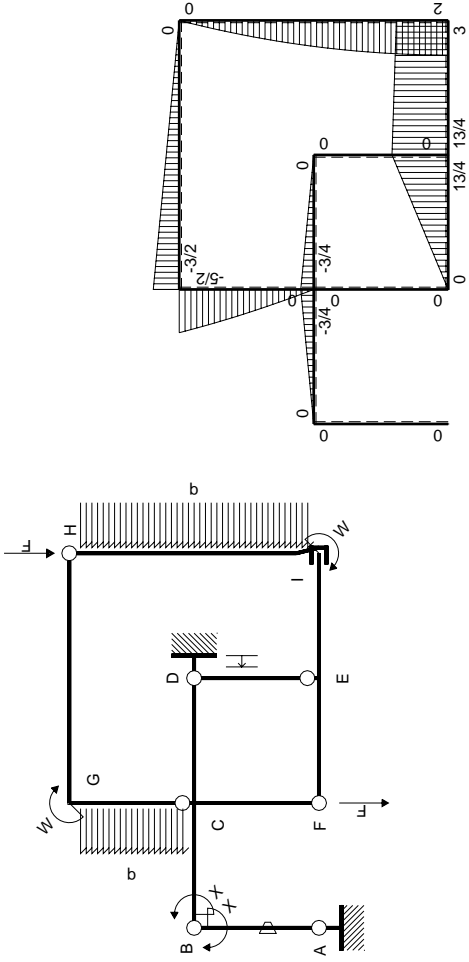
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



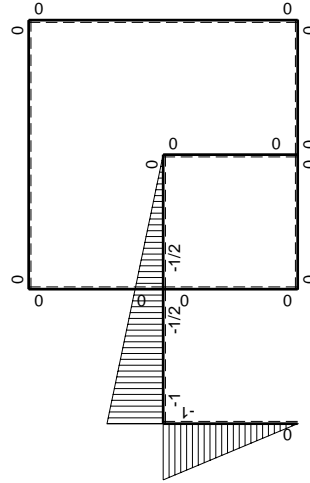
- A = 618. mm²
- J_u = 157731. mm⁴
- J_v = 27774. mm⁴
- y_g = 17.48 mm
- T_y = -1593. N
- M_x = 1003280. Nmm
- x_m = 18. mm
- y_m = 55. mm
- u_m = 3. mm
- v_m = 37.52 mm
- σ_m = -Mv/J_u = -238.6 N/mm²
- x_c = 15. mm
- y_c = 39. mm
- v_c = 21.52 mm
- σ_c = -Mv/J_u = -136.9 N/mm²
- τ_c = 4.769 N/mm²
- σ_q = √σ²+3τ² = 137.1 N/mm²
- S = 2834. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-13/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$5/2Fb-2Fx-1/2qx^2$	0	0	0	0			
GH 2b	0	$-3/2Fb+3/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$3/4Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-13/4Fb+1/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

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

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

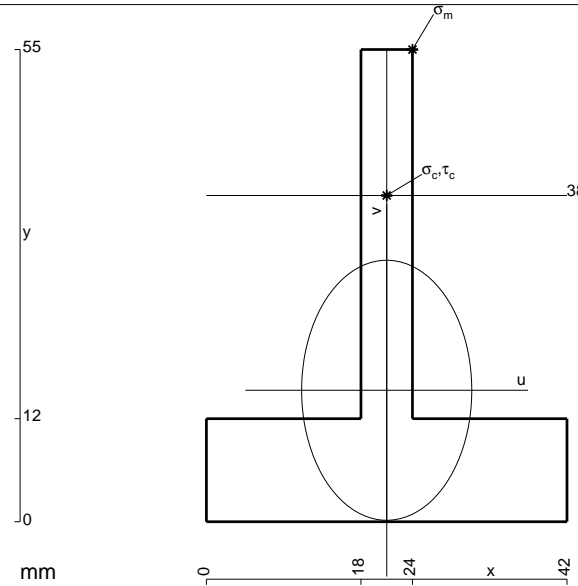
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

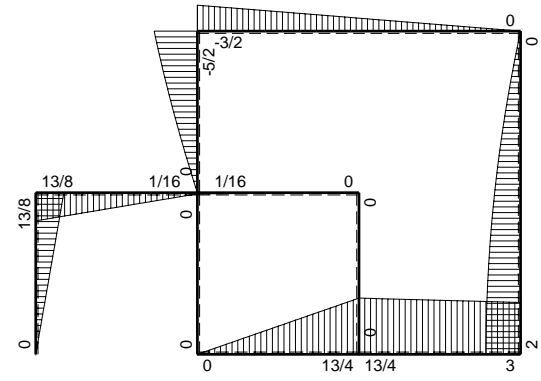
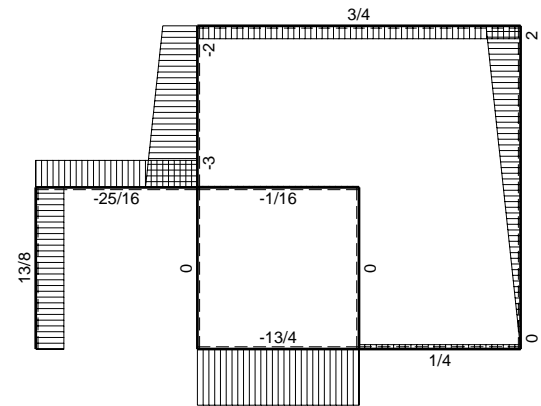
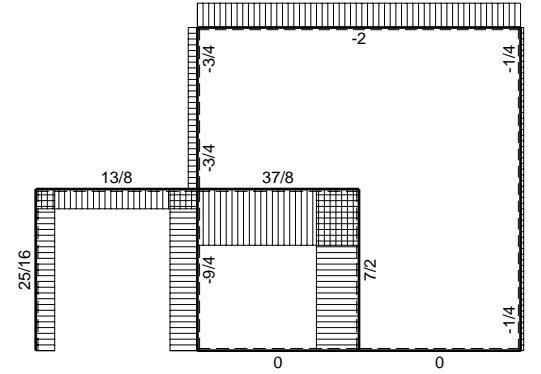
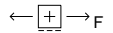
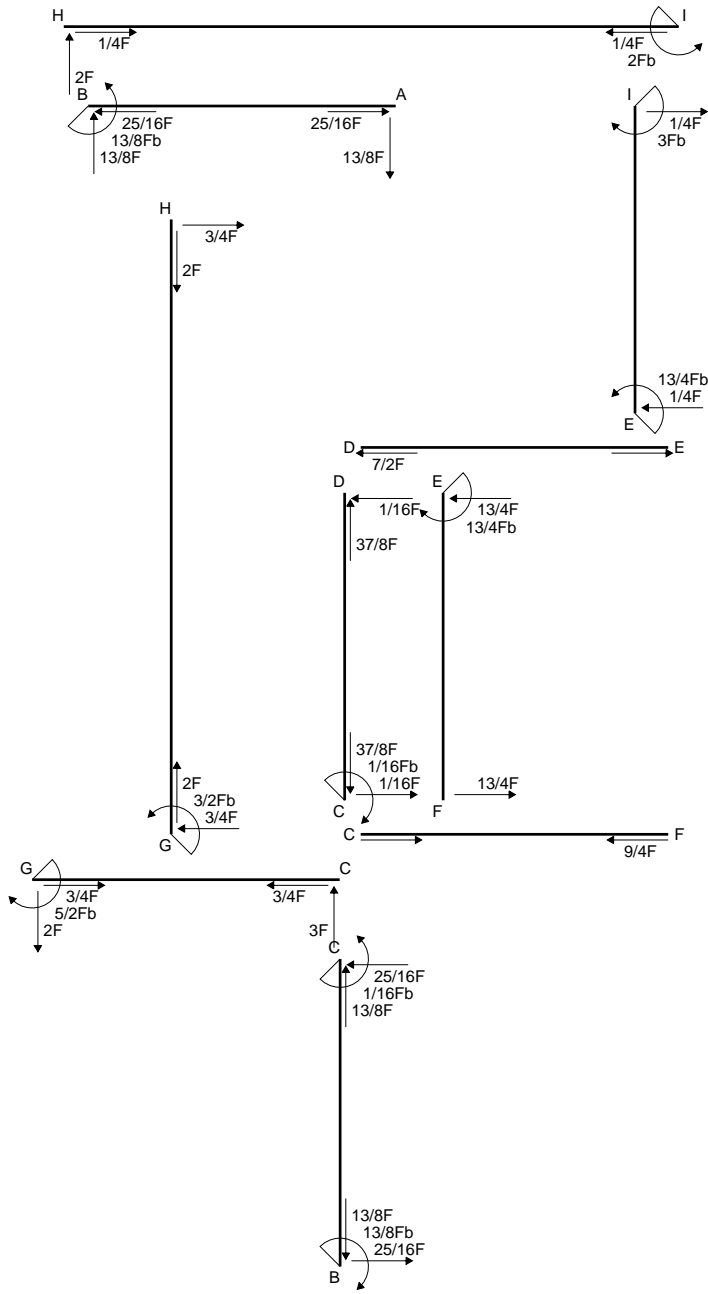
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

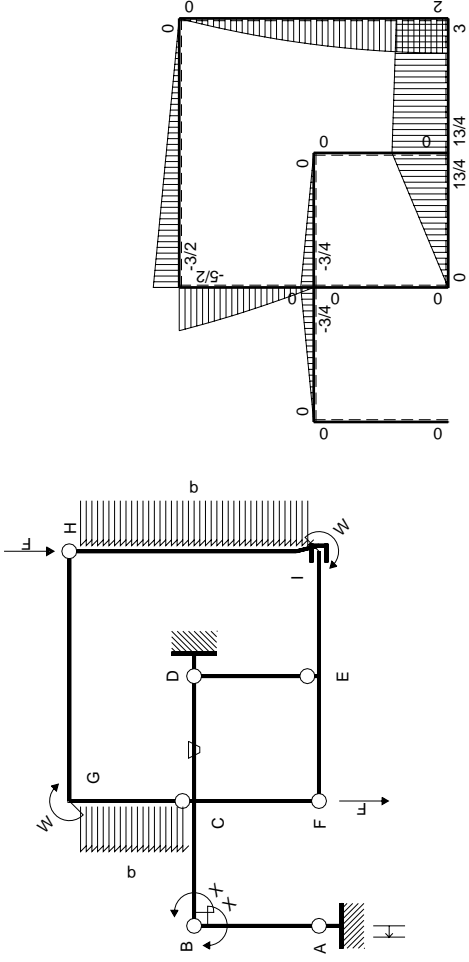
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



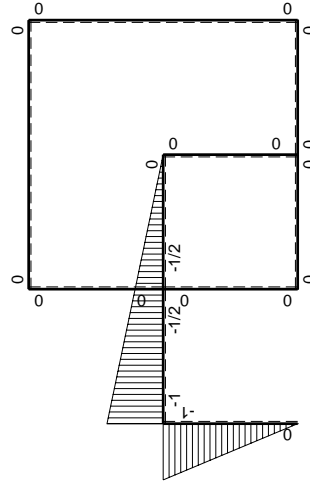
- A = 762. mm²
- J_u = 174852. mm⁴
- J_v = 74862. mm⁴
- y_g = 15.31 mm
- T_y = -1300. N
- M_x = 871000. Nmm
- x_m = 24. mm
- y_m = 55. mm
- u_m = 3. mm
- v_m = 39.69 mm
- σ_m = -Mv/J_u = -197.7 N/mm²
- x_c = 21. mm
- y_c = 38. mm
- v_c = 22.69 mm
- σ_c = -Mv/J_u = -113. N/mm²
- τ_c = 3.942 N/mm²
- σ_q = √σ²+3τ² = 113.2 N/mm²
- S = 3181. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0
FE b	0	$-13/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-3Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$5/2Fb-2Fx-1/2qx^2$	0	0	0	0		
GH 2b	0	$-3/2Fb+3/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$3/4Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/4Fx$	0	0	0	0	0+0	0
EI b	0	$-13/4Fb+1/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$13/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-13/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

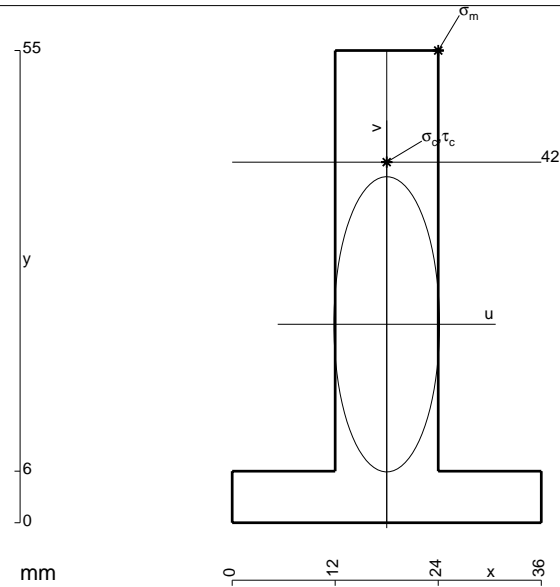
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

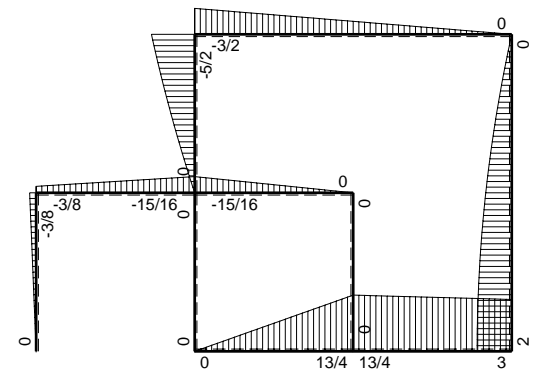
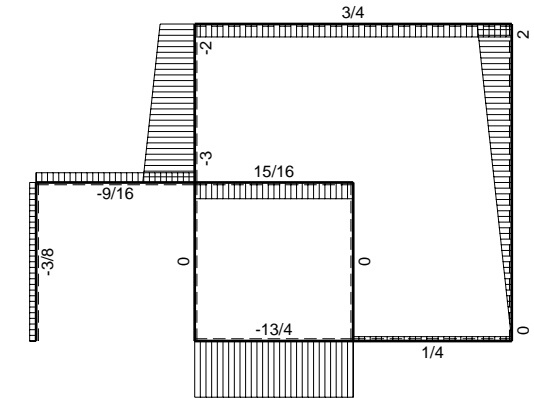
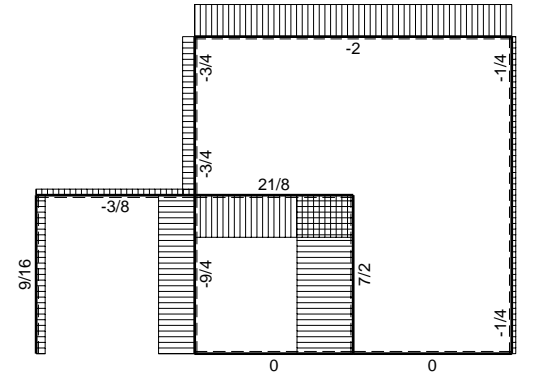
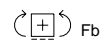
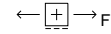
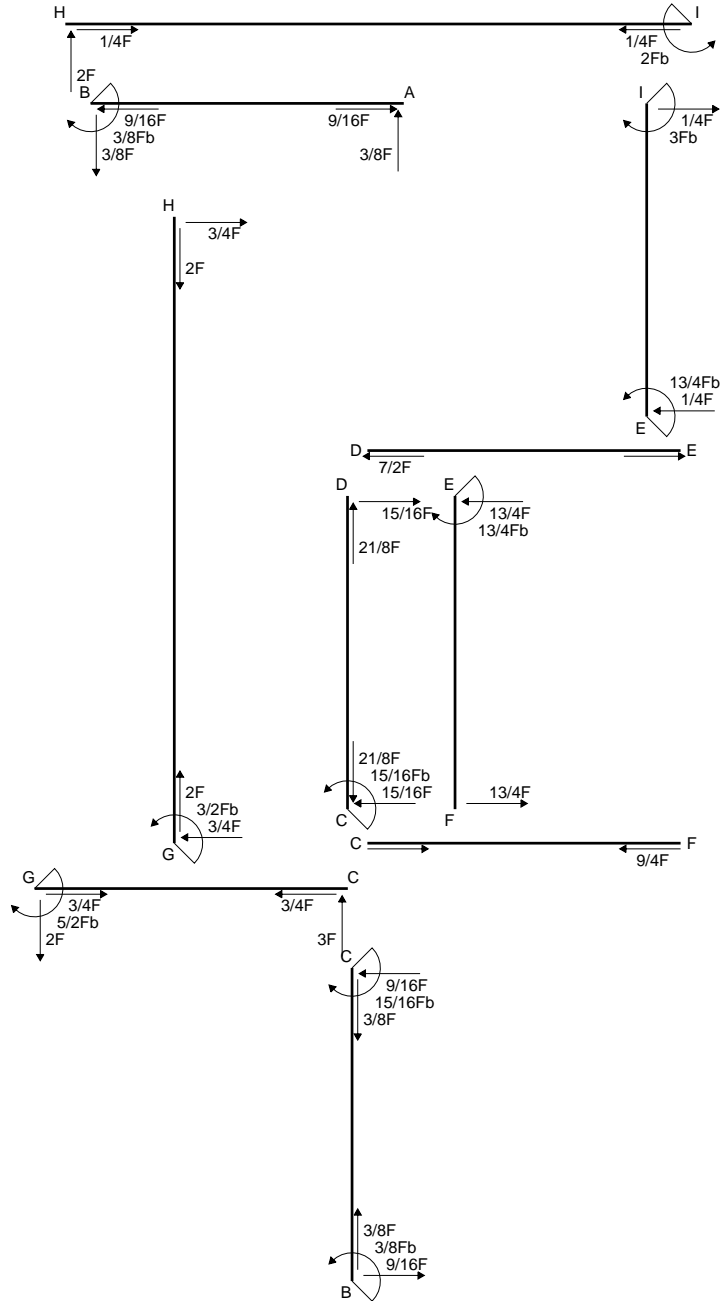
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

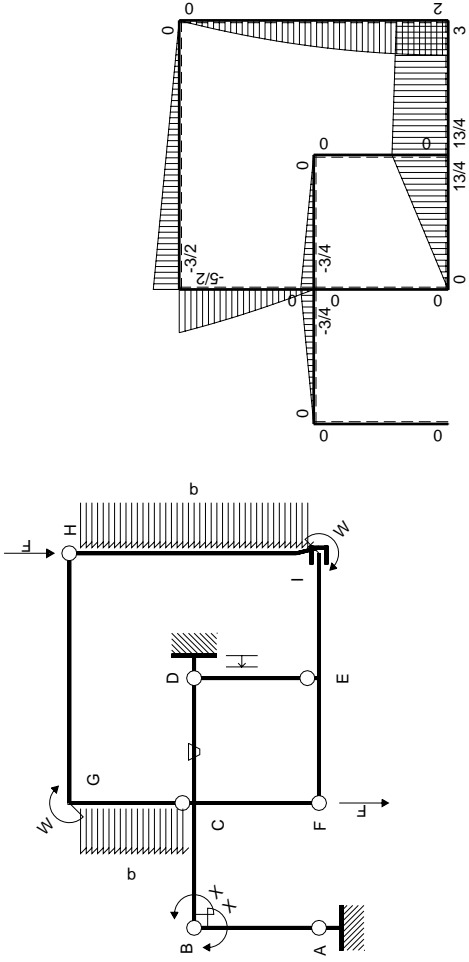
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



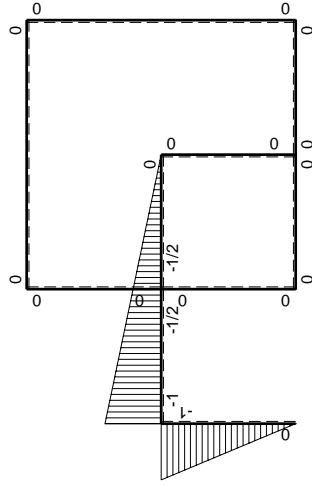
- A = 804. mm²
- J_u = 237762. mm⁴
- J_v = 30384. mm⁴
- y_g = 23.11 mm
- T_y = -2145. N
- M_x = 1544400. Nmm
- x_m = 24. mm
- y_m = 55. mm
- u_m = 6. mm
- v_m = 31.89 mm
- σ_m = -Mv/J_u = -207.1 N/mm²
- x_c = 18. mm
- y_c = 42. mm
- v_c = 18.89 mm
- σ_c = -Mv/J_u = -122.7 N/mm²
- τ_c = 2.978 N/mm²
- σ_q = √σ²+3τ² = 122.8 N/mm²
- S = 3961. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0
FE b	0	$-13/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-3Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$5/2Fb-2Fx-1/2qx^2$	0	0	0	0		
GH 2b	0	$-3/2Fb+3/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$3/4Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/4Fx$	0	0	0	0	0+0	0
EI b	0	$-13/4Fb+1/4Fx$	0	0	0	0		
D	cedimento nodo $-H_{iD}u_D$						$-Fb^2/EJ$	
	totali						$-3/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$3/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

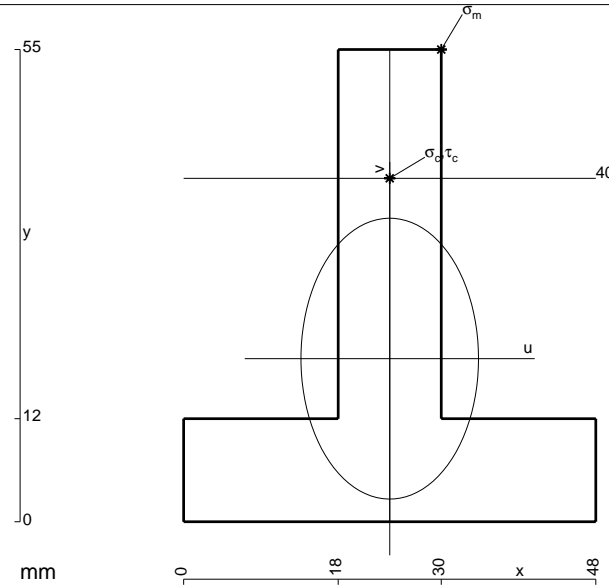
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

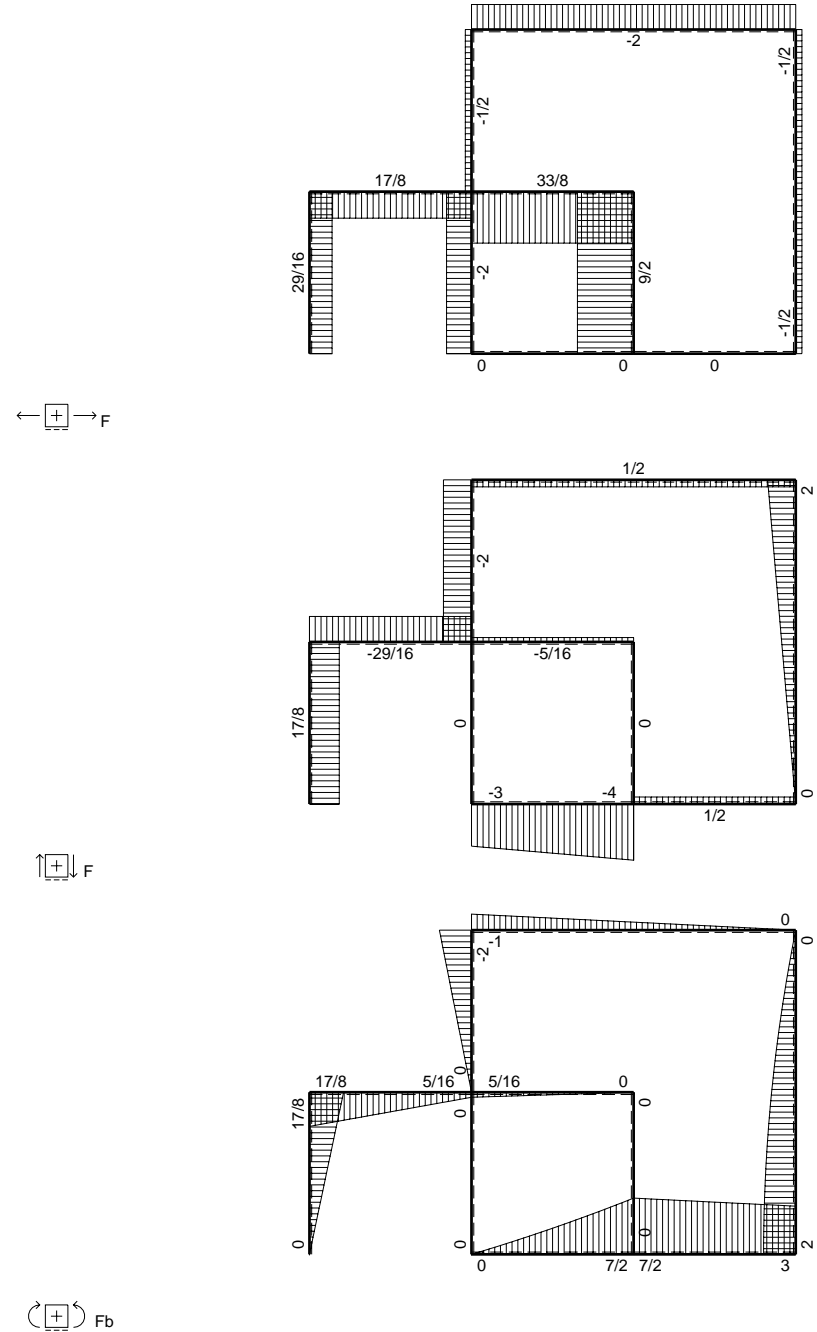
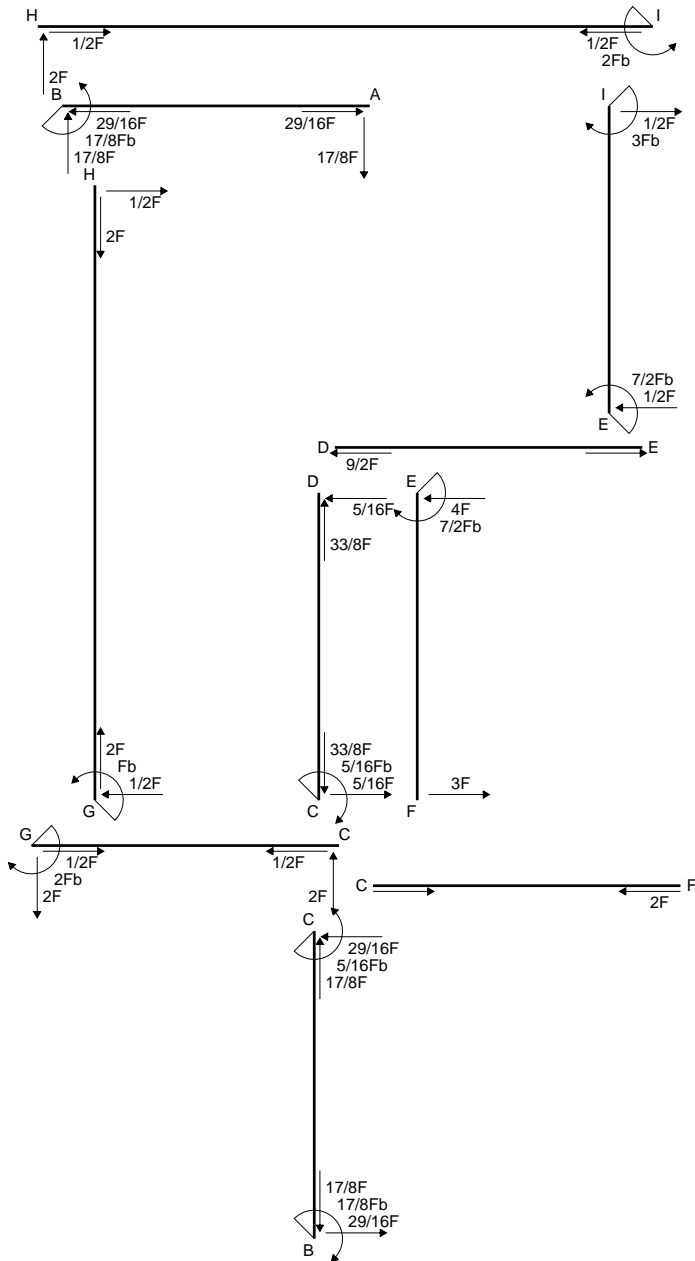
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

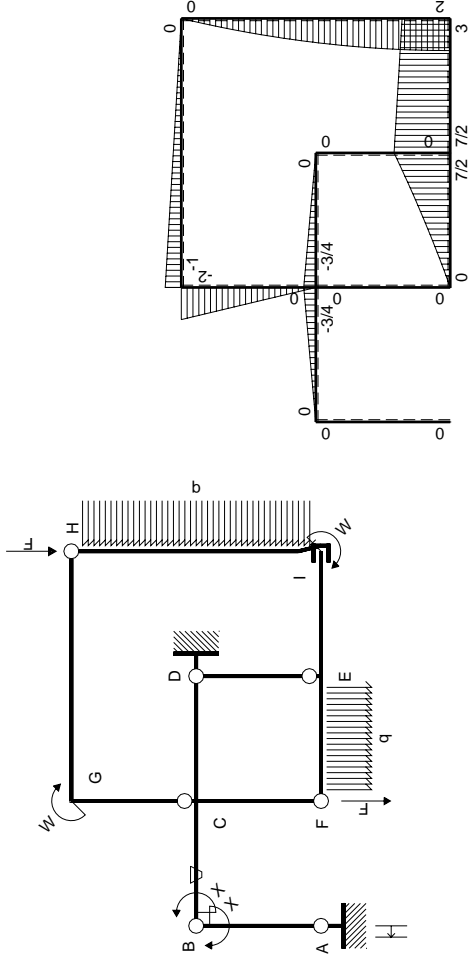
$$= (1/8 b) Fb 1/EJ + (-1/4 b) \theta = 3/8 Fb^2/EJ$$



- A = 1092. mm²
- J_u = 292252. mm⁴
- J_v = 116784. mm⁴
- y_g = 18.99 mm
- T_y = -2340. N
- M_x = 1778400. Nmm
- x_m = 30. mm
- y_m = 55. mm
- u_m = 6. mm
- v_m = 36.01 mm
- σ_m = -Mv/J_u = -219.1 N/mm²
- x_c = 24. mm
- y_c = 40. mm
- v_c = 21.01 mm
- σ_c = -Mv/J_u = -127.8 N/mm²
- τ_c = 3.424 N/mm²
- σ_φ = √(σ² + 3τ²) = 128. N/mm²
- S = 5131. mm³

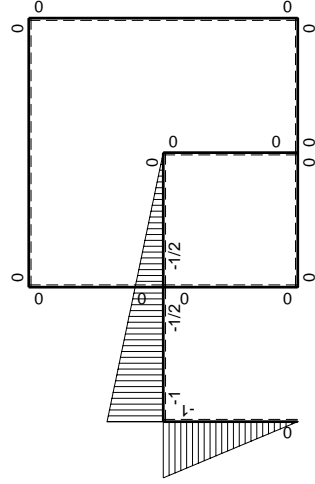


$\left[\begin{matrix} + \\ + \end{matrix} \right] F_b$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$17/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-17/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

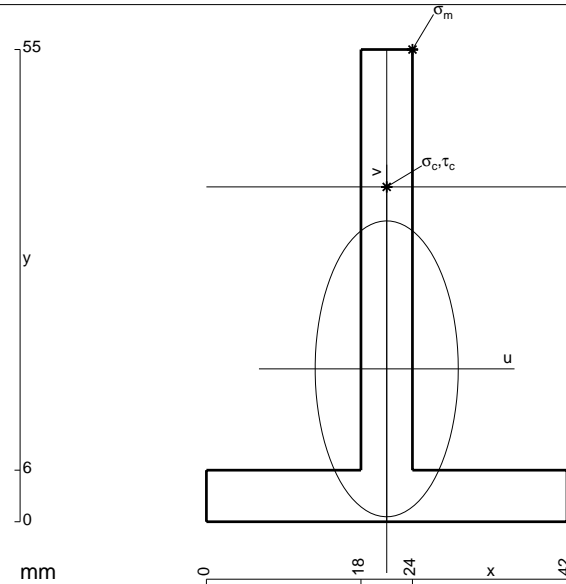
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

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

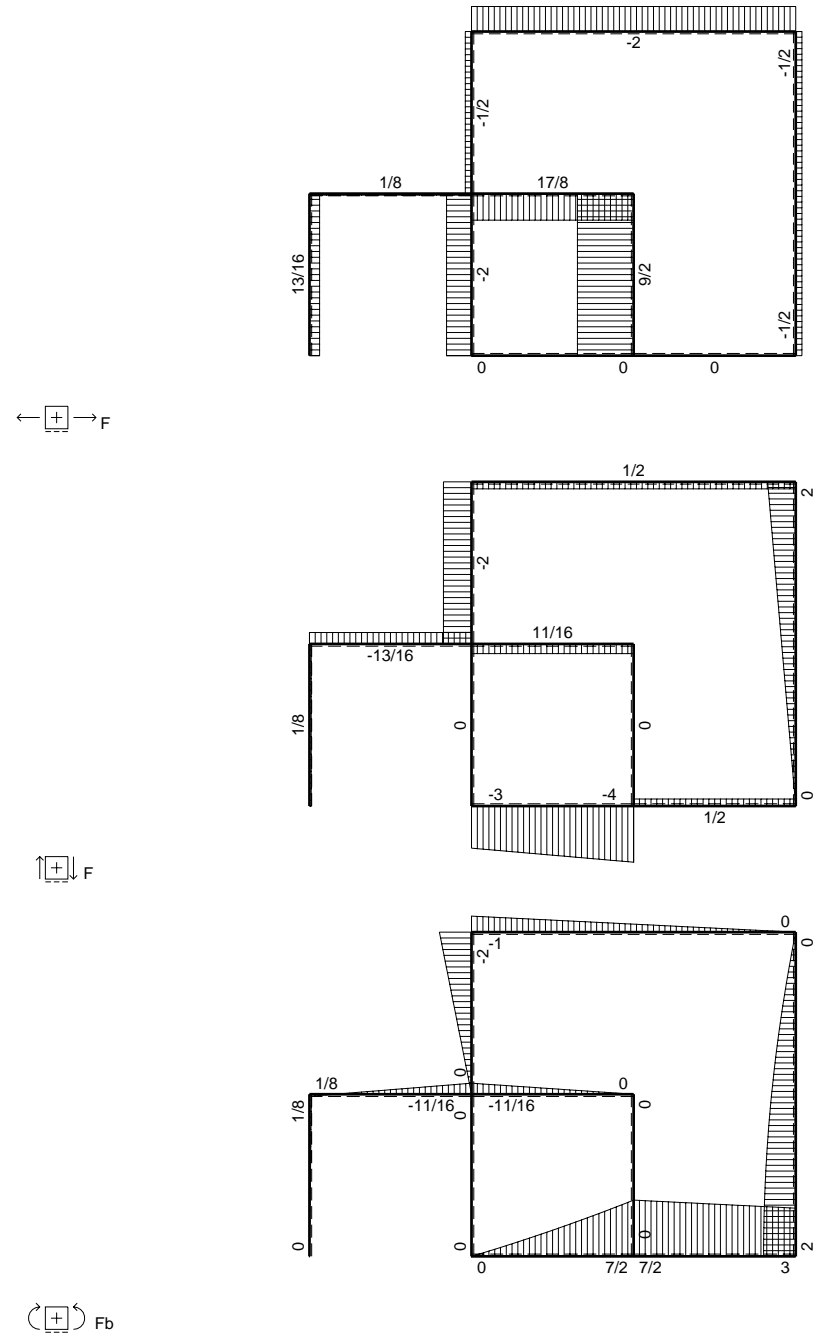
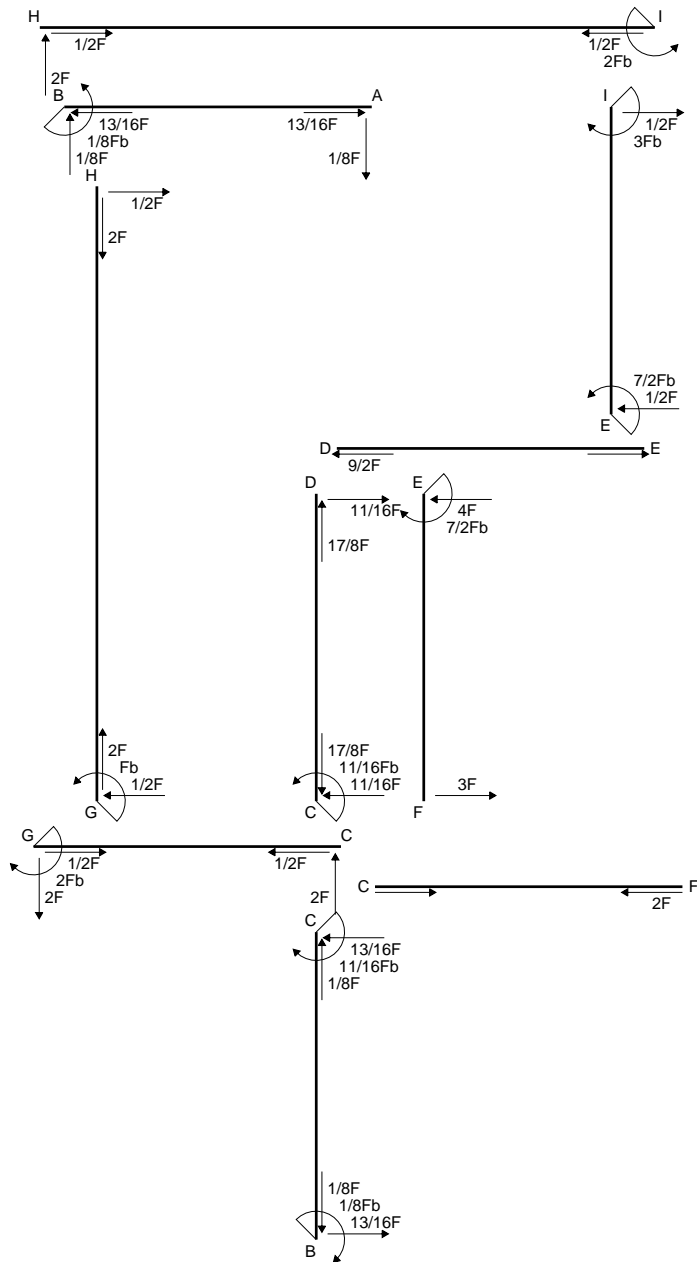
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

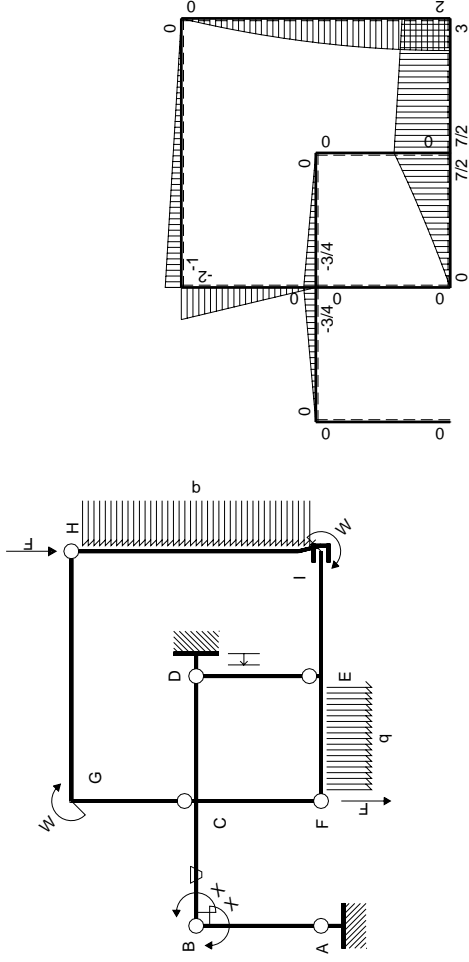
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



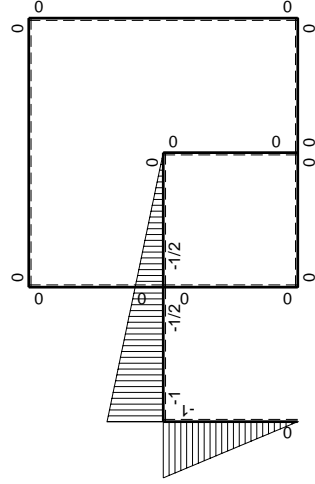
- A = 546. mm²
- J_u = 162198. mm⁴
- J_v = 37926. mm⁴
- y_g = 17.81 mm
- T_y = -1400. N
- M_x = 992250. Nmm
- x_m = 24. mm
- y_m = 55. mm
- u_m = 3. mm
- v_m = 37.19 mm
- σ_m = -M_v/J_u = -227.5 N/mm²
- x_c = 21. mm
- y_c = 39. mm
- v_c = 21.19 mm
- σ_c = -M_v/J_u = -129.6 N/mm²
- τ_c = 4.032 N/mm²
- σ_q = √σ²+3τ² = 129.8 N/mm²
- S = 2802. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

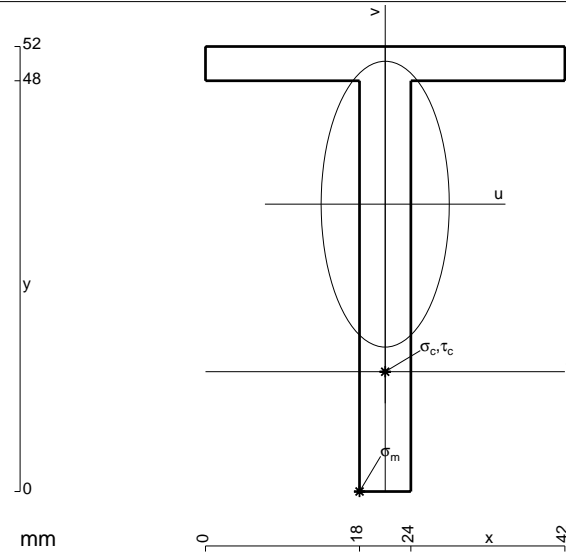
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

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

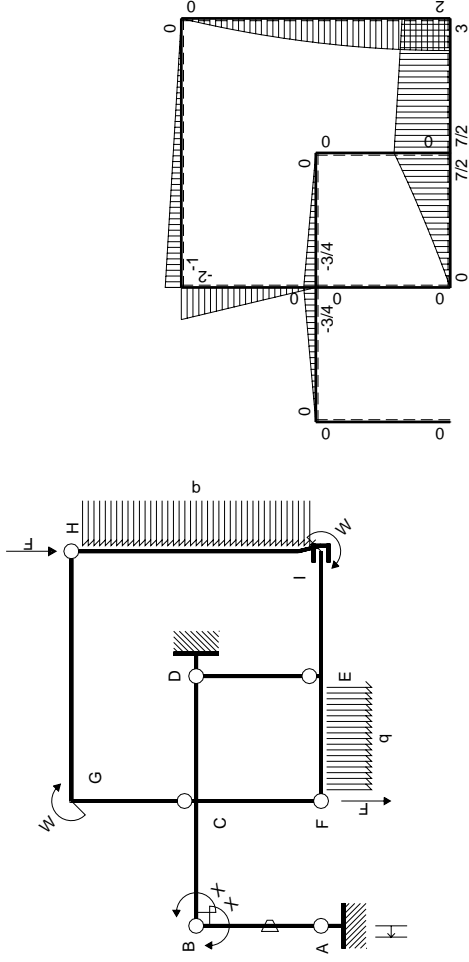
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

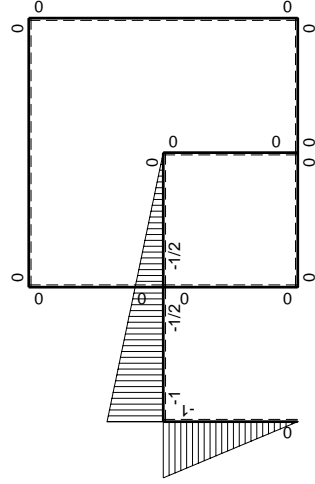


- A = 456. mm²
- J_u = 127247. mm⁴
- J_v = 25560. mm⁴
- y_g = 33.58 mm
- T_y = -1280. N
- M_x = 907200. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -33.58 mm
- σ_m = -Mv/J_u = 239.4 N/mm²
- x_c = 21. mm
- y_c = 14. mm
- v_c = -19.58 mm
- σ_c = -Mv/J_u = 139.6 N/mm²
- τ_c = 3.743 N/mm²
- σ_o = √σ²+3τ² = 139.7 N/mm²
- S = 2233. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$15/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-15/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

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

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

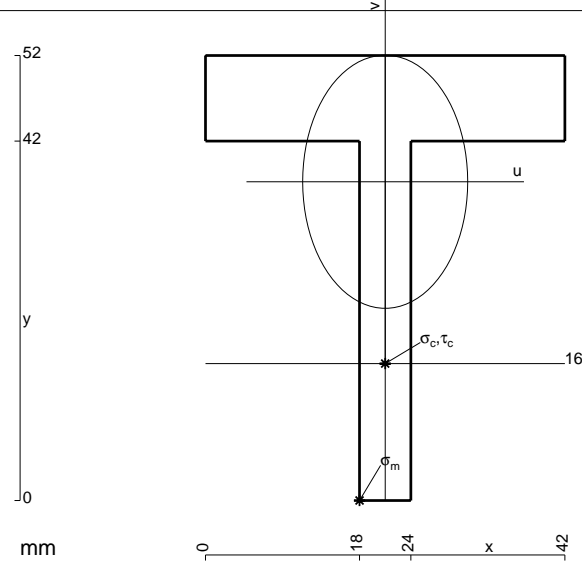
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

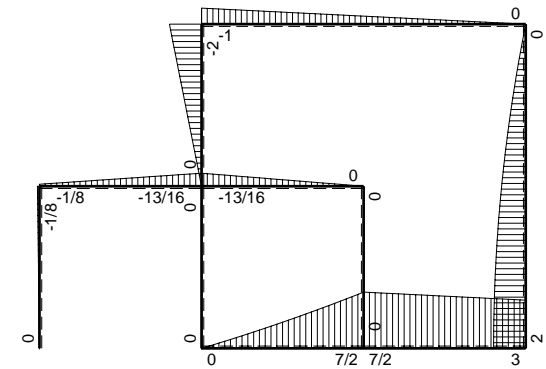
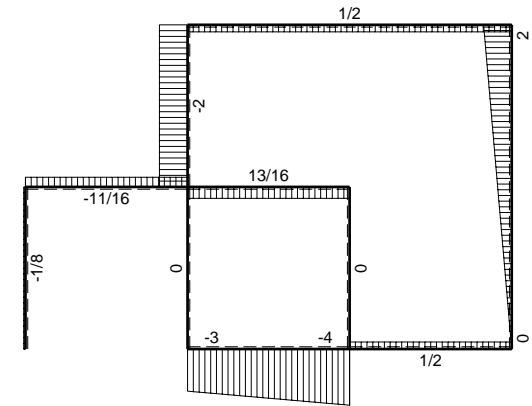
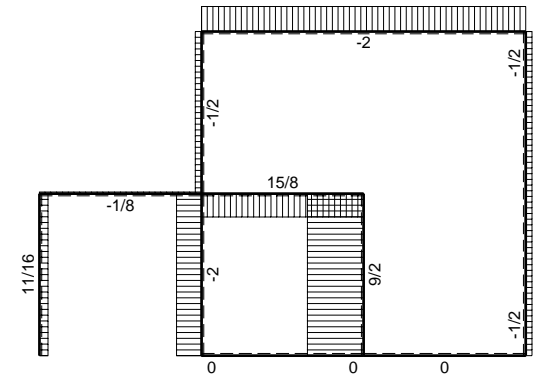
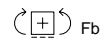
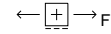
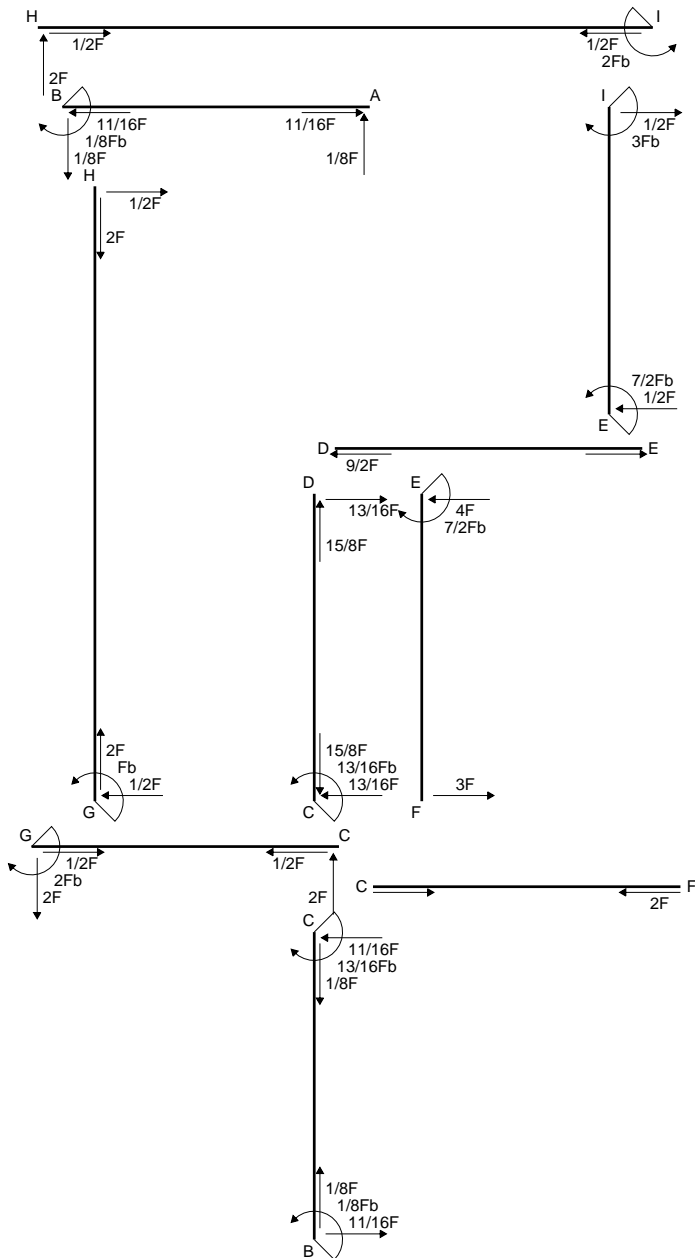
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

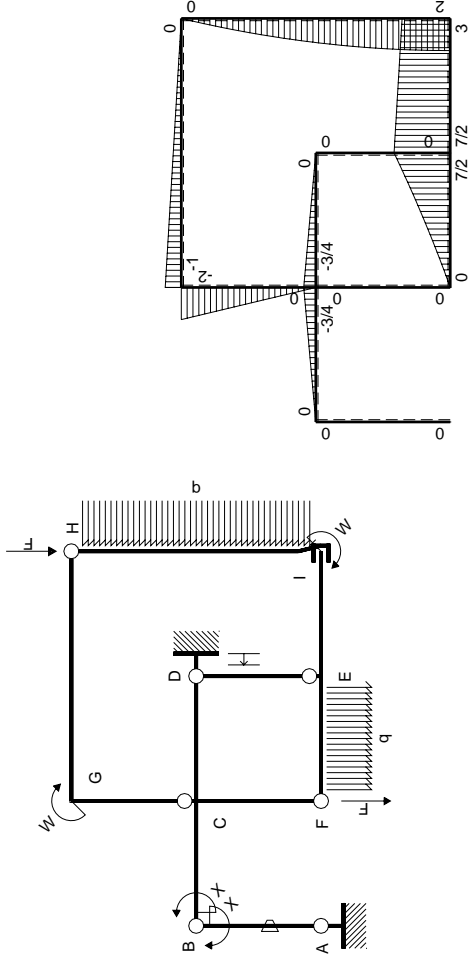
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



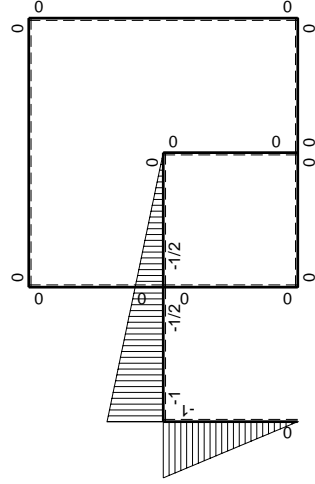
- A = 672. mm²
- J_u = 147014. mm⁴
- J_v = 62496. mm⁴
- y_g = 37.25 mm
- T_y = -2080. N
- M_x = 782600. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -37.25 mm
- σ_m = -Mv/J_u = 198.3 N/mm²
- x_c = 21. mm
- y_c = 16. mm
- v_c = -21.25 mm
- σ_c = -Mv/J_u = 113.1 N/mm²
- τ_c = 6.621 N/mm²
- σ_o = √σ²+3τ² = 113.7 N/mm²
- S = 2808. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$-1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$1/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

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

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

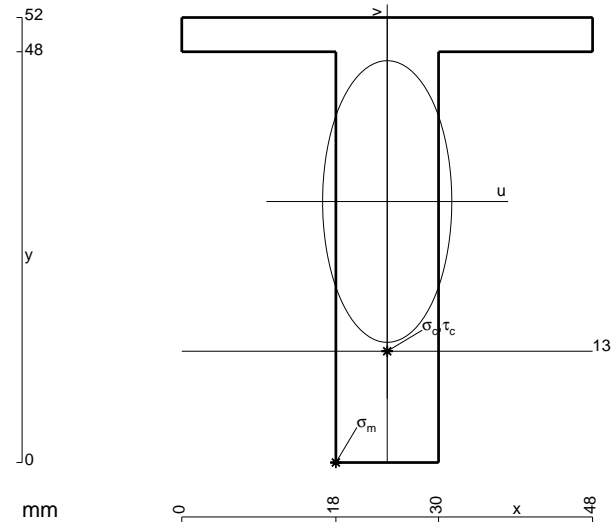
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



$$A = 768. \text{ mm}^2$$

$$J_u = 208192. \text{ mm}^4$$

$$J_v = 43776. \text{ mm}^4$$

$$y_g = 30.5 \text{ mm}$$

$$T_y = -3480. \text{ N}$$

$$M_x = 1431150. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$u_m = -6. \text{ mm}$$

$$v_m = -30.5 \text{ mm}$$

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

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

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

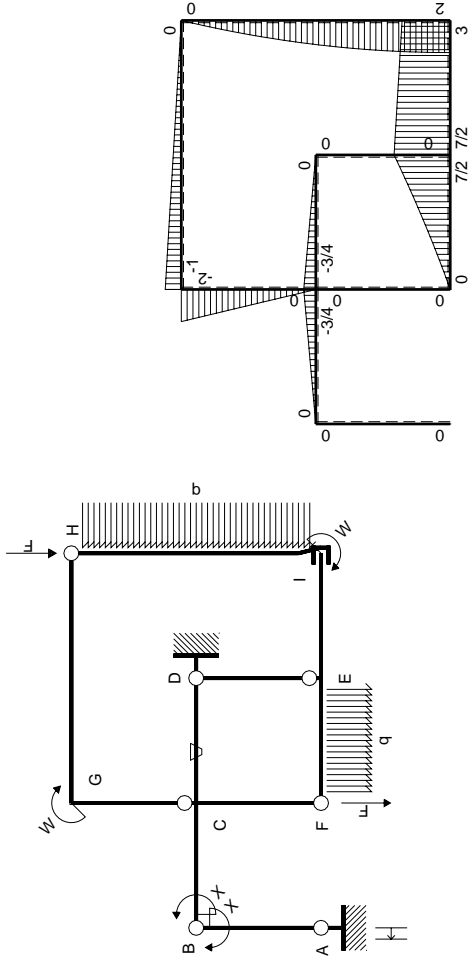
$$v_c = -17.5 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 120.3 \text{ N/mm}^2$$

$$\tau_c = 5.215 \text{ N/mm}^2$$

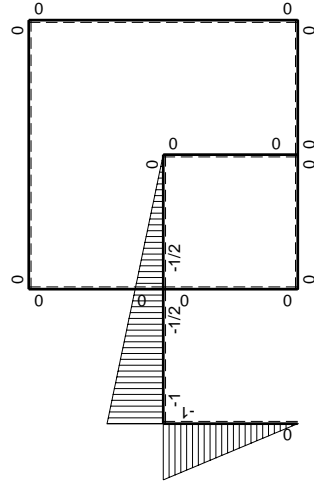
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 120.6 \text{ N/mm}^2$$

$$S = 3744. \text{ mm}^3$$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$							Fb^2/EJ	
	totali							$13/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-13/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

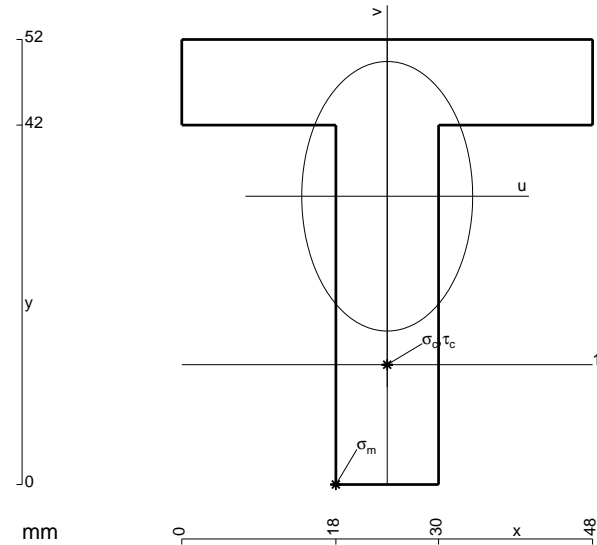
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



$$A = 984. \text{ mm}^2$$

$$J_u = 244285. \text{ mm}^4$$

$$J_v = 98208. \text{ mm}^4$$

$$y_g = 33.68 \text{ mm}$$

$$T_y = -3560. \text{ N}$$

$$M_x = 1588650. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$u_m = -6. \text{ mm}$$

$$v_m = -33.68 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 219. \text{ N/mm}^2$$

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

$$y_c = 14. \text{ mm}$$

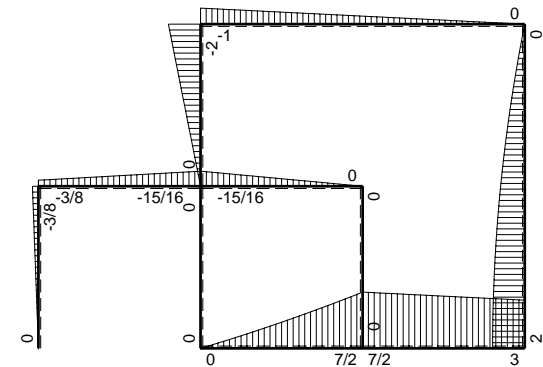
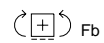
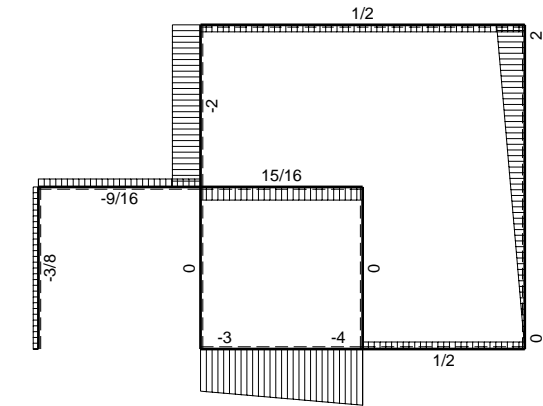
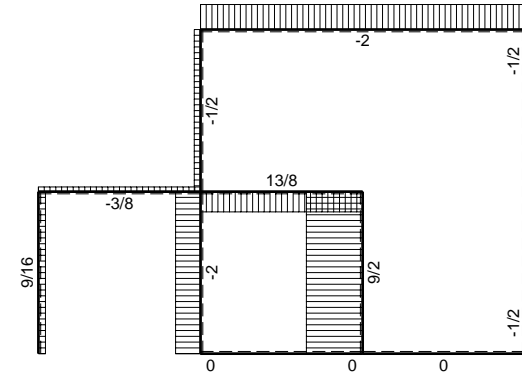
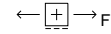
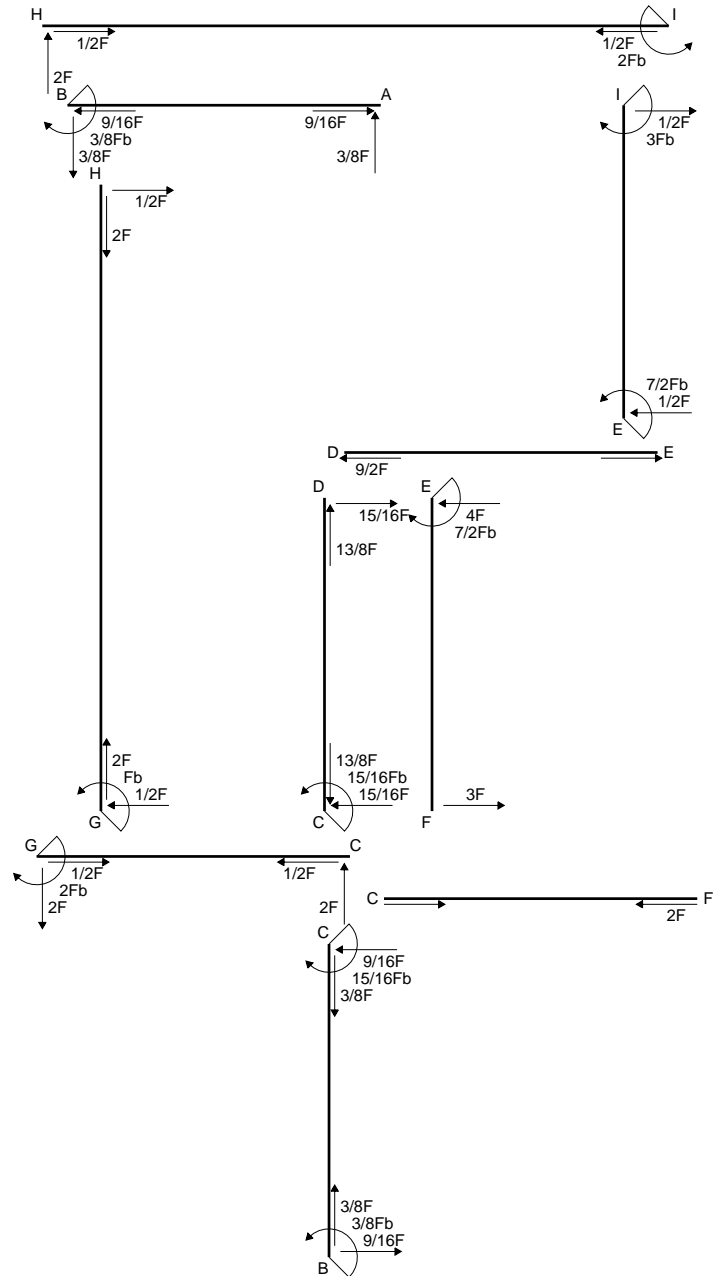
$$v_c = -19.68 \text{ mm}$$

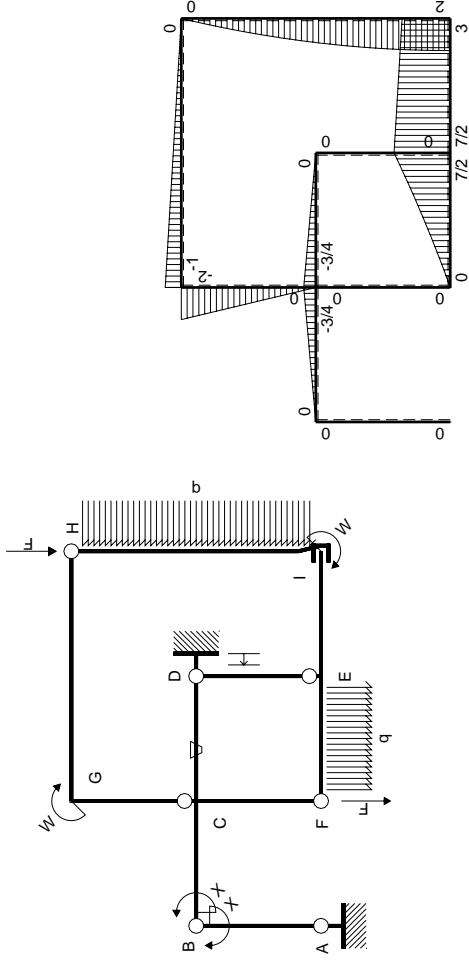
$$\sigma_c = -Mv/J_u = 128. \text{ N/mm}^2$$

$$\tau_c = 5.444 \text{ N/mm}^2$$

$$\sigma_\rho = \sqrt{\sigma^2 + 3\tau^2} = 128.4 \text{ N/mm}^2$$

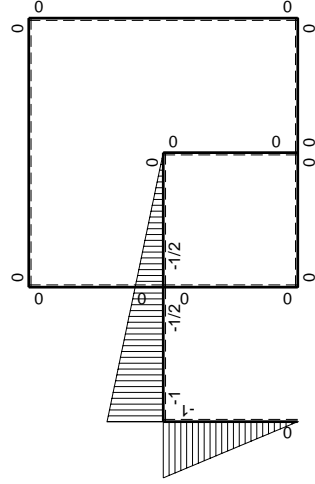
$$S = 4483. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	-x/b	0	0	0	0	x^2/b^2	0+0	1/3Xb/EJ	
BA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	-1+1/2x/b	-3/4Fx	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	7/12Xb/EJ	
CB b	1/2+1/2x/b	3/4Fb-3/4Fx	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	-1/2+1/2x/b	-3/4Fb+3/4Fx	-Fb/EJ	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	1/12Xb/EJ	
DC b	1/2x/b	3/4Fx	Fb/EJ	$3/8Fx^2/b$	1/2Fx/EJ	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	-2Fx	0	0	0	0	0+0	0	
GC b	0	2Fb-2Fx	0	0	0	0			
GH 2b	0	-Fb+1/2Fx	0	0	0	0	0+0	0	
HG 2b	0	1/2Fx	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	3Fb+1/2Fx	0	0	0	0	0+0	0	
EI b	0	-7/2Fb+1/2Fx	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-3/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							3/8Fb	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

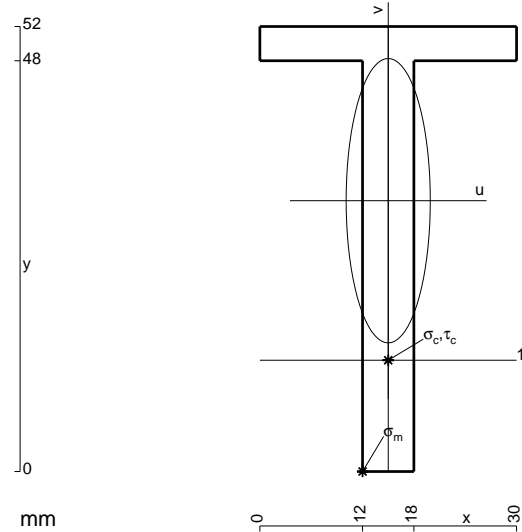
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

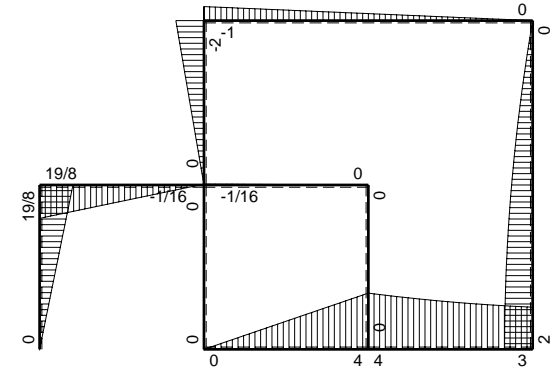
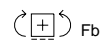
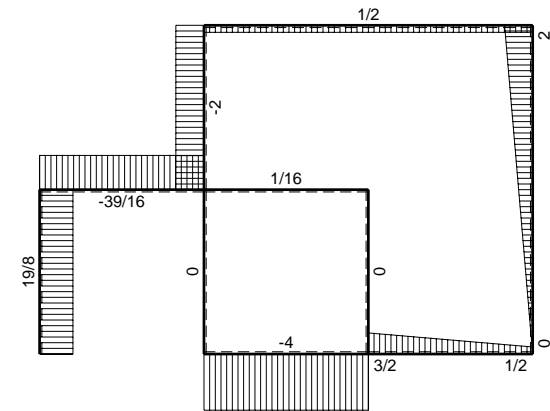
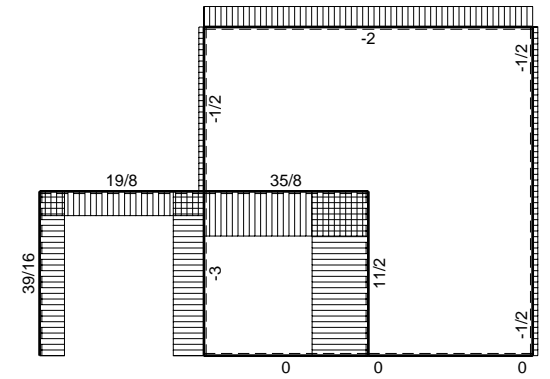
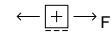
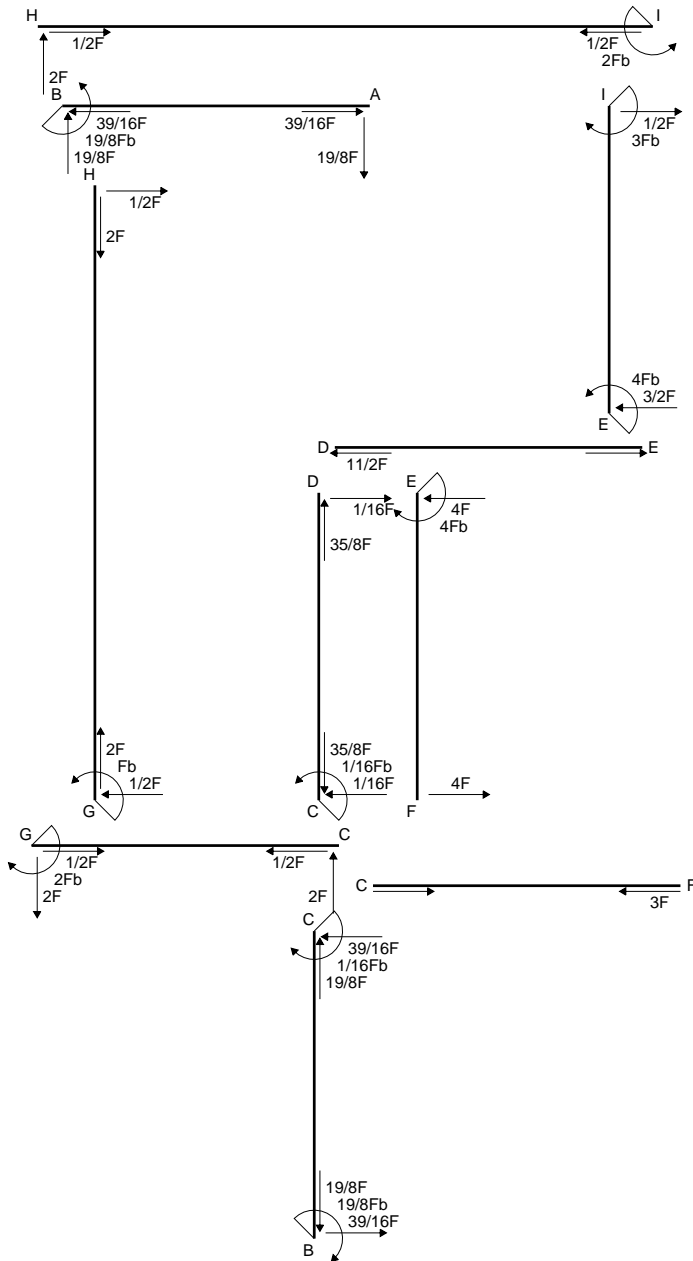
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

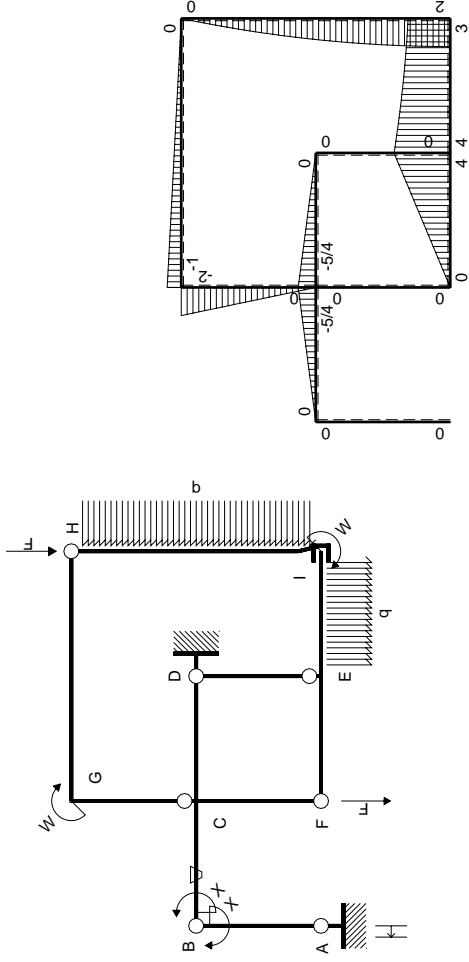
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



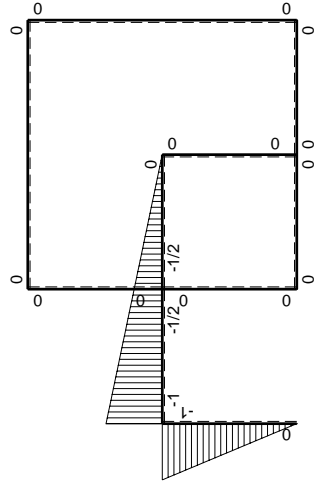
- A = 408. mm²
- J_u = 112717. mm⁴
- J_v = 9864. mm⁴
- y_g = 31.65 mm
- T_y = -1680. N
- M_x = 808500. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -31.65 mm
- σ_m = -Mv/J_u = 227. N/mm²
- x_c = 15. mm
- y_c = 13. mm
- v_c = -18.65 mm
- σ_c = -Mv/J_u = 133.8 N/mm²
- τ_c = 4.872 N/mm²
- σ_ρ = √(σ²+3τ²) = 134. N/mm²
- S = 1961. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$4Fb-4Fx$	0	0	0	0	0+0	0
FE b	0	$-4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-4Fb+3/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$19/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-19/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

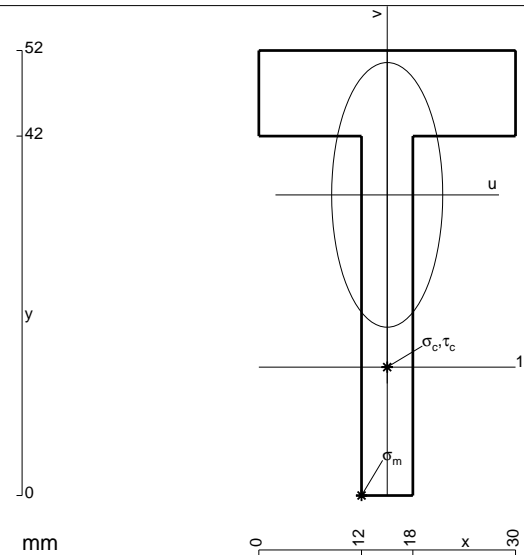
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



$$A = 552. \text{ mm}^2$$

$$J_u = 132127. \text{ mm}^4$$

$$J_v = 23256. \text{ mm}^4$$

$$y_g = 35.13 \text{ mm}$$

$$T_y = -1480. \text{ N}$$

$$M_x = 888000. \text{ Nmm}$$

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

$$u_m = -3. \text{ mm}$$

$$v_m = -35.13 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 236.1 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 15. \text{ mm}$$

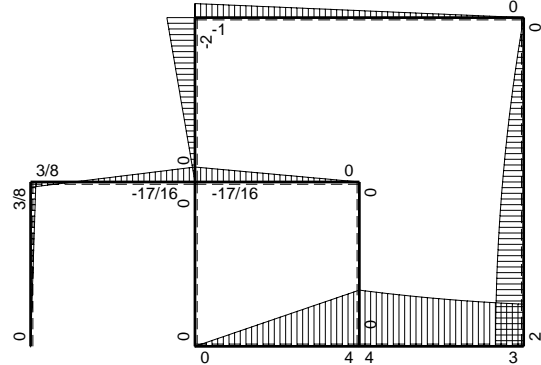
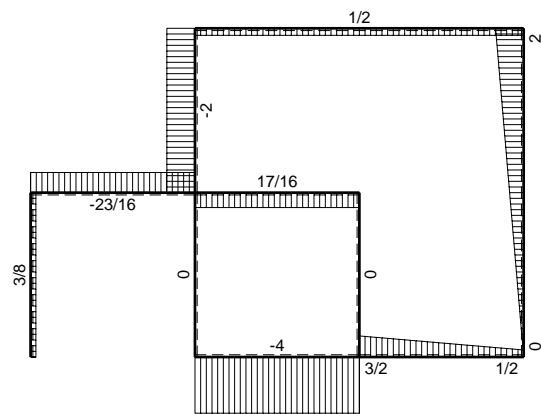
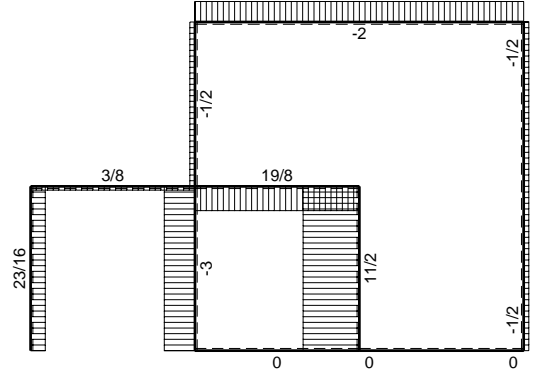
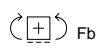
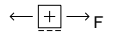
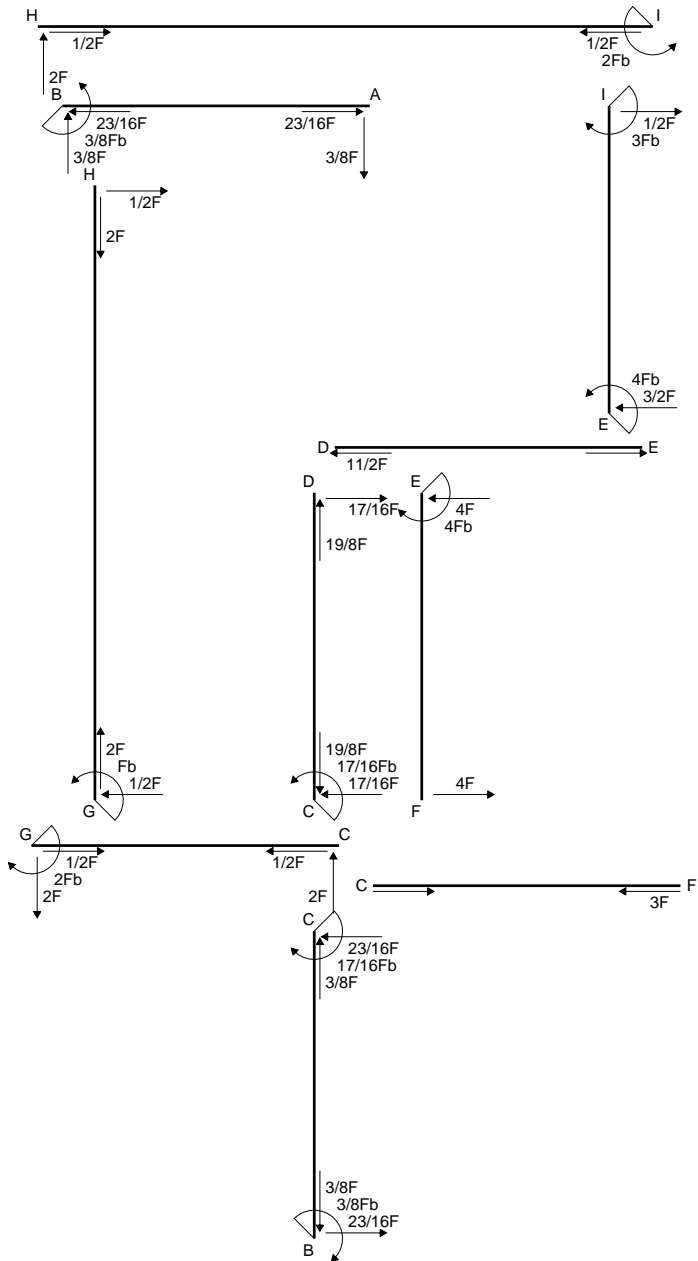
$$v_c = -20.13 \text{ mm}$$

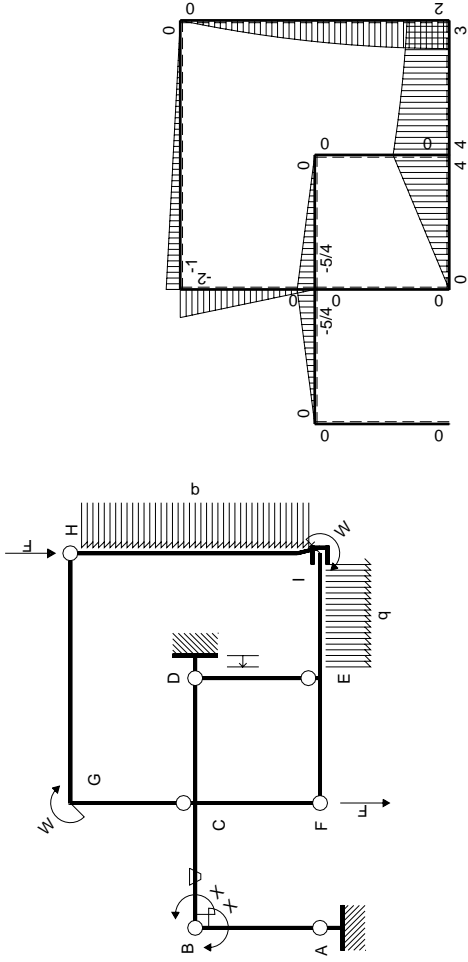
$$\sigma_c = -Mv/J_u = 135.3 \text{ N/mm}^2$$

$$\tau_c = 4.642 \text{ N/mm}^2$$

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

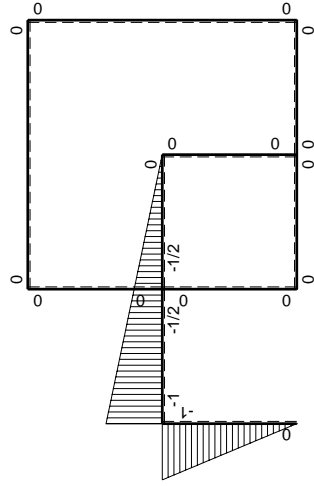
$$S = 2487. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	1/3Xb/EJ	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	7/12Xb/EJ	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	1/12Xb/EJ	
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$4Fb-4Fx$	0	0	0	0	0+0	0	
FE b	0	$-4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-4Fb+3/2Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$3/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-3/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

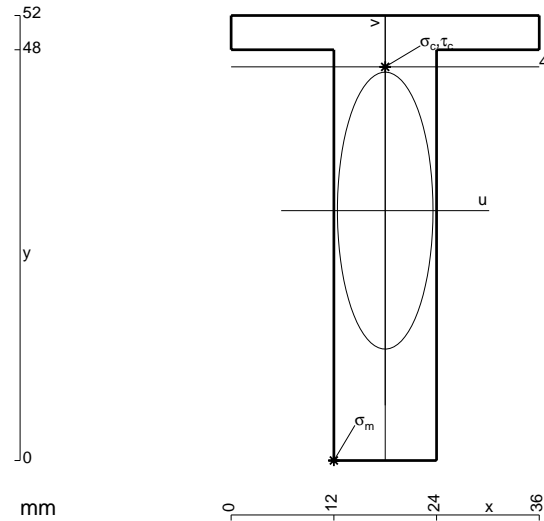
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

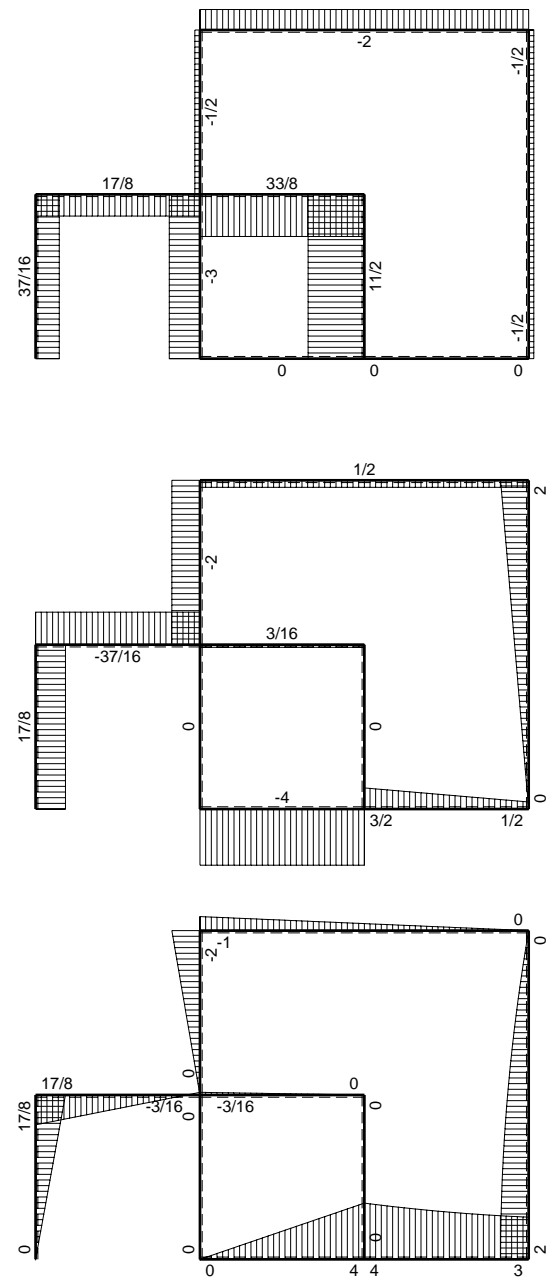
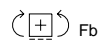
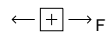
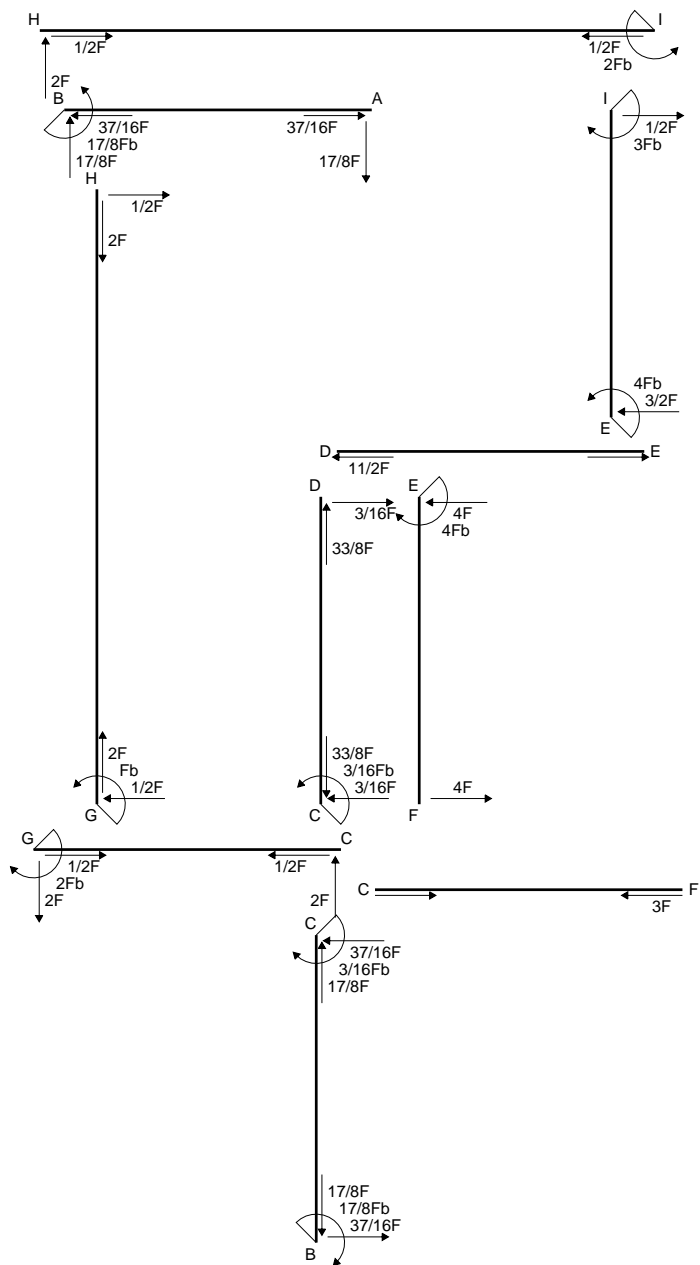
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

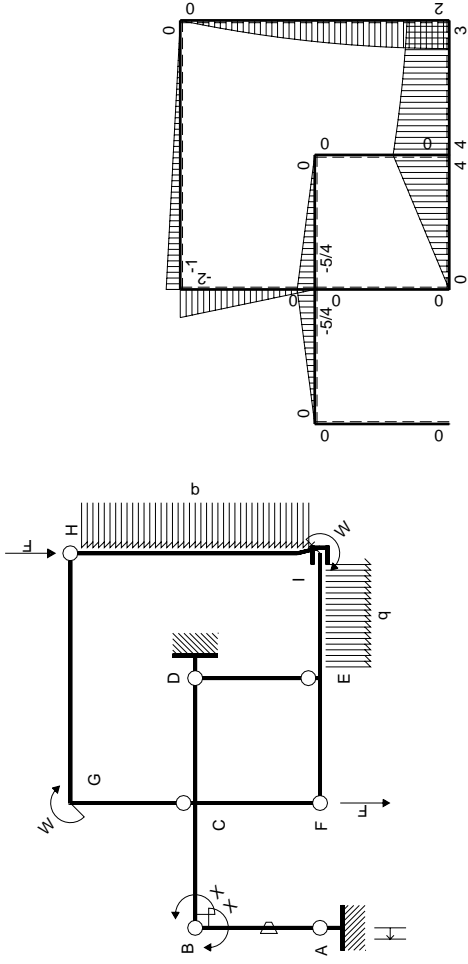
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



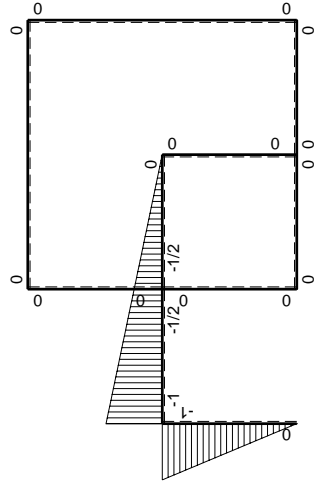
- A = 720. mm²
- J_u = 188659. mm⁴
- J_v = 22464. mm⁴
- y_g = 29.2 mm
- T_y = -2000. N
- M_x = 1280000. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -29.2 mm
- σ_m = -Mv/J_u = 198.1 N/mm²
- x_c = 18. mm
- y_c = 46. mm
- v_c = 16.8 mm
- σ_c = -Mv/J_u = -114. N/mm²
- τ_c = 3.023 N/mm²
- σ_o = √σ²+3τ² = 114.1 N/mm²
- S = 3422. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$4Fb-4Fx$	0	0	0	0	0+0	0
FE b	0	$-4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-4Fb+3/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$17/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-17/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

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

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

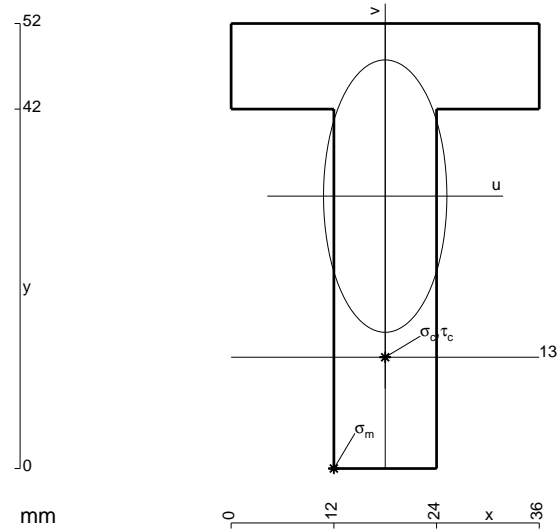
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

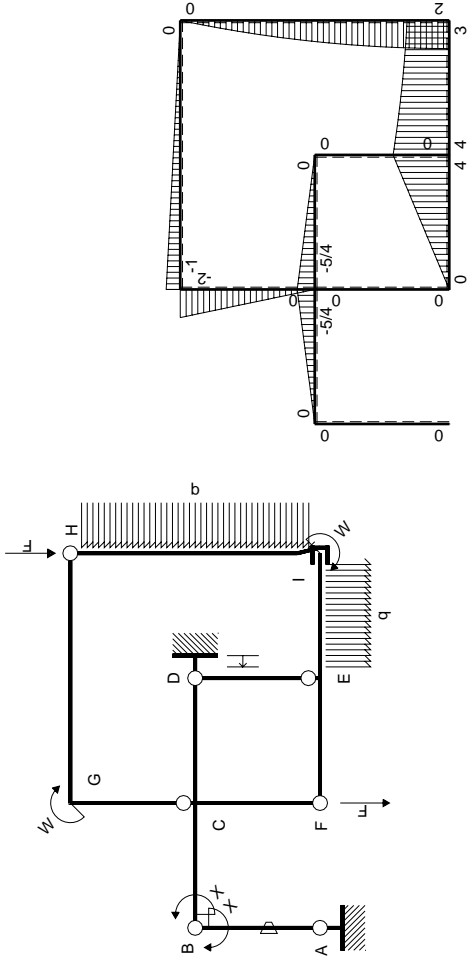
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

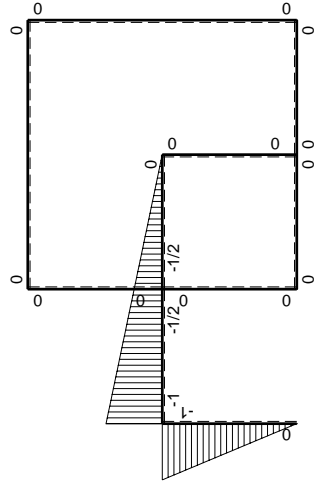


- A = 864. mm²
- J_u = 219048. mm⁴
- J_v = 44928. mm⁴
- y_g = 31.83 mm
- T_y = -2120. N
- M_x = 1441600. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -31.83 mm
- σ_m = -Mv/J_u = 209.5 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -18.83 mm
- σ_c = -Mv/J_u = 123.9 N/mm²
- τ_c = 3.187 N/mm²
- σ_o = √σ²+3τ² = 124.1 N/mm²
- S = 3952. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$4Fb-4Fx$	0	0	0	0	0+0	0	
FE b	0	$-4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-4Fb+3/2Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

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

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

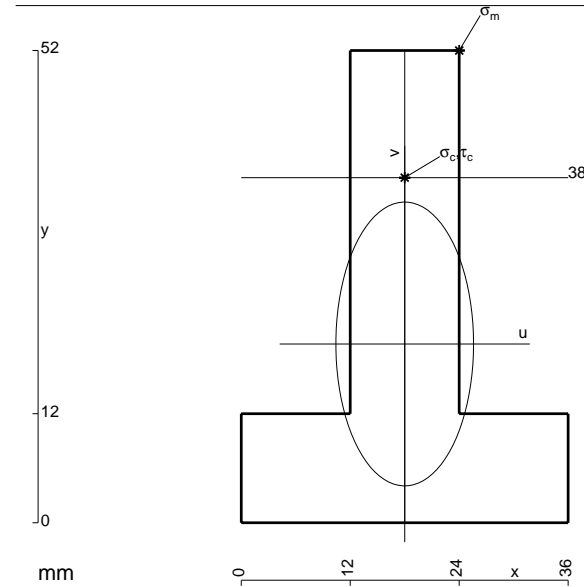
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

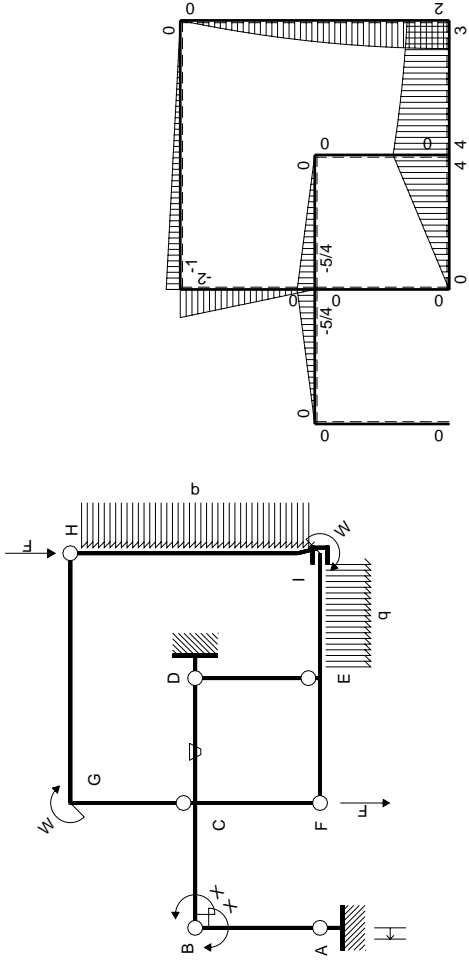
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

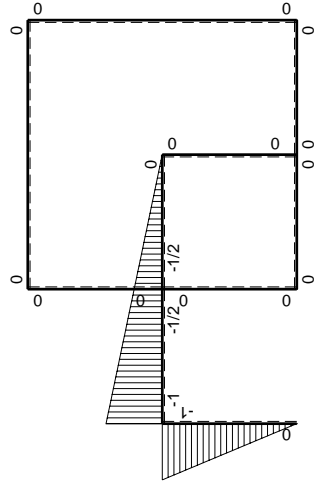


- A = 912. mm²
- J_u = 222885. mm⁴
- J_v = 52416. mm⁴
- y_g = 19.68 mm
- T_y = -2040. N
- M_x = 1489200. Nmm
- x_m = 24. mm
- y_m = 52. mm
- u_m = 6. mm
- v_m = 32.32 mm
- σ_m = -Mv/J_u = -215.9 N/mm²
- x_c = 18. mm
- y_c = 38. mm
- v_c = 18.32 mm
- σ_c = -Mv/J_u = -122.4 N/mm²
- τ_c = 3.244 N/mm²
- σ_q = √σ²+3τ² = 122.5 N/mm²
- S = 4253. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	$-Fb/EJ$	$5/8Fb-5/4Fx+5/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	Fb/EJ	$5/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$4Fb-4Fx$	0	0	0	0	0+0	0
FE b	0	$-4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-4Fb+3/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$15/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-15/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

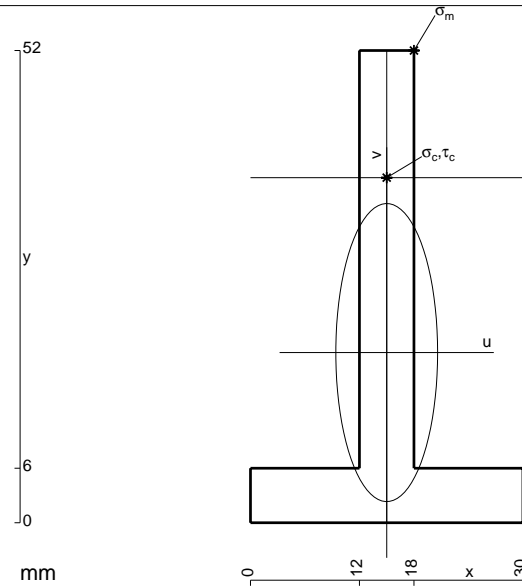
$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

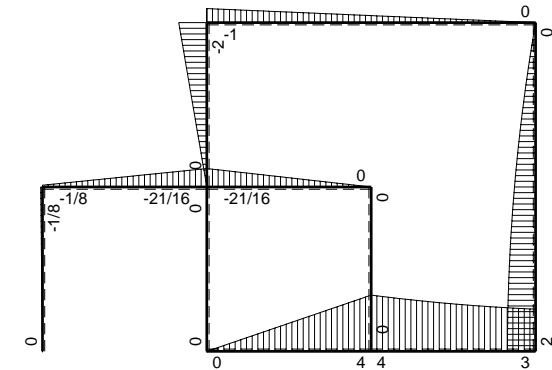
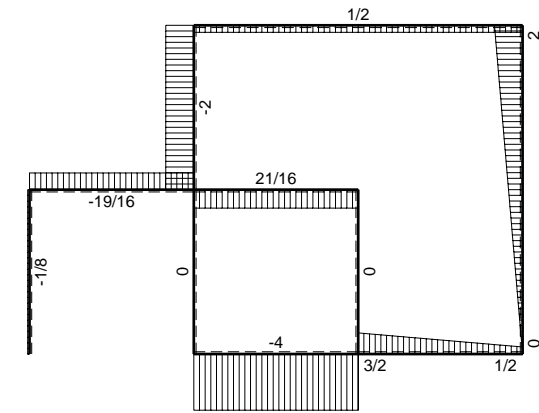
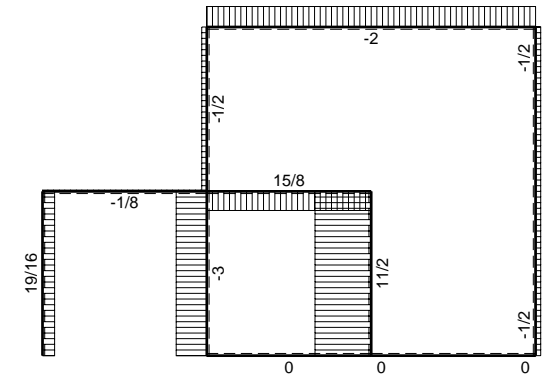
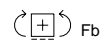
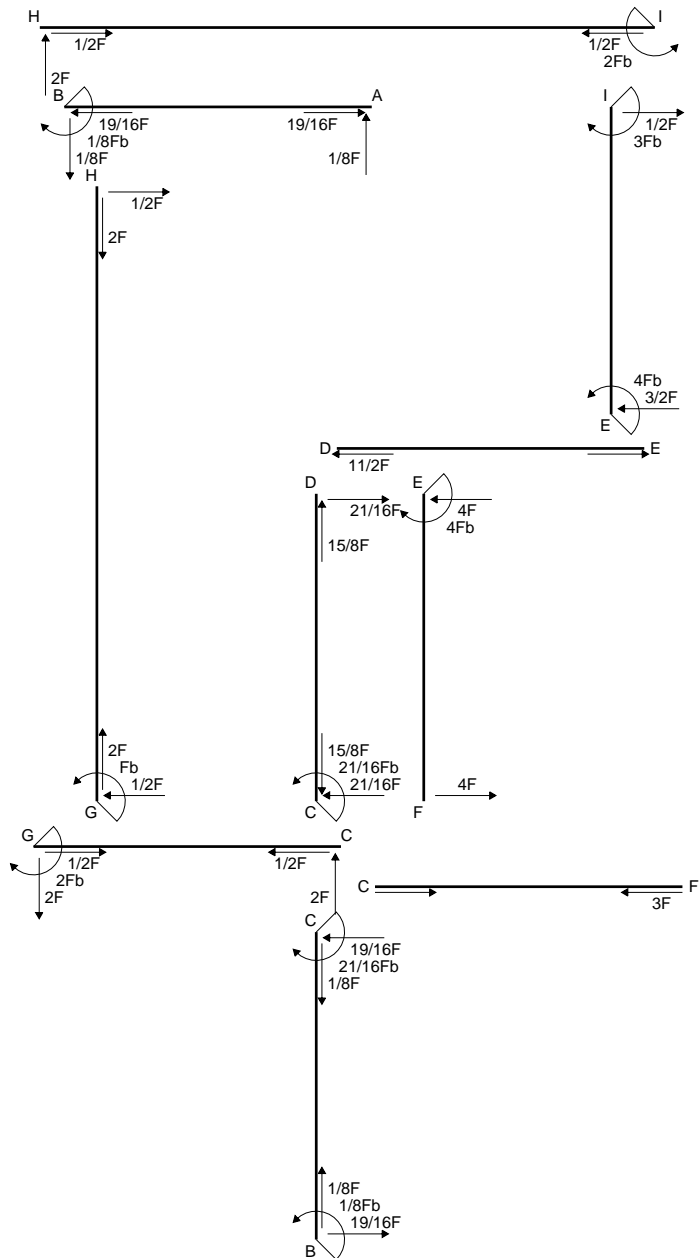
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 11/24 Fb^2/EJ$$

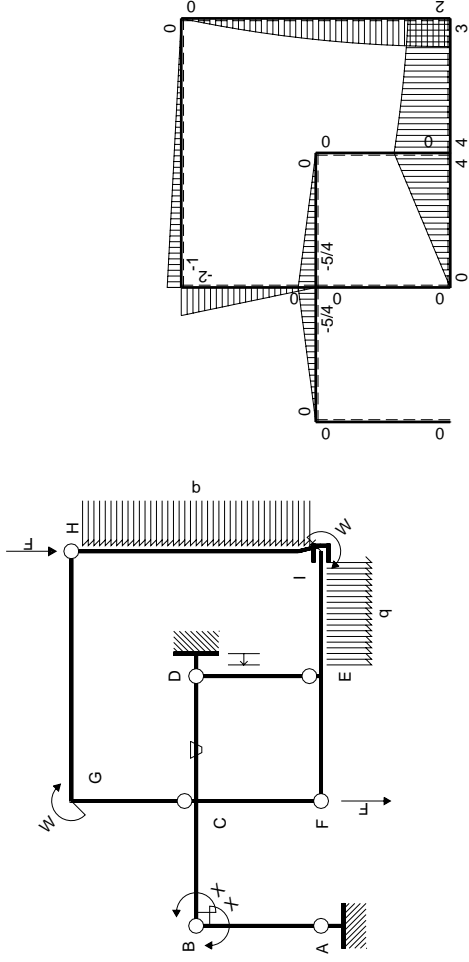
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (5/24 b) Fb 1/EJ + (-1/4 b) \theta = 11/24 Fb^2/EJ$$



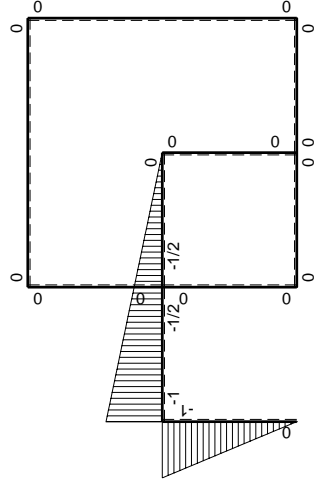
- A = 456. mm²
- J_u = 122856. mm⁴
- J_v = 14328. mm⁴
- y_g = 18.74 mm
- T_y = -1080. N
- M_x = 831600. Nmm
- x_m = 18. mm
- y_m = 52. mm
- u_m = 3. mm
- v_m = 33.26 mm
- σ_m = -M_v/J_u = -225.2 N/mm²
- x_c = 15. mm
- y_c = 38. mm
- v_c = 19.26 mm
- σ_c = -M_v/J_u = -130.4 N/mm²
- τ_c = 3.232 N/mm²
- σ_q = √σ²+3τ² = 130.5 N/mm²
- S = 2206. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	$-Fb/EJ$	$5/8Fb-5/4Fx+5/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$5/4Fx$	Fb/EJ	$5/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$4Fb-4Fx$	0	0	0	0	0+0	0	
FE b	0	$-4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-4Fb+3/2Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

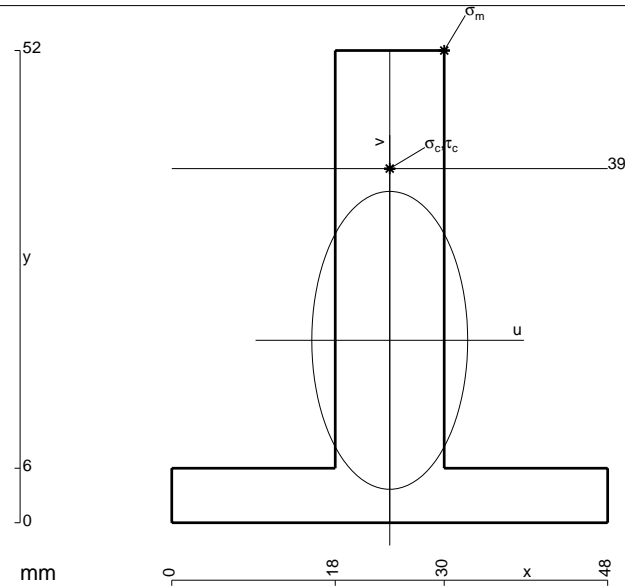
$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 11/24 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (5/24 b) Fb 1/EJ + (-1/4 b) \theta = 11/24 Fb^2/EJ$$



$$A = 840. \text{ mm}^2$$

$$J_u = 226138. \text{ mm}^4$$

$$J_v = 61920. \text{ mm}^4$$

$$y_g = 20.09 \text{ mm}$$

$$T_y = -2080. \text{ N}$$

$$M_x = 1684800. \text{ Nmm}$$

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

$$y_m = 52. \text{ mm}$$

$$u_m = 6. \text{ mm}$$

$$v_m = 31.91 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -237.8 \text{ N/mm}^2$$

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

$$y_c = 39. \text{ mm}$$

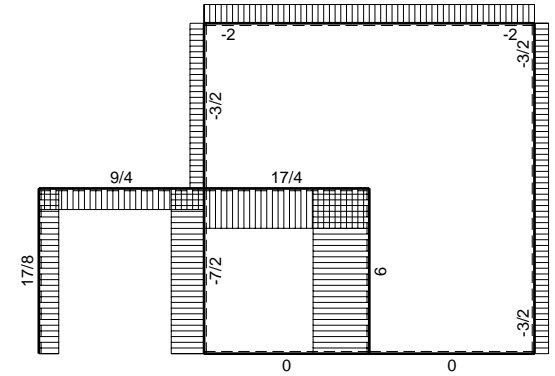
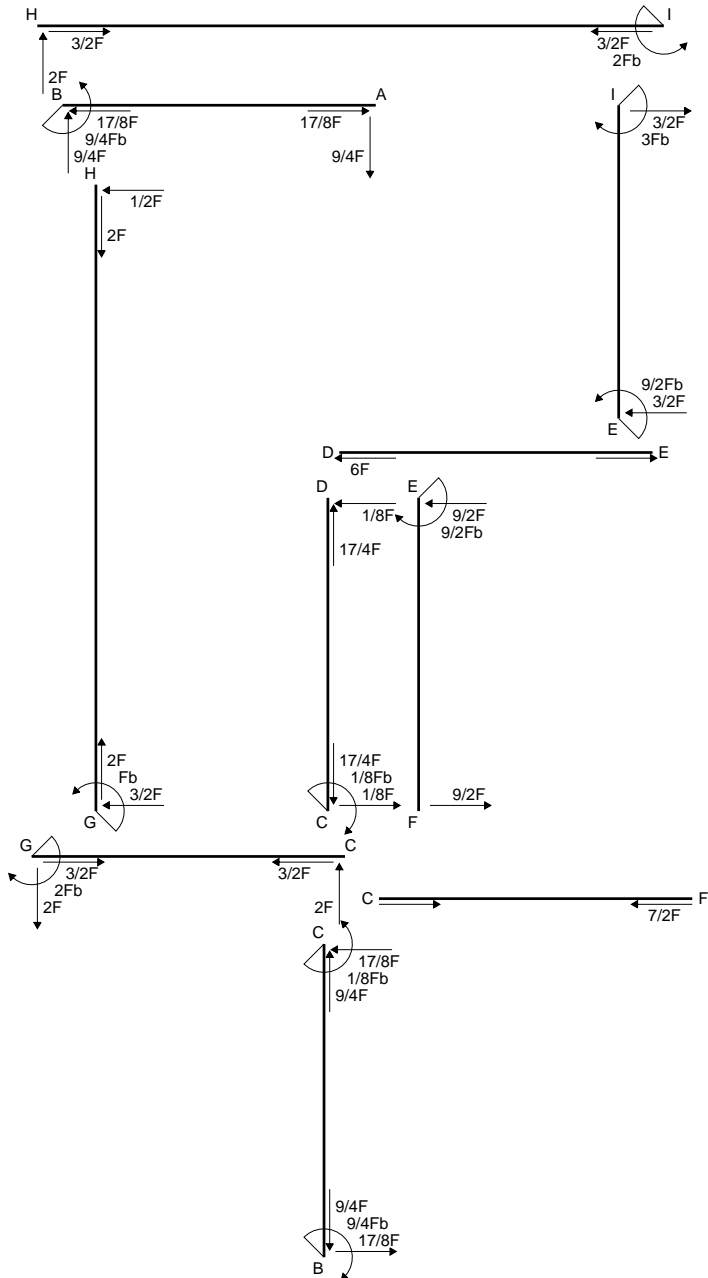
$$v_c = 18.91 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -140.9 \text{ N/mm}^2$$

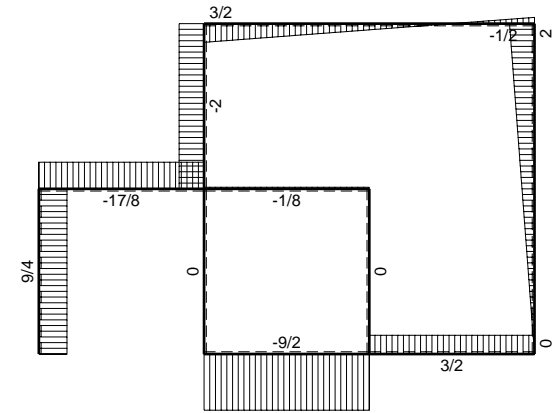
$$\tau_c = 3.039 \text{ N/mm}^2$$

$$\sigma_\rho = \sqrt{\sigma^2 + 3\tau^2} = 141. \text{ N/mm}^2$$

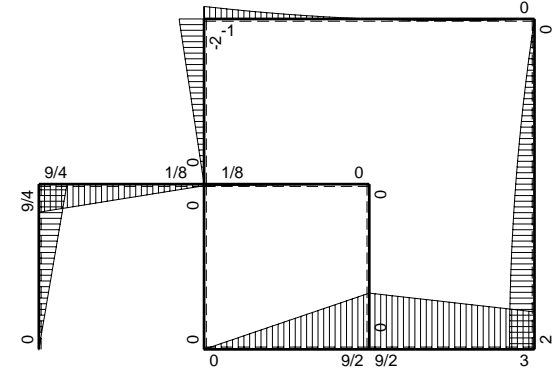
$$S = 3965. \text{ mm}^3$$



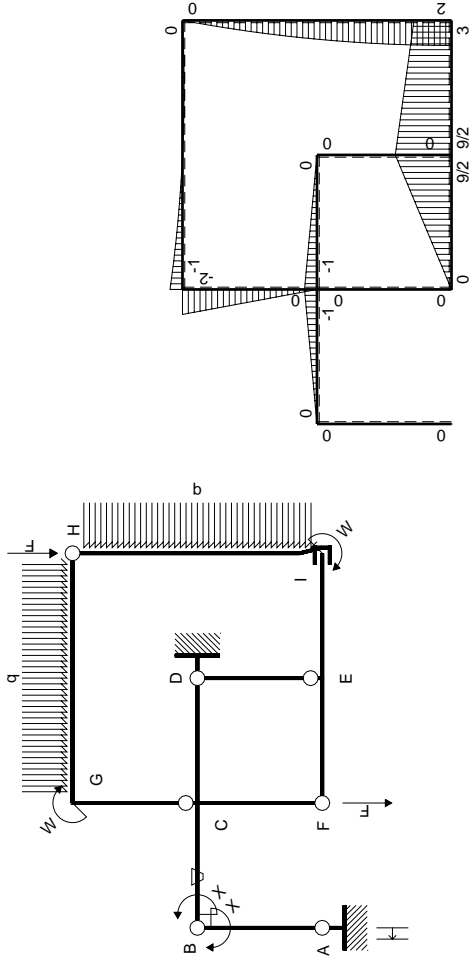
← ⊕ → F



↑ ⊕ ↓ F

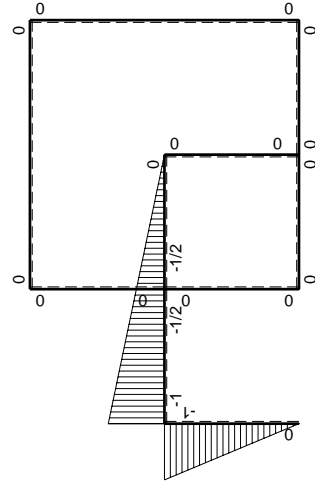


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/2Fb-9/2Fx$	0	0	0	0	0+0	0
FE b	0	$-9/2Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+3/2Fx-1/2qx^2$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-9/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$9/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-9/4Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

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

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

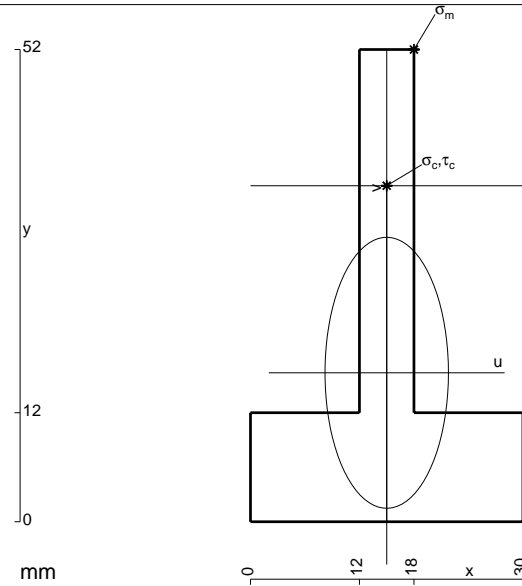
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

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

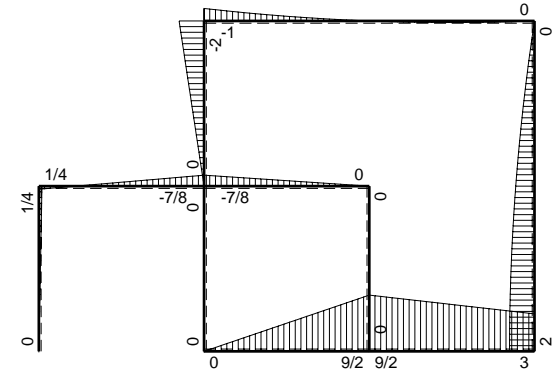
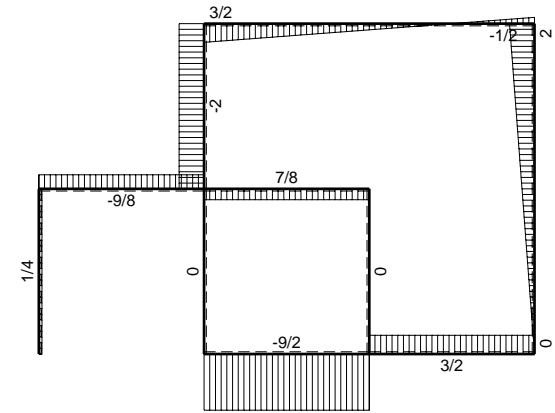
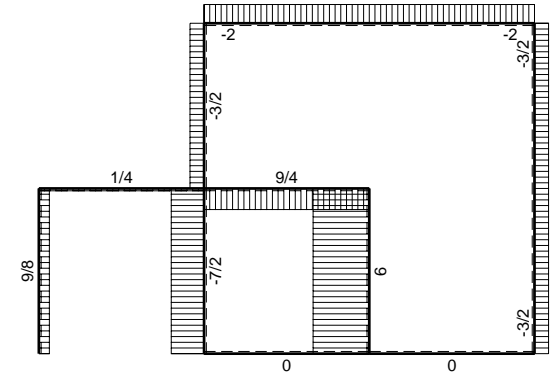
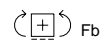
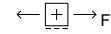
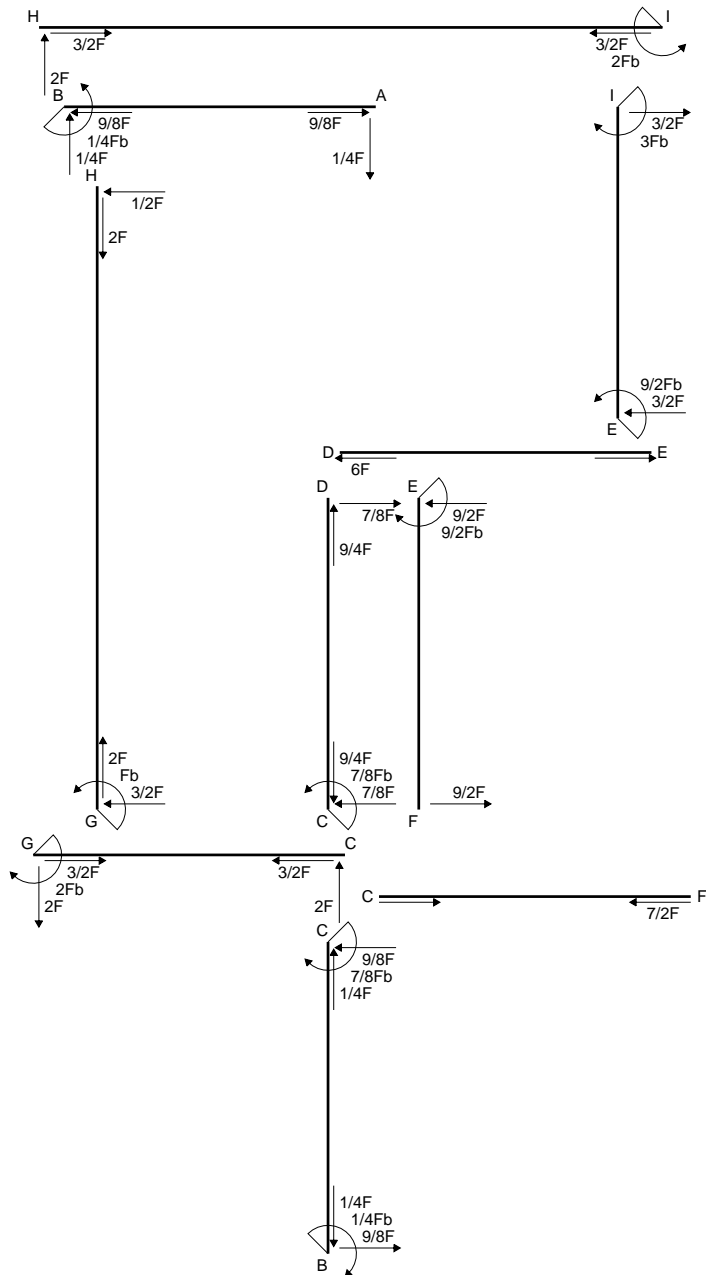
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

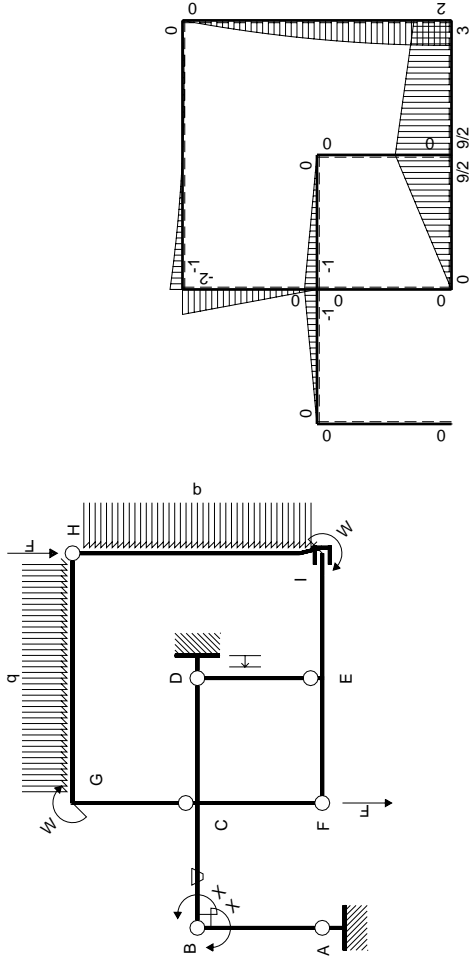
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

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



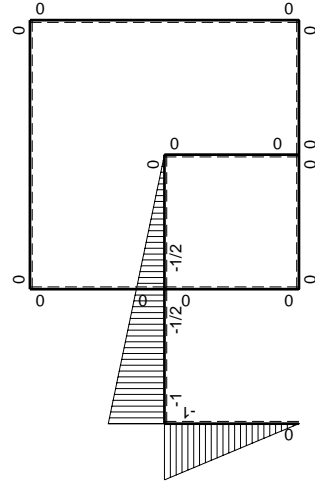
- A = 600. mm²
- J_u = 133664. mm⁴
- J_v = 27720. mm⁴
- y_g = 16.4 mm
- T_y = -1710. N
- M_x = 735300. Nmm
- x_m = 18. mm
- y_m = 52. mm
- u_m = 3. mm
- v_m = 35.6 mm
- σ_m = -M_v/J_u = -195.8 N/mm²
- x_c = 15. mm
- y_c = 37. mm
- v_c = 20.6 mm
- σ_c = -M_v/J_u = -113.3 N/mm²
- τ_c = 5.392 N/mm²
- σ_q = √σ²+3τ² = 113.7 N/mm²
- S = 2529. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/2Fb-9/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/2Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+3/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx+1/2qx^2$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/4Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

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

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

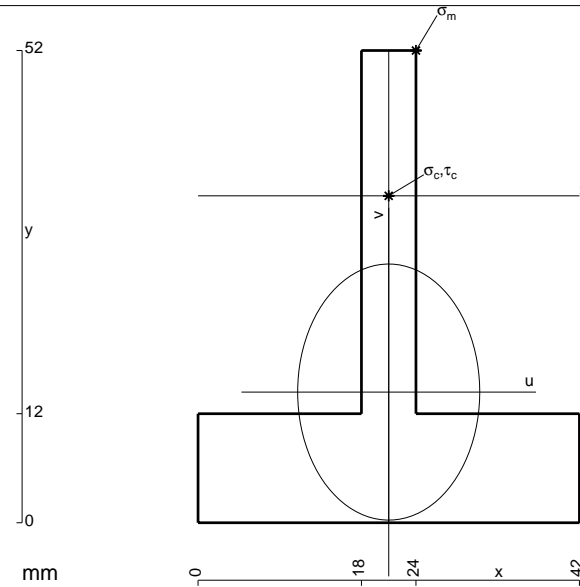
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

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

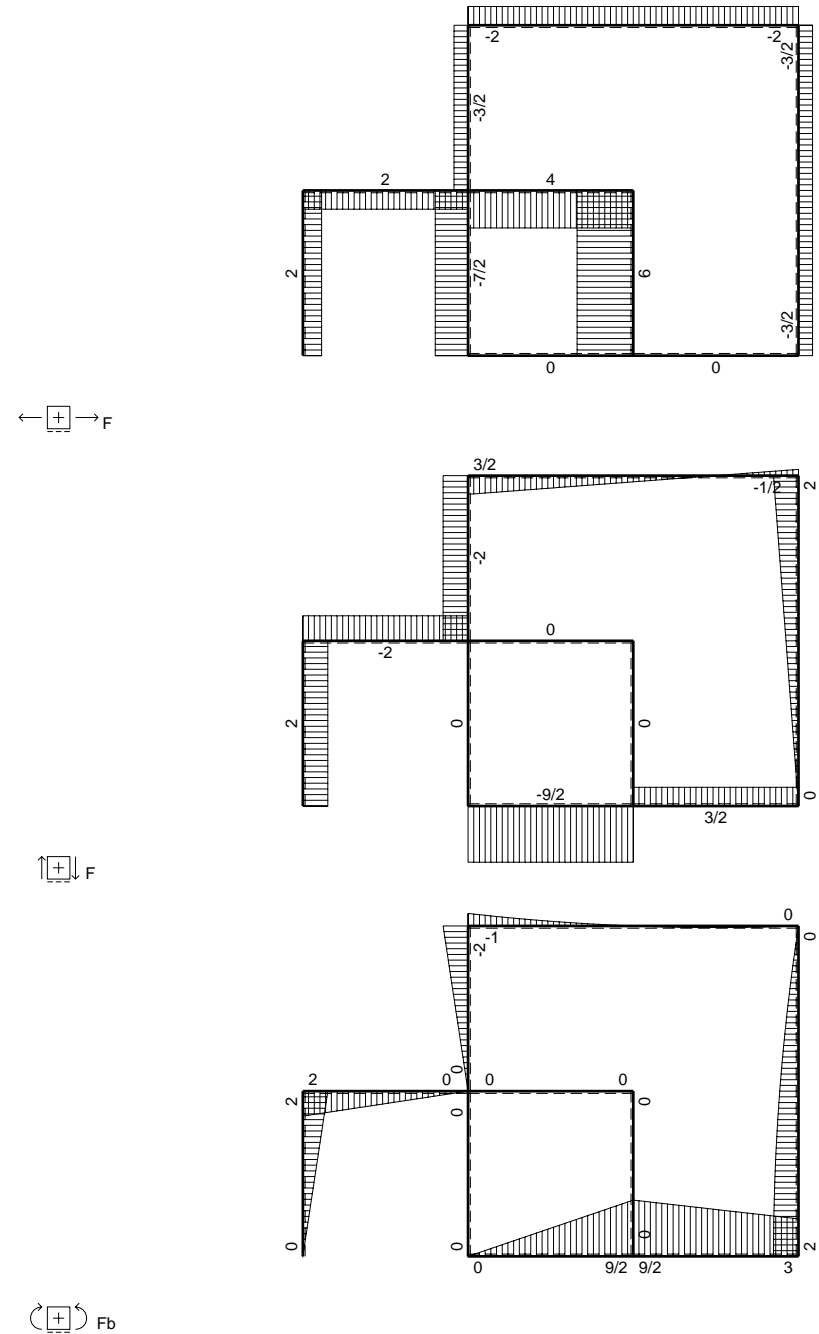
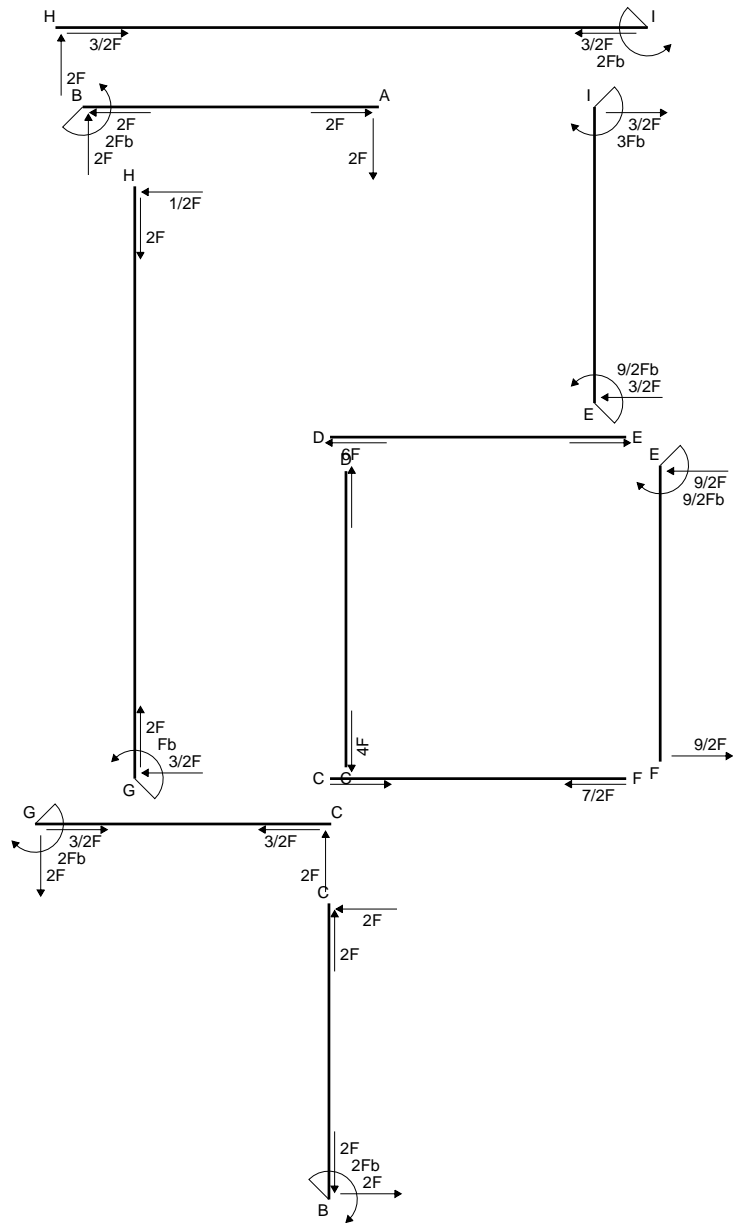
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

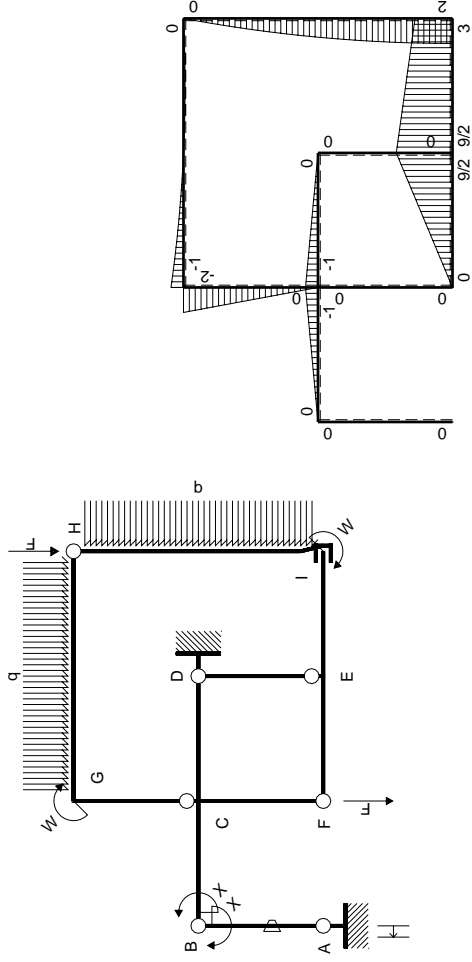
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

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



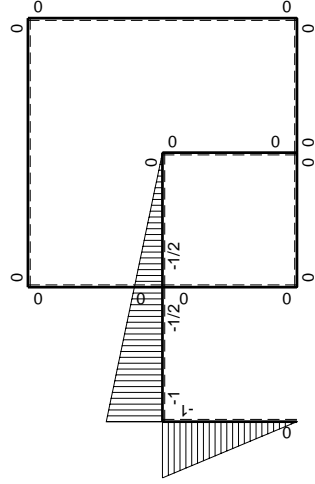
- A = 744. mm²
- J_u = 147953. mm⁴
- J_v = 74808. mm⁴
- y_g = 14.39 mm
- T_y = -1755. N
- M_x = 824850. Nmm
- x_m = 24. mm
- y_m = 52. mm
- u_m = 3. mm
- v_m = 37.61 mm
- σ_m = -Mv/J_u = -209.7 N/mm²
- x_c = 21. mm
- y_c = 36. mm
- v_c = 21.61 mm
- σ_c = -Mv/J_u = -120.5 N/mm²
- τ_c = 5.62 N/mm²
- σ_q = √σ²+3τ² = 120.9 N/mm²
- S = 2843. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/2Fb-9/2Fx$	0	0	0	0	0+0	0
FE b	0	$-9/2Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+3/2Fx-1/2qx^2$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-9/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$2Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-2Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

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

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

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

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

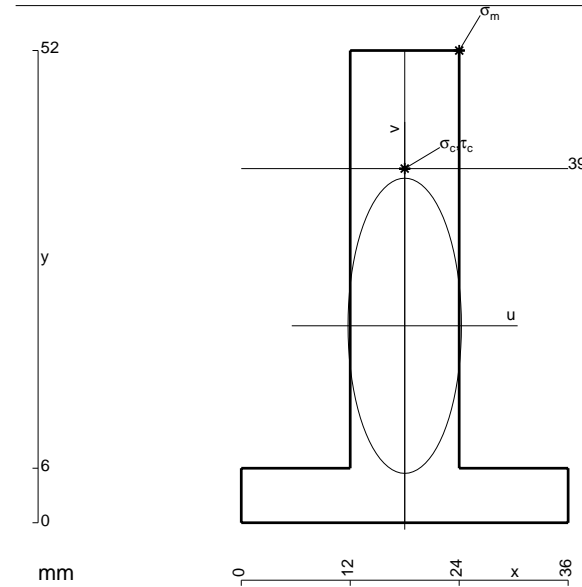
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

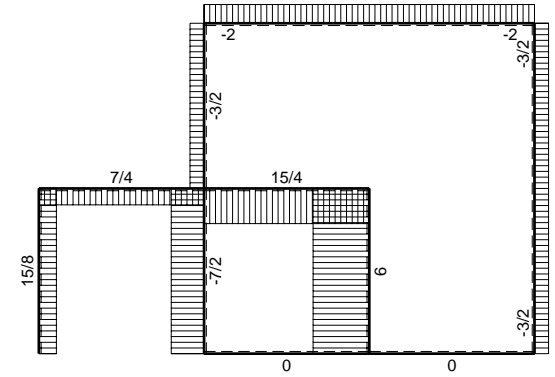
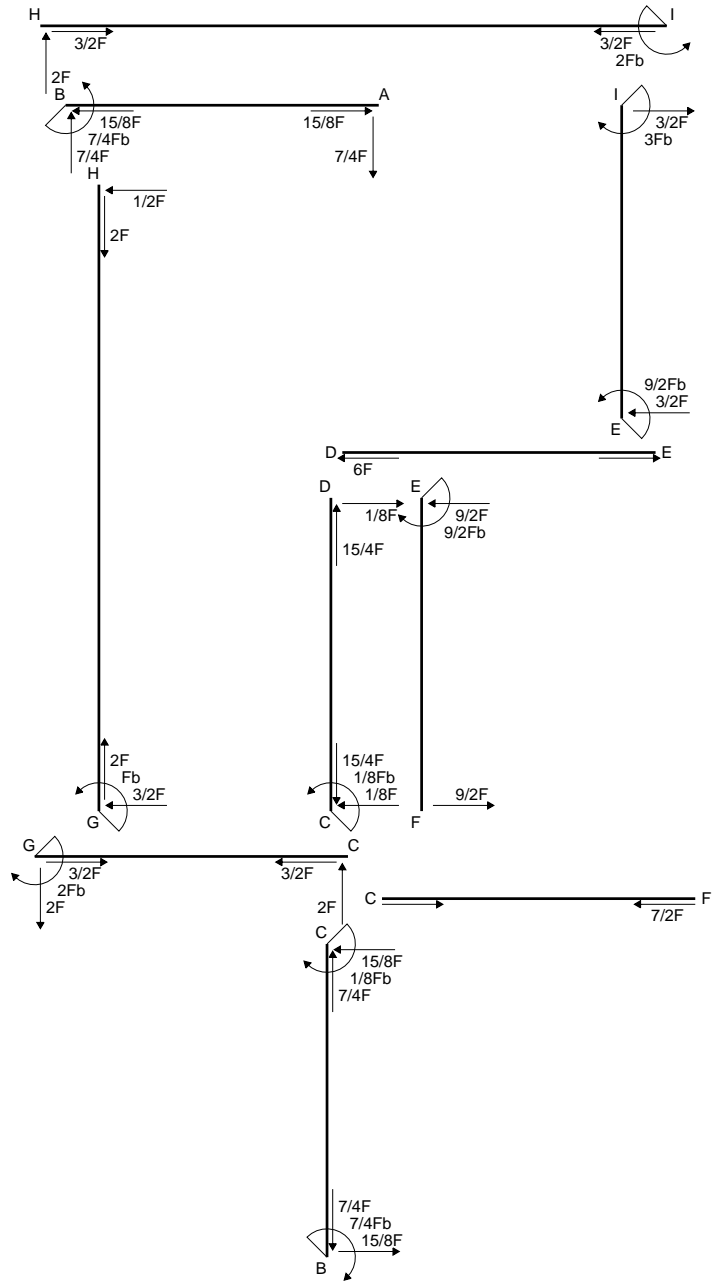
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

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

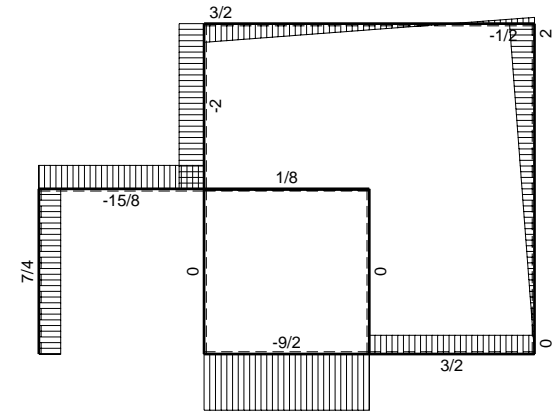
$$= (1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$



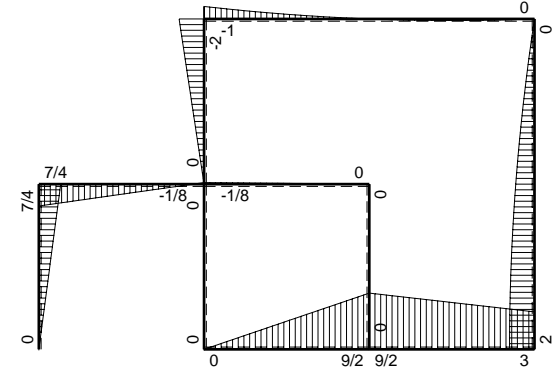
- A = 768. mm²
- J_u = 202933. mm⁴
- J_v = 29952. mm⁴
- y_g = 21.69 mm
- T_y = -2880. N
- M_x = 1468800. Nmm
- x_m = 24. mm
- y_m = 52. mm
- u_m = 6. mm
- v_m = 30.31 mm
- σ_m = -Mv/J_u = -219.4 N/mm²
- x_c = 18. mm
- y_c = 39. mm
- v_c = 17.31 mm
- σ_c = -Mv/J_u = -125.3 N/mm²
- τ_c = 4.393 N/mm²
- σ_q = √σ²+3τ² = 125.5 N/mm²
- S = 3715. mm³



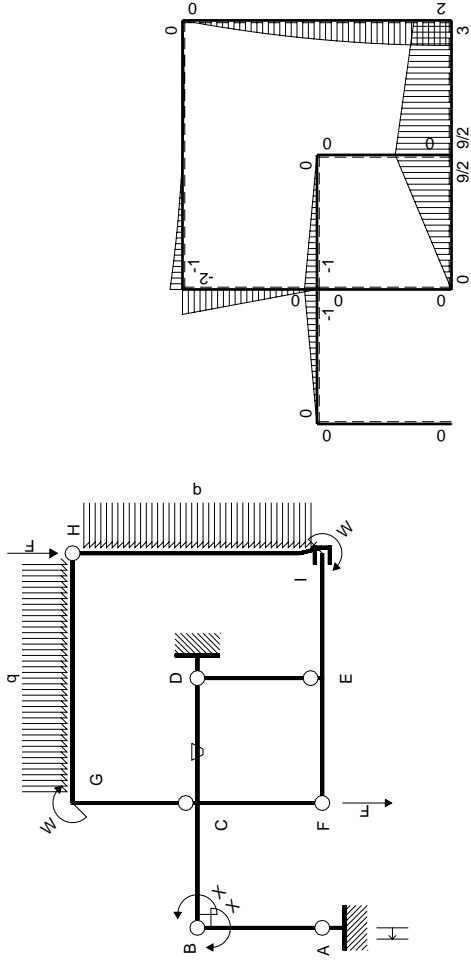
← ⊕ → F



↑ ⊕ ↓ F

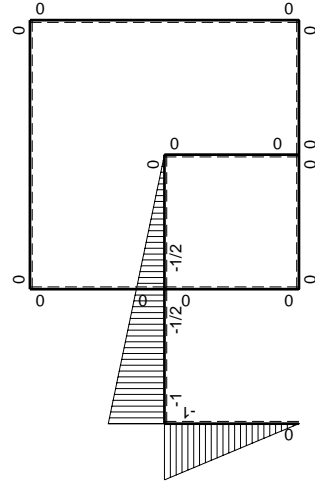


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	Fb/EJ	$1/2Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/2Fb-9/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/2Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+3/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx+1/2qx^2$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/2Fb+3/2Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$							Fb^2/EJ	
	totali							$7/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-7/4Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

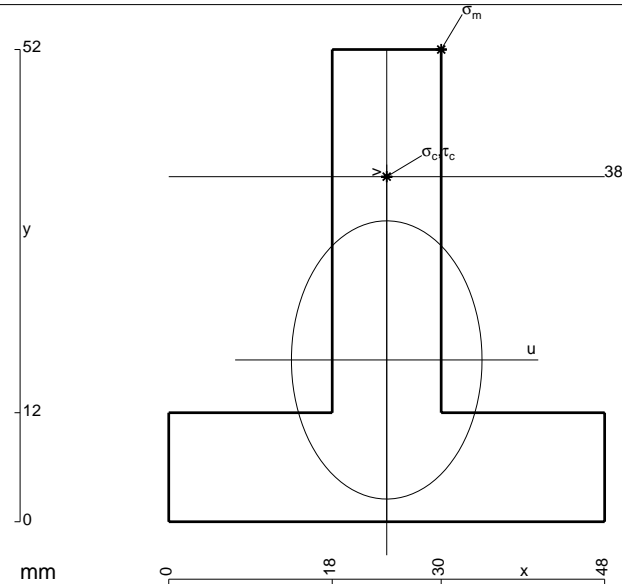
$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

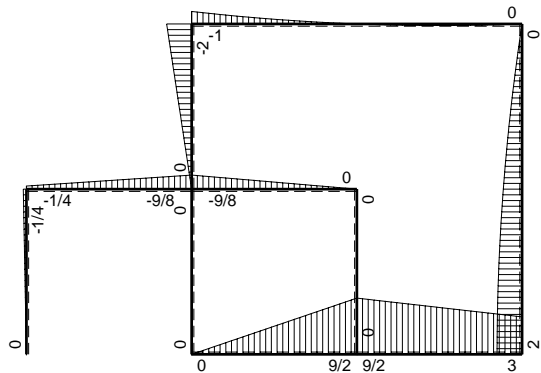
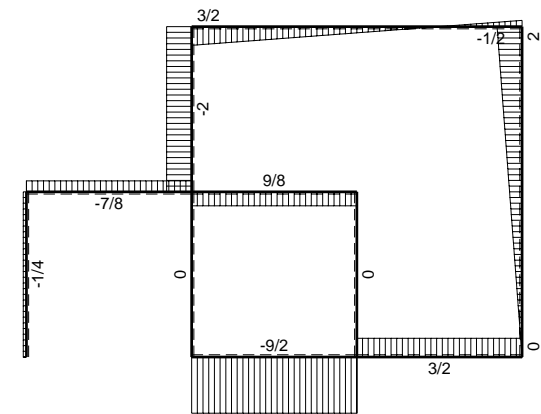
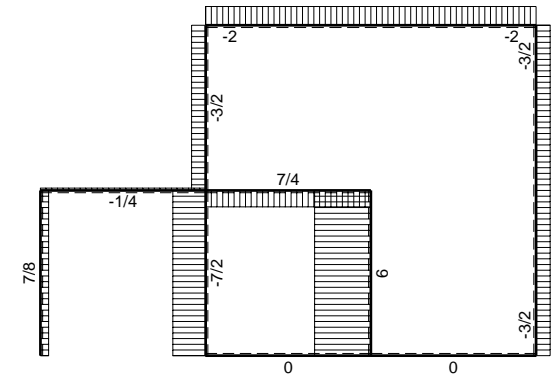
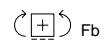
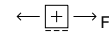
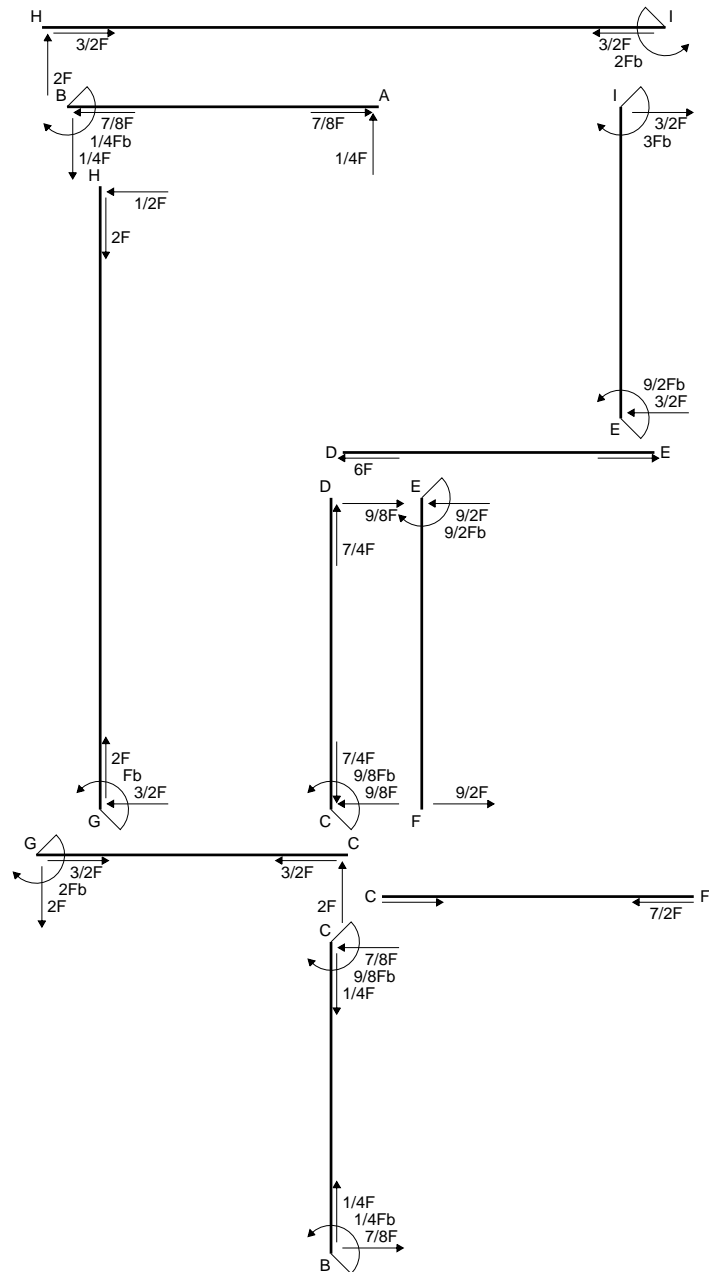
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 5/12 Fb^2/EJ$$

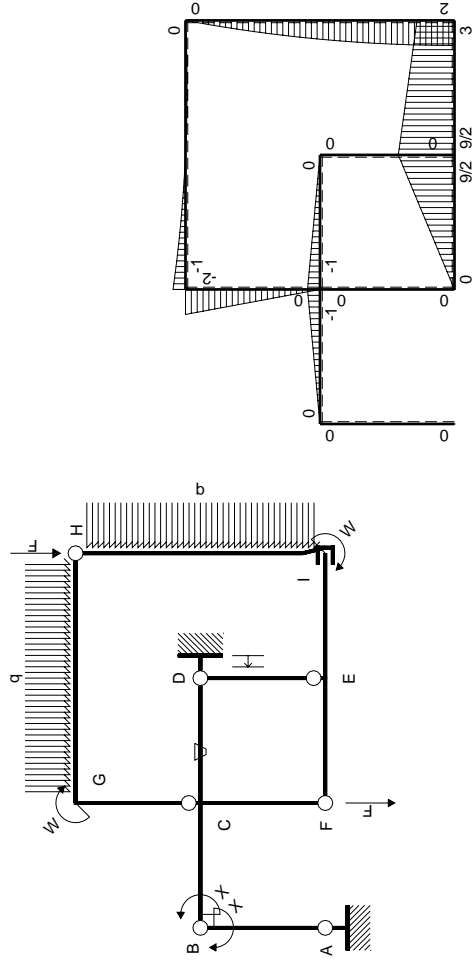
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/6 b) Fb 1/EJ + (-1/4 b) \theta = 5/12 Fb^2/EJ$$



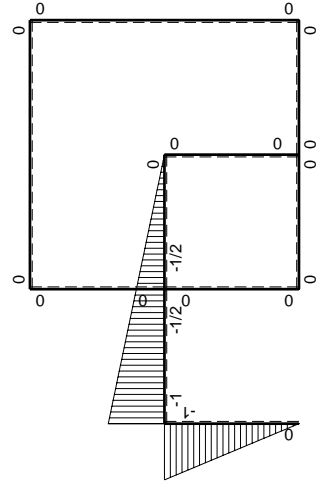
- A = 1056. mm²
- J_u = 247901. mm⁴
- J_v = 116352. mm⁴
- y_g = 17.82 mm
- T_y = -3015. N
- M_x = 1658250. Nmm
- x_m = 30. mm
- y_m = 52. mm
- u_m = 6. mm
- v_m = 34.18 mm
- σ_m = -M_v/J_u = -228.6 N/mm²
- x_c = 24. mm
- y_c = 38. mm
- v_c = 20.18 mm
- σ_c = -M_v/J_u = -135. N/mm²
- τ_c = 4.628 N/mm²
- σ_q = √σ²+3τ² = 135.2 N/mm²
- S = 4567. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	Fb/EJ	$1/2Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/2Fb-9/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/2Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+3/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx+1/2qx^2$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/4Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

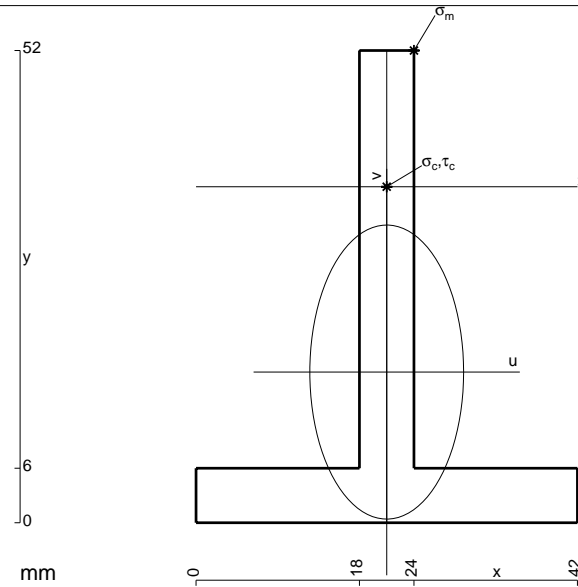
$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

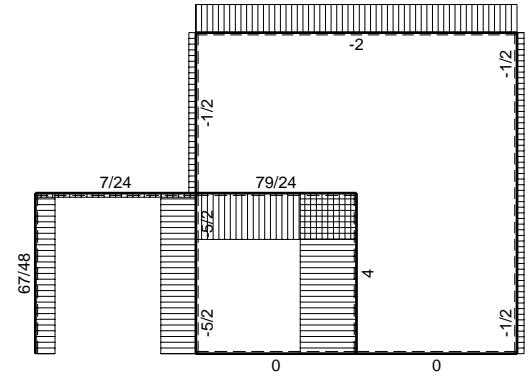
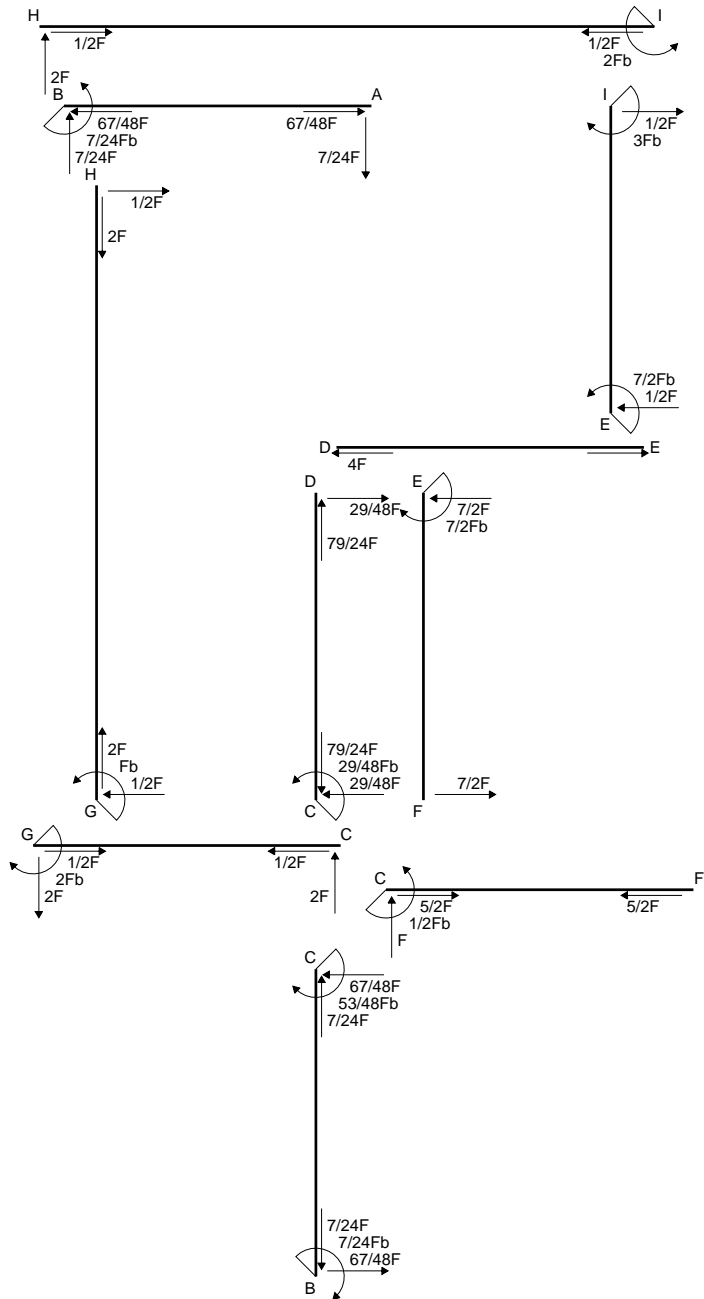
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 5/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

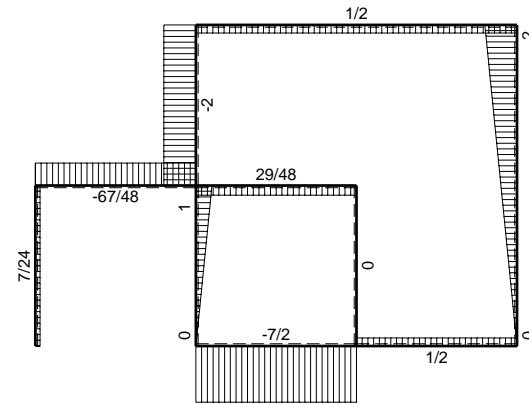
$$= (1/6 b) Fb 1/EJ + (-1/4 b) \theta = 5/12 Fb^2/EJ$$



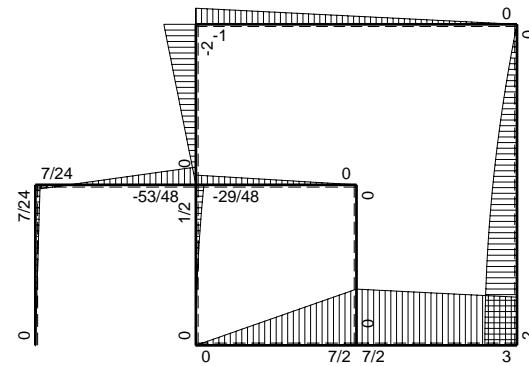
- A = 528. mm²
- J_u = 138472. mm⁴
- J_v = 37872. mm⁴
- y_g = 16.59 mm
- T_y = -1530. N
- M_x = 918000. Nmm
- x_m = 24. mm
- y_m = 52. mm
- u_m = 3. mm
- v_m = 35.41 mm
- σ_m = -Mv/J_u = -234.7 N/mm²
- x_c = 21. mm
- y_c = 37. mm
- v_c = 20.41 mm
- σ_c = -Mv/J_u = -135.3 N/mm²
- τ_c = 4.626 N/mm²
- σ_q = √σ²+3τ² = 135.5 N/mm²
- S = 2512. mm³



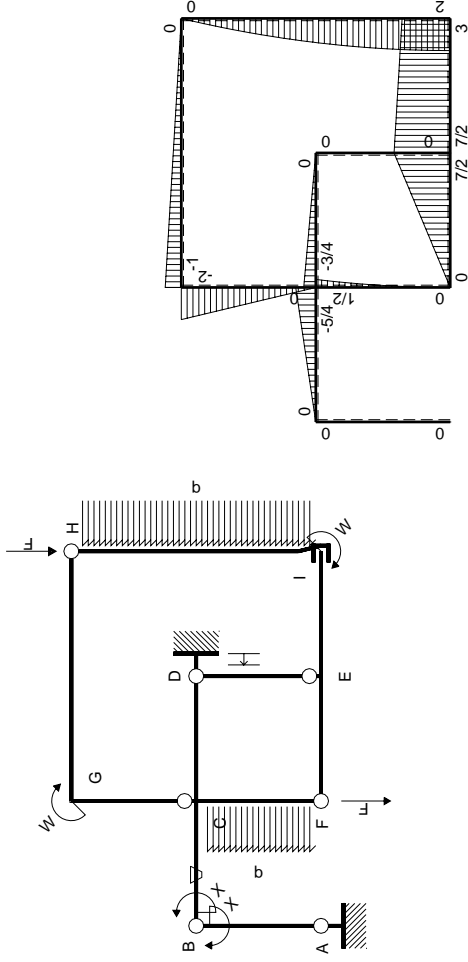
$\leftarrow \boxed{+} \rightarrow F$



$\uparrow \boxed{+} \downarrow F$

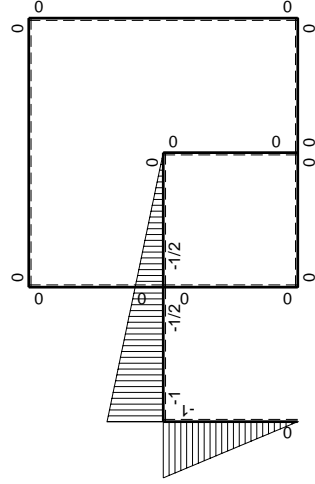


$\leftarrow \boxed{+} \rightarrow F_b$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-7/2Fx$	0	0	0	0			
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$7/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-7/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

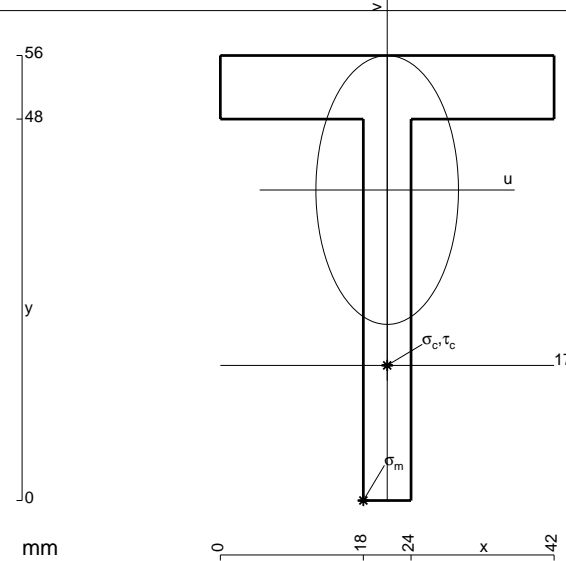
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

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

$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



$$A = 624. \text{ mm}^2$$

$$J_u = 178668. \text{ mm}^4$$

$$J_v = 50256. \text{ mm}^4$$

$$y_g = 39.08 \text{ mm}$$

$$T_y = -1295. \text{ N}$$

$$M_x = 893550. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$u_m = -3. \text{ mm}$$

$$v_m = -39.08 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 195.4 \text{ N/mm}^2$$

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

$$y_c = 17. \text{ mm}$$

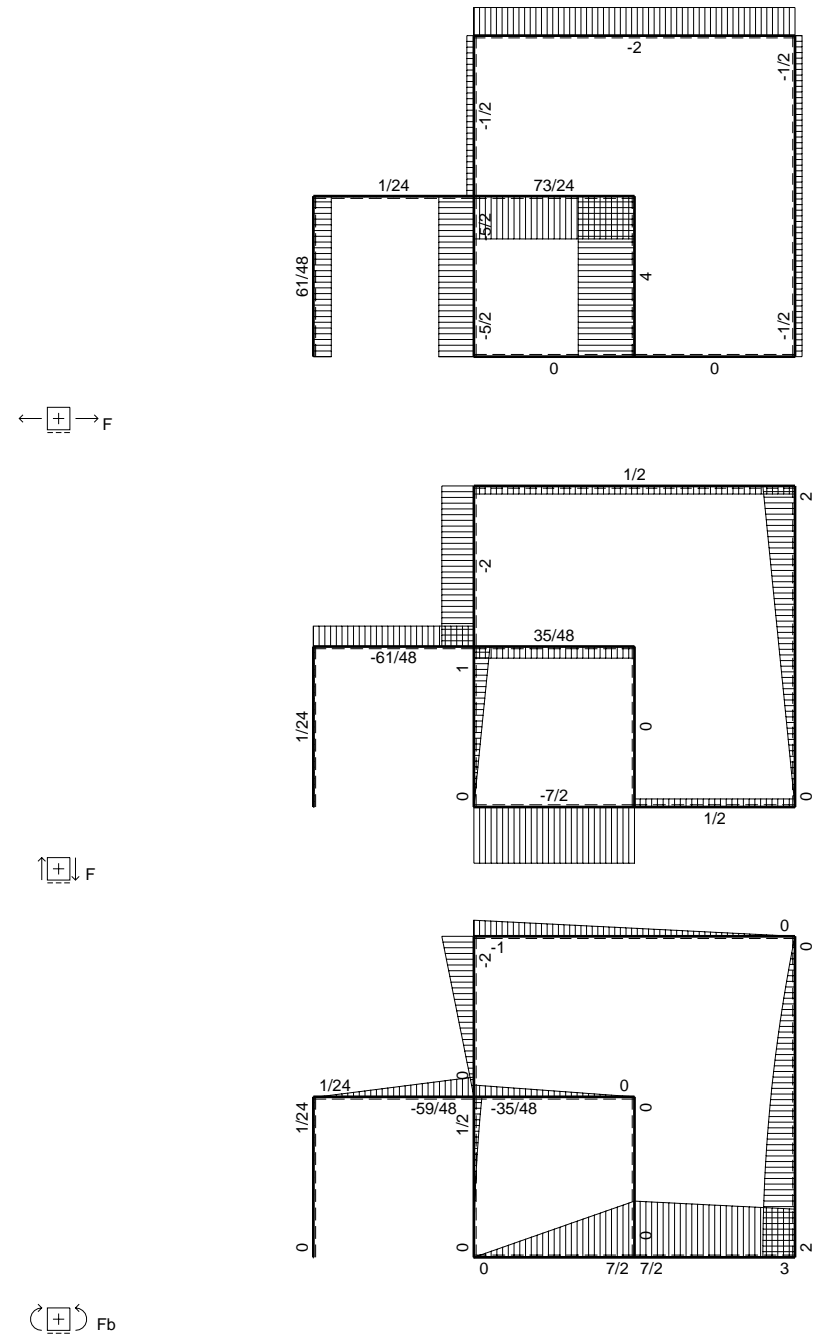
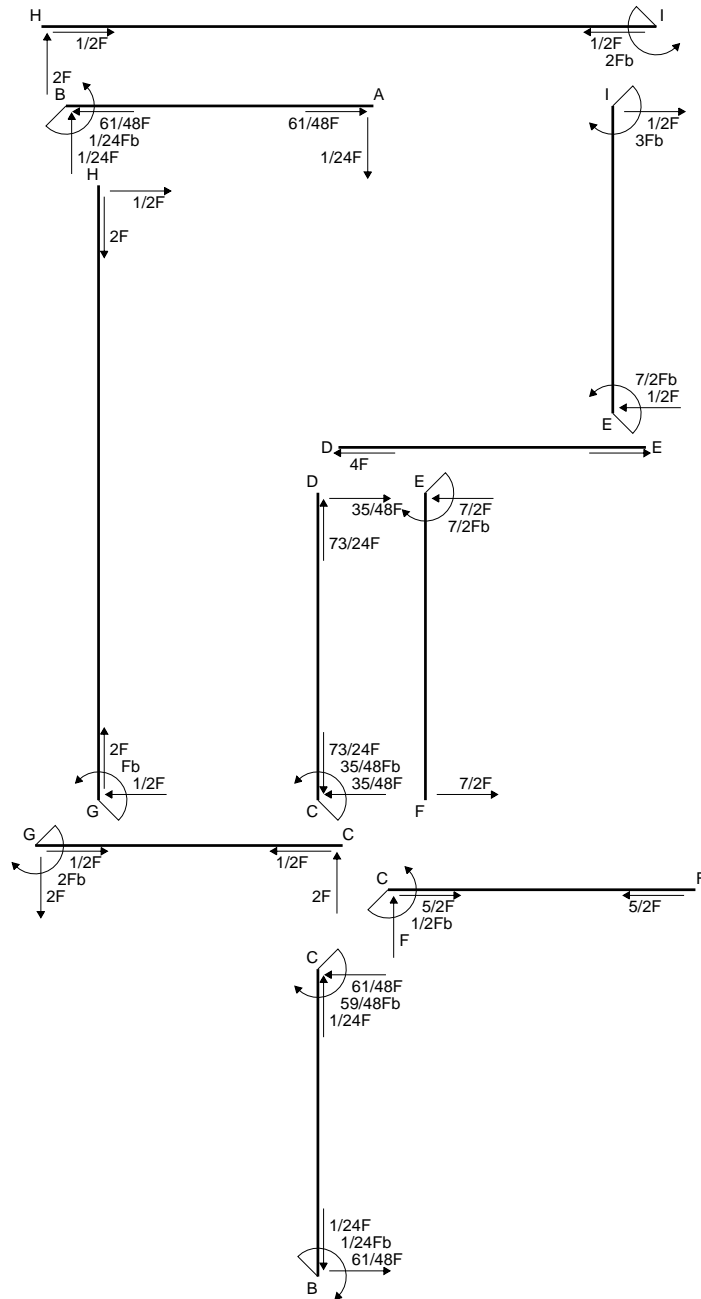
$$v_c = -22.08 \text{ mm}$$

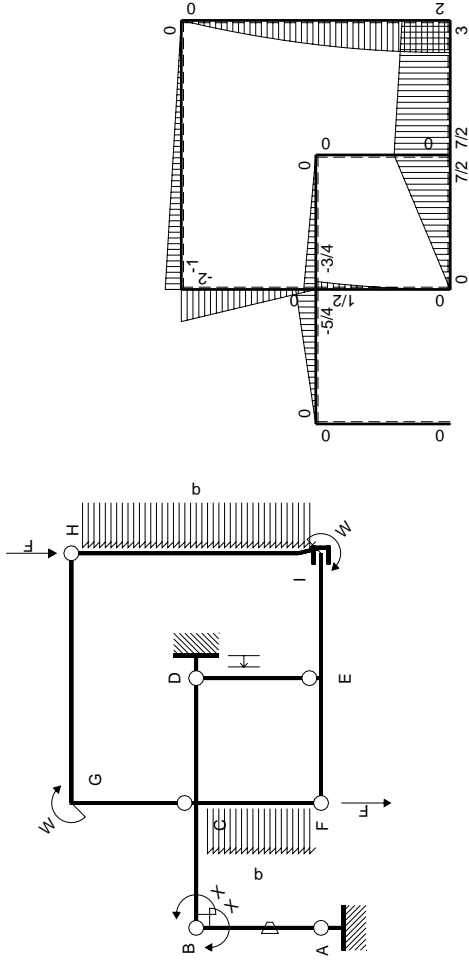
$$\sigma_c = -Mv/J_u = 110.4 \text{ N/mm}^2$$

$$\tau_c = 3.768 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 110.6 \text{ N/mm}^2$$

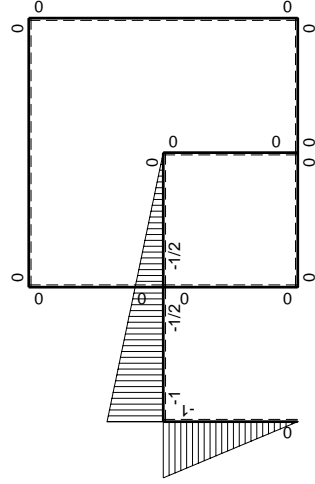
$$S = 3119. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0
FE b	0	$-7/2Fx$	0	0	0	0		
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$1/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-1/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

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

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

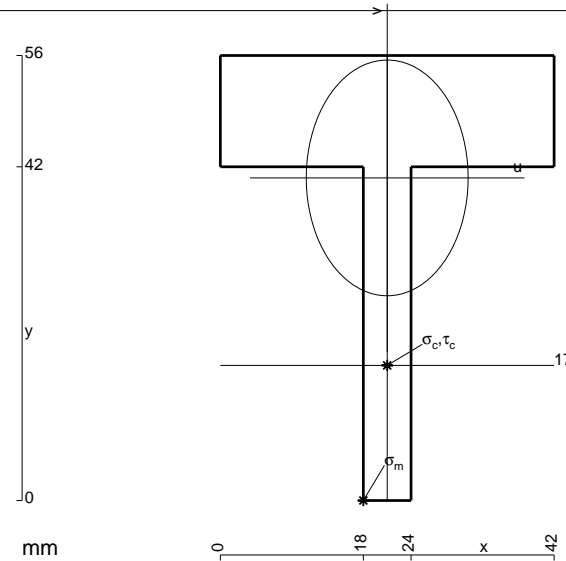
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

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

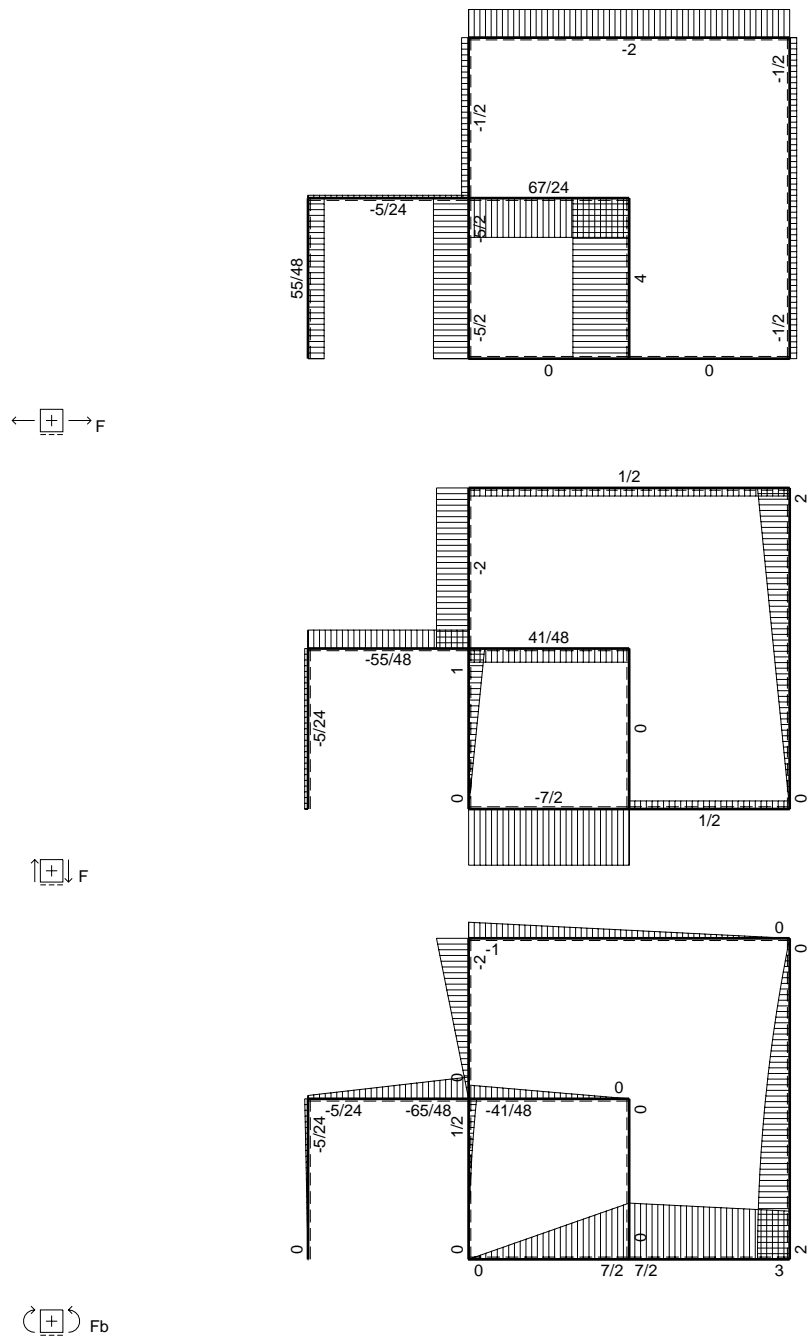
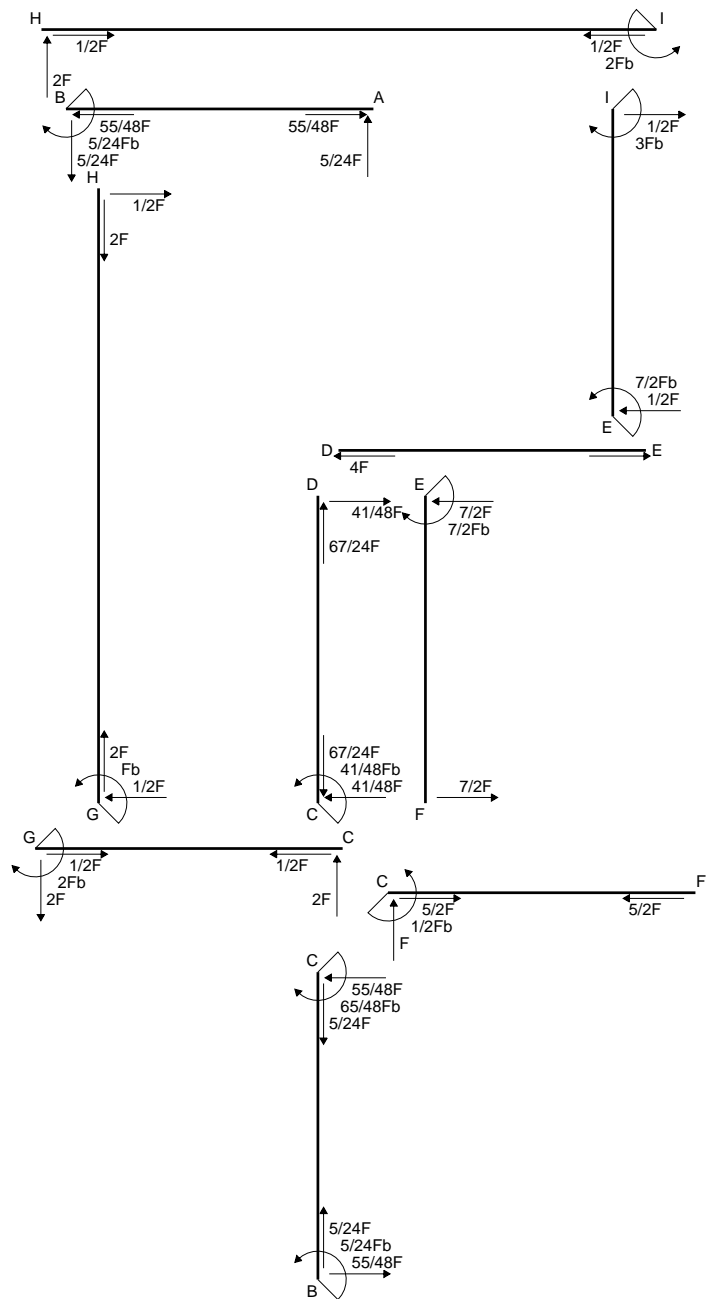
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

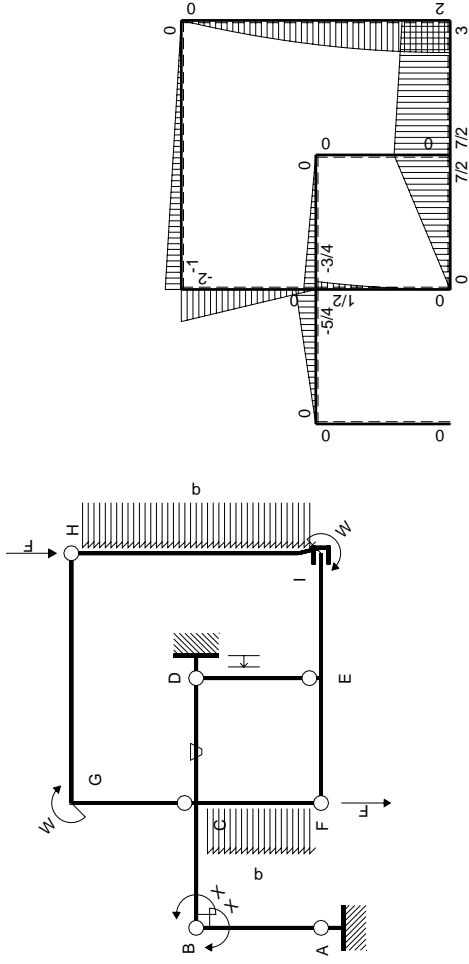
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



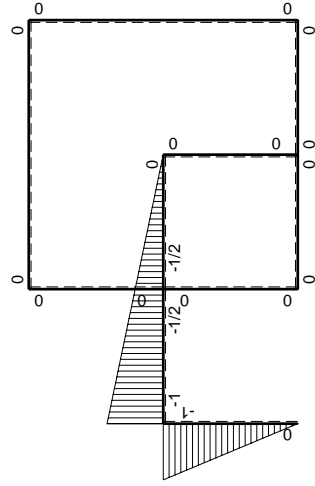
- A = 840. mm²
- J_u = 184946. mm⁴
- J_v = 87192. mm⁴
- y_g = 40.6 mm
- T_y = -1295. N
- M_x = 945350. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -40.6 mm
- σ_m = -Mv/J_u = 207.5 N/mm²
- x_c = 21. mm
- y_c = 17. mm
- v_c = -23.6 mm
- σ_c = -Mv/J_u = 120.6 N/mm²
- τ_c = 3.821 N/mm²
- σ_o = √σ²+3τ² = 120.8 N/mm²
- S = 3274. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-7/2Fx$	0	0	0	0			
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-5/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$5/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

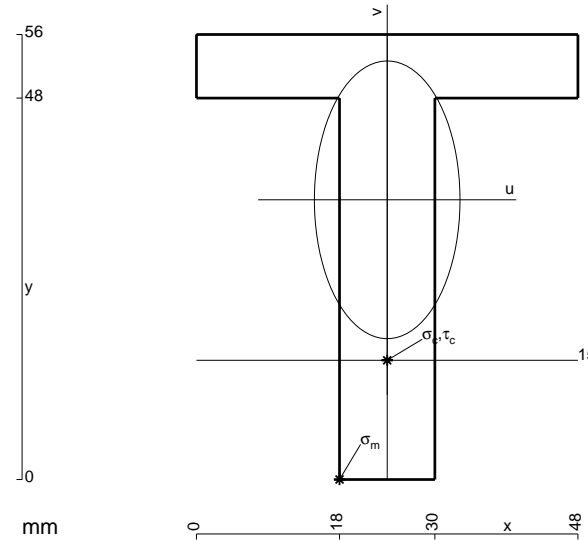
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



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

$$J_u = 293274. \text{ mm}^4$$

$$J_v = 80640. \text{ mm}^4$$

$$y_g = 35.2 \text{ mm}$$

$$T_y = -2345. \text{ N}$$

$$M_x = 1829100. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$u_m = -6. \text{ mm}$$

$$v_m = -35.2 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 219.5 \text{ N/mm}^2$$

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

$$y_c = 15. \text{ mm}$$

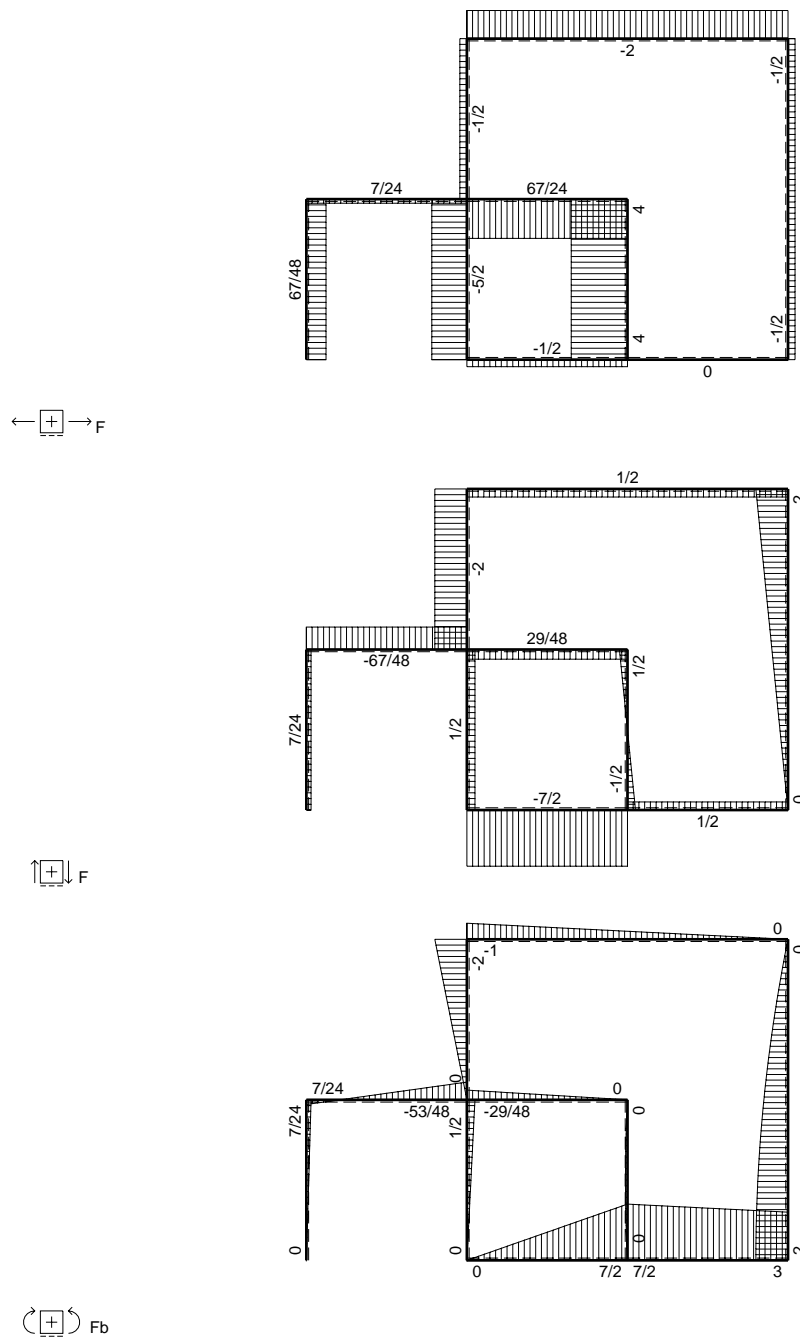
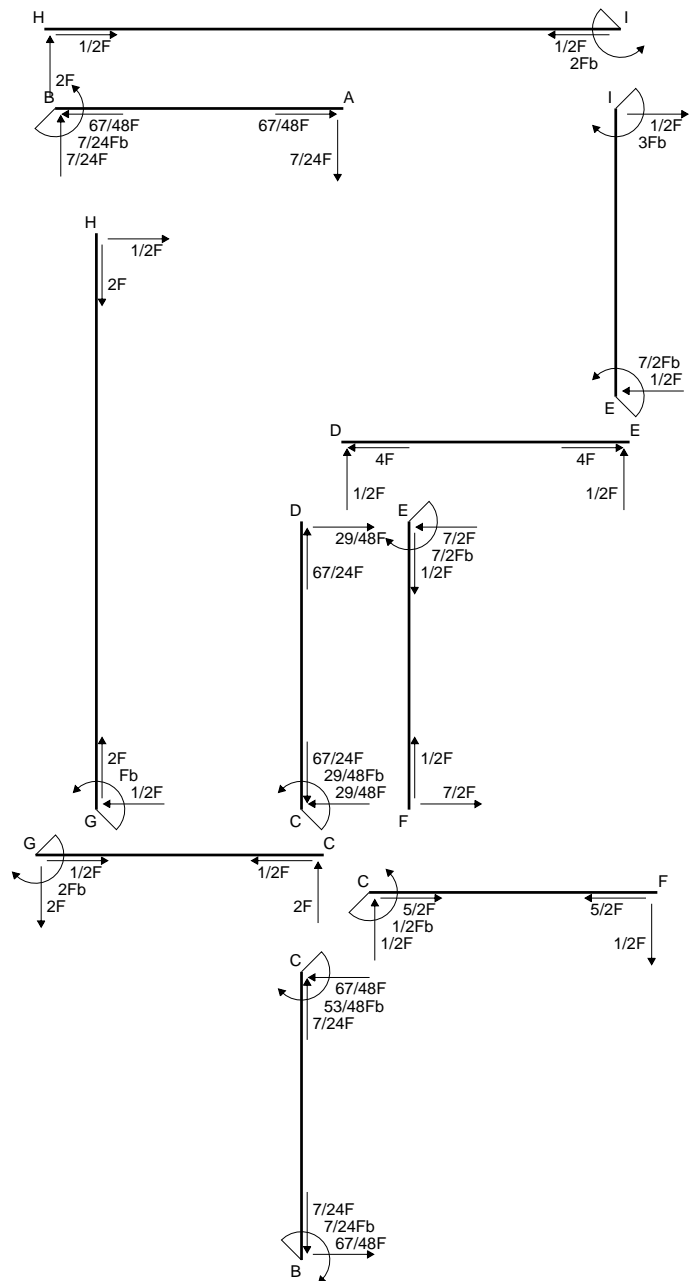
$$v_c = -20.2 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 126. \text{ N/mm}^2$$

$$\tau_c = 3.322 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 126.1 \text{ N/mm}^2$$

$$S = 4986. \text{ mm}^3$$



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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0
FE b	0	$-7/2Fx$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$7/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-7/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

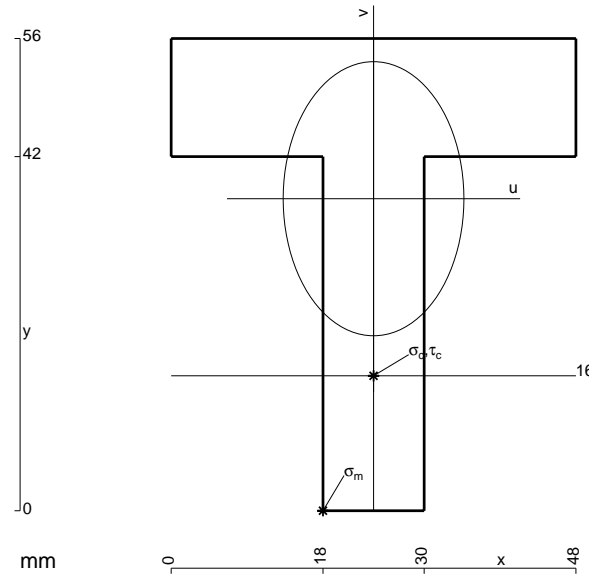
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

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

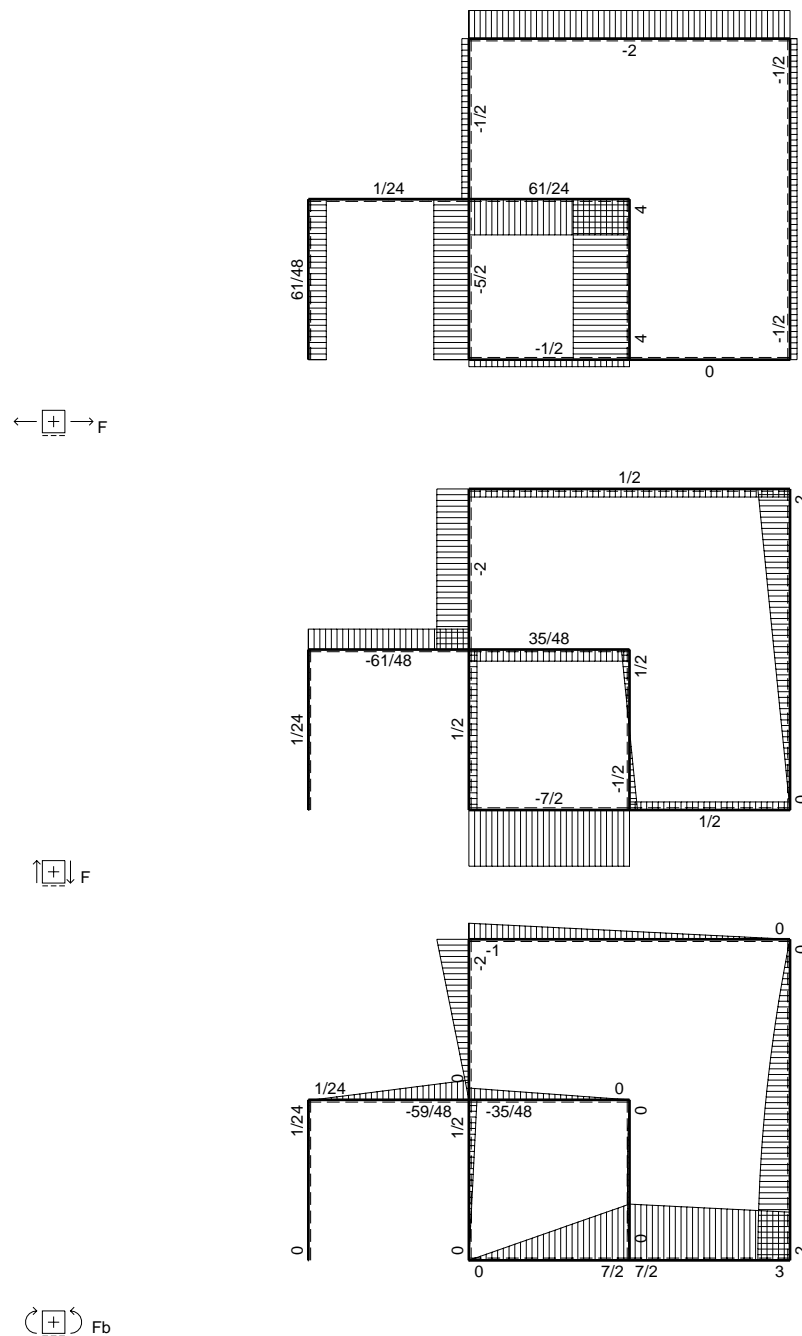
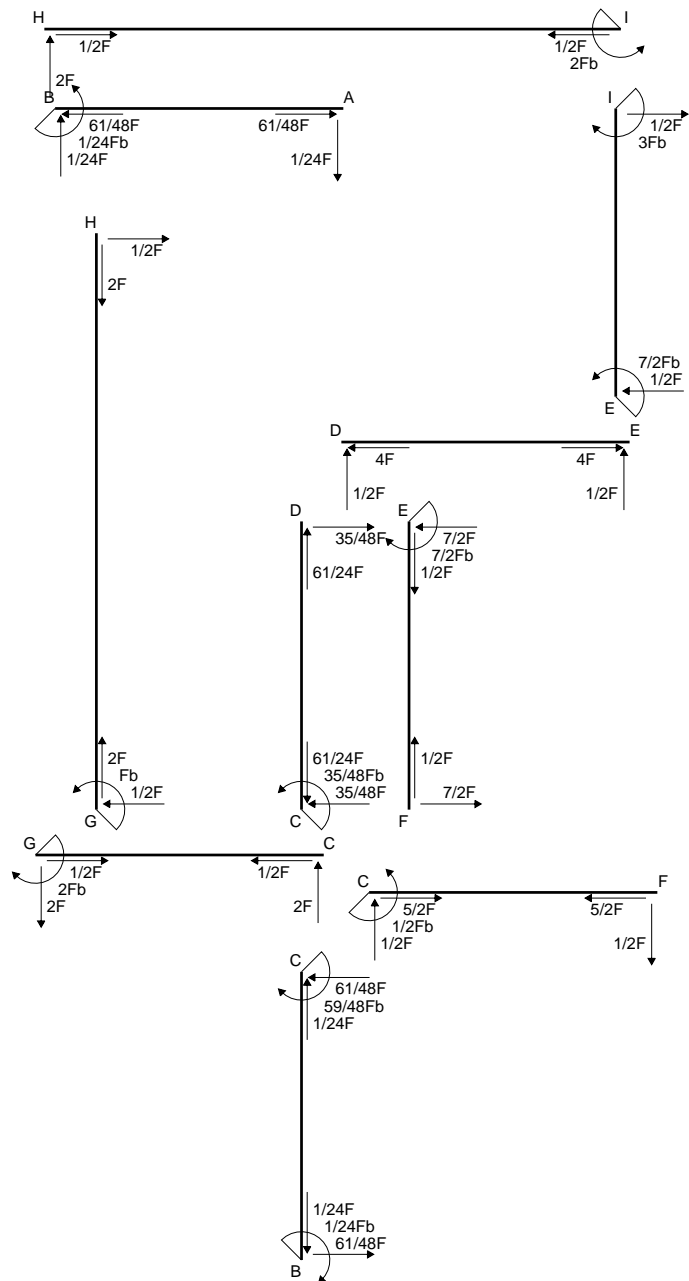
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 1176. mm²
- J_u = 310856. mm⁴
- J_v = 135072. mm⁴
- y_g = 37. mm
- N = -335. N
- T_y = -2345. N
- M_x = 1922900. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -37. mm
- σ_m = N/A - Mv/J_u = 228.6 N/mm²
- x_c = 24. mm
- y_c = 16. mm
- v_c = -21. mm
- σ_c = N/A - Mv/J_u = 129.6 N/mm²
- τ_c = 3.5 N/mm²
- σ_q = √(σ² + 3τ²) = 129.8 N/mm²
- S = 5568. mm³



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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0
FE b	0	$-7/2Fx$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$1/24Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-1/24Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

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

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

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

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

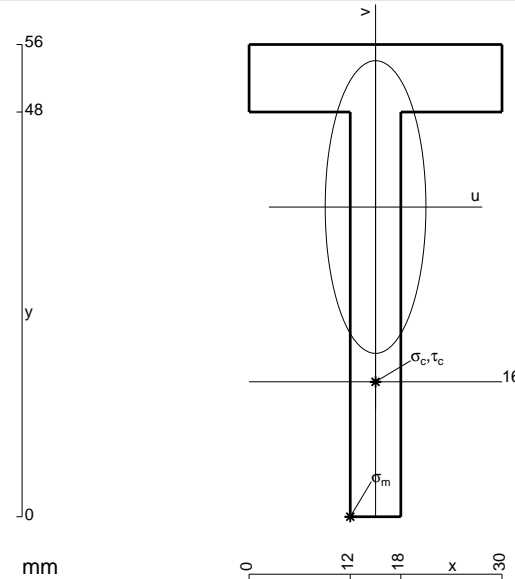
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

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

$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



$$A = 528. \text{ mm}^2$$

$$J_u = 159209. \text{ mm}^4$$

$$J_v = 18864. \text{ mm}^4$$

$$y_g = 36.73 \text{ mm}$$

$$N = -170. \text{ N}$$

$$T_y = -1190. \text{ N}$$

$$M_x = 1035300. \text{ Nmm}$$

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

$$u_m = -3. \text{ mm}$$

$$v_m = -36.73 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = 238.5 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 16. \text{ mm}$$

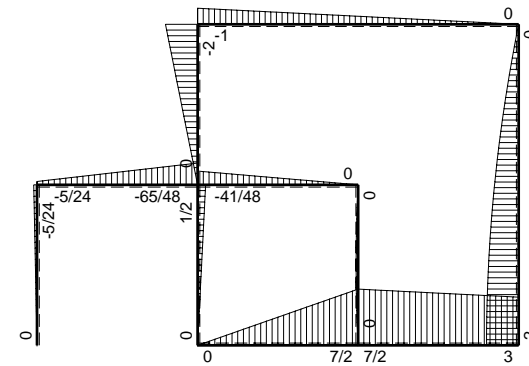
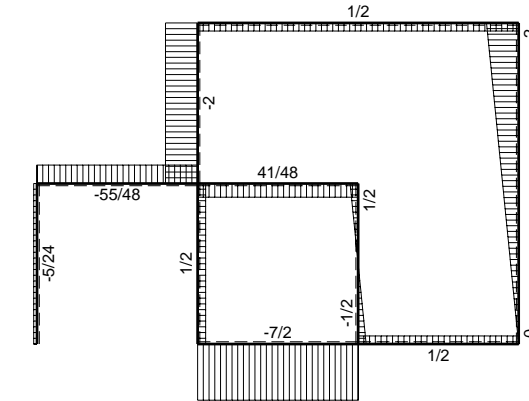
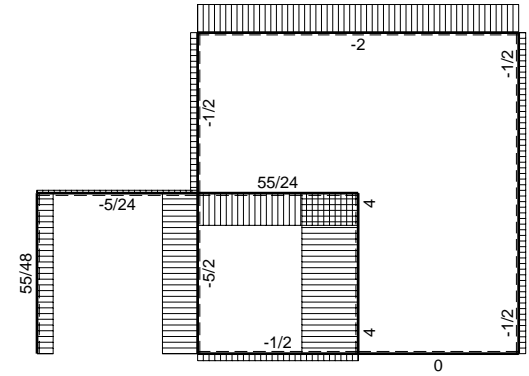
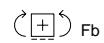
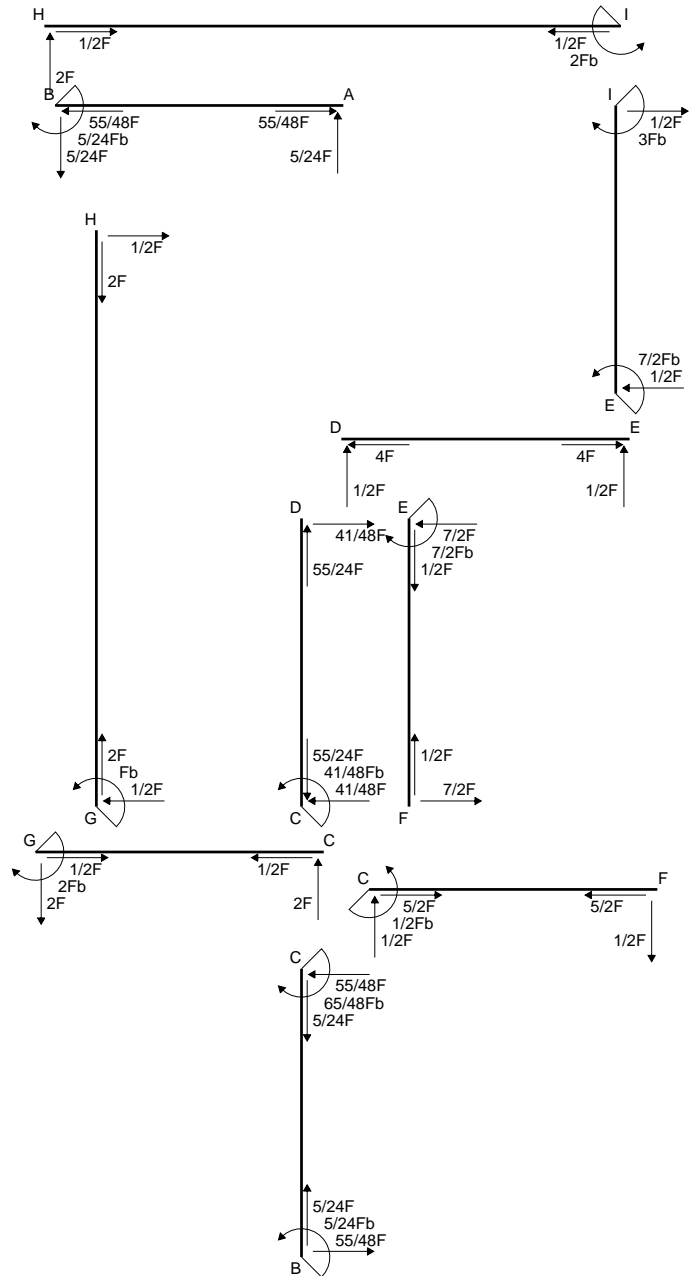
$$v_c = -20.73 \text{ mm}$$

$$\sigma_c = N/A - Mv/J_u = 134.5 \text{ N/mm}^2$$

$$\tau_c = 3.436 \text{ N/mm}^2$$

$$\sigma_\varphi = \sqrt{\sigma^2 + 3\tau^2} = 134.6 \text{ N/mm}^2$$

$$S = 2758. \text{ mm}^3$$



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

→	$M_x(x)$	$M_o(x)$	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	-x/b	0	0	0	0	x^2/b^2	0+0	1/3Xb/EJ	
BA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	-1+1/2x/b	-5/4Fx	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	7/12Xb/EJ	
CB b	1/2+1/2x/b	5/4Fb-5/4Fx	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	-1/2+1/2x/b	-3/4Fb+3/4Fx	-Fb/EJ	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	1/12Xb/EJ	
DC b	1/2x/b	3/4Fx	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0			
EF b	0	$7/2Fb-7/2Fx$	0	0	0	0	0+0	0	
FE b	0	-7/2Fx	0	0	0	0			
FC b	0	1/2Fx	0	0	0	0	0+0	0	
CF b	0	-1/2Fb+1/2Fx	0	0	0	0			
CG b	0	-2Fx	0	0	0	0	0+0	0	
GC b	0	2Fb-2Fx	0	0	0	0			
GH 2b	0	-Fb+1/2Fx	0	0	0	0	0+0	0	
HG 2b	0	1/2Fx	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	-7/2Fb+1/2Fx	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							-Fb ² /EJ	
	totali							-5/24Fb ² /EJ	Xb/EJ
	iperstatica $X=W_{BC}$							5/24Fb	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

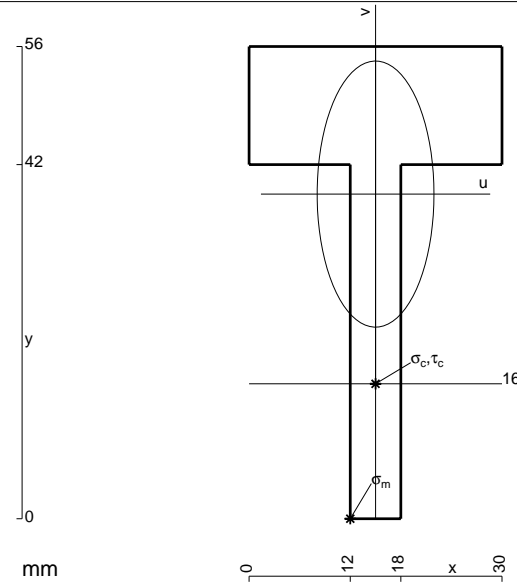
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



$$A = 672. \text{ mm}^2$$

$$J_u = 167384. \text{ mm}^4$$

$$J_v = 32256. \text{ mm}^4$$

$$y_g = 38.5 \text{ mm}$$

$$N = -270. \text{ N}$$

$$T_y = -1890. \text{ N}$$

$$M_x = 869400. \text{ Nmm}$$

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

$$u_m = -3. \text{ mm}$$

$$v_m = -38.5 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = 199.6 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 16. \text{ mm}$$

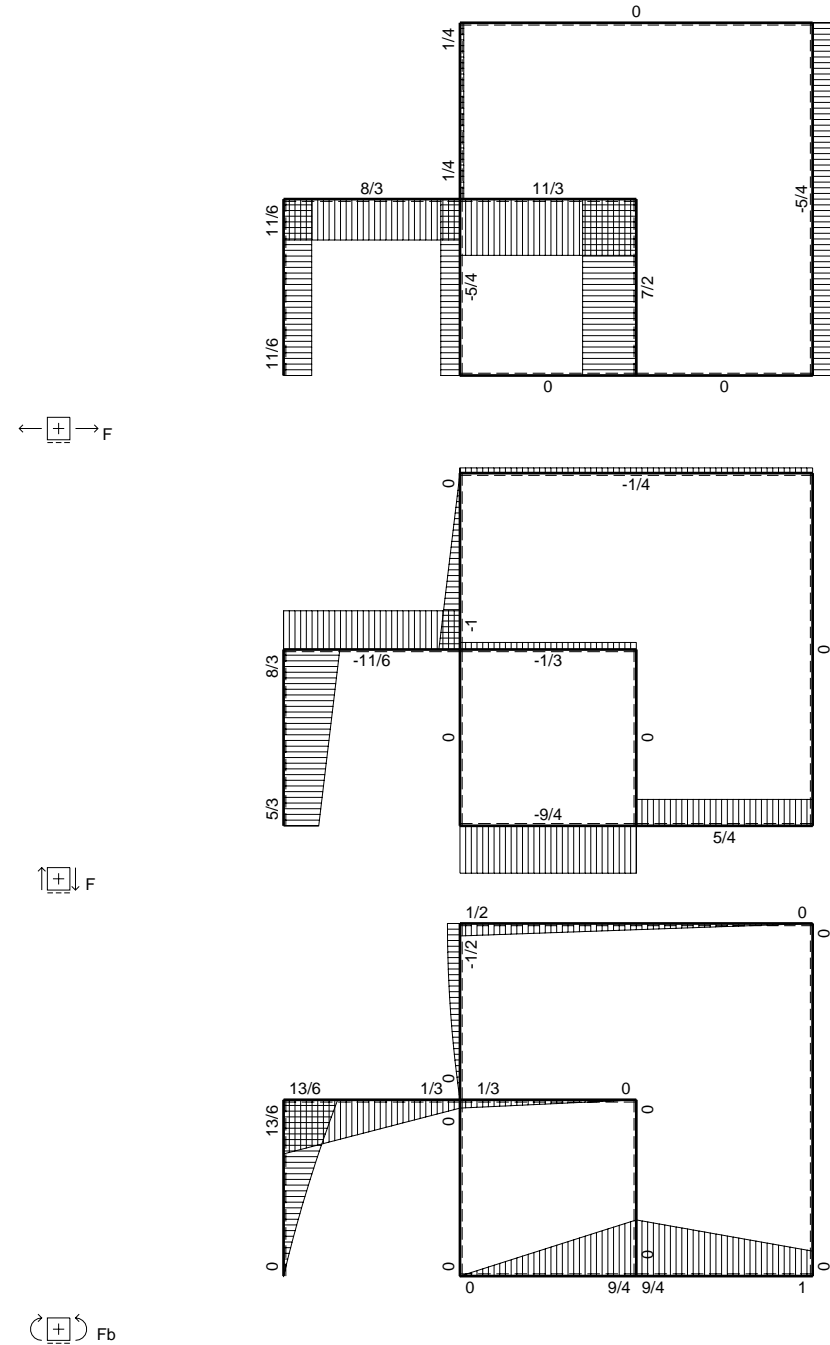
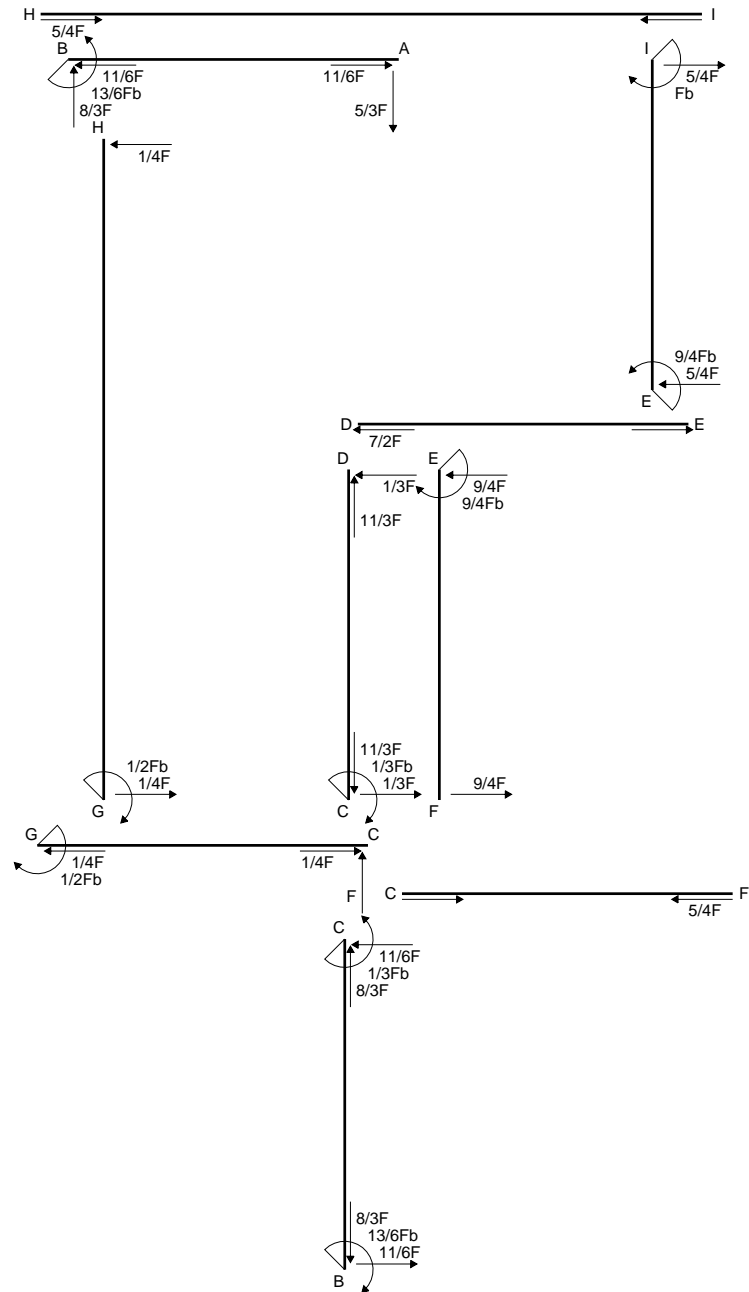
$$v_c = -22.5 \text{ mm}$$

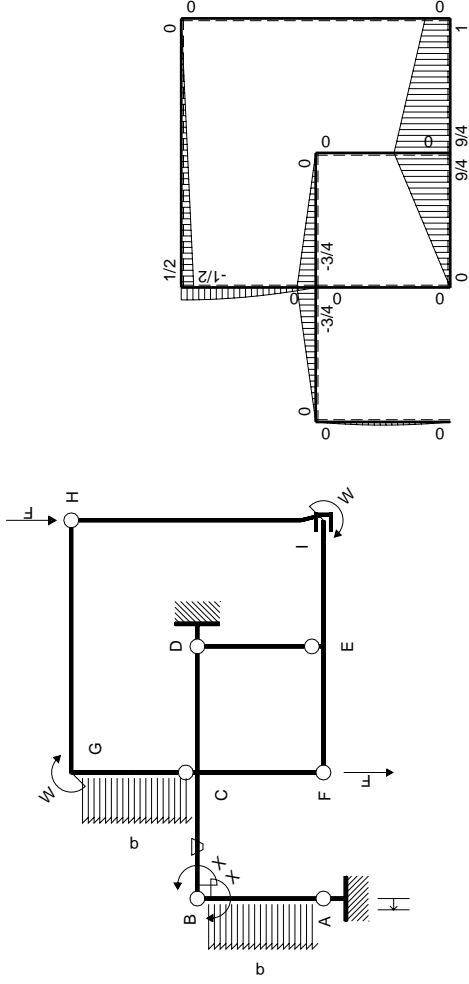
$$\sigma_c = N/A - Mv/J_u = 116.5 \text{ N/mm}^2$$

$$\tau_c = 5.51 \text{ N/mm}^2$$

$$\sigma_\varphi = \sqrt{\sigma^2 + 3\tau^2} = 116.9 \text{ N/mm}^2$$

$$S = 2928. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0
FE b	0	$-9/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$13/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-13/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

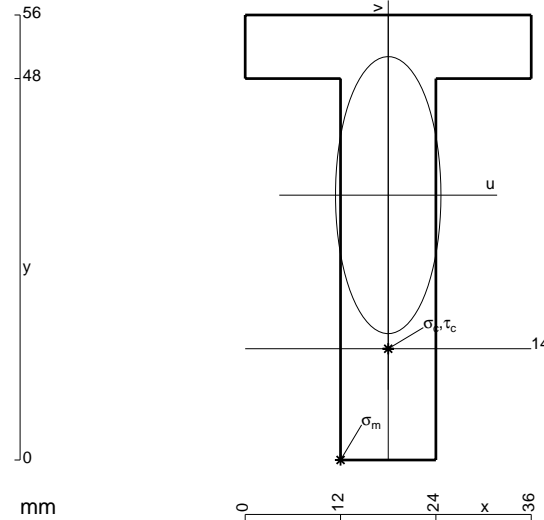
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

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

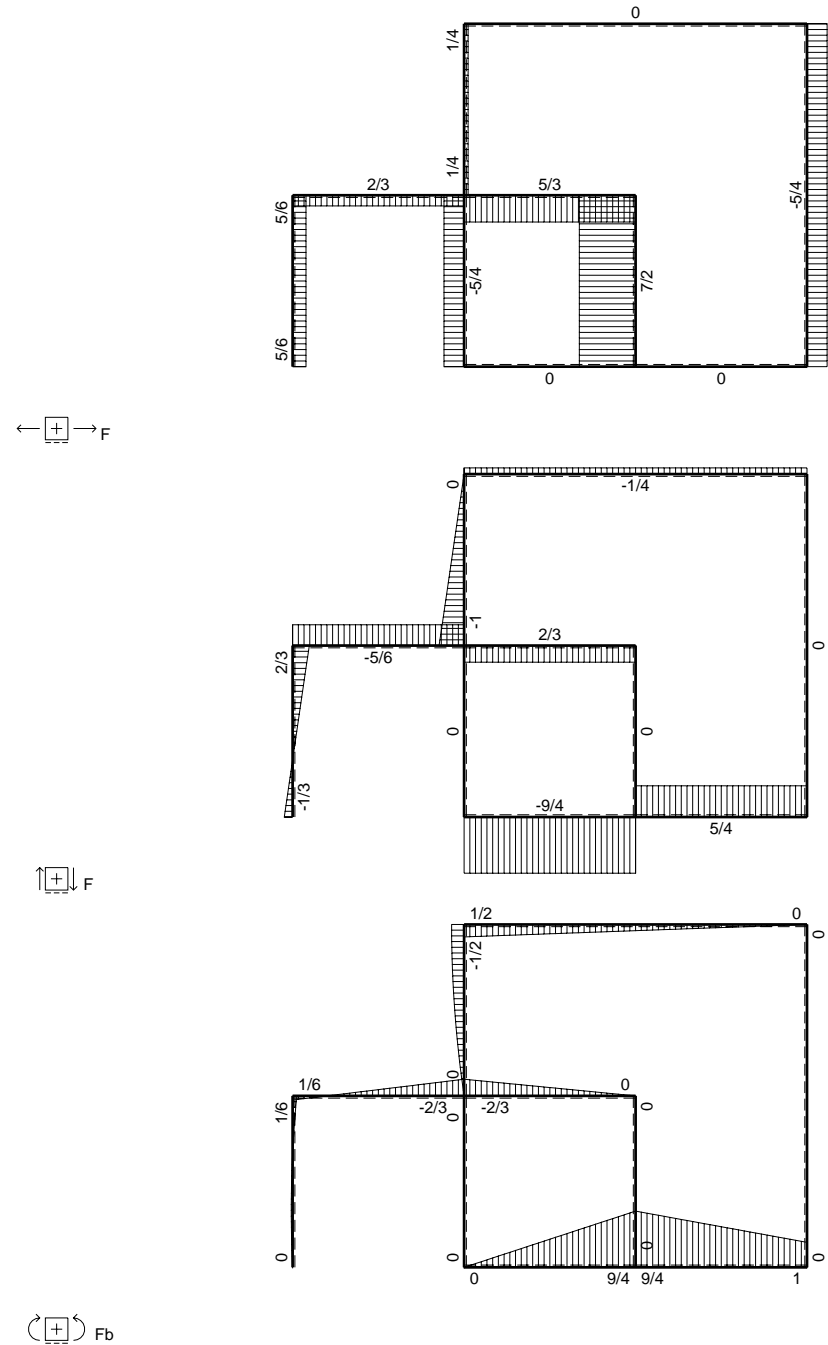
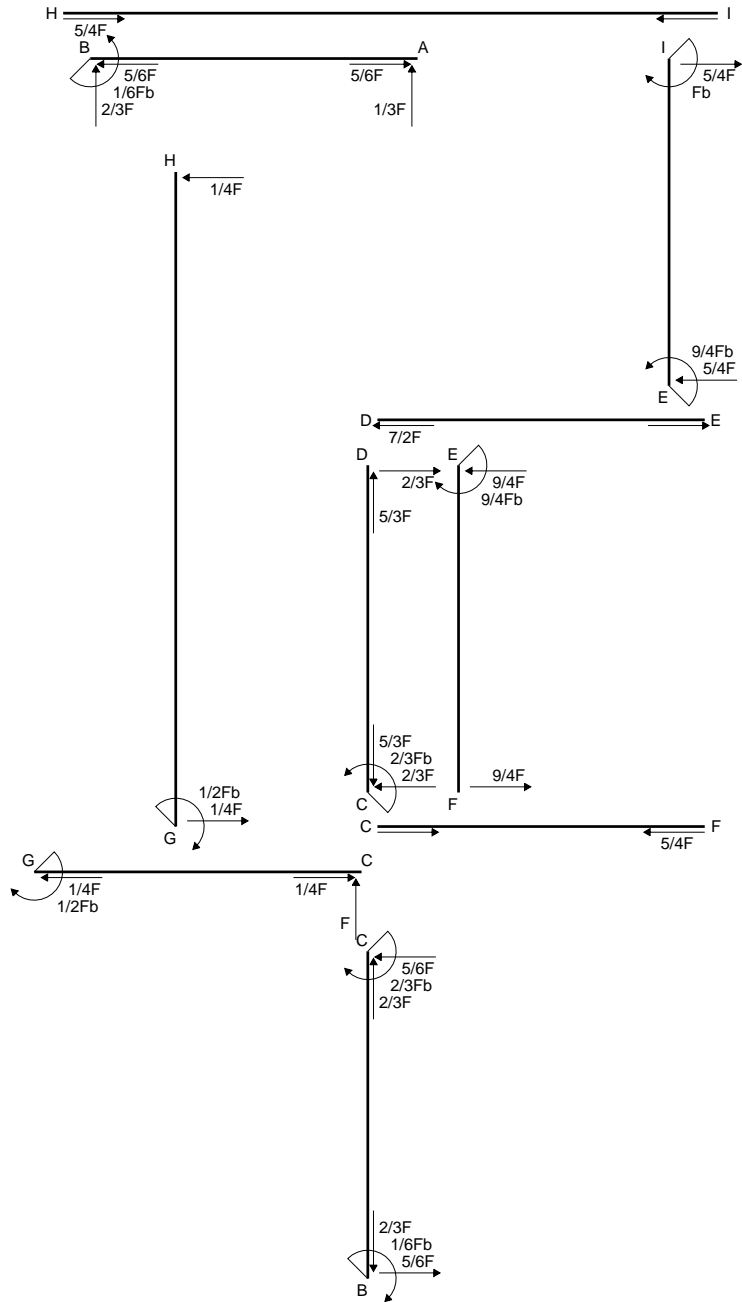
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

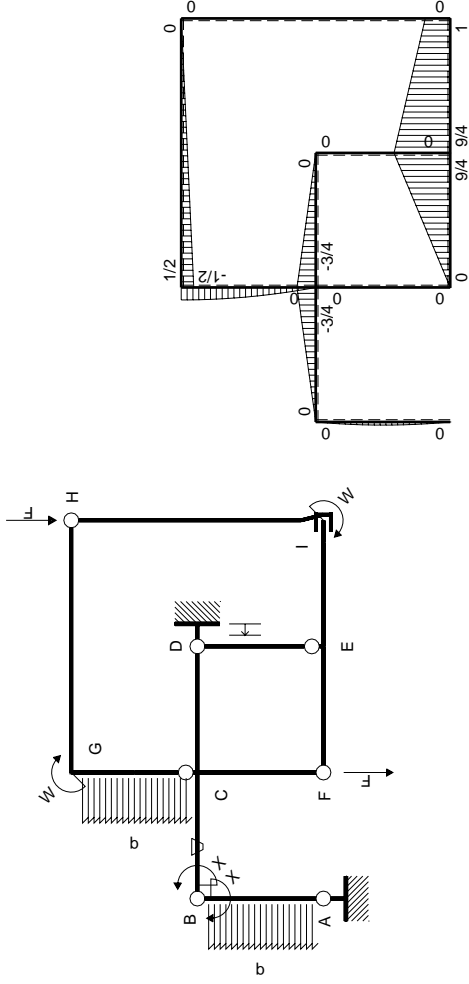
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



$A = 864. \text{ mm}^2$
 $J_u = 262656. \text{ mm}^4$
 $J_v = 38016. \text{ mm}^4$
 $y_g = 33.33 \text{ mm}$
 $T_y = -3308. \text{ N}$
 $M_x = 1653750. \text{ Nmm}$
 $x_m = 12. \text{ mm}$
 $u_m = -6. \text{ mm}$
 $v_m = -33.33 \text{ mm}$
 $\sigma_m = -Mv/J_u = 209.9 \text{ N/mm}^2$
 $x_c = 18. \text{ mm}$
 $y_c = 14. \text{ mm}$
 $v_c = -19.33 \text{ mm}$
 $\sigma_c = -Mv/J_u = 121.7 \text{ N/mm}^2$
 $\tau_c = 4.642 \text{ N/mm}^2$
 $\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 122. \text{ N/mm}^2$
 $S = 4424. \text{ mm}^3$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

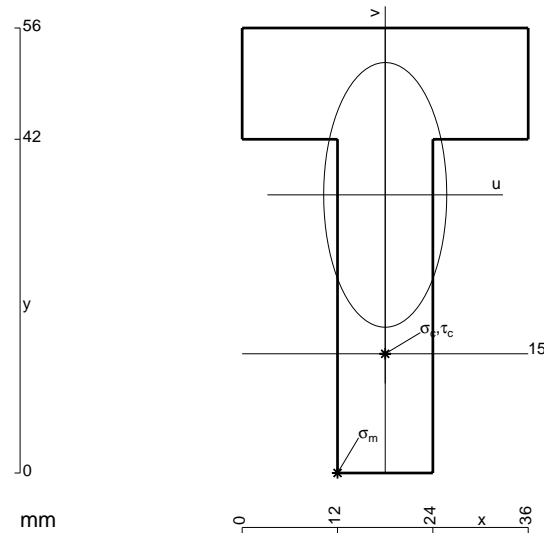
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

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

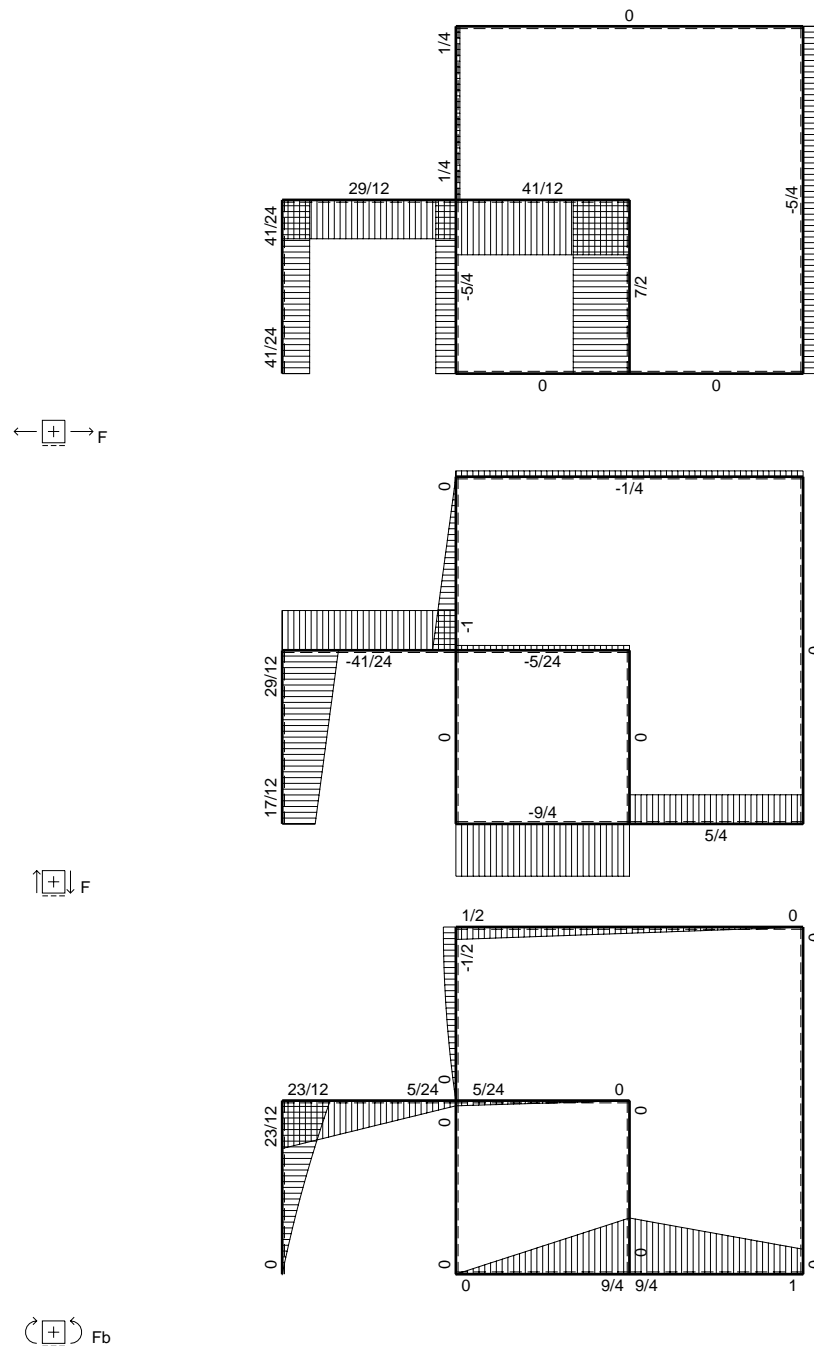
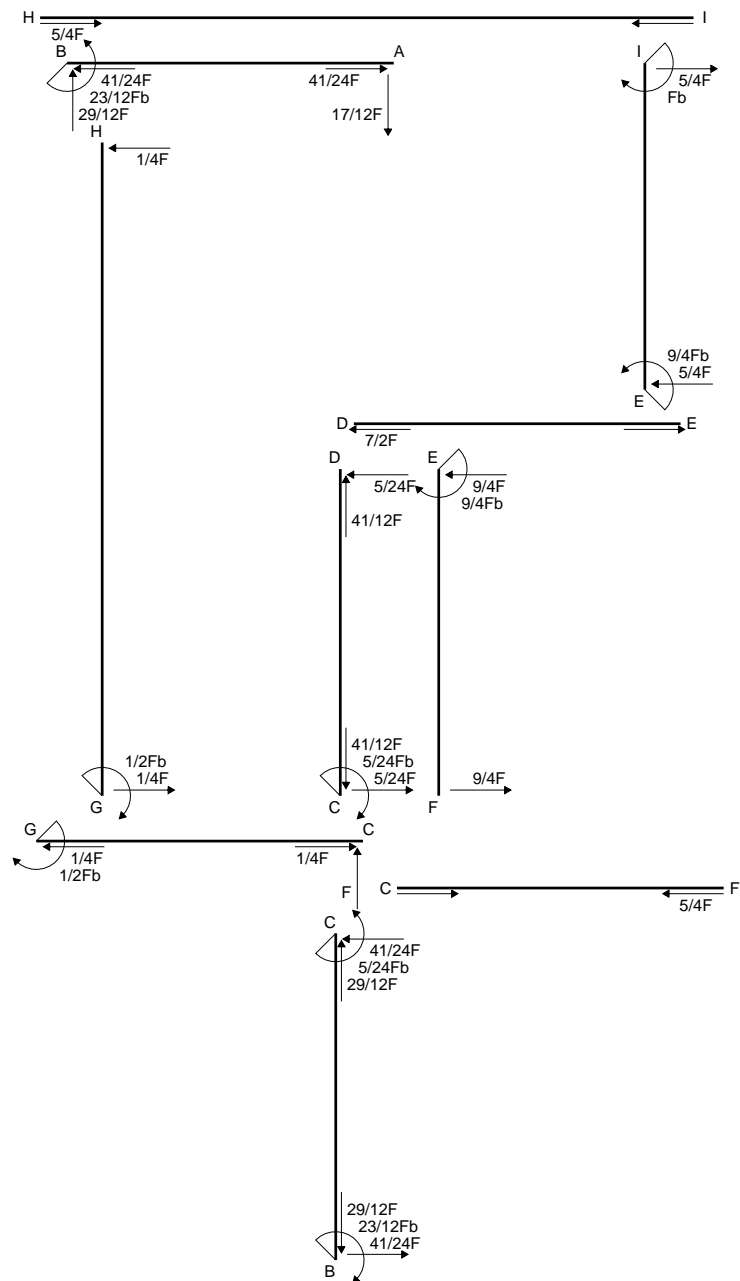
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



$A = 1008. \text{ mm}^2$
 $J_u = 279888. \text{ mm}^4$
 $J_v = 60480. \text{ mm}^4$
 $y_g = 35. \text{ mm}$
 $T_y = -3195. \text{ N}$
 $M_x = 1757250. \text{ Nmm}$
 $x_m = 12. \text{ mm}$
 $u_m = -6. \text{ mm}$
 $v_m = -35. \text{ mm}$
 $\sigma_m = -Mv/J_u = 219.7 \text{ N/mm}^2$
 $x_c = 18. \text{ mm}$
 $y_c = 15. \text{ mm}$
 $v_c = -20. \text{ mm}$
 $\sigma_c = -Mv/J_u = 125.6 \text{ N/mm}^2$
 $\tau_c = 4.709 \text{ N/mm}^2$
 $\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 125.8 \text{ N/mm}^2$
 $S = 4950. \text{ mm}^3$



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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0
FE b	0	$-9/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$23/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-23/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

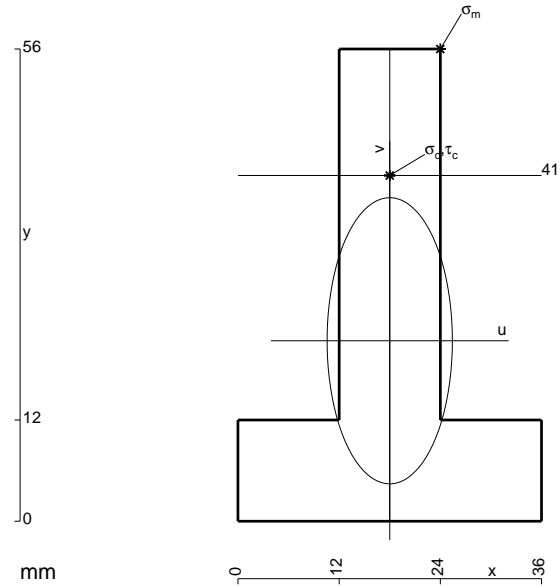
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

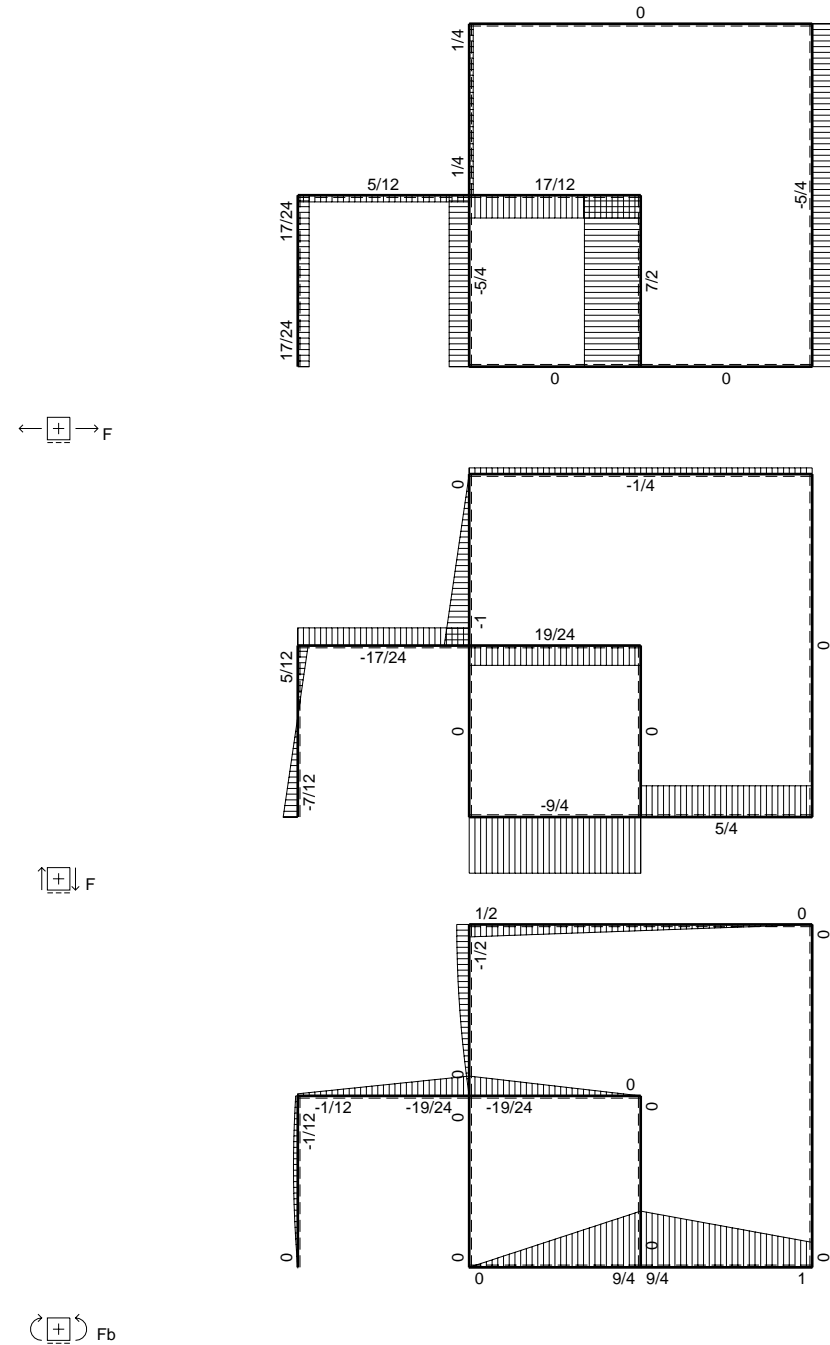
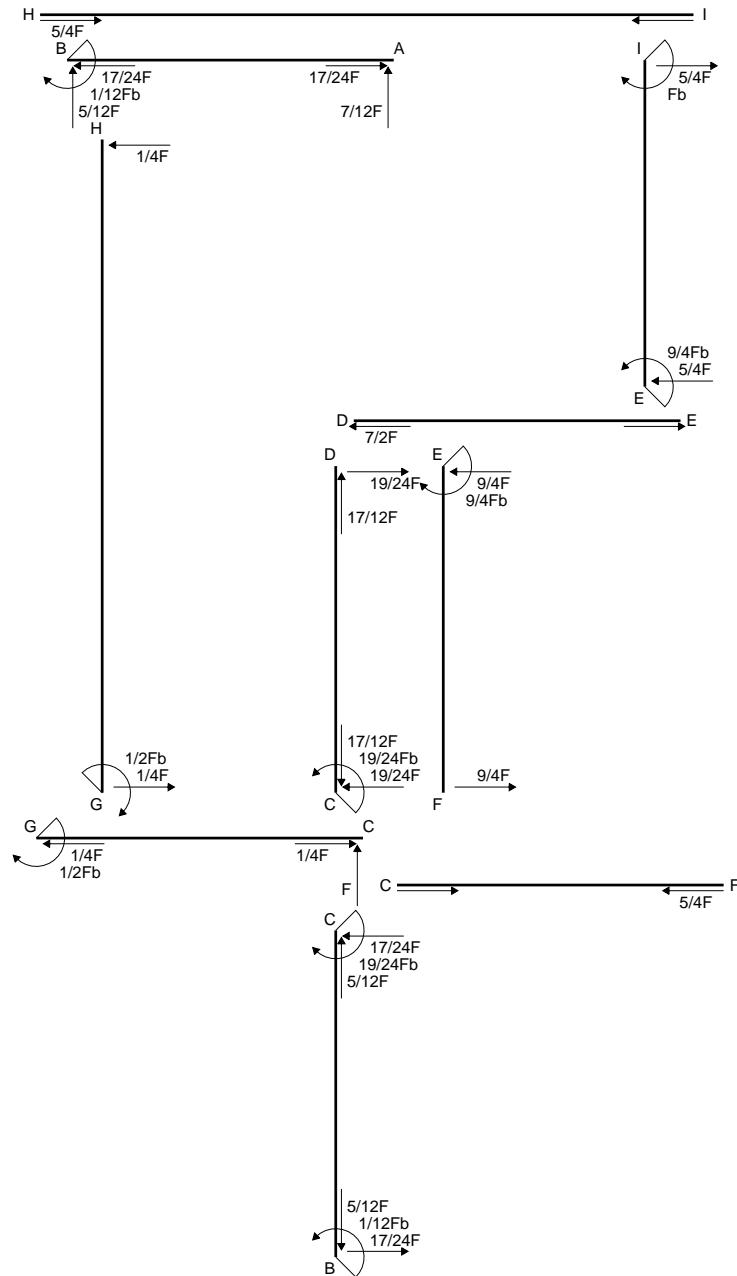
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

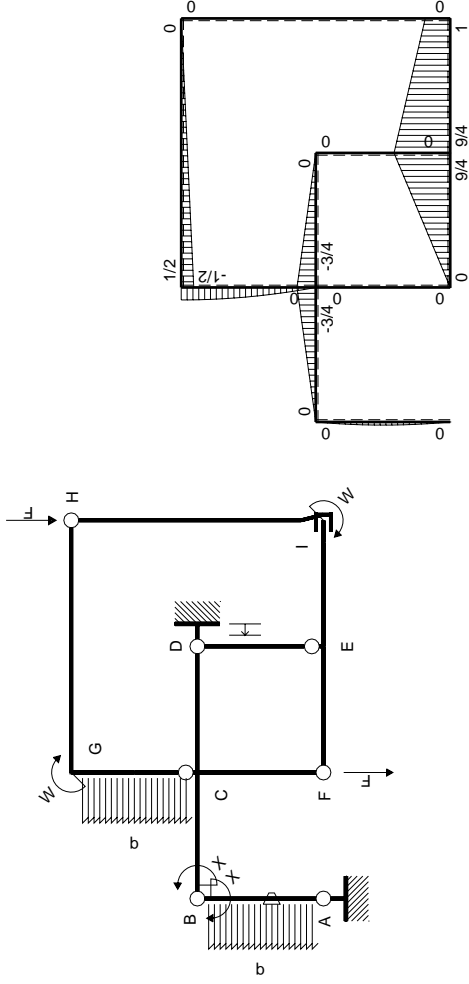
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 960. mm²
- J_u = 276646. mm⁴
- J_v = 52992. mm⁴
- y_g = 21.4 mm
- T_y = -3105. N
- M_x = 1831950. Nmm
- x_m = 24. mm
- y_m = 56. mm
- u_m = 6. mm
- v_m = 34.6 mm
- σ_m = -Mv/J_u = -229.1 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 19.6 mm
- σ_c = -Mv/J_u = -129.8 N/mm²
- τ_c = 4.562 N/mm²
- σ_o = √σ²+3τ² = 130. N/mm²
- S = 4878. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

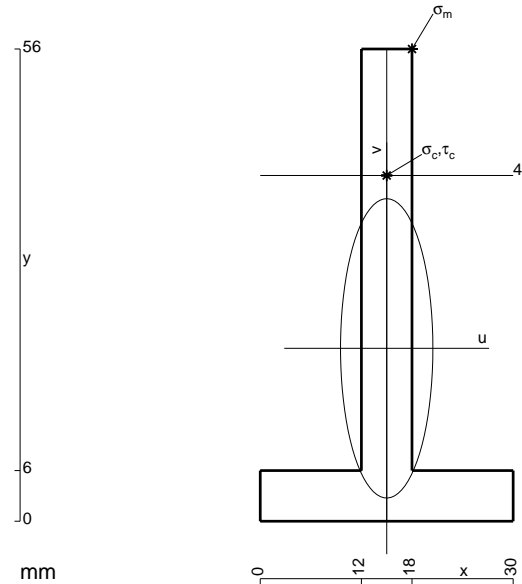
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

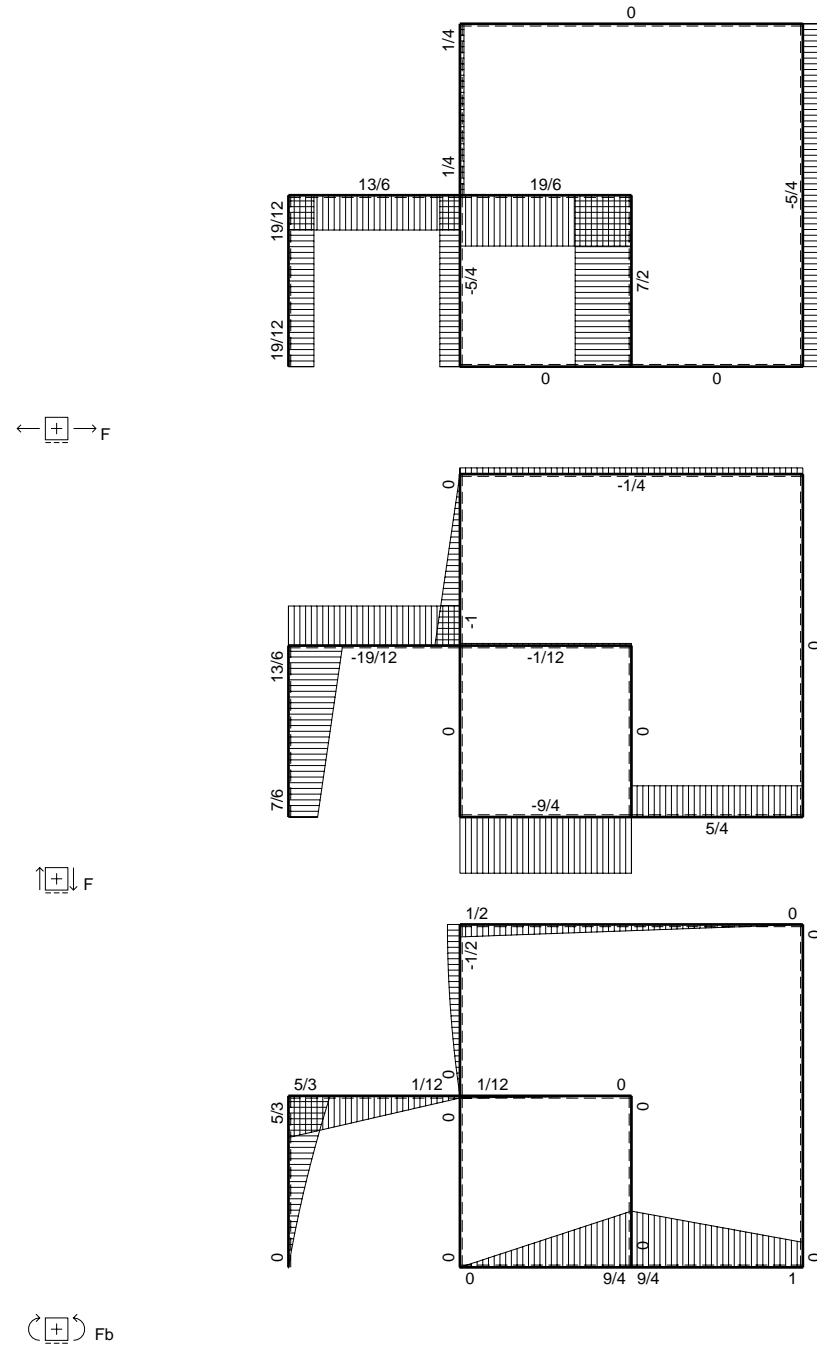
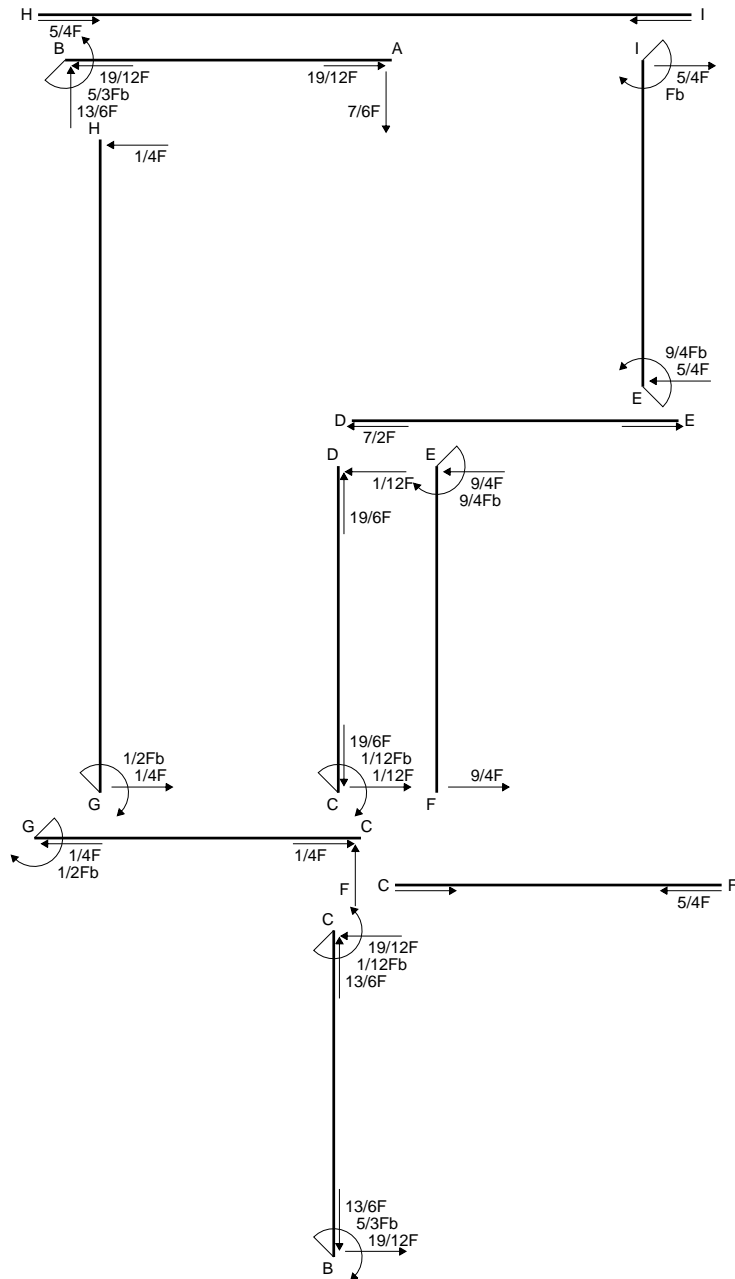
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

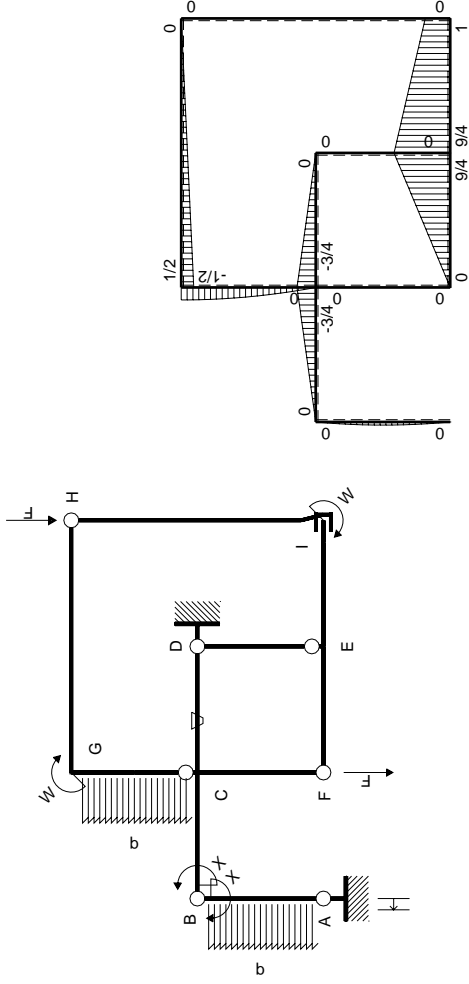
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



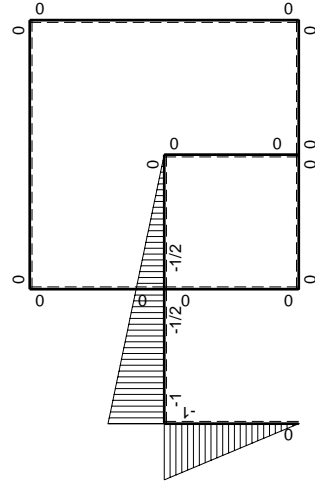
- A = 480. mm²
- J_u = 151240. mm⁴
- J_v = 14400. mm⁴
- y_g = 20.5 mm
- T_y = -1598. N
- M_x = 1022400. Nmm
- x_m = 18. mm
- y_m = 56. mm
- u_m = 3. mm
- v_m = 35.5 mm
- σ_m = -Mv/J_u = -240. N/mm²
- x_c = 15. mm
- y_c = 41. mm
- v_c = 20.5 mm
- σ_c = -Mv/J_u = -138.6 N/mm²
- τ_c = 4.436 N/mm²
- σ_o = √σ²+3τ² = 138.8 N/mm²
- S = 2520. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$							Fb^2/EJ	
	totali							$5/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-5/3Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

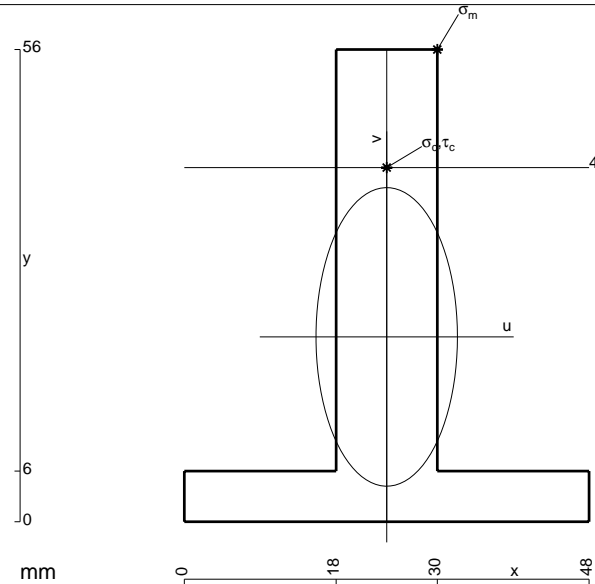
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

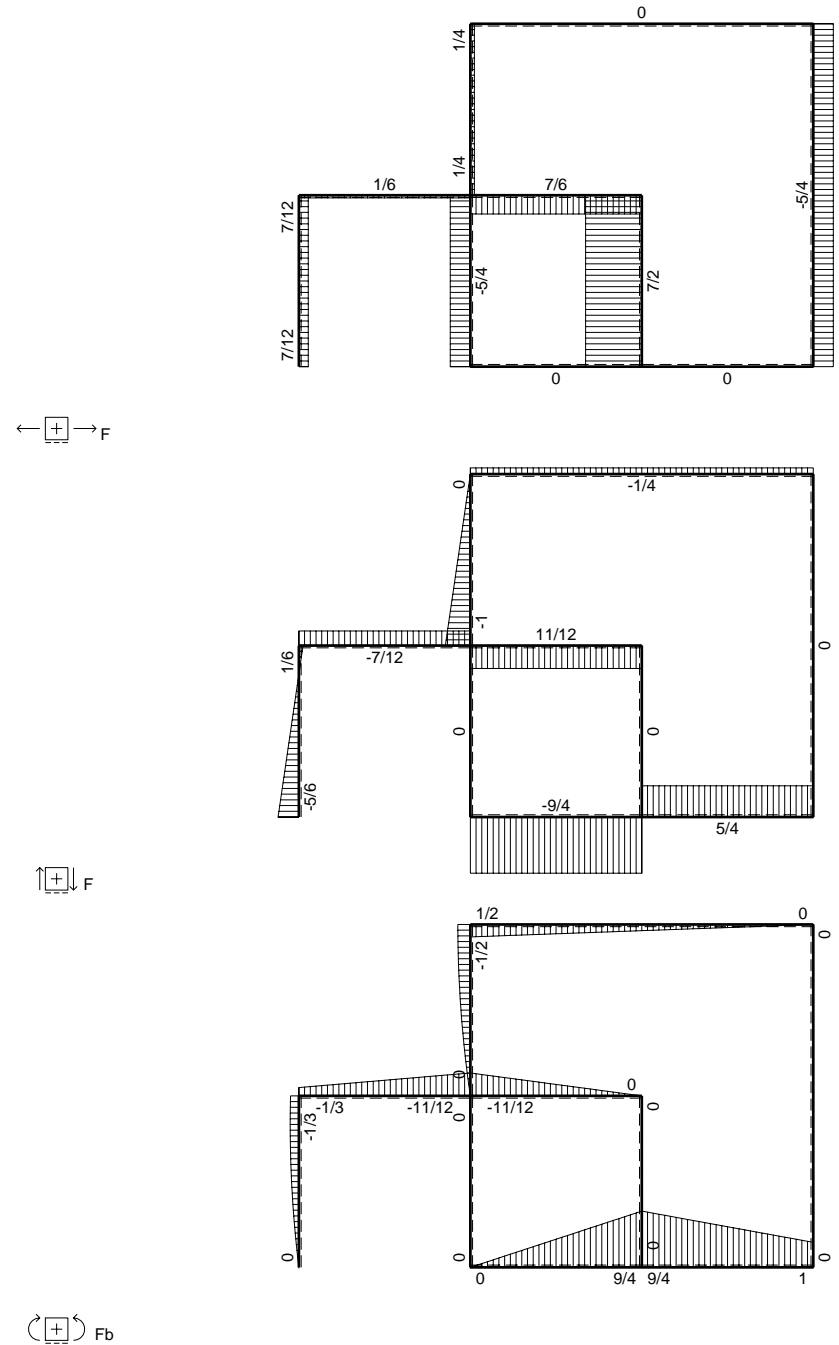
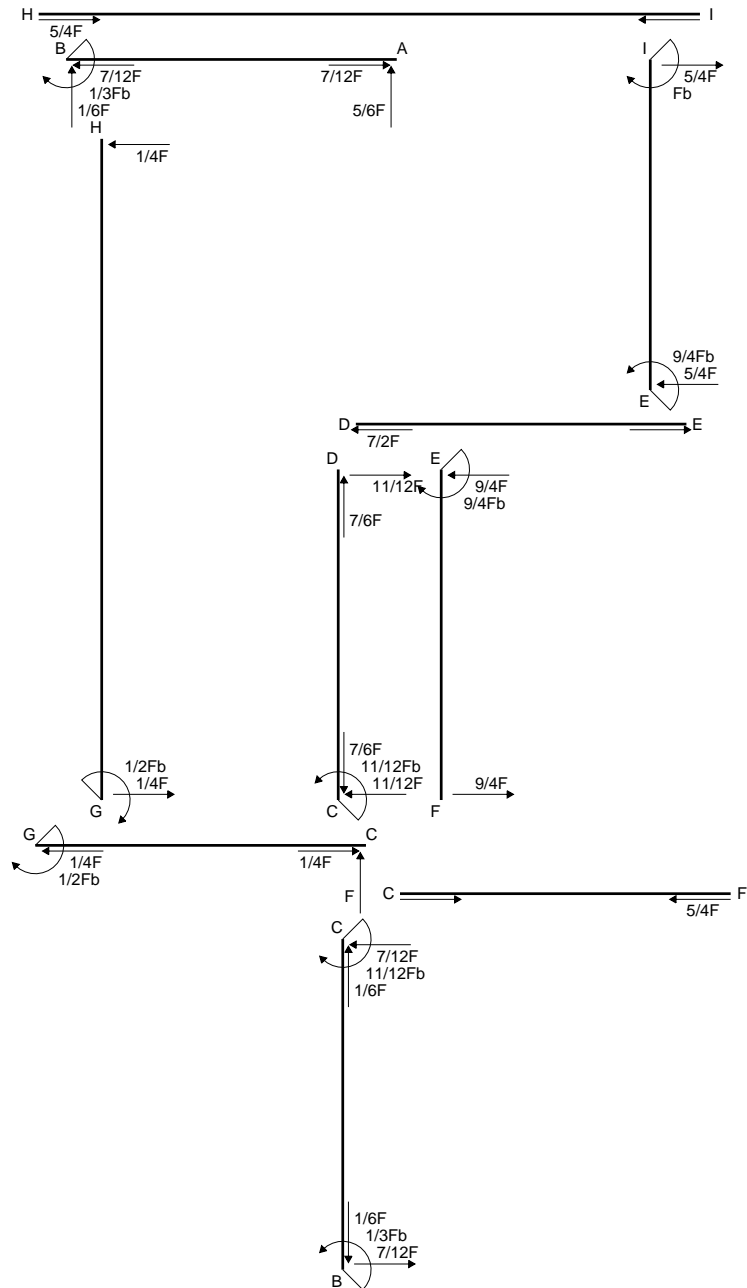
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

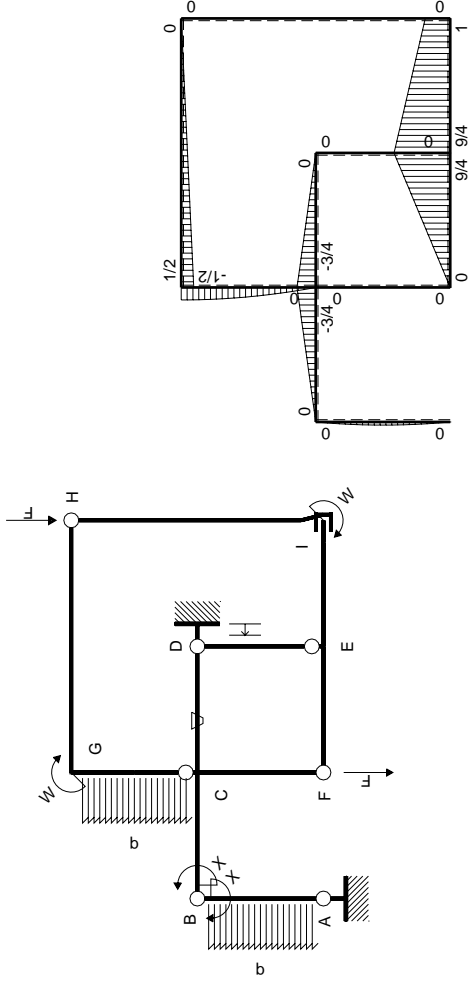
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



- A = 888. mm²
- J_u = 278426. mm⁴
- J_v = 62496. mm⁴
- y_g = 21.92 mm
- T_y = -2363. N
- M_x = 1630130. Nmm
- x_m = 30. mm
- y_m = 56. mm
- u_m = 6. mm
- v_m = 34.08 mm
- σ_m = -Mv/J_u = -199.5 N/mm²
- x_c = 24. mm
- y_c = 42. mm
- v_c = 20.08 mm
- σ_c = -Mv/J_u = -117.6 N/mm²
- τ_c = 3.217 N/mm²
- σ_q = √σ²+3τ² = 117.7 N/mm²
- S = 4550. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/3Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

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

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

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

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

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

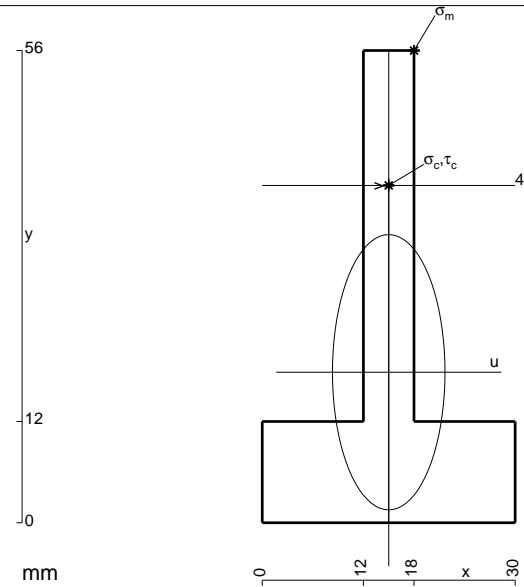
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

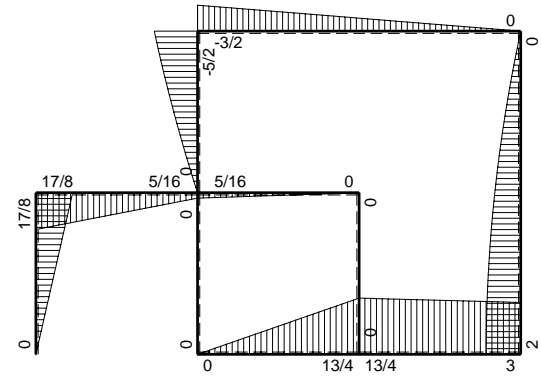
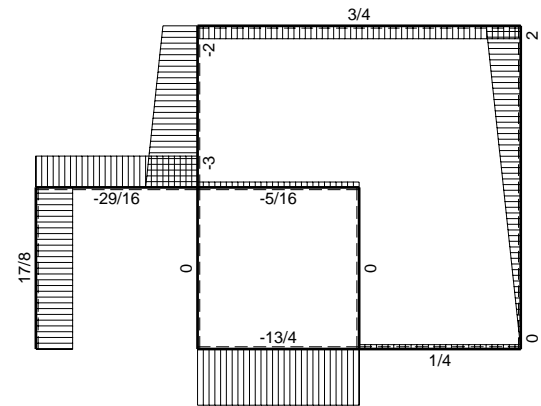
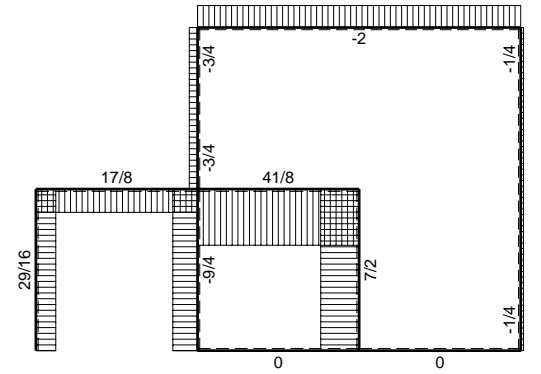
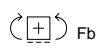
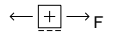
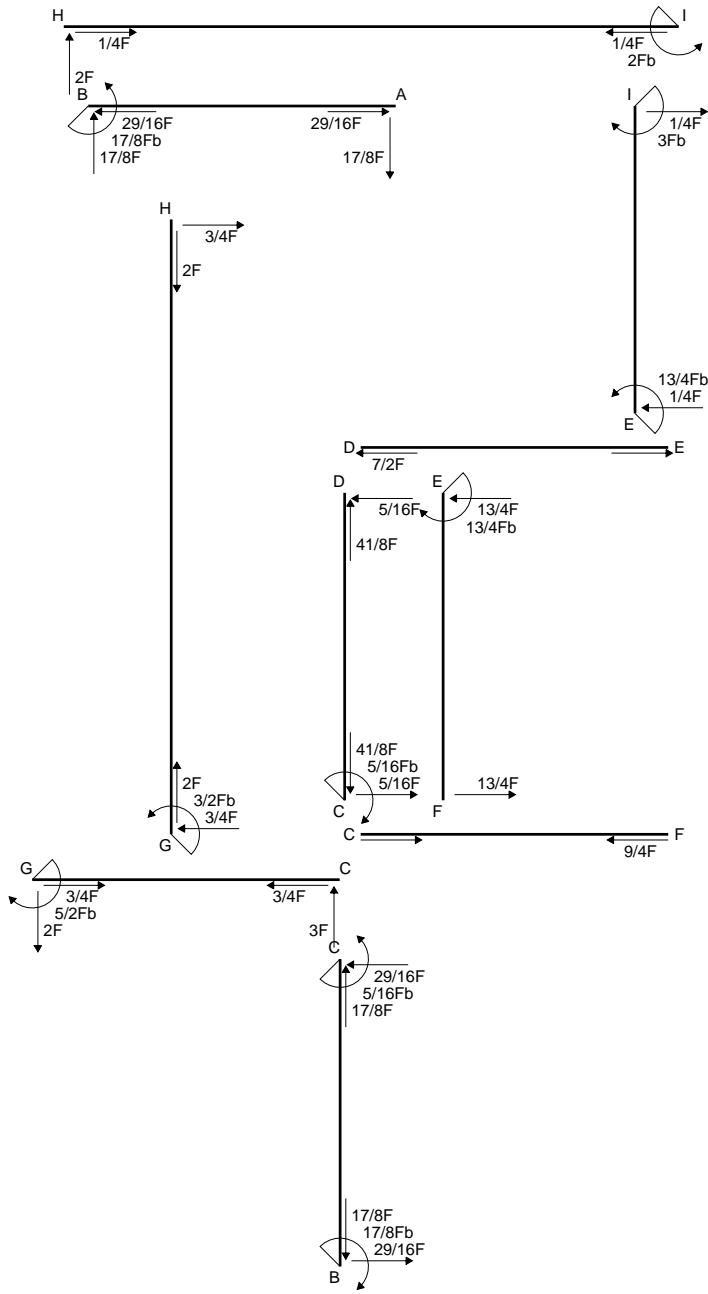
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

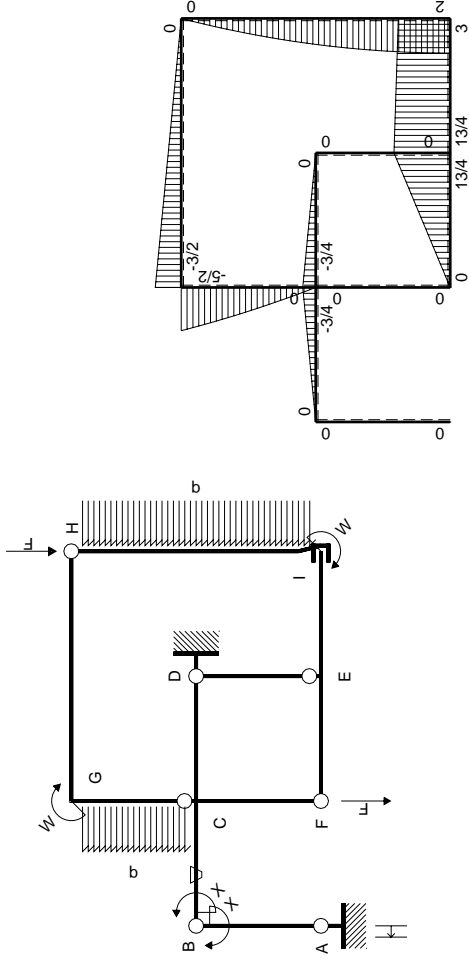
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

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



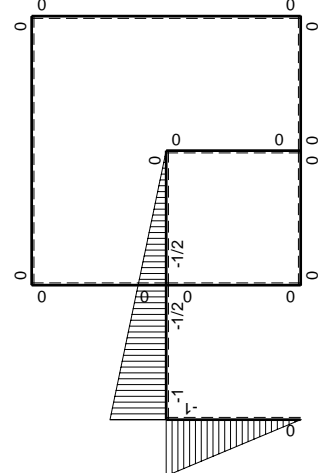
- A = 624. mm²
- J_u = 166321. mm⁴
- J_v = 27792. mm⁴
- y_g = 17.85 mm
- T_y = -1238. N
- M_x = 903375. Nmm
- x_m = 18. mm
- y_m = 56. mm
- u_m = 3. mm
- v_m = 38.15 mm
- σ_m = -Mv/J_u = -207.2 N/mm²
- x_c = 15. mm
- y_c = 40. mm
- v_c = 22.15 mm
- σ_c = -Mv/J_u = -120.3 N/mm²
- τ_c = 3.59 N/mm²
- σ_q = √σ²+3τ² = 120.5 N/mm²
- S = 2895. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0
FE b	0	$-13/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-3Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$5/2Fb-2Fx-1/2qx^2$	0	0	0	0		
GH 2b	0	$-3/2Fb+3/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$3/4Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/4Fx$	0	0	0	0	0+0	0
EI b	0	$-13/4Fb+1/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$17/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-17/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

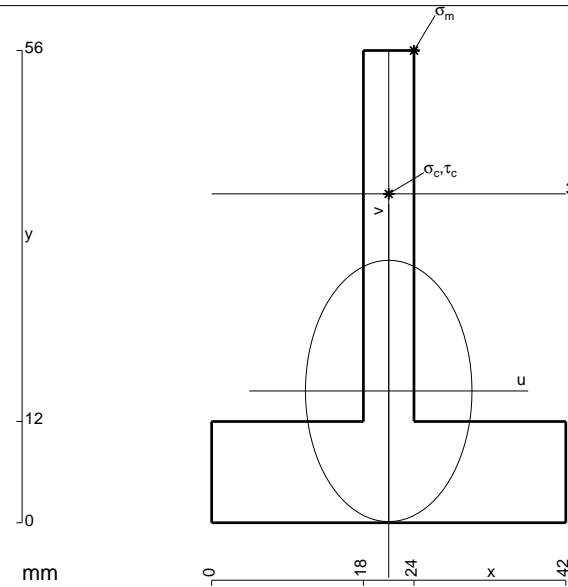
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

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

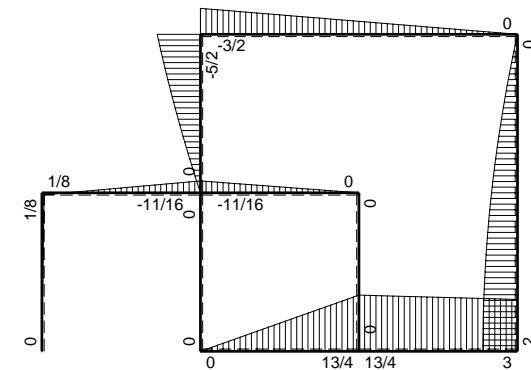
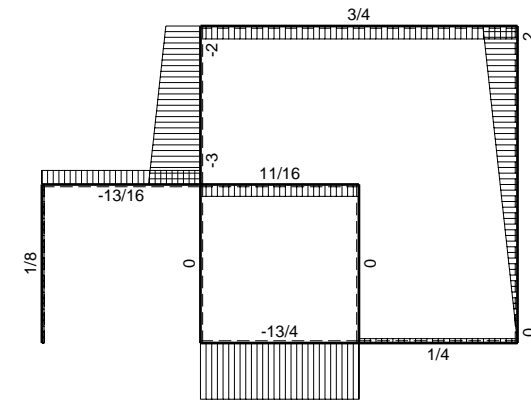
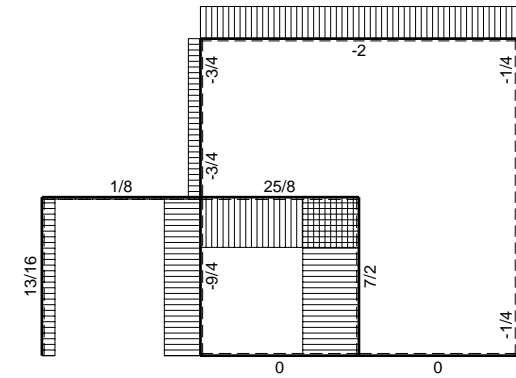
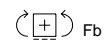
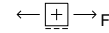
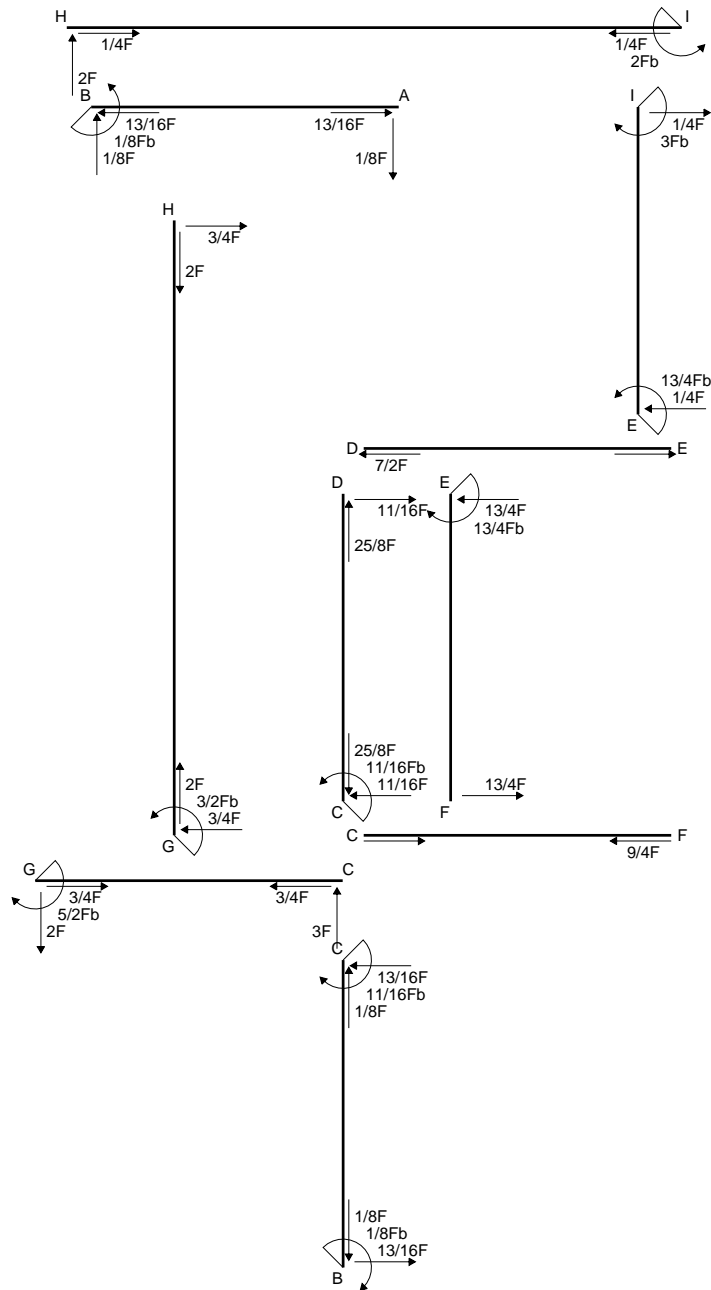
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

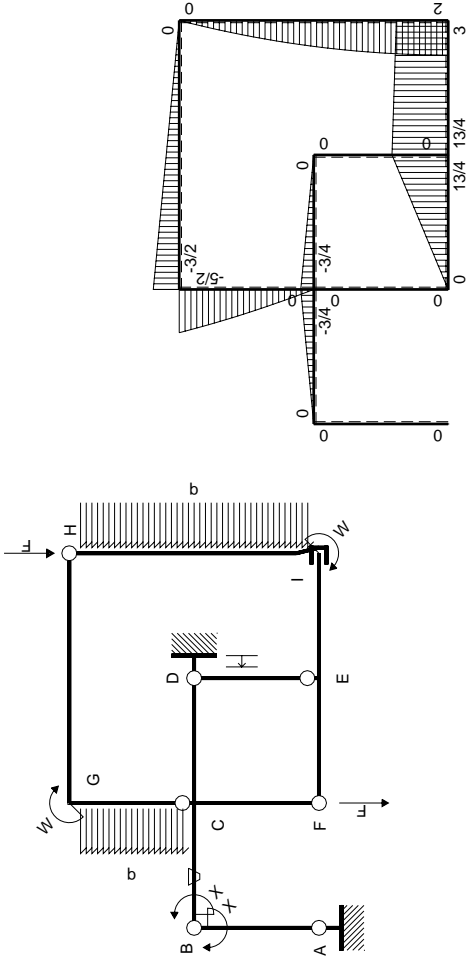
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



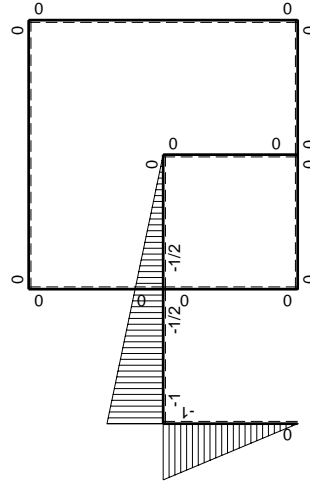
- A = 768. mm²
- J_u = 184468. mm⁴
- J_v = 74880. mm⁴
- y_g = 15.63 mm
- T_y = -1268. N
- M_x = 988650. Nmm
- x_m = 24. mm
- y_m = 56. mm
- u_m = 3. mm
- v_m = 40.38 mm
- σ_m = -Mv/J_u = -216.4 N/mm²
- x_c = 21. mm
- y_c = 39. mm
- v_c = 23.38 mm
- σ_c = -Mv/J_u = -125.3 N/mm²
- τ_c = 3.723 N/mm²
- σ_q = √σ²+3τ² = 125.4 N/mm²
- S = 3251. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0
FE b	0	$-13/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-3Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$5/2Fb-2Fx-1/2qx^2$	0	0	0	0		
GH 2b	0	$-3/2Fb+3/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$3/4Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/4Fx$	0	0	0	0	0+0	0
EI b	0	$-13/4Fb+1/4Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-1/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

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

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

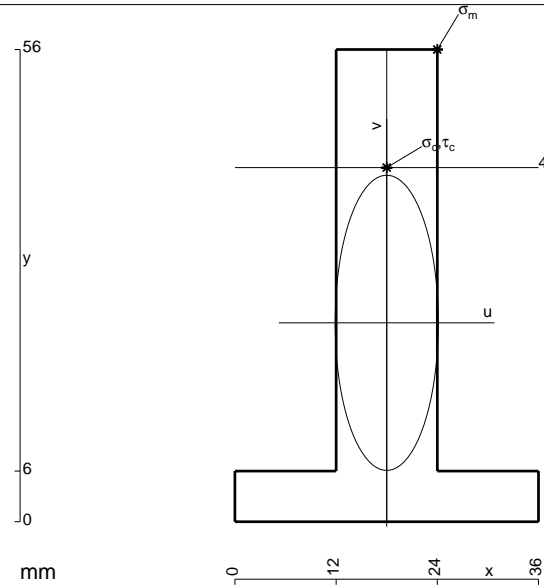
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

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

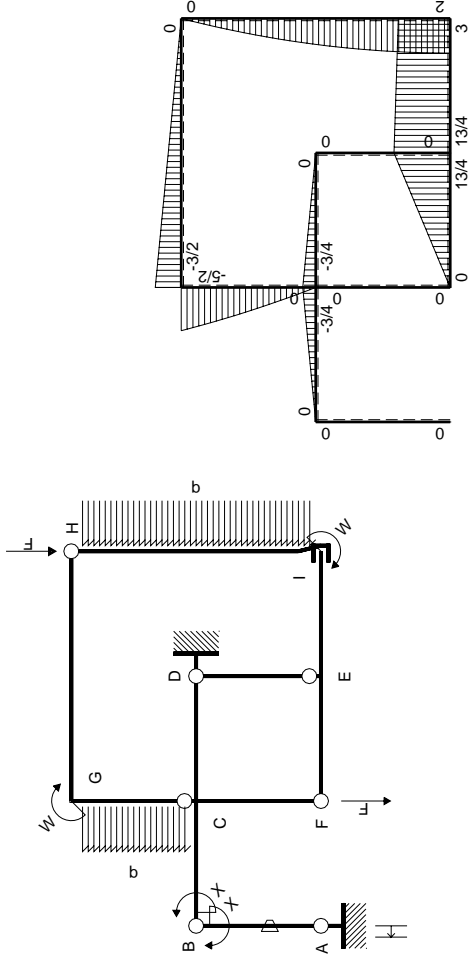
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

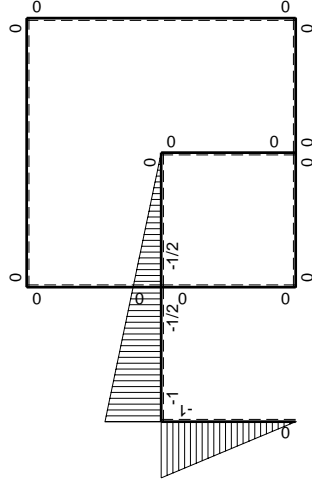


- A = 816. mm²
- J_u = 250166. mm⁴
- J_v = 30528. mm⁴
- y_g = 23.59 mm
- T_y = -2145. N
- M_x = 1758900. Nmm
- x_m = 24. mm
- y_m = 56. mm
- u_m = 6. mm
- v_m = 32.41 mm
- σ_m = -Mv/J_u = -227.9 N/mm²
- x_c = 18. mm
- y_c = 42. mm
- v_c = 18.41 mm
- σ_c = -Mv/J_u = -129.5 N/mm²
- τ_c = 3.05 N/mm²
- σ_q = √σ²+3τ² = 129.6 N/mm²
- S = 4269. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0
FE b	0	$-13/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-3Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$5/2Fb-2Fx-1/2qx^2$	0	0	0	0		
GH 2b	0	$-3/2Fb+3/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$3/4Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/4Fx$	0	0	0	0	0+0	0
EI b	0	$-13/4Fb+1/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$15/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-15/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

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

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

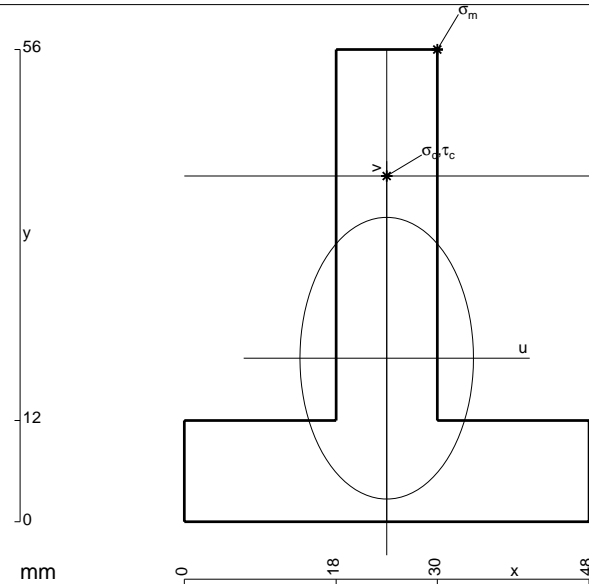
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

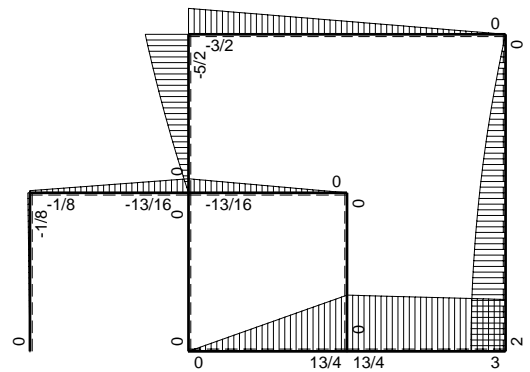
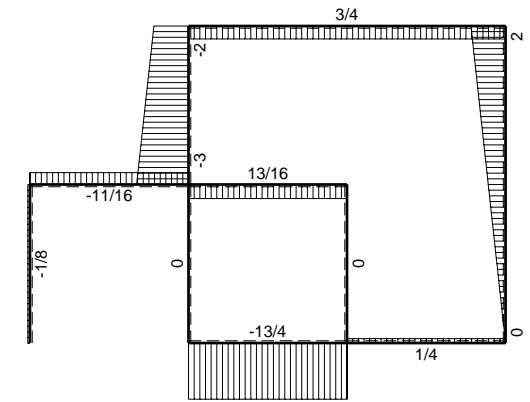
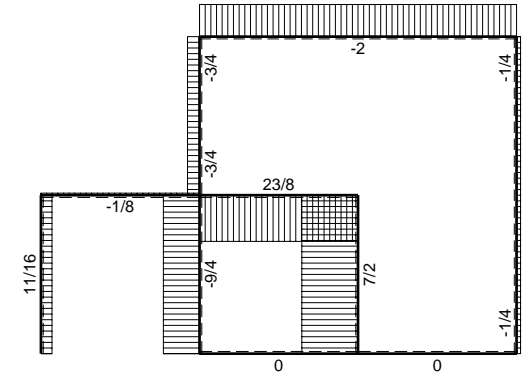
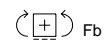
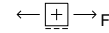
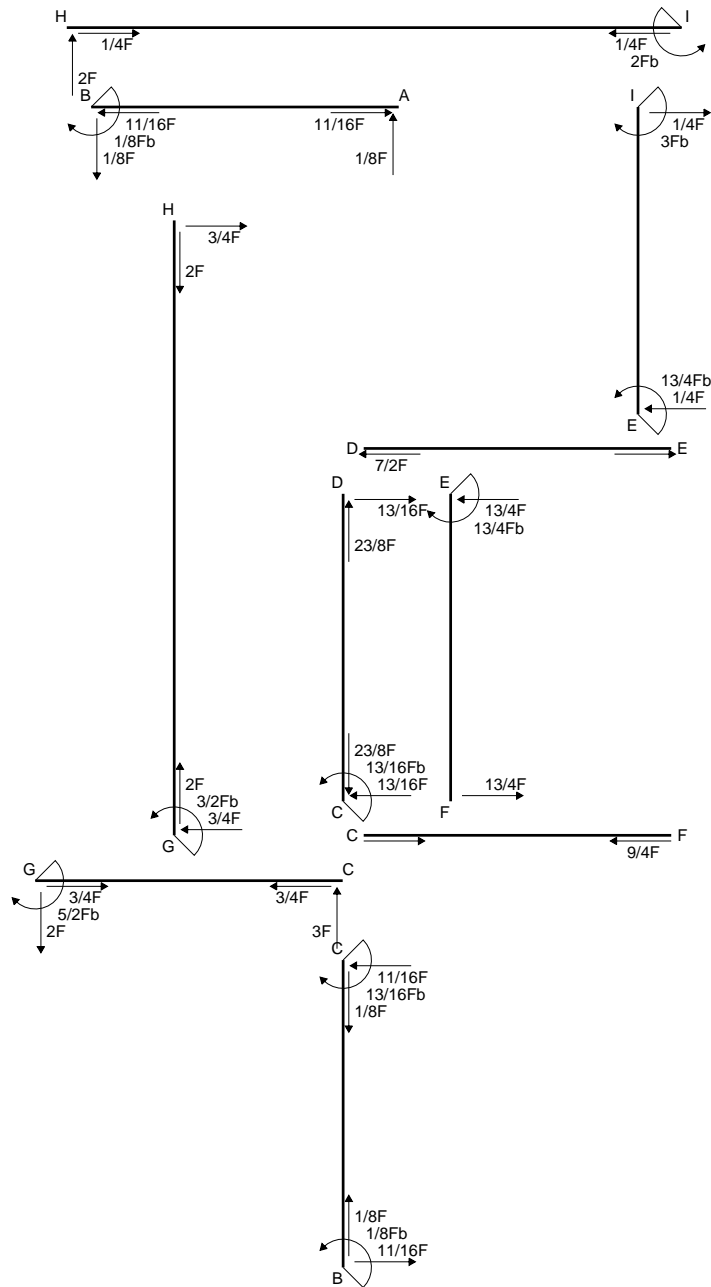
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

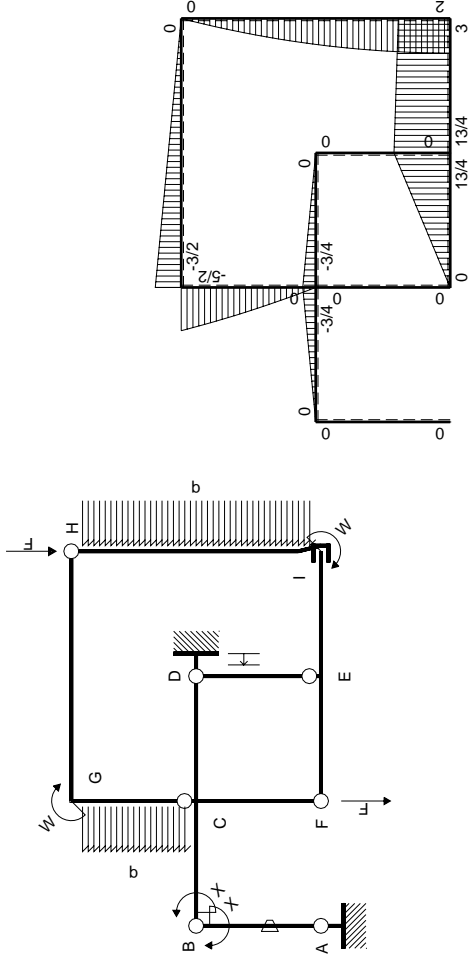
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



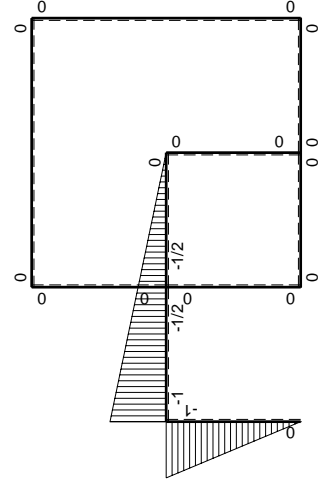
- A = 1104. mm²
- J_u = 308071. mm⁴
- J_v = 116928. mm⁴
- y_g = 19.39 mm
- T_y = -2308. N
- M_x = 2007530. Nmm
- x_m = 30. mm
- y_m = 56. mm
- u_m = 6. mm
- v_m = 36.61 mm
- σ_m = -Mv/J_u = -238.6 N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 21.61 mm
- σ_c = -Mv/J_u = -140.8 N/mm²
- τ_c = 3.27 N/mm²
- σ_q = √σ²+3τ² = 140.9 N/mm²
- S = 5240. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-13/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$5/2Fb-2Fx-1/2qx^2$	0	0	0	0			
GH 2b	0	$-3/2Fb+3/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$3/4Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-13/4Fb+1/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

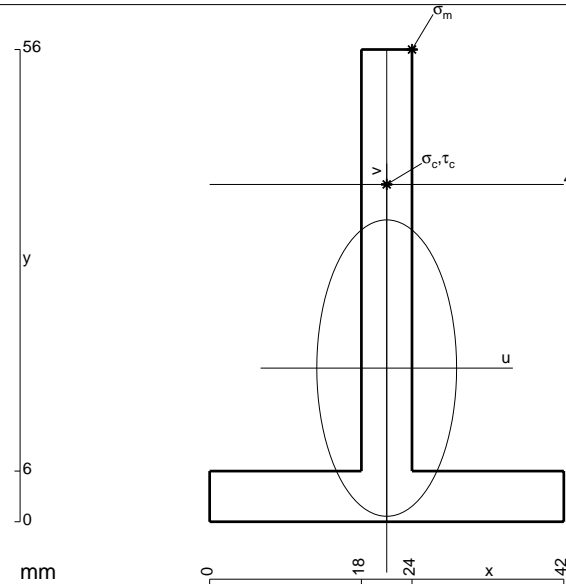
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

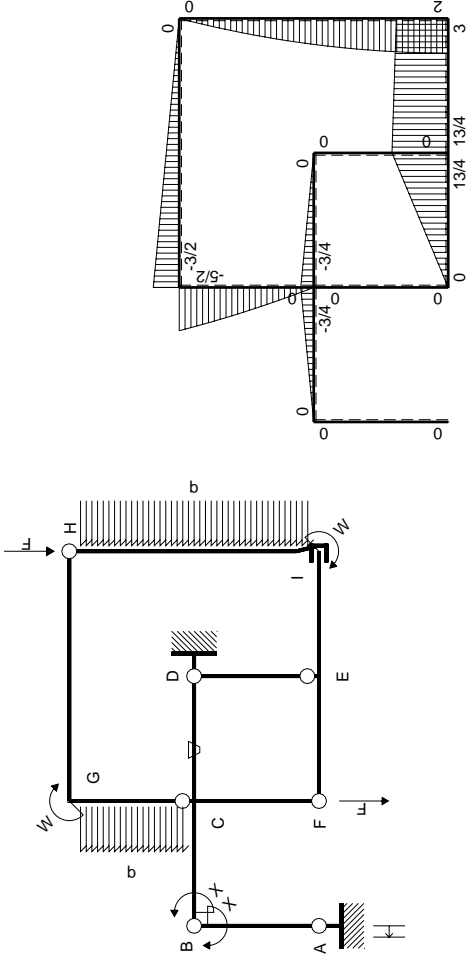
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

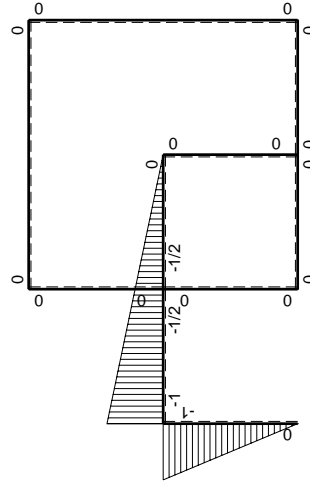


- A = 552. mm²
- J_u = 170630. mm⁴
- J_v = 37944. mm⁴
- y_g = 18.22 mm
- T_y = -1950. N
- M_x = 897000. Nmm
- x_m = 24. mm
- y_m = 56. mm
- u_m = 3. mm
- v_m = 37.78 mm
- σ_m = -Mv/J_u = -198.6 N/mm²
- x_c = 21. mm
- y_c = 40. mm
- v_c = 21.78 mm
- σ_c = -Mv/J_u = -114.5 N/mm²
- τ_c = 5.446 N/mm²
- σ_q = √σ²+3τ² = 114.9 N/mm²
- S = 2859. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0
FE b	0	$-13/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-3Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$5/2Fb-2Fx-1/2qx^2$	0	0	0	0		
GH 2b	0	$-3/2Fb+3/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$3/4Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/4Fx$	0	0	0	0	0+0	0
EI b	0	$-13/4Fb+1/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$13/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-13/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

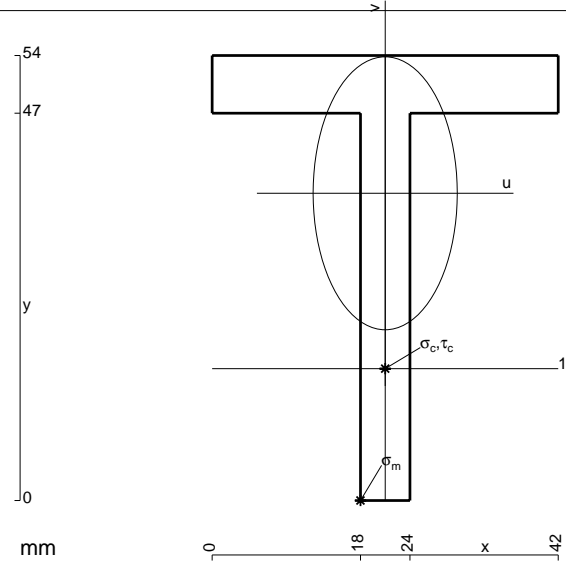
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

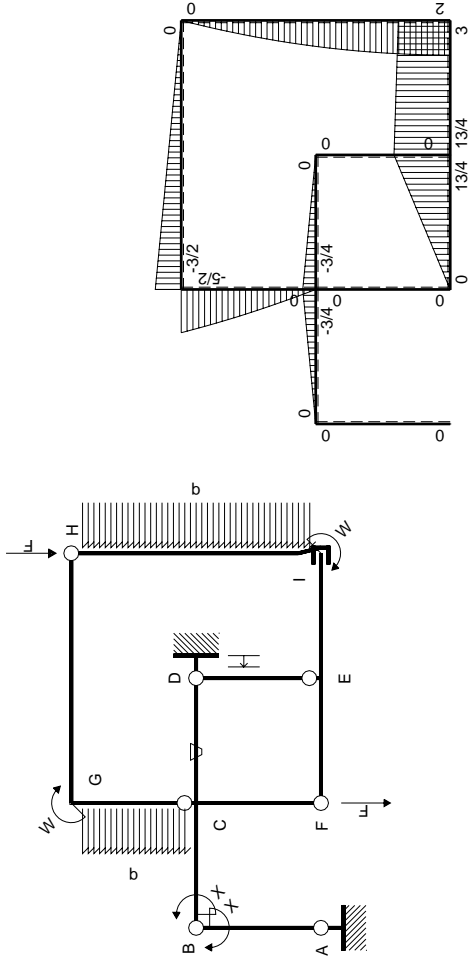
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/8 b) Fb 1/EJ + (-1/4 b) \theta = 3/8 Fb^2/EJ$$

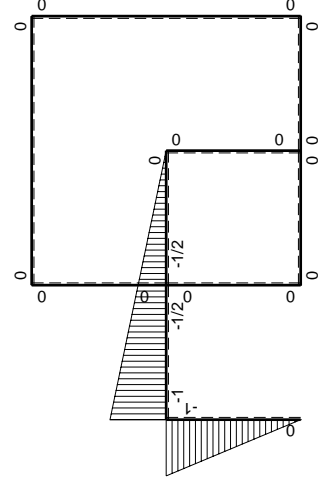


- A = 576. mm²
- J_u = 158042. mm⁴
- J_v = 44064. mm⁴
- y_g = 37.28 mm
- T_y = -1788. N
- M_x = 875875. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -37.28 mm
- σ_m = -Mv/J_u = 206.6 N/mm²
- x_c = 21. mm
- y_c = 16. mm
- v_c = -21.28 mm
- σ_c = -Mv/J_u = 117.9 N/mm²
- τ_c = 5.299 N/mm²
- σ_o = √σ² + 3τ² = 118.3 N/mm²
- S = 2811. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-13/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$5/2Fb-2Fx-1/2qx^2$	0	0	0	0			
GH 2b	0	$-3/2Fb+3/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$3/4Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-13/4Fb+1/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-3/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$3/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

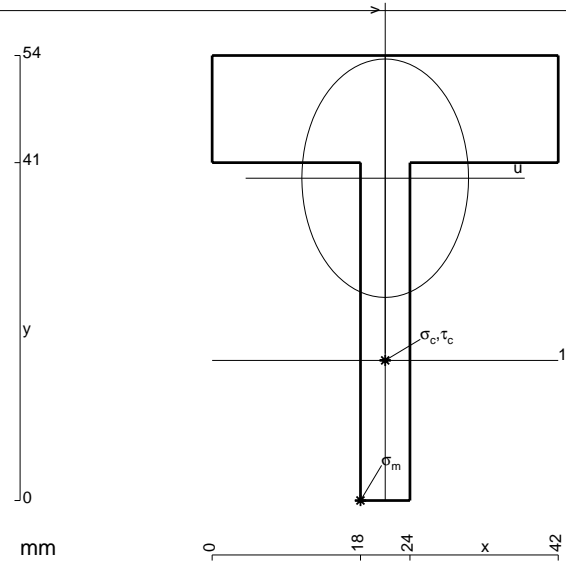
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

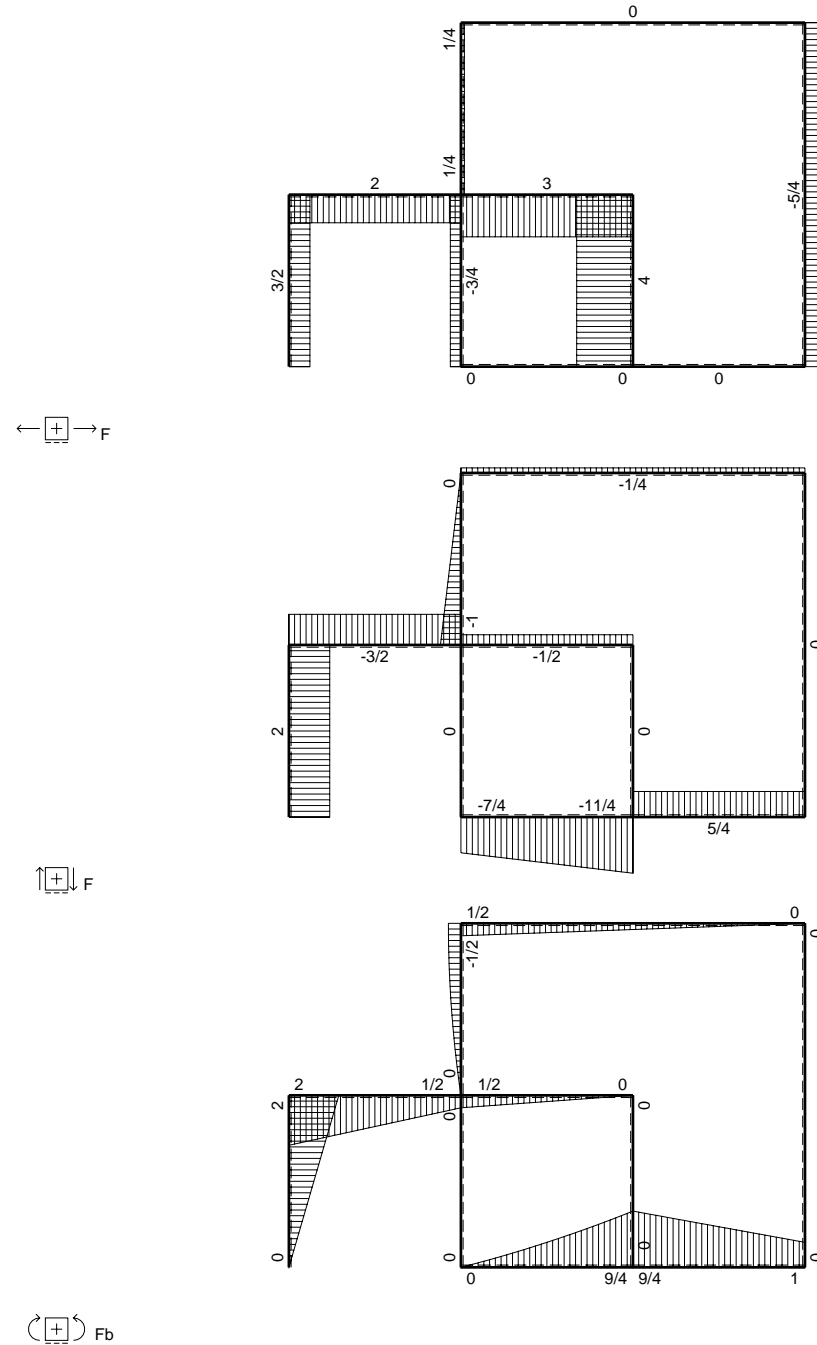
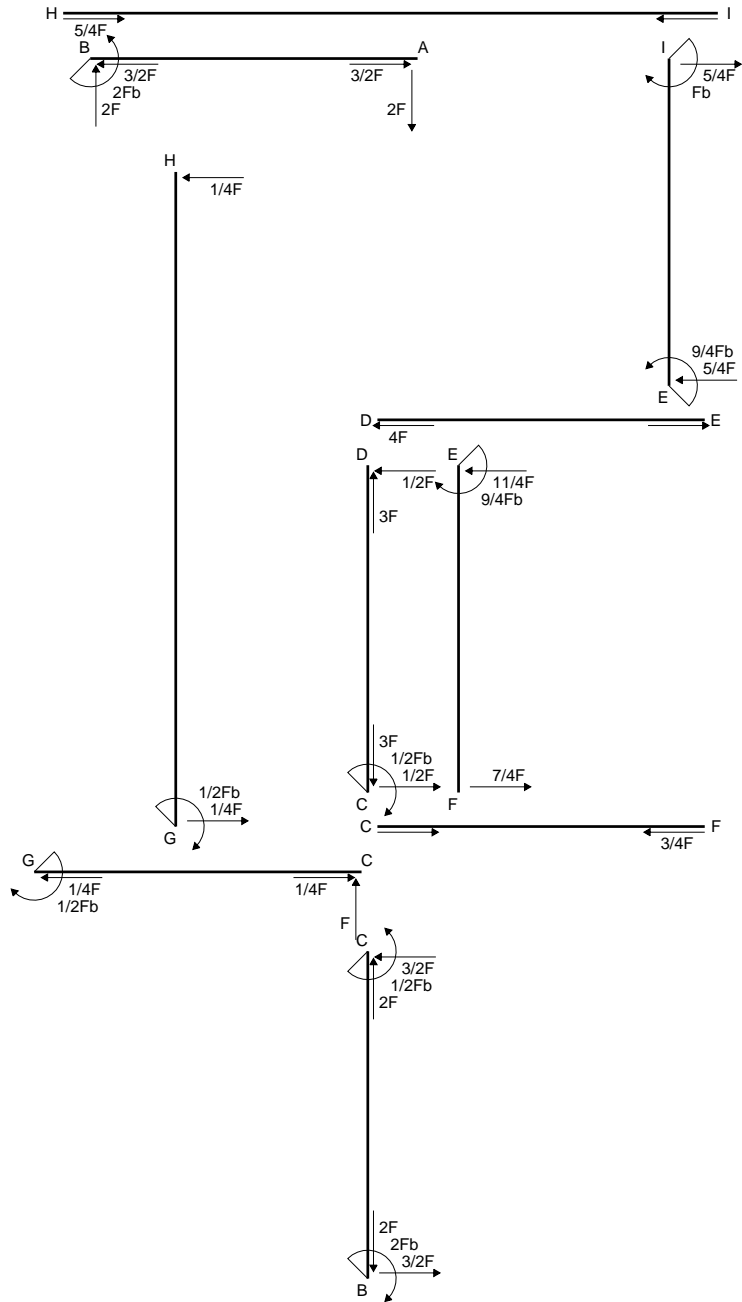
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

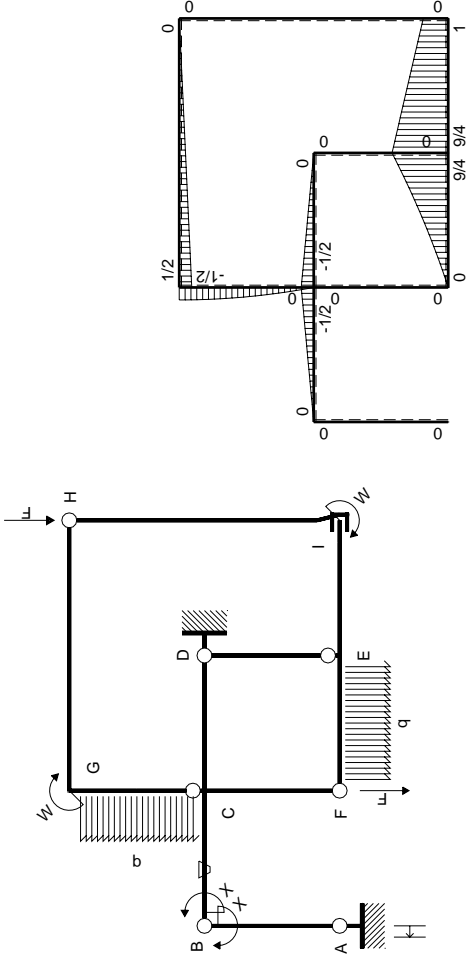
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/8 b) Fb 1/EJ + (-1/4 b) \theta = 3/8 Fb^2/EJ$$



- A = 792. mm²
- J_u = 165782. mm⁴
- J_v = 81000. mm⁴
- y_g = 39.11 mm
- T_y = -1723. N
- M_x = 930150. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -39.11 mm
- σ_m = -Mv/J_u = 219.5 N/mm²
- x_c = 21. mm
- y_c = 17. mm
- v_c = -22.11 mm
- σ_c = -Mv/J_u = 124.1 N/mm²
- τ_c = 5.407 N/mm²
- σ_o = √σ²+3τ² = 124.4 N/mm²
- S = 3123. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-1/2Fx$	$-Fb/EJ$	$1/2Fx-1/4Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/6+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	Fb/EJ	$1/4Fb-1/4Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-11/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-7/4Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ		
	totali						$2Fb^2/EJ$	Xb/EJ	
	iperstatica $X=W_{BC}$						$-2Fb$		

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/12 b) Fb 1/EJ + (b - 1/4 b) \theta = 11/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

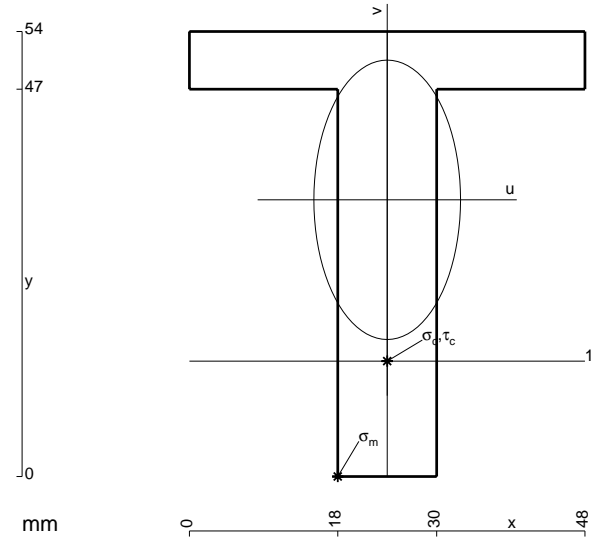
$$= (1/4 b - 1/12 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 11/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

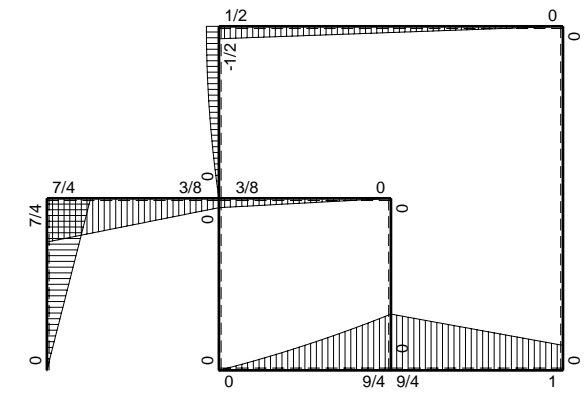
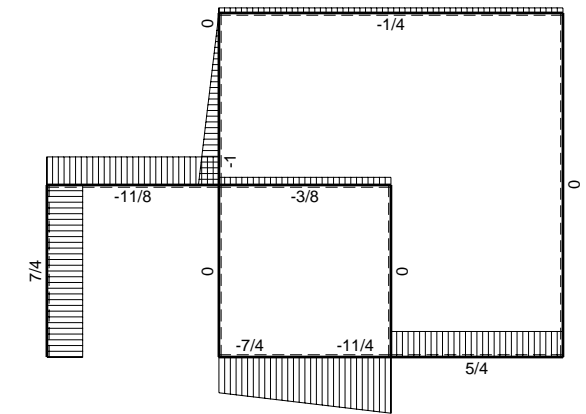
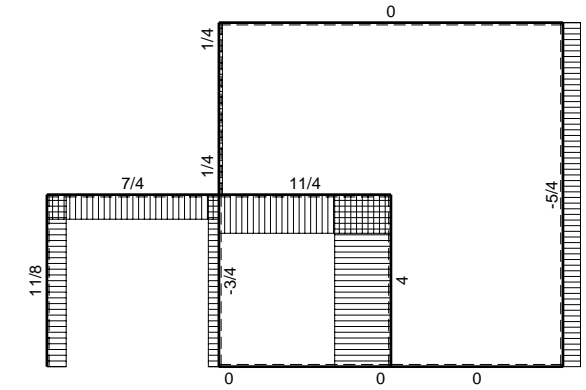
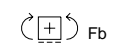
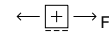
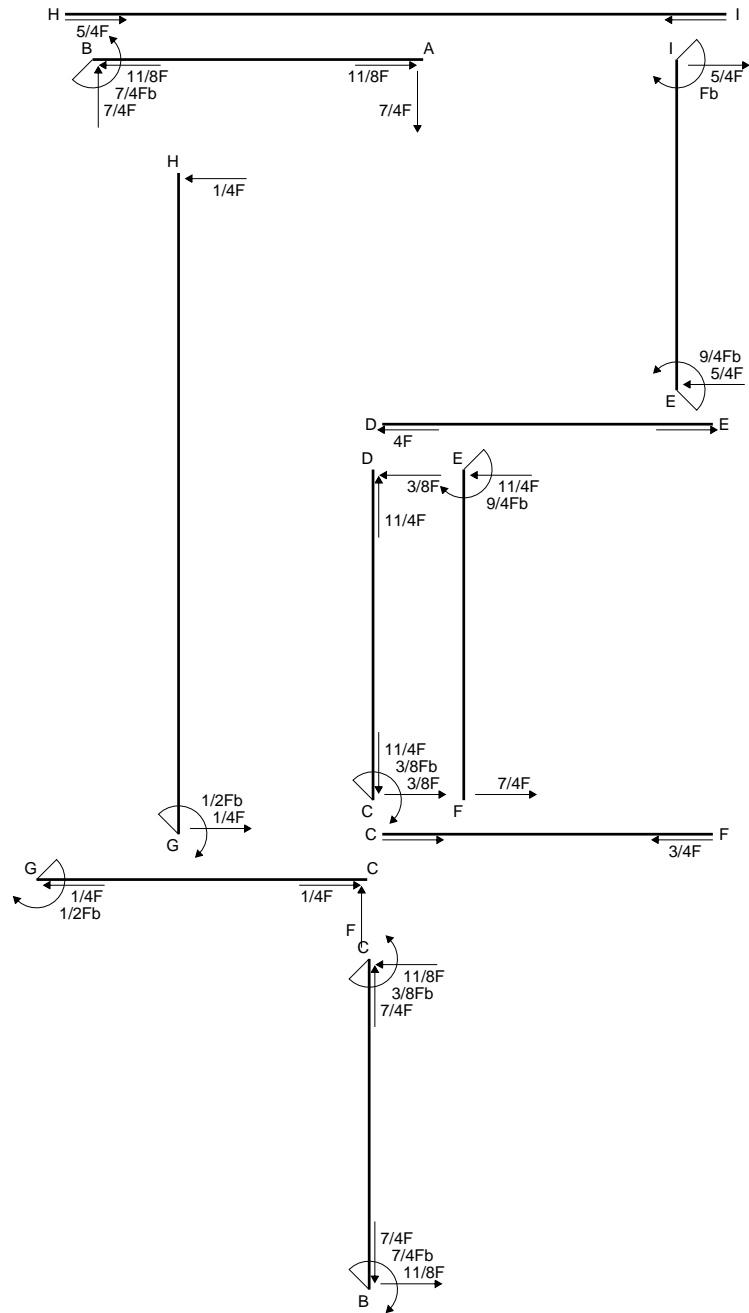
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

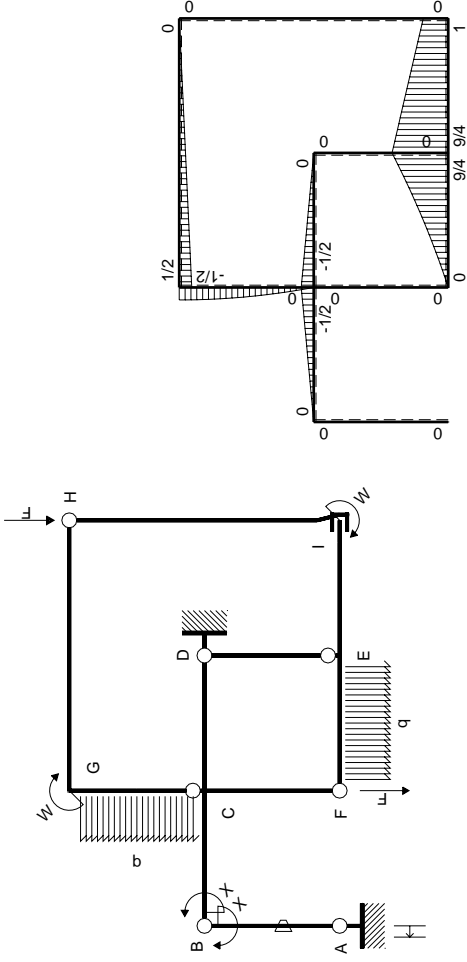
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 900. mm²
- J_u = 258693. mm⁴
- J_v = 71280. mm⁴
- y_g = 33.58 mm
- T_y = -3713. N
- M_x = 1761750. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -33.58 mm
- σ_m = -Mv/J_u = 228.7 N/mm²
- x_c = 24. mm
- y_c = 14. mm
- v_c = -19.58 mm
- σ_c = -Mv/J_u = 133.3 N/mm²
- τ_c = 5.34 N/mm²
- σ_o = √σ²+3τ² = 133.7 N/mm²
- S = 4465. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-1/2Fx$	0	$1/2Fx-1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$1/4Fb-1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/4Fb-11/4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-7/4Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$7/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-7/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

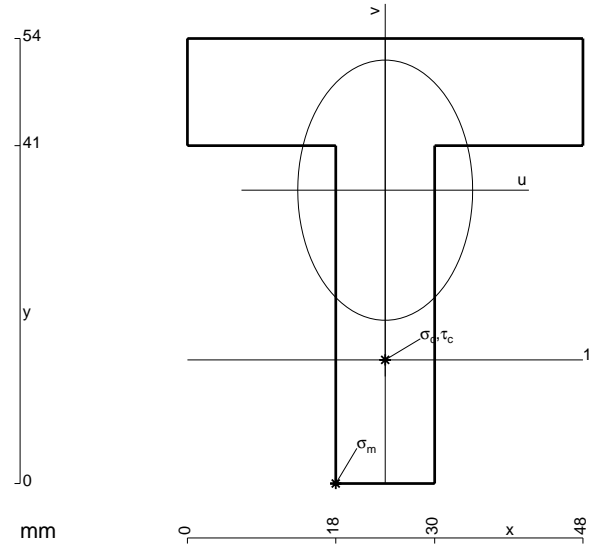
$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

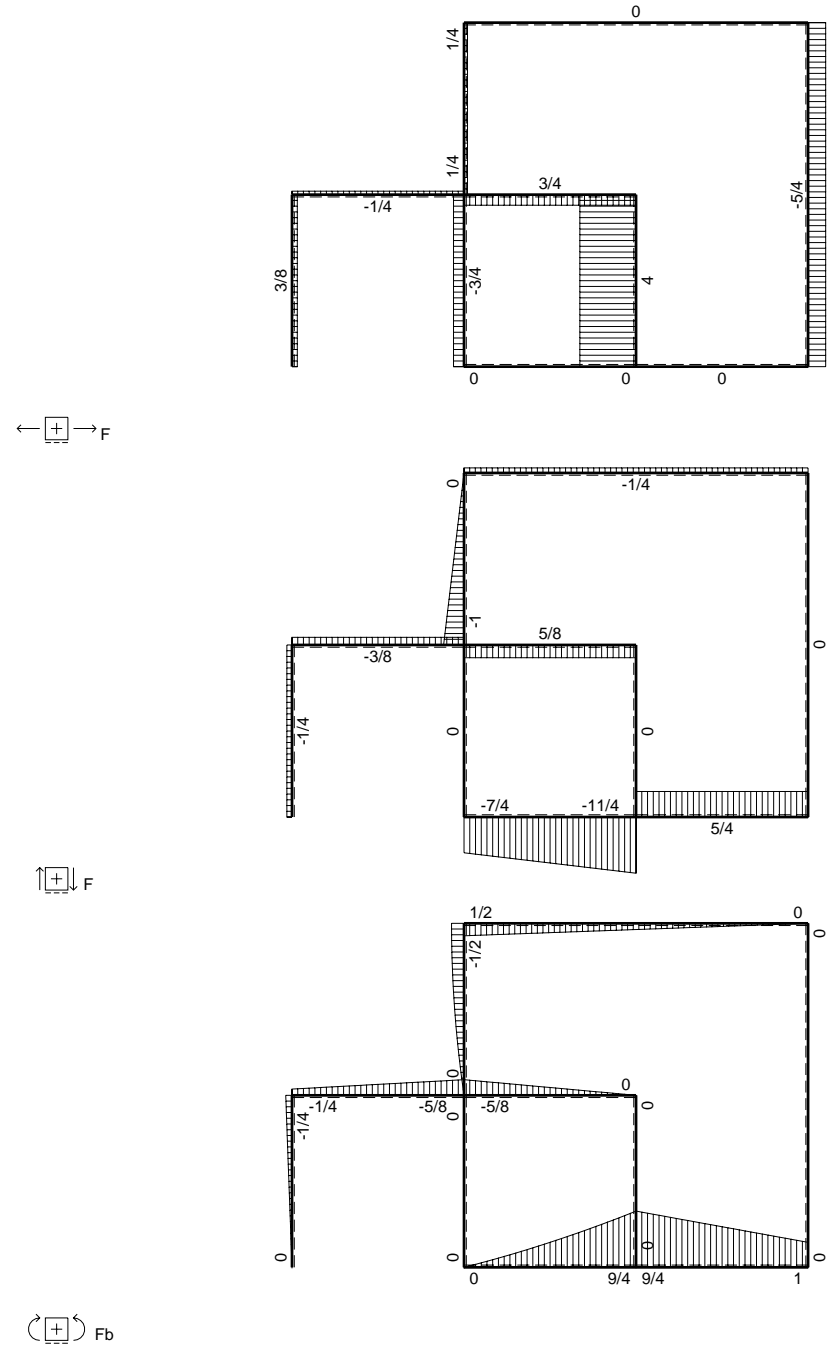
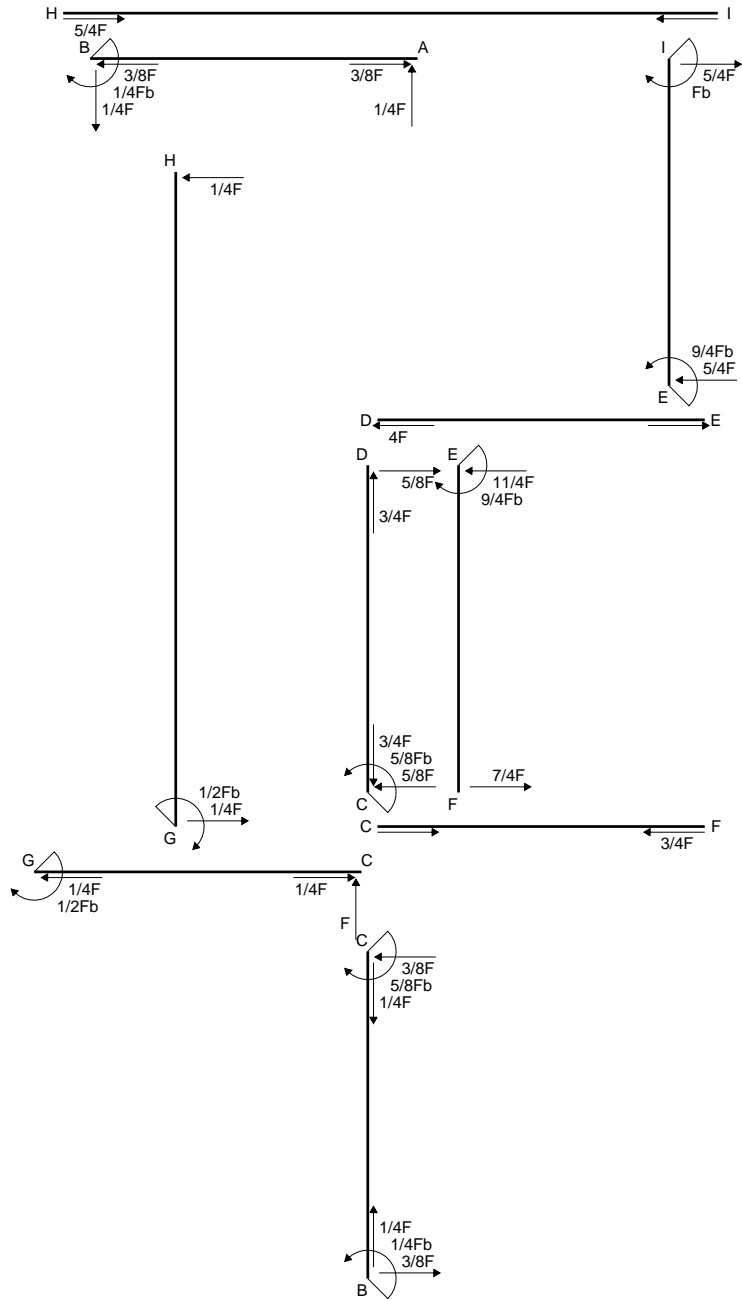
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

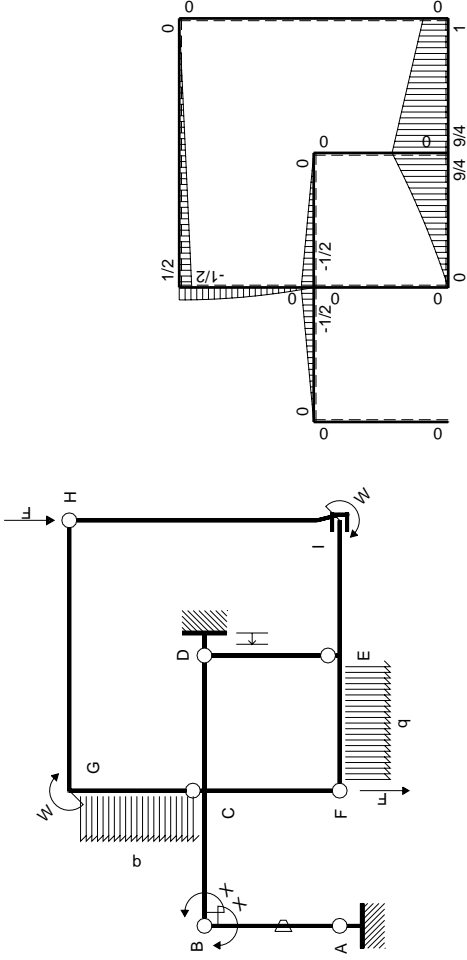
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 1116. mm²
- J_u = 278254. mm⁴
- J_v = 125712. mm⁴
- y_g = 35.6 mm
- T_y = -3630. N
- M_x = 1871100. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -35.6 mm
- σ_m = -Mv/J_u = 239.4 N/mm²
- x_c = 24. mm
- y_c = 15. mm
- v_c = -20.6 mm
- σ_c = -Mv/J_u = 138.5 N/mm²
- τ_c = 5.498 N/mm²
- σ_o = √σ²+3τ² = 138.8 N/mm²
- S = 5057. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-1/2Fx$	0	$1/2Fx-1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$1/4Fb-1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/4Fb-11/4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-7/4Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$-1/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$1/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

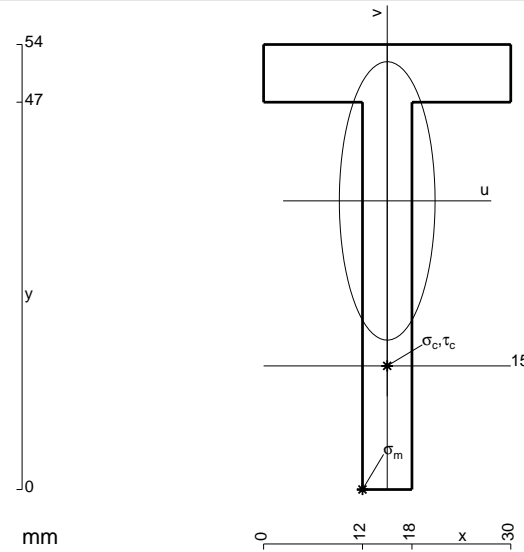
$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

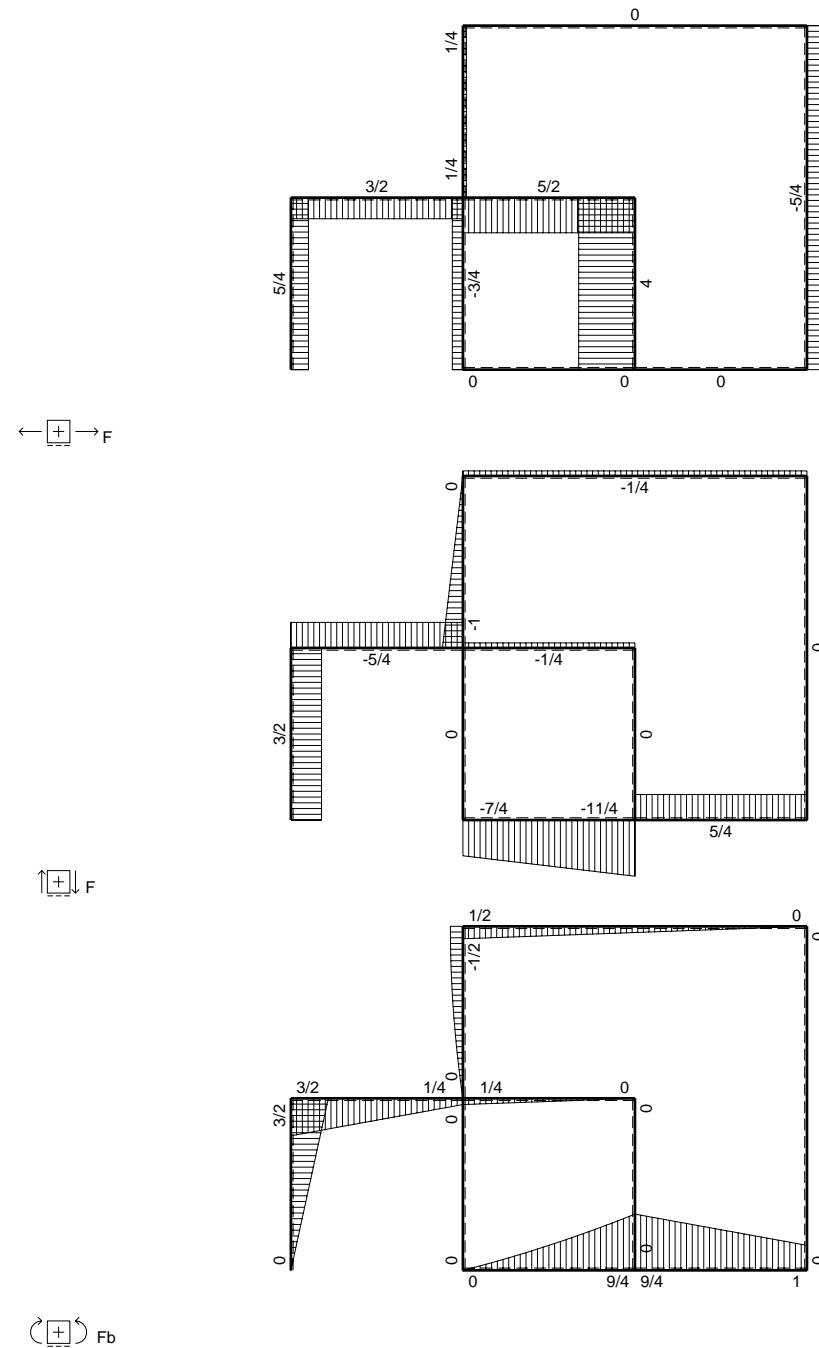
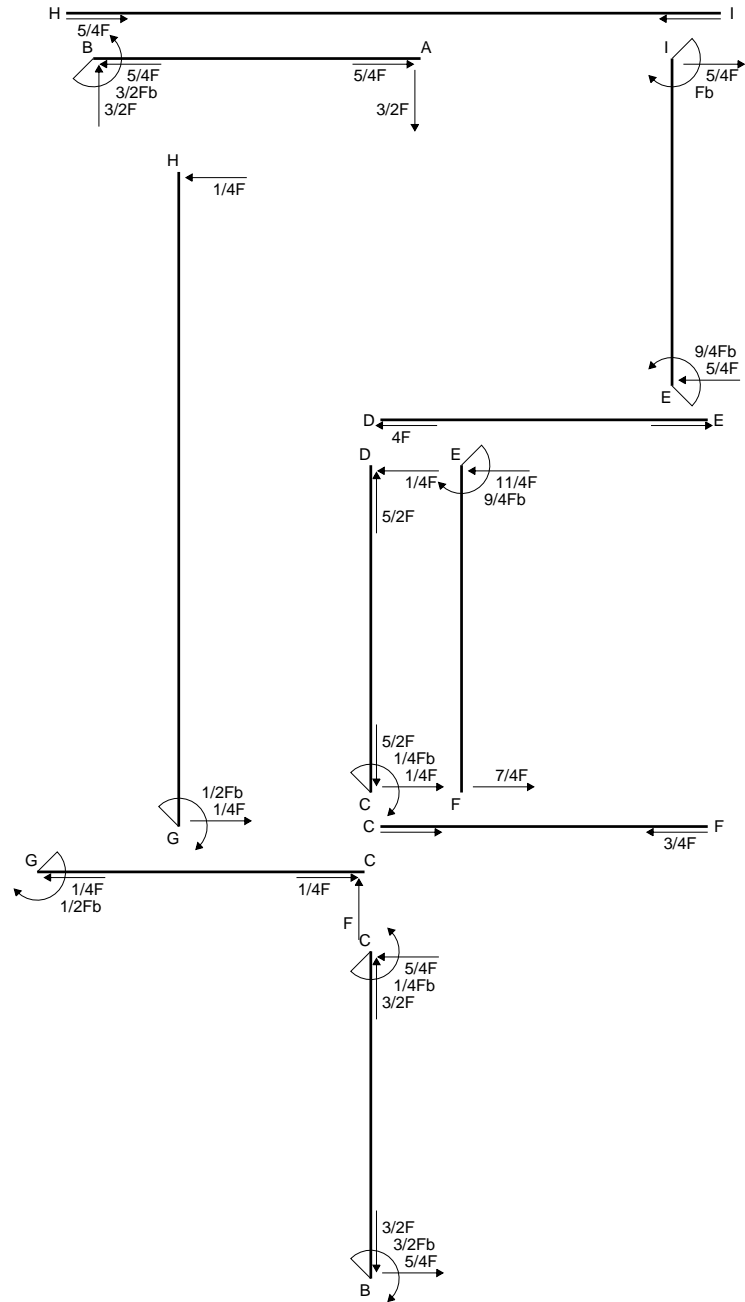
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

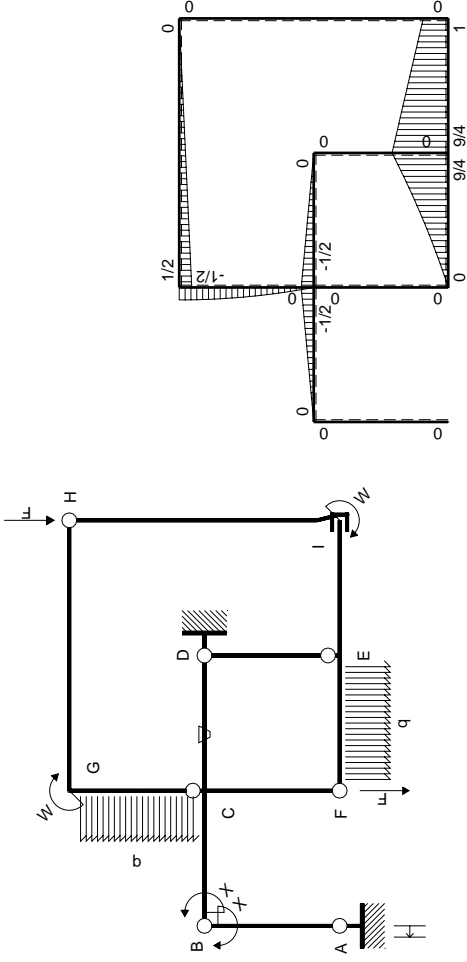
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 492. mm²
- J_u = 140516. mm⁴
- J_v = 16596. mm⁴
- y_g = 35.02 mm
- T_y = -1458. N
- M_x = 798975. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -35.02 mm
- σ_m = -Mv/J_u = 199.1 N/mm²
- x_c = 15. mm
- y_c = 15. mm
- v_c = -20.02 mm
- σ_c = -Mv/J_u = 113.9 N/mm²
- τ_c = 4.282 N/mm²
- σ_o = √σ²+3τ² = 114.1 N/mm²
- S = 2477. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-1/2Fx$	0	$1/2Fx-1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$1/4Fb-1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	$-Fb/EJ$	$1/4Fb-1/2Fx+1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	Fb/EJ	$1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/4Fb-11/4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-7/4Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$3/2Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-3/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

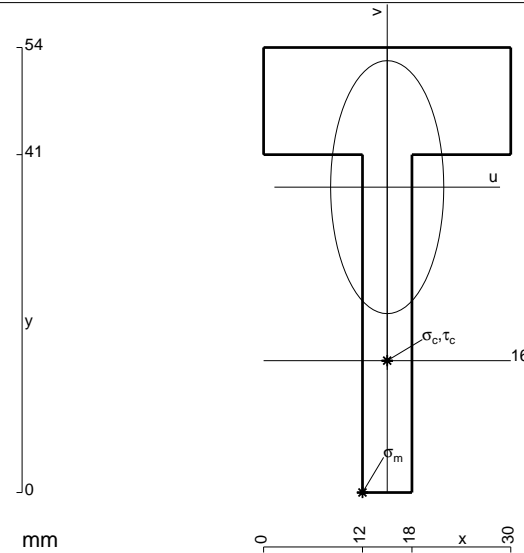
$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/3 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/3 Fb^2/EJ$$



$$A = 636. \text{ mm}^2$$

$$J_u = 149922. \text{ mm}^4$$

$$J_v = 29988. \text{ mm}^4$$

$$y_g = 37.06 \text{ mm}$$

$$T_y = -1430. \text{ N}$$

$$M_x = 842400. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -3. \text{ mm}$$

$$v_m = -37.06 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 208.2 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 16. \text{ mm}$$

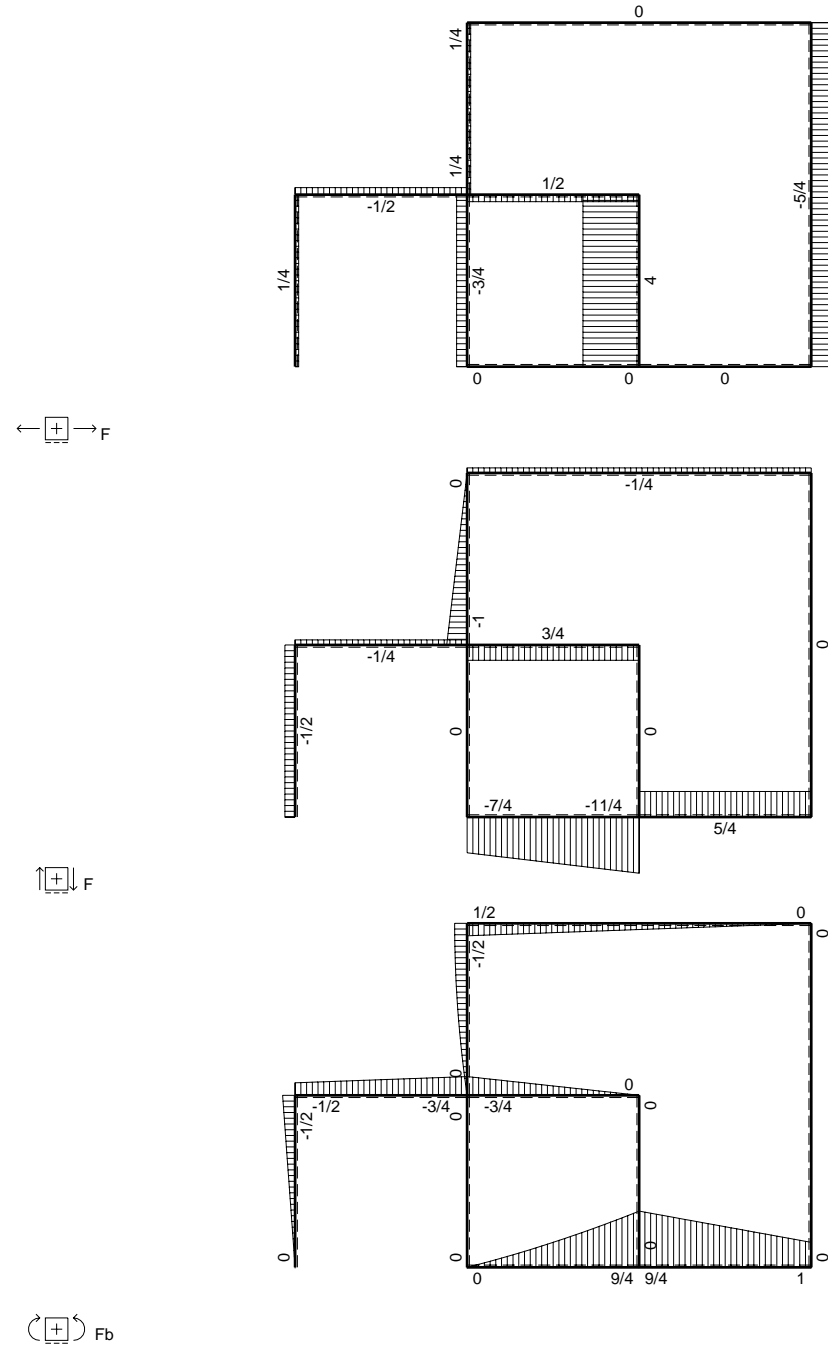
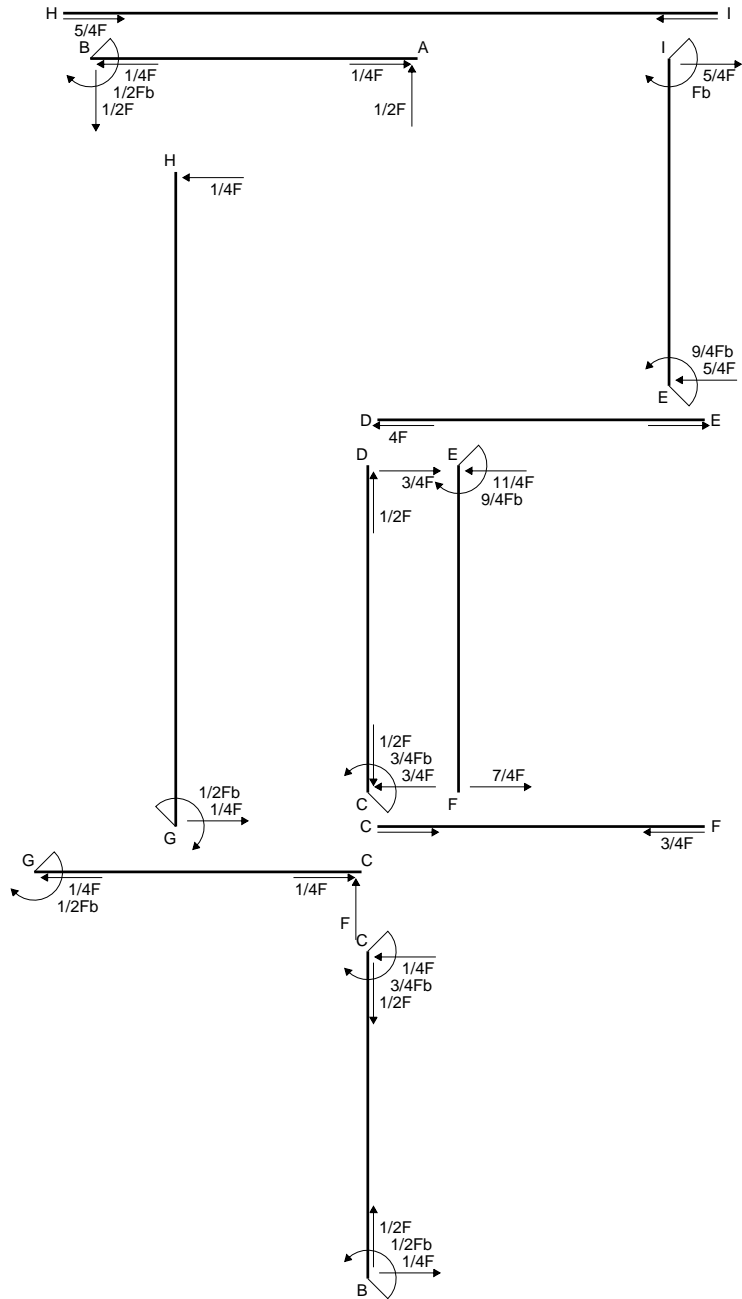
$$v_c = -21.06 \text{ mm}$$

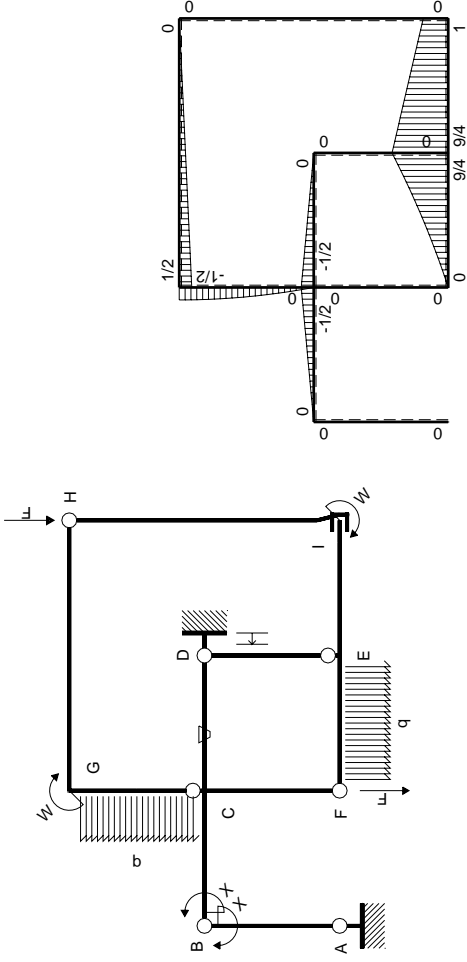
$$\sigma_c = -Mv/J_u = 118.3 \text{ N/mm}^2$$

$$\tau_c = 4.434 \text{ N/mm}^2$$

$$\sigma_\rho = \sqrt{\sigma^2 + 3\tau^2} = 118.6 \text{ N/mm}^2$$

$$S = 2789. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-1/2Fx$	0	$1/2Fx-1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$1/4Fb-1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	$-Fb/EJ$	$1/4Fb-1/2Fx+1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	Fb/EJ	$1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-11/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-7/4Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/2Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

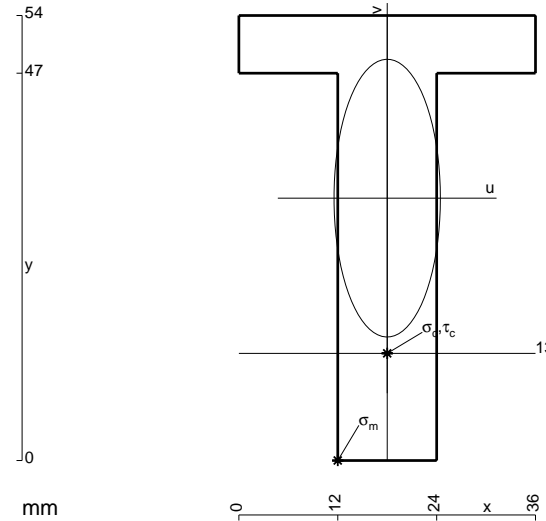
$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

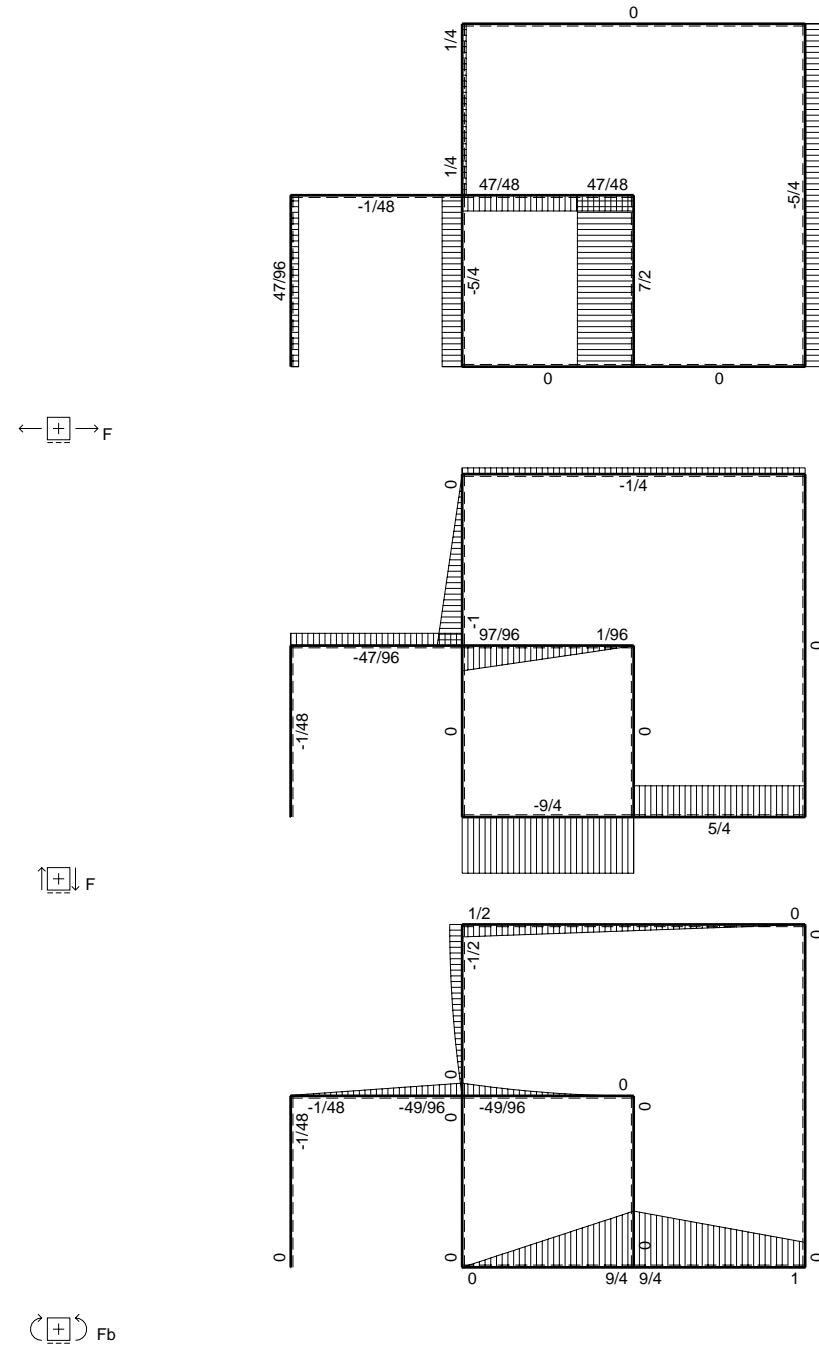
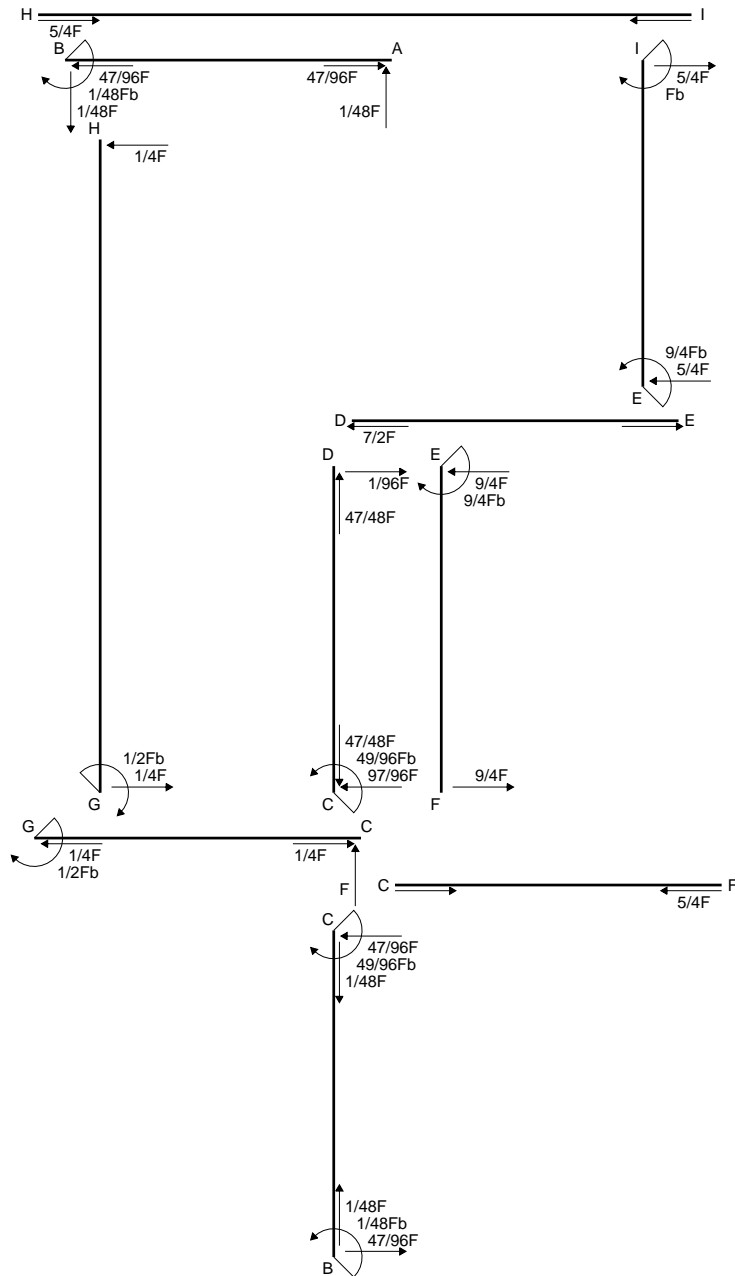
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/3 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/3 Fb^2/EJ$$



- A = 816. mm²
- J_u = 231827. mm⁴
- J_v = 33984. mm⁴
- y_g = 31.84 mm
- T_y = -2558. N
- M_x = 1590300. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -31.84 mm
- σ_m = -Mv/J_u = 218.4 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -18.84 mm
- σ_c = -Mv/J_u = 129.2 N/mm²
- τ_c = 3.634 N/mm²
- σ_o = √σ²+3τ² = 129.4 N/mm²
- S = 3953. mm³



Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-1/2Fx$	$-Fb/EJ$	$1/2Fx-1/4Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/6+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	Fb/EJ	$1/4Fb-1/4Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+Fx-1/2qx^2$	0	$1/4Fb-3/4Fx+3/4Fx^2/b-1/4qx^3/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/16+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2qx^2$	0	$1/4qx^3/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/48Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/48Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/12 b) Fb 1/EJ + (b - 1/4 b) \theta = 11/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/12 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 11/12 Fb^2/EJ$$

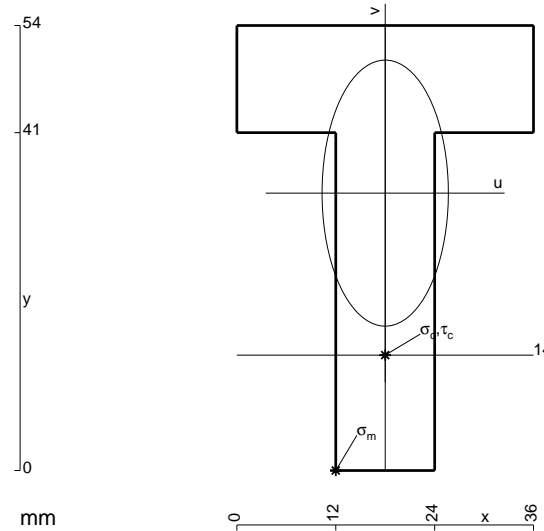
$$L_{CD}^{xo} = \int_0^b (1/4 - 3/4 x/b + 3/4 x^2/b^2 - 1/4 x^3/b^3) Fb 1/EJ dx$$

$$= [1/4 x - 3/8 x^2/b + 1/4 x^3/b^2 - 1/16 x^4/b^3]_0^b Fb 1/EJ$$

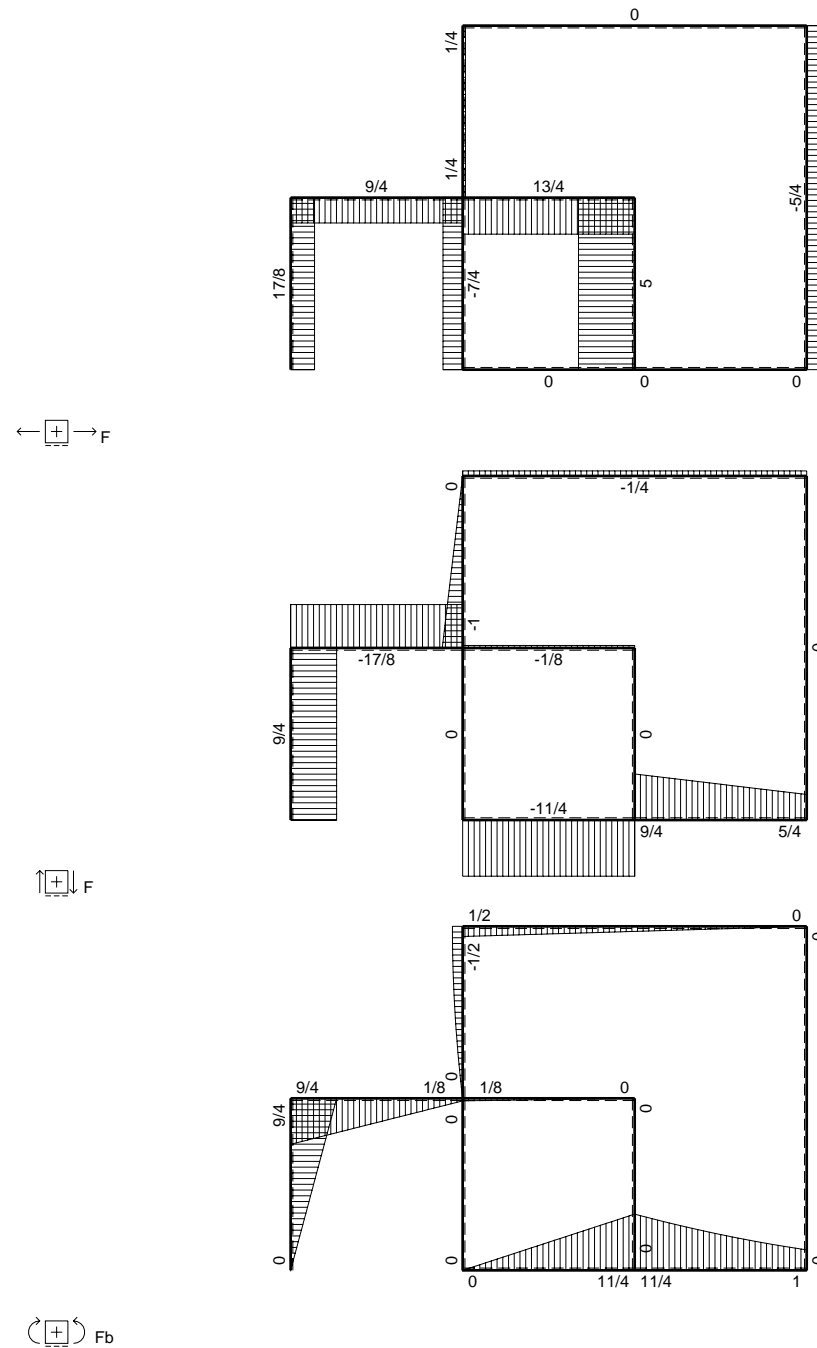
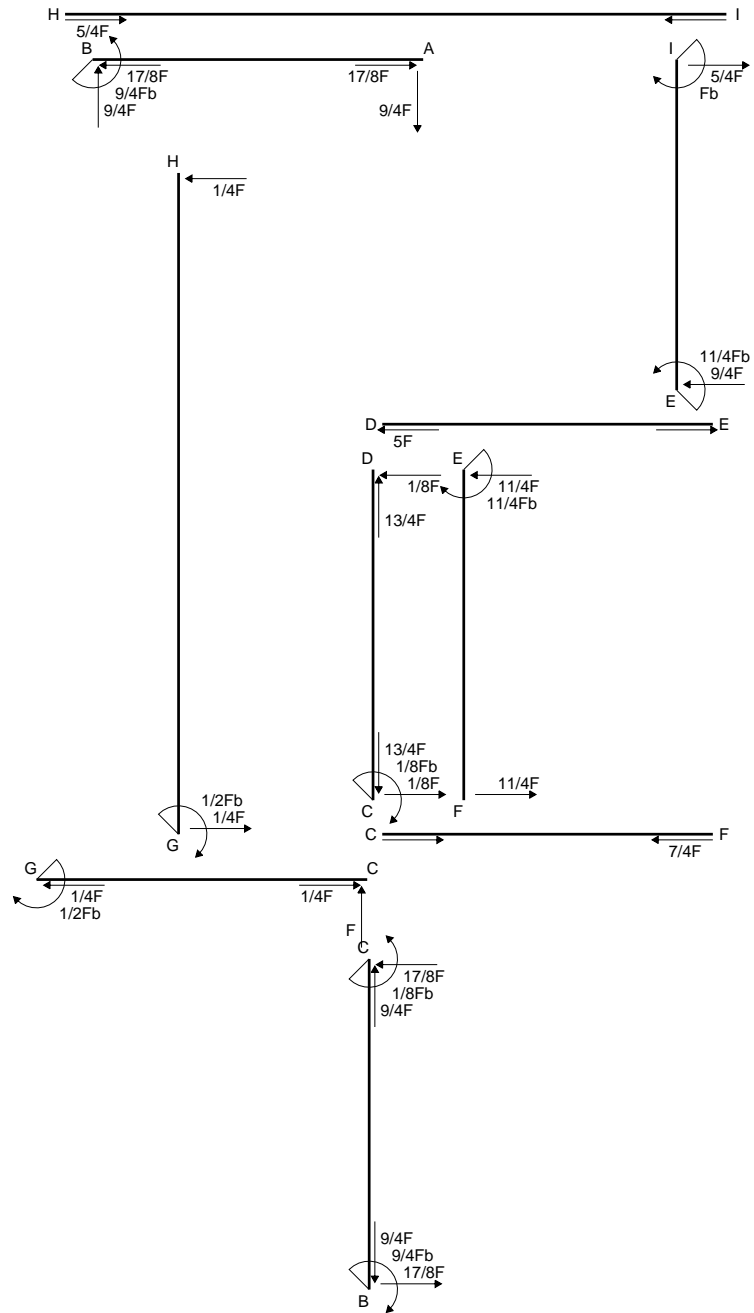
$$= (1/4 b - 3/8 b + 1/4 b - 1/16 b) Fb 1/EJ = 1/16 Fb^2/EJ$$

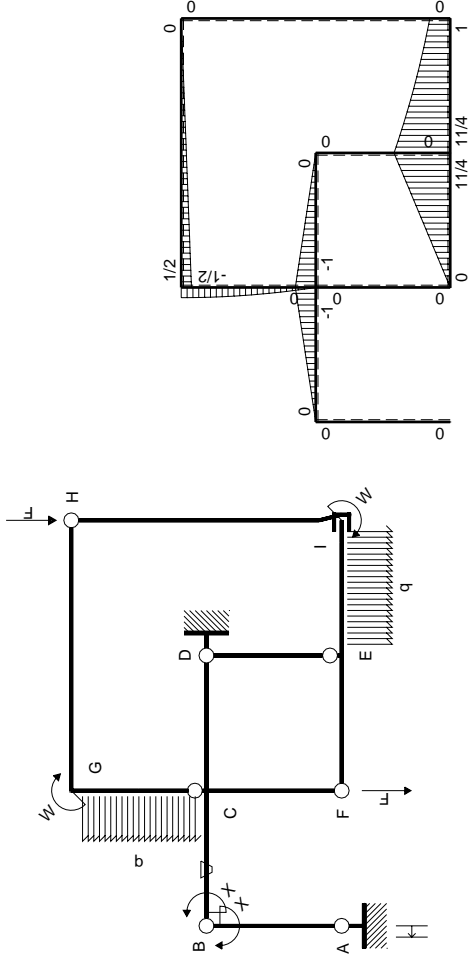
$$L_{DC}^{xo} = \int_0^b (1/4 x^3/b^3) Fb 1/EJ dx = [1/16 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/16 b) Fb 1/EJ = 1/16 Fb^2/EJ$$



- A = 960. mm²
- J_u = 250363. mm⁴
- J_v = 56448. mm⁴
- y_g = 33.66 mm
- T_y = -2093. N
- M_x = 1694930. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -33.66 mm
- σ_m = -Mv/J_u = 227.9 N/mm²
- x_c = 18. mm
- y_c = 14. mm
- v_c = -19.66 mm
- σ_c = -Mv/J_u = 133.1 N/mm²
- τ_c = 3.12 N/mm²
- σ_o = √σ²+3τ² = 133.2 N/mm²
- S = 4479. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	-Fx	-Fb/EJ	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	Fb-Fx	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	-Fb+Fx	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$11/4Fb-11/4Fx$	0	0	0	0	0+0	0
FE b	0	$-11/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-11/4Fb+9/4Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$9/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-9/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

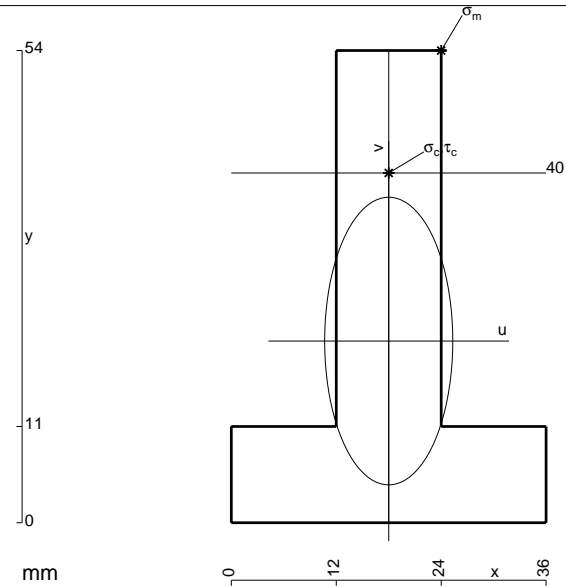
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

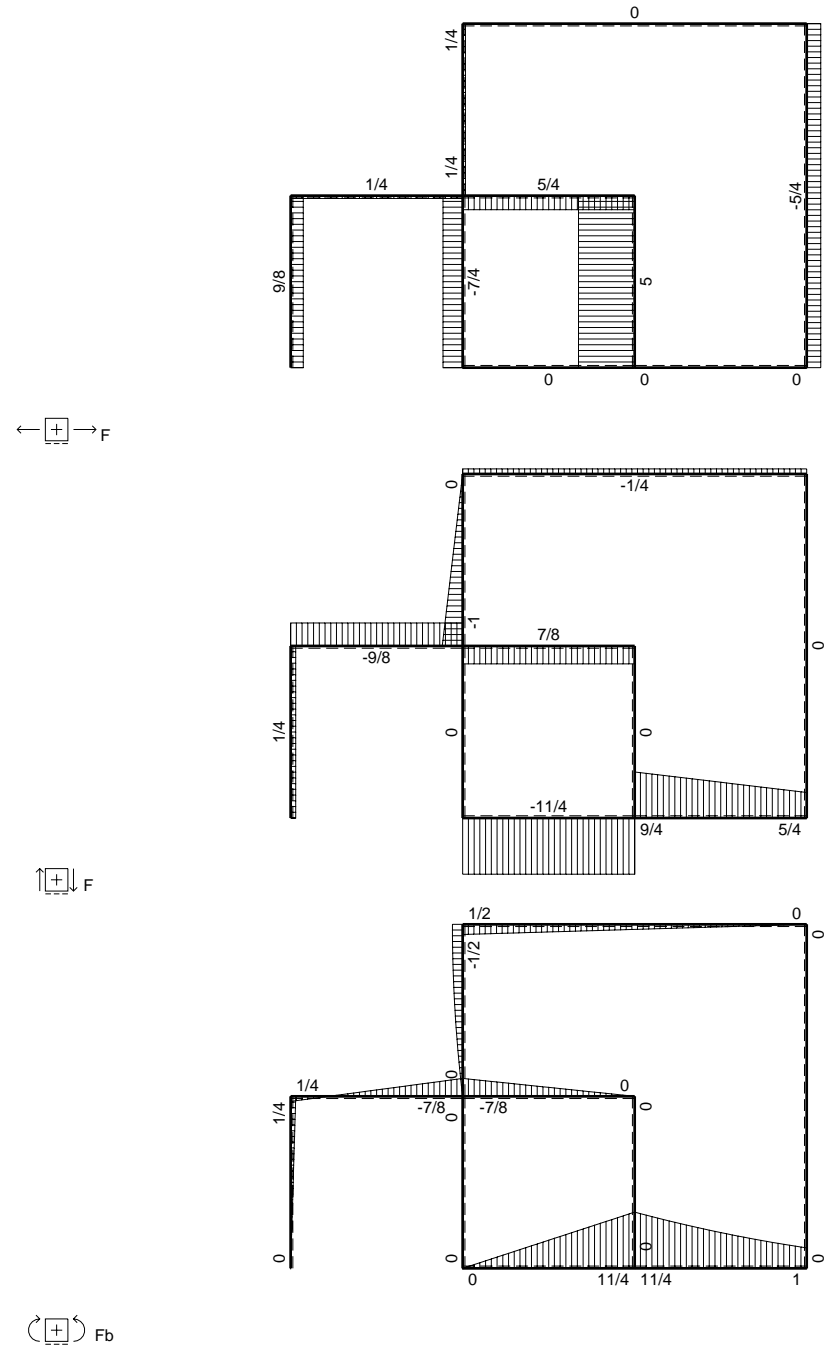
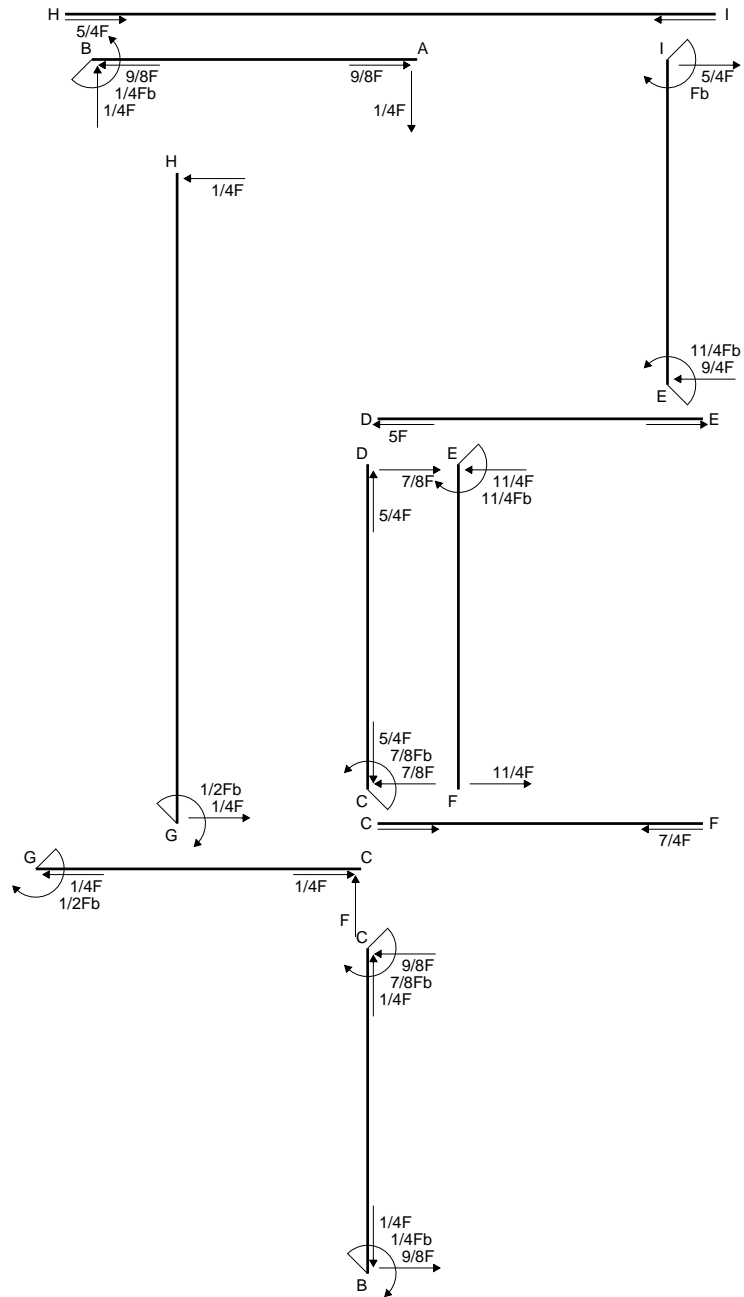
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

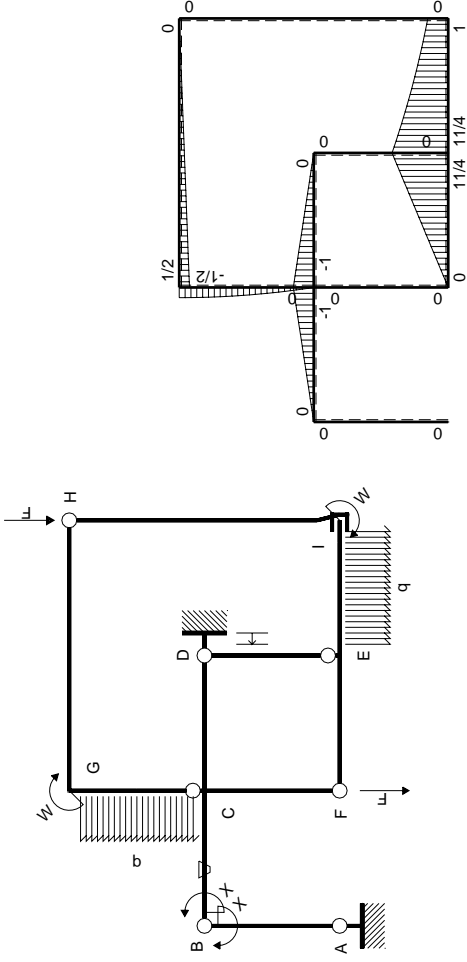
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$



- A = 912. mm²
- J_u = 246834. mm⁴
- J_v = 48960. mm⁴
- y_g = 20.78 mm
- T_y = -2090. N
- M_x = 1776500. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 6. mm
- v_m = 33.22 mm
- σ_m = -Mv/J_u = -239.1 N/mm²
- x_c = 18. mm
- y_c = 40. mm
- v_c = 19.22 mm
- σ_c = -Mv/J_u = -138.4 N/mm²
- τ_c = 3.109 N/mm²
- σ_q = √σ²+3τ² = 138.5 N/mm²
- S = 4406. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$11/4Fb-11/4Fx$	0	0	0	0	0+0	0
FE b	0	$-11/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-11/4Fb+9/4Fx-1/2qx^2$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$1/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-1/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

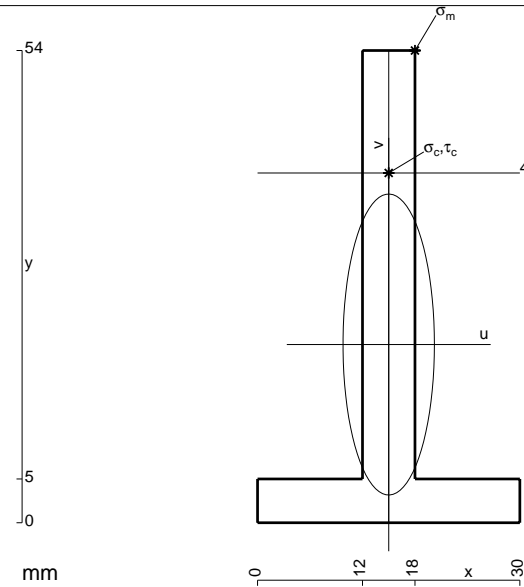
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

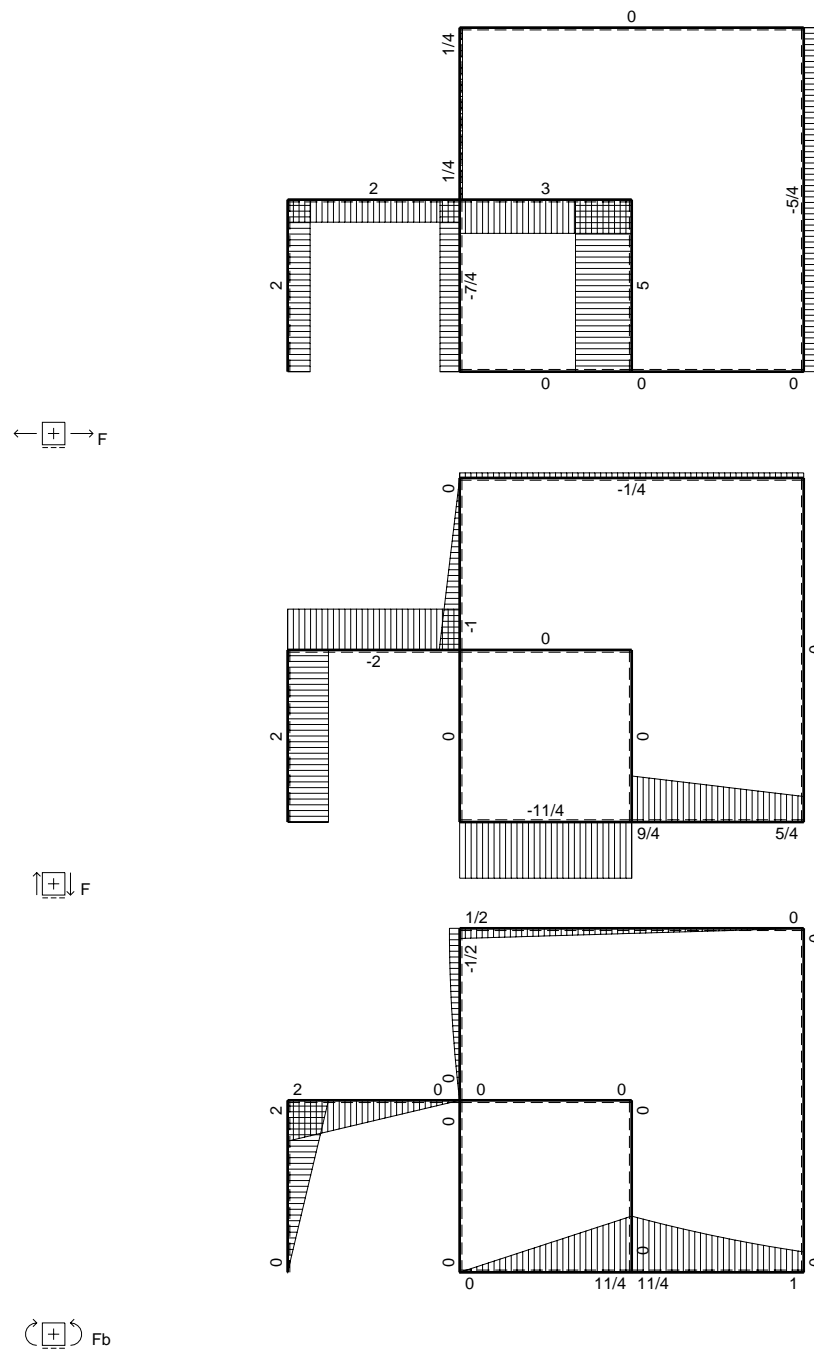
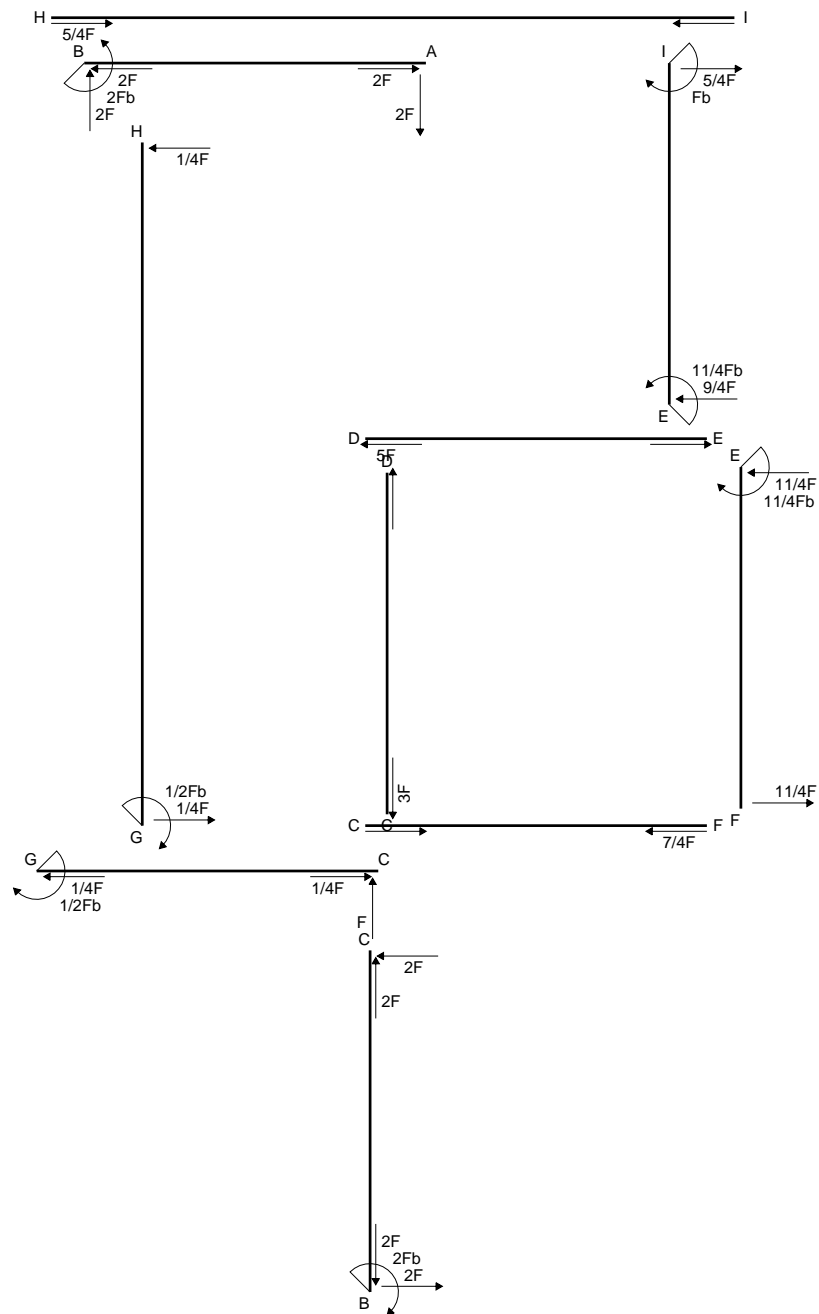
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

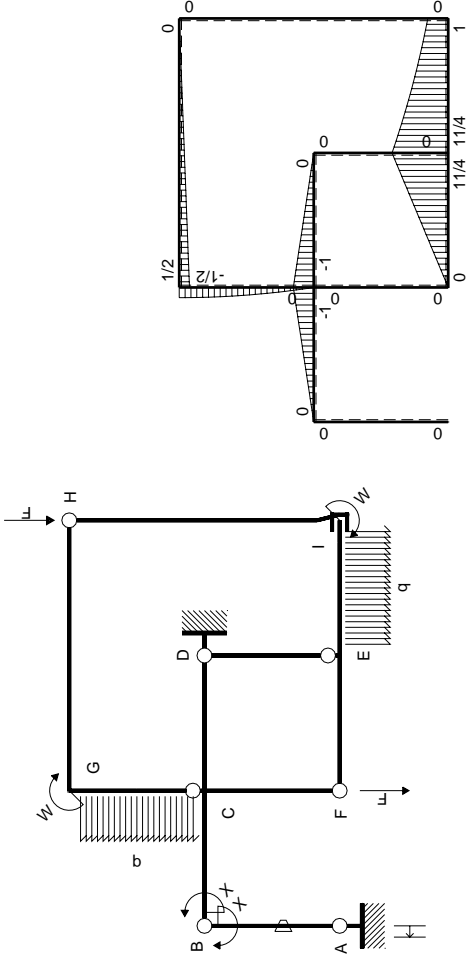
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$



- A = 444. mm²
- J_u = 131544. mm⁴
- J_v = 12132. mm⁴
- y_g = 20.38 mm
- T_y = -1733. N
- M_x = 779625. Nmm
- x_m = 18. mm
- y_m = 54. mm
- u_m = 3. mm
- v_m = 33.62 mm
- σ_m = -Mv/J_u = -199.3 N/mm²
- x_c = 15. mm
- y_c = 40. mm
- v_c = 19.62 mm
- σ_c = -Mv/J_u = -116.3 N/mm²
- τ_c = 4.909 N/mm²
- σ_q = √σ²+3τ² = 116.6 N/mm²
- S = 2236. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$11/4Fb-11/4Fx$	0	0	0	0	0+0	0
FE b	0	$-11/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-11/4Fb+9/4Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$2Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

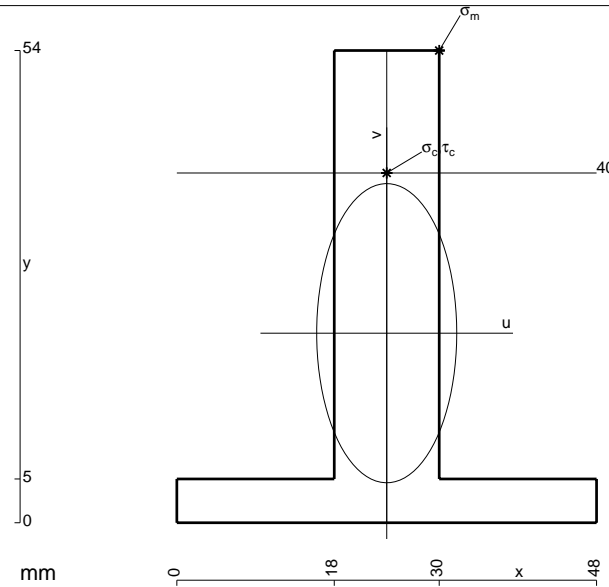
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

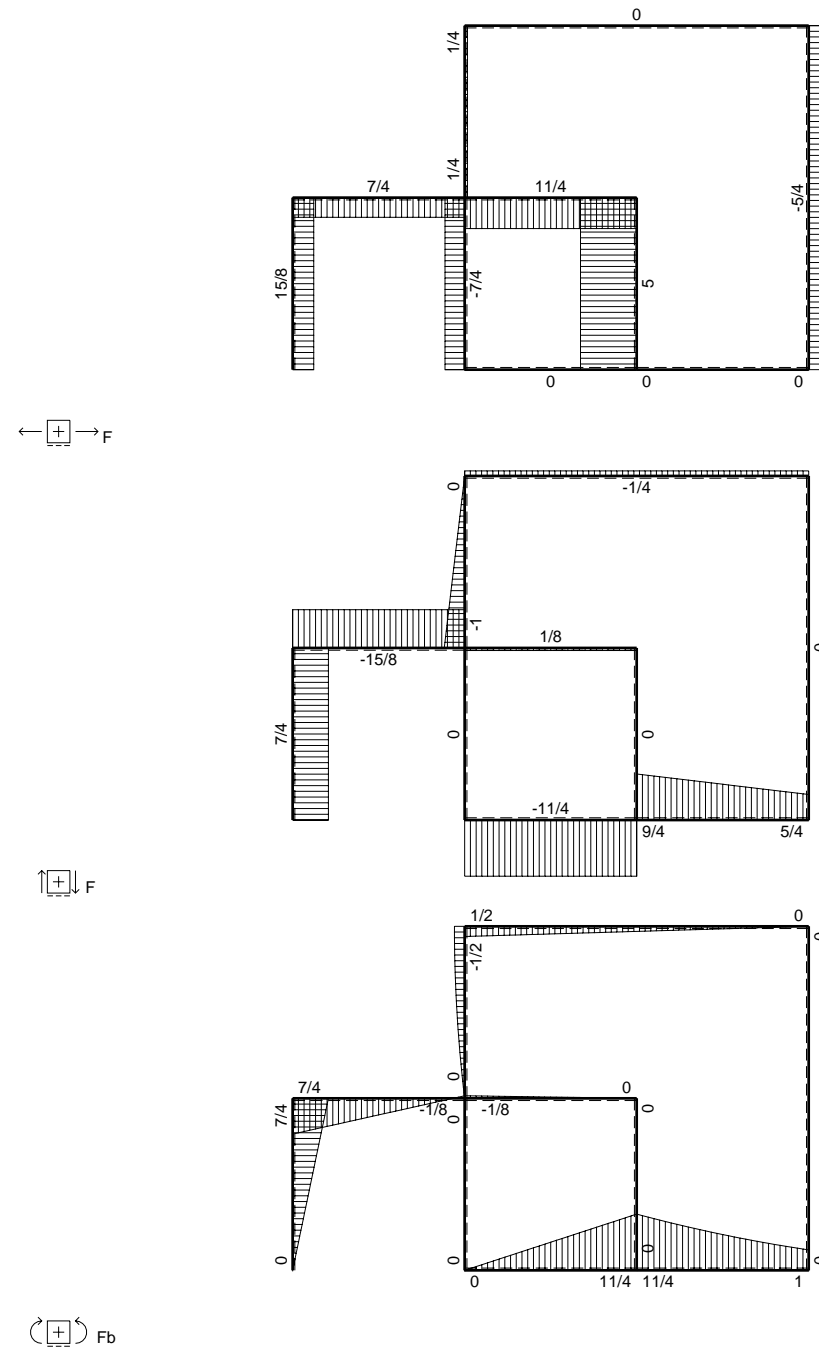
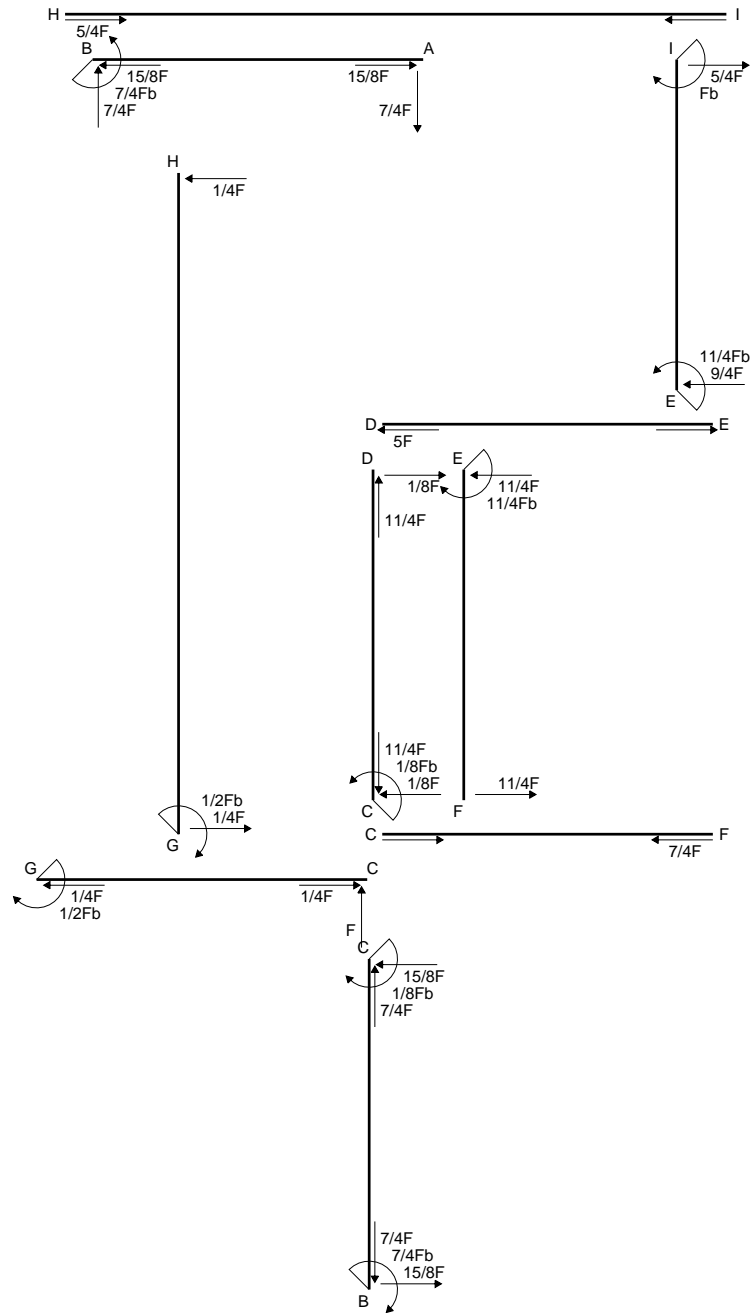
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

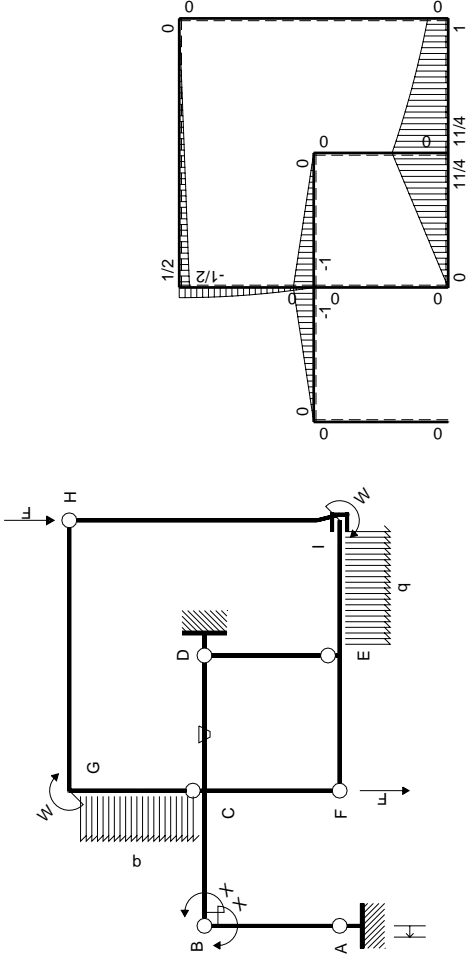
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$



- A = 828. mm²
- J_u = 242396. mm⁴
- J_v = 53136. mm⁴
- y_g = 21.67 mm
- T_y = -3190. N
- M_x = 1563100. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 6. mm
- v_m = 32.33 mm
- σ_m = -M_v/J_u = -208.5 N/mm²
- x_c = 24. mm
- y_c = 40. mm
- v_c = 18.33 mm
- σ_c = -M_v/J_u = -118.2 N/mm²
- τ_c = 4.666 N/mm²
- σ_q = √σ²+3τ² = 118.5 N/mm²
- S = 4255. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	-x/b	0	0	0	0	x^2/b^2	0+0	1/3Xb/EJ
BA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	-1+1/2x/b	-Fx	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	7/12Xb/EJ
CB b	1/2+1/2x/b	Fb-Fx	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	-1/2+1/2x/b	-Fb+Fx	-Fb/EJ	$1/2Fb-Fx+1/2Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+1/4)Fb^2/EJ$	1/12Xb/EJ
DC b	1/2x/b	Fx	Fb/EJ	$1/2Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$11/4Fb-11/4Fx$	0	0	0	0	0+0	0
FE b	0	$-11/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-11/4Fb+9/4Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$7/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-7/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = \left[\frac{1}{3} x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = \left[x - 1/2 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[1/4 x + 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[1/4 x - 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = \left[1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = \left[1/2 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = \left[1/2 x - 1/6 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

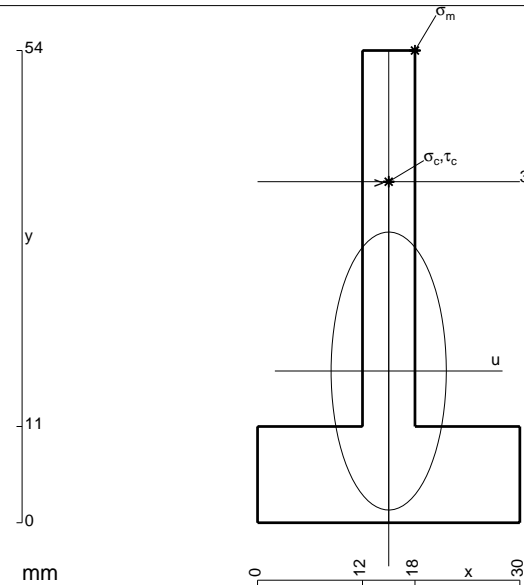
$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= \left[1/2 x - 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb 1/EJ + \left[1/2 x - 1/4 x^2/b \right]_0^b \theta$$

$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 5/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = \left[1/6 x^3/b^2 \right]_0^b Fb 1/EJ + \left[-1/4 x^2/b \right]_0^b \theta$$

$$= (1/6 b) Fb 1/EJ + (-1/4 b) \theta = 5/12 Fb^2/EJ$$



$$A = 588. \text{ mm}^2$$

$$J_u = 148637. \text{ mm}^4$$

$$J_v = 25524. \text{ mm}^4$$

$$y_g = 17.35 \text{ mm}$$

$$T_y = -1650. \text{ N}$$

$$M_x = 891000. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$y_m = 54. \text{ mm}$$

$$u_m = 3. \text{ mm}$$

$$v_m = 36.65 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -219.7 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 39. \text{ mm}$$

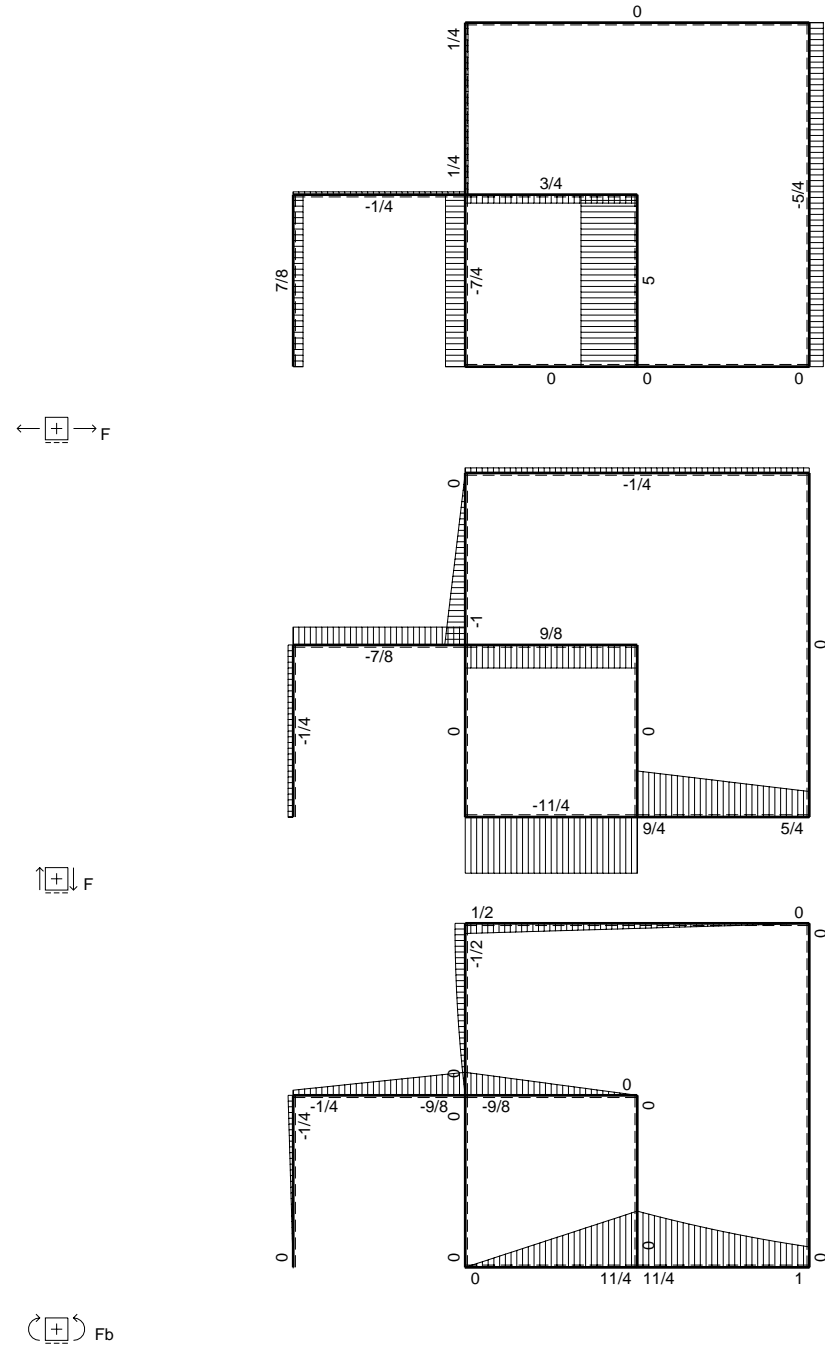
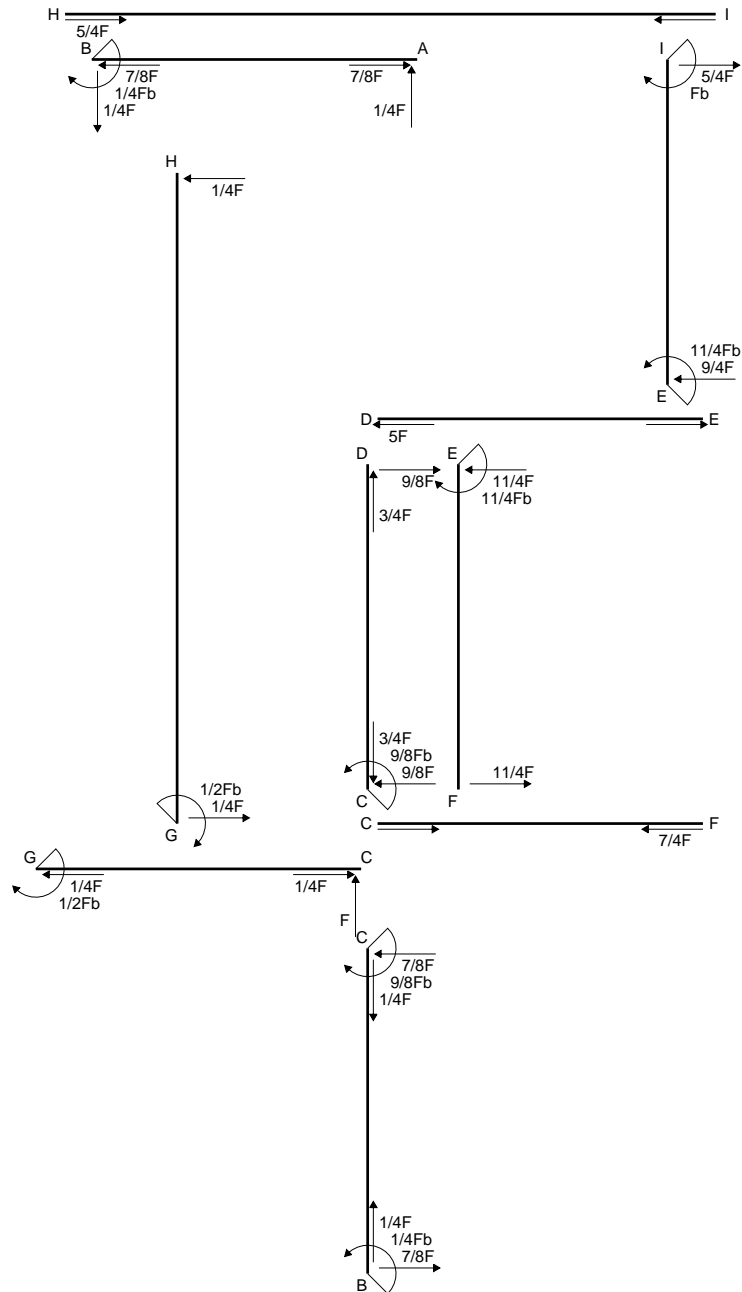
$$v_c = 21.65 \text{ mm}$$

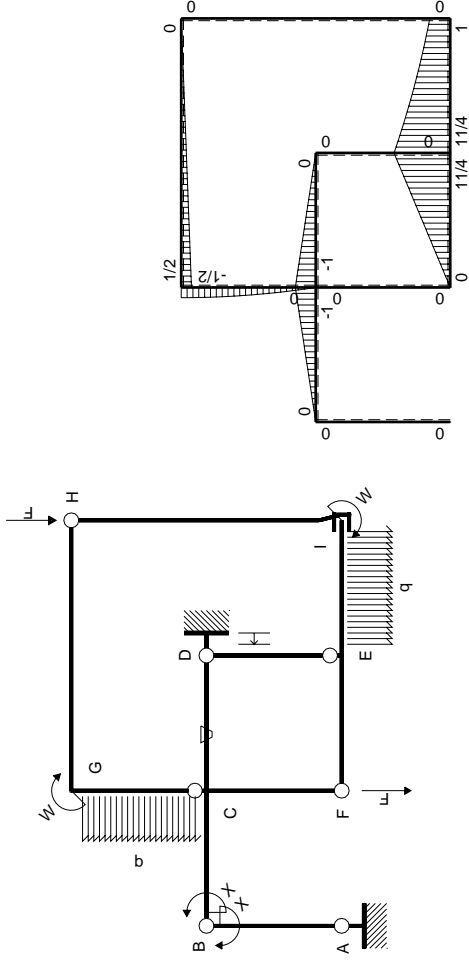
$$\sigma_c = -Mv/J_u = -129.8 \text{ N/mm}^2$$

$$\tau_c = 4.854 \text{ N/mm}^2$$

$$\sigma_\varphi = \sqrt{\sigma^2 + 3\tau^2} = 130.1 \text{ N/mm}^2$$

$$S = 2624. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	Fb/EJ	$1/2Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$11/4Fb-11/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-11/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-11/4Fb+9/4Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

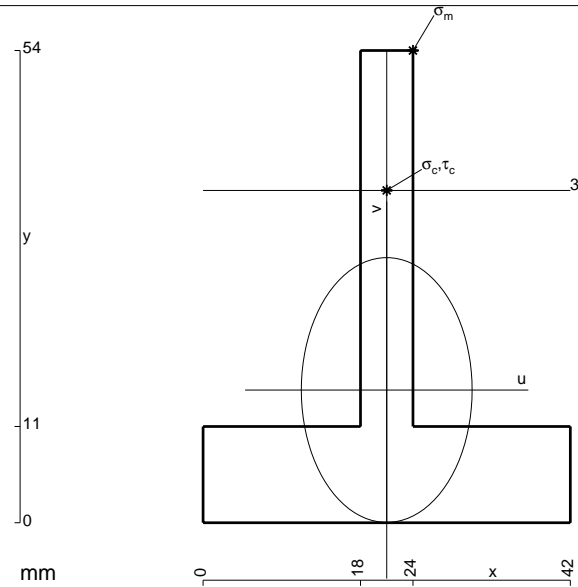
$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 5/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/6 b) Fb 1/EJ + (-1/4 b) \theta = 5/12 Fb^2/EJ$$



- A = 720. mm²
- J_u = 165098. mm⁴
- J_v = 68688. mm⁴
- y_g = 15.18 mm
- T_y = -1678. N
- M_x = 972950. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 3. mm
- v_m = 38.83 mm
- σ_m = -Mv/J_u = -228.8 N/mm²
- x_c = 21. mm
- y_c = 38. mm
- v_c = 22.83 mm
- σ_c = -Mv/J_u = -134.5 N/mm²
- τ_c = 5.011 N/mm²
- σ_q = √σ²+3τ² = 134.8 N/mm²
- S = 2959. mm³

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-13/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG 2b	0	$-5/4Fx+1/2qx^2$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+9/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-13/4Fb+9/4Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ		
	totali						$17/8Fb^2/EJ$	Xb/EJ	
	iperstatica $X=W_{BC}$						$-17/8Fb$		

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (3/8 b - 1/8 b) Fb 1/EJ + (b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

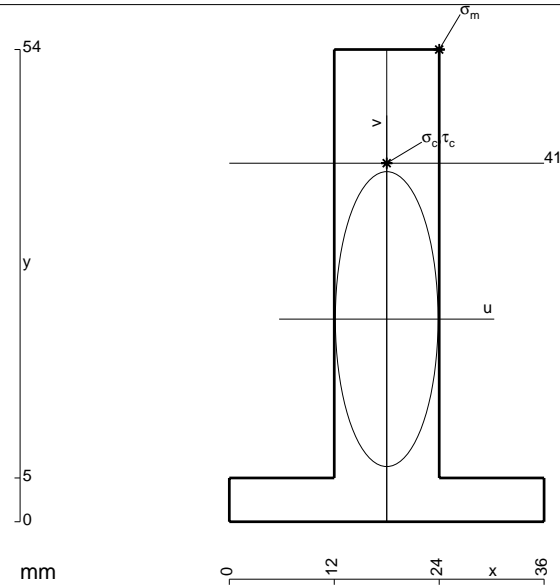
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

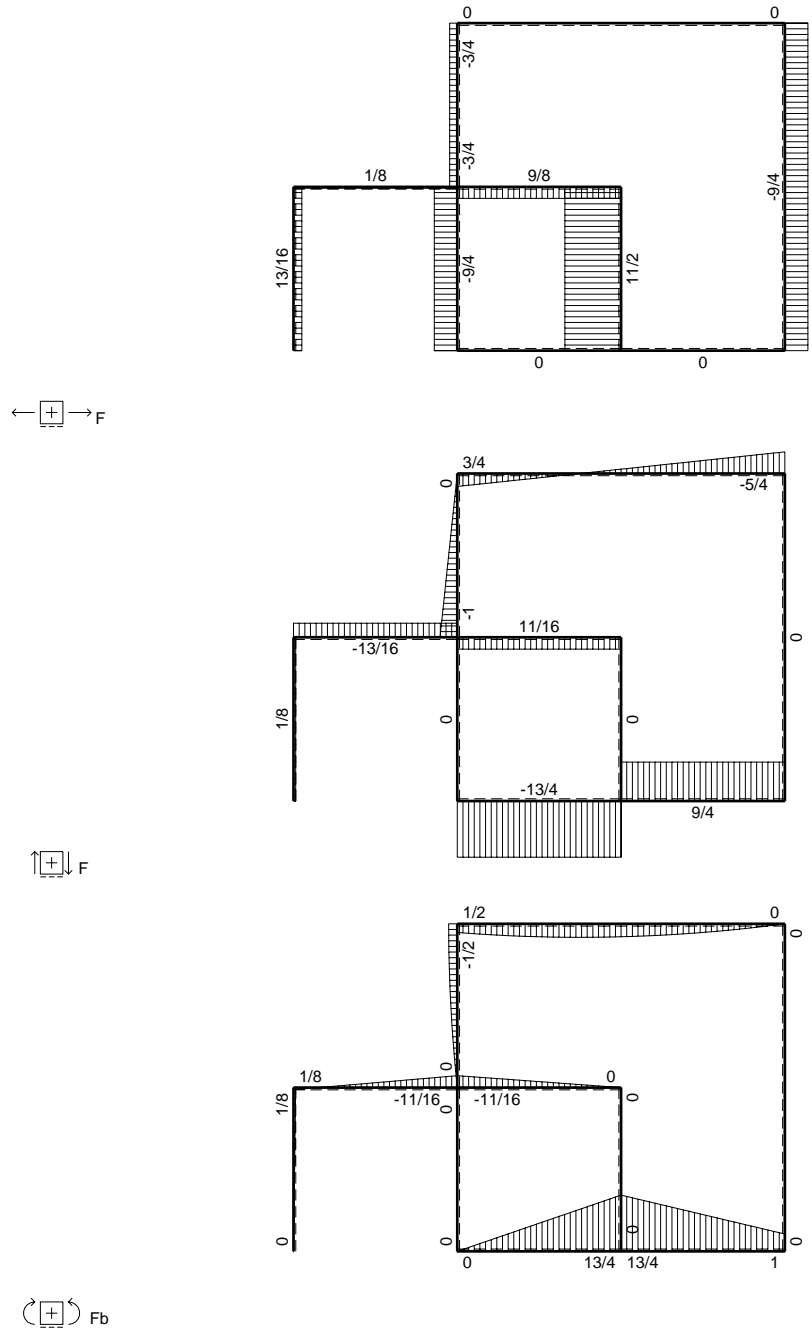
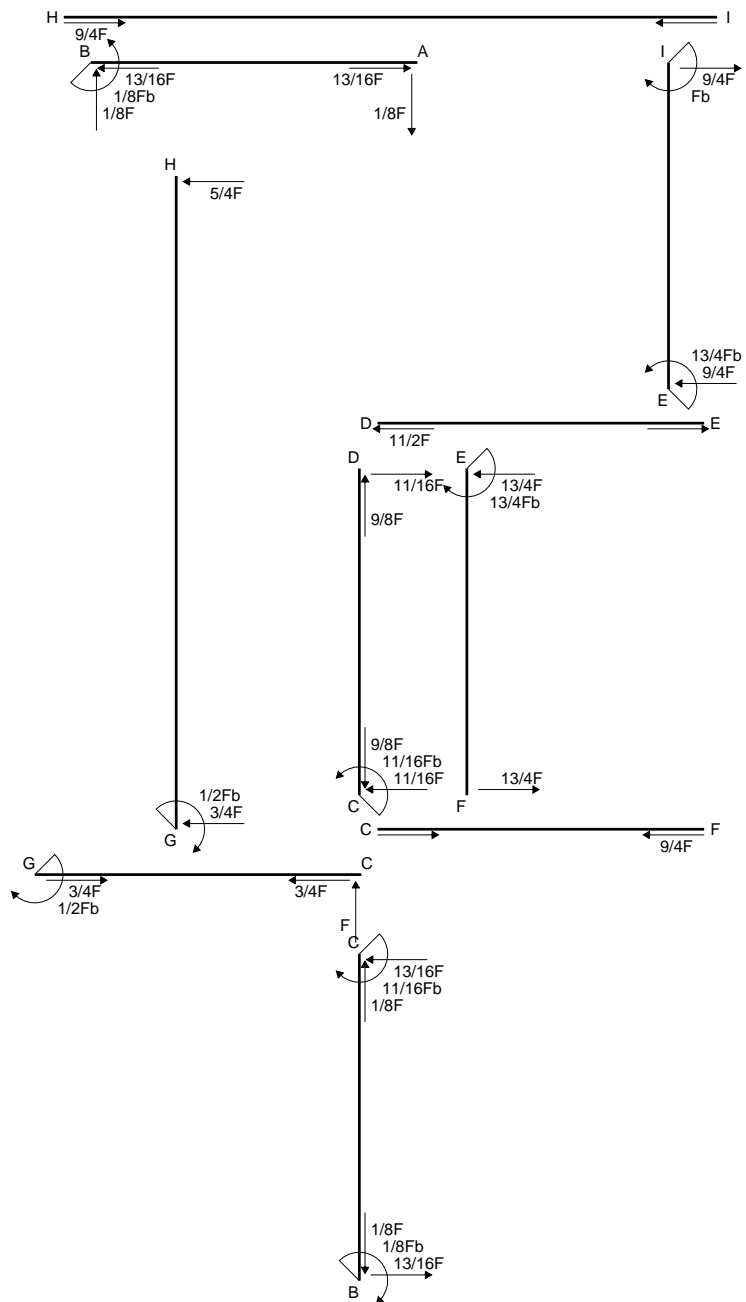
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

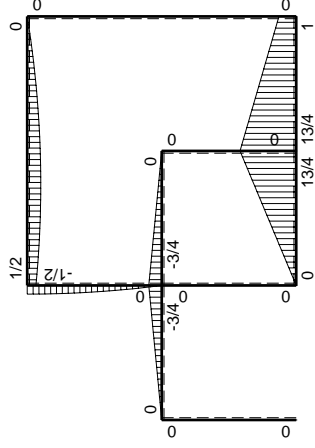
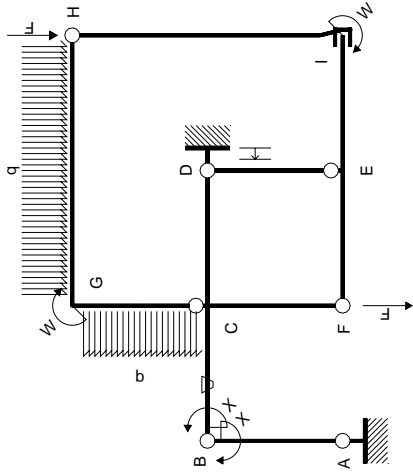
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



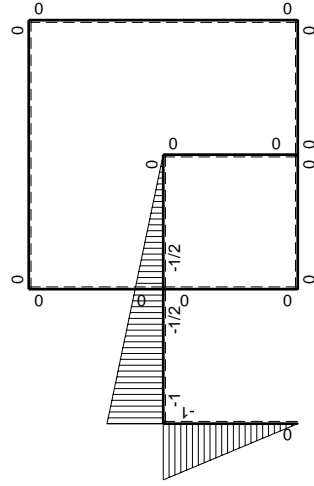
- A = 768. mm²
- J_u = 218489. mm⁴
- J_v = 26496. mm⁴
- y_g = 23.17 mm
- T_y = -2698. N
- M_x = 1699430. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 6. mm
- v_m = 30.83 mm
- σ_m = -Mv/J_u = -239.8 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 17.83 mm
- σ_c = -Mv/J_u = -138.7 N/mm²
- τ_c = 3.905 N/mm²
- σ_q = √σ²+3τ² = 138.8 N/mm²
- S = 3795. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-13/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG 2b	0	$-5/4Fx+1/2qx^2$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+9/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-13/4Fb+9/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (3/8 b - 1/8 b) Fb 1/EJ + (b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

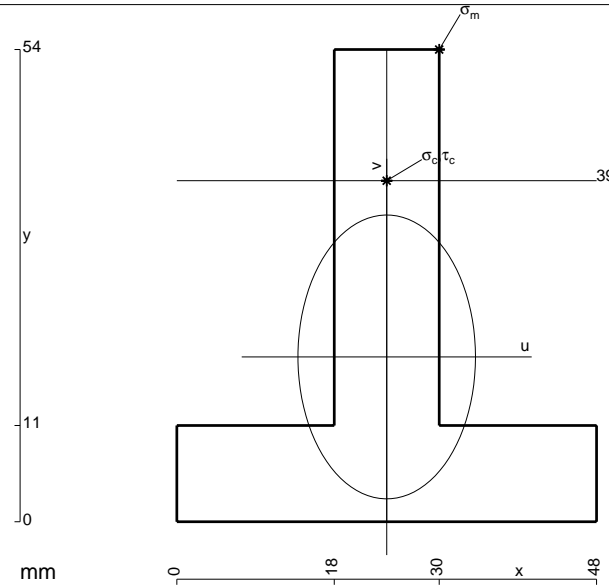
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

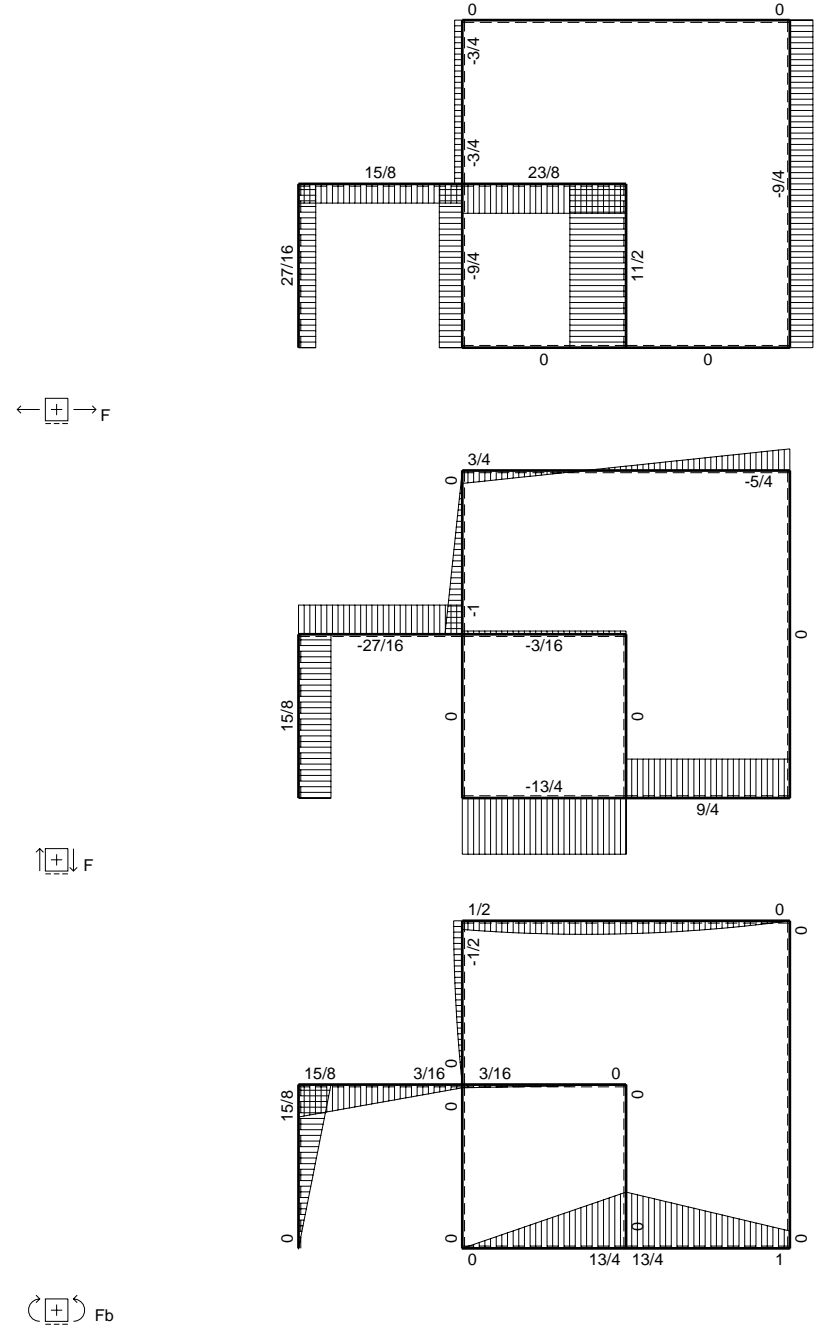
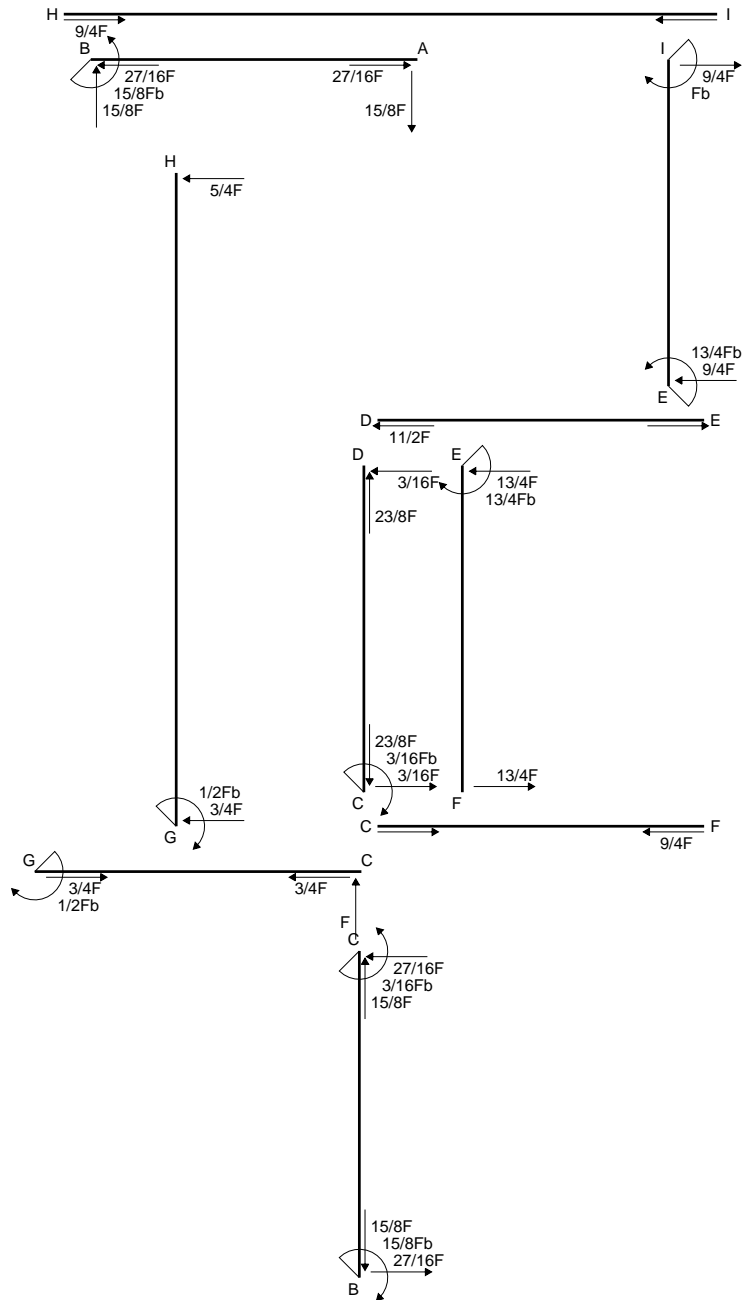
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 1044. mm²
- J_u = 275075. mm⁴
- J_v = 107568. mm⁴
- y_g = 18.84 mm
- T_y = -2308. N
- M_x = 1546030. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 6. mm
- v_m = 35.16 mm
- σ_m = -M_v/J_u = -197.6 N/mm²
- x_c = 24. mm
- y_c = 39. mm
- v_c = 20.16 mm
- σ_c = -M_v/J_u = -113.3 N/mm²
- τ_c = 3.48 N/mm²
- σ_q = √σ²+3τ² = 113.4 N/mm²
- S = 4978. mm³



Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0
FE b	0	$-13/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
HG 2b	0	$-5/4Fx+1/2qx^2$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+9/4Fx$	0	0	0	0	0+0	0
EI b	0	$-13/4Fb+9/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$15/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-15/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

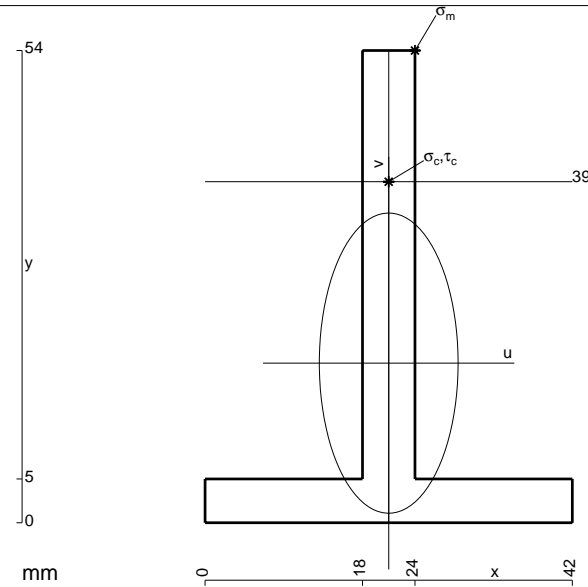
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

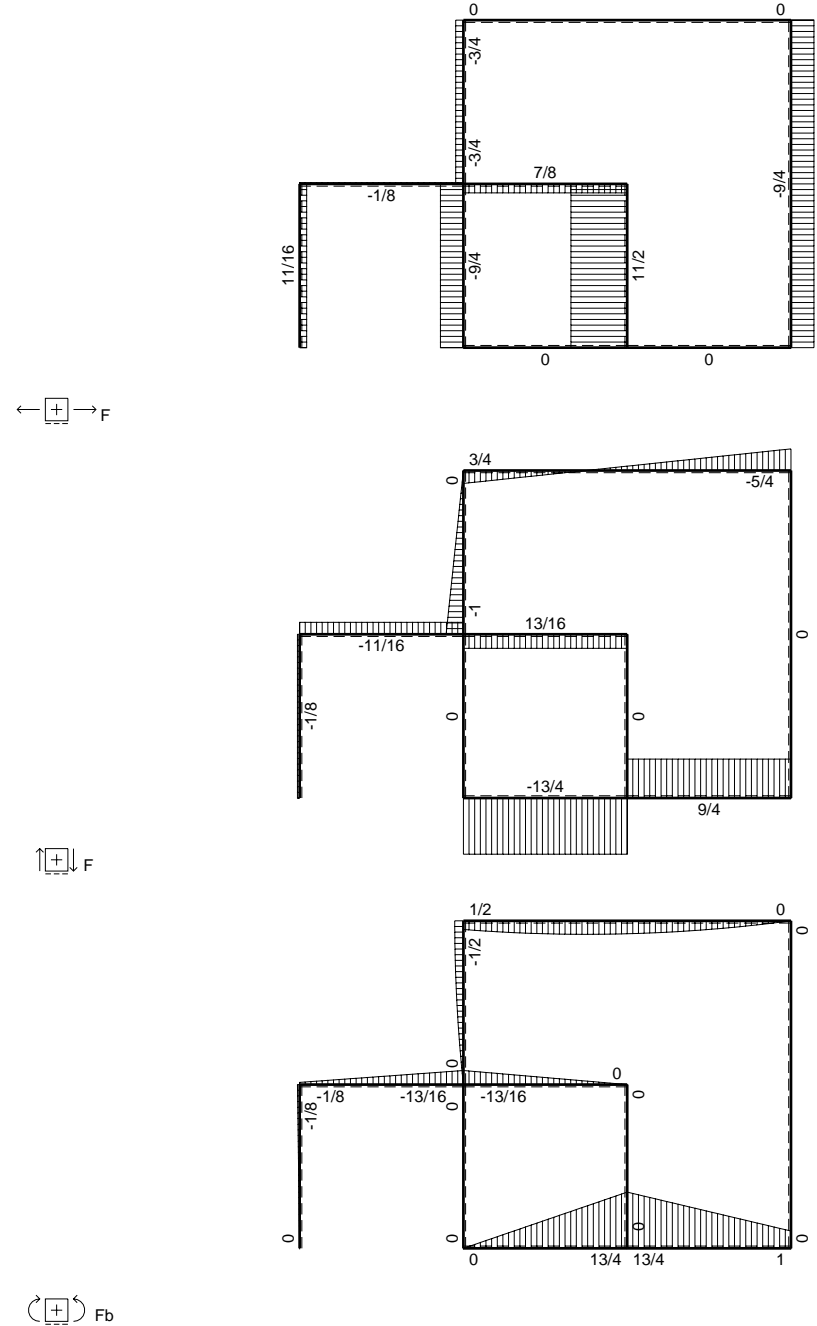
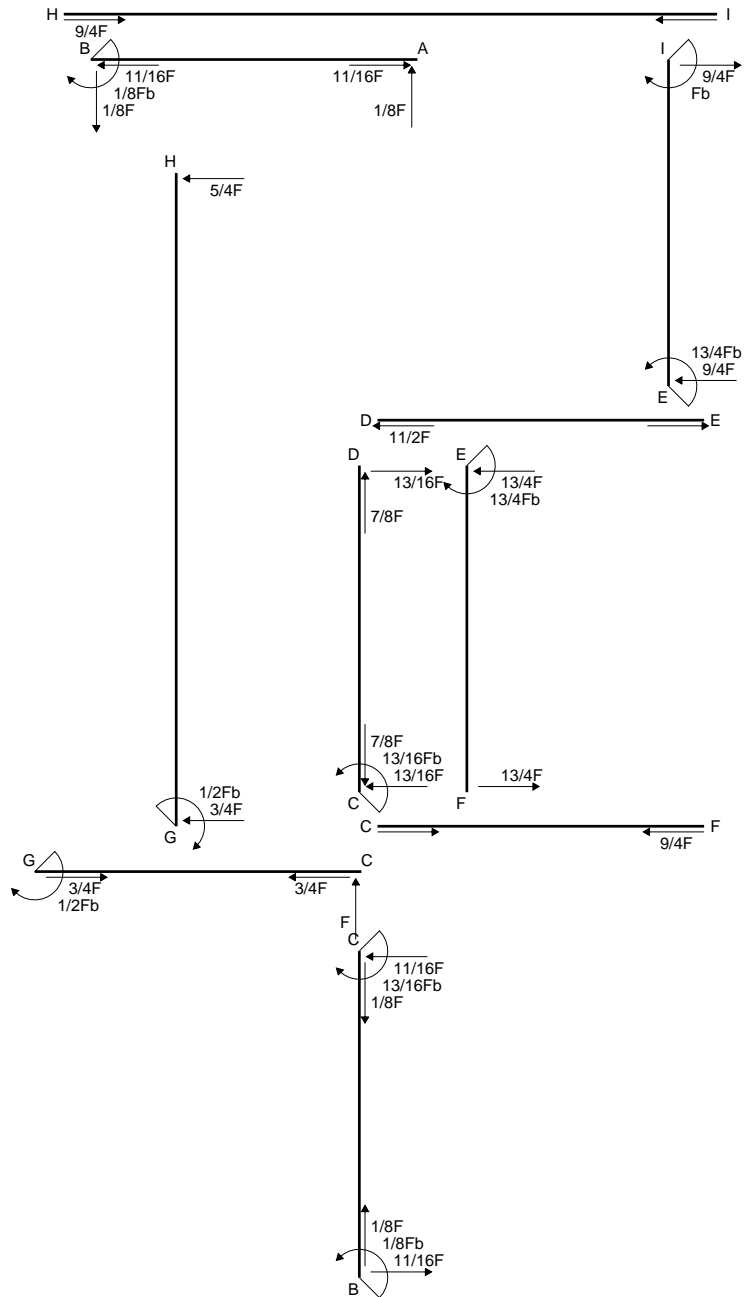
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

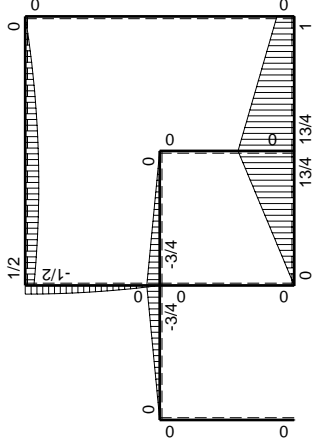
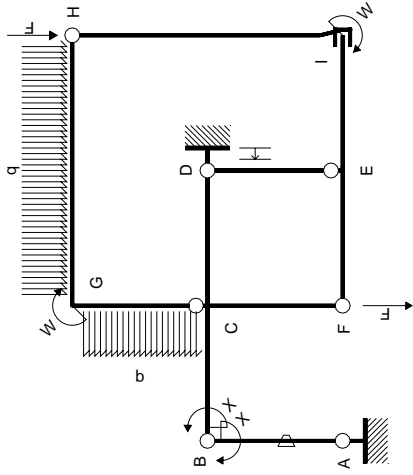
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



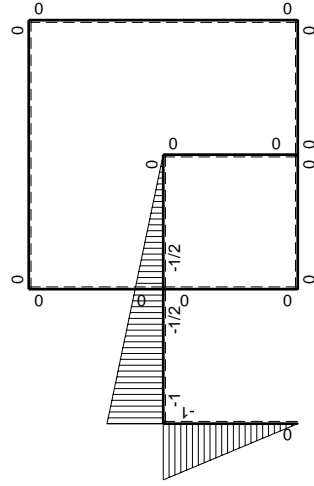
- A = 504. mm²
- J_u = 148565. mm⁴
- J_v = 31752. mm⁴
- y_g = 18.25 mm
- T_y = -1203. N
- M_x = 865800. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 3. mm
- v_m = 35.75 mm
- σ_m = -Mv/J_u = -208.3 N/mm²
- x_c = 21. mm
- y_c = 39. mm
- v_c = 20.75 mm
- σ_c = -Mv/J_u = -120.9 N/mm²
- τ_c = 3.43 N/mm²
- σ_q = √σ²+3τ² = 121.1 N/mm²
- S = 2543. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0
FE b	0	$-13/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
HG 2b	0	$-5/4Fx+1/2qx^2$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+9/4Fx$	0	0	0	0	0+0	0
EI b	0	$-13/4Fb+9/4Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$-1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

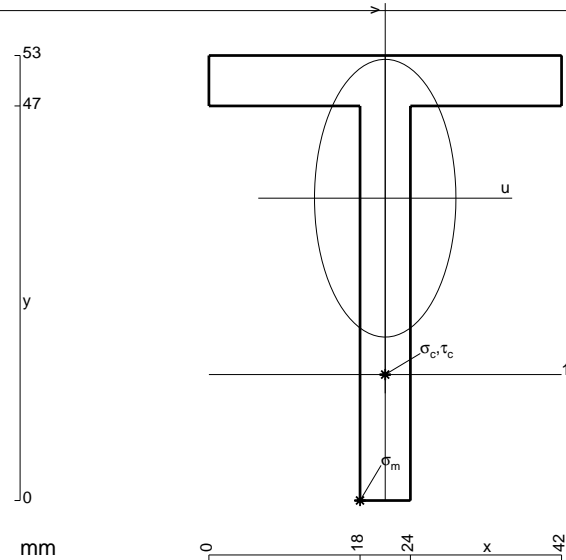
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

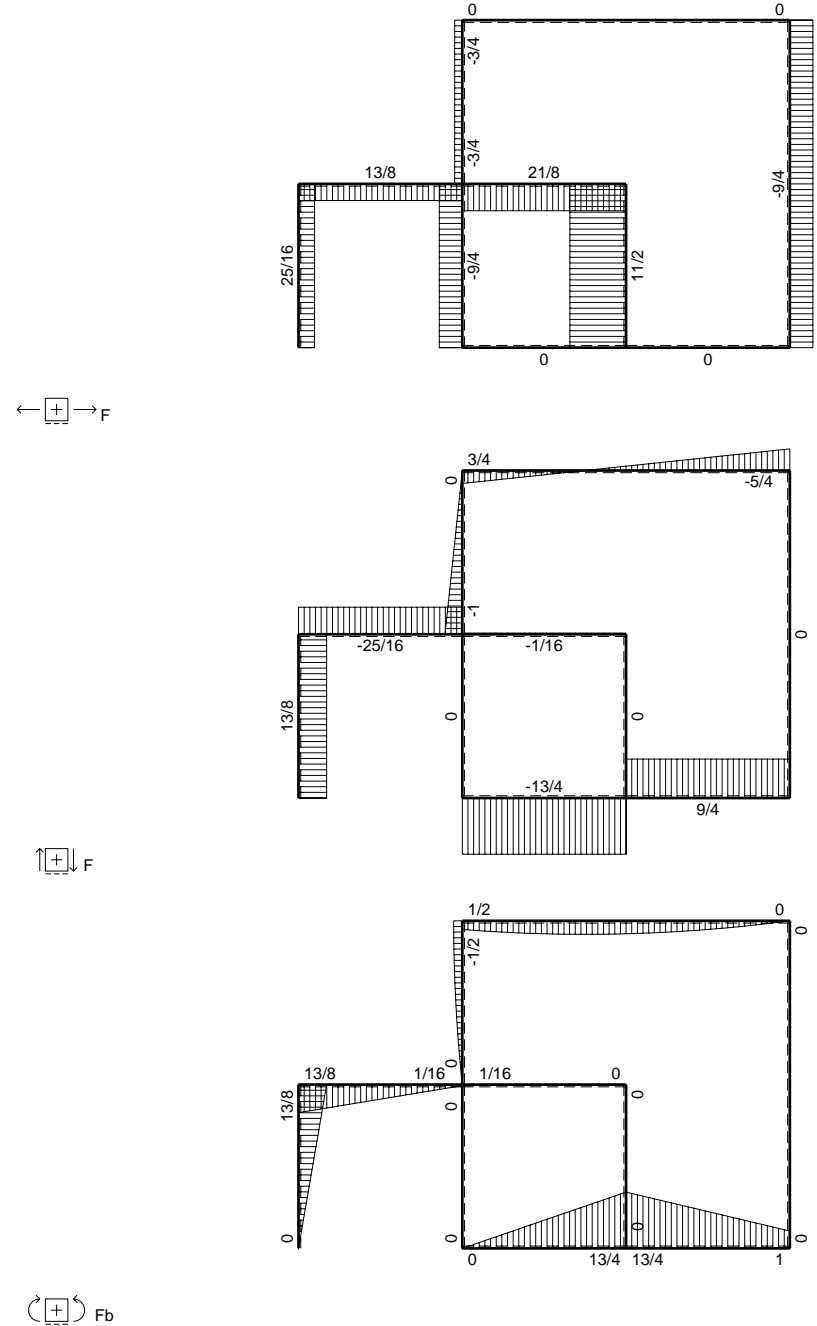
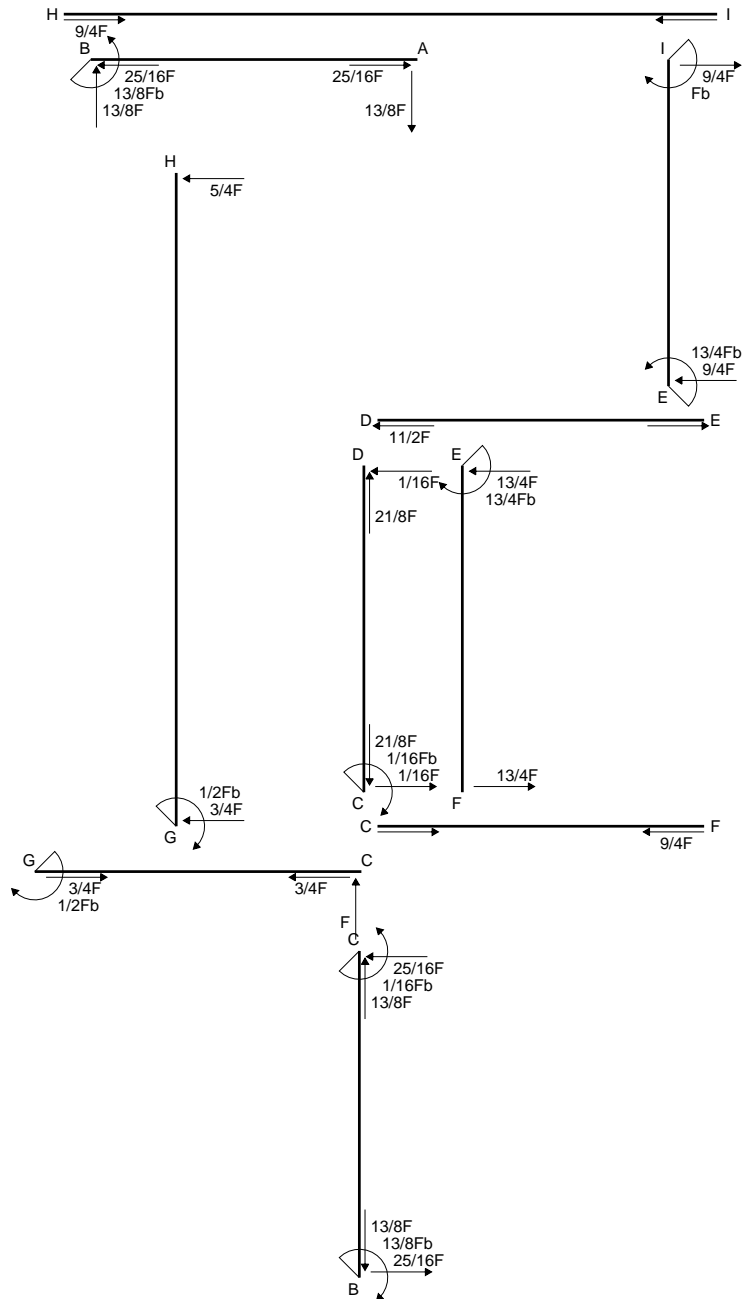
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

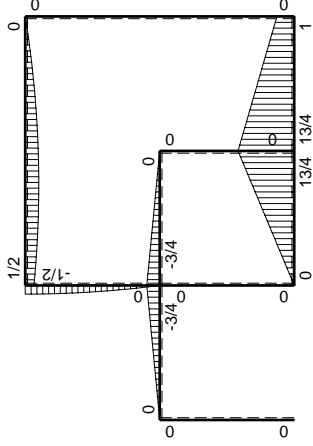
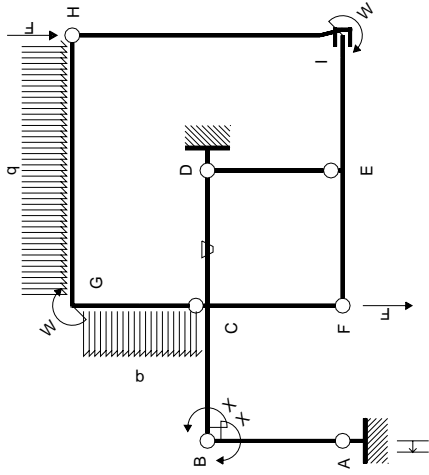
$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 534. mm²
- J_u = 146122. mm⁴
- J_v = 37890. mm⁴
- y_g = 36.01 mm
- T_y = -1203. N
- M_x = 889850. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -36.01 mm
- σ_m = -Mv/J_u = 219.3 N/mm²
- x_c = 21. mm
- y_c = 15. mm
- v_c = -21.01 mm
- σ_c = -Mv/J_u = 127.9 N/mm²
- τ_c = 3.519 N/mm²
- σ_o = √σ²+3τ² = 128.1 N/mm²
- S = 2566. mm³

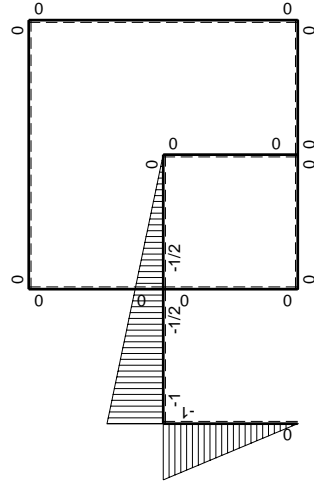


⊕ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-13/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG 2b	0	$-5/4Fx+1/2qx^2$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+9/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-13/4Fb+9/4Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ		
	totali						$13/8Fb^2/EJ$	Xb/EJ	
	iperstatica $X=W_{BC}$						$-13/8Fb$		

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

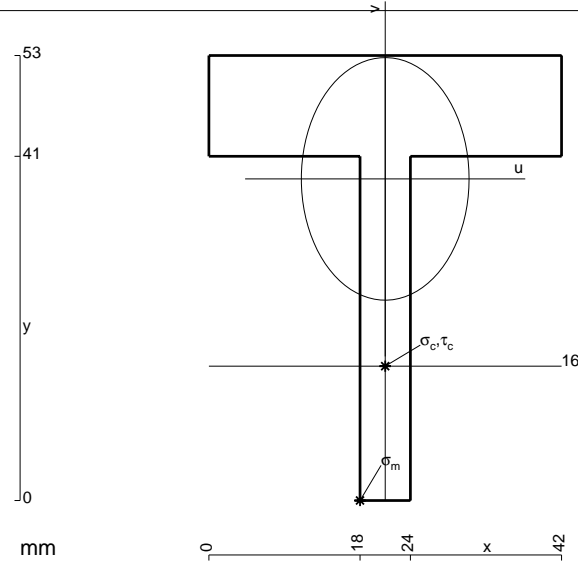
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

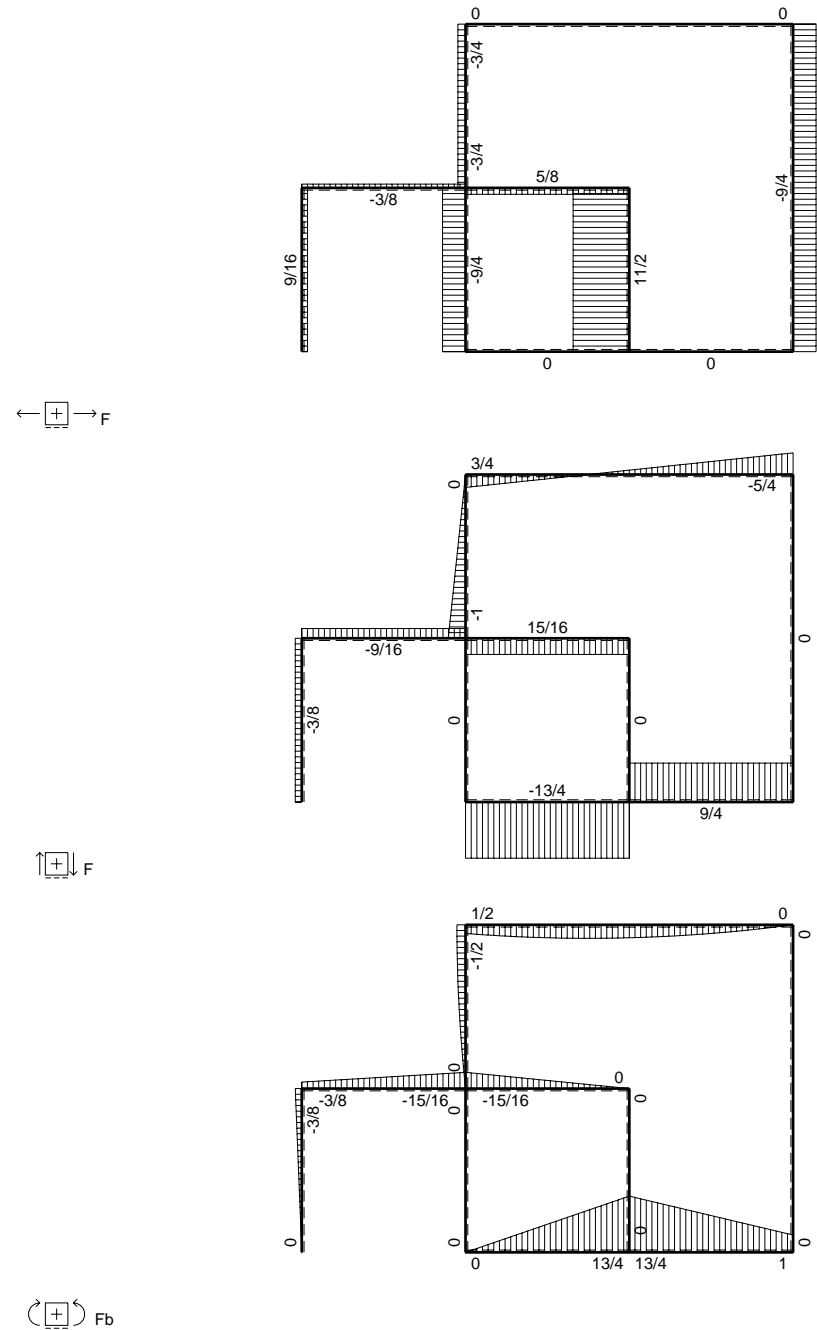
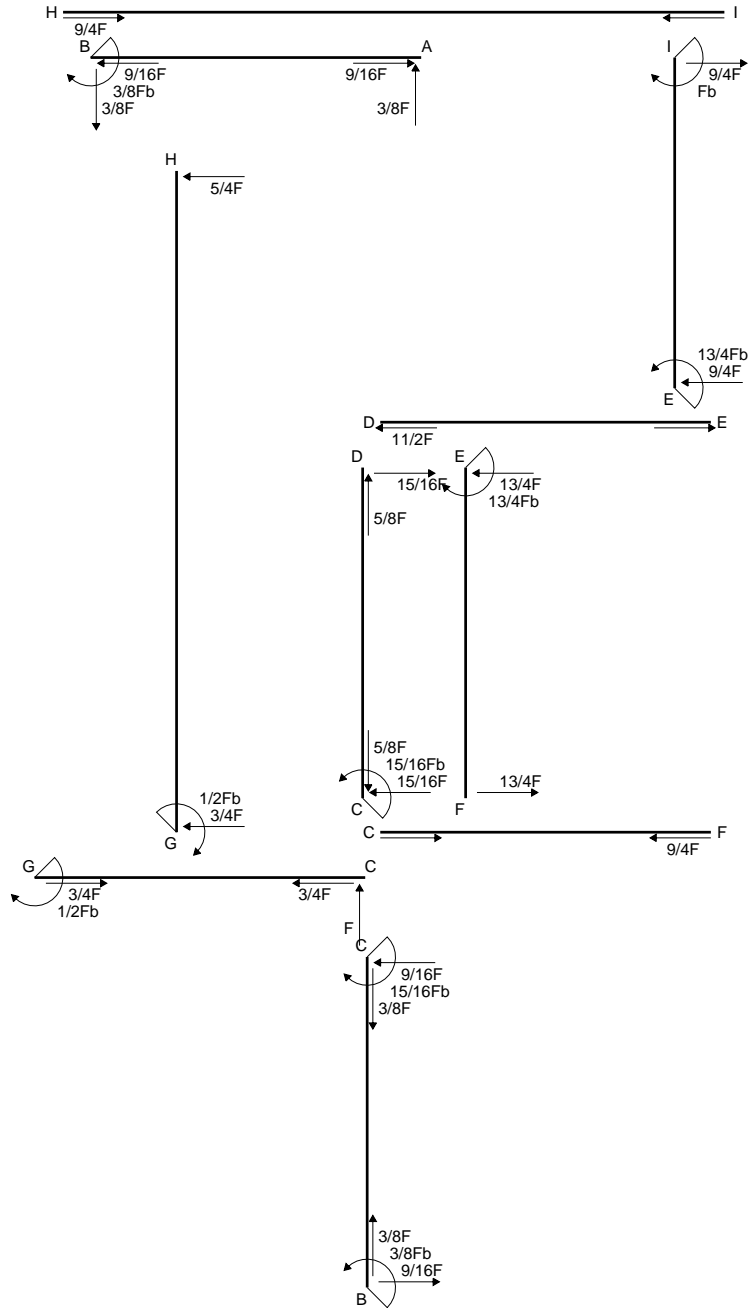
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

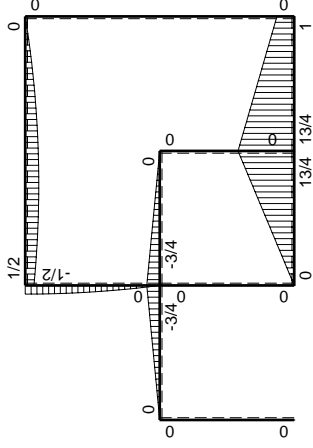
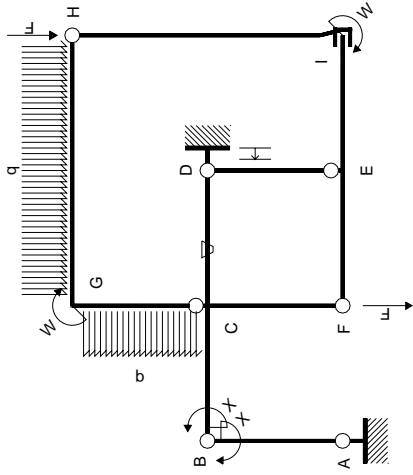
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/8 b) Fb 1/EJ + (-1/4 b) \theta = 3/8 Fb^2/EJ$$



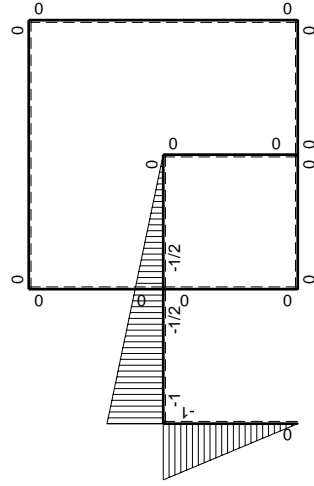
- A = 750. mm²
- J_u = 156599. mm⁴
- J_v = 74826. mm⁴
- y_g = 38.31 mm
- T_y = -1170. N
- M_x = 924300. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -38.31 mm
- σ_m = -Mv/J_u = 226.1 N/mm²
- x_c = 21. mm
- y_c = 16. mm
- v_c = -22.31 mm
- σ_c = -Mv/J_u = 131.7 N/mm²
- τ_c = 3.623 N/mm²
- σ_o = √σ²+3τ² = 131.8 N/mm²
- S = 2910. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$13/4Fb-13/4Fx$	0	0	0	0	0+0	0
FE b	0	$-13/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb+3/4Fx-1/2qx^2$	0	0	0	0	0+0	0
HG 2b	0	$-5/4Fx+1/2qx^2$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+9/4Fx$	0	0	0	0	0+0	0
EI b	0	$-13/4Fb+9/4Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$-3/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$3/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

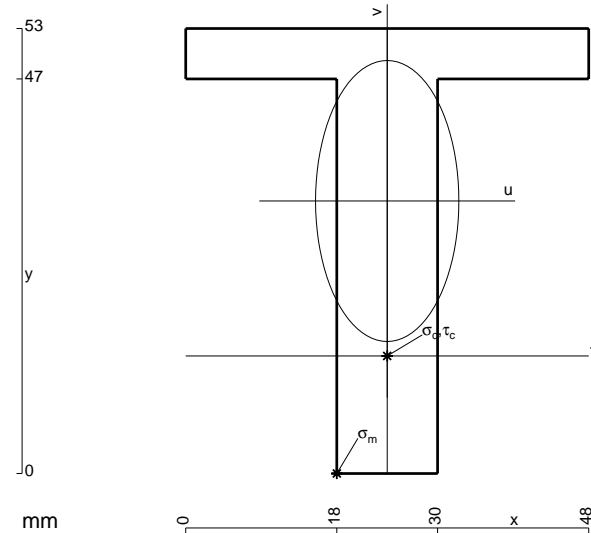
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/8 b) Fb 1/EJ + (-1/4 b) \theta = 3/8 Fb^2/EJ$$



$$A = 852. \text{ mm}^2$$

$$J_u = 238570. \text{ mm}^4$$

$$J_v = 62064. \text{ mm}^4$$

$$y_g = 32.46 \text{ mm}$$

$$T_y = -2113. \text{ N}$$

$$M_x = 1753380. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$u_m = -6. \text{ mm}$$

$$v_m = -32.46 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 238.5 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 14. \text{ mm}$$

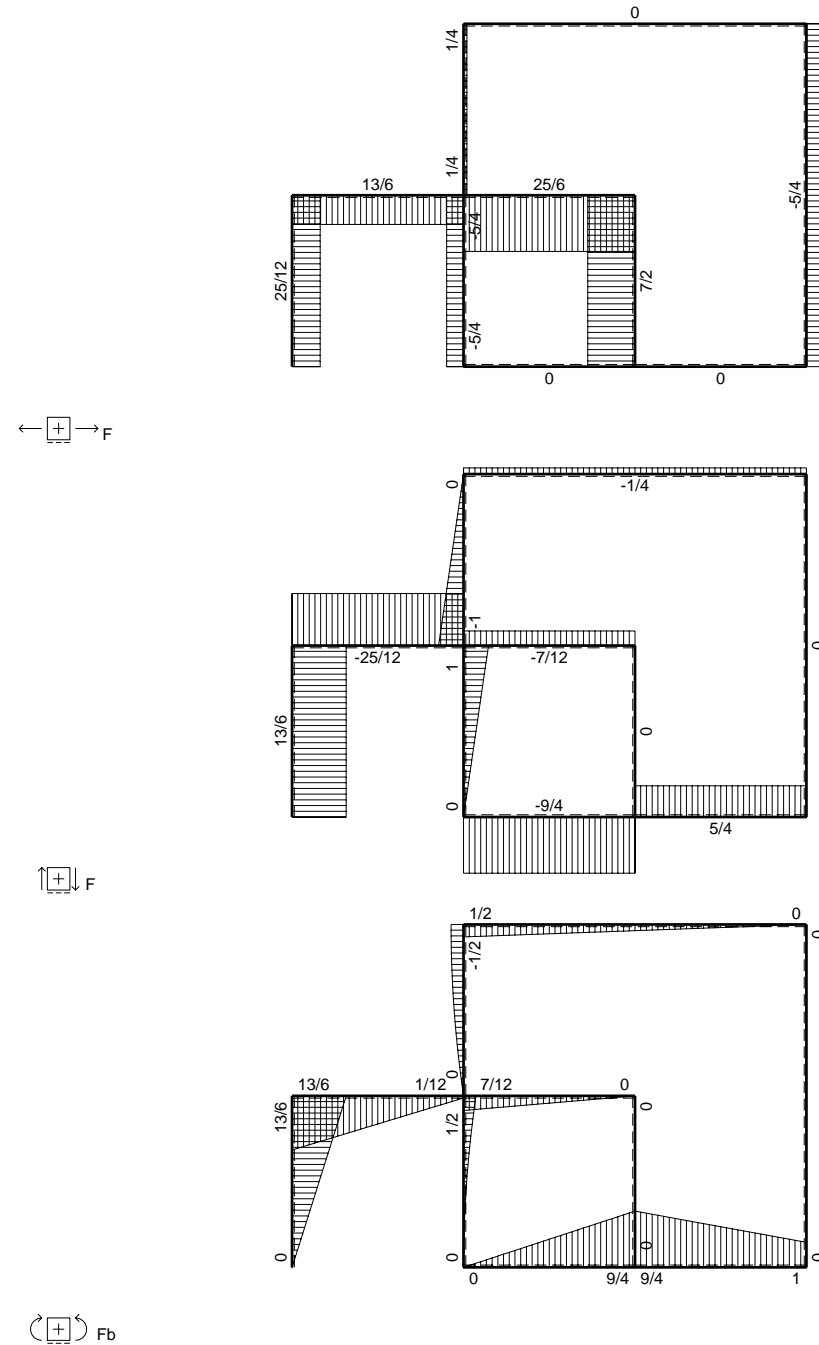
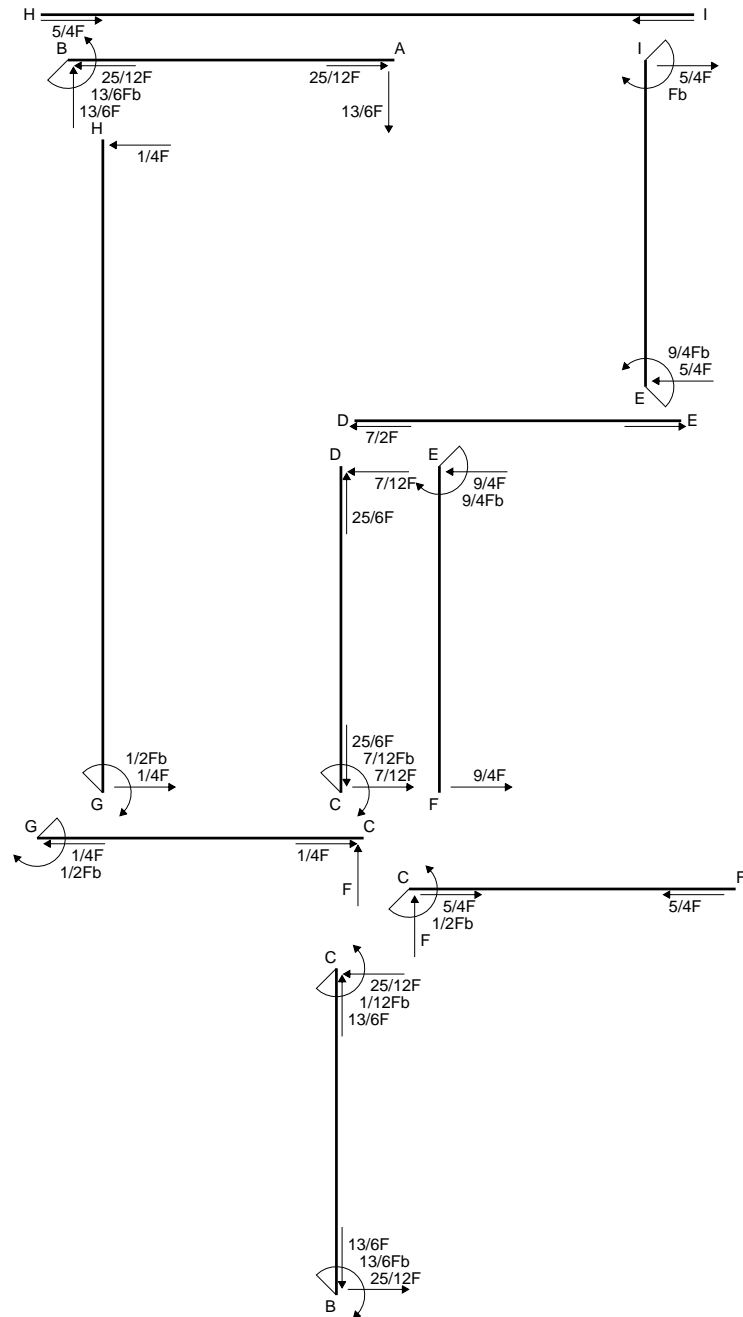
$$v_c = -18.46 \text{ mm}$$

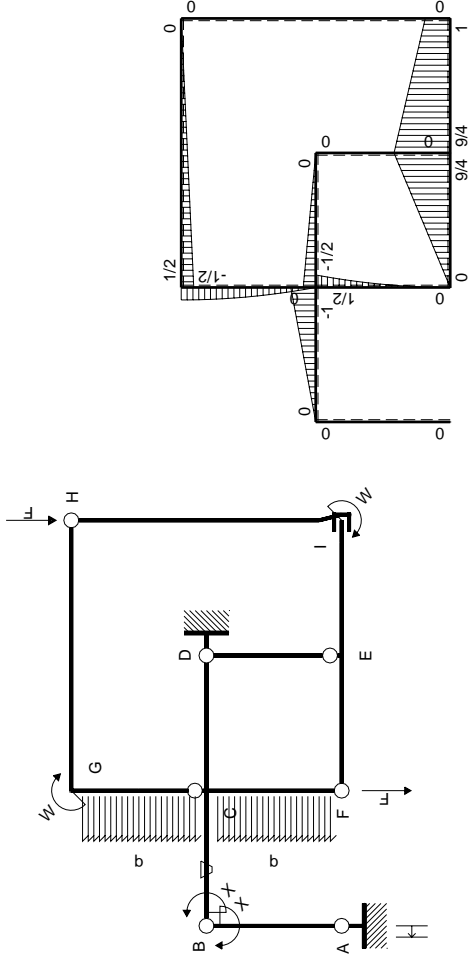
$$\sigma_c = -Mv/J_u = 135.7 \text{ N/mm}^2$$

$$\tau_c = 3.156 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 135.8 \text{ N/mm}^2$$

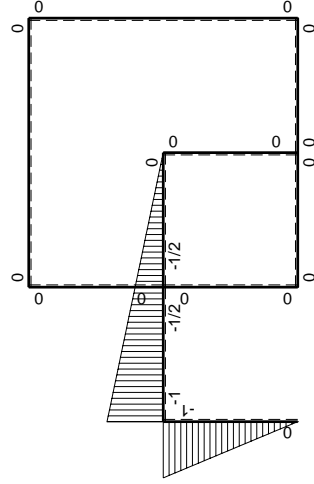
$$S = 4277. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ		
	totali						$13/6Fb^2/EJ$	Xb/EJ	
	iperstatica $X=W_{BC}$						$-13/6Fb$		

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

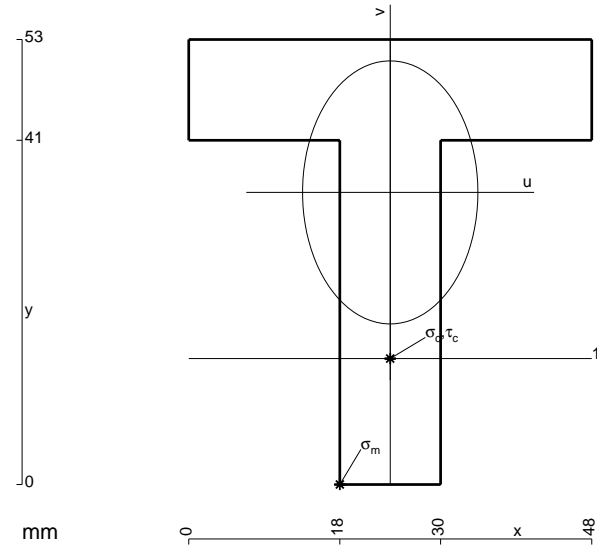
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

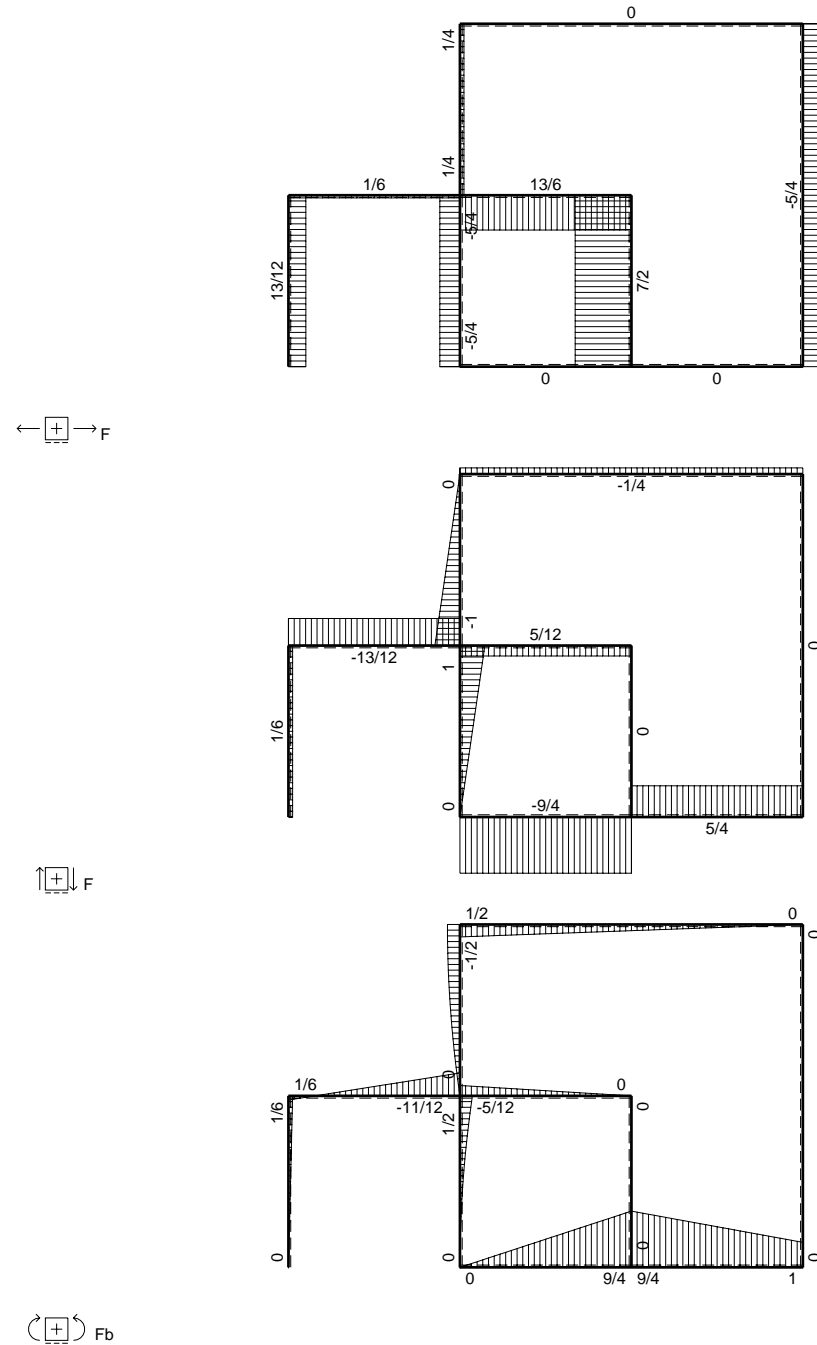
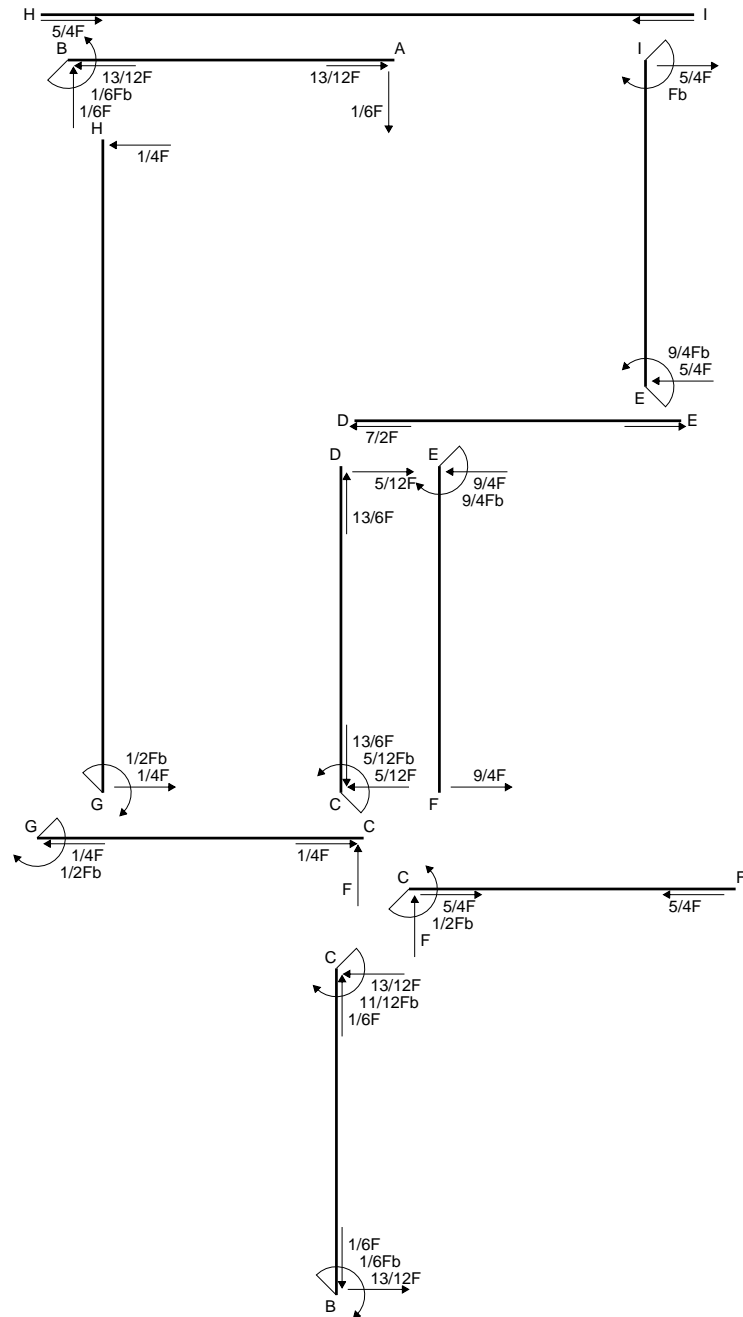
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

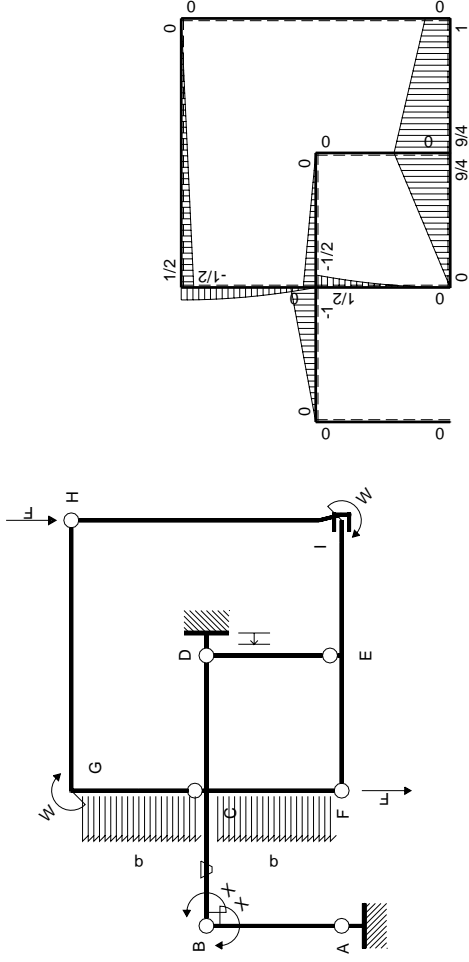
$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 1068. mm²
- J_u = 262174. mm⁴
- J_v = 116496. mm⁴
- y_g = 34.79 mm
- T_y = -3420. N
- M_x = 1504800. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -34.79 mm
- σ_m = -Mv/J_u = 199.7 N/mm²
- x_c = 24. mm
- y_c = 15. mm
- v_c = -19.79 mm
- σ_c = -Mv/J_u = 113.6 N/mm²
- τ_c = 5.34 N/mm²
- σ_ρ = √σ²+3τ² = 114. N/mm²
- S = 4913. mm³



⊕ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

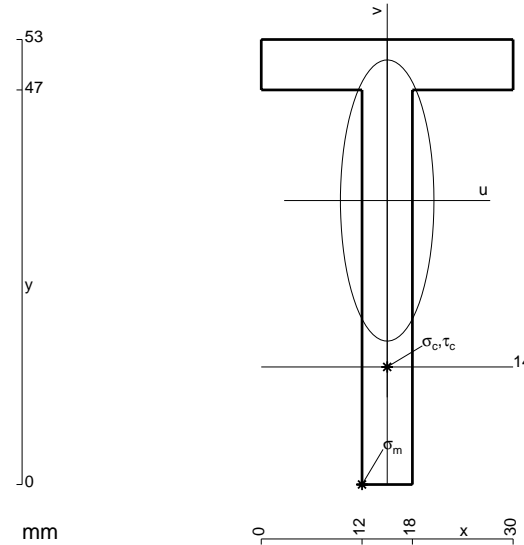
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

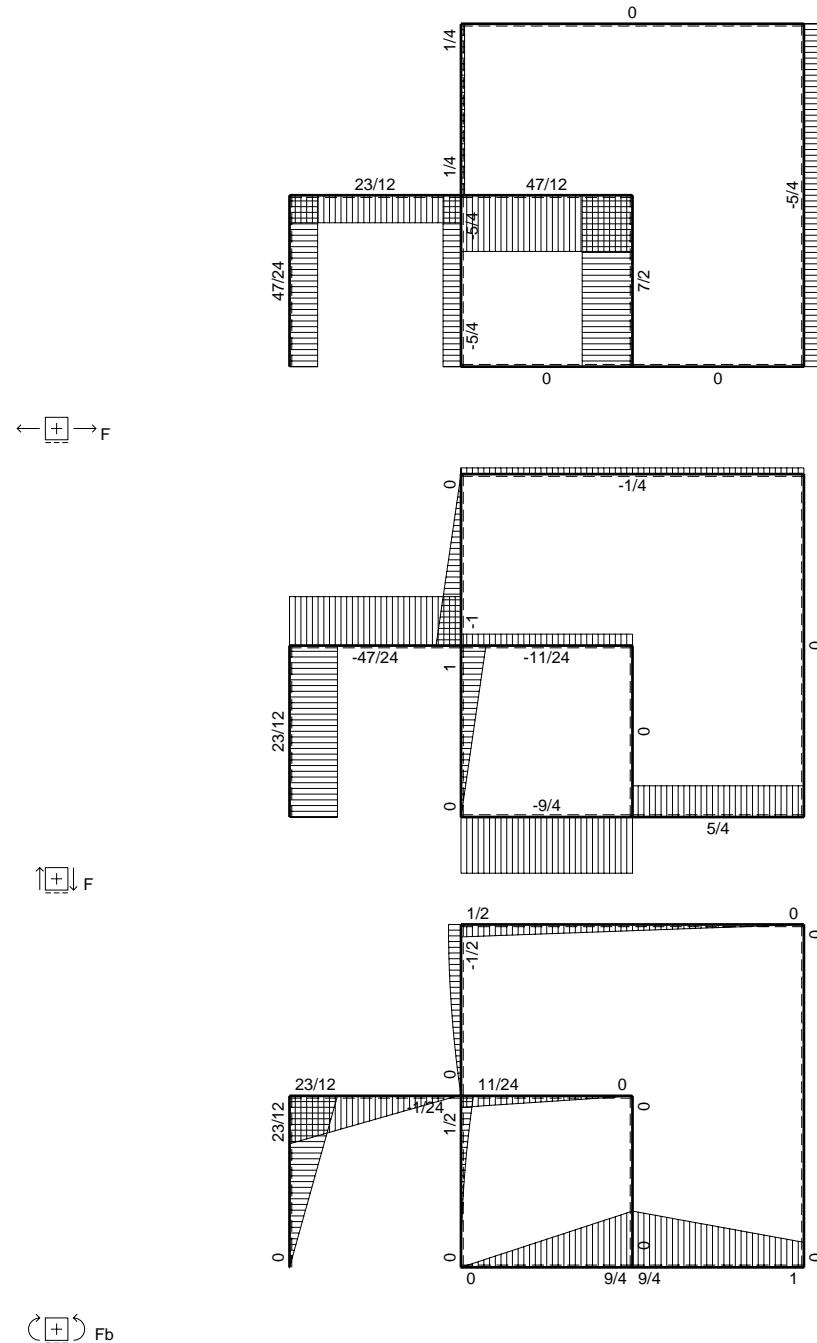
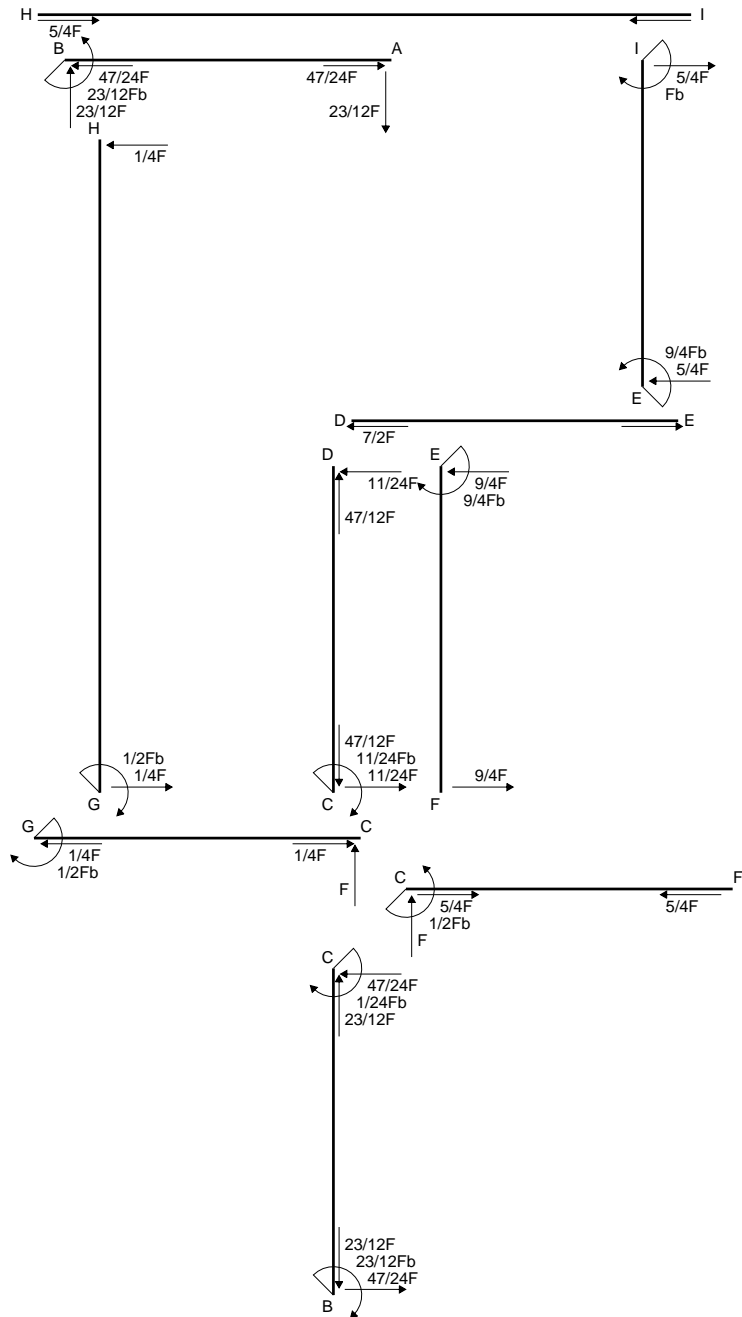
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

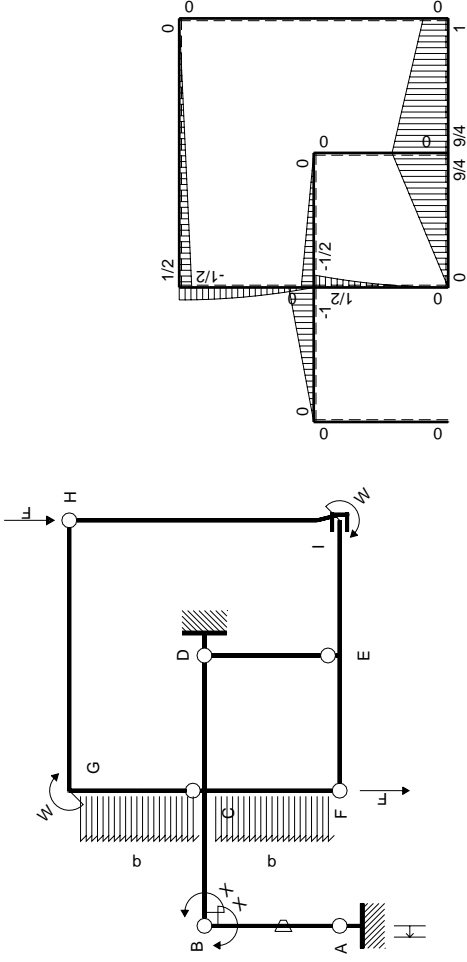
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 462. mm²
- J_u = 129608. mm⁴
- J_v = 14346. mm⁴
- y_g = 33.82 mm
- T_y = -1665. N
- M_x = 799200. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -33.82 mm
- σ_m = -Mv/J_u = 208.6 N/mm²
- x_c = 15. mm
- y_c = 14. mm
- v_c = -19.82 mm
- σ_c = -Mv/J_u = 122.2 N/mm²
- τ_c = 4.824 N/mm²
- σ_o = √σ²+3τ² = 122.5 N/mm²
- S = 2253. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0
FE b	0	$-9/4Fx$	0	0	0	0		
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$23/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-23/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

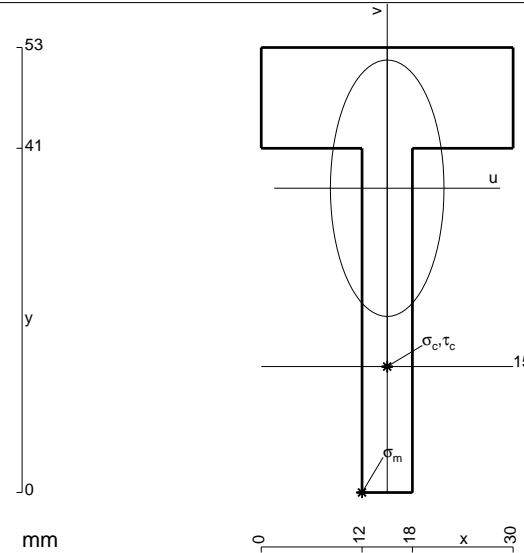
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

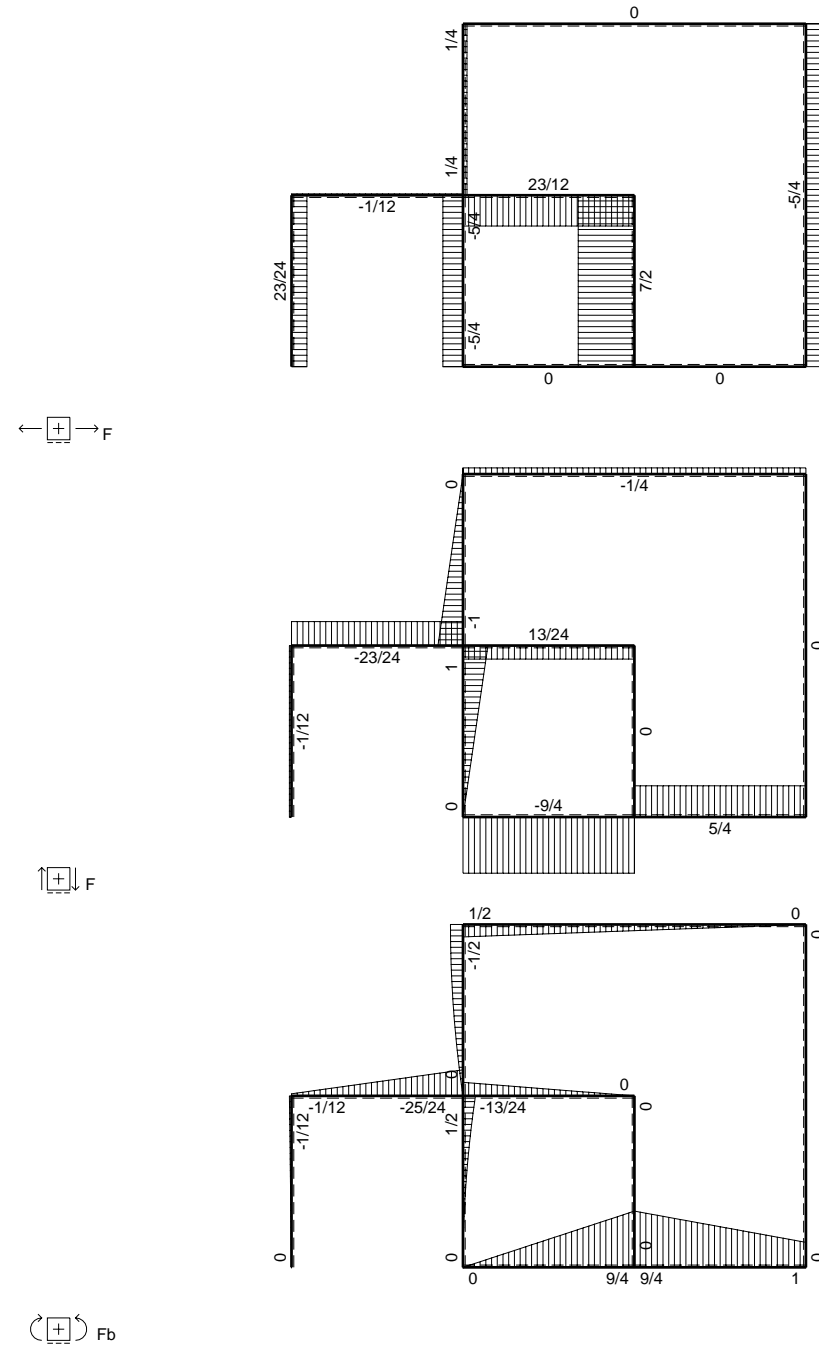
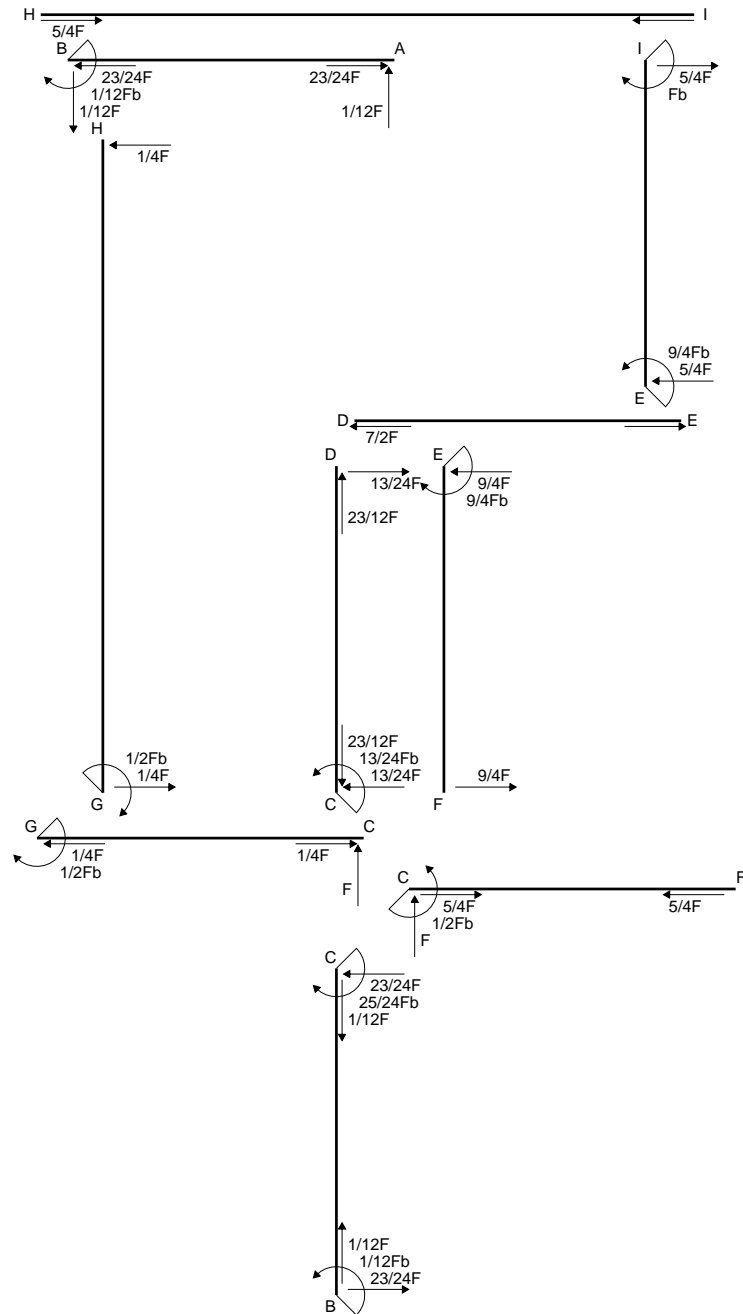
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



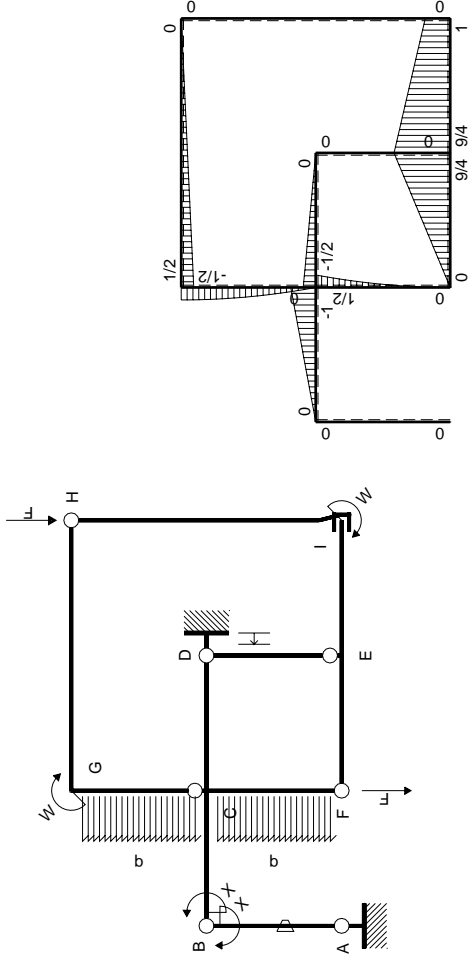
- A = 606. mm²
- J_u = 141406. mm⁴
- J_v = 27738. mm⁴
- y_g = 36.24 mm
- T_y = -1643. N
- M_x = 854100. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -36.24 mm
- σ_m = -Mv/J_u = 218.9 N/mm²
- x_c = 15. mm
- y_c = 15. mm
- v_c = -21.24 mm
- σ_c = -Mv/J_v = 128.3 N/mm²
- τ_c = 5.008 N/mm²
- σ_o = √σ²+3τ² = 128.6 N/mm²
- S = 2587. mm³



← ⊕ → 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 $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

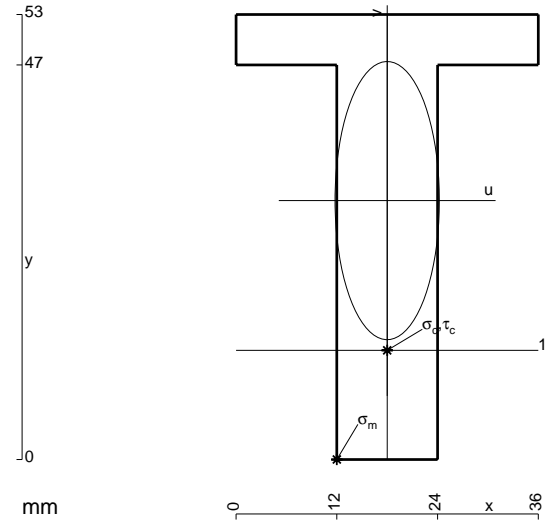
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

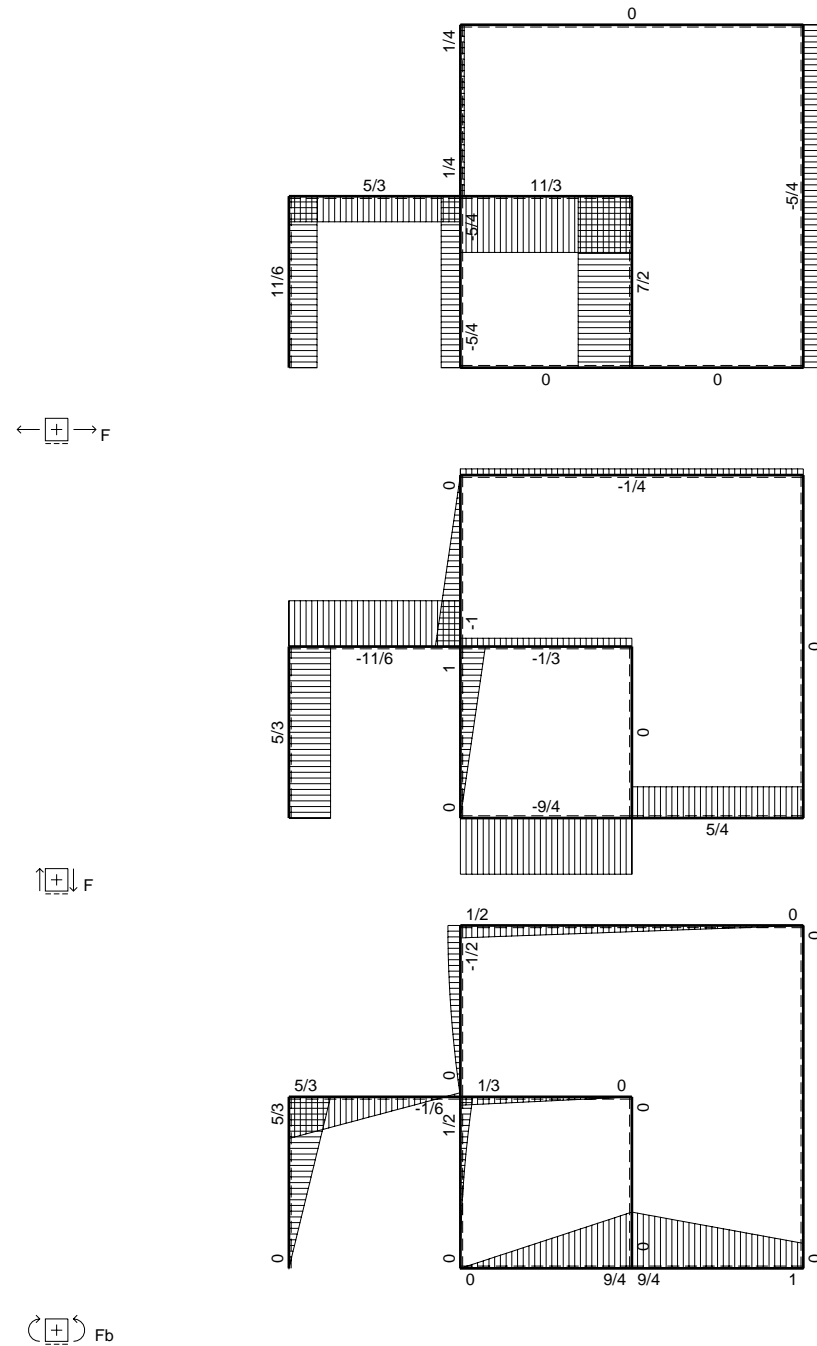
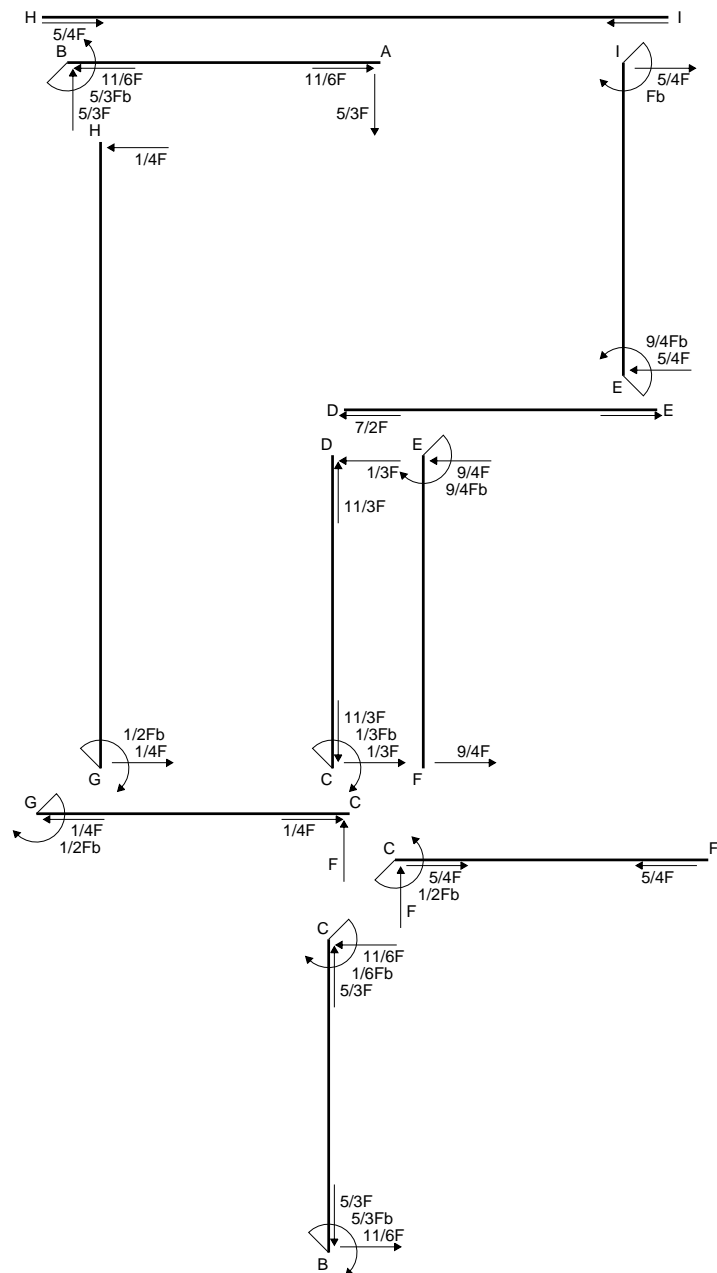
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

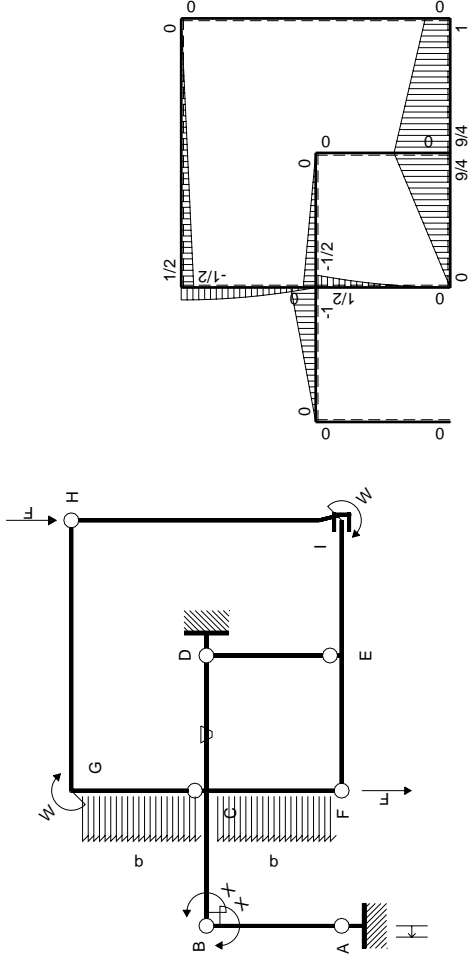
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 780. mm²
- J_u = 214152. mm⁴
- J_v = 30096. mm⁴
- y_g = 30.84 mm
- T_y = -2790. N
- M_x = 1590300. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -30.84 mm
- σ_m = -Mv/J_u = 229. N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -17.84 mm
- σ_c = -Mv/J_u = 132.5 N/mm²
- τ_c = 4.122 N/mm²
- σ_o = √σ²+3τ² = 132.7 N/mm²
- S = 3797. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	$-Fb/EJ$	$1/4Fb-1/2Fx+1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	Fb/EJ	$1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$							Fb^2/EJ	
	totali							$5/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-5/3Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

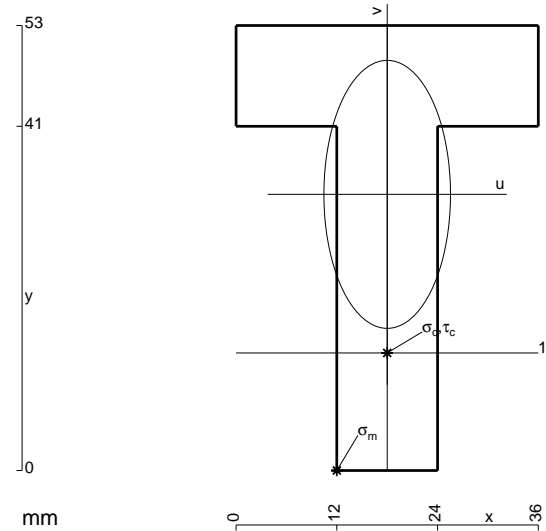
$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

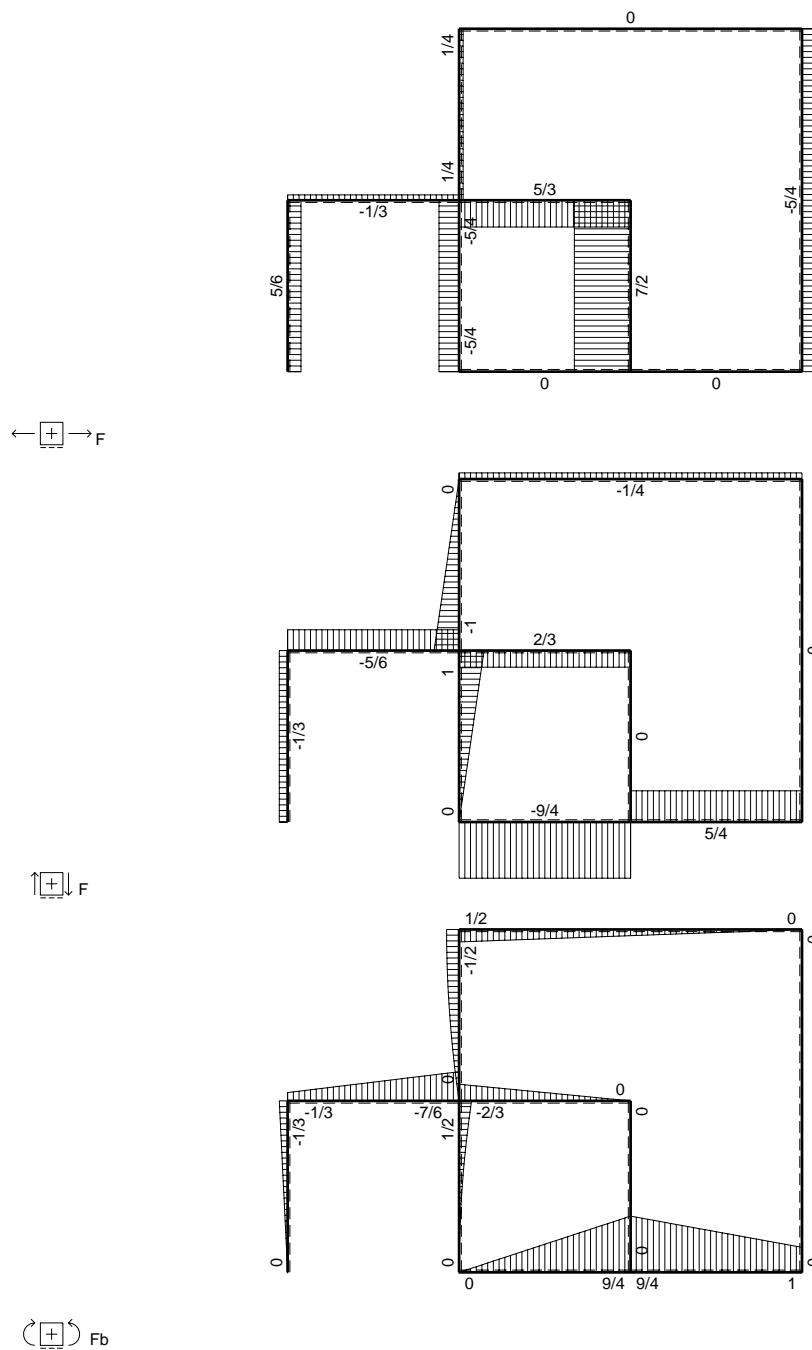
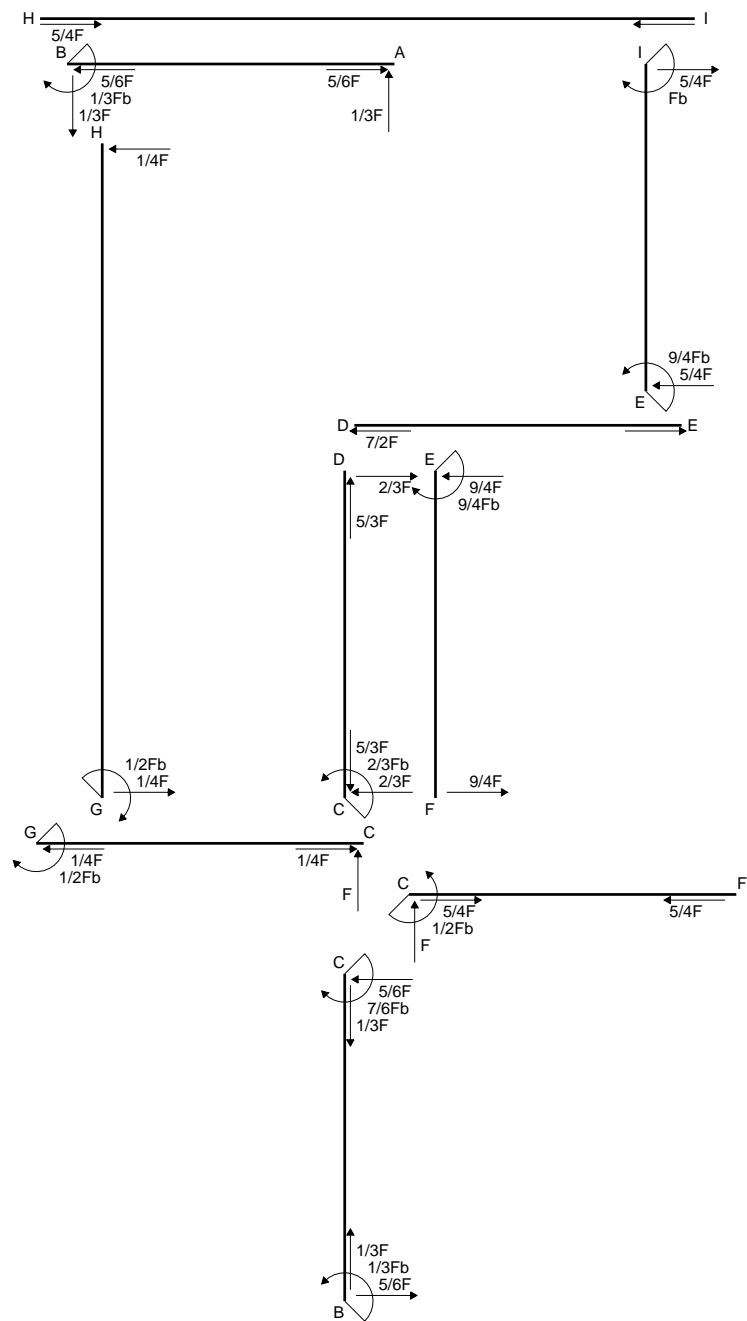
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/3 Fb^2/EJ$$

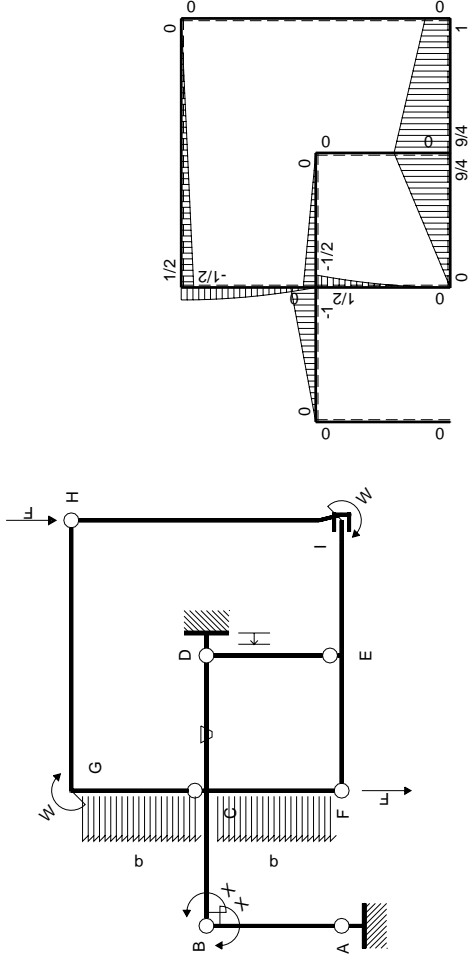
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/3 Fb^2/EJ$$



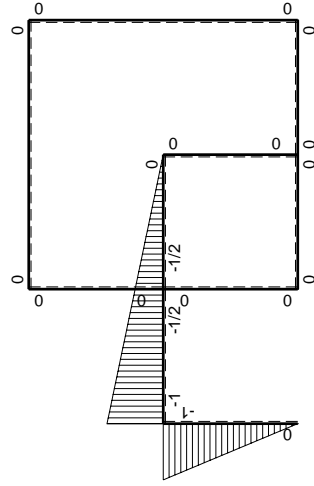
- A = 924. mm²
- J_u = 235641. mm⁴
- J_v = 52560. mm⁴
- y_g = 32.89 mm
- T_y = -2813. N
- M_x = 1715630. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -32.89 mm
- σ_m = -Mv/J_u = 239.5 N/mm²
- x_c = 18. mm
- y_c = 14. mm
- v_c = -18.89 mm
- σ_c = -Mv/J_u = 137.5 N/mm²
- τ_c = 4.326 N/mm²
- σ_o = √σ²+3τ² = 137.7 N/mm²
- S = 4349. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	$-Fb/EJ$	$1/4Fb-1/2Fx+1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	Fb/EJ	$1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/3Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

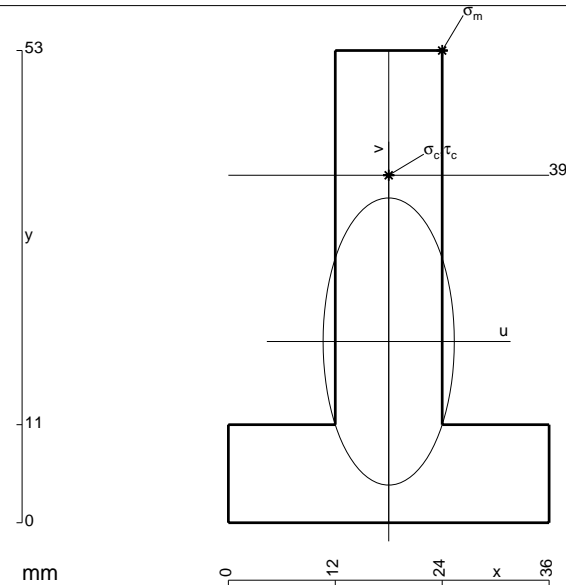
$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/3 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/3 Fb^2/EJ$$



$$A = 900. \text{ mm}^2$$

$$J_u = 233812. \text{ mm}^4$$

$$J_v = 48816. \text{ mm}^4$$

$$y_g = 20.34 \text{ mm}$$

$$T_y = -2160. \text{ N}$$

$$M_x = 1425600. \text{ Nmm}$$

$$x_m = 24. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 6. \text{ mm}$$

$$v_m = 32.66 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -199.1 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 39. \text{ mm}$$

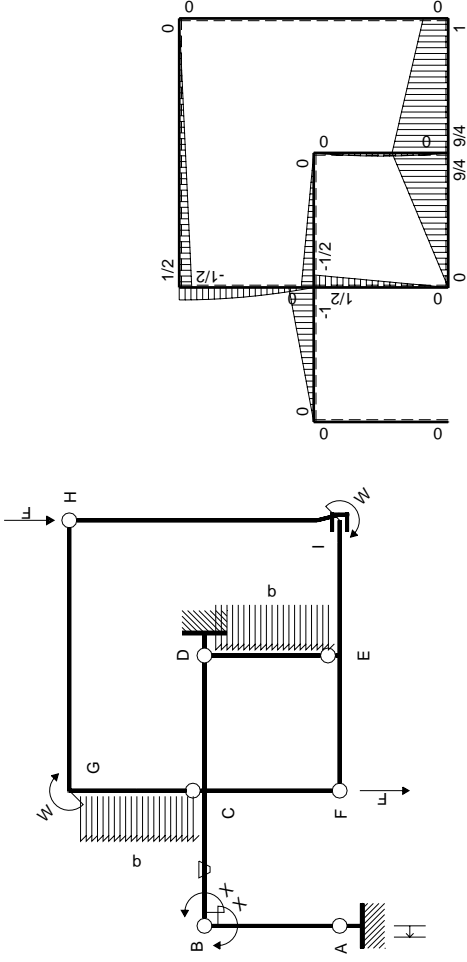
$$v_c = 18.66 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -113.8 \text{ N/mm}^2$$

$$\tau_c = 3.319 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 113.9 \text{ N/mm}^2$$

$$S = 4311. \text{ mm}^3$$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0
FE b	0	$-9/4Fx$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$13/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-13/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

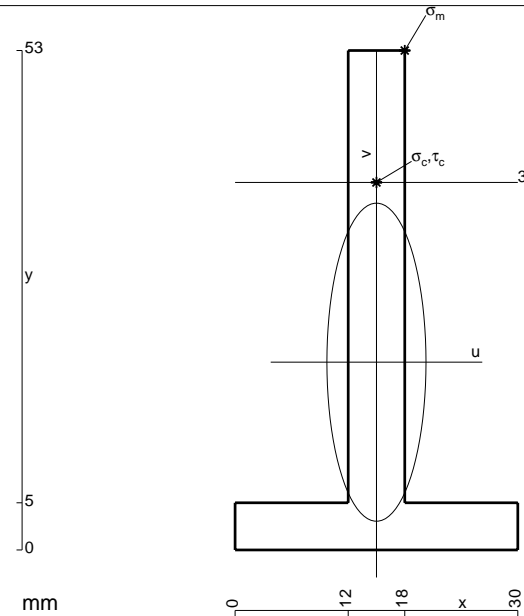
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

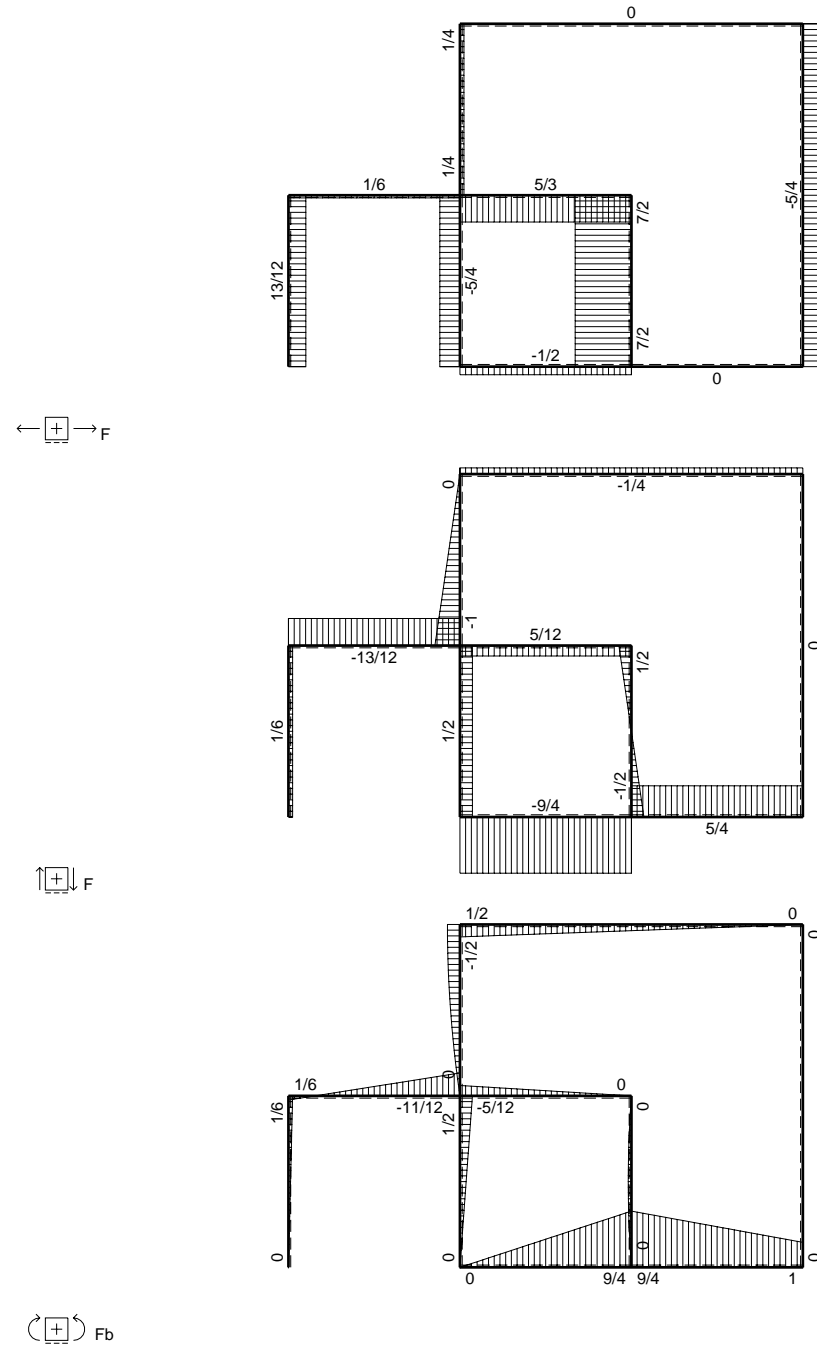
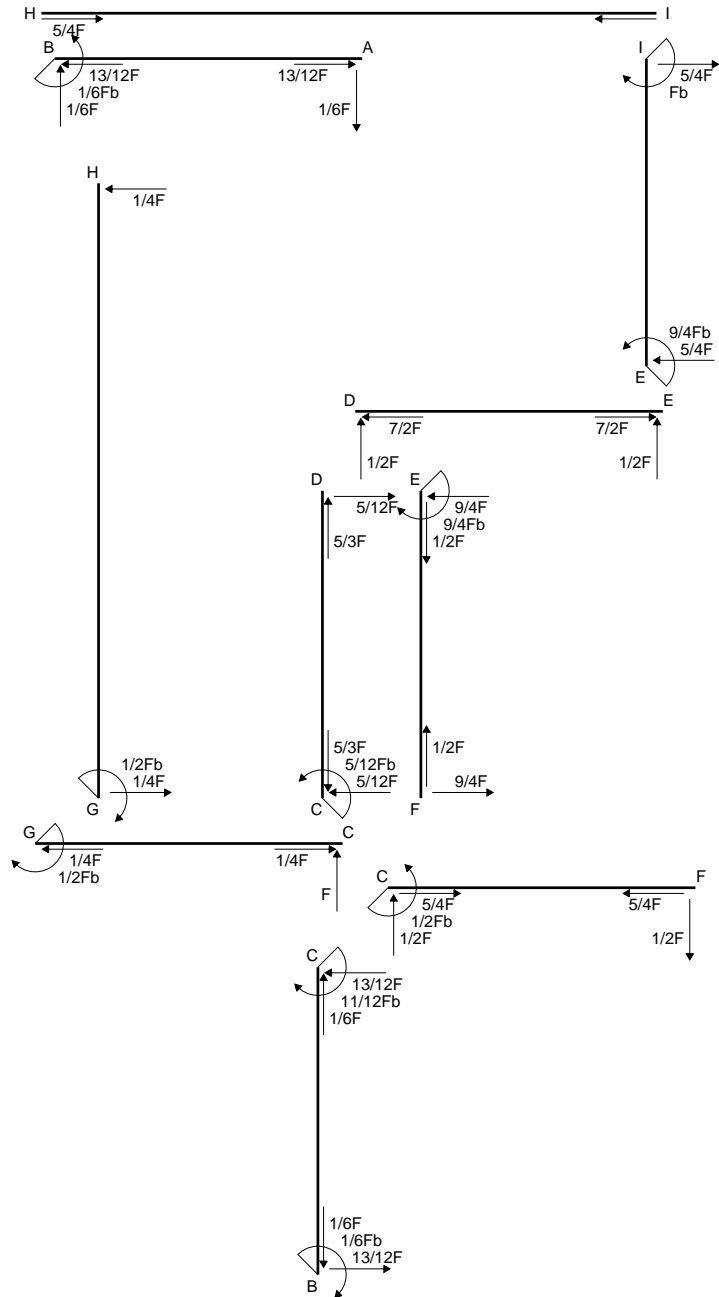
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

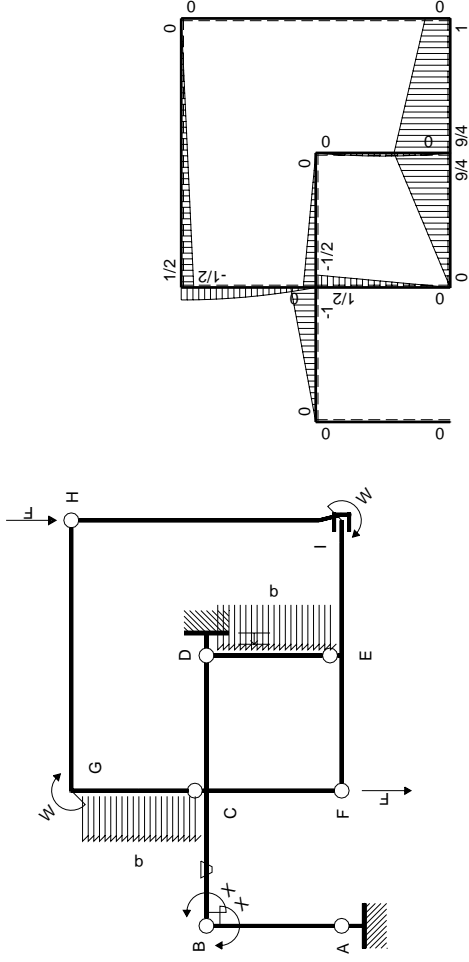
$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 438. mm²
- J_u = 124872. mm⁴
- J_v = 12114. mm⁴
- y_g = 19.92 mm
- N = -250. N
- T_y = -1125. N
- M_x = 787500. Nmm
- x_m = 18. mm
- y_m = 53. mm
- u_m = 3. mm
- v_m = 33.08 mm
- σ_m = N/A - Mv/J_u = -209.2 N/mm²
- x_c = 15. mm
- y_c = 39. mm
- v_c = 19.08 mm
- σ_c = N/A - Mv/J_u = -120.9 N/mm²
- τ_c = 3.289 N/mm²
- σ_q = √(σ² + 3τ²) = 121. N/mm²
- S = 2190. mm³



$\left[\begin{matrix} + \\ - \end{matrix} \right] F_b$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0
FE b	0	$-9/4Fx$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$1/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-1/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

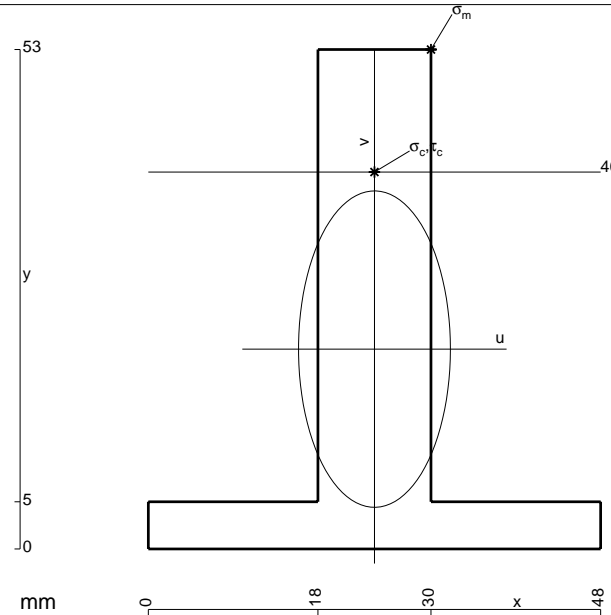
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

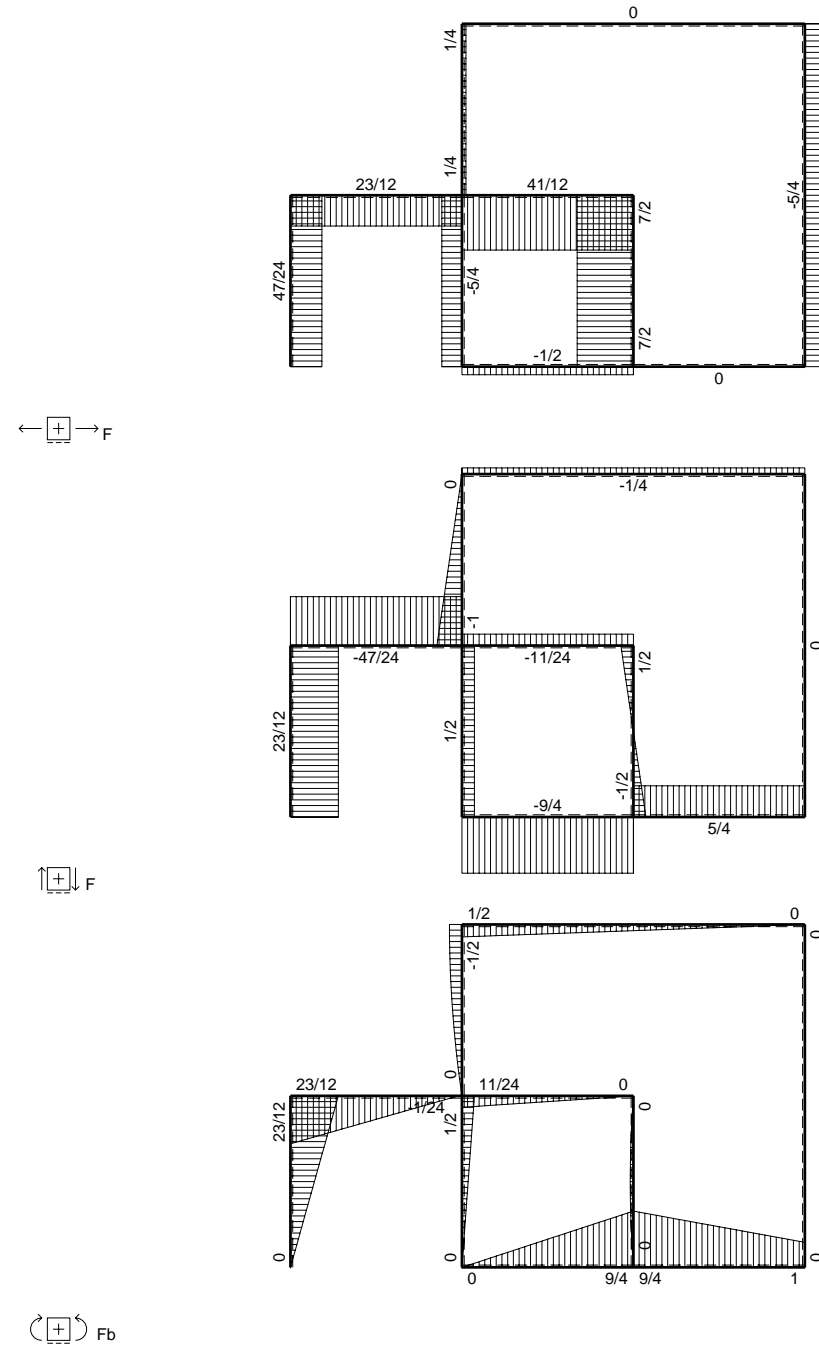
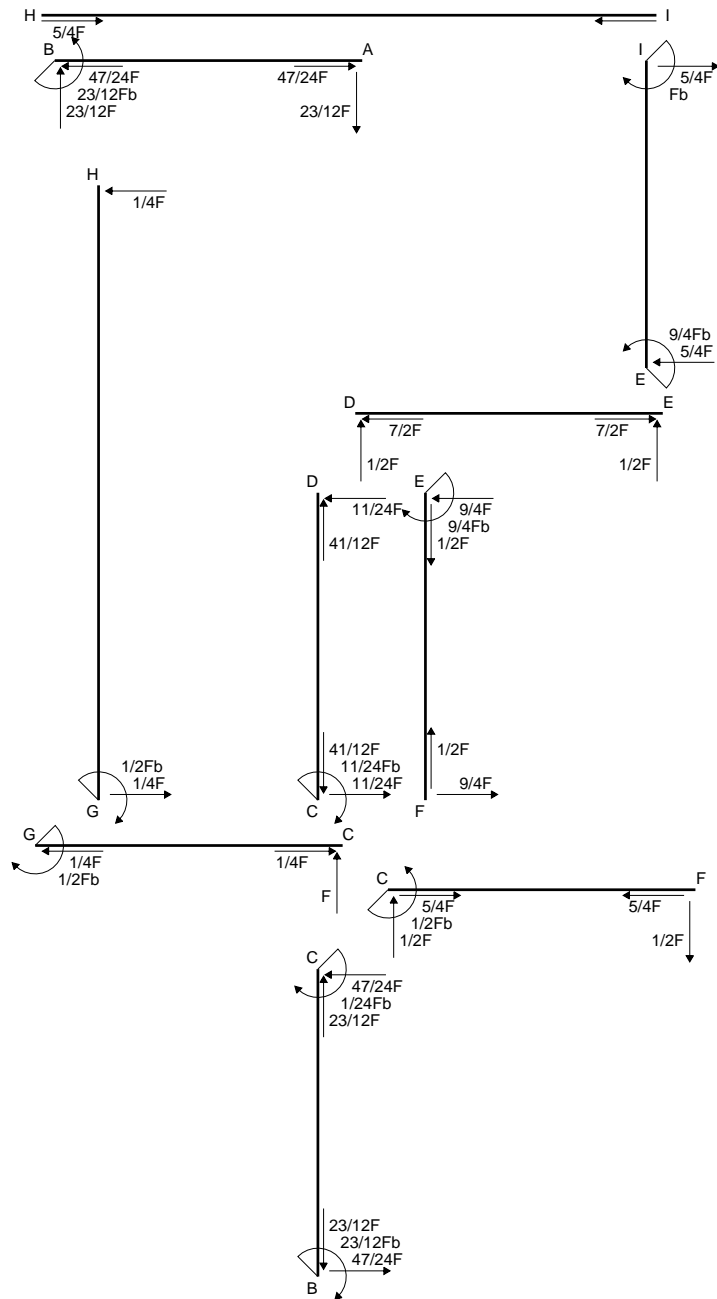
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

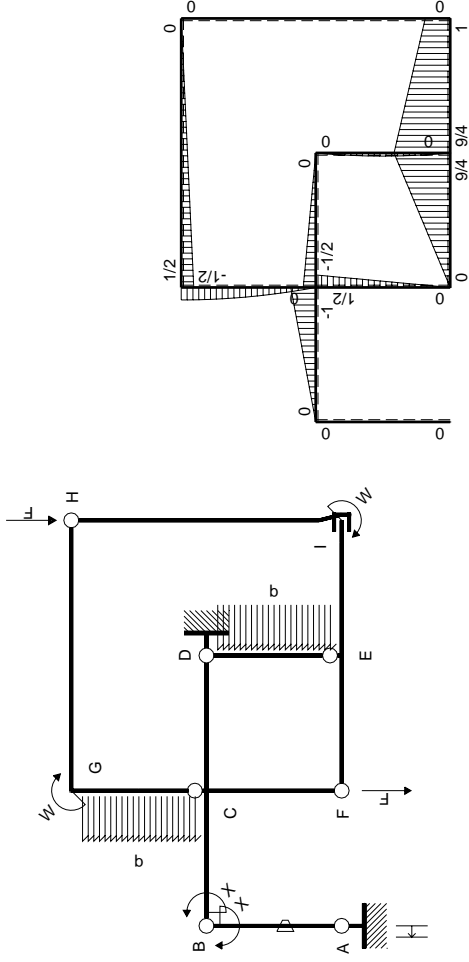
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 816. mm²
- J_u = 230061. mm⁴
- J_v = 52992. mm⁴
- y_g = 21.21 mm
- N = -475. N
- T_y = -2138. N
- M_x = 1581750. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 6. mm
- v_m = 31.79 mm
- σ_m = N/A-Mv/J_u = -219.2 N/mm²
- x_c = 24. mm
- y_c = 40. mm
- v_c = 18.79 mm
- σ_c = N/A-Mv/J_u = -129.8 N/mm²
- τ_c = 3.055 N/mm²
- σ_q = √(σ²+3τ²) = 129.9 N/mm²
- S = 3946. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0
FE b	0	$-9/4Fx$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$23/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-23/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

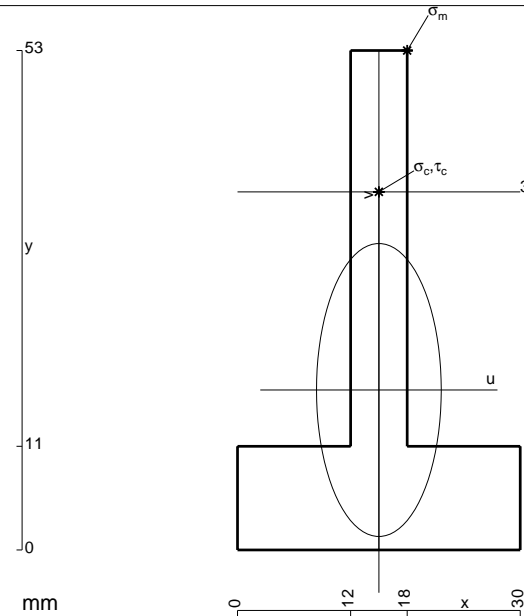
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



$$A = 582. \text{ mm}^2$$

$$J_u = 140714. \text{ mm}^4$$

$$J_v = 25506. \text{ mm}^4$$

$$y_g = 16.97 \text{ mm}$$

$$N = -250. \text{ N}$$

$$T_y = -1125. \text{ N}$$

$$M_x = 888750. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 3. \text{ mm}$$

$$v_m = 36.03 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = -228. \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 38. \text{ mm}$$

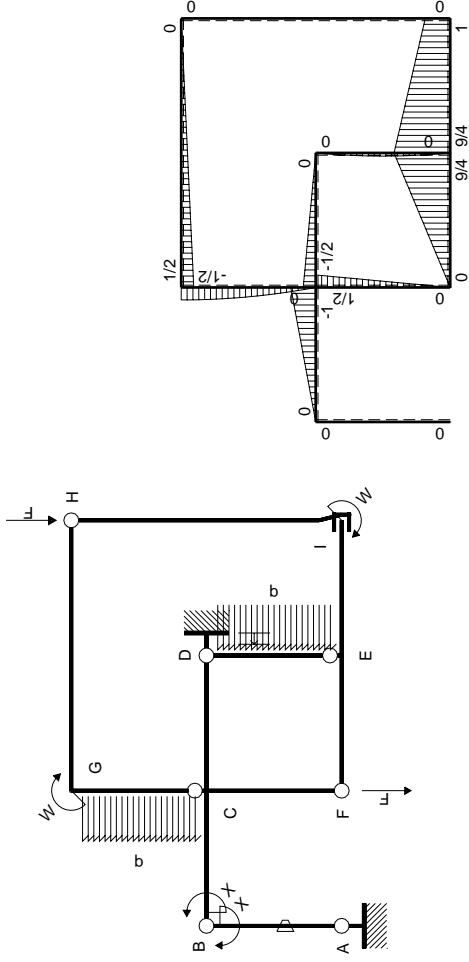
$$v_c = 21.03 \text{ mm}$$

$$\sigma_c = N/A - Mv/J_u = -133.2 \text{ N/mm}^2$$

$$\tau_c = 3.421 \text{ N/mm}^2$$

$$\sigma_g = \sqrt{\sigma^2 + 3\tau^2} = 133.4 \text{ N/mm}^2$$

$$S = 2567. \text{ mm}^3$$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0
FE b	0	$-9/4Fx$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$-1/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$1/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

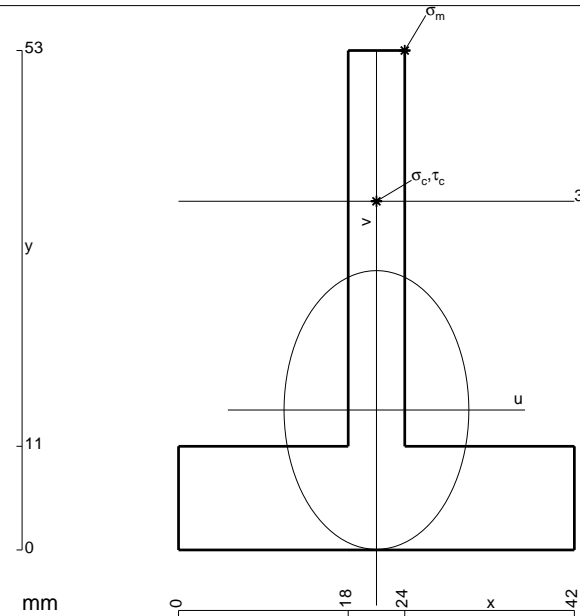
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

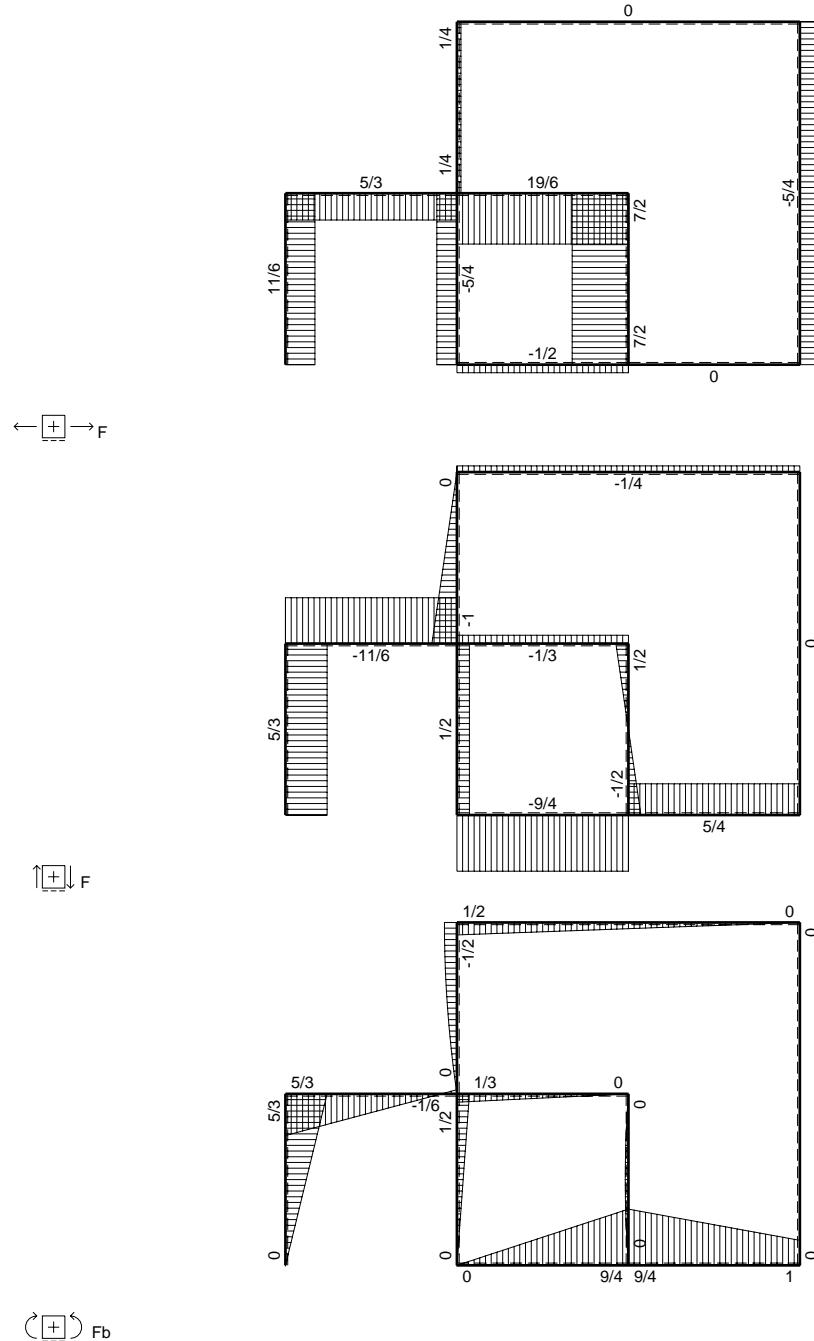
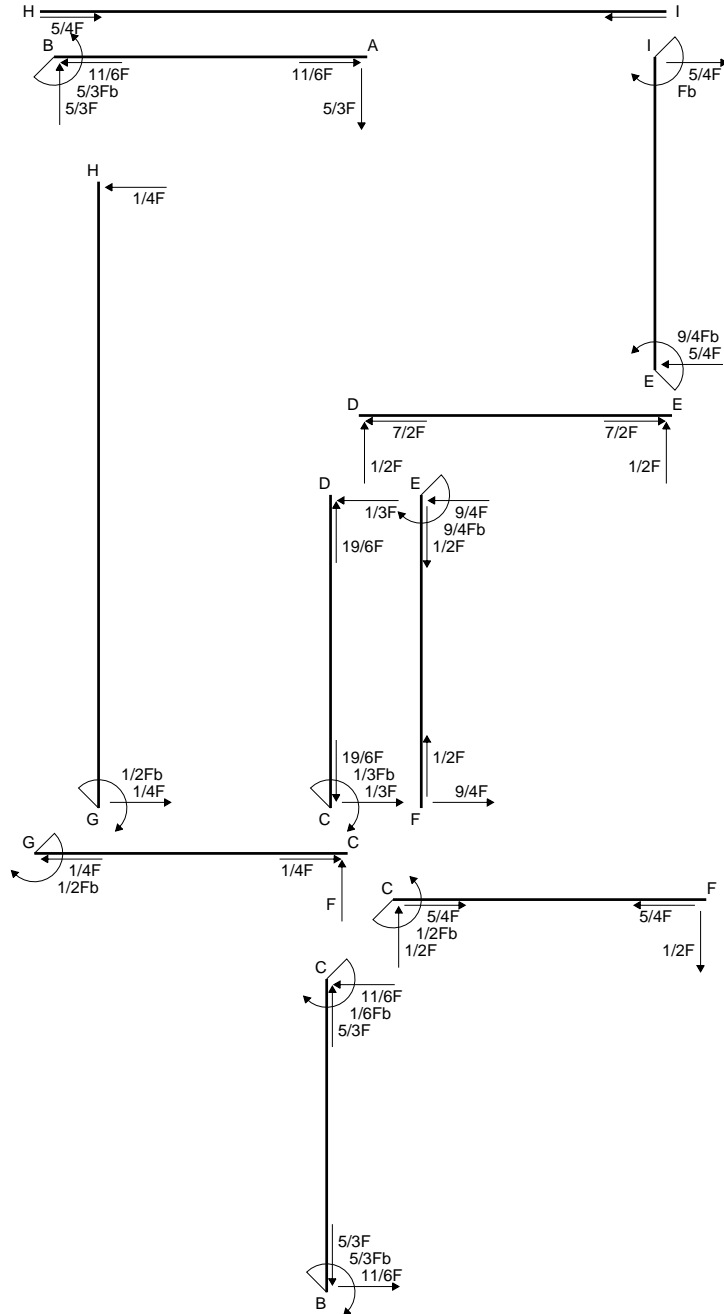
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

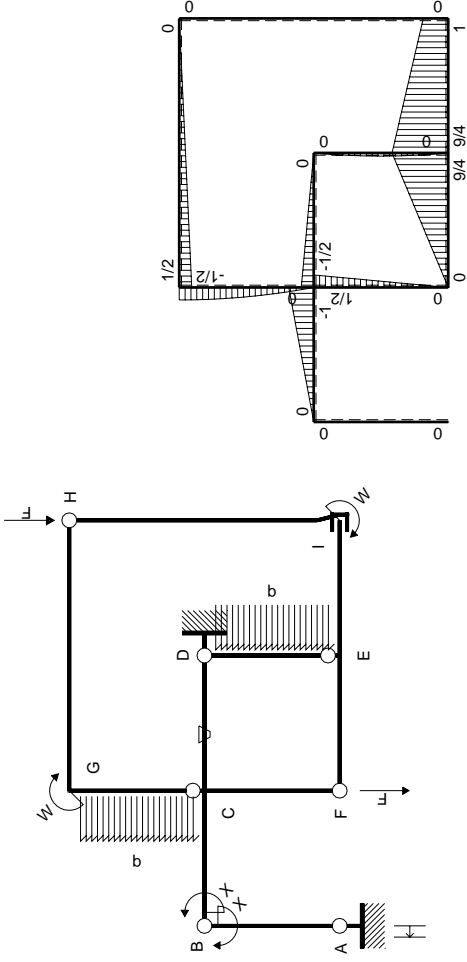
$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 714. mm²
- J_u = 156211. mm⁴
- J_v = 68670. mm⁴
- y_g = 14.85 mm
- N = -260. N
- T_y = -1170. N
- M_x = 971100. Nmm
- x_m = 24. mm
- y_m = 53. mm
- u_m = 3. mm
- v_m = 38.15 mm
- σ_m = N/A - Mv/J_u = -237.5 N/mm²
- x_c = 21. mm
- y_c = 37. mm
- v_c = 22.15 mm
- σ_c = N/A - Mv/J_u = -138. N/mm²
- τ_c = 3.613 N/mm²
- σ_o = √(σ² + 3τ²) = 138.2 N/mm²
- S = 2894. mm³



$\left[\begin{matrix} \oplus \\ \ominus \end{matrix} \right] F_b$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	1/3Xb/EJ	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	-Fx	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	7/12Xb/EJ	
CB b	$1/2+1/2x/b$	Fb-Fx	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	-Fb/EJ	$1/4Fb-1/2Fx+1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+1/4)Fb^2/EJ$	1/12Xb/EJ	
DC b	$1/2x/b$	$1/2Fx$	Fb/EJ	$1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	$1/2Fx$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$							Fb^2/EJ	
	totali							$5/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-5/3Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

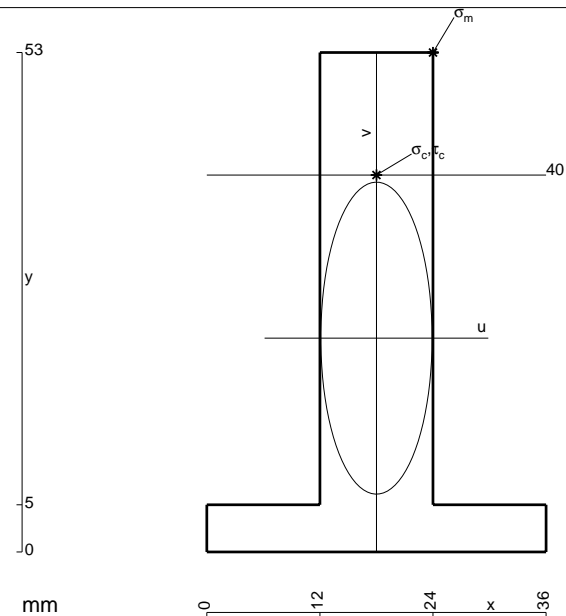
$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/3 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/3 Fb^2/EJ$$



$$A = 756. \text{ mm}^2$$

$$J_u = 207276. \text{ mm}^4$$

$$J_v = 26352. \text{ mm}^4$$

$$y_g = 22.69 \text{ mm}$$

$$N = -685. \text{ N}$$

$$T_y = -3083. \text{ N}$$

$$M_x = 1356300. \text{ Nmm}$$

$$x_m = 24. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 6. \text{ mm}$$

$$v_m = 30.31 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = -199.2 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

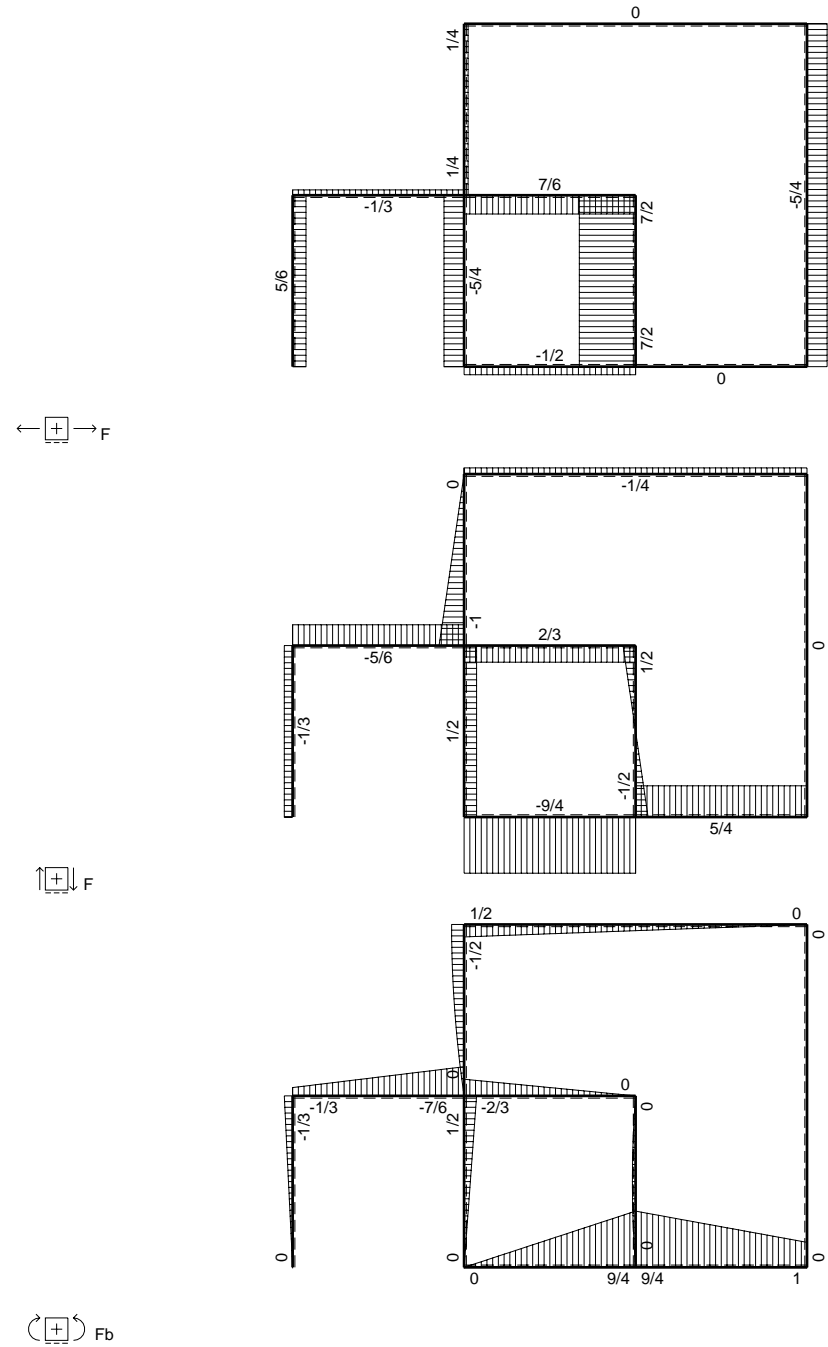
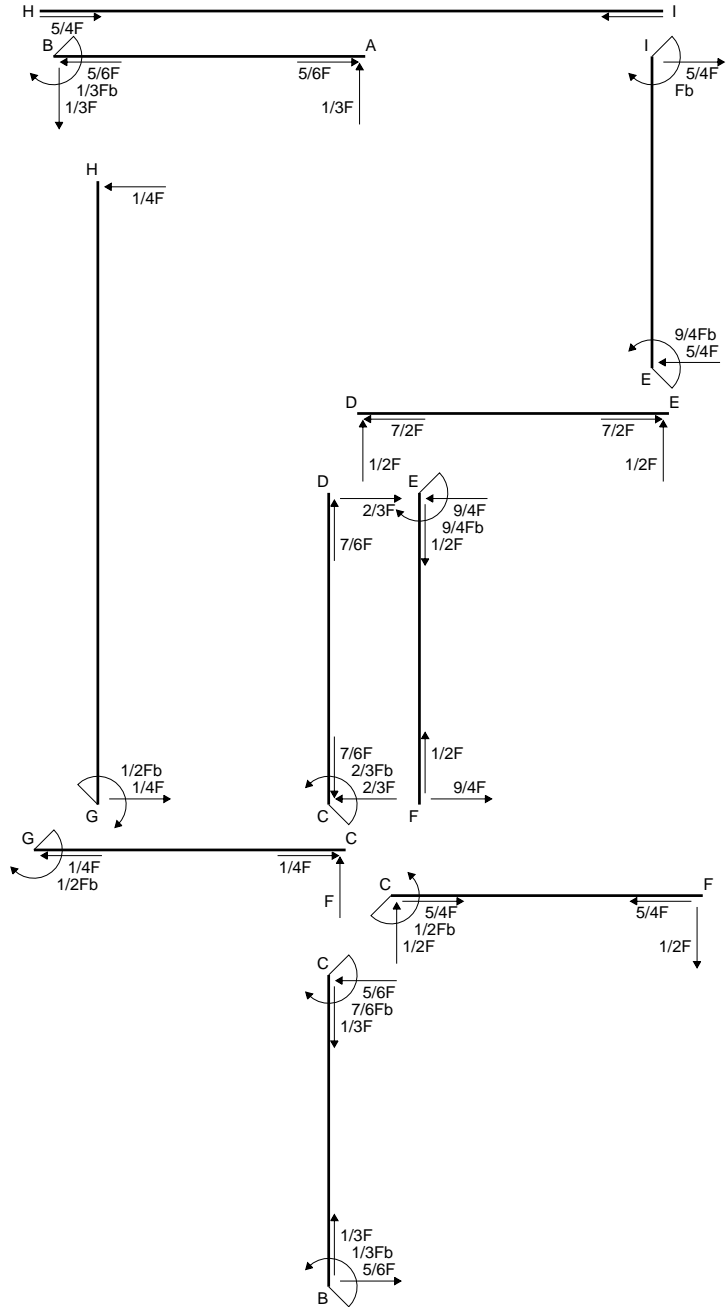
$$v_c = 17.31 \text{ mm}$$

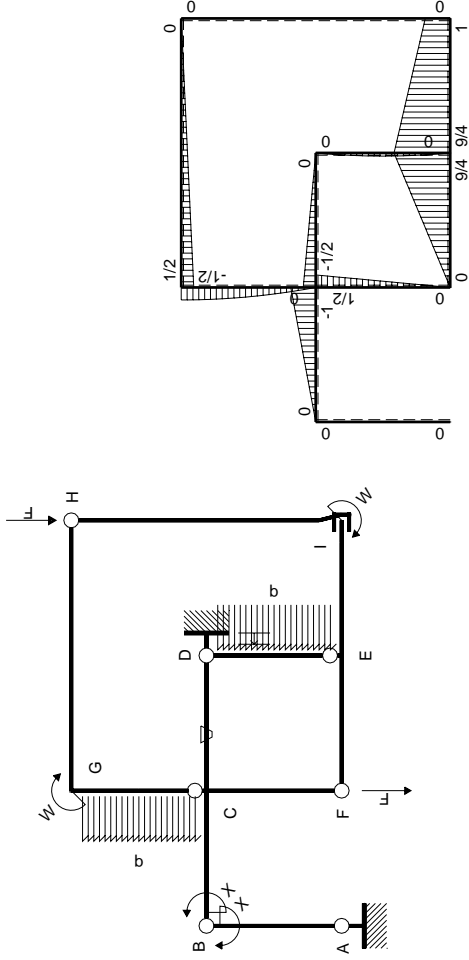
$$\sigma_c = N/A - Mv/J_u = -114.2 \text{ N/mm}^2$$

$$\tau_c = 4.603 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 114.4 \text{ N/mm}^2$$

$$S = 3714. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	$-Fb/EJ$	$1/4Fb-1/2Fx+1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	Fb/EJ	$1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	$1/2Fx$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/3Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

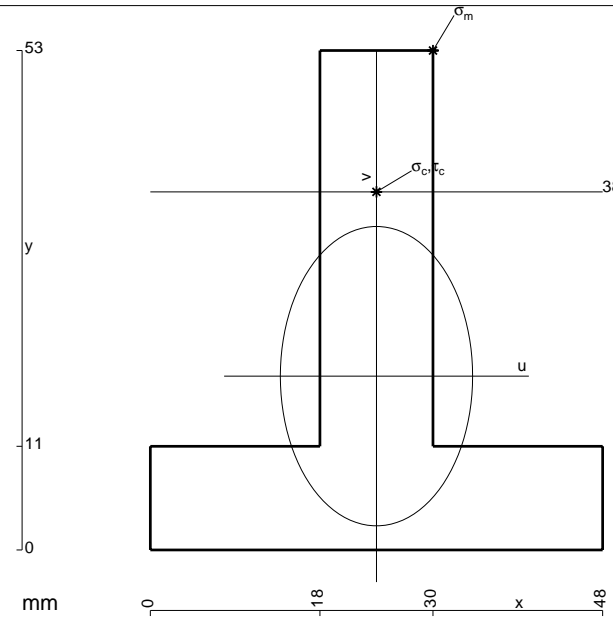
$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

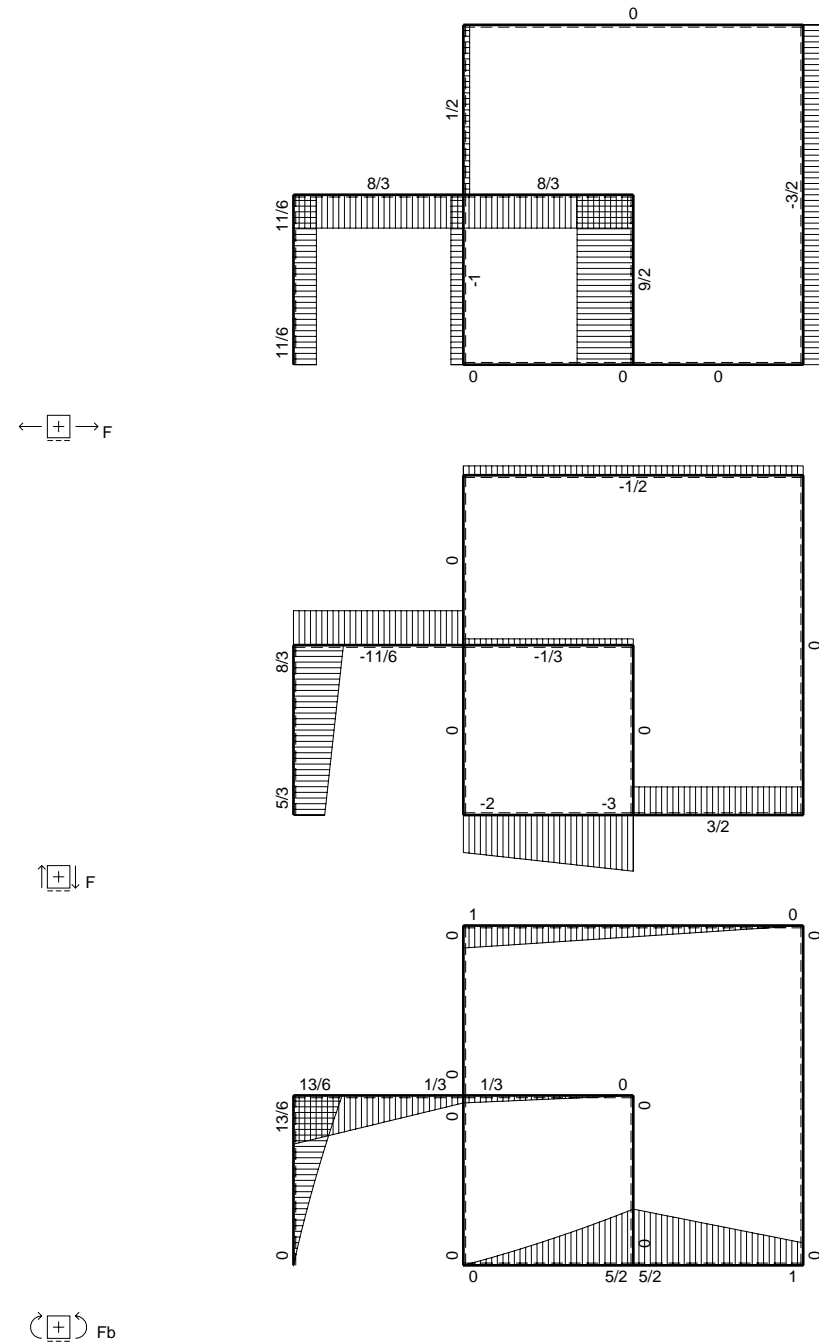
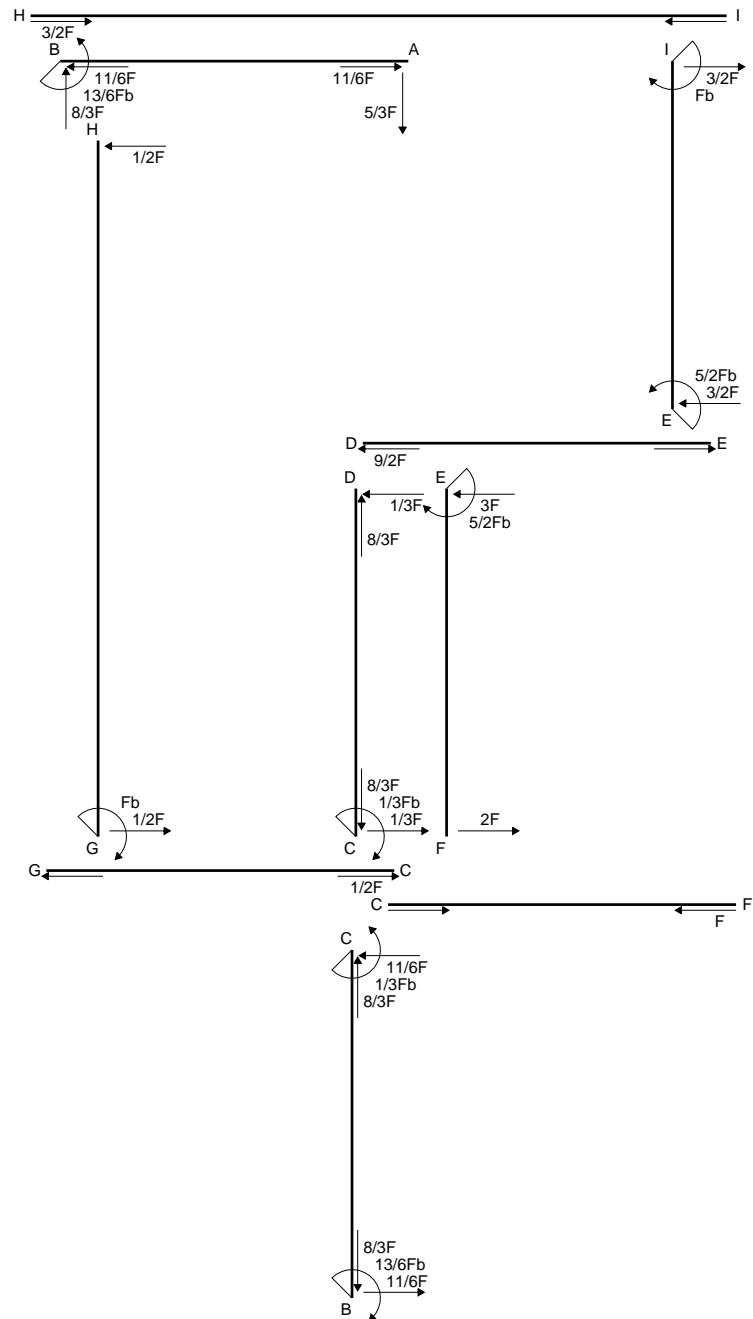
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/3 Fb^2/EJ$$

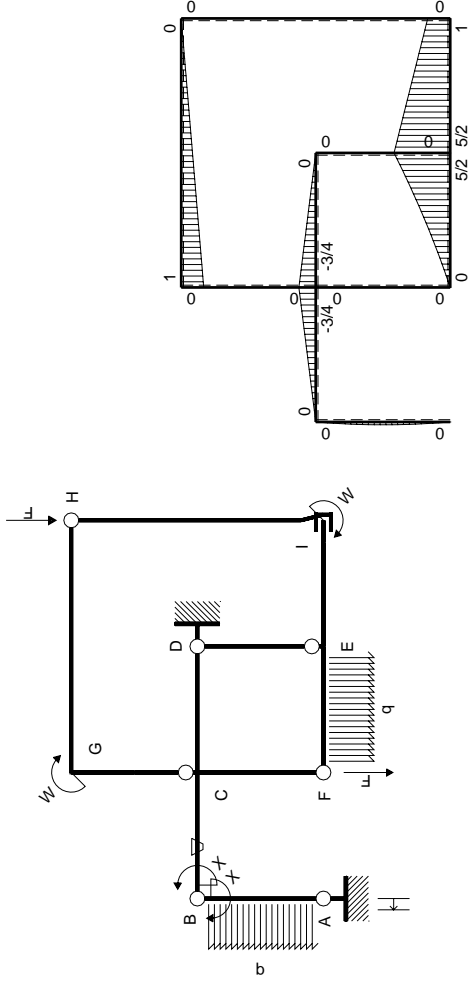
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/3 Fb^2/EJ$$



- A = 1032. mm²
- J_u = 260495. mm⁴
- J_v = 107424. mm⁴
- y_g = 18.44 mm
- N = -730. N
- T_y = -3285. N
- M_x = 1576800. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 6. mm
- v_m = 34.56 mm
- σ_m = N/A-Mv/J_u = -209.9 N/mm²
- x_c = 24. mm
- y_c = 38. mm
- v_c = 19.56 mm
- σ_c = N/A-Mv/J_u = -119.1 N/mm²
- τ_c = 5.118 N/mm²
- σ_q = √(σ²+3τ²) = 119.4 N/mm²
- S = 4870. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$13/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-13/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{x_0} = \int_0^b (1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BA}^{x_0} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BC}^{x_0} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (3/8 b - 1/8 b) Fb 1/EJ + (b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CB}^{x_0} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

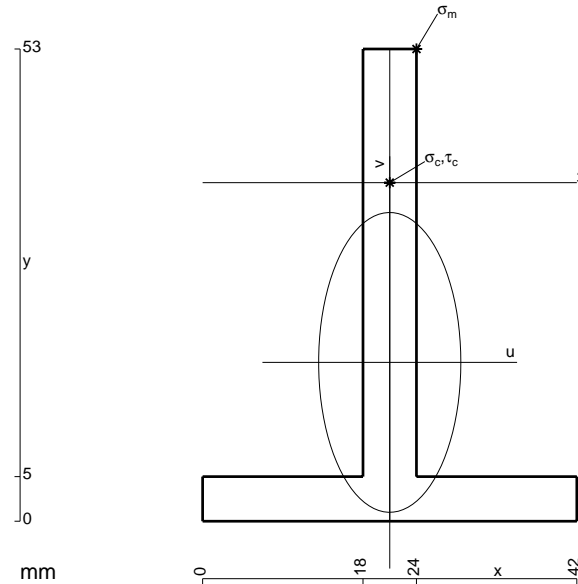
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CD}^{x_0} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

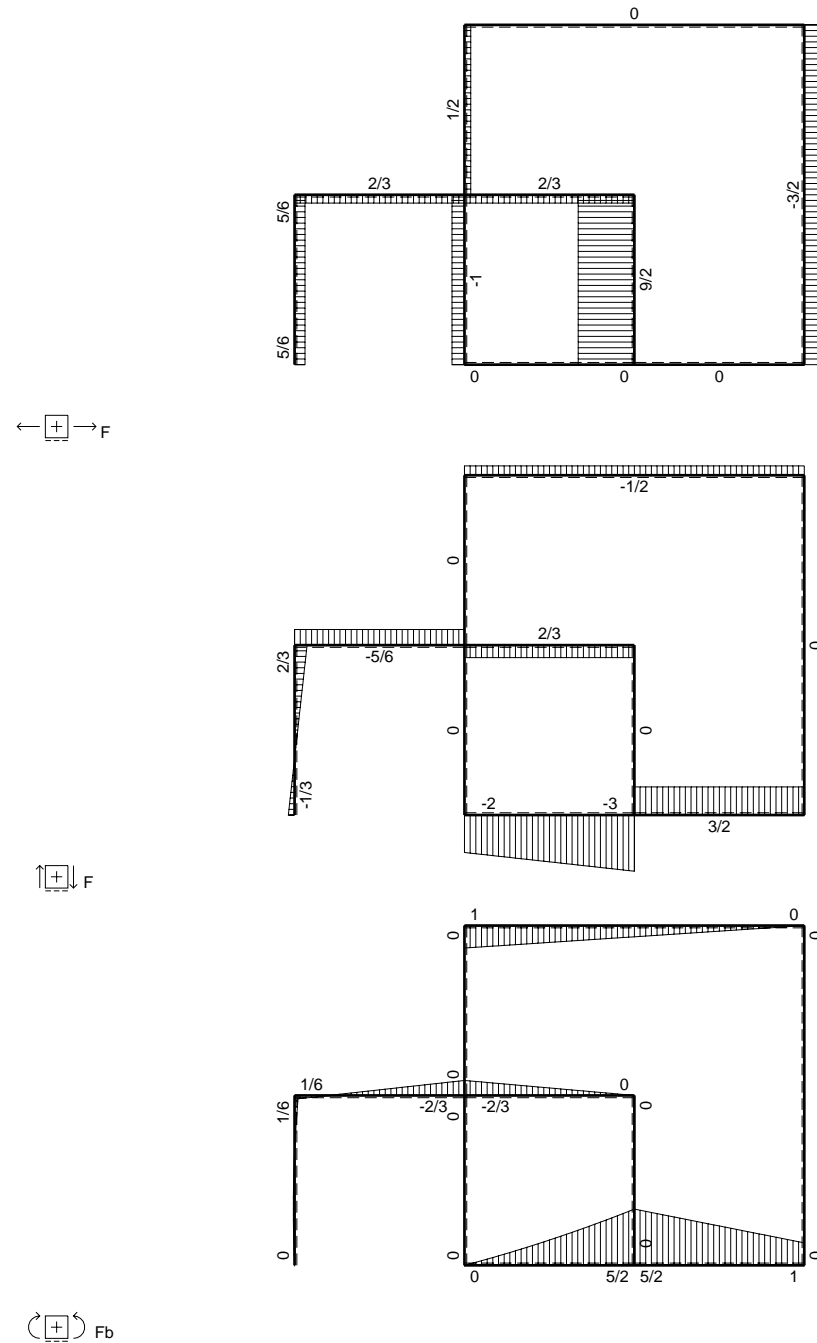
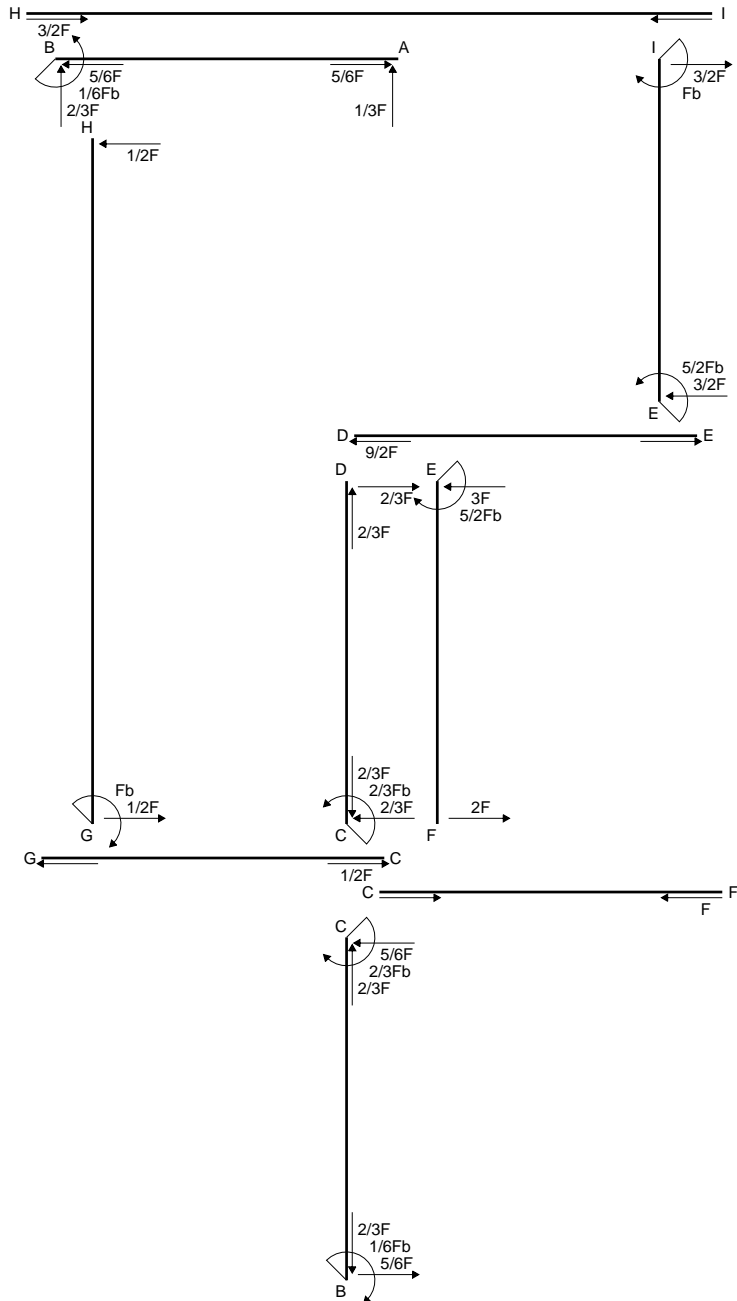
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{x_0} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

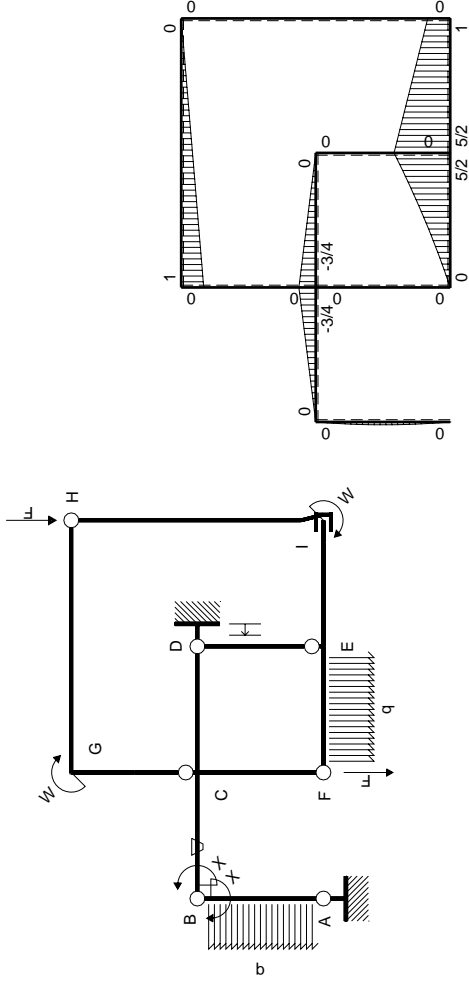
$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 498. mm²
- J_u = 141019. mm⁴
- J_v = 31734. mm⁴
- y_g = 17.83 mm
- T_y = -2010. N
- M_x = 871000. Nmm
- x_m = 24. mm
- y_m = 53. mm
- u_m = 3. mm
- v_m = 35.17 mm
- σ_m = -Mv/J_u = -217.3 N/mm²
- x_c = 21. mm
- y_c = 38. mm
- v_c = 20.17 mm
- σ_c = -Mv/J_u = -124.6 N/mm²
- τ_c = 5.917 N/mm²
- σ_o = √σ²+3τ² = 125. N/mm²
- S = 2491. mm³



$\boxed{+}$ \uparrow \curvearrowright F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{x_0} = \int_0^b (1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BA}^{x_0} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BC}^{x_0} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (3/8 b - 1/8 b) Fb 1/EJ + (b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CB}^{x_0} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

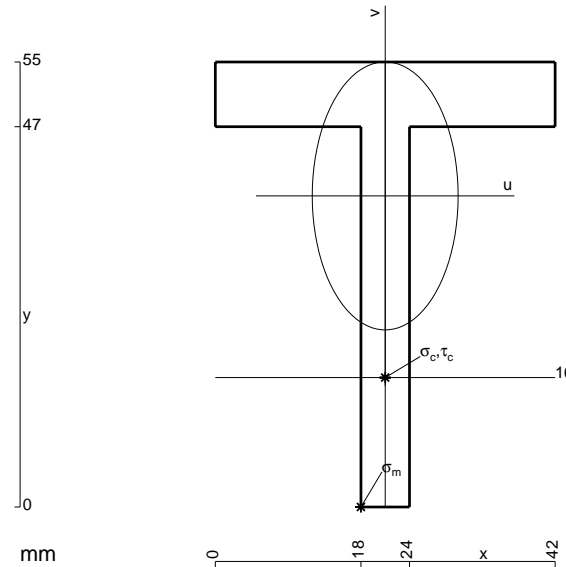
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CD}^{x_0} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

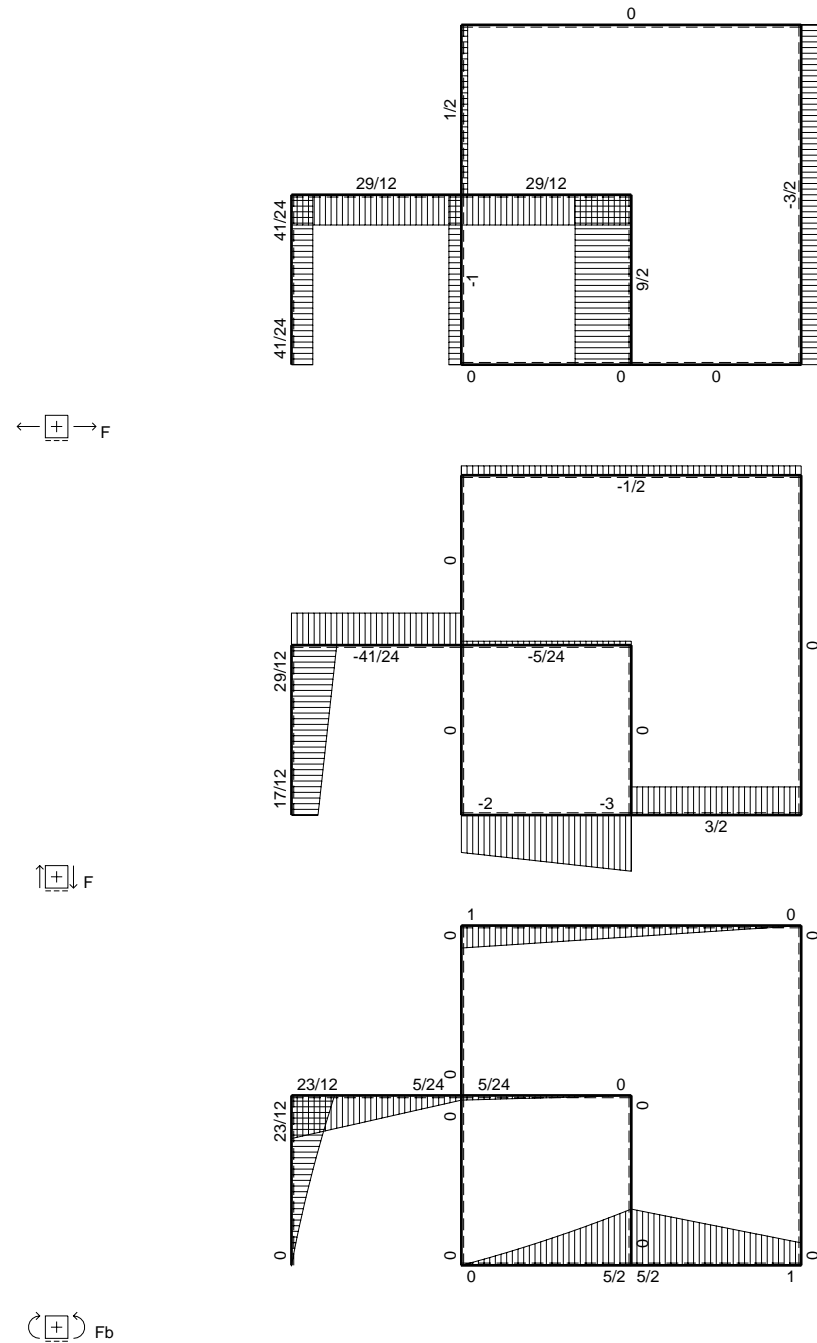
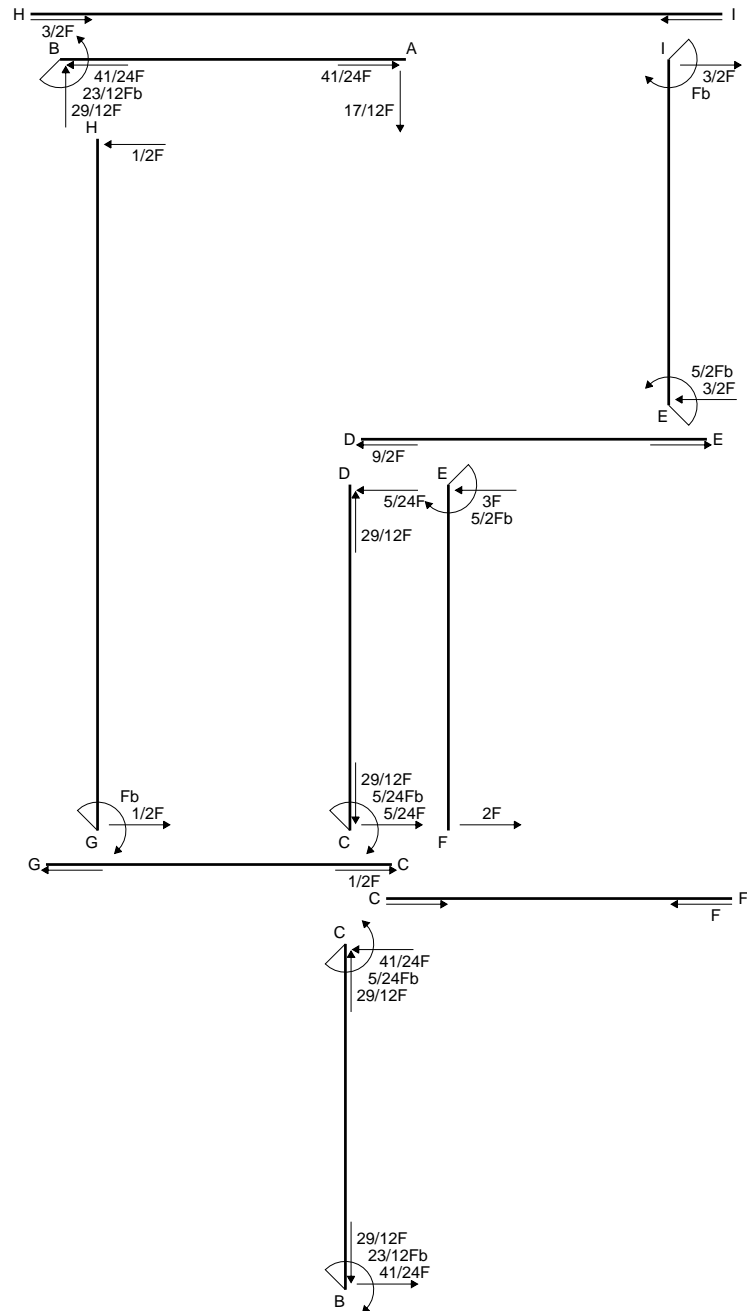
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

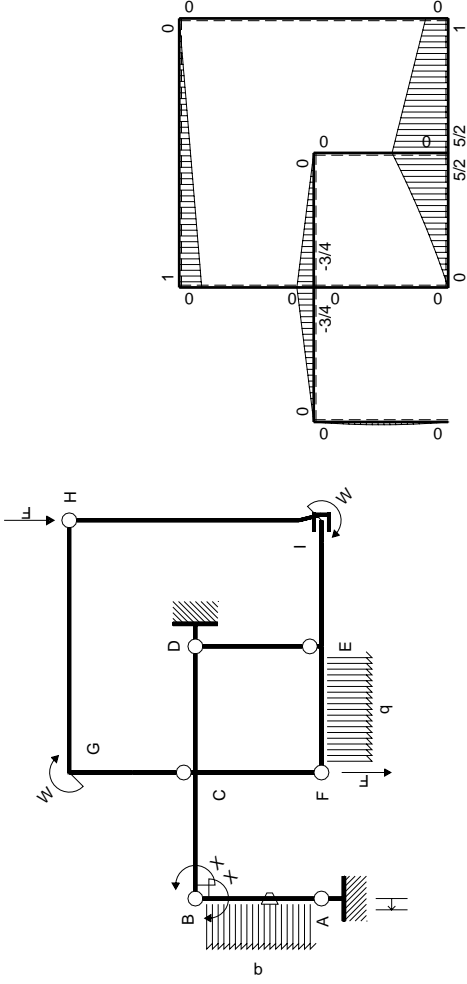
$$L_{DC}^{x_0} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 618. mm²
- J_u = 169652. mm⁴
- J_v = 50238. mm⁴
- y_g = 38.45 mm
- T_y = -2070. N
- M_x = 1000500. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -38.45 mm
- σ_m = -Mv/J_u = 226.8 N/mm²
- x_c = 21. mm
- y_c = 16. mm
- v_c = -22.45 mm
- σ_c = -Mv/J_u = 132.4 N/mm²
- τ_c = 5.945 N/mm²
- σ_q = √σ²+3τ² = 132.8 N/mm²
- S = 2923. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$23/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-23/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{x\theta} = \int_0^b (1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{x\theta} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{x\theta} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{x\theta} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

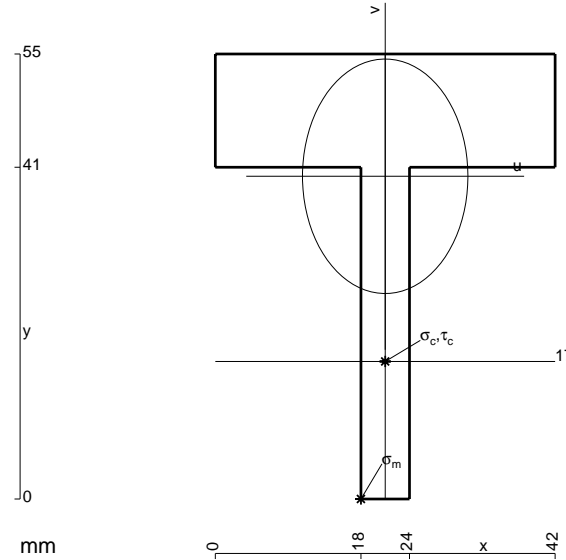
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CD}^{x\theta} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

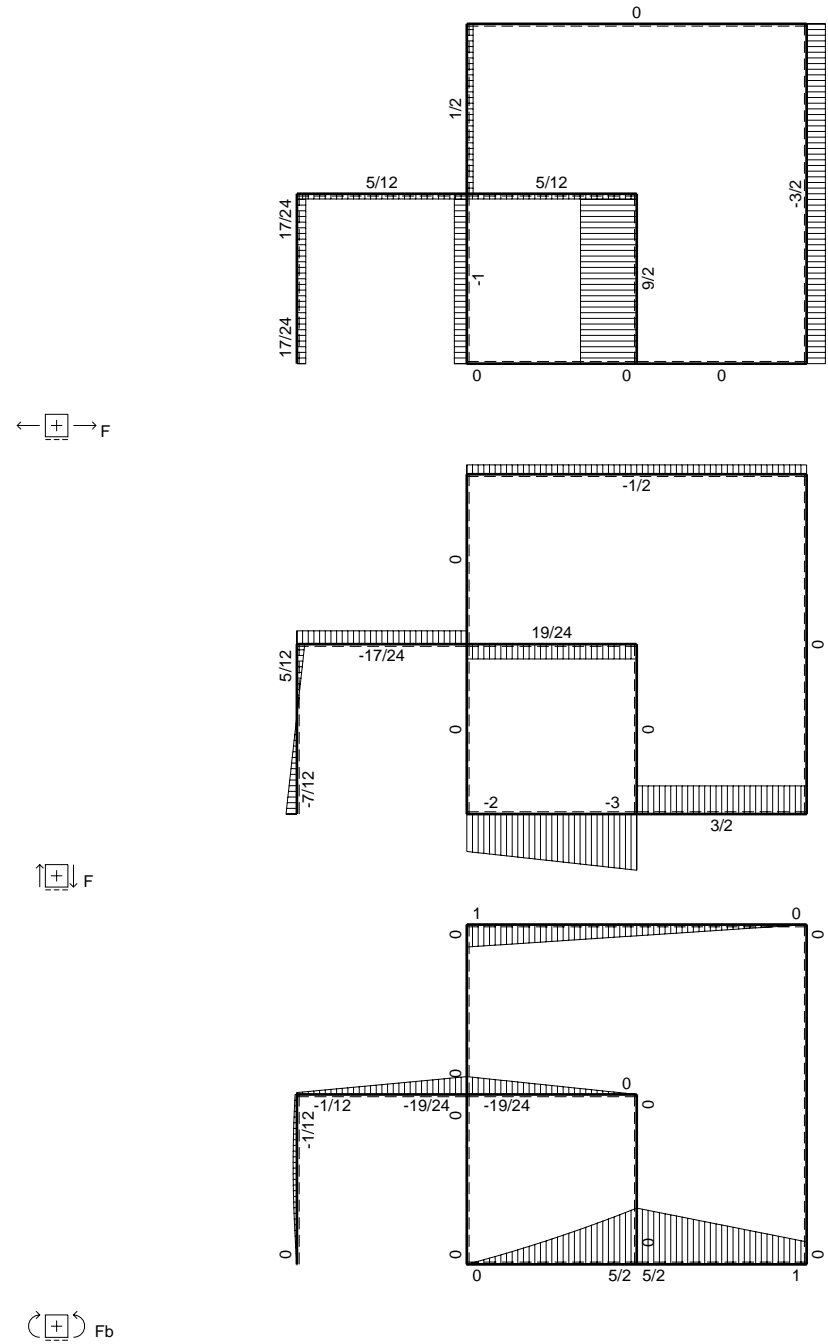
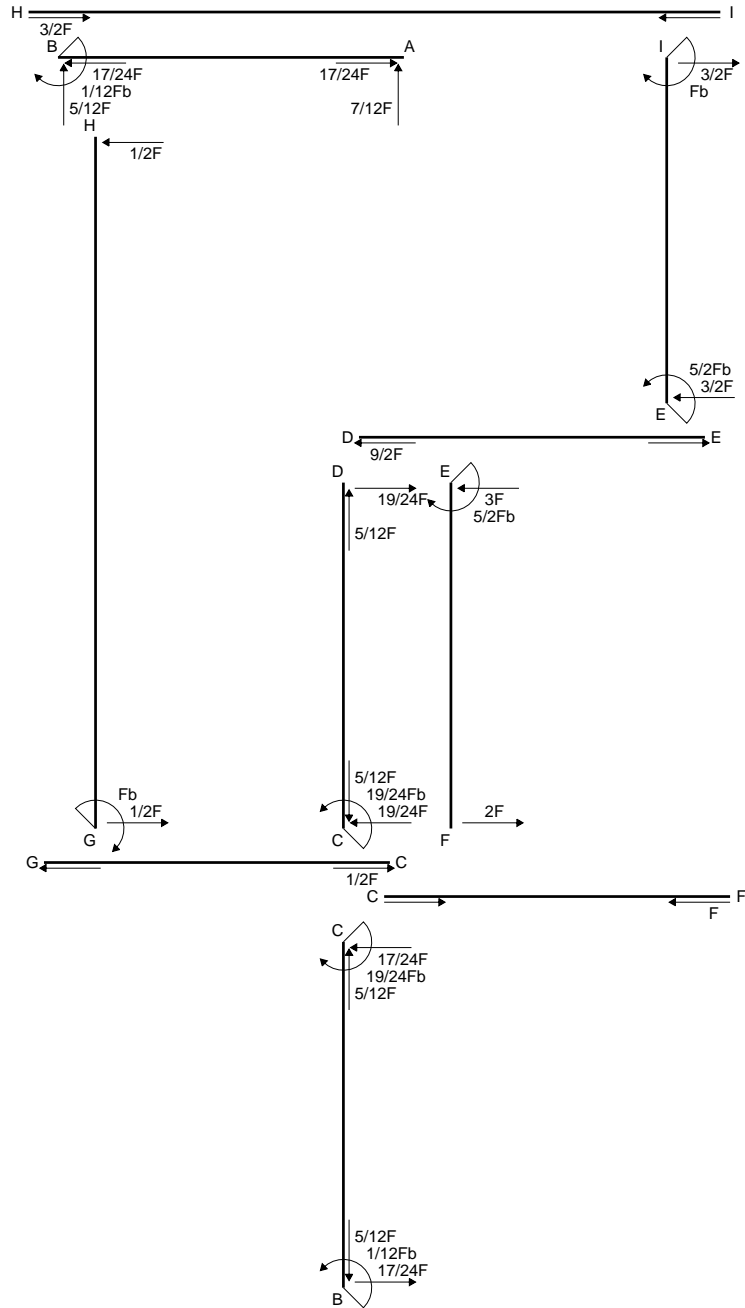
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

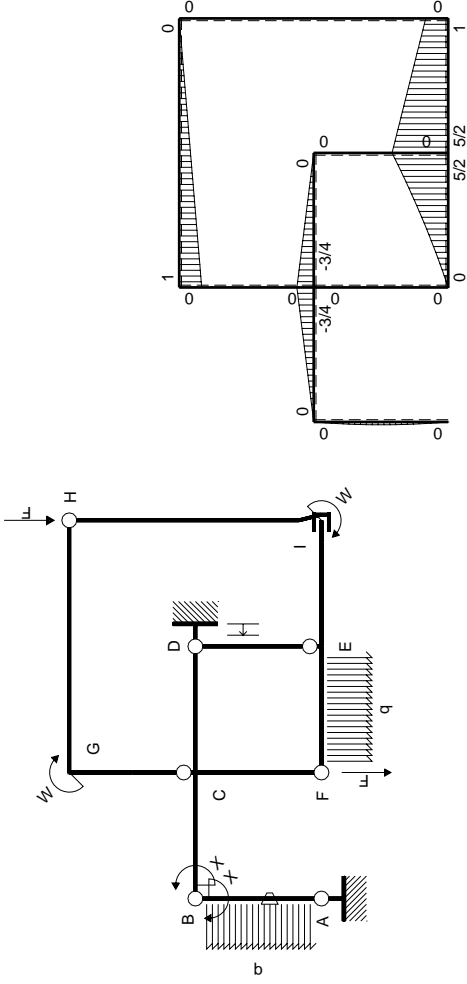
$$L_{DC}^{x\theta} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



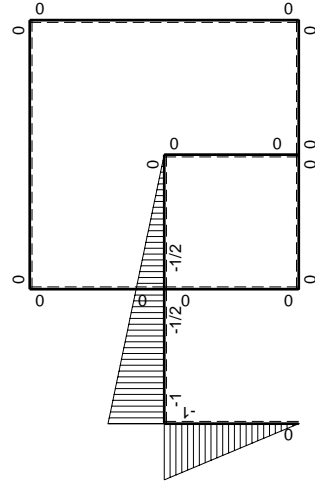
- A = 834. mm²
- J_u = 175228. mm⁴
- J_v = 87174. mm⁴
- y_g = 39.89 mm
- T_y = -1980. N
- M_x = 1039500. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -39.89 mm
- σ_m = -Mv/J_u = 236.6 N/mm²
- x_c = 21. mm
- y_c = 17. mm
- v_c = -22.89 mm
- σ_c = -Mv/J_u = 135.8 N/mm²
- τ_c = 6.03 N/mm²
- σ_q = √σ² + 3τ² = 136.2 N/mm²
- S = 3202. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

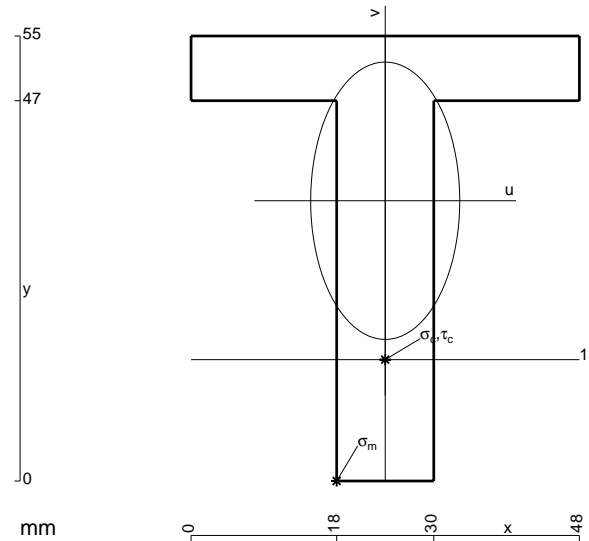
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

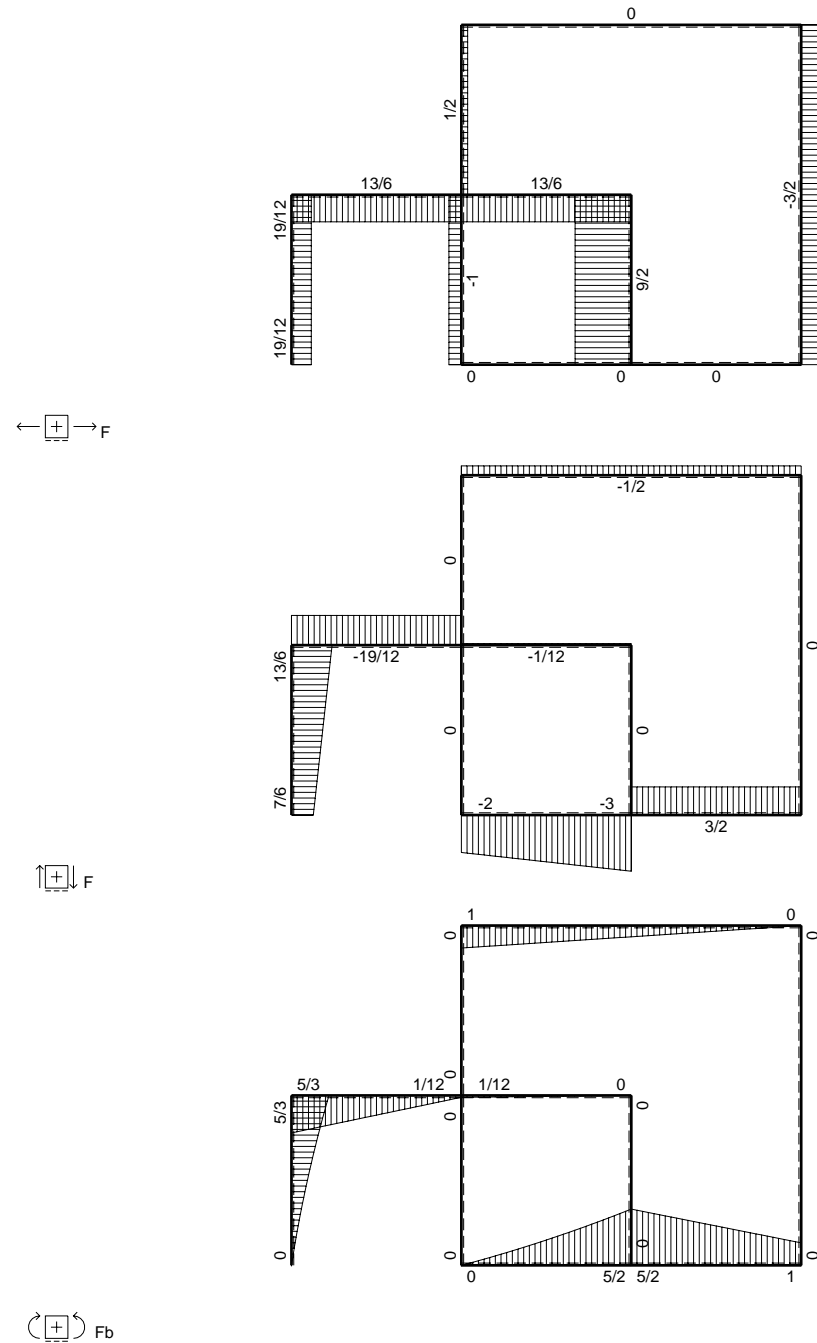
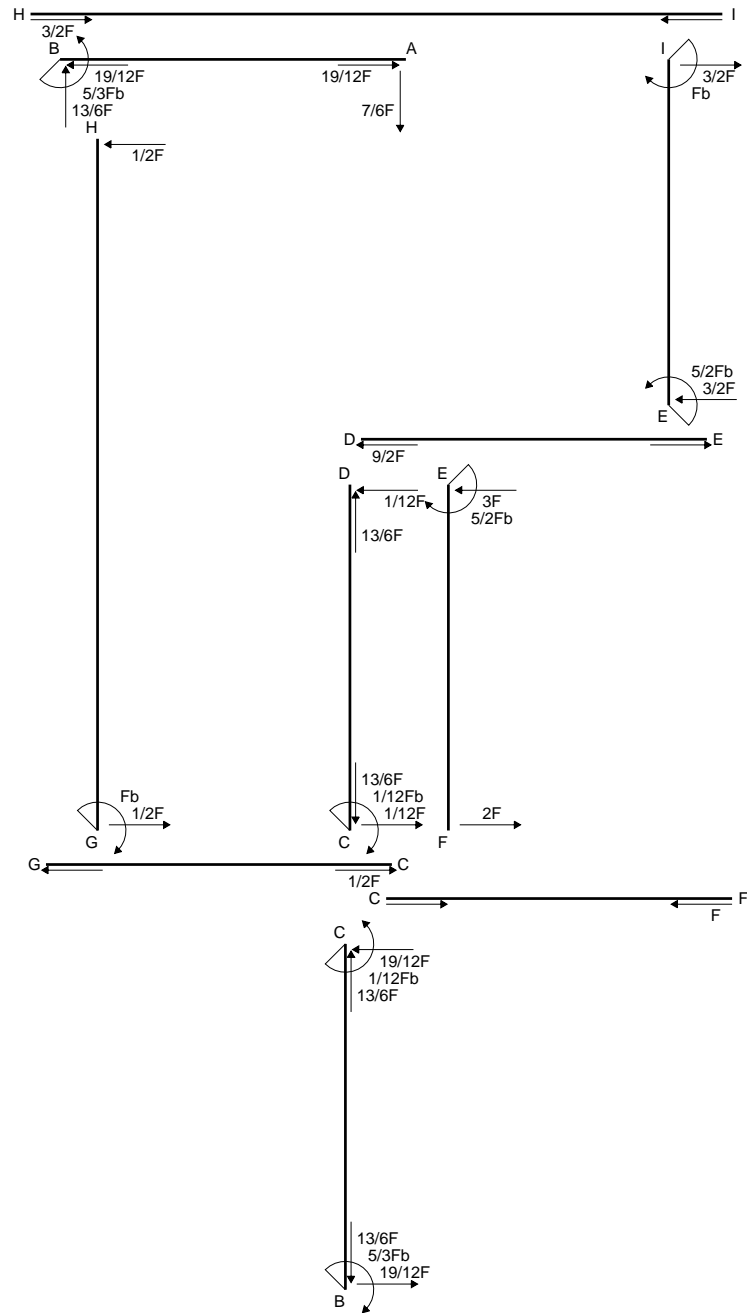
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

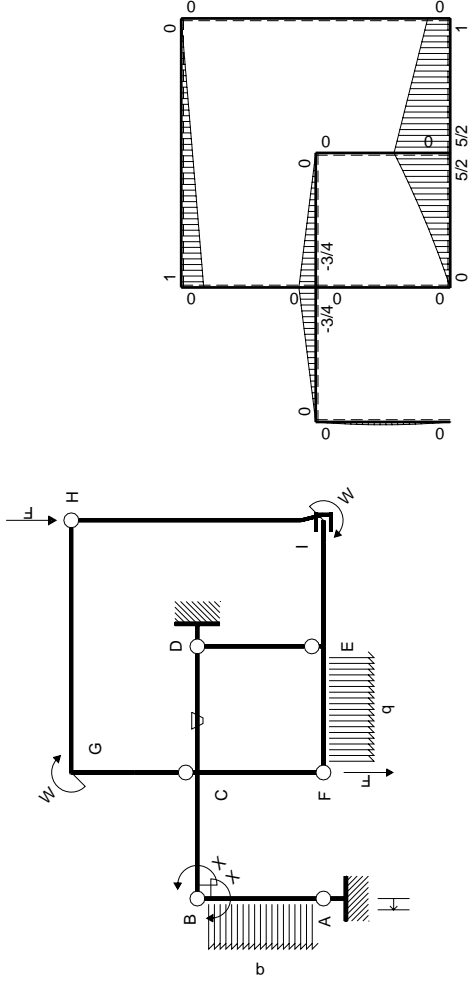
$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 948. mm²
- J_u = 278641. mm⁴
- J_v = 80496. mm⁴
- y_g = 34.64 mm
- T_y = -2880. N
- M_x = 1608000. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -34.64 mm
- σ_m = -Mv/J_u = 199.9 N/mm²
- x_c = 24. mm
- y_c = 15. mm
- v_c = -19.64 mm
- σ_c = -Mv/J_u = 113.3 N/mm²
- τ_c = 4.208 N/mm²
- σ_q = √σ² + 3τ² = 113.6 N/mm²
- S = 4885. mm³



$\left[\begin{matrix} + \\ - \end{matrix} \right] F_b$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$5/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-5/3Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

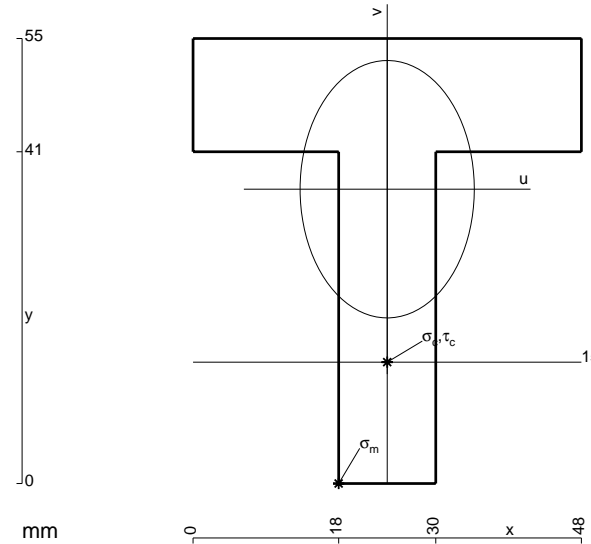
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/8 b) Fb 1/EJ + (-1/4 b) \theta = 3/8 Fb^2/EJ$$



$$A = 1164. \text{ mm}^2$$

$$J_u = 294703. \text{ mm}^4$$

$$J_v = 134928. \text{ mm}^4$$

$$y_g = 36.38 \text{ mm}$$

$$T_y = -2820. \text{ N}$$

$$M_x = 1692000. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$u_m = -6. \text{ mm}$$

$$v_m = -36.38 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 208.9 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 15. \text{ mm}$$

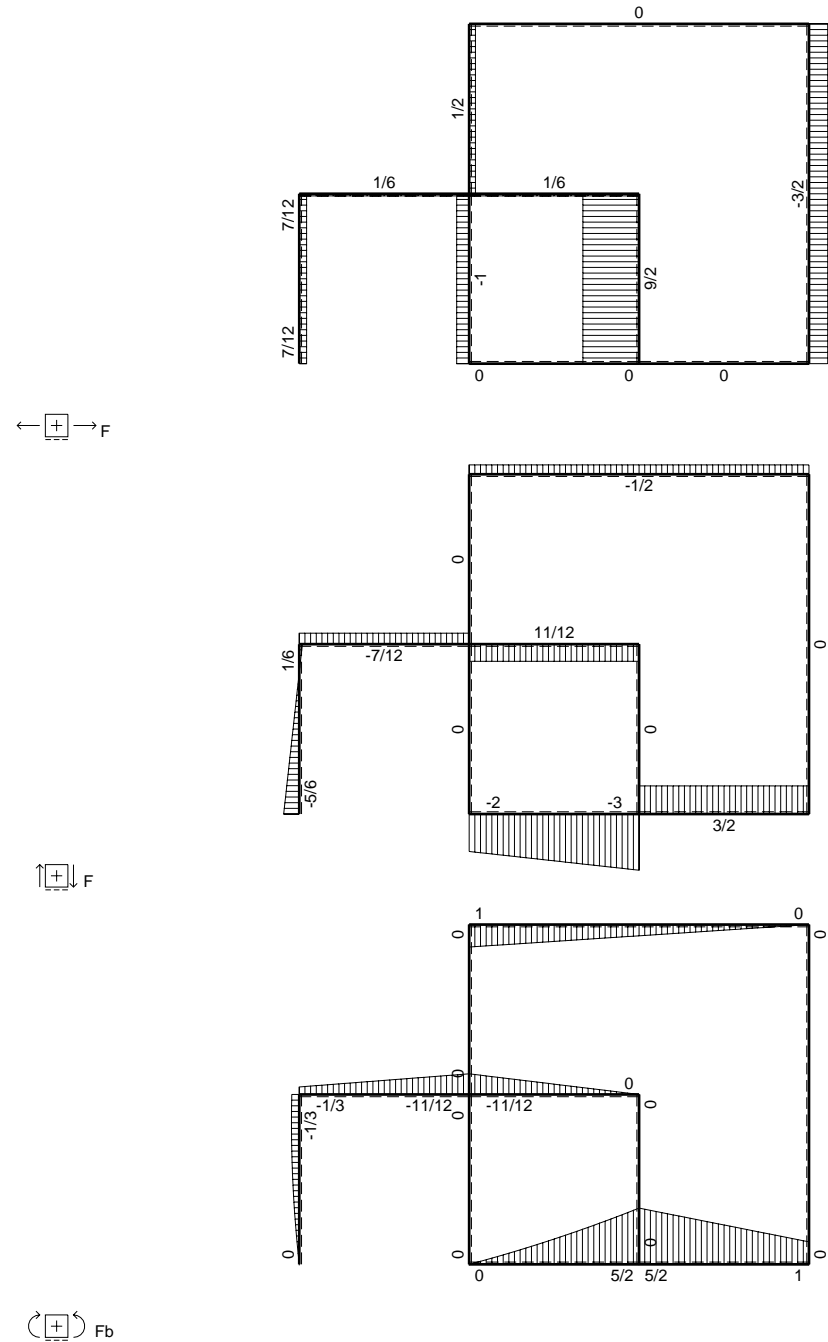
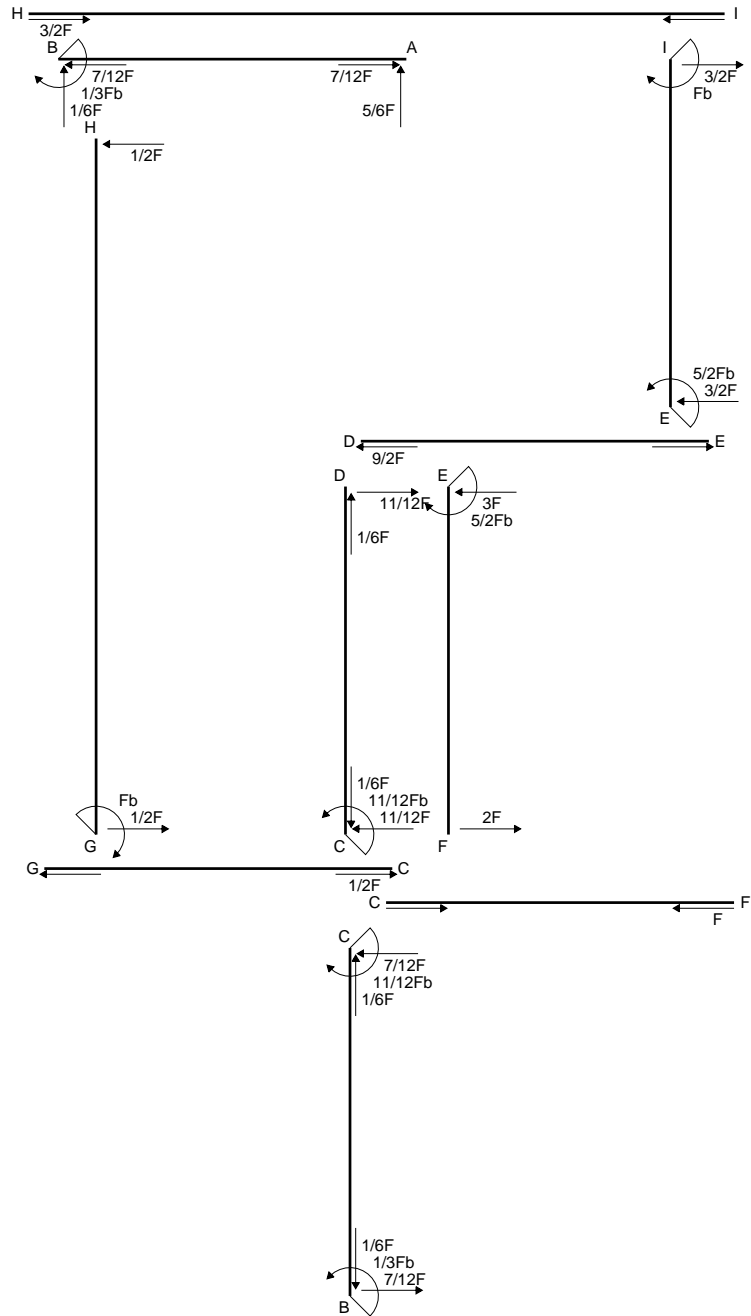
$$v_c = -21.38 \text{ mm}$$

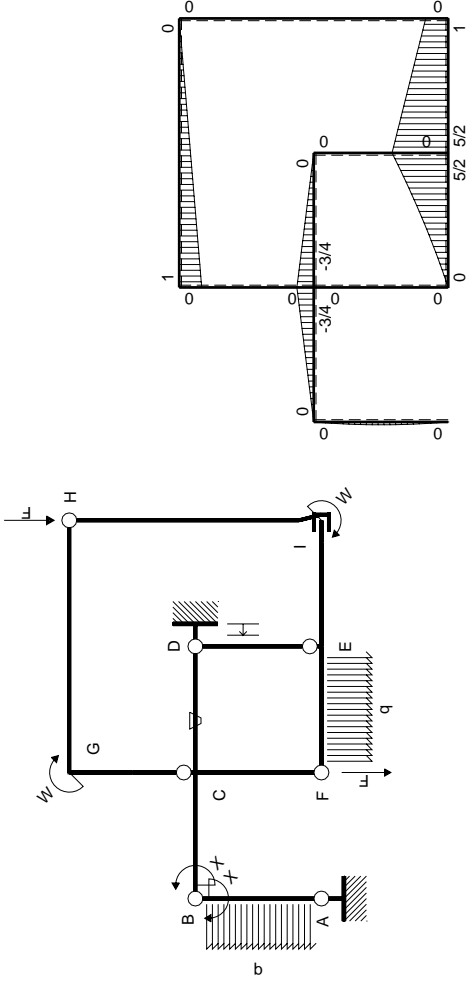
$$\sigma_c = -Mv/J_u = 122.7 \text{ N/mm}^2$$

$$\tau_c = 4.145 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 122.9 \text{ N/mm}^2$$

$$S = 5198. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/3Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

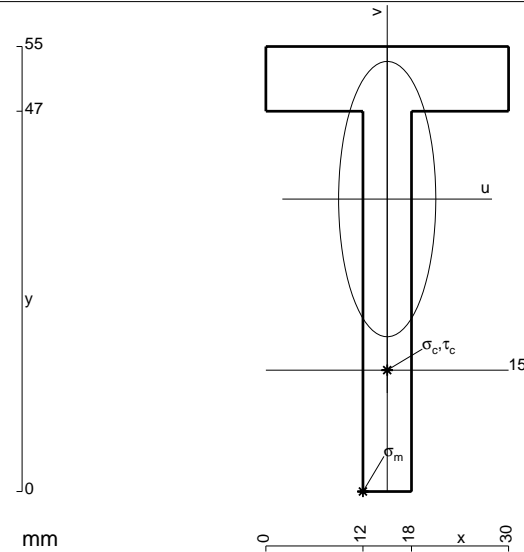
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

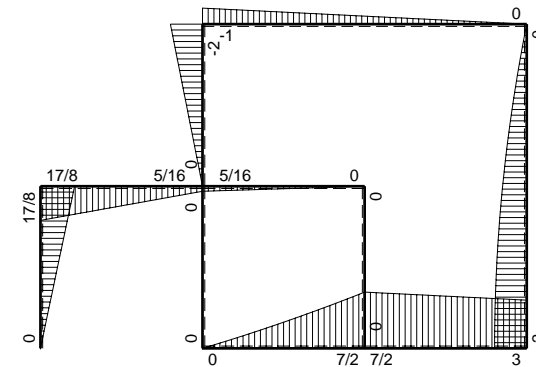
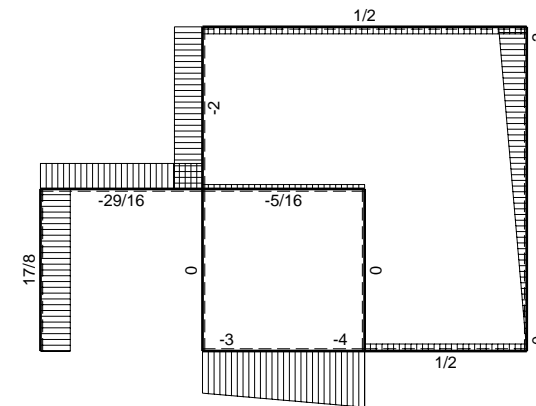
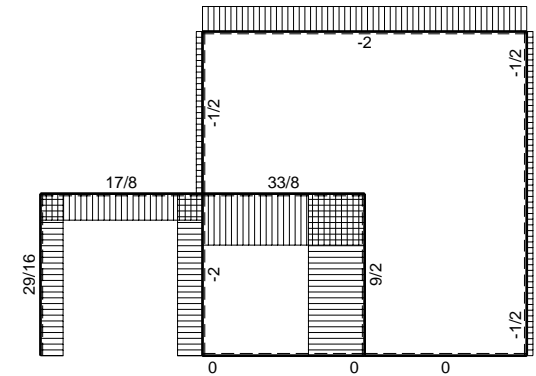
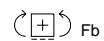
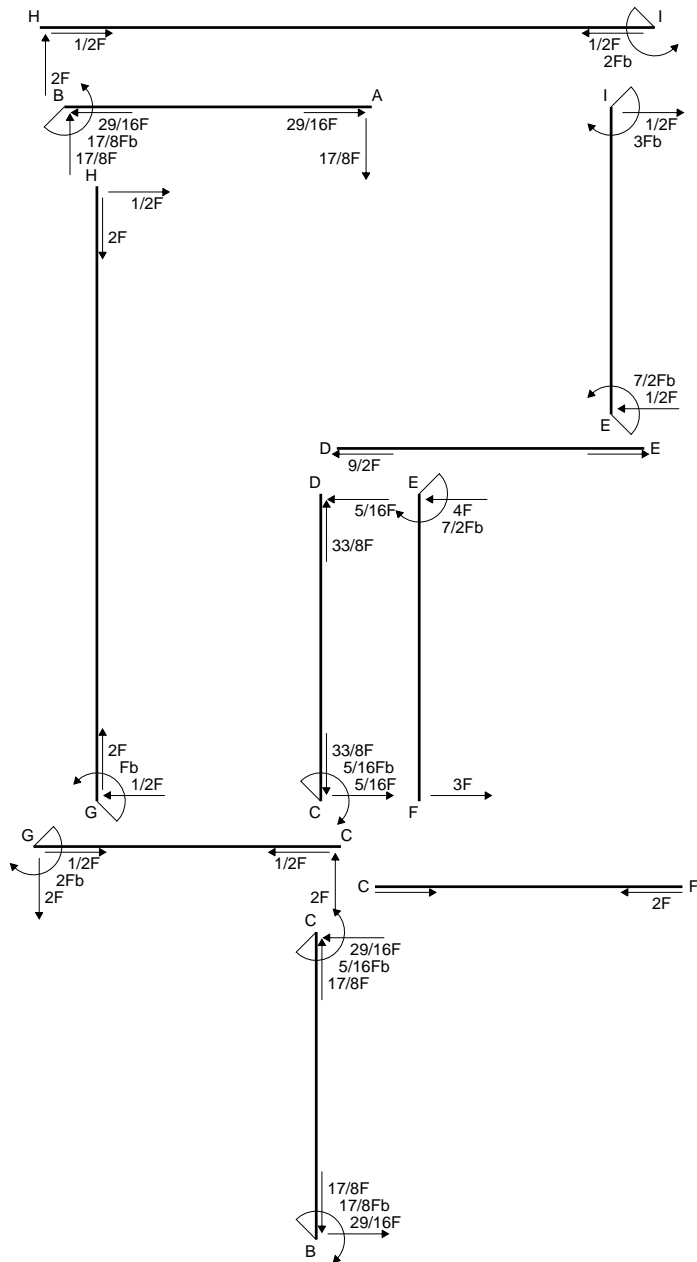
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

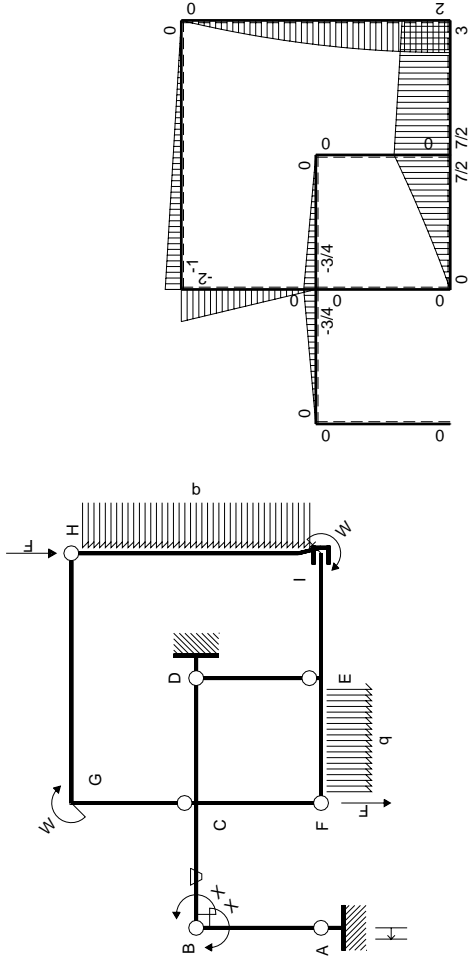
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/8 b) Fb 1/EJ + (-1/4 b) \theta = 3/8 Fb^2/EJ$$



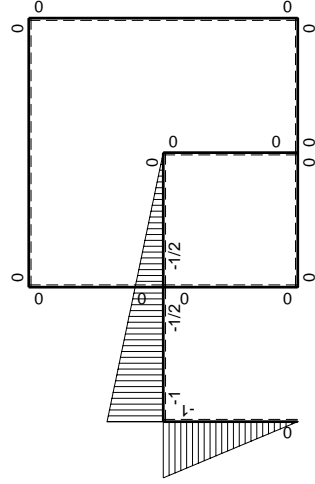
- A = 522. mm²
- J_u = 151243. mm⁴
- J_v = 18846. mm⁴
- y_g = 36.14 mm
- T_y = -1440. N
- M_x = 912000. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -36.14 mm
- σ_m = -Mv/J_u = 217.9 N/mm²
- x_c = 15. mm
- y_c = 15. mm
- v_c = -21.14 mm
- σ_c = -Mv/J_u = 127.5 N/mm²
- τ_c = 4.091 N/mm²
- σ_o = √σ² + 3τ² = 127.7 N/mm²
- S = 2578. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$17/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-17/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (3/8 b - 1/8 b) Fb 1/EJ + (b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

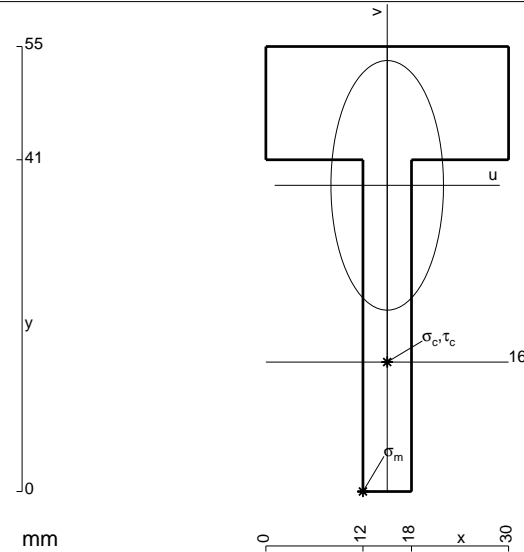
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

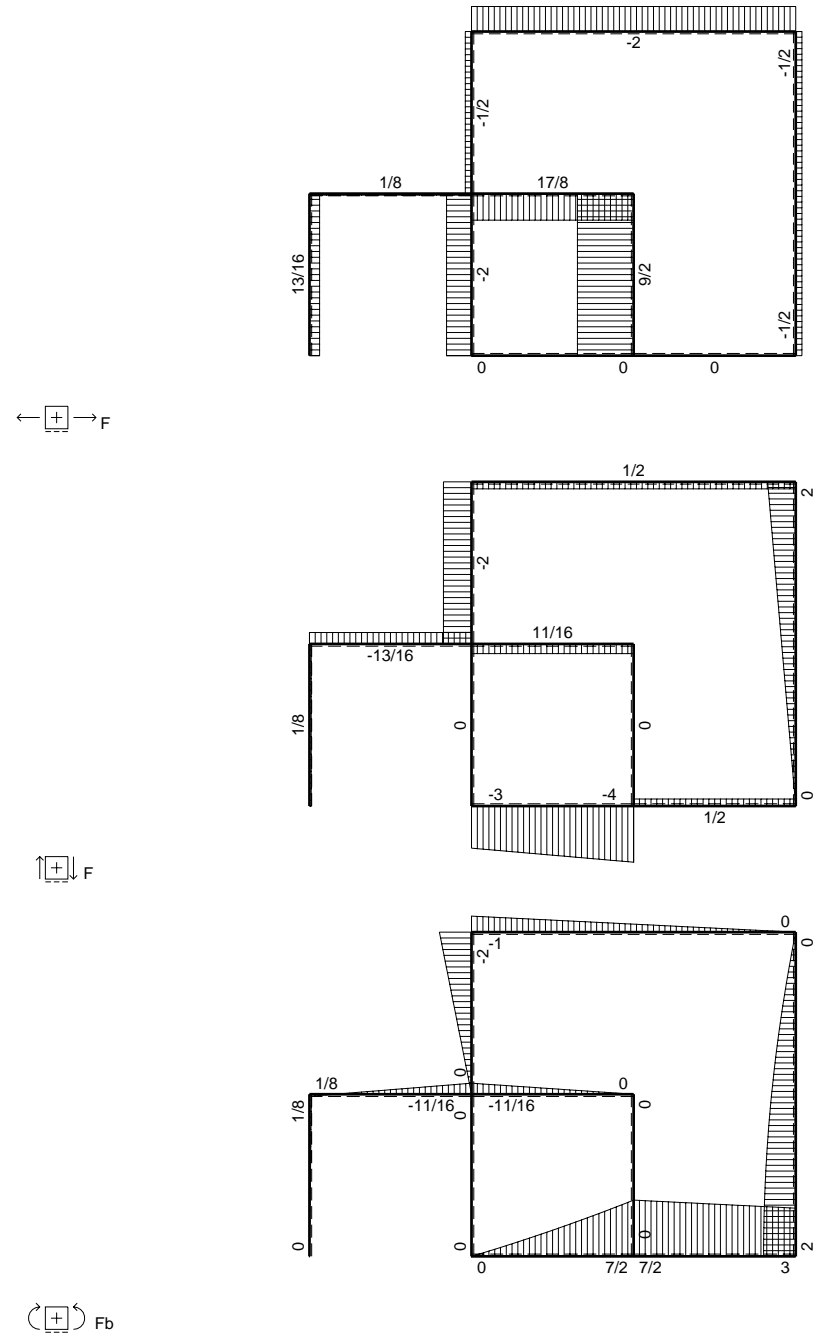
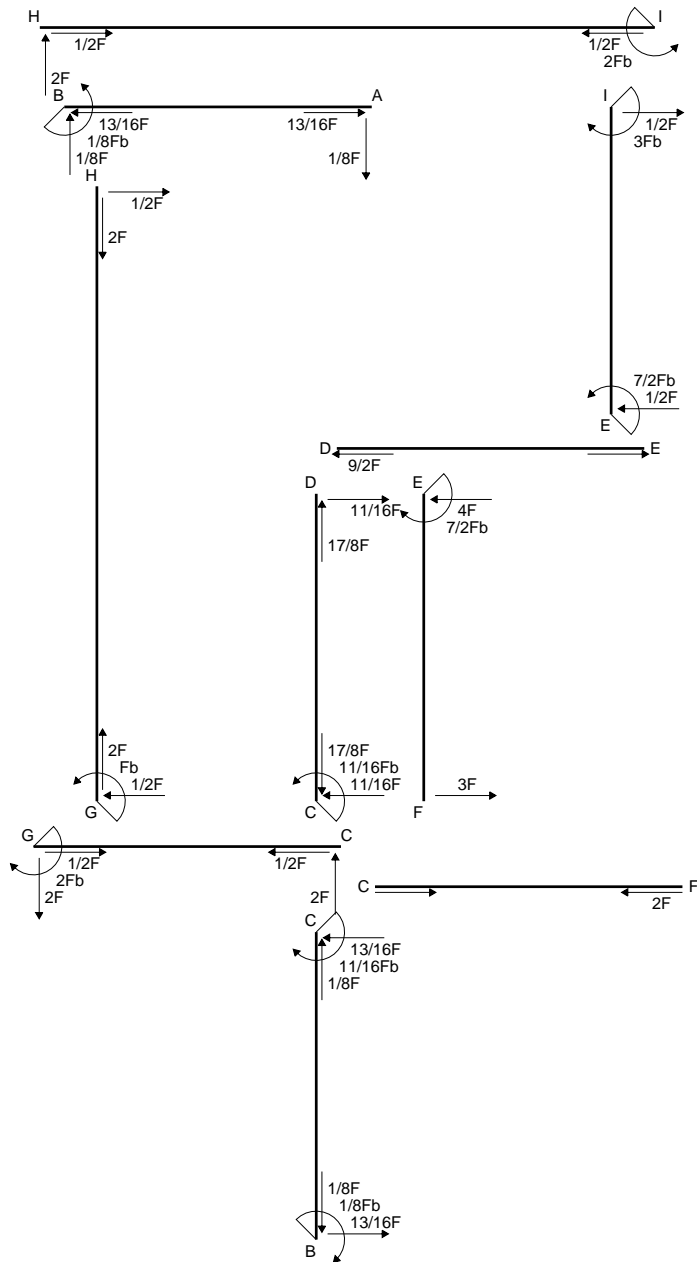
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

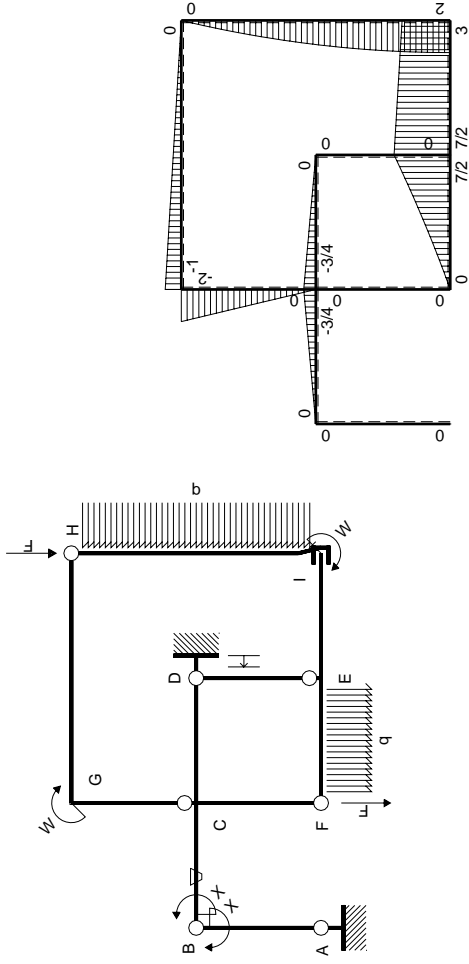
$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 666. mm²
- J_u = 158641. mm⁴
- J_v = 32238. mm⁴
- y_g = 37.84 mm
- T_y = -1360. N
- M_x = 963900. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -37.84 mm
- σ_m = -Mv/J_u = 229.9 N/mm²
- x_c = 15. mm
- y_c = 16. mm
- v_c = -21.84 mm
- σ_c = -Mv/J_v = 132.7 N/mm²
- τ_c = 4.093 N/mm²
- σ_o = √σ²+3τ² = 132.9 N/mm²
- S = 2865. mm³

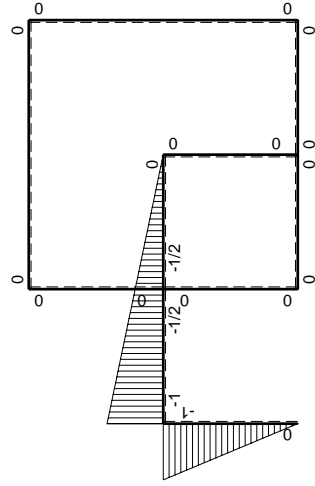


⊕ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (3/8 b - 1/8 b) Fb 1/EJ + (b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

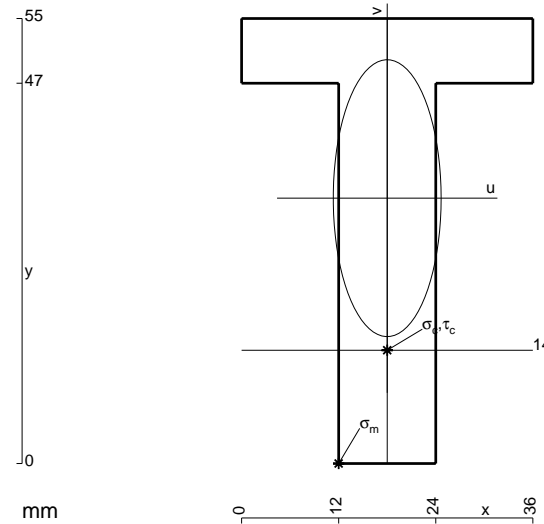
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



$$A = 852. \text{ mm}^2$$

$$J_u = 249536. \text{ mm}^4$$

$$J_v = 37872. \text{ mm}^4$$

$$y_g = 32.8 \text{ mm}$$

$$T_y = -2440. \text{ N}$$

$$M_x = 1814750. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -6. \text{ mm}$$

$$v_m = -32.8 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 238.5 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 14. \text{ mm}$$

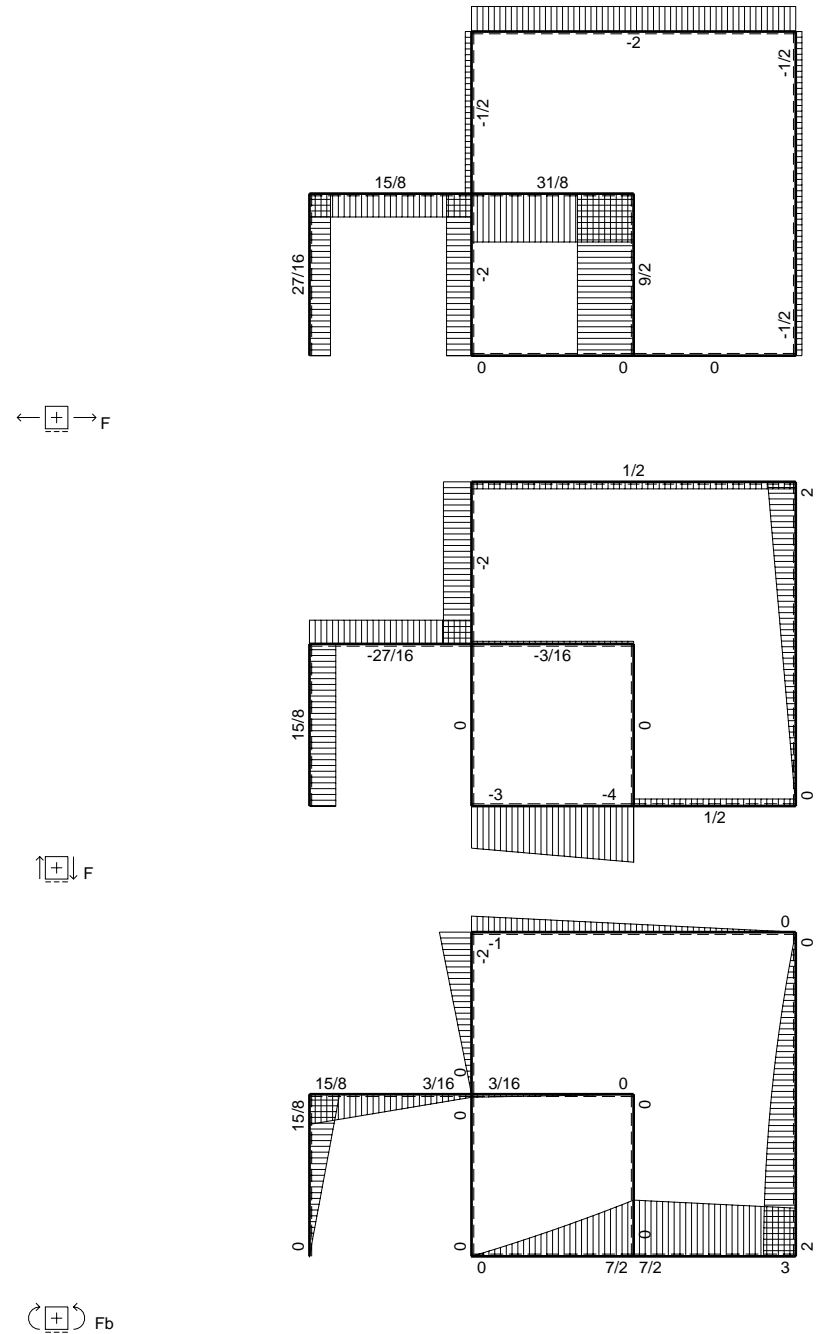
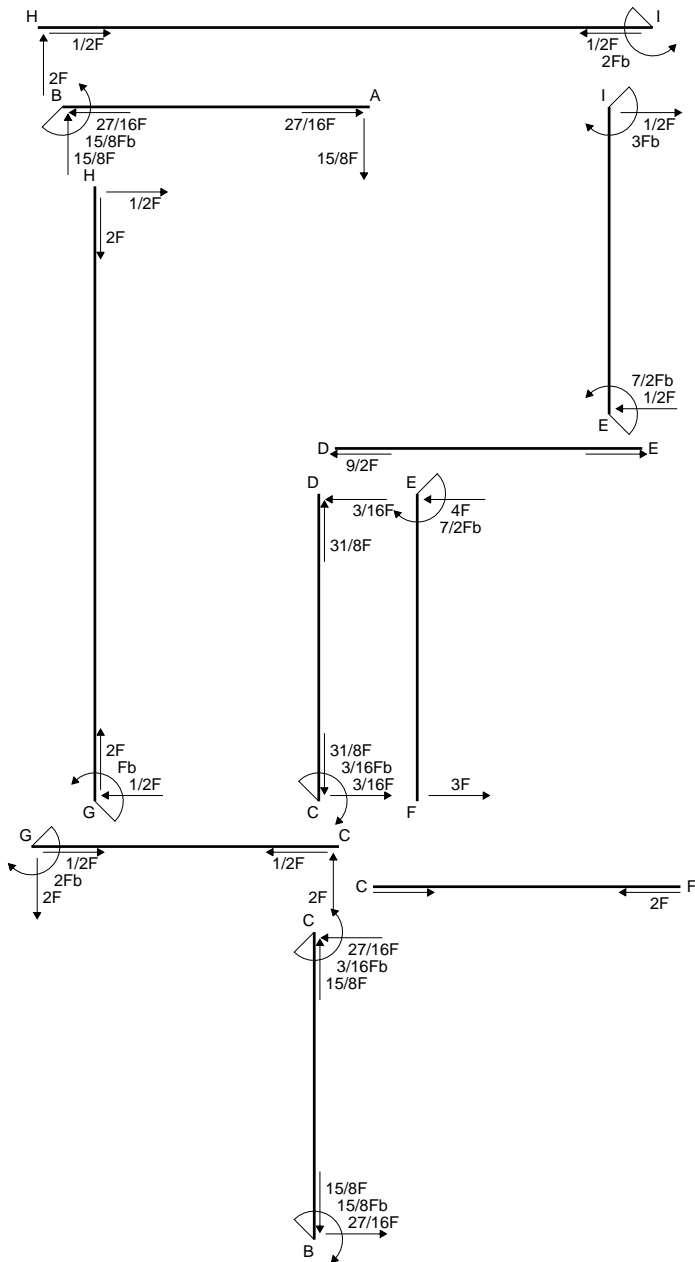
$$v_c = -18.8 \text{ mm}$$

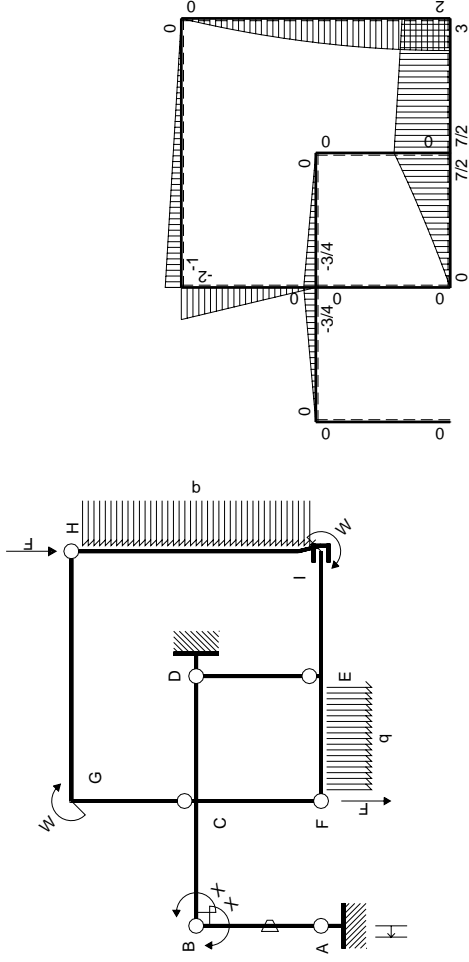
$$\sigma_c = -Mv/J_u = 136.7 \text{ N/mm}^2$$

$$\tau_c = 3.531 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 136.8 \text{ N/mm}^2$$

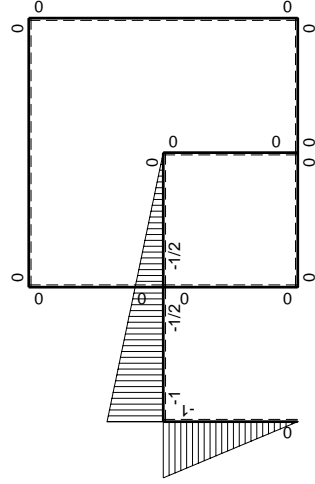
$$S = 4334. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$15/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-15/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

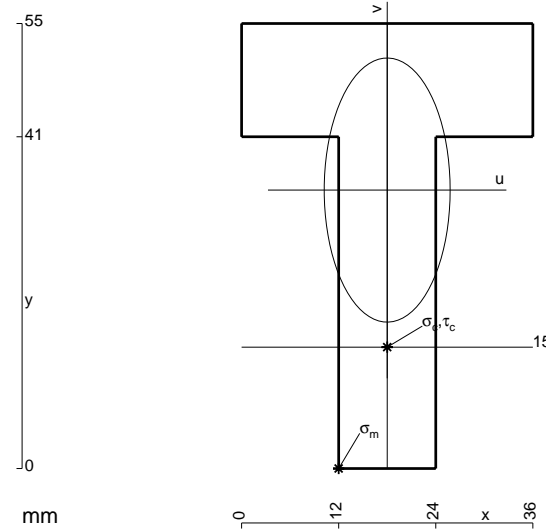
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

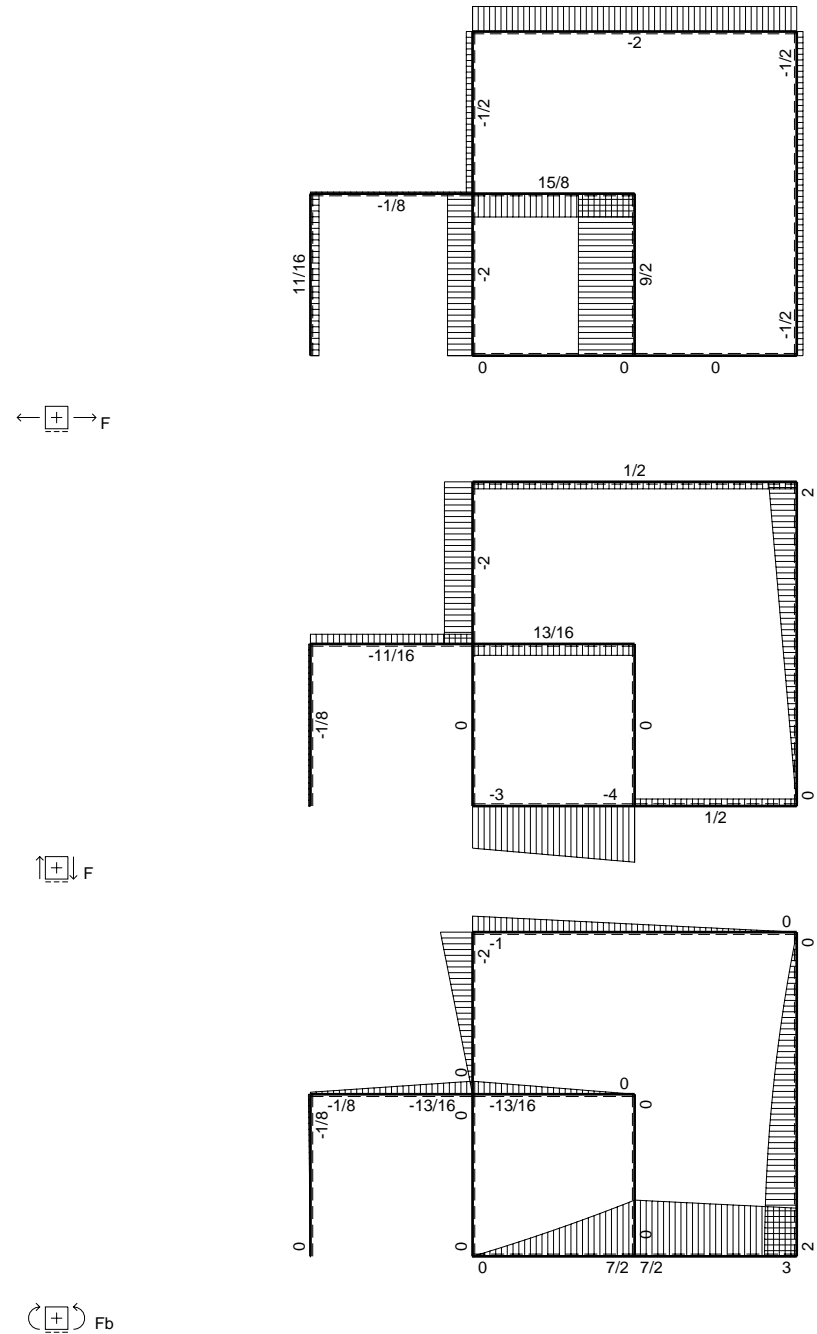
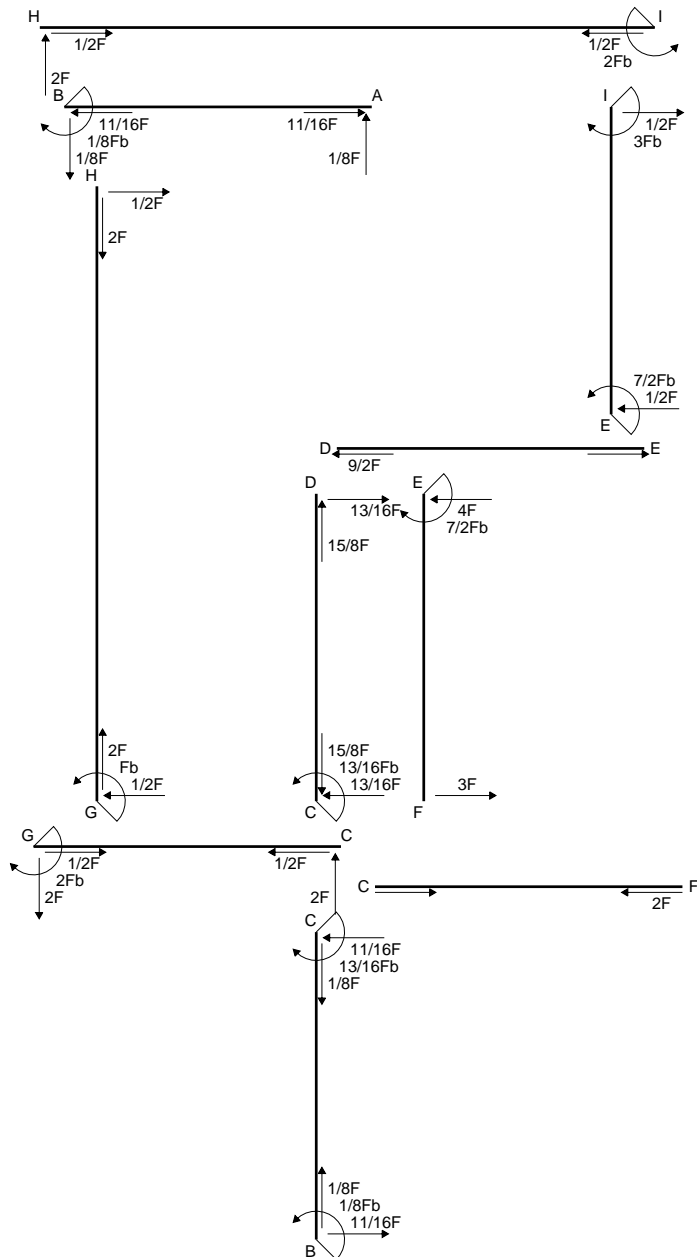
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

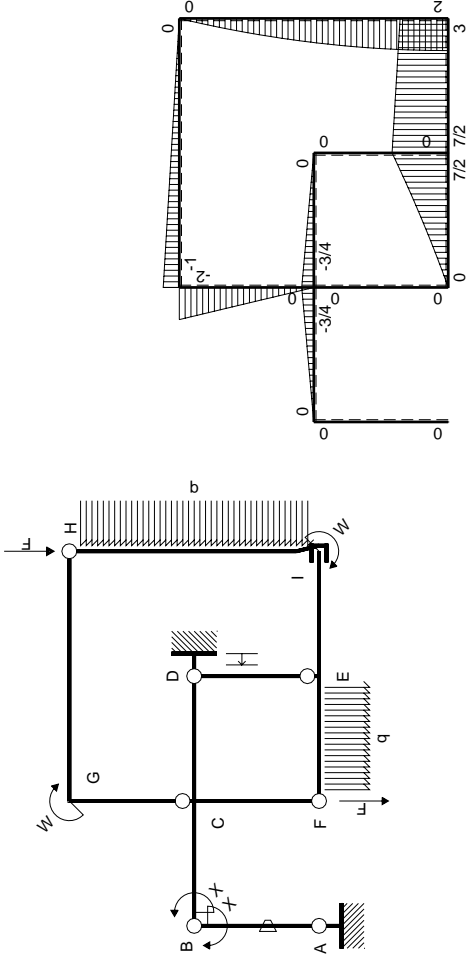
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



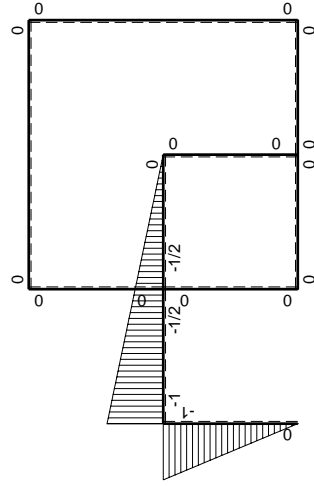
- A = 996. mm²
- J_u = 265432. mm⁴
- J_v = 60336. mm⁴
- y_g = 34.42 mm
- T_y = -3880. N
- M_x = 1527750. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -34.42 mm
- σ_m = -Mv/J_u = 198.1 N/mm²
- x_c = 18. mm
- y_c = 15. mm
- v_c = -19.42 mm
- σ_c = -Mv/J_u = 111.8 N/mm²
- τ_c = 5.902 N/mm²
- σ_o = √σ²+3τ² = 112.2 N/mm²
- S = 4845. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

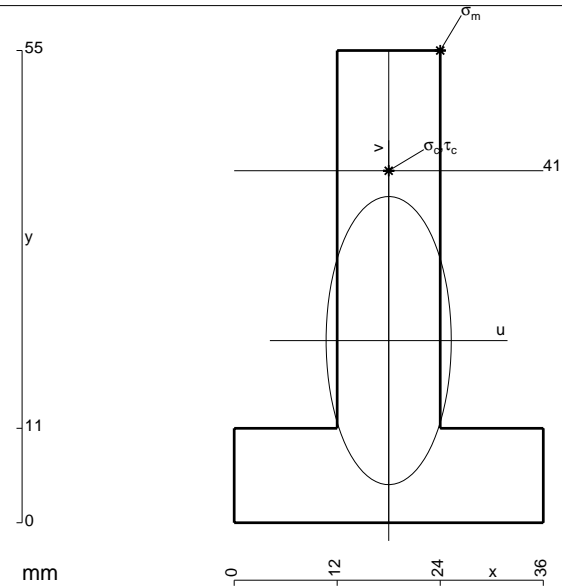
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



$$A = 924. \text{ mm}^2$$

$$J_u = 260306. \text{ mm}^4$$

$$J_v = 49104. \text{ mm}^4$$

$$y_g = 21.21 \text{ mm}$$

$$T_y = -3760. \text{ N}$$

$$M_x = 1612100. \text{ Nmm}$$

$$x_m = 24. \text{ mm}$$

$$y_m = 55. \text{ mm}$$

$$u_m = 6. \text{ mm}$$

$$v_m = 33.79 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -209.2 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 41. \text{ mm}$$

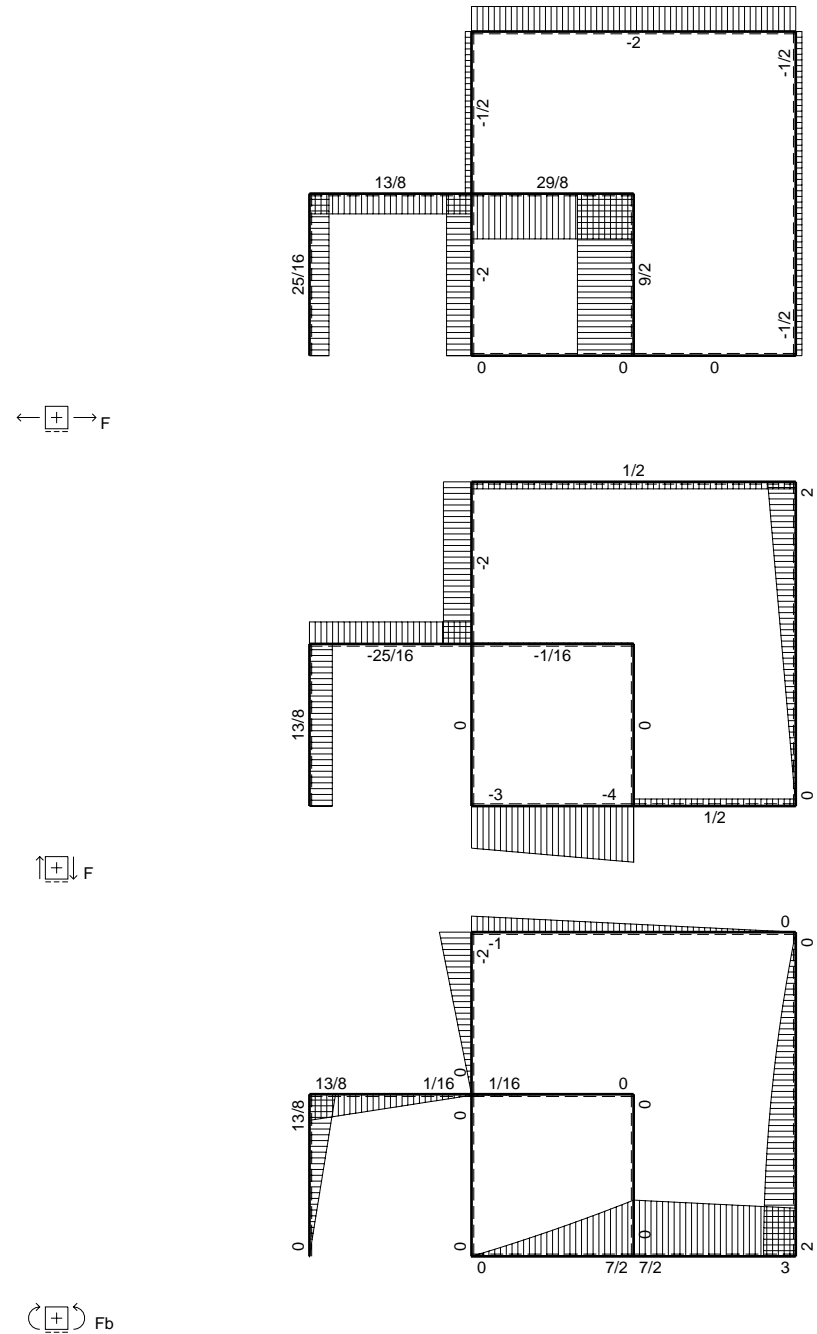
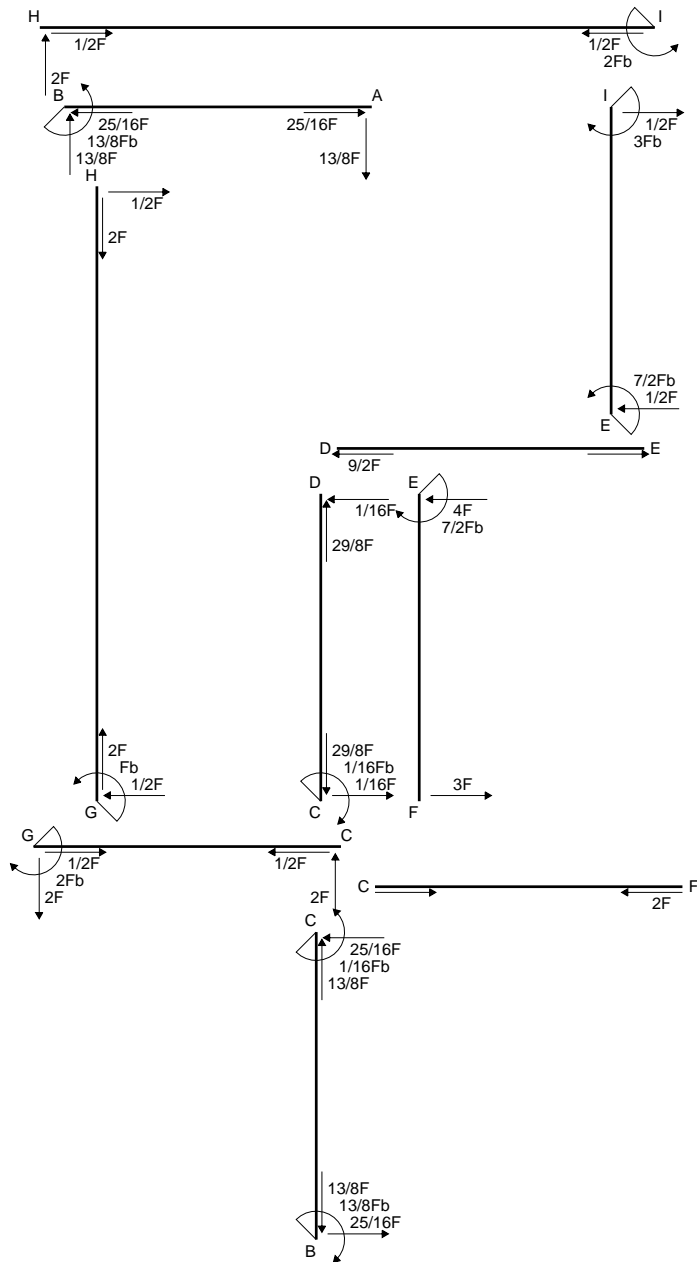
$$v_c = 19.79 \text{ mm}$$

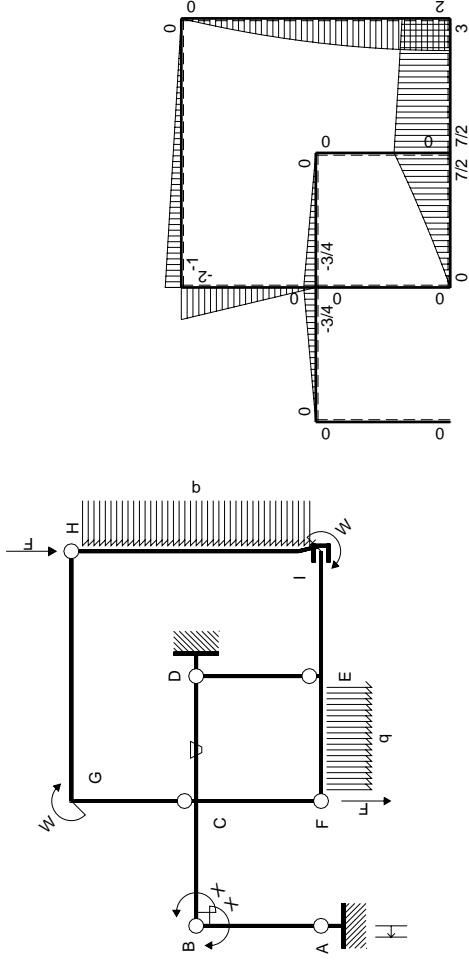
$$\sigma_c = -Mv/J_u = -122.5 \text{ N/mm}^2$$

$$\tau_c = 5.417 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 122.9 \text{ N/mm}^2$$

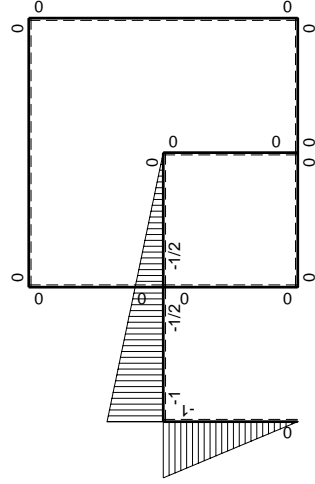
$$S = 4500. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$							Fb^2/EJ	
	totali							$13/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-13/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

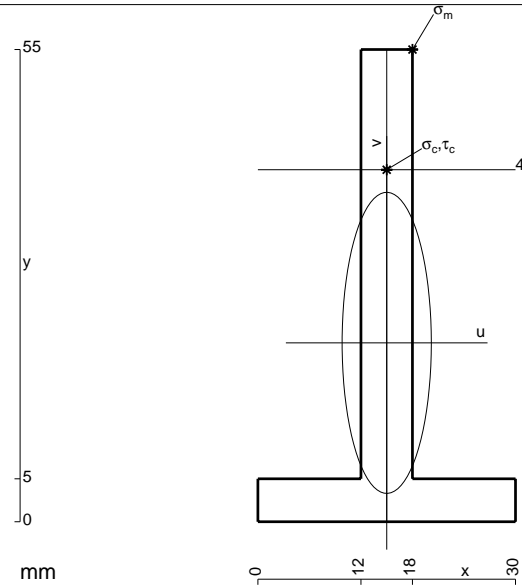
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

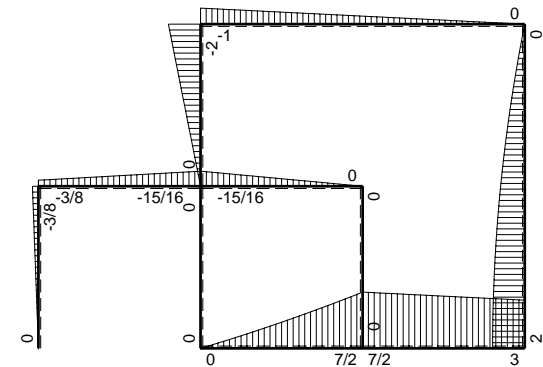
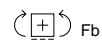
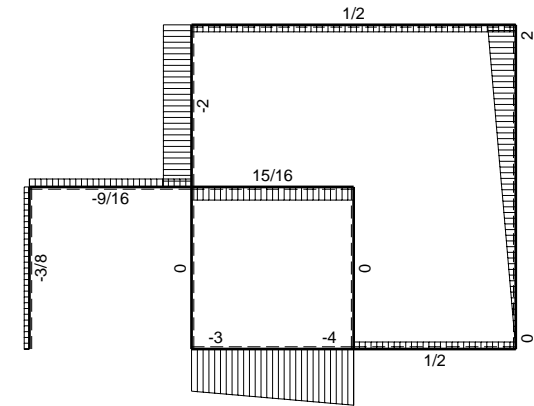
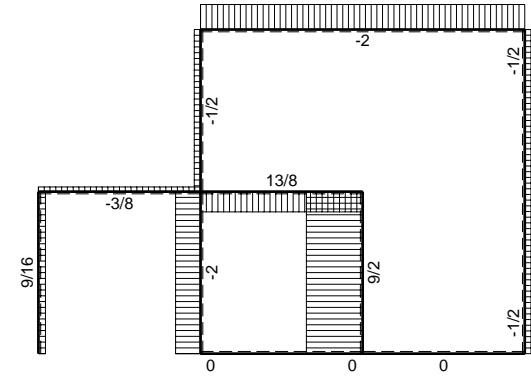
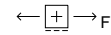
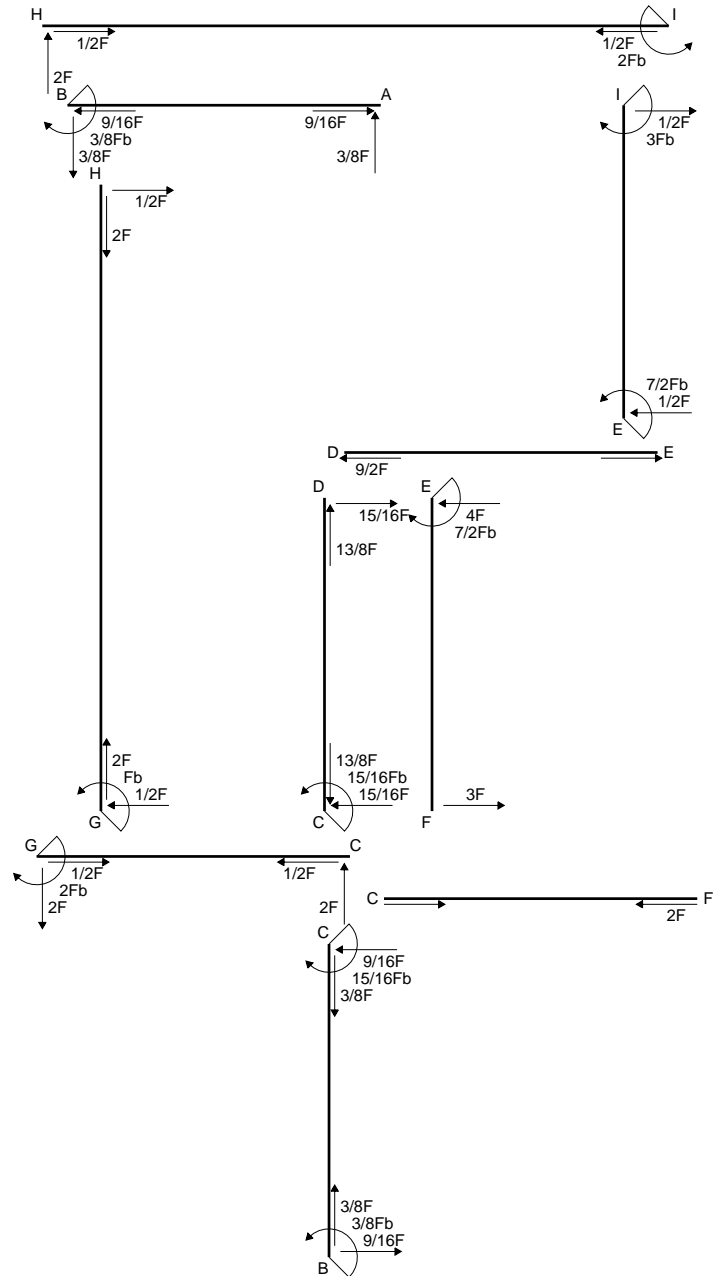
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

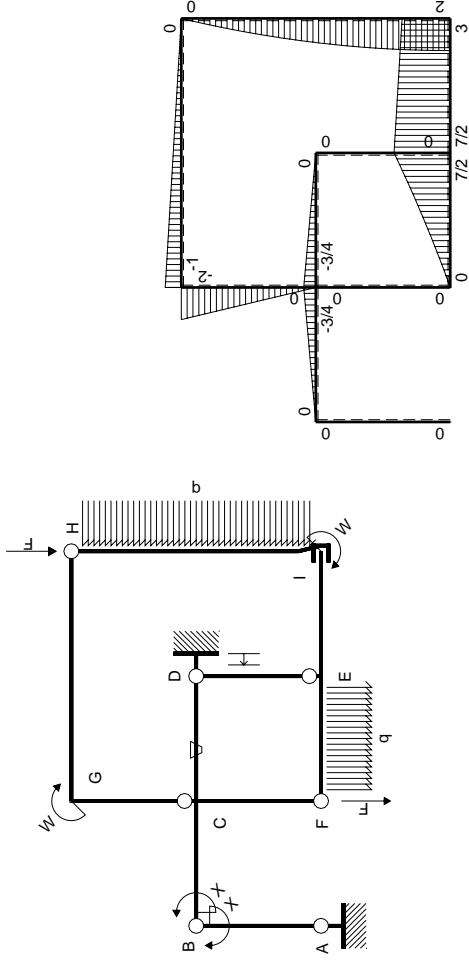
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/8 b) Fb 1/EJ + (-1/4 b) \theta = 3/8 Fb^2/EJ$$



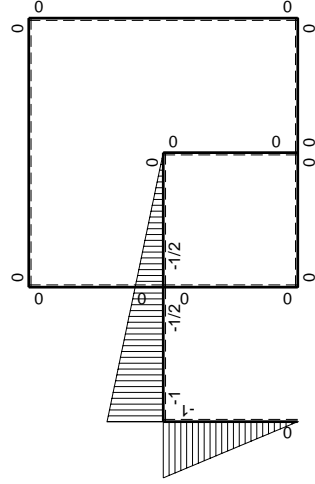
- A = 450. mm²
- J_u = 138437. mm⁴
- J_v = 12150. mm⁴
- y_g = 20.83 mm
- T_y = -1880. N
- M_x = 888300. Nmm
- x_m = 18. mm
- y_m = 55. mm
- u_m = 3. mm
- v_m = 34.17 mm
- σ_m = -M_v/J_u = -219.2 N/mm²
- x_c = 15. mm
- y_c = 41. mm
- v_c = 20.17 mm
- σ_c = -M_v/J_u = -129.4 N/mm²
- τ_c = 5.165 N/mm²
- σ_q = √σ²+3τ² = 129.7 N/mm²
- S = 2282. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+1/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-3/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$3/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

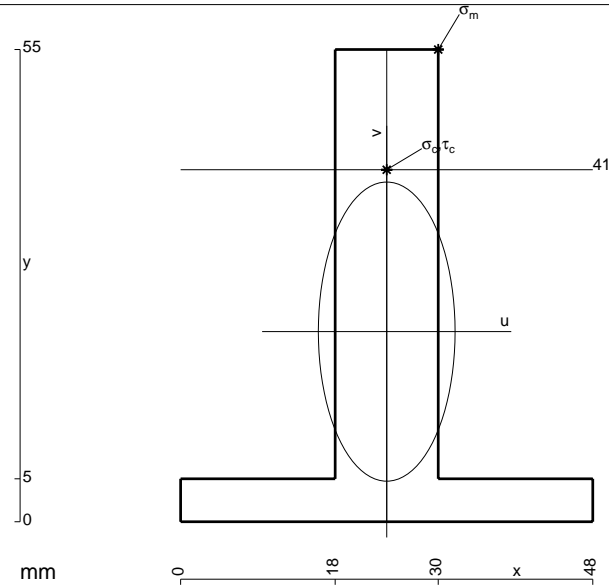
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

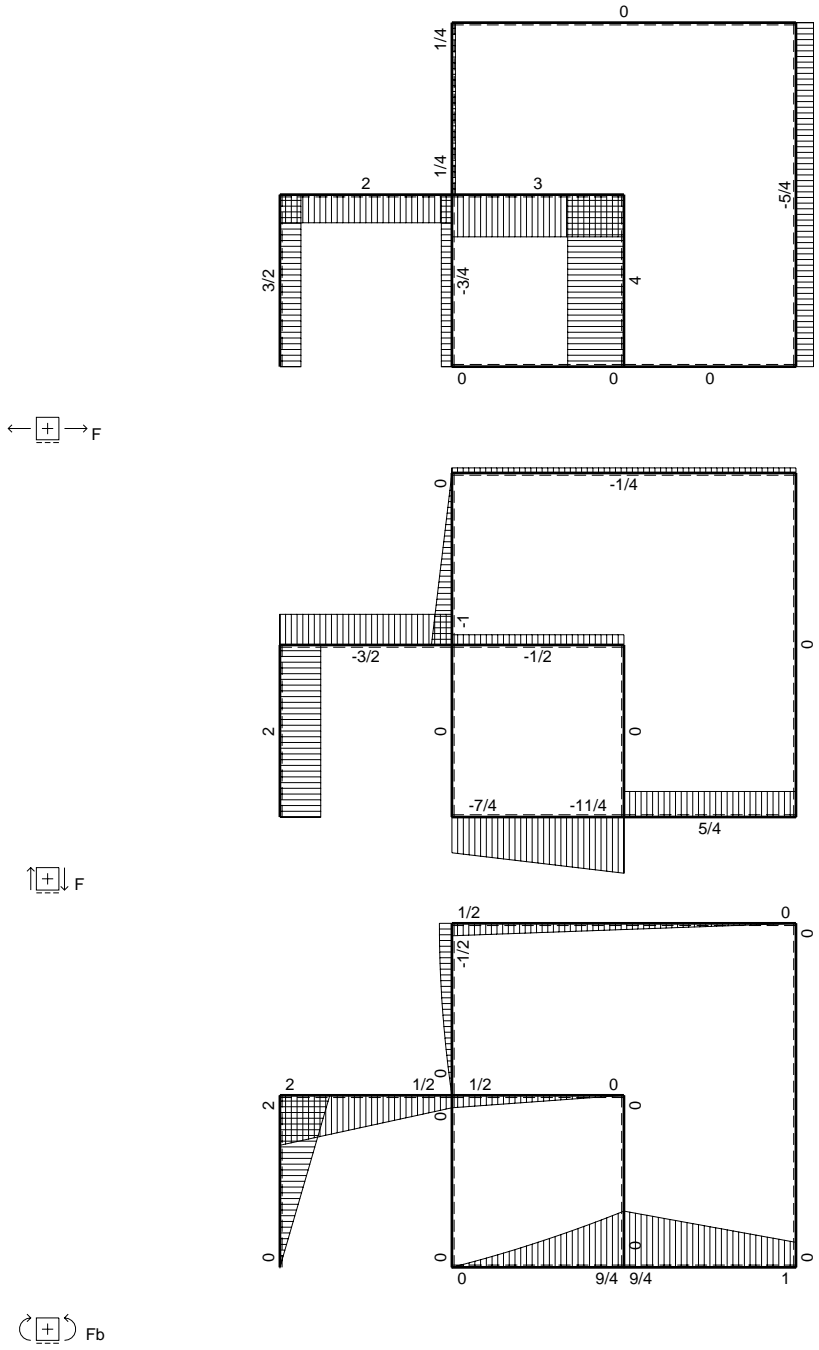
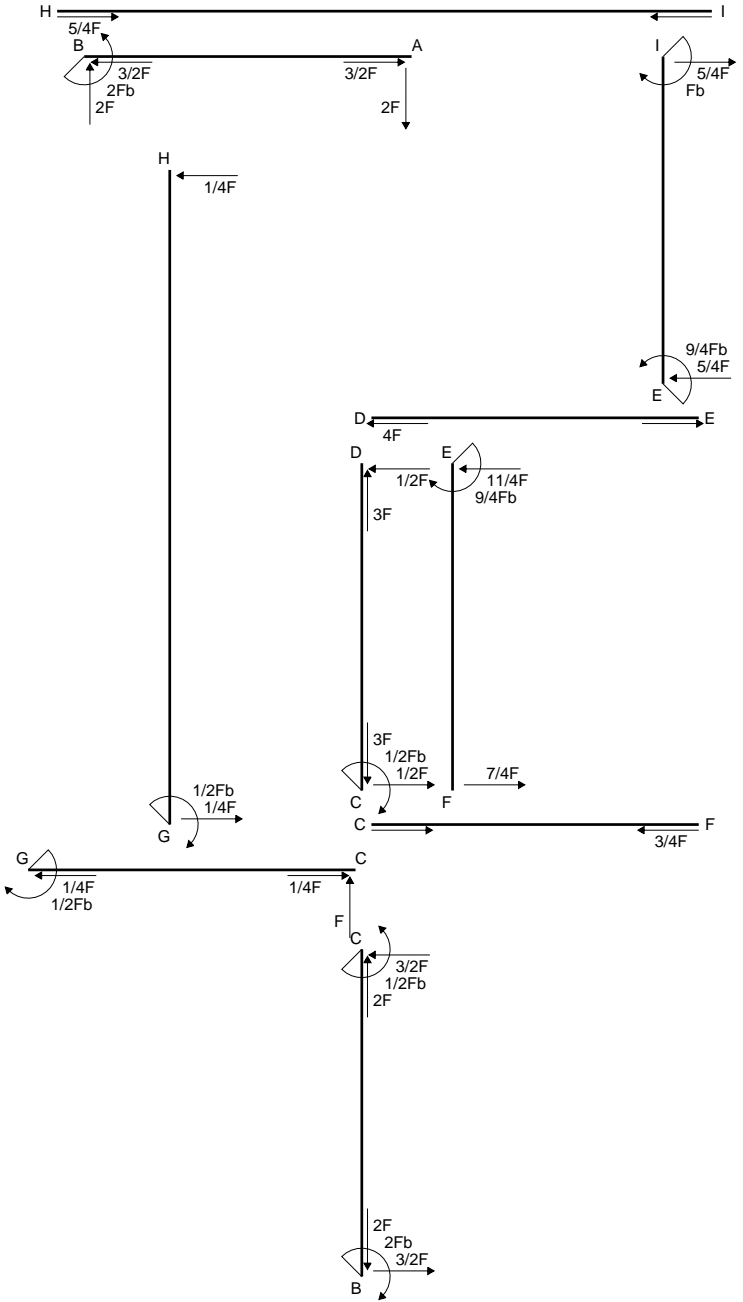
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

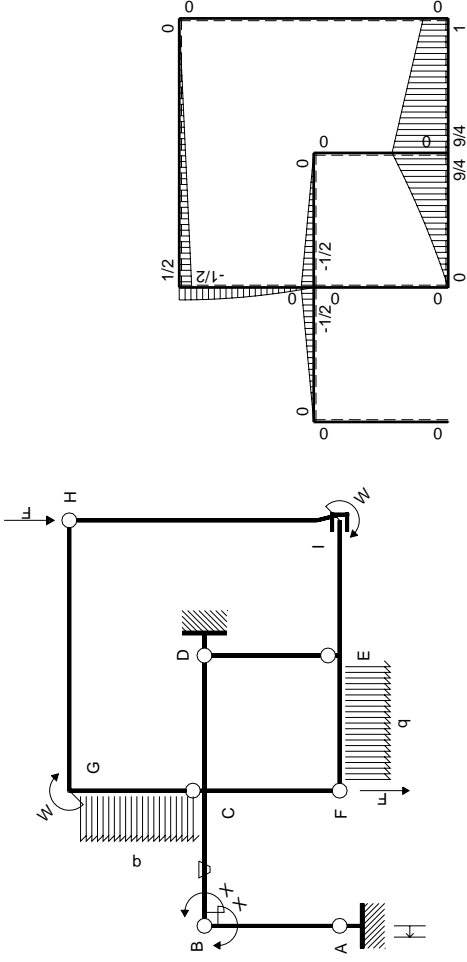
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/8 b) Fb 1/EJ + (-1/4 b) \theta = 3/8 Fb^2/EJ$$



- A = 840. mm²
- J_u = 255143. mm⁴
- J_v = 53280. mm⁴
- y_g = 22.14 mm
- T_y = -3480. N
- M_x = 1766100. Nmm
- x_m = 30. mm
- y_m = 55. mm
- u_m = 6. mm
- v_m = 32.86 mm
- σ_m = -Mv/J_u = -227.4 N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 18.86 mm
- σ_c = -Mv/J_u = -130.5 N/mm²
- τ_c = 4.937 N/mm²
- σ_q = √σ²+3τ² = 130.8 N/mm²
- S = 4344. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-1/2Fx$	$-Fb/EJ$	$1/2Fx-1/4Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/6+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	Fb/EJ	$1/4Fb-1/4Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/4Fb-11/4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-7/4Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$2Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/12 b) Fb 1/EJ + (b - 1/4 b) \theta = 11/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

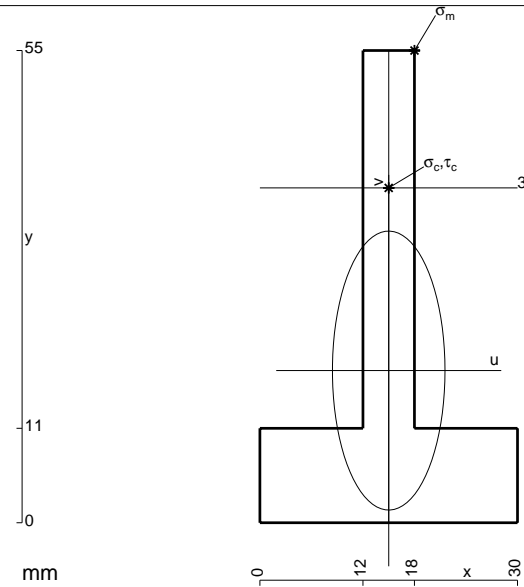
$$= (1/4 b - 1/12 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 11/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

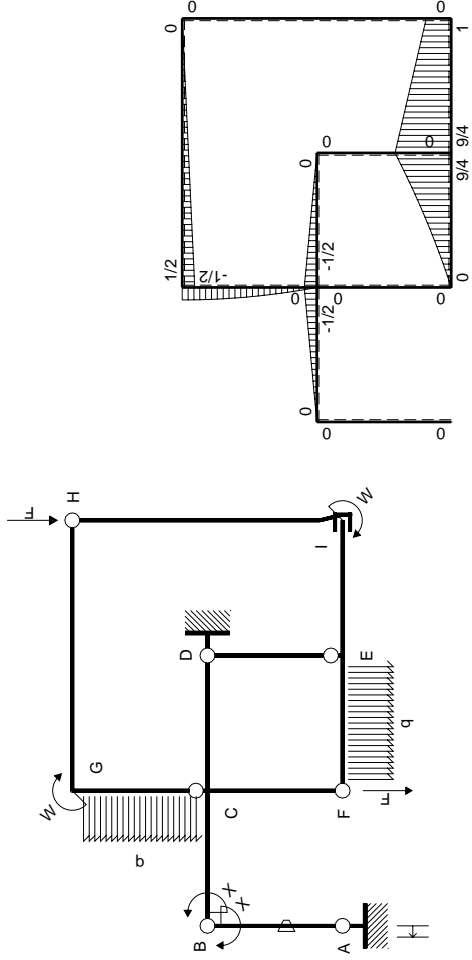
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

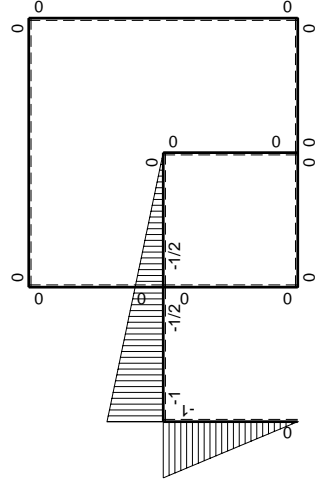


- A = 594. mm²
- J_u = 156836. mm⁴
- J_v = 25542. mm⁴
- y_g = 17.72 mm
- T_y = -1953. N
- M_x = 1006430. Nmm
- x_m = 18. mm
- y_m = 55. mm
- u_m = 3. mm
- v_m = 37.28 mm
- σ_m = -Mv/J_u = -239.2 N/mm²
- x_c = 15. mm
- y_c = 39. mm
- v_c = 21.28 mm
- σ_c = -Mv/J_u = -136.5 N/mm²
- τ_c = 5.832 N/mm²
- σ_q = √σ² + 3τ² = 136.9 N/mm²
- S = 2811. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-1/2Fx$	0	$1/2Fx-1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$1/4Fb-1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$9/4Fb-11/4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-7/4Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$7/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-7/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

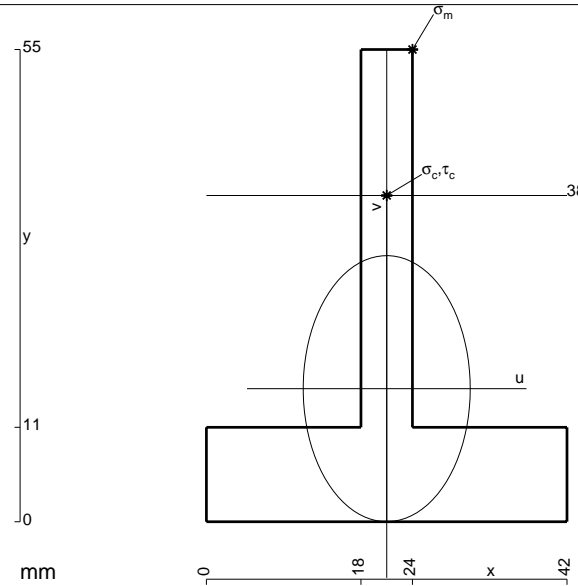
$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

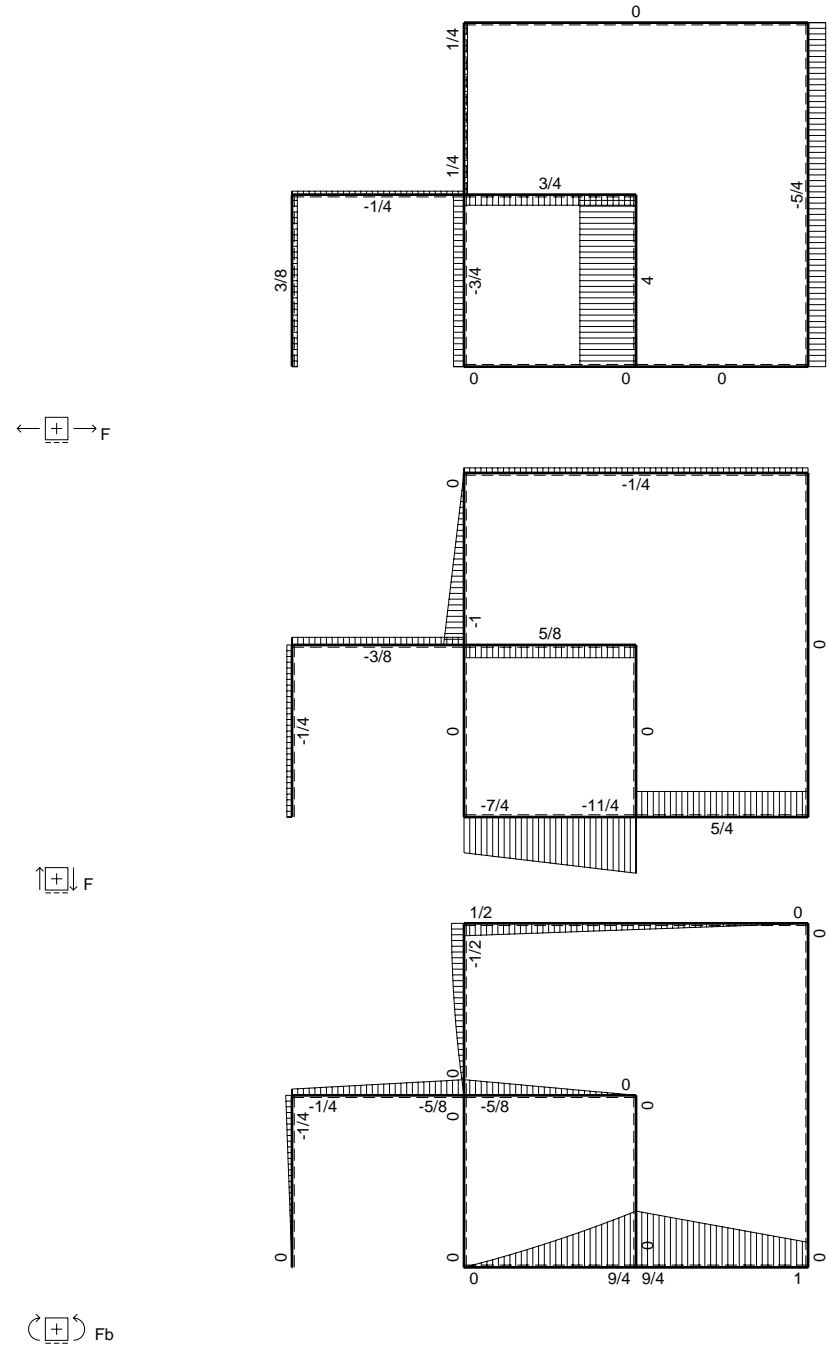
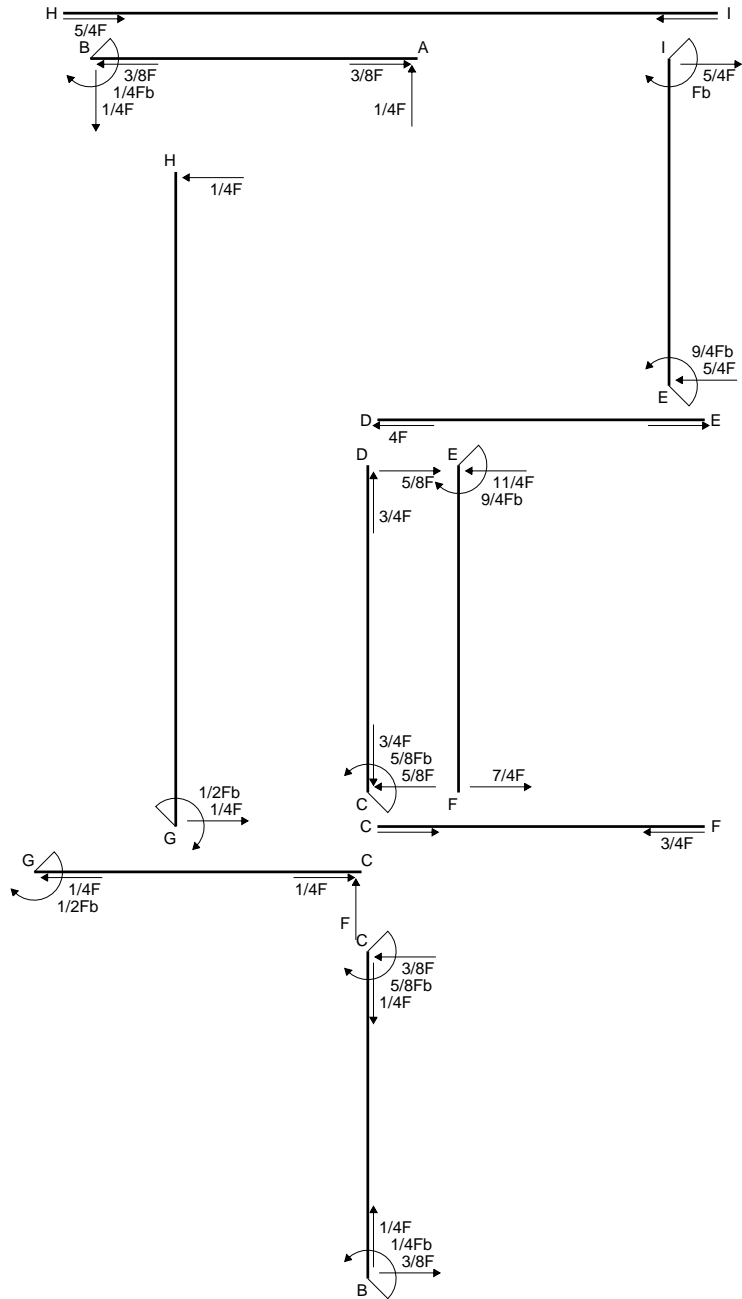
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

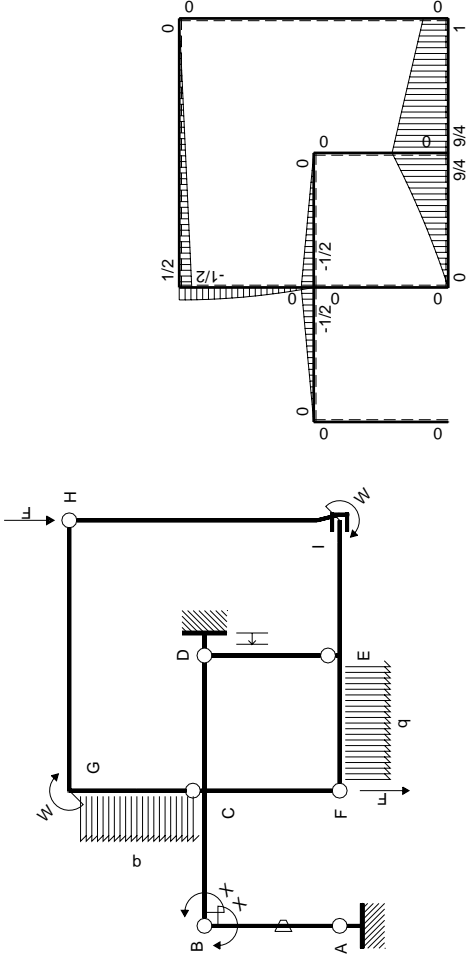
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 726. mm²
- J_u = 174301. mm⁴
- J_v = 68706. mm⁴
- y_g = 15.5 mm
- T_y = -1595. N
- M_x = 874350. Nmm
- x_m = 24. mm
- y_m = 55. mm
- u_m = 3. mm
- v_m = 39.5 mm
- σ_m = -Mv/J_u = -198.1 N/mm²
- x_c = 21. mm
- y_c = 38. mm
- v_c = 22.5 mm
- σ_c = -Mv/J_u = -112.9 N/mm²
- τ_c = 4.823 N/mm²
- σ_q = √σ²+3τ² = 113.2 N/mm²
- S = 3162. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-1/2Fx$	0	$1/2Fx-1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$1/4Fb-1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-11/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-7/4Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

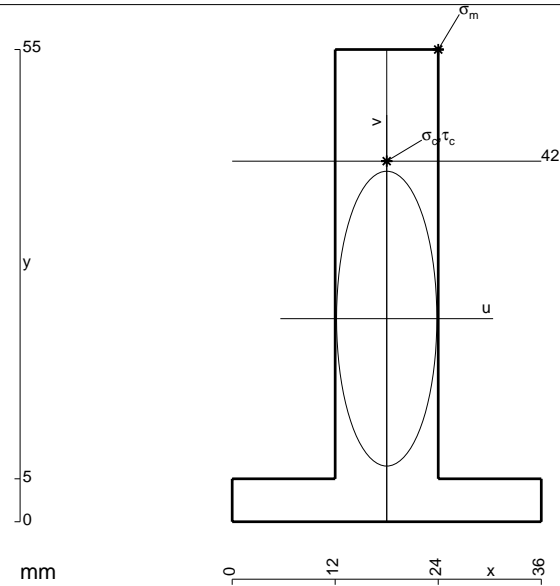
$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

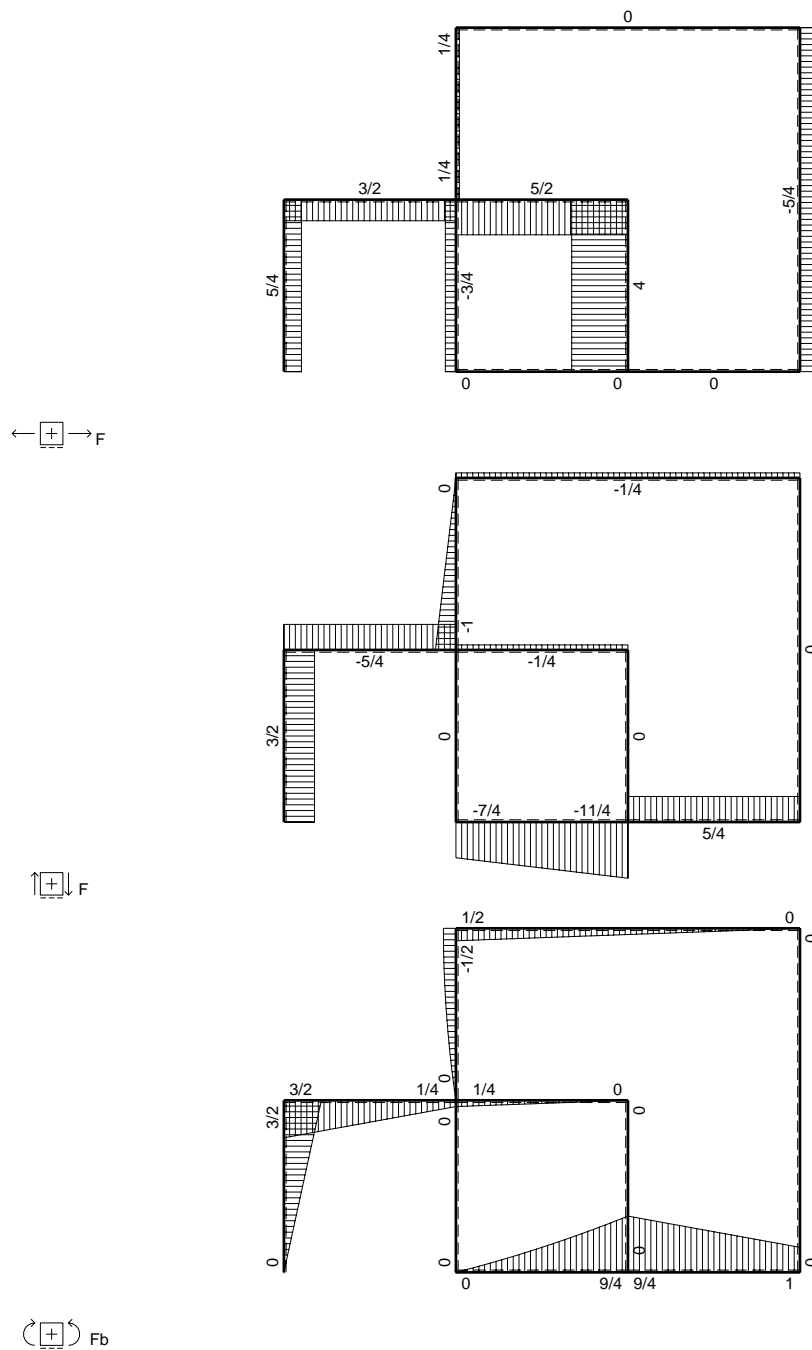
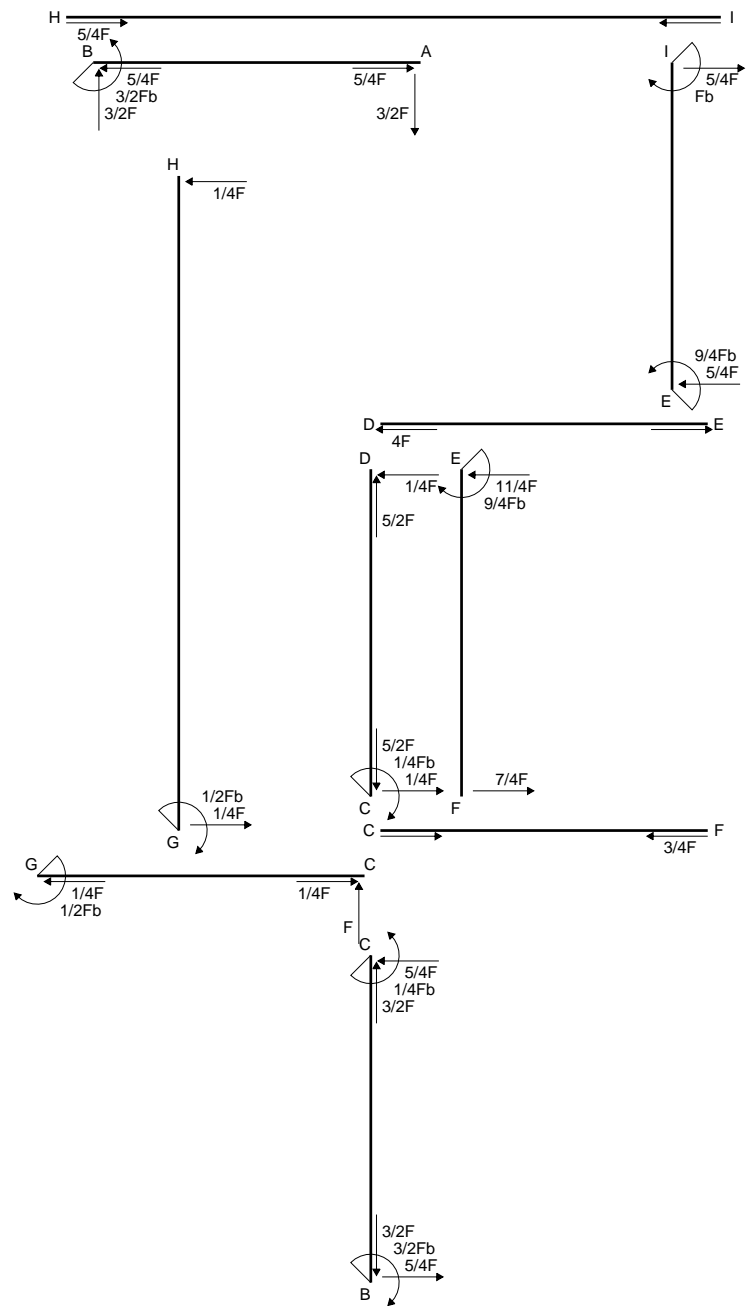
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

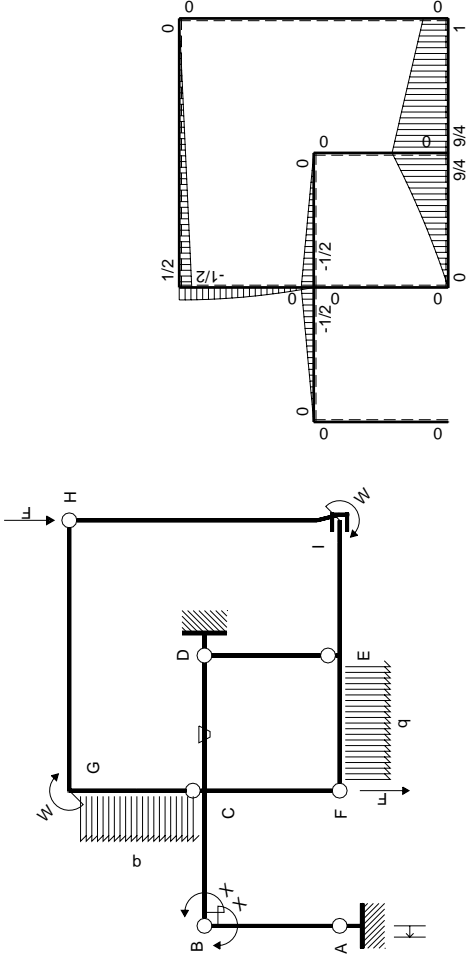
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 780. mm²
- J_u = 230087. mm⁴
- J_v = 26640. mm⁴
- y_g = 23.65 mm
- T_y = -2613. N
- M_x = 1539000. Nmm
- x_m = 24. mm
- y_m = 55. mm
- u_m = 6. mm
- v_m = 31.35 mm
- σ_m = -Mv/J_u = -209.7 N/mm²
- x_c = 18. mm
- y_c = 42. mm
- v_c = 18.35 mm
- σ_c = -Mv/J_u = -122.7 N/mm²
- τ_c = 3.667 N/mm²
- σ_q = √σ²+3τ² = 122.9 N/mm²
- S = 3876. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	1/3Xb/EJ	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-1/2Fx$	0	$1/2Fx-1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	7/12Xb/EJ	
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$1/4Fb-1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	$-Fb/EJ$	$1/4Fb-1/2Fx+1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+1/4)Fb^2/EJ$	1/12Xb/EJ	
DC b	$1/2x/b$	$1/2Fx$	Fb/EJ	$1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-11/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-7/4Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$							Fb^2/EJ	
	totali							$3/2Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-3/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

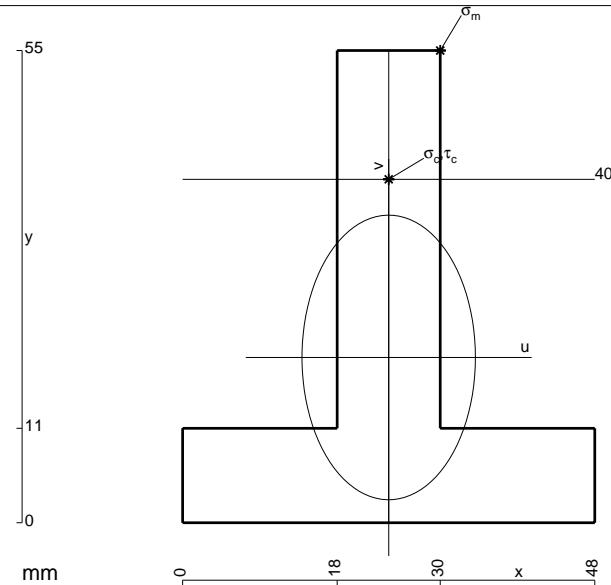
$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/3 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/3 Fb^2/EJ$$



$$A = 1056. \text{ mm}^2$$

$$J_u = 290158. \text{ mm}^4$$

$$J_v = 107712. \text{ mm}^4$$

$$y_g = 19.25 \text{ mm}$$

$$T_y = -2860. \text{ N}$$

$$M_x = 1778400. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 55. \text{ mm}$$

$$u_m = 6. \text{ mm}$$

$$v_m = 35.75 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -219.1 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

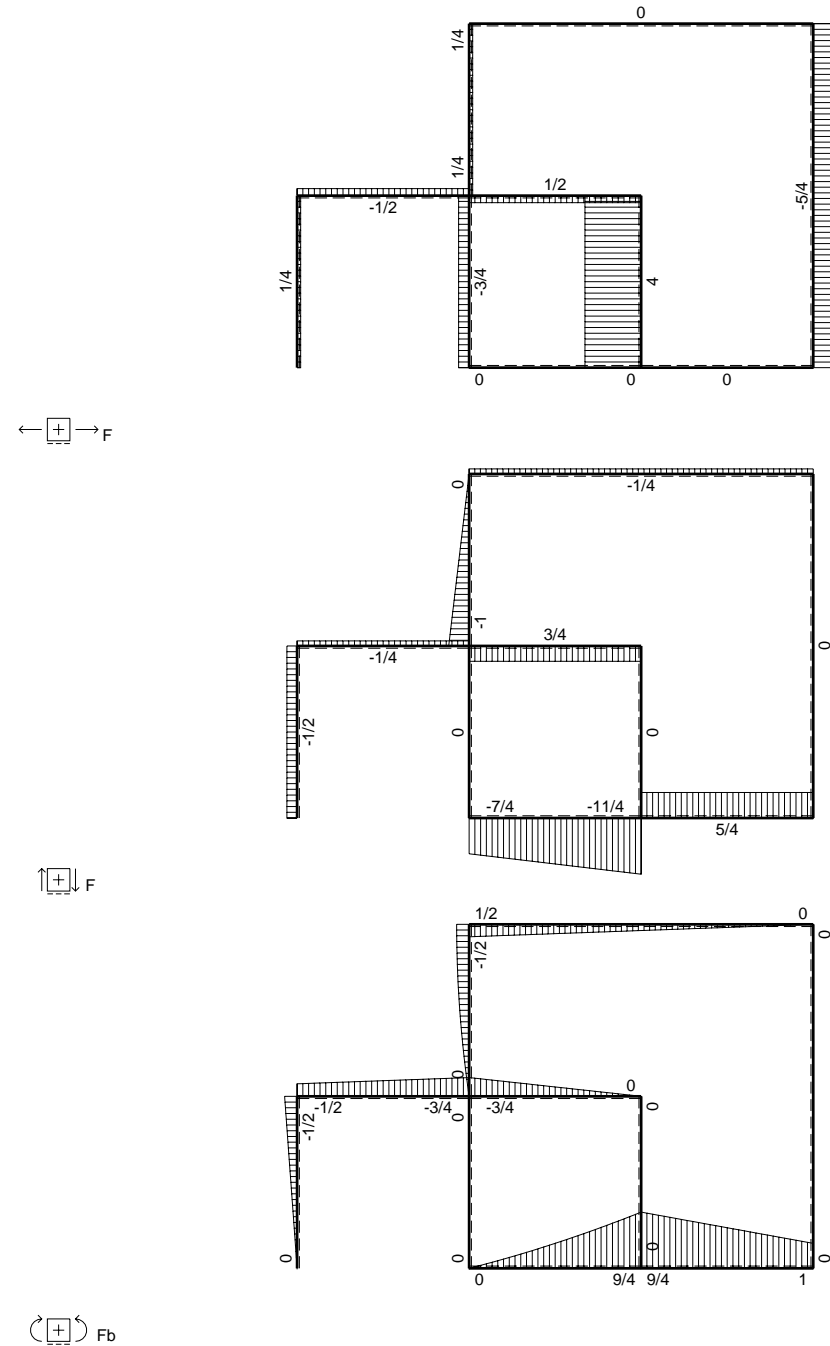
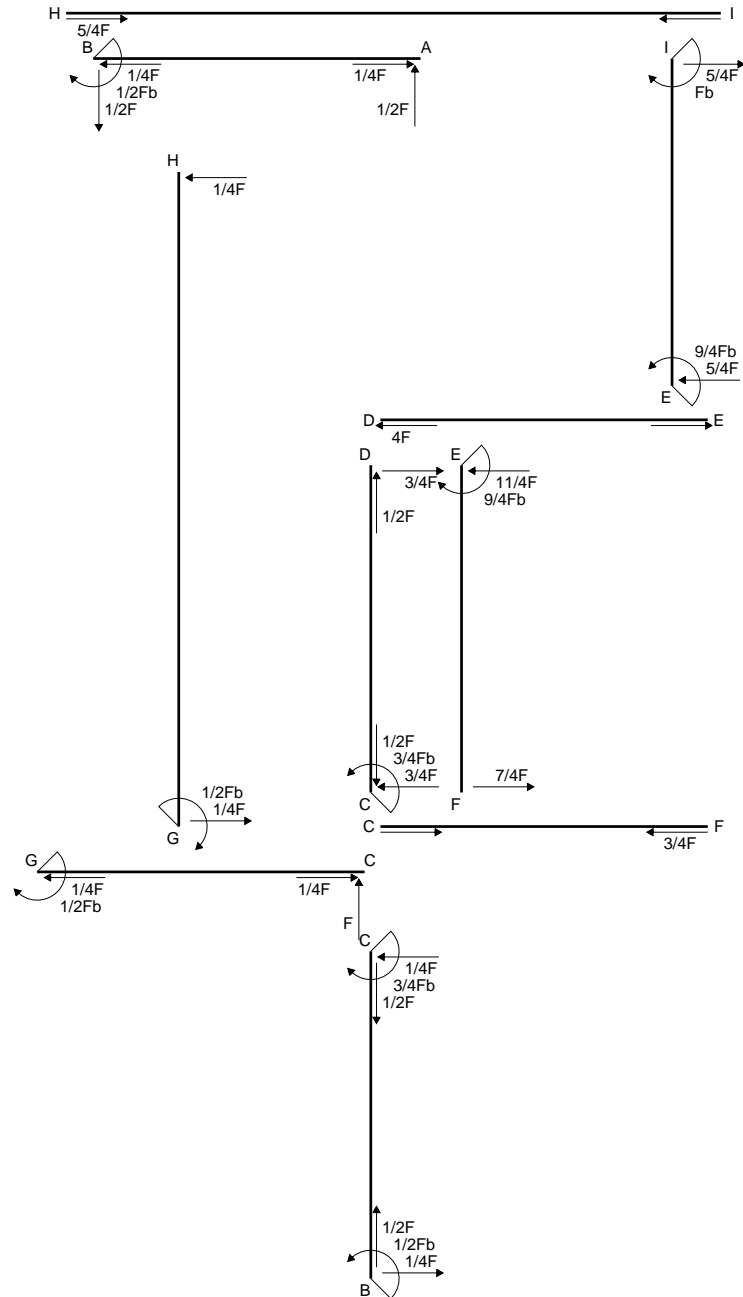
$$v_c = 20.75 \text{ mm}$$

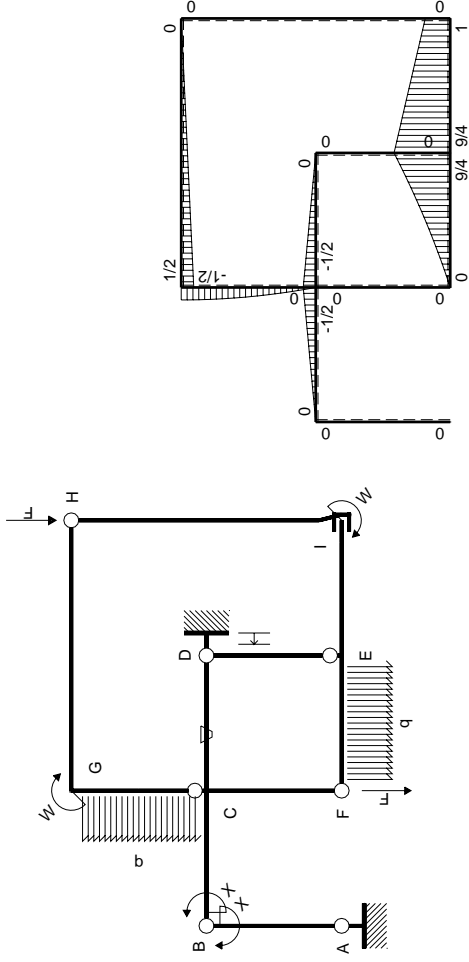
$$\sigma_c = -Mv/J_u = -127.2 \text{ N/mm}^2$$

$$\tau_c = 4.177 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 127.4 \text{ N/mm}^2$$

$$S = 5085. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-1/2Fx$	0	$1/2Fx-1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$1/4Fb-1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	$-Fb/EJ$	$1/4Fb-1/2Fx+1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	Fb/EJ	$1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-11/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-7/4Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/2Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/12 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

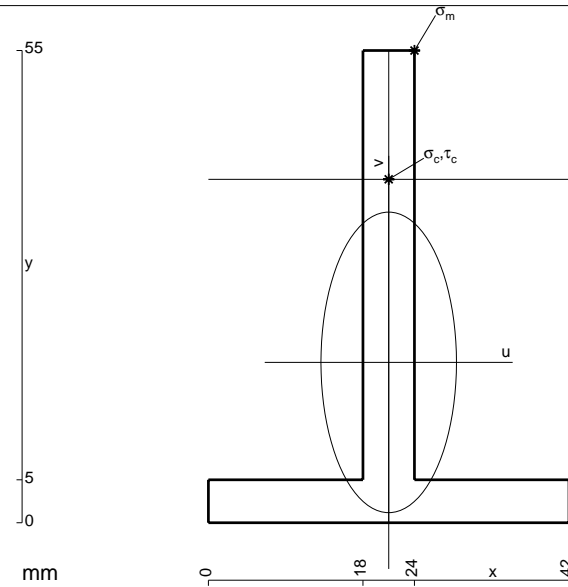
$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

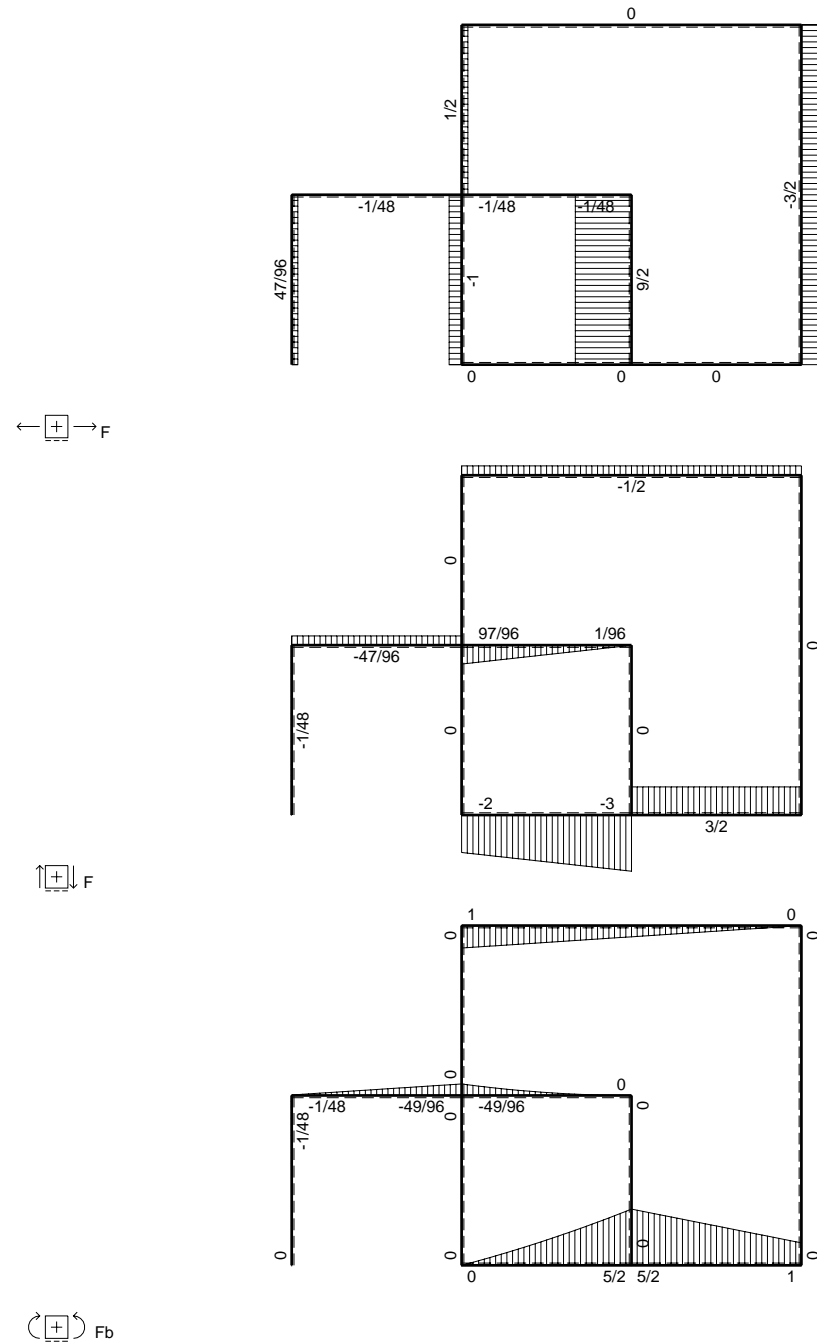
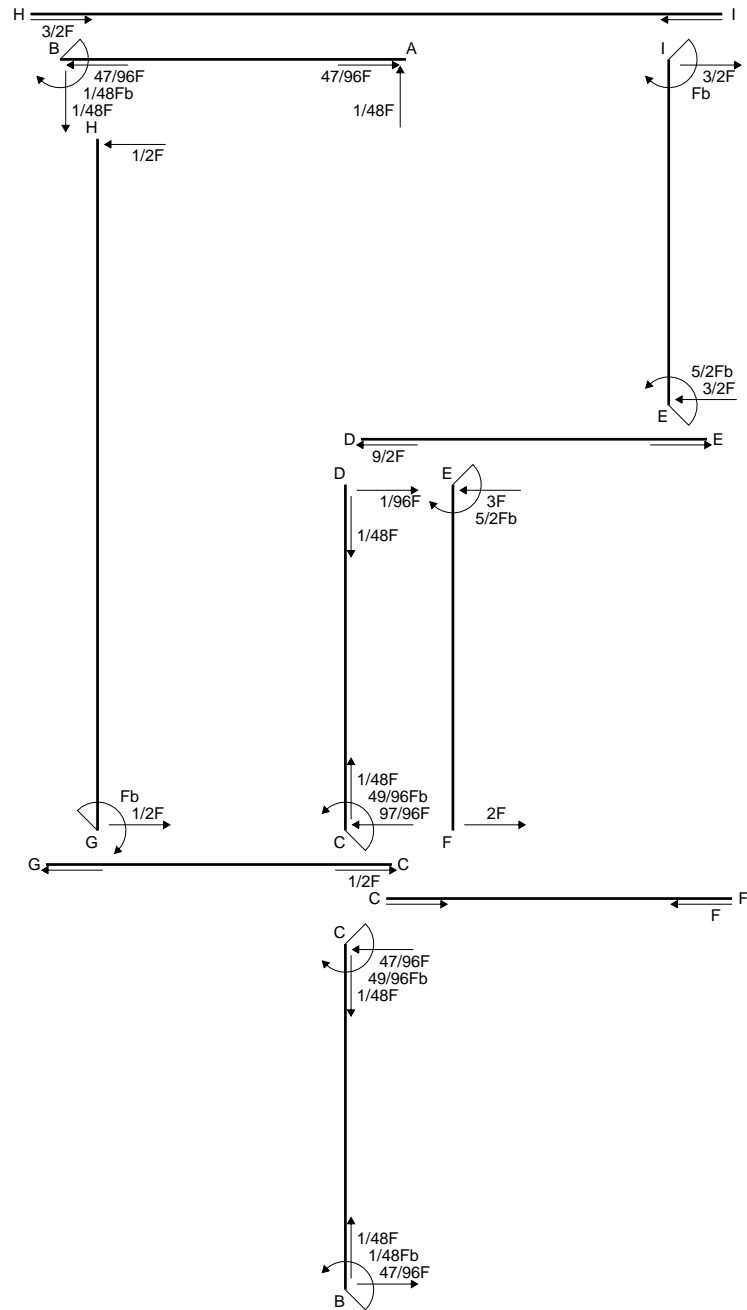
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/3 Fb^2/EJ$$

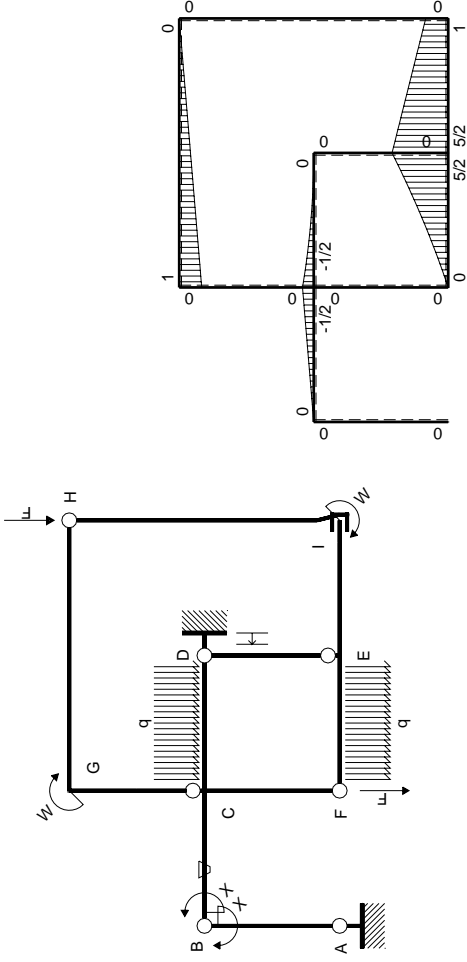
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/3 Fb^2/EJ$$



- A = 510. mm²
- J_u = 156357. mm⁴
- J_v = 31770. mm⁴
- y_g = 18.68 mm
- T_y = -1485. N
- M_x = 984150. Nmm
- x_m = 24. mm
- y_m = 55. mm
- u_m = 3. mm
- v_m = 36.32 mm
- σ_m = -Mv/J_u = -228.6 N/mm²
- x_c = 21. mm
- y_c = 40. mm
- v_c = 21.32 mm
- σ_c = -Mv/J_u = -134.2 N/mm²
- τ_c = 4.106 N/mm²
- σ_q = √σ²+3τ² = 134.4 N/mm²
- S = 2594. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-1/2Fx$	$-Fb/EJ$	$1/2Fx-1/4Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/6+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	Fb/EJ	$1/4Fb-1/4Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+Fx-1/2qx^2$	0	$1/4Fb-3/4Fx+3/4Fx^2/b-1/4qx^3/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/16+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2qx^2$	0	$1/4qx^3/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/48Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/48Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/12 b) Fb 1/EJ + (b - 1/4 b) \theta = 11/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/12 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 11/12 Fb^2/EJ$$

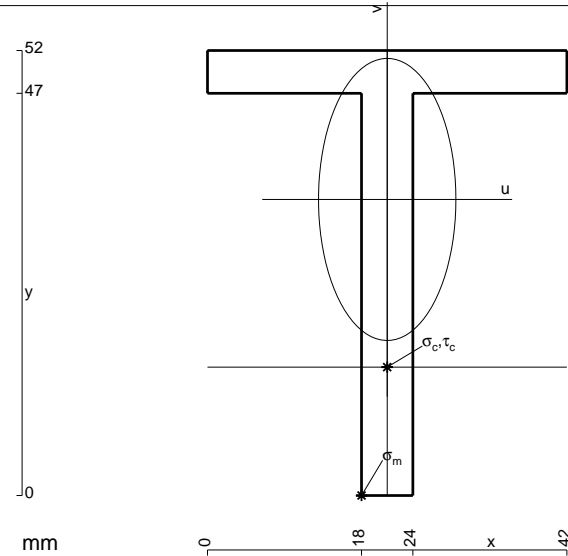
$$L_{CD}^{xo} = \int_0^b (1/4 - 3/4 x/b + 3/4 x^2/b^2 - 1/4 x^3/b^3) Fb 1/EJ dx$$

$$= [1/4 x - 3/8 x^2/b + 1/4 x^3/b^2 - 1/16 x^4/b^3]_0^b Fb 1/EJ$$

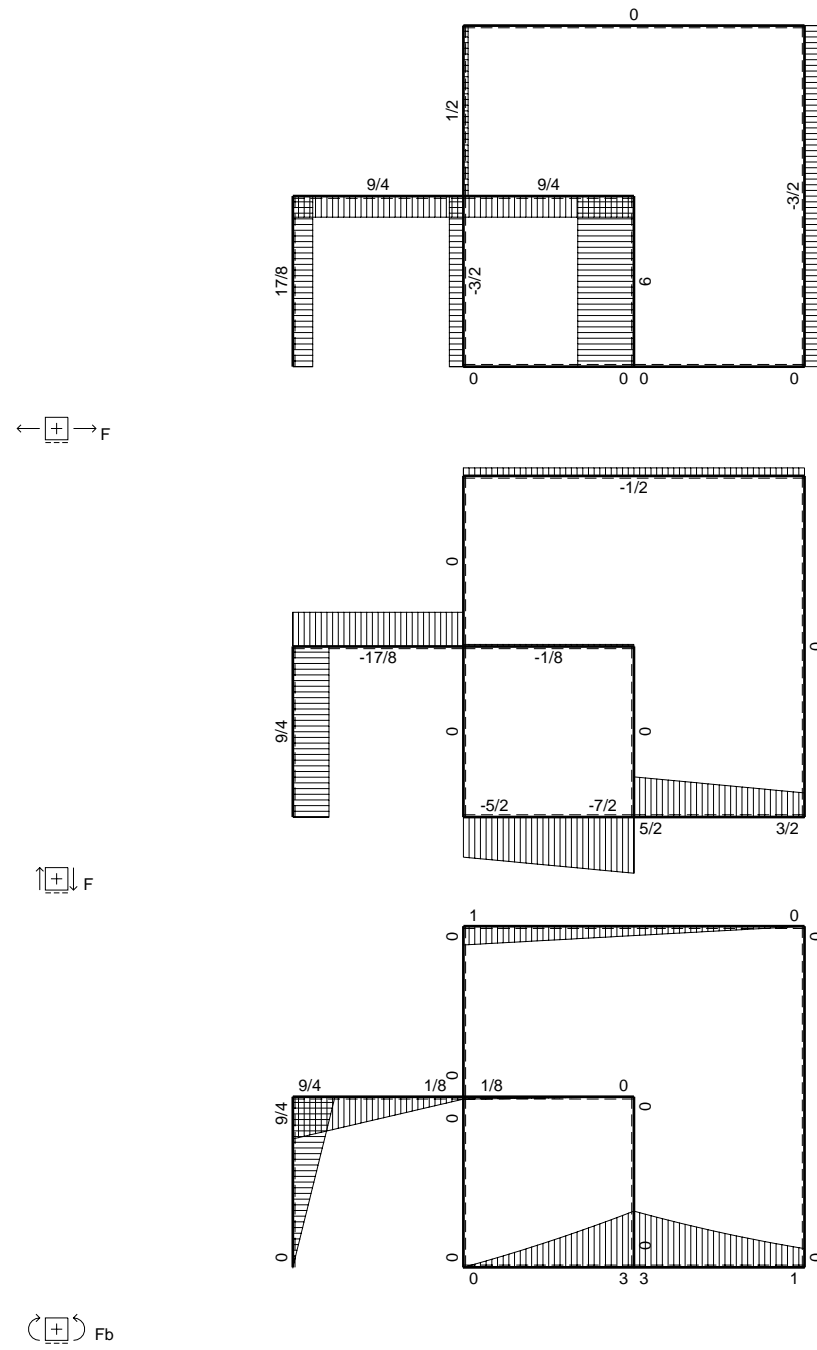
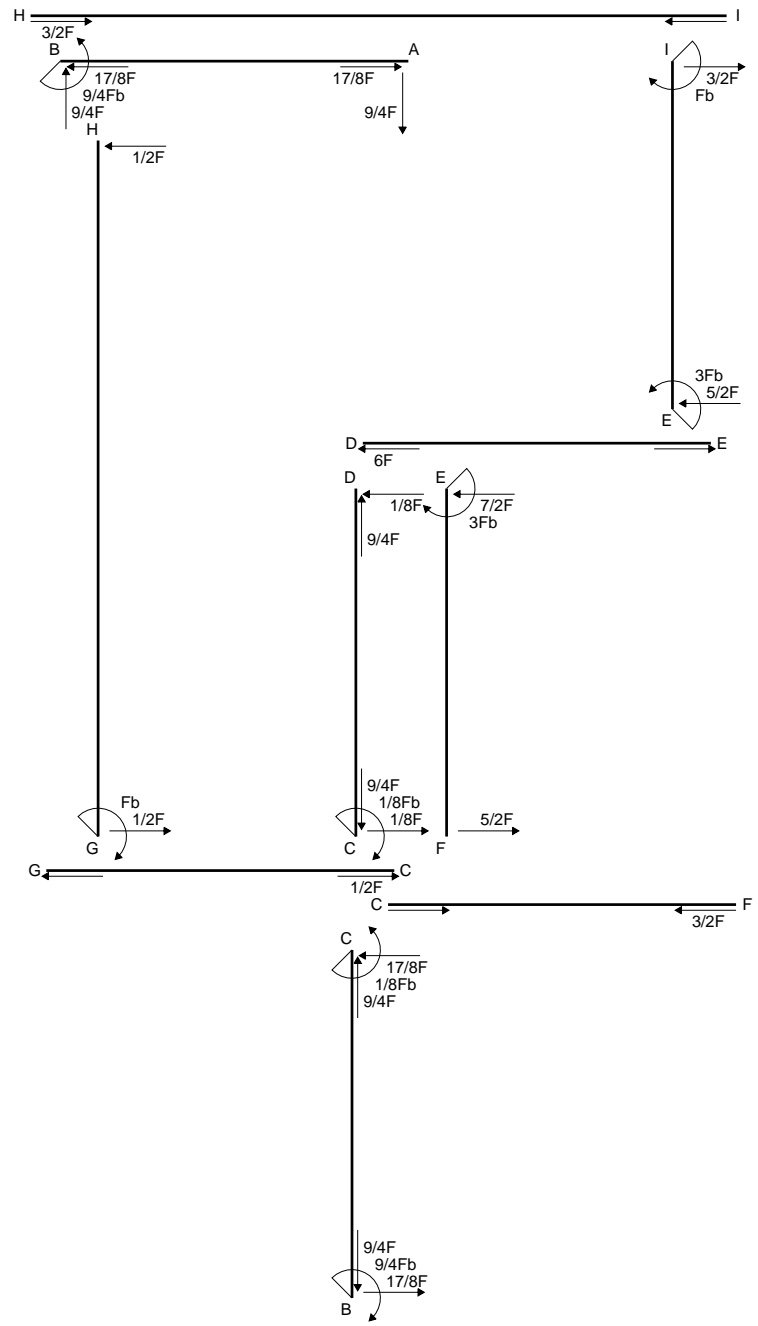
$$= (1/4 b - 3/8 b + 1/4 b - 1/16 b) Fb 1/EJ = 1/16 Fb^2/EJ$$

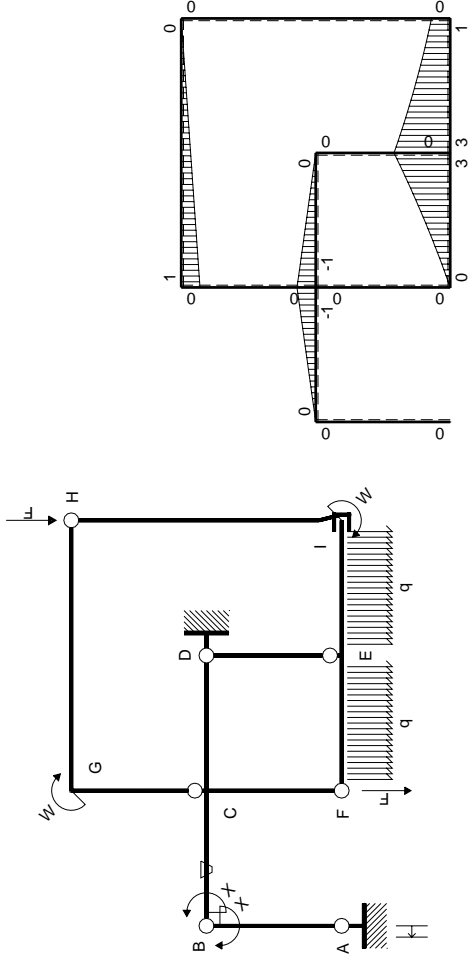
$$L_{DC}^{xo} = \int_0^b (1/4 x^3/b^3) Fb 1/EJ dx = [1/16 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/16 b) Fb 1/EJ = 1/16 Fb^2/EJ$$



- A = 492. mm²
- J_u = 133716. mm⁴
- J_v = 31716. mm⁴
- y_g = 34.6 mm
- T_y = -1350. N
- M_x = 911250. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -34.6 mm
- σ_m = -Mv/J_u = 235.8 N/mm²
- x_c = 21. mm
- y_c = 15. mm
- v_c = -19.6 mm
- σ_c = -Mv/J_u = 133.6 N/mm²
- τ_c = 4.104 N/mm²
- σ_o = √σ² + 3τ² = 133.7 N/mm²
- S = 2439. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$3Fb-7/2Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-5/2Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$9/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-9/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

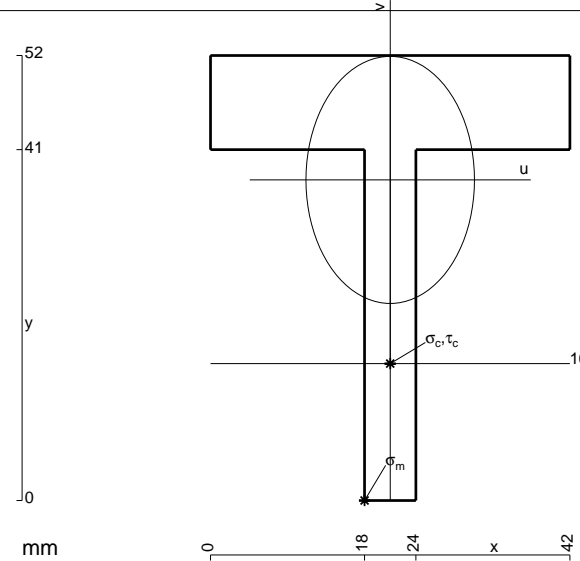
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

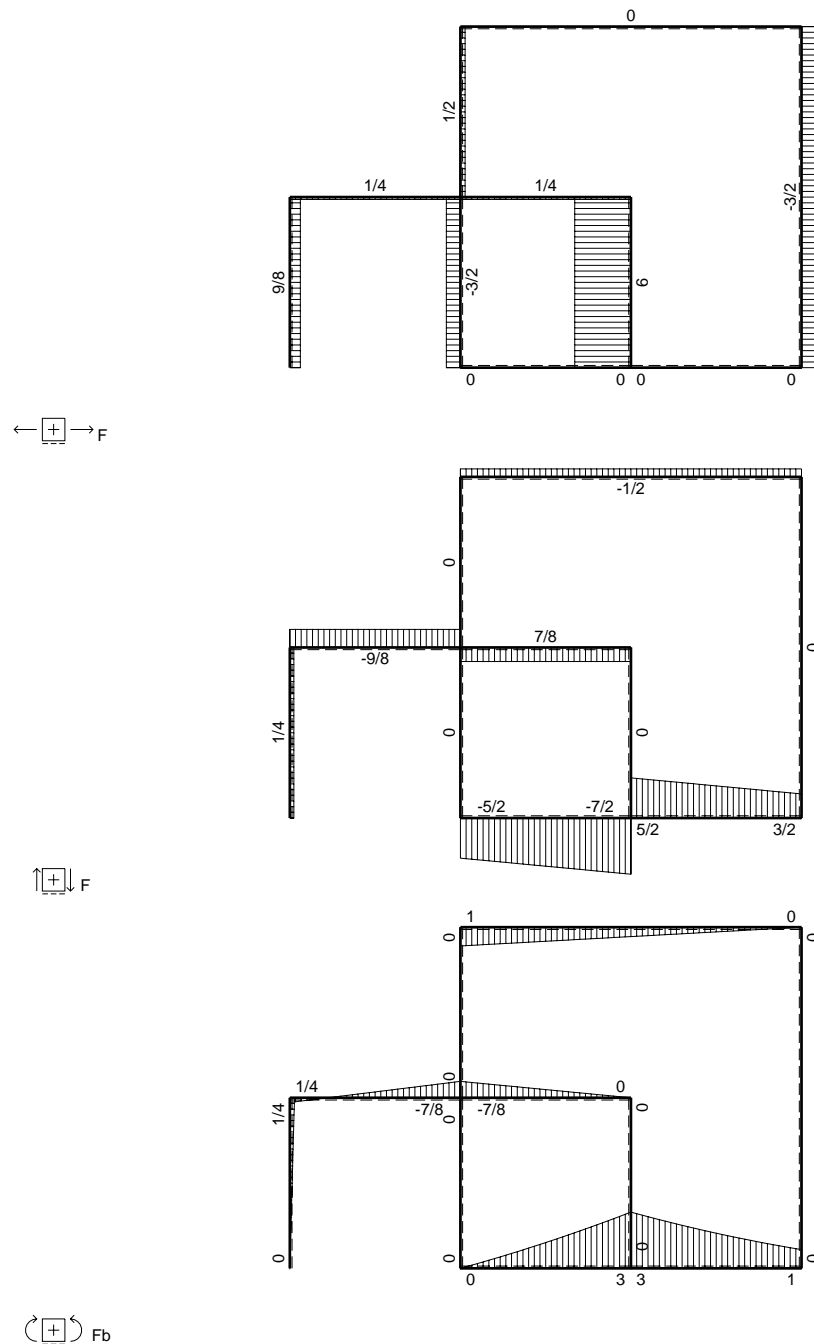
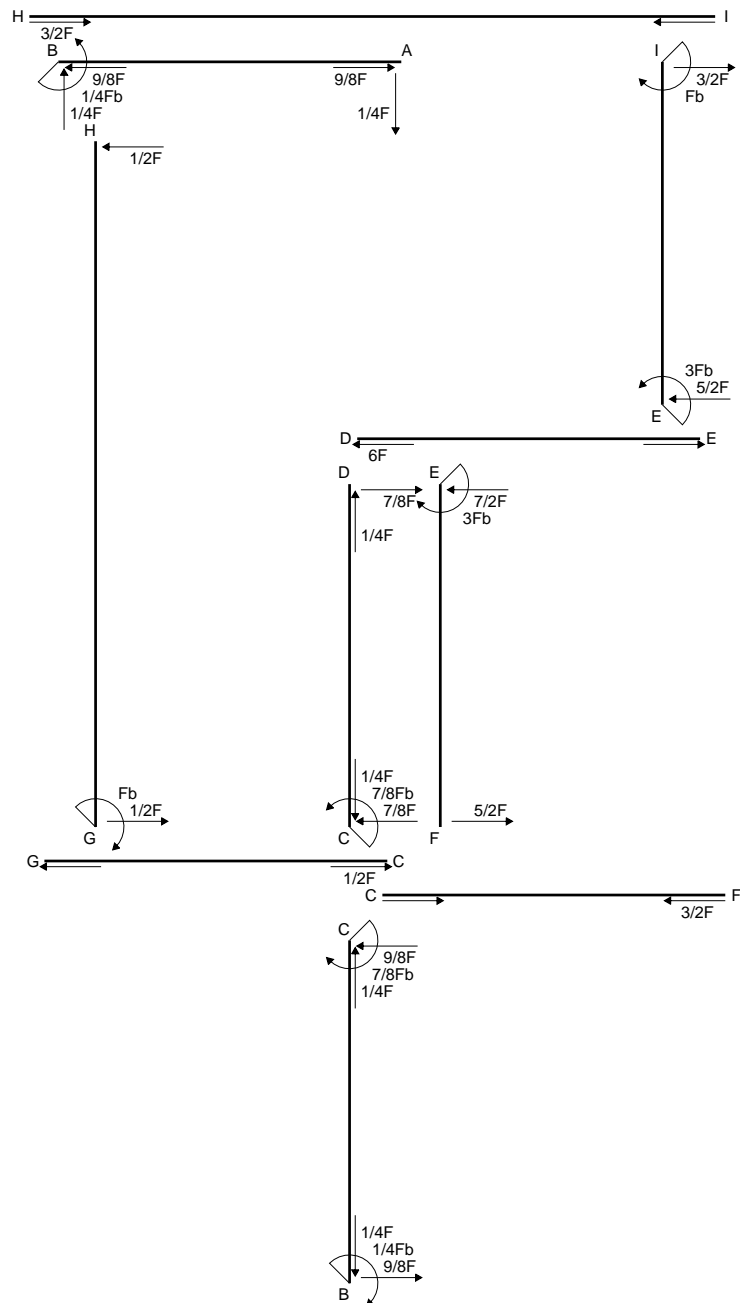
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

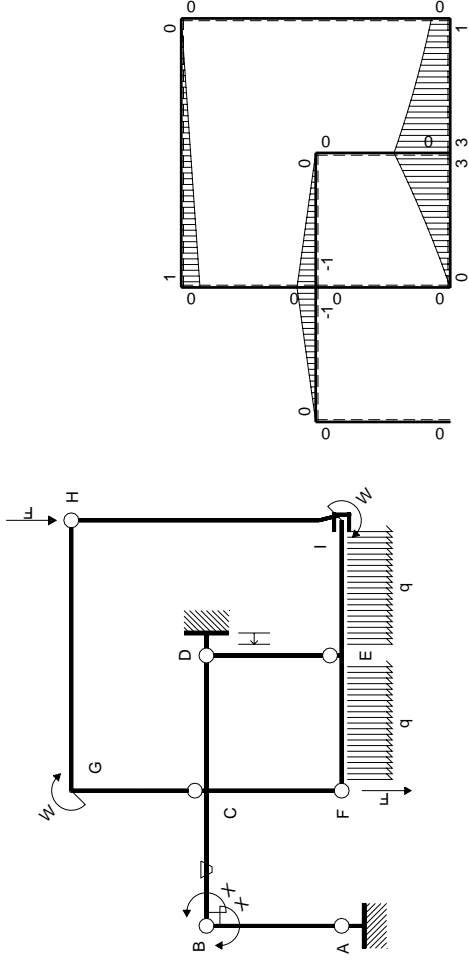
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$



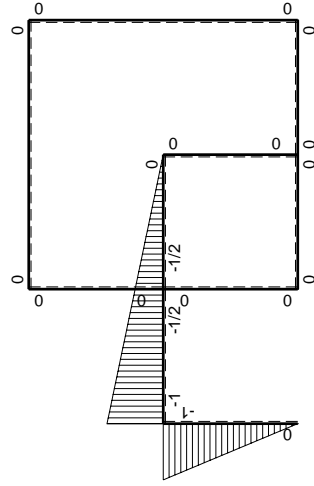
- A = 708. mm²
- J_u = 147634. mm⁴
- J_v = 68652. mm⁴
- y_g = 37.47 mm
- T_y = -2135. N
- M_x = 786900. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -37.47 mm
- σ_m = -Mv/J_u = 199.7 N/mm²
- x_c = 21. mm
- y_c = 16. mm
- v_c = -21.47 mm
- σ_c = -Mv/J_u = 114.4 N/mm²
- τ_c = 6.818 N/mm²
- σ_o = √σ²+3τ² = 115. N/mm²
- S = 2829. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$3Fb-7/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-5/2Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

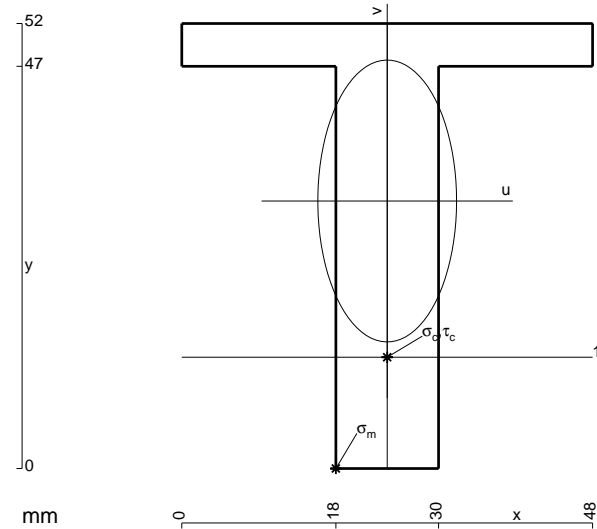
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

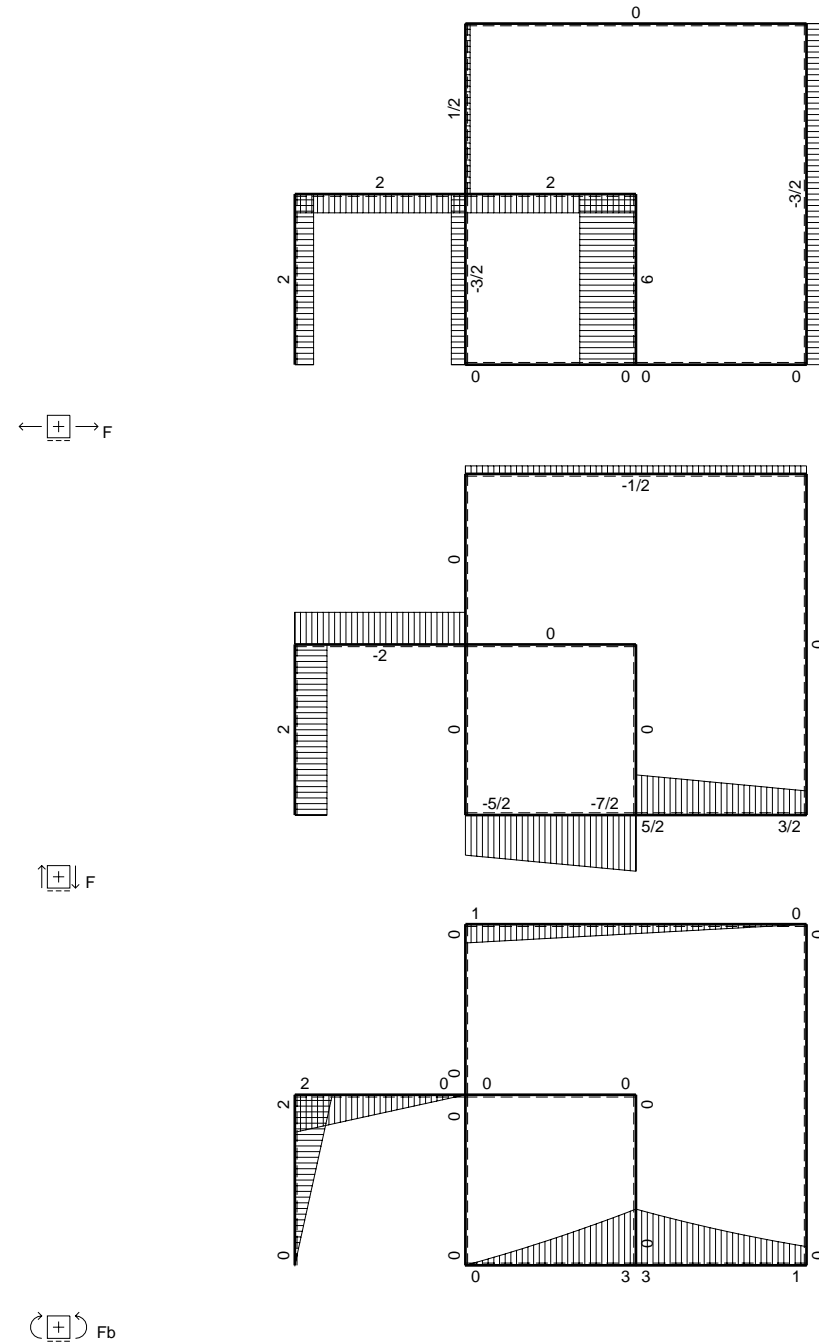
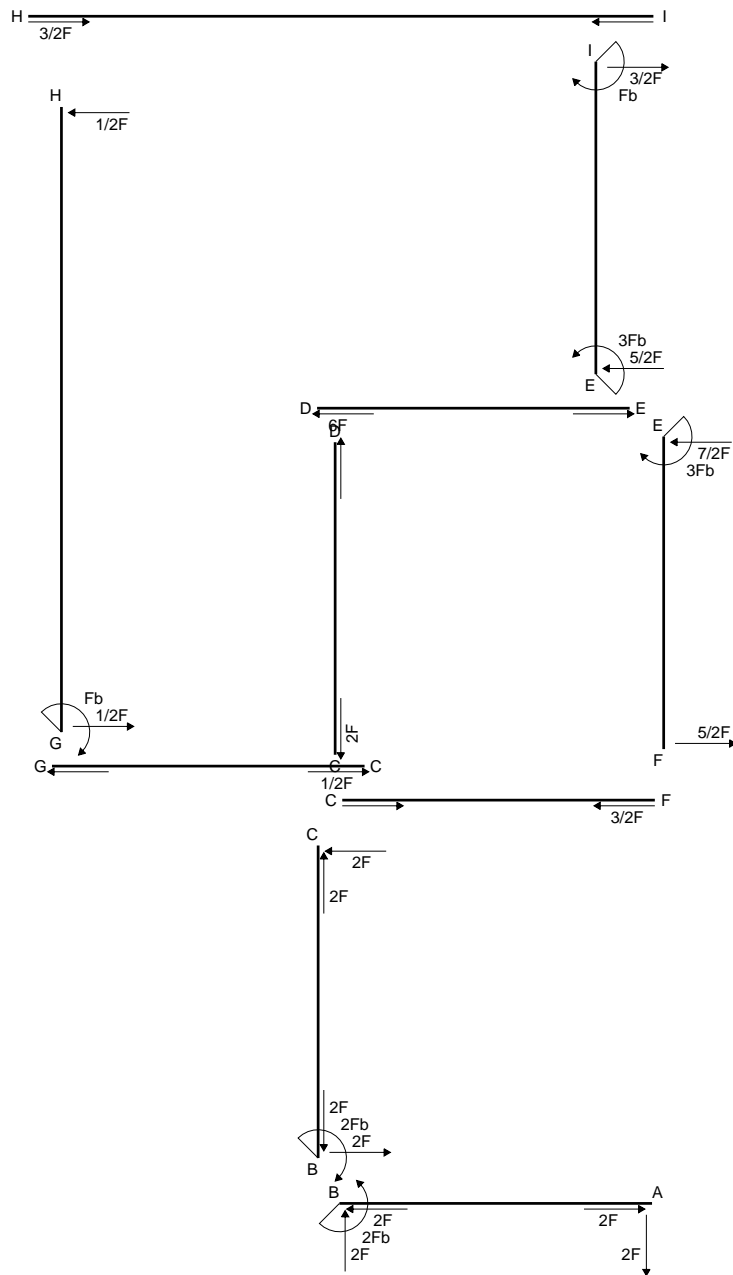
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

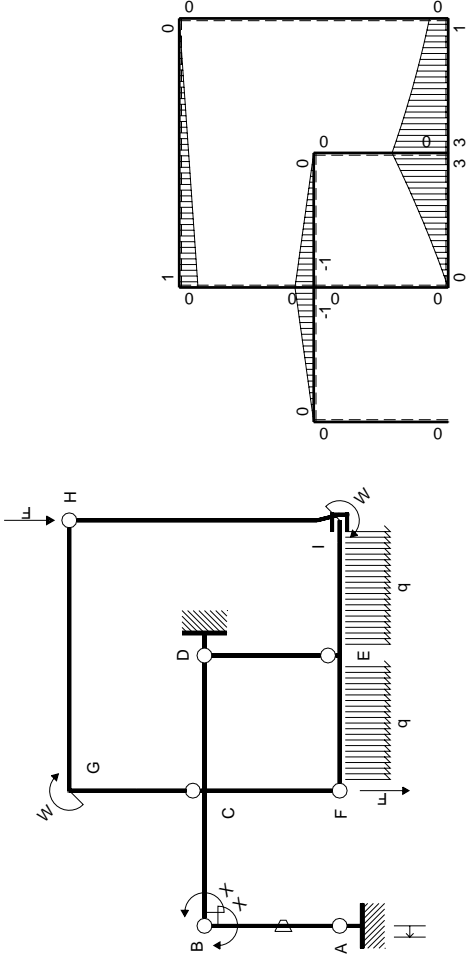
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$



- A = 804. mm²
- J_u = 218133. mm⁴
- J_v = 52848. mm⁴
- y_g = 31.26 mm
- T_y = -3605. N
- M_x = 1452300. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -31.26 mm
- σ_m = -Mv/J_u = 208.1 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -18.26 mm
- σ_c = -Mv/J_u = 121.6 N/mm²
- τ_c = 5.32 N/mm²
- σ_o = √σ²+3τ² = 121.9 N/mm²
- S = 3863. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$3Fb-7/2Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-5/2Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$2Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

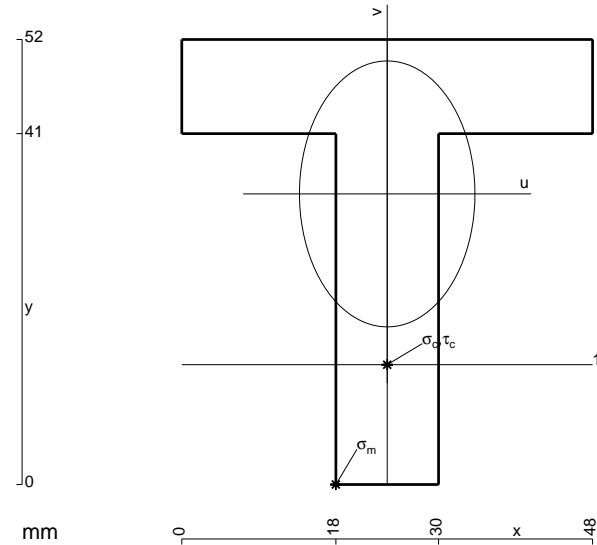
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

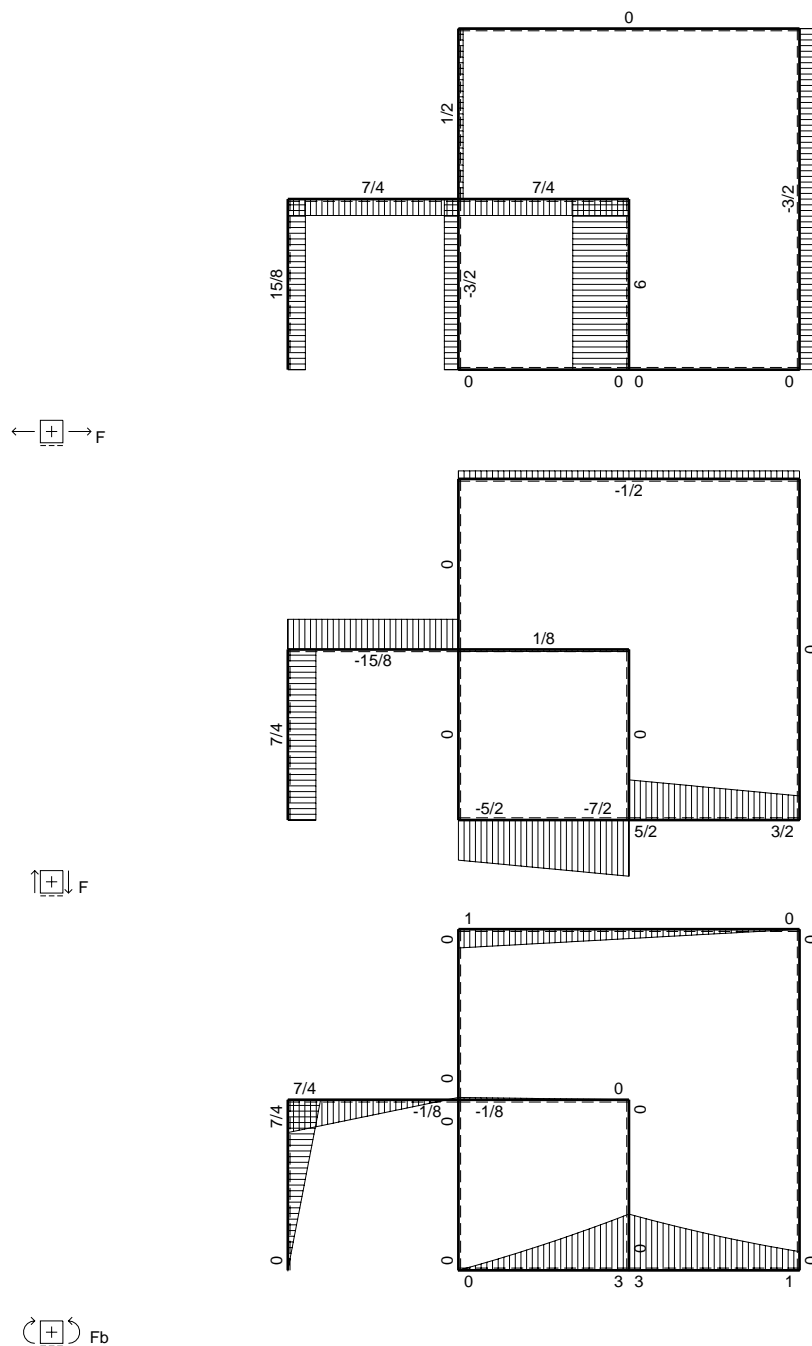
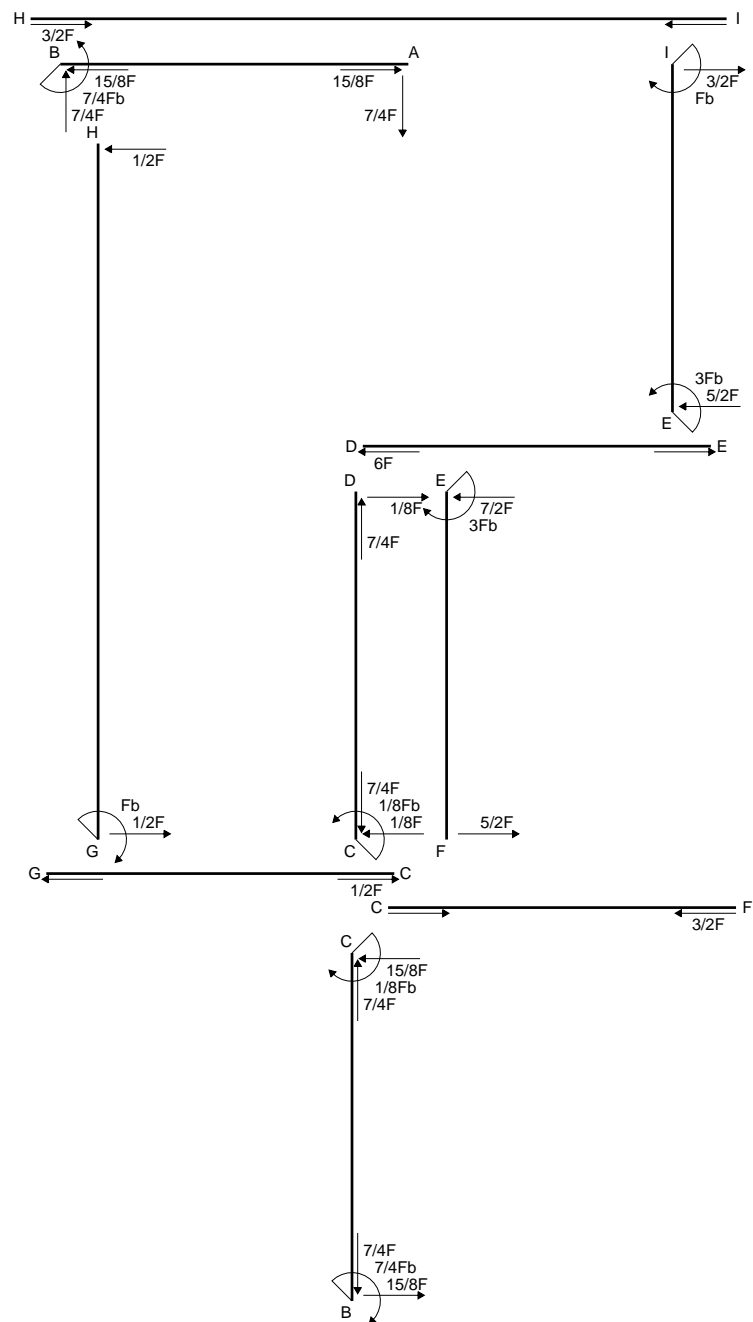
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

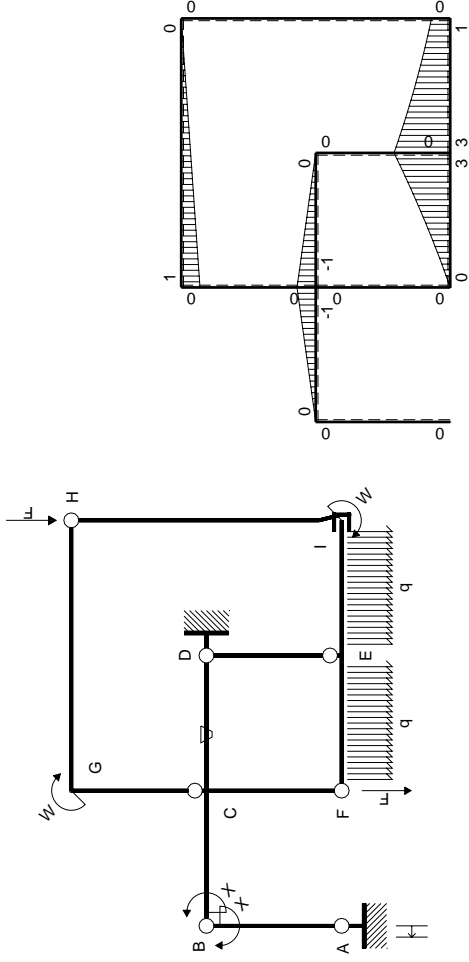
$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$



- A = 1020. mm²
- J_u = 246410. mm⁴
- J_v = 107280. mm⁴
- y_g = 33.96 mm
- T_y = -3640. N
- M_x = 1591200. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -33.96 mm
- σ_m = -Mv/J_u = 219.3 N/mm²
- x_c = 24. mm
- y_c = 14. mm
- v_c = -19.96 mm
- σ_c = -Mv/J_u = 128.9 N/mm²
- τ_c = 5.575 N/mm²
- σ_o = √σ²+3τ² = 129.2 N/mm²
- S = 4529. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	Fx	Fb/EJ	$1/2Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$3Fb-7/2Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-5/2Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$7/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-7/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

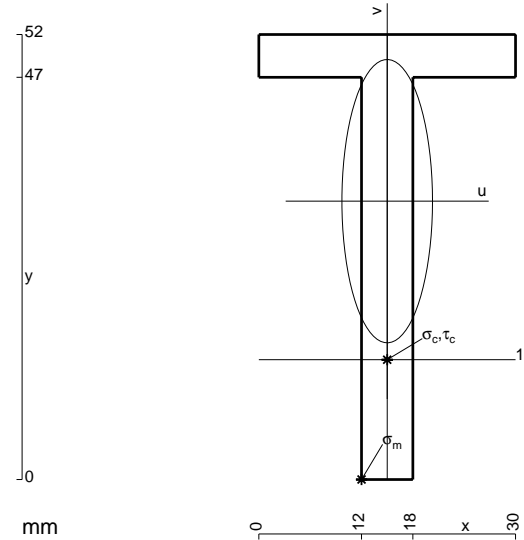
$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 5/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/6 b) Fb 1/EJ + (-1/4 b) \theta = 5/12 Fb^2/EJ$$



$$A = 432. \text{ mm}^2$$

$$J_u = 118416. \text{ mm}^4$$

$$J_v = 12096. \text{ mm}^4$$

$$y_g = 32.53 \text{ mm}$$

$$T_y = -1750. \text{ N}$$

$$M_x = 825000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -3. \text{ mm}$$

$$v_m = -32.53 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 226.6 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 14. \text{ mm}$$

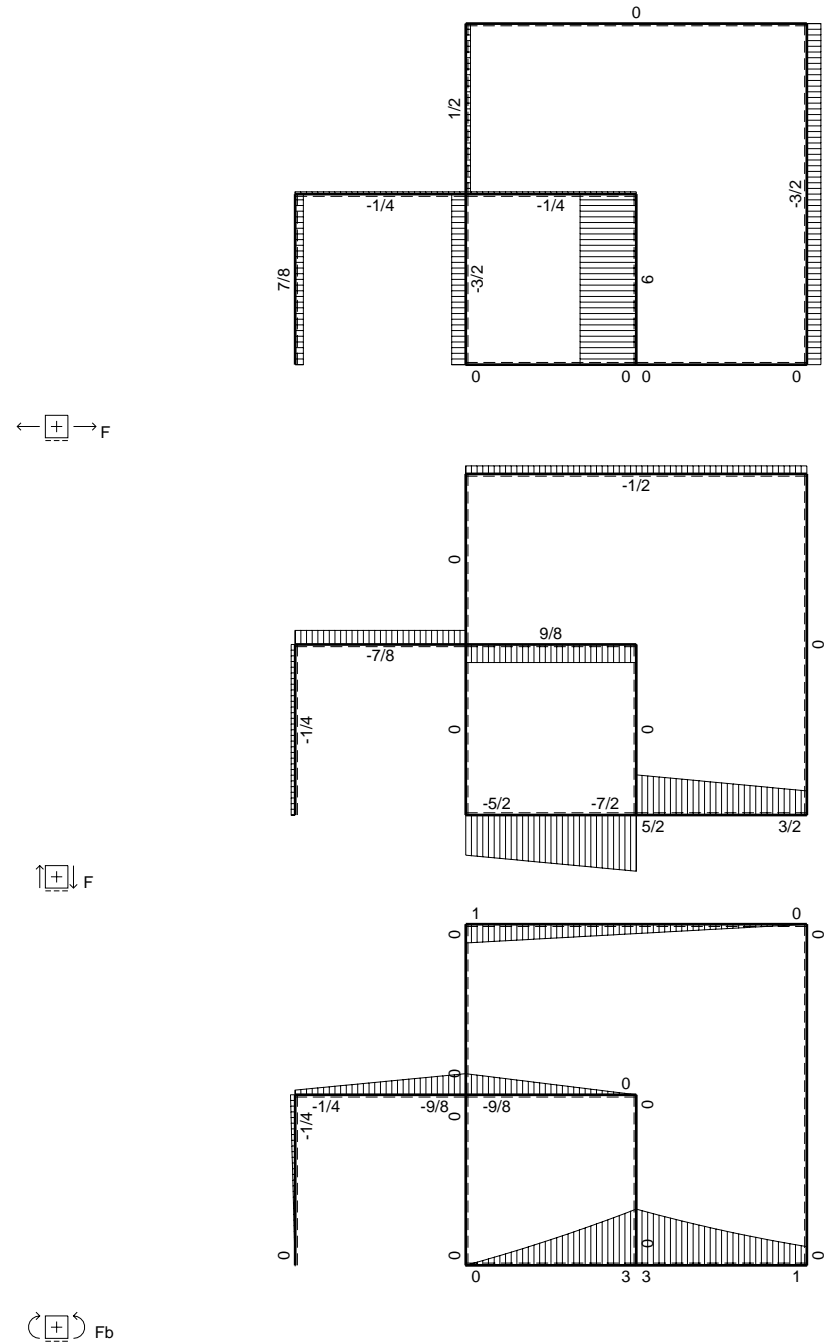
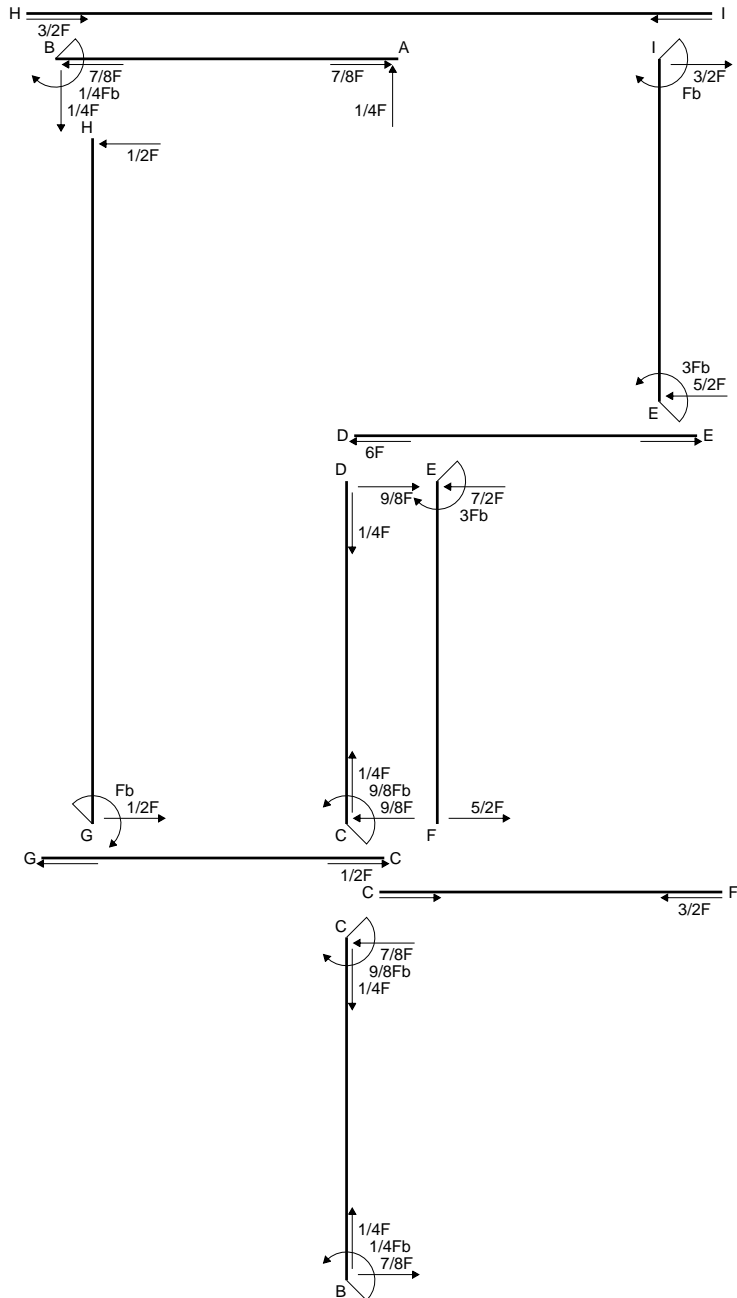
$$v_c = -18.53 \text{ mm}$$

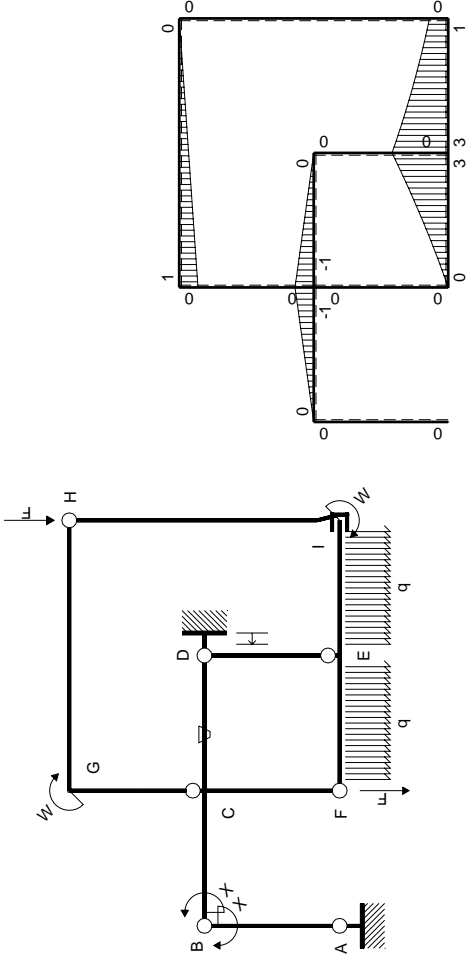
$$\sigma_c = -Mv/J_u = 129.1 \text{ N/mm}^2$$

$$\tau_c = 5.282 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 129.4 \text{ N/mm}^2$$

$$S = 2144. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-Fb+Fx$	$-Fb/EJ$	$1/2Fb-Fx+1/2Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	Fb/EJ	$1/2Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$3Fb-7/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-5/2Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

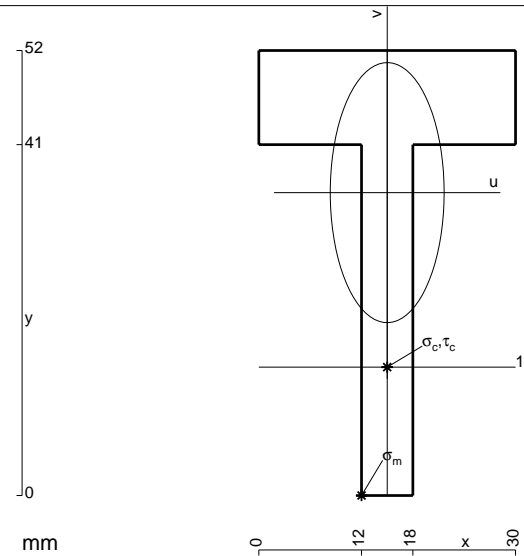
$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 5/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/6 b) Fb 1/EJ + (-1/4 b) \theta = 5/12 Fb^2/EJ$$



$$A = 576. \text{ mm}^2$$

$$J_u = 133062. \text{ mm}^4$$

$$J_v = 25488. \text{ mm}^4$$

$$y_g = 35.4 \text{ mm}$$

$$T_y = -1750. \text{ N}$$

$$M_x = 900000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -3. \text{ mm}$$

$$v_m = -35.4 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 239.4 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 15. \text{ mm}$$

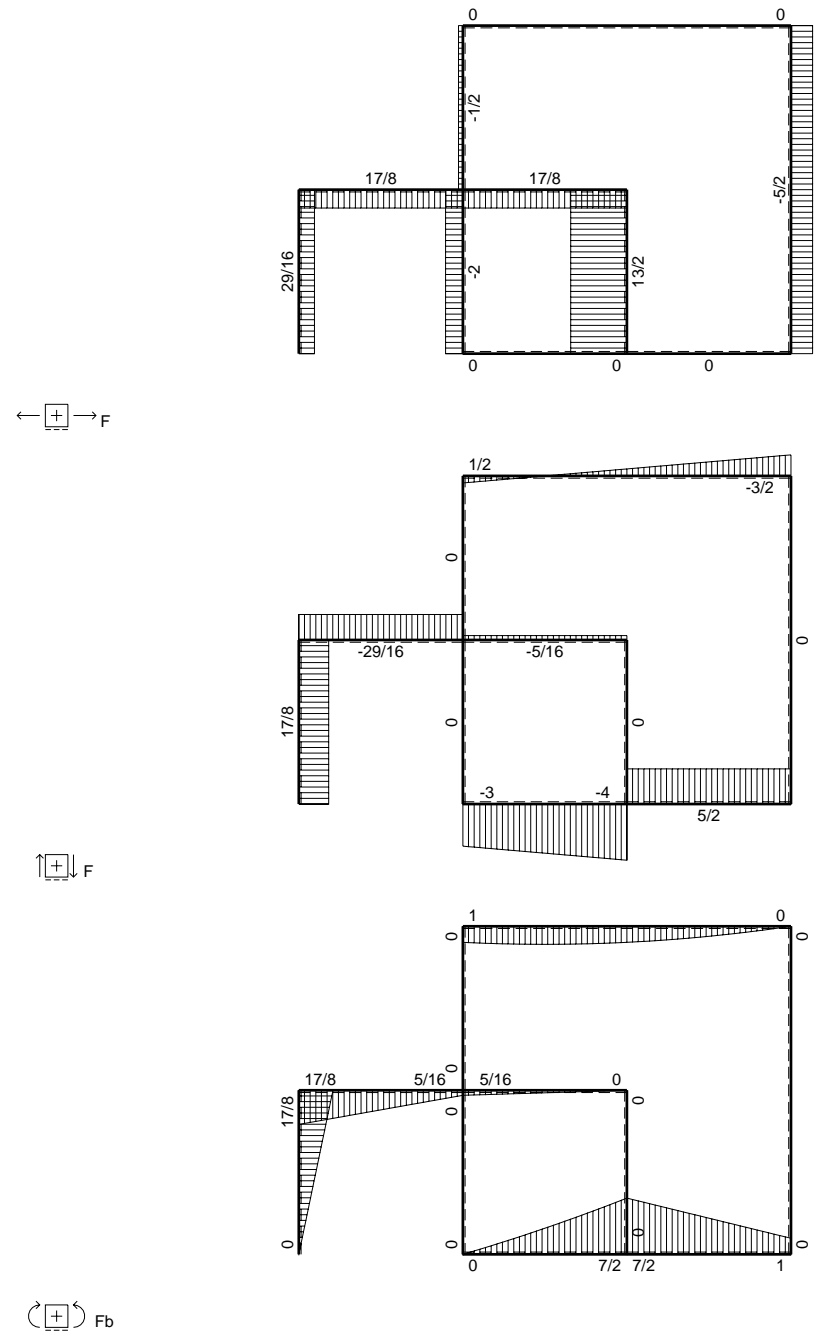
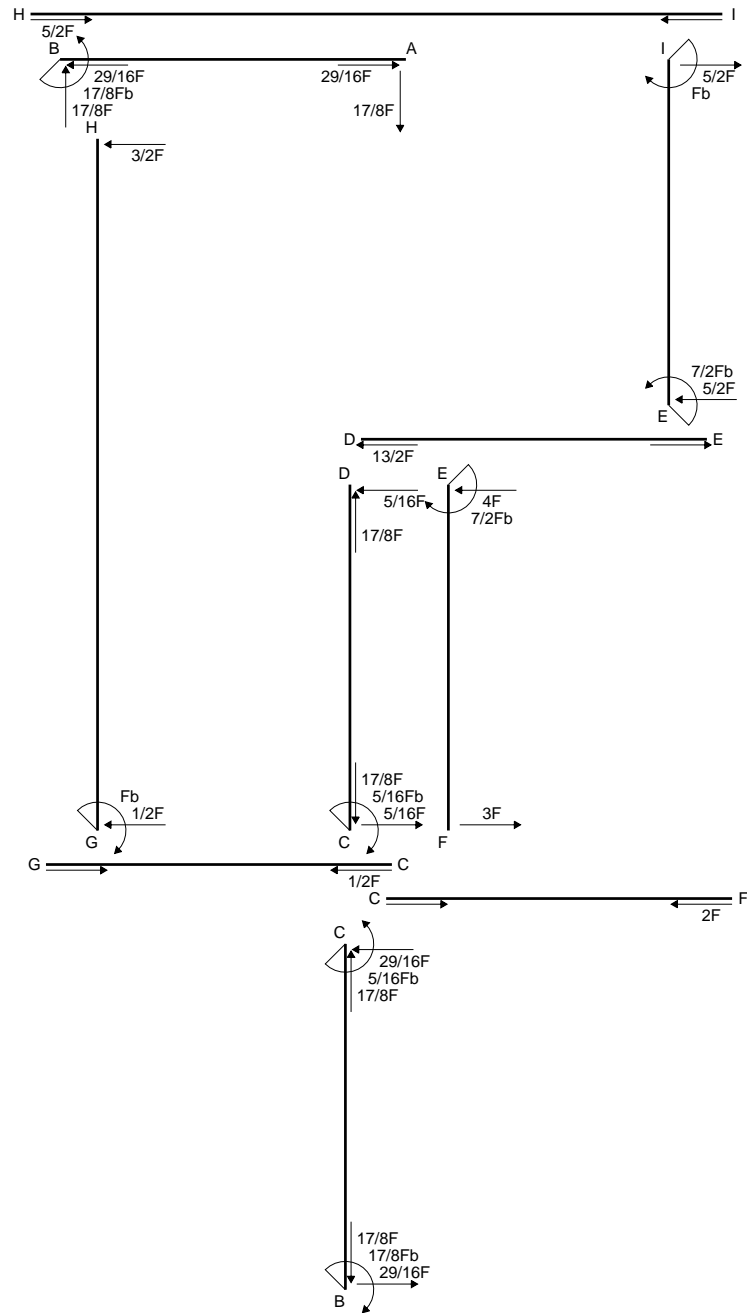
$$v_c = -20.4 \text{ mm}$$

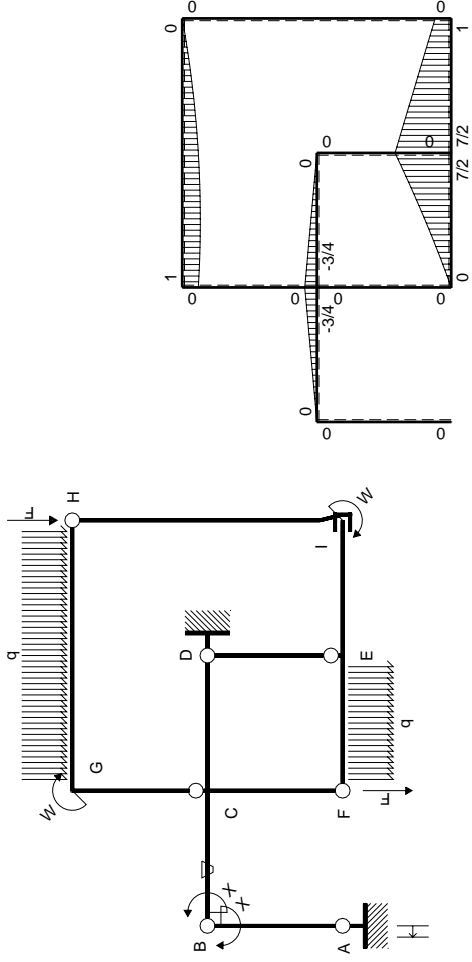
$$\sigma_c = -Mv/J_u = 138. \text{ N/mm}^2$$

$$\tau_c = 5.503 \text{ N/mm}^2$$

$$\sigma_\rho = \sqrt{\sigma^2 + 3\tau^2} = 138.3 \text{ N/mm}^2$$

$$S = 2511. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb+1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
HG 2b	0	$-3/2Fx+1/2qx^2$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+5/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$17/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-17/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (3/8 b - 1/8 b) Fb 1/EJ + (b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

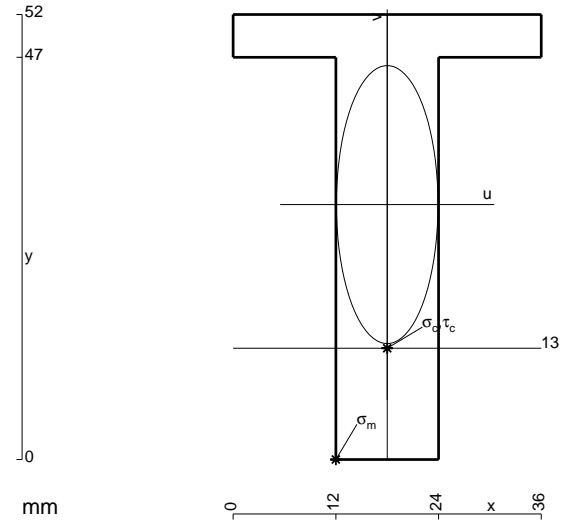
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

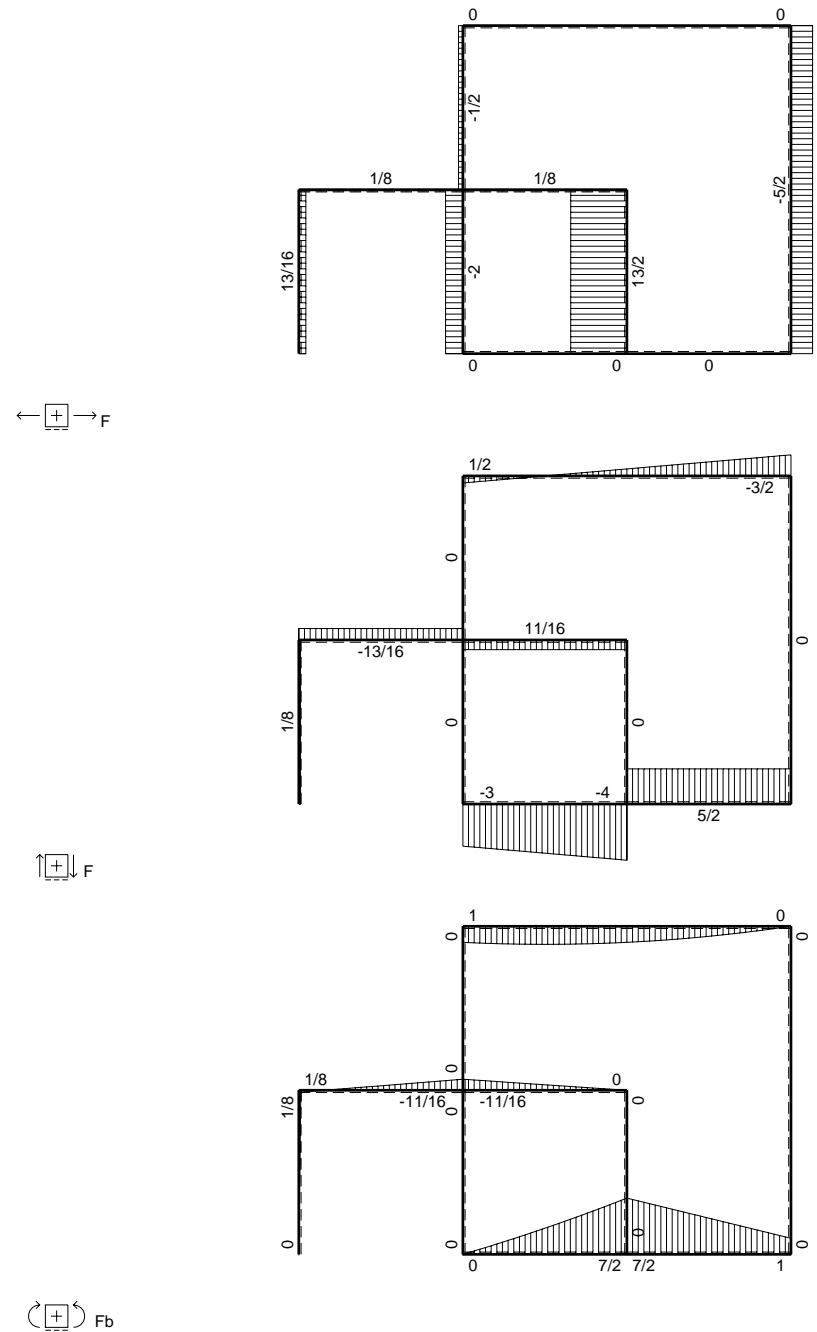
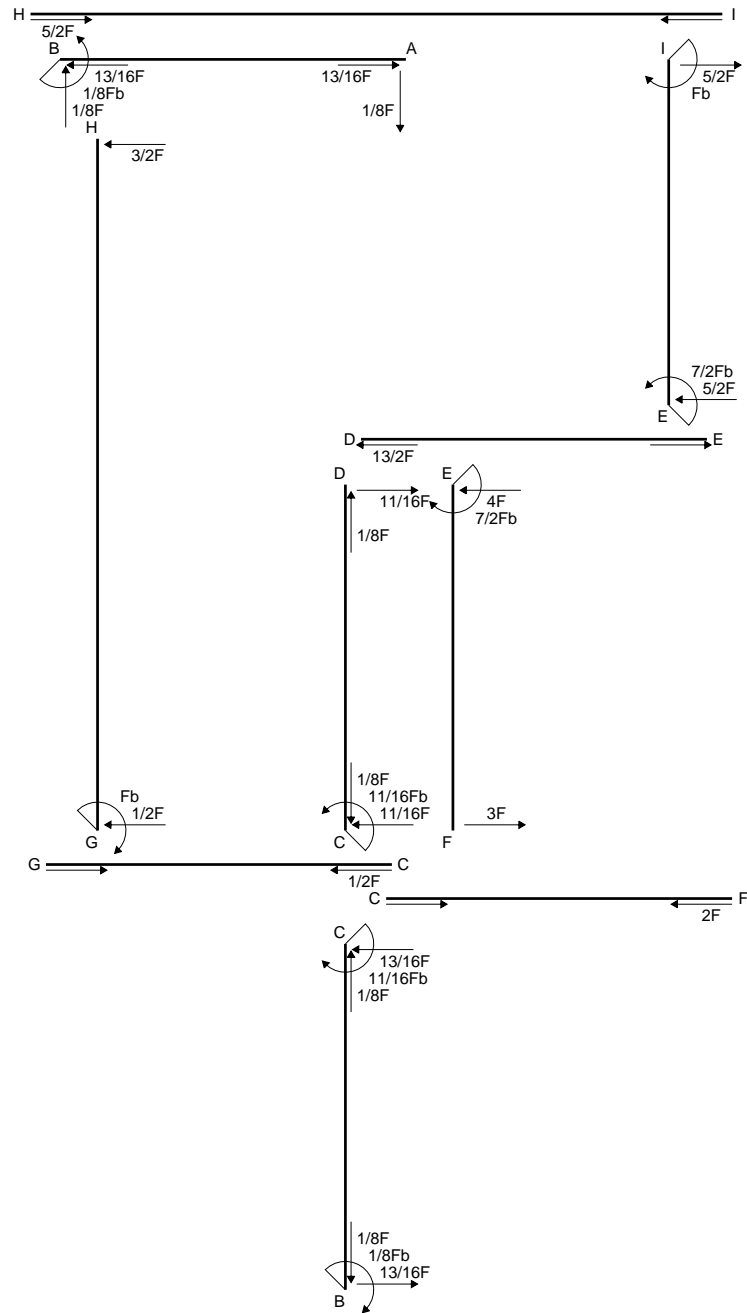
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

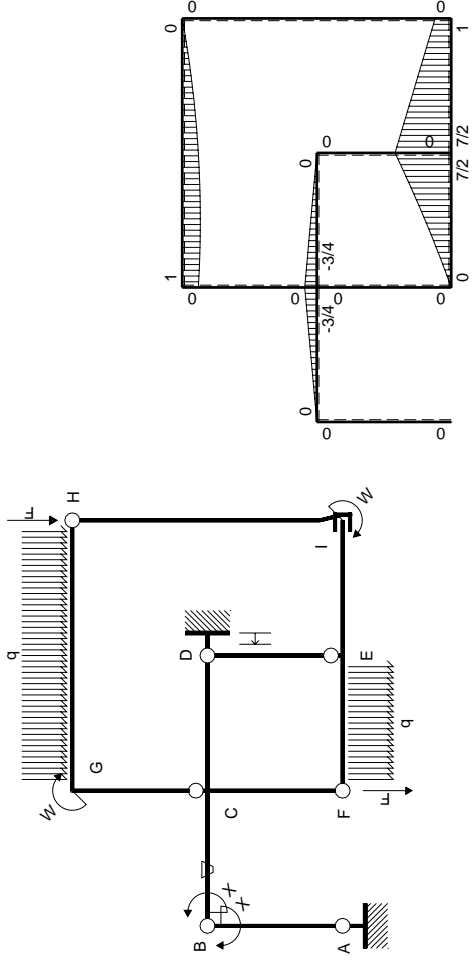
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 744. mm²
- J_u = 196439. mm⁴
- J_v = 26208. mm⁴
- y_g = 29.79 mm
- T_y = -2320. N
- M_x = 1299200. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -29.79 mm
- σ_m = -Mv/J_u = 197. N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -16.79 mm
- σ_c = -Mv/J_u = 111. N/mm²
- τ_c = 3.576 N/mm²
- σ_o = √σ²+3τ² = 111.2 N/mm²
- S = 3633. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	$-Fb/EJ$	$3/4Fx-3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	Fb/EJ	$3/8Fb-3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb+1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG 2b	0	$-3/2Fx+1/2qx^2$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+5/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (3/8 b - 1/8 b) Fb 1/EJ + (b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

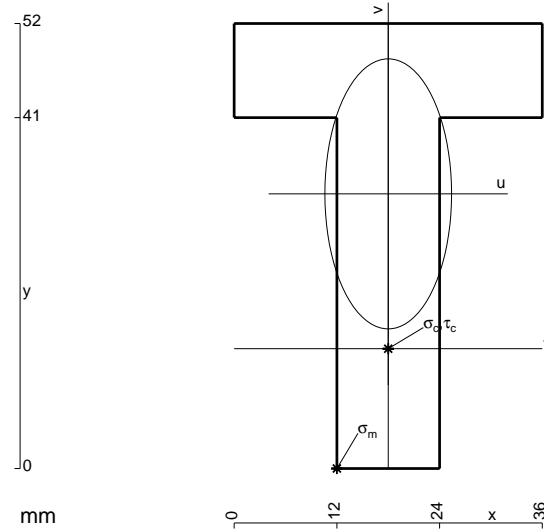
$$= (3/8 b - 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

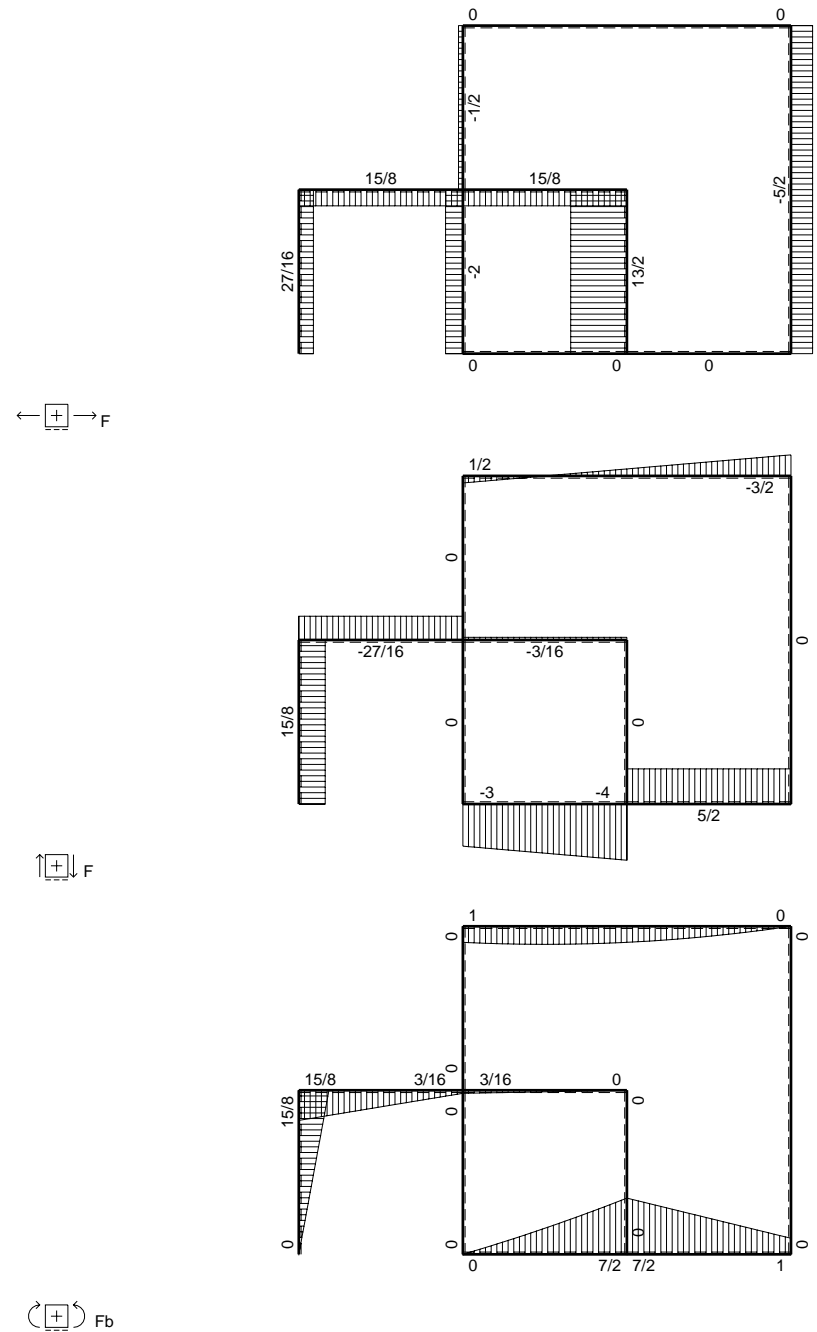
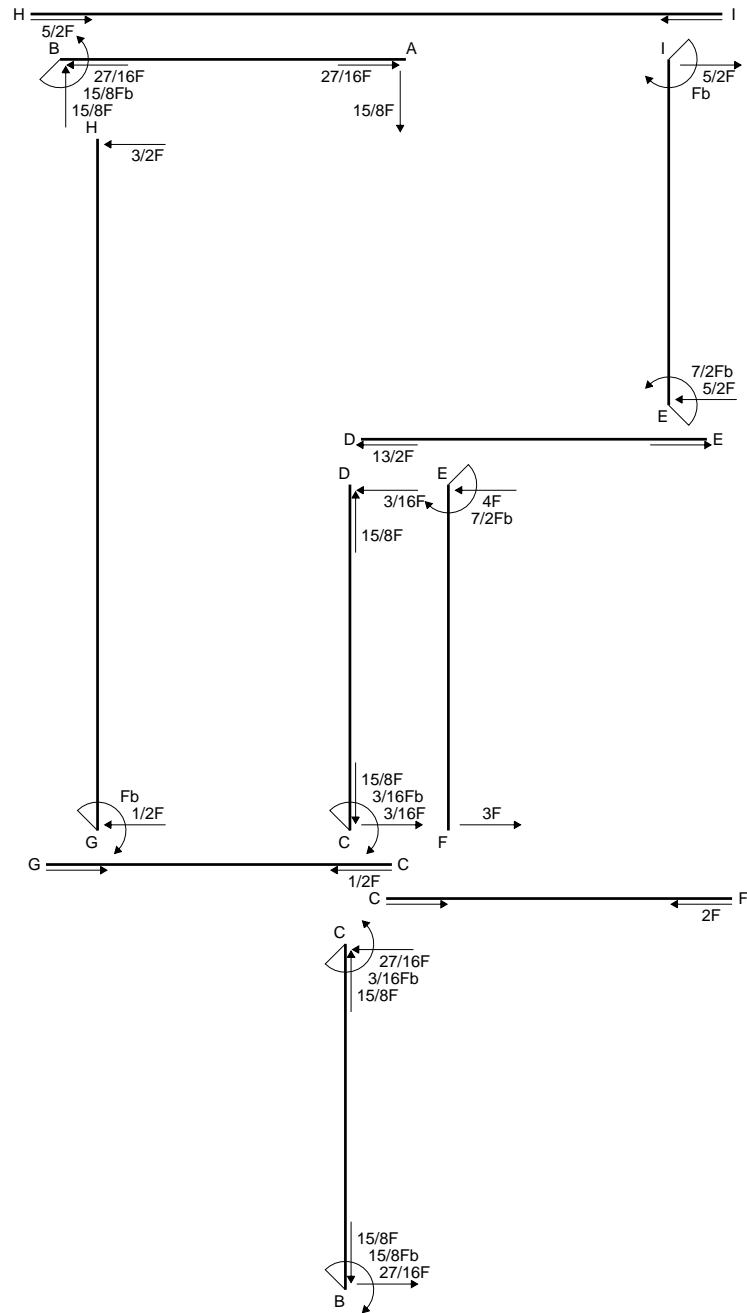
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

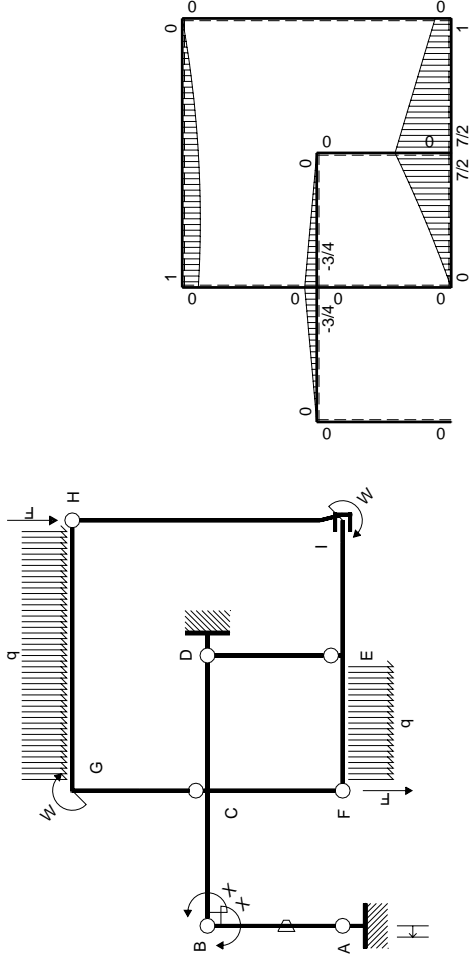
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 888. mm²
- J_u = 221232. mm⁴
- J_v = 48672. mm⁴
- y_g = 32.09 mm
- T_y = -2400. N
- M_x = 1428000. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -32.09 mm
- σ_m = -Mv/J_u = 207.2 N/mm²
- x_c = 18. mm
- y_c = 14. mm
- v_c = -18.09 mm
- σ_c = -Mv/J_u = 116.8 N/mm²
- τ_c = 3.811 N/mm²
- σ_q = √σ²+3τ² = 117. N/mm²
- S = 4216. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb+1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
HG 2b	0	$-3/2Fx+1/2qx^2$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+5/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$15/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-15/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

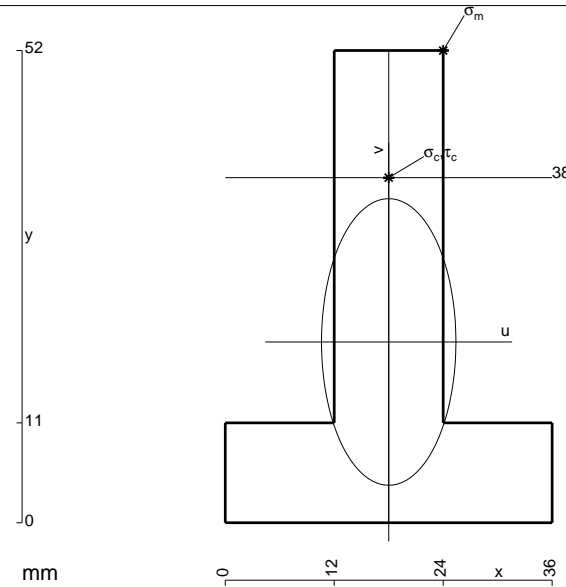
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

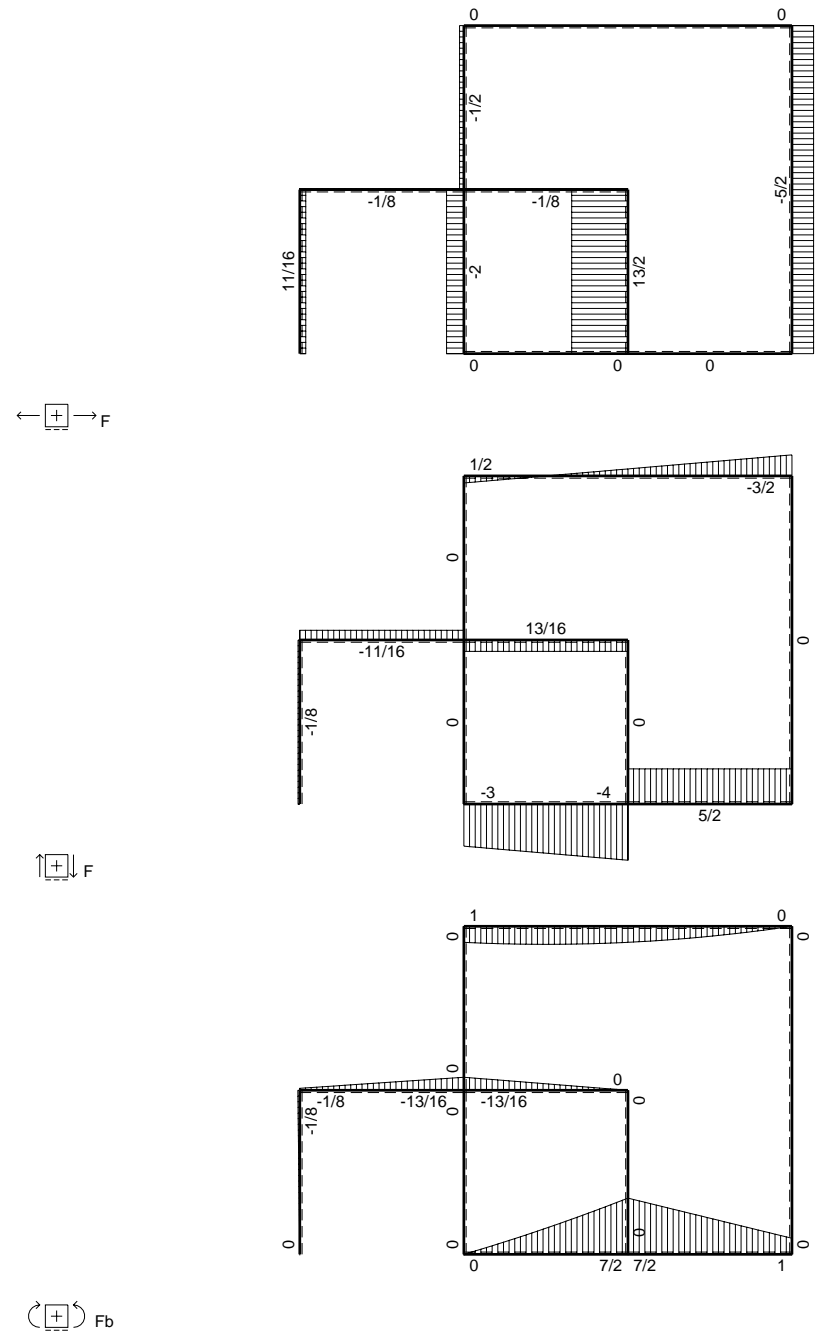
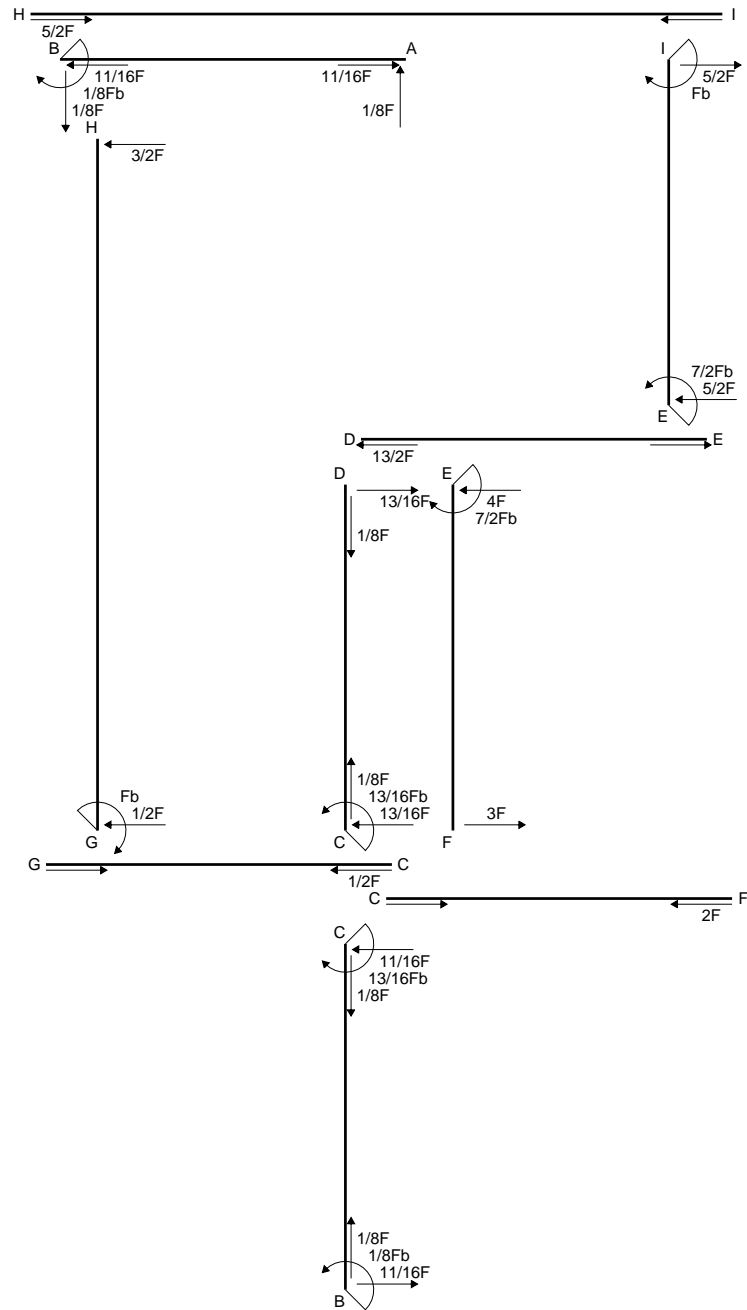
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

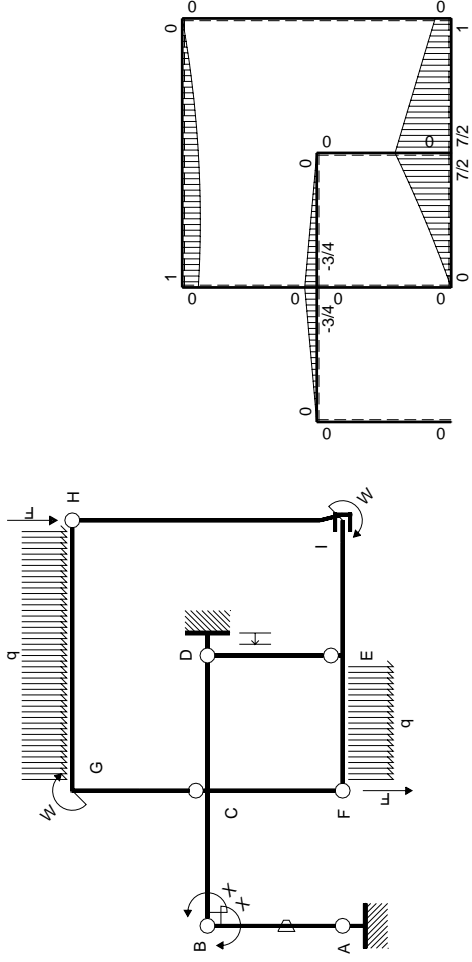
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



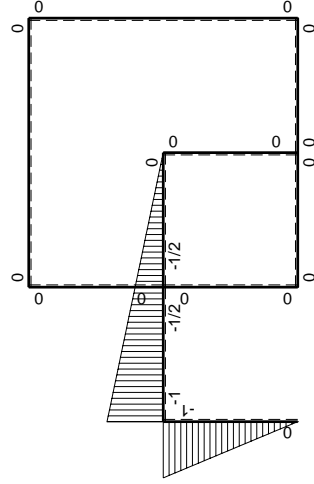
- A = 888. mm²
- J_u = 221232. mm⁴
- J_v = 48672. mm⁴
- y_g = 19.91 mm
- T_y = -2360. N
- M_x = 1507450. Nmm
- x_m = 24. mm
- y_m = 52. mm
- u_m = 6. mm
- v_m = 32.09 mm
- σ_m = -Mv/J_u = -218.7 N/mm²
- x_c = 18. mm
- y_c = 38. mm
- v_c = 18.09 mm
- σ_c = -Mv/J_u = -123.3 N/mm²
- τ_c = 3.748 N/mm²
- σ_g = √σ²+3τ² = 123.5 N/mm²
- S = 4216. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$3/8Fb-3/4Fx+3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	0	$3/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb+1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG 2b	0	$-3/2Fx+1/2qx^2$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+5/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

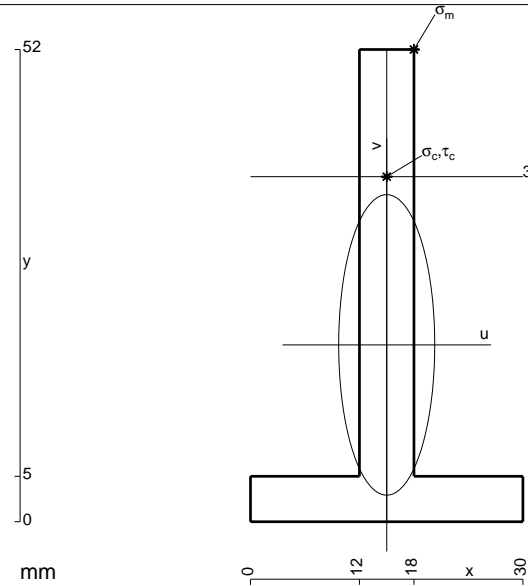
$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

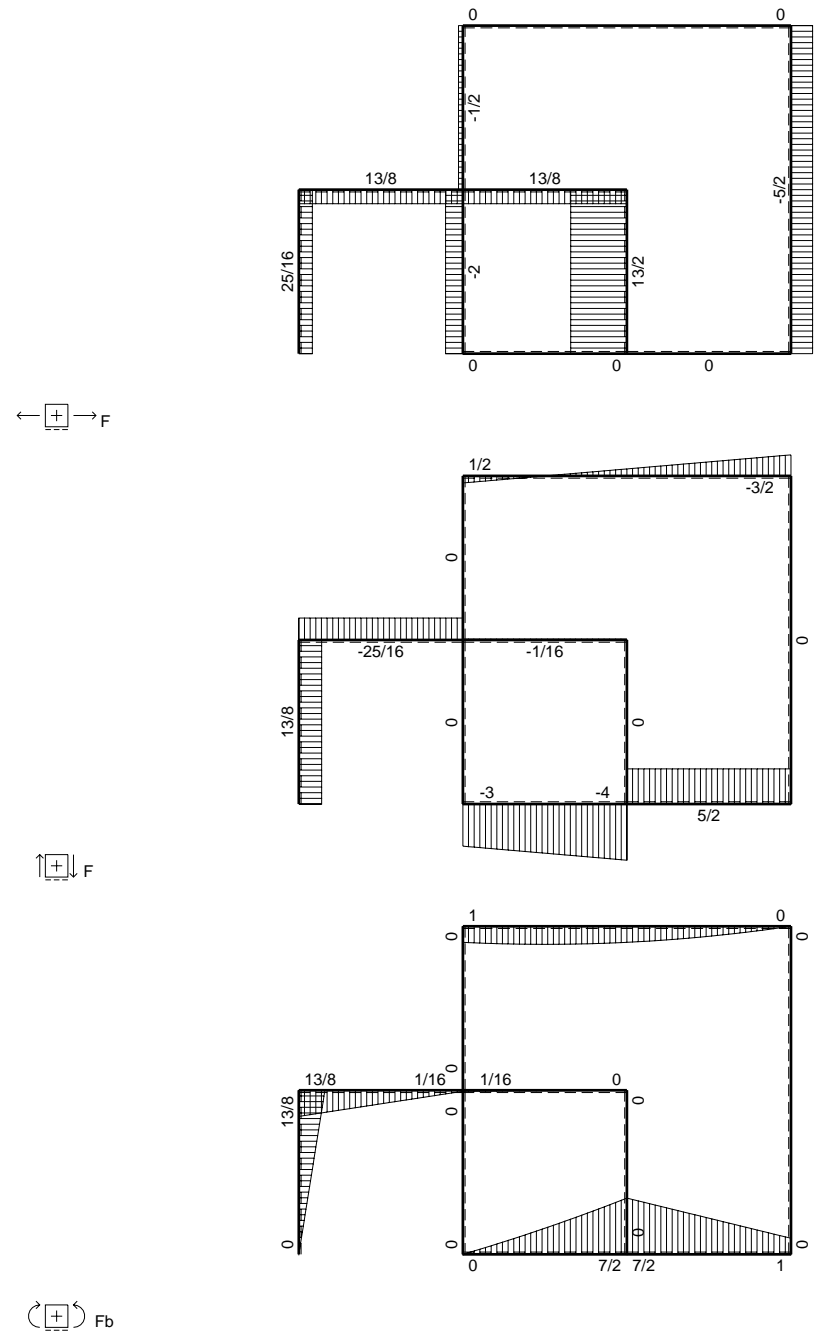
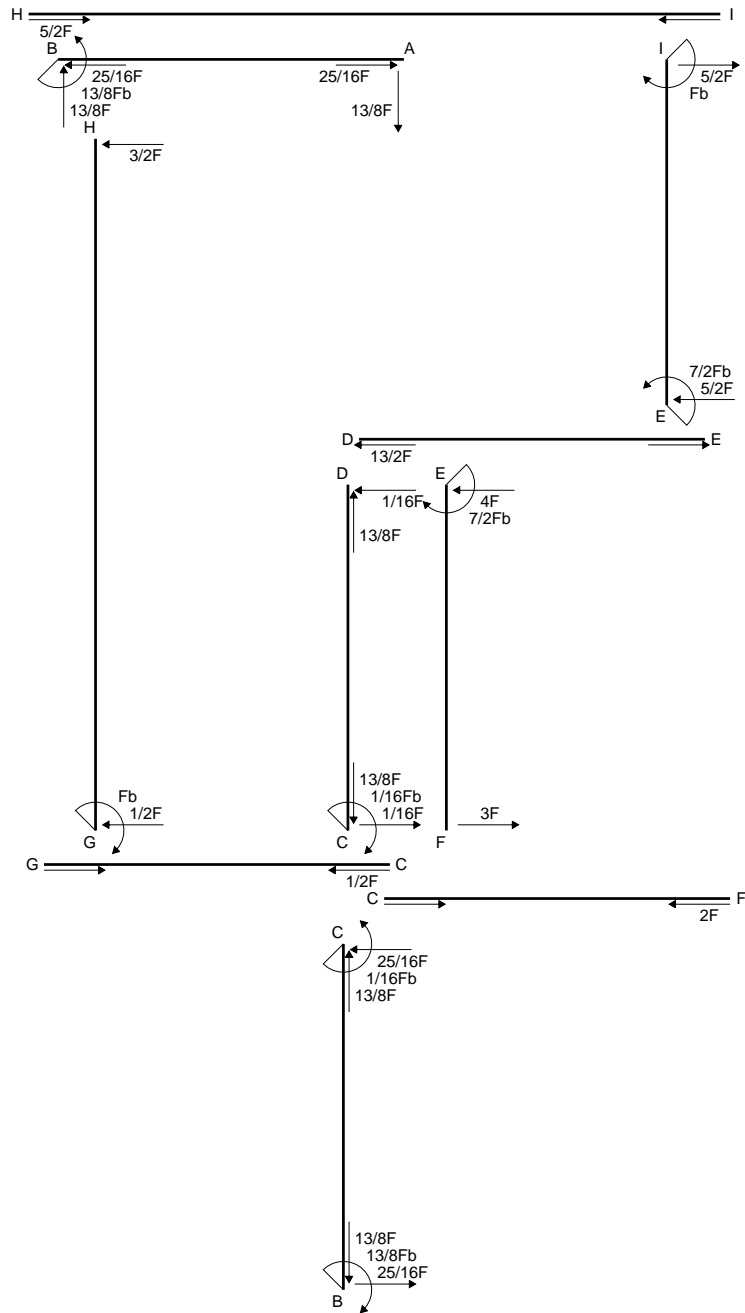
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$

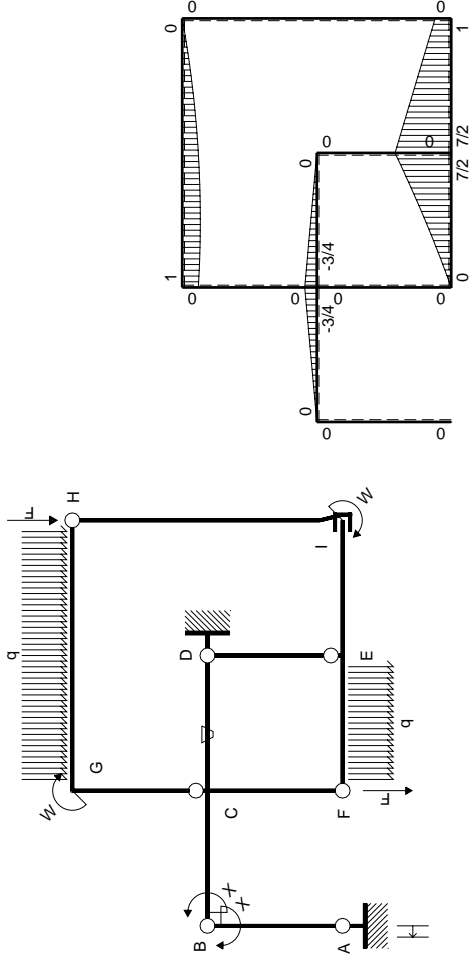
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx = [1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/8 b) Fb 1/EJ = 1/8 Fb^2/EJ$$



- A = 432. mm²
- J_u = 118416. mm⁴
- J_v = 12096. mm⁴
- y_g = 19.47 mm
- T_y = -1240. N
- M_x = 835450. Nmm
- x_m = 18. mm
- y_m = 52. mm
- u_m = 3. mm
- v_m = 32.53 mm
- σ_m = -Mv/J_u = -229.5 N/mm²
- x_c = 15. mm
- y_c = 38. mm
- v_c = 18.53 mm
- σ_c = -Mv/J_u = -130.7 N/mm²
- τ_c = 3.742 N/mm²
- σ_q = √σ²+3τ² = 130.9 N/mm²
- S = 2144. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb+1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
HG 2b	0	$-3/2Fx+1/2qx^2$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/2Fx$	0	0	0	0	0+0	0
EI b	0	$-7/2Fb+5/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$13/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-13/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

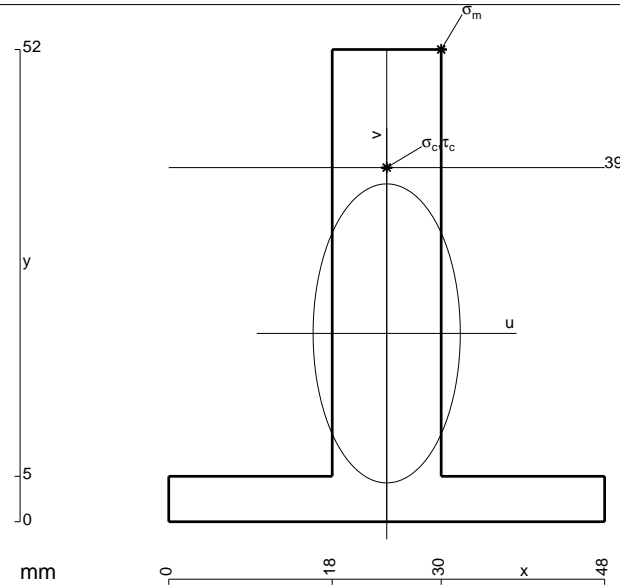
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

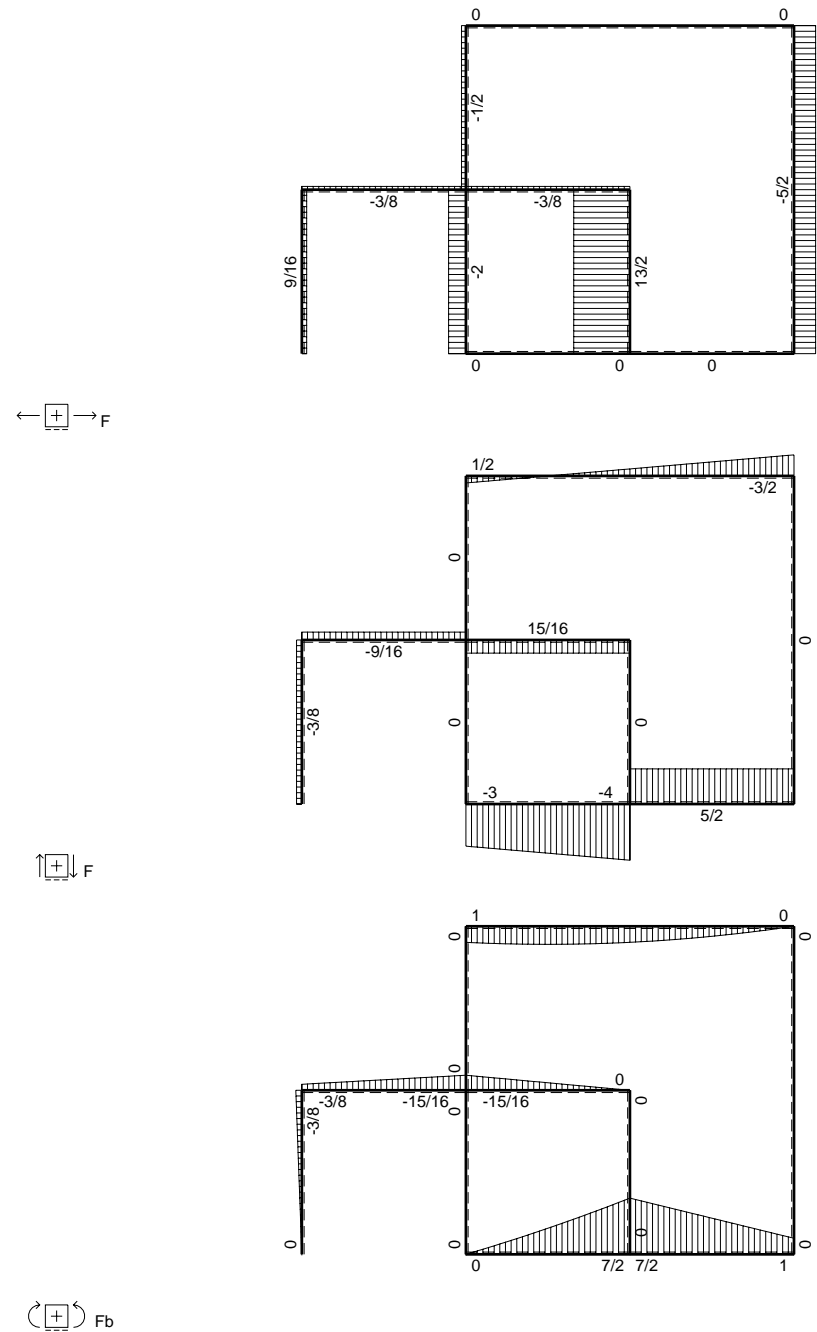
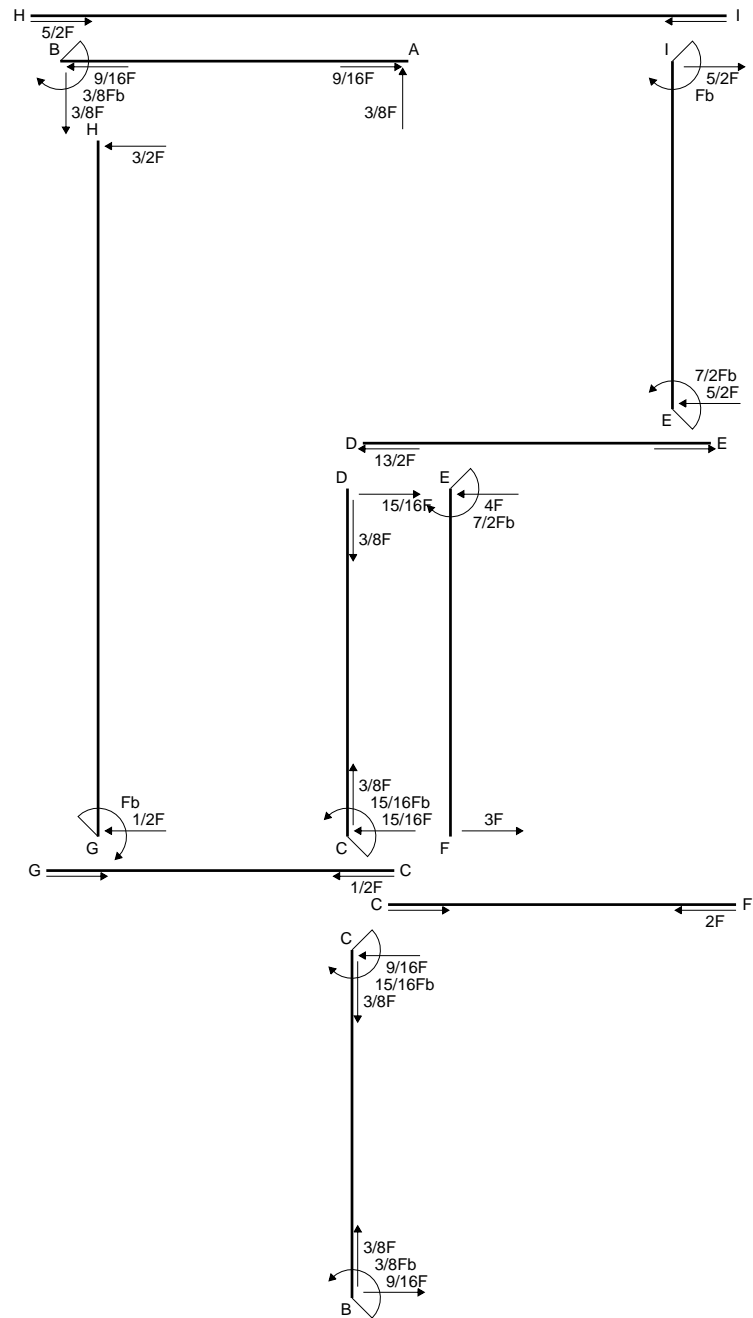
$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

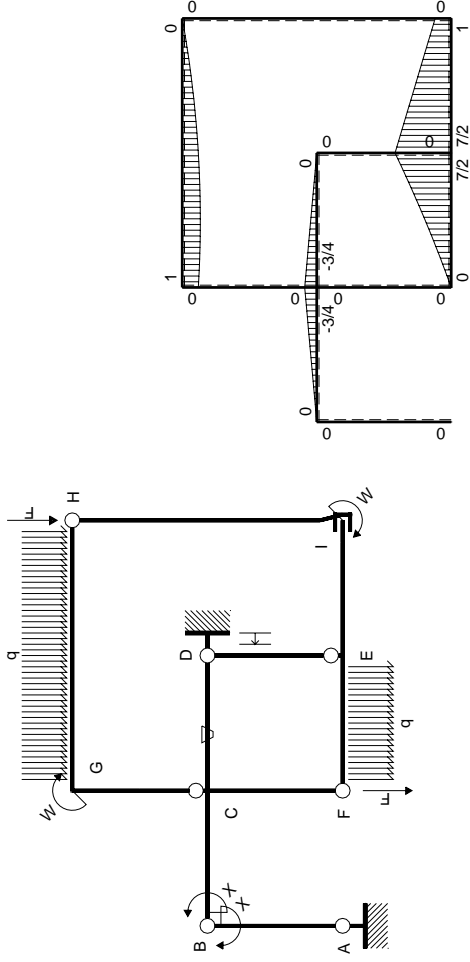
$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/8 b) Fb 1/EJ + (-1/4 b) \theta = 3/8 Fb^2/EJ$$



- A = 804. mm²
- J_u = 218133. mm⁴
- J_v = 52848. mm⁴
- y_g = 20.74 mm
- T_y = -2360. N
- M_x = 1672650. Nmm
- x_m = 30. mm
- y_m = 52. mm
- u_m = 6. mm
- v_m = 31.26 mm
- σ_m = -M_v/J_u = -239.7 N/mm²
- x_c = 24. mm
- y_c = 39. mm
- v_c = 18.26 mm
- σ_c = -M_v/J_u = -140. N/mm²
- τ_c = 3.483 N/mm²
- σ_q = √σ²+3τ² = 140.2 N/mm²
- S = 3863. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-3/4Fx$	0	$3/4Fx-3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$3/8Fb-3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$-Fb/EJ$	$3/8Fb-3/4Fx+3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$3/4Fx$	Fb/EJ	$3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$7/2Fb-4Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-3Fx-1/2qx^2$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb+1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG 2b	0	$-3/2Fx+1/2qx^2$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-7/2Fb+5/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-3/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$3/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (3/8 - 3/8 x^2/b^2) Fb 1/EJ dx = [3/8 x - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

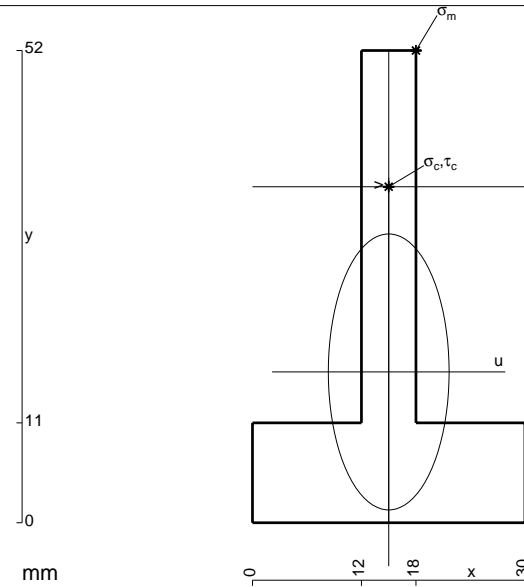
$$L_{CD}^{xo} = \int_0^b (3/8 - 3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [3/8 x - 3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (3/8 b - 3/8 b + 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 3/8 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/8 b) Fb 1/EJ + (-1/4 b) \theta = 3/8 Fb^2/EJ$$



$$A = 576. \text{ mm}^2$$

$$J_u = 133062. \text{ mm}^4$$

$$J_v = 25488. \text{ mm}^4$$

$$y_g = 16.6 \text{ mm}$$

$$T_y = -1960. \text{ N}$$

$$M_x = 737450. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$y_m = 52. \text{ mm}$$

$$u_m = 3. \text{ mm}$$

$$v_m = 35.4 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -196.2 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 37. \text{ mm}$$

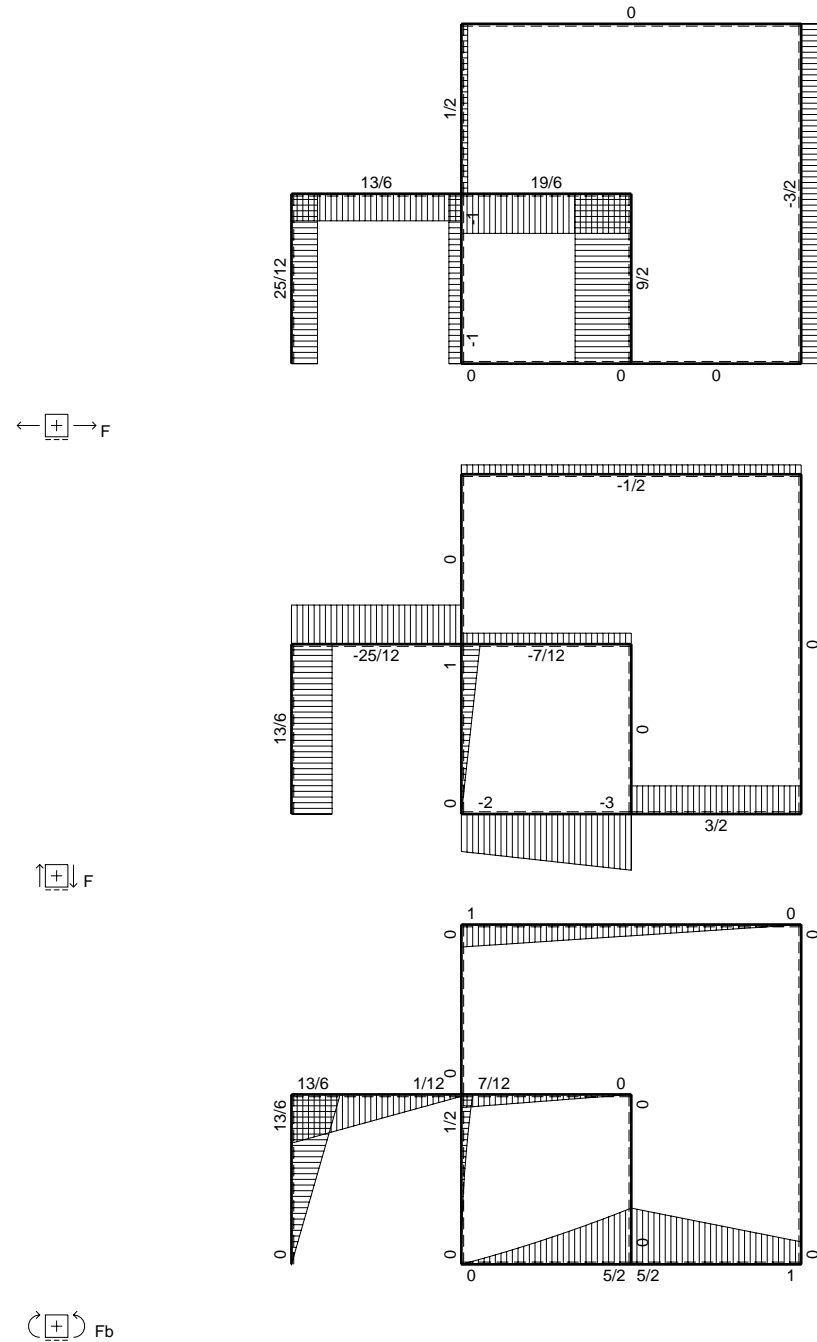
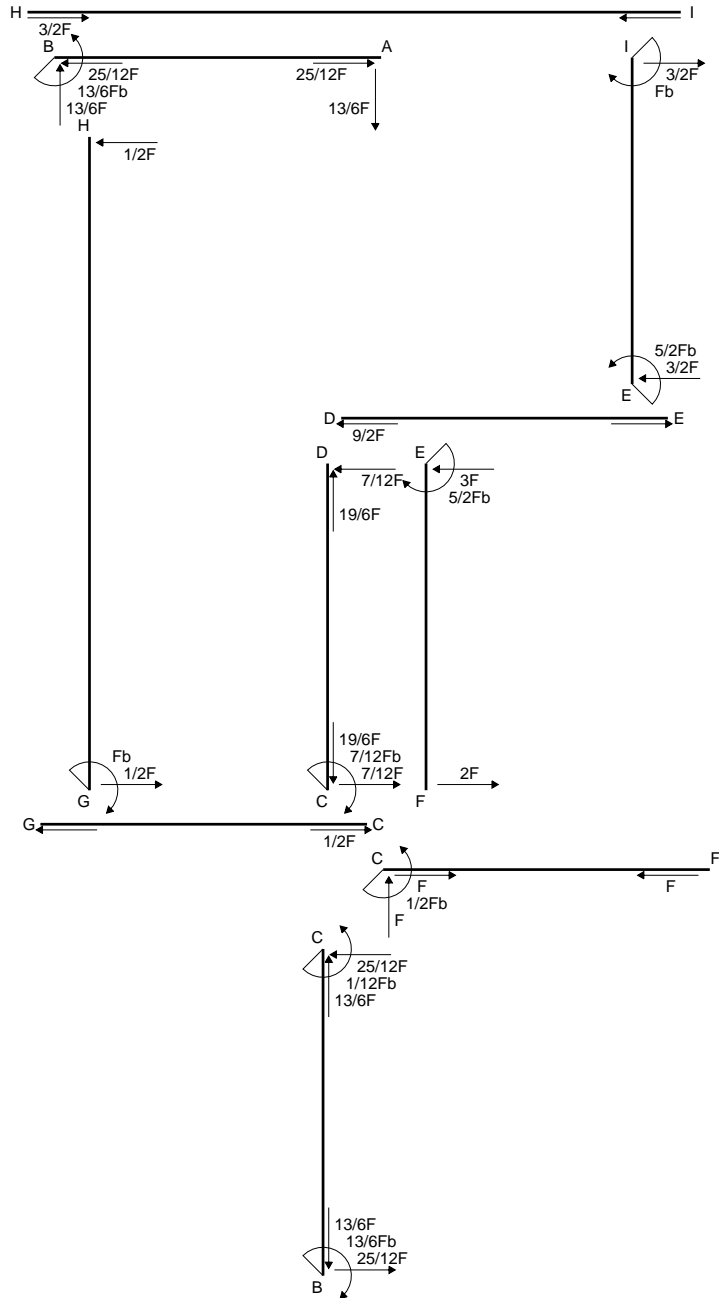
$$v_c = 20.4 \text{ mm}$$

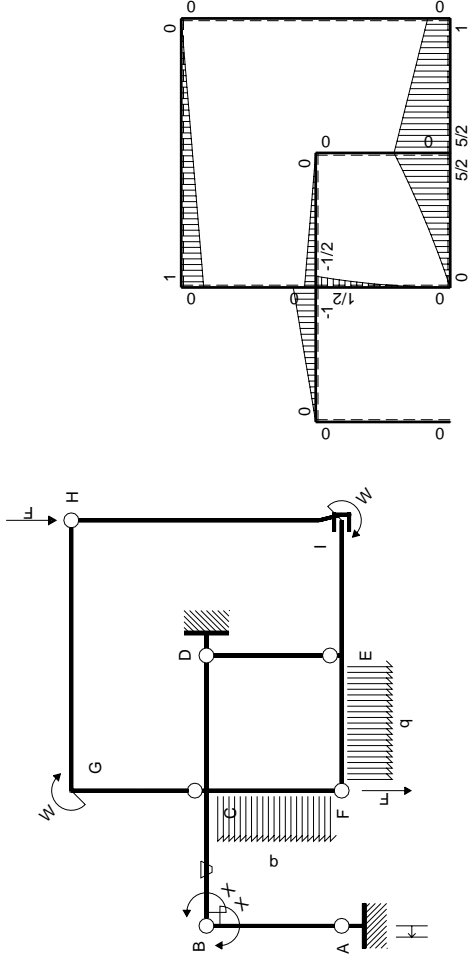
$$\sigma_c = -Mv/J_u = -113. \text{ N/mm}^2$$

$$\tau_c = 6.164 \text{ N/mm}^2$$

$$\sigma_\varphi = \sqrt{\sigma^2 + 3\tau^2} = 113.5 \text{ N/mm}^2$$

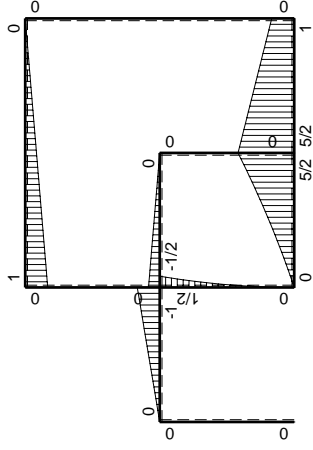
$$S = 2511. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$13/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-13/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

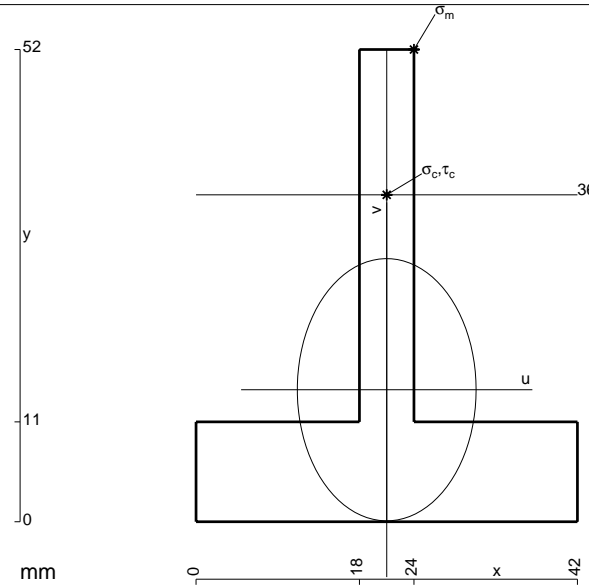
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

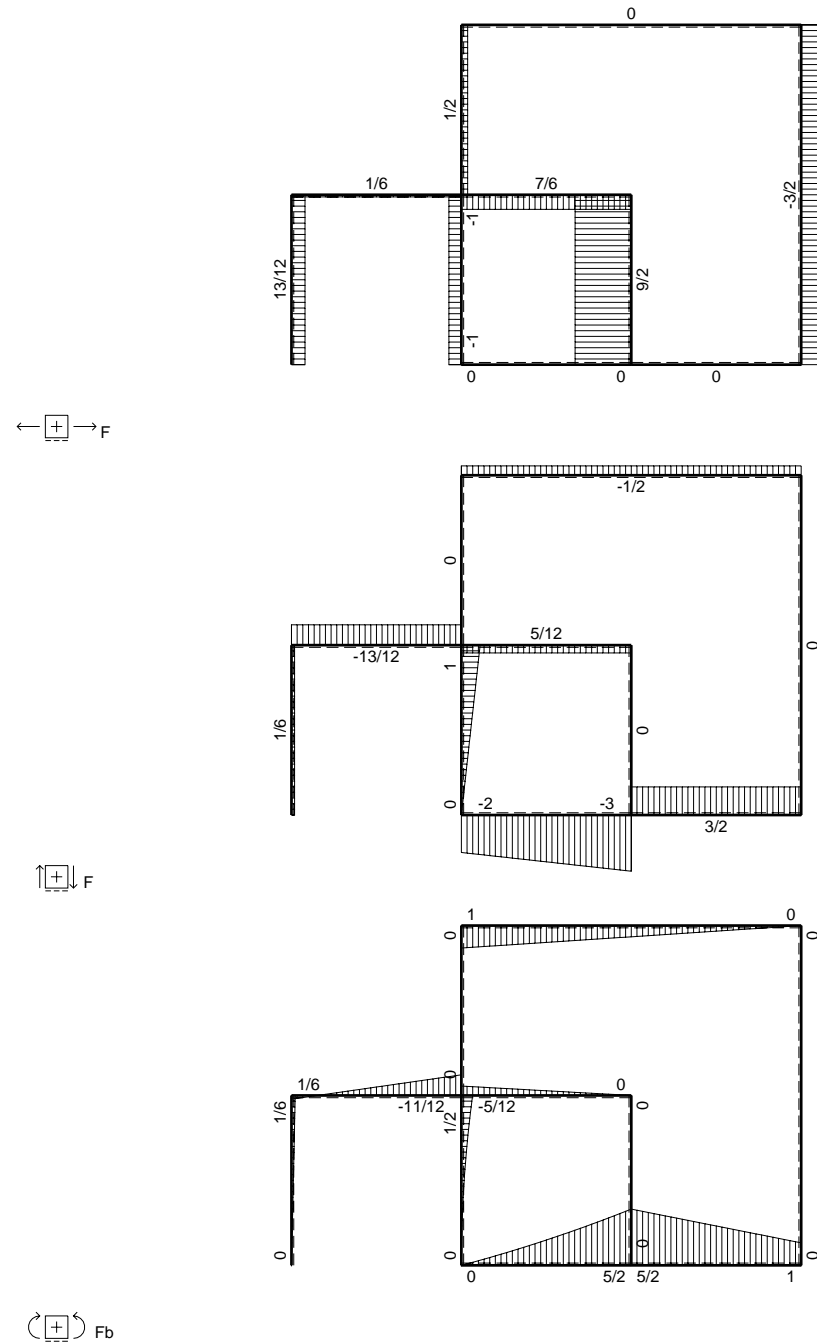
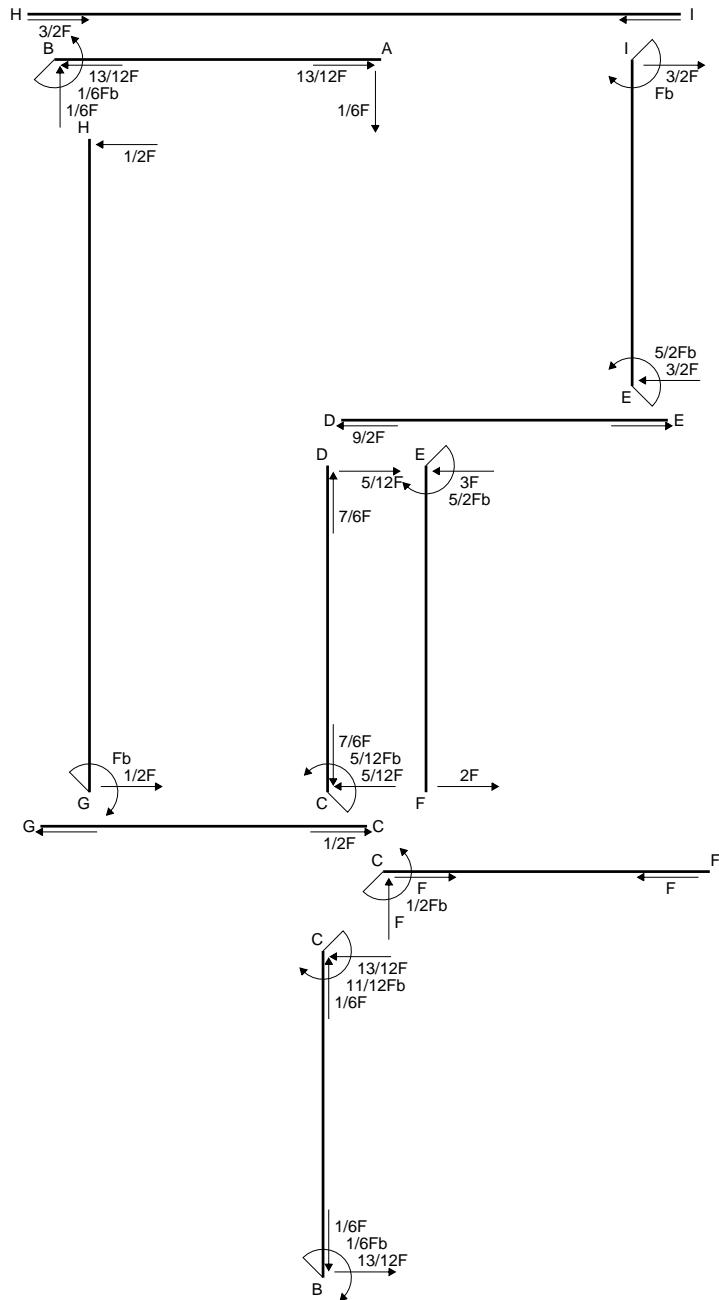
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

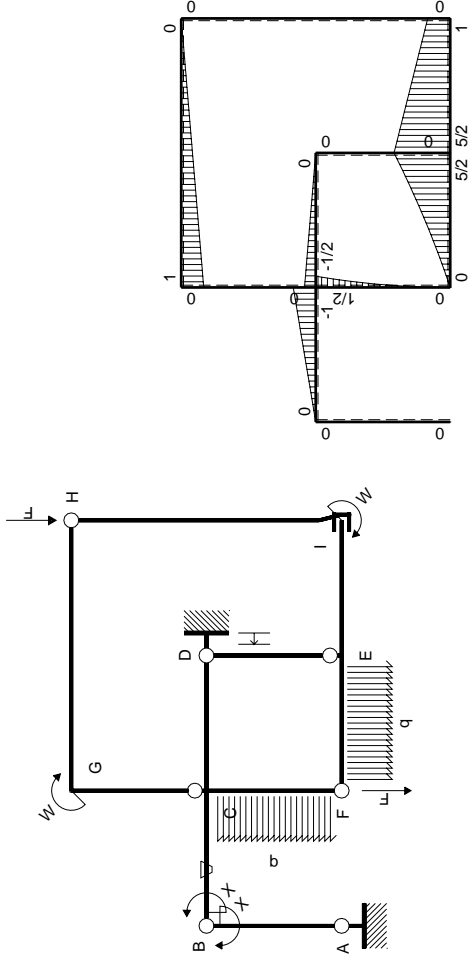
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 708. mm²
- J_u = 147634. mm⁴
- J_v = 68652. mm⁴
- y_g = 14.53 mm
- T_y = -2100. N
- M_x = 822500. Nmm
- x_m = 24. mm
- y_m = 52. mm
- u_m = 3. mm
- v_m = 37.47 mm
- σ_m = -Mv/J_u = -208.7 N/mm²
- x_c = 21. mm
- y_c = 36. mm
- v_c = 21.47 mm
- σ_c = -Mv/J_u = -119.6 N/mm²
- τ_c = 6.706 N/mm²
- σ_q = √σ²+3τ² = 120.2 N/mm²
- S = 2829. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0			
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

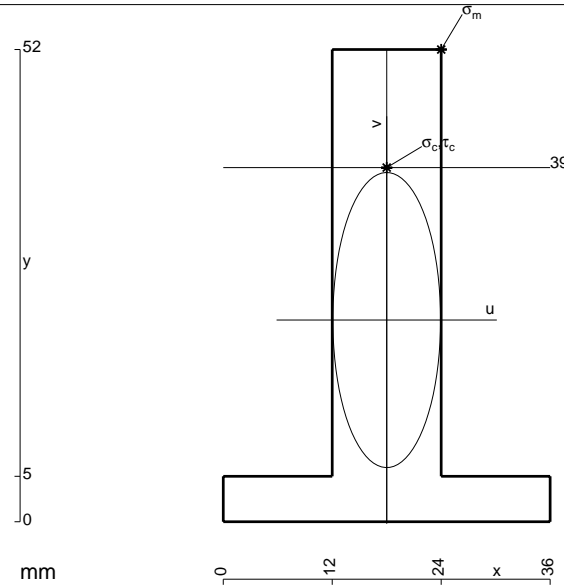
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

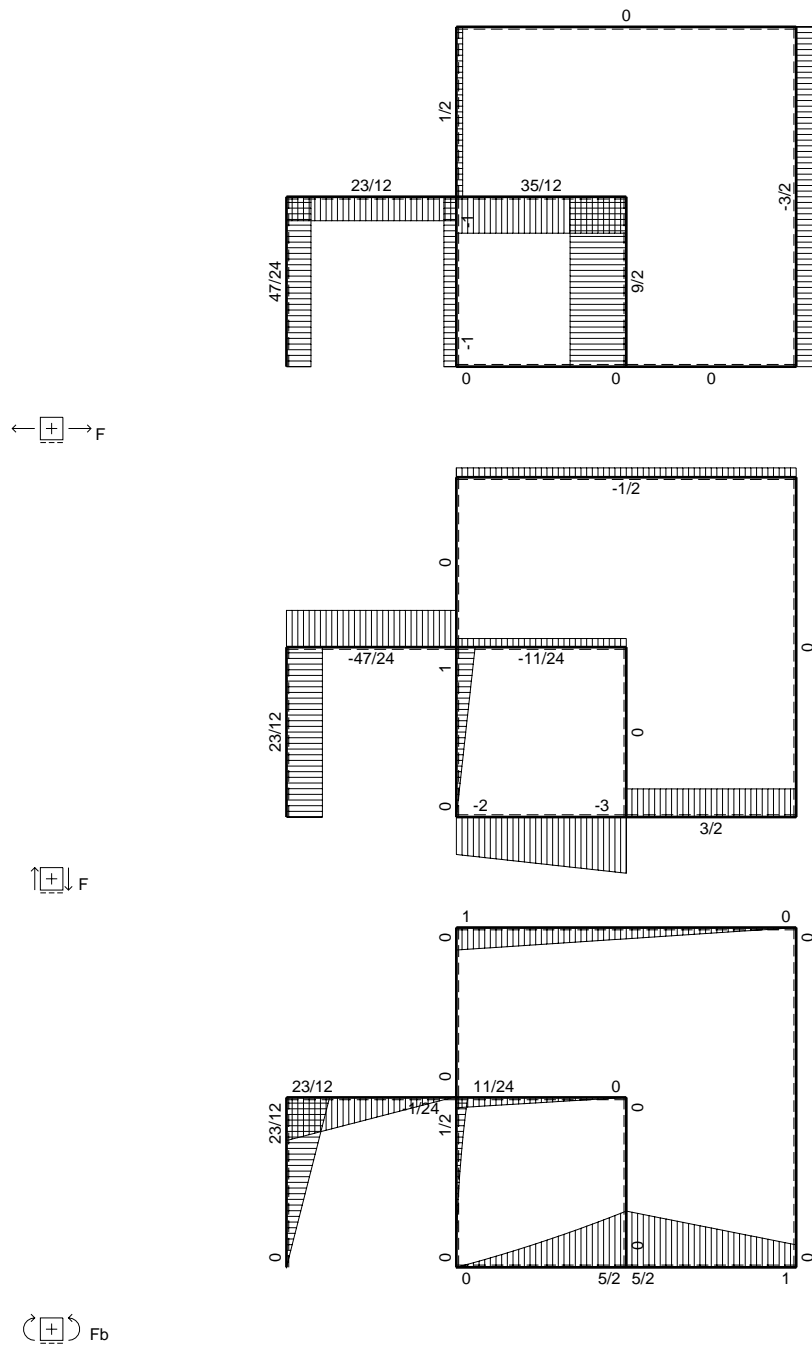
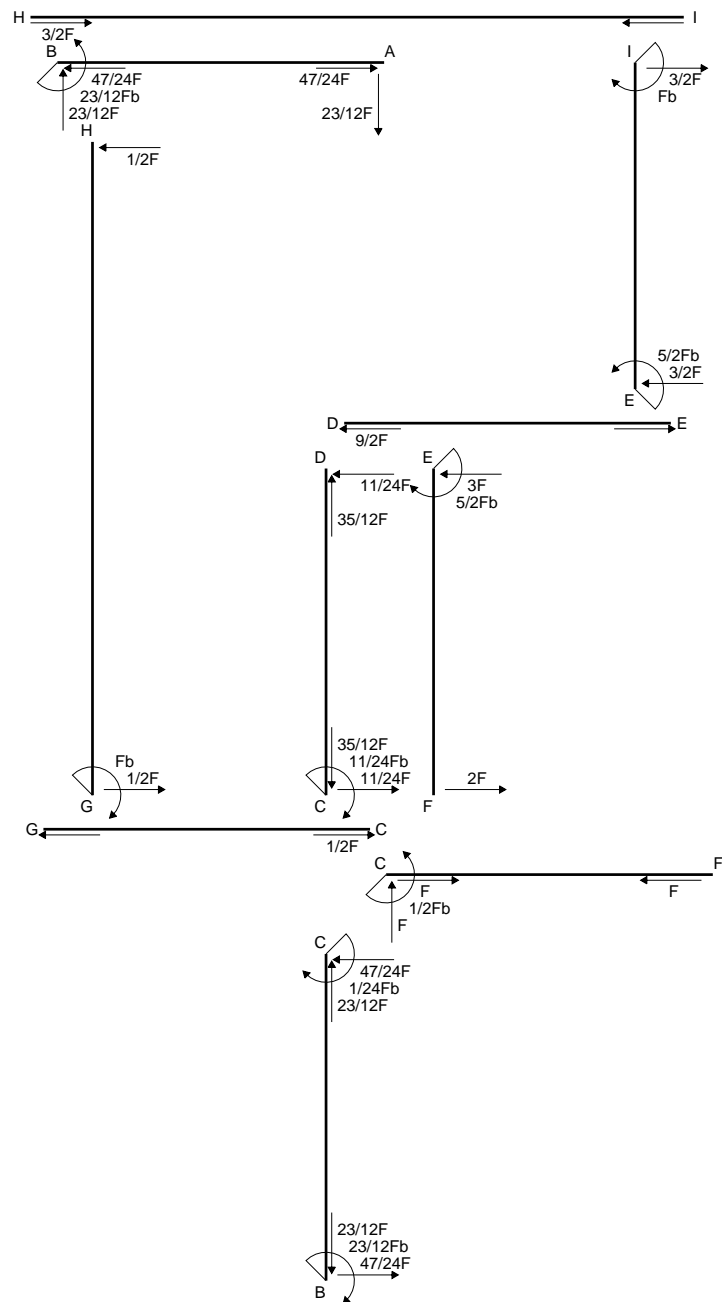
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

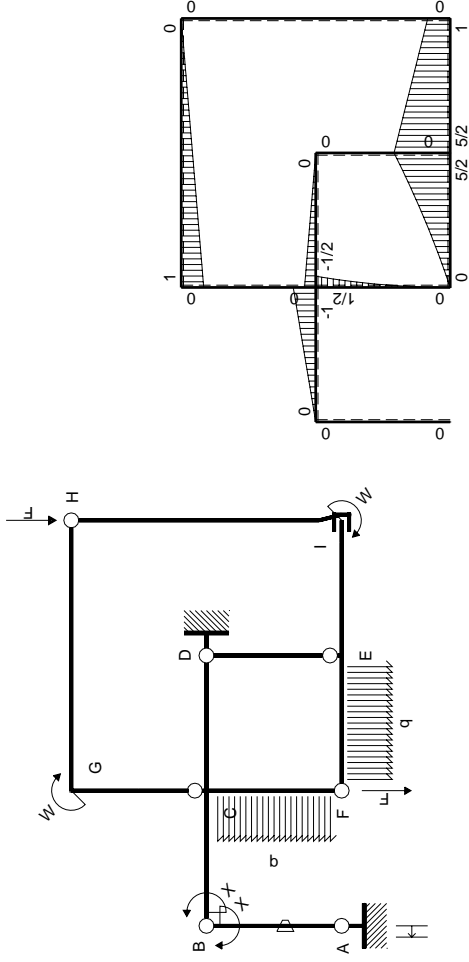
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



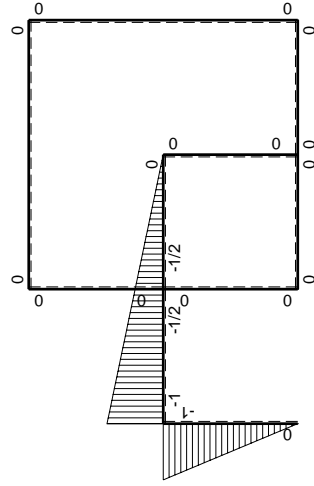
- A = 744. mm²
- J_u = 196439. mm⁴
- J_v = 26208. mm⁴
- y_g = 22.21 mm
- T_y = -3390. N
- M_x = 1440750. Nmm
- x_m = 24. mm
- y_m = 52. mm
- u_m = 6. mm
- v_m = 29.79 mm
- $\sigma_m = -Mv/J_u = -218.5 \text{ N/mm}^2$
- x_c = 18. mm
- y_c = 39. mm
- v_c = 16.79 mm
- $\sigma_c = -Mv/J_u = -123.1 \text{ N/mm}^2$
- $\tau_c = 5.225 \text{ N/mm}^2$
- $\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 123.5 \text{ N/mm}^2$
- S = 3633. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$23/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-23/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

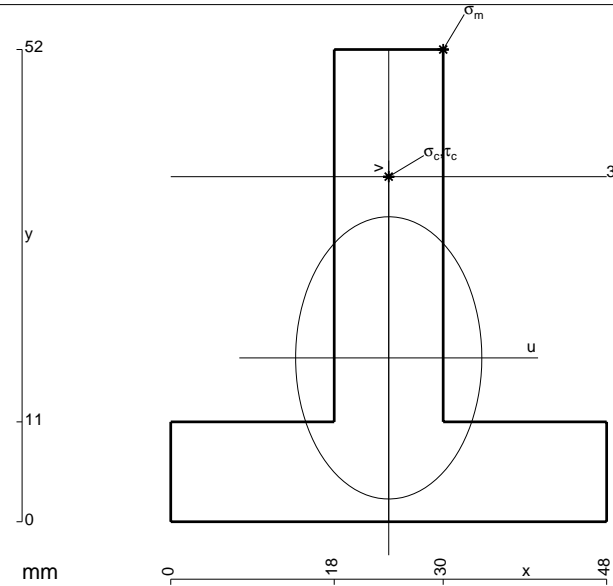
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

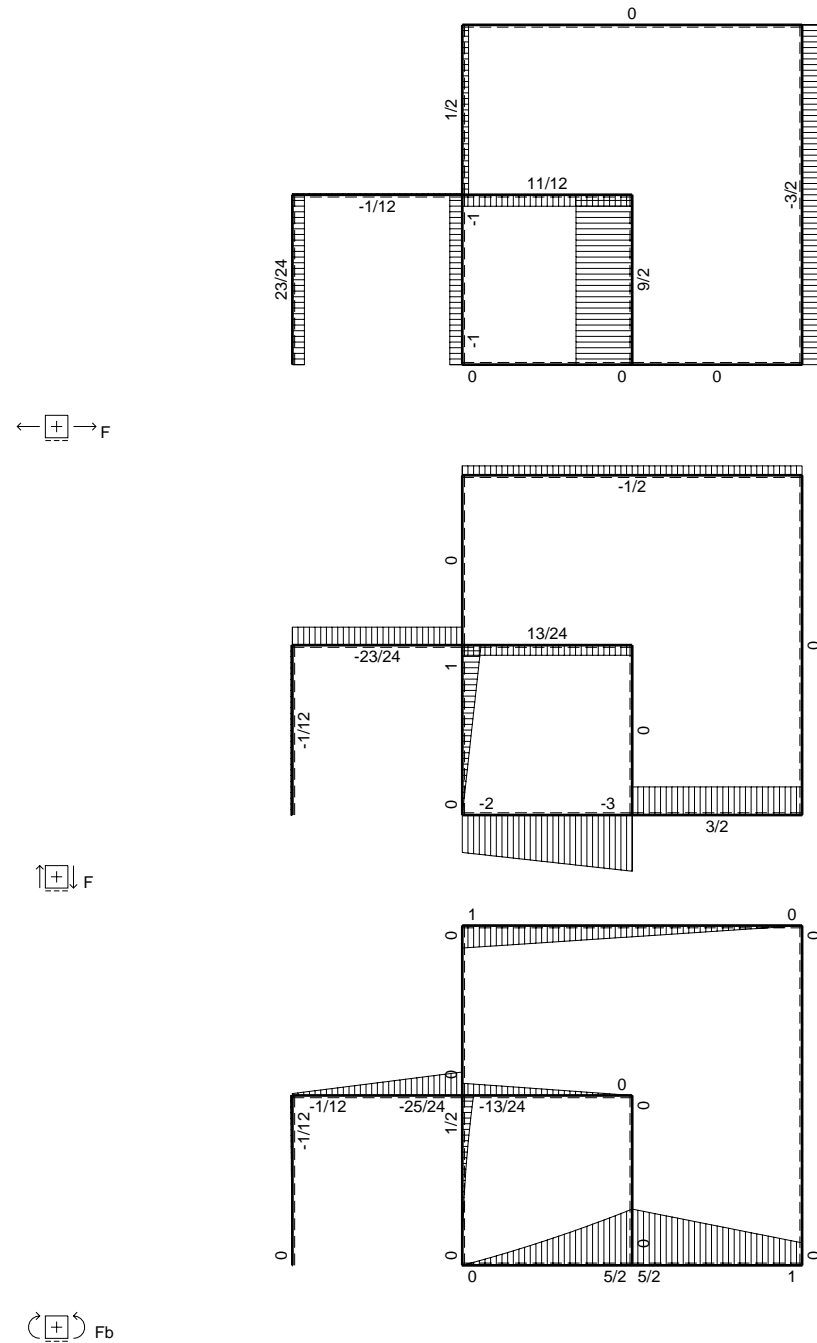
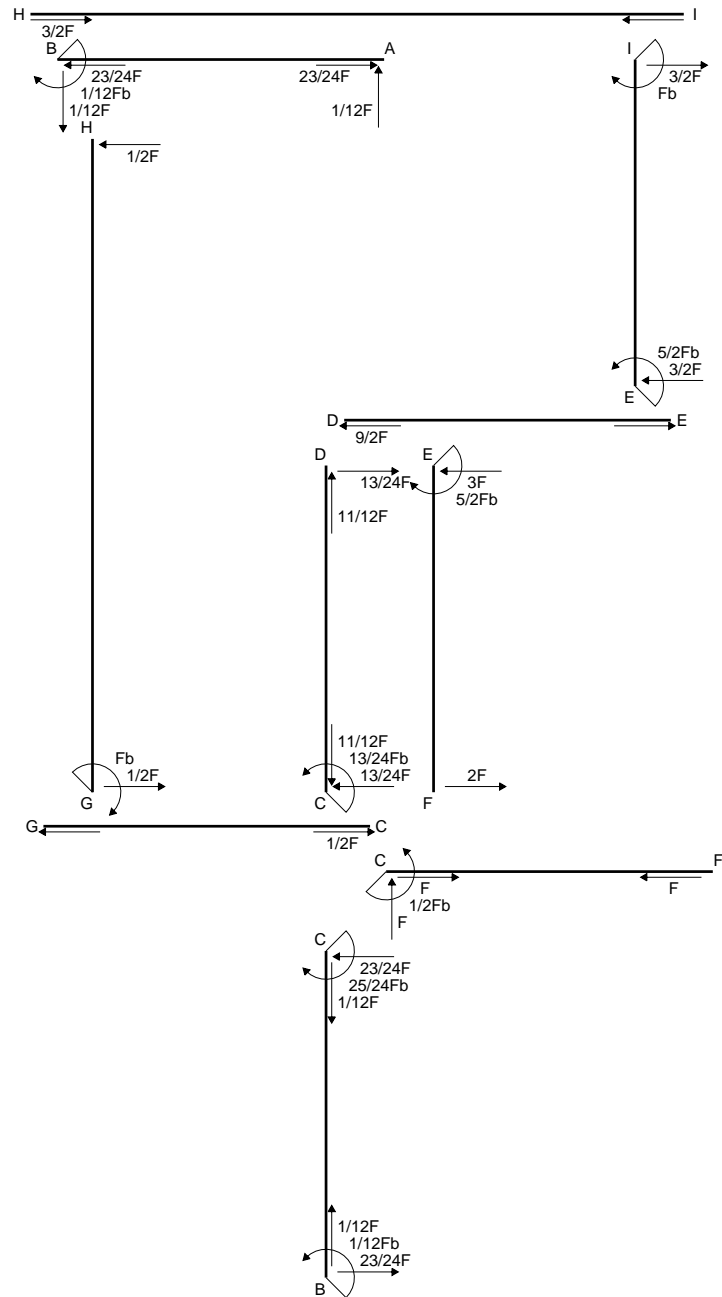
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

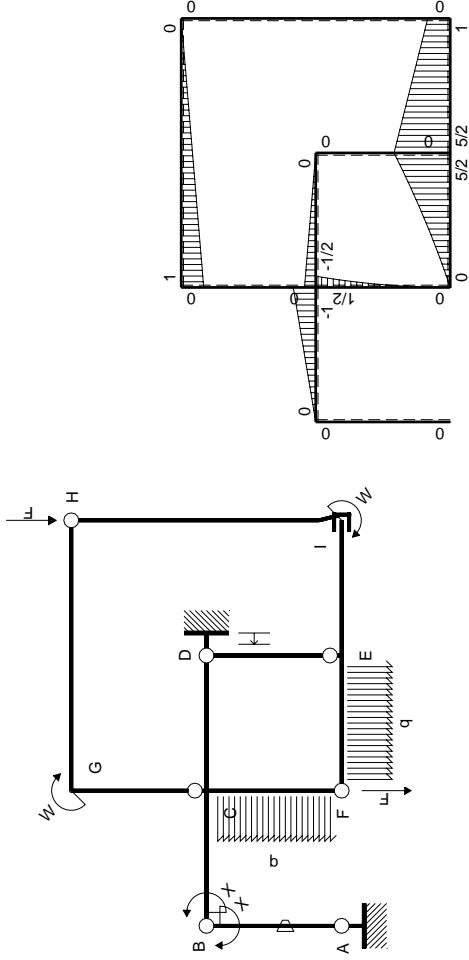
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 1020. mm²
- J_u = 246410. mm⁴
- J_v = 107280. mm⁴
- y_g = 18.04 mm
- T_y = -3630. N
- M_x = 1663750. Nmm
- x_m = 30. mm
- y_m = 52. mm
- u_m = 6. mm
- v_m = 33.96 mm
- σ_m = -Mv/J_u = -229.3 N/mm²
- x_c = 24. mm
- y_c = 38. mm
- v_c = 19.96 mm
- σ_c = -Mv/J_u = -134.8 N/mm²
- τ_c = 5.56 N/mm²
- σ_q = √σ²+3τ² = 135.1 N/mm²
- S = 4529. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0			
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

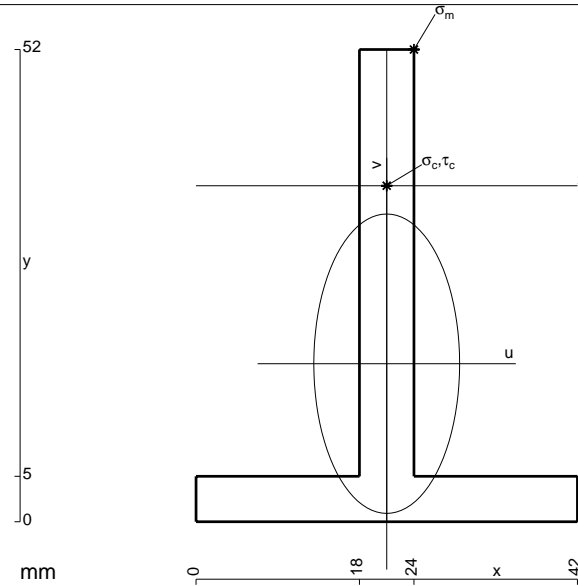
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

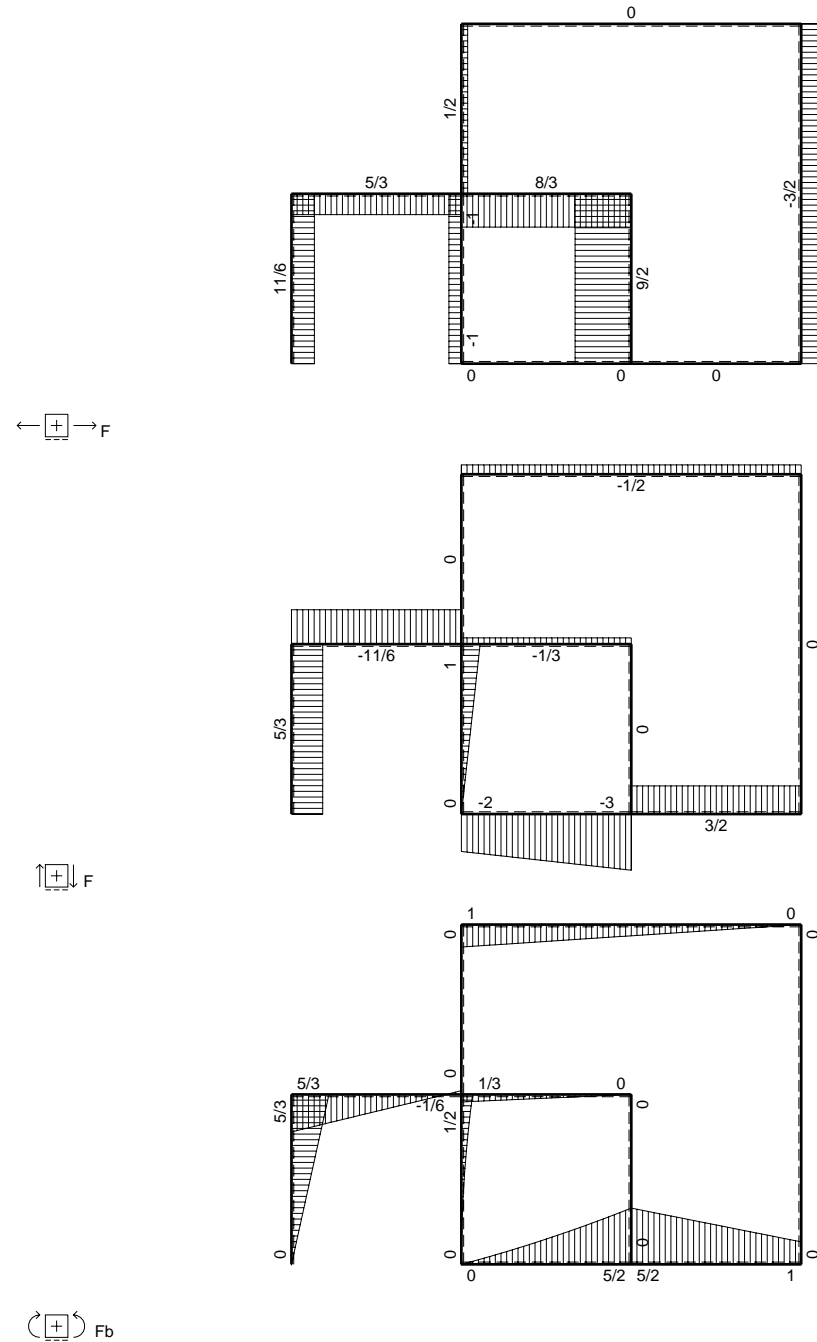
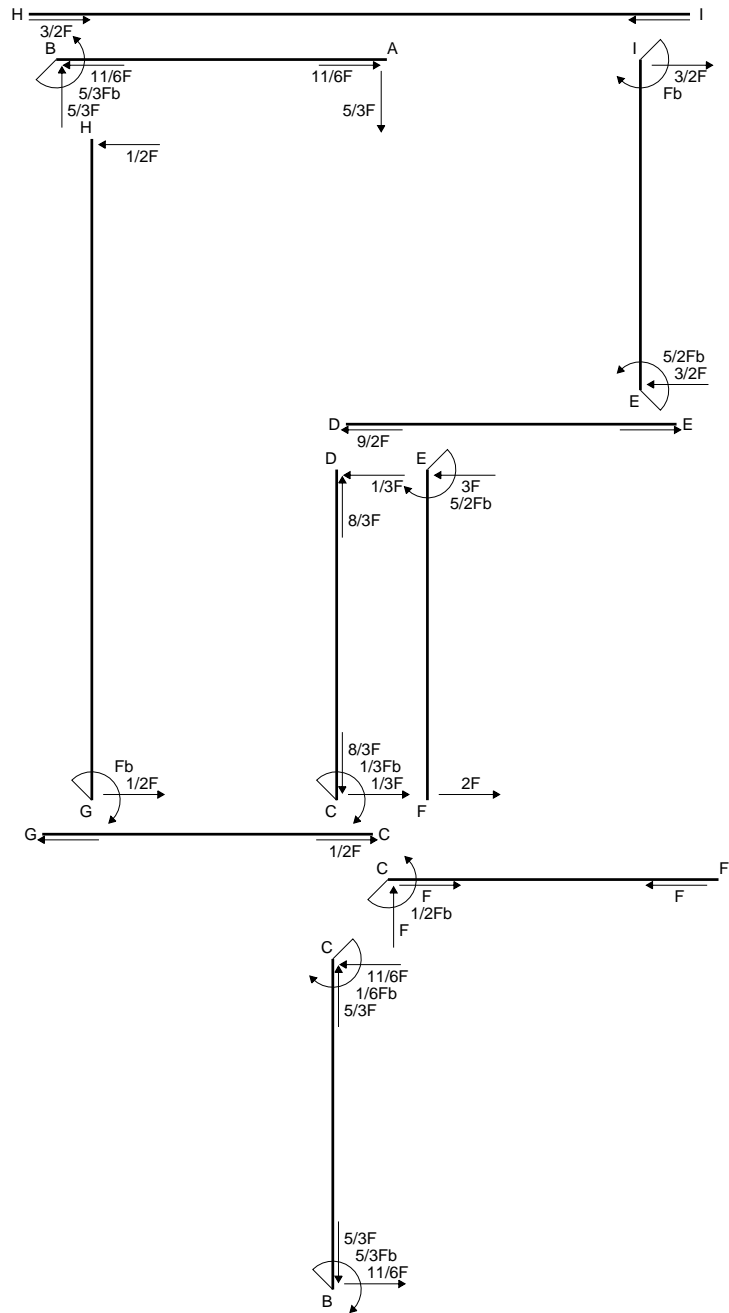
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

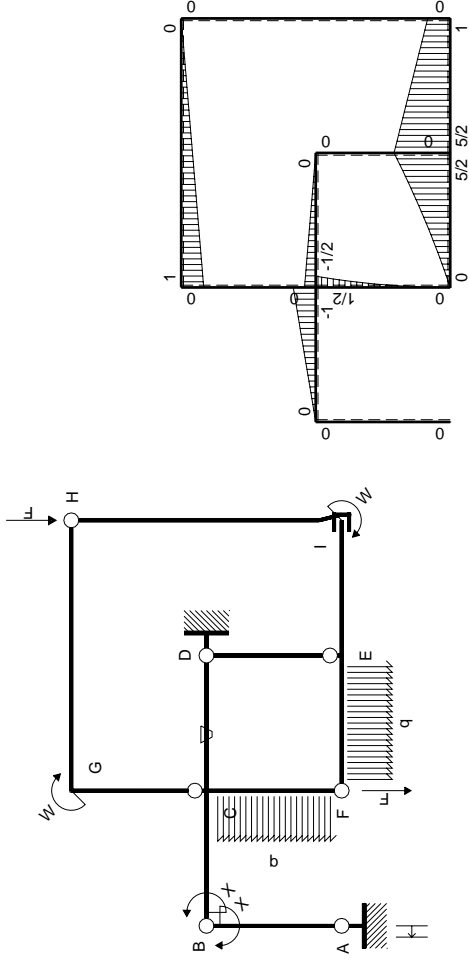
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 492. mm²
- J_u = 133716. mm⁴
- J_v = 31716. mm⁴
- y_g = 17.4 mm
- T_y = -1830. N
- M_x = 915000. Nmm
- x_m = 24. mm
- y_m = 52. mm
- u_m = 3. mm
- v_m = 34.6 mm
- σ_m = -Mv/J_u = -236.7 N/mm²
- x_c = 21. mm
- y_c = 37. mm
- v_c = 19.6 mm
- σ_c = -Mv/J_u = -134.1 N/mm²
- τ_c = 5.563 N/mm²
- σ_q = √σ²+3τ² = 134.4 N/mm²
- S = 2439. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	-x/b	0	0	0	0	x^2/b^2	0+0	1/3Xb/EJ
BA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	-1+1/2x/b	-Fx	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	7/12Xb/EJ
CB b	1/2+1/2x/b	Fb-Fx	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	-1/2+1/2x/b	-1/2Fb+1/2Fx	-Fb/EJ	$1/4Fb-1/2Fx+1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+1/4)Fb^2/EJ$	1/12Xb/EJ
DC b	1/2x/b	1/2Fx	Fb/EJ	$1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$5/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-5/3Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

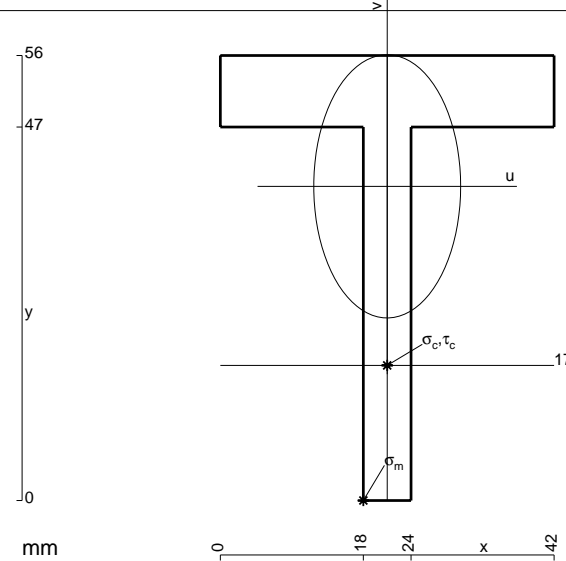
$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

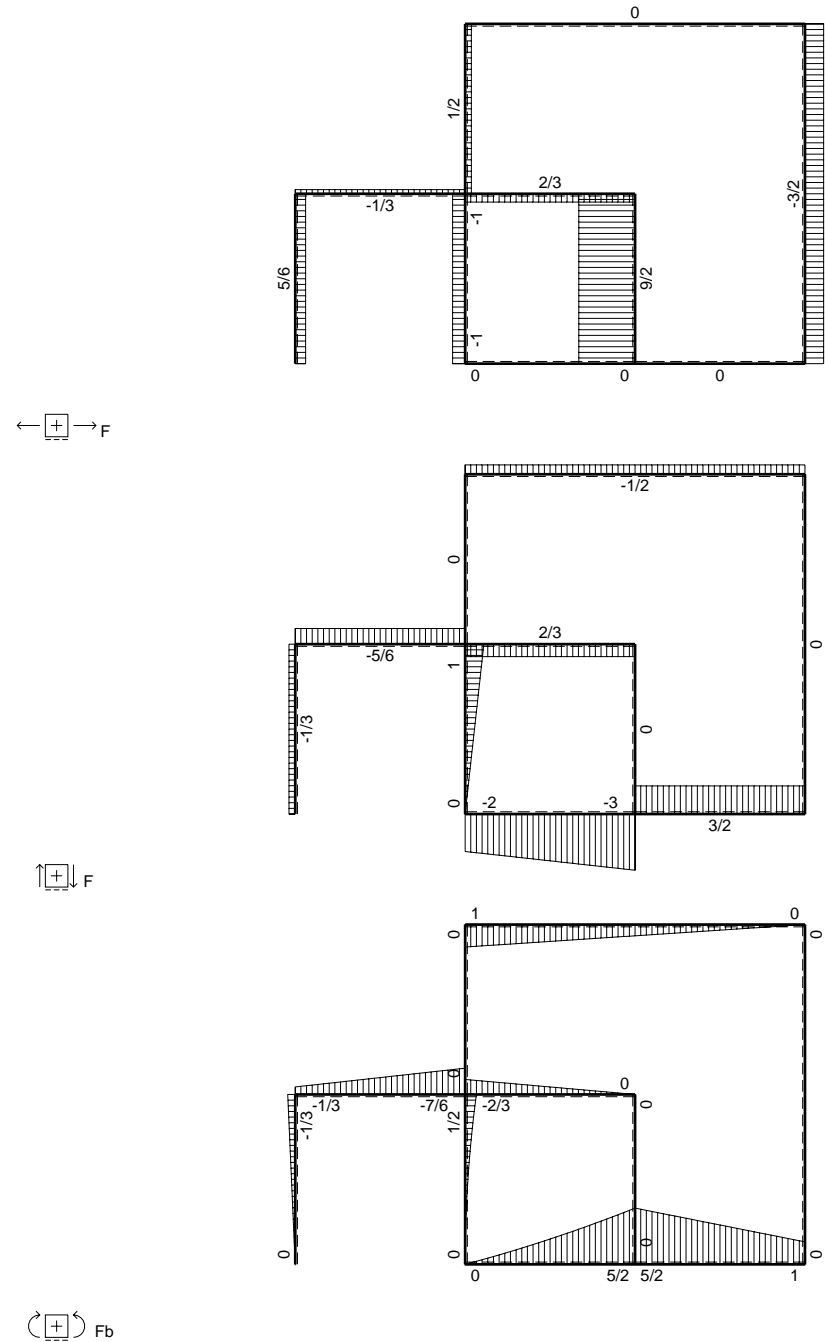
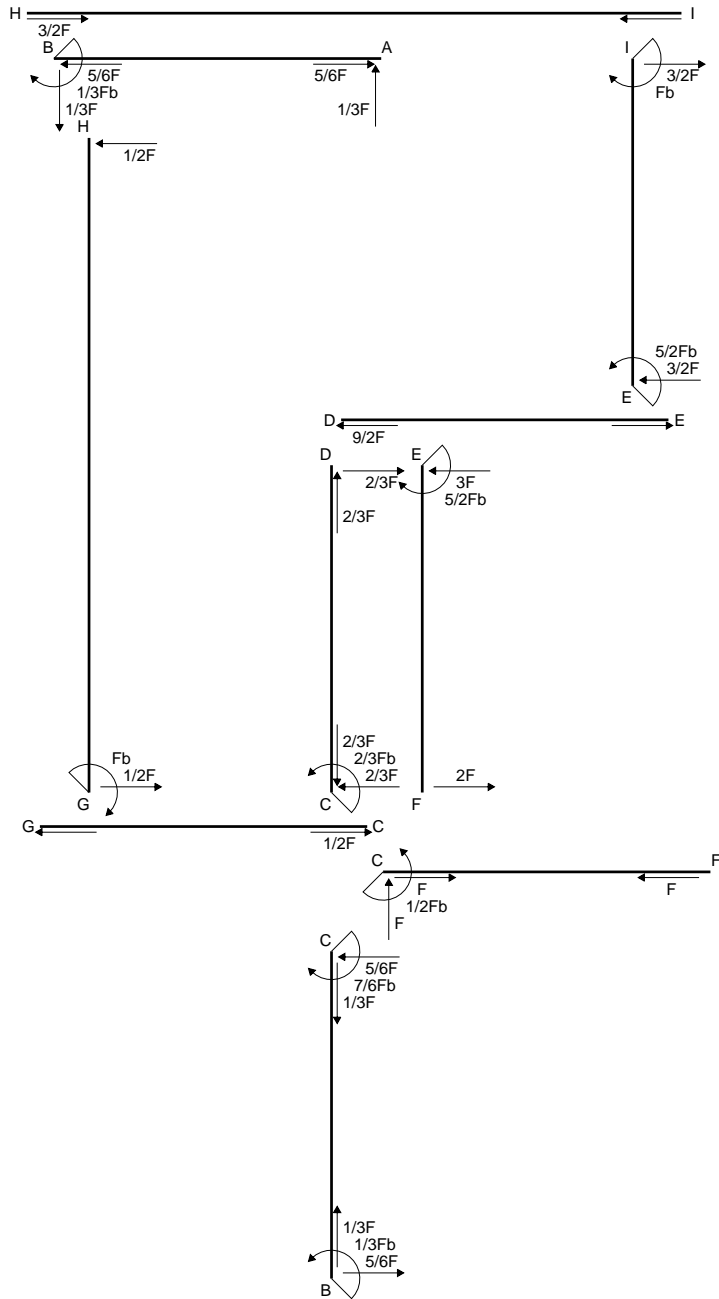
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/3 Fb^2/EJ$$

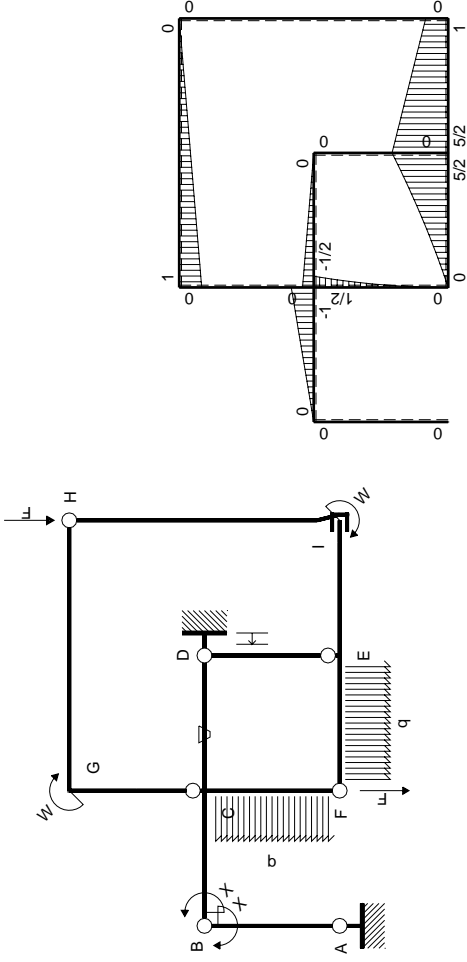
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/3 Fb^2/EJ$$



- A = 660. mm²
- J_u = 181086. mm⁴
- J_v = 56412. mm⁴
- y_g = 39.54 mm
- T_y = -1590. N
- M_x = 914250. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -39.54 mm
- σ_m = -Mv/J_u = 199.6 N/mm²
- x_c = 21. mm
- y_c = 17. mm
- v_c = -22.54 mm
- σ_c = -Mv/J_u = 113.8 N/mm²
- τ_c = 4.633 N/mm²
- σ_o = √σ²+3τ² = 114.1 N/mm²
- S = 3166. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	$-Fb/EJ$	$1/4Fb-1/2Fx+1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	Fb/EJ	$1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0			
FC b	0	$1/2qx^2$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/3Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

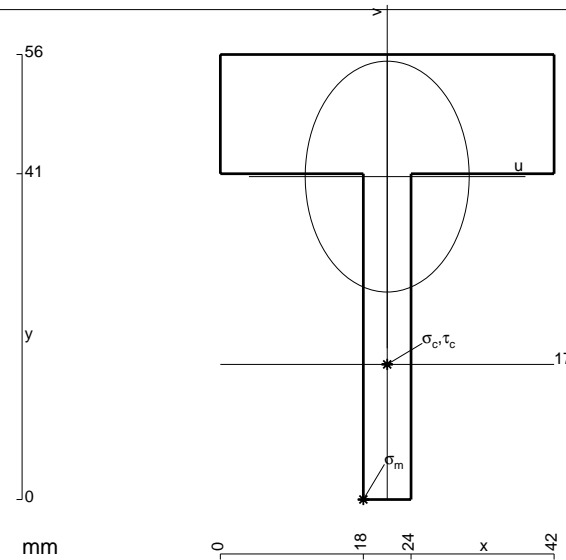
$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

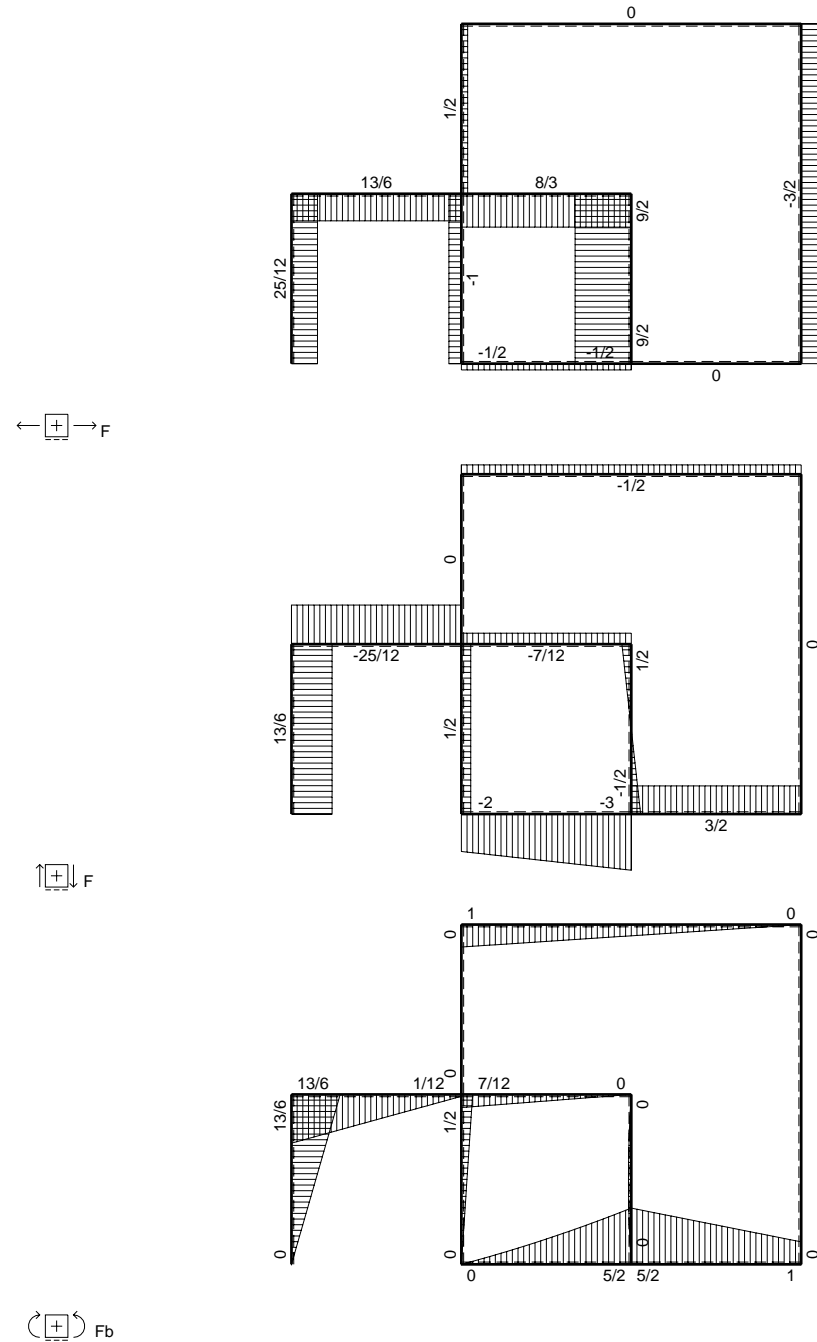
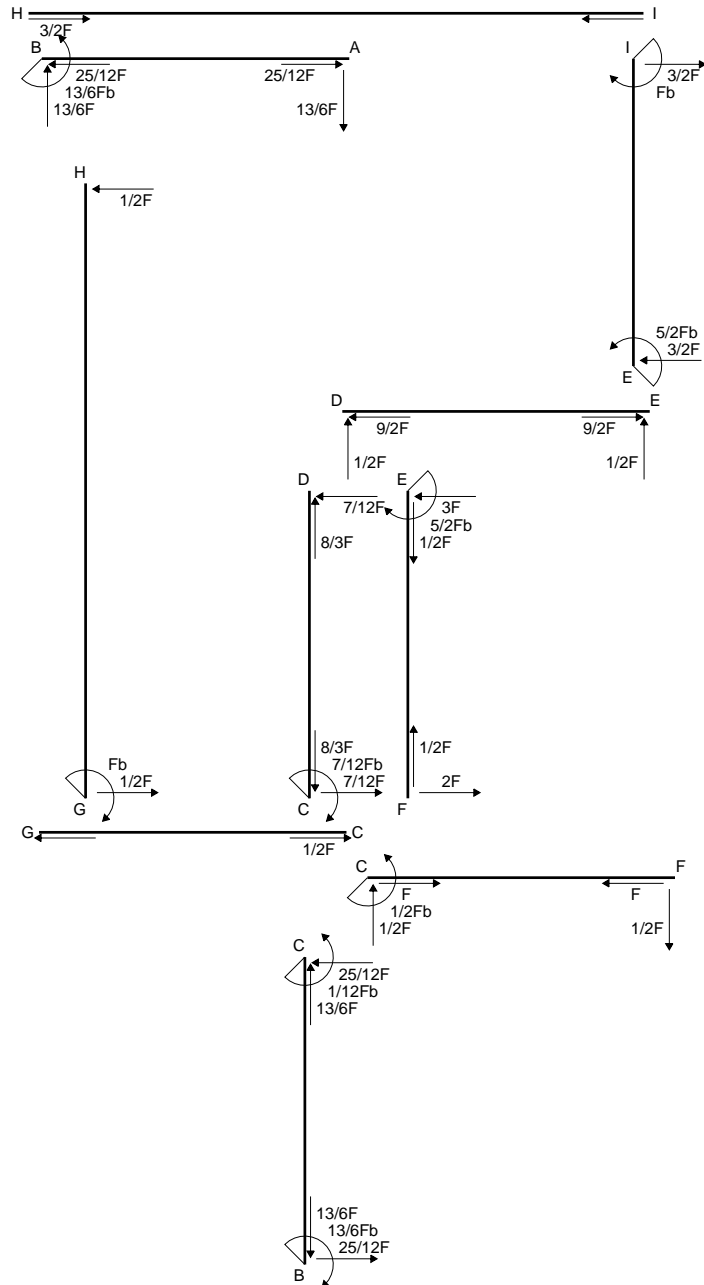
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/3 Fb^2/EJ$$

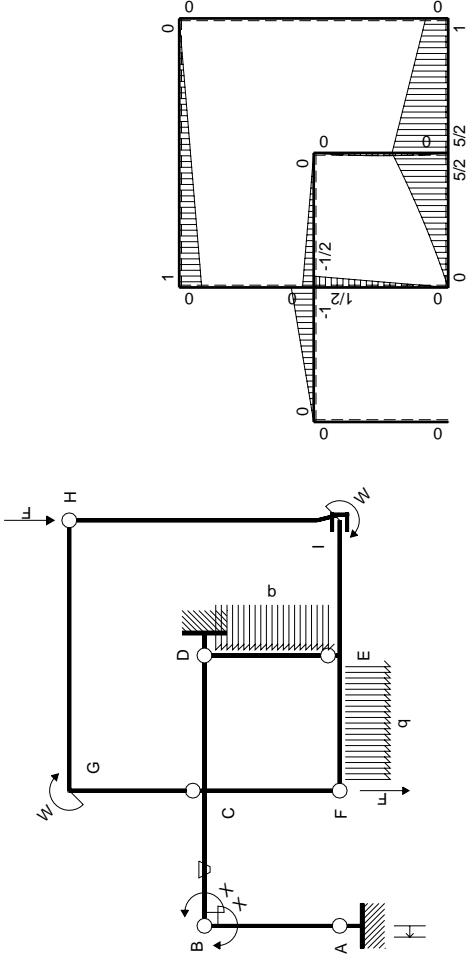
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/3 Fb^2/EJ$$



- A = 876. mm²
- J_u = 184977. mm⁴
- J_v = 93348. mm⁴
- y_g = 40.64 mm
- T_y = -1560. N
- M_x = 949000. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -40.64 mm
- σ_m = -Mv/J_u = 208.5 N/mm²
- x_c = 21. mm
- y_c = 17. mm
- v_c = -23.64 mm
- σ_c = -Mv/J_u = 121.3 N/mm²
- τ_c = 4.607 N/mm²
- σ_o = √σ²+3τ² = 121.5 N/mm²
- S = 3278. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-Fx$	$-Fb/EJ$	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$Fb-Fx$	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0			
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0			
FC b	0	$1/2Fx$	0	0	0	0	0+0	0	
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0	
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ		
	totali						$13/6Fb^2/EJ$	Xb/EJ	
	iperstatica $X=W_{BC}$						$-13/6Fb$		

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

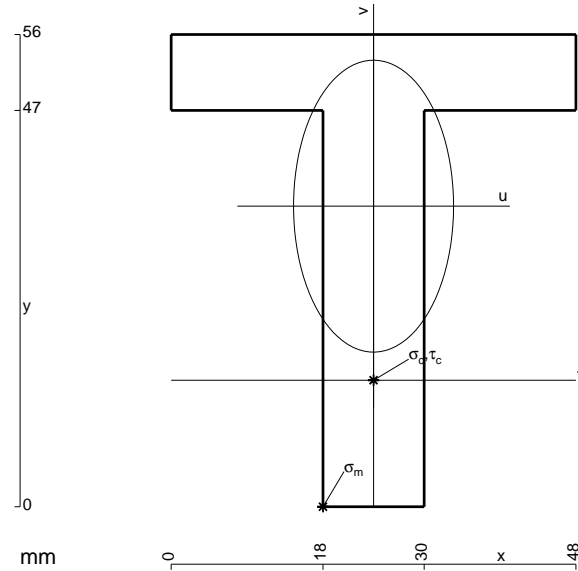
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

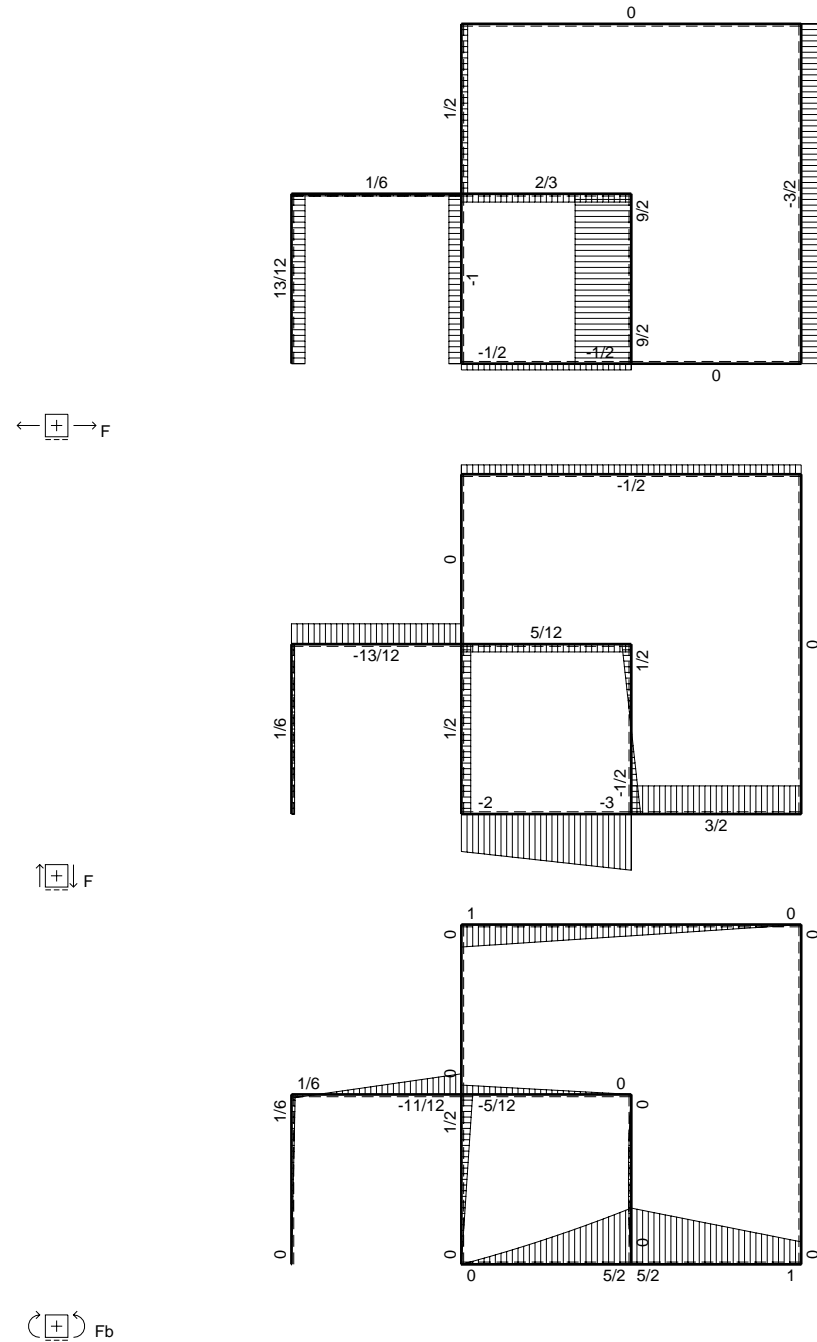
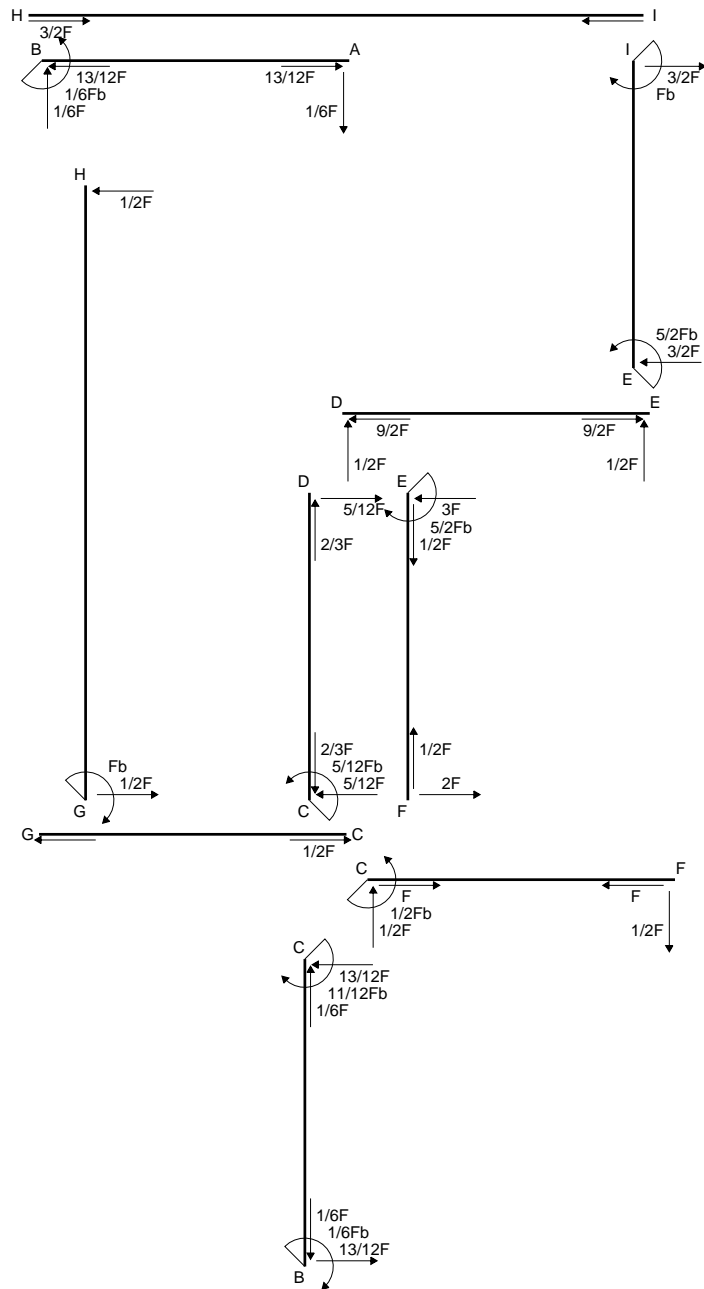
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

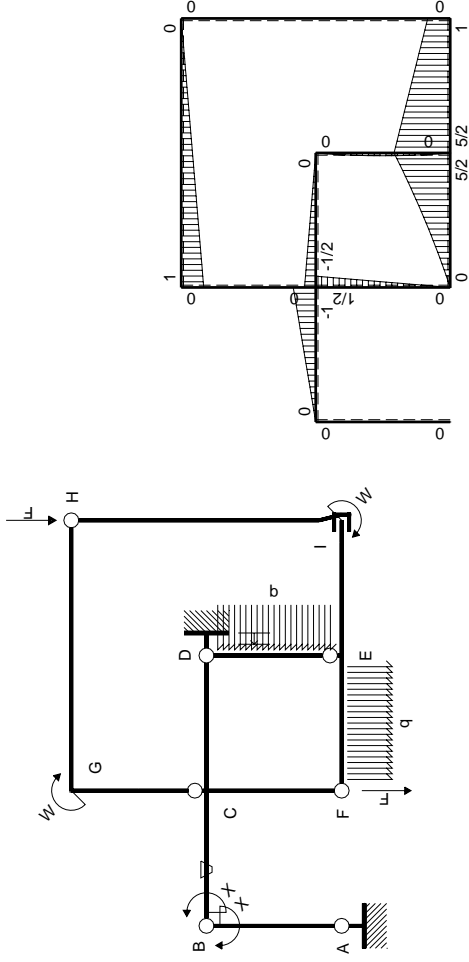
$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 996. mm²
- J_u = 298526. mm⁴
- J_v = 89712. mm⁴
- y_g = 35.64 mm
- N = -470. N
- T_y = -2820. N
- M_x = 1833000. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -35.64 mm
- σ_m = N/A - Mv/J_u = 218.4 N/mm²
- x_c = 24. mm
- y_c = 15. mm
- v_c = -20.64 mm
- σ_c = N/A - Mv/J_u = 126.3 N/mm²
- τ_c = 3.988 N/mm²
- σ_q = √(σ² + 3τ²) = 126.5 N/mm²
- S = 5066. mm³



$\boxed{+}$ \curvearrowright F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	-x/b	0	0	0	0	x^2/b^2	0+0	1/3Xb/EJ	
BA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	-1+1/2x/b	-Fx	-Fb/EJ	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	7/12Xb/EJ	
CB b	1/2+1/2x/b	Fb-Fx	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	-1/2+1/2x/b	-1/2Fb+1/2Fx	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	1/12Xb/EJ	
DC b	1/2x/b	1/2Fx	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0			
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0			
FC b	0	1/2Fx	0	0	0	0	0+0	0	
CF b	0	-1/2Fb+1/2Fx	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	Fb-1/2Fx	0	0	0	0	0+0	0	
HG 2b	0	-1/2Fx	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	Fb+3/2Fx	0	0	0	0	0+0	0	
EI b	0	-5/2Fb+3/2Fx	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

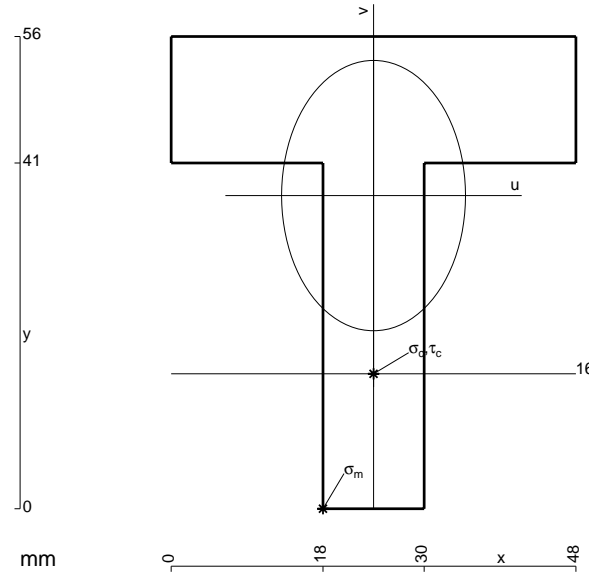
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

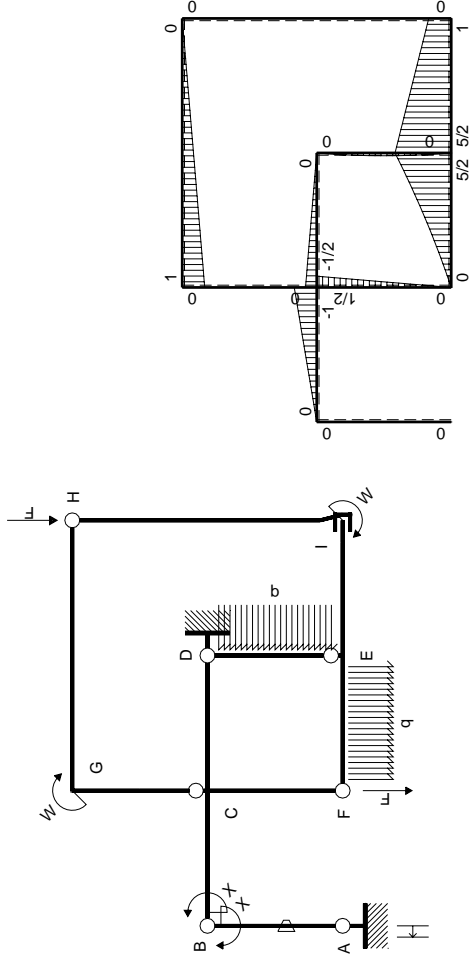
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 1212. mm²
- J_u = 311566. mm⁴
- J_v = 144144. mm⁴
- y_g = 37.13 mm
- N = -470. N
- T_y = -2820. N
- M_x = 1927000. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -37.13 mm
- σ_m = N/A - Mv/J_u = 229.3 N/mm²
- x_c = 24. mm
- y_c = 16. mm
- v_c = -21.13 mm
- σ_c = N/A - Mv/J_u = 130.3 N/mm²
- τ_c = 4.219 N/mm²
- σ_φ = √(σ² + 3τ²) = 130.5 N/mm²
- S = 5594. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$23/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-23/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

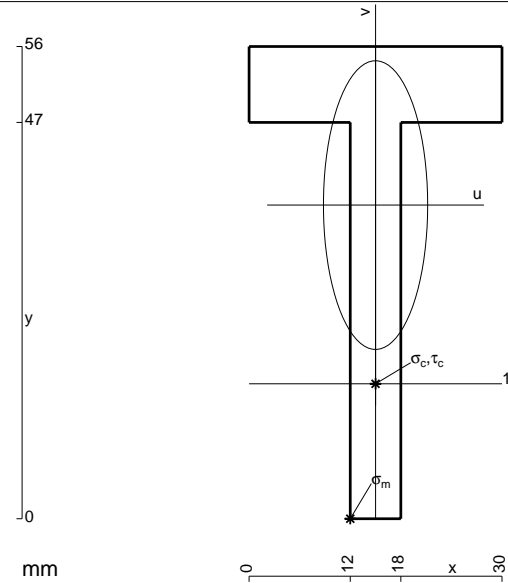
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

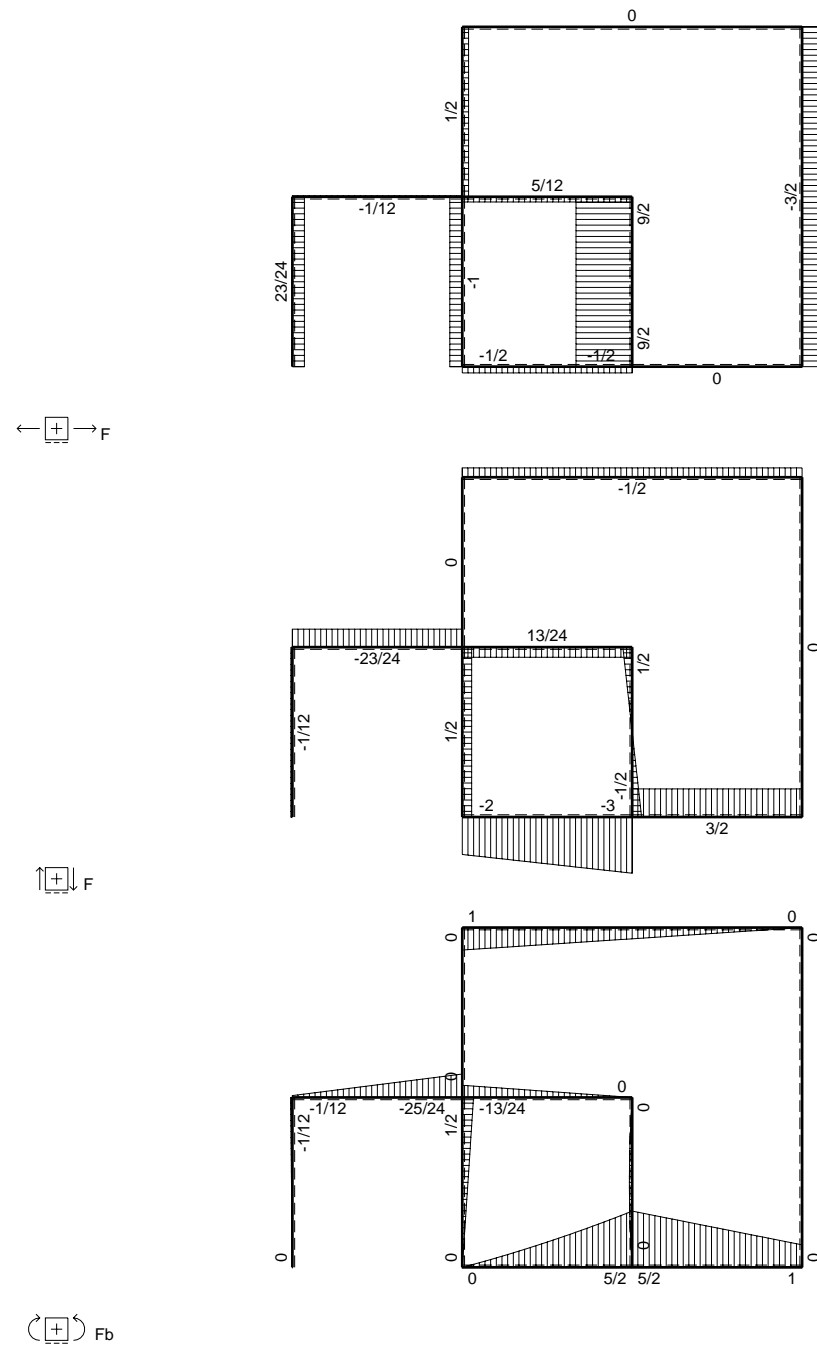
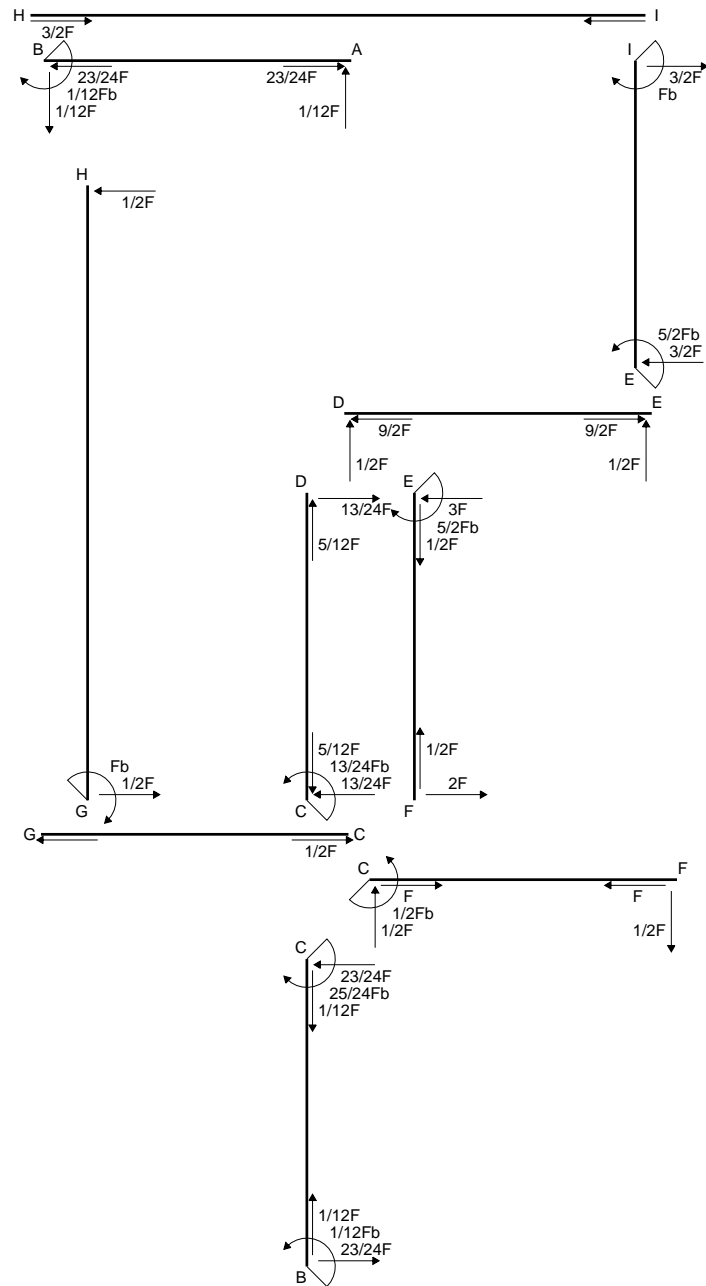
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

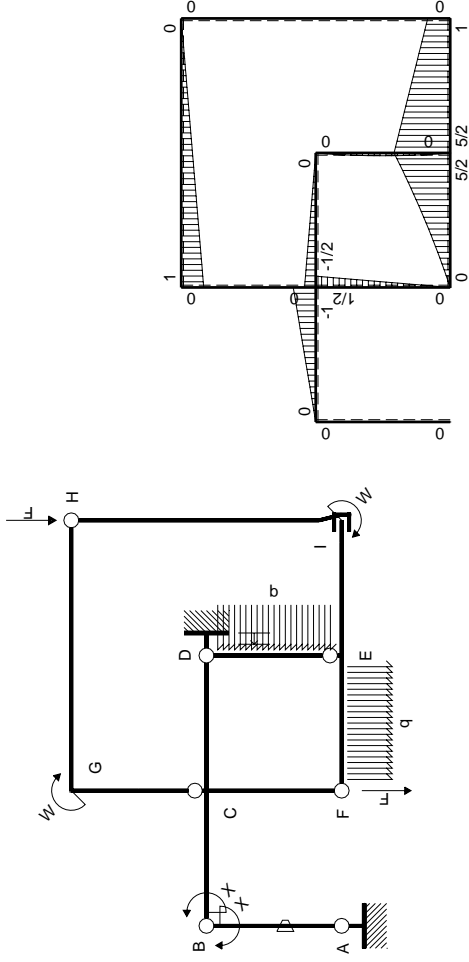
$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 552. mm²
- J_u = 161875. mm⁴
- J_v = 21096. mm⁴
- y_g = 37.2 mm
- N = -240. N
- T_y = -1440. N
- M_x = 1044000. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -37.2 mm
- σ_m = N/A - Mv/J_u = 239.5 N/mm²
- x_c = 15. mm
- y_c = 16. mm
- v_c = -21.2 mm
- σ_c = N/A - Mv/J_u = 136.3 N/mm²
- τ_c = 4.155 N/mm²
- σ_q = √(σ² + 3τ²) = 136.5 N/mm²
- S = 2803. mm³



$\left(\begin{smallmatrix} + \\ + \end{smallmatrix}\right) F_b$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$1/4Fb-1/2Fx+1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	0	$1/4Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$-1/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$1/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

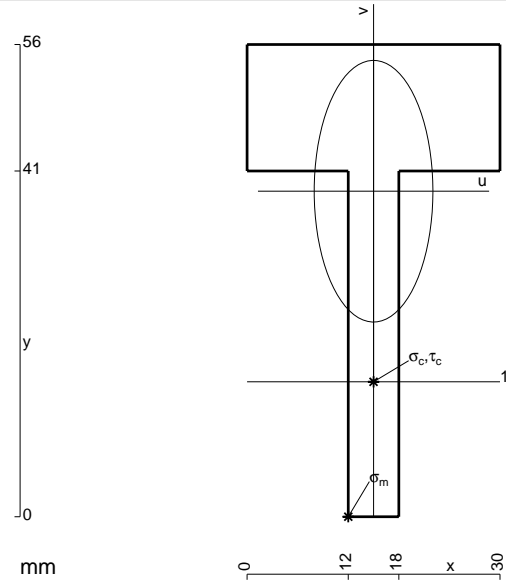
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

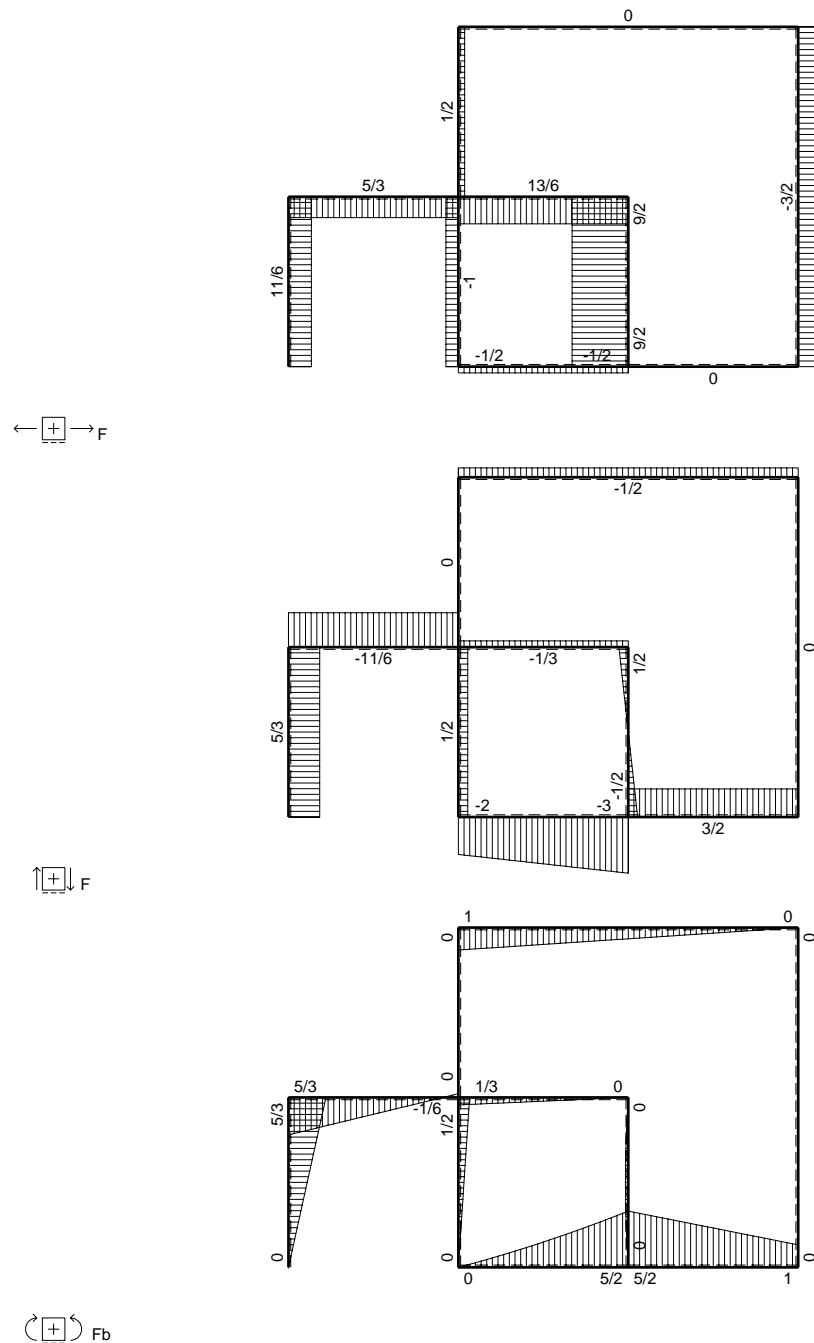
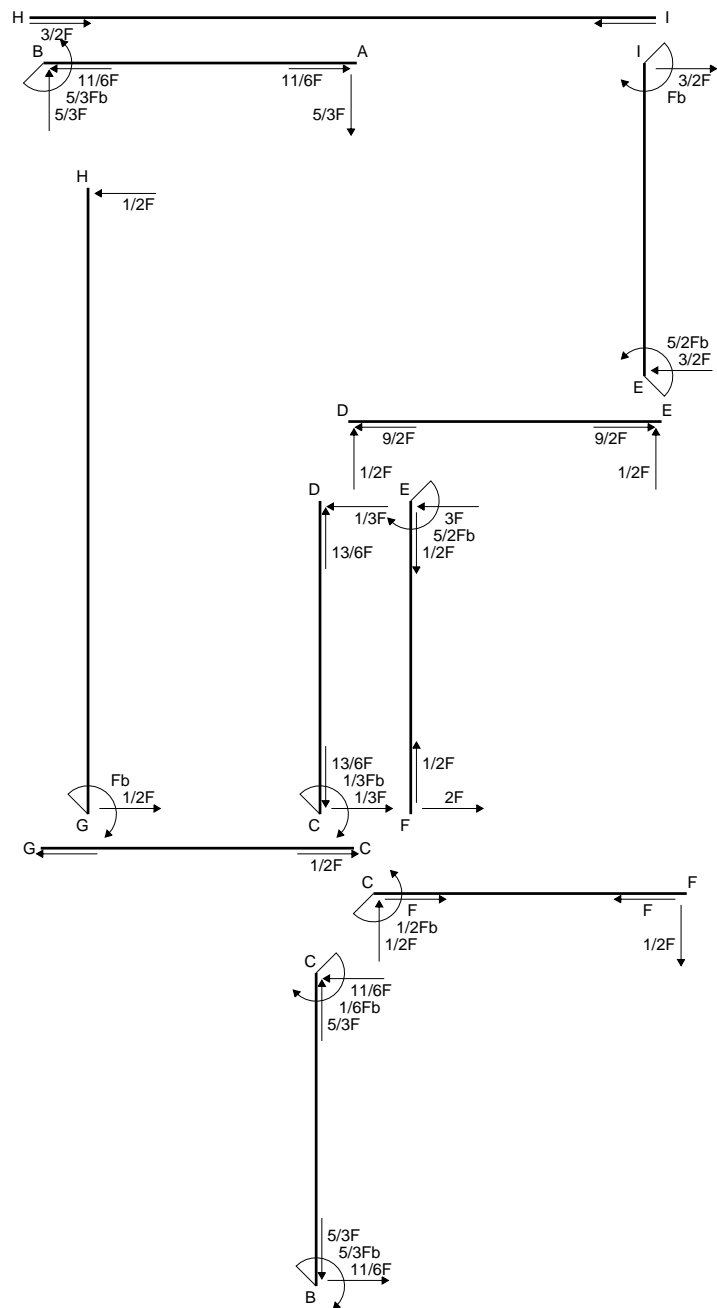
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

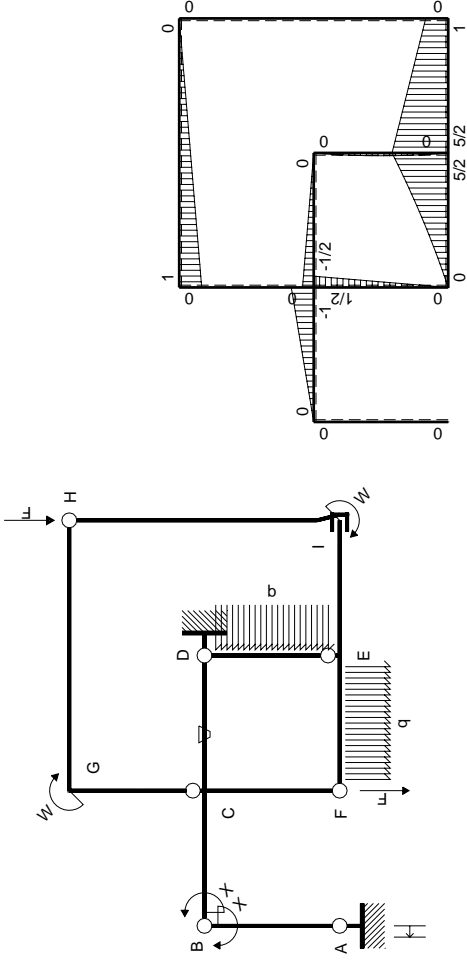
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx = [1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/12 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



- A = 696. mm²
- J_u = 167595. mm⁴
- J_v = 34488. mm⁴
- y_g = 38.6 mm
- N = -375. N
- T_y = -2250. N
- M_x = 862500. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -38.6 mm
- σ_m = N/A - Mv/J_u = 198.1 N/mm²
- x_c = 15. mm
- y_c = 16. mm
- v_c = -22.6 mm
- σ_c = N/A - Mv/J_u = 115.8 N/mm²
- τ_c = 6.574 N/mm²
- σ_φ = √(σ² + 3τ²) = 116.3 N/mm²
- S = 2938. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	-x/b	0	0	0	0	x^2/b^2	0+0	1/3Xb/EJ
BA b	1-x/b	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	-1+1/2x/b	-Fx	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	7/12Xb/EJ
CB b	1/2+1/2x/b	Fb-Fx	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	-1/2+1/2x/b	-1/2Fb+1/2Fx	-Fb/EJ	$1/4Fb-1/2Fx+1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+1/4)Fb^2/EJ$	1/12Xb/EJ
DC b	1/2x/b	1/2Fx	Fb/EJ	$1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	1/2Fx	0	0	0	0	0+0	0
CF b	0	-1/2Fb+1/2Fx	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	Fb-1/2Fx	0	0	0	0	0+0	0
HG 2b	0	-1/2Fx	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	Fb+3/2Fx	0	0	0	0	0+0	0
EI b	0	-5/2Fb+3/2Fx	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$5/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						-5/3Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

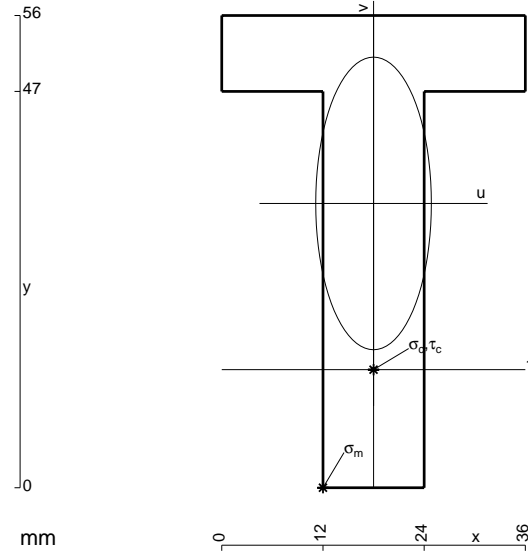
$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

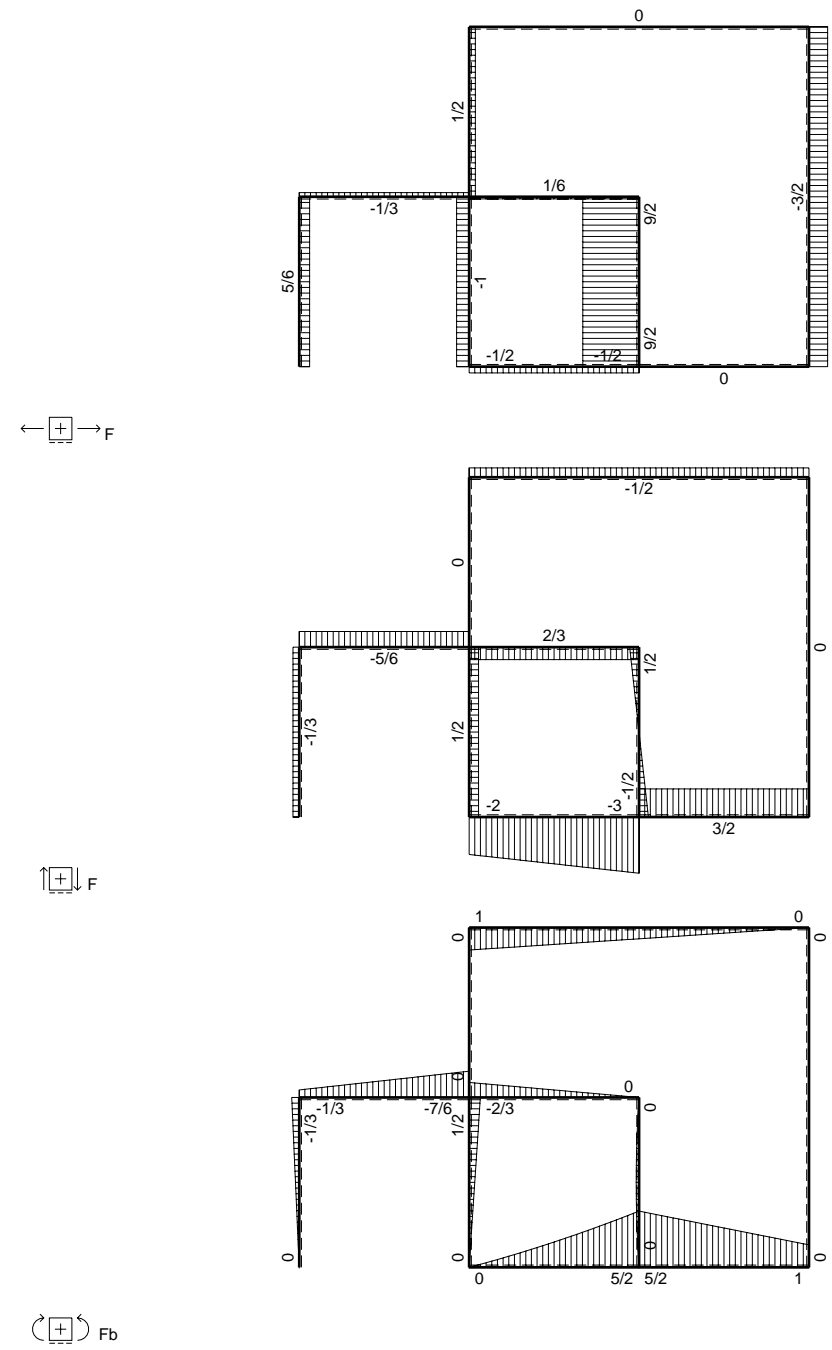
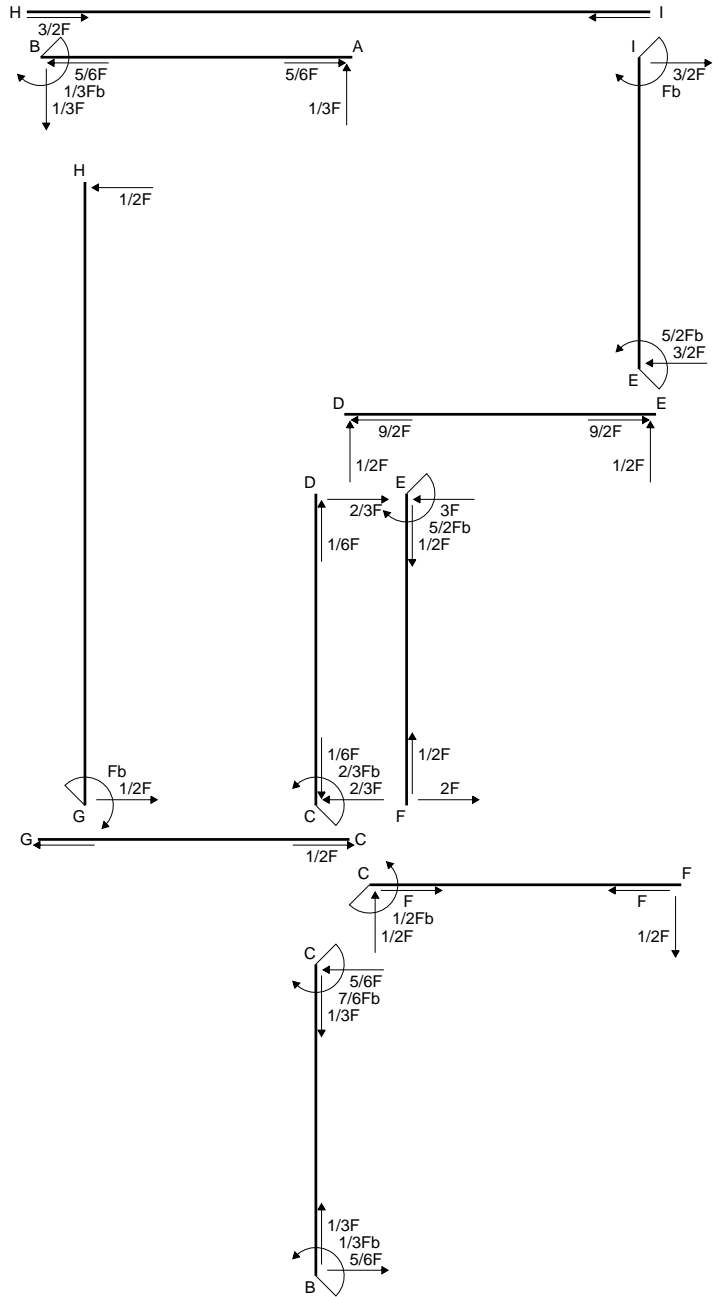
$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/3 Fb^2/EJ$$

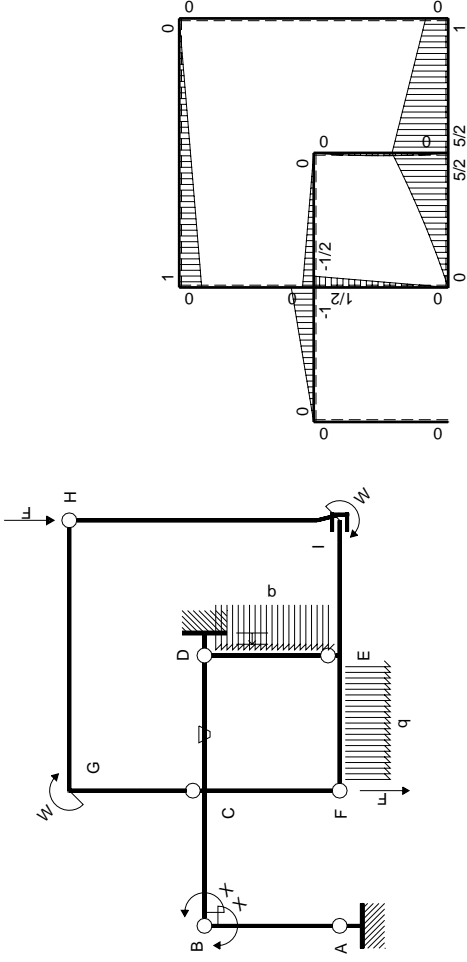
$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/3 Fb^2/EJ$$



- A = 888. mm²
- J_u = 267344. mm⁴
- J_v = 41760. mm⁴
- y_g = 33.72 mm
- N = -665. N
- T_y = -3990. N
- M_x = 1662500. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -33.72 mm
- σ_m = N/A - Mv/J_u = 208.9 N/mm²
- x_c = 18. mm
- y_c = 14. mm
- v_c = -19.72 mm
- σ_c = N/A - Mv/J_u = 121.9 N/mm²
- τ_c = 5.582 N/mm²
- σ_q = √(σ² + 3τ²) = 122.2 N/mm²
- S = 4488. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-Fx$	0	$Fx-1/2Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(1/3+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$Fb-Fx$	0	$1/2Fb-1/2Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+1/2Fx$	$-Fb/EJ$	$1/4Fb-1/2Fx+1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(1/12+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2Fx$	Fb/EJ	$1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0
ED b	0	$-1/2Fx+1/2qx^2$	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	$1/2Fx$	0	0	0	0	0+0	0
CF b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$-1/3Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$1/3Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

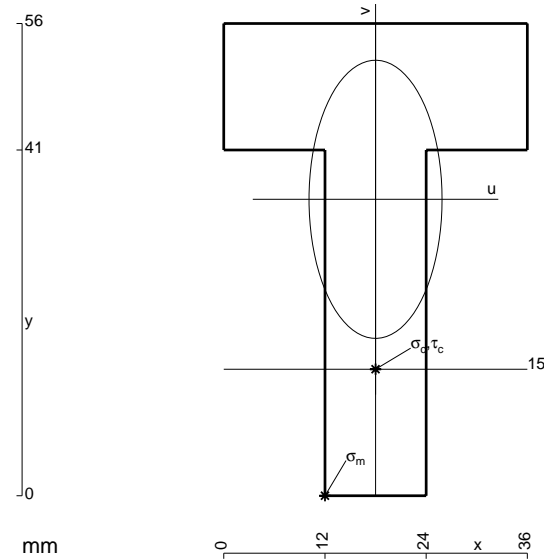
$$L_{CD}^{xo} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/4 b + 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/3 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/3 Fb^2/EJ$$



$$A = 1032. \text{ mm}^2$$

$$J_u = 280881. \text{ mm}^4$$

$$J_v = 64224. \text{ mm}^4$$

$$y_g = 35.15 \text{ mm}$$

$$N = -640. \text{ N}$$

$$T_y = -3840. \text{ N}$$

$$M_x = 1760000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -6. \text{ mm}$$

$$v_m = -35.15 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = 219.6 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 15. \text{ mm}$$

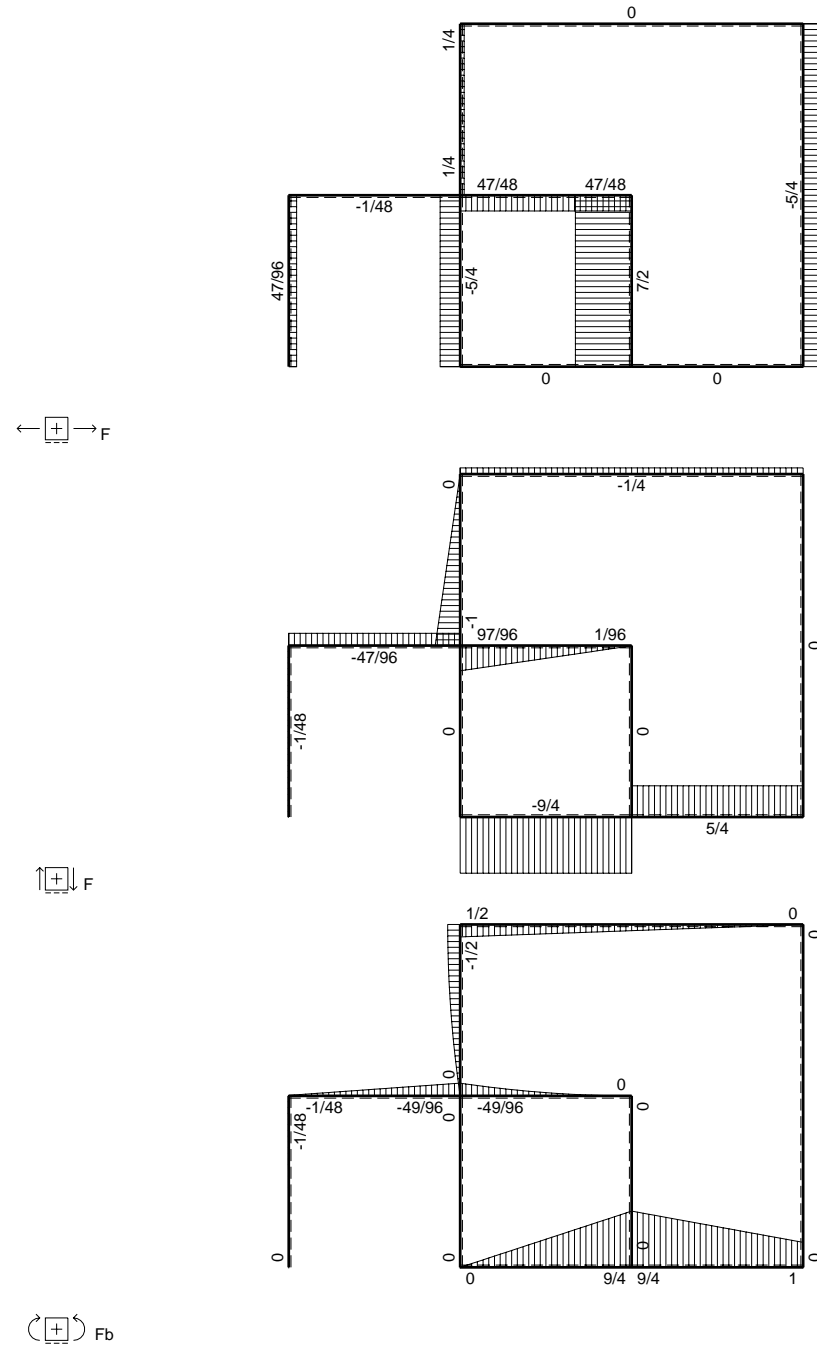
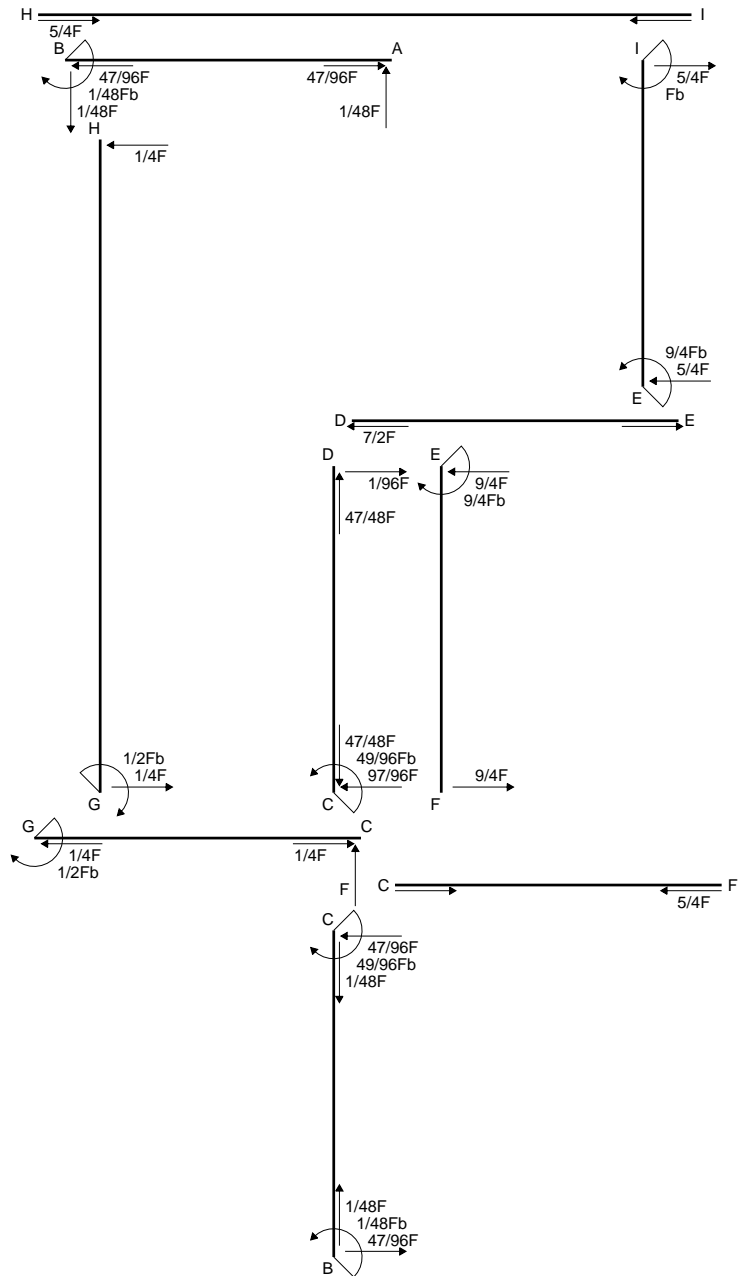
$$v_c = -20.15 \text{ mm}$$

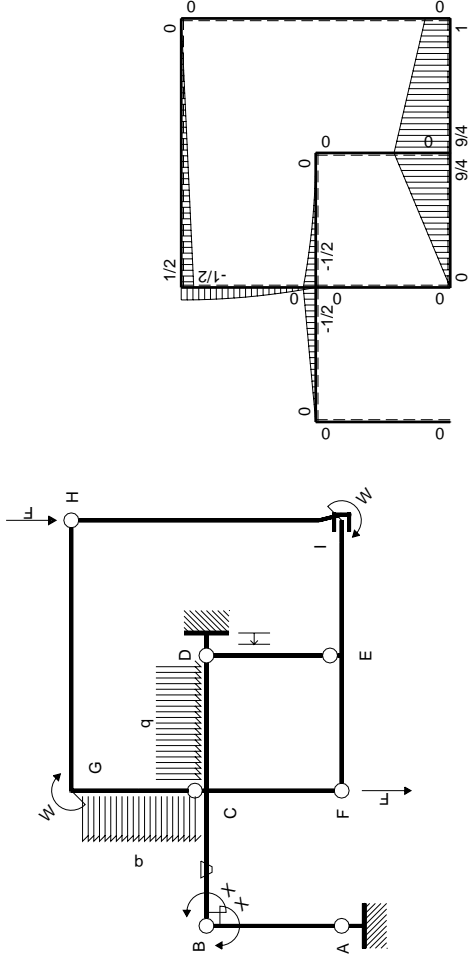
$$\sigma_c = N/A - Mv/J_u = 125.6 \text{ N/mm}^2$$

$$\tau_c = 5.67 \text{ N/mm}^2$$

$$\sigma_\rho = \sqrt{\sigma^2 + 3\tau^2} = 126. \text{ N/mm}^2$$

$$S = 4977. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-1/2Fx$	$-Fb/EJ$	$1/2Fx-1/4Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/6+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	Fb/EJ	$1/4Fb-1/4Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-1/2Fb+Fx-1/2qx^2$	0	$1/4Fb-3/4Fx+3/4Fx^2/b-1/4qx^3/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/16+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$1/2qx^2$	0	$1/4qx^3/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-9/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx$	0	0	0	0	0+0	0	
EI b	0	$-9/4Fb+5/4Fx$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/48Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/48Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/12 b) Fb 1/EJ + (b - 1/4 b) \theta = 11/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/12 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 11/12 Fb^2/EJ$$

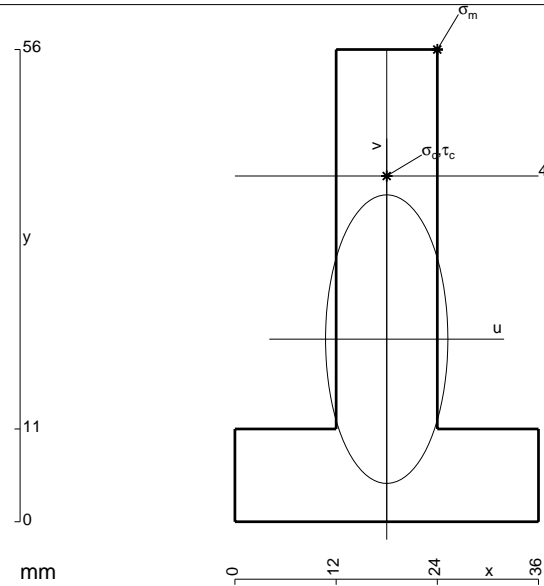
$$L_{CD}^{xo} = \int_0^b (1/4 - 3/4 x/b + 3/4 x^2/b^2 - 1/4 x^3/b^3) Fb 1/EJ dx$$

$$= [1/4 x - 3/8 x^2/b + 1/4 x^3/b^2 - 1/16 x^4/b^3]_0^b Fb 1/EJ$$

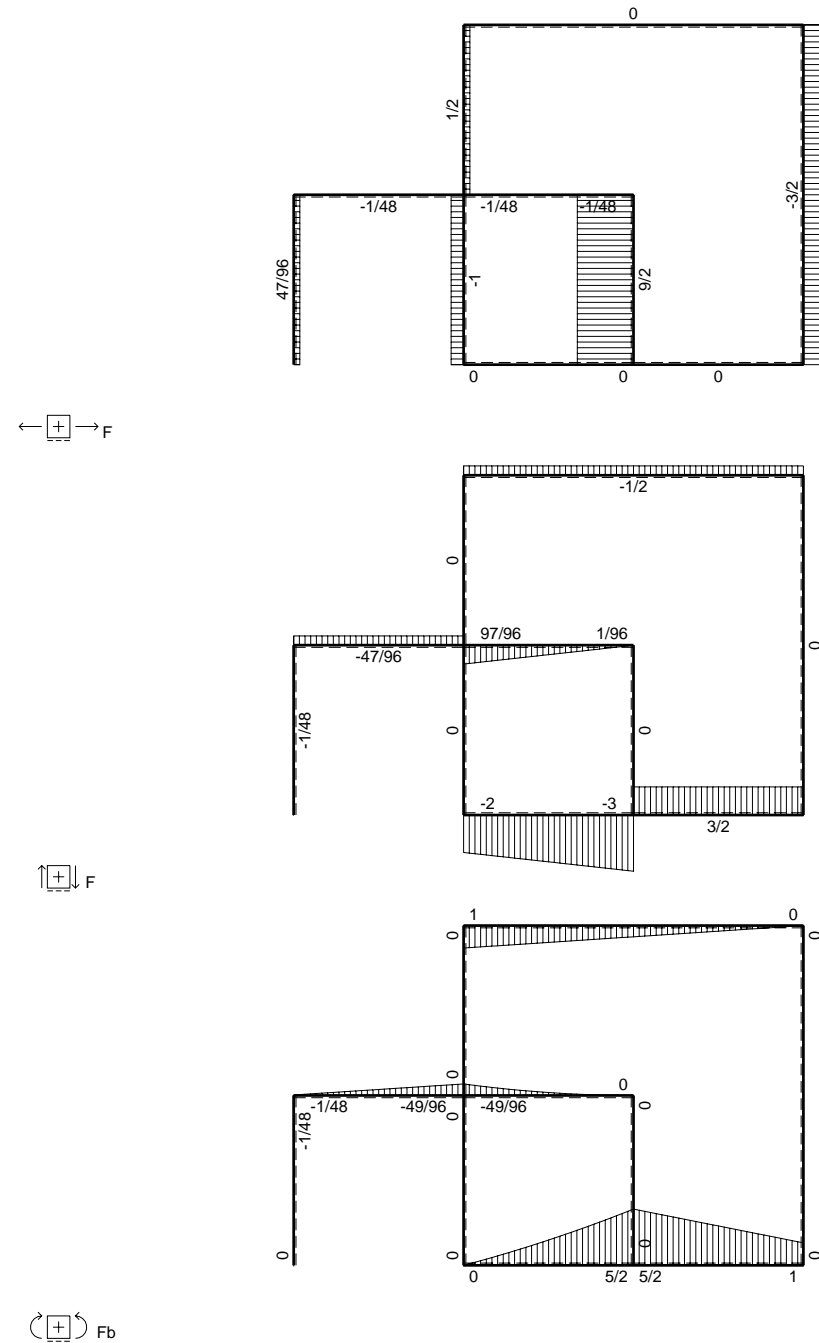
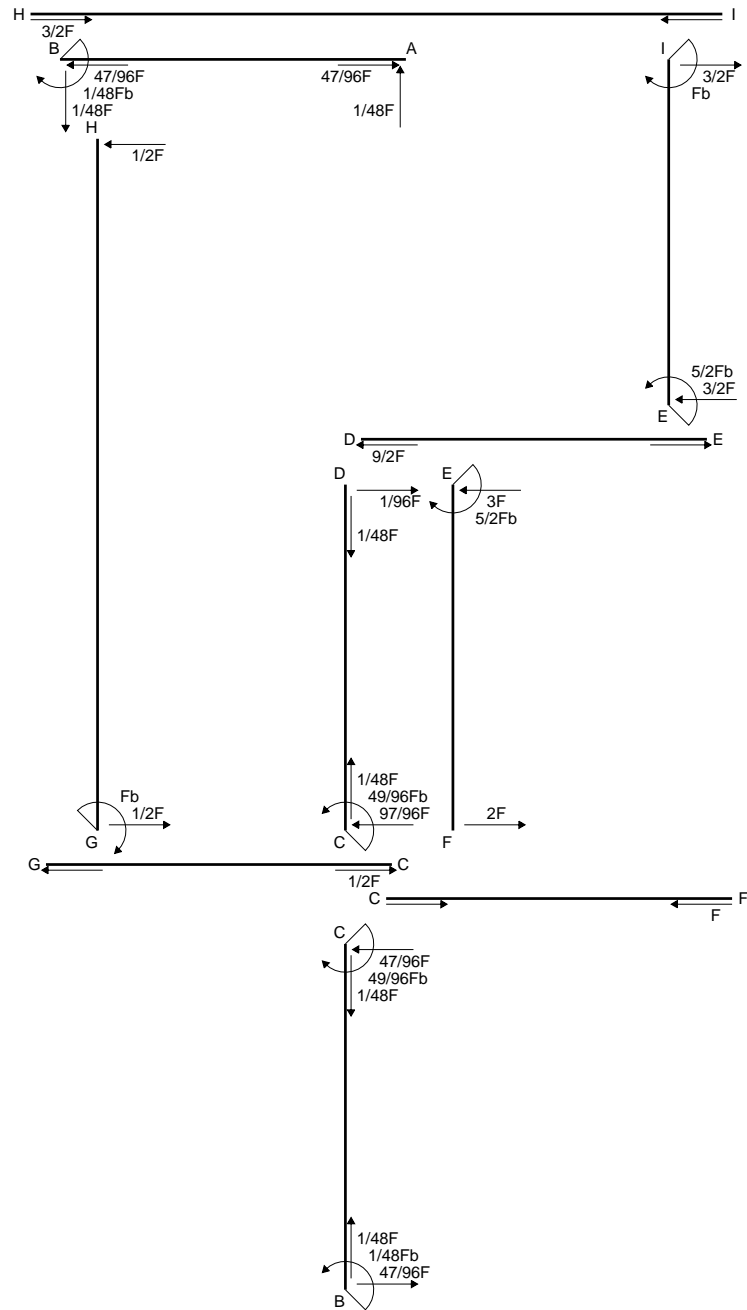
$$= (1/4 b - 3/8 b + 1/4 b - 1/16 b) Fb 1/EJ = 1/16 Fb^2/EJ$$

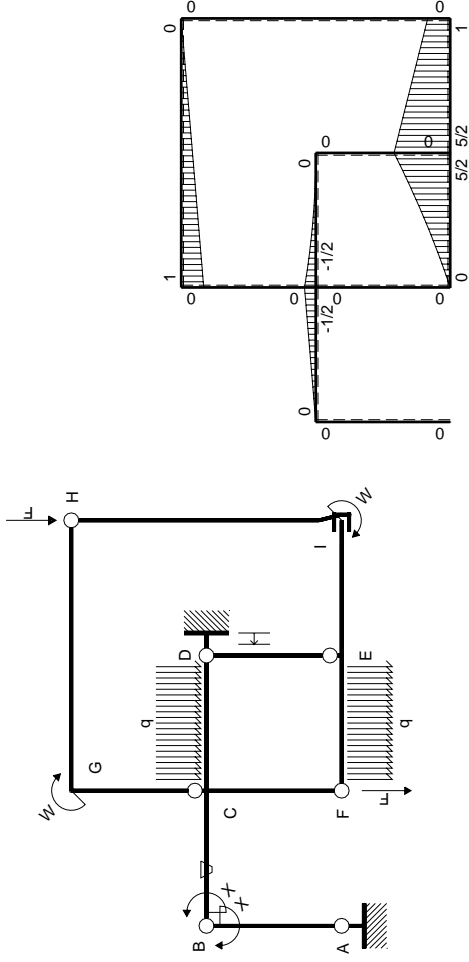
$$L_{DC}^{xo} = \int_0^b (1/4 x^3/b^3) Fb 1/EJ dx = [1/16 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/16 b) Fb 1/EJ = 1/16 Fb^2/EJ$$



- A = 936. mm²
- J_u = 274232. mm⁴
- J_v = 49248. mm⁴
- y_g = 21.65 mm
- T_y = -3105. N
- M_x = 1831950. Nmm
- x_m = 24. mm
- y_m = 56. mm
- u_m = 6. mm
- v_m = 34.35 mm
- σ_m = -Mv/J_u = -229.4 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 19.35 mm
- σ_c = -Mv/J_u = -129.2 N/mm²
- τ_c = 4.56 N/mm²
- σ_q = √σ²+3τ² = 129.5 N/mm²
- S = 4832. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-1/2Fx$	$-Fb/EJ$	$1/2Fx-1/4Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/6+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$1/2Fb-1/2Fx$	Fb/EJ	$1/4Fb-1/4Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-1/2Fb+Fx-1/2qx^2$	0	$1/4Fb-3/4Fx+3/4Fx^2/b-1/4qx^3/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/16+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$1/2qx^2$	0	$1/4qx^3/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
FE b	0	$-2Fx-1/2qx^2$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx$	0	0	0	0	0+0	0
EI b	0	$-5/2Fb+3/2Fx$	0	0	0	0		
D	cedimento nodo $-H_{1D}u_D$						$-Fb^2/EJ$	
	totali						$-1/48Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$1/48Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/12 b) Fb 1/EJ + (b - 1/4 b) \theta = 11/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/4 - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/4 x - 1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/12 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 11/12 Fb^2/EJ$$

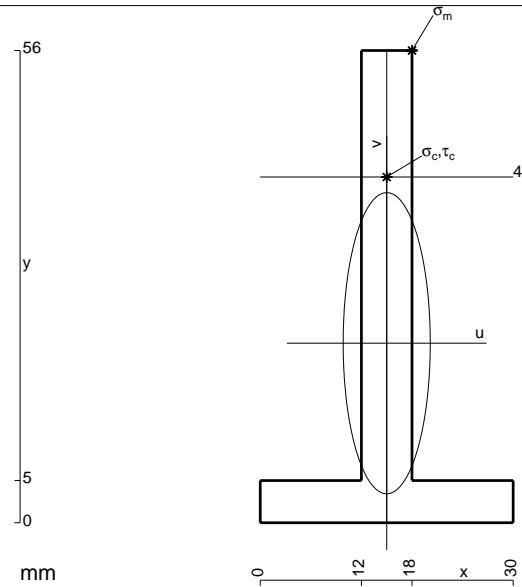
$$L_{CD}^{xo} = \int_0^b (1/4 - 3/4 x/b + 3/4 x^2/b^2 - 1/4 x^3/b^3) Fb 1/EJ dx$$

$$= [1/4 x - 3/8 x^2/b + 1/4 x^3/b^2 - 1/16 x^4/b^3]_0^b Fb 1/EJ$$

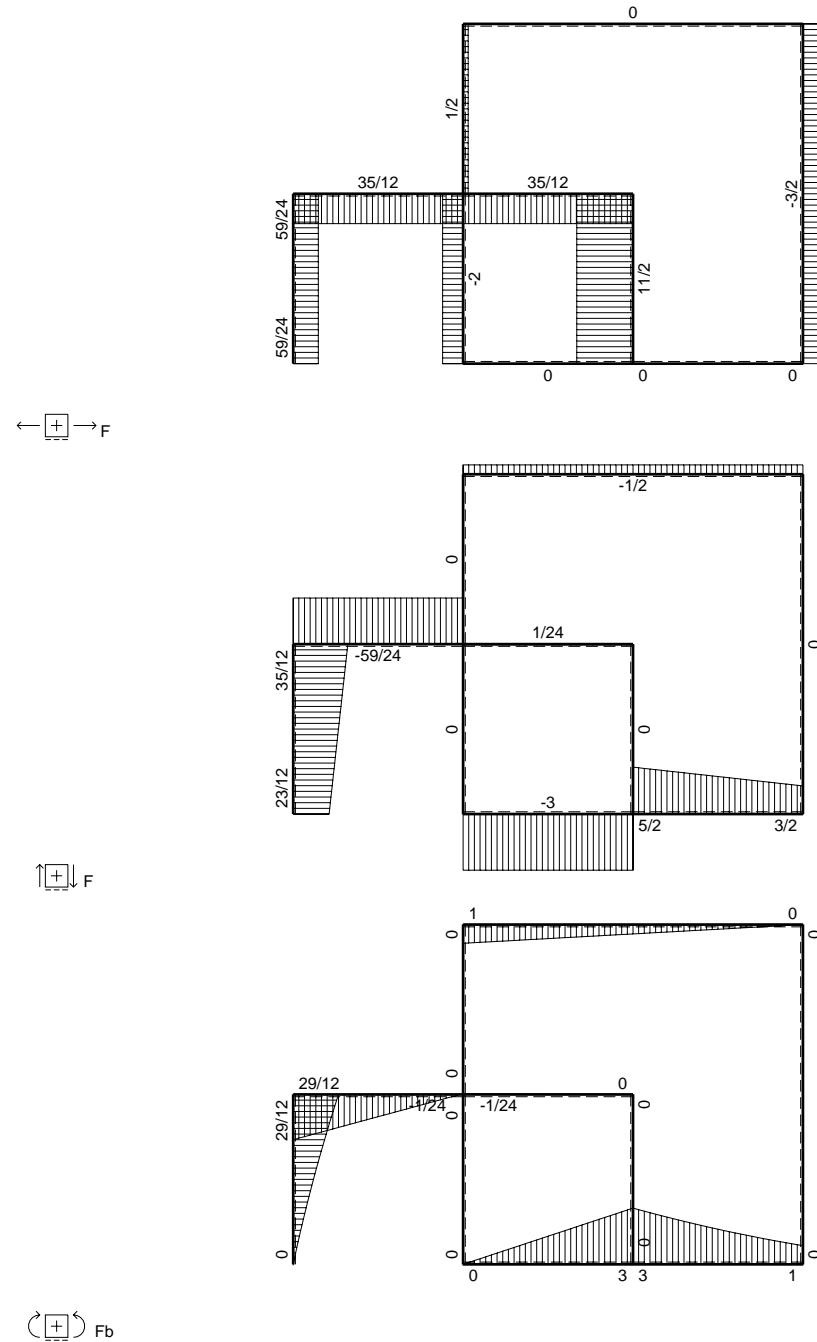
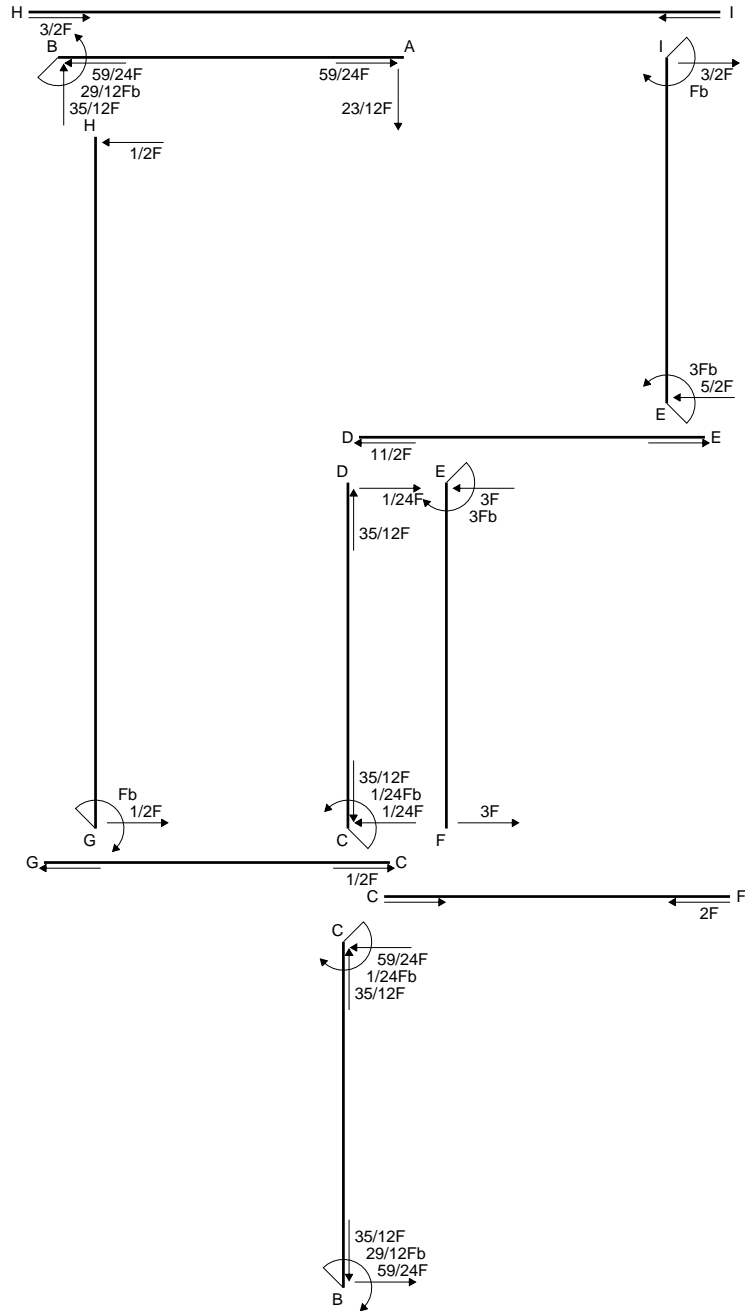
$$= (1/4 b - 3/8 b + 1/4 b - 1/16 b) Fb 1/EJ = 1/16 Fb^2/EJ$$

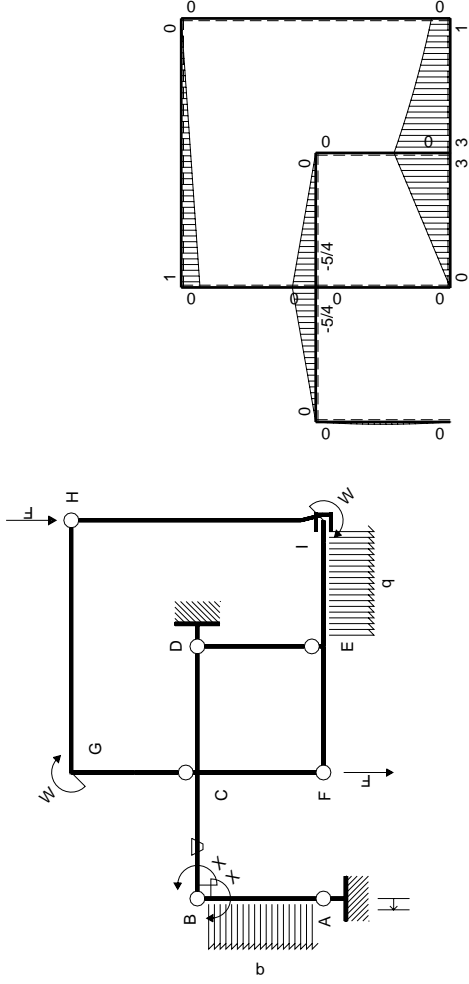
$$L_{DC}^{xo} = \int_0^b (1/4 x^3/b^3) Fb 1/EJ dx = [1/16 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/16 b) Fb 1/EJ = 1/16 Fb^2/EJ$$



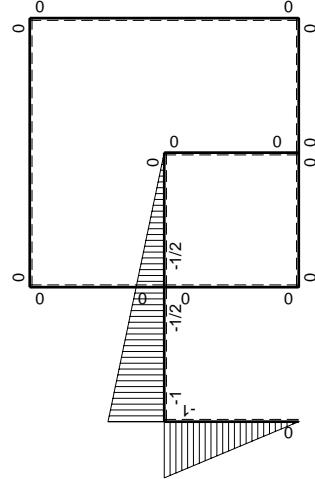
- A = 456. mm²
- J_u = 145554. mm⁴
- J_v = 12168. mm⁴
- y_g = 21.29 mm
- T_y = -1860. N
- M_x = 992000. Nmm
- x_m = 18. mm
- y_m = 56. mm
- u_m = 3. mm
- v_m = 34.71 mm
- σ_m = -Mv/J_u = -236.6 N/mm²
- x_c = 15. mm
- y_c = 41. mm
- v_c = 19.71 mm
- σ_c = -Mv/J_u = -134.3 N/mm²
- τ_c = 5.216 N/mm²
- σ_q = √σ²+3τ² = 134.6 N/mm²
- S = 2449. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$3Fb-3Fx$	0	0	0	0	0+0	0
FE b	0	$-3Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$29/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-29/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{x_0} = \int_0^b (1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BA}^{x_0} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BC}^{x_0} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (5/8 b - 5/24 b) Fb 1/EJ + (b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

$$L_{CB}^{x_0} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

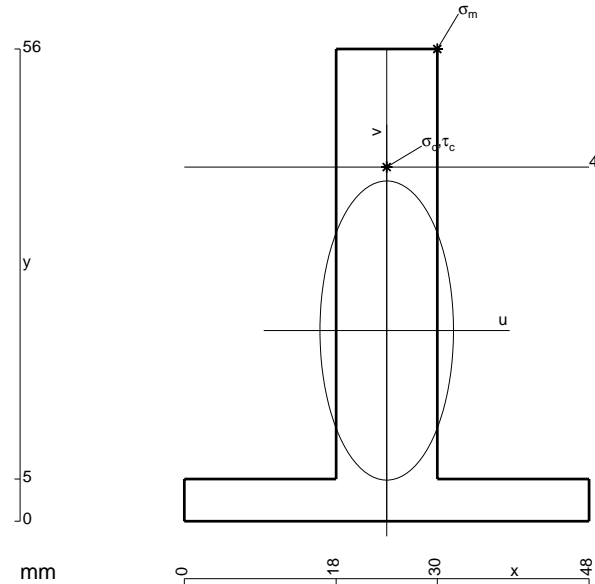
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

$$L_{CD}^{x_0} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

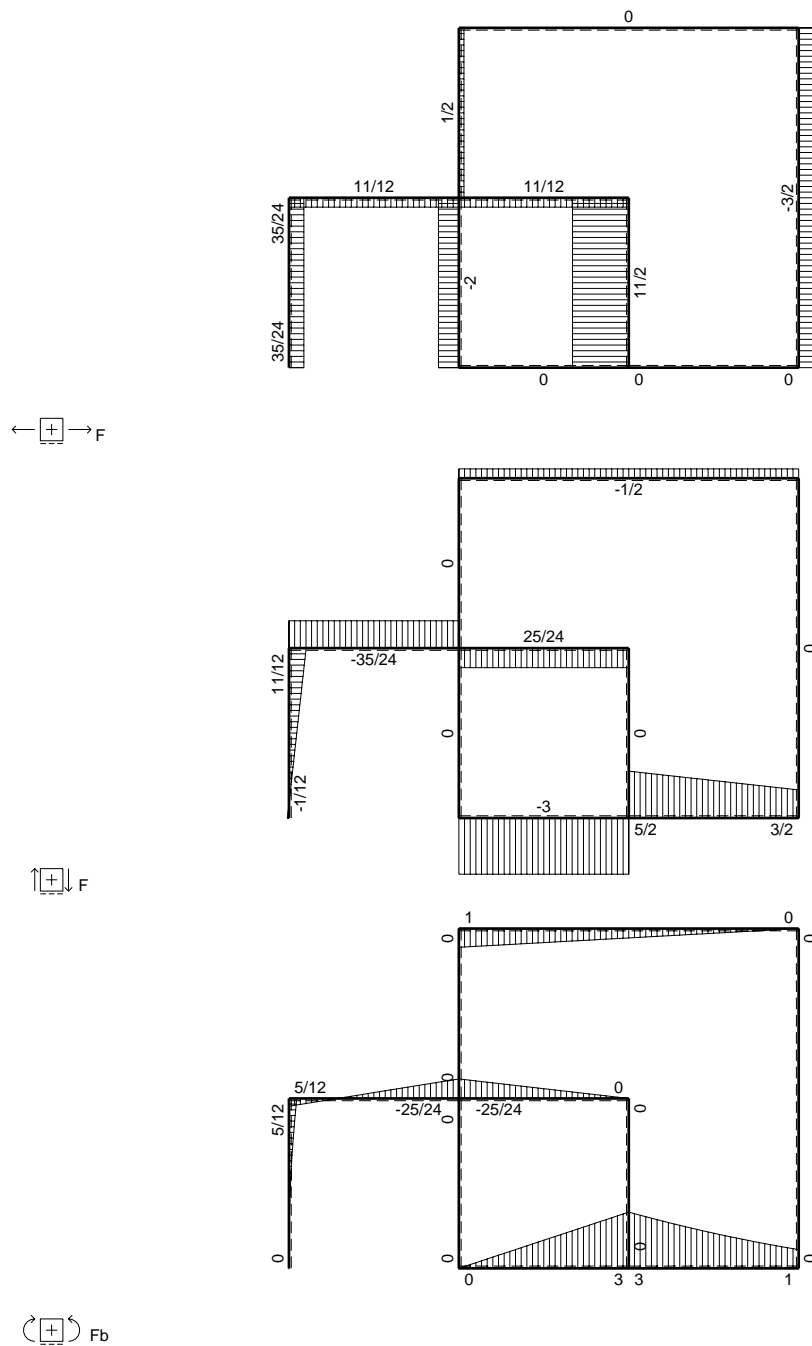
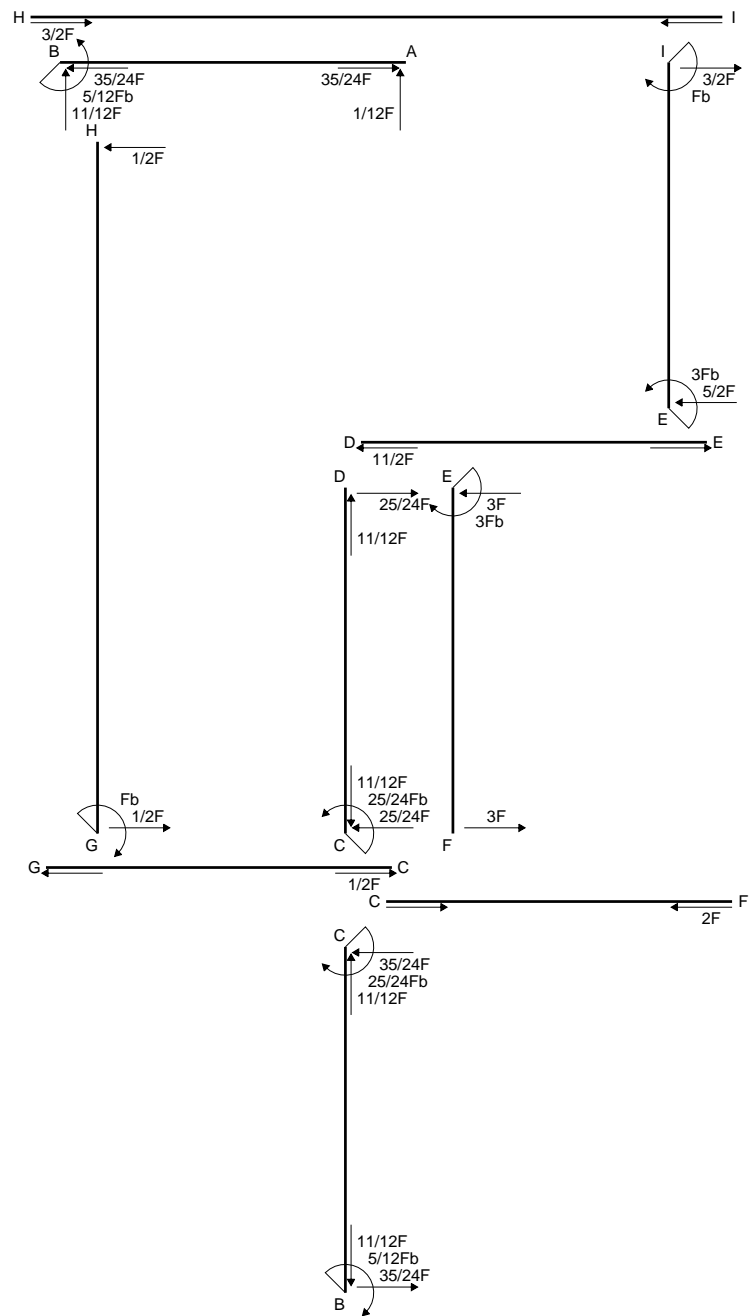
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

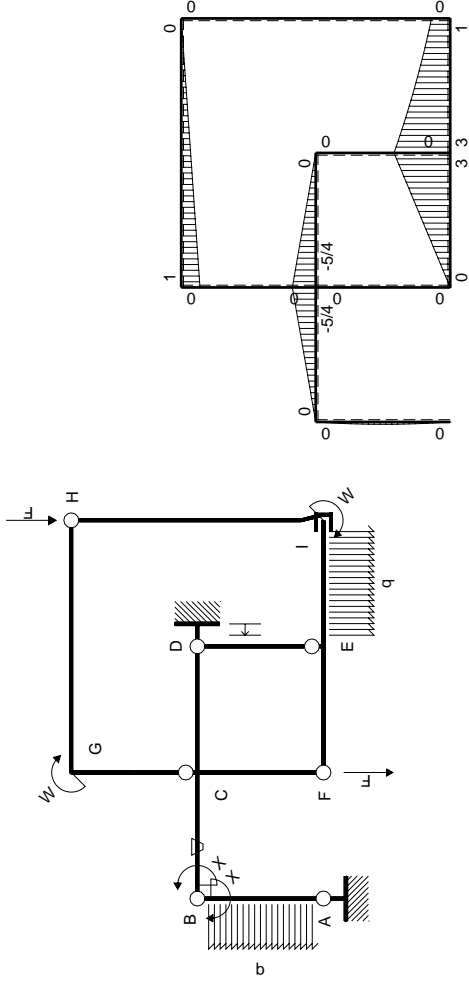
$$L_{DC}^{x_0} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



- A = 852. mm²
- J_u = 268308. mm⁴
- J_v = 53424. mm⁴
- y_g = 22.61 mm
- T_y = -2310. N
- M_x = 1593900. Nmm
- x_m = 30. mm
- y_m = 56. mm
- u_m = 6. mm
- v_m = 33.39 mm
- σ_m = -Mv/J_u = -198.3 N/mm²
- x_c = 24. mm
- y_c = 42. mm
- v_c = 19.39 mm
- σ_c = -Mv/J_u = -115.2 N/mm²
- τ_c = 3.181 N/mm²
- σ_σ = √σ²+3τ² = 115.3 N/mm²
- S = 4433. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$3Fb-3Fx$	0	0	0	0	0+0	0	
FE b	0	$-3Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$5/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-5/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{x_0} = \int_0^b (1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BA}^{x_0} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BC}^{x_0} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (5/8 b - 5/24 b) Fb 1/EJ + (b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

$$L_{CB}^{x_0} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

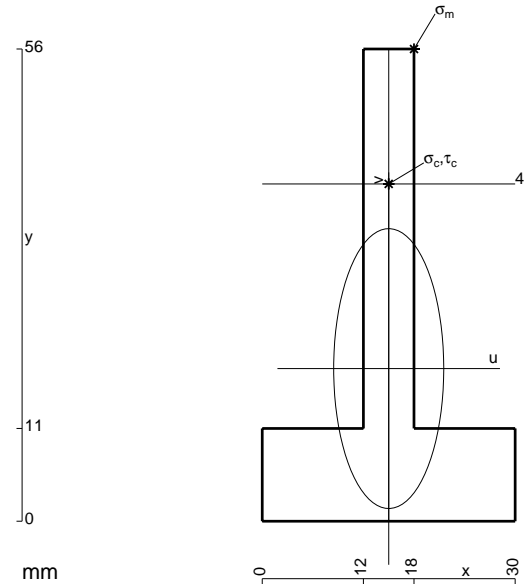
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

$$L_{CD}^{x_0} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

$$L_{DC}^{x_0} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



$$A = 600. \text{ mm}^2$$

$$J_u = 165314. \text{ mm}^4$$

$$J_v = 25560. \text{ mm}^4$$

$$y_g = 18.1 \text{ mm}$$

$$T_y = -1230. \text{ N}$$

$$M_x = 897900. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$y_m = 56. \text{ mm}$$

$$u_m = 3. \text{ mm}$$

$$v_m = 37.9 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -205.9 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

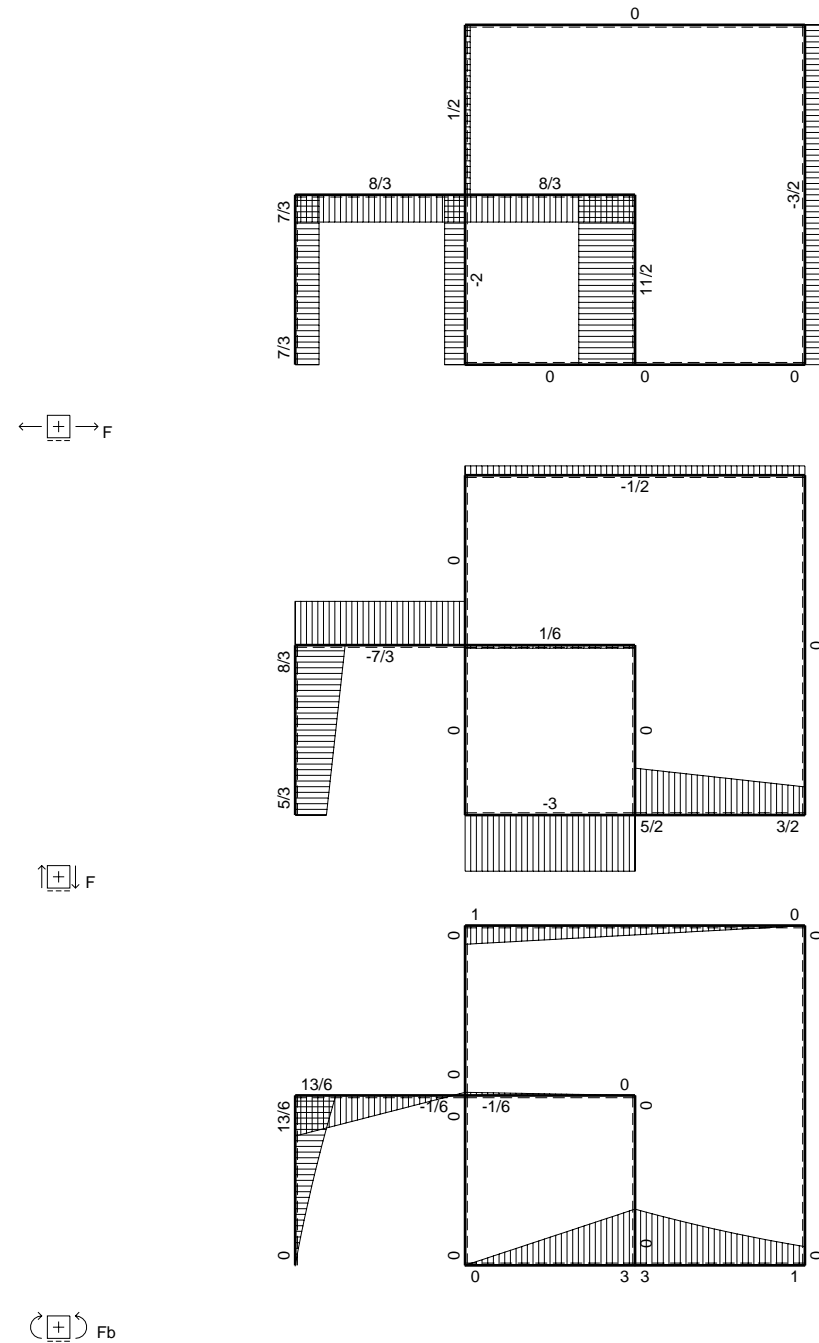
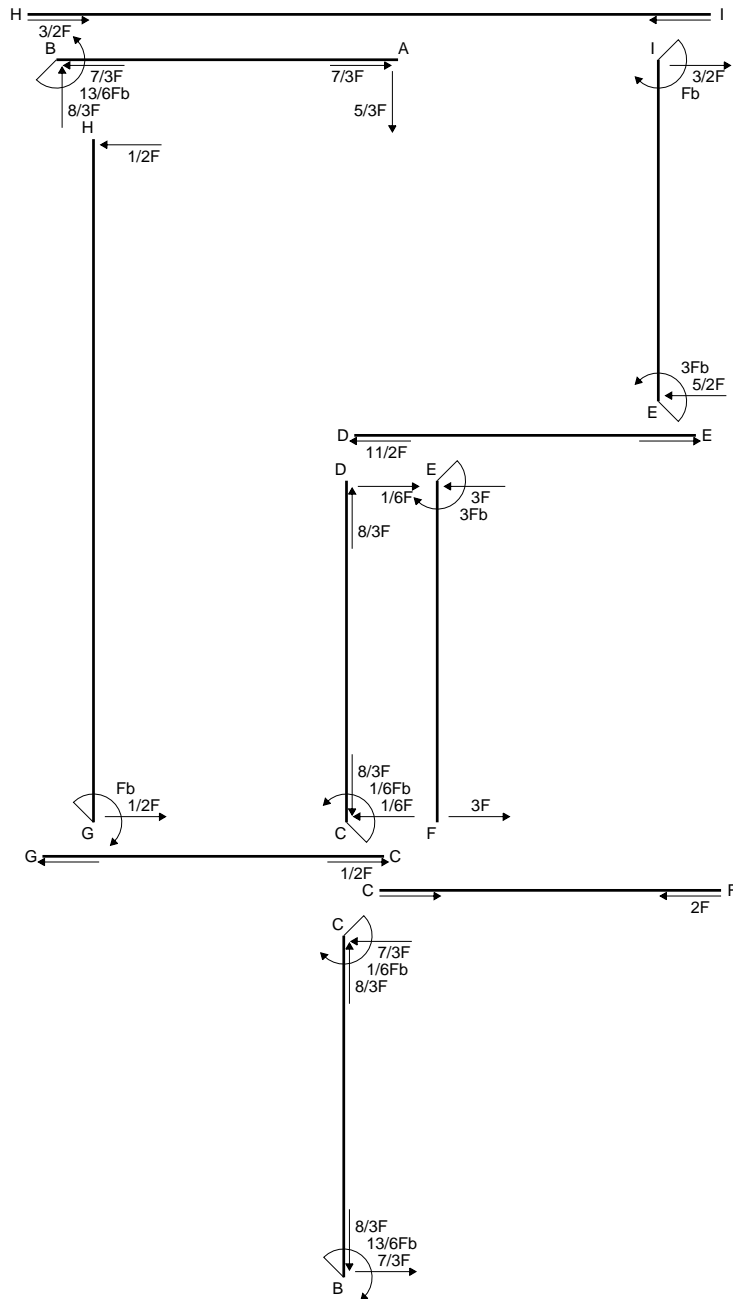
$$v_c = 21.9 \text{ mm}$$

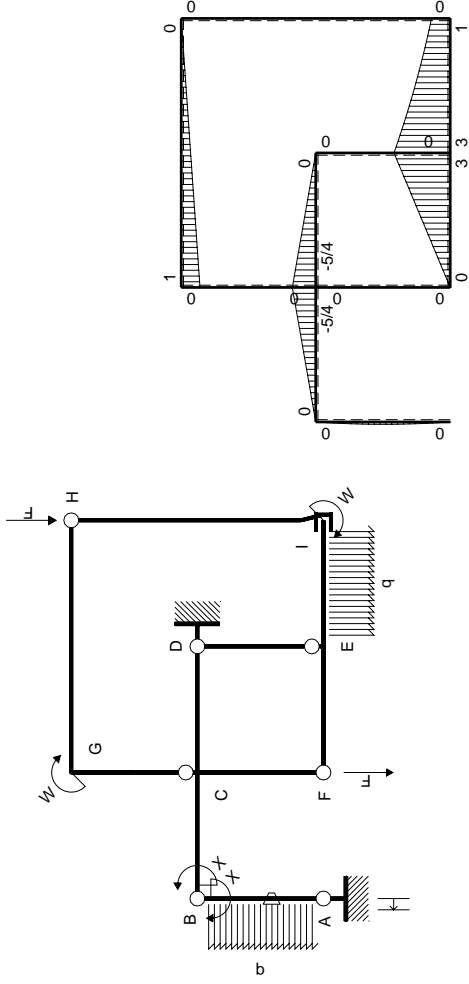
$$\sigma_c = -Mv/J_u = -118.9 \text{ N/mm}^2$$

$$\tau_c = 3.559 \text{ N/mm}^2$$

$$\sigma_\varrho = \sqrt{\sigma^2 + 3\tau^2} = 119.1 \text{ N/mm}^2$$

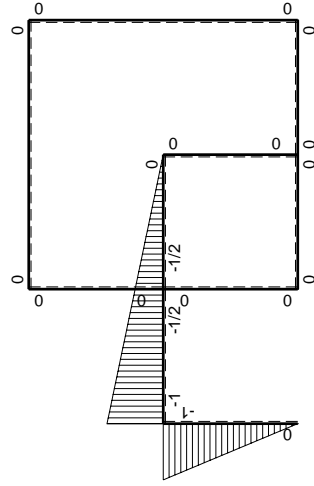
$$S = 2870. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$3Fb-3Fx$	0	0	0	0	0+0	0
FE b	0	$-3Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$13/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-13/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

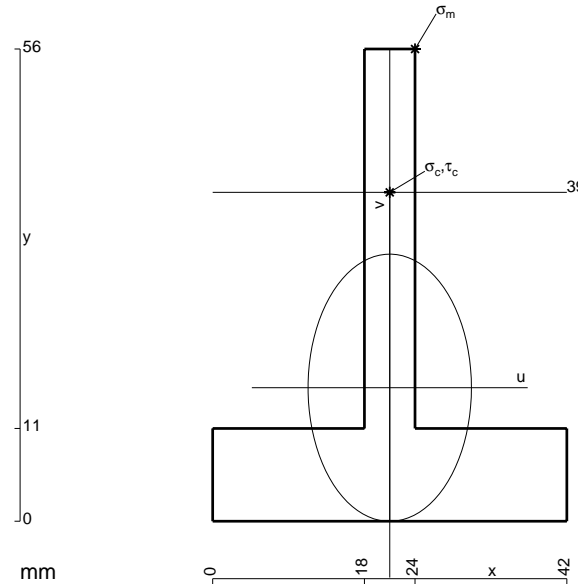
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

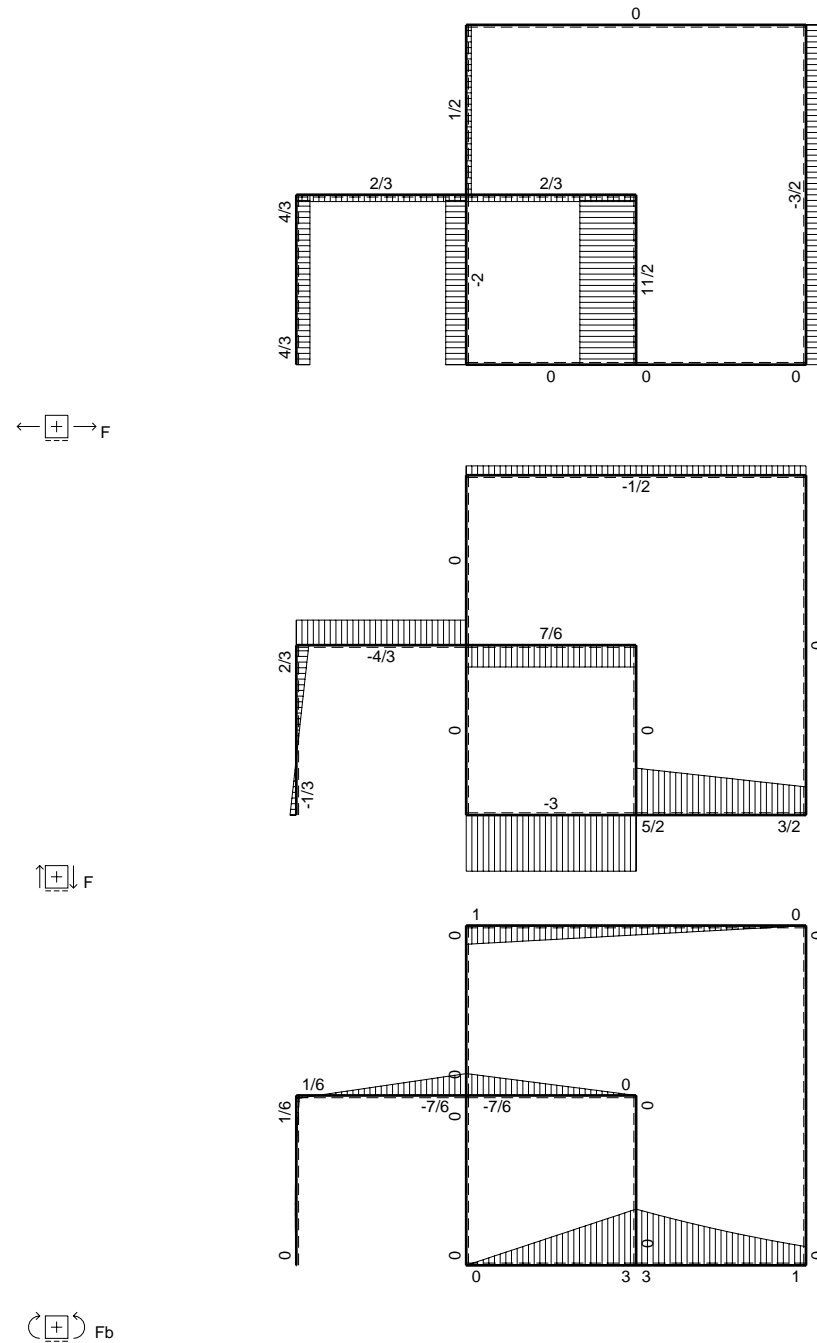
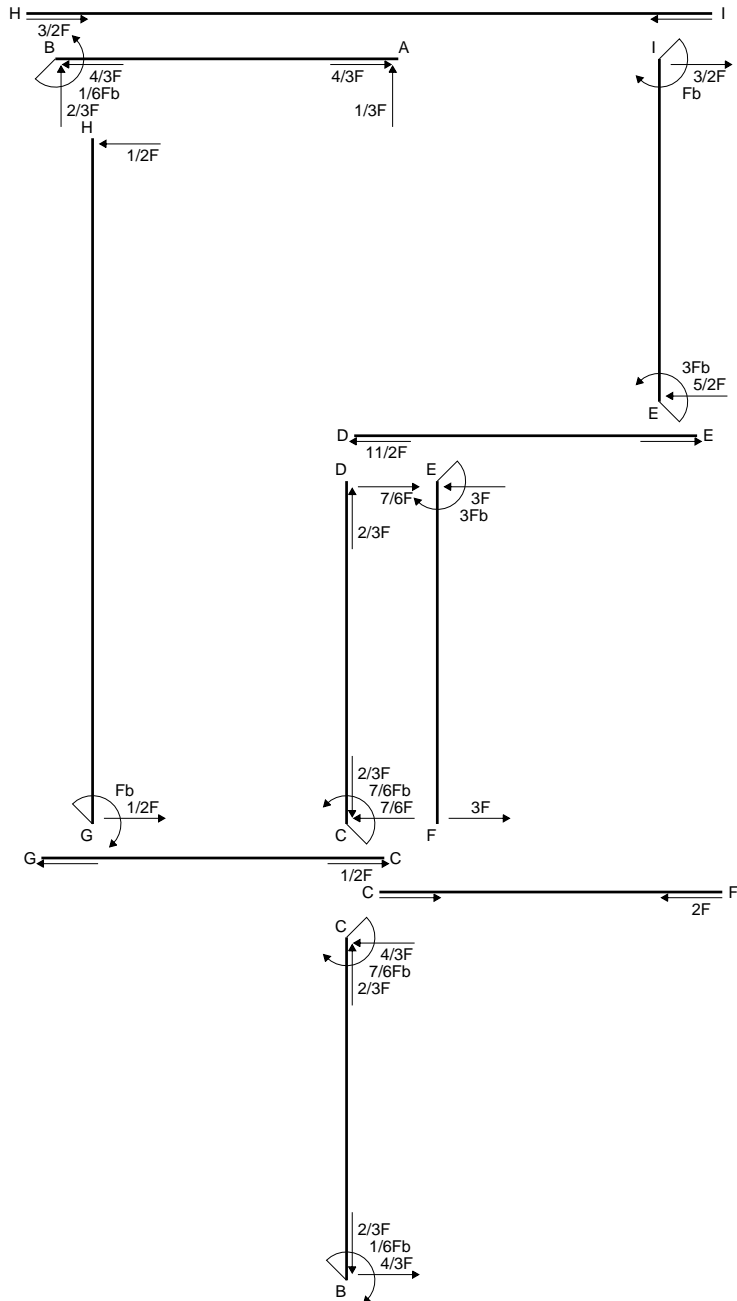
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

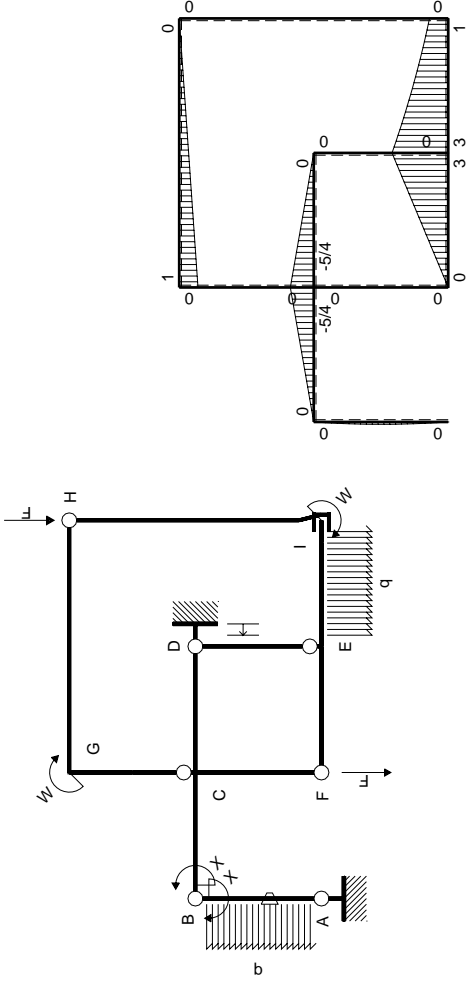
$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



- A = 732. mm²
- J_u = 183822. mm⁴
- J_v = 68724. mm⁴
- y_g = 15.83 mm
- T_y = -1290. N
- M_x = 1006200. Nmm
- x_m = 24. mm
- y_m = 56. mm
- u_m = 3. mm
- v_m = 40.17 mm
- σ_m = -Mv/J_u = -219.9 N/mm²
- x_c = 21. mm
- y_c = 39. mm
- v_c = 23.17 mm
- σ_c = -Mv/J_u = -126.8 N/mm²
- τ_c = 3.778 N/mm²
- σ_o = √σ²+3τ² = 127. N/mm²
- S = 3231. mm³



Legend for internal force diagrams:
 ◀ (+) → F (Normal force)
 ↑ (+) ↓ F (Shear force)
 (◻) (+) (◻) F_b (Bending moment)



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	$1/2Fx^2/b-1/2qx^3/b$	Fx/EJ	x^2/b^2	$(1/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	Fb/EJ	$1/2Fx-Fx^2/b+1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$3Fb-3Fx$	0	0	0	0	0+0	0	
FE b	0	$-3Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/6Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

$$= [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (1/6 b - 1/8 b) Fb 1/EJ + (1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 13/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

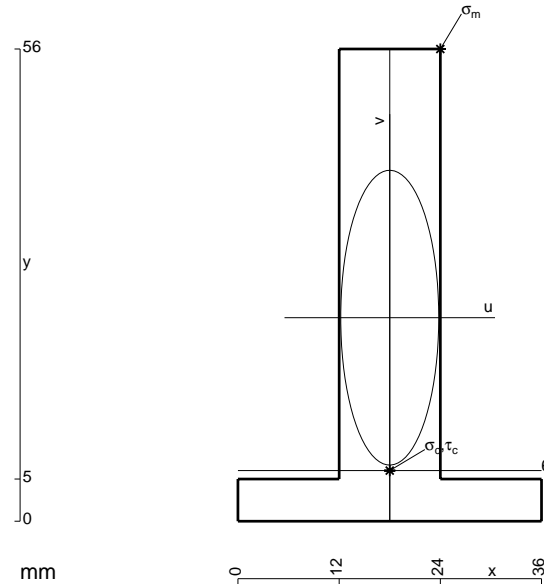
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

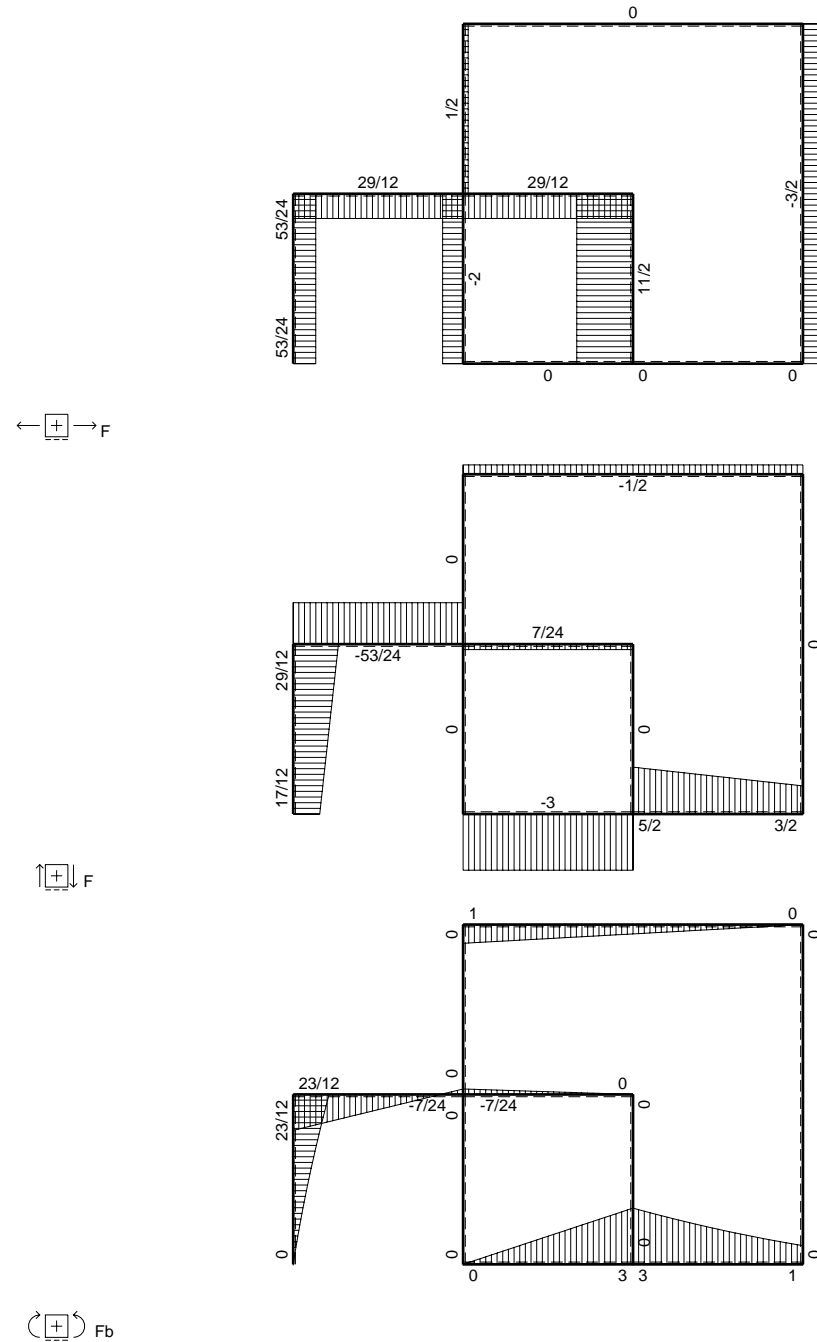
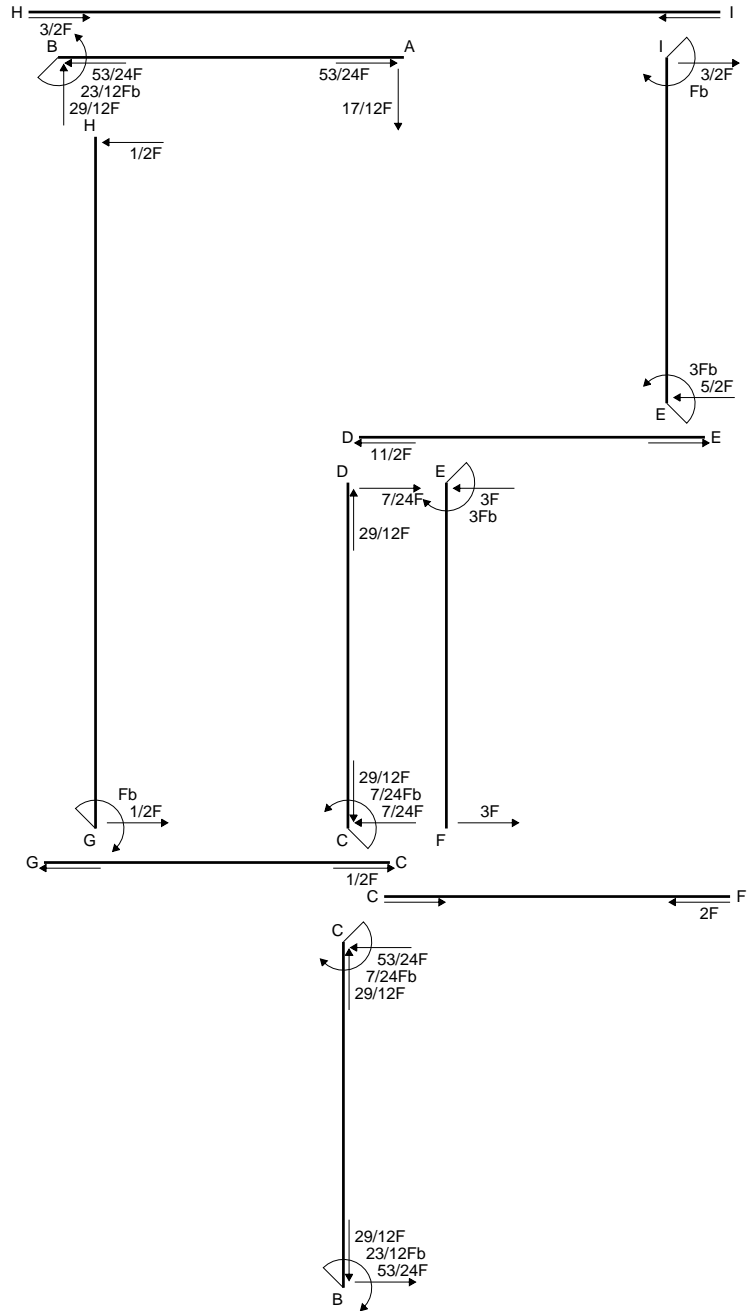
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

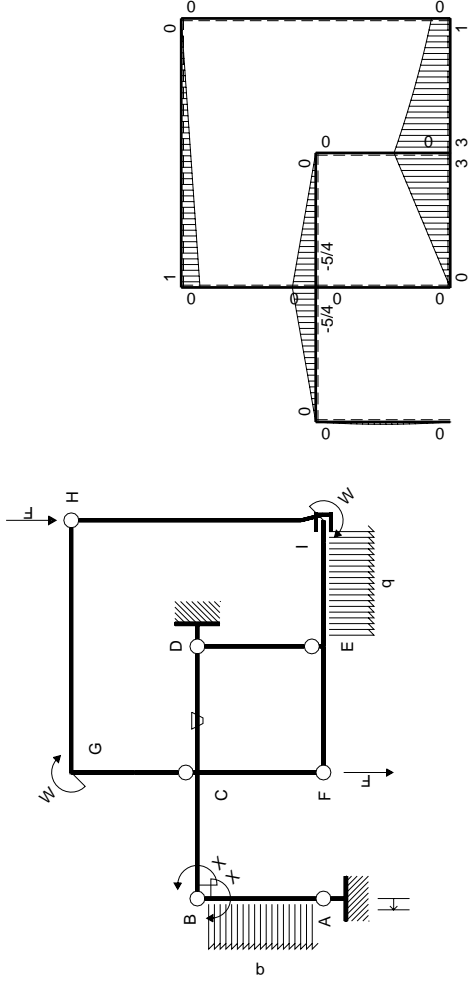
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



- A = 792. mm²
- J_u = 242073. mm⁴
- J_v = 26784. mm⁴
- y_g = 24.14 mm
- T_y = -2130. N
- M_x = 1746600. Nmm
- x_m = 24. mm
- y_m = 56. mm
- u_m = 6. mm
- v_m = 31.86 mm
- σ_m = -Mv/J_u = -229.9 N/mm²
- x_c = 18. mm
- y_c = 6. mm
- v_c = -18.14 mm
- σ_c = -Mv/J_u = 130.9 N/mm²
- τ_c = 3.02 N/mm²
- σ_o = √σ²+3τ² = 131. N/mm²
- S = 4118. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	$-Fb/EJ$	$5/8Fb-5/4Fx+5/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+1/4)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	Fb/EJ	$5/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$3Fb-3Fx$	0	0	0	0	0+0	0
FE b	0	$-3Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	0	0	0	0	0	0+0	0
GC b	0	0	0	0	0	0		
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/2Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$23/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-23/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

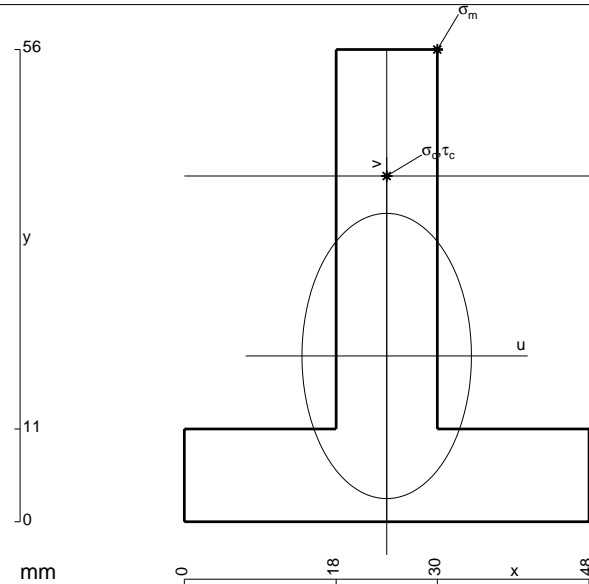
$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

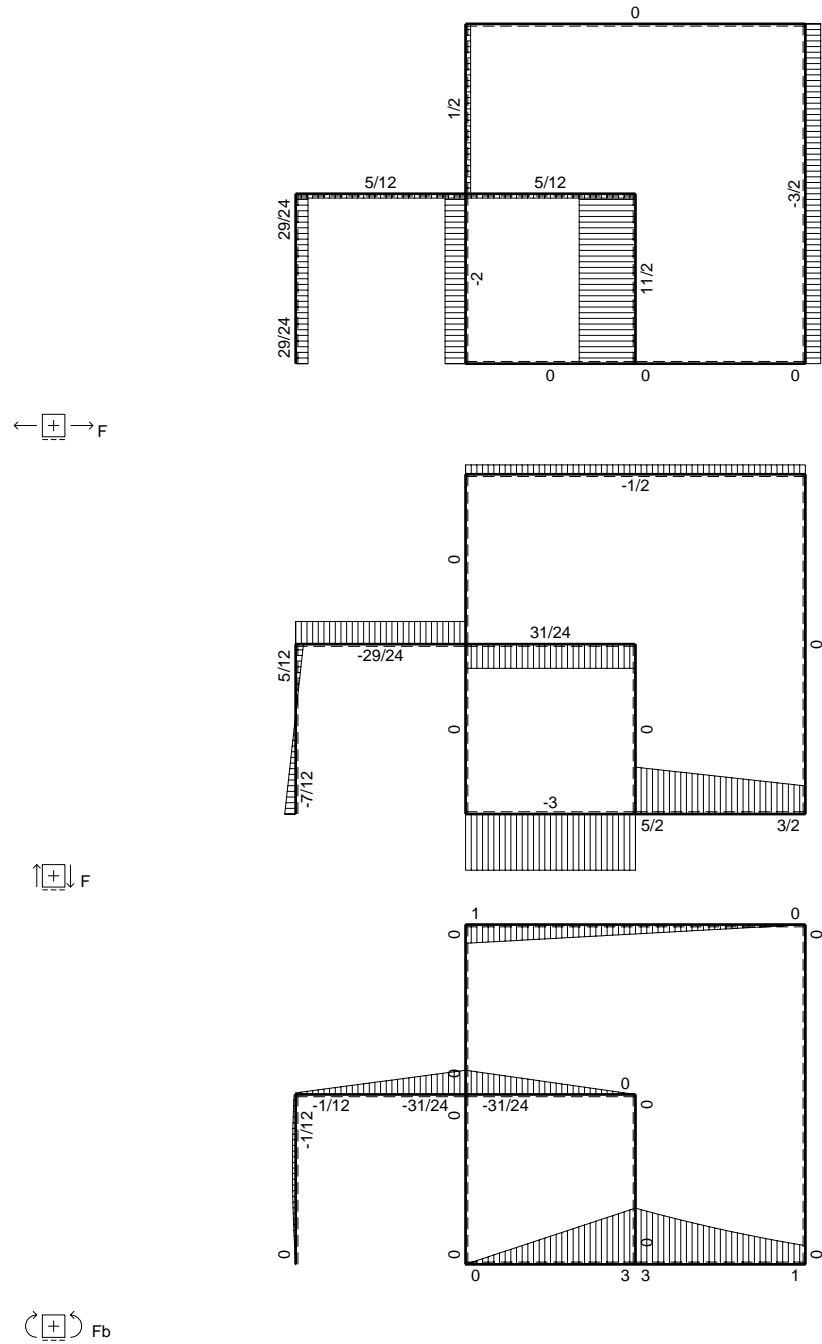
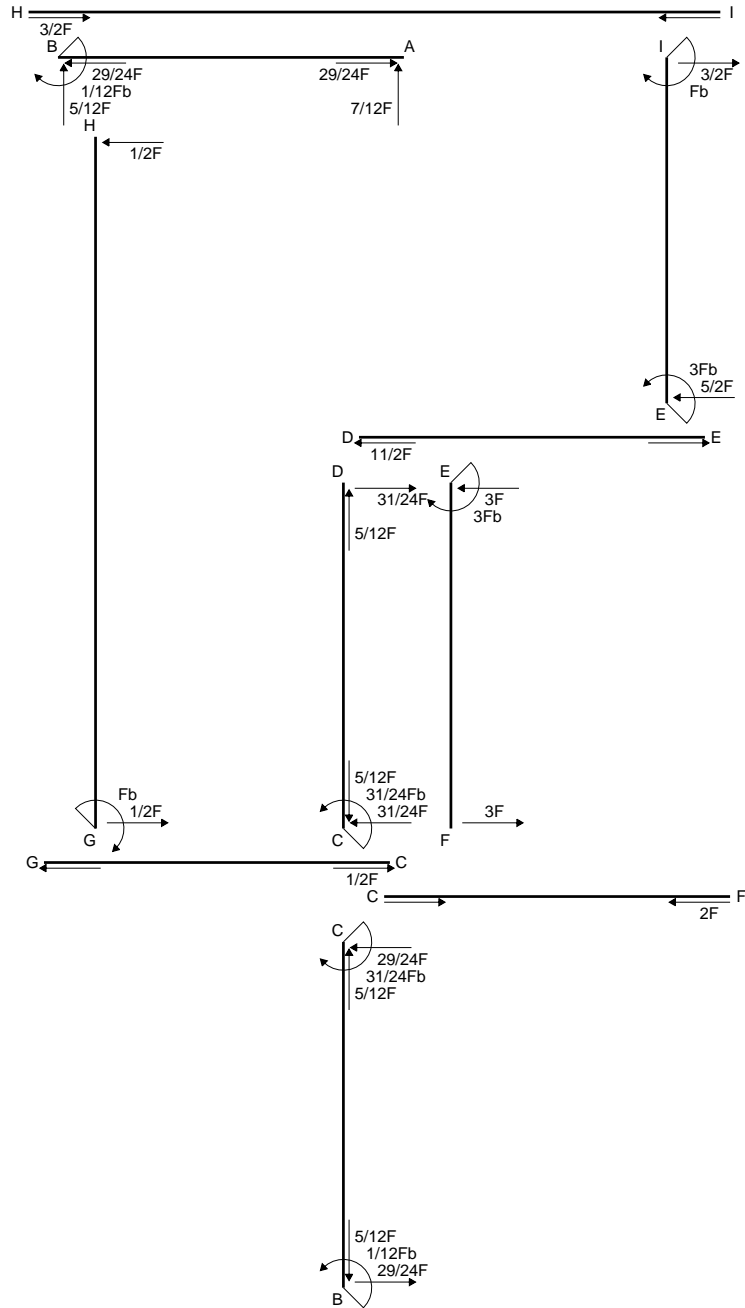
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 11/24 Fb^2/EJ$$

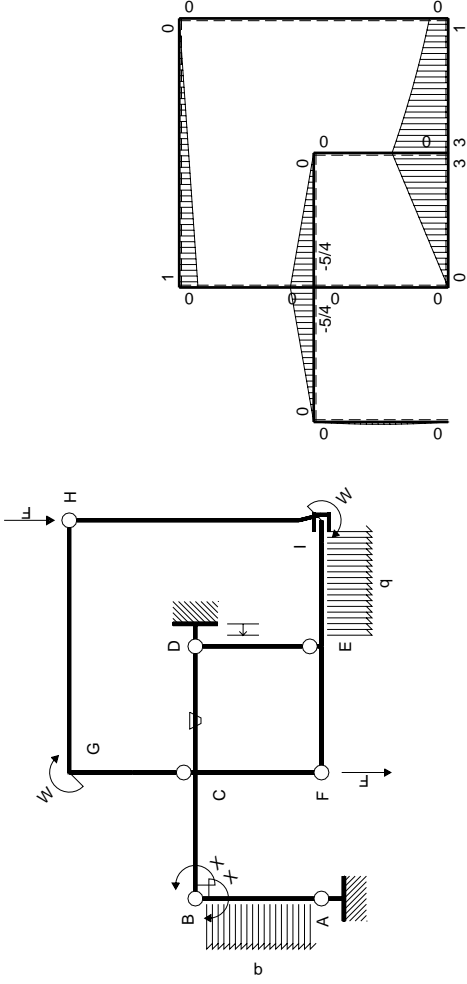
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (5/24 b) Fb 1/EJ + (-1/4 b) \theta = 11/24 Fb^2/EJ$$



- A = 1068. mm²
- J_u = 305751. mm⁴
- J_v = 107856. mm⁴
- y_g = 19.66 mm
- T_y = -2310. N
- M_x = 2009700. Nmm
- x_m = 30. mm
- y_m = 56. mm
- u_m = 6. mm
- v_m = 36.34 mm
- σ_m = -M_v/J_u = -238.9 N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 21.34 mm
- σ_c = -M_v/J_u = -140.3 N/mm²
- τ_c = 3.269 N/mm²
- σ_q = √σ²+3τ² = 140.4 N/mm²
- S = 5192. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	$-1/2Fx+1/2qx^2$	0	$1/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(1/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	$1/2Fx-1/2qx^2$	0	$1/2Fx-Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	$-Fb/EJ$	$5/8Fb-5/4Fx+5/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$5/4Fx$	Fb/EJ	$5/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$3Fb-3Fx$	0	0	0	0	0+0	0	
FE b	0	$-3Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	0	0	0	0	0	0+0	0	
GC b	0	0	0	0	0	0			
GH 2b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/2Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+3/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-3Fb+5/2Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/12Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/6 b - 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (1/2 x/b - x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [1/4 x^2/b - 1/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/3 b + 1/8 b) Fb 1/EJ = 1/24 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

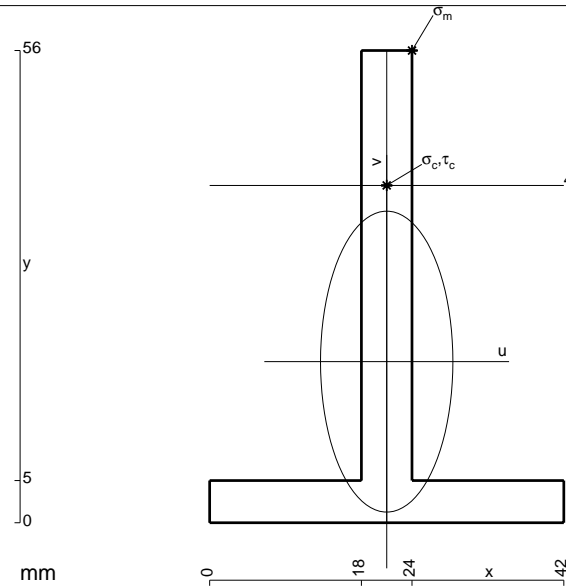
$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

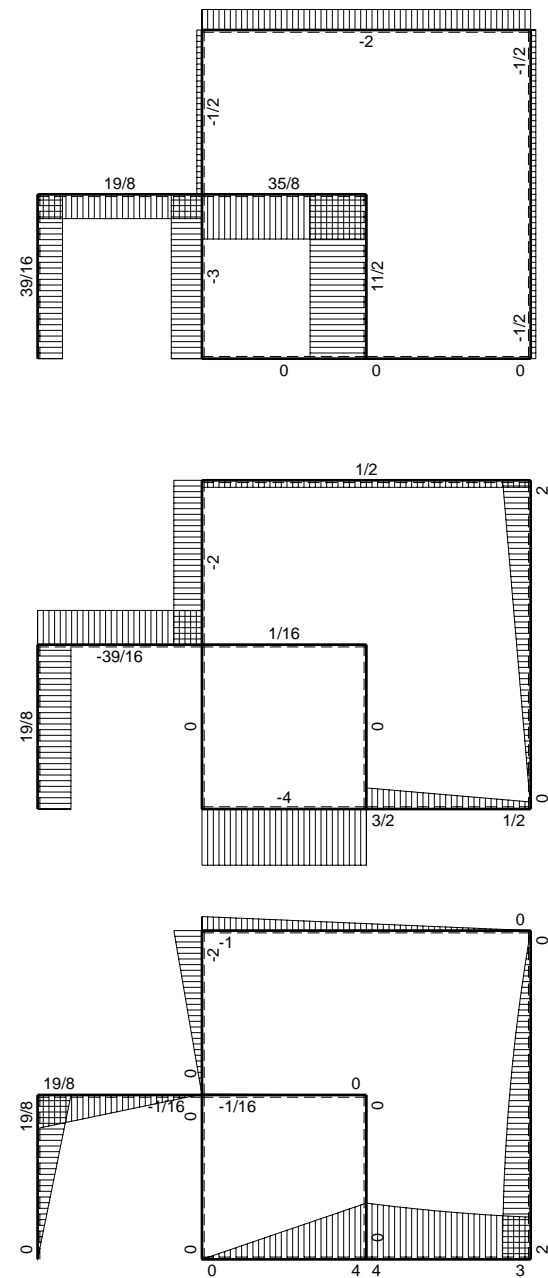
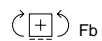
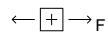
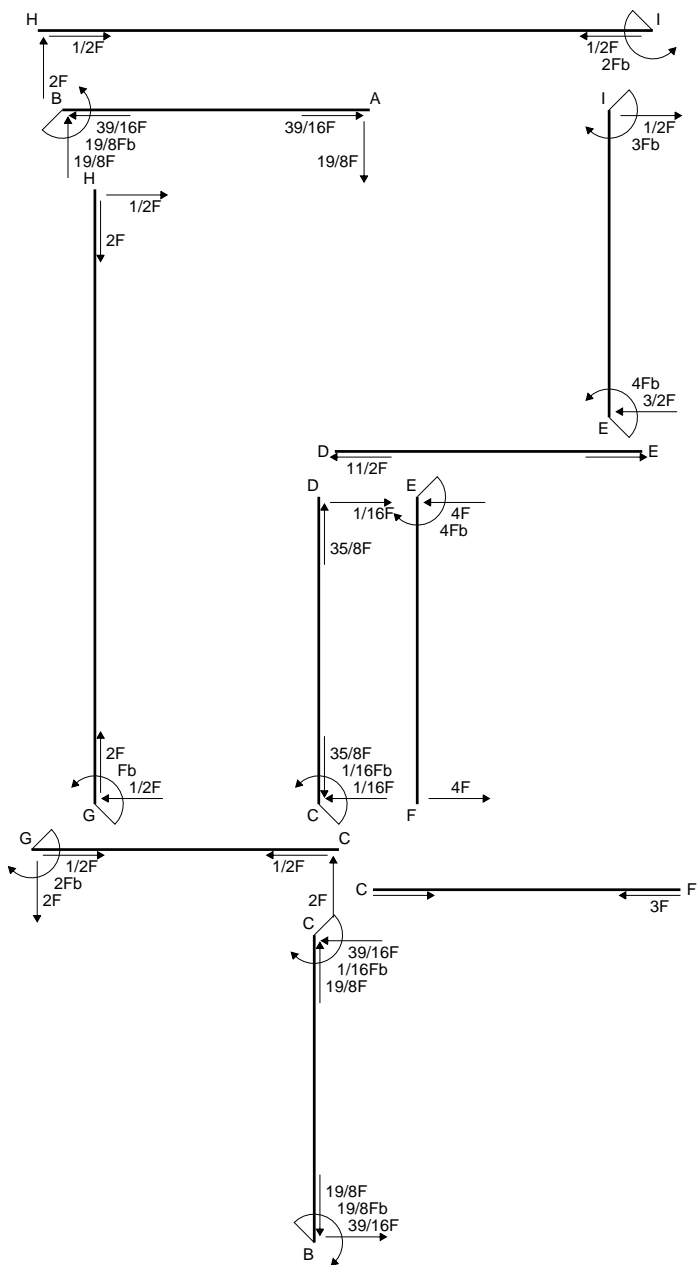
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 11/24 Fb^2/EJ$$

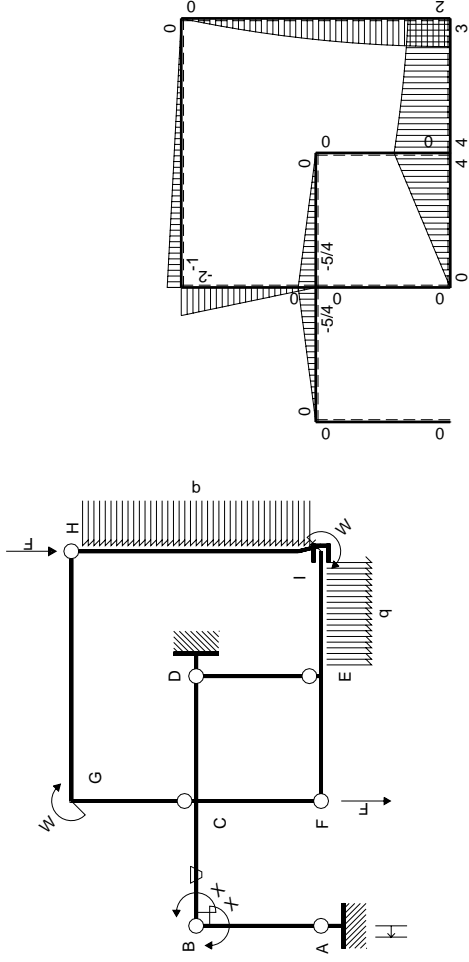
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (5/24 b) Fb 1/EJ + (-1/4 b) \theta = 11/24 Fb^2/EJ$$



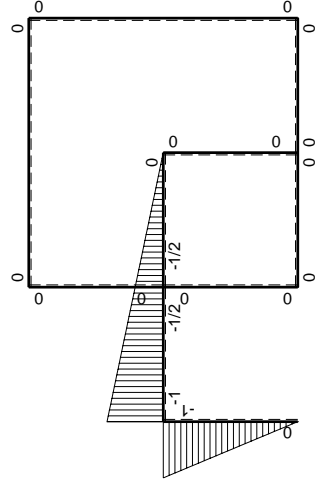
- A = 516. mm²
- J_u = 164398. mm⁴
- J_v = 31788. mm⁴
- y_g = 19.1 mm
- T_y = -1920. N
- M_x = 883200. Nmm
- x_m = 24. mm
- y_m = 56. mm
- u_m = 3. mm
- v_m = 36.9 mm
- $\sigma_m = -Mv/J_u = -198.2$ N/mm²
- x_c = 21. mm
- y_c = 40. mm
- v_c = 20.9 mm
- $\sigma_c = -Mv/J_u = -112.3$ N/mm²
- $\tau_c = 5.399$ N/mm²
- $\sigma_\varrho = \sqrt{\sigma^2 + 3\tau^2} = 112.6$ N/mm²
- S = 2774. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$4Fb-4Fx$	0	0	0	0	0+0	0
FE b	0	$-4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-4Fb+3/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$19/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-19/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (5/8 b - 5/24 b) Fb 1/EJ + (b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

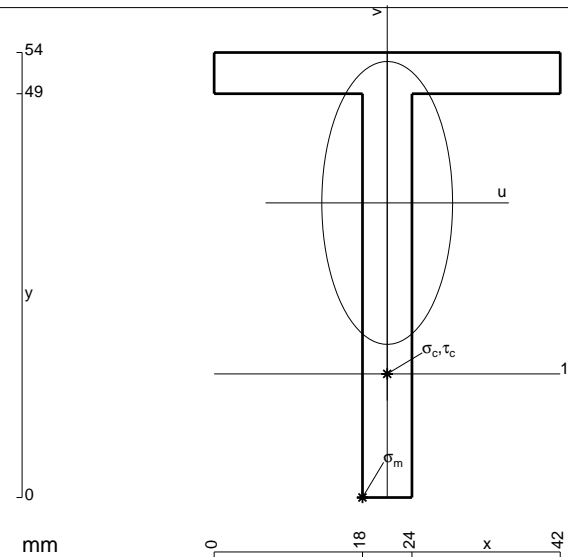
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



$$A = 504. \text{ mm}^2$$

$$J_u = 148565. \text{ mm}^4$$

$$J_v = 31752. \text{ mm}^4$$

$$y_g = 35.75 \text{ mm}$$

$$T_y = -1760. \text{ N}$$

$$M_x = 862400. \text{ Nmm}$$

$$x_m = 18. \text{ mm}$$

$$u_m = -3. \text{ mm}$$

$$v_m = -35.75 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 207.5 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 15. \text{ mm}$$

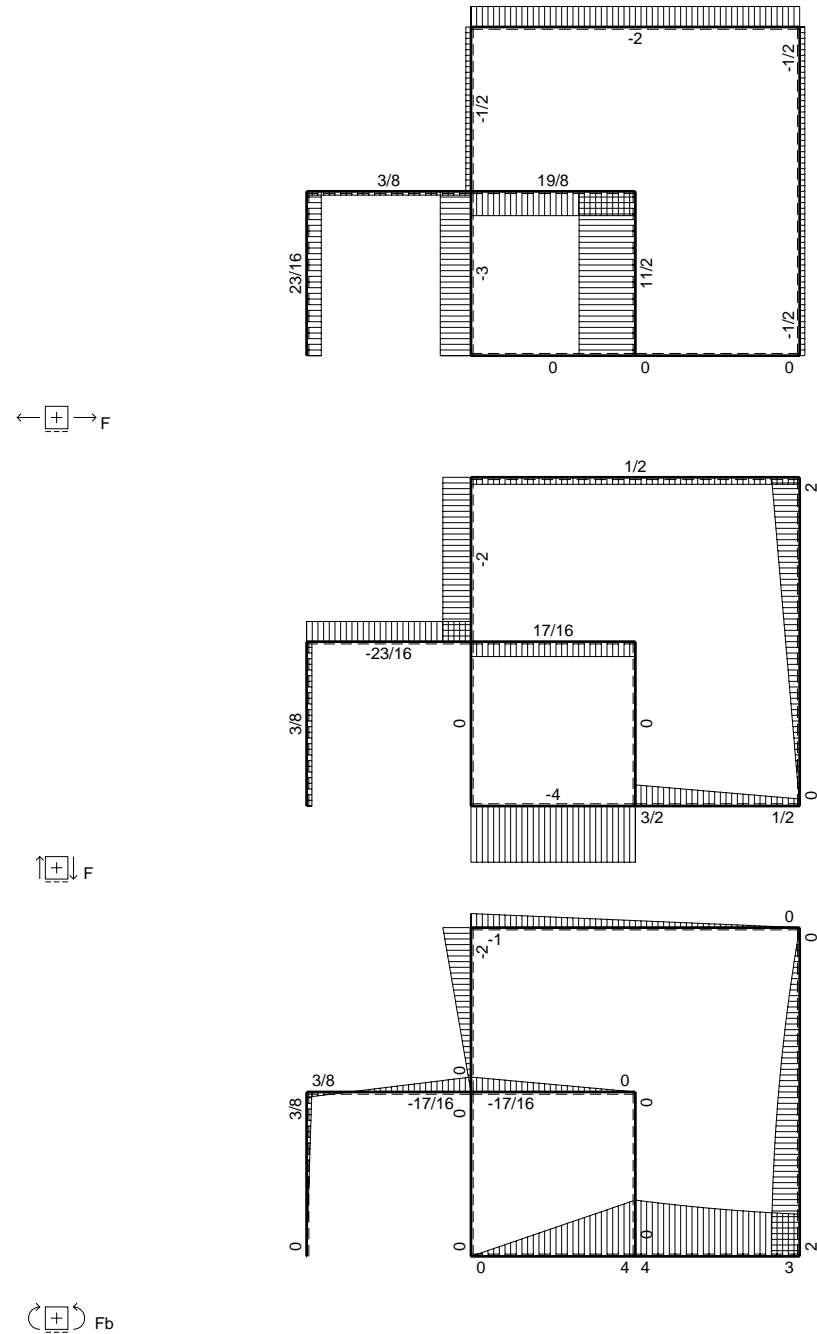
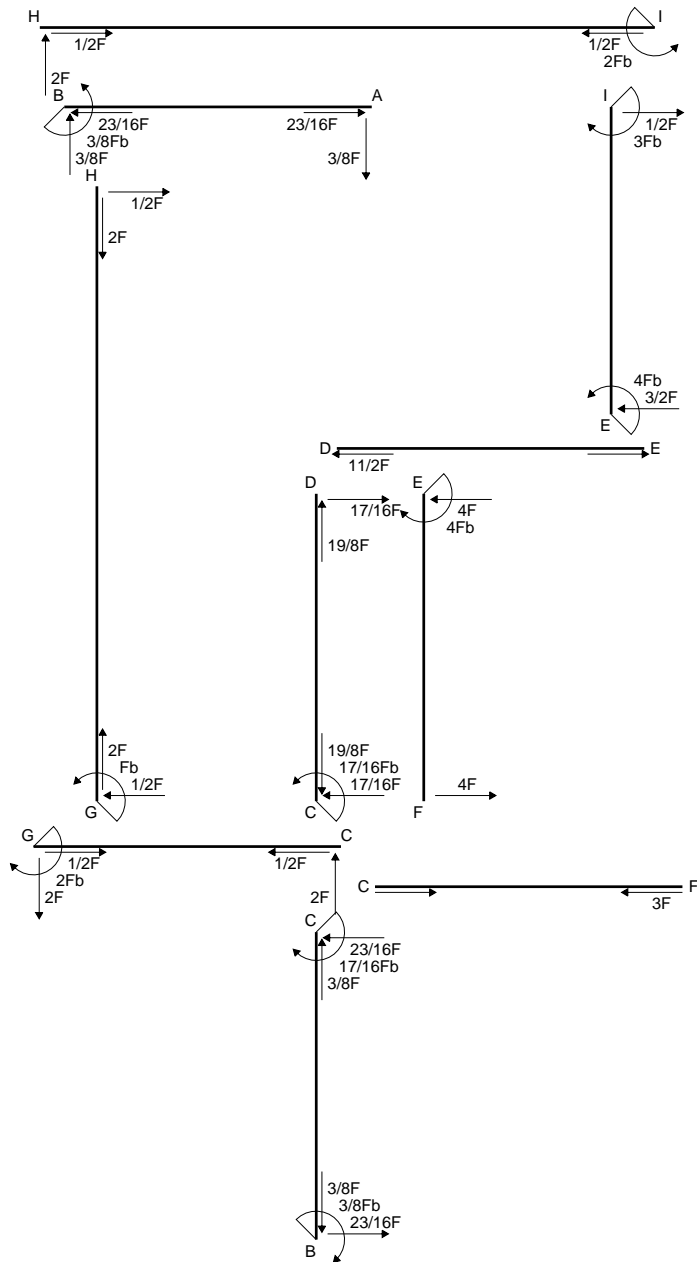
$$v_c = -20.75 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 120.5 \text{ N/mm}^2$$

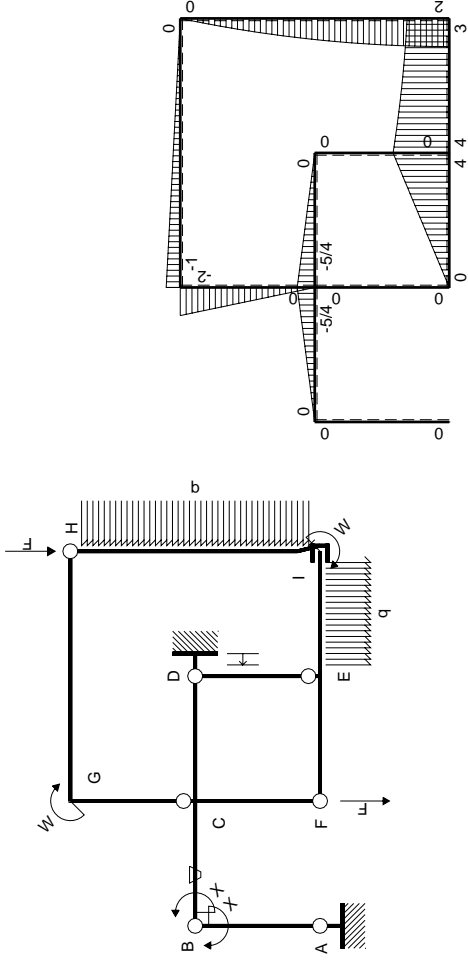
$$\tau_c = 5.02 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 120.8 \text{ N/mm}^2$$

$$S = 2543. \text{ mm}^3$$

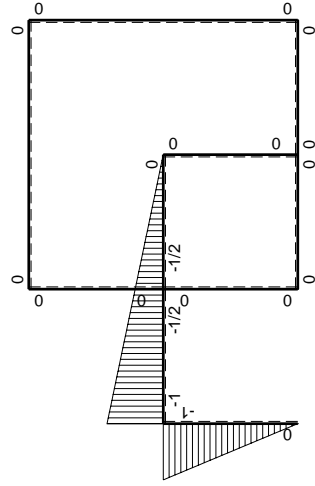


⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	$-Fb/EJ$	$5/4Fx-5/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(5/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	Fb/EJ	$5/8Fb-5/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$4Fb-4Fx$	0	0	0	0	0+0	0	
FE b	0	$-4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-4Fb+3/2Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$3/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-3/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (5/8 b - 5/24 b) Fb 1/EJ + (b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

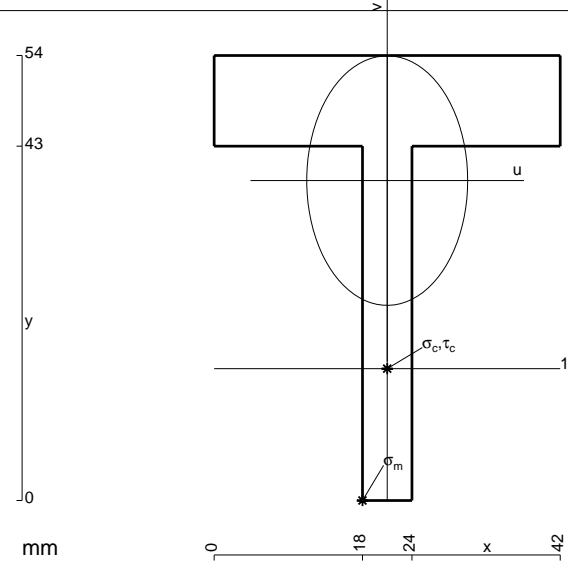
$$= (5/8 b - 5/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/6 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

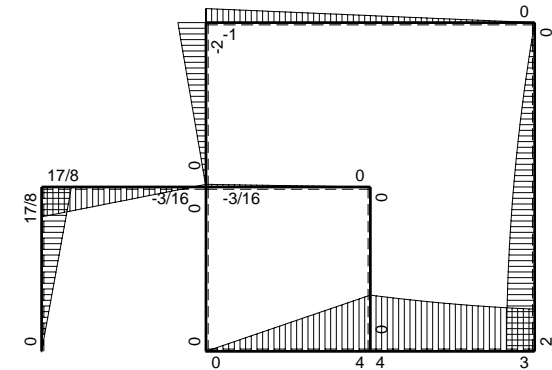
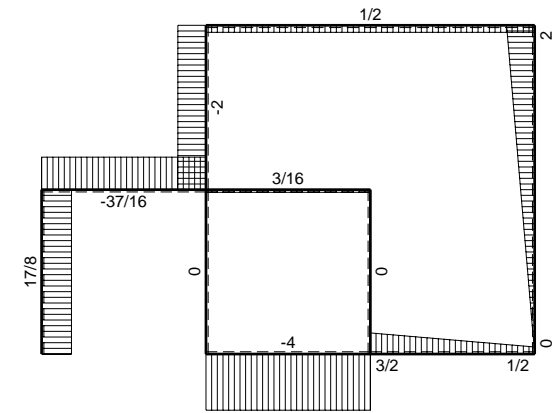
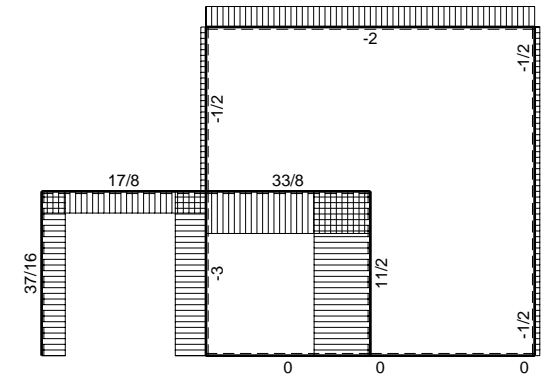
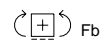
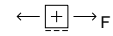
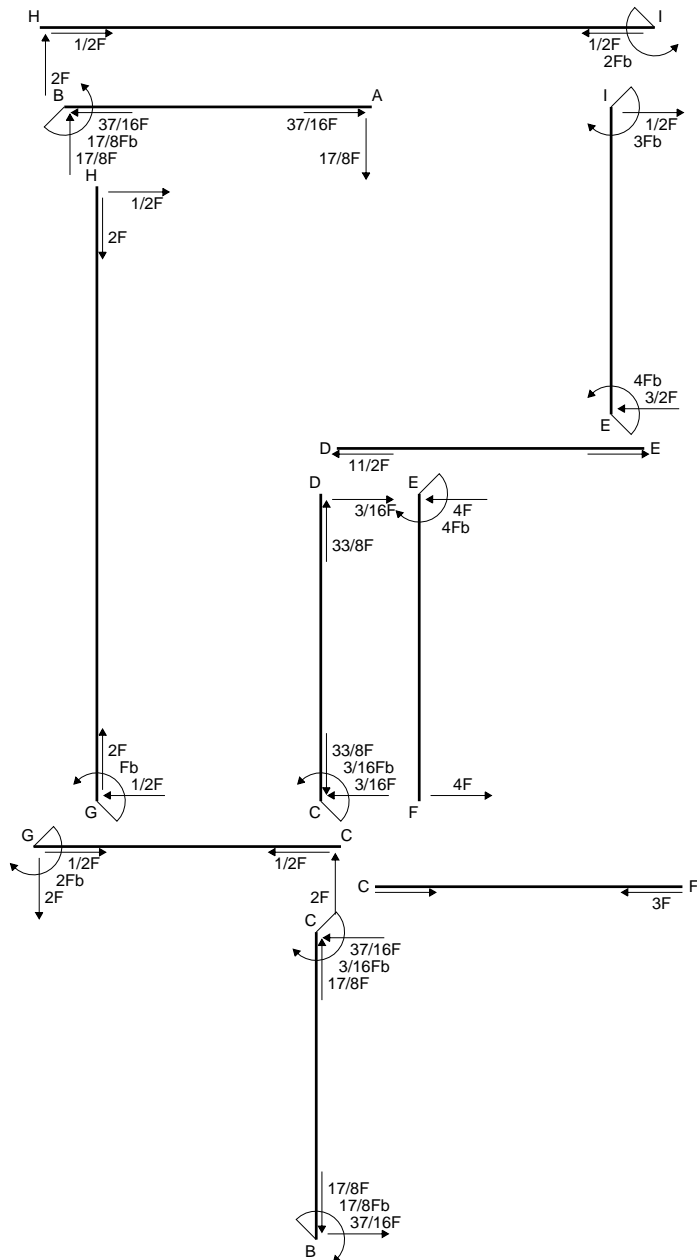
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

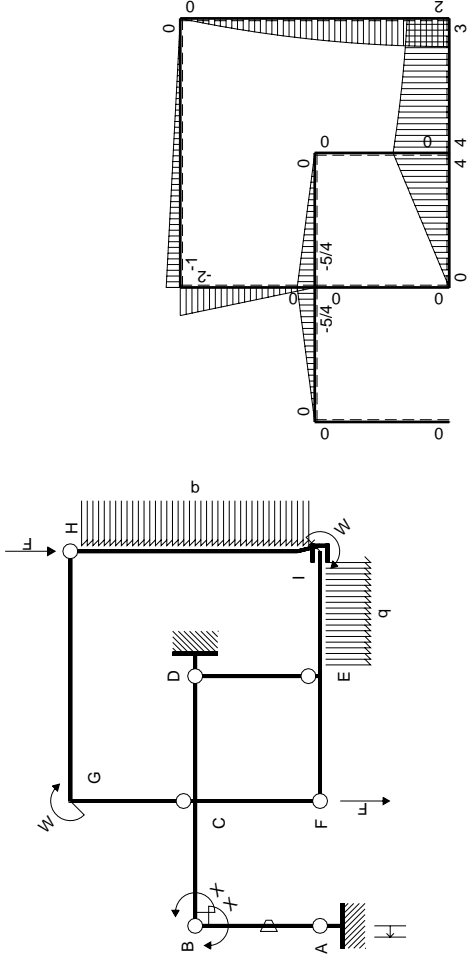
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



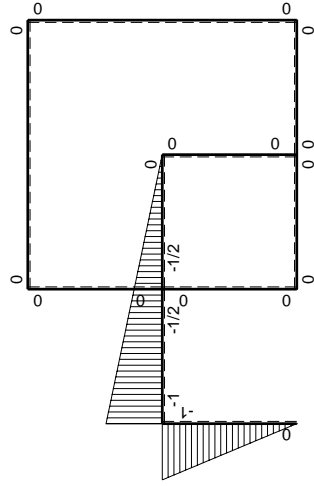
- A = 720. mm²
- J_u = 165098. mm⁴
- J_v = 68688. mm⁴
- y_g = 38.83 mm
- T_y = -1720. N
- M_x = 928800. Nmm
- x_m = 18. mm
- u_m = -3. mm
- v_m = -38.83 mm
- σ_m = -Mv/J_u = 218.4 N/mm²
- x_c = 21. mm
- y_c = 16. mm
- v_c = -22.83 mm
- σ_c = -Mv/J_u = 128.4 N/mm²
- τ_c = 5.138 N/mm²
- σ_o = √σ²+3τ² = 128.7 N/mm²
- S = 2959. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$4Fb-4Fx$	0	0	0	0	0+0	0
FE b	0	$-4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-2Fx$	0	0	0	0	0+0	0
GC b	0	$2Fb-2Fx$	0	0	0	0		
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0
HG 2b	0	$1/2Fx$	0	0	0	0		
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0		
IE b	0	$3Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-4Fb+3/2Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$17/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-17/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

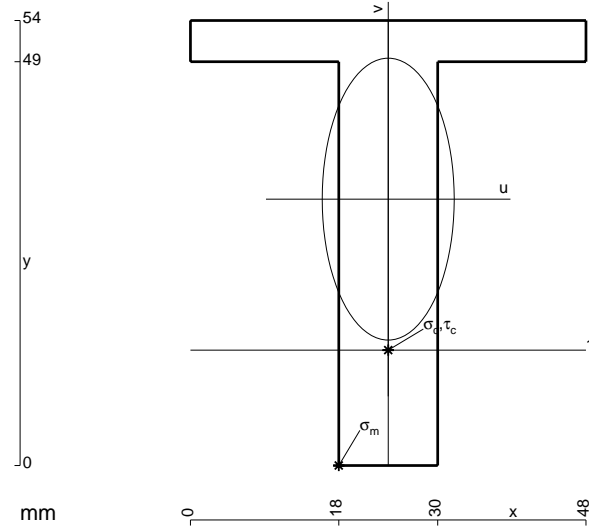
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

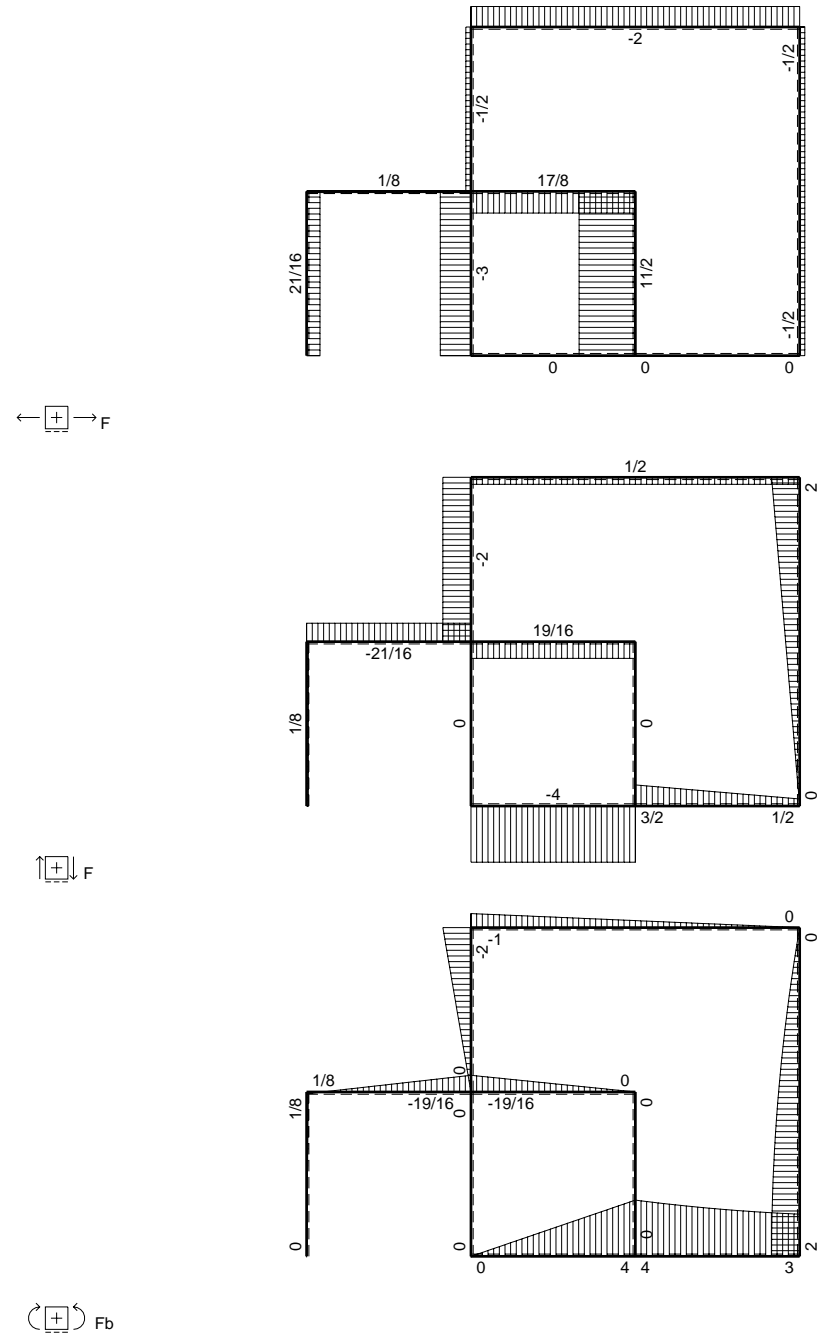
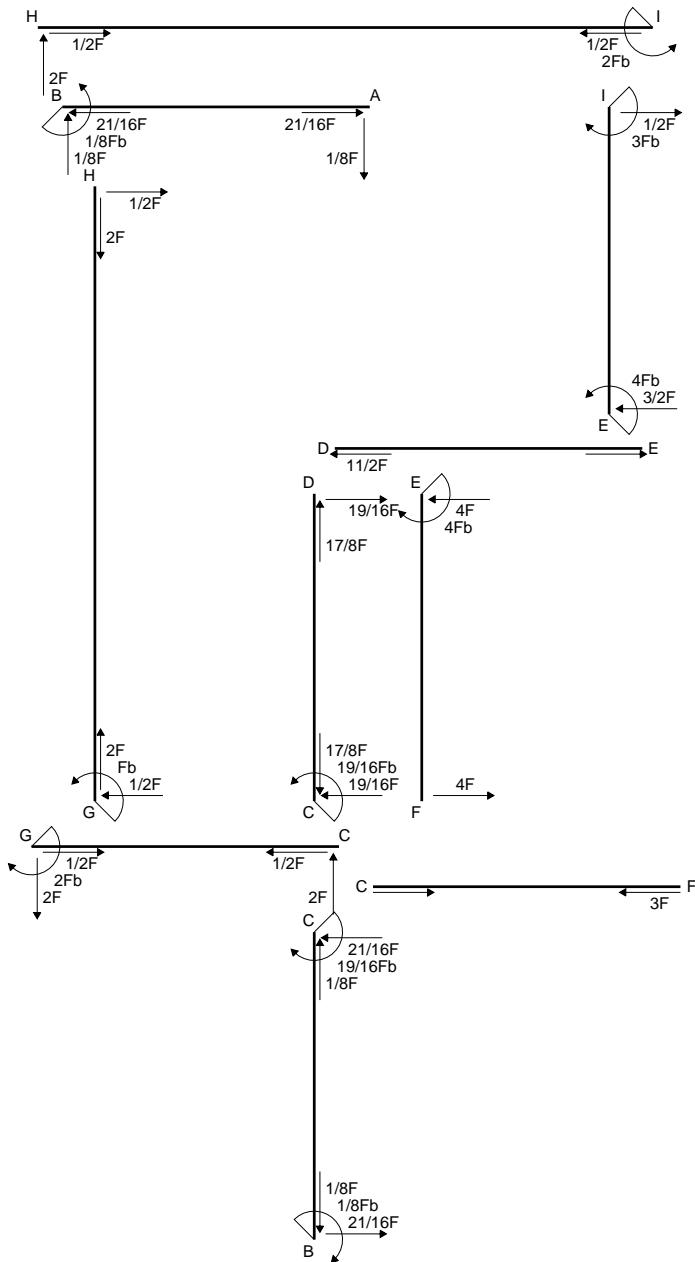
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

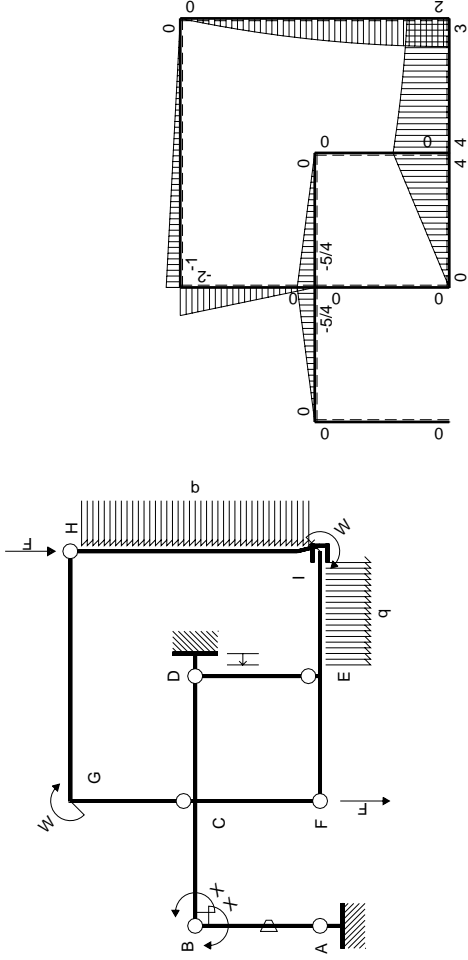
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



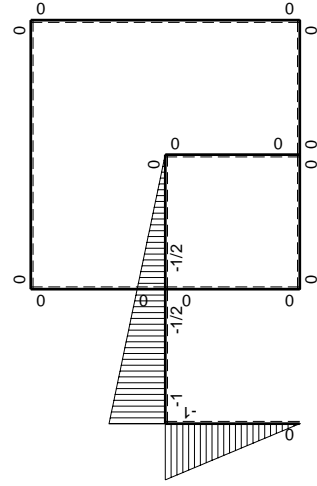
- A = 828. mm²
- J_u = 242396. mm⁴
- J_v = 53136. mm⁴
- y_g = 32.33 mm
- T_y = -2960. N
- M_x = 1716800. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -32.33 mm
- σ_m = -Mv/J_u = 229. N/mm²
- x_c = 24. mm
- y_c = 14. mm
- v_c = -18.33 mm
- σ_c = -Mv/J_u = 129.8 N/mm²
- τ_c = 4.33 N/mm²
- σ_q = √(σ² + 3τ²) = 130. N/mm²
- S = 4255. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	$-Fb/EJ$	0	Fx/EJ	x^2/b^2	$(0+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
BA b	$1-x/b$	0	Fb/EJ	0	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	0	$5/8Fb-5/4Fx+5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$5/4Fx$	0	$5/8Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$4Fb-4Fx$	0	0	0	0	0+0	0	
FE b	0	$-4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-4Fb+3/2Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (x/b) \theta dx = [1/2 x^2/b]_0^b \theta$$

$$= (1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1 + x/b) \theta dx = [-x + 1/2 x^2/b]_0^b \theta$$

$$= (-b + 1/2 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

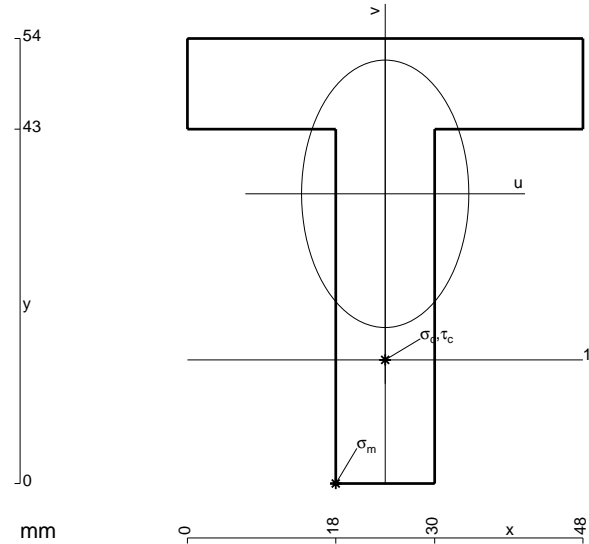
$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ$$

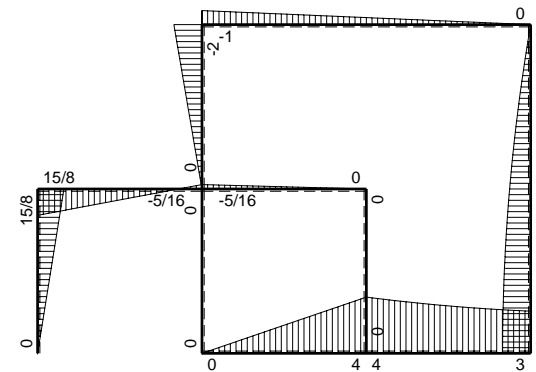
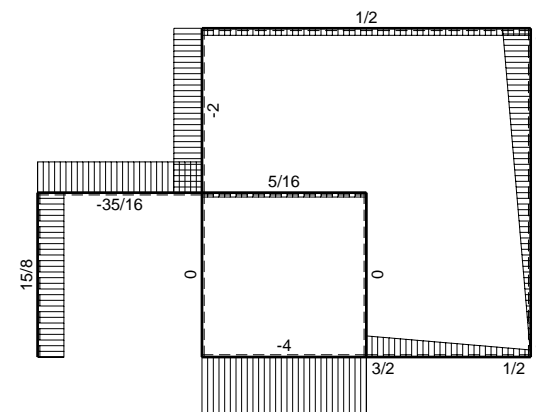
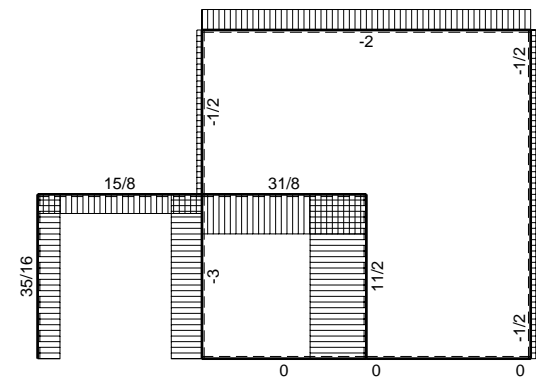
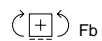
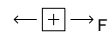
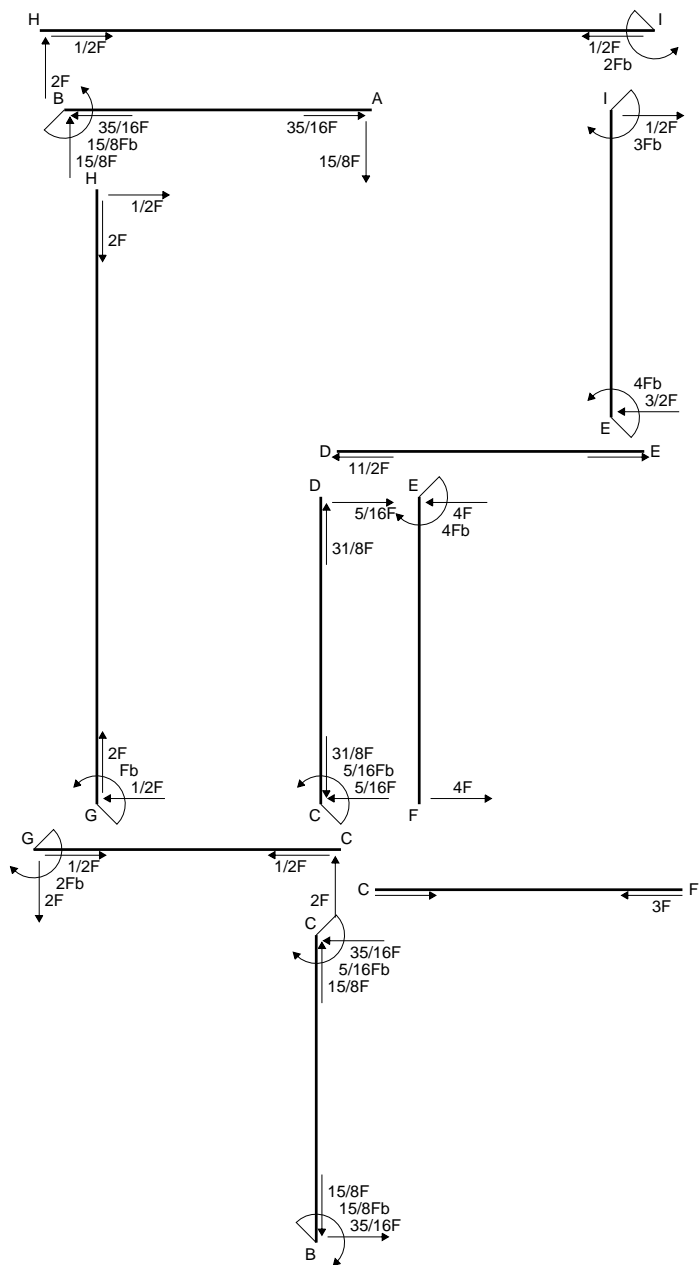
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

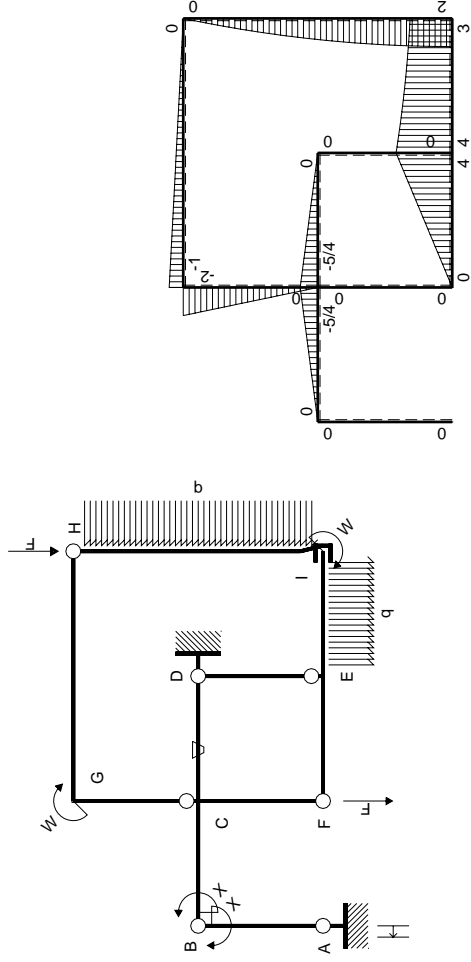
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx = [5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/24 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



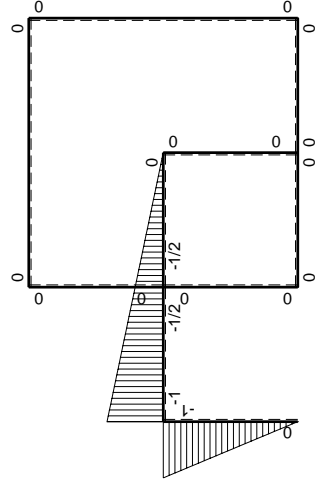
- A = 1044. mm²
- J_u = 275075. mm⁴
- J_v = 107568. mm⁴
- y_g = 35.16 mm
- T_y = -2960. N
- M_x = 1864800. Nmm
- x_m = 18. mm
- u_m = -6. mm
- v_m = -35.16 mm
- σ_m = -Mv/J_u = 238.3 N/mm²
- x_c = 24. mm
- y_c = 15. mm
- v_c = -20.16 mm
- σ_c = -Mv/J_u = 136.6 N/mm²
- τ_c = 4.464 N/mm²
- σ_o = √σ²+3τ² = 136.9 N/mm²
- S = 4978. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	$-Fb/EJ$	$5/8Fb-5/4Fx+5/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$5/4Fx$	Fb/EJ	$5/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$4Fb-4Fx$	0	0	0	0	0+0	0	
FE b	0	$-4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-4Fb+3/2Fx-1/2qx^2$	0	0	0	0			
A	cedimento nodo $-H_{1A}u_A$							Fb^2/EJ	
	totali							$15/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-15/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

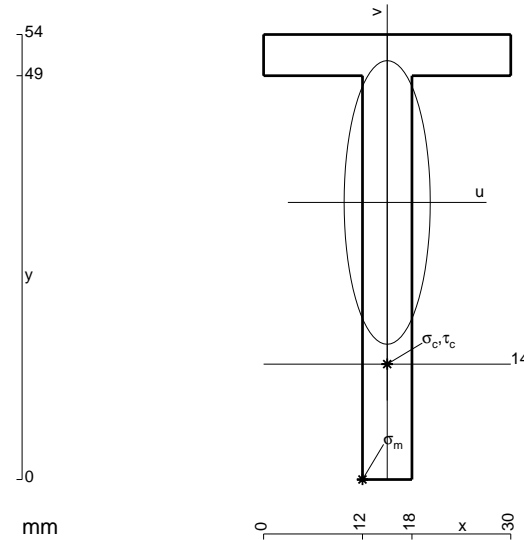
$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

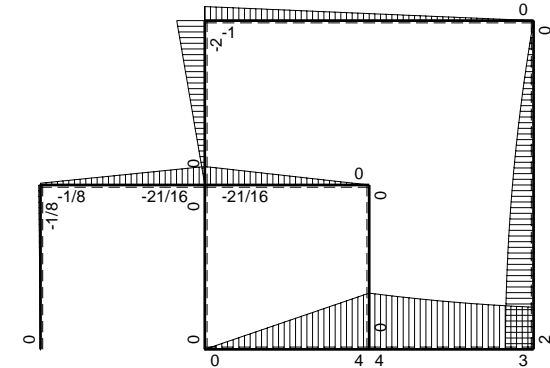
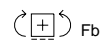
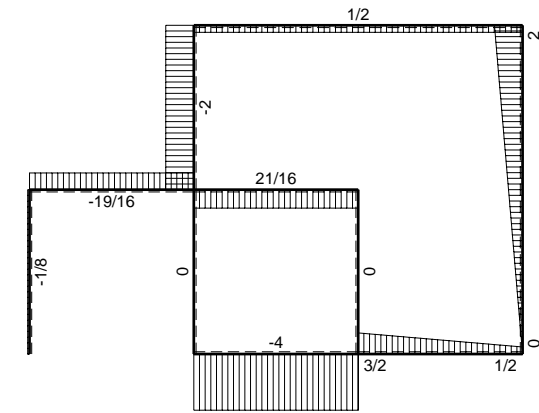
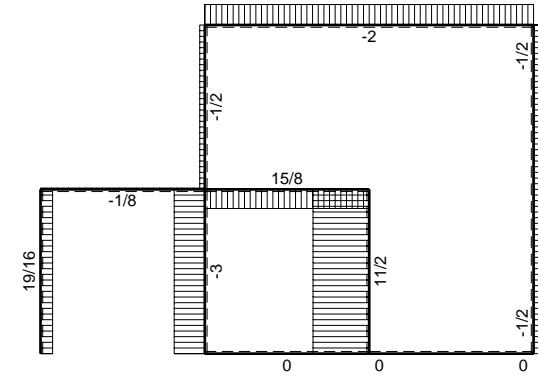
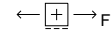
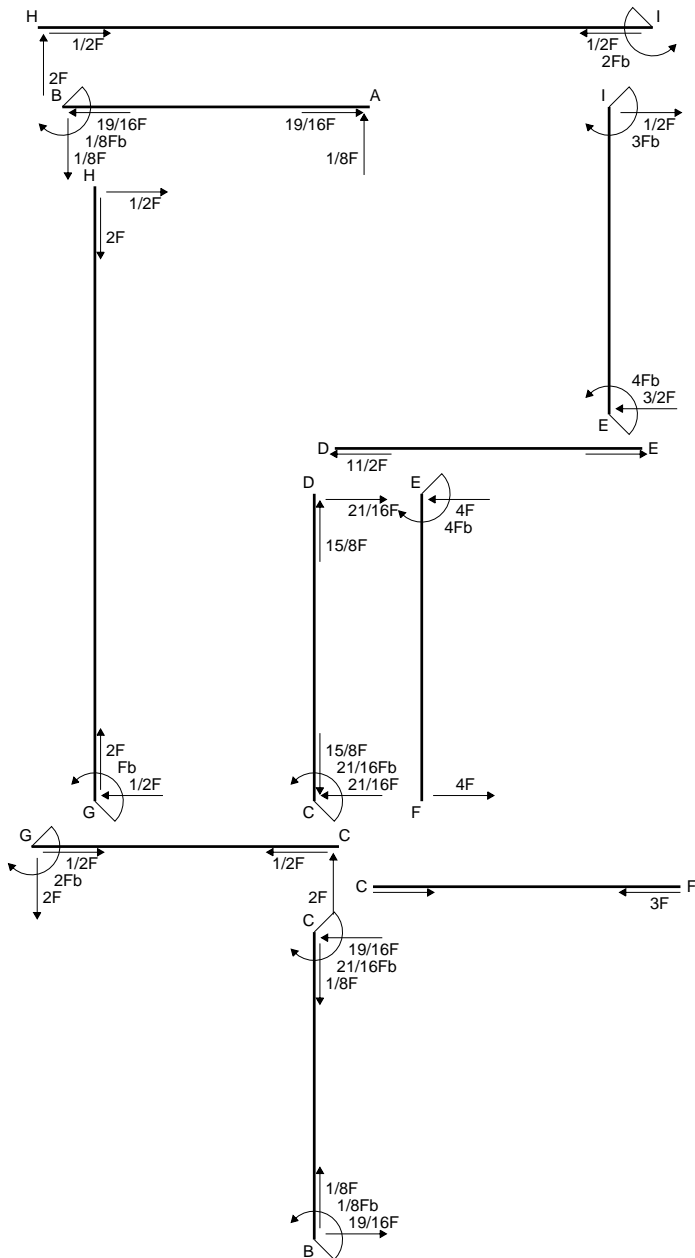
$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 11/24 Fb^2/EJ$$

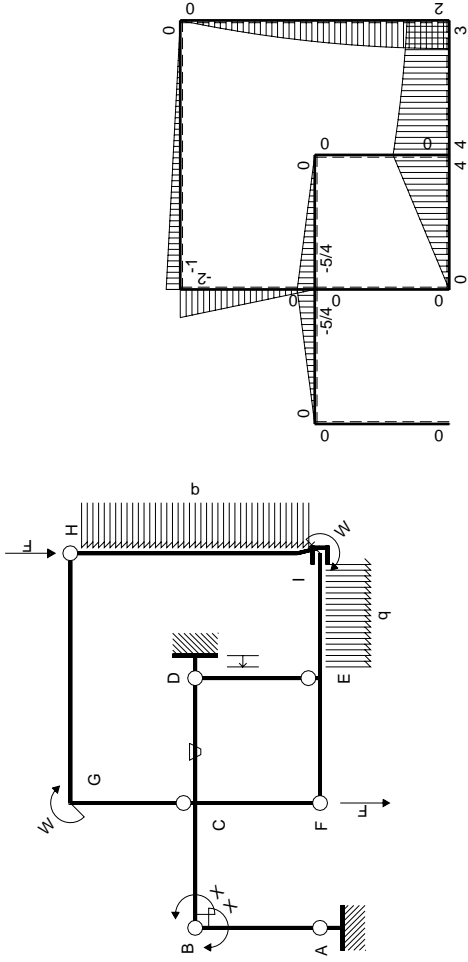
$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (5/24 b) Fb 1/EJ + (-1/4 b) \theta = 11/24 Fb^2/EJ$$



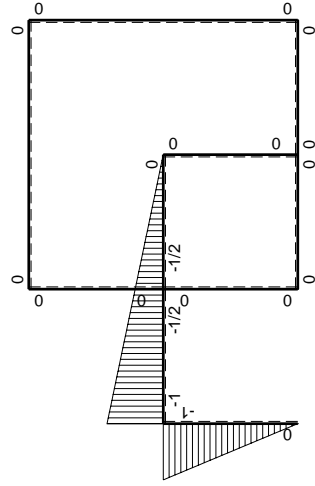
- A = 444. mm²
- J_u = 131544. mm⁴
- J_v = 12132. mm⁴
- y_g = 33.62 mm
- T_y = -1160. N
- M_x = 777200. Nmm
- x_m = 12. mm
- u_m = -3. mm
- v_m = -33.62 mm
- σ_m = -Mv/J_u = 198.6 N/mm²
- x_c = 15. mm
- y_c = 14. mm
- v_c = -19.62 mm
- σ_c = -Mv/J_u = 115.9 N/mm²
- τ_c = 3.287 N/mm²
- σ_o = √σ²+3τ² = 116.1 N/mm²
- S = 2236. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	$-5/4Fx$	0	$5/4Fx-5/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(5/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$5/8Fb-5/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	$-5/4Fb+5/4Fx$	$-Fb/EJ$	$5/8Fb-5/4Fx+5/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(5/24+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	$5/4Fx$	Fb/EJ	$5/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$4Fb-4Fx$	0	0	0	0	0+0	0	
FE b	0	$-4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-2Fx$	0	0	0	0	0+0	0	
GC b	0	$2Fb-2Fx$	0	0	0	0			
GH 2b	0	$-Fb+1/2Fx$	0	0	0	0	0+0	0	
HG 2b	0	$1/2Fx$	0	0	0	0			
HI 2b	0	$2Fx-1/2qx^2$	0	0	0	0	0+0	0	
IH 2b	0	$-2Fb+1/2qx^2$	0	0	0	0			
IE b	0	$3Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-4Fb+3/2Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$-1/8Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (5/8 - 5/8 x^2/b^2) Fb 1/EJ dx = [5/8 x - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (5/8 b - 5/24 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

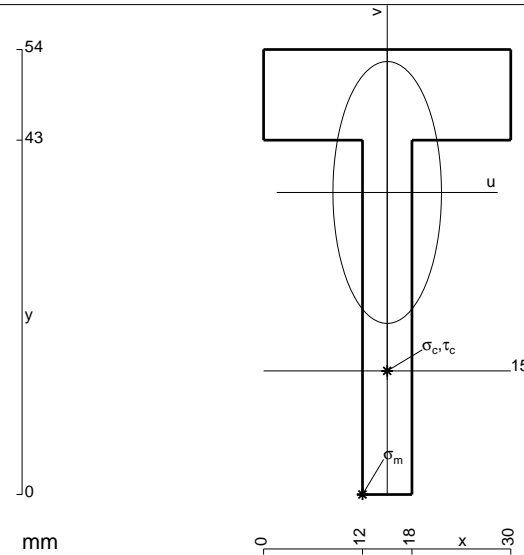
$$L_{CD}^{xo} = \int_0^b (5/8 - 5/4 x/b + 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [5/8 x - 5/8 x^2/b + 5/24 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (5/8 b - 5/8 b + 5/24 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 11/24 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

$$= (5/24 b) Fb 1/EJ + (-1/4 b) \theta = 11/24 Fb^2/EJ$$



$$A = 588. \text{ mm}^2$$

$$J_u = 148637. \text{ mm}^4$$

$$J_v = 25524. \text{ mm}^4$$

$$y_g = 36.65 \text{ mm}$$

$$T_y = -1160. \text{ N}$$

$$M_x = 835200. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -3. \text{ mm}$$

$$v_m = -36.65 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 206. \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 15. \text{ mm}$$

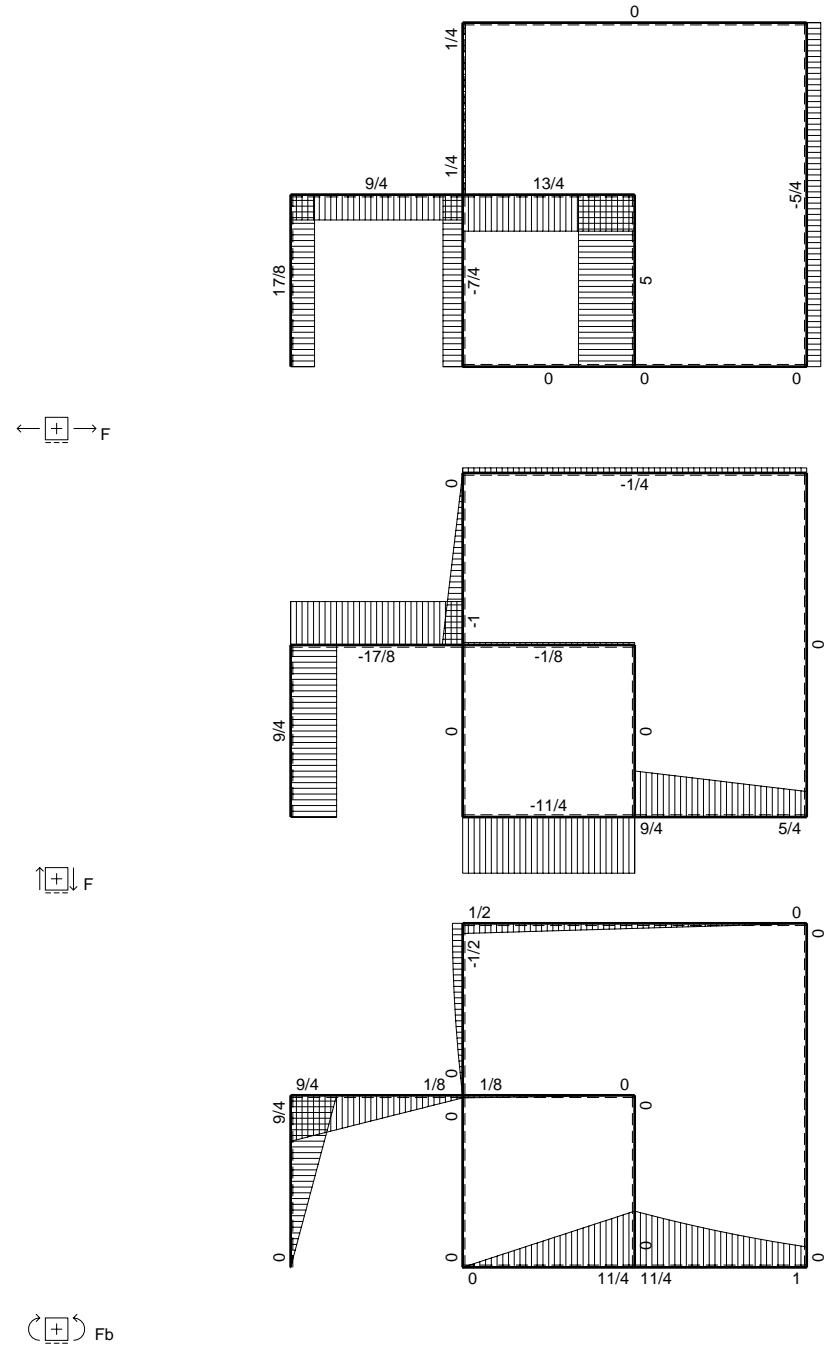
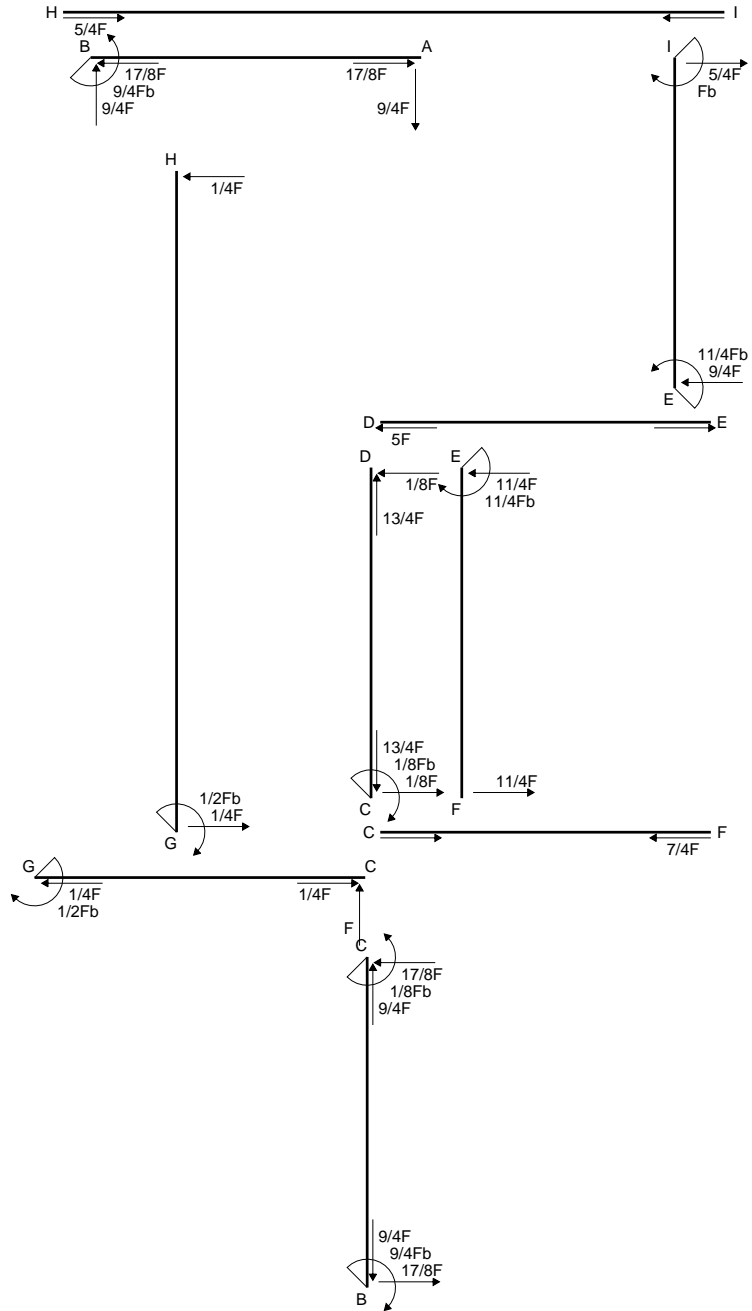
$$v_c = -21.65 \text{ mm}$$

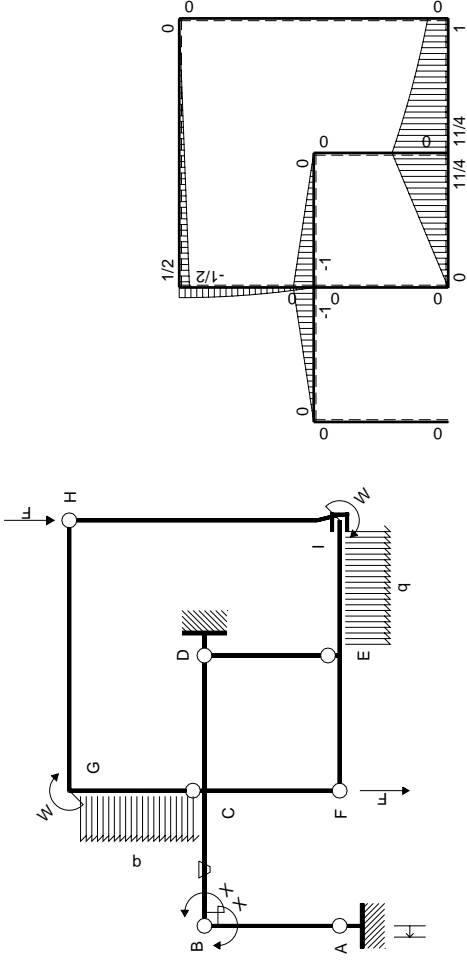
$$\sigma_c = -Mv/J_u = 121.7 \text{ N/mm}^2$$

$$\tau_c = 3.413 \text{ N/mm}^2$$

$$\sigma_\rho = \sqrt{\sigma^2 + 3\tau^2} = 121.8 \text{ N/mm}^2$$

$$S = 2624. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$		
BC b	$-1+1/2x/b$	-Fx	-Fb/EJ	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$
CB b	$1/2+1/2x/b$	Fb-Fx	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$		
CD b	$-1/2+1/2x/b$	-Fb+Fx	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$		
DE b	0	0	0	0	0	0	0+0	0
ED b	0	0	0	0	0	0		
EF b	0	$11/4Fb-11/4Fx$	0	0	0	0	0+0	0
FE b	0	$-11/4Fx$	0	0	0	0		
FC b	0	0	0	0	0	0	0+0	0
CF b	0	0	0	0	0	0		
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0
HG 2b	0	$-1/4Fx$	0	0	0	0		
HI 2b	0	0	0	0	0	0	0+0	0
IH 2b	0	0	0	0	0	0		
IE b	0	$Fb+5/4Fx+1/2qx^2$	0	0	0	0	0+0	0
EI b	0	$-11/4Fb+9/4Fx-1/2qx^2$	0	0	0	0		
A	cedimento nodo $-H_{1A}u_A$						Fb^2/EJ	
	totali						$9/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$						$-9/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

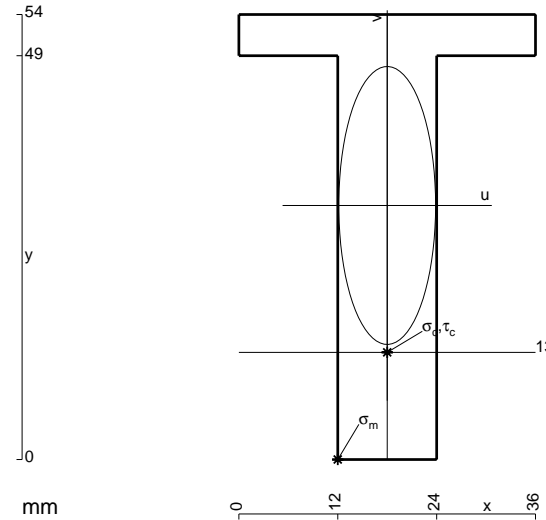
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

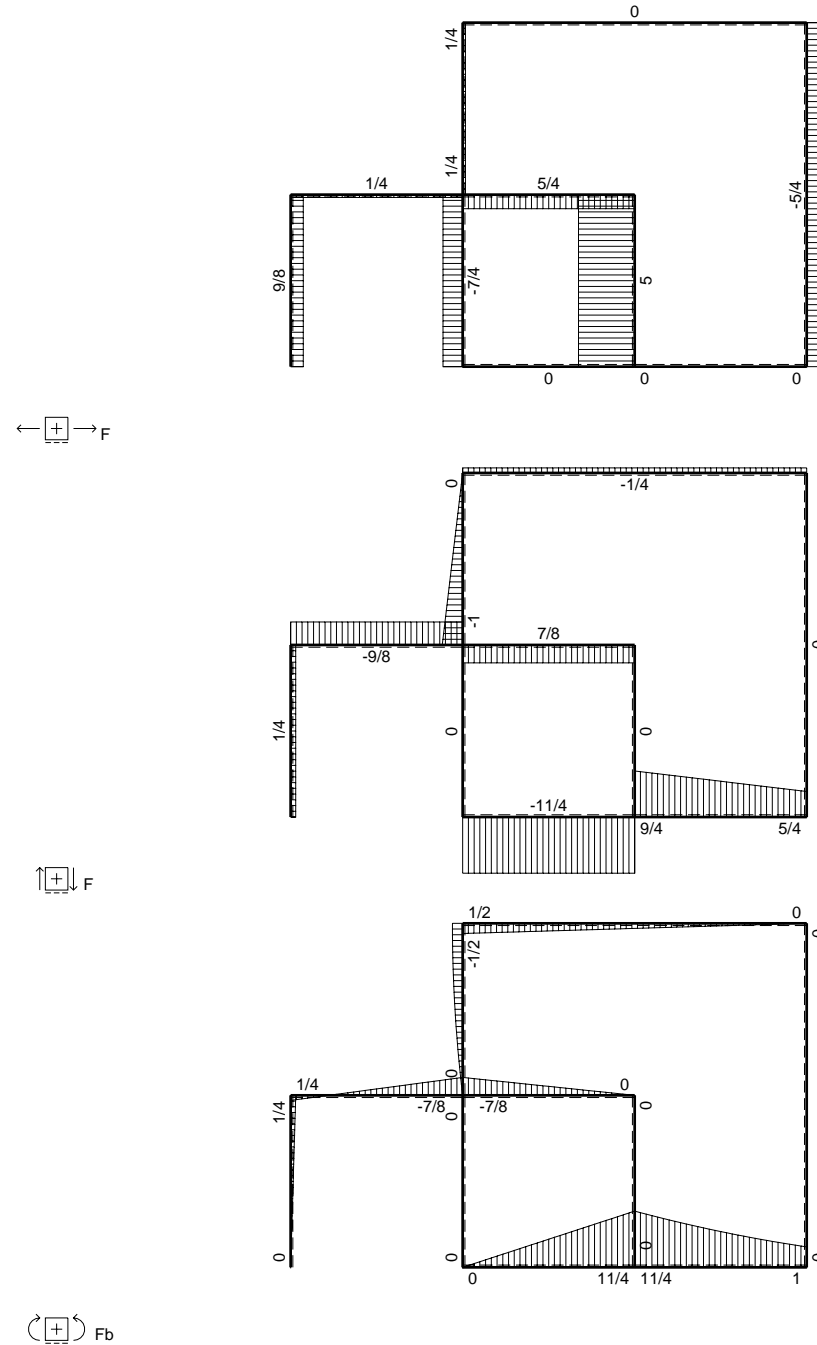
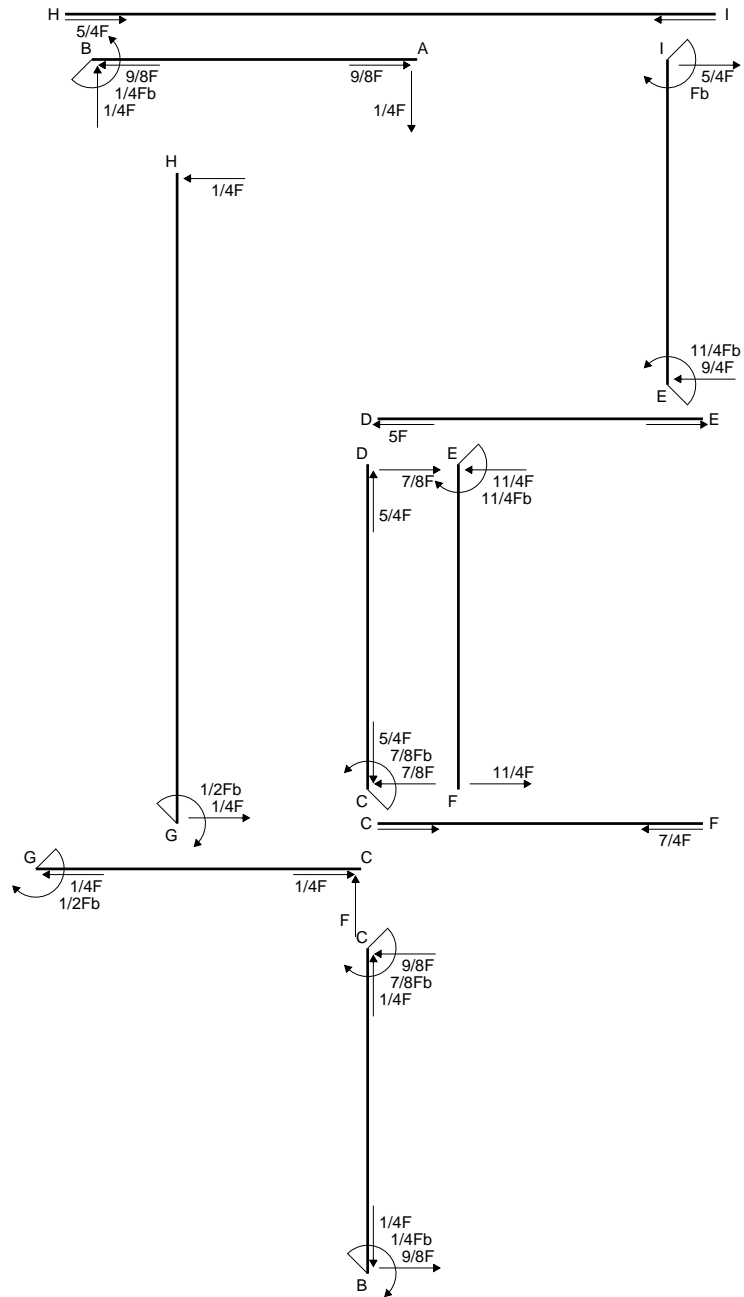
$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$



- A = 768. mm²
- J_u = 218489. mm⁴
- J_v = 26496. mm⁴
- y_g = 30.83 mm
- T_y = -2035. N
- M_x = 1546600. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -30.83 mm
- σ_m = -Mv/J_u = 218.2 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -17.83 mm
- σ_c = -Mv/J_u = 126.2 N/mm²
- τ_c = 2.946 N/mm²
- σ_o = √σ²+3τ² = 126.3 N/mm²
- S = 3795. mm³



Quadro contributi PLV per iperstatica $X=W_{BC}$

→	$M_x(x)$	$M_o(x)$	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	$-x/b$	0	0	0	0	x^2/b^2	0+0	$1/3Xb/EJ$	
BA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$			
BC b	$-1+1/2x/b$	-Fx	-Fb/EJ	$Fx-1/2Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(1/3+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
CB b	$1/2+1/2x/b$	Fb-Fx	Fb/EJ	$1/2Fb-1/2Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
CD b	$-1/2+1/2x/b$	-Fb+Fx	0	$1/2Fb-Fx+1/2Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/12Xb/EJ$	
DC b	$1/2x/b$	Fx	0	$1/2Fx^2/b$	0	$1/4x^2/b^2$			
DE b	0	0	0	0	0	0	0+0	0	
ED b	0	0	0	0	0	0			
EF b	0	$11/4Fb-11/4Fx$	0	0	0	0	0+0	0	
FE b	0	$-11/4Fx$	0	0	0	0			
FC b	0	0	0	0	0	0	0+0	0	
CF b	0	0	0	0	0	0			
CG b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0	
GC b	0	$1/2Fb-1/2qx^2$	0	0	0	0			
GH 2b	0	$1/2Fb-1/4Fx$	0	0	0	0	0+0	0	
HG 2b	0	$-1/4Fx$	0	0	0	0			
HI 2b	0	0	0	0	0	0	0+0	0	
IH 2b	0	0	0	0	0	0			
IE b	0	$Fb+5/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
EI b	0	$-11/4Fb+9/4Fx-1/2qx^2$	0	0	0	0			
D	cedimento nodo $-H_{1D}u_D$							$-Fb^2/EJ$	
	totali							$1/4Fb^2/EJ$	Xb/EJ
	iperstatica $X=W_{BC}$							$-1/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{CD}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{DC}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b) Fb 1/EJ + (b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (1/2 - 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [1/2 x - 1/6 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

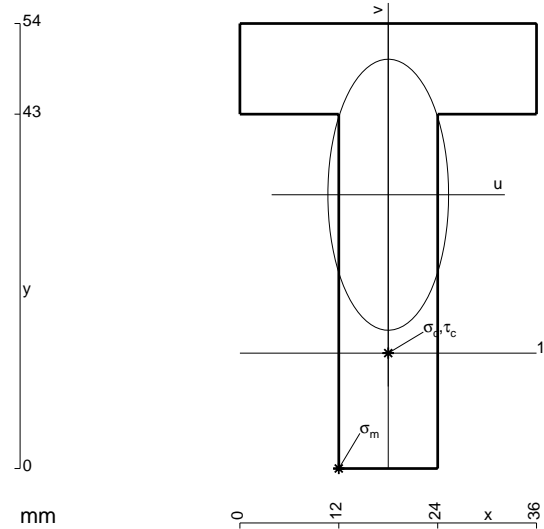
$$= (1/2 b - 1/6 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 13/12 Fb^2/EJ$$

$$L_{CD}^{xo} = \int_0^b (1/2 - x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [1/2 x - 1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/2 b + 1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{DC}^{xo} = \int_0^b (1/2 x^2/b^2) Fb 1/EJ dx = [1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/6 b) Fb 1/EJ = 1/6 Fb^2/EJ$$



- A = 912. mm²
- J_u = 246834. mm⁴
- J_v = 48960. mm⁴
- y_g = 33.22 mm
- T_y = -2090. N
- M_x = 1692900. Nmm
- x_m = 12. mm
- u_m = -6. mm
- v_m = -33.22 mm
- σ_m = -Mv/J_u = 227.9 N/mm²
- x_c = 18. mm
- y_c = 14. mm
- v_c = -19.22 mm
- σ_c = -Mv/J_u = 131.8 N/mm²
- τ_c = 3.109 N/mm²
- σ_ρ = √σ²+3τ² = 132. N/mm²
- S = 4406. mm³