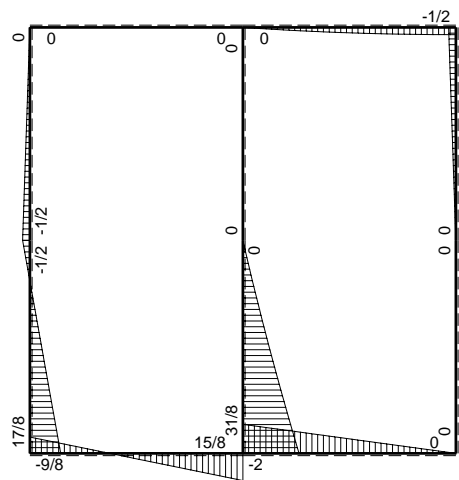
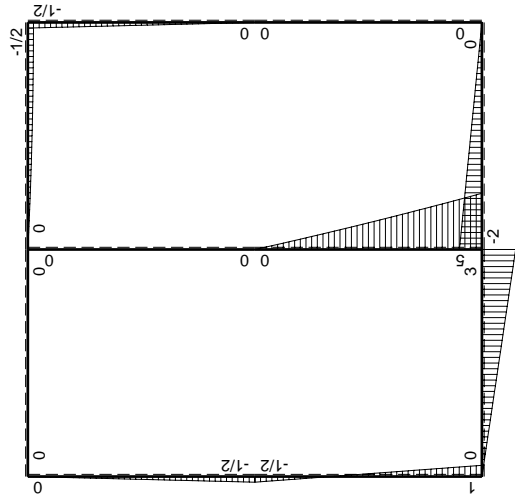
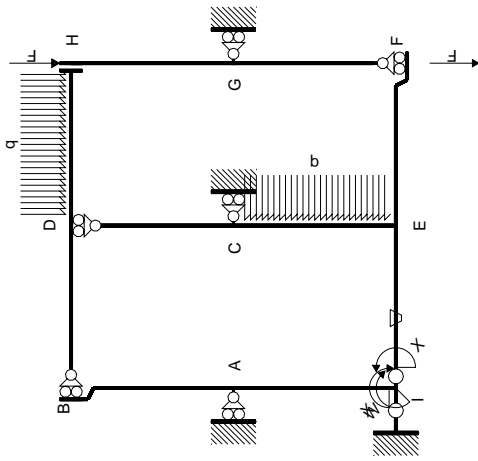


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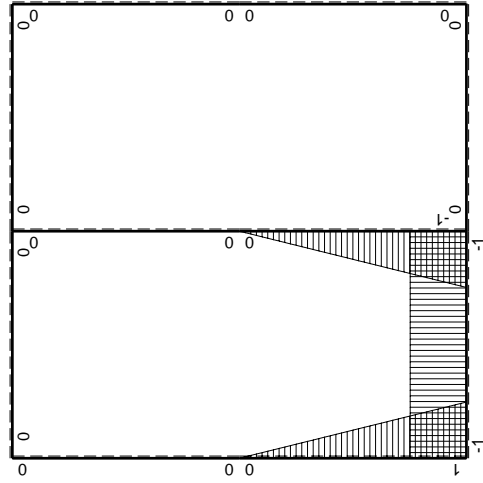


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0	0+0	0
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0	0+0	0
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0	0+0	0
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0	0+0	0
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0	0+0	0
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EC b	$-1+x/b$	$5Fb-11/2Fx+1/2qx^2$	0	$-5Fb+21/2Fx-6Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-13/8+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-9/2Fx-1/2qx^2$	0	$-9/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2	$(-13/8+0)Fb^2/EJ$	$1/3Xb/EJ$
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
	totali						$-15/8Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$9/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 21/2 x/b - 6x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx = [-5x + 21/4 x^2/b - 2x^3/b^2 + 1/8 x^4/b^3]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 21/4 b - 2b + 1/8 b) Fb \frac{1}{EJ} = -13/8 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-9/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx = [-3/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb \frac{1}{EJ}$$

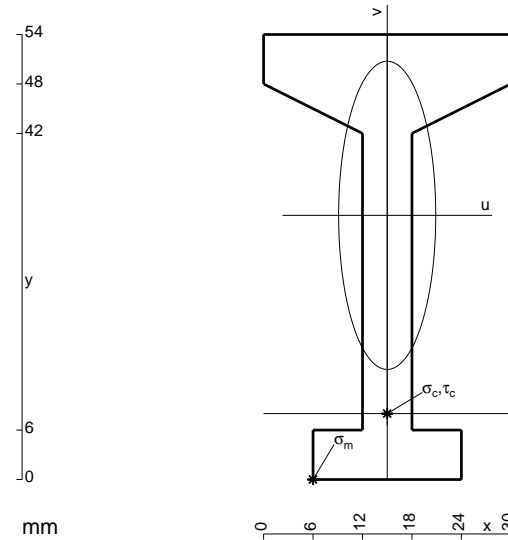
$$= (-3/2 b - 1/8 b) Fb \frac{1}{EJ} = -13/8 Fb^2/EJ$$

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

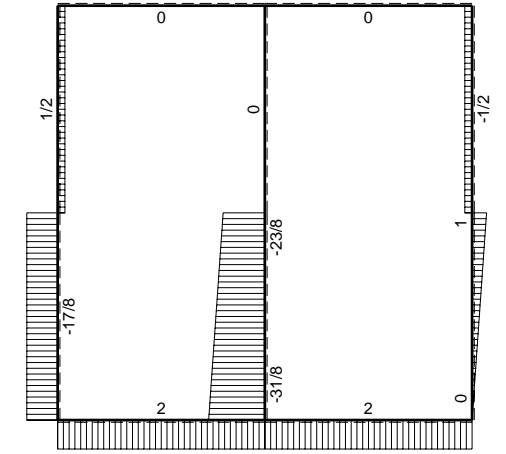
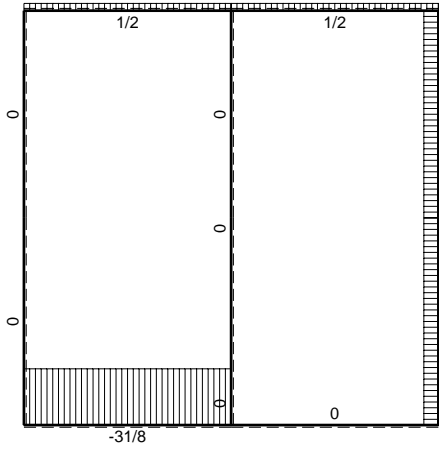
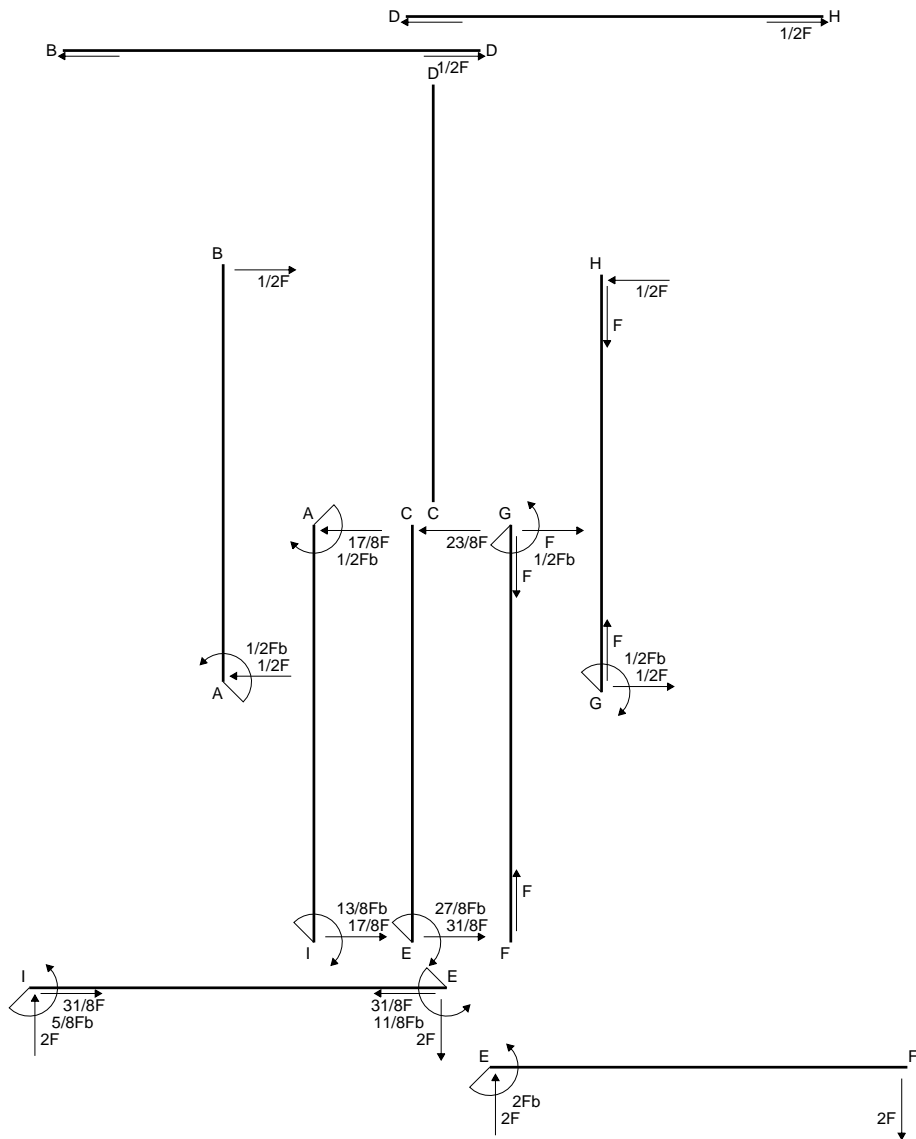
$$= (b - 5/4 b + 1/2 b) Fb \frac{1}{EJ} = 1/4 Fb^2/EJ$$

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

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

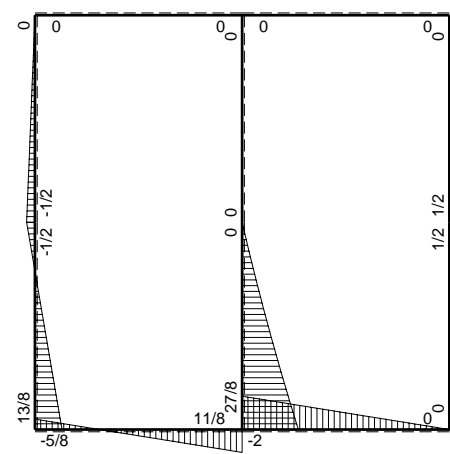


- A = 612. mm²
- J_u = 214270. mm⁴
- J_v = 21276. mm⁴
- y_g = 32.06 mm
- T_y = 2360. N
- M_x = -1392400. Nmm
- x_m = 6. mm
- u_m = -9. mm
- v_m = -32.06 mm
- σ_m = -Mv/J_u = -208.3 N/mm²
- x_c = 15. mm
- y_c = 8. mm
- v_c = -24.06 mm
- σ_c = -Mv/J_u = -156.3 N/mm²
- τ_c = 6.313 N/mm²
- σ_o = √σ²+3τ² = 156.7 N/mm²
- S = 3439. mm³

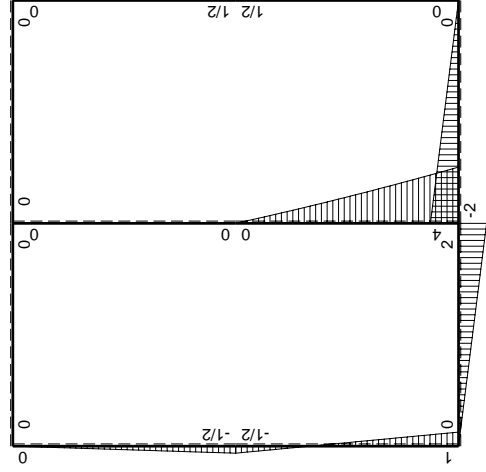
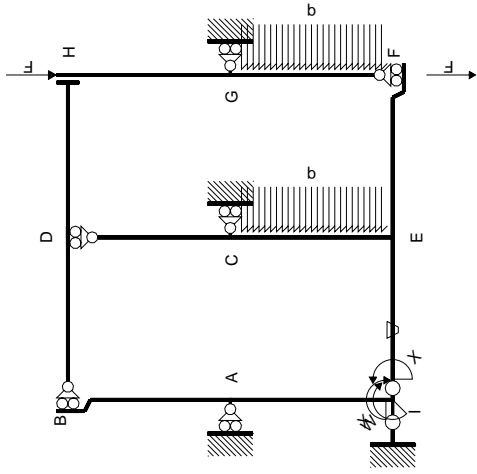


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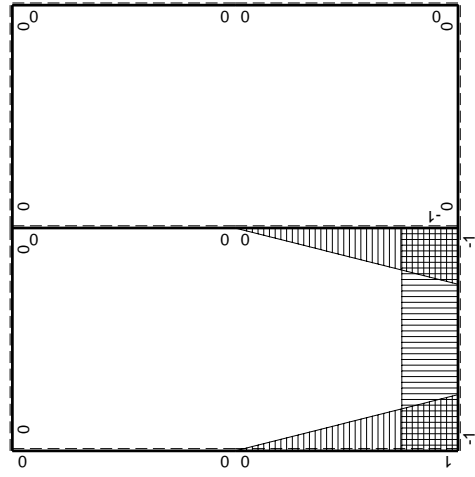


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Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-9/2Fx+1/2qx^2$	0	$-4Fb+17/2Fx-5Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-31/24+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-7/2Fx-1/2qx^2$	0	$-7/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/24Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$5/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

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

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 17/2 x/b - 5x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx$$

$$= [-4x + 17/4 x^2/b - 5/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-4b + 17/4 b - 5/3 b + 1/8 b) Fb 1/EJ = -31/24 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-7/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [-7/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

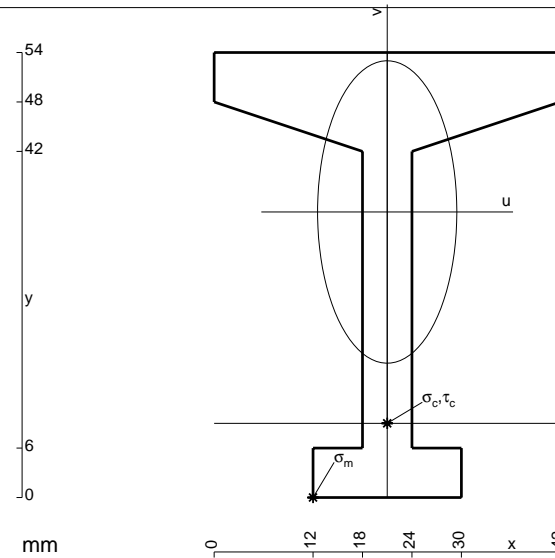
$$= (-7/6 b - 1/8 b) Fb 1/EJ = -31/24 Fb^2/EJ$$

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

$$= (b - 5/4 b + 1/2 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

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



$$A = 720. \text{ mm}^2$$

$$J_u = 242552. \text{ mm}^4$$

$$J_v = 51408. \text{ mm}^4$$

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

$$T_y = 2400. \text{ N}$$

$$M_x = -1536000. \text{ Nmm}$$

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

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

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

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

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

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

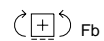
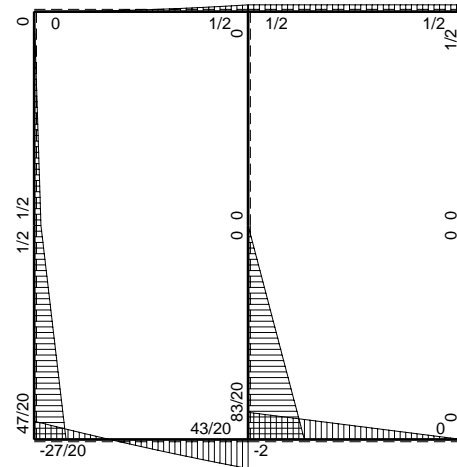
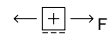
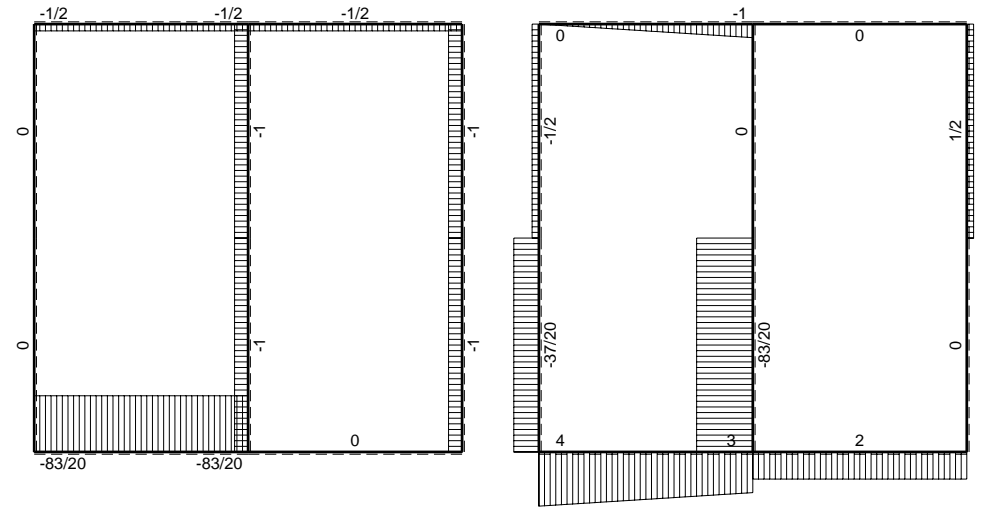
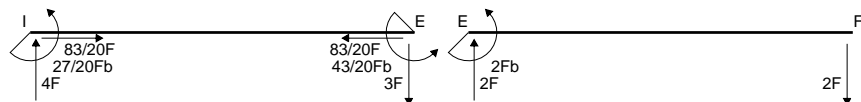
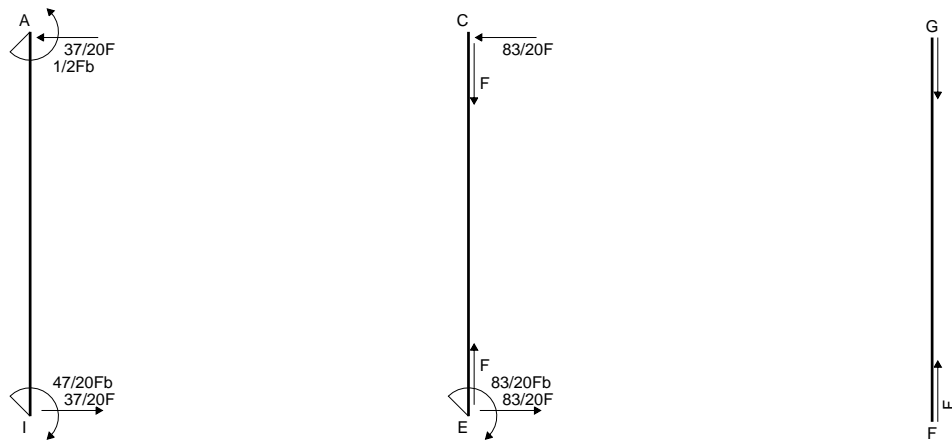
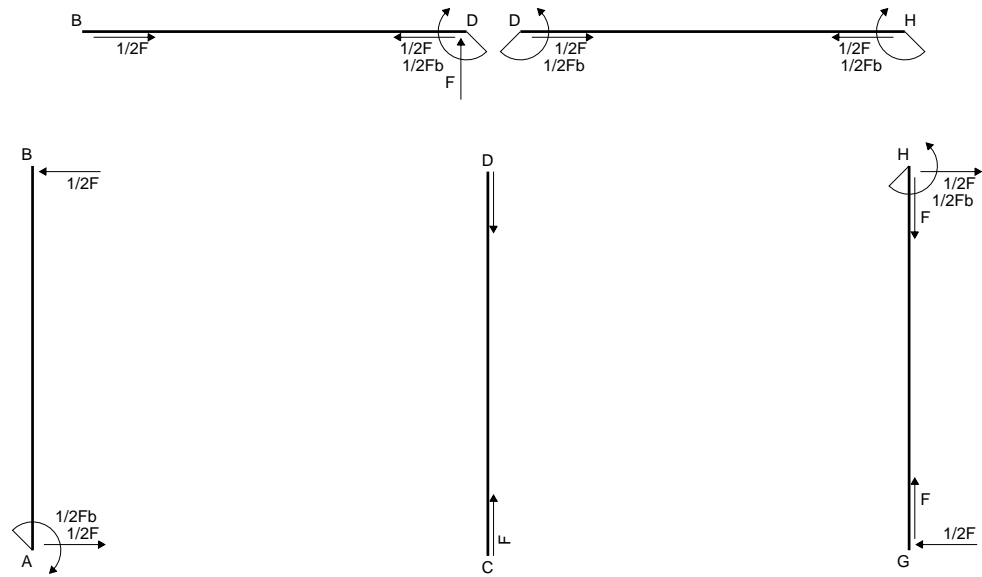
$$v_c = -25.65 \text{ mm}$$

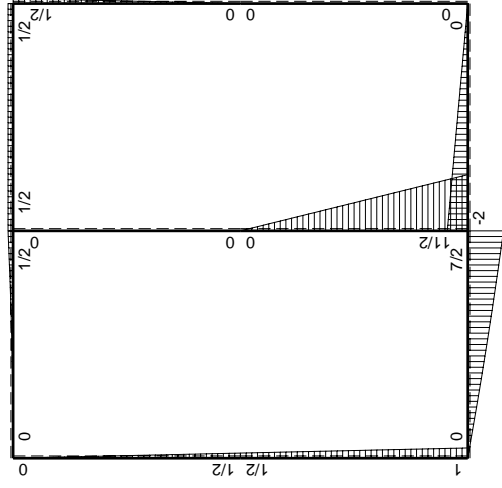
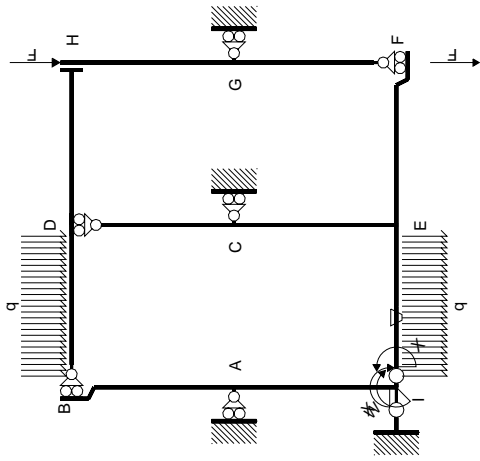
$$\sigma_c = -Mv/J_u = -162.4 \text{ N/mm}^2$$

$$\tau_c = 6.443 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 162.8 \text{ N/mm}^2$$

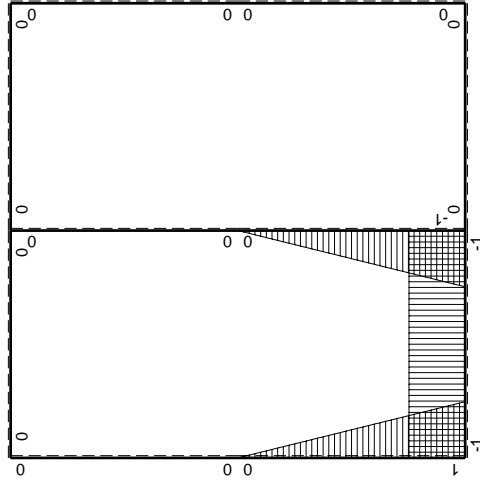
$$S = 3907. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$-1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0			
HD b	0	$1/2Fb$	0	0	0	0	0+0	0	
DH b	0	$-1/2Fb$	0	0	0	0			
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
BD b	0	$-1/2qx^2$	0	0	0	0			
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$Fb-1/2Fx$	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$-1/2Fb-1/2Fx$	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-9/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$27/20Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

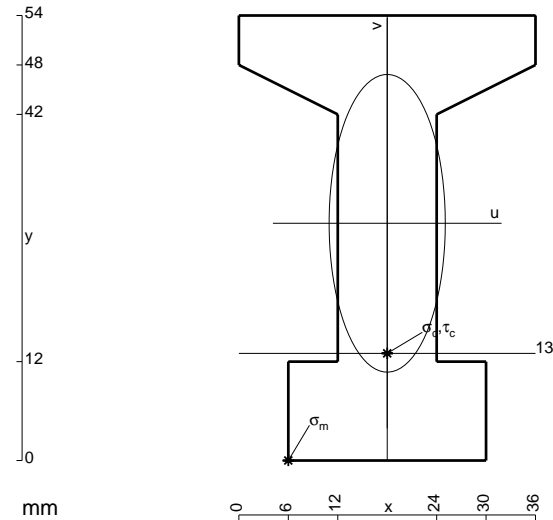
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

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

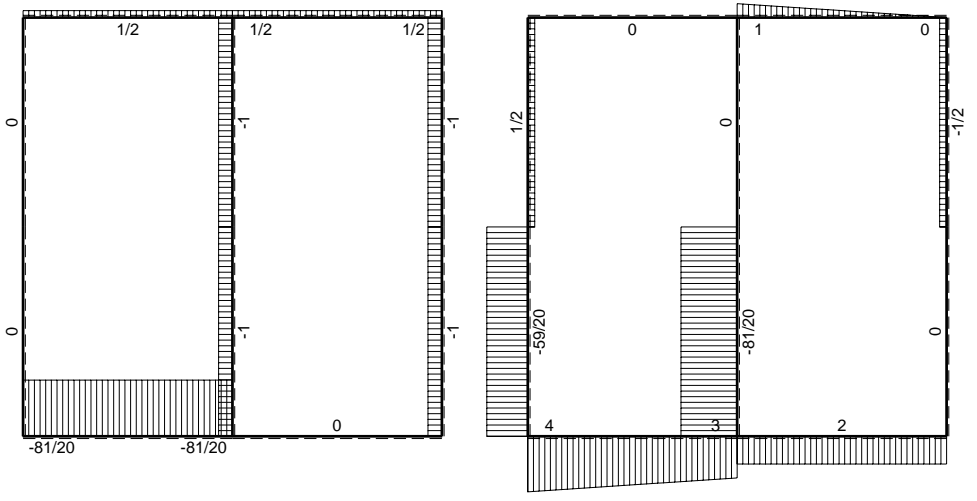
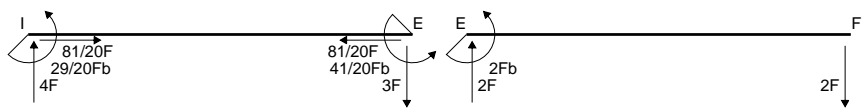
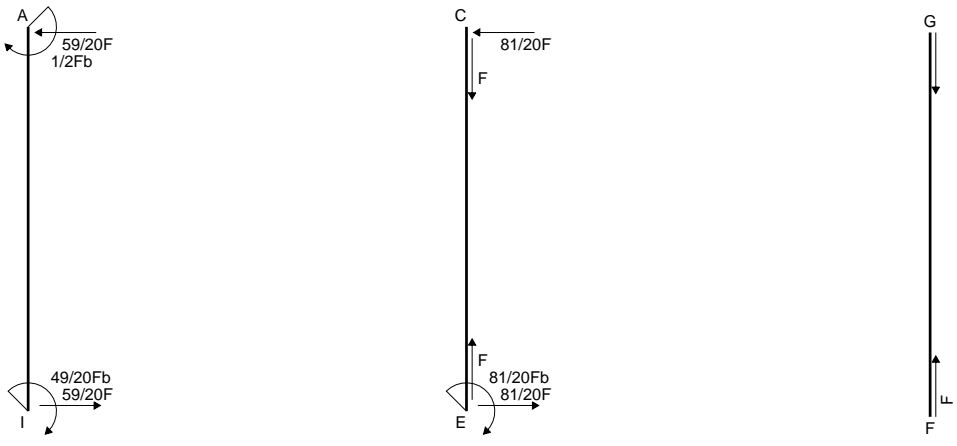
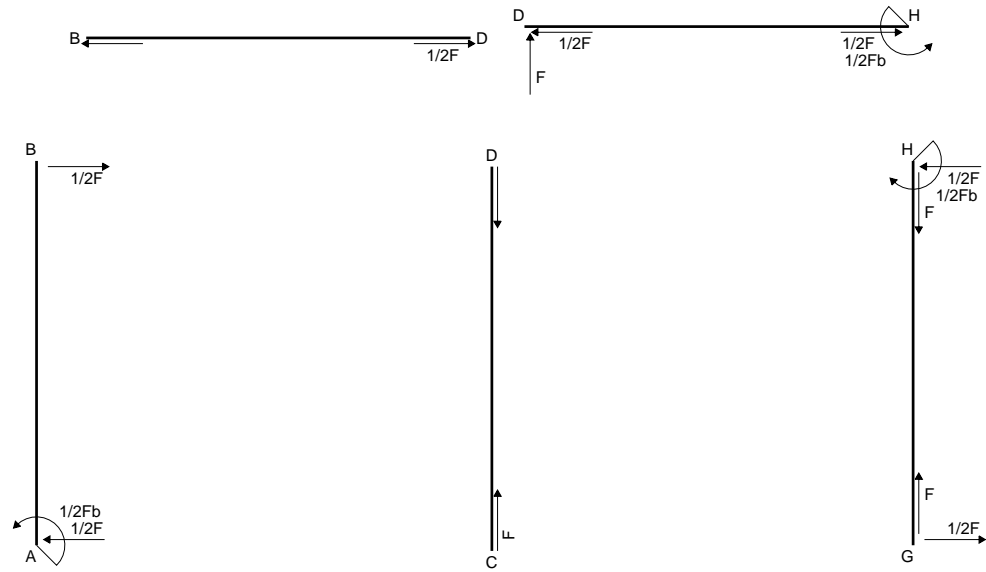
$$= (b - 3/4 b + 1/6 b) Fb \frac{1}{EJ} = 5/12 Fb^2/EJ$$

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

$$= (1/4 b + 1/6 b) Fb \frac{1}{EJ} = 5/12 Fb^2/EJ$$

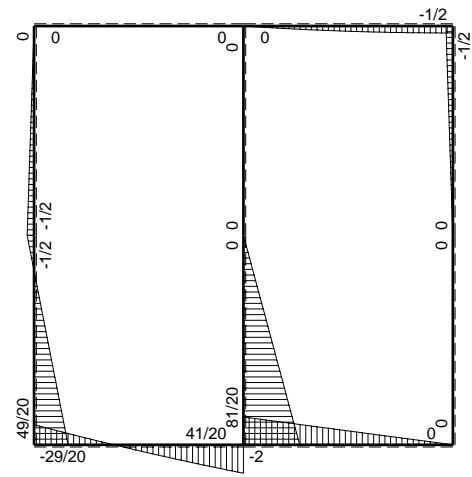


- A = 1008. mm²
- J_u = 328994. mm⁴
- J_v = 50112. mm⁴
- y_g = 28.79 mm
- T_y = 3740. N
- M_x = -2618000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.79 mm
- σ_m = -Mv/J_u = -229.1 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.79 mm
- σ_c = -Mv/J_u = -125.6 N/mm²
- τ_c = 6.402 N/mm²
- σ_o = √σ² + 3τ² = 126.1 N/mm²
- S = 6758. mm³

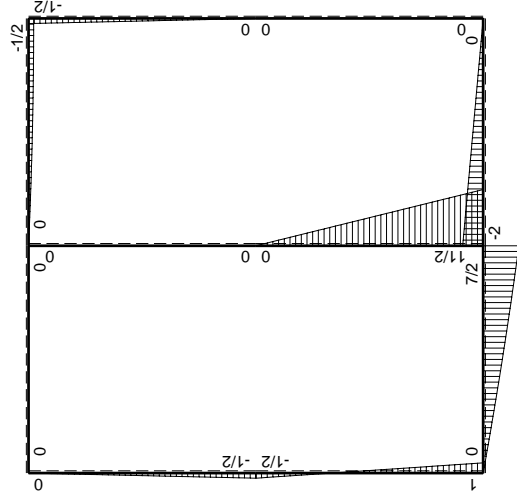
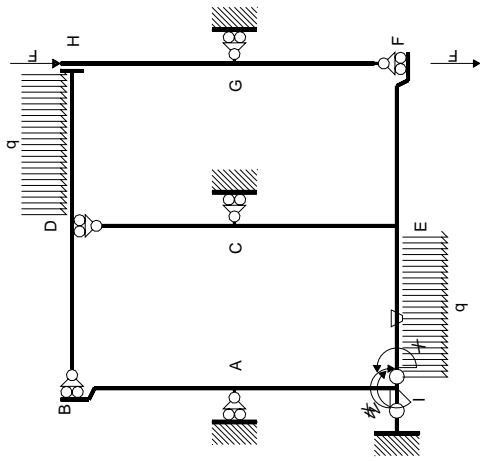


← ⊕ → F

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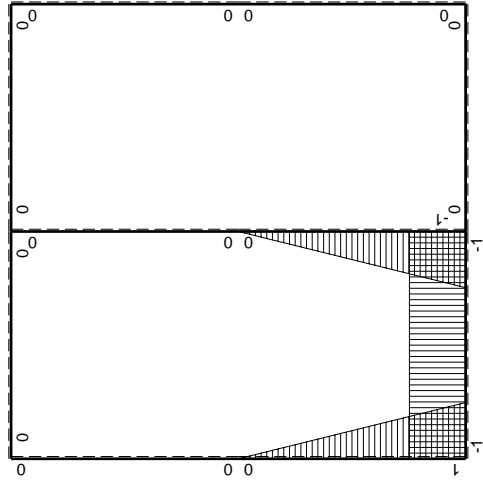


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0			
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
DH b	0	$Fx-1/2qx^2$	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2			
	totali							$-29/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$29/20Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [-x]_0^b \theta$$

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

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb 1/EJ dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb 1/EJ dx = [-11/6 x^3/b^2]_0^b Fb 1/EJ$$

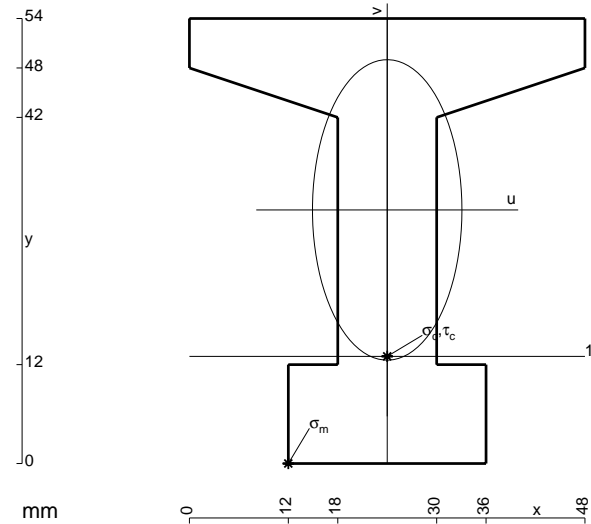
$$= (-11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

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

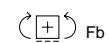
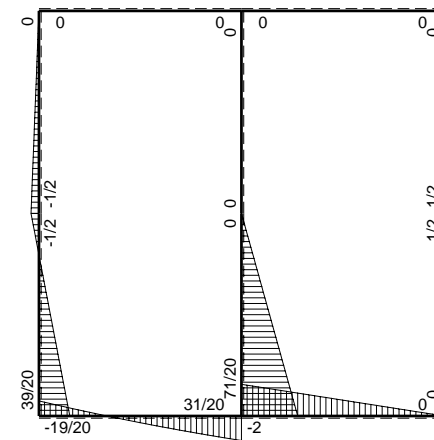
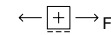
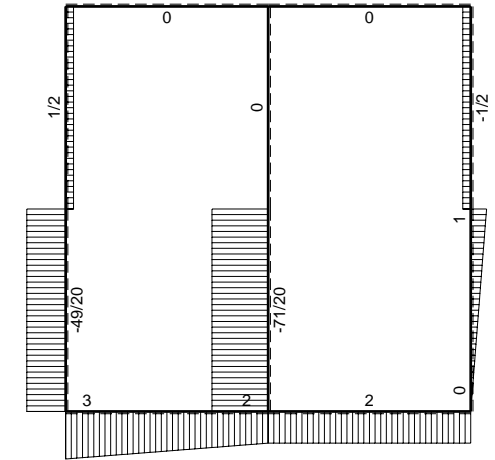
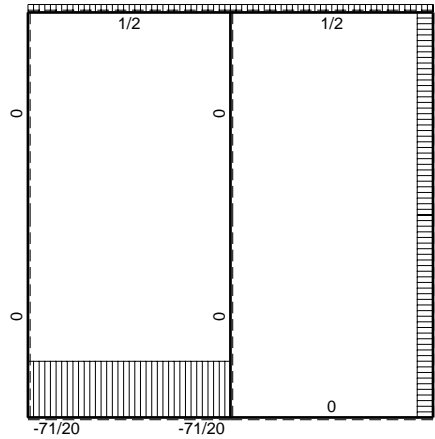
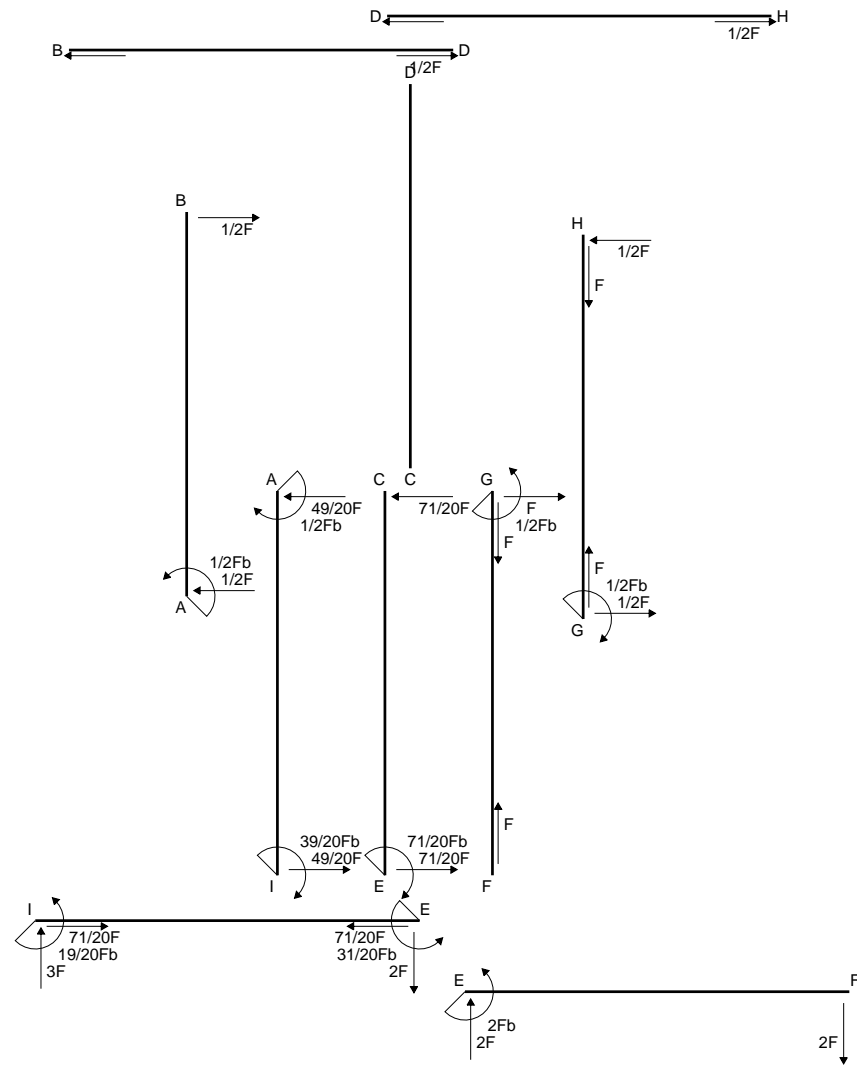
$$= (b - 5/4 b + 1/2 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

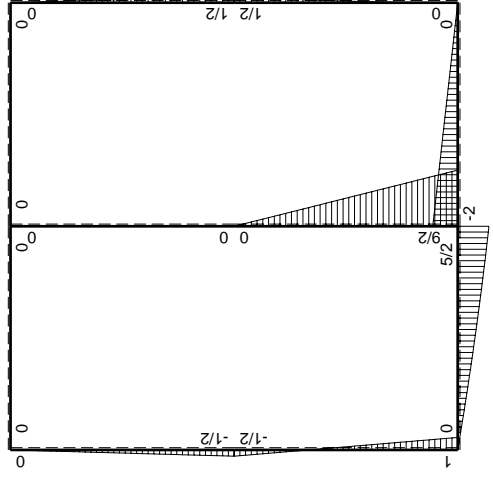
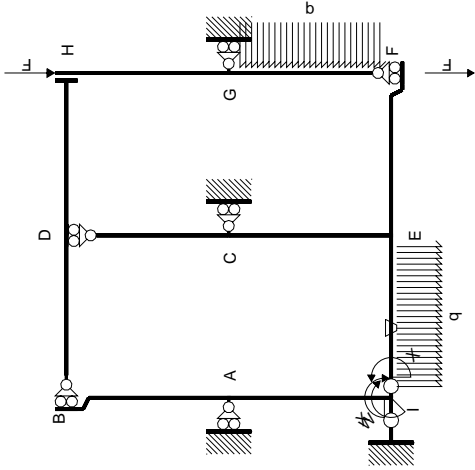
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 3/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/2 x^3/b^2]_0^b Fb 1/EJ$$

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



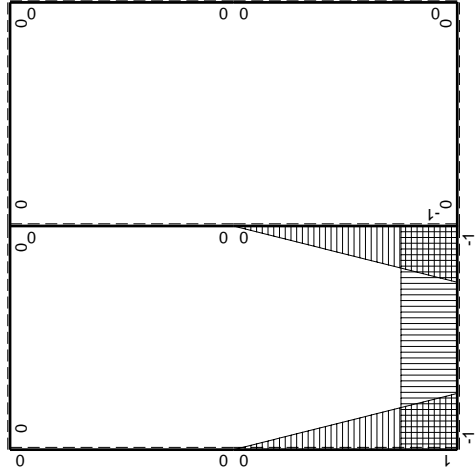
- A = 1116. mm²
- J_u = 371067. mm⁴
- J_v = 91800. mm⁴
- y_g = 30.77 mm
- T_y = 3840. N
- M_x = -2880000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.77 mm
- σ_m = -Mv/J_u = -238.9 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -17.77 mm
- σ_c = -Mv/J_u = -138. N/mm²
- τ_c = 6.342 N/mm²
- σ_o = √σ²+3τ² = 138.4 N/mm²
- S = 7354. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fx$	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$9/2Fb-9/2Fx$	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-9/2Fx$	0	$-9/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2			
	totali							$-19/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$19/20Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

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

$$L_{EC}^{xo} = \int_0^b (-9/2 + 9x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-9/2 x + 9/2 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-9/2 b + 9/2 b - 3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

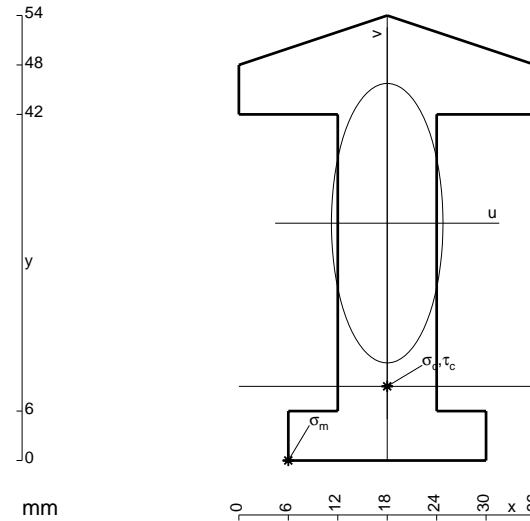
$$= (-3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

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

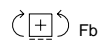
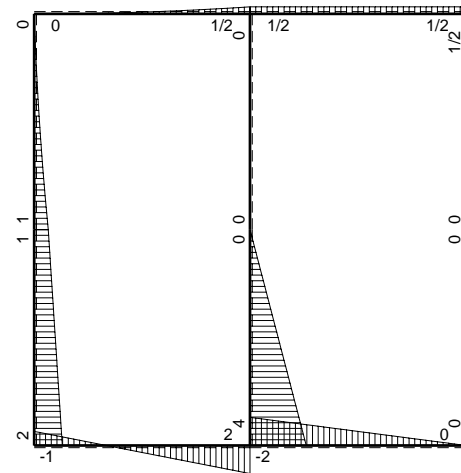
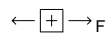
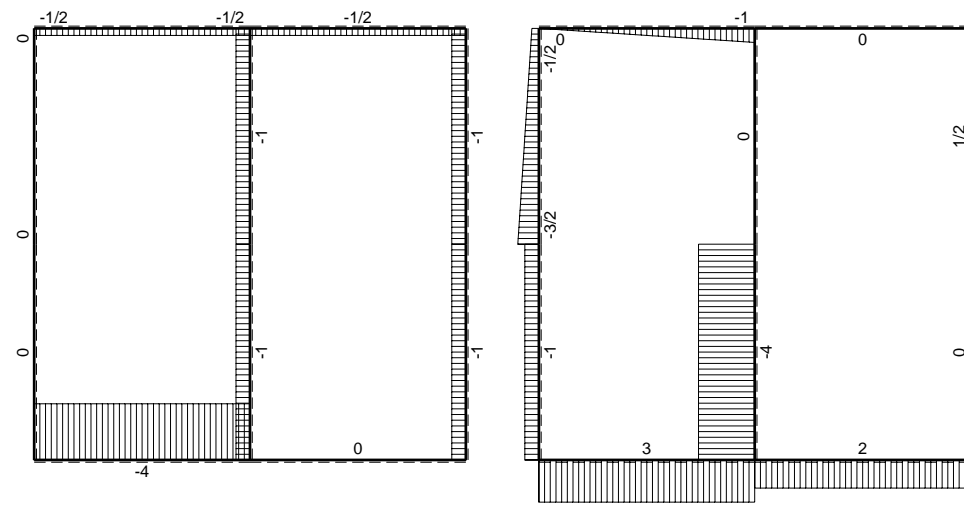
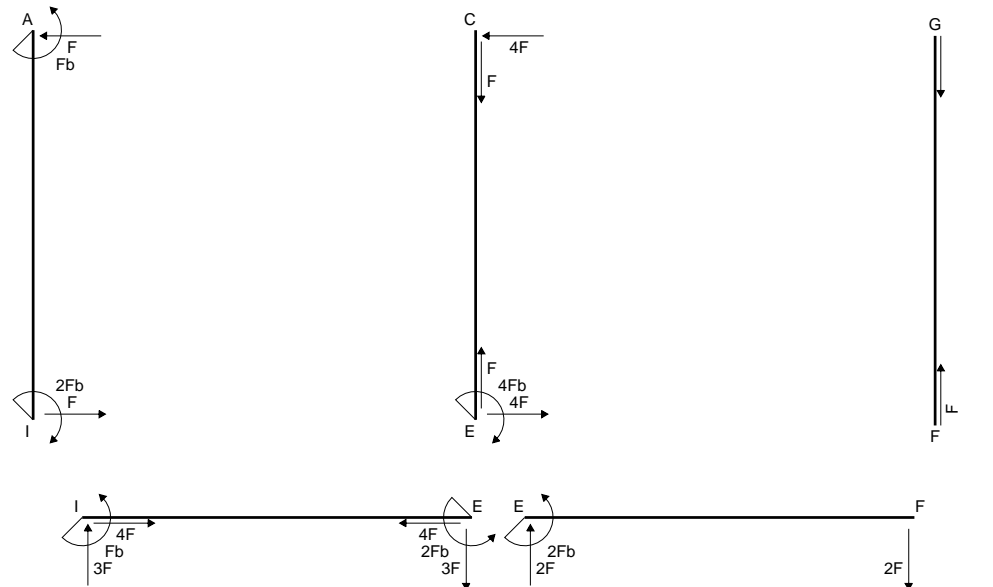
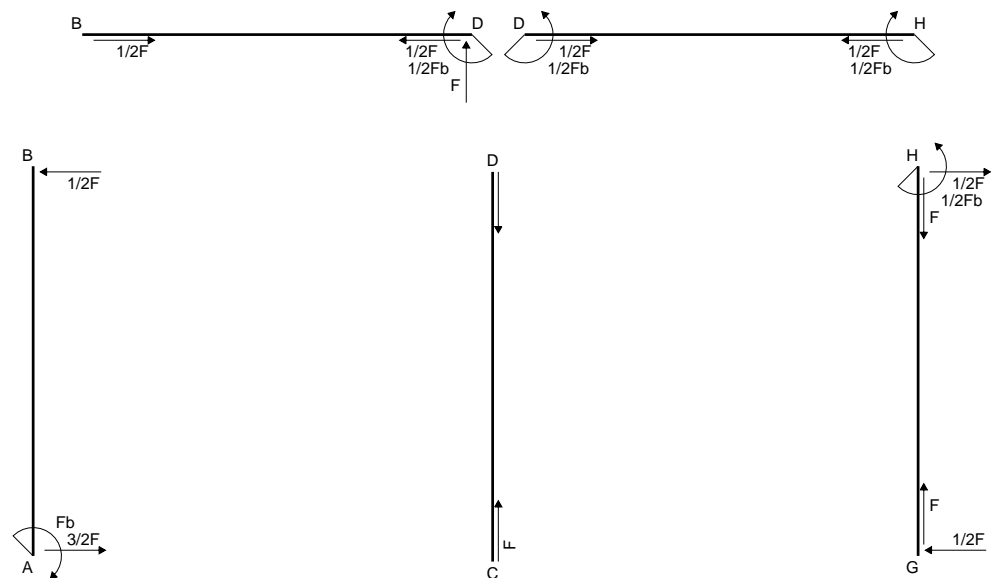
$$= (b - 5/4 b + 1/2 b) Fb \frac{1}{EJ} = 1/4 Fb^2/EJ$$

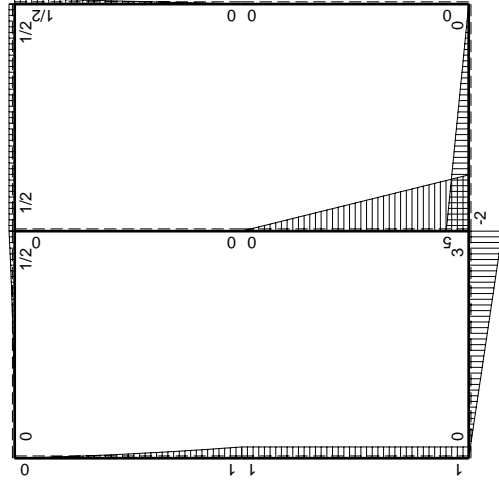
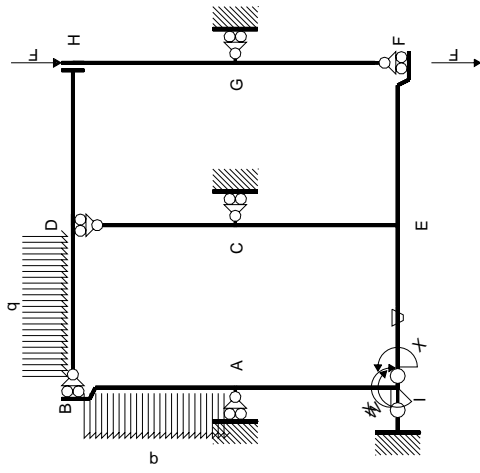
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

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



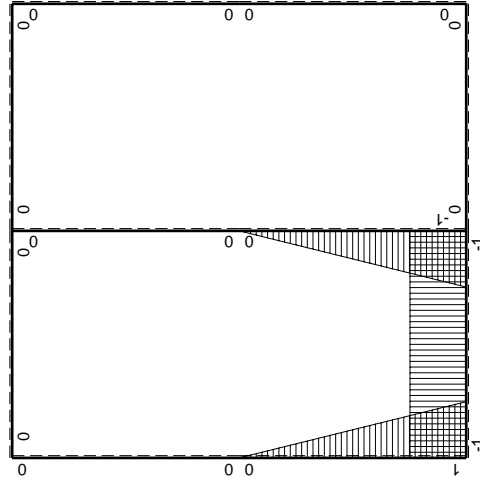
- A = 900. mm²
- J_u = 258984. mm⁴
- J_v = 41256. mm⁴
- y_g = 28.8 mm
- T_y = 2220. N
- M_x = -1798200. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.8 mm
- σ_m = -Mv/J_u = -200. N/mm²
- x_c = 18. mm
- y_c = 9. mm
- v_c = -19.8 mm
- σ_c = -Mv/J_u = -137.5 N/mm²
- τ_c = 3.202 N/mm²
- σ_o = √σ²+3τ² = 137.6 N/mm²
- S = 4482. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fb	0	$Fb-Fx$	0	$1-2x/b+x^2/b^2$	$(1/2+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fb$	0	Fx	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

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

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

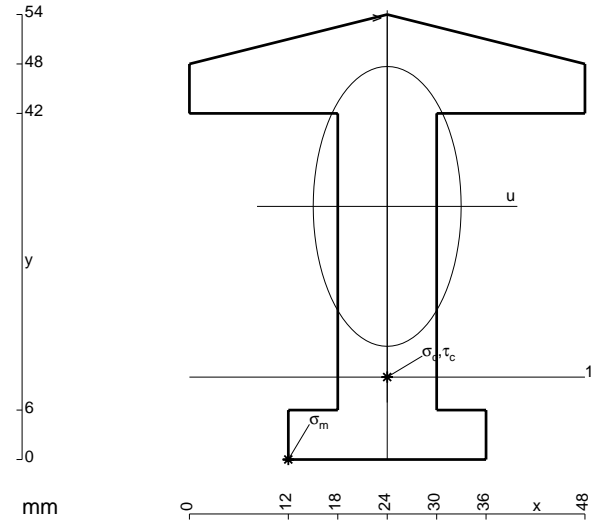
$$= (-5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

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

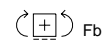
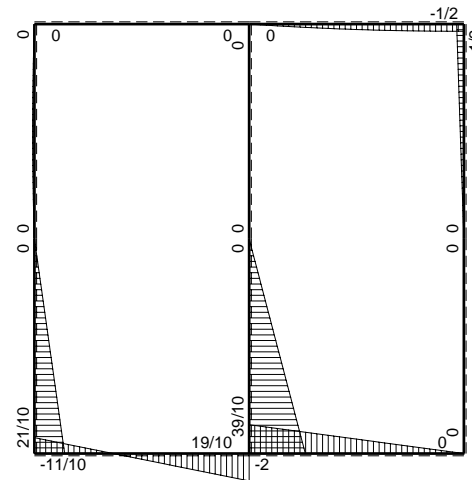
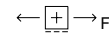
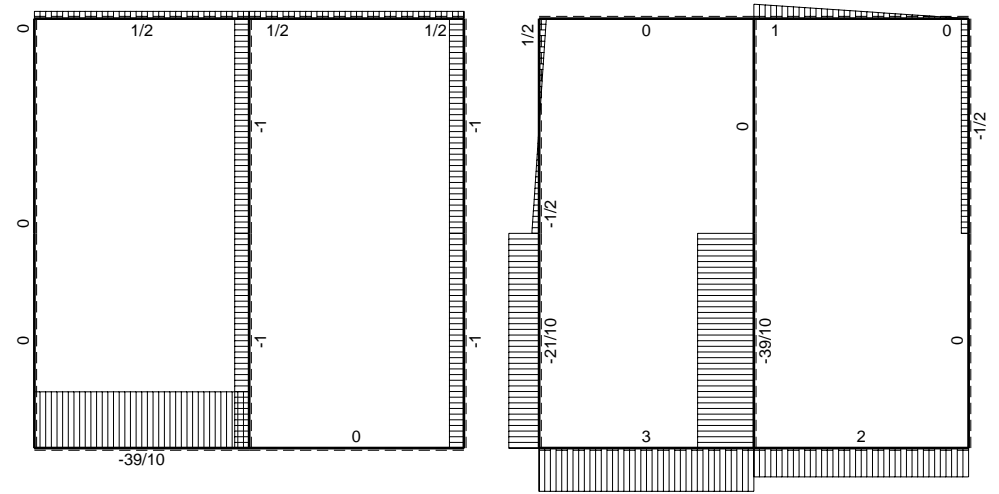
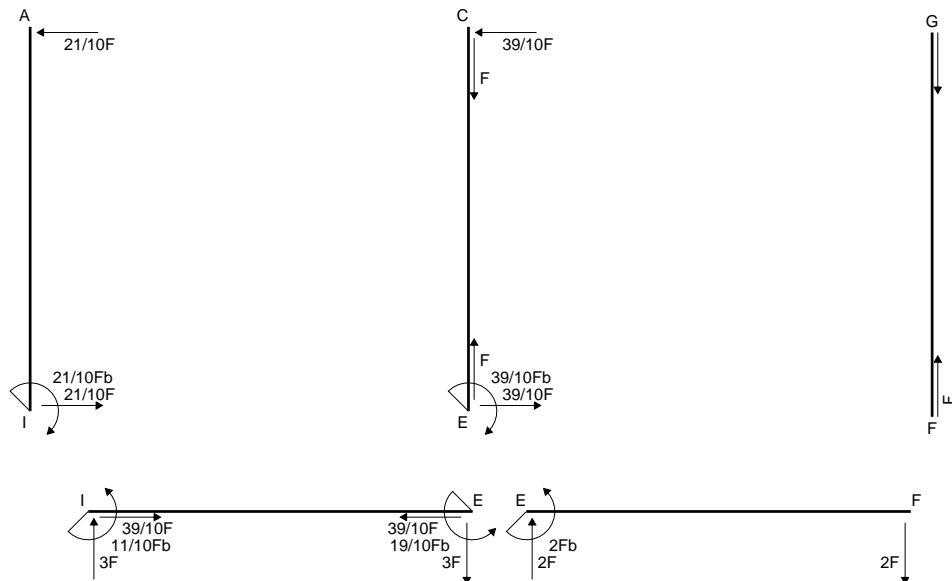
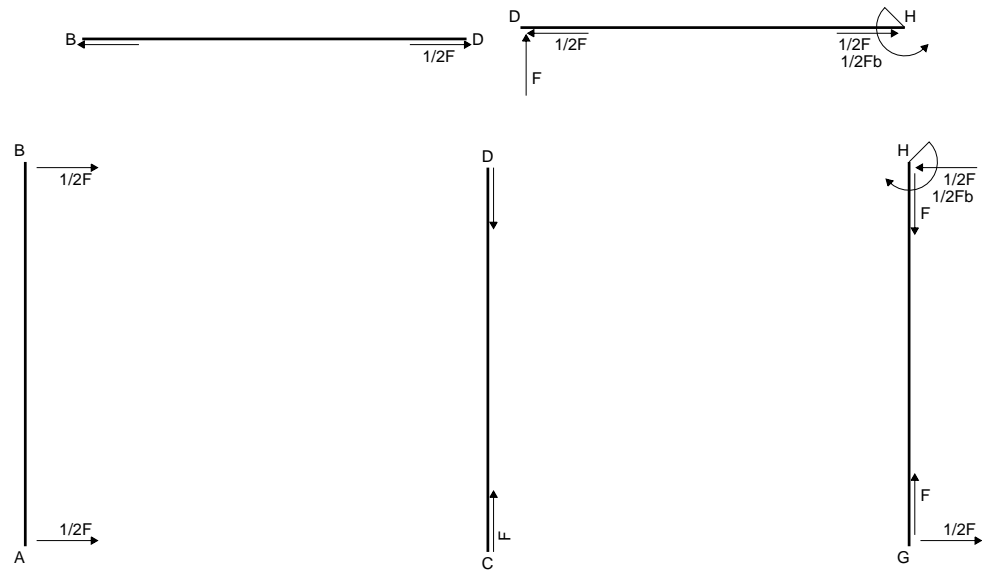
$$= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 Fb^2/EJ$$

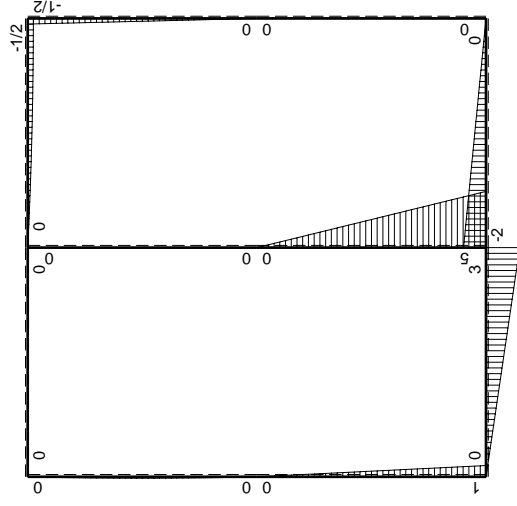
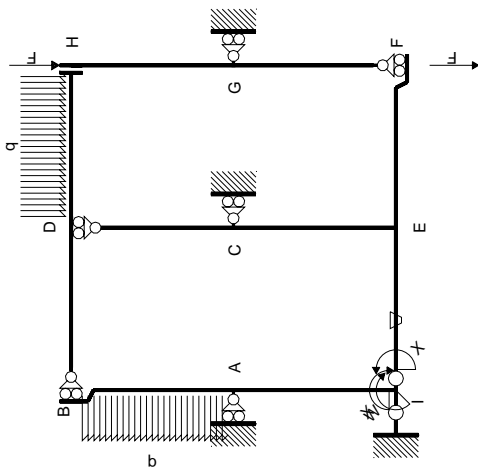
$$L_{AI}^{xo} = \int_0^b (x/b) Fb \frac{1}{EJ} dx = [1/2 x^2/b]_0^b Fb \frac{1}{EJ}$$

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



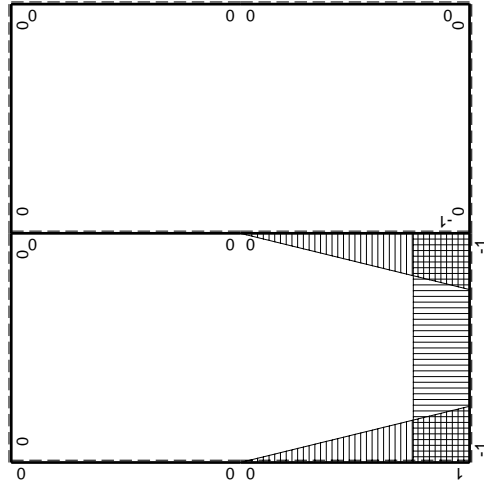
- A = 1008. mm²
- J_u = 290654. mm⁴
- J_v = 81216. mm⁴
- y_g = 30.71 mm
- T_y = 2300. N
- M_x = -1978000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.71 mm
- σ_m = -Mv/J_u = -209. N/mm²
- x_c = 24. mm
- y_c = 10. mm
- v_c = -20.71 mm
- σ_c = -Mv/J_u = -141. N/mm²
- τ_c = 3.351 N/mm²
- σ_o = √σ_c² + 3τ_c² = 141.1 N/mm²
- S = 5081. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-Fx$	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fx$	0	Fx^2/b	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/10Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

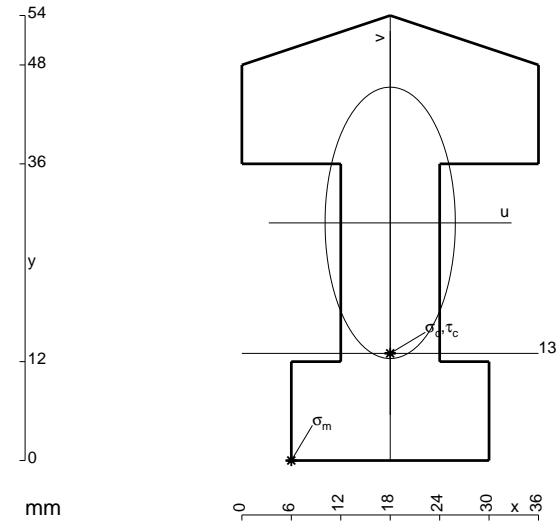
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

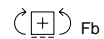
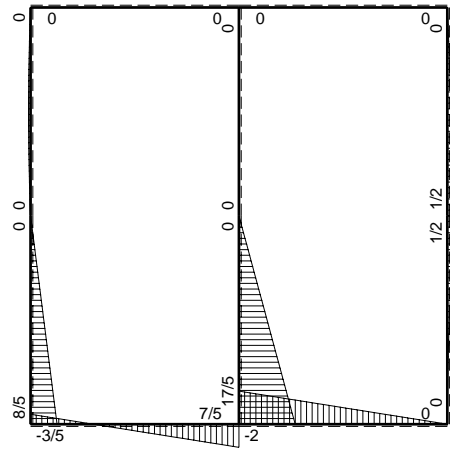
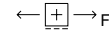
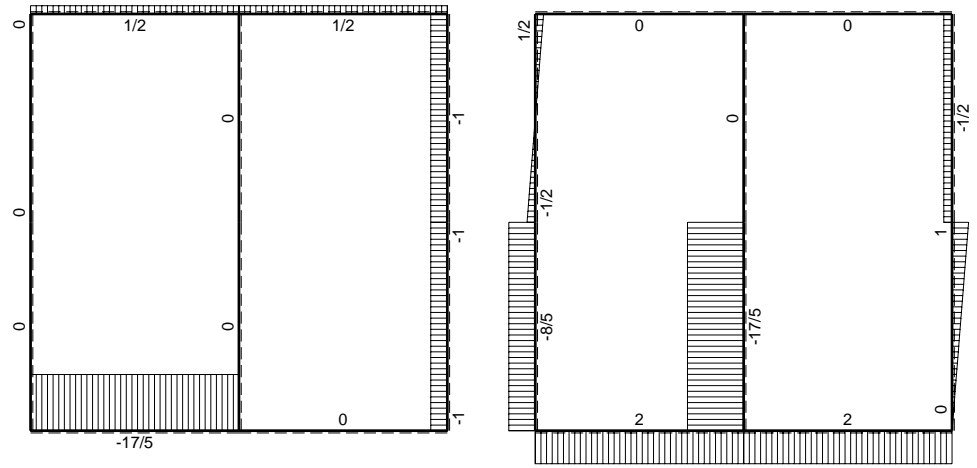
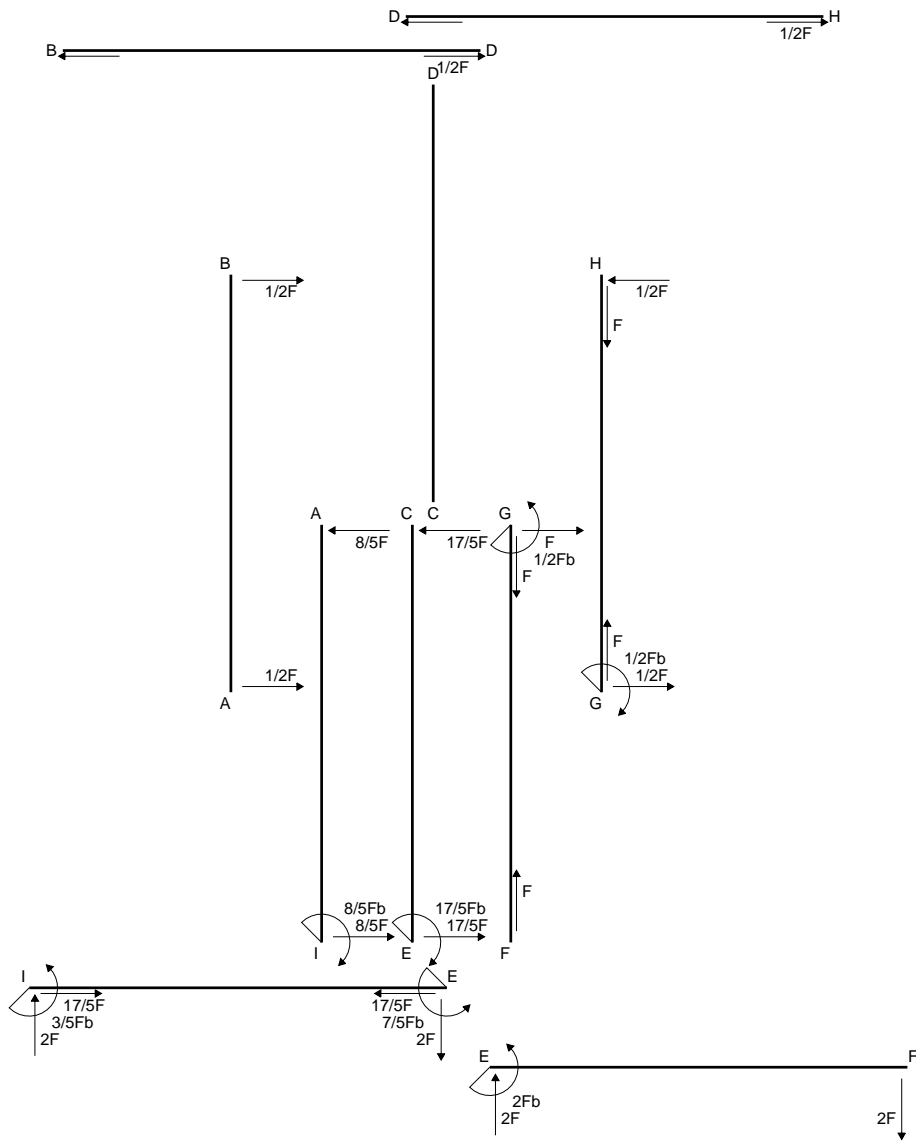
$$= (b - b + 1/3 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

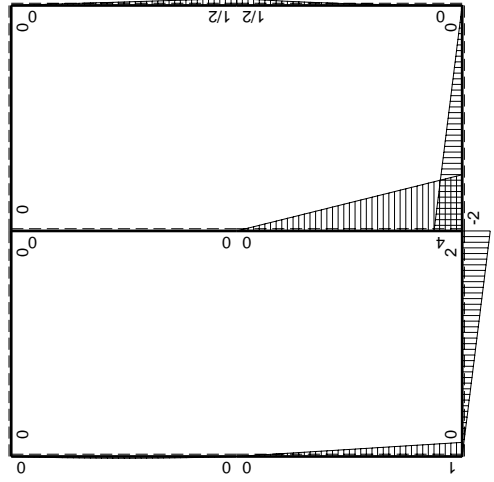
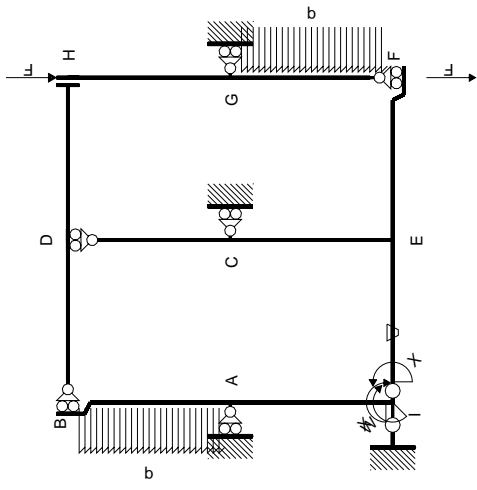
$$L_{AI}^{xo} = \int_0^b (x^2/b^2) Fb 1/EJ dx = [1/3 x^3/b^2]_0^b Fb 1/EJ$$

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



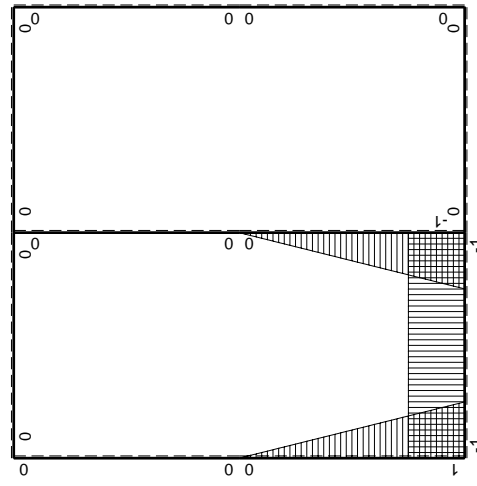
- A = 1116. mm²
- J_u = 302839. mm⁴
- J_v = 69768. mm⁴
- y_g = 28.84 mm
- T_y = 2520. N
- M_x = -2293200. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.84 mm
- σ_m = -Mv/J_u = -218.4 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.84 mm
- σ_c = -Mv/J_u = -119.9 N/mm²
- τ_c = 4.697 N/mm²
- σ_o = √σ²+3τ² = 120.2 N/mm²
- S = 6774. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-Fx$	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fx$	0	Fx^2/b	0	x^2/b^2		
	totali						$-Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/5Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

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

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

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

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

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

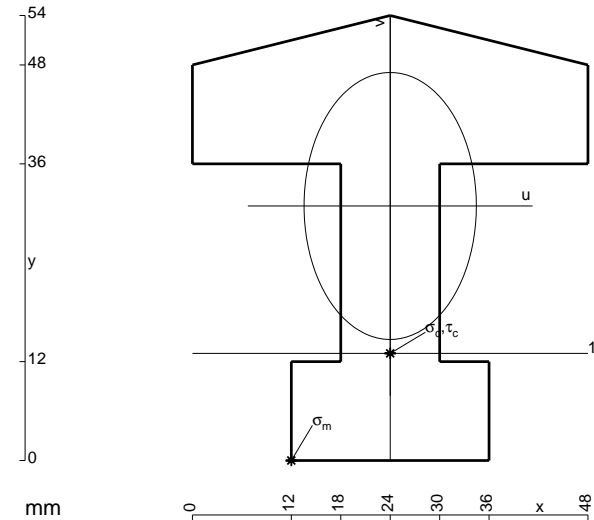
$$= (-4/3 b) Fb 1/EJ = -4/3 Fb^2/EJ$$

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

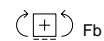
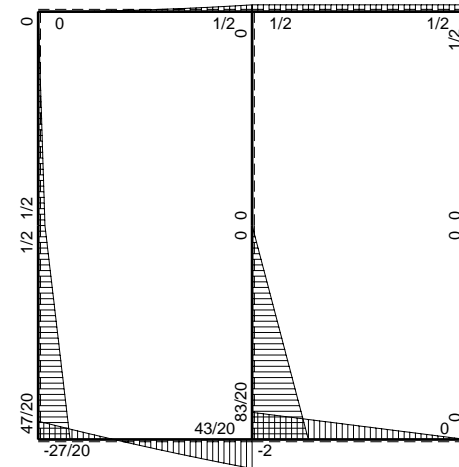
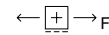
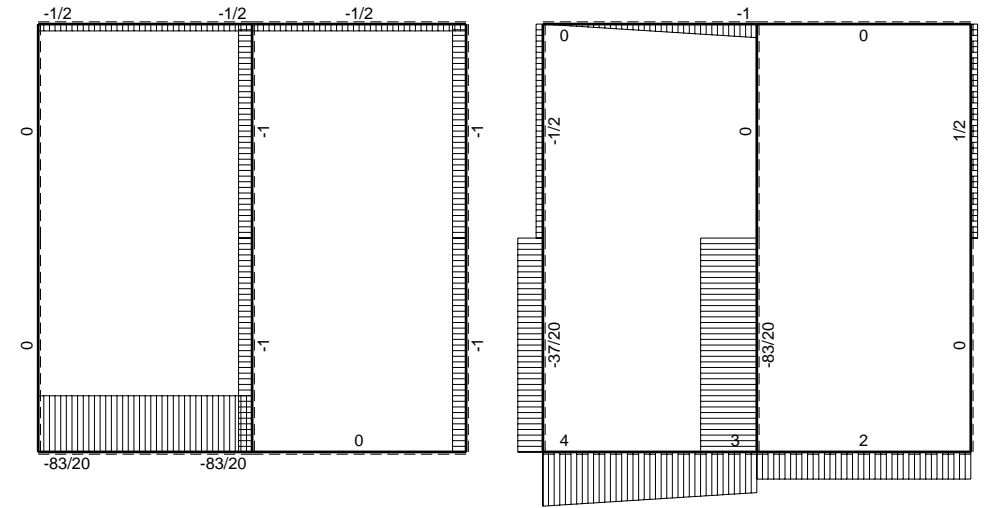
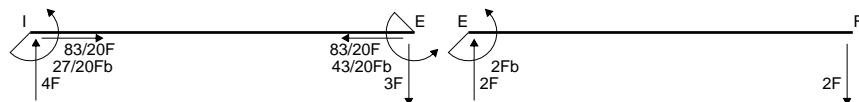
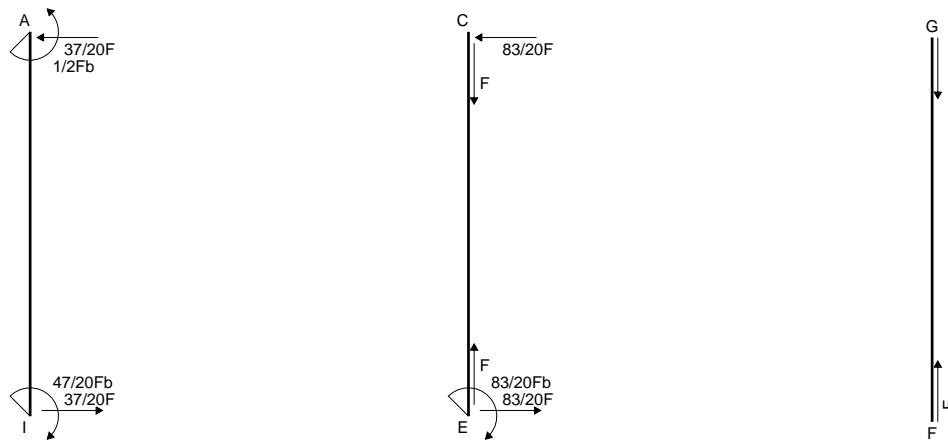
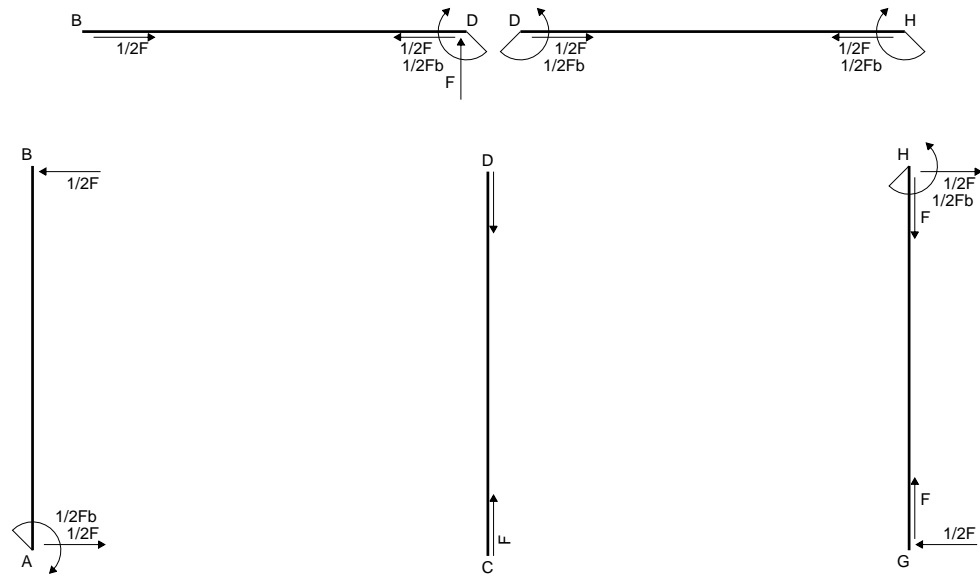
$$= (b - b + 1/3 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

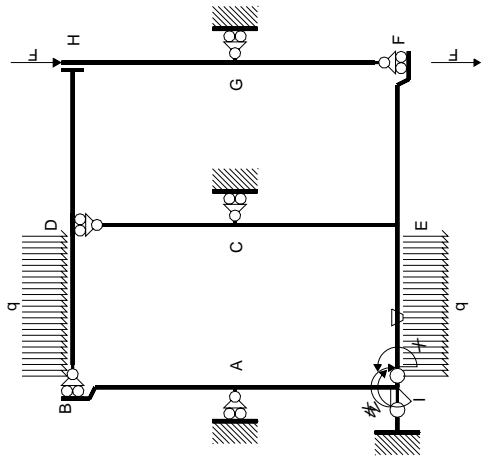
$$L_{AI}^{xo} = \int_0^b (x^2/b^2) Fb 1/EJ dx = [1/3 x^3/b^2]_0^b Fb 1/EJ$$

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

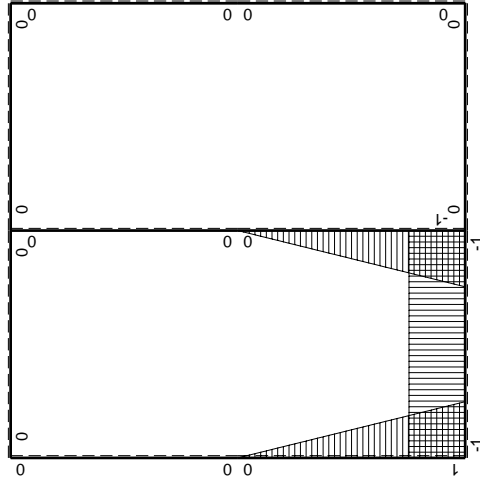


- A = 1296. mm²
- J_u = 340256. mm⁴
- J_v = 141696. mm⁴
- y_g = 30.89 mm
- T_y = 2600. N
- M_x = -2522000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.89 mm
- σ_m = -Mv/J_u = -229. N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -17.89 mm
- σ_c = -Mv/J_u = -132.6 N/mm²
- τ_c = 4.705 N/mm²
- σ_o = √σ²+3τ² = 132.8 N/mm²
- S = 7389. mm³

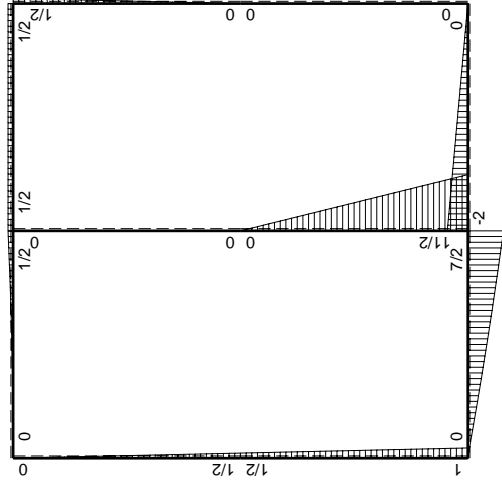




Schema di calcolo iperstatico



M_x , flessione da iperstatica $X=1$



M_0 , flessione da carichi assegnati

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$-1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0			
HD b	0	$1/2Fb$	0	0	0	0	0+0	0	
DH b	0	$-1/2Fb$	0	0	0	0			
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
BD b	0	$-1/2qx^2$	0	0	0	0			
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$Fb-1/2Fx$	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$-1/2Fb-1/2Fx$	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-9/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$27/20Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

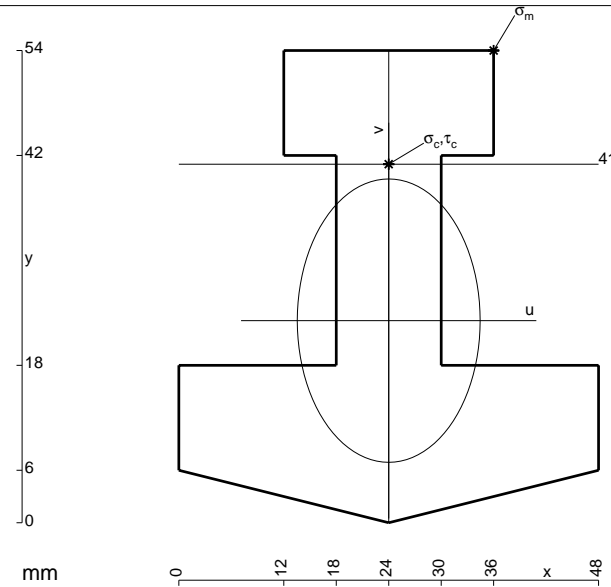
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

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

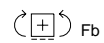
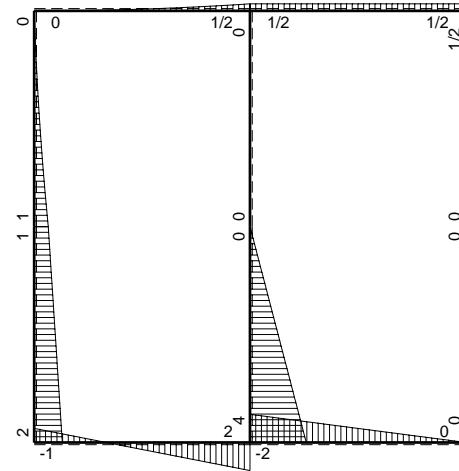
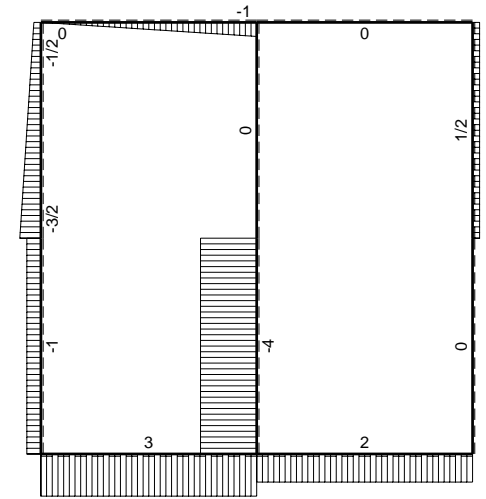
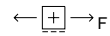
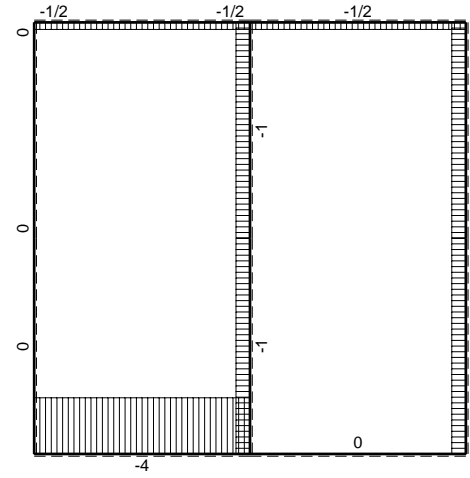
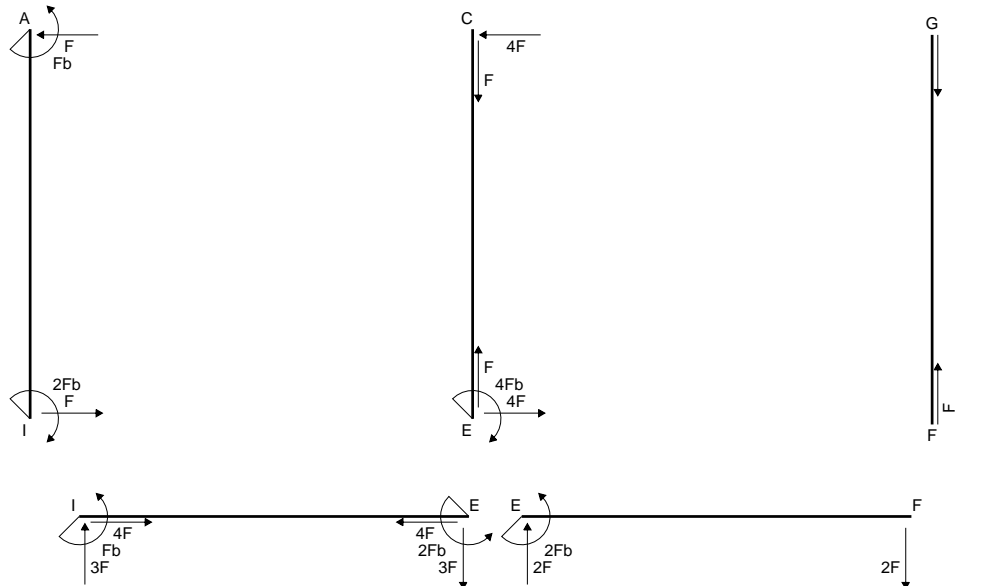
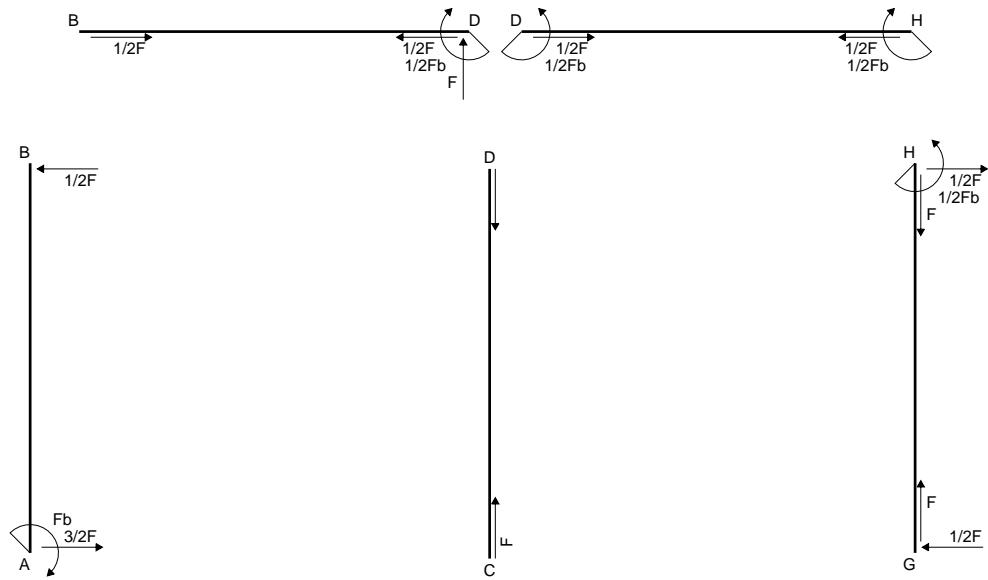
$$= (b - 3/4 b + 1/6 b) Fb \frac{1}{EJ} = 5/12 Fb^2/EJ$$

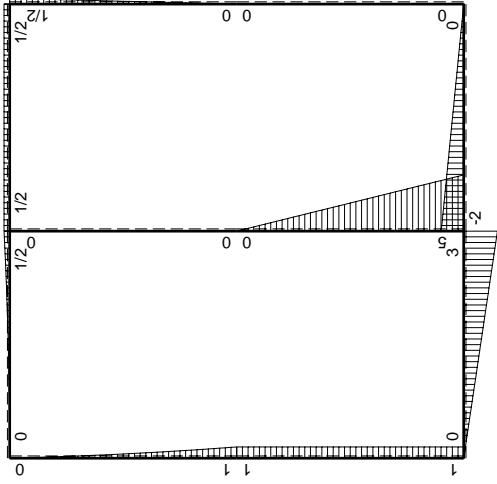
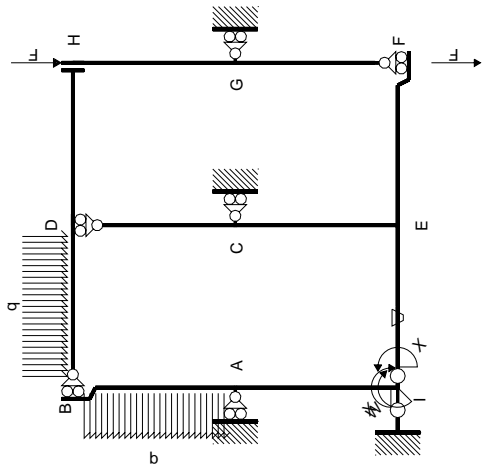
$$L_{AI}^{xo} = \int_0^b (1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/4 b + 1/6 b) Fb \frac{1}{EJ} = 5/12 Fb^2/EJ$$



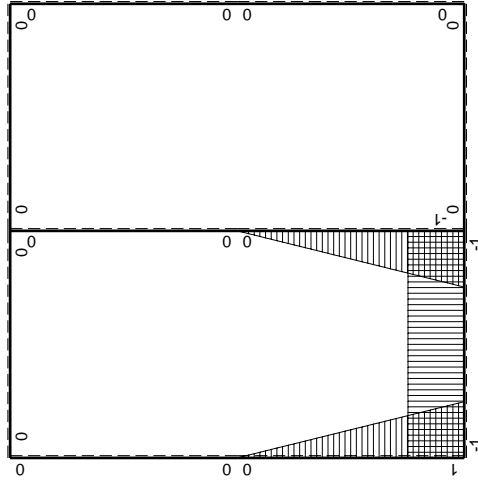
- A = 1296. mm²
- J_u = 340256. mm⁴
- J_v = 141696. mm⁴
- y_g = 23.11 mm
- T_y = 2580. N
- M_x = -2631600. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 30.89 mm
- σ_m = -Mv/J_u = 238.9 N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 17.89 mm
- σ_c = -Mv/J_u = 138.4 N/mm²
- τ_c = 4.669 N/mm²
- σ_q = √σ²+3τ² = 138.6 N/mm²
- S = 7389. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fb	0	$Fb-Fx$	0	$1-2x/b+x^2/b^2$	$(1/2+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fb$	0	Fx	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

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

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

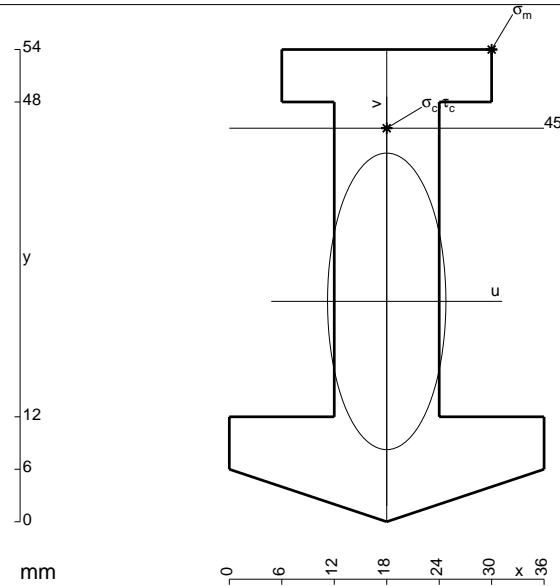
$$= (-5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

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

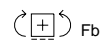
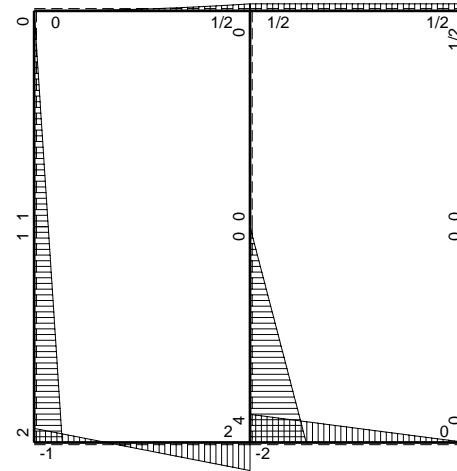
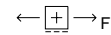
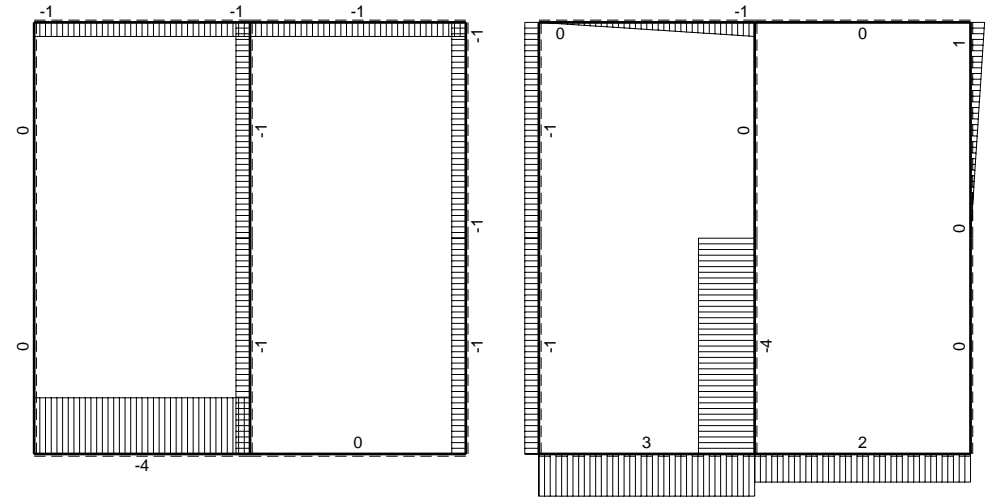
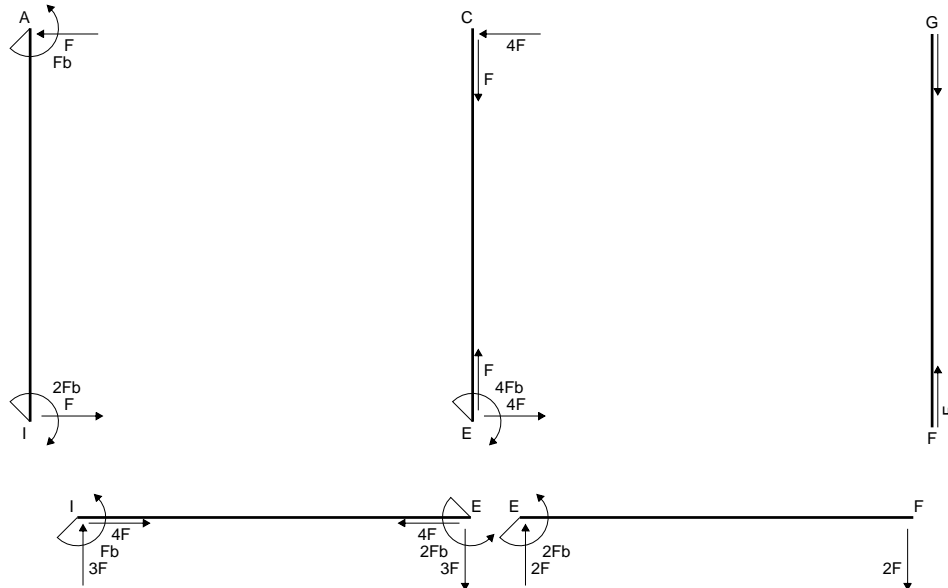
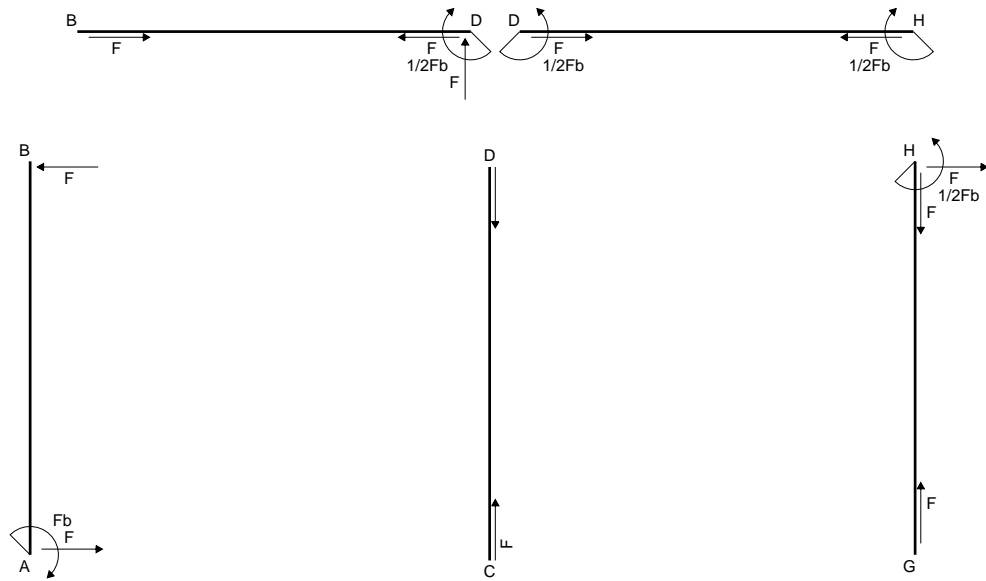
$$= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 Fb^2/EJ$$

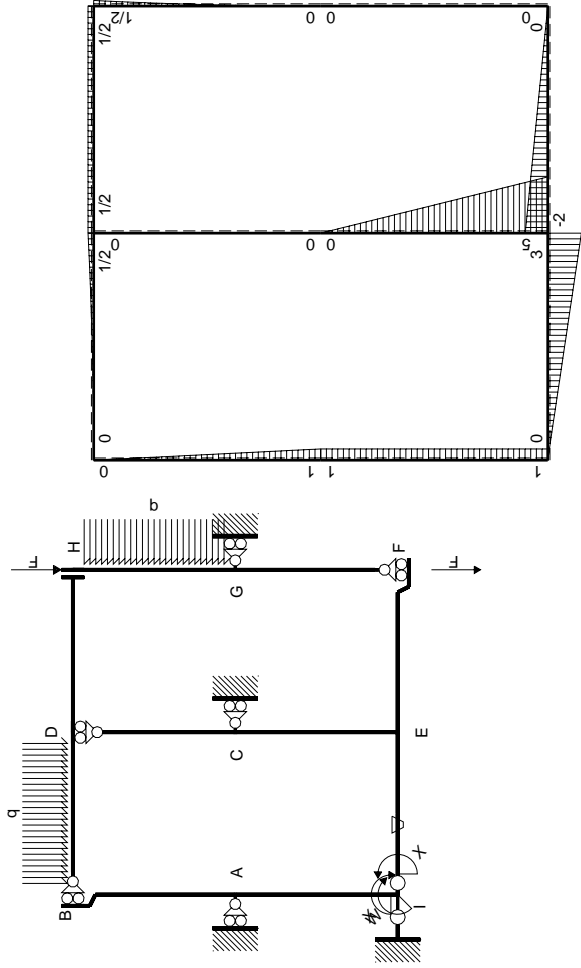
$$L_{AI}^{xo} = \int_0^b (x/b) Fb \frac{1}{EJ} dx = [1/2 x^2/b]_0^b Fb \frac{1}{EJ}$$

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



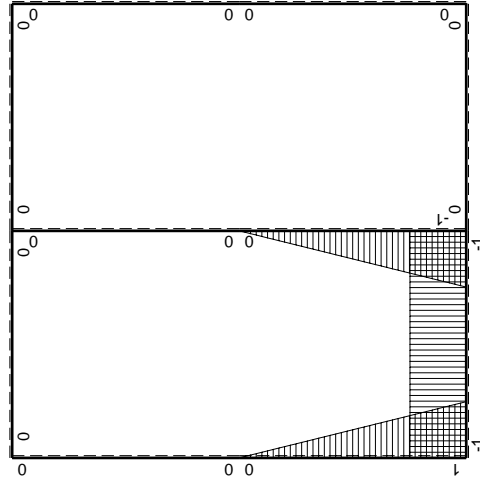
- A = 900. mm²
- J_u = 258984. mm⁴
- J_v = 41256. mm⁴
- y_g = 25.2 mm
- T_y = 3320. N
- M_x = -1792800. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 28.8 mm
- σ_m = -Mv/J_u = 199.4 N/mm²
- x_c = 18. mm
- y_c = 45. mm
- v_c = 19.8 mm
- σ_c = -Mv/J_u = 137.1 N/mm²
- τ_c = 4.788 N/mm²
- σ_q = √σ²+3τ² = 137.3 N/mm²
- S = 4482. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fb	0	Fb-Fx	0	$1-2x/b+x^2/b^2$	$(1/2+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	-Fb	0	Fx	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

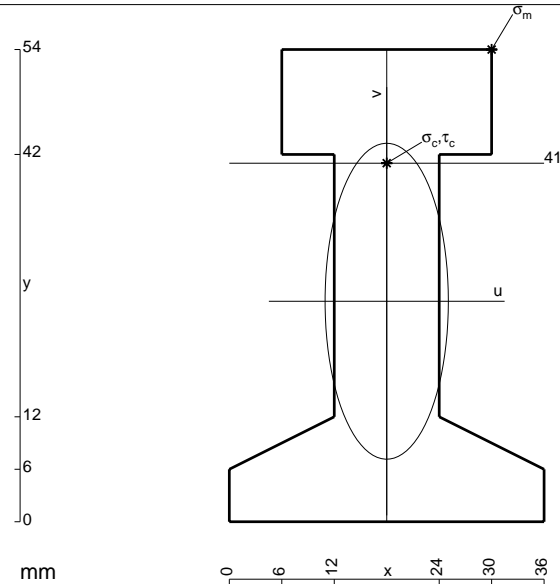
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

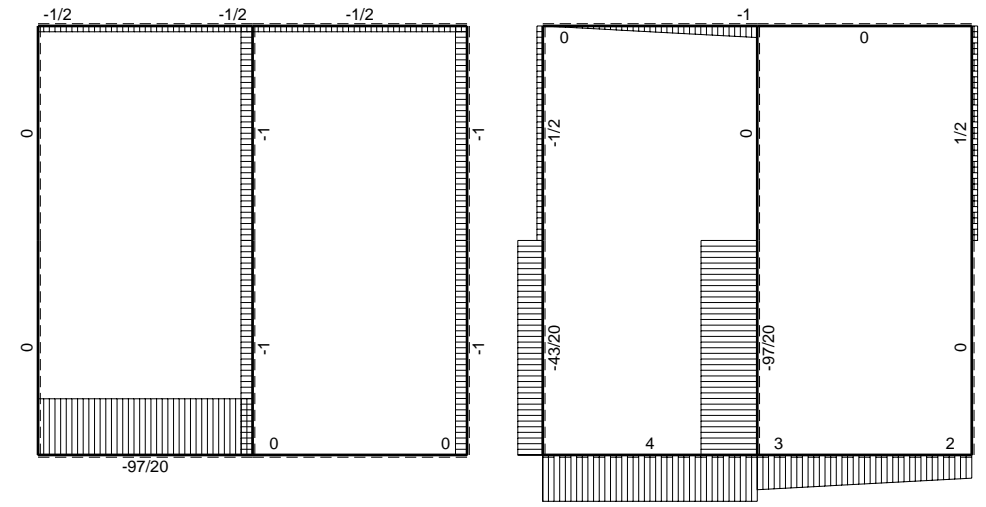
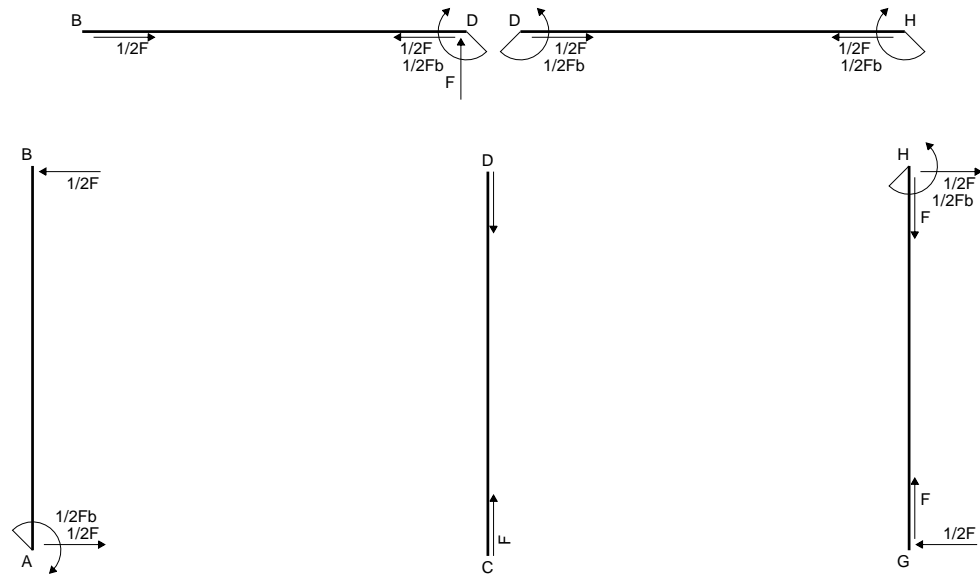
$$= (b - 1/2 b) Fb 1/EJ = 1/2 Fb^2/EJ$$

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

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

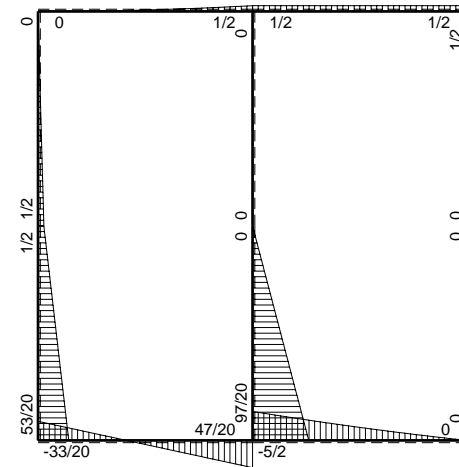
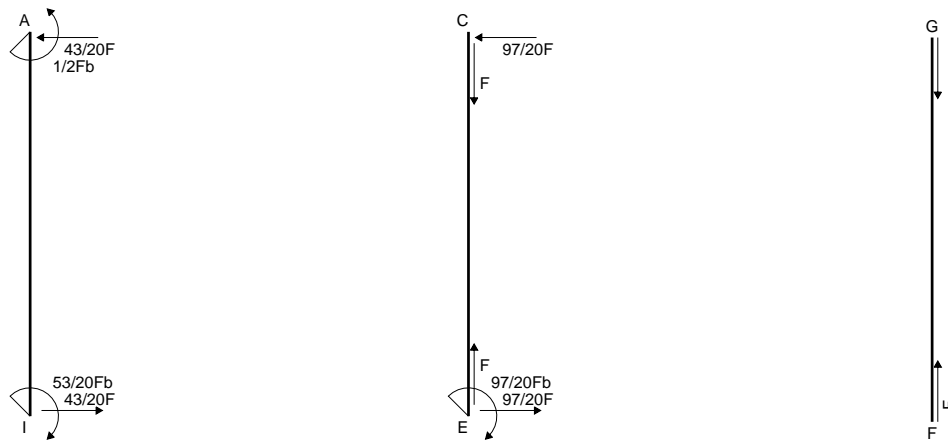


- A = 1008. mm²
- J_u = 328994. mm⁴
- J_v = 50112. mm⁴
- y_g = 25.21 mm
- T_y = 4060. N
- M_x = -2395400. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 28.79 mm
- σ_m = -Mv/J_u = 209.6 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 15.79 mm
- σ_c = -Mv/J_u = 114.9 N/mm²
- τ_c = 6.95 N/mm²
- σ_q = √(σ² + 3τ²) = 115.6 N/mm²
- S = 6758. mm³

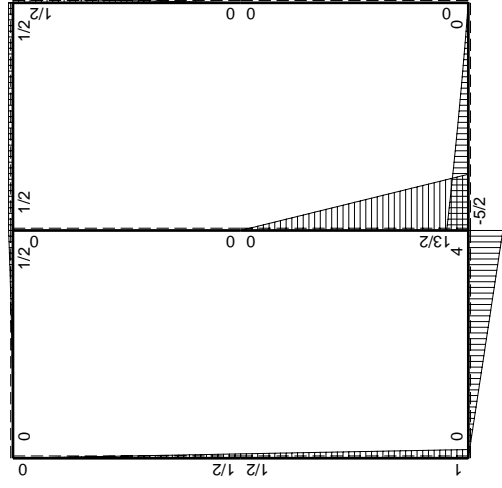
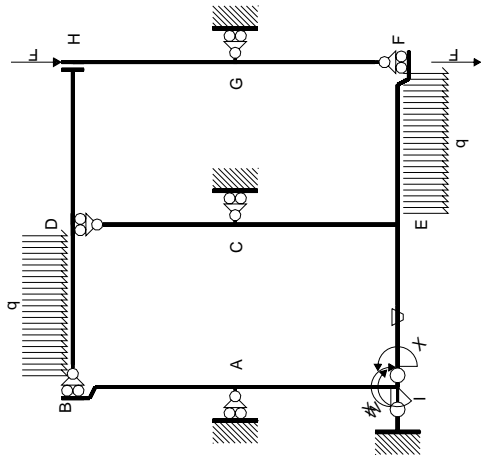


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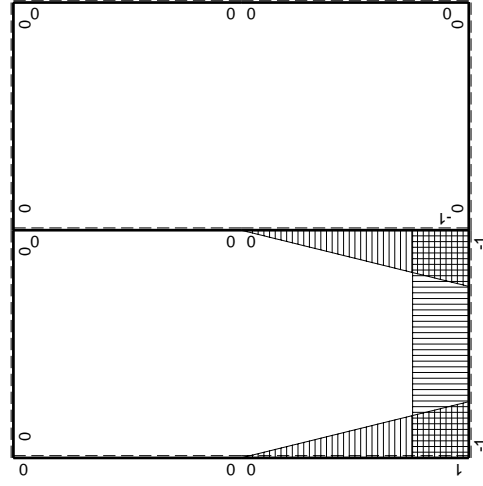


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-1/2Fx$	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb-1/2Fx$	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$33/20Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{x_0} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb 1/EJ dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

$$L_{CE}^{x_0} = \int_0^b (-13/2 x^2/b^2) Fb 1/EJ dx = [-13/6 x^3/b^2]_0^b Fb 1/EJ$$

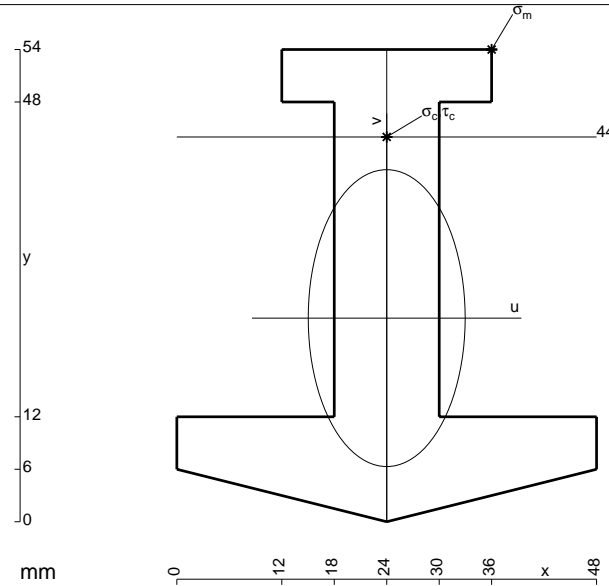
$$= (-13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

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

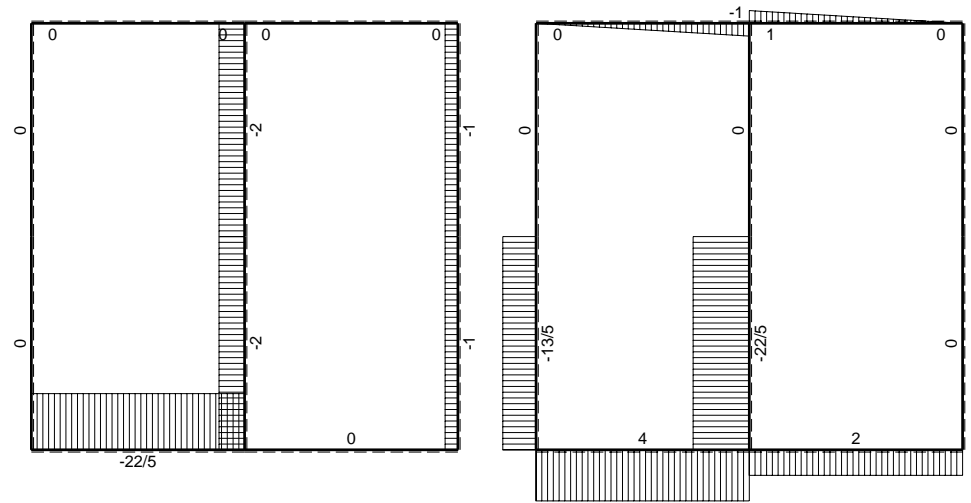
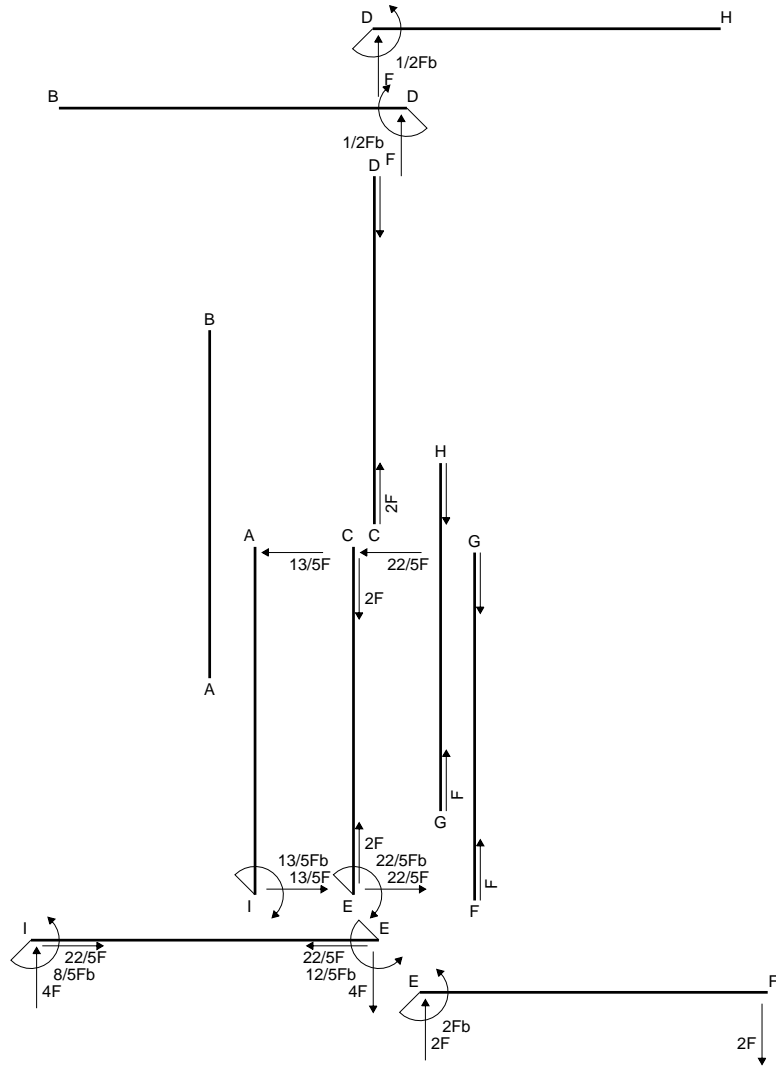
$$= (b - 3/4 b + 1/6 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

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

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

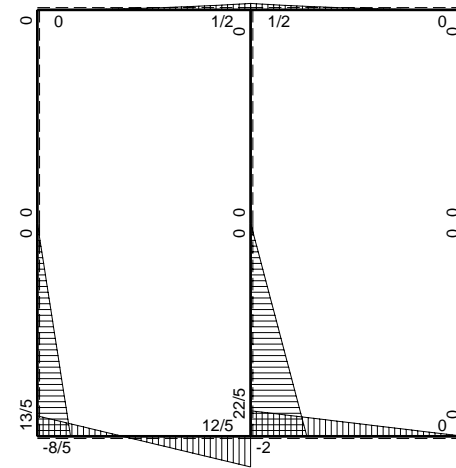


- A = 1008. mm²
- J_u = 290654. mm⁴
- J_v = 81216. mm⁴
- y_g = 23.29 mm
- T_y = 3900. N
- M_x = -2080000. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 30.71 mm
- σ_m = -Mv/J_u = 219.8 N/mm²
- x_c = 24. mm
- y_c = 44. mm
- v_c = 20.71 mm
- σ_c = -Mv/J_u = 148.2 N/mm²
- τ_c = 5.682 N/mm²
- σ_q = √σ²+3τ² = 148.6 N/mm²
- S = 5081. mm³

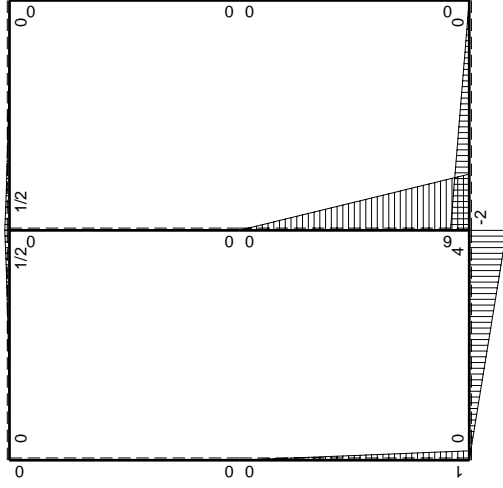
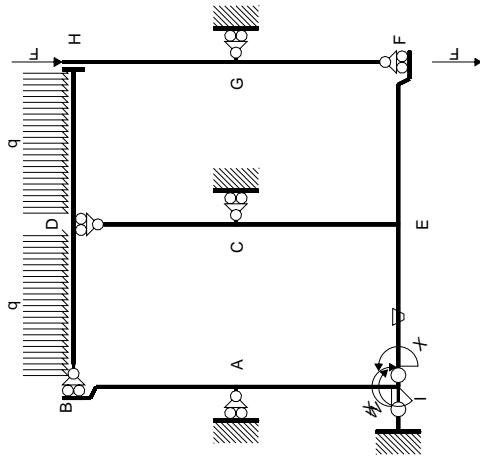


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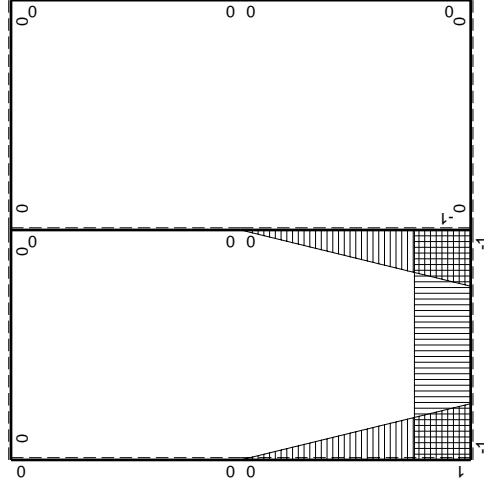


⊕ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-Fx$	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fx$	0	Fx^2/b	0	x^2/b^2		
	totali						$-8/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$8/5Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb 1/EJ dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

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

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

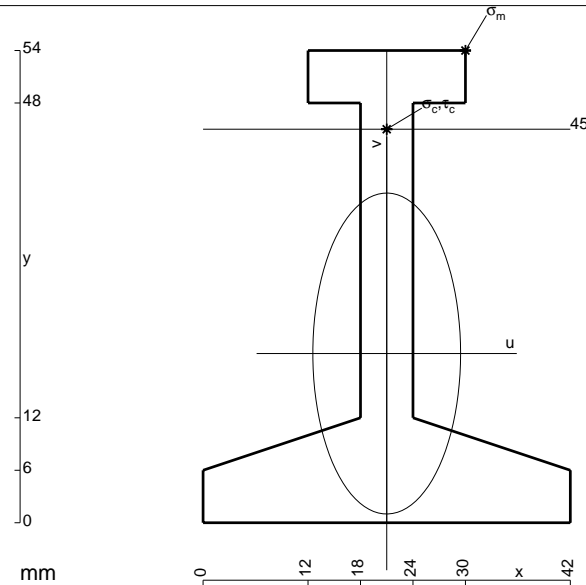
$$= (-2b) Fb 1/EJ = -2 Fb^2/EJ$$

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

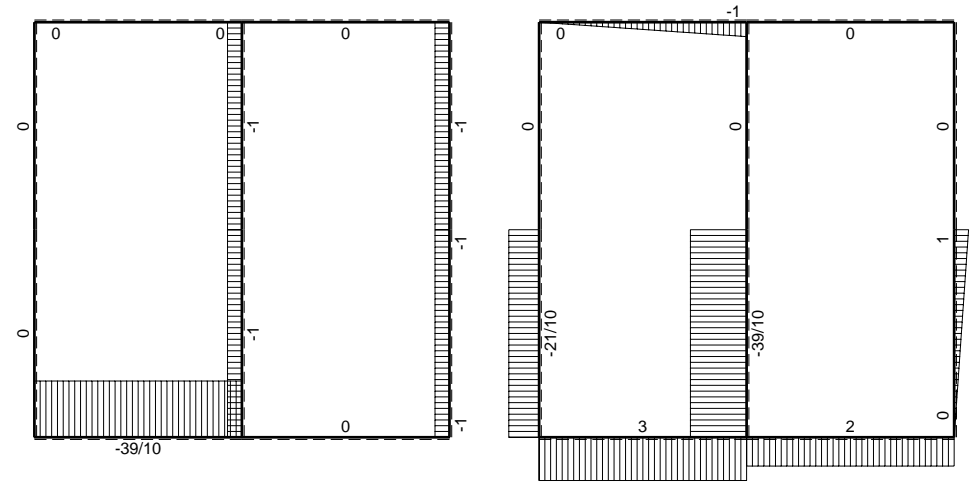
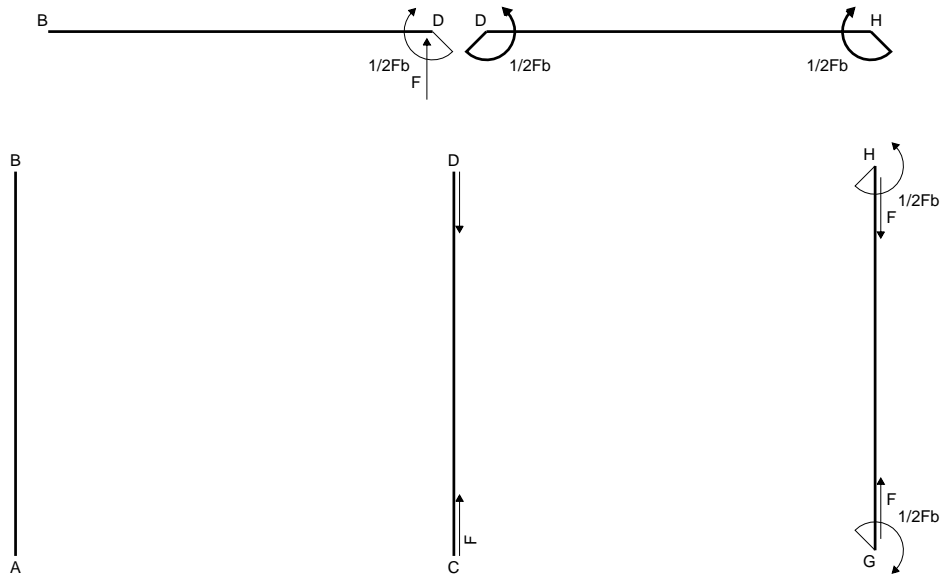
$$= (b - b + 1/3 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

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

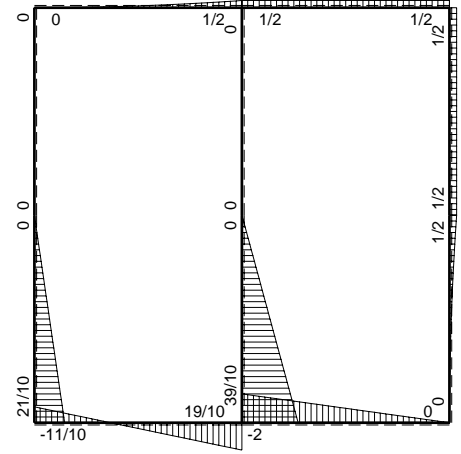
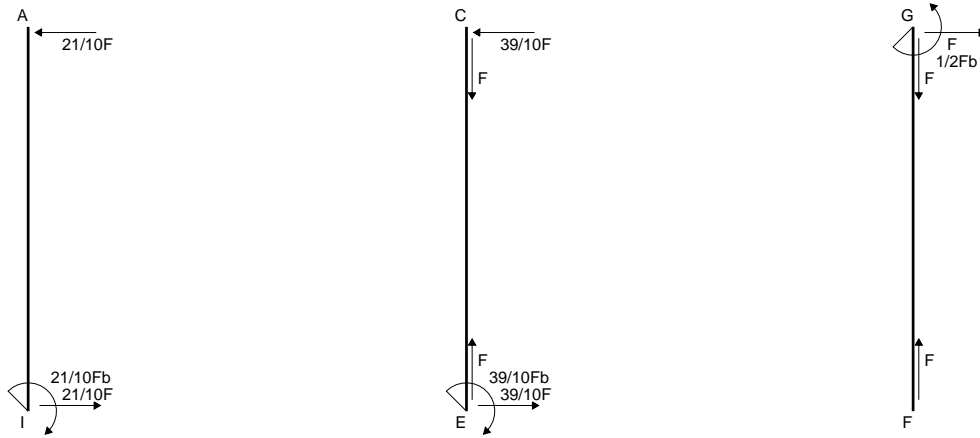


- A = 720. mm²
- J_u = 242552. mm⁴
- J_v = 51408. mm⁴
- y_g = 19.35 mm
- T_y = 2300. N
- M_x = -1610000. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 9. mm
- v_m = 34.65 mm
- σ_m = -Mv/J_u = 230. N/mm²
- x_c = 21. mm
- y_c = 45. mm
- v_c = 25.65 mm
- σ_c = -Mv/J_u = 170.3 N/mm²
- τ_c = 6.175 N/mm²
- σ_q = √σ²+3τ² = 170.6 N/mm²
- S = 3907. mm³

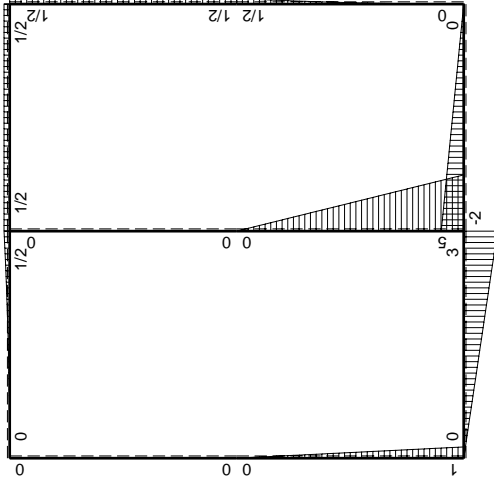
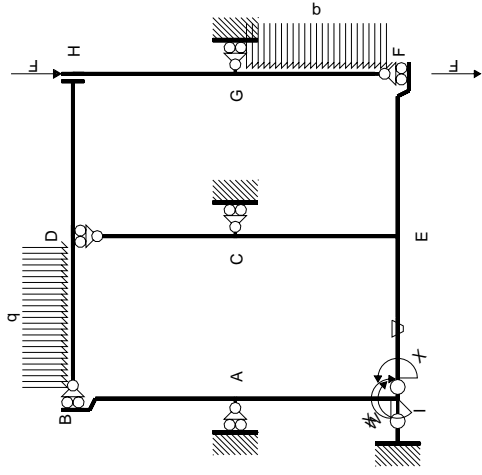


← ⊕ → F

↑ ⊕ ↓ F

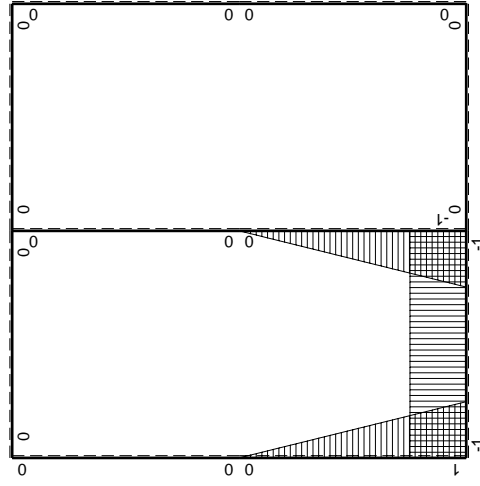


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	0	0	0	0	0	0+0	0	
BA b	0	0	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	1/2qx ²	0	0	0	0	0+0	0	
GF b	0	-1/2Fb+Fx-1/2qx ²	0	0	0	0			
GH b	0	1/2Fb	0	0	0	0	0+0	0	
HG b	0	-1/2Fb	0	0	0	0			
HD b	0	1/2Fb	0	0	0	0	0+0	0	
DH b	0	-1/2Fb	0	0	0	0			
DB b	0	1/2Fb-Fx+1/2qx ²	0	0	0	0	0+0	0	
BD b	0	-1/2qx ²	0	0	0	0			
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	(-3/2+1)Fb ² /EJ	Xb/EJ	
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1			
EC b	-1+x/b	5Fb-5Fx	0	-5Fb+10Fx-5Fx ² /b	0	1-2x/b+x ² /b ²	(-5/3+0)Fb ² /EJ	1/3Xb/EJ	
CE b	x/b	-5Fx	0	-5Fx ² /b	0	x ² /b ²			
IA b	1-x/b	Fb-Fx	0	Fb-2Fx+Fx ² /b	0	1-2x/b+x ² /b ²	(1/3+0)Fb ² /EJ	1/3Xb/EJ	
AI b	-x/b	-Fx	0	Fx ² /b	0	x ² /b ²			
	totali							-11/6Fb ² /EJ	5/3Xb/EJ
	iperstatica $X=W_{IE}$							11/10Fb	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

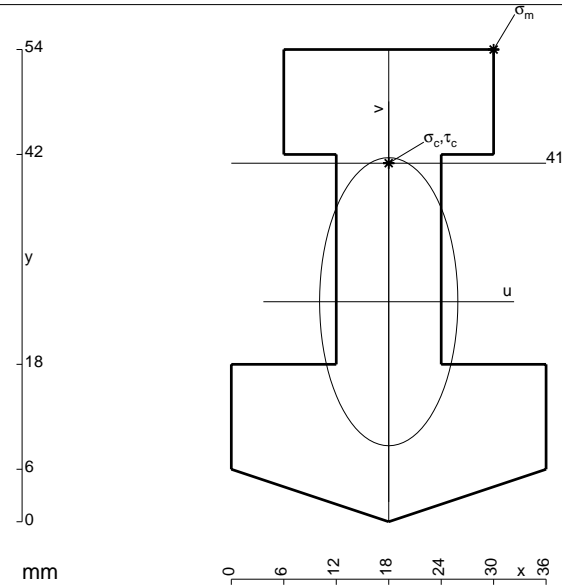
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

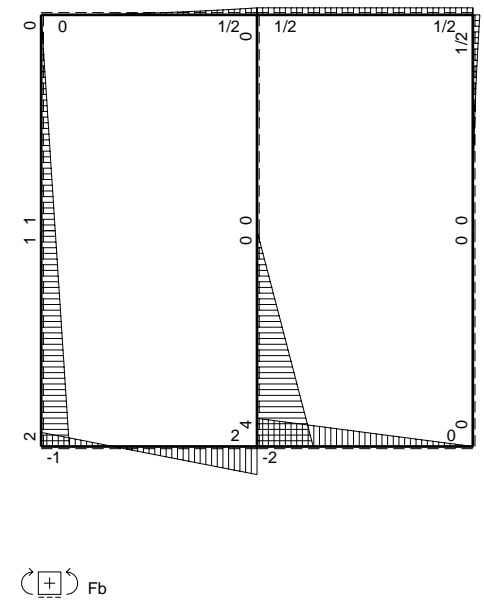
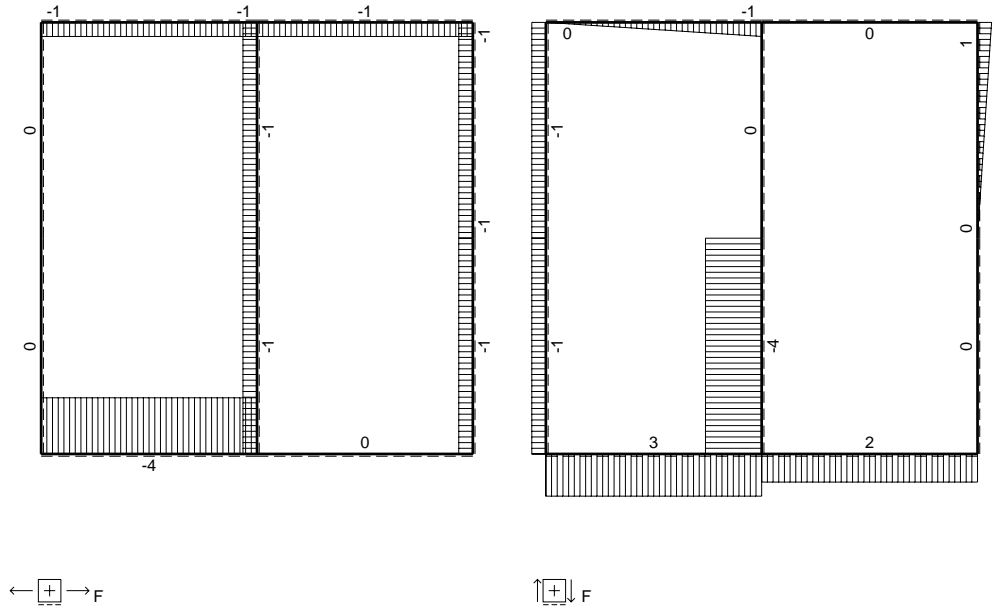
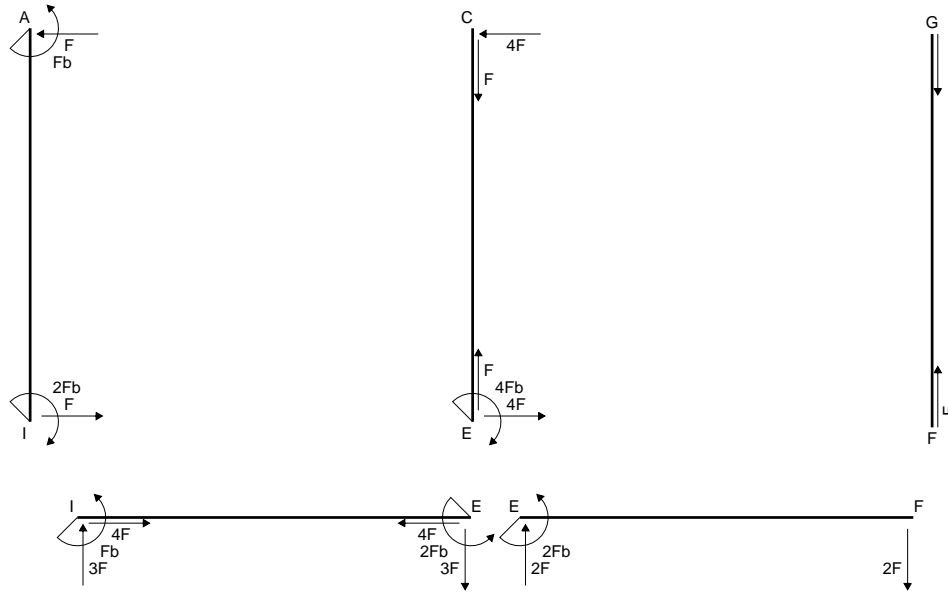
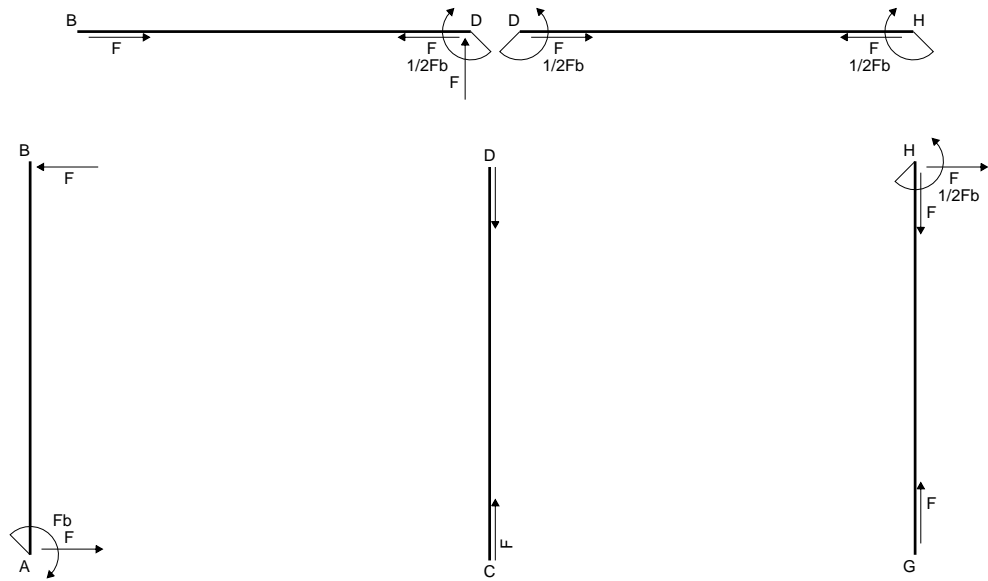
$$= (b - b + 1/3 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

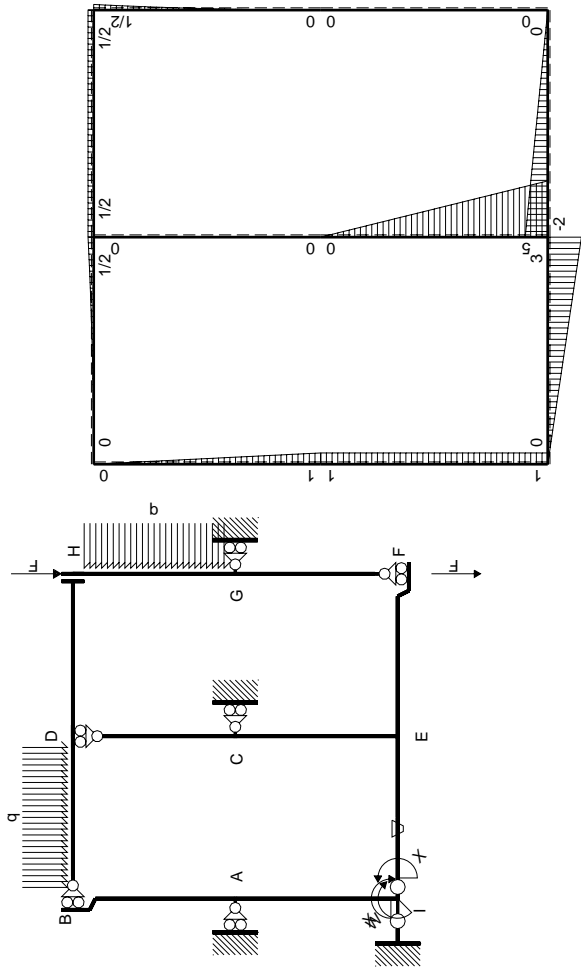
$$L_{AI}^{xo} = \int_0^b (x^2/b^2) Fb 1/EJ dx = [1/3 x^3/b^2]_0^b Fb 1/EJ$$

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



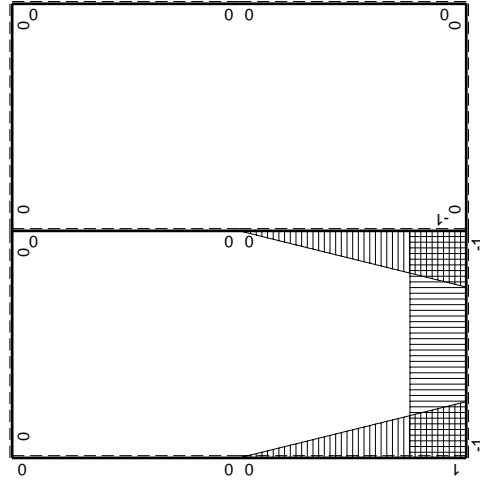
- A = 1116. mm²
- J_u = 302839. mm⁴
- J_v = 69768. mm⁴
- y_g = 25.16 mm
- T_y = 3360. N
- M_x = -2520000. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 28.84 mm
- σ_m = -Mv/J_u = 240. N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 15.84 mm
- σ_c = -Mv/J_u = 131.8 N/mm²
- τ_c = 6.263 N/mm²
- σ_q = √σ_c² + 3τ_c² = 132.2 N/mm²
- S = 6774. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fb	0	Fb-Fx	0	$1-2x/b+x^2/b^2$	$(1/2+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	-Fb	0	Fx	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

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

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

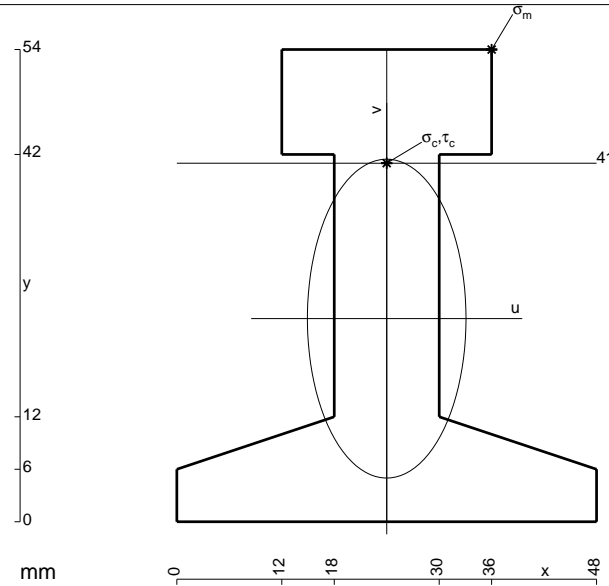
$$= (-5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

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

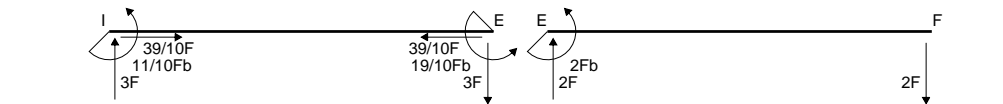
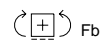
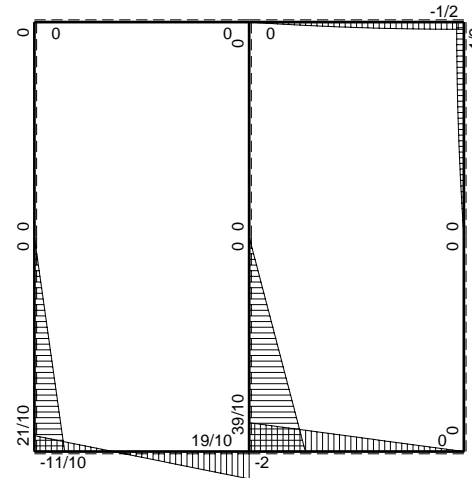
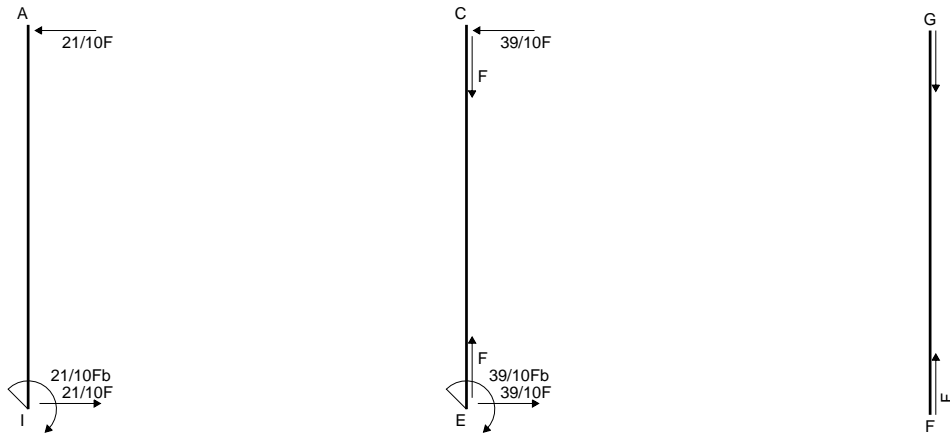
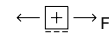
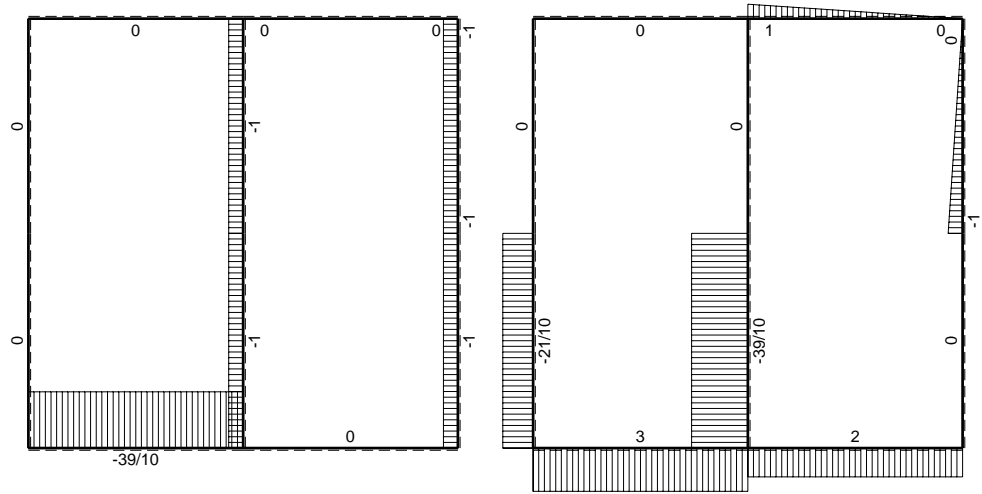
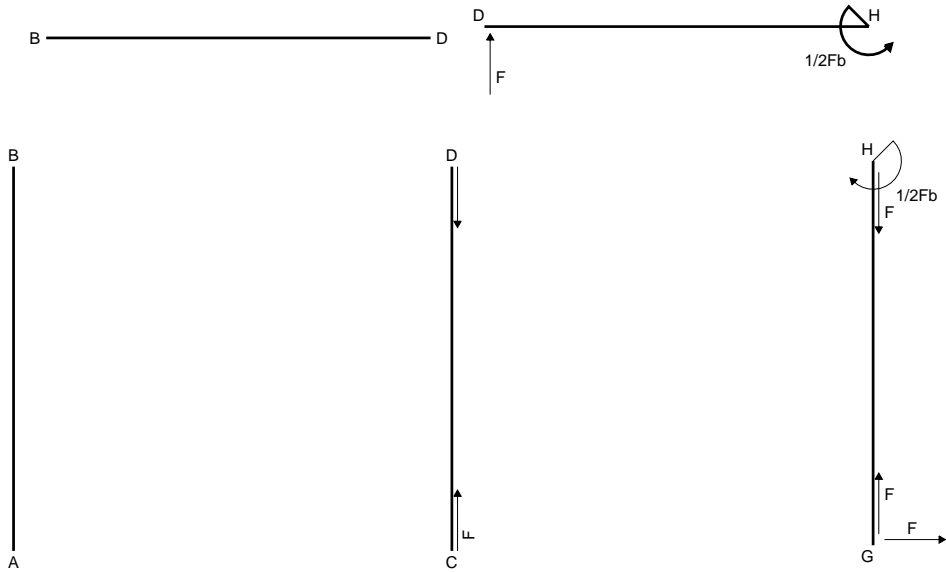
$$= (b - 1/2 b) Fb \frac{1}{EJ} = 1/2 Fb^2/EJ$$

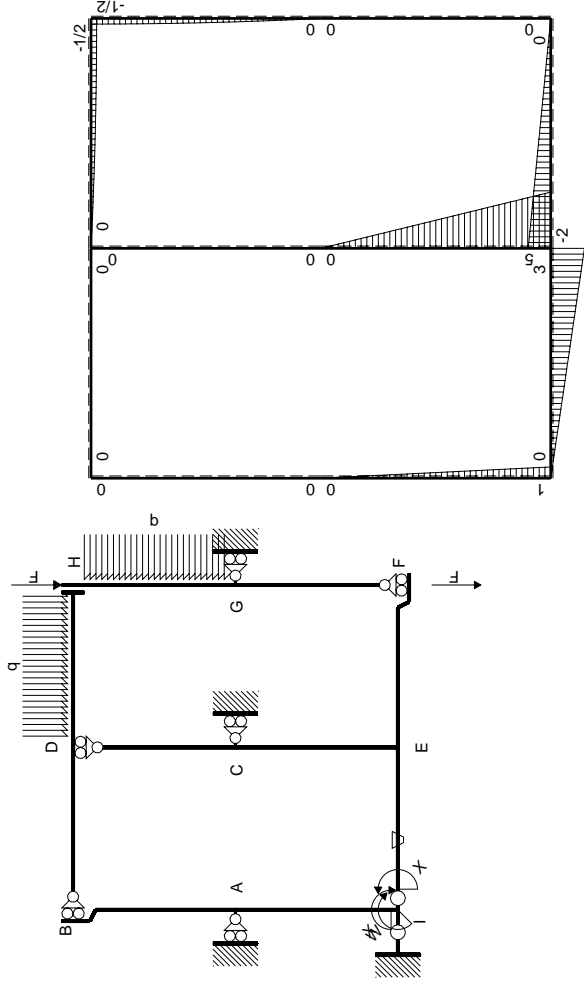
$$L_{AI}^{xo} = \int_0^b (x/b) Fb \frac{1}{EJ} dx = [1/2 x^2/b]_0^b Fb \frac{1}{EJ}$$

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



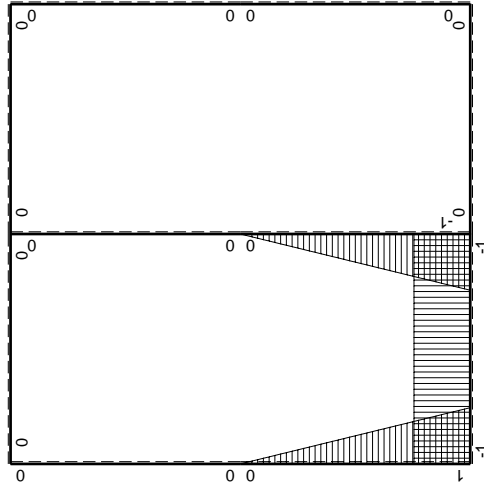
- A = 1116. mm²
- J_u = 371067. mm⁴
- J_v = 91800. mm⁴
- y_g = 23.23 mm
- T_y = 2960. N
- M_x = -2397600. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 30.77 mm
- σ_m = -Mv/J_u = 198.8 N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 17.77 mm
- σ_c = -Mv/J_u = 114.8 N/mm²
- τ_c = 4.889 N/mm²
- σ_q = √σ²+3τ² = 115.2 N/mm²
- S = 7354. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	0	0	0	0	0	0+0	0	
BA b	0	0	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	-Fx+1/2qx ²	0	0	0	0	0+0	0	
HG b	0	1/2Fb-1/2qx ²	0	0	0	0			
HD b	0	-1/2Fb+1/2qx ²	0	0	0	0	0+0	0	
DH b	0	Fx-1/2qx ²	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	(-3/2+1)Fb ² /EJ	Xb/EJ	
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1			
EC b	-1+x/b	5Fb-5Fx	0	-5Fb+10Fx-5Fx ² /b	0	1-2x/b+x ² /b ²	(-5/3+0)Fb ² /EJ	1/3Xb/EJ	
CE b	x/b	-5Fx	0	-5Fx ² /b	0	x ² /b ²			
IA b	1-x/b	Fb-Fx	0	Fb-2Fx+Fx ² /b	0	1-2x/b+x ² /b ²	(1/3+0)Fb ² /EJ	1/3Xb/EJ	
AI b	-x/b	-Fx	0	Fx ² /b	0	x ² /b ²			
	totali							-11/6Fb ² /EJ	5/3Xb/EJ
	iperstatica $X=W_{IE}$							11/10Fb	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

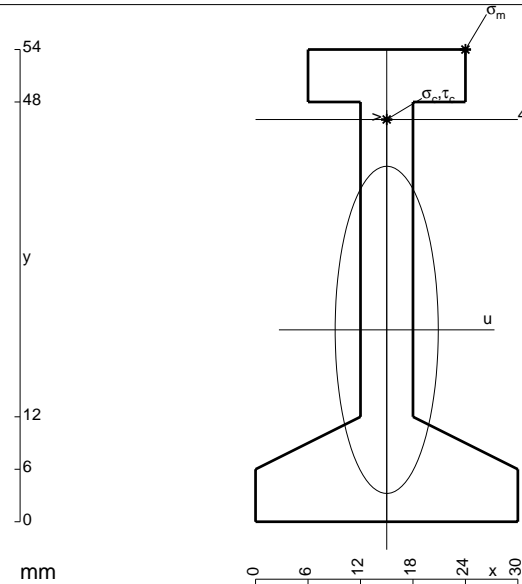
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

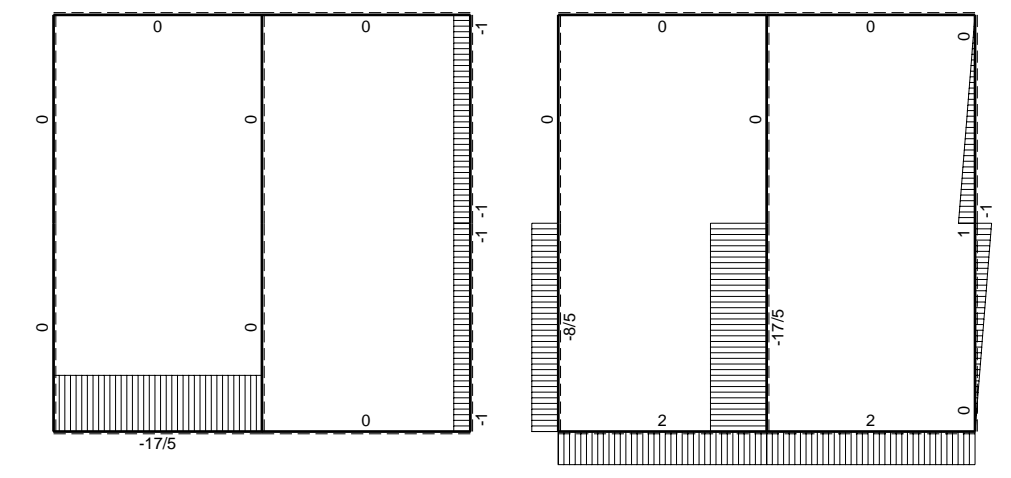
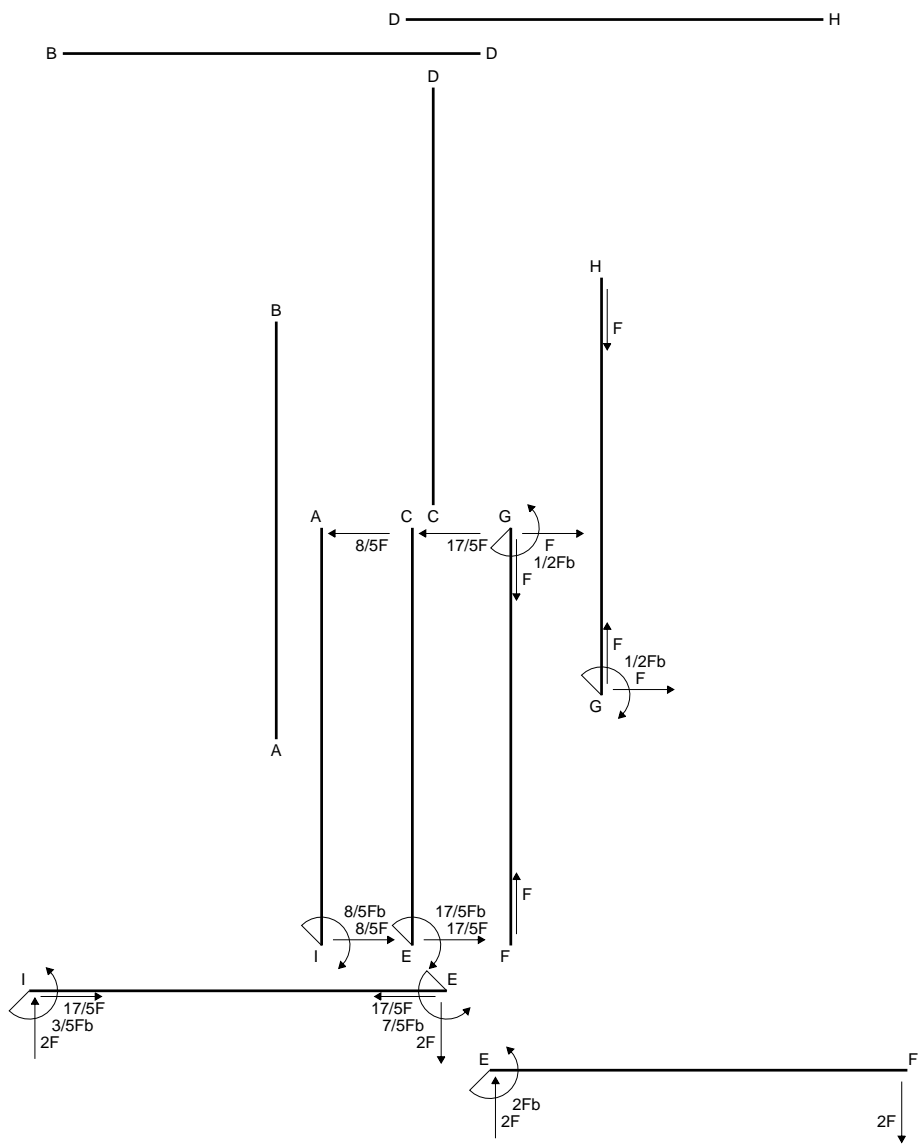
$$= (b - b + 1/3 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

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

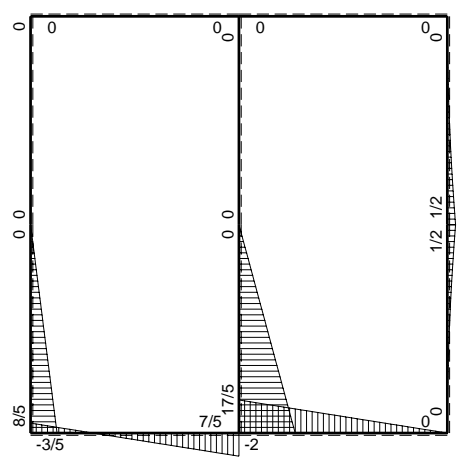


- A = 612. mm²
- J_u = 214270. mm⁴
- J_v = 21276. mm⁴
- y_g = 21.94 mm
- T_y = 1620. N
- M_x = -1393200. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 9. mm
- v_m = 32.06 mm
- σ_m = -Mv/J_u = 208.4 N/mm²
- x_c = 15. mm
- y_c = 46. mm
- v_c = 24.06 mm
- σ_c = -Mv/J_u = 156.4 N/mm²
- τ_c = 4.334 N/mm²
- σ_q = √σ²+3τ² = 156.6 N/mm²
- S = 3439. mm³

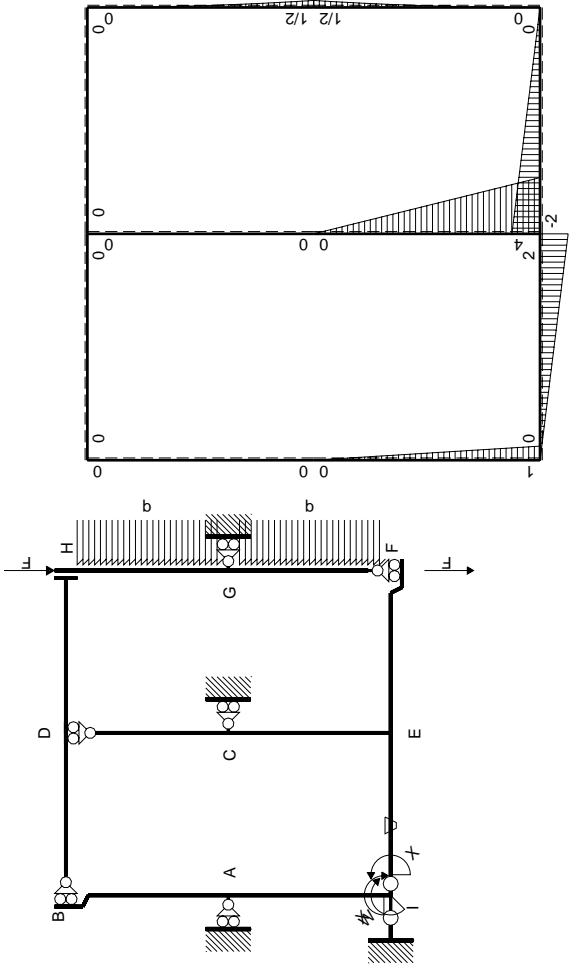


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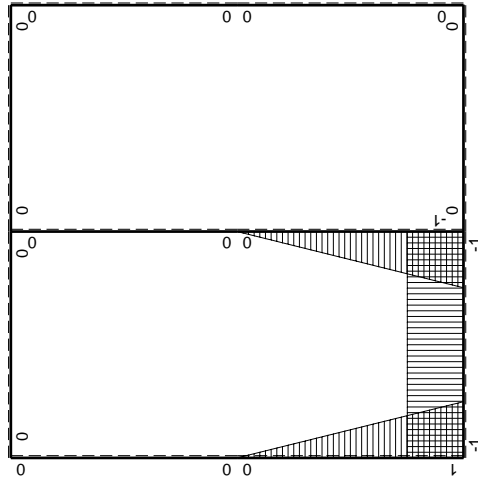


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-Fx$	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fx$	0	Fx^2/b	0	x^2/b^2		
	totali						$-Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/5Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

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

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

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

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

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

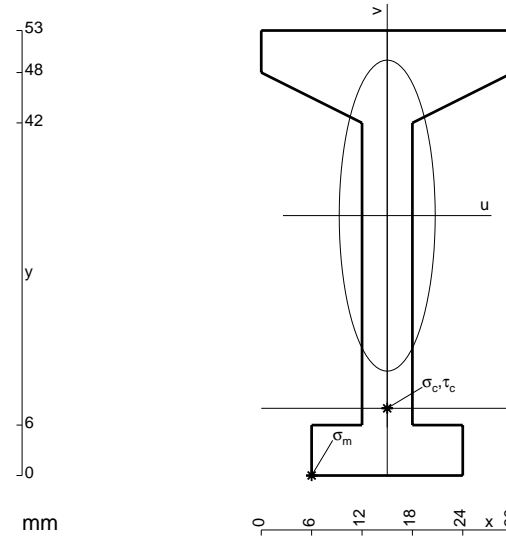
$$= (-4/3 b) Fb 1/EJ = -4/3 Fb^2/EJ$$

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

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

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

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



$$A = 582. \text{ mm}^2$$

$$J_u = 199765. \text{ mm}^4$$

$$J_v = 19026. \text{ mm}^4$$

$$y_g = 30.95 \text{ mm}$$

$$T_y = 1560. \text{ N}$$

$$M_x = -1404000. \text{ Nmm}$$

$$x_m = 6. \text{ mm}$$

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

$$v_m = -30.95 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -217.6 \text{ N/mm}^2$$

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

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

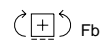
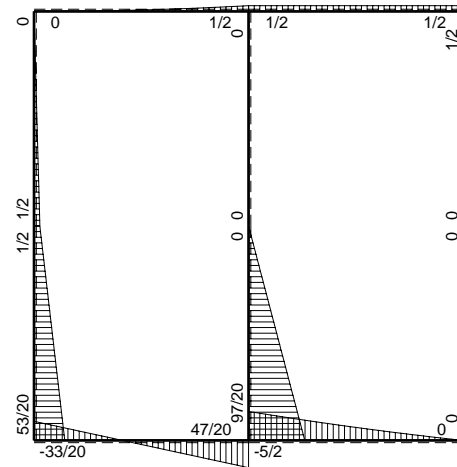
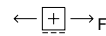
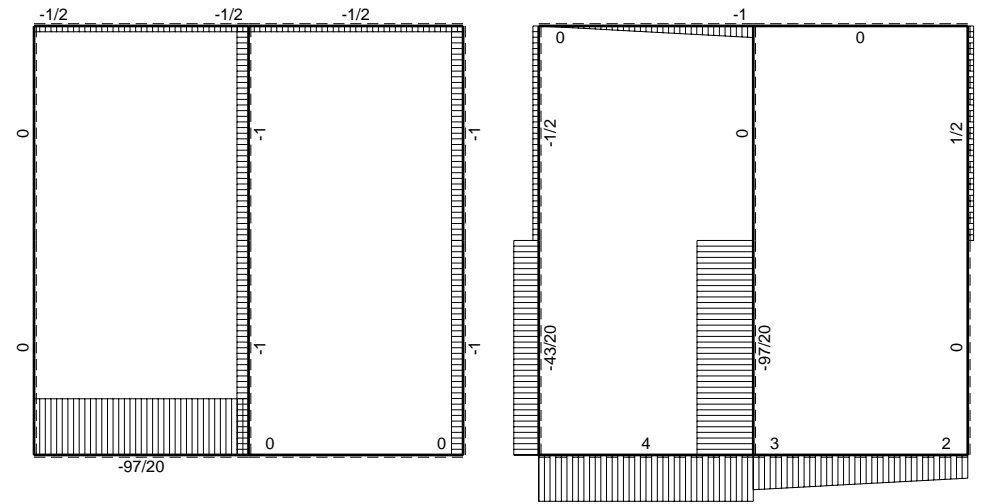
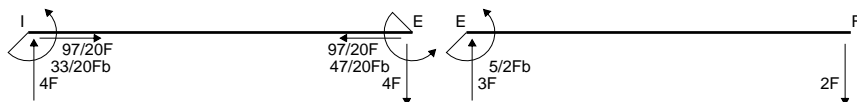
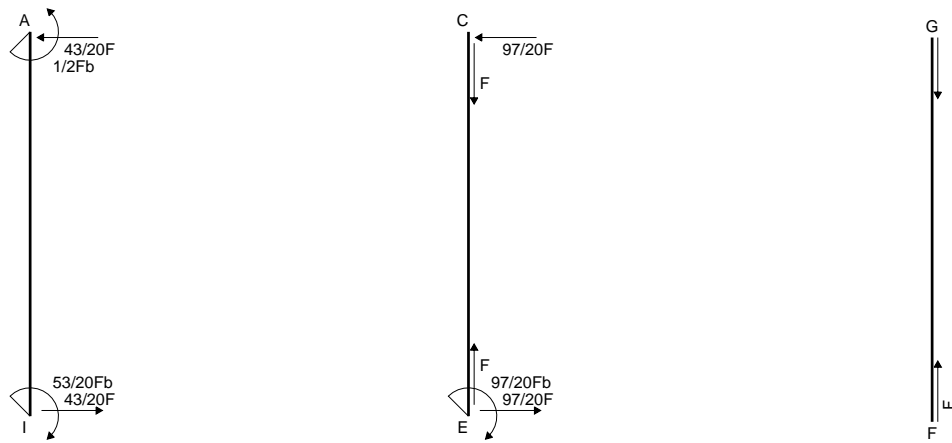
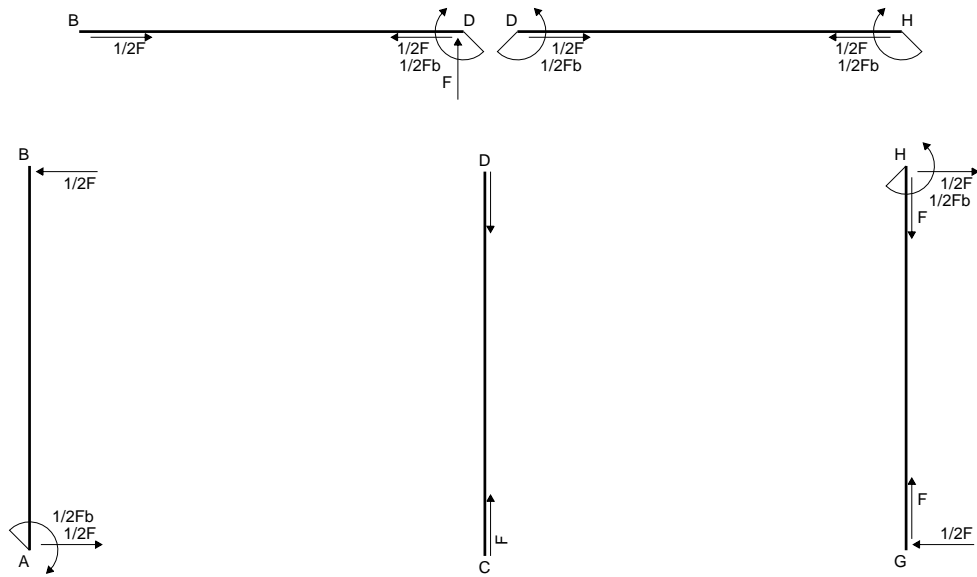
$$v_c = -22.95 \text{ mm}$$

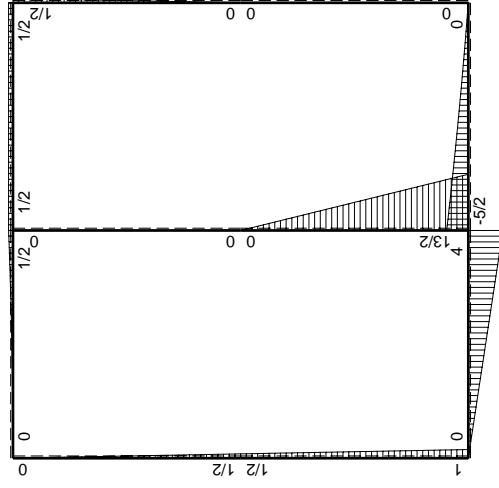
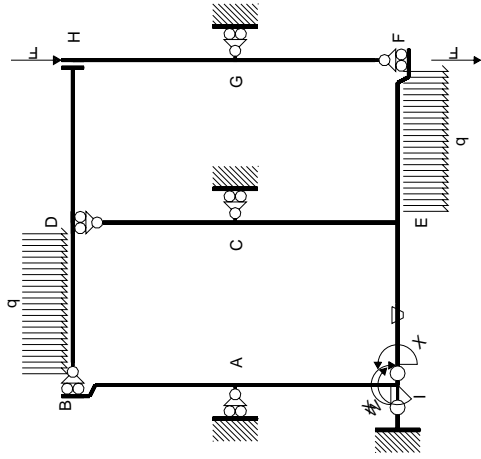
$$\sigma_c = -Mv/J_u = -161.3 \text{ N/mm}^2$$

$$\tau_c = 4.303 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 161.5 \text{ N/mm}^2$$

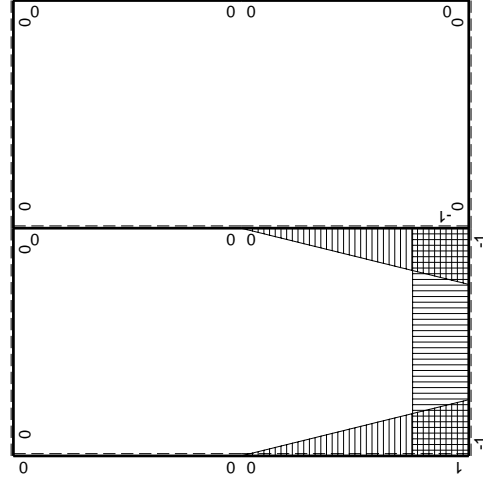
$$S = 3306. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-1/2Fx$	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb-1/2Fx$	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$33/20Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{x\theta} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb 1/EJ dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

$$L_{CE}^{x\theta} = \int_0^b (-13/2 x^2/b^2) Fb 1/EJ dx = [-13/6 x^3/b^2]_0^b Fb 1/EJ$$

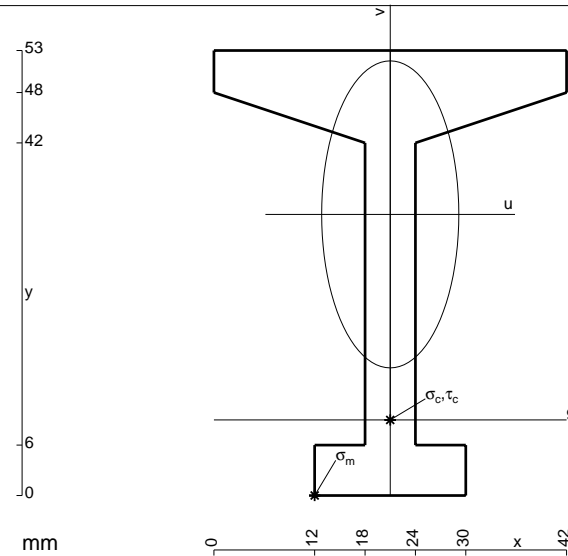
$$= (-13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

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

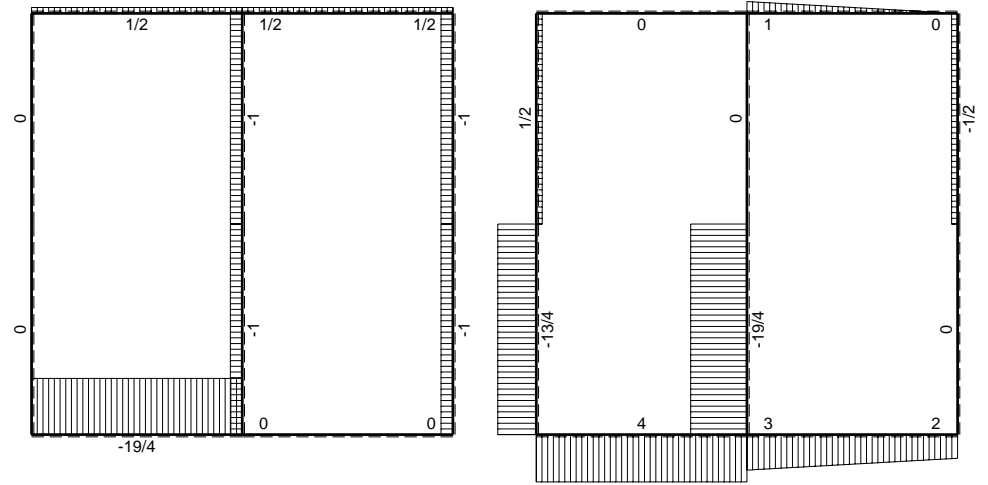
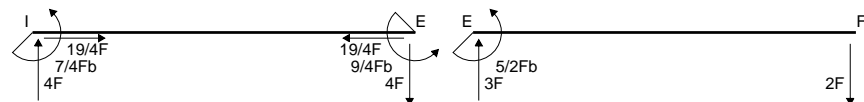
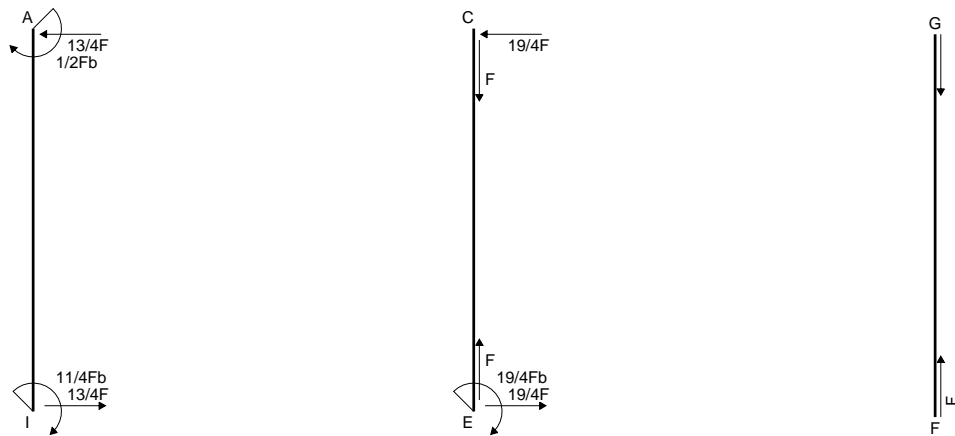
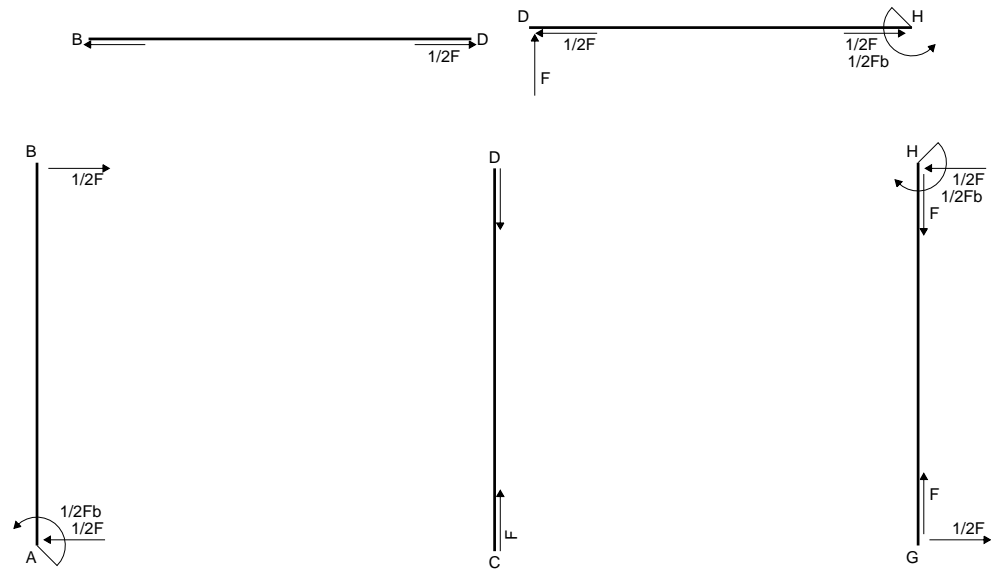
$$= (b - 3/4 b + 1/6 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

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

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

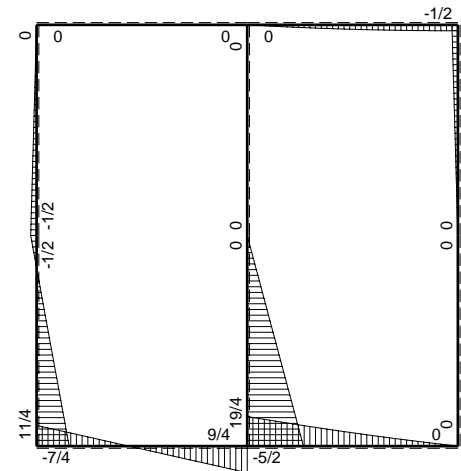


- A = 678. mm²
- J_u = 226700. mm⁴
- J_v = 45234. mm⁴
- y_g = 33.48 mm
- T_y = 1950. N
- M_x = -1543750. Nmm
- x_m = 12. mm
- u_m = -9. mm
- v_m = -33.48 mm
- σ_m = -Mv/J_u = -228. N/mm²
- x_c = 21. mm
- y_c = 9. mm
- v_c = -24.48 mm
- σ_c = -Mv/J_u = -166.7 N/mm²
- τ_c = 5.39 N/mm²
- σ_ρ = √σ²+3τ² = 167. N/mm²
- S = 3760. mm³

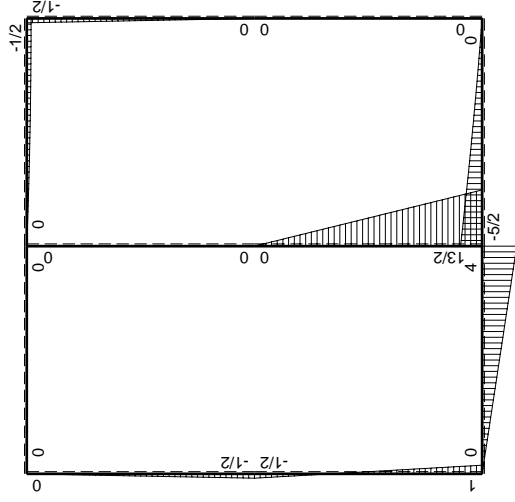
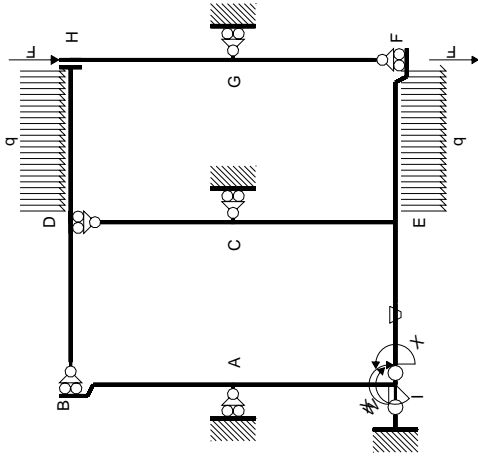


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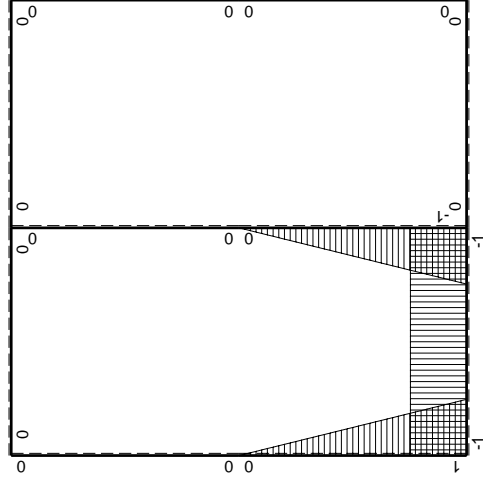


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/4Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb 1/EJ dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-13/2 x^2/b^2) Fb 1/EJ dx = [-13/6 x^3/b^2]_0^b Fb 1/EJ$$

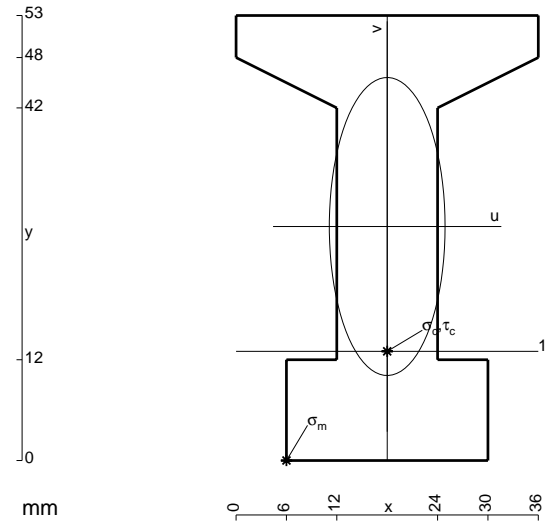
$$= (-13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

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

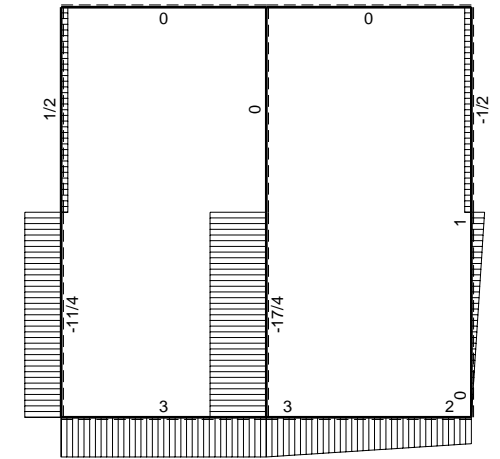
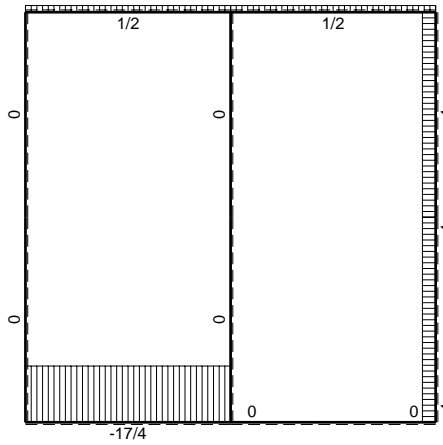
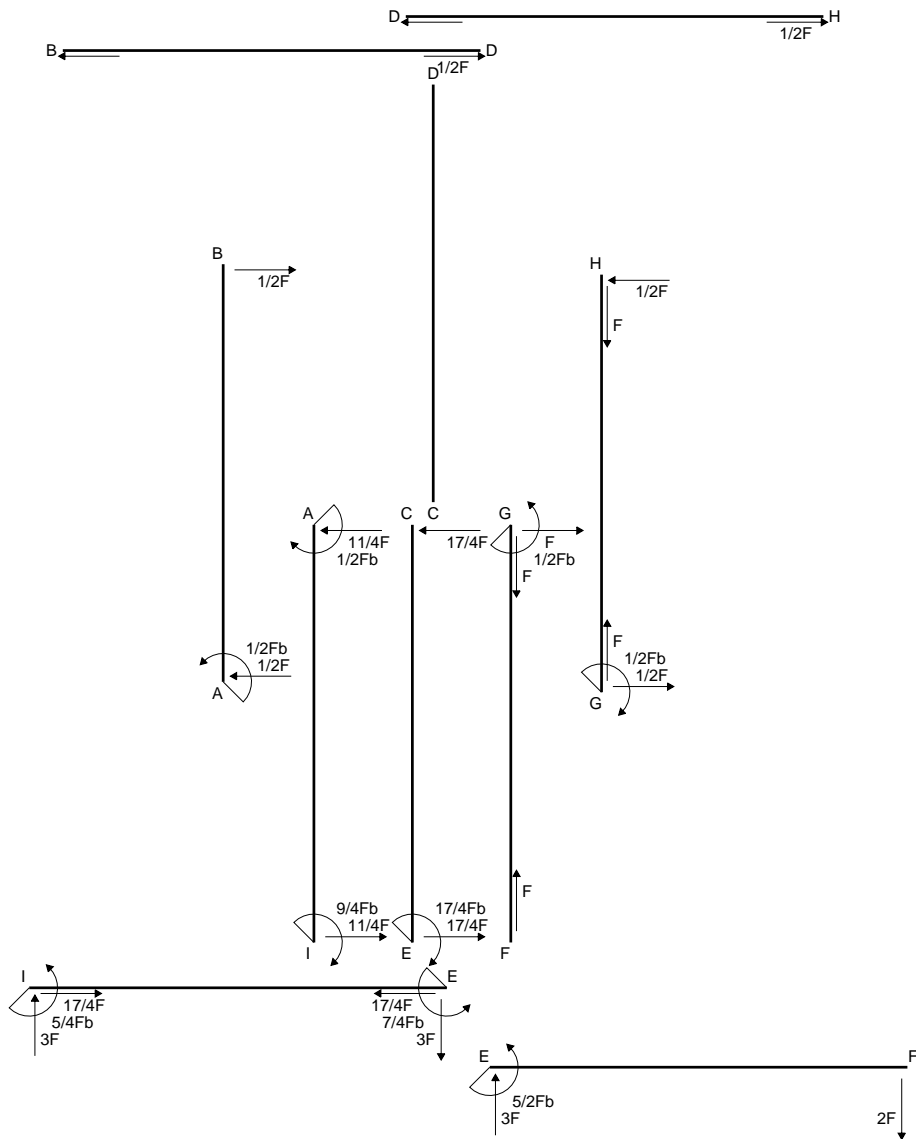
$$= (b - 5/4 b + 1/2 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

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

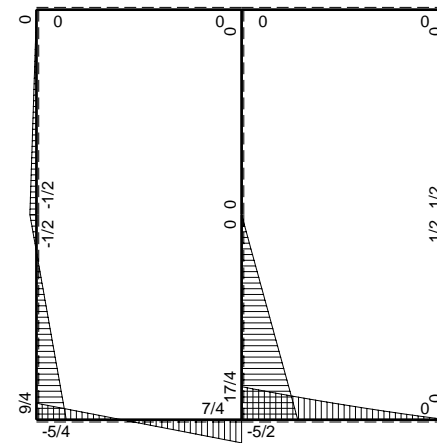


- A = 972. mm²
- J_u = 306188. mm⁴
- J_v = 46224. mm⁴
- y_g = 27.87 mm
- T_y = 3150. N
- M_x = -2625000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -27.87 mm
- σ_m = -Mv/J_u = -238.9 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -14.87 mm
- σ_c = -Mv/J_u = -127.5 N/mm²
- τ_c = 5.558 N/mm²
- σ_o = √σ²+3τ² = 127.8 N/mm²
- S = 6483. mm³

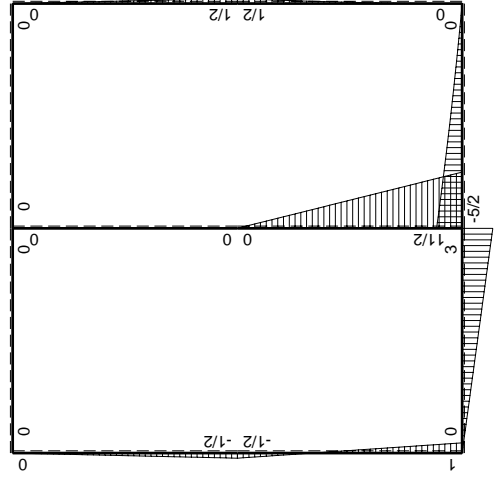
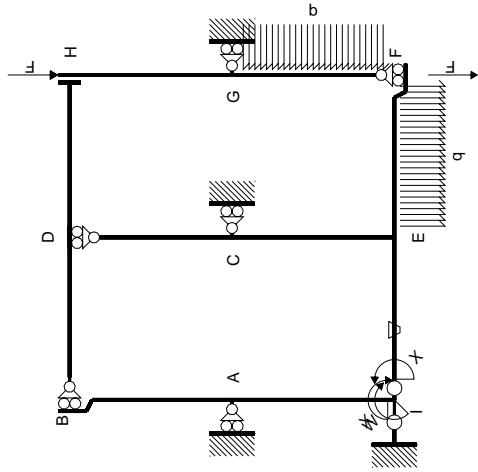


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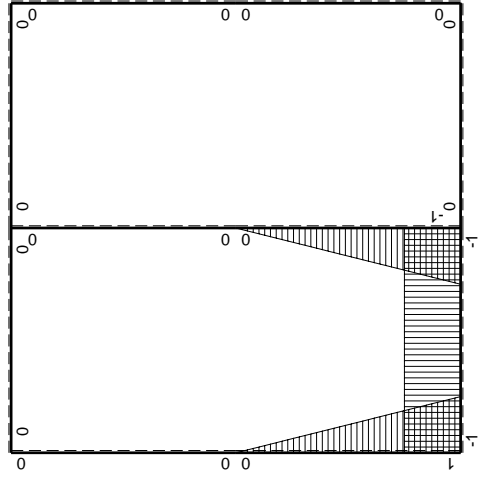


⊕ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$5/4Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb 1/EJ dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb 1/EJ dx = [-11/6 x^3/b^2]_0^b Fb 1/EJ$$

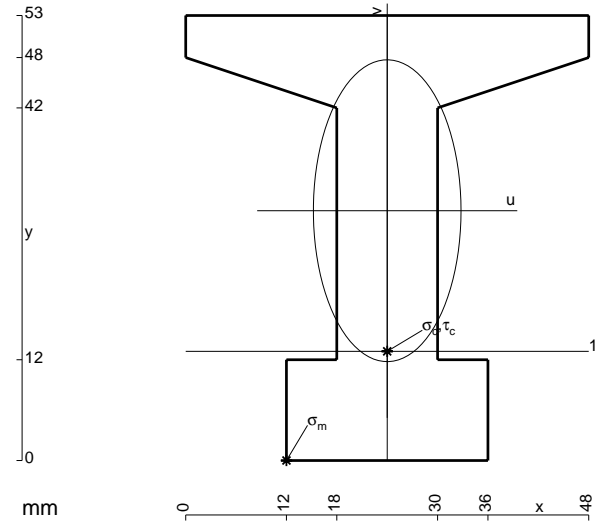
$$= (-11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

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

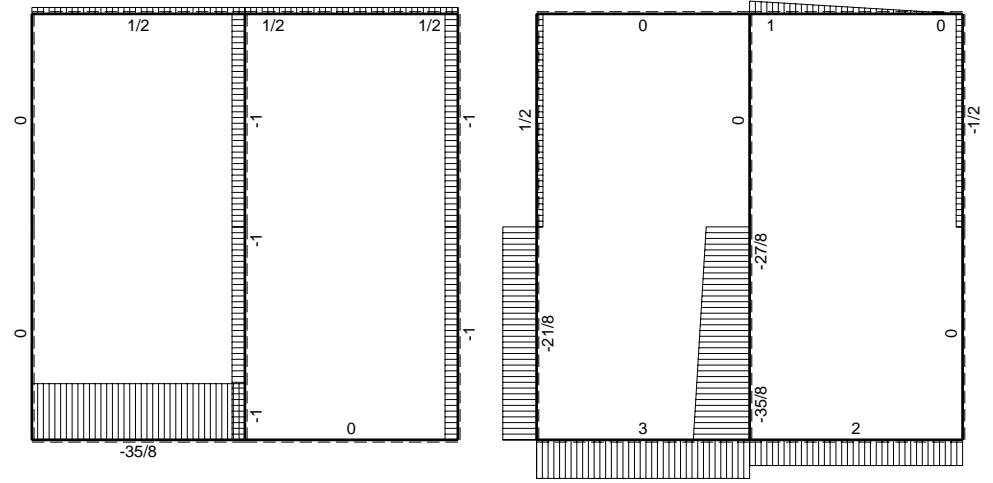
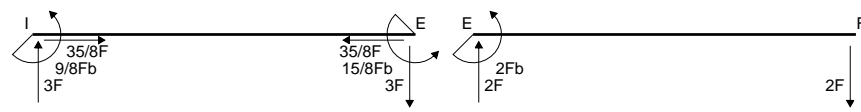
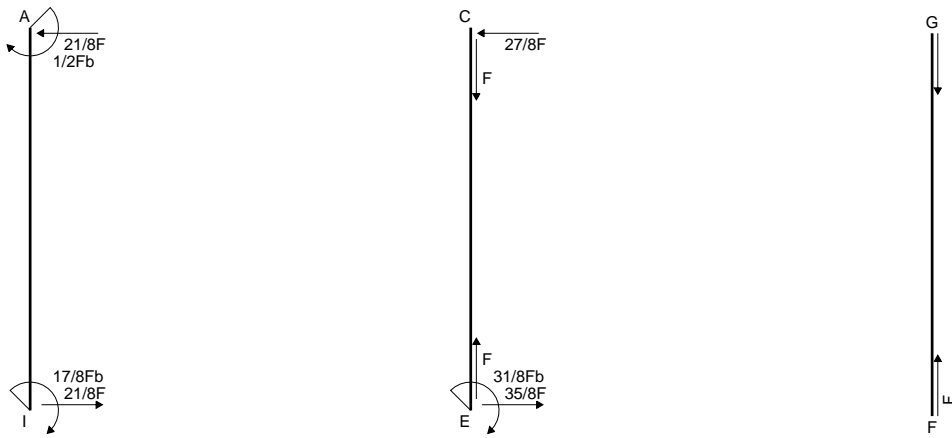
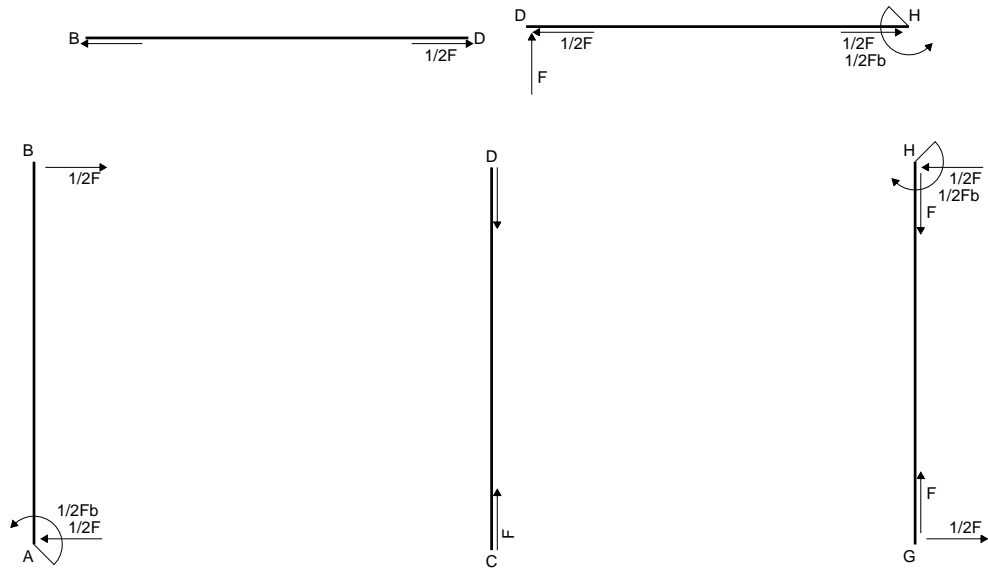
$$= (b - 5/4 b + 1/2 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

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

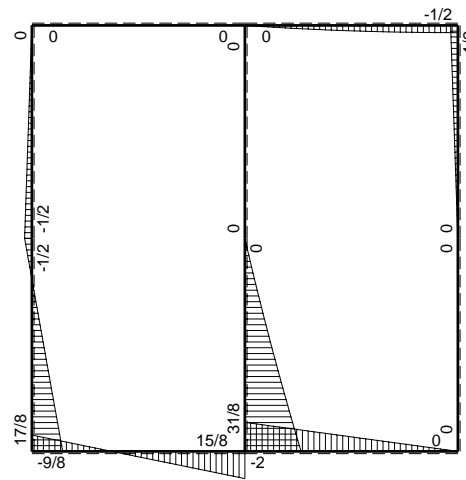


- A = 1068. mm²
- J_u = 345159. mm⁴
- J_v = 82584. mm⁴
- y_g = 29.75 mm
- T_y = 5250. N
- M_x = -2318750. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -29.75 mm
- σ_m = -Mv/J_u = -199.9 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -16.75 mm
- σ_c = -Mv/J_u = -112.5 N/mm²
- τ_c = 8.933 N/mm²
- σ_o = √σ²+3τ² = 113.6 N/mm²
- S = 7048. mm³

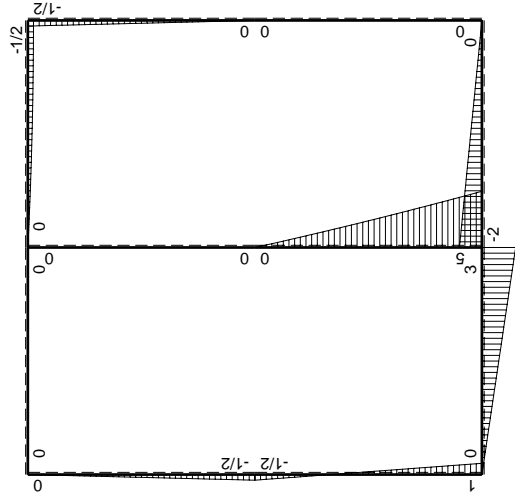
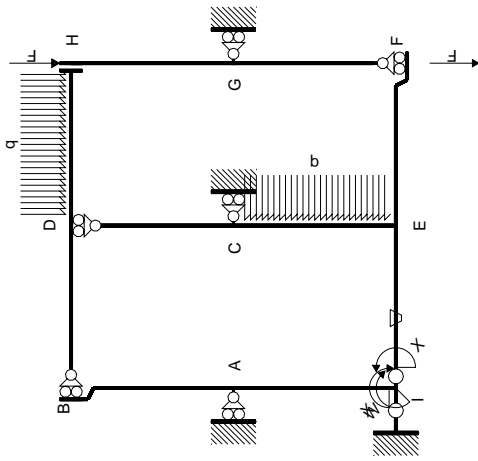


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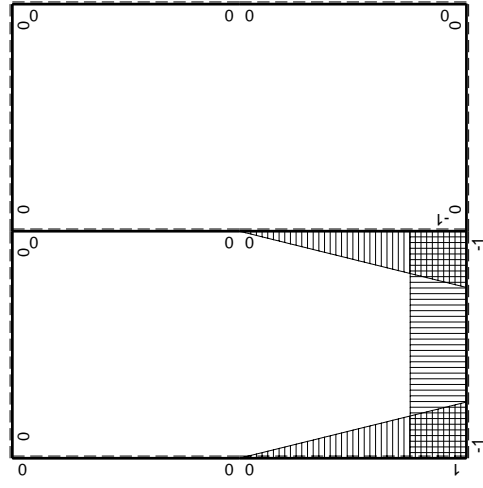


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0			
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
DH b	0	$Fx-1/2qx^2$	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1			
EC b	$-1+x/b$	$5Fb-11/2Fx+1/2qx^2$	0	$-5Fb+21/2Fx-6Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-13/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-9/2Fx-1/2qx^2$	0	$-9/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2			
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2			
	totali							$-15/8Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$9/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 21/2 x/b - 6x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [-5x + 21/4 x^2/b - 2x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-5b + 21/4 b - 2b + 1/8 b) Fb 1/EJ = -13/8 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-9/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [-3/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

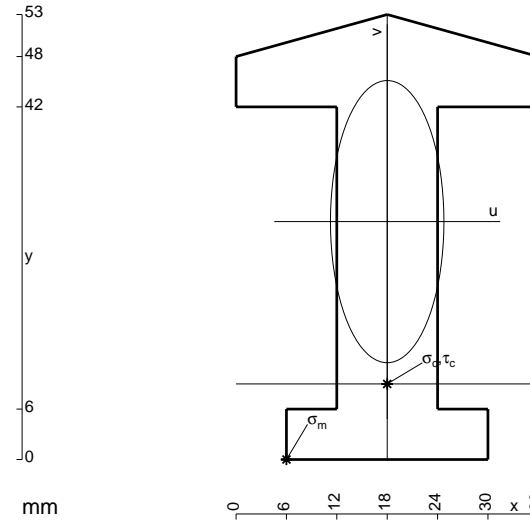
$$= (-3/2 b - 1/8 b) Fb 1/EJ = -13/8 Fb^2/EJ$$

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

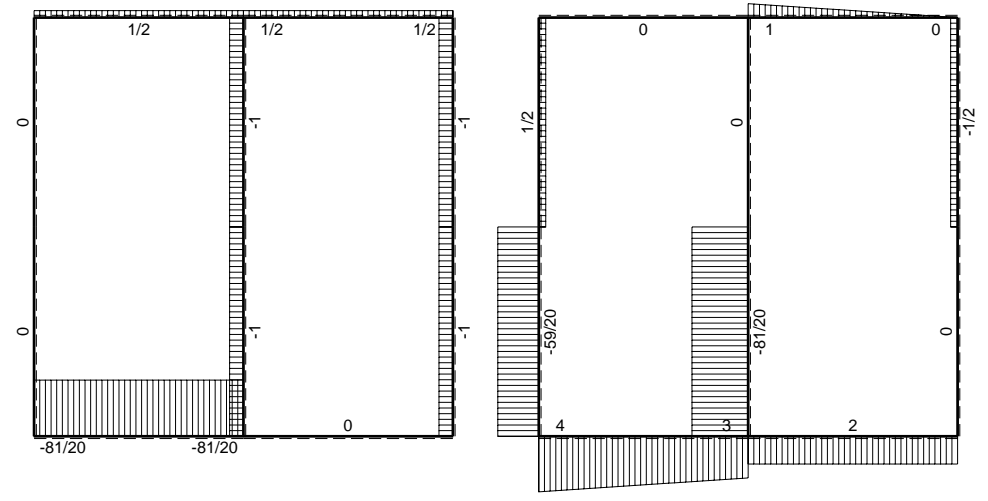
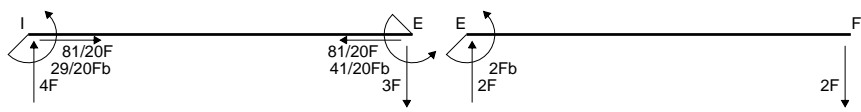
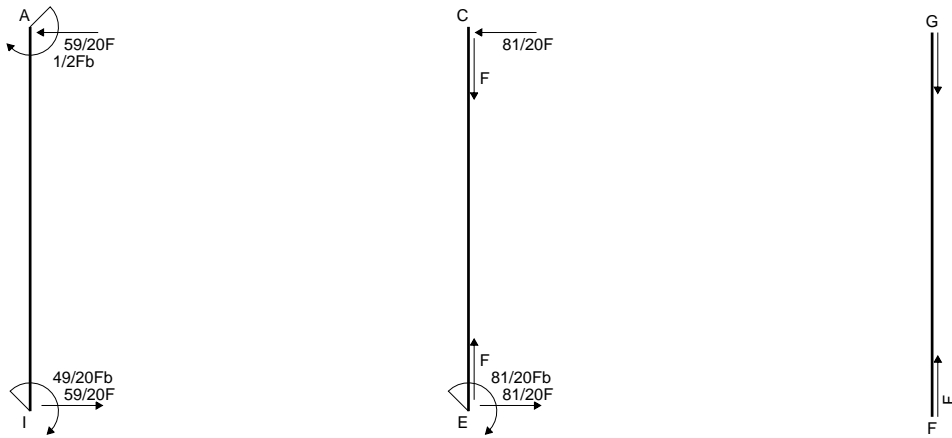
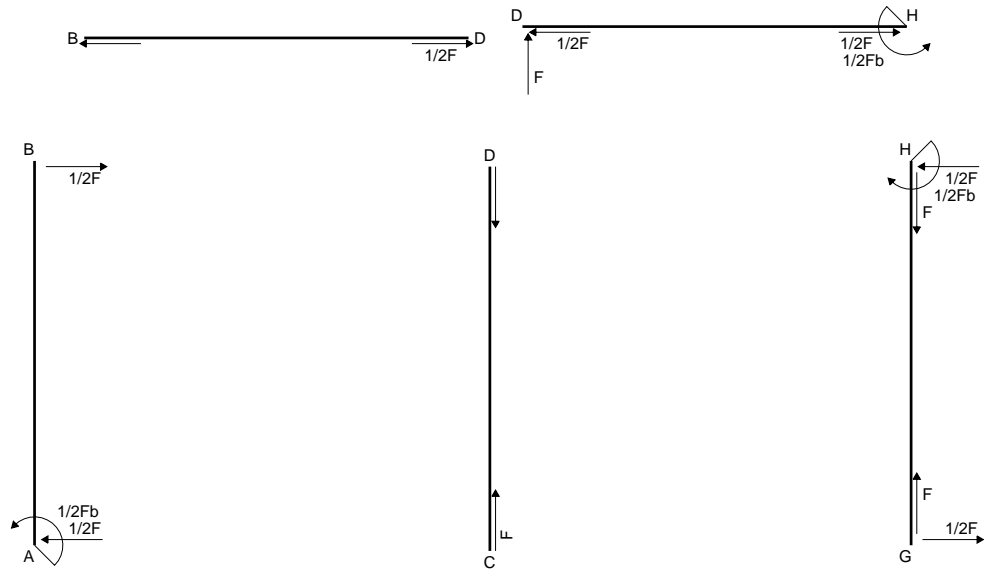
$$= (b - 5/4 b + 1/2 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

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

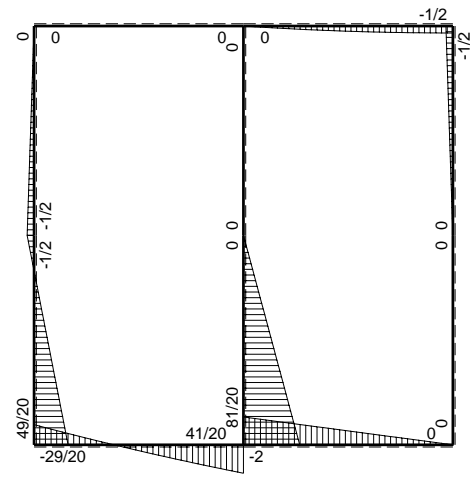


- A = 882. mm²
- J_u = 249349. mm⁴
- J_v = 40284. mm⁴
- y_g = 28.33 mm
- T_y = 3180. N
- M_x = -1844400. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.33 mm
- σ_m = -Mv/J_u = -209.6 N/mm²
- x_c = 18. mm
- y_c = 9. mm
- v_c = -19.33 mm
- σ_c = -Mv/J_u = -143. N/mm²
- τ_c = 4.674 N/mm²
- σ_o = √σ²+3τ² = 143.2 N/mm²
- S = 4398. mm³

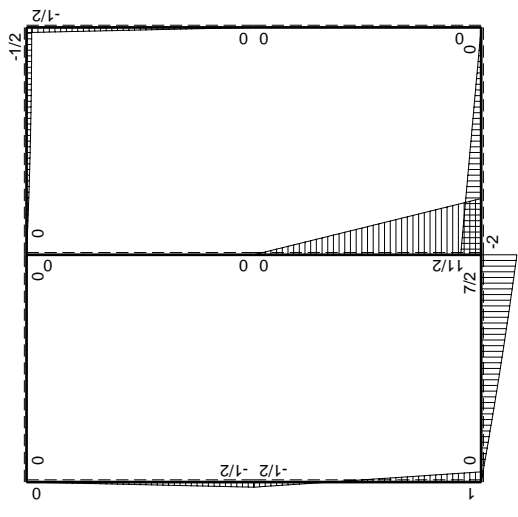
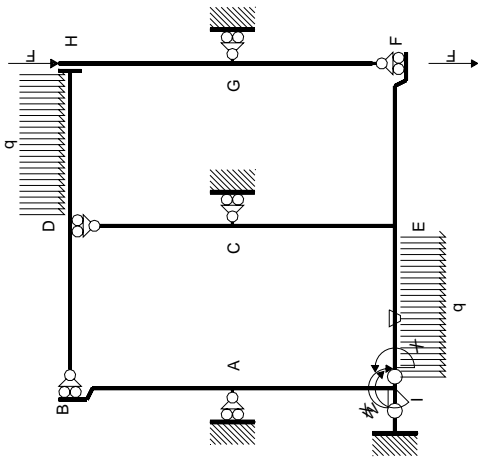


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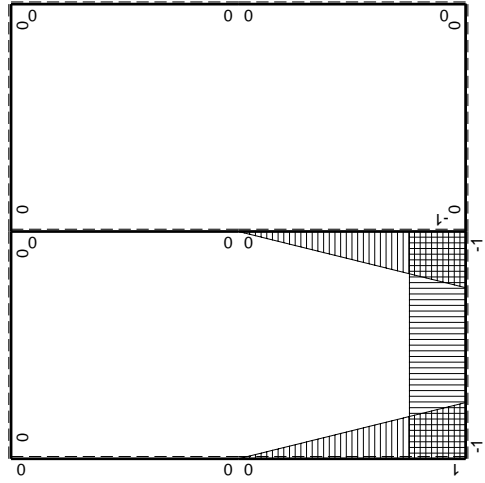


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0	
BA b	0	1/2Fx	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	-1/2Fx	0	0	0	0	0+0	0	
HG b	0	1/2Fb-1/2Fx	0	0	0	0			
HD b	0	-1/2Fb+1/2qx ²	0	0	0	0	0+0	0	
DH b	0	Fx-1/2qx ²	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	4Fx-1/2qx ²	-Fb/EJ	-4Fx+1/2Fx ² /b	Fb/EJ	1	(-11/6+1)Fb ² /EJ	Xb/EJ	
EI b	1	-7/2Fb+3Fx+1/2qx ²	Fb/EJ	-7/2Fb+3Fx+1/2Fx ² /b	Fb/EJ	1			
EC b	-1+x/b	11/2Fb-11/2Fx	0	-11/2Fb+11Fx-11/2Fx ² /b	0	1-2x/b+x ² /b ²	(-11/6+0)Fb ² /EJ	1/3Xb/EJ	
CE b	x/b	-11/2Fx	0	-11/2Fx ² /b	0	x ² /b ²			
IA b	1-x/b	Fb-3/2Fx	0	Fb-5/2Fx+3/2Fx ² /b	0	1-2x/b+x ² /b ²	(1/4+0)Fb ² /EJ	1/3Xb/EJ	
AI b	-x/b	1/2Fb-3/2Fx	0	-1/2Fx+3/2Fx ² /b	0	x ² /b ²			
	totali							-29/12Fb ² /EJ	5/3Xb/EJ
	iperstatica $X=W_{IE}$							29/20Fb	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [-x]_0^b \theta$$

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

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb 1/EJ dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb 1/EJ dx = [-11/6 x^3/b^2]_0^b Fb 1/EJ$$

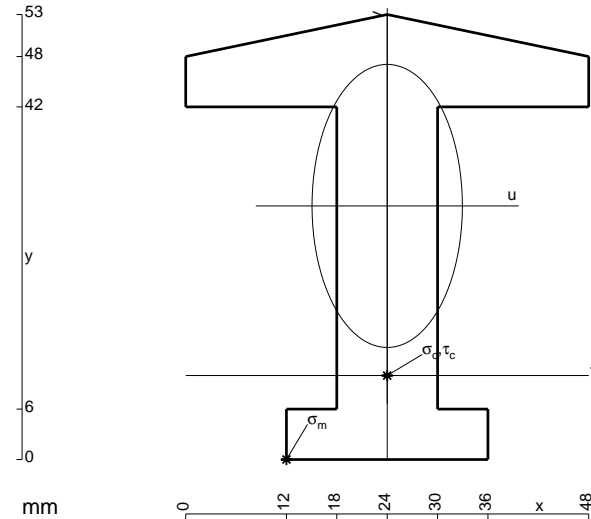
$$= (-11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

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

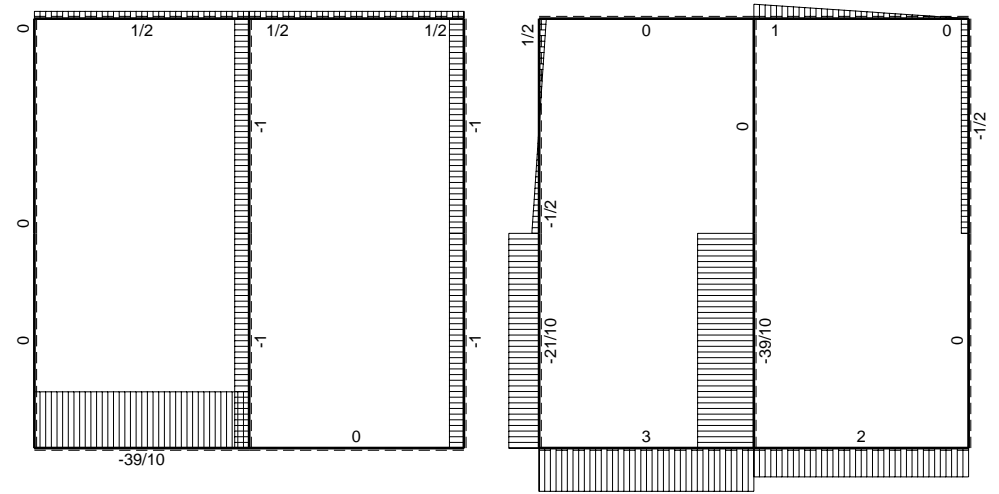
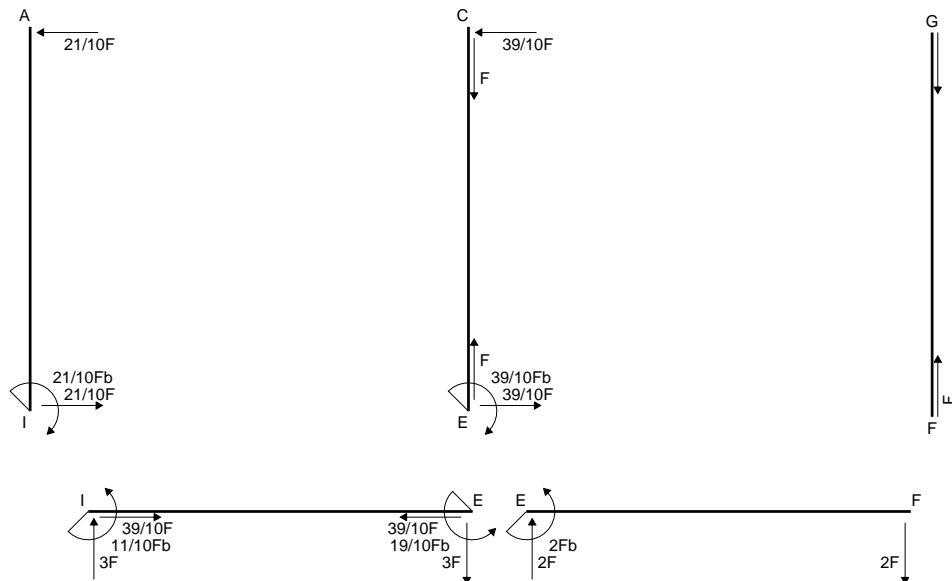
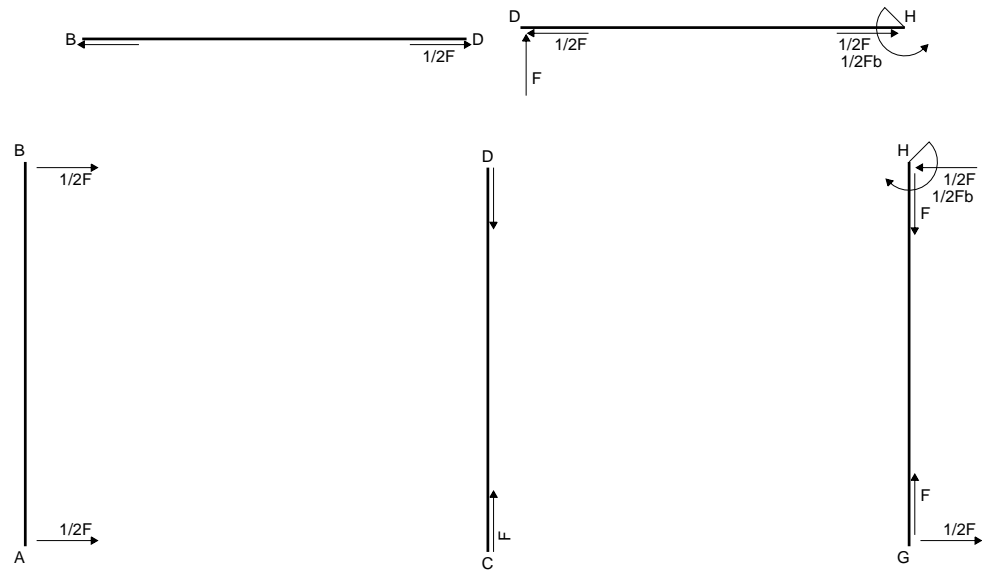
$$= (b - 5/4 b + 1/2 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

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

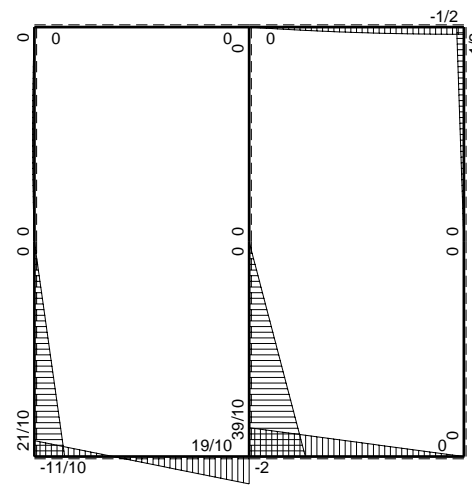


- A = 984. mm²
- J_u = 279819. mm⁴
- J_v = 78912. mm⁴
- y_g = 30.2 mm
- T_y = 3220. N
- M_x = -2028600. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.2 mm
- σ_m = -Mv/J_u = -219. N/mm²
- x_c = 24. mm
- y_c = 10. mm
- v_c = -20.2 mm
- σ_c = -Mv/J_u = -146.5 N/mm²
- τ_c = 4.778 N/mm²
- σ_o = √σ² + 3τ² = 146.7 N/mm²
- S = 4983. mm³

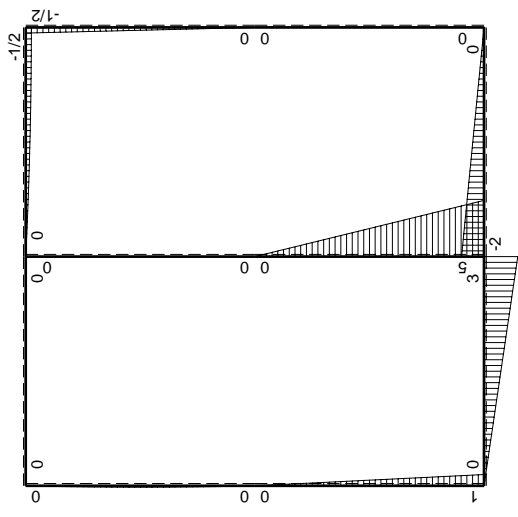
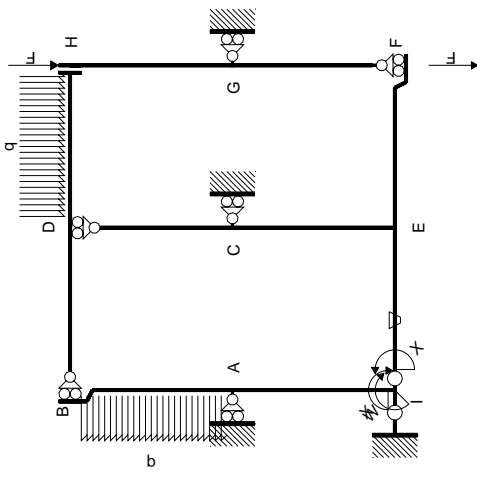


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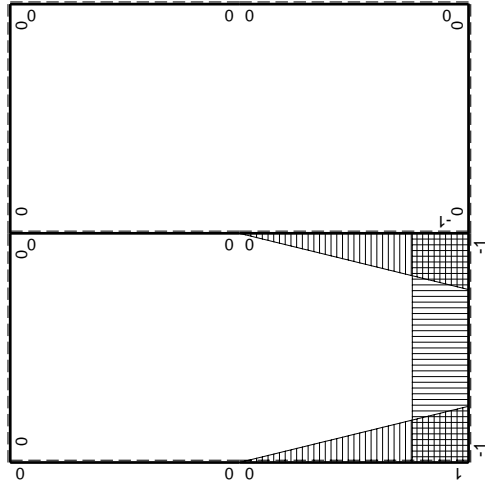


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-Fx$	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fx$	0	Fx^2/b	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/10Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

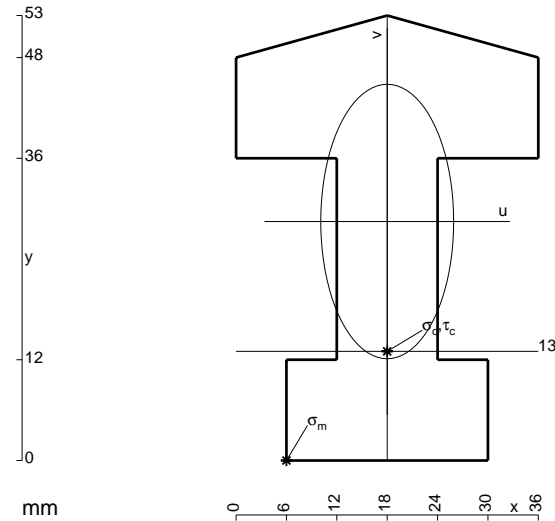
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

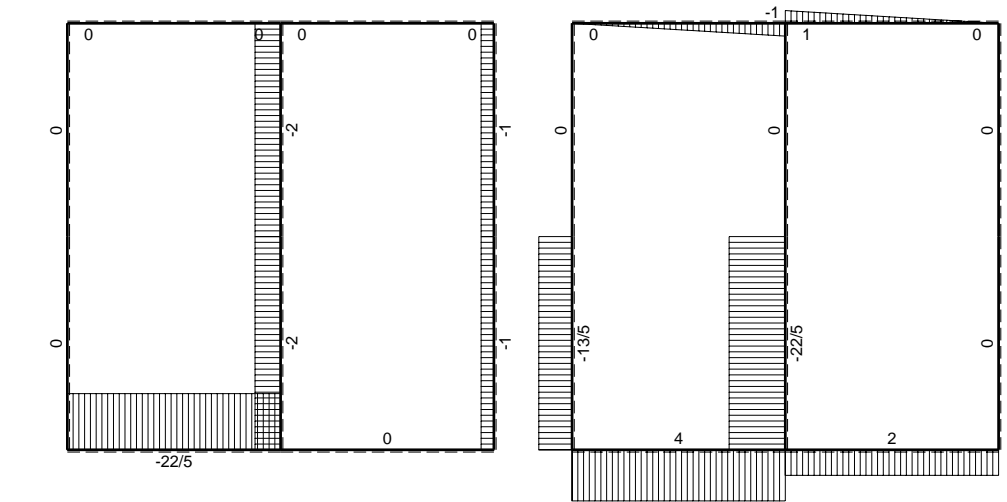
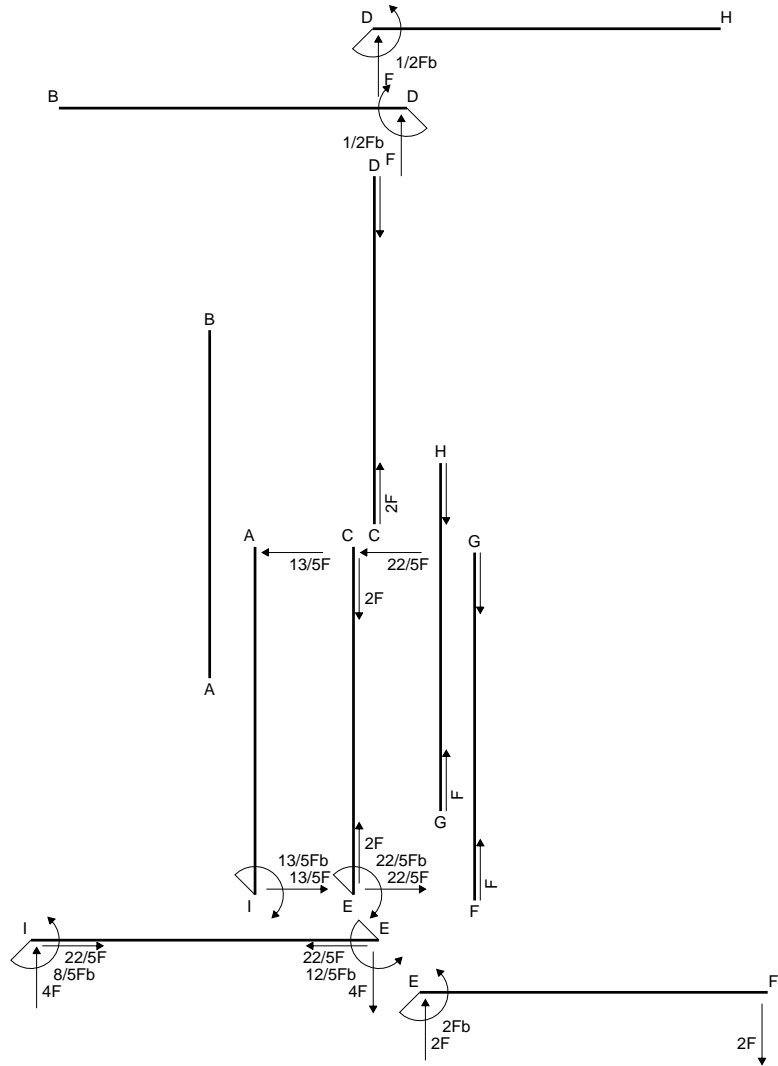
$$= (b - b + 1/3 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

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

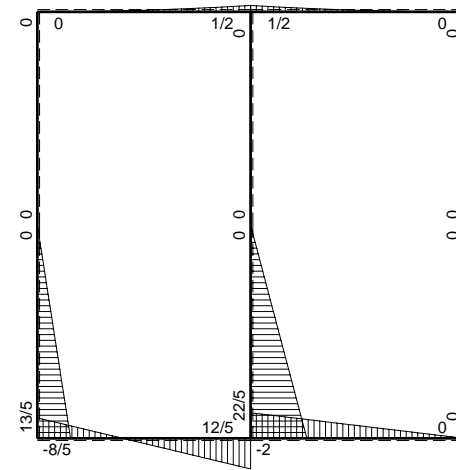


- A = 1098. mm²
- J_u = 293274. mm⁴
- J_v = 68796. mm⁴
- y_g = 28.46 mm
- T_y = 3480. N
- M_x = -2366400. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.46 mm
- σ_m = -Mv/J_u = -229.7 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.46 mm
- σ_c = -Mv/J_u = -124.8 N/mm²
- τ_c = 6.587 N/mm²
- σ_o = √σ²+3τ² = 125.3 N/mm²
- S = 6661. mm³

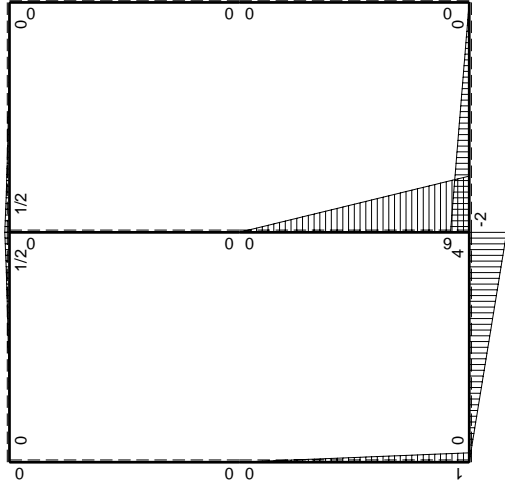
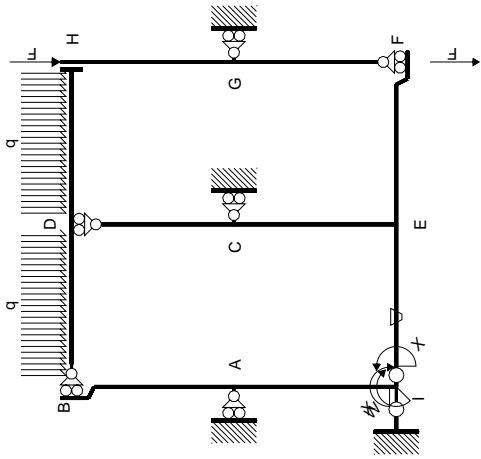


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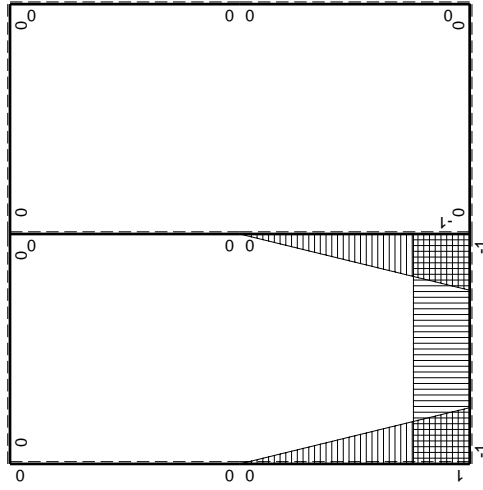


⊕ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-Fx$	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fx$	0	Fx^2/b	0	x^2/b^2		
	totali						$-8/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$8/5Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb 1/EJ dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

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

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

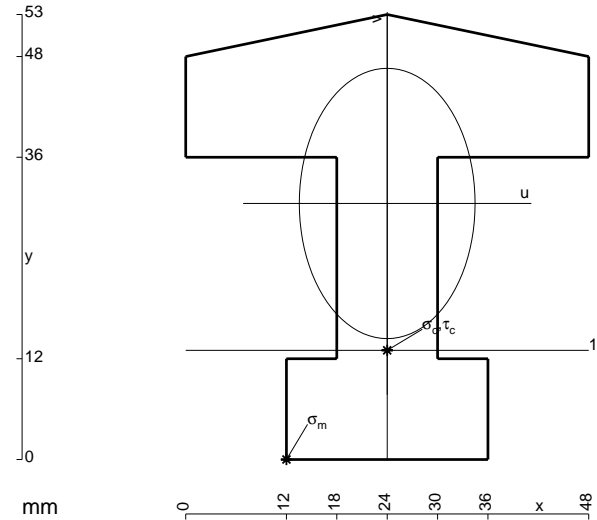
$$= (-2b) Fb 1/EJ = -2 Fb^2/EJ$$

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

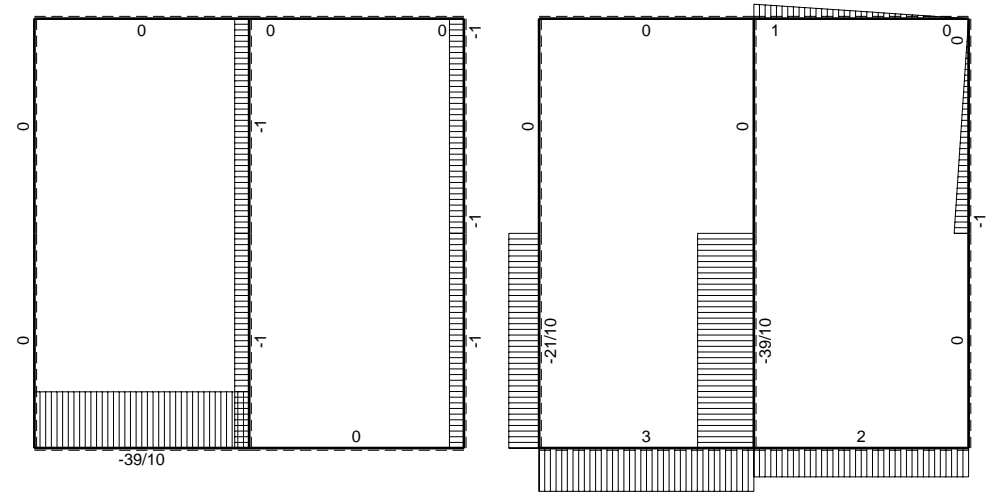
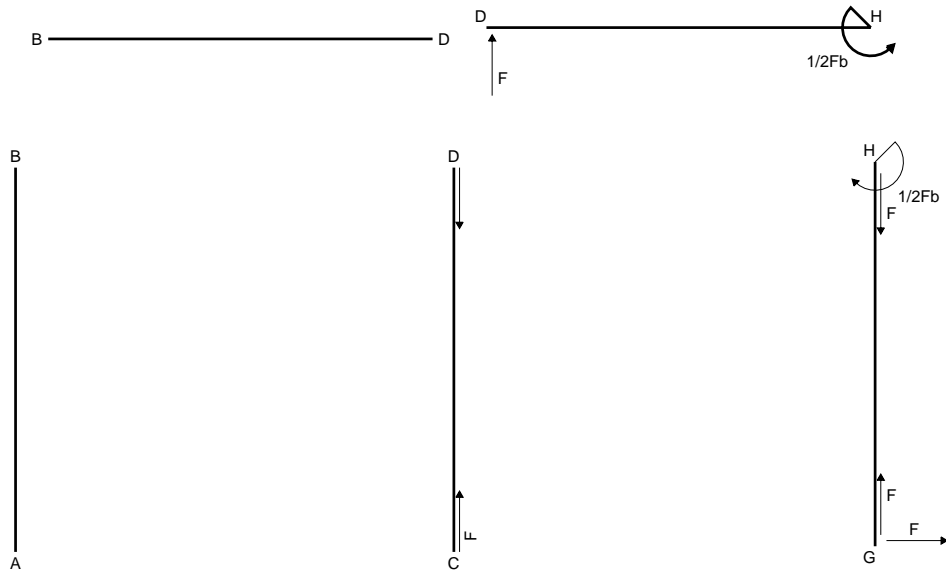
$$= (b - b + 1/3 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

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

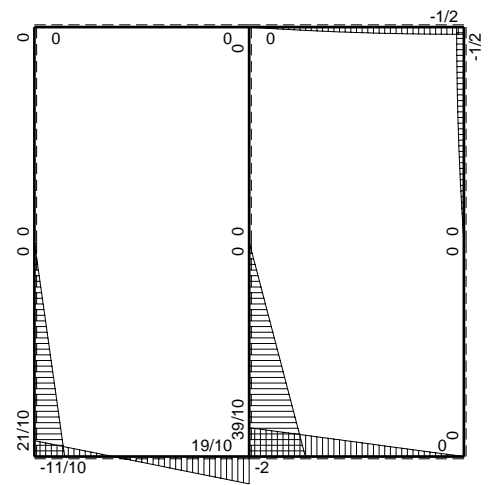
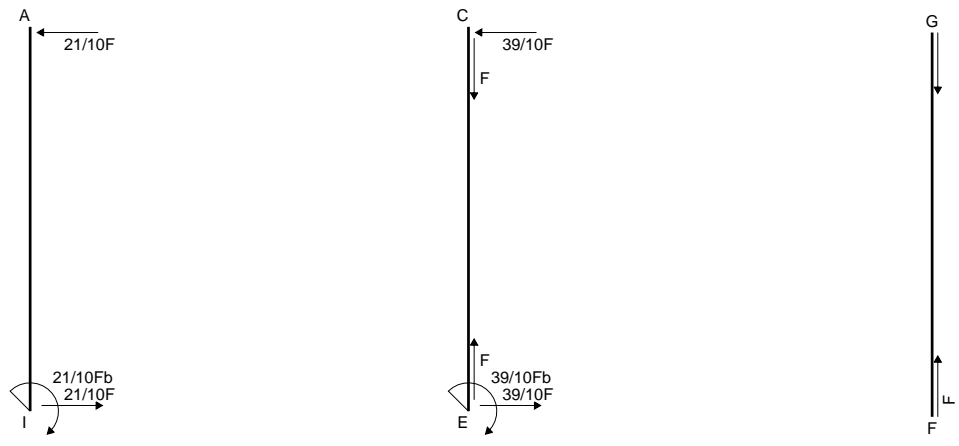


$A = 1272. \text{ mm}^2$
 $J_u = 329658. \text{ mm}^4$
 $J_v = 139392. \text{ mm}^4$
 $y_g = 30.5 \text{ mm}$
 $T_y = 3500. \text{ N}$
 $M_x = -2590000. \text{ Nmm}$
 $x_m = 12. \text{ mm}$
 $u_m = -12. \text{ mm}$
 $v_m = -30.5 \text{ mm}$
 $\sigma_m = -Mv/J_u = -239.6 \text{ N/mm}^2$
 $x_c = 24. \text{ mm}$
 $y_c = 13. \text{ mm}$
 $v_c = -17.5 \text{ mm}$
 $\sigma_c = -Mv/J_u = -137.5 \text{ N/mm}^2$
 $\tau_c = 6.433 \text{ N/mm}^2$
 $\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 137.9 \text{ N/mm}^2$
 $S = 7271. \text{ mm}^3$

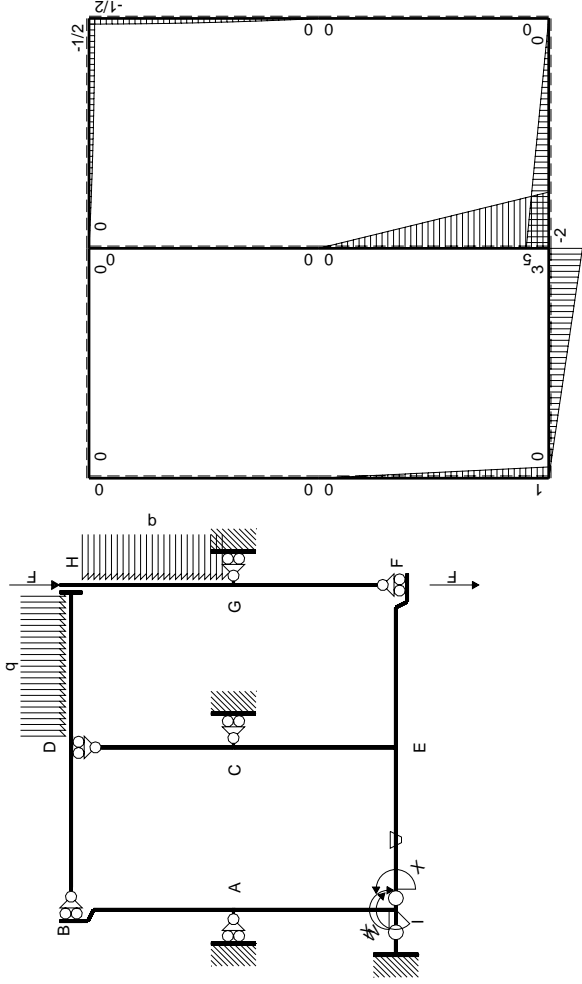


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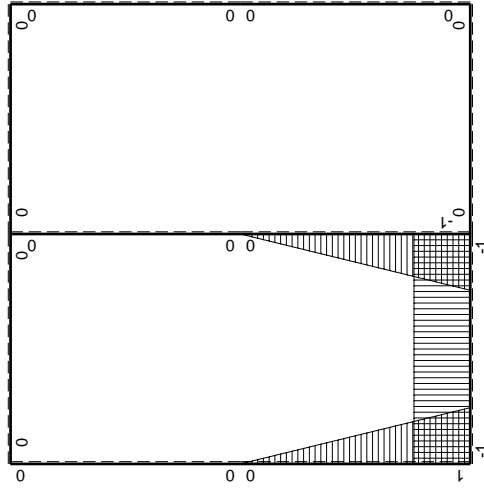


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-Fx$	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fx$	0	Fx^2/b	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/10Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{x_0} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{x_0} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

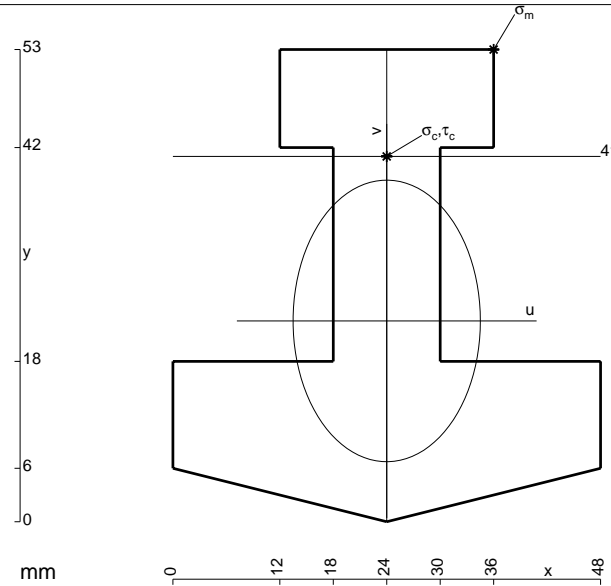
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

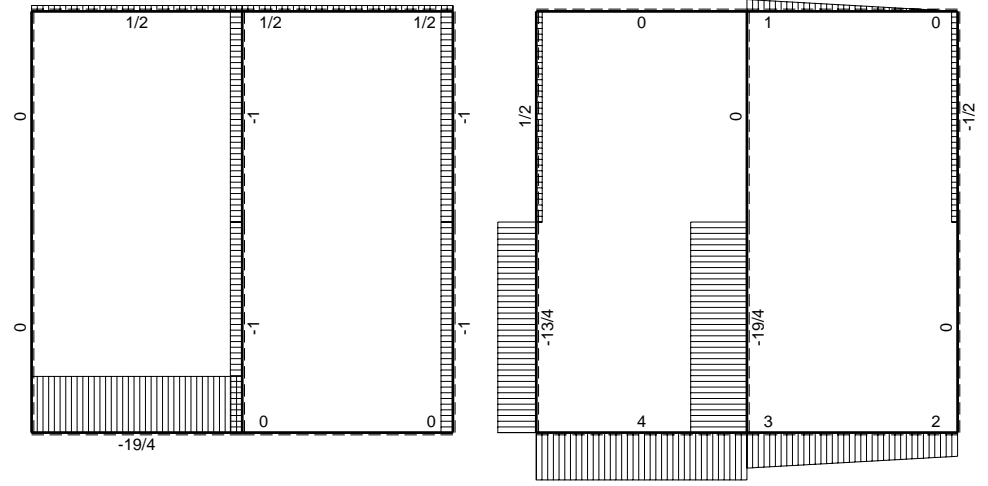
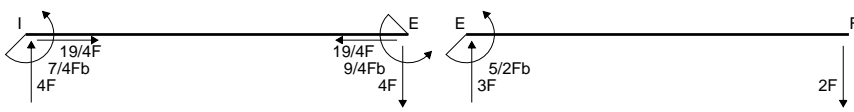
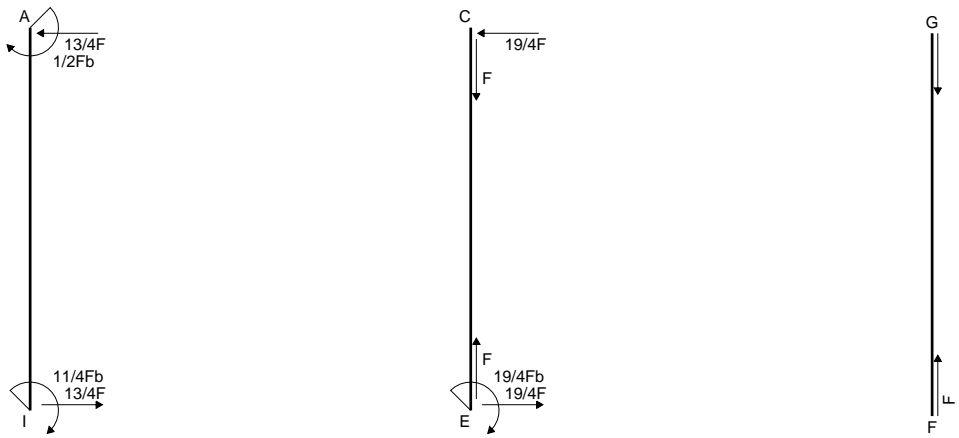
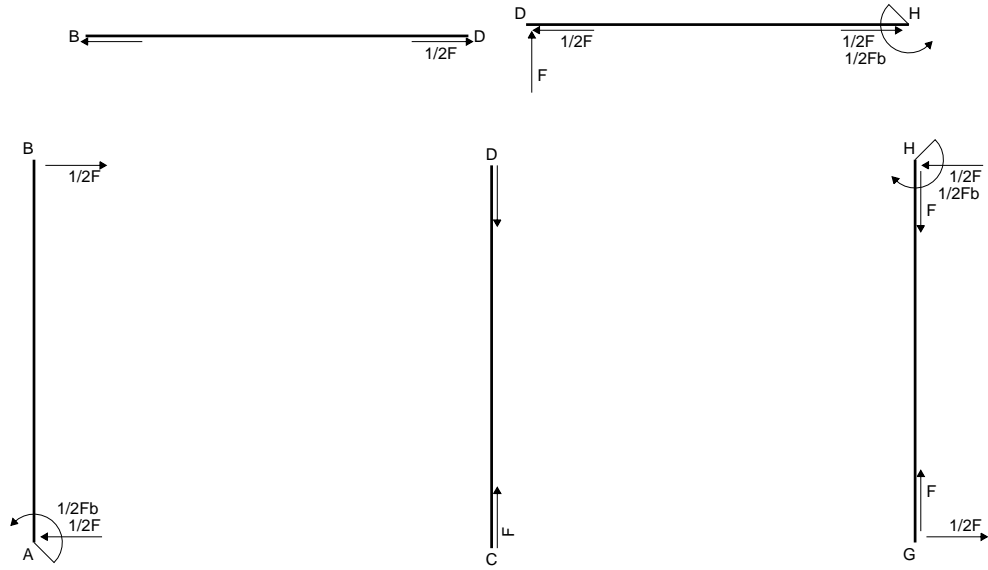
$$= (b - b + 1/3 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

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

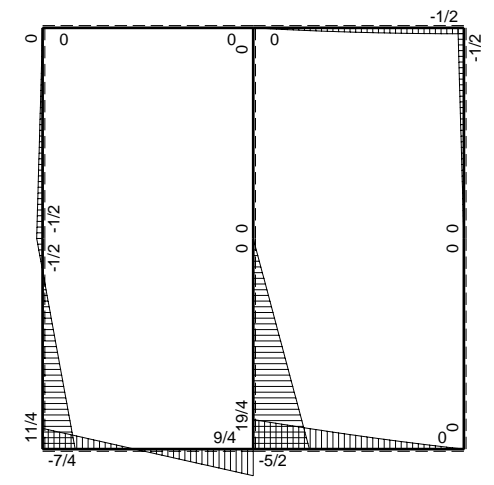


- A = 1272. mm²
- J_u = 317672. mm⁴
- J_v = 140544. mm⁴
- y_g = 22.54 mm
- T_y = 2640. N
- M_x = -2085600. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.46 mm
- σ_m = -Mv/J_u = 200. N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 18.46 mm
- σ_c = -Mv/J_u = 121.2 N/mm²
- τ_c = 4.721 N/mm²
- σ_q = √σ²+3τ² = 121.5 N/mm²
- S = 6818. mm³

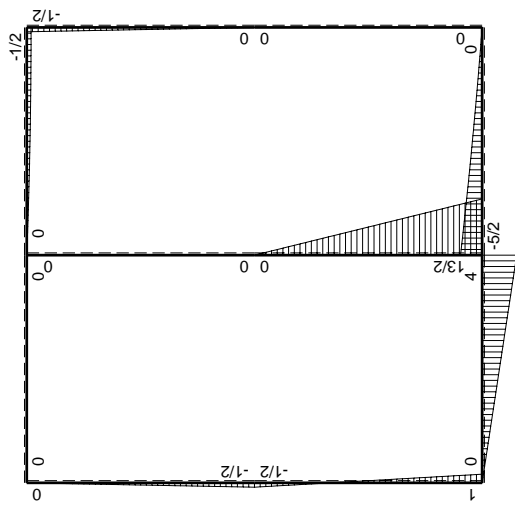
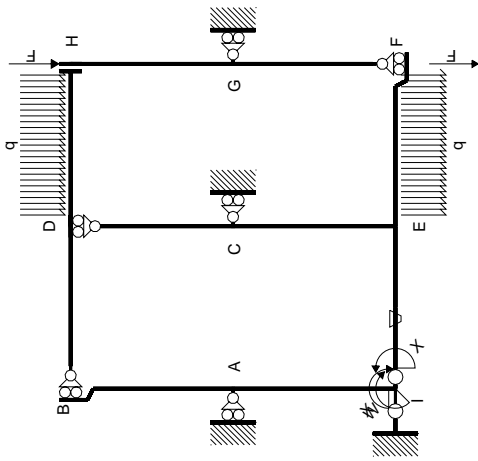


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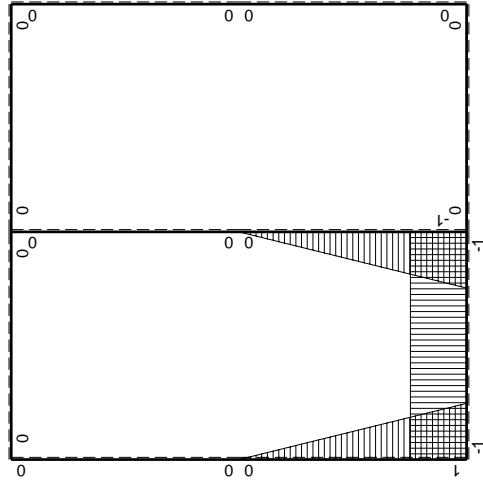


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/4Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb 1/EJ dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-13/2 x^2/b^2) Fb 1/EJ dx = [-13/6 x^3/b^2]_0^b Fb 1/EJ$$

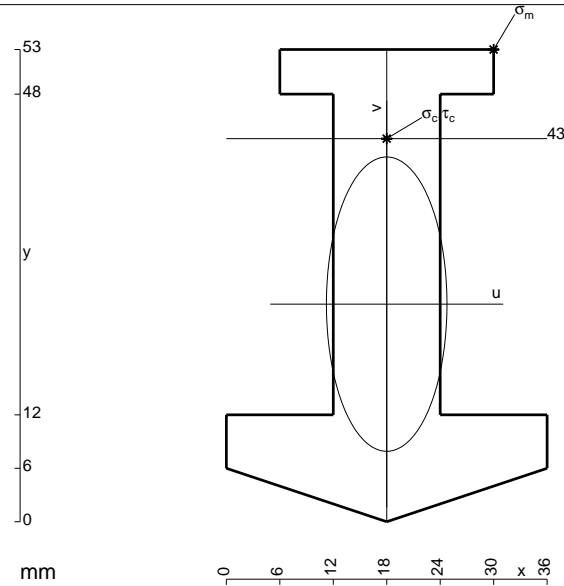
$$= (-13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

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

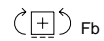
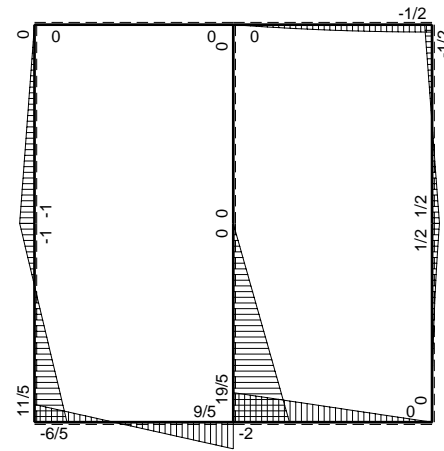
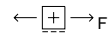
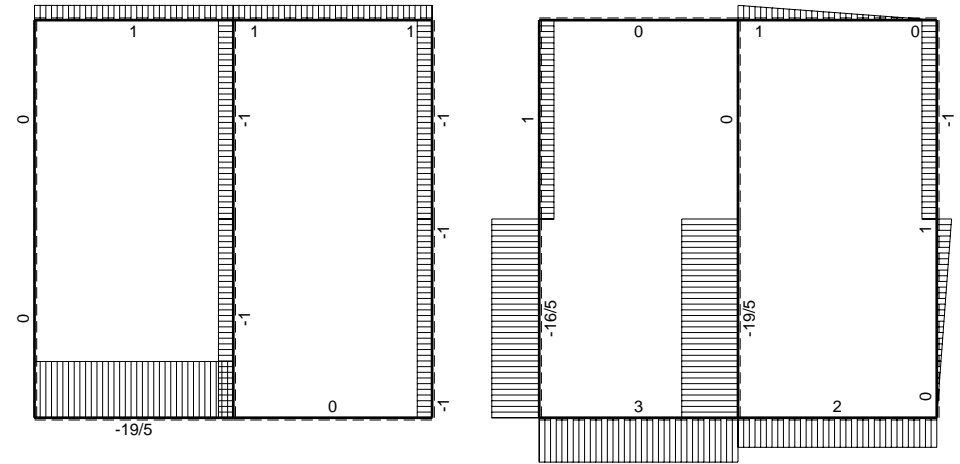
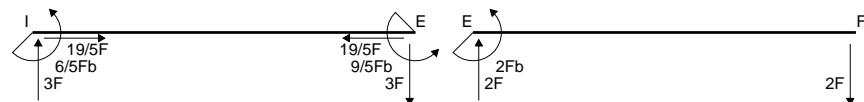
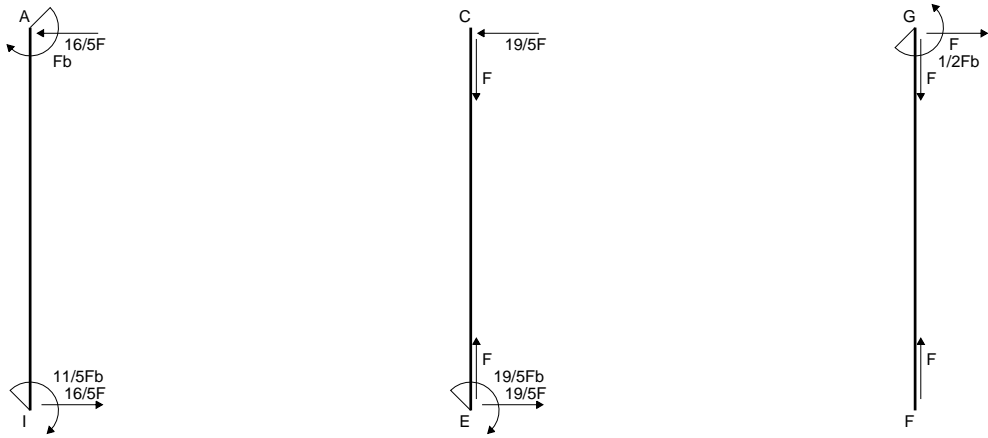
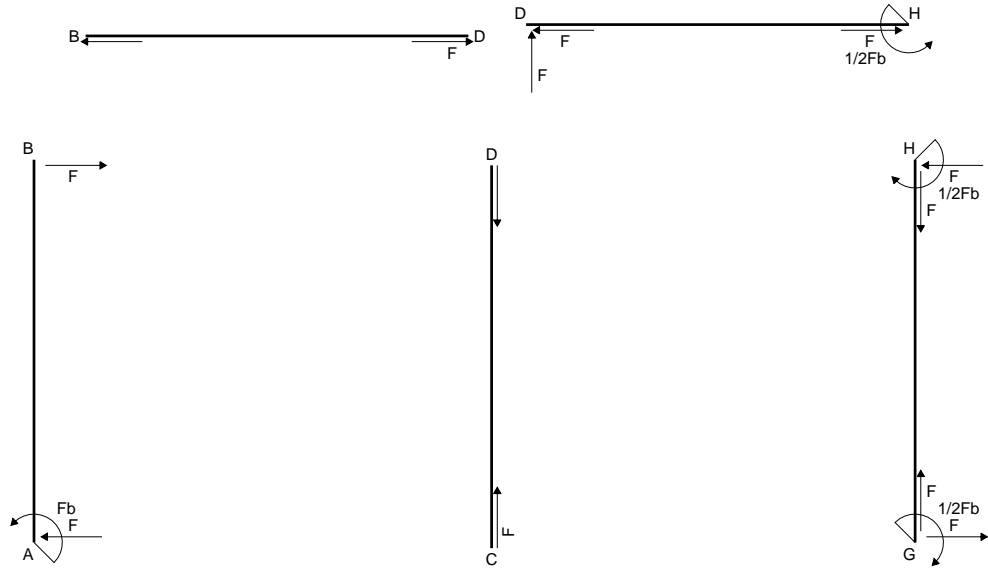
$$= (b - 5/4 b + 1/2 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

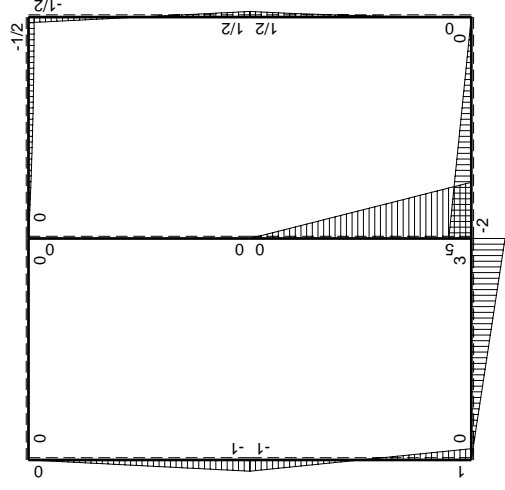
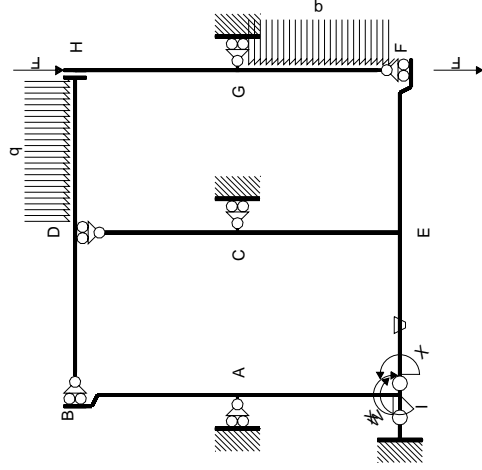
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 3/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/2 x^3/b^2]_0^b Fb 1/EJ$$

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



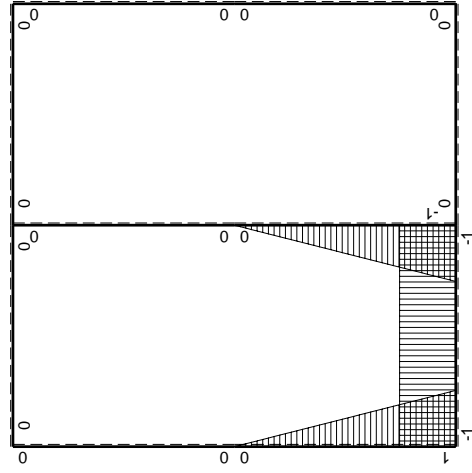
- A = 876. mm²
- J_u = 239234. mm⁴
- J_v = 40104. mm⁴
- y_g = 24.42 mm
- T_y = 2490. N
- M_x = -1743000. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.58 mm
- σ_m = -Mv/J_u = 208.2 N/mm²
- x_c = 18. mm
- y_c = 43. mm
- v_c = 18.58 mm
- σ_c = -Mv/J_u = 135.3 N/mm²
- τ_c = 3.811 N/mm²
- σ_q = √σ²+3τ² = 135.5 N/mm²
- S = 4394. mm³





Schema di calcolo iperstatico

M_0 flexione da carichi assegnati



M_1 flexione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-2Fx$	0	$Fb-3Fx+2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-2Fx$	0	$-Fx+2Fx^2/b$	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$6/5Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

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

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

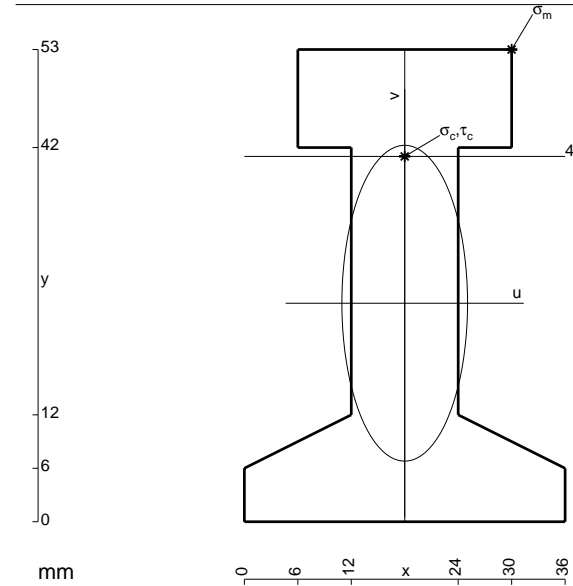
$$= (-5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

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

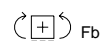
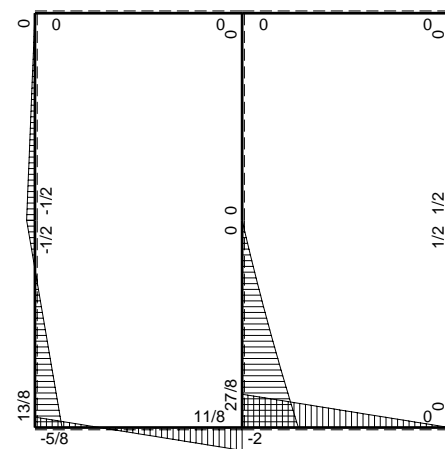
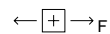
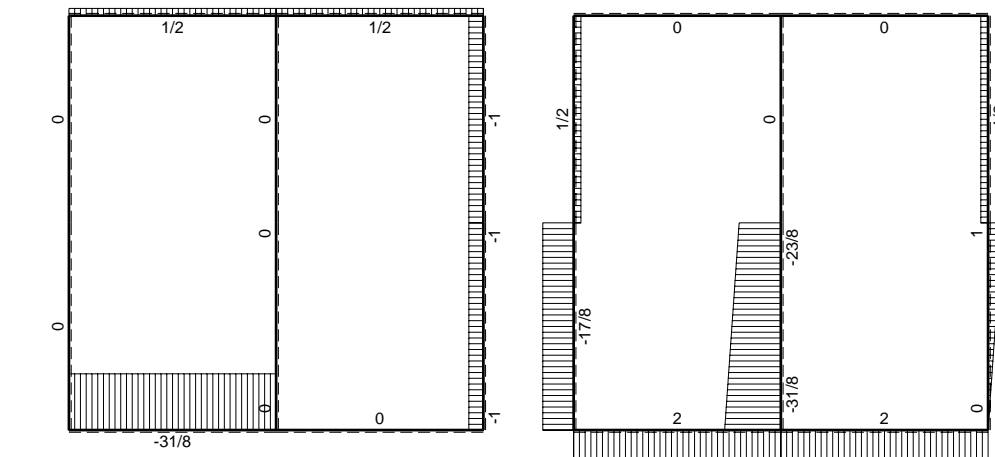
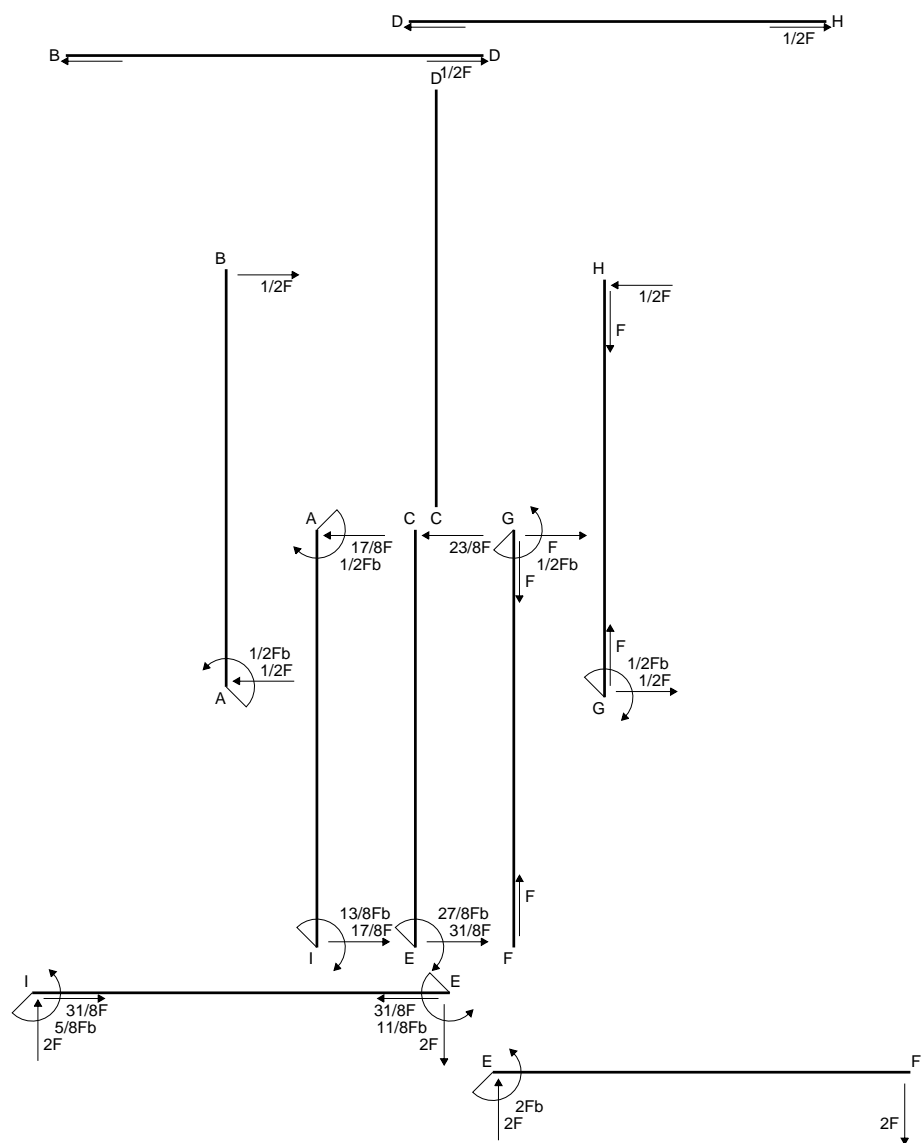
$$= (b - 3/2 b + 2/3 b) Fb \frac{1}{EJ} = 1/6 Fb^2/EJ$$

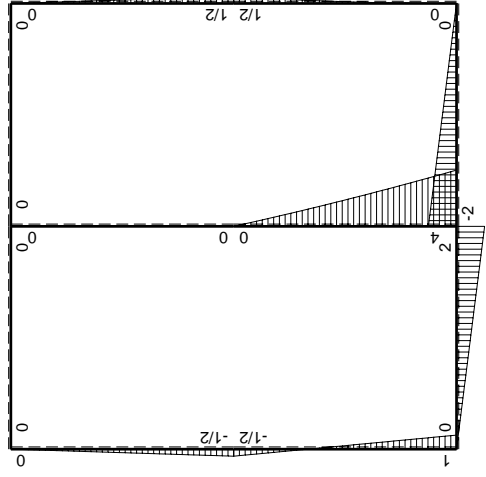
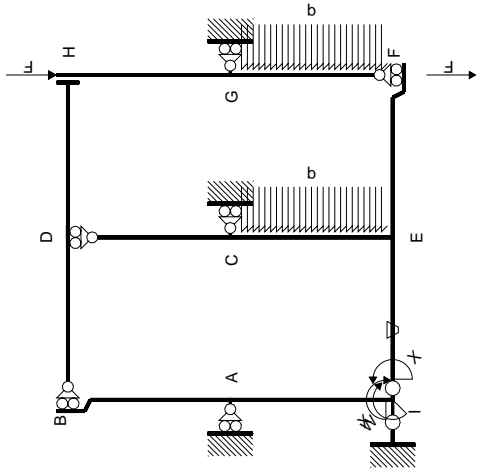
$$L_{AI}^{xo} = \int_0^b (-x/b + 2x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 2/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

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



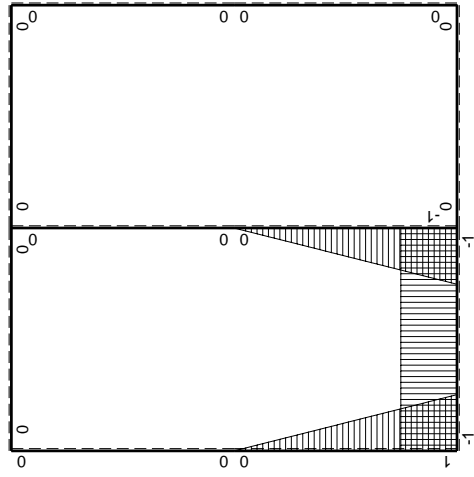
- A = 984. mm²
- J_u = 309321. mm⁴
- J_v = 48960. mm⁴
- y_g = 24.52 mm
- T_y = 2640. N
- M_x = -2376000. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.48 mm
- σ_m = -Mv/J_u = 218.7 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 16.48 mm
- σ_c = -Mv/J_u = 126.6 N/mm²
- τ_c = 4.459 N/mm²
- σ_q = √σ²+3τ² = 126.8 N/mm²
- S = 6269. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-9/2Fx+1/2qx^2$	0	$-4Fb+17/2Fx-5Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-31/24+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-7/2Fx-1/2qx^2$	0	$-7/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/24Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$5/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (-b) Fb \frac{1}{EJ} + (b) \theta = 0$$

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

$$= (-2b + b) Fb \frac{1}{EJ} + (-b) \theta = 0$$

$$L_{EC}^{x_0} = \int_0^b (-4 + 17/2 x/b - 5x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx$$

$$= [-4x + 17/4 x^2/b - 5/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb \frac{1}{EJ}$$

$$= (-4b + 17/4 b - 5/3 b + 1/8 b) Fb \frac{1}{EJ} = -31/24 Fb^2/EJ$$

$$L_{CE}^{x_0} = \int_0^b (-7/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx = [-7/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb \frac{1}{EJ}$$

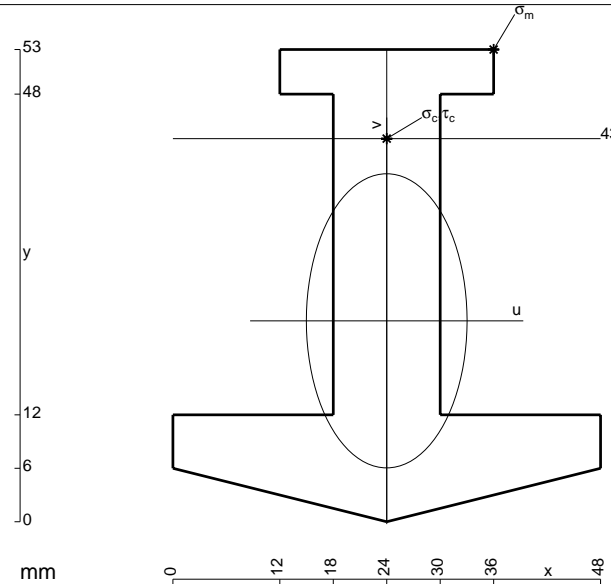
$$= (-7/6 b - 1/8 b) Fb \frac{1}{EJ} = -31/24 Fb^2/EJ$$

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

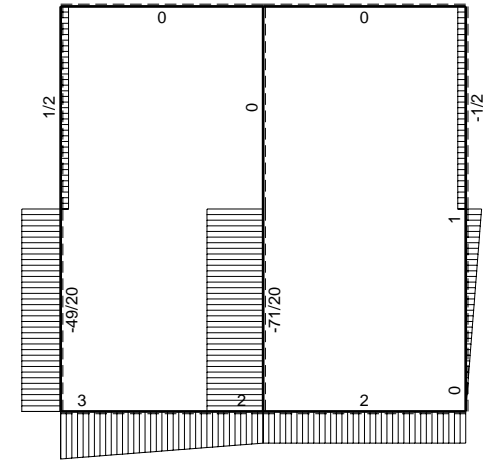
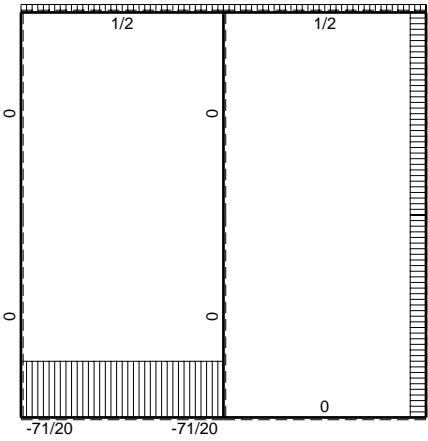
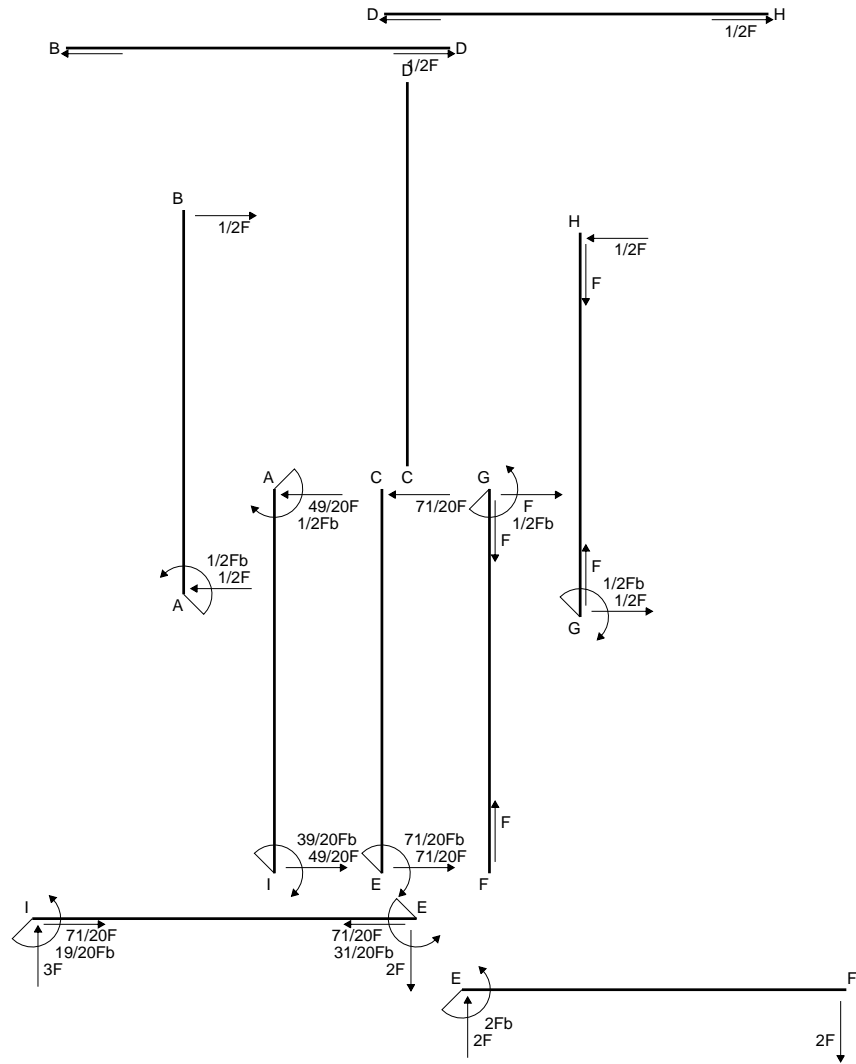
$$= (b - 5/4 b + 1/2 b) Fb \frac{1}{EJ} = 1/4 Fb^2/EJ$$

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

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

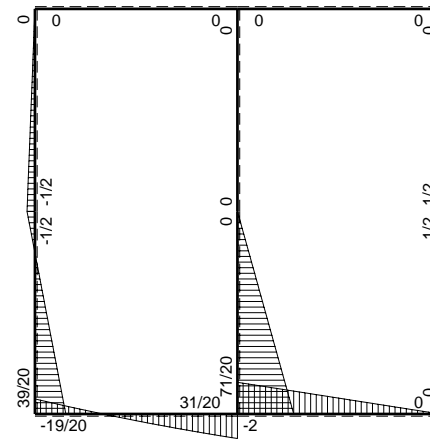


- A = 984. mm²
- J_u = 268208. mm⁴
- J_v = 80064. mm⁴
- y_g = 22.55 mm
- T_y = 2120. N
- M_x = -2014000. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.45 mm
- σ_m = -Mv/J_u = 228.7 N/mm²
- x_c = 24. mm
- y_c = 43. mm
- v_c = 20.45 mm
- σ_c = -Mv/J_u = 153.6 N/mm²
- τ_c = 3.116 N/mm²
- σ_q = √σ²+3τ² = 153.7 N/mm²
- S = 4731. mm³

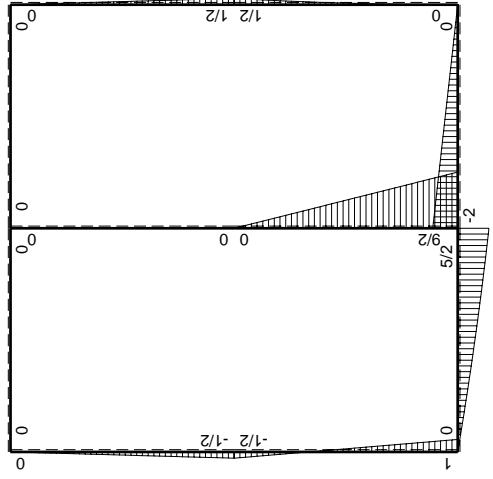
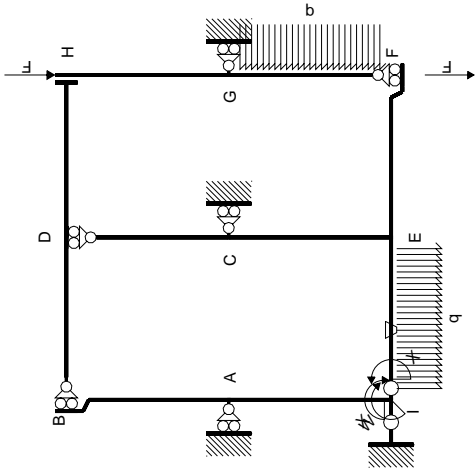


← ⊕ → F

↑ ⊕ ↓ F

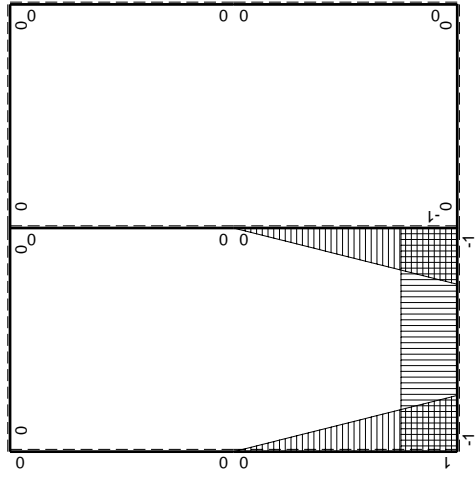


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0	0+0	0
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0	0+0	0
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0	0+0	0
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0	0+0	0
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0	0+0	0
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0	0+0	0
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$9/2Fb-9/2Fx$	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-9/2Fx$	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-19/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$19/20Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

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

$$L_{EC}^{xo} = \int_0^b (-9/2 + 9x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-9/2 x + 9/2 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-9/2 b + 9/2 b - 3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

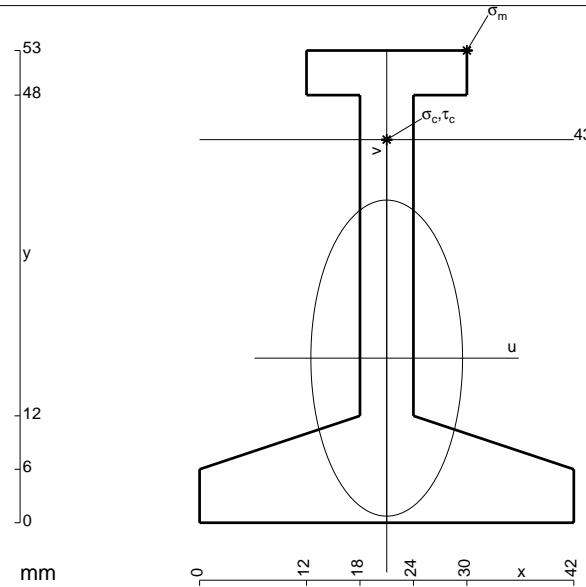
$$= (-3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

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

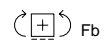
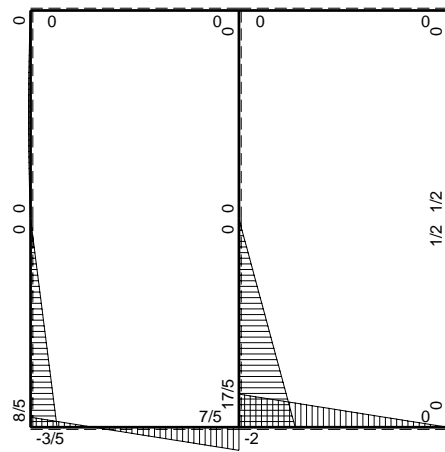
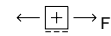
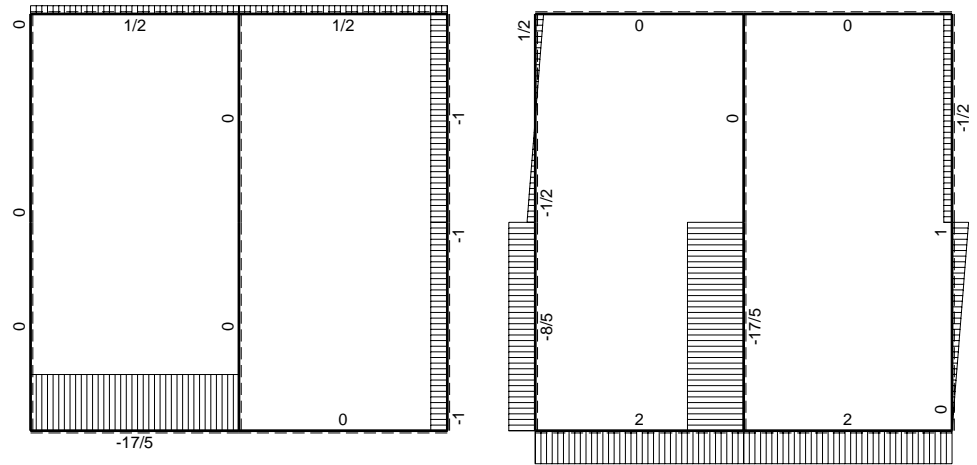
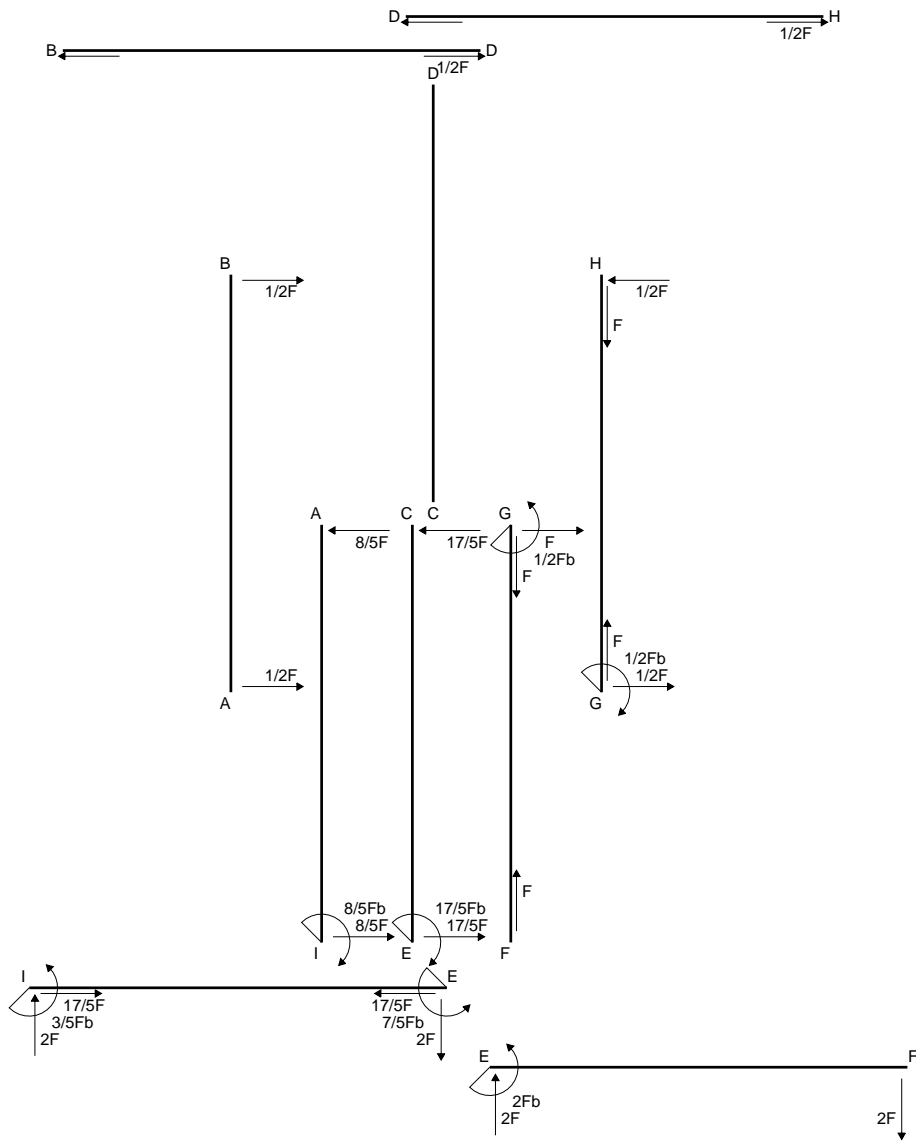
$$= (b - 5/4 b + 1/2 b) Fb \frac{1}{EJ} = 1/4 Fb^2/EJ$$

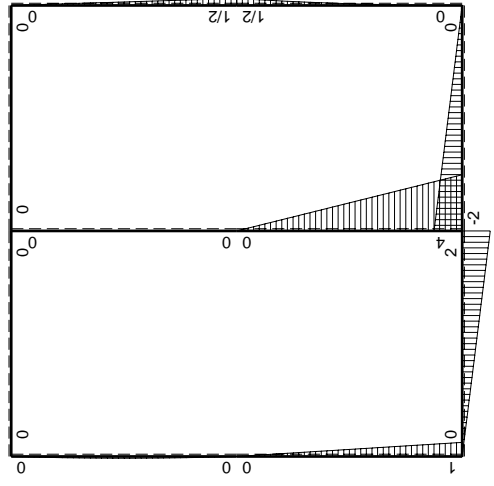
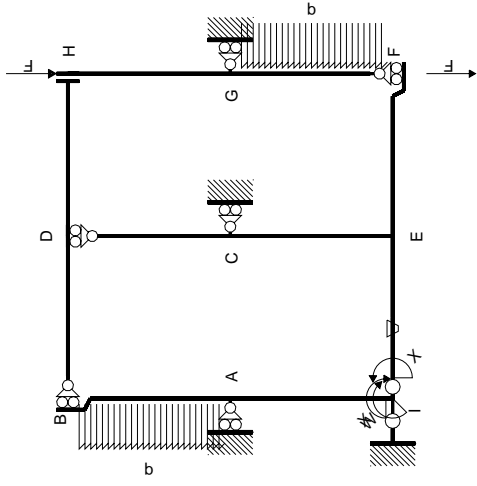
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

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



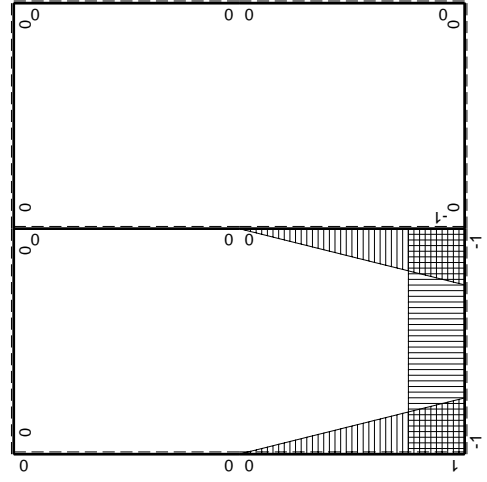
- A = 702. mm²
- J_u = 221020. mm⁴
- J_v = 50922. mm⁴
- y_g = 18.47 mm
- T_y = 1520. N
- M_x = -1520000. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 9. mm
- v_m = 34.53 mm
- σ_m = -Mv/J_u = 237.4 N/mm²
- x_c = 21. mm
- y_c = 43. mm
- v_c = 24.53 mm
- σ_c = -Mv/J_u = 168.7 N/mm²
- τ_c = 4.233 N/mm²
- σ_q = √σ²+3τ² = 168.8 N/mm²
- S = 3693. mm³





Schema di calcolo iperstatico

M_0 flexione da carichi assegnati



M_x flexione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-Fx$	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fx$	0	Fx^2/b	0	x^2/b^2		
	totali						$-Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/5Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

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

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

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

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

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

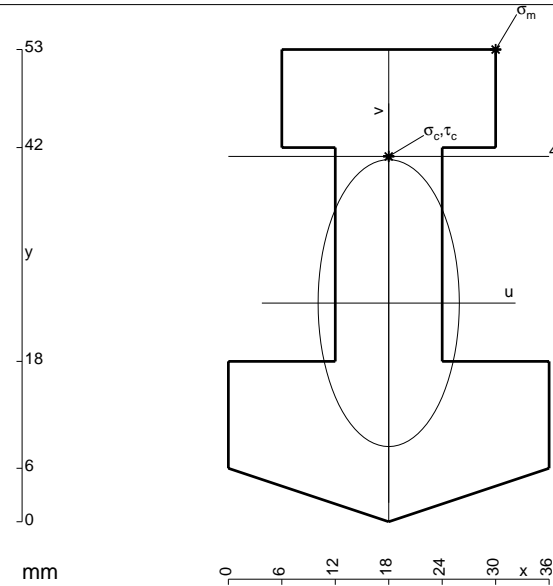
$$= (-4/3 b) Fb 1/EJ = -4/3 Fb^2/EJ$$

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

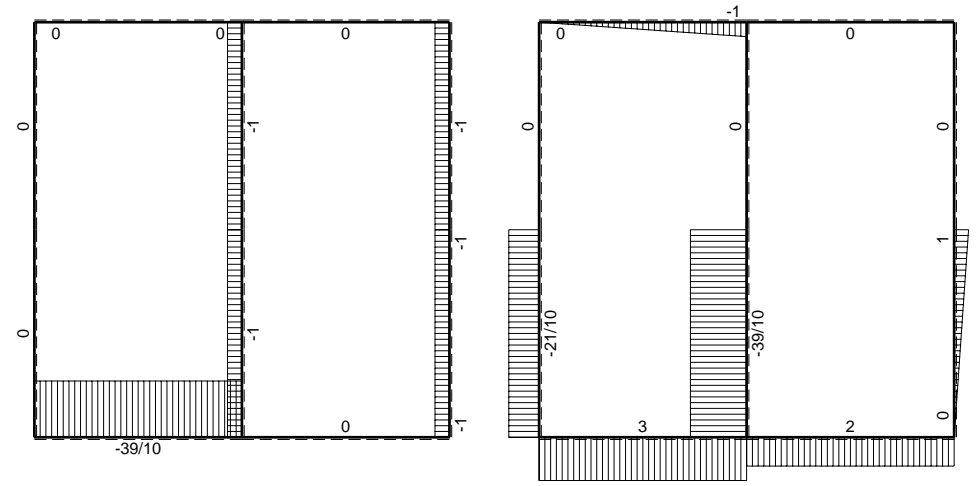
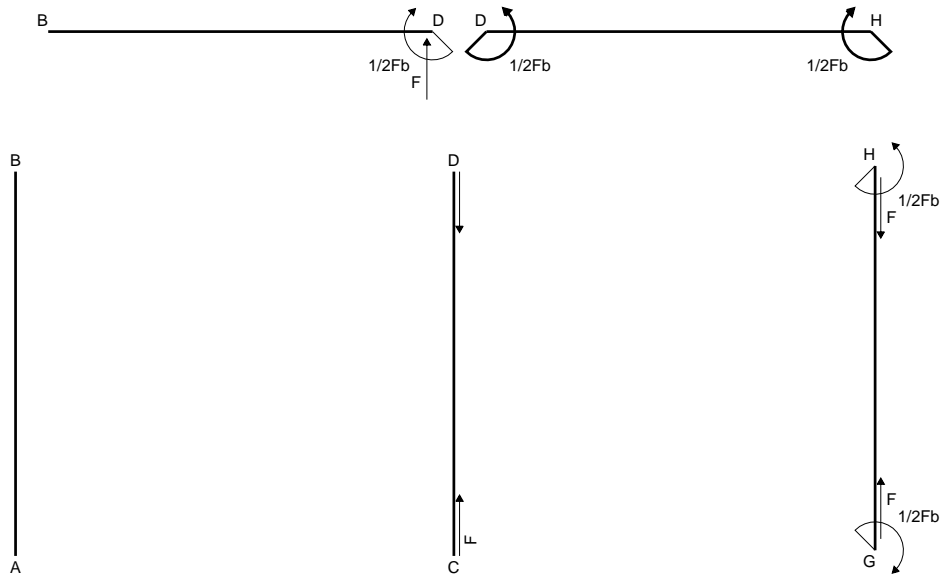
$$= (b - b + 1/3 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

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

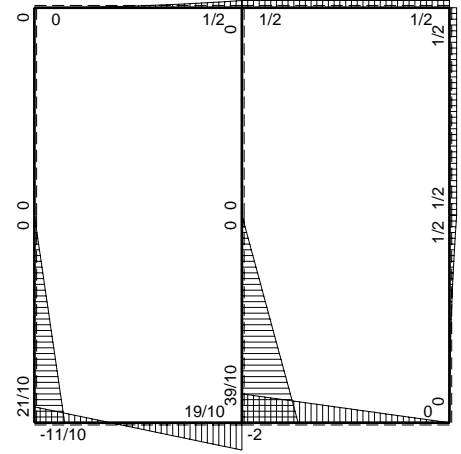
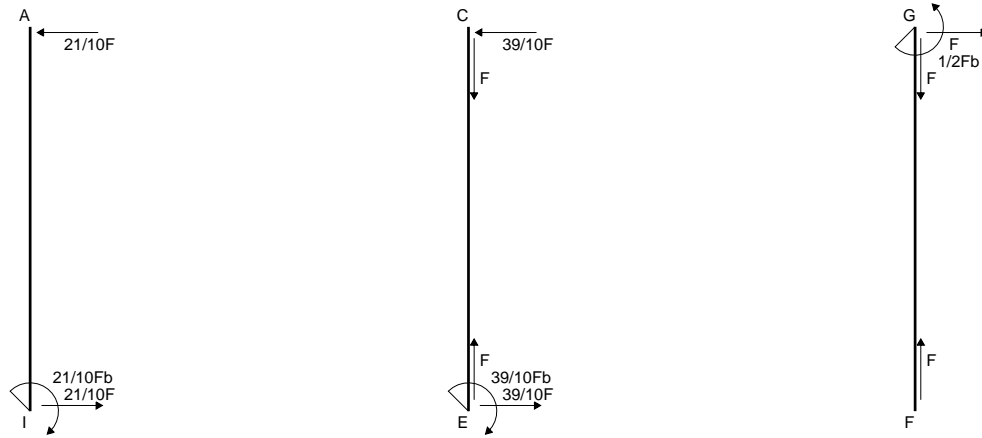


- A = 1092. mm²
- J_u = 283139. mm⁴
- J_v = 68616. mm⁴
- y_g = 24.54 mm
- T_y = 3740. N
- M_x = -1982200. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.46 mm
- σ_m = -Mv/J_u = 199.3 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 16.46 mm
- σ_c = -Mv/J_u = 115.2 N/mm²
- τ_c = 6.897 N/mm²
- σ_q = √σ²+3τ² = 115.9 N/mm²
- S = 6265. mm³

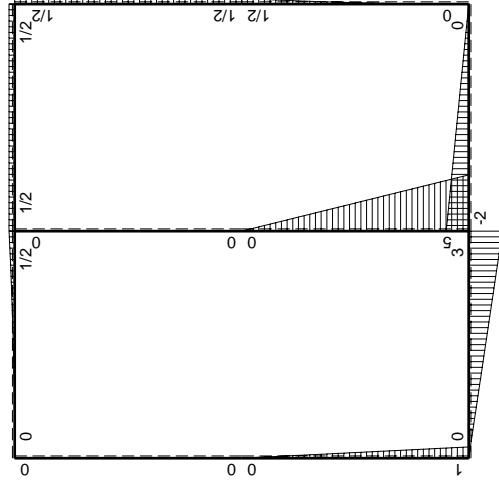
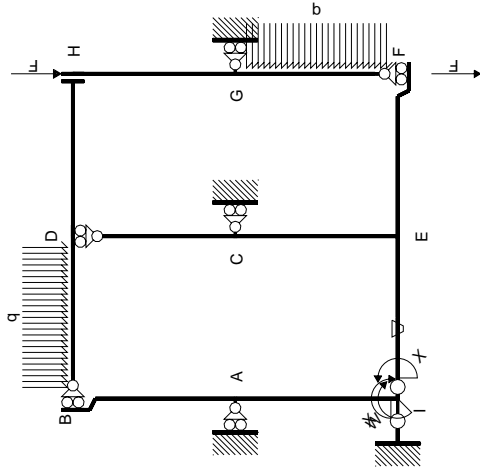


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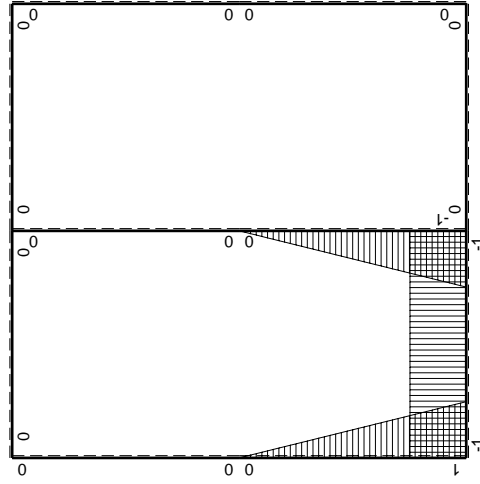


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-Fx$	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fx$	0	Fx^2/b	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/10Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

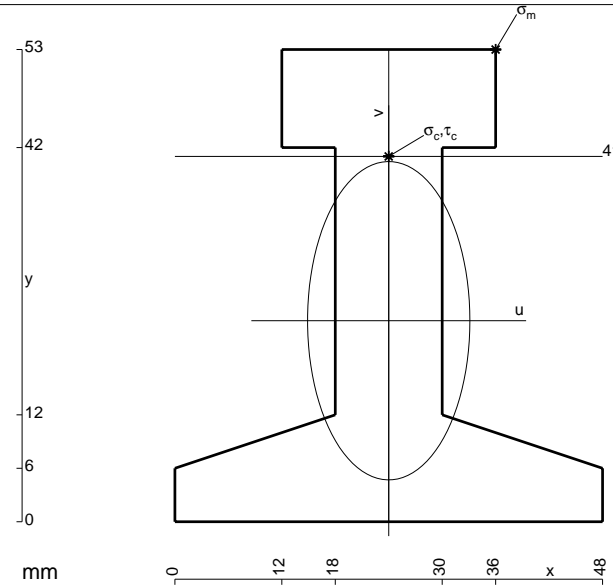
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

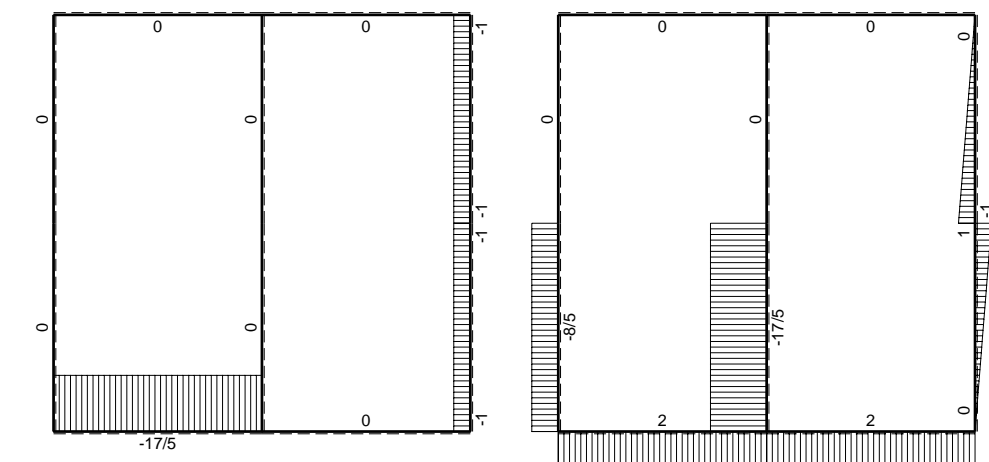
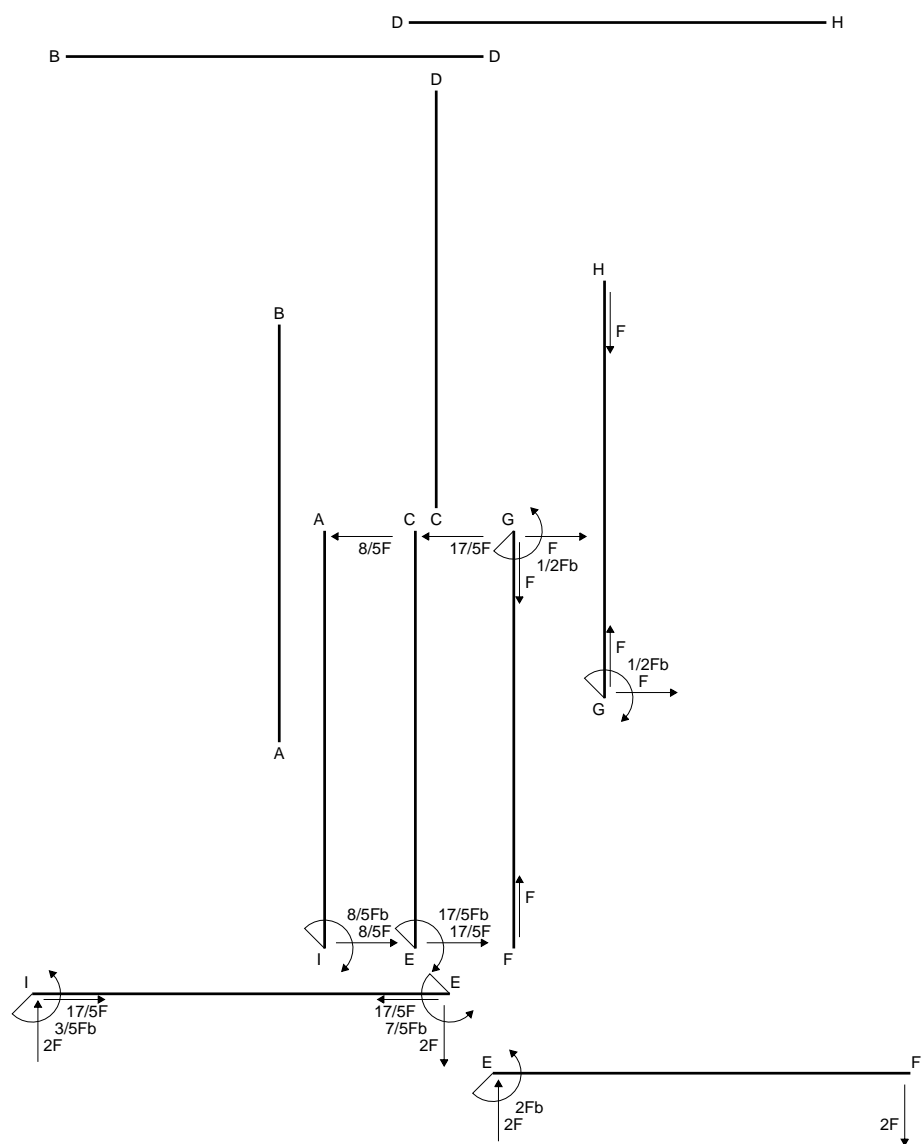
$$= (b - b + 1/3 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

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

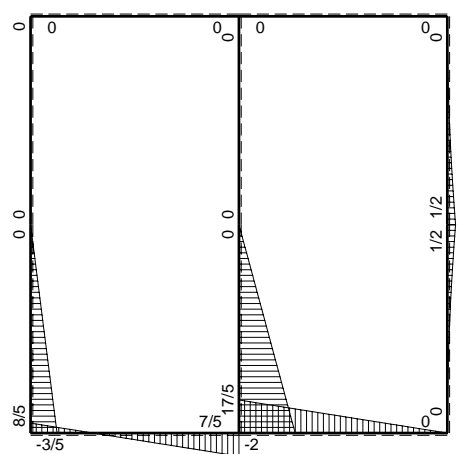


- A = 1092. mm²
- J_u = 348585. mm⁴
- J_v = 90648. mm⁴
- y_g = 22.56 mm
- T_y = 4140. N
- M_x = -2401200. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.44 mm
- σ_m = -Mv/J_u = 209.7 N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 18.44 mm
- σ_c = -Mv/J_u = 127. N/mm²
- τ_c = 6.741 N/mm²
- σ_q = √σ²+3τ² = 127.6 N/mm²
- S = 6811. mm³

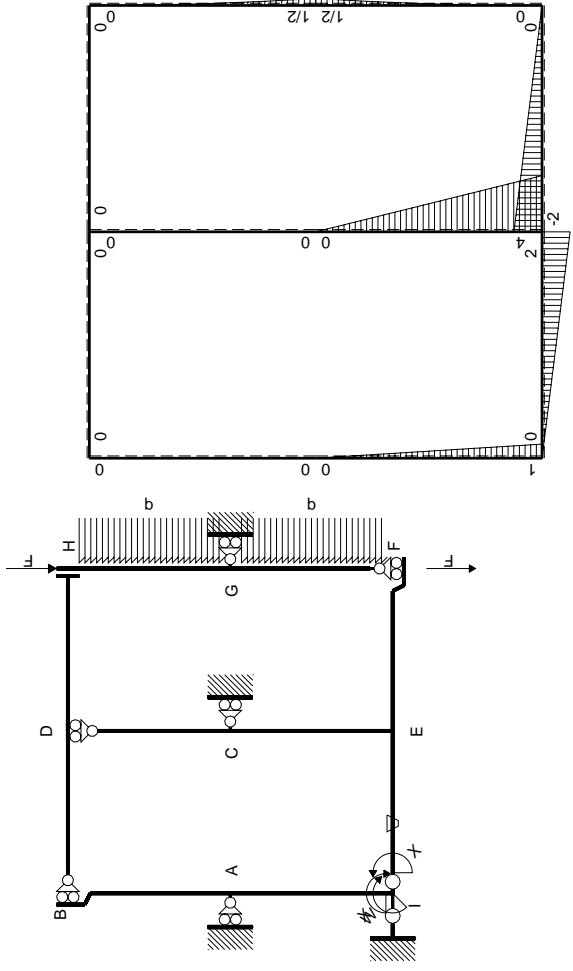


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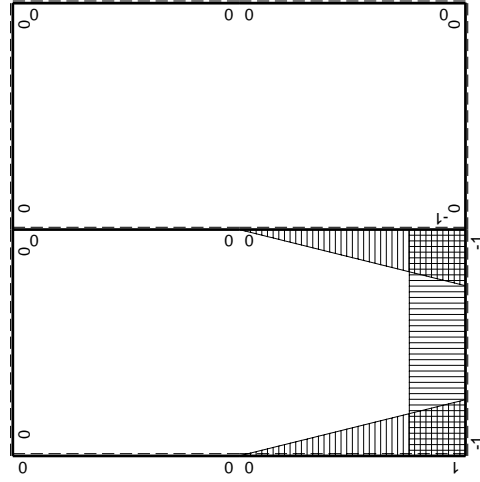


⊕ ⊖ F_b



Schema di calcolo iperstatico

\oplus M_0 flessione da carichi assegnati



\oplus M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-Fx$	0	$Fb-2Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fx$	0	Fx^2/b	0	x^2/b^2		
	totali						$-Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/5Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

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

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

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

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

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

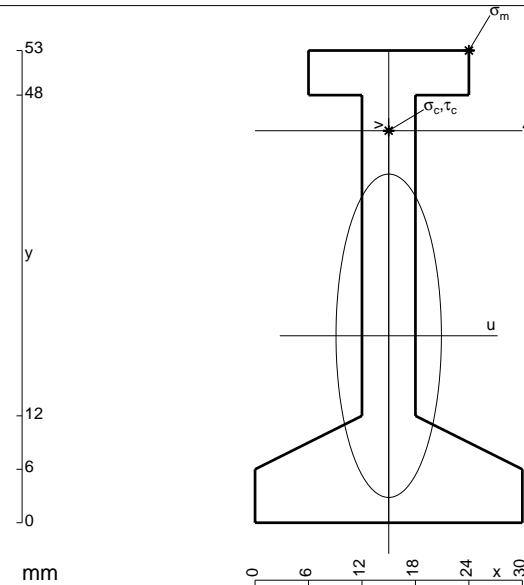
$$= (-4/3 b) Fb 1/EJ = -4/3 Fb^2/EJ$$

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

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

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

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



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

$$J_u = 195798. \text{ mm}^4$$

$$J_v = 20790. \text{ mm}^4$$

$$y_g = 20.98 \text{ mm}$$

$$T_y = 2120. \text{ N}$$

$$M_x = -1335600. \text{ Nmm}$$

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

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

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

$$v_m = 32.02 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 218.4 \text{ N/mm}^2$$

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

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

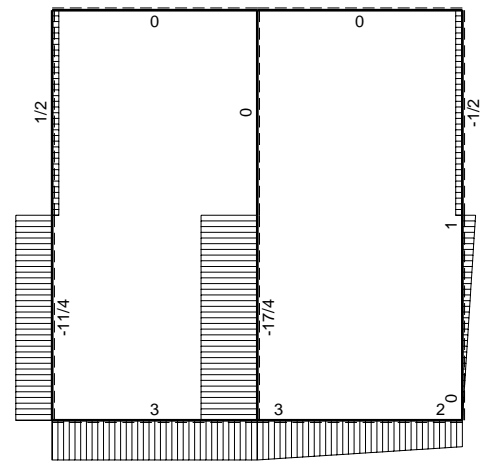
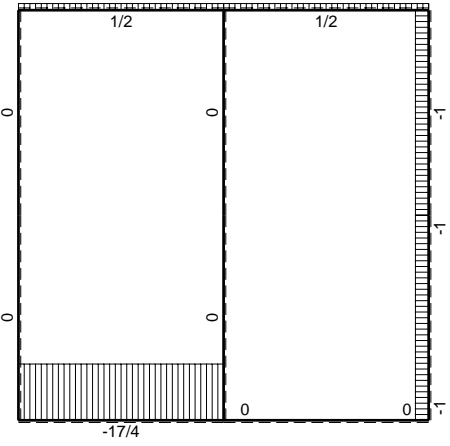
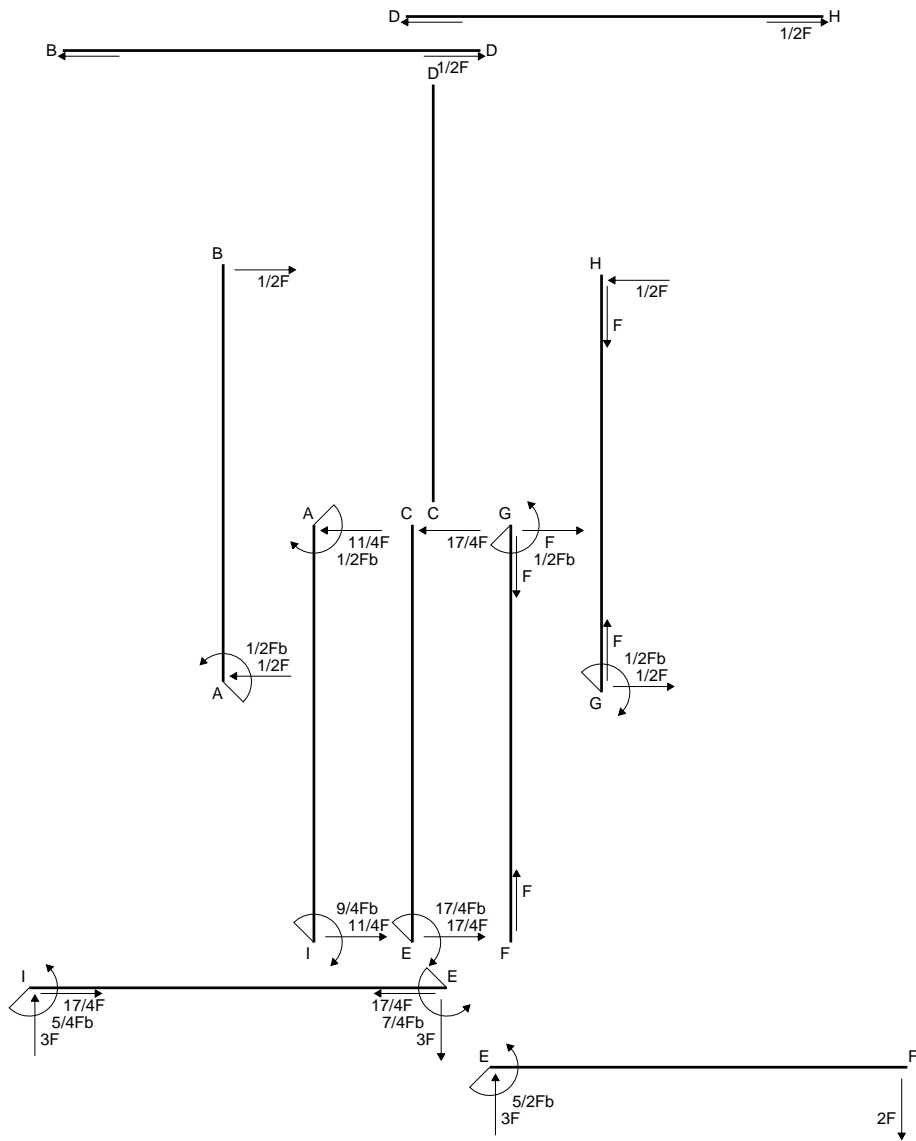
$$v_c = 23.02 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 157. \text{ N/mm}^2$$

$$\tau_c = 5.877 \text{ N/mm}^2$$

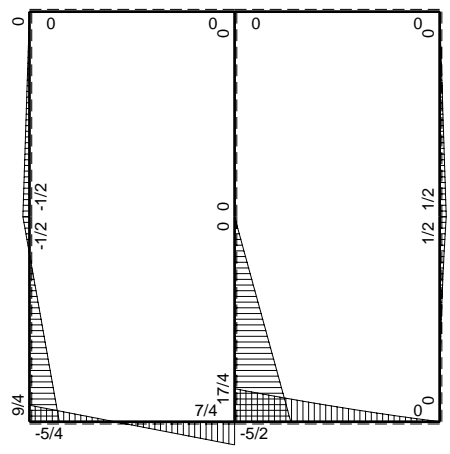
$$\sigma_\varrho = \sqrt{\sigma^2 + 3\tau^2} = 157.3 \text{ N/mm}^2$$

$$S = 3257. \text{ mm}^3$$

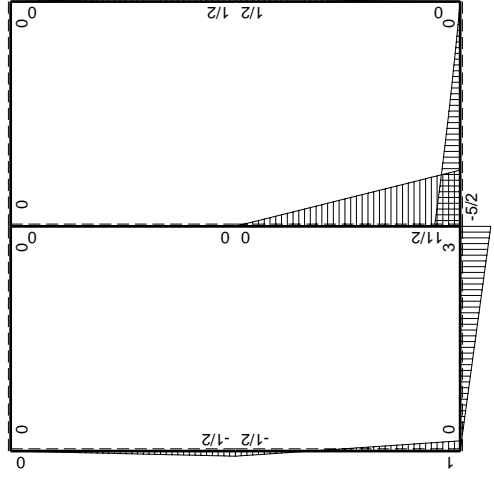
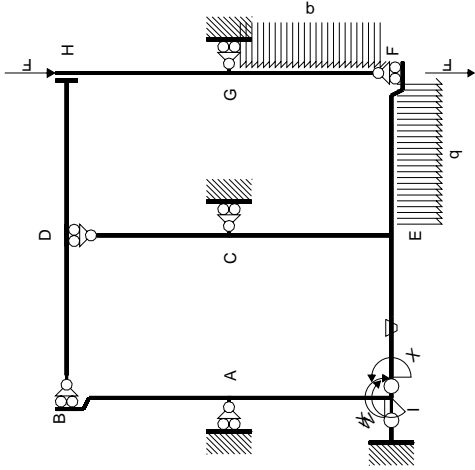


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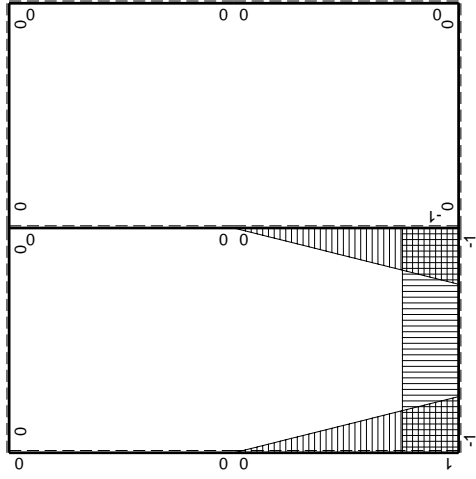


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$5/4Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb 1/EJ dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb 1/EJ dx = [-11/6 x^3/b^2]_0^b Fb 1/EJ$$

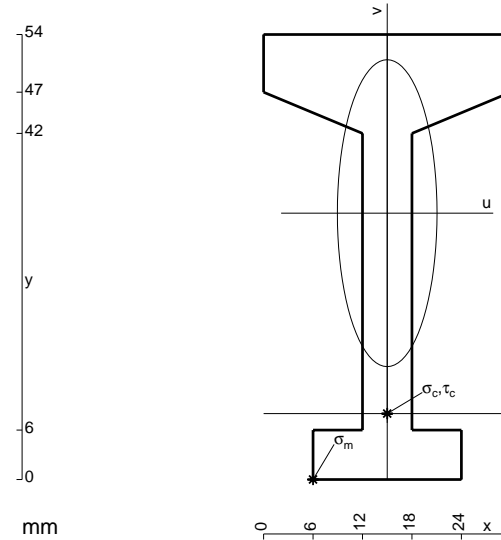
$$= (-11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

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

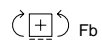
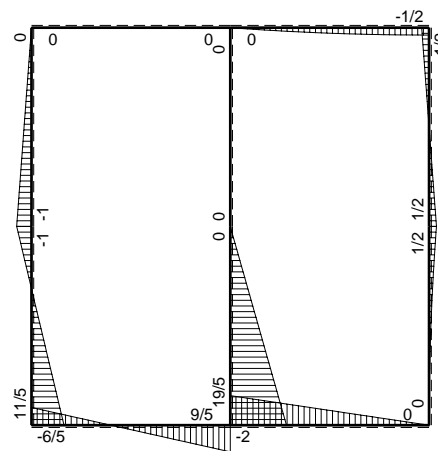
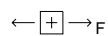
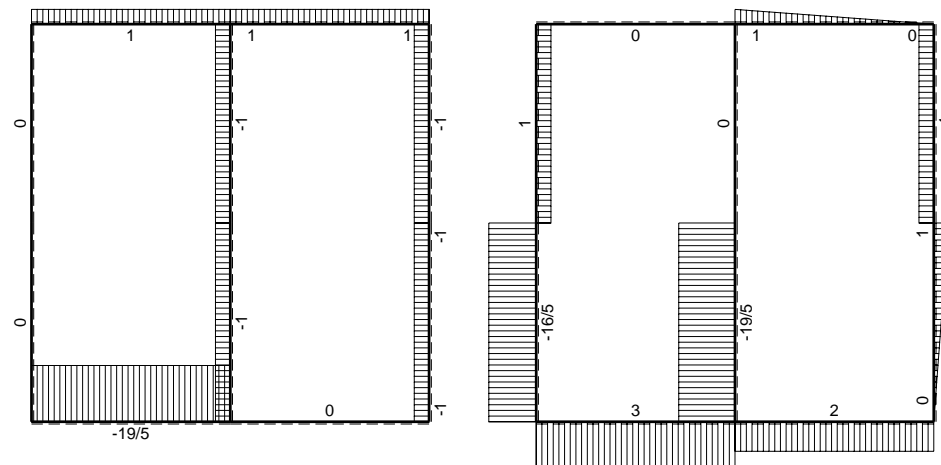
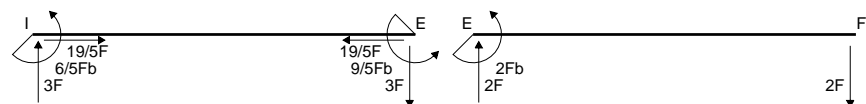
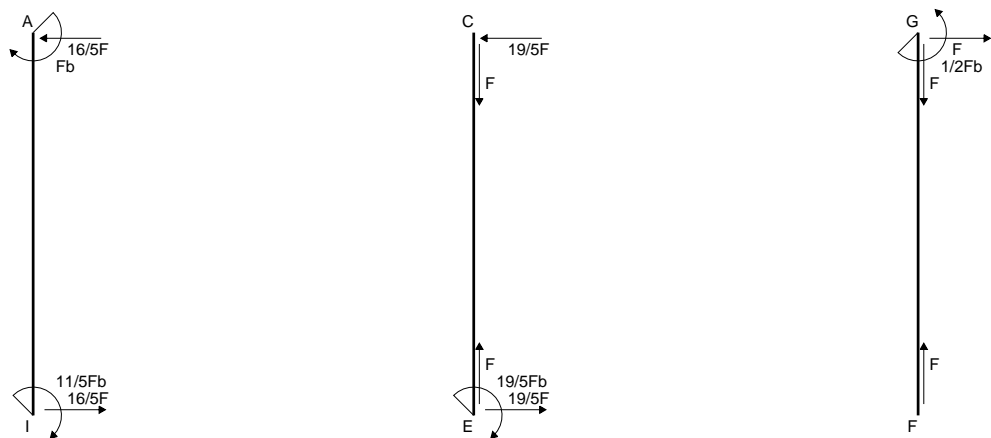
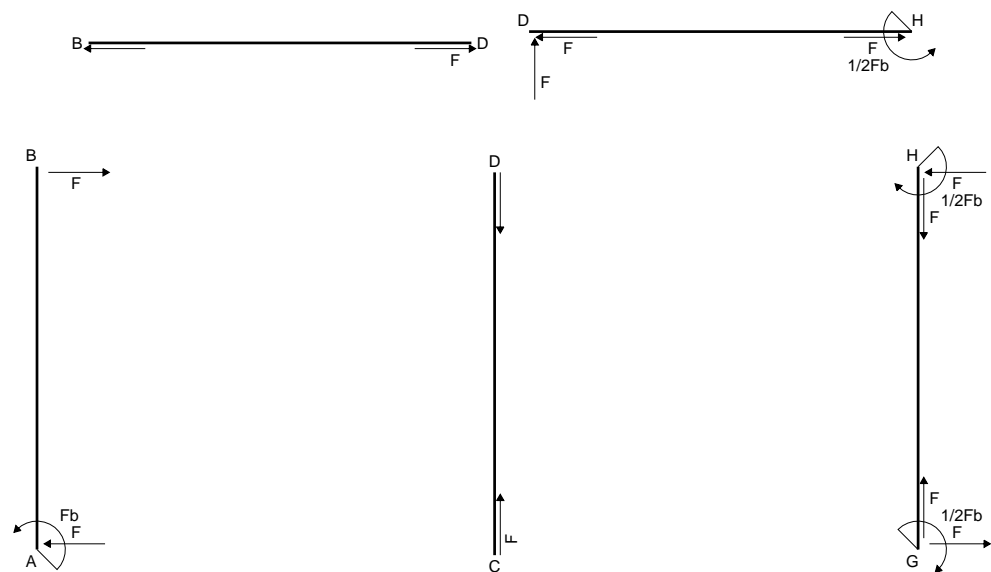
$$= (b - 5/4 b + 1/2 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

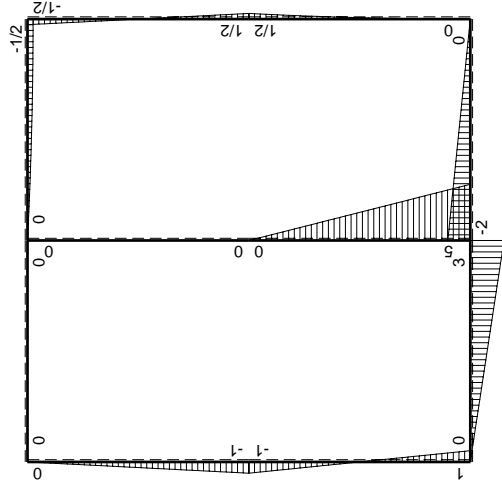
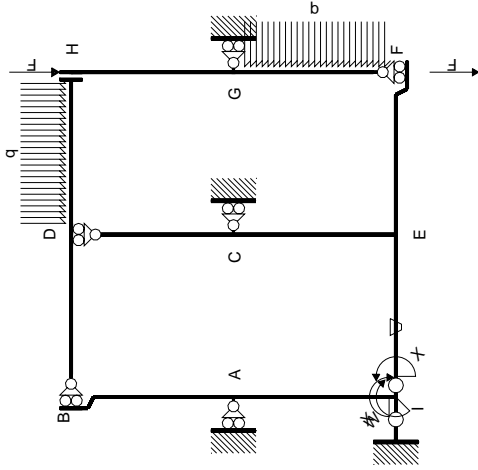
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 3/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/2 x^3/b^2]_0^b Fb 1/EJ$$

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



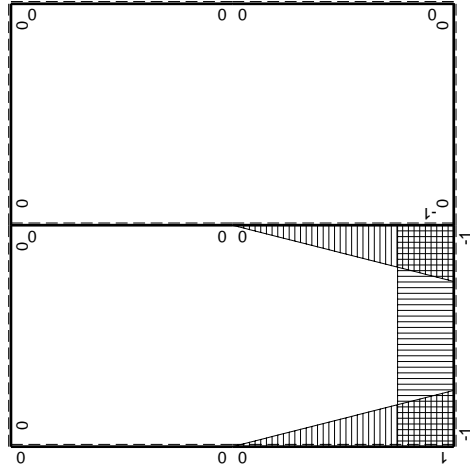
- A = 624. mm²
- J_u = 216470. mm⁴
- J_v = 22824. mm⁴
- y_g = 32.32 mm
- T_y = 2640. N
- M_x = -1540000. Nmm
- x_m = 6. mm
- u_m = -9. mm
- v_m = -32.32 mm
- σ_m = -Mv/J_u = -229.9 N/mm²
- x_c = 15. mm
- y_c = 8. mm
- v_c = -24.32 mm
- σ_c = -Mv/J_u = -173. N/mm²
- τ_c = 7.054 N/mm²
- σ_o = √σ² + 3τ² = 173.5 N/mm²
- S = 3470. mm³





Schema di calcolo iperstatico

M₀ flessione da carichi assegnati



M_x flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-2Fx$	0	$Fb-3Fx+2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-2Fx$	0	$-Fx+2Fx^2/b$	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$6/5Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

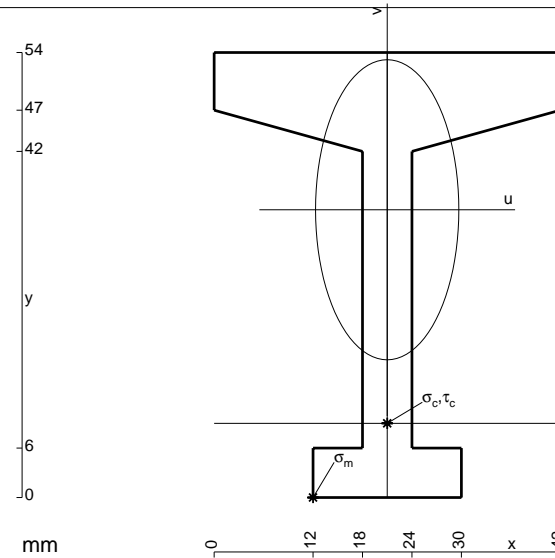
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

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

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

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

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



$$A = 738. \text{ mm}^2$$

$$J_u = 244714. \text{ mm}^4$$

$$J_v = 55782. \text{ mm}^4$$

$$y_g = 34.92 \text{ mm}$$

$$T_y = 2240. \text{ N}$$

$$M_x = -1680000. \text{ Nmm}$$

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

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

$$v_m = -34.92 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -239.7 \text{ N/mm}^2$$

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

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

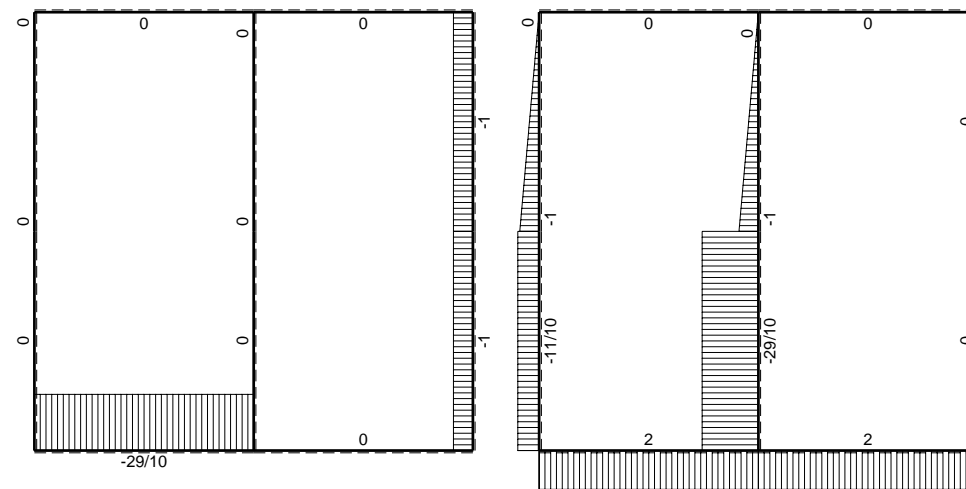
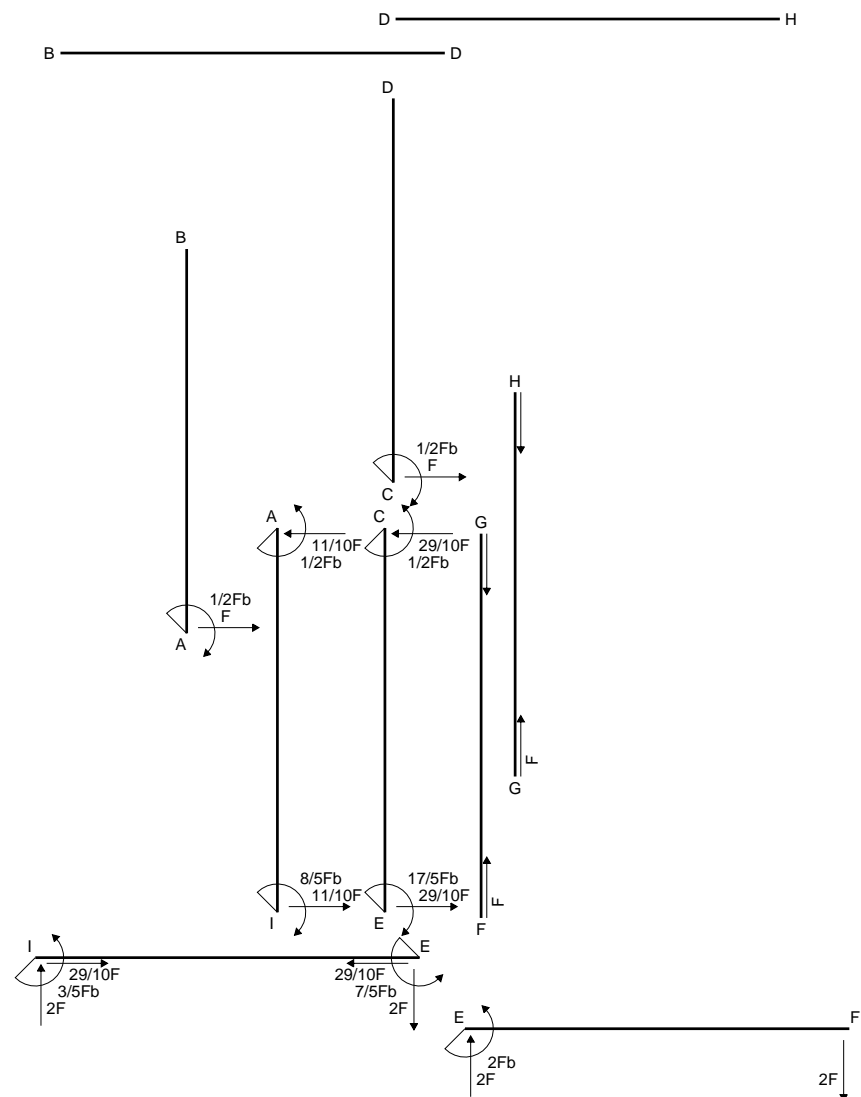
$$v_c = -25.92 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -177.9 \text{ N/mm}^2$$

$$\tau_c = 6.012 \text{ N/mm}^2$$

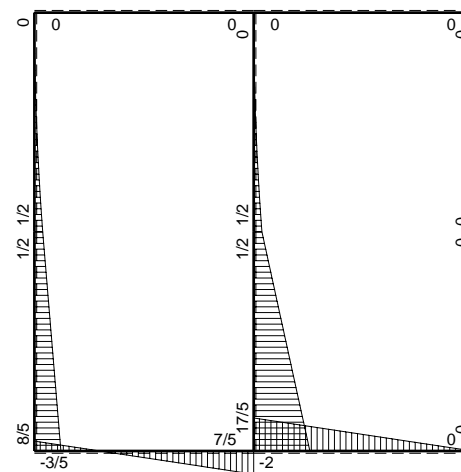
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 178.2 \text{ N/mm}^2$$

$$S = 3941. \text{ mm}^3$$

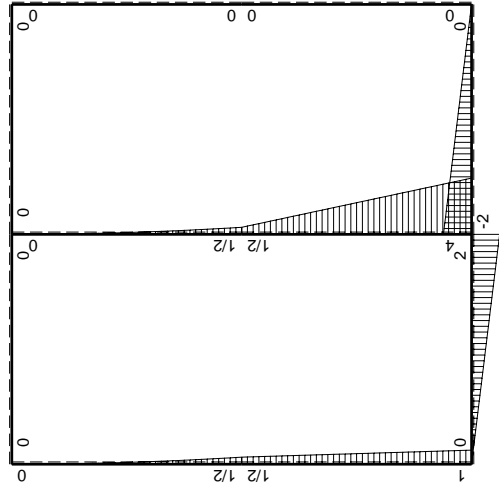
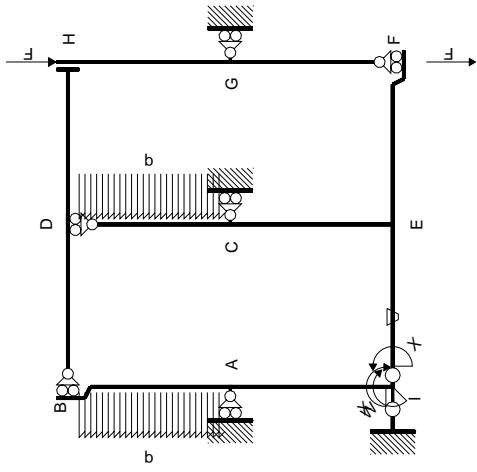


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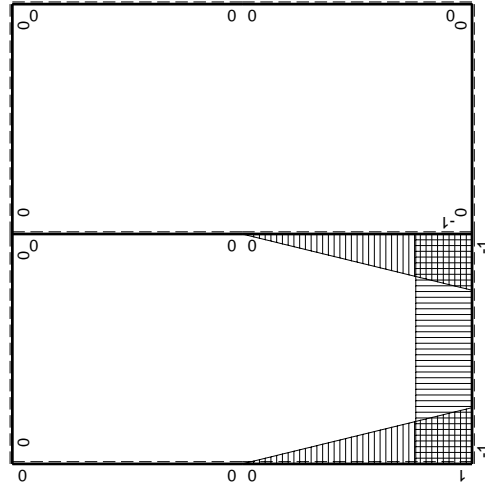


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
BA b	0	$-1/2qx^2$	0	0	0	0			
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$-1/2qx^2$	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	0	0	0	0	0	0+0	0	
HG b	0	0	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1			
EC b	$-1+x/b$	$4Fb-7/2Fx$	0	$-4Fb+15/2Fx-7/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-17/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-1/2Fb-7/2Fx$	0	$-1/2Fx-7/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$Fb-1/2Fx$	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$-1/2Fb-1/2Fx$	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$3/5Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

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

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 15/2 x/b - 7/2 x^2/b^2) Fb 1/EJ dx = [-4x + 15/4 x^2/b - 7/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-4b + 15/4 b - 7/6 b) Fb 1/EJ = -17/12 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 7/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b - 7/6 x^3/b^2]_0^b Fb 1/EJ$$

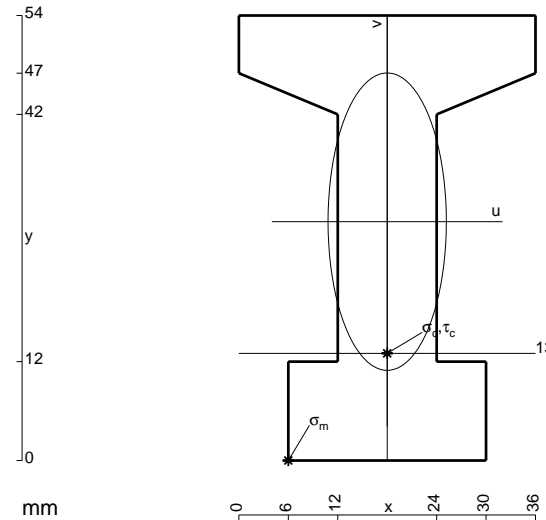
$$= (-1/4 b - 7/6 b) Fb 1/EJ = -17/12 Fb^2/EJ$$

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

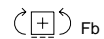
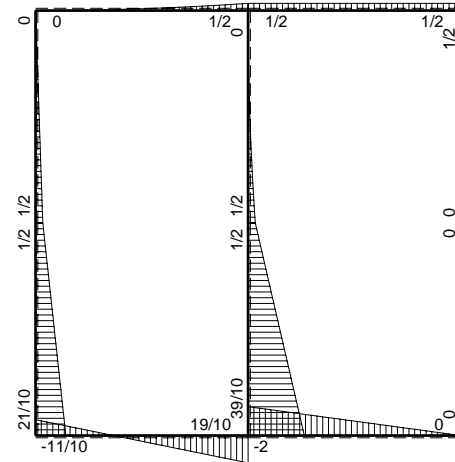
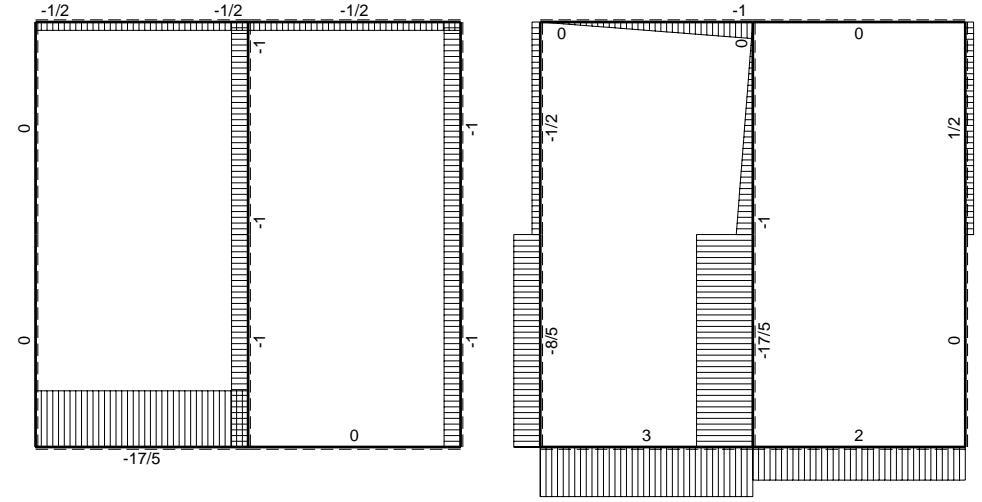
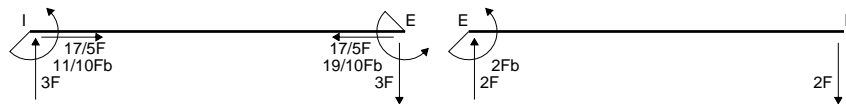
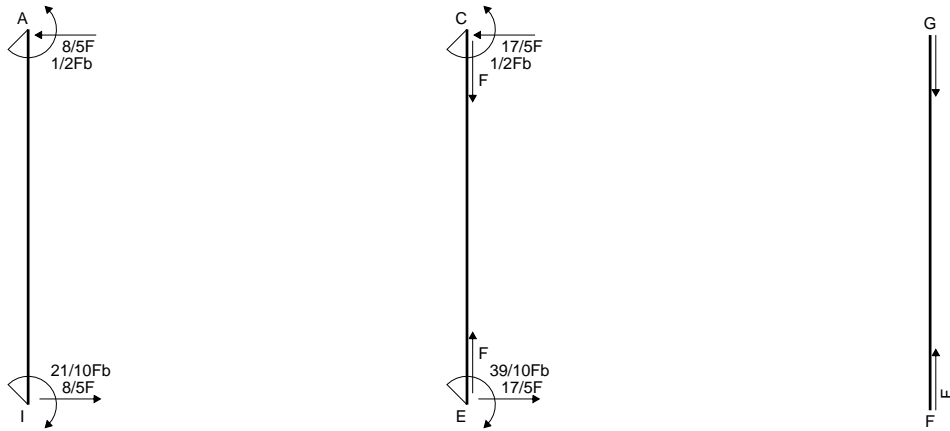
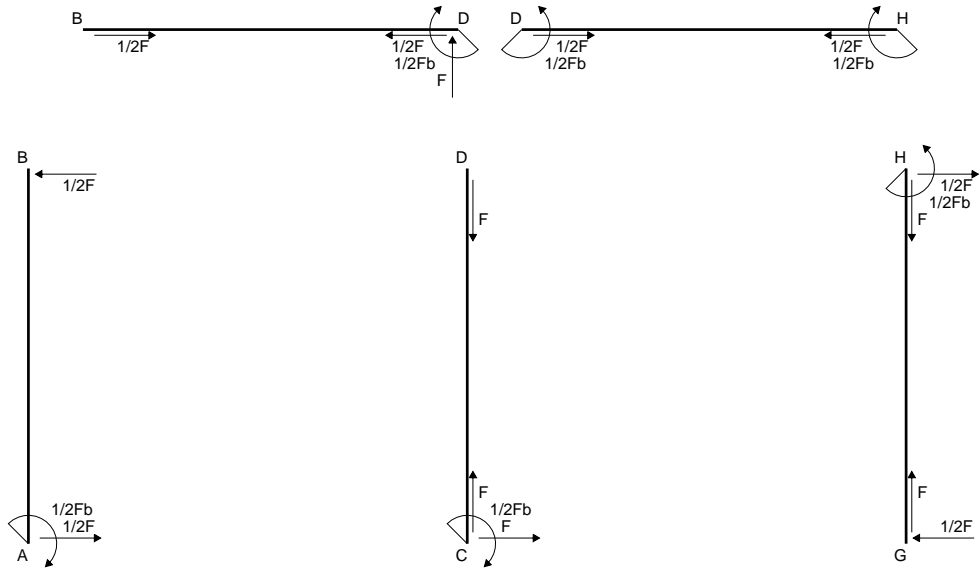
$$= (b - 3/4 b + 1/6 b) Fb 1/EJ = 5/12 Fb^2/EJ$$

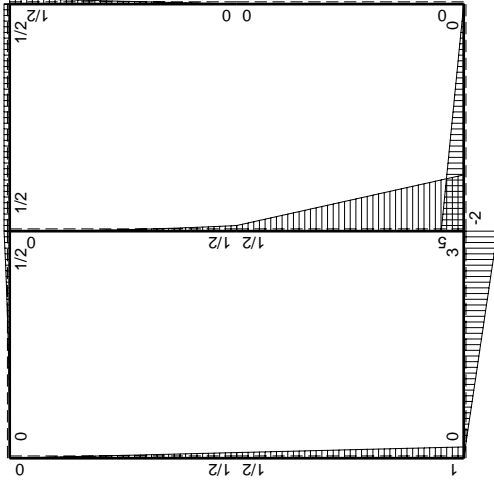
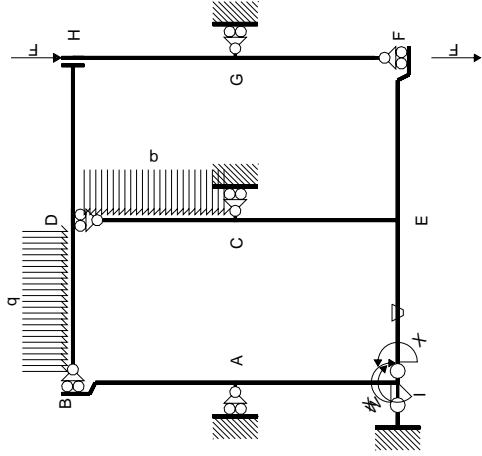
$$L_{AI}^{xo} = \int_0^b (1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

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



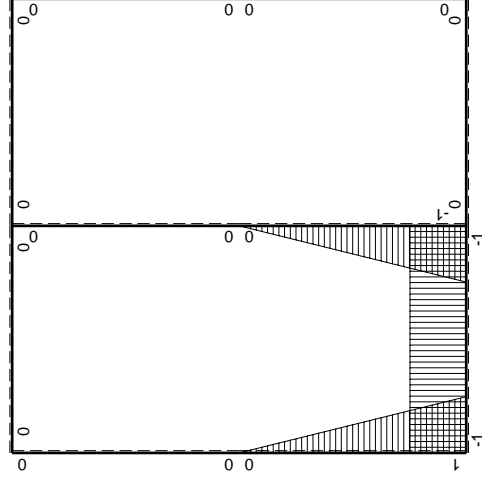
- A = 1020. mm²
- J_u = 332394. mm⁴
- J_v = 52560. mm⁴
- y_g = 28.98 mm
- T_y = 2820. N
- M_x = -2284200. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.98 mm
- σ_m = -Mv/J_u = -199.2 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.98 mm
- σ_c = -Mv/J_u = -109.8 N/mm²
- τ_c = 4.82 N/mm²
- σ_o = √σ²+3τ² = 110.2 N/mm²
- S = 6817. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-9/2Fx$	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-1/2Fx$	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb-1/2Fx$	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/10Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{EC}^{xo} = \int_0^b (-5 + 19/2 x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 19/4 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 19/4 b - 3/2 b) Fb \frac{1}{EJ} = -7/4 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

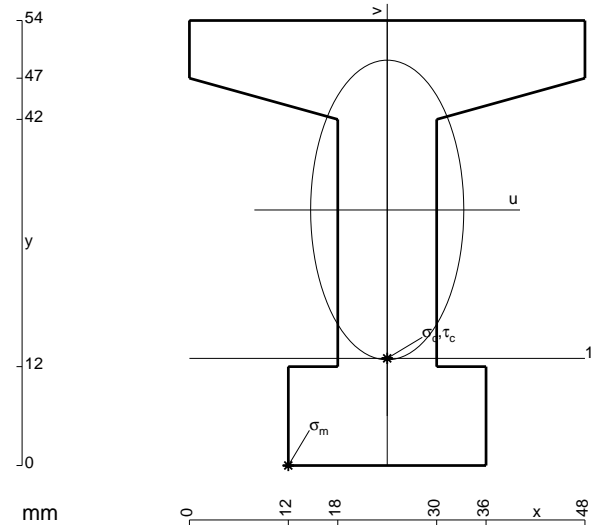
$$= (-1/4 b - 3/2 b) Fb \frac{1}{EJ} = -7/4 Fb^2/EJ$$

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

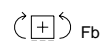
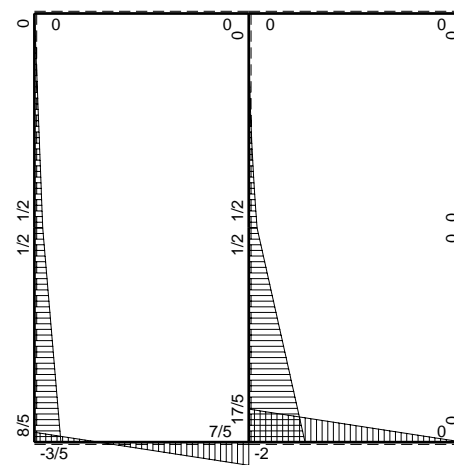
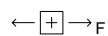
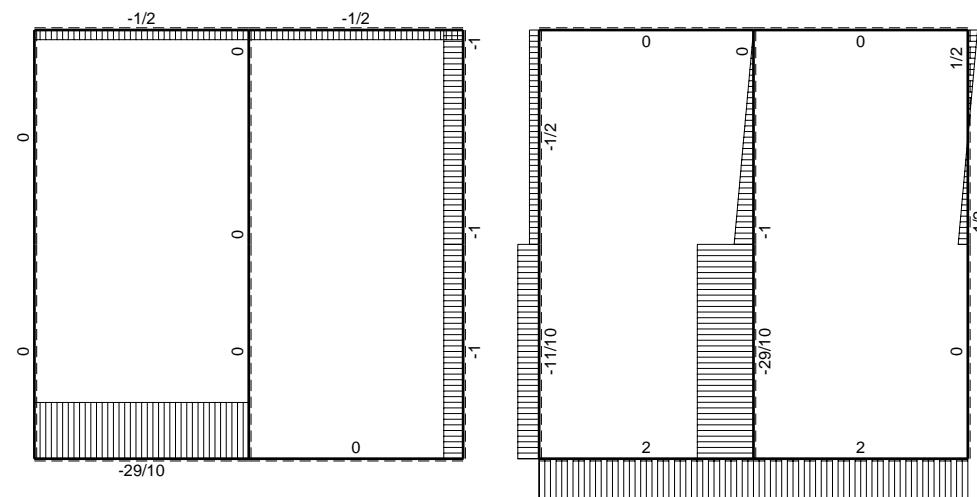
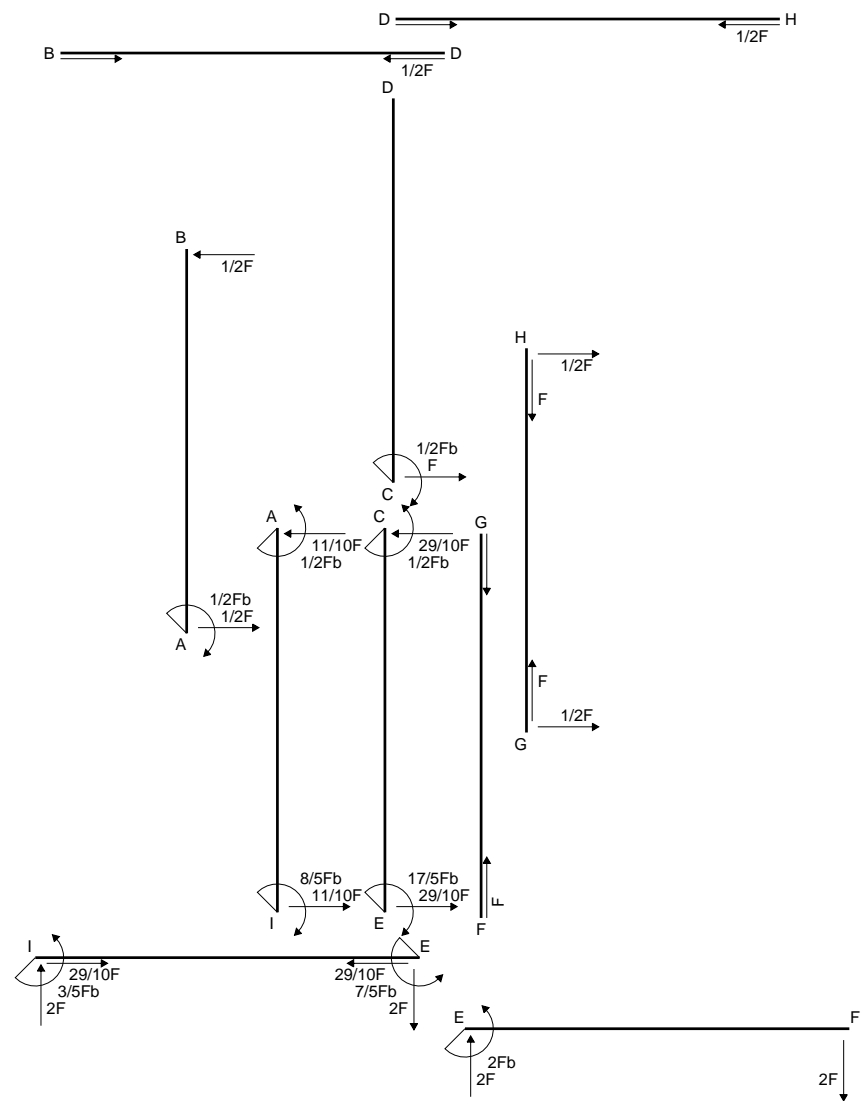
$$= (b - 3/4 b + 1/6 b) Fb \frac{1}{EJ} = 5/12 Fb^2/EJ$$

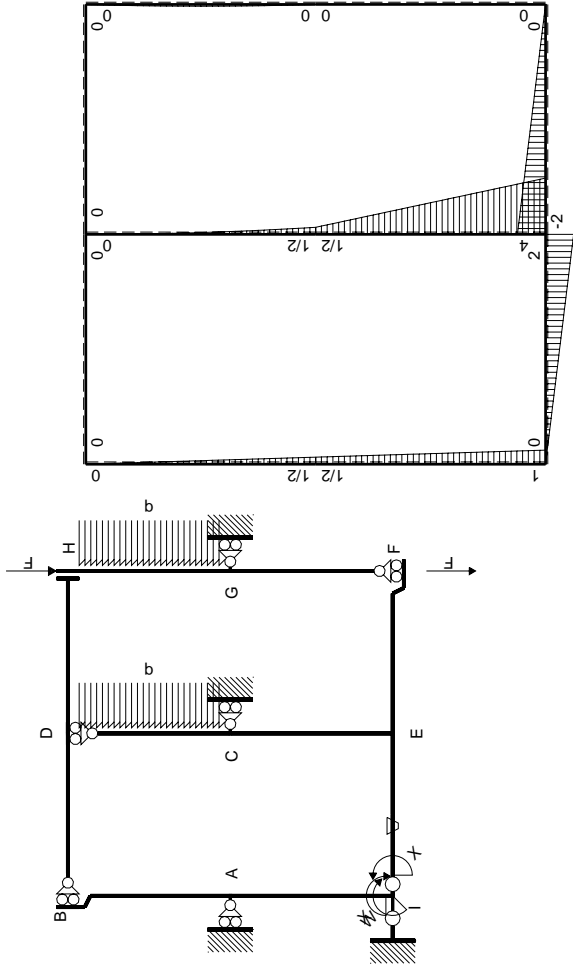
$$L_{AI}^{xo} = \int_0^b (1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/4 b + 1/6 b) Fb \frac{1}{EJ} = 5/12 Fb^2/EJ$$



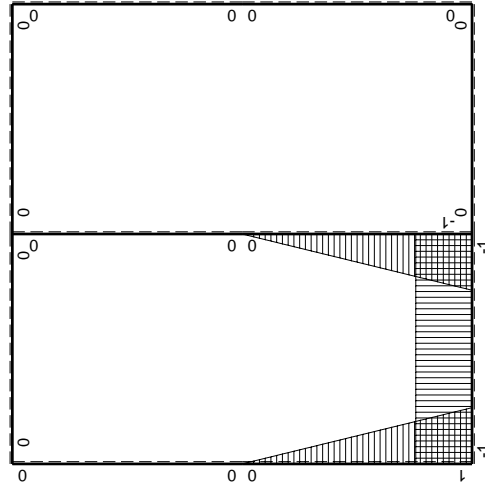
- A = 1134. mm²
- J_u = 375027. mm⁴
- J_v = 97956. mm⁴
- y_g = 31.01 mm
- T_y = 2940. N
- M_x = -2528400. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -31.01 mm
- σ_m = -Mv/J_u = -209.1 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -18.01 mm
- σ_c = -Mv/J_u = -121.4 N/mm²
- τ_c = 4.851 N/mm²
- σ_o = √σ²+3τ² = 121.7 N/mm²
- S = 7425. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

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

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-7/2Fx$	0	$-4Fb+15/2Fx-7/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-17/12+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-7/2Fx$	0	$-1/2Fx-7/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-1/2Fx$	0	$Fb-3/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(5/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb-1/2Fx$	0	$1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/5Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (-b) Fb \frac{1}{EJ} + (b) \theta = 0$$

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

$$= (-2b + b) Fb \frac{1}{EJ} + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 15/2 x/b - 7/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-4x + 15/4 x^2/b - 7/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-4b + 15/4 b - 7/6 b) Fb \frac{1}{EJ} = -17/12 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 7/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b - 7/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

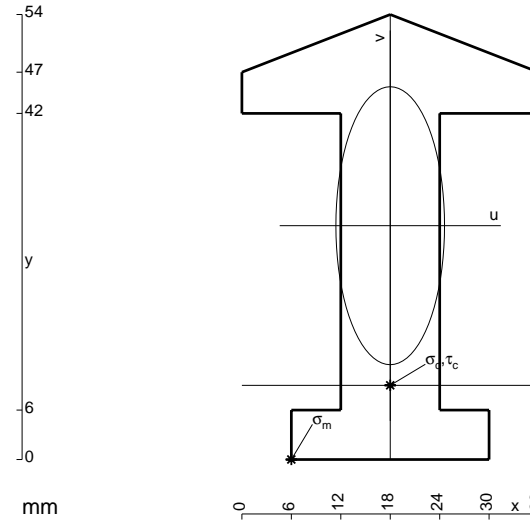
$$= (-1/4 b - 7/6 b) Fb \frac{1}{EJ} = -17/12 Fb^2/EJ$$

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

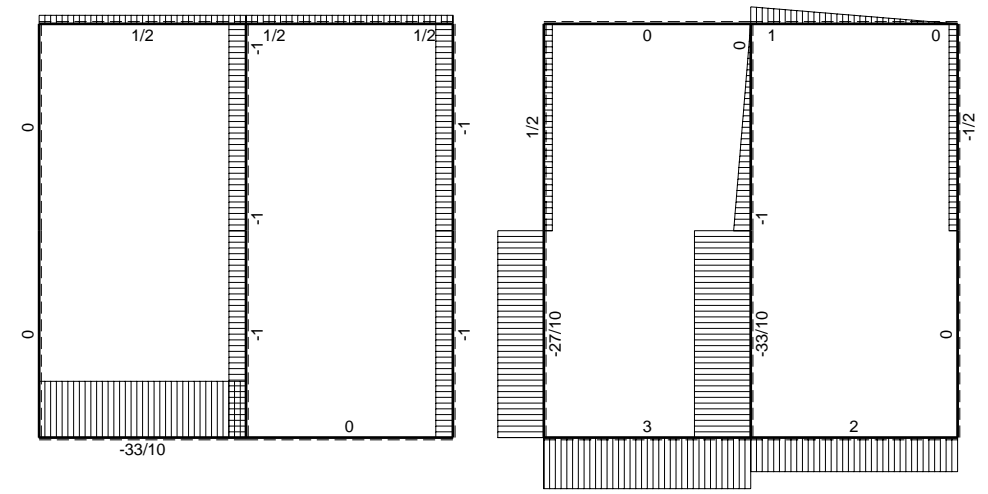
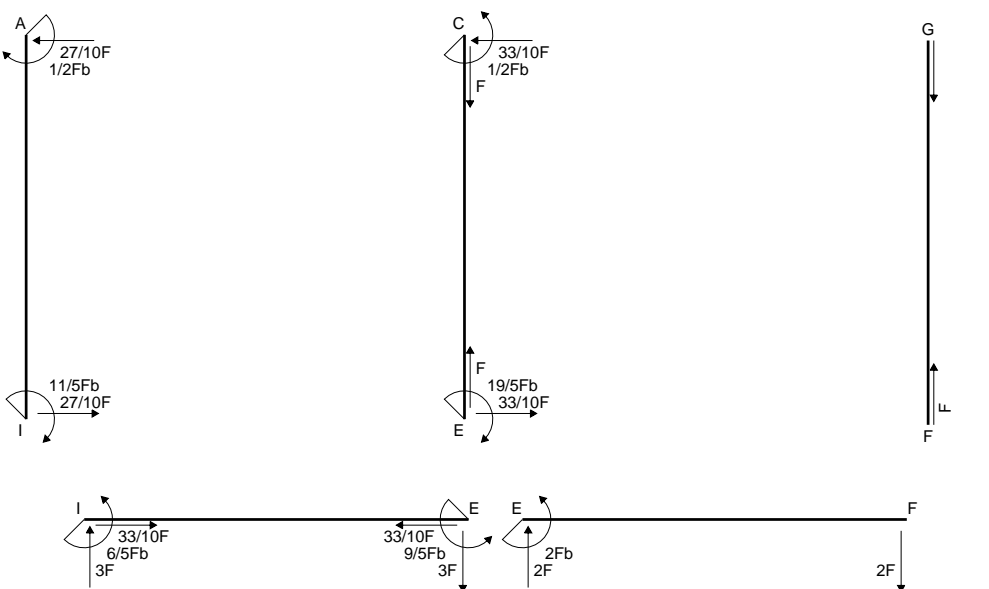
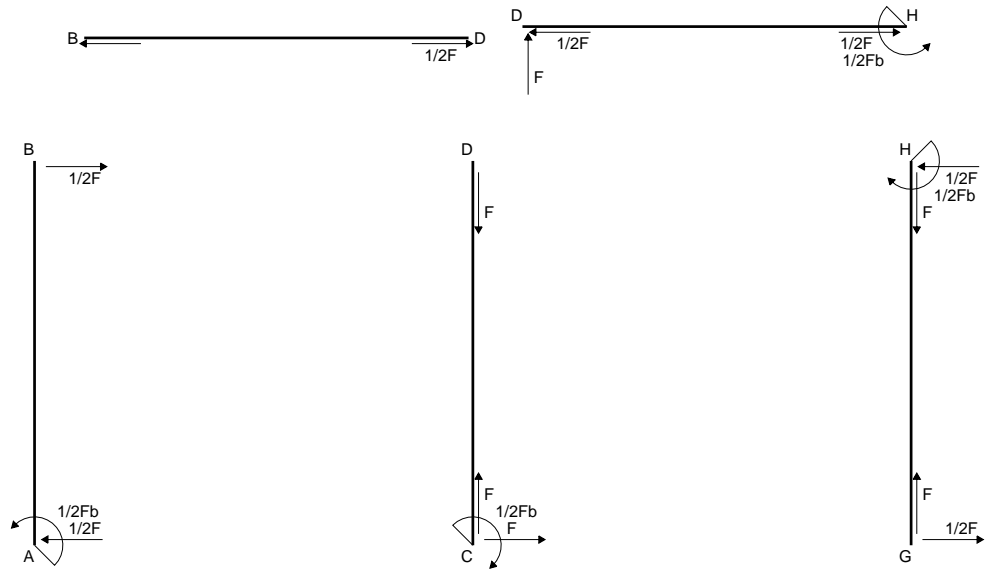
$$= (b - 3/4 b + 1/6 b) Fb \frac{1}{EJ} = 5/12 Fb^2/EJ$$

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

$$= (1/4 b + 1/6 b) Fb \frac{1}{EJ} = 5/12 Fb^2/EJ$$

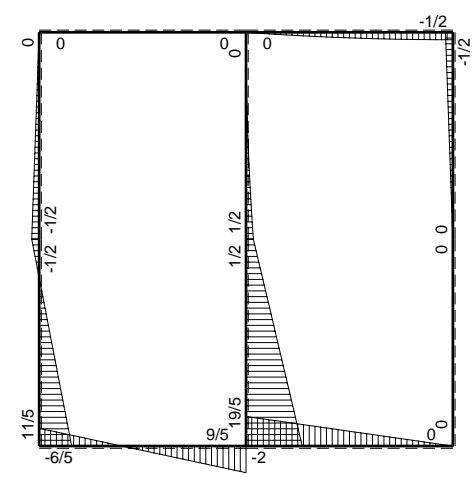


- A = 882. mm²
- J_u = 250944. mm⁴
- J_v = 38340. mm⁴
- y_g = 28.37 mm
- T_y = 2120. N
- M_x = -1929200. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.37 mm
- σ_m = -Mv/J_u = -218.1 N/mm²
- x_c = 18. mm
- y_c = 9. mm
- v_c = -19.37 mm
- σ_c = -Mv/J_u = -148.9 N/mm²
- τ_c = 3.101 N/mm²
- σ_q = √σ²+3τ² = 149. N/mm²
- S = 4405. mm³

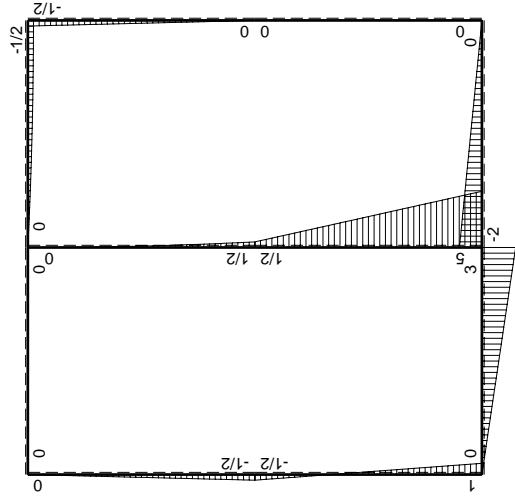
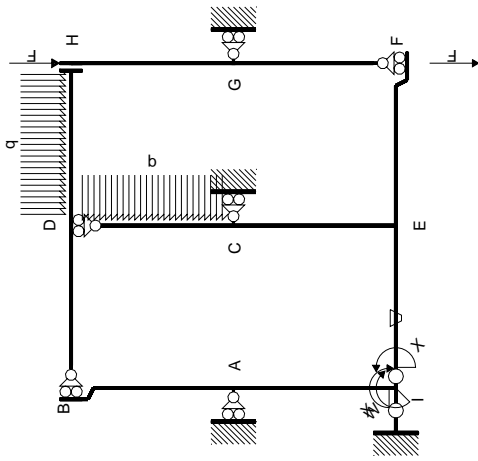


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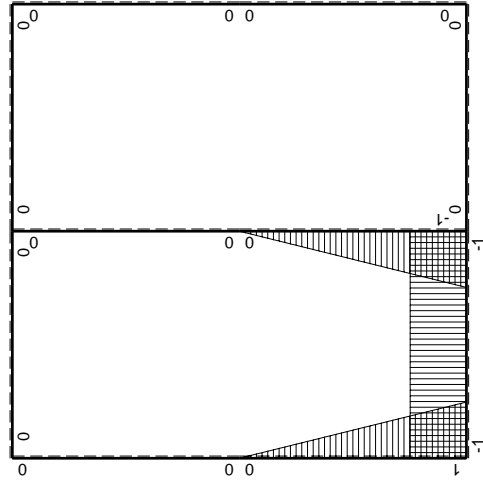


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$-1/2qx^2$	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0			
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
DH b	0	$Fx-1/2qx^2$	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1			
EC b	$-1+x/b$	$5Fb-9/2Fx$	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2			
	totali							$-2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$6/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 19/2 x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 19/4 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 19/4 b - 3/2 b) Fb \frac{1}{EJ} = -7/4 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

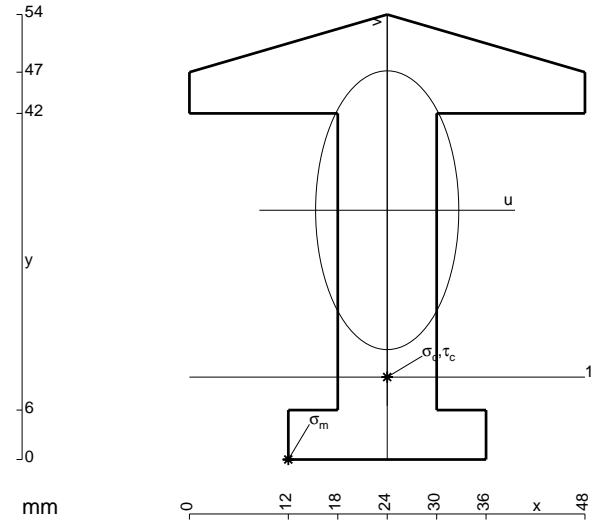
$$= (-1/4 b - 3/2 b) Fb \frac{1}{EJ} = -7/4 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (1 - 5/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [x - 5/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

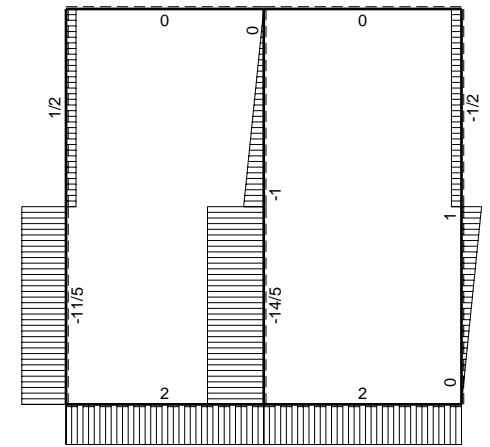
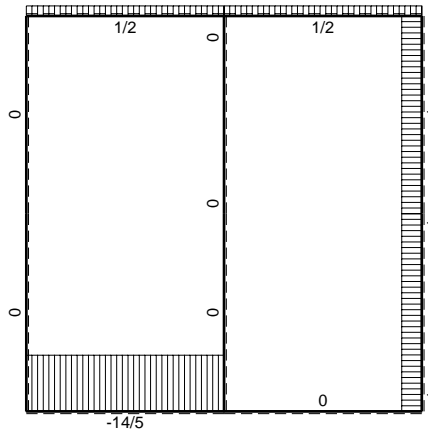
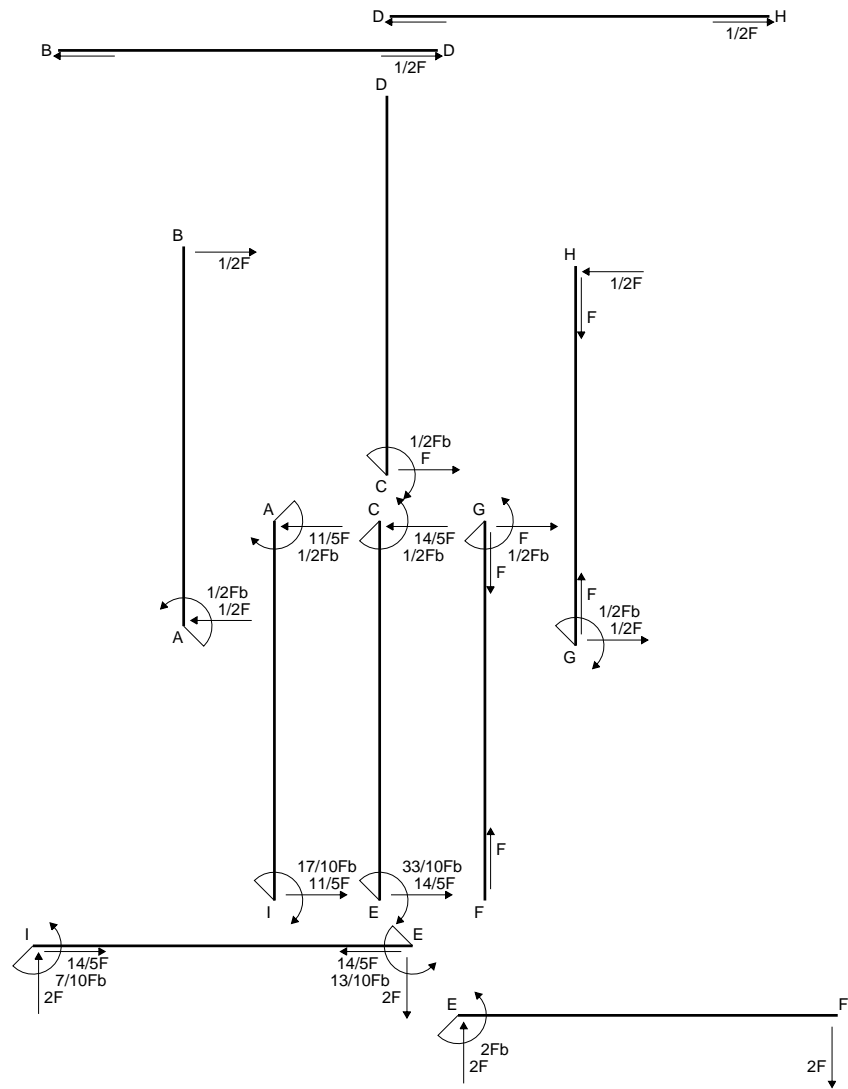
$$= (b - 5/4 b + 1/2 b) Fb \frac{1}{EJ} = 1/4 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/2 b) Fb \frac{1}{EJ} = 1/4 Fb^2/EJ$$

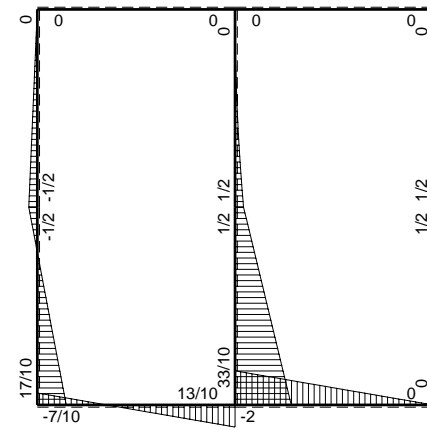


- A = 984. mm²
- J_u = 281765. mm⁴
- J_v = 74304. mm⁴
- y_g = 30.25 mm
- T_y = 2200. N
- M_x = -2134000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.25 mm
- σ_m = -Mv/J_u = -229.1 N/mm²
- x_c = 24. mm
- y_c = 10. mm
- v_c = -20.25 mm
- σ_c = -Mv/J_u = -153.4 N/mm²
- τ_c = 3.248 N/mm²
- σ_o = √σ²+3τ² = 153.5 N/mm²
- S = 4992. mm³

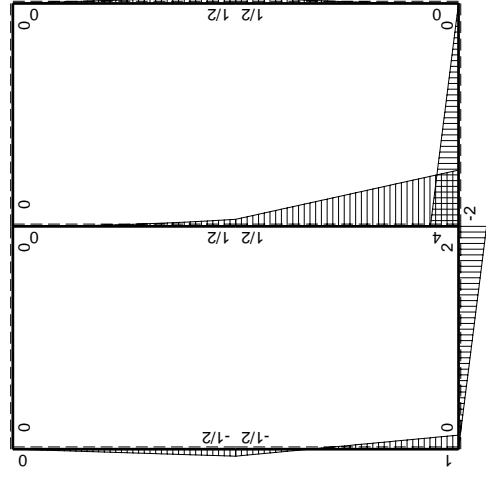
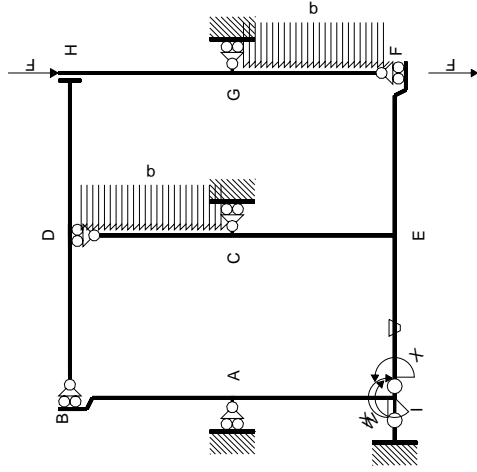


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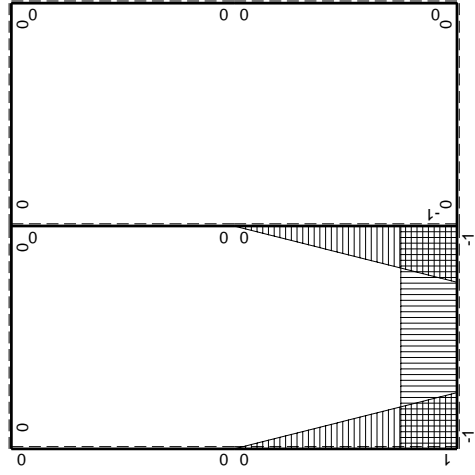


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-7/2Fx$	0	$-4Fb+15/2Fx-7/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-17/12+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-7/2Fx$	0	$-1/2Fx-7/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$Fb-3/2Fx$	0	$Fb-5/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-3/2Fx$	0	$-1/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-7/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-b) Fb \frac{1}{EJ} + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-2b + b) Fb \frac{1}{EJ} + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 15/2 x/b - 7/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-4x + 15/4 x^2/b - 7/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-4b + 15/4 b - 7/6 b) Fb \frac{1}{EJ} = -17/12 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 7/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b - 7/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

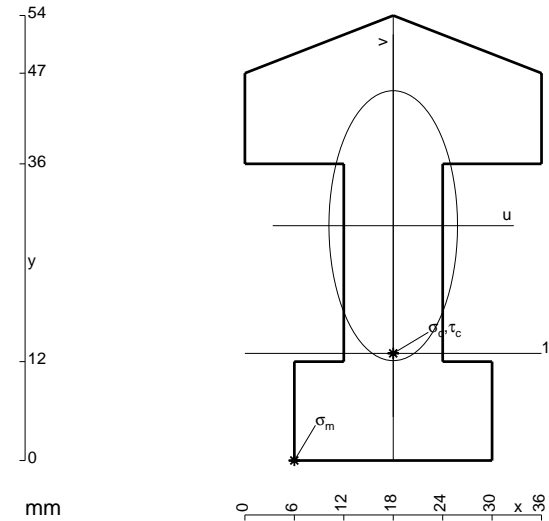
$$= (-1/4 b - 7/6 b) Fb \frac{1}{EJ} = -17/12 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (1 - 5/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [x - 5/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

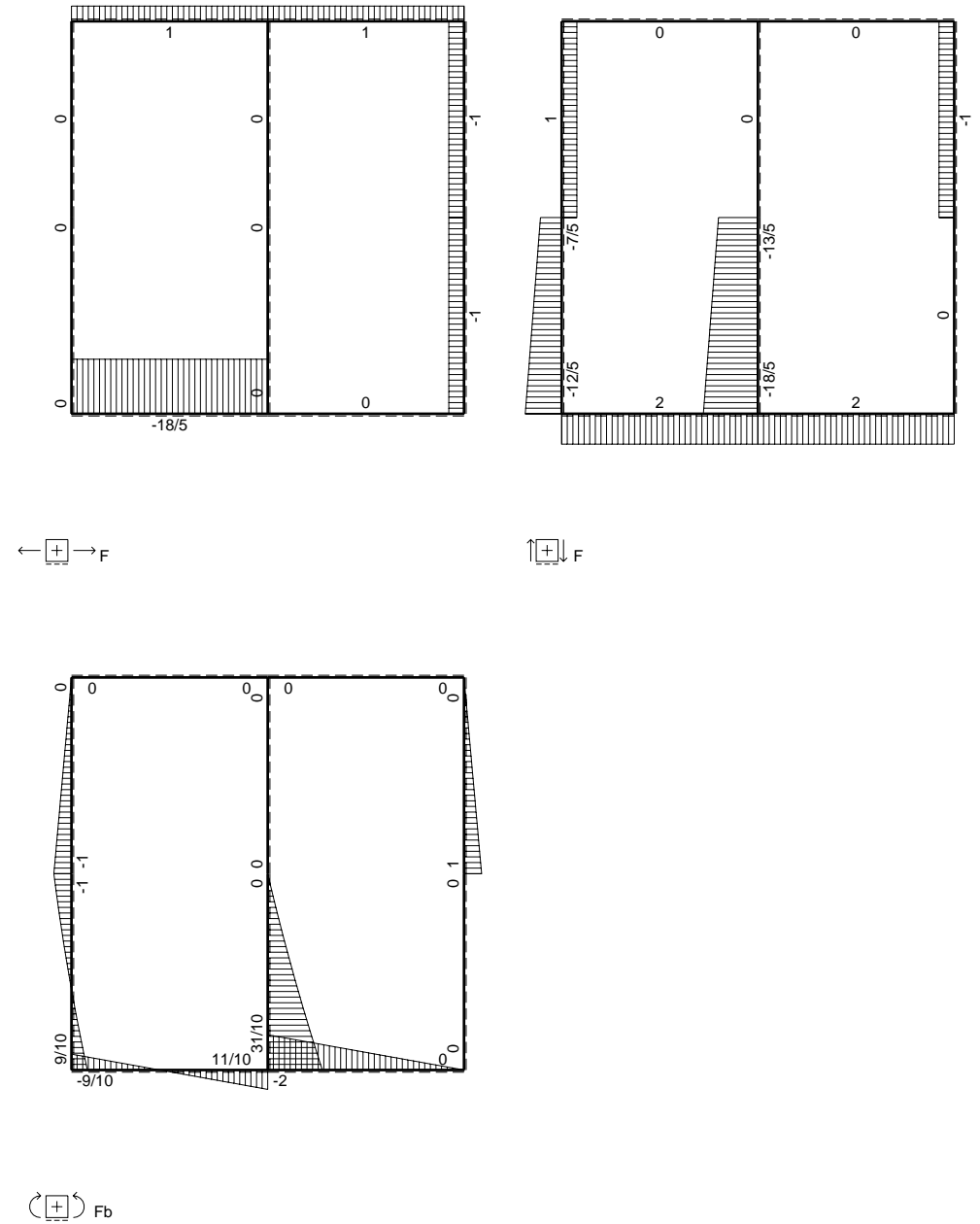
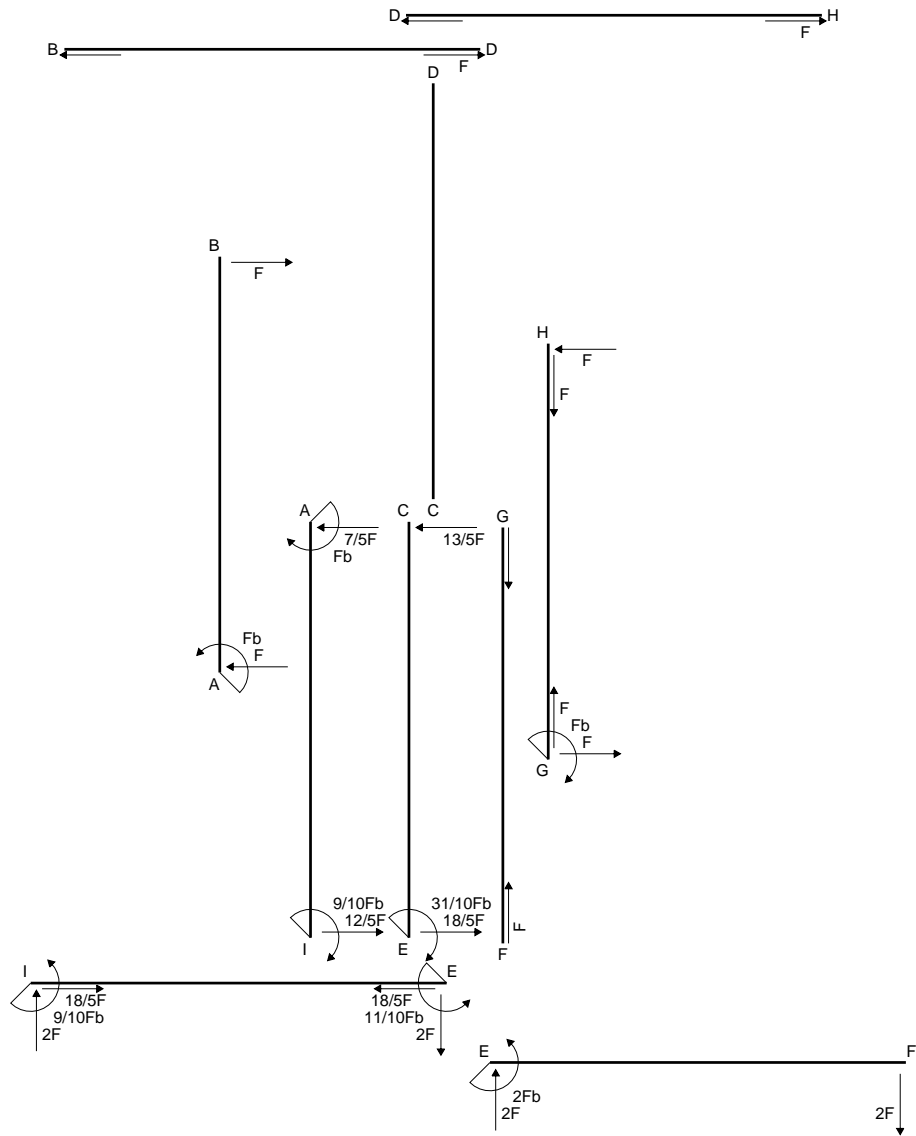
$$= (b - 5/4 b + 1/2 b) Fb \frac{1}{EJ} = 1/4 Fb^2/EJ$$

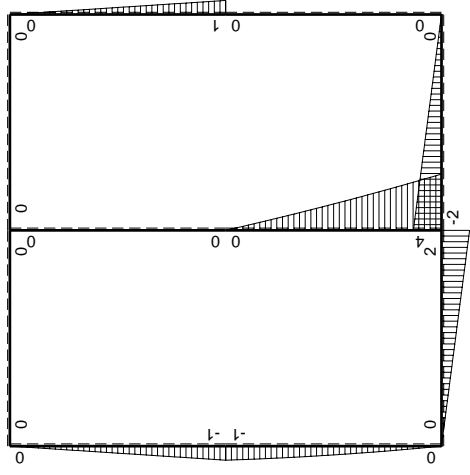
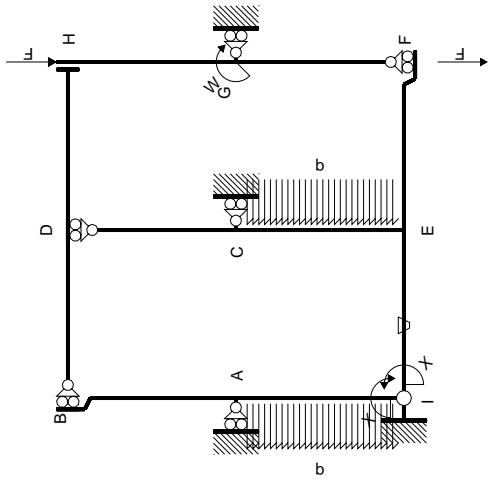
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/2 b) Fb \frac{1}{EJ} = 1/4 Fb^2/EJ$$



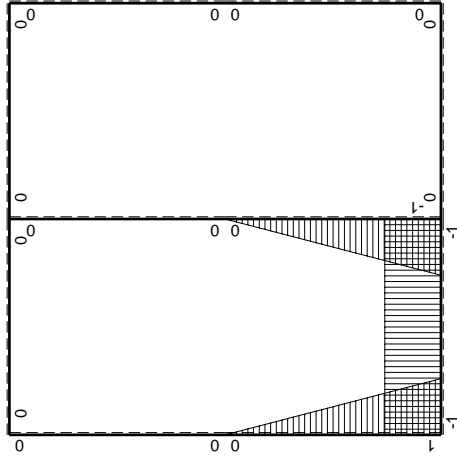
- A = 1098. mm²
- J_u = 294859. mm⁴
- J_v = 66852. mm⁴
- y_g = 28.5 mm
- T_y = 2420. N
- M_x = -2468400. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.5 mm
- σ_m = -Mv/J_u = -238.6 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.5 mm
- σ_c = -Mv/J_u = -129.7 N/mm²
- τ_c = 4.563 N/mm²
- σ_q = √(σ² + 3τ²) = 130. N/mm²
- S = 6671. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-9/2Fx+1/2qx^2$	0	$-4Fb+17/2Fx-5Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-31/24+0)Fb^2/EJ$	1/3Xb/EJ
CE b	x/b	$-7/2Fx-1/2qx^2$	0	$-7/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	$1-x/b$	$-3/2Fx+1/2qx^2$	0	$-3/2Fx+2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-5/24+0)Fb^2/EJ$	1/3Xb/EJ
AI b	$-x/b$	$Fb-1/2Fx-1/2qx^2$	0	$-Fx+1/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$						9/10Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 17/2 x/b - 5x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx$$

$$= [-4x + 17/4 x^2/b - 5/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-4b + 17/4 b - 5/3 b + 1/8 b) Fb 1/EJ = -31/24 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-7/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [-7/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

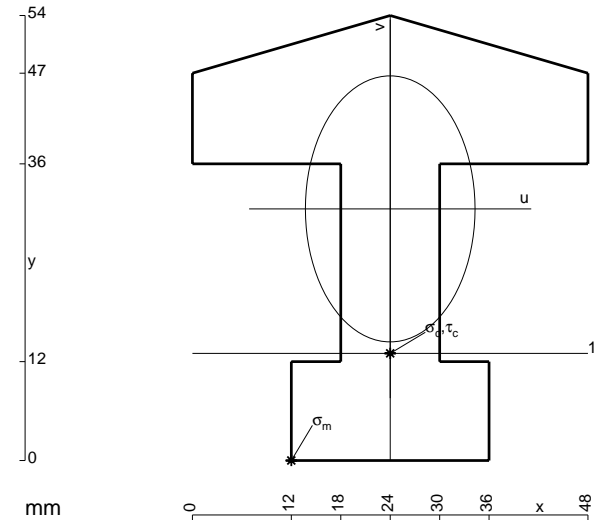
$$= (-7/6 b - 1/8 b) Fb 1/EJ = -31/24 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-3/2 x/b + 2x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [-3/4 x^2/b + 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

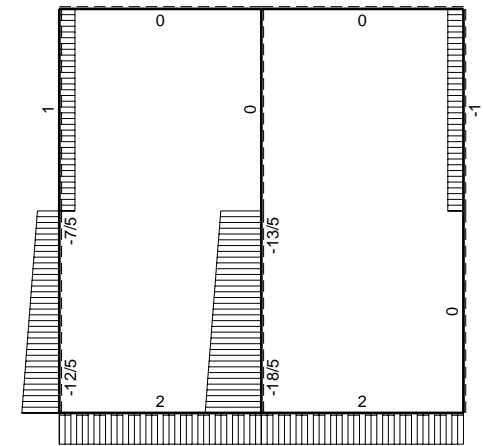
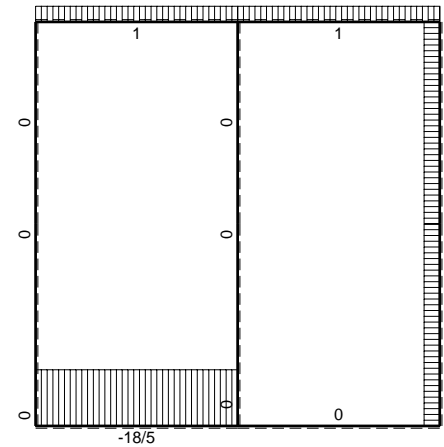
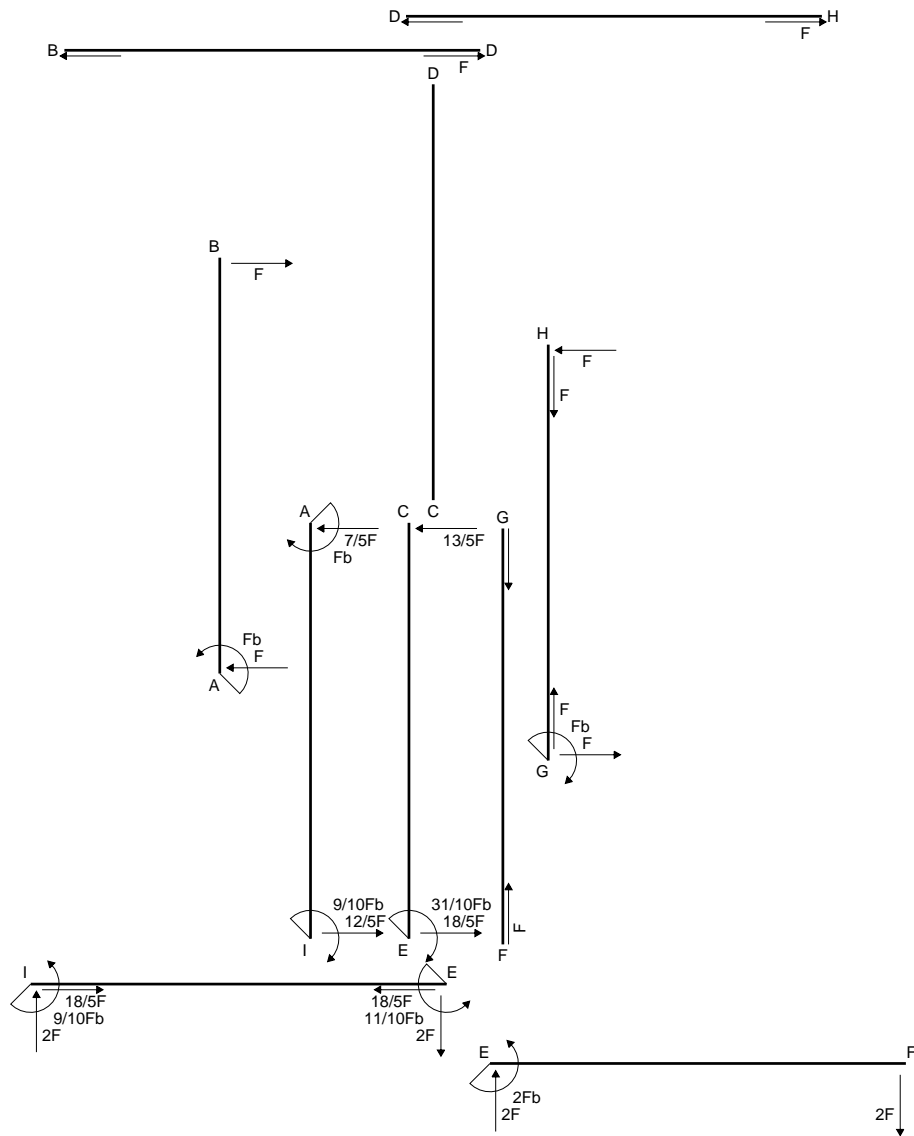
$$= (-3/4 b + 2/3 b - 1/8 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + 1/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [-1/2 x^2/b + 1/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/6 b + 1/8 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

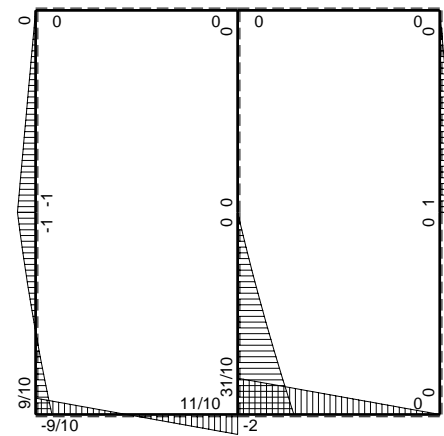


- A = 1272. mm²
- J_u = 331576. mm⁴
- J_v = 134784. mm⁴
- y_g = 30.53 mm
- T_y = 4020. N
- M_x = -2170800. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.53 mm
- σ_m = -Mv/J_u = -199.9 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -17.53 mm
- σ_c = -Mv/J_u = -114.8 N/mm²
- τ_c = 7.358 N/mm²
- σ_o = √σ²+3τ² = 115.5 N/mm²
- S = 7282. mm³

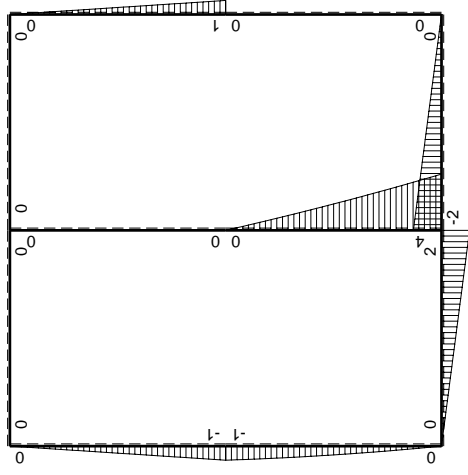
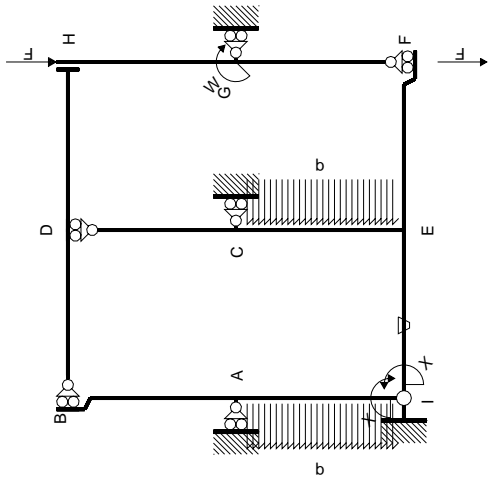


← ⊕ → F

↑ ⊕ ↓ F

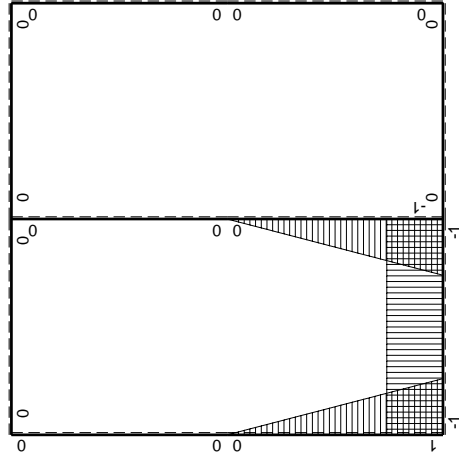


⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	0	-Fb+Fx	0	0	0	0	0+0	0	
BA b	0	Fx	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	Fb-Fx	0	0	0	0	0+0	0	
HG b	0	-Fx	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ	
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1			
EC b	$-1+x/b$	$4Fb-9/2Fx+1/2qx^2$	0	$-4Fb+17/2Fx-5Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-31/24+0)Fb^2/EJ$	1/3Xb/EJ	
CE b	x/b	$-7/2Fx-1/2qx^2$	0	$-7/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2			
IA b	$1-x/b$	$-3/2Fx+1/2qx^2$	0	$-3/2Fx+2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-5/24+0)Fb^2/EJ$	1/3Xb/EJ	
AI b	$-x/b$	$Fb-1/2Fx-1/2qx^2$	0	$-Fx+1/2Fx^2/b+1/2qx^3/b$	0	x^2/b^2			
	totali							$-3/2Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$							9/10Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 17/2 x/b - 5x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx$$

$$= [-4x + 17/4 x^2/b - 5/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-4b + 17/4 b - 5/3 b + 1/8 b) Fb 1/EJ = -31/24 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-7/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [-7/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

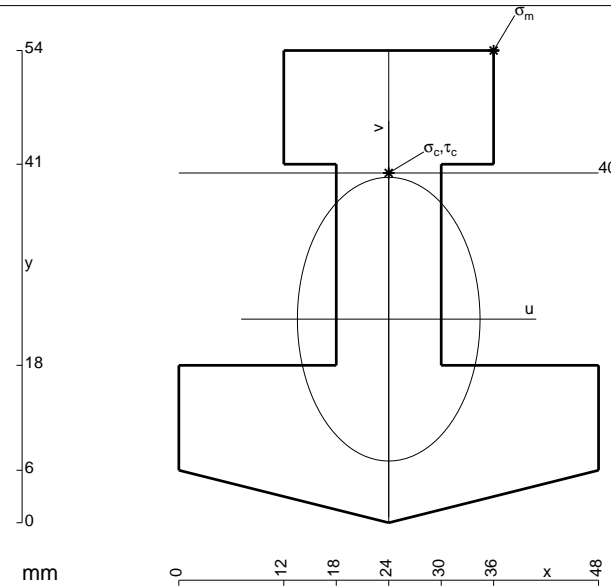
$$= (-7/6 b - 1/8 b) Fb 1/EJ = -31/24 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-3/2 x/b + 2x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [-3/4 x^2/b + 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

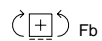
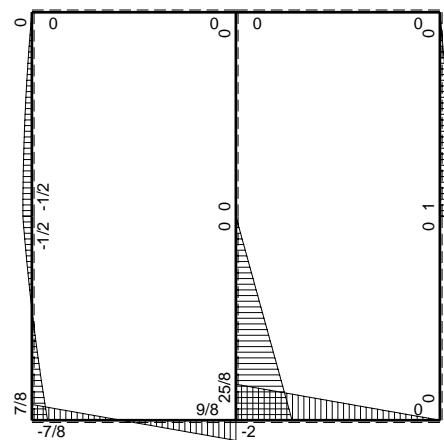
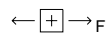
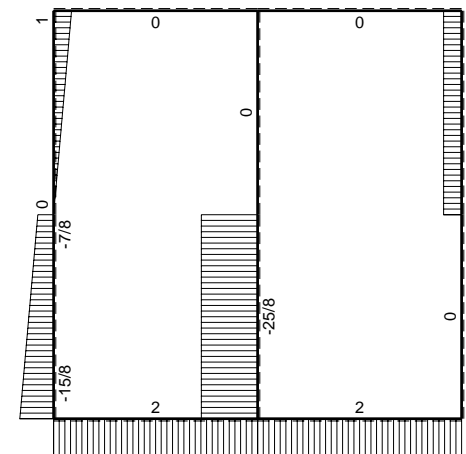
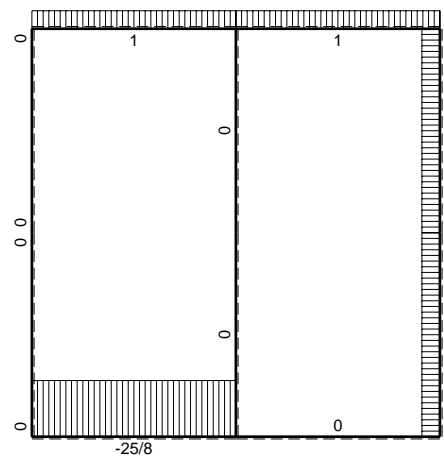
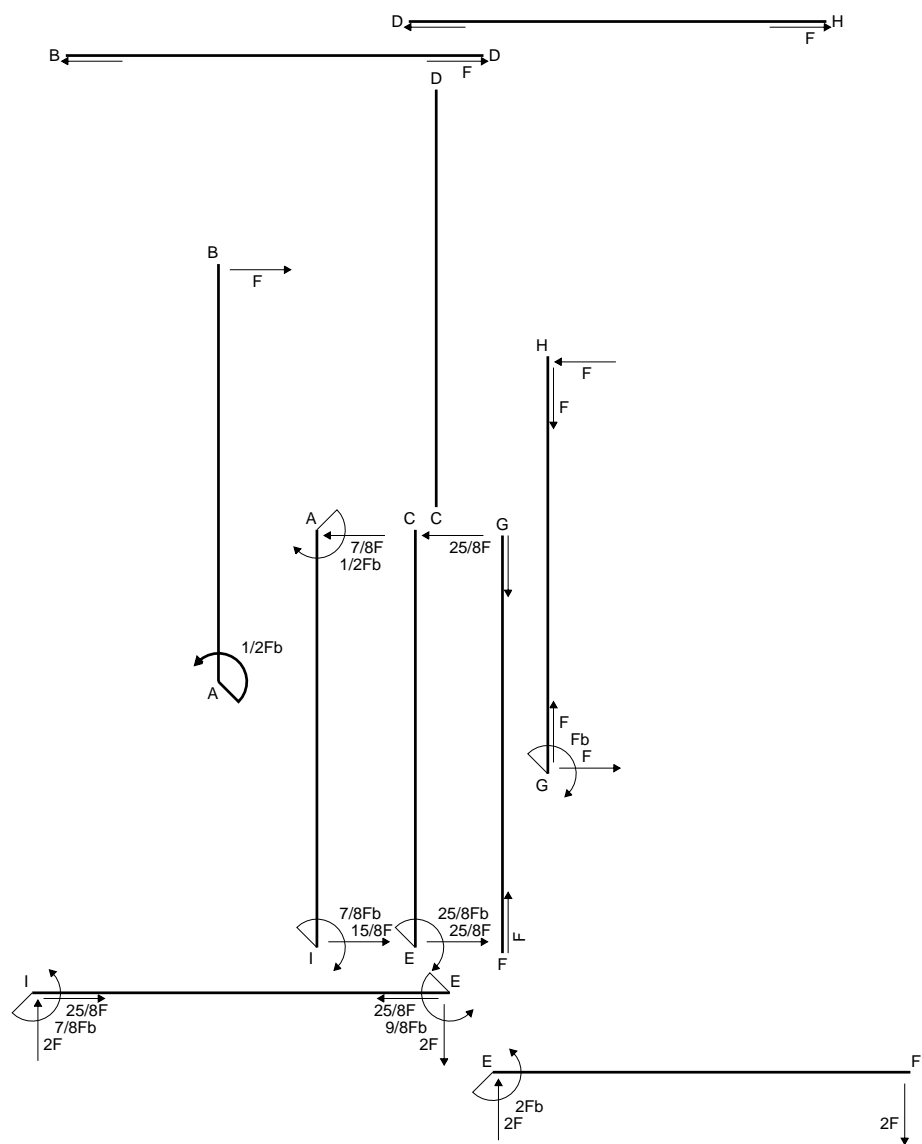
$$= (-3/4 b + 2/3 b - 1/8 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

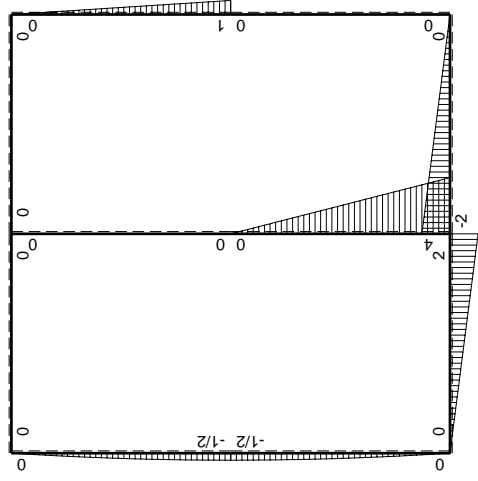
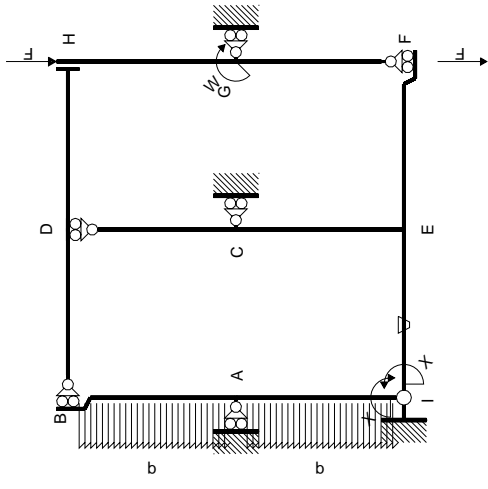
$$L_{AI}^{xo} = \int_0^b (-x/b + 1/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [-1/2 x^2/b + 1/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/6 b + 1/8 b) Fb 1/EJ = -5/24 Fb^2/EJ$$



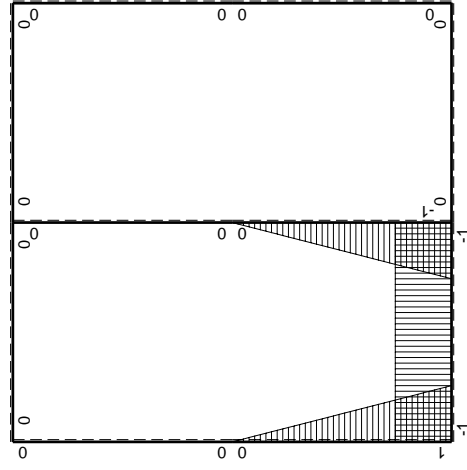
- A = 1308. mm²
- J_u = 344278. mm⁴
- J_v = 142704. mm⁴
- y_g = 23.28 mm
- T_y = 3980. N
- M_x = -2348200. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 30.72 mm
- σ_m = -Mv/J_u = 209.5 N/mm²
- x_c = 24. mm
- y_c = 40. mm
- v_c = 16.72 mm
- σ_c = -Mv/J_u = 114. N/mm²
- τ_c = 7.479 N/mm²
- σ_q = √σ²+3τ² = 114.8 N/mm²
- S = 7763. mm³





Schema di calcolo iperstatico

M_0 flexione da carichi assegnati



M_x flexione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$-Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2qx^2$	0	$-1/2Fx+1/2qx^3/b$	0	x^2/b^2		
	totali						$-35/24Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{x_0} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{x_0} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{x_0} = \int_0^b (-4 + 8x/b - 4x^2/b^2) Fb 1/EJ dx = [-4x + 4x^2/b - 4/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-4b + 4b - 4/3 b) Fb 1/EJ = -4/3 Fb^2/EJ$$

$$L_{CE}^{x_0} = \int_0^b (-4x^2/b^2) Fb 1/EJ dx = [-4/3 x^3/b^2]_0^b Fb 1/EJ$$

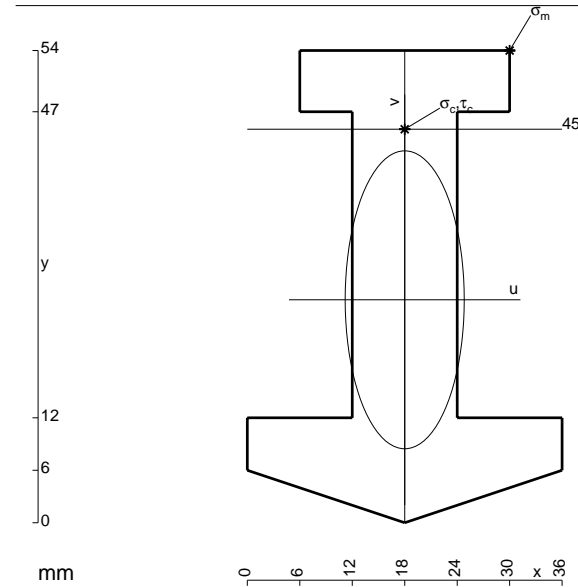
$$= (-4/3 b) Fb 1/EJ = -4/3 Fb^2/EJ$$

$$L_{IA}^{x_0} = \int_0^b (-x/b + 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [-1/2 x^2/b + 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

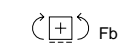
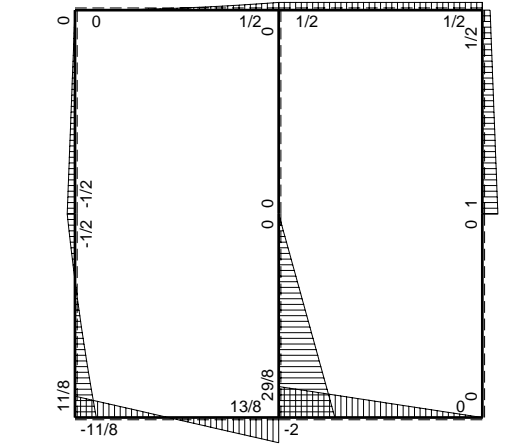
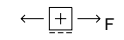
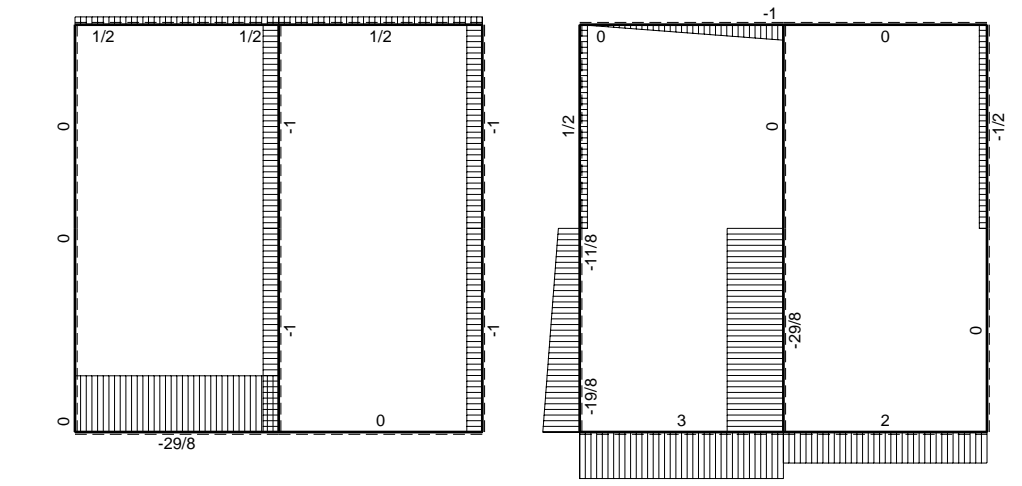
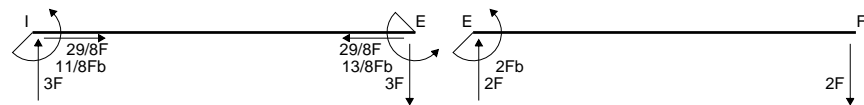
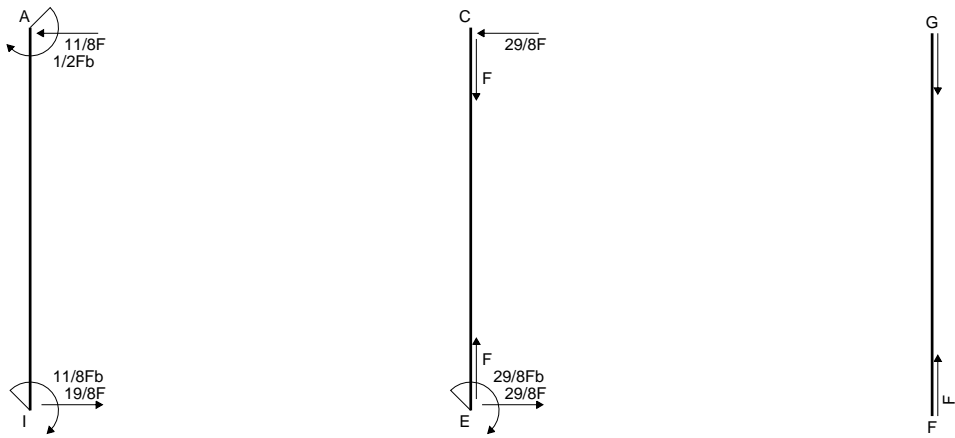
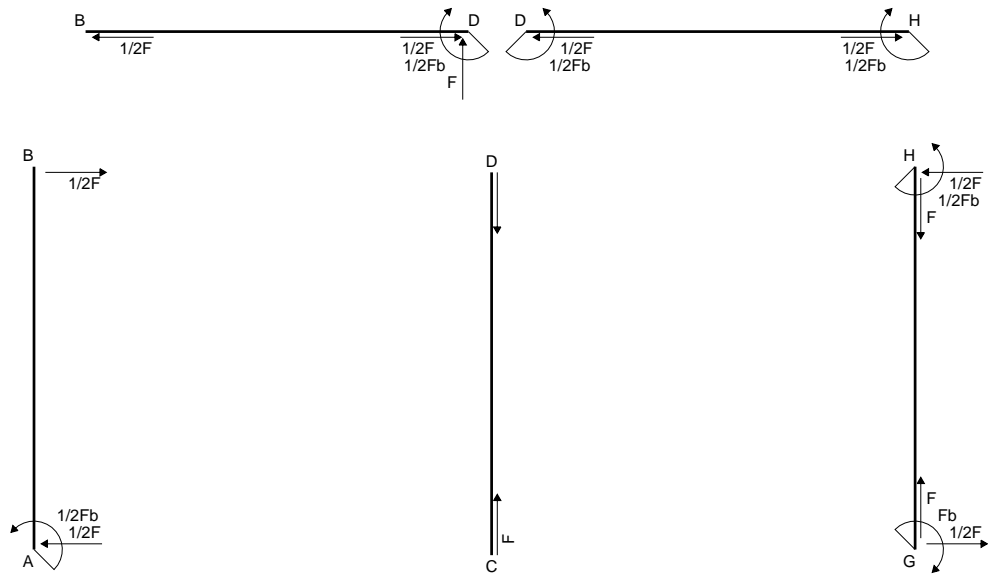
$$= (-1/2 b + 1/2 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

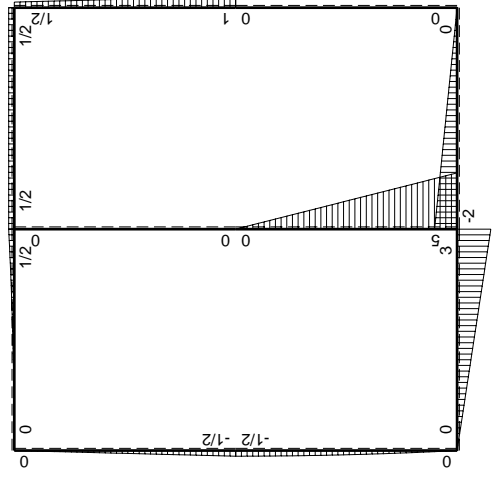
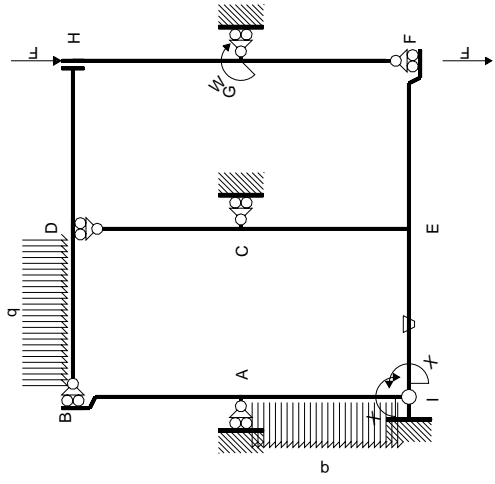
$$L_{AI}^{x_0} = \int_0^b (-1/2 x/b + 1/2 x^3/b^3) Fb 1/EJ dx = [-1/4 x^2/b + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$



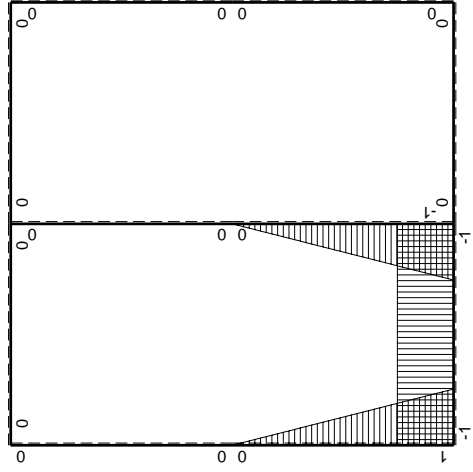
- A = 912. mm²
- J_u = 264874. mm⁴
- J_v = 42264. mm⁴
- y_g = 25.49 mm
- T_y = 3180. N
- M_x = -2035200. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 28.51 mm
- σ_m = -Mv/J_u = 219. N/mm²
- x_c = 18. mm
- y_c = 45. mm
- v_c = 19.51 mm
- σ_c = -Mv/J_u = 149.9 N/mm²
- τ_c = 4.695 N/mm²
- σ_q = √σ²+3τ² = 150.1 N/mm²
- S = 4693. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0	
BA b	0	1/2Fx	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	Fb-1/2Fx	0	0	0	0	0+0	0	
HG b	0	-1/2Fb-1/2Fx	0	0	0	0			
HD b	0	1/2Fb	0	0	0	0	0+0	0	
DH b	0	-1/2Fb	0	0	0	0			
DB b	0	1/2Fb-Fx+1/2qx ²	0	0	0	0	0+0	0	
BD b	0	-1/2qx ²	0	0	0	0			
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	(-3/2+1)Fb ² /EJ	Xb/EJ	
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1			
EC b	-1+x/b	5Fb-5Fx	0	-5Fb+10Fx-5Fx ² /b	0	1-2x/b+x ² /b ²	(-5/3+0)Fb ² /EJ	1/3Xb/EJ	
CE b	x/b	-5Fx	0	-5Fx ² /b	0	x ² /b ²			
IA b	1-x/b	-Fx+1/2qx ²	0	-Fx+3/2Fx ² /b-1/2qx ³ /b	0	1-2x/b+x ² /b ²	(-1/8+0)Fb ² /EJ	1/3Xb/EJ	
AI b	-x/b	1/2Fb-1/2qx ²	0	-1/2Fx+1/2qx ³ /b	0	x ² /b ²			
	totali							-55/24Fb ² /EJ	5/3Xb/EJ
	iperstatica $X=W_{IE}$							11/8Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

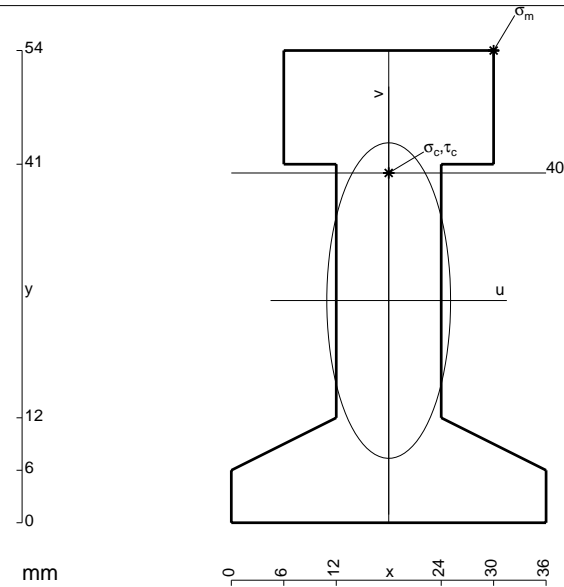
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [-1/2 x^2/b + 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/2 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^3/b^3) Fb 1/EJ dx = [-1/4 x^2/b + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$



$$A = 1020. \text{ mm}^2$$

$$J_u = 332140. \text{ mm}^4$$

$$J_v = 51120. \text{ mm}^4$$

$$y_g = 25.41 \text{ mm}$$

$$T_y = 3800. \text{ N}$$

$$M_x = -2660000. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 54. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 28.59 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 229. \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

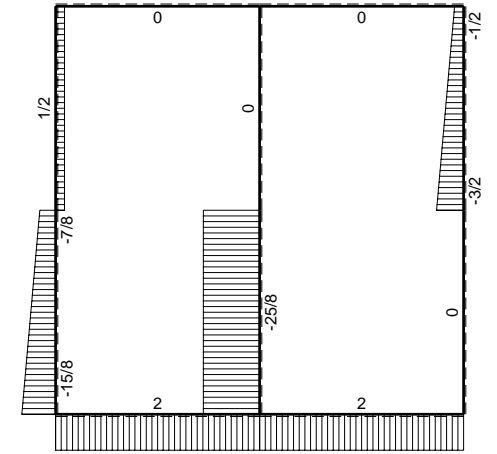
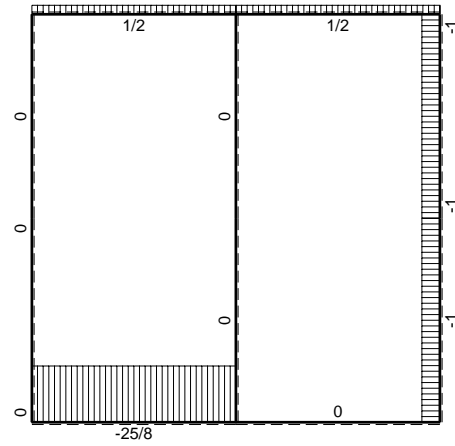
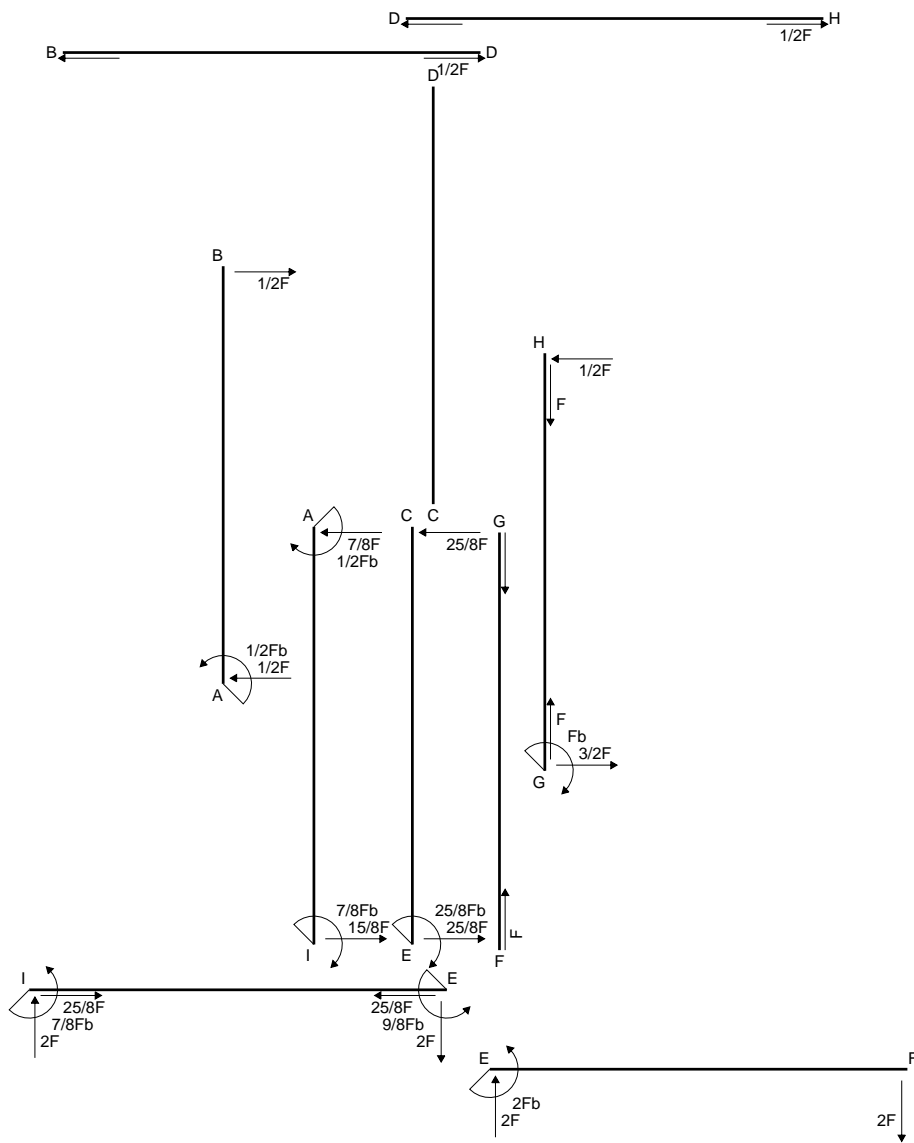
$$v_c = 14.59 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 116.9 \text{ N/mm}^2$$

$$\tau_c = 6.745 \text{ N/mm}^2$$

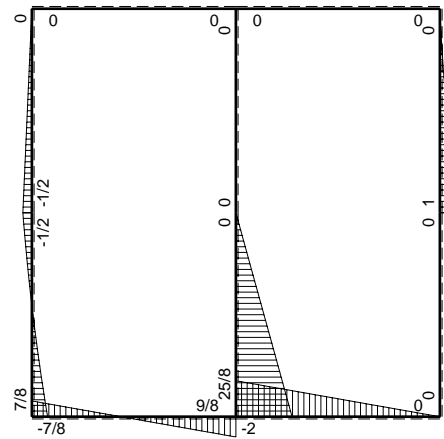
$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 117.5 \text{ N/mm}^2$$

$$S = 7074. \text{ mm}^3$$

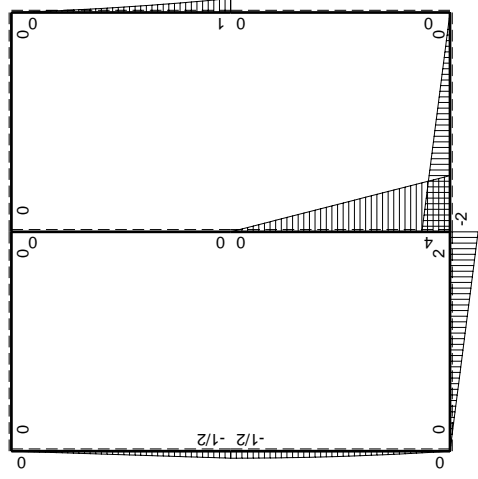
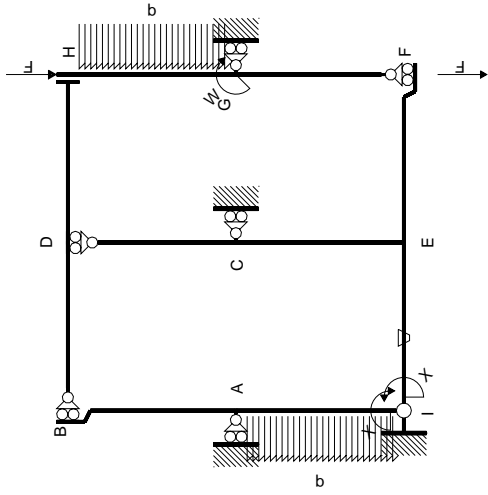


← ⊕ → F

↑ ⊕ ↓ F

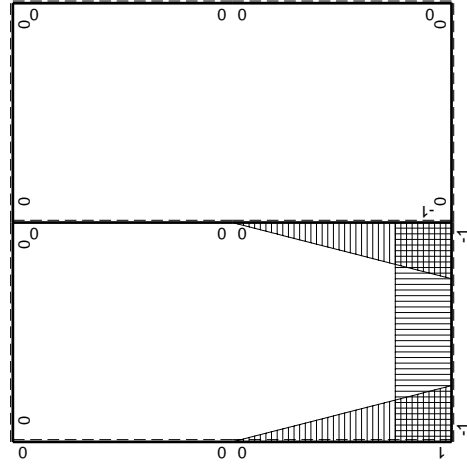


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2qx^2$	0	$-1/2Fx+1/2qx^3/b$	0	x^2/b^2		
	totali						$-35/24Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-b) Fb \frac{1}{EJ} + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-2b + b) Fb \frac{1}{EJ} + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 8x/b - 4x^2/b^2) Fb \frac{1}{EJ} dx = [-4x + 4x^2/b - 4/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-4b + 4b - 4/3 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-4x^2/b^2) Fb \frac{1}{EJ} dx = [-4/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

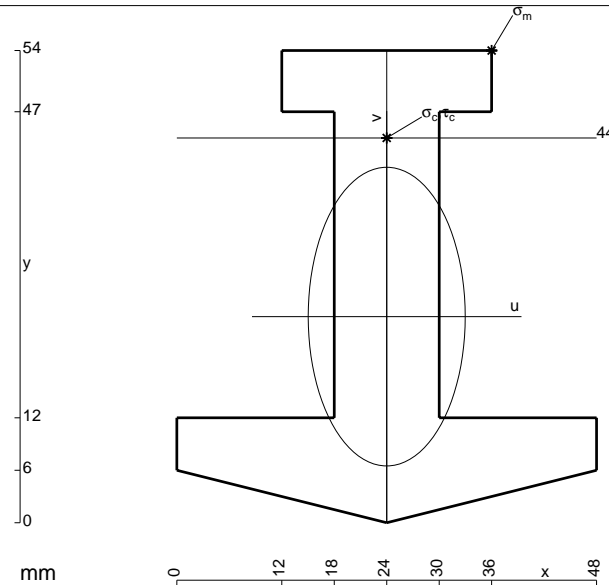
$$= (-4/3 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb \frac{1}{EJ}$$

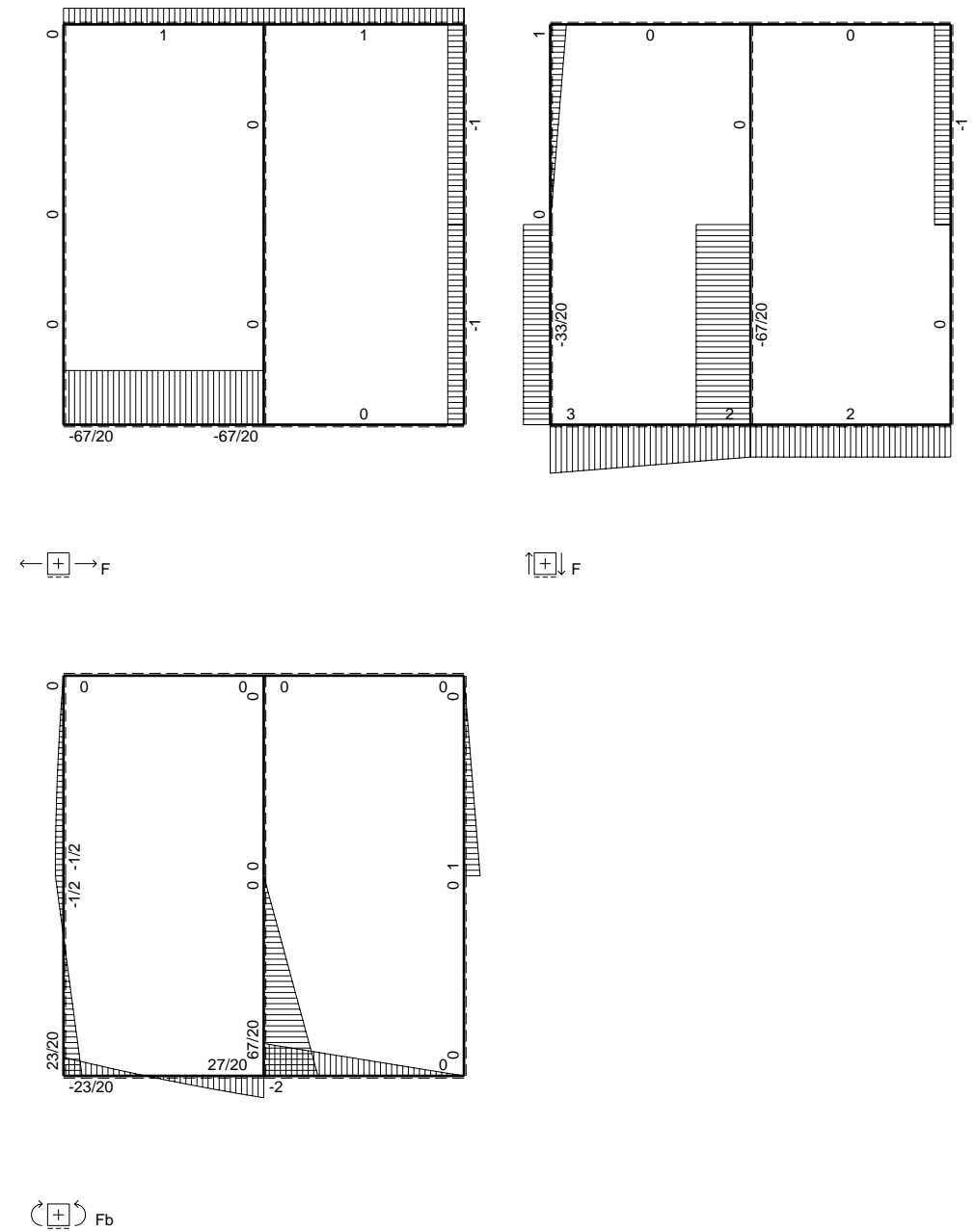
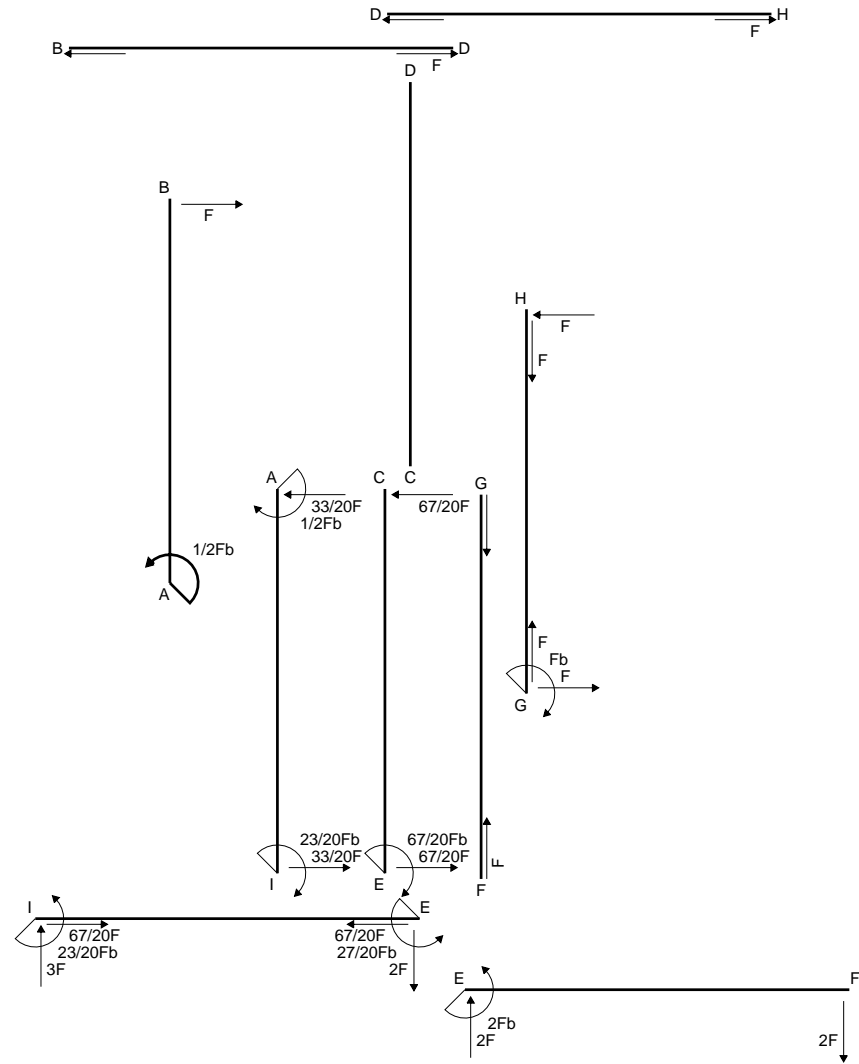
$$= (-1/2 b + 1/2 b - 1/8 b) Fb \frac{1}{EJ} = -1/8 Fb^2/EJ$$

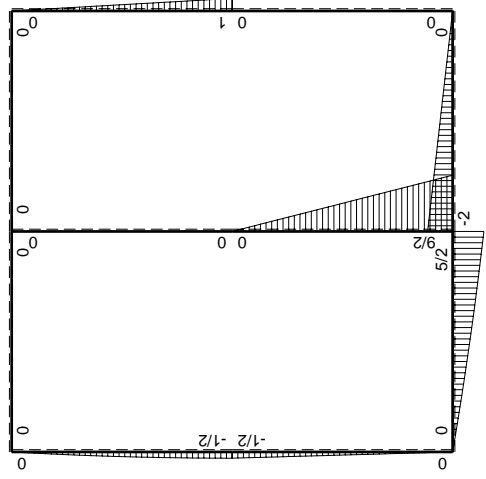
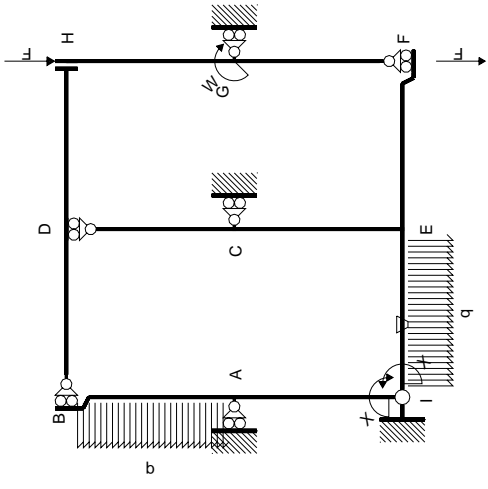
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/8 x^4/b^3]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/8 b) Fb \frac{1}{EJ} = -1/8 Fb^2/EJ$$



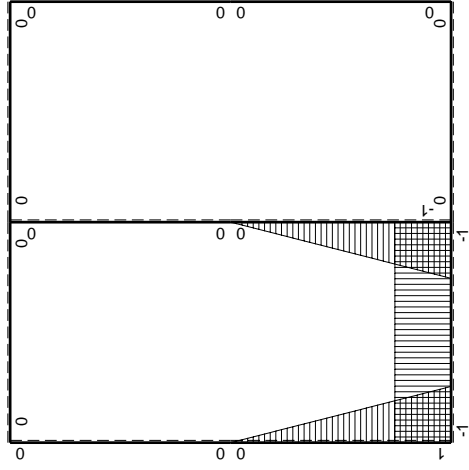
- A = 1020. mm²
- J_u = 297608. mm⁴
- J_v = 82224. mm⁴
- y_g = 23.57 mm
- T_y = 3120. N
- M_x = -2340000. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 30.43 mm
- σ_m = -Mv/J_u = 239.3 N/mm²
- x_c = 24. mm
- y_c = 44. mm
- v_c = 20.43 mm
- σ_c = -Mv/J_u = 160.6 N/mm²
- τ_c = 4.642 N/mm²
- σ_q = √σ²+3τ² = 160.8 N/mm²
- S = 5314. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$-Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$9/2Fb-9/2Fx$	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-9/2Fx$	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-23/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$23/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -1/3 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-5/2 + 2x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-5/2 b + b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -1/3 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-9/2 + 9x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-9/2 x + 9/2 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-9/2 b + 9/2 b - 3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

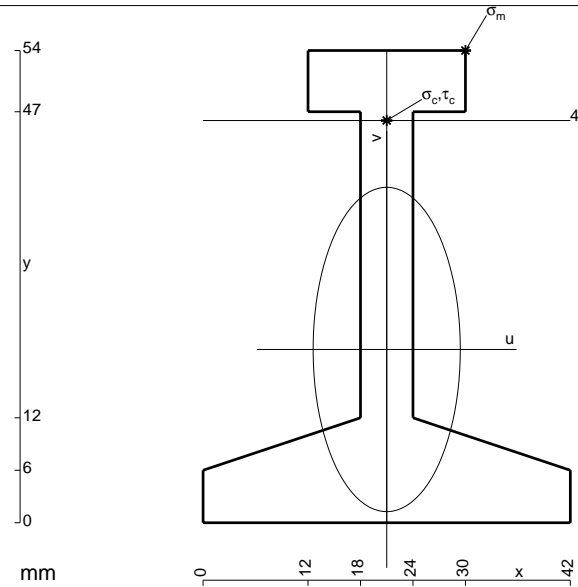
$$= (-3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

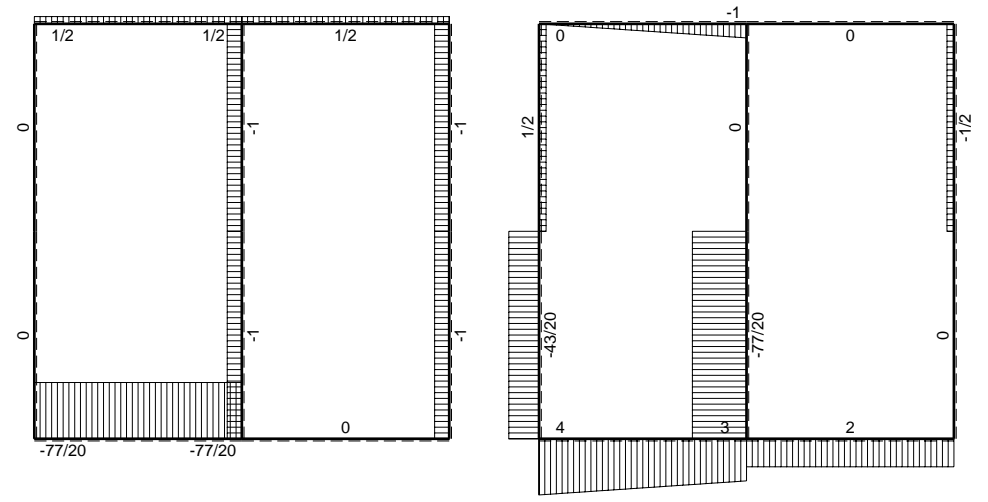
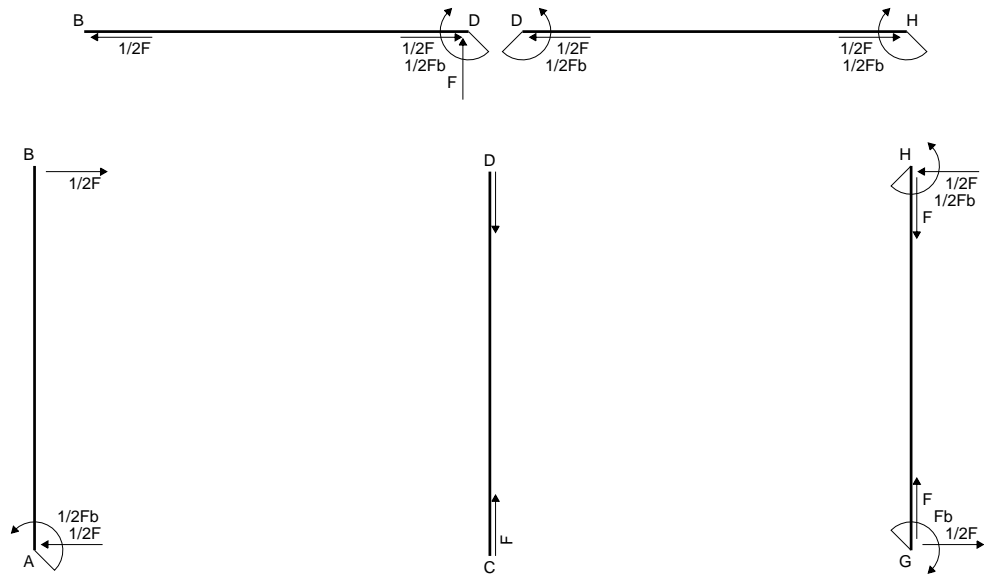
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

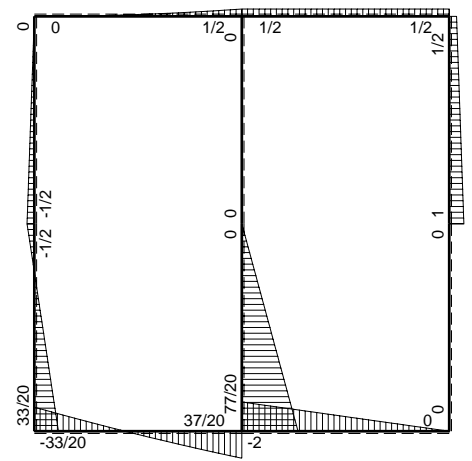
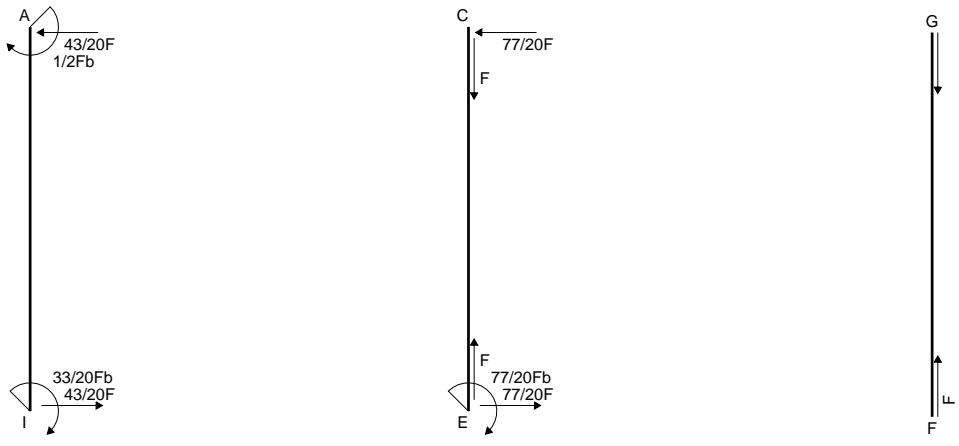


- A = 732. mm²
- J_u = 251906. mm⁴
- J_v = 51876. mm⁴
- y_g = 19.81 mm
- T_y = 1800. N
- M_x = -1458000. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 9. mm
- v_m = 34.19 mm
- σ_m = -Mv/J_u = 197.9 N/mm²
- x_c = 21. mm
- y_c = 46. mm
- v_c = 26.19 mm
- σ_c = -Mv/J_u = 151.6 N/mm²
- τ_c = 4.796 N/mm²
- σ_q = √σ²+3τ² = 151.8 N/mm²
- S = 4027. mm³

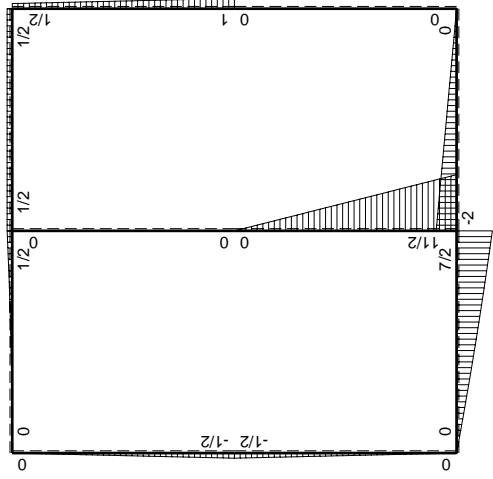
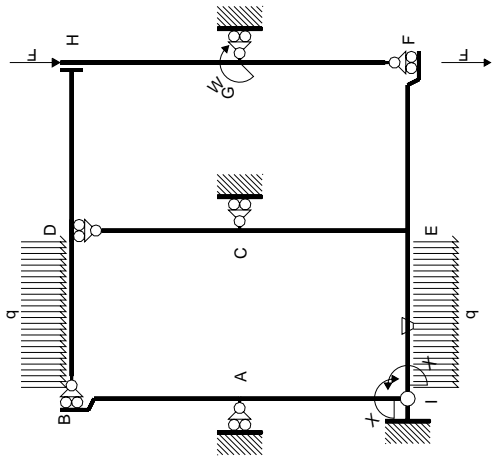


← ⊕ → F

↑ ⊕ ↓ F

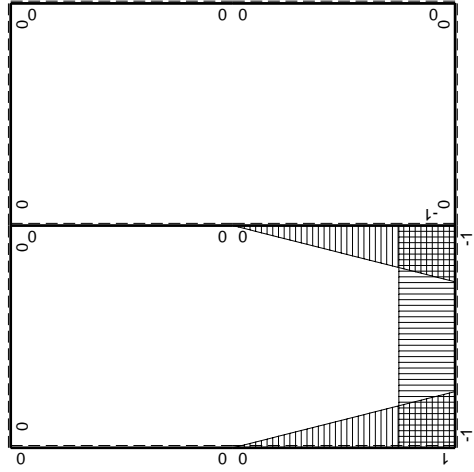


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$33/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

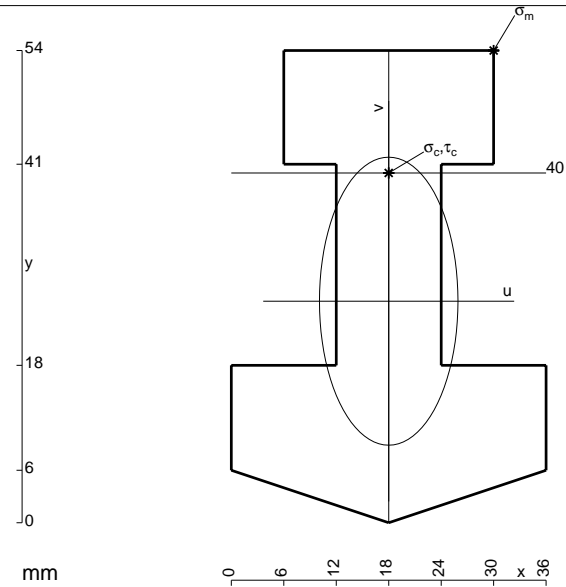
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

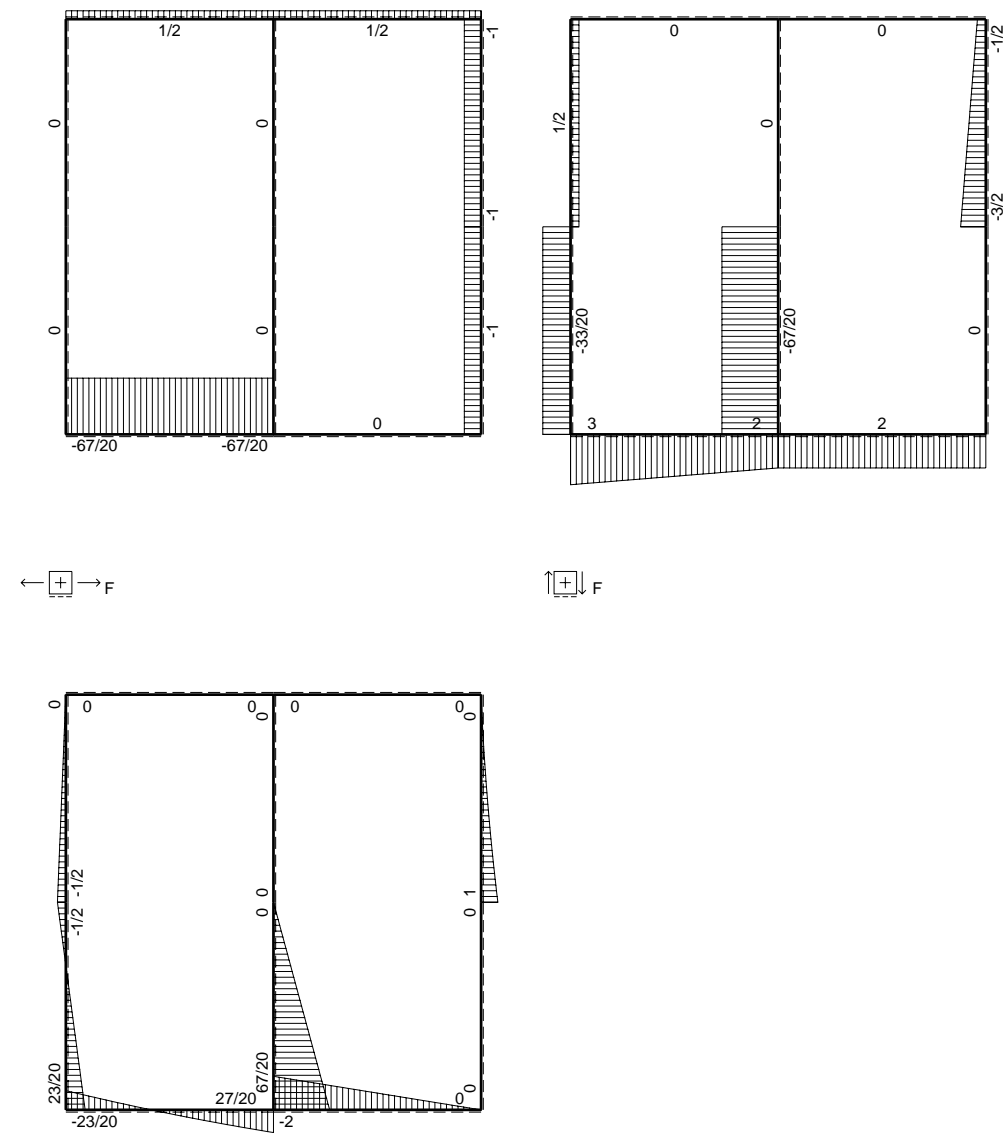
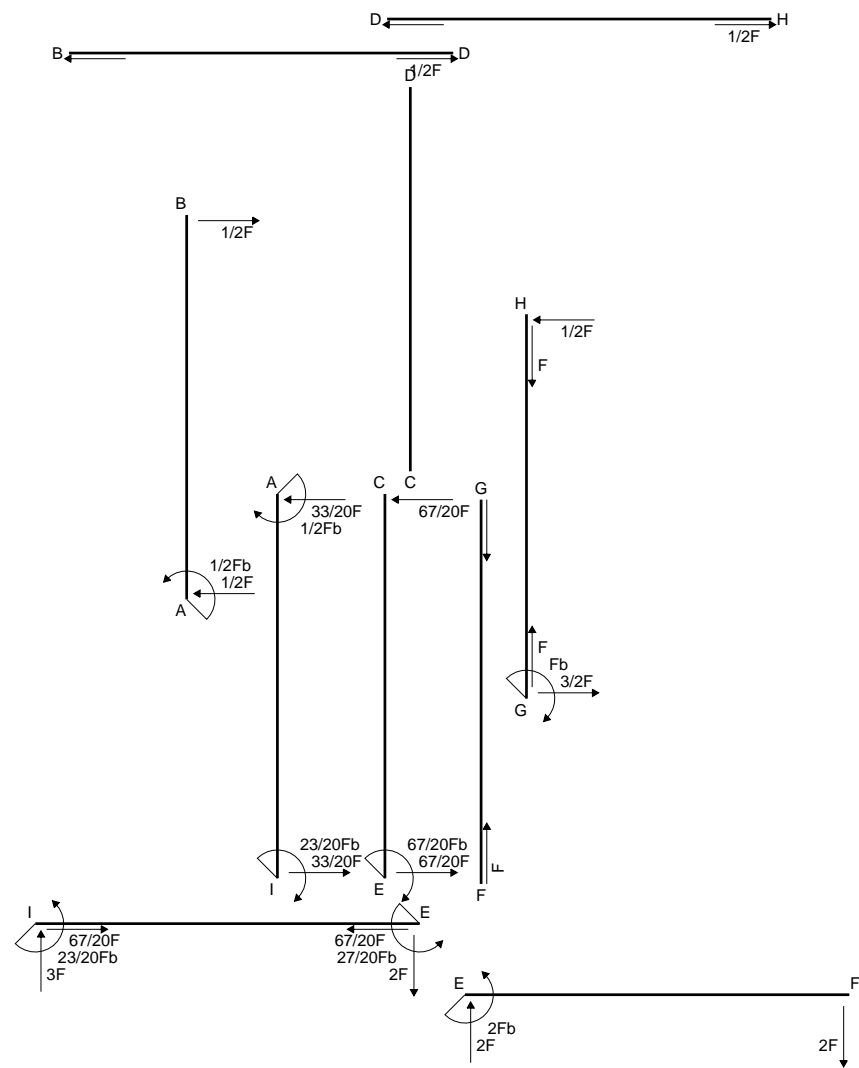
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

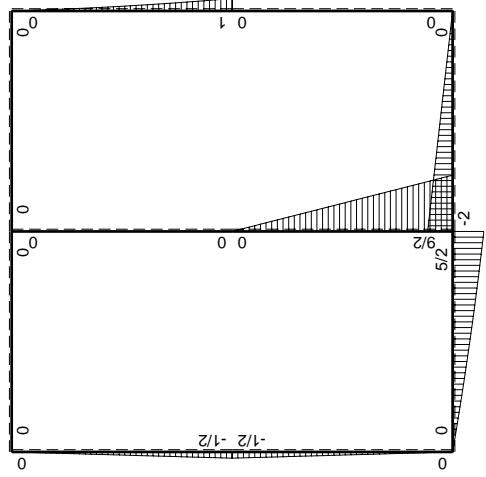
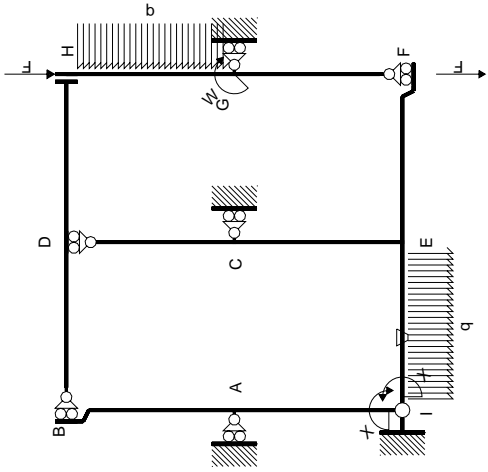
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



- A = 1128. mm²
- J_u = 306009. mm⁴
- J_v = 70776. mm⁴
- y_g = 25.34 mm
- T_y = 2600. N
- M_x = -2236000. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 28.66 mm
- σ_m = -Mv/J_u = 209.5 N/mm²
- x_c = 18. mm
- y_c = 40. mm
- v_c = 14.66 mm
- σ_c = -Mv/J_u = 107.2 N/mm²
- τ_c = 5.025 N/mm²
- σ_q = √σ² + 3τ² = 107.5 N/mm²
- S = 7097. mm³

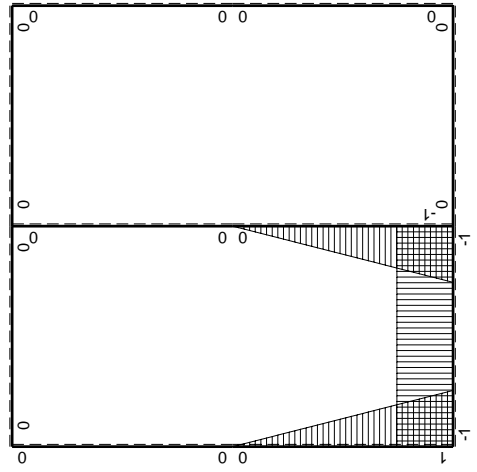


$\left[\begin{matrix} + \\ + \end{matrix} \right] F_b$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$9/2Fb-9/2Fx$	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-9/2Fx$	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-23/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$23/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -1/3 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-5/2 + 2x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-5/2 b + b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -1/3 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-9/2 + 9x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-9/2 x + 9/2 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-9/2 b + 9/2 b - 3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

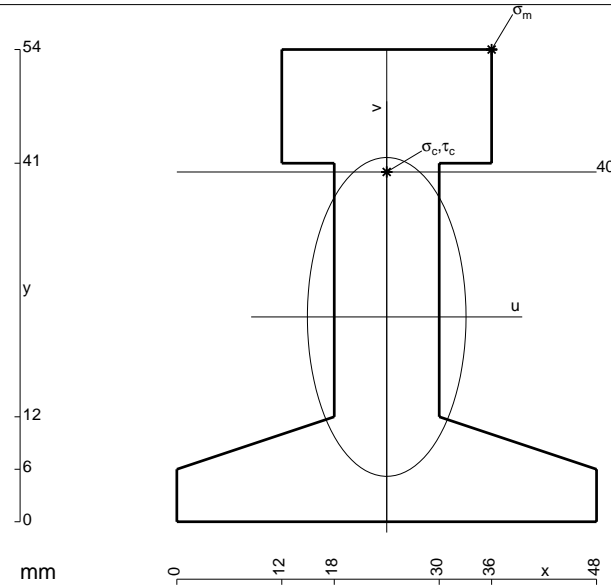
$$= (-3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

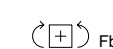
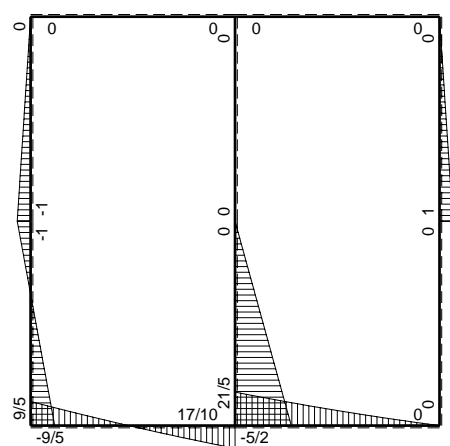
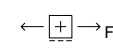
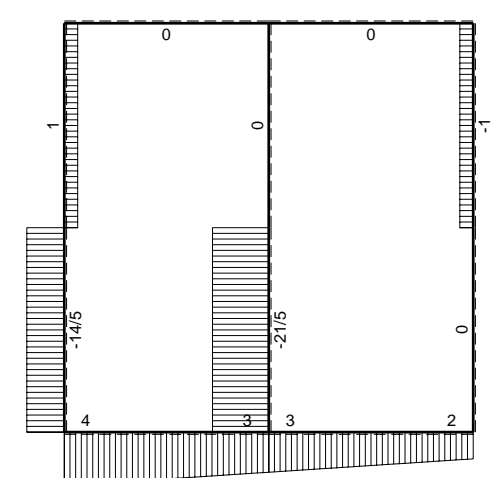
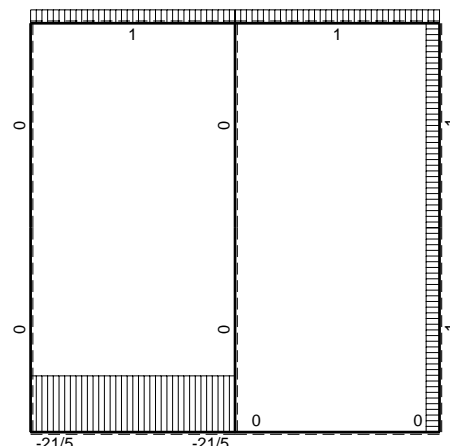
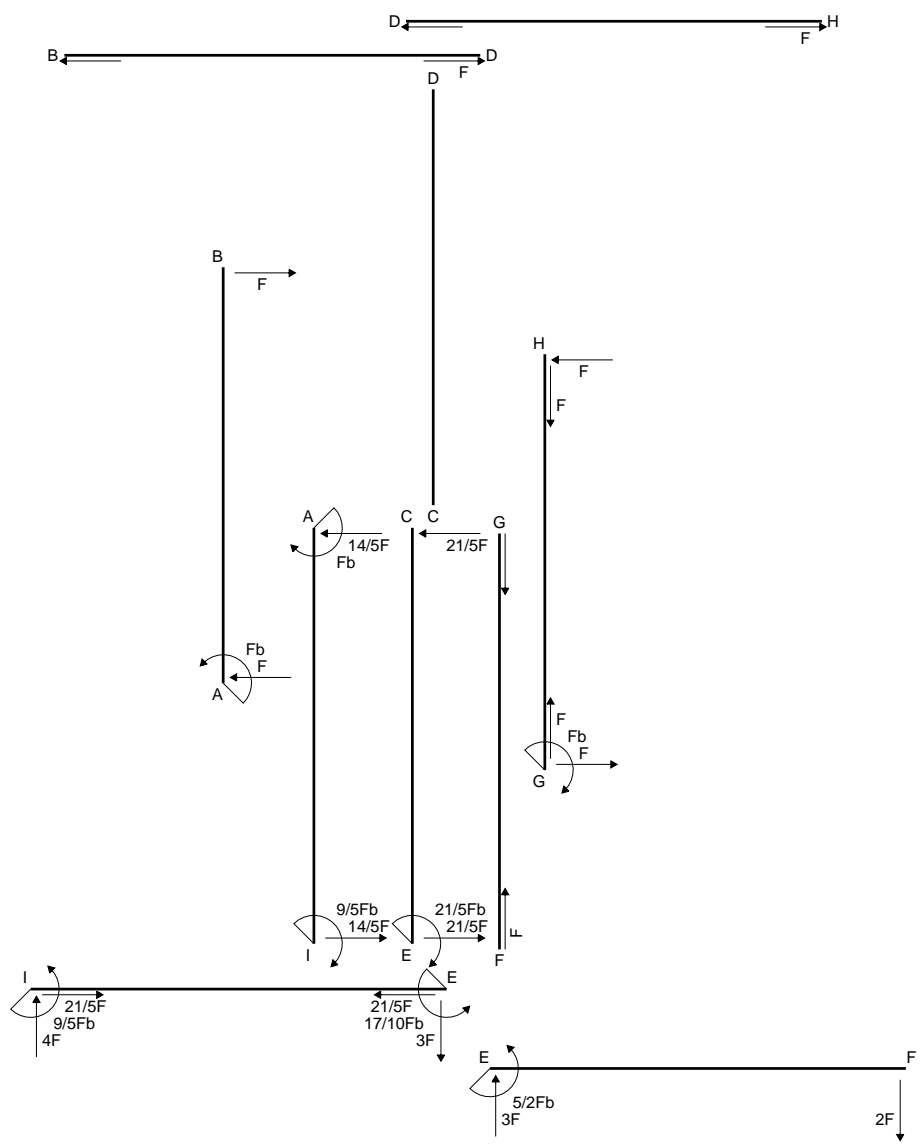
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

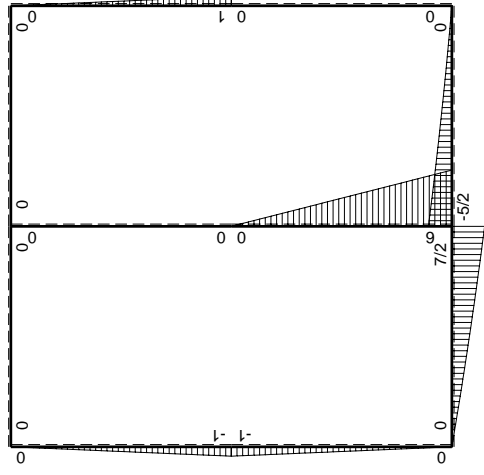
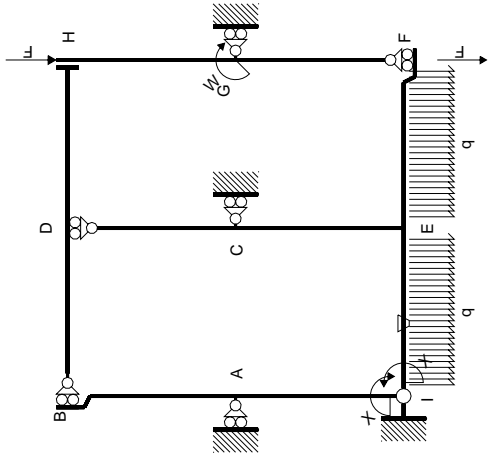
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



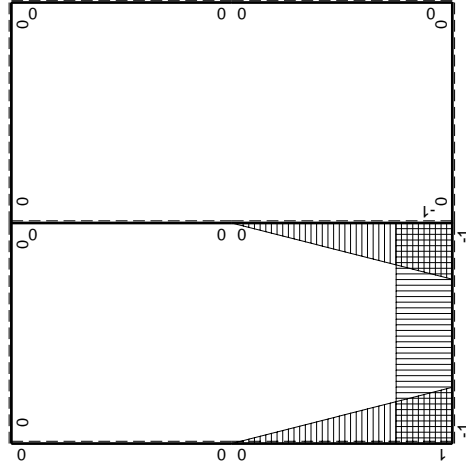
- A = 1128. mm²
- J_u = 375033. mm⁴
- J_v = 92808. mm⁴
- y_g = 23.42 mm
- T_y = 2960. N
- M_x = -2693600. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 30.58 mm
- σ_m = -Mv/J_u = 219.6 N/mm²
- x_c = 24. mm
- y_c = 40. mm
- v_c = 16.58 mm
- σ_c = -Mv/J_u = 119.1 N/mm²
- τ_c = 5.076 N/mm²
- σ_q = √σ²+3τ² = 119.4 N/mm²
- S = 7718. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0	0+0	0
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	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	0+0	0
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0	0+0	0
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0	0+0	0
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0	0+0	0
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0	0+0	0
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$9/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb 1/EJ + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb 1/EJ + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb 1/EJ dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

$$= (-6b + 6b - 2b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb 1/EJ dx = [-2x^3/b^2]_0^b Fb 1/EJ$$

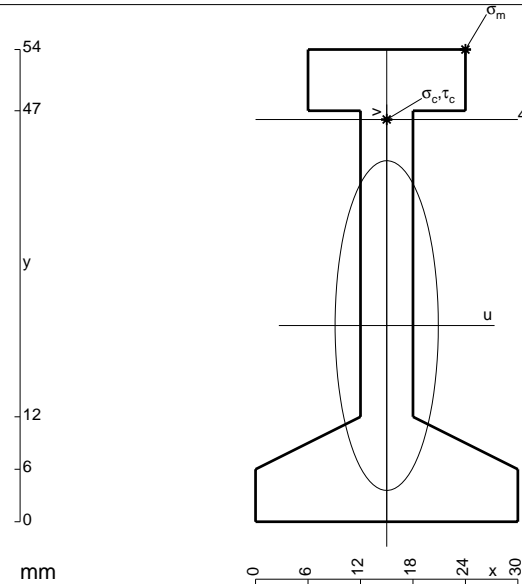
$$= (-2b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

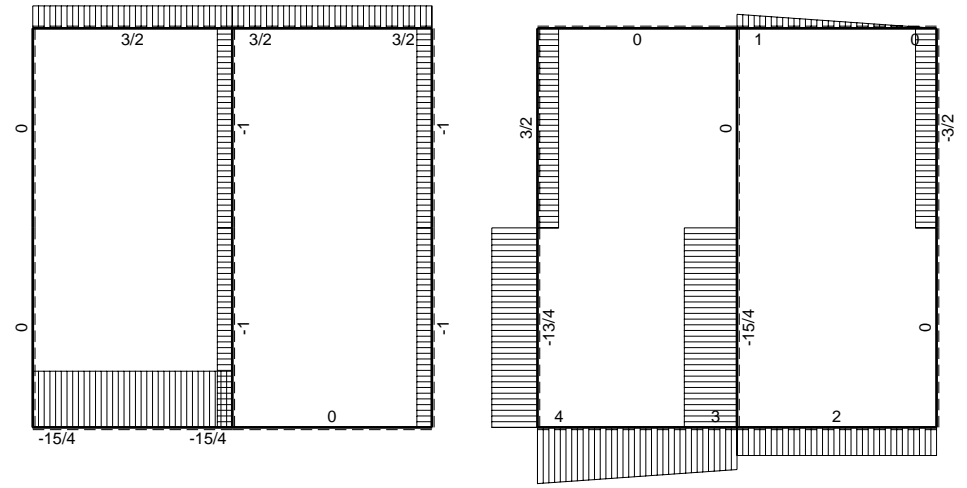
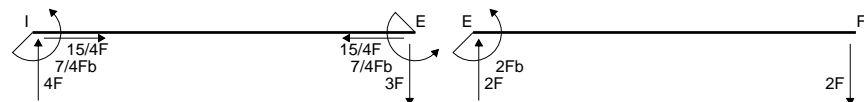
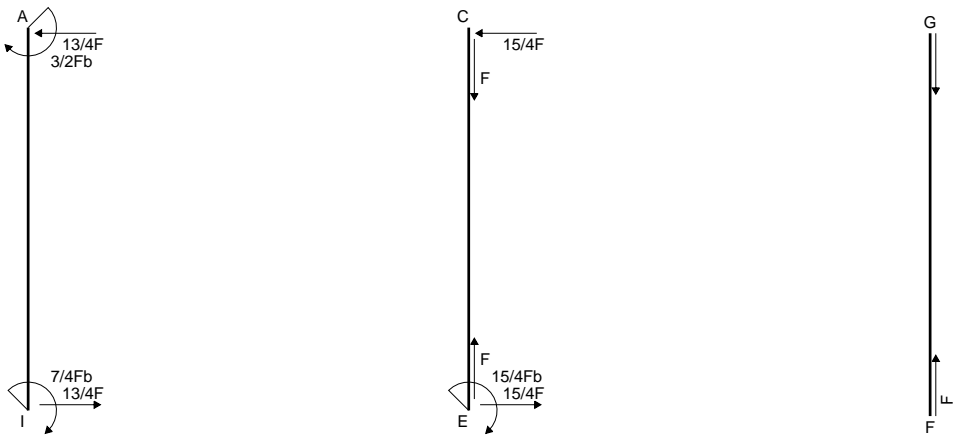
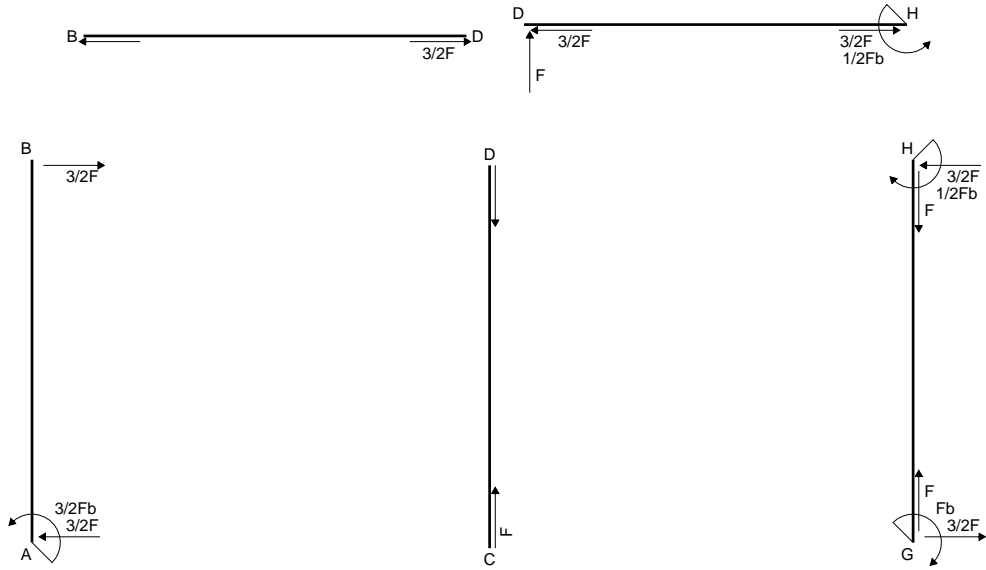
$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

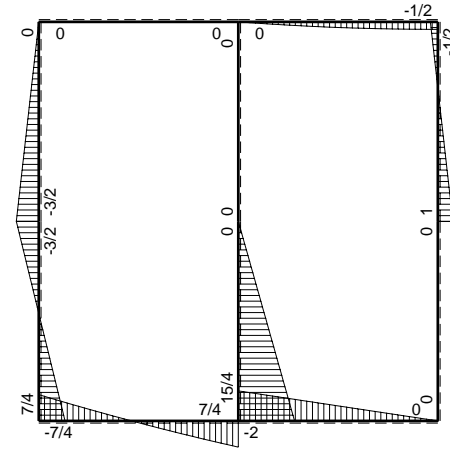


- A = 624. mm²
- J_u = 221959. mm⁴
- J_v = 21744. mm⁴
- y_g = 22.43 mm
- T_y = 1980. N
- M_x = -1600500. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 9. mm
- v_m = 31.57 mm
- σ_m = -Mv/J_u = 227.6 N/mm²
- x_c = 15. mm
- y_c = 46. mm
- v_c = 23.57 mm
- σ_c = -Mv/J_u = 169.9 N/mm²
- τ_c = 5.473 N/mm²
- σ_q = √σ²+3τ² = 170.2 N/mm²
- S = 3681. mm³

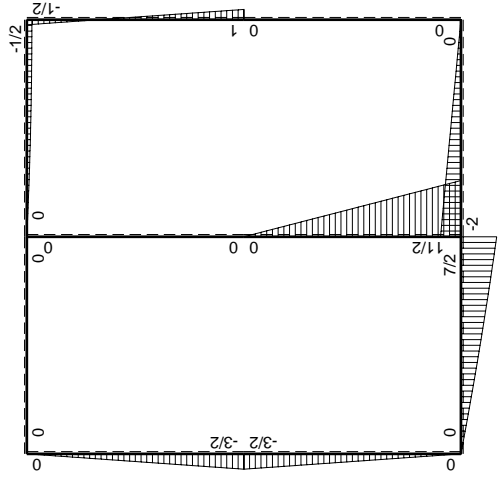
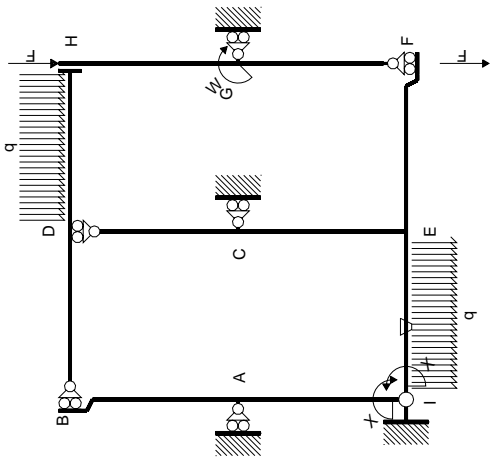


← ⊕ → F

↑ ⊕ ↓ F

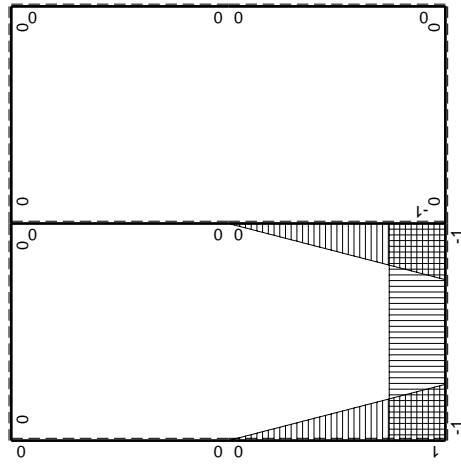


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0	
BA b	0	$3/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$Fb-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$1/2Fb-3/2Fx$	0	0	0	0			
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
DH b	0	$Fx-1/2qx^2$	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2			
	totali							$-35/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$7/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

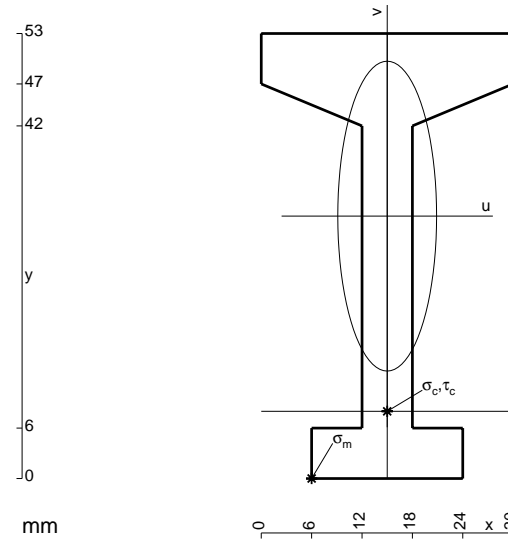
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

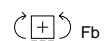
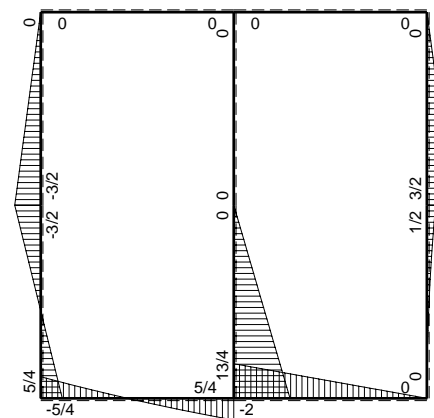
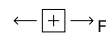
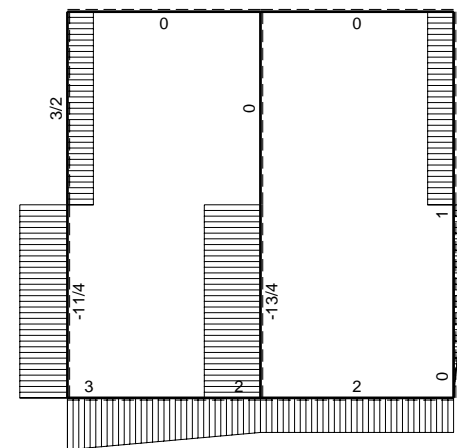
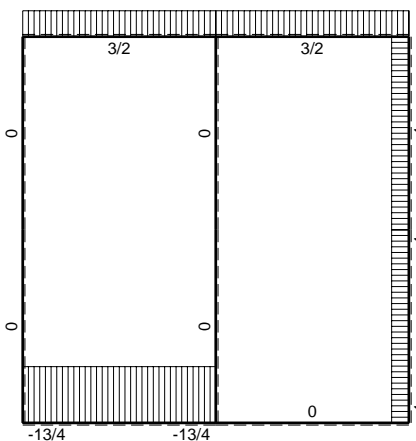
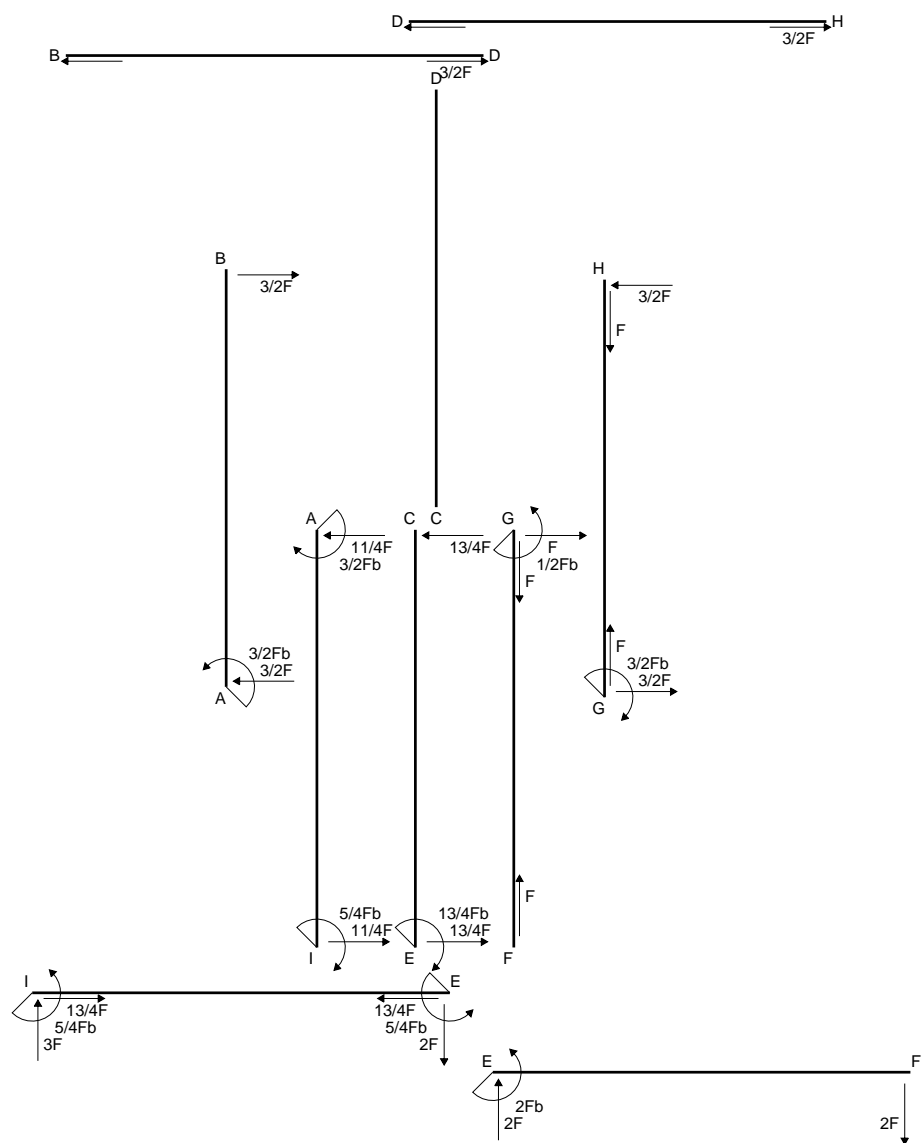
$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

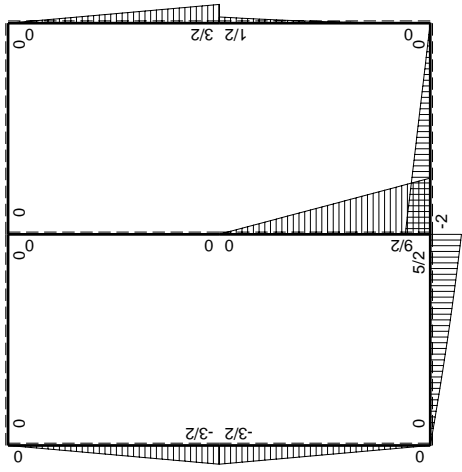
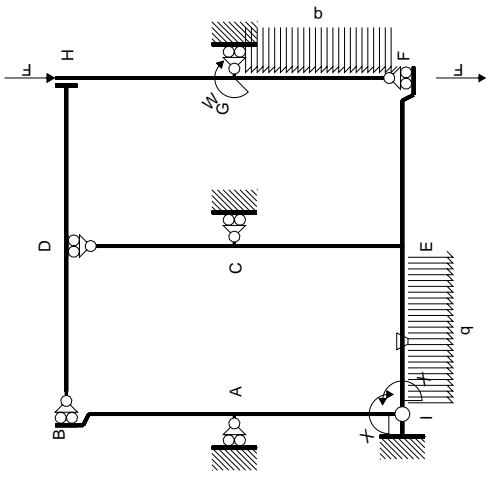
$$L_{AI}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$



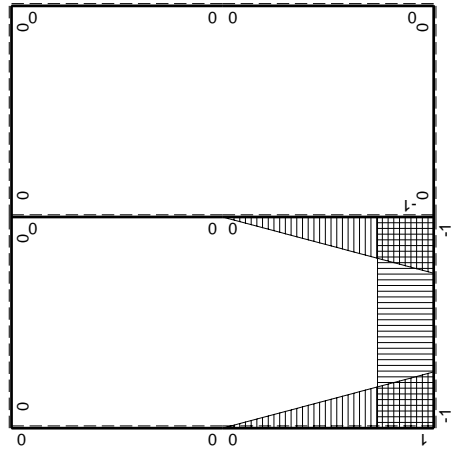
- A = 594. mm²
- J_u = 202331. mm⁴
- J_v = 20574. mm⁴
- y_g = 31.25 mm
- T_y = 1540. N
- M_x = -1540000. Nmm
- x_m = 6. mm
- u_m = -9. mm
- v_m = -31.25 mm
- σ_m = -Mv/J_u = -237.9 N/mm²
- x_c = 15. mm
- y_c = 8. mm
- v_c = -23.25 mm
- σ_c = -Mv/J_u = -177. N/mm²
- τ_c = 4.24 N/mm²
- σ_o = √σ²+3τ² = 177.1 N/mm²
- S = 3342. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0
BA b	0	$3/2Fx$	0	0	0	0	0+0	0
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0	0+0	0
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0	0+0	0
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0	0+0	0
GH b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$-3/2Fx$	0	0	0	0	0+0	0
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0	0+0	0
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0	0+0	0
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$9/2Fb-9/2Fx$	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-9/2Fx$	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$5/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -1/3 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-5/2 + 2x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-5/2 b + b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -1/3 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-9/2 + 9x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-9/2 x + 9/2 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-9/2 b + 9/2 b - 3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

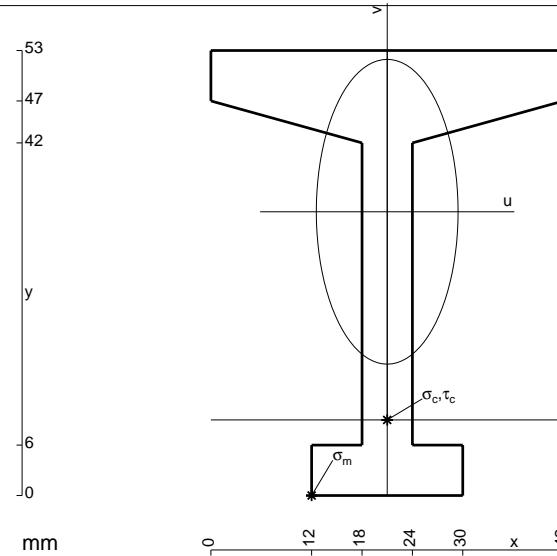
$$= (-3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

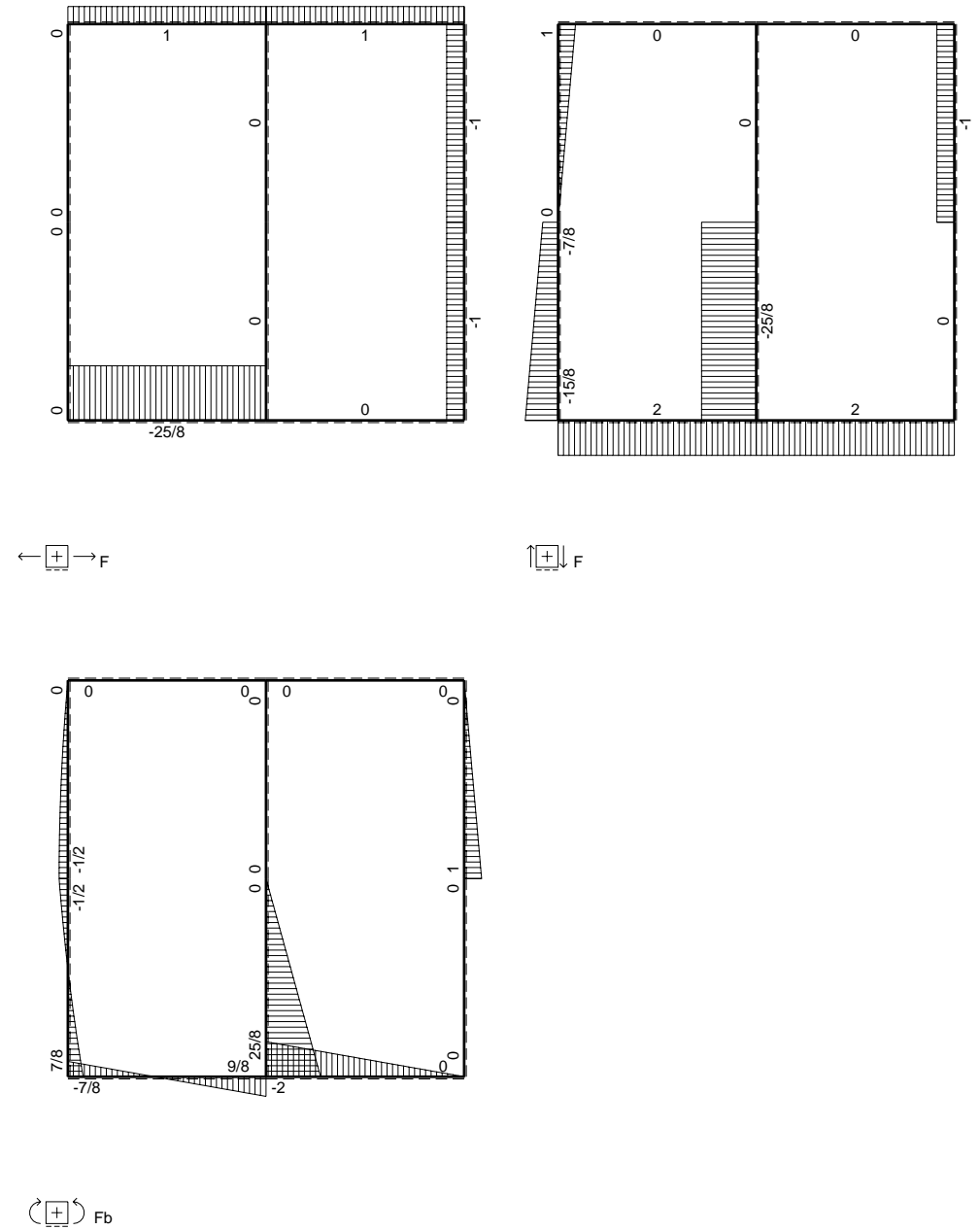
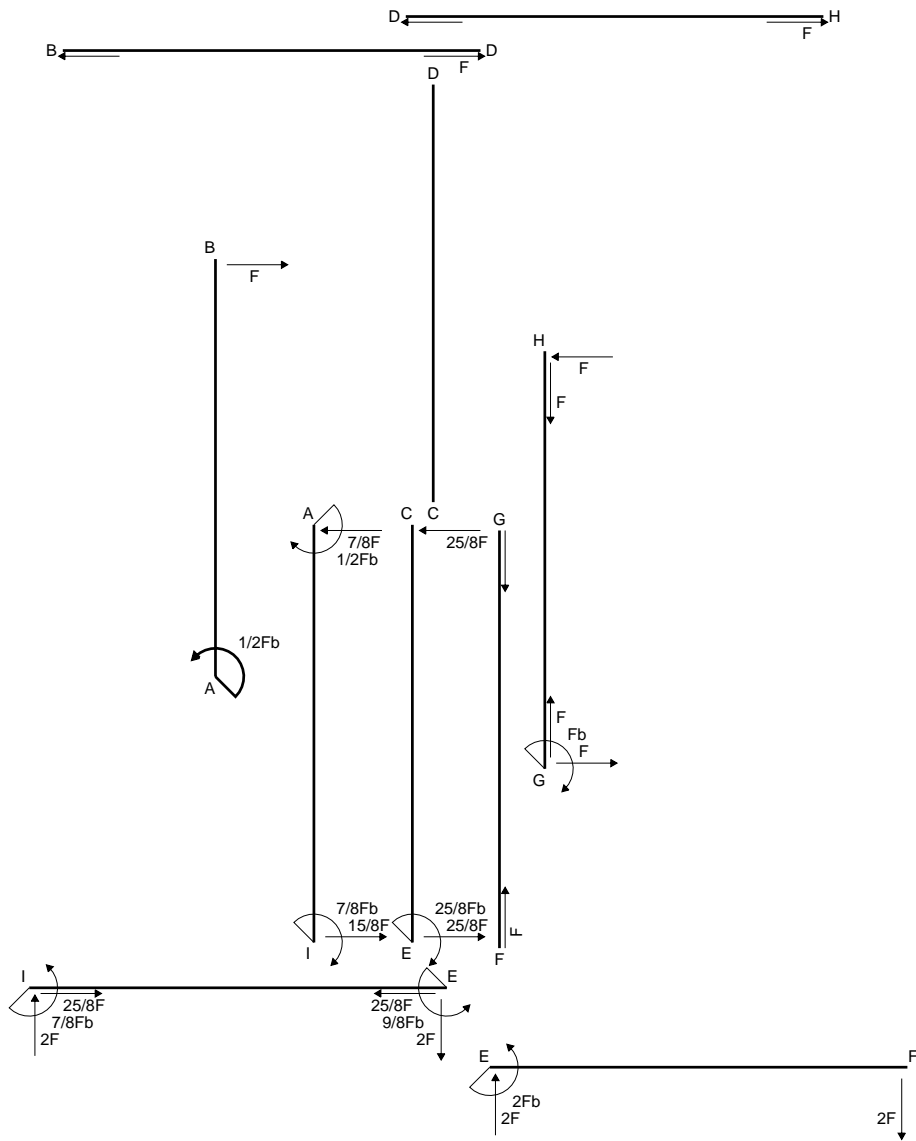
$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

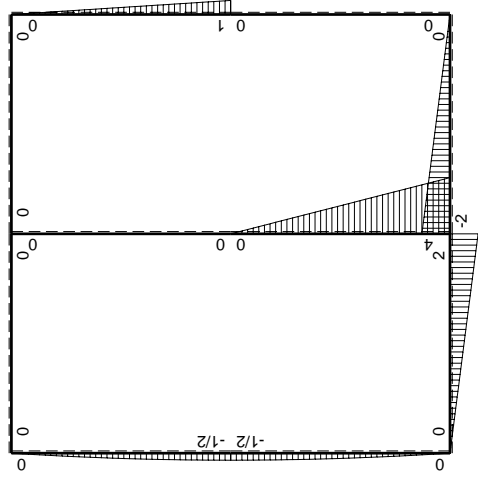
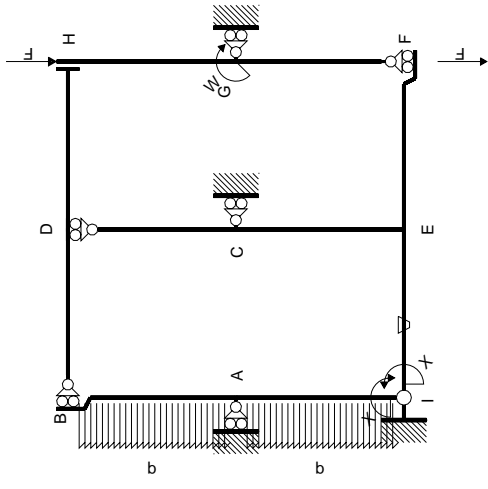
$$L_{AI}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$



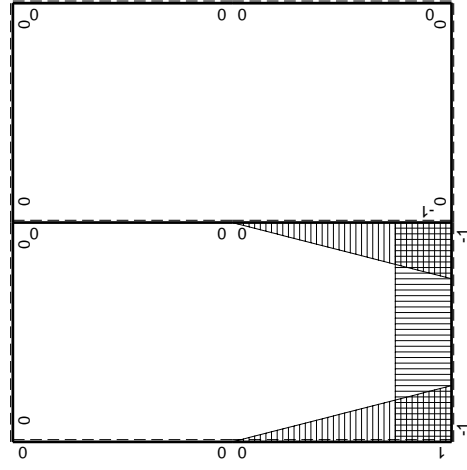
- A = 696. mm²
- J_u = 229334. mm⁴
- J_v = 49608. mm⁴
- y_g = 33.8 mm
- T_y = 2560. N
- M_x = -1356800. Nmm
- x_m = 12. mm
- u_m = -9. mm
- v_m = -33.8 mm
- σ_m = -Mv/J_u = -200. N/mm²
- x_c = 21. mm
- y_c = 9. mm
- v_c = -24.8 mm
- σ_c = -Mv/J_u = -146.7 N/mm²
- τ_c = 7.069 N/mm²
- σ_o = √σ² + 3τ² = 147.2 N/mm²
- S = 3799. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
BA b	0	$Fx-1/2qx^2$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$Fb-Fx$	0	0	0	0	0+0	0	
HG b	0	$-Fx$	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1			
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-1/2qx^2$	0	$-1/2Fx+1/2qx^3/b$	0	x^2/b^2			
	totali							$-35/24Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 8x/b - 4x^2/b^2) Fb 1/EJ dx = [-4x + 4x^2/b - 4/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-4b + 4b - 4/3 b) Fb 1/EJ = -4/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-4x^2/b^2) Fb 1/EJ dx = [-4/3 x^3/b^2]_0^b Fb 1/EJ$$

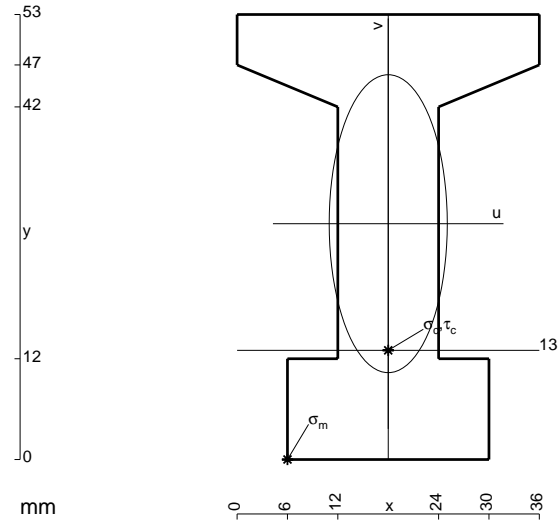
$$= (-4/3 b) Fb 1/EJ = -4/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [-1/2 x^2/b + 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

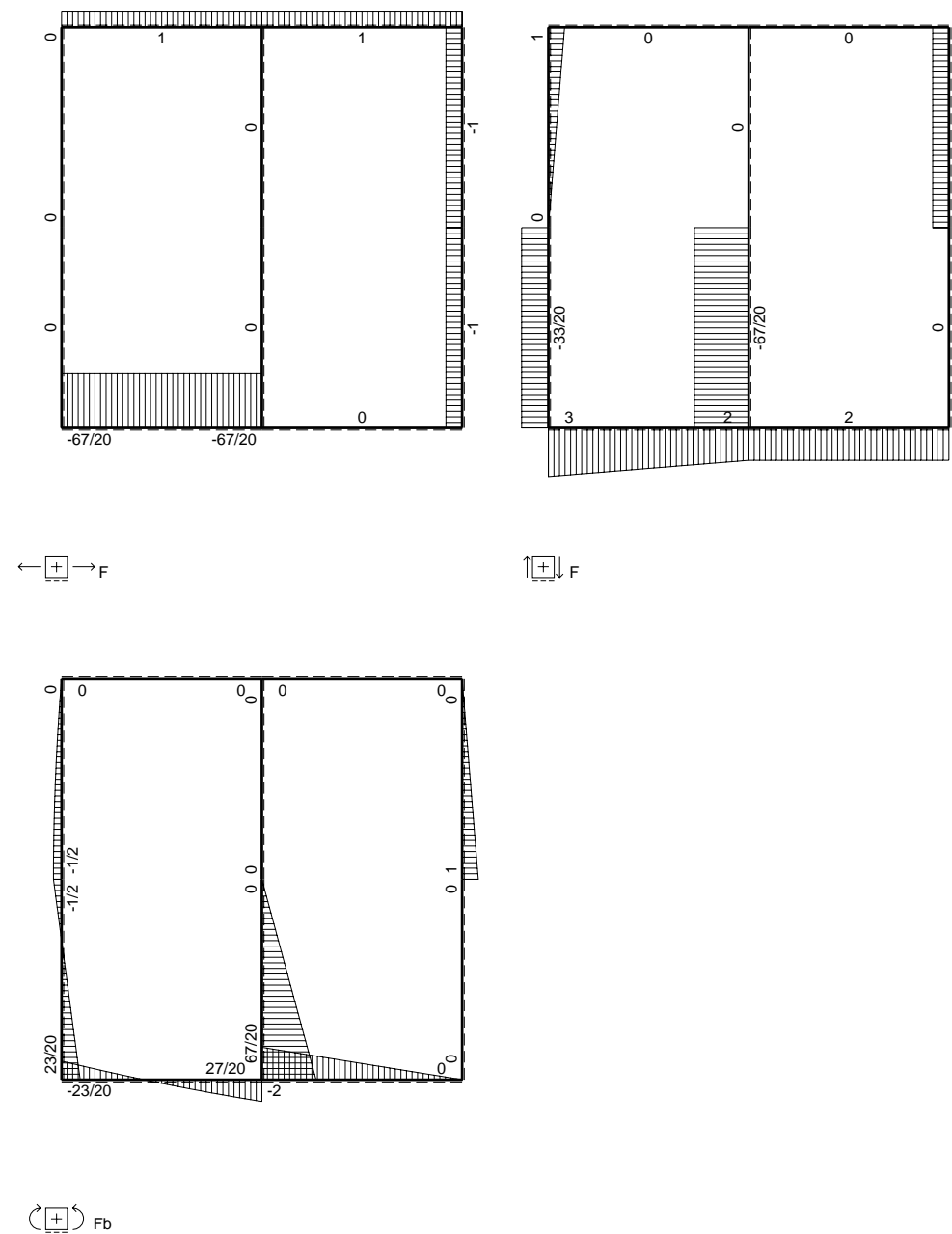
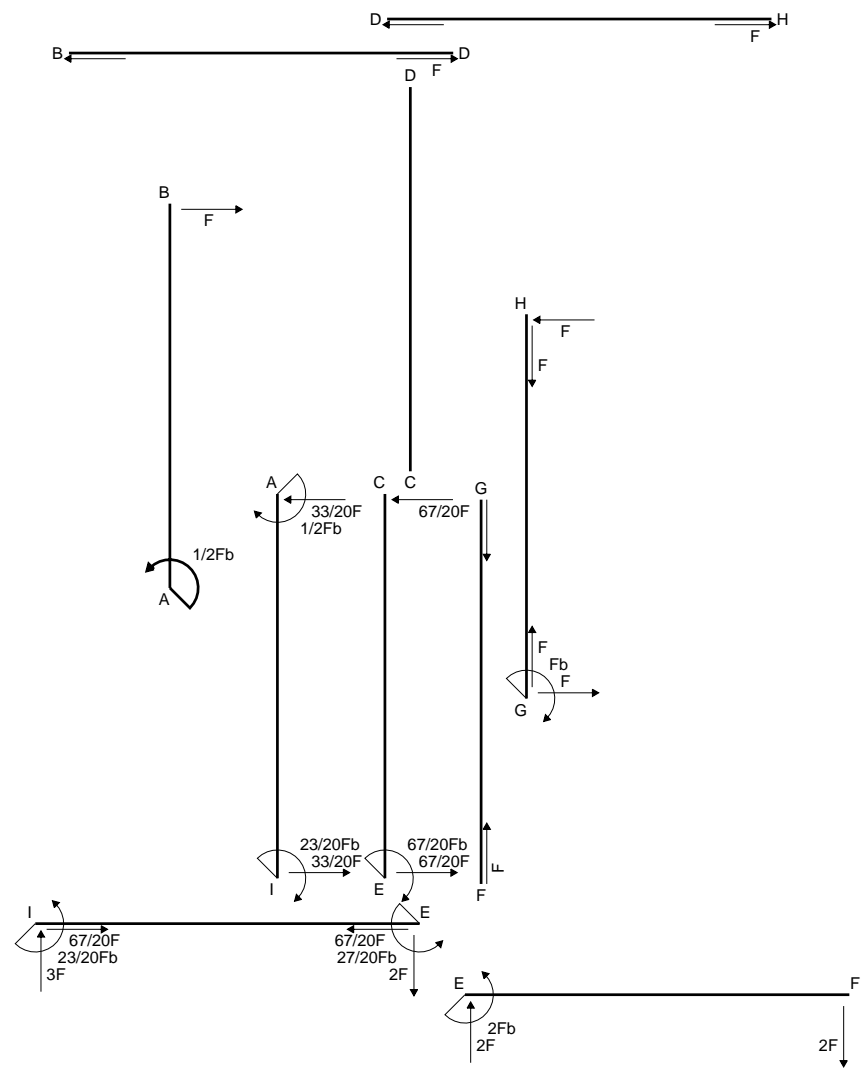
$$= (-1/2 b + 1/2 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

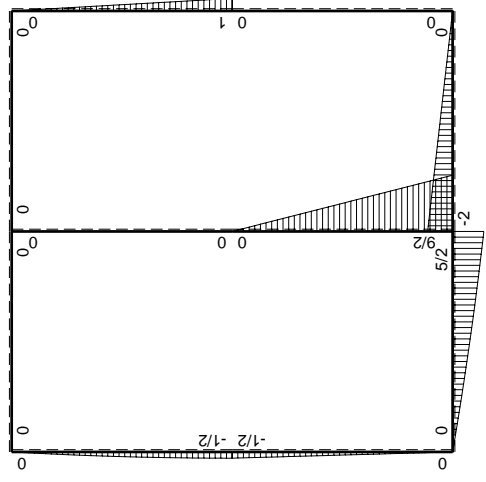
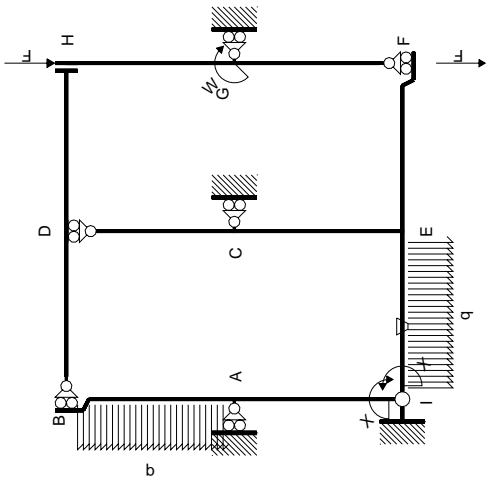
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^3/b^3) Fb 1/EJ dx = [-1/4 x^2/b + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$



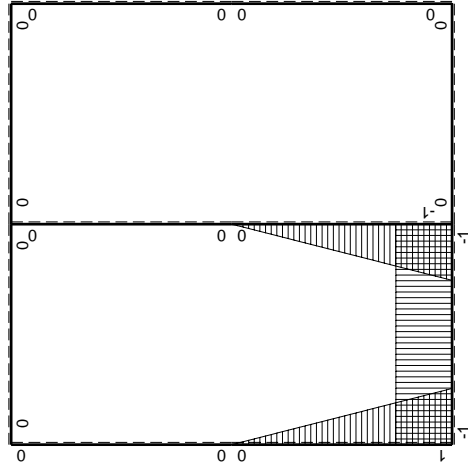
- A = 984. mm²
- J_u = 309962. mm⁴
- J_v = 48672. mm⁴
- y_g = 28.09 mm
- T_y = 3980. N
- M_x = -2308400. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.09 mm
- σ_m = -Mv/J_u = -209.2 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.09 mm
- σ_c = -Mv/J_u = -112.4 N/mm²
- τ_c = 7.007 N/mm²
- σ_q = √(σ² + 3τ²) = 113. N/mm²
- S = 6548. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$-Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$9/2Fb-9/2Fx$	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-9/2Fx$	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-23/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$23/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -1/3 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-5/2 + 2x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-5/2 b + b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -1/3 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-9/2 + 9x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-9/2 x + 9/2 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-9/2 b + 9/2 b - 3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

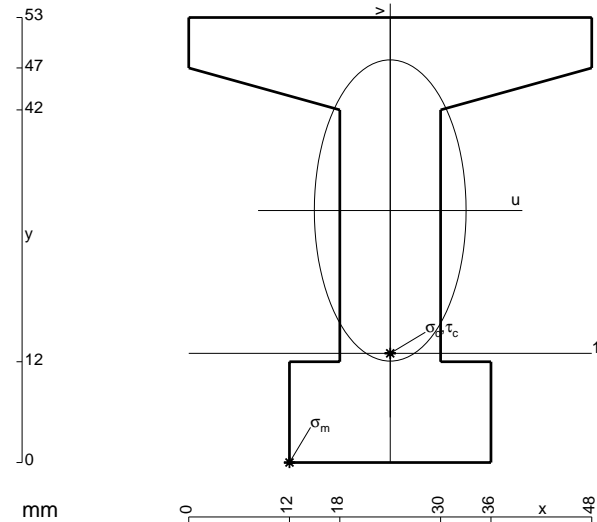
$$= (-3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

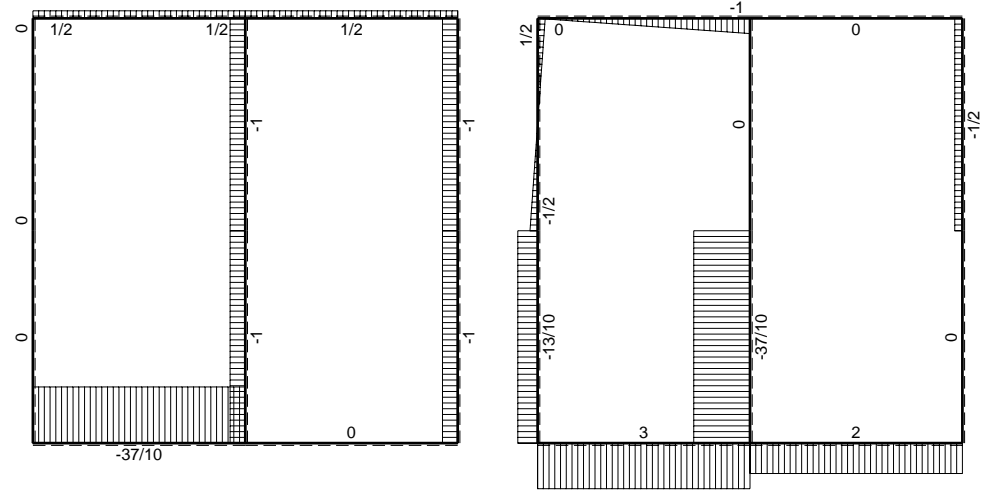
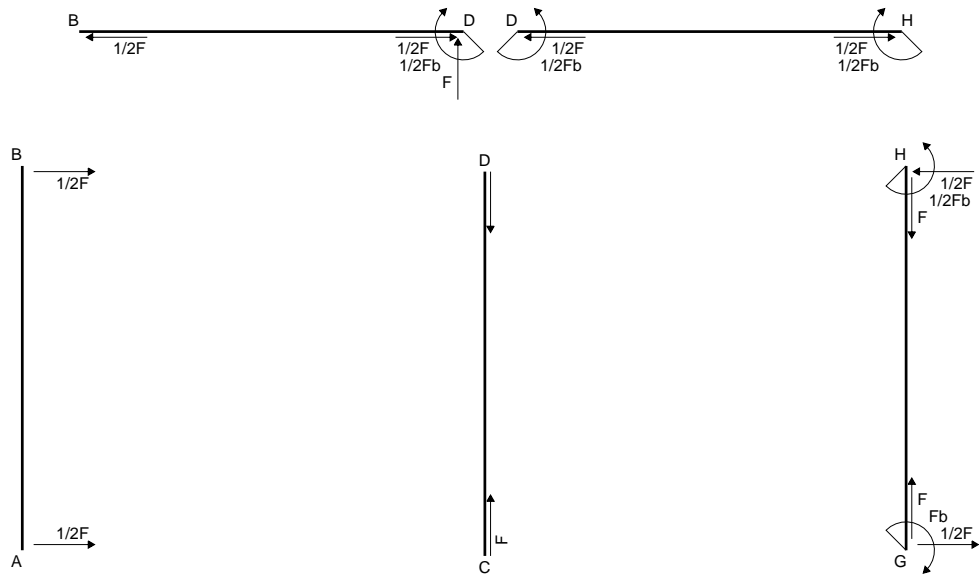
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

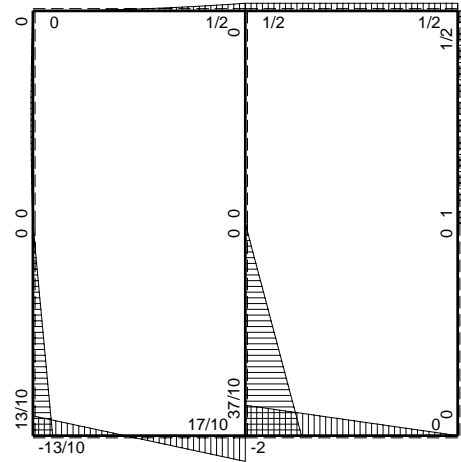
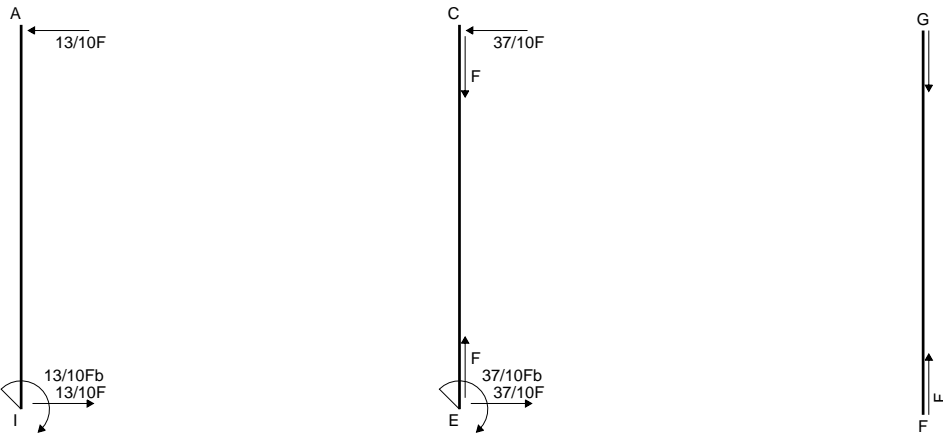


- A = 1086. mm²
- J_u = 349673. mm⁴
- J_v = 88740. mm⁴
- y_g = 30.02 mm
- T_y = 4060. N
- M_x = -2557800. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.02 mm
- σ_m = -Mv/J_u = -219.6 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -17.02 mm
- σ_c = -Mv/J_u = -124.5 N/mm²
- τ_c = 6.896 N/mm²
- σ_ρ = √(σ² + 3τ²) = 125. N/mm²
- S = 7127. mm³

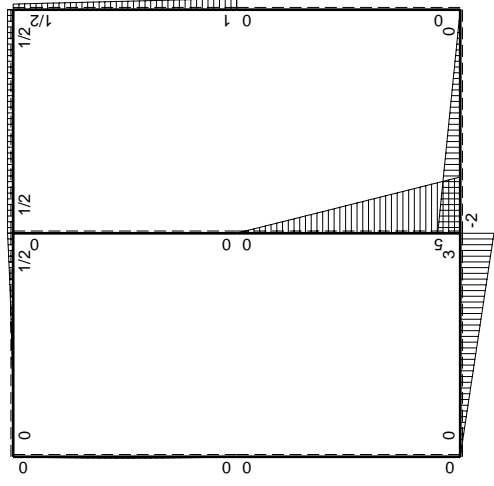
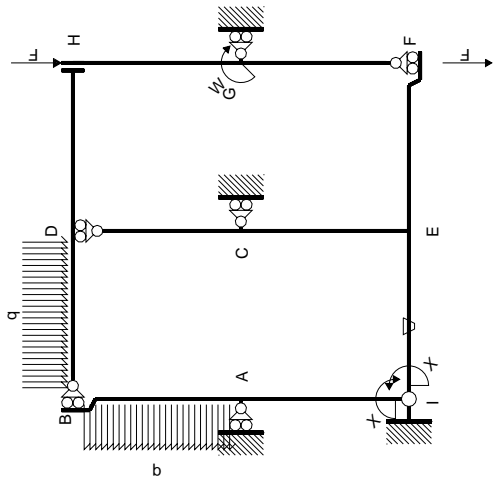


← ⊕ → F

↑ ⊕ ↓ F

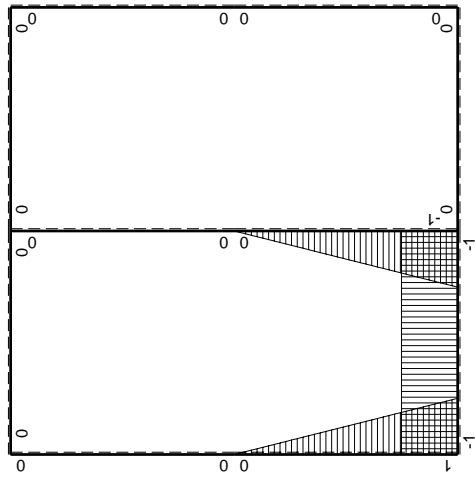


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$13/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

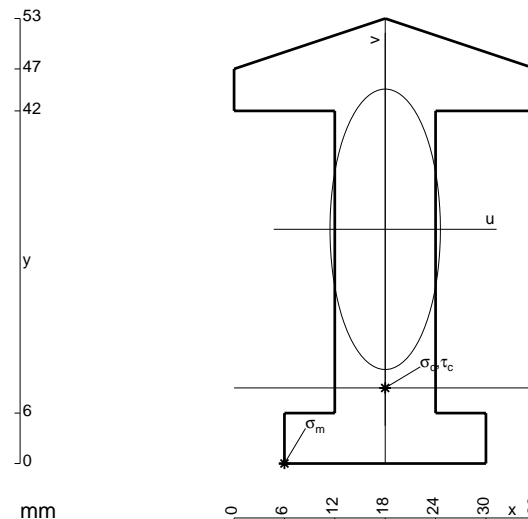
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

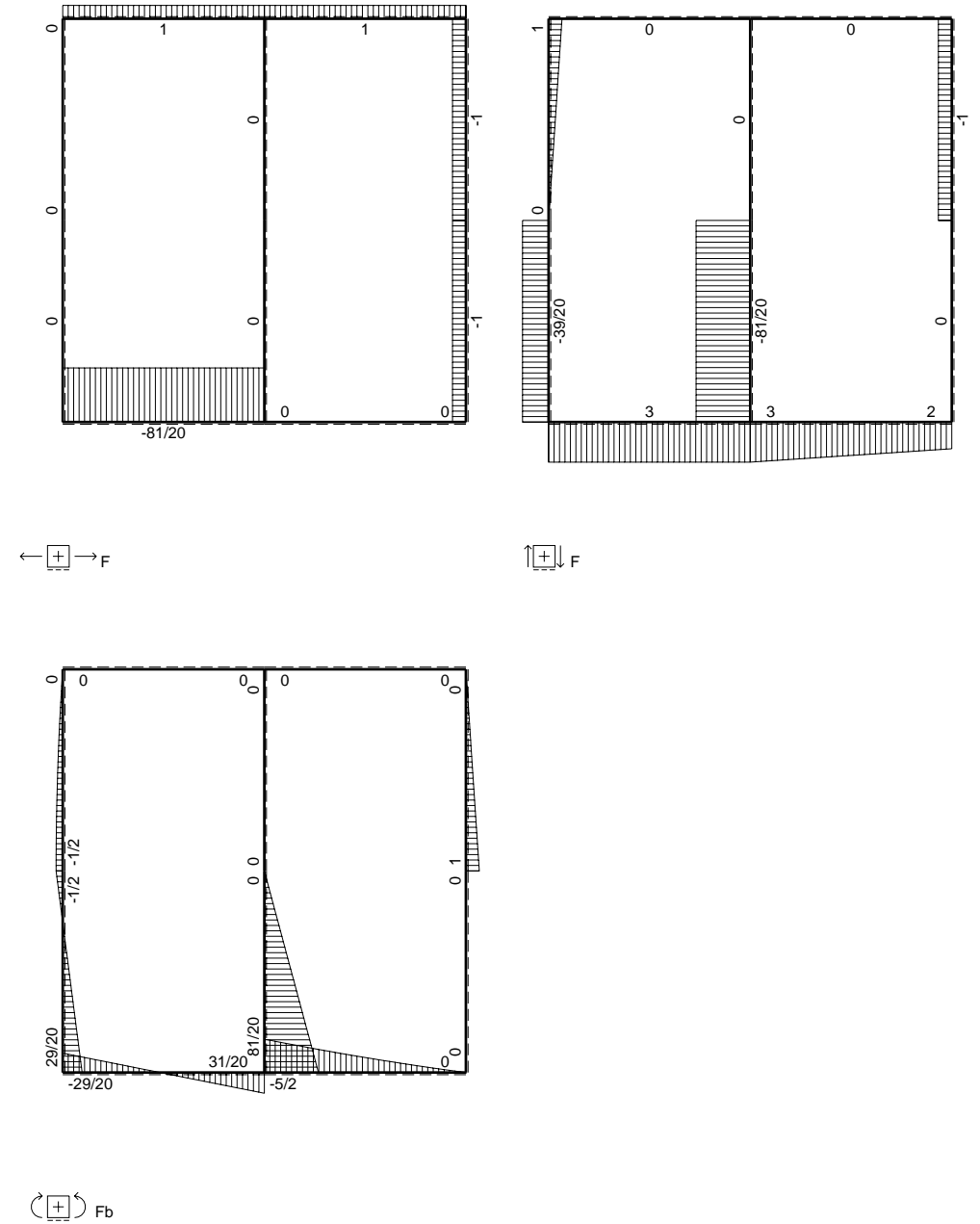
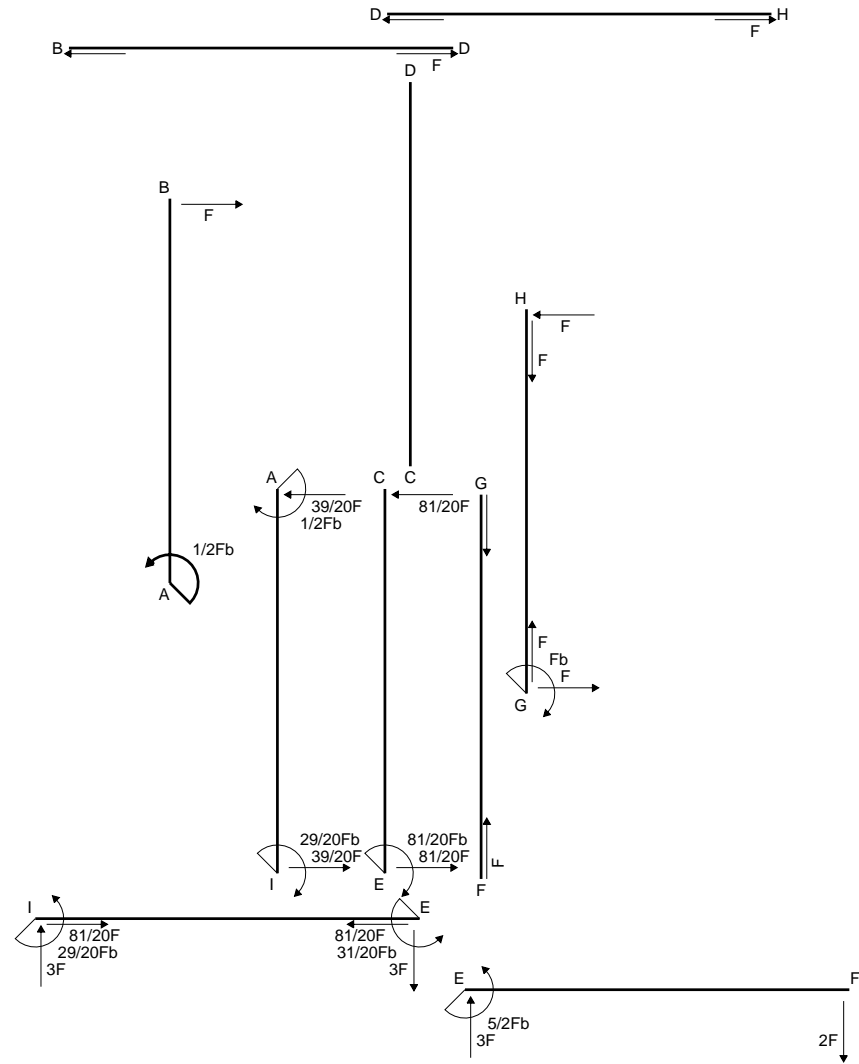
$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

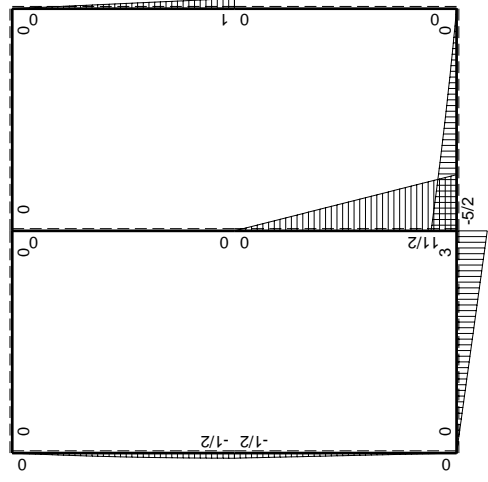
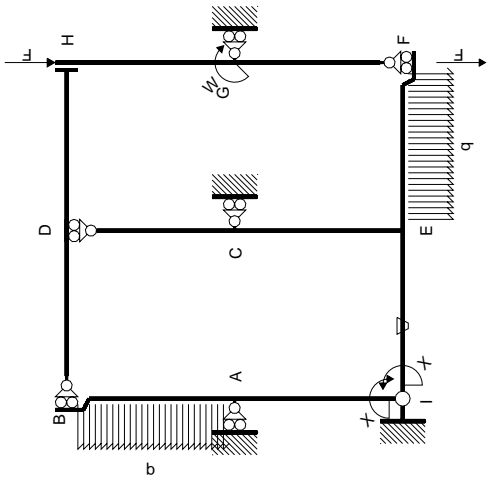
$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$



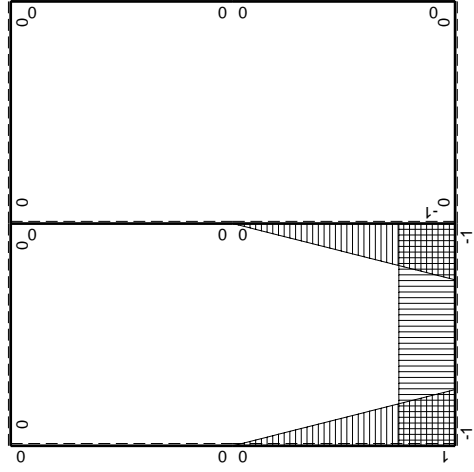
- A = 864. mm²
- J_u = 241215. mm⁴
- J_v = 37368. mm⁴
- y_g = 27.9 mm
- T_y = 2920. N
- M_x = -1985600. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -27.9 mm
- σ_m = -Mv/J_u = -229.6 N/mm²
- x_c = 18. mm
- y_c = 9. mm
- v_c = -18.9 mm
- σ_c = -Mv/J_u = -155.5 N/mm²
- τ_c = 4.357 N/mm²
- σ_o = √σ²+3τ² = 155.7 N/mm²
- S = 4319. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$-Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-29/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$29/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

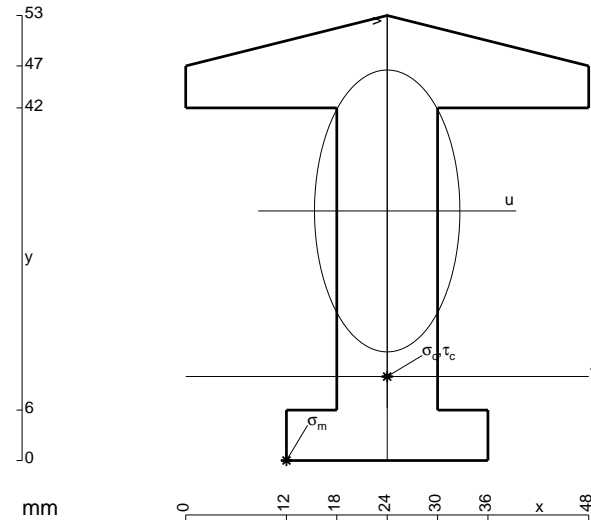
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

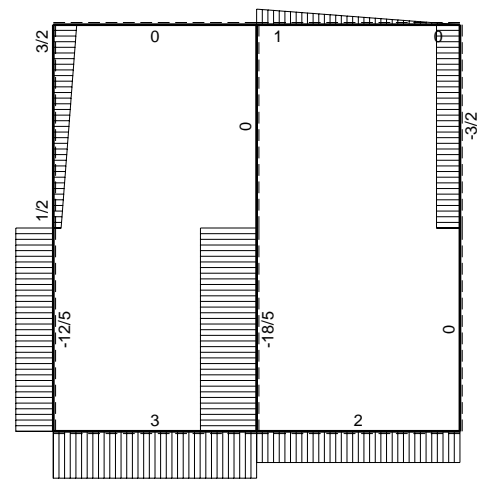
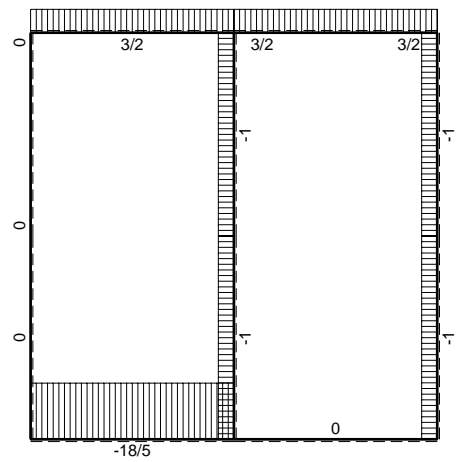
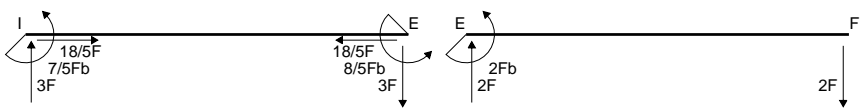
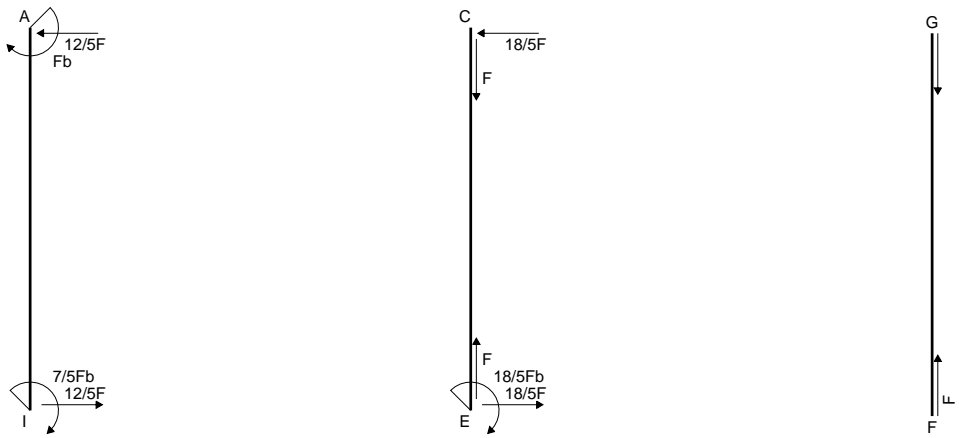
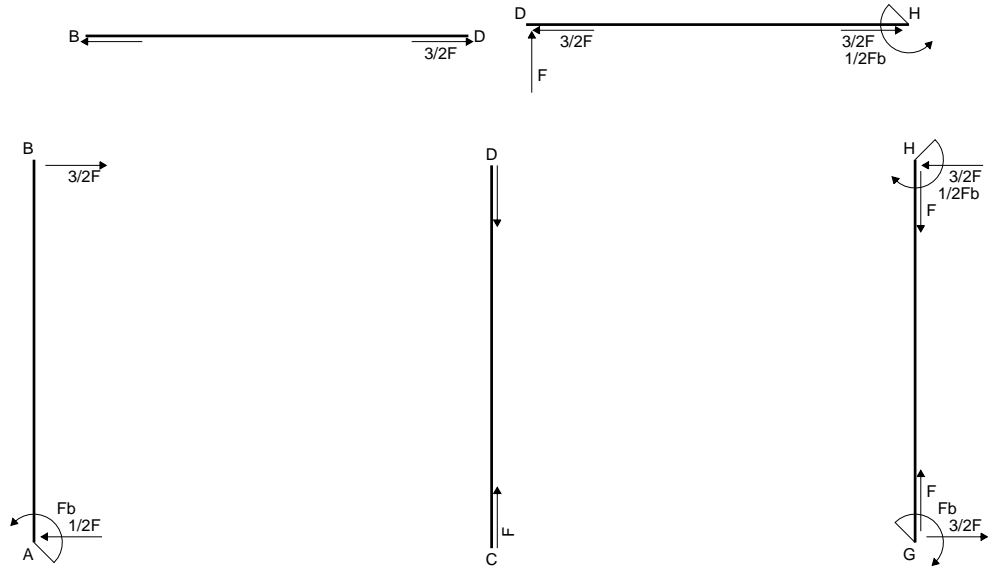
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

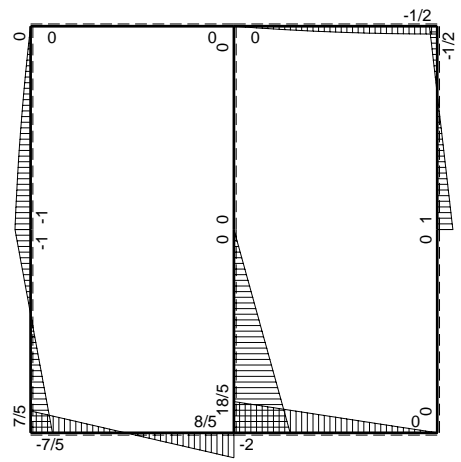


- A = 960. mm²
- J_u = 270775. mm⁴
- J_v = 72000. mm⁴
- y_g = 29.73 mm
- T_y = 3540. N
- M_x = -2183000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -29.73 mm
- σ_m = -Mv/J_u = -239.6 N/mm²
- x_c = 24. mm
- y_c = 10. mm
- v_c = -19.73 mm
- σ_c = -Mv/J_u = -159. N/mm²
- τ_c = 5.329 N/mm²
- σ_o = √σ²+3τ² = 159.3 N/mm²
- S = 4891. mm³

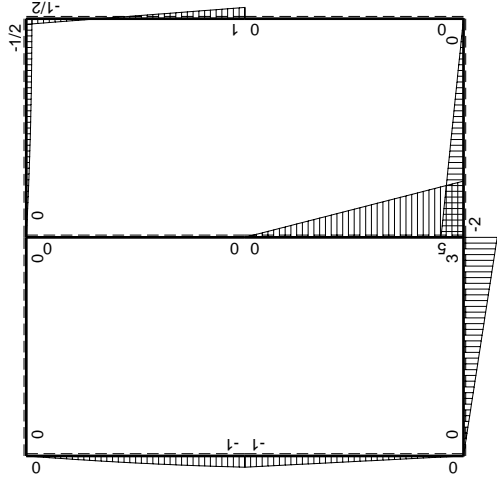
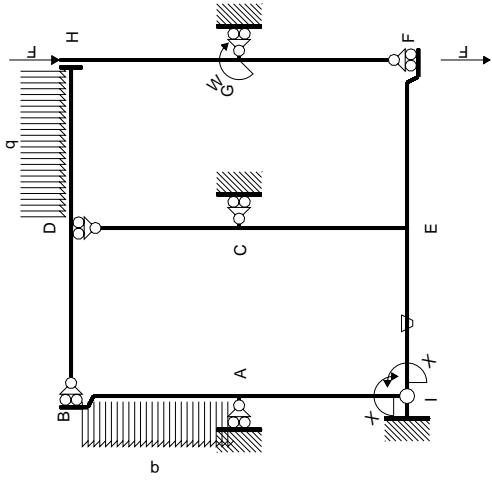


← (+) → F

↑ (+) ↓ F

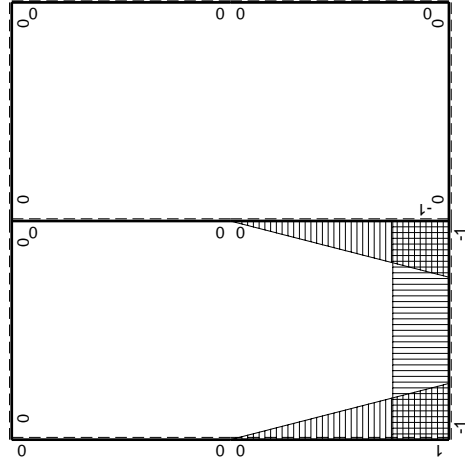


⊕ (+) ⊖ (-) Fb



Schema di calcolo iperstatico

M₀ flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	$-Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$3/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-3/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

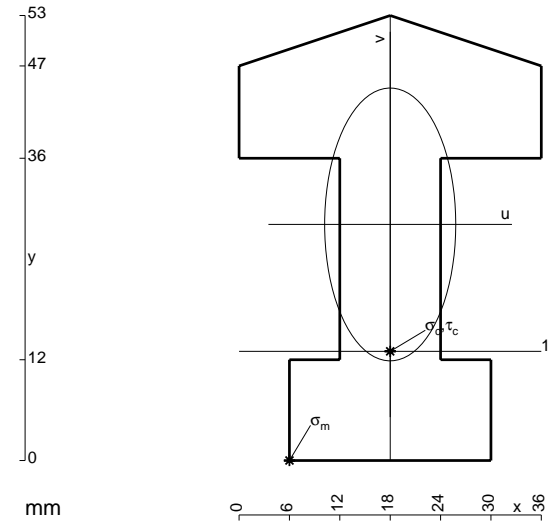
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

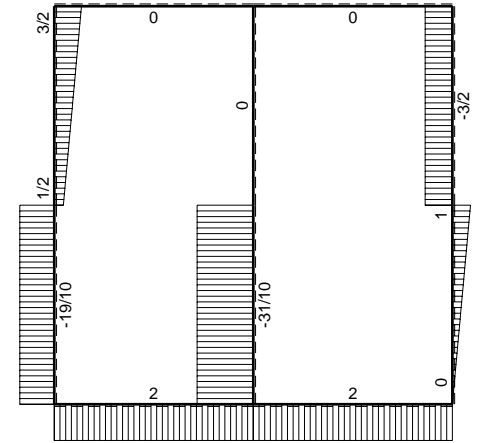
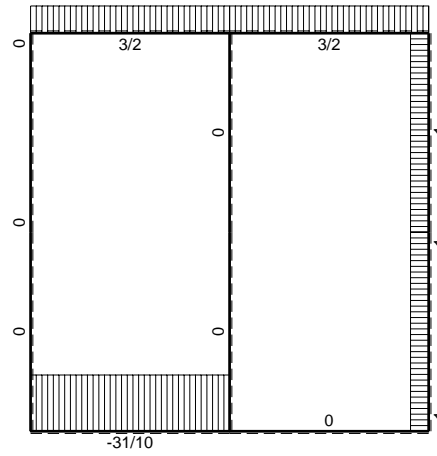
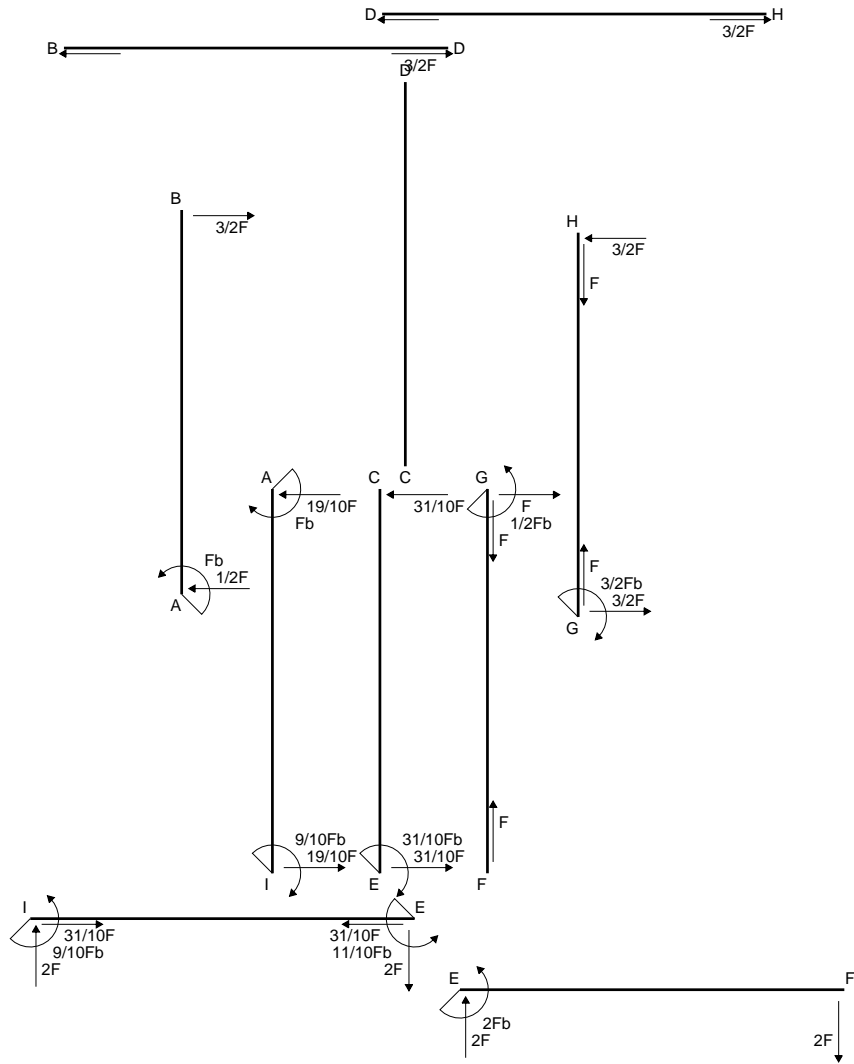
$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

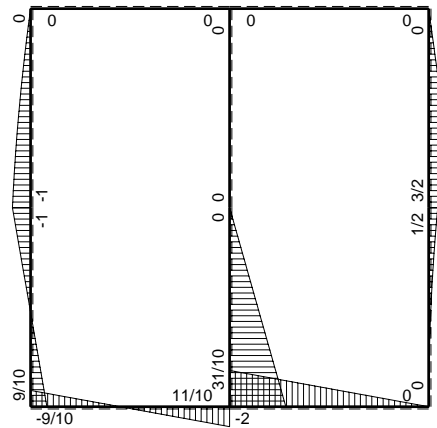


- A = 1080. mm²
- J_u = 285273. mm⁴
- J_v = 65880. mm⁴
- y_g = 28.12 mm
- T_y = 2560. N
- M_x = -2022400. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.12 mm
- σ_m = -Mv/J_u = -199.3 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.12 mm
- σ_c = -Mv/J_u = -107.2 N/mm²
- τ_c = 4.903 N/mm²
- σ_o = √σ² + 3τ² = 107.5 N/mm²
- S = 6557. mm³

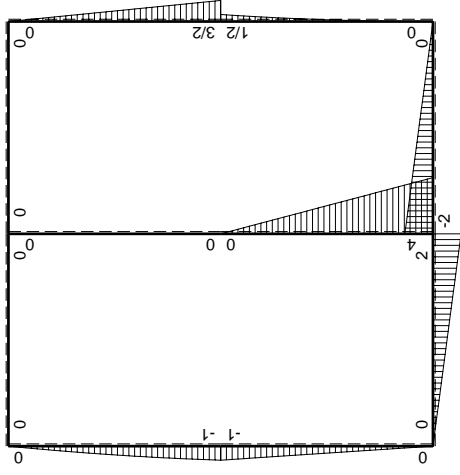
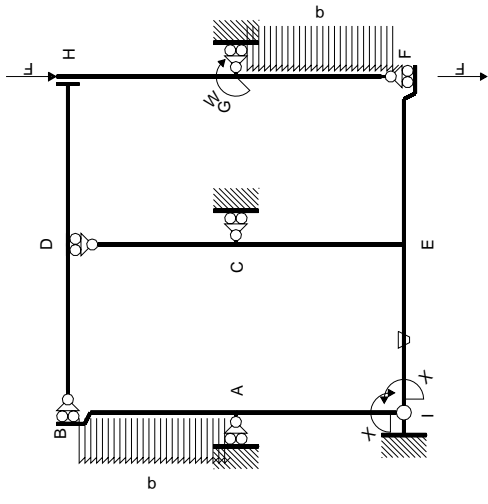


← ⊕ → F

↑ ⊕ ↓ F

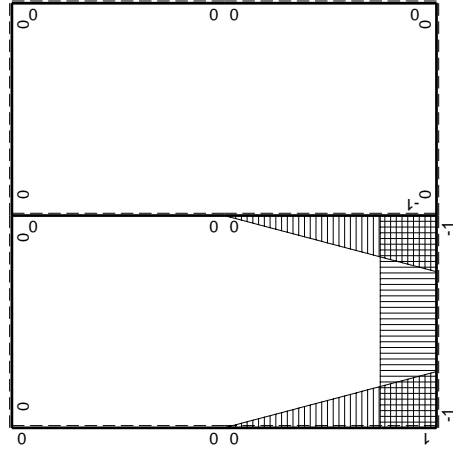


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$3/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$-3/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$9/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-b) Fb \frac{1}{EJ} + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-2b + b) Fb \frac{1}{EJ} + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 8x/b - 4x^2/b^2) Fb \frac{1}{EJ} dx = [-4x + 4x^2/b - 4/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-4b + 4b - 4/3 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-4x^2/b^2) Fb \frac{1}{EJ} dx = [-4/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

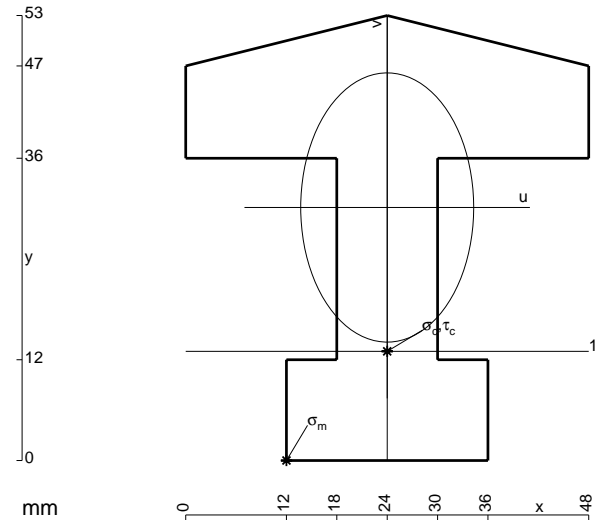
$$= (-4/3 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

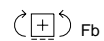
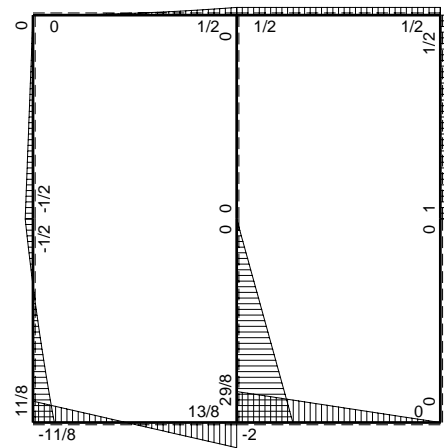
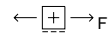
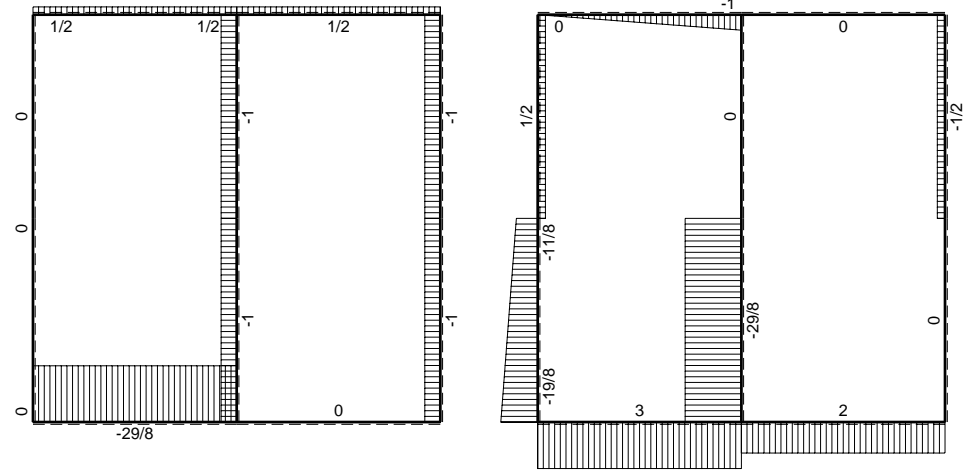
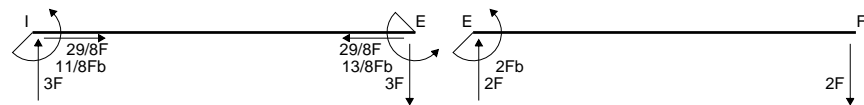
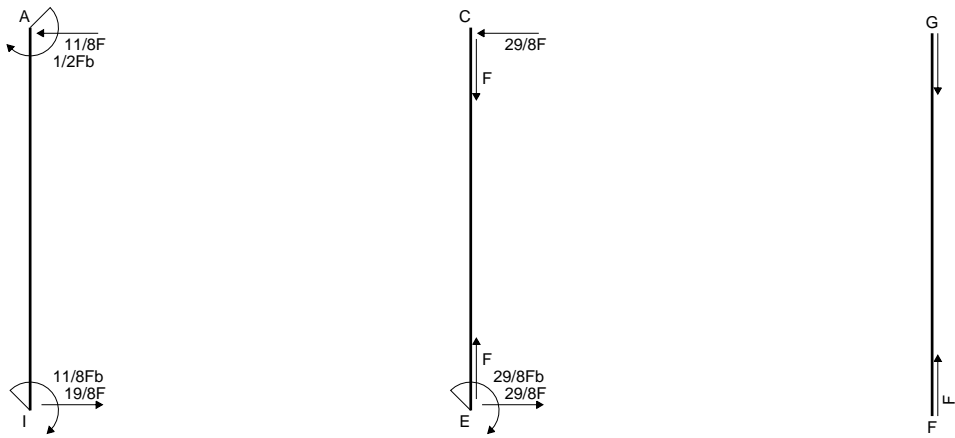
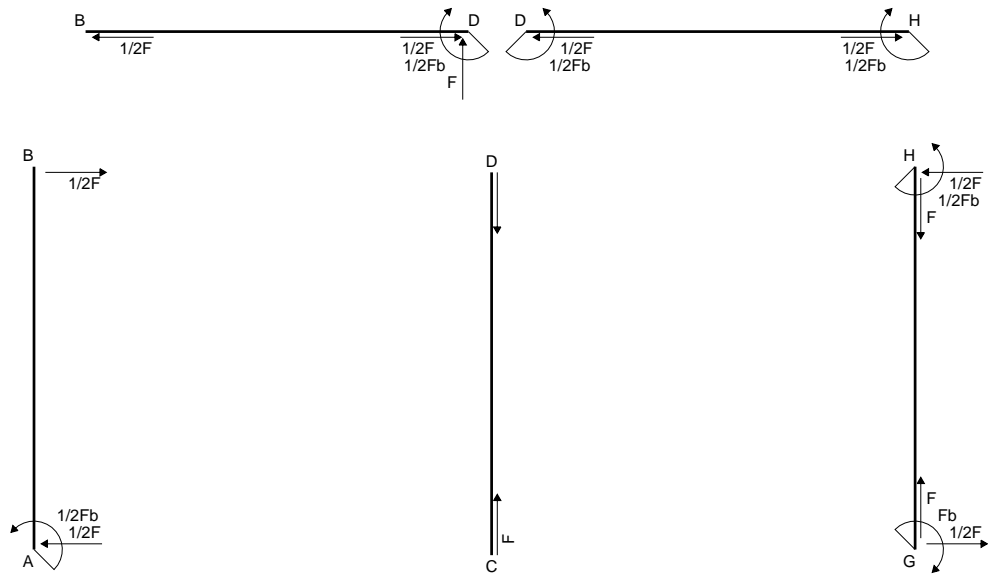
$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

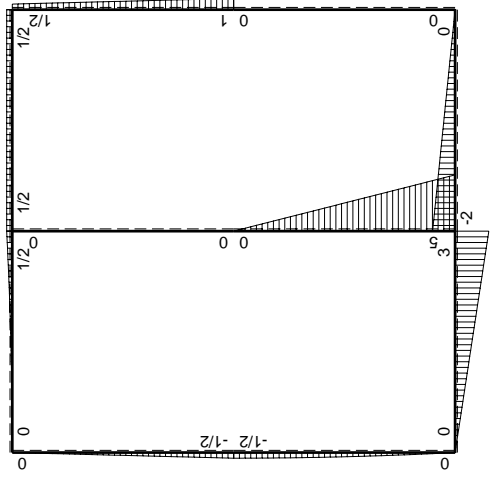
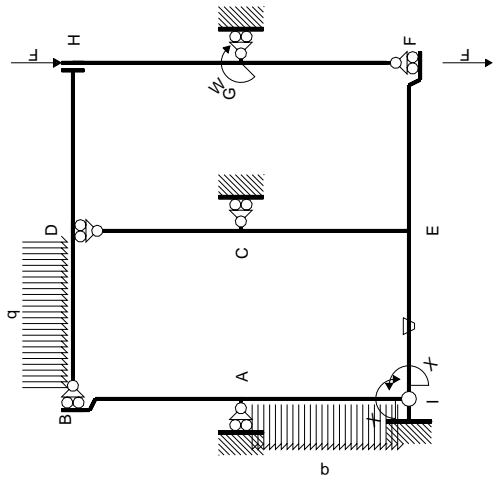
$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$



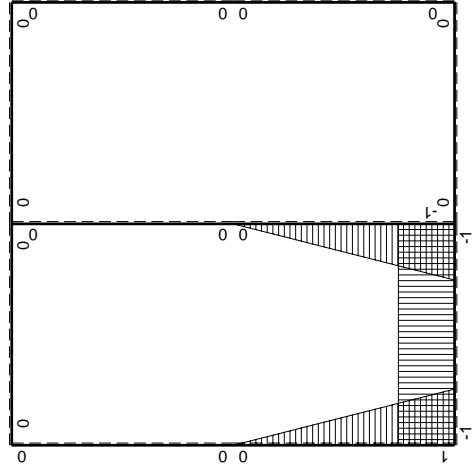
- A = 1248. mm²
- J_u = 320937. mm⁴
- J_v = 132480. mm⁴
- y_g = 30.13 mm
- T_y = 2660. N
- M_x = -2234400. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.13 mm
- σ_m = -Mv/J_u = -209.8 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -17.13 mm
- σ_c = -Mv/J_u = -119.3 N/mm²
- τ_c = 4.947 N/mm²
- σ_o = √σ²+3τ² = 119.6 N/mm²
- S = 7162. mm³





Schema di calcolo iperstatico

M₀ flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	0	-1/2Fb+1/2Fx	0	0	0	0	0+0	0	
BA b	0	1/2Fx	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	Fb-1/2Fx	0	0	0	0	0+0	0	
HG b	0	-1/2Fb-1/2Fx	0	0	0	0			
HD b	0	1/2Fb	0	0	0	0	0+0	0	
DH b	0	-1/2Fb	0	0	0	0			
DB b	0	1/2Fb-Fx+1/2qx ²	0	0	0	0	0+0	0	
BD b	0	-1/2qx ²	0	0	0	0			
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	(-3/2+1)Fb ² /EJ	Xb/EJ	
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1			
EC b	-1+x/b	5Fb-5Fx	0	-5Fb+10Fx-5Fx ² /b	0	1-2x/b+x ² /b ²	(-5/3+0)Fb ² /EJ	1/3Xb/EJ	
CE b	x/b	-5Fx	0	-5Fx ² /b	0	x ² /b ²			
IA b	1-x/b	-Fx+1/2qx ²	0	-Fx+3/2Fx ² /b-1/2qx ³ /b	0	1-2x/b+x ² /b ²	(-1/8+0)Fb ² /EJ	1/3Xb/EJ	
AI b	-x/b	1/2Fb-1/2qx ²	0	-1/2Fx+1/2qx ³ /b	0	x ² /b ²			
	totali							-55/24Fb ² /EJ	5/3Xb/EJ
	iperstatica $X=W_{IE}$							11/8Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{x_0} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{x_0} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{x_0} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 5b - 5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{CE}^{x_0} = \int_0^b (-5x^2/b^2) Fb \frac{1}{EJ} dx = [-5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

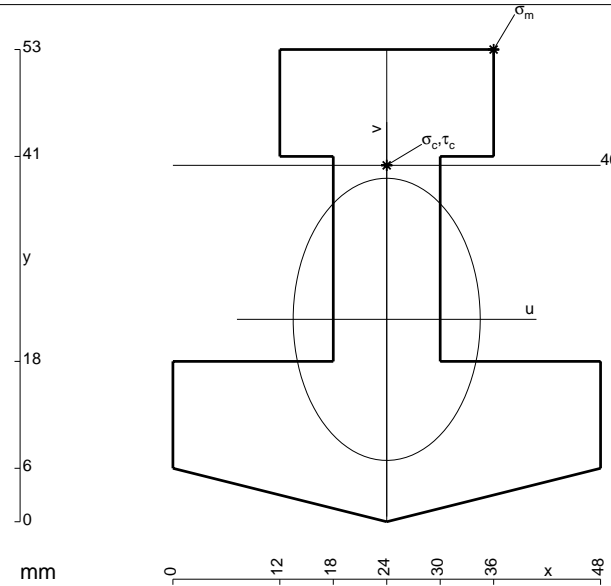
$$= (-5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{IA}^{x_0} = \int_0^b (-x/b + 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb \frac{1}{EJ}$$

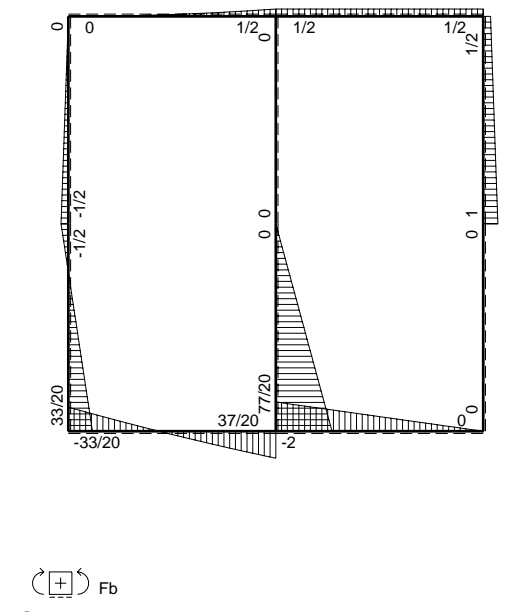
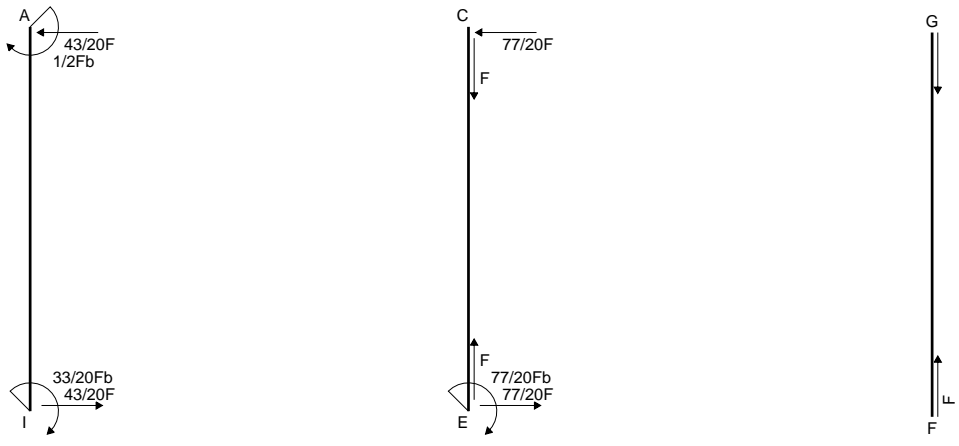
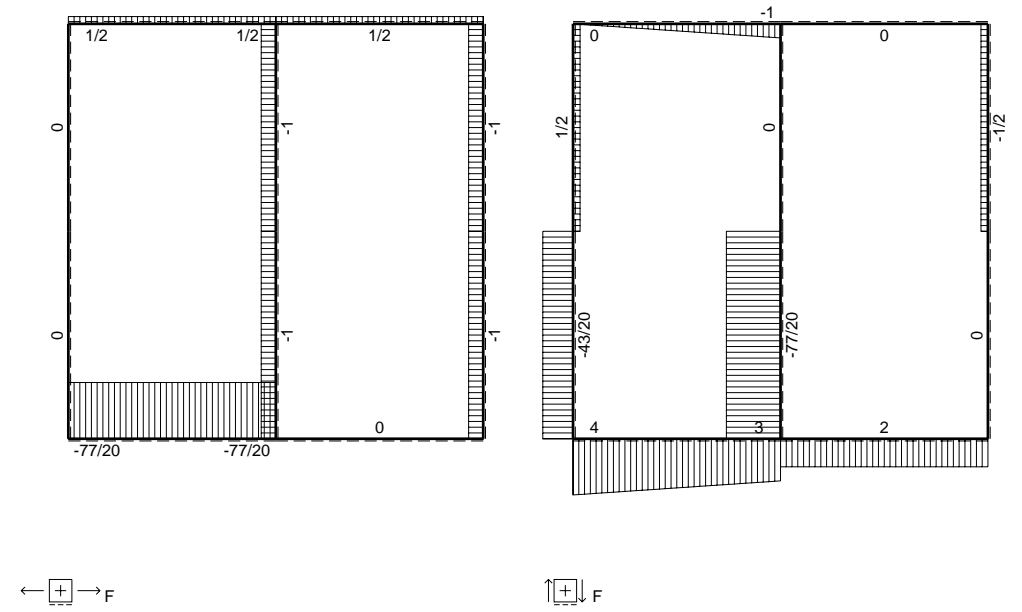
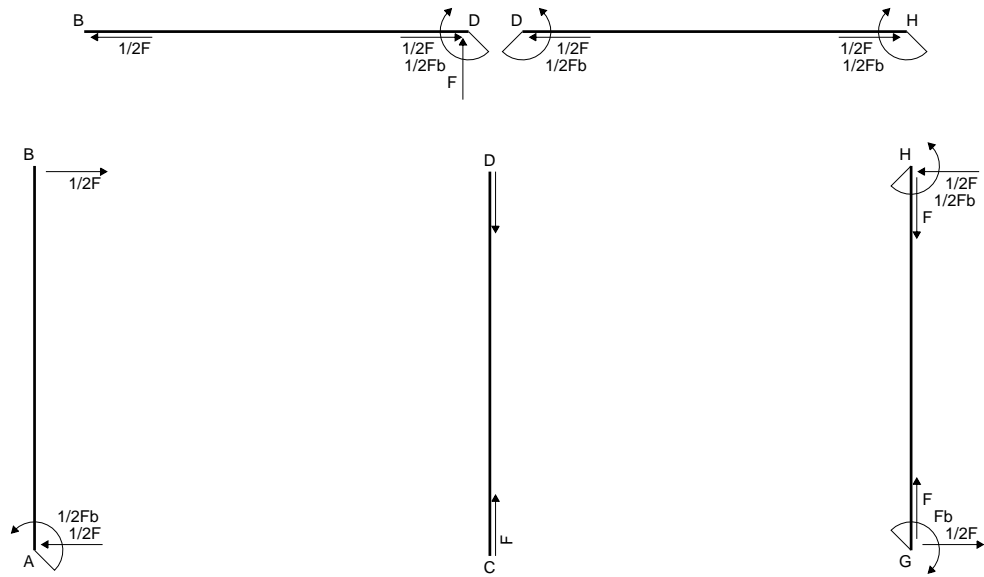
$$= (-1/2 b + 1/2 b - 1/8 b) Fb \frac{1}{EJ} = -1/8 Fb^2/EJ$$

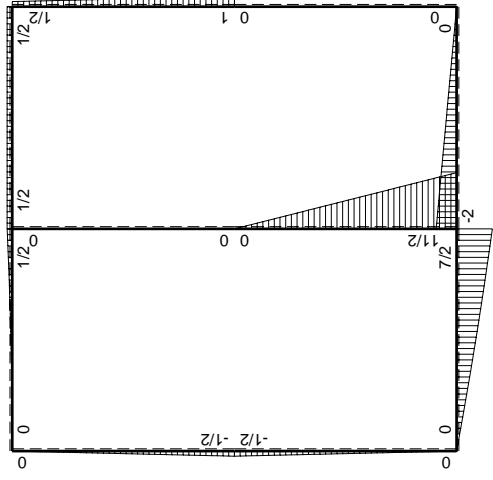
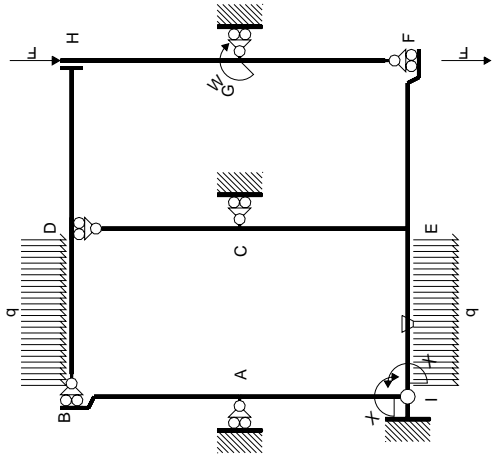
$$L_{AI}^{x_0} = \int_0^b (-1/2 x/b + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/8 x^4/b^3]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/8 b) Fb \frac{1}{EJ} = -1/8 Fb^2/EJ$$



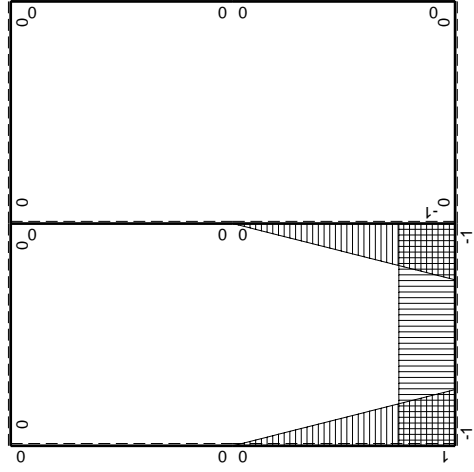
- A = 1284. mm²
- J_u = 321948. mm⁴
- J_v = 141552. mm⁴
- y_g = 22.72 mm
- T_y = 2580. N
- M_x = -2322000. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.28 mm
- σ_m = -Mv/J_u = 218.4 N/mm²
- x_c = 24. mm
- y_c = 40. mm
- v_c = 17.28 mm
- σ_c = -Mv/J_u = 124.7 N/mm²
- τ_c = 4.813 N/mm²
- σ_q = √σ²+3τ² = 124.9 N/mm²
- S = 7208. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fb-1/2Fx$	0	0	0	0			
HD b	0	$1/2Fb$	0	0	0	0	0+0	0	
DH b	0	$-1/2Fb$	0	0	0	0			
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
BD b	0	$-1/2qx^2$	0	0	0	0			
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-11/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$33/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

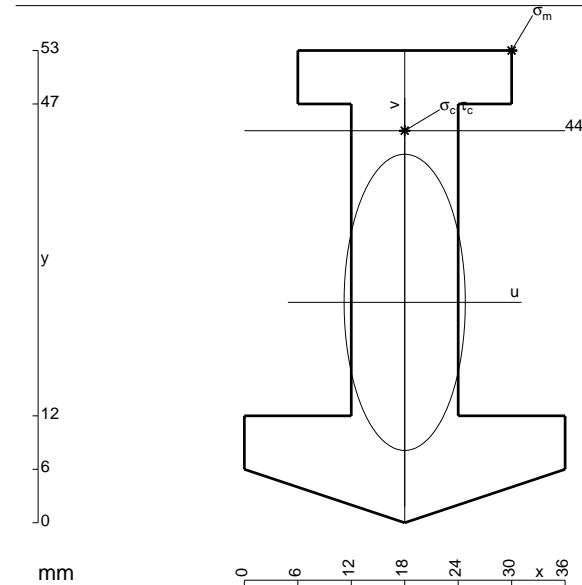
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

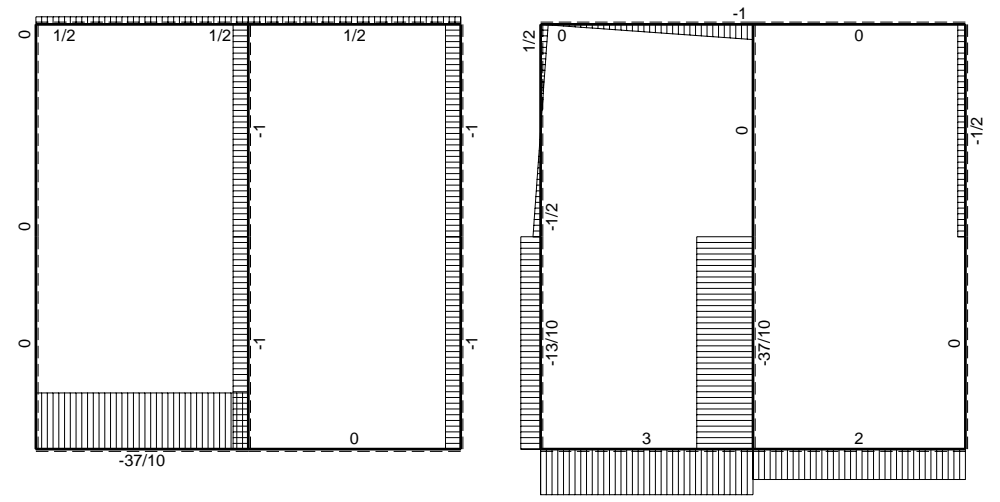
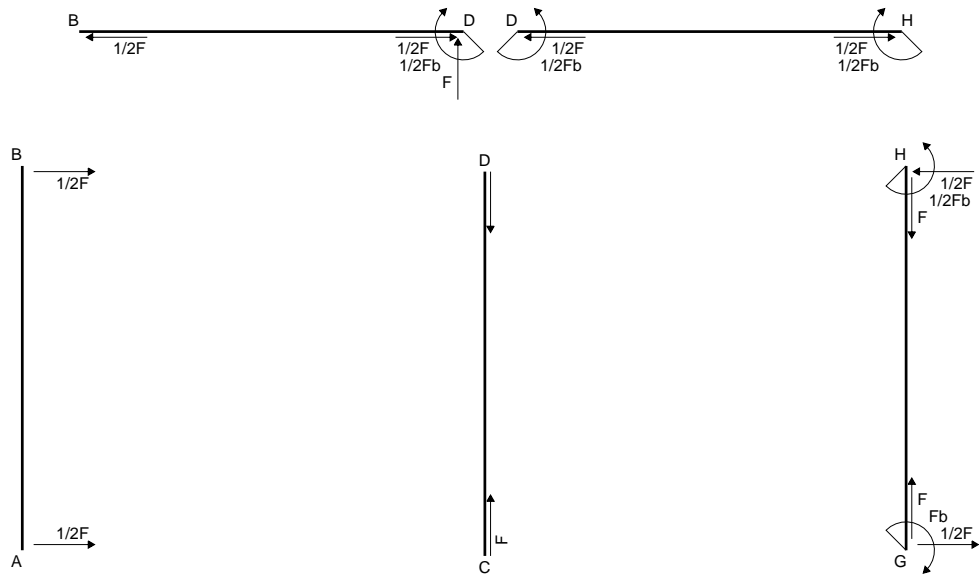
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

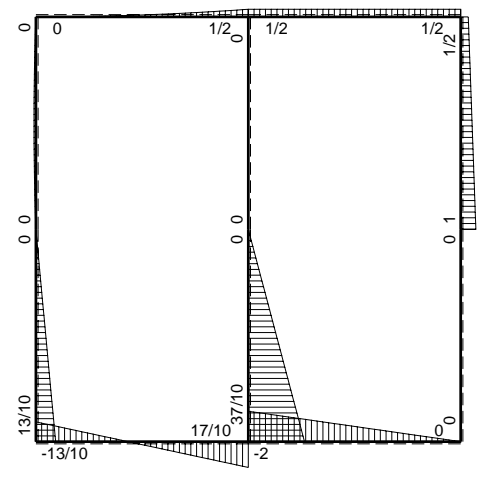
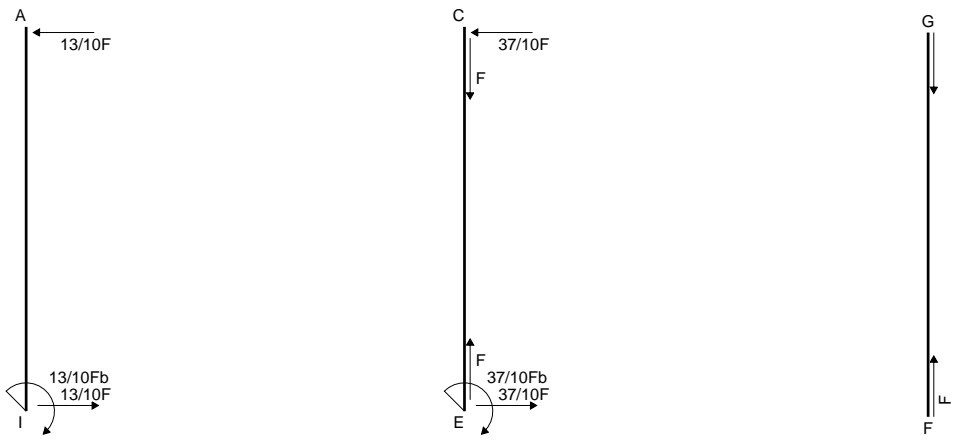


- A = 888. mm²
- J_u = 245538. mm⁴
- J_v = 41112. mm⁴
- y_g = 24.74 mm
- T_y = 2100. N
- M_x = -1995000. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.26 mm
- σ_m = -Mv/J_u = 229.6 N/mm²
- x_c = 18. mm
- y_c = 44. mm
- v_c = 19.26 mm
- σ_c = -Mv/J_u = 156.5 N/mm²
- τ_c = 3.126 N/mm²
- σ_q = √σ²+3τ² = 156.6 N/mm²
- S = 4385. mm³

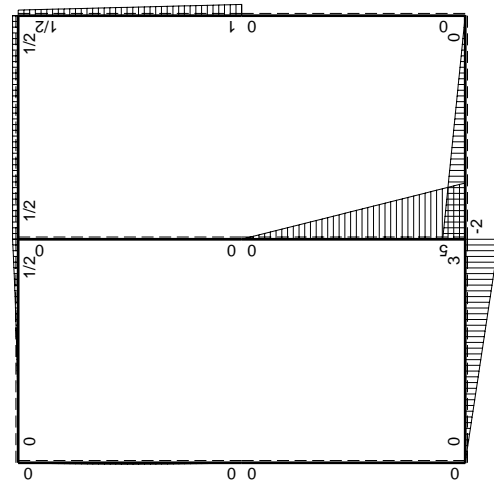
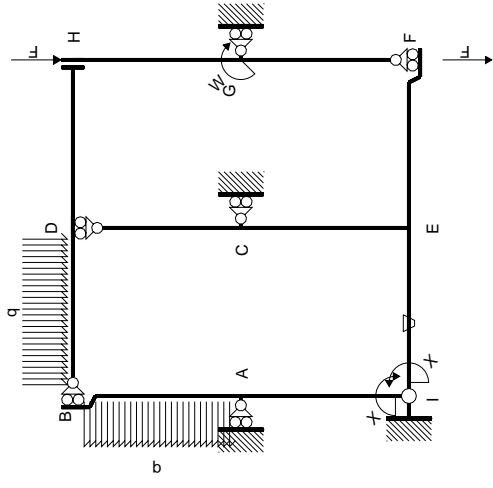


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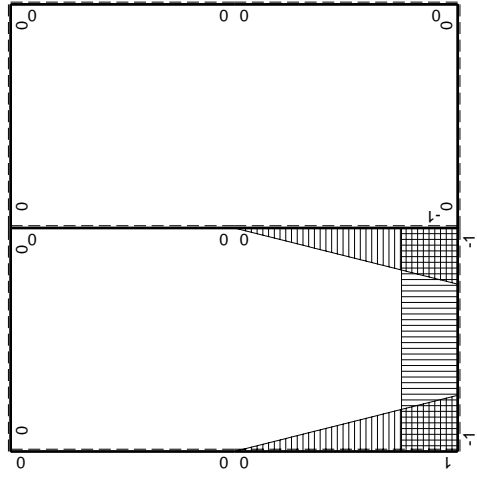


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$13/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

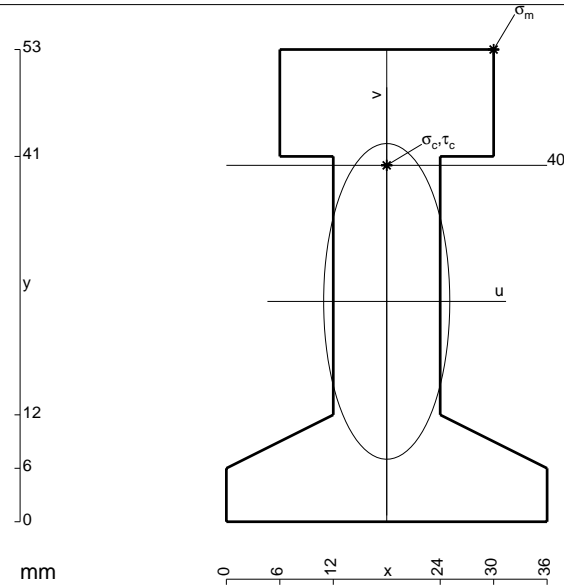
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$



$$A = 996. \text{ mm}^2$$

$$J_u = 312739. \text{ mm}^4$$

$$J_v = 49968. \text{ mm}^4$$

$$y_g = 24.73 \text{ mm}$$

$$T_y = 2640. \text{ N}$$

$$M_x = -2640000. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 28.27 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 238.7 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

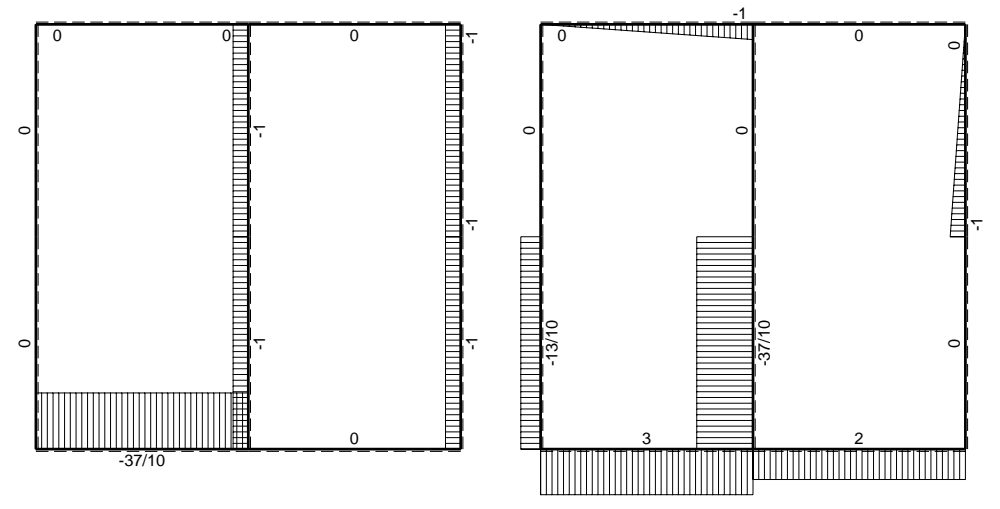
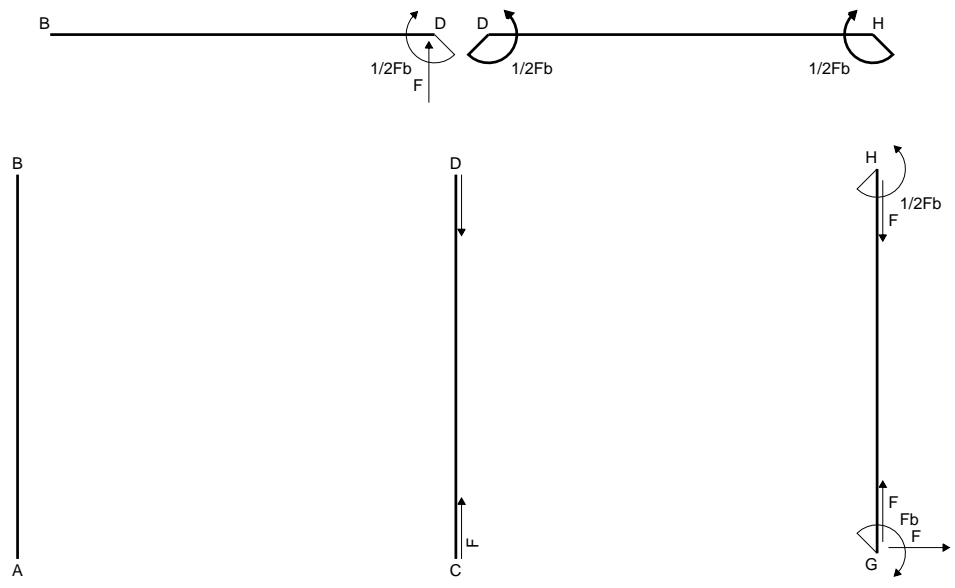
$$v_c = 15.27 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 128.9 \text{ N/mm}^2$$

$$\tau_c = 4.645 \text{ N/mm}^2$$

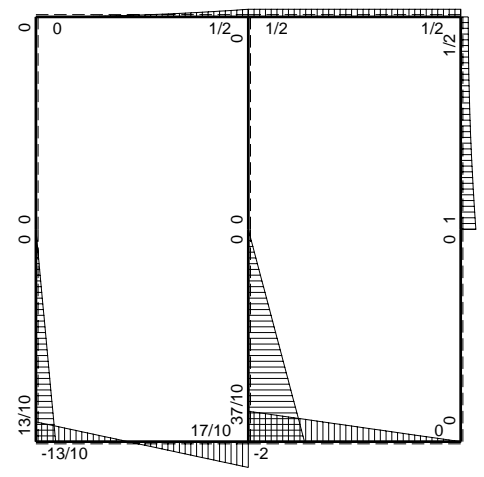
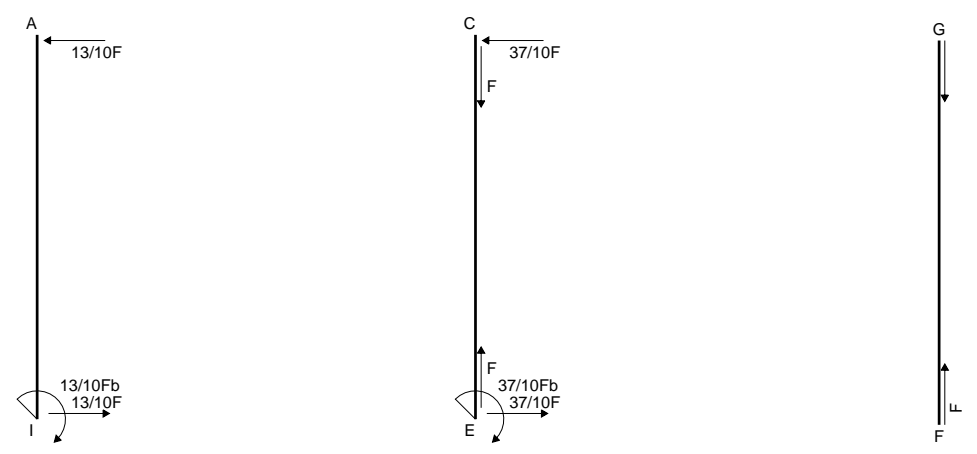
$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 129.2 \text{ N/mm}^2$$

$$S = 6603. \text{ mm}^3$$

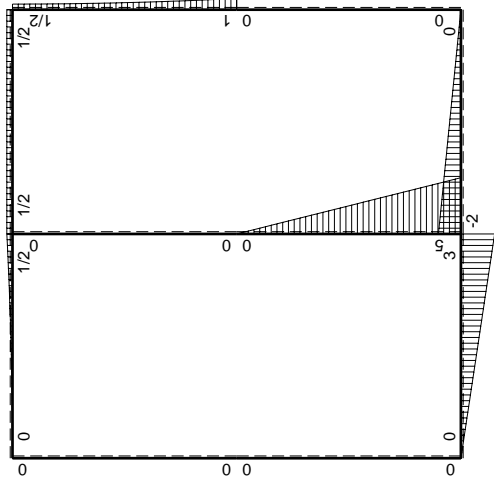
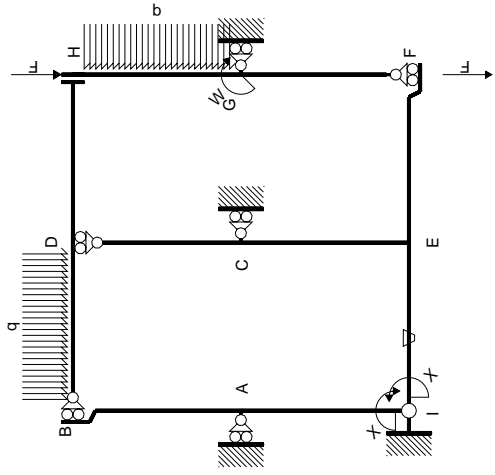


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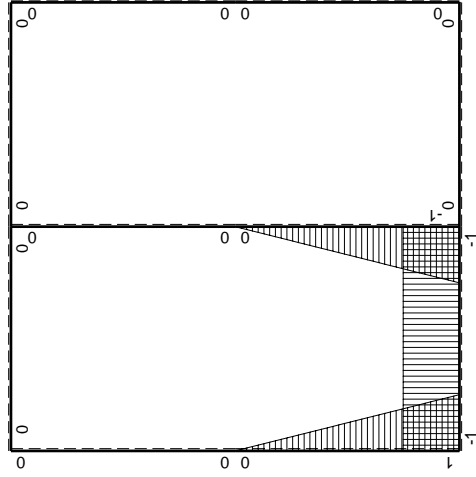


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	0	0	0	0	0	0+0	0	
BA b	0	0	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	Fb-Fx+1/2qx ²	0	0	0	0	0+0	0	
HG b	0	-1/2Fb-1/2qx ²	0	0	0	0			
HD b	0	1/2Fb	0	0	0	0	0+0	0	
DH b	0	-1/2Fb	0	0	0	0			
DB b	0	1/2Fb-Fx+1/2qx ²	0	0	0	0	0+0	0	
BD b	0	-1/2qx ²	0	0	0	0			
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ	
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1			
EC b	-1+x/b	5Fb-5Fx	0	-5Fb+10Fx-5Fx ² /b	0	1-2x/b+x ² /b ²	$(-5/3+0)Fb^2/EJ$	1/3Xb/EJ	
CE b	x/b	-5Fx	0	-5Fx ² /b	0	x ² /b ²			
IA b	1-x/b	0	0	0	0	1-2x/b+x ² /b ²	0+0	1/3Xb/EJ	
AI b	-x/b	0	0	0	0	x ² /b ²			
	totali							-13/6Fb ² /EJ	5/3Xb/EJ
	iperstatica $X=W_{IE}$							13/10Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

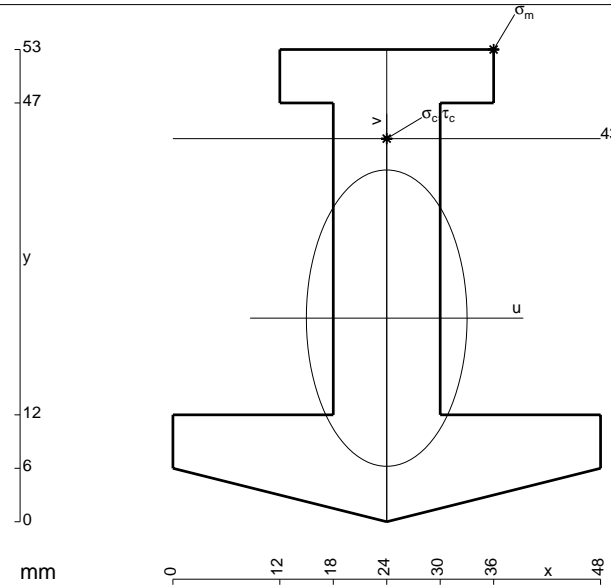
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

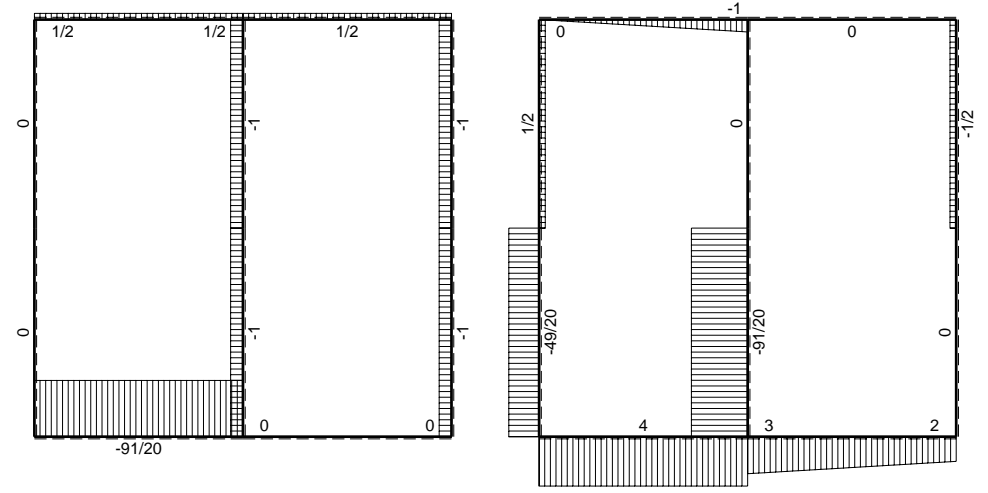
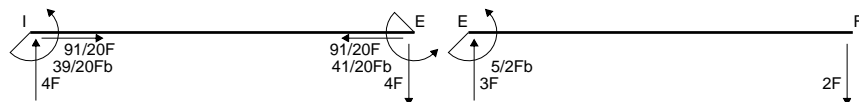
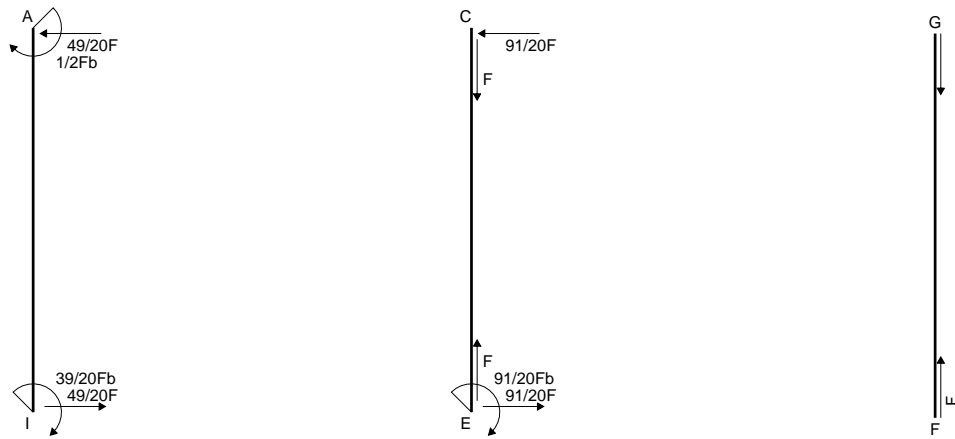
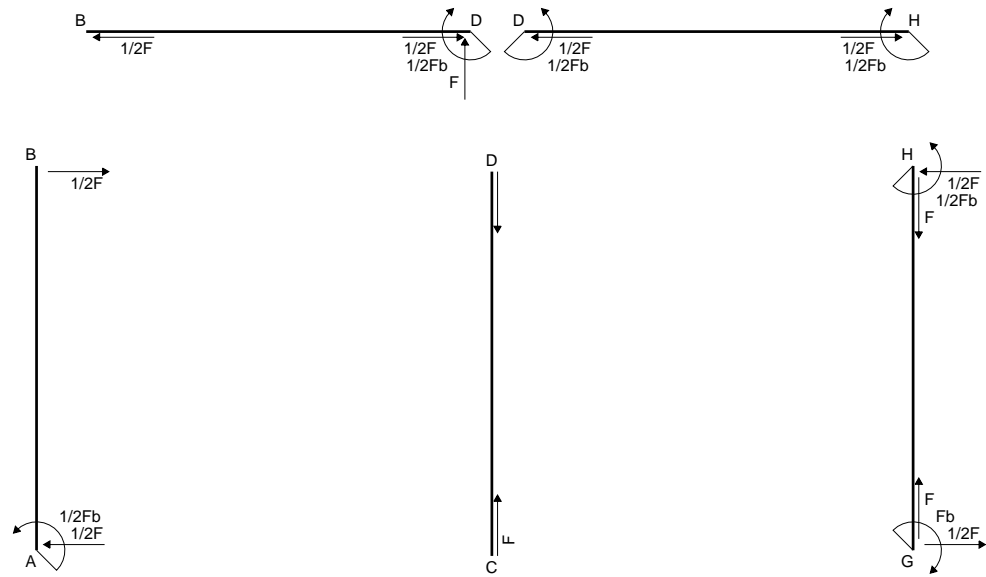
$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

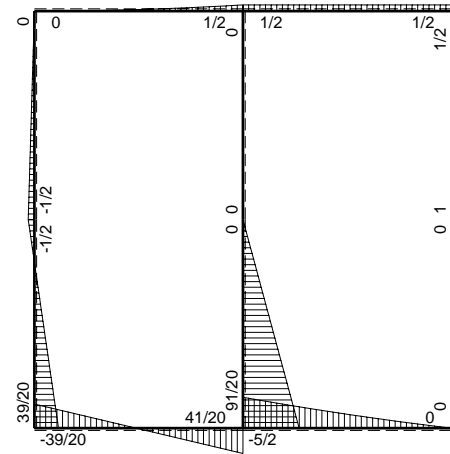


- A = 996. mm²
- J_u = 275589. mm⁴
- J_v = 81072. mm⁴
- y_g = 22.85 mm
- T_y = 3440. N
- M_x = -1823200. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.15 mm
- σ_m = -Mv/J_u = 199.5 N/mm²
- x_c = 24. mm
- y_c = 43. mm
- v_c = 20.15 mm
- σ_c = -Mv/J_u = 133.3 N/mm²
- τ_c = 5.173 N/mm²
- σ_q = √σ²+3τ² = 133.6 N/mm²
- S = 4973. mm³

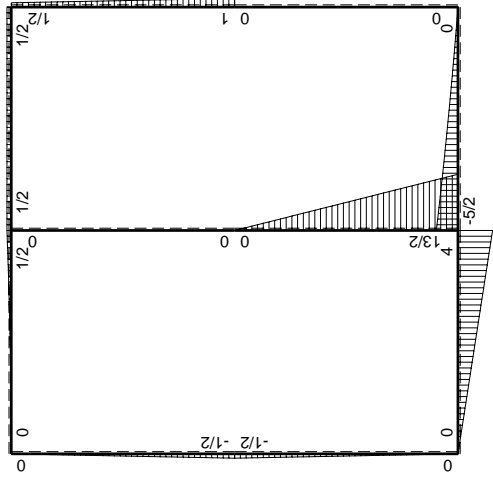
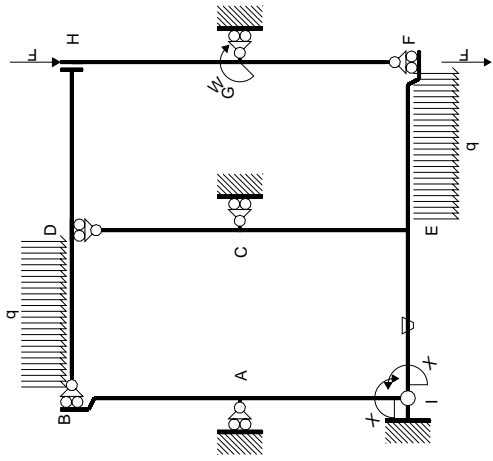


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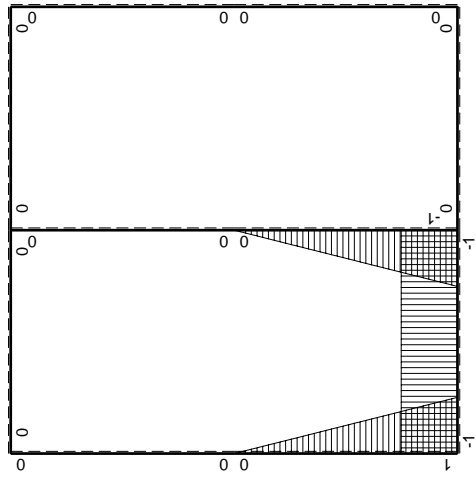


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-13/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$39/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b) Fb \frac{1}{EJ} + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-4 + 4x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-4b + 2b) Fb \frac{1}{EJ} + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

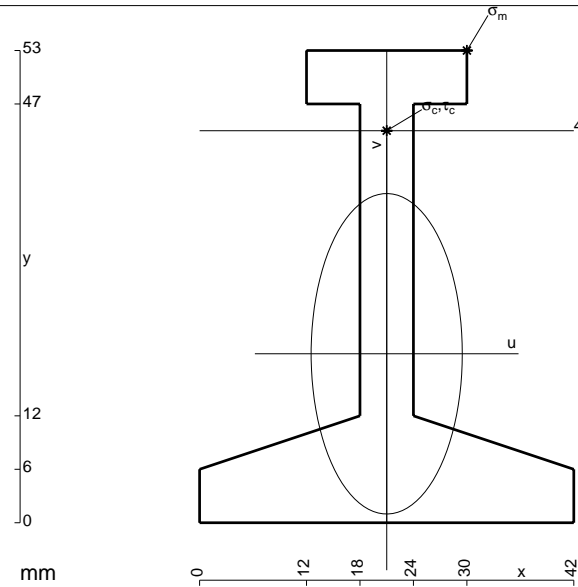
$$= (-13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

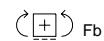
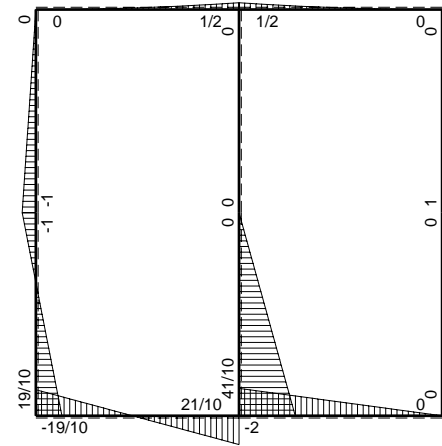
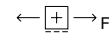
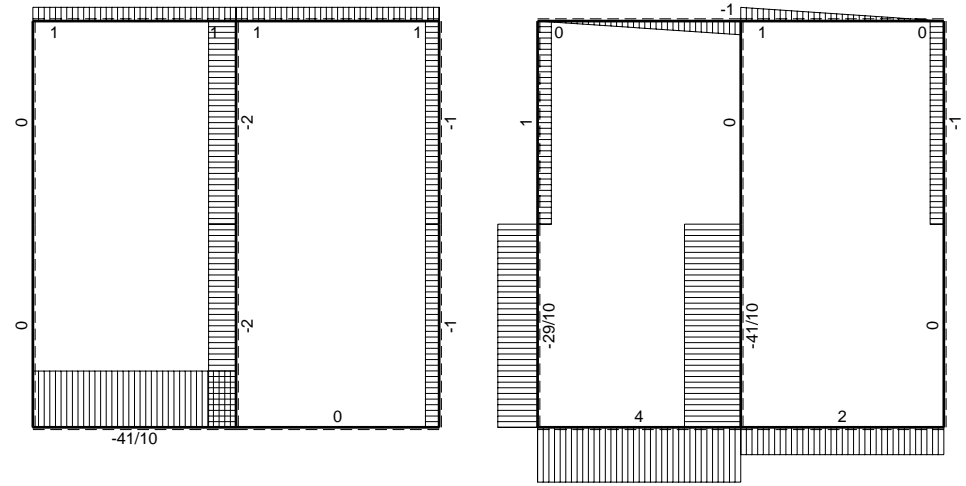
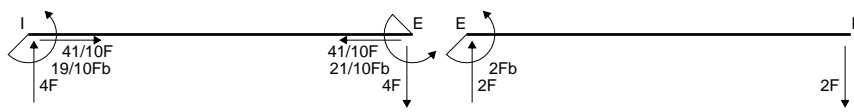
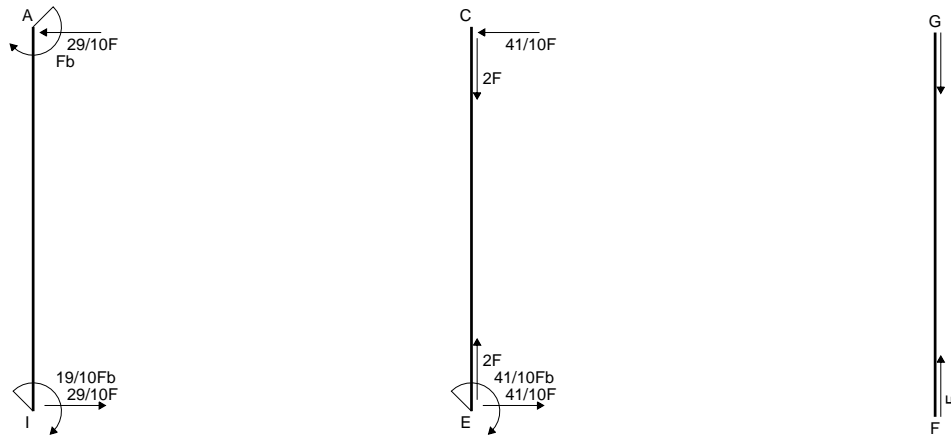
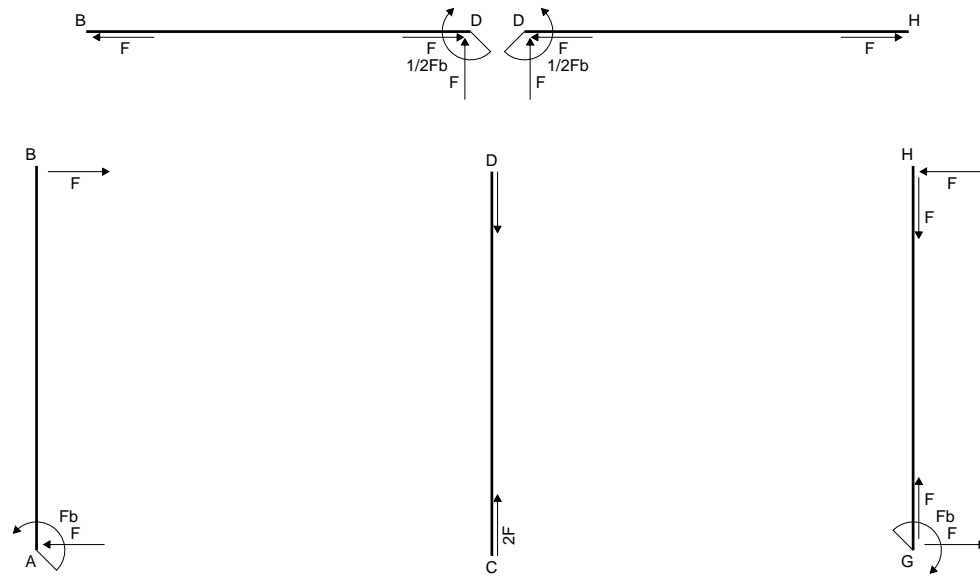
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

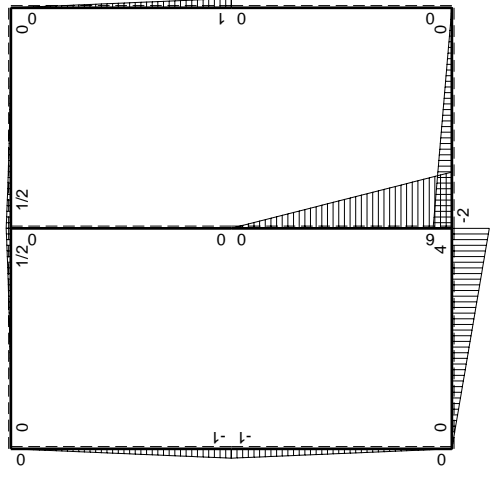
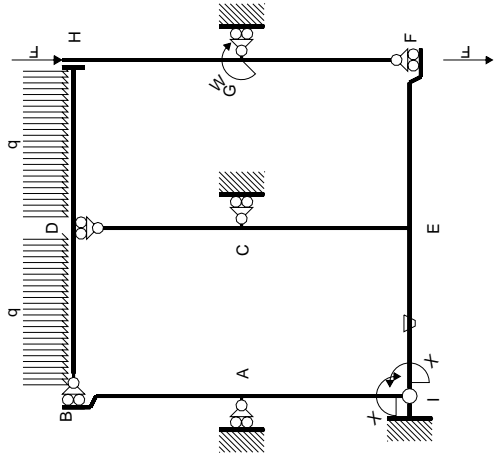
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



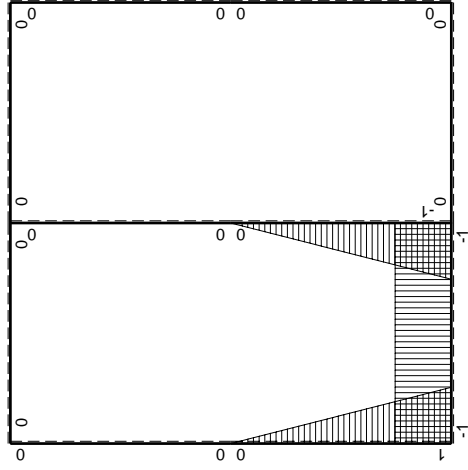
- A = 714. mm²
- J_u = 230961. mm⁴
- J_v = 51390. mm⁴
- y_g = 18.96 mm
- T_y = 2940. N
- M_x = -1421000. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 9. mm
- v_m = 34.04 mm
- σ_m = -Mv/J_u = 209.4 N/mm²
- x_c = 21. mm
- y_c = 44. mm
- v_c = 25.04 mm
- σ_c = -Mv/J_u = 154. N/mm²
- τ_c = 8.125 N/mm²
- σ_q = √σ²+3τ² = 154.7 N/mm²
- S = 3830. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-19/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						19/10Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b) Fb 1/EJ + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-4 + 4x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-4b + 2b) Fb 1/EJ + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb 1/EJ dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

$$= (-6b + 6b - 2b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb 1/EJ dx = [-2x^3/b^2]_0^b Fb 1/EJ$$

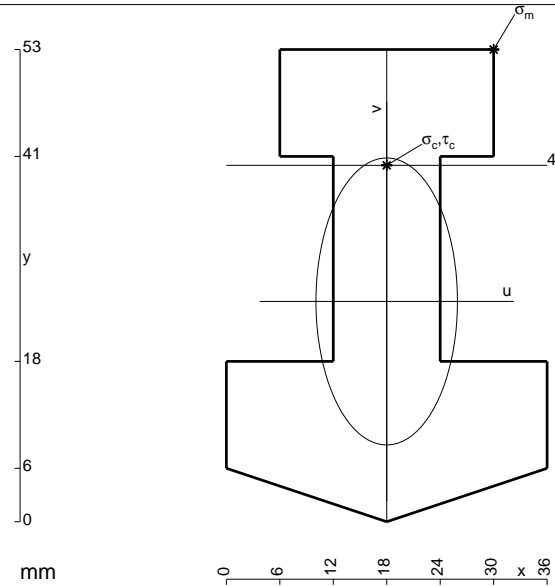
$$= (-2b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

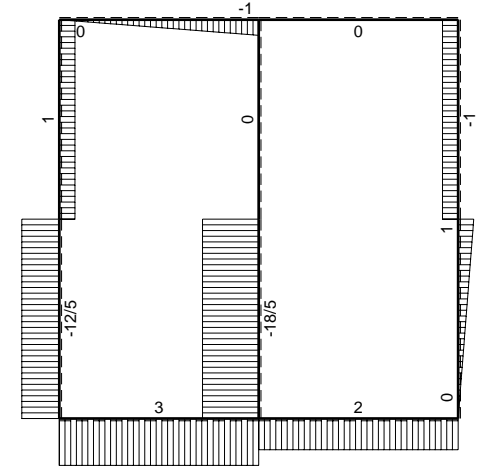
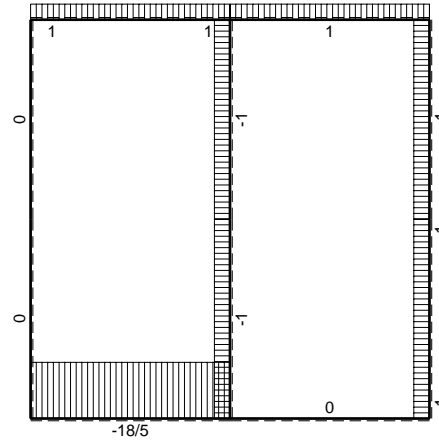
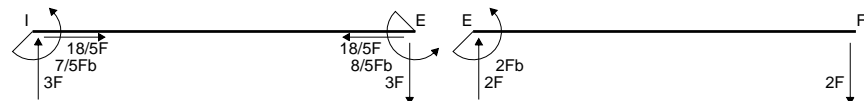
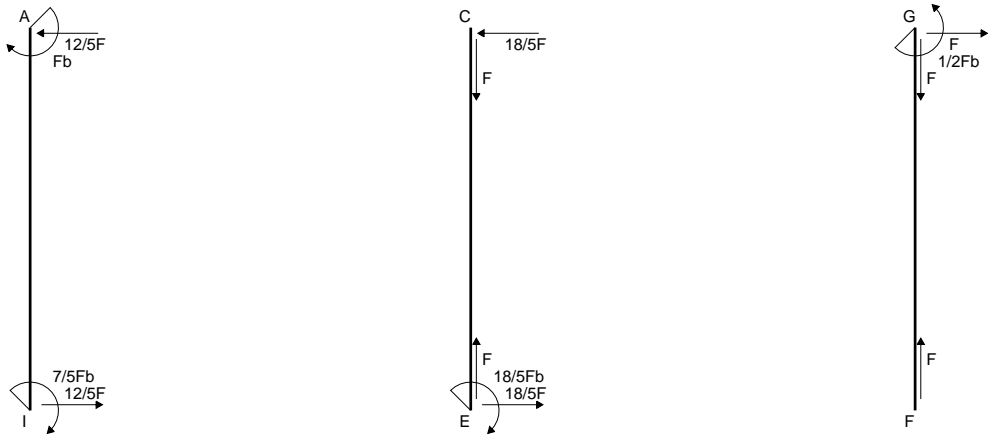
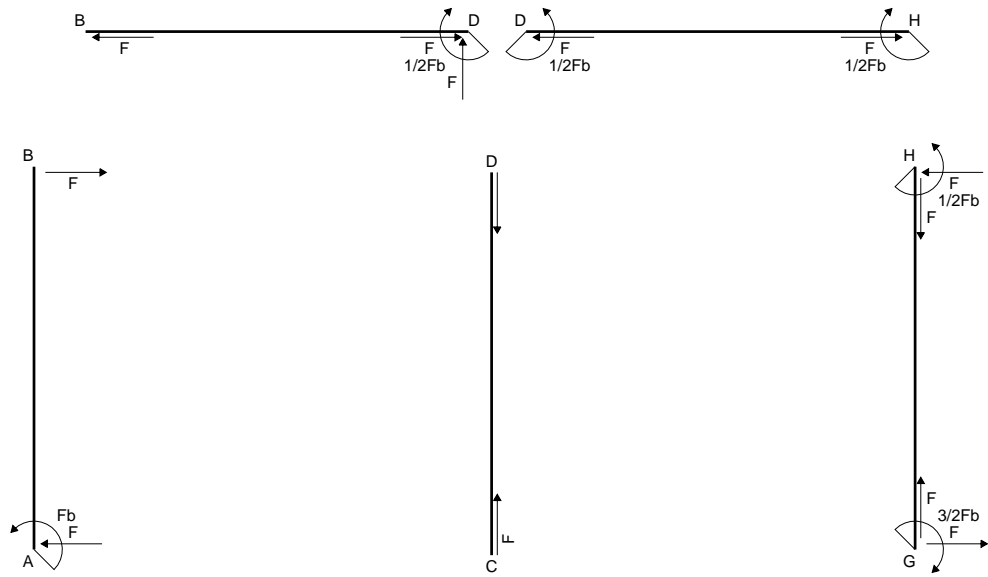
$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

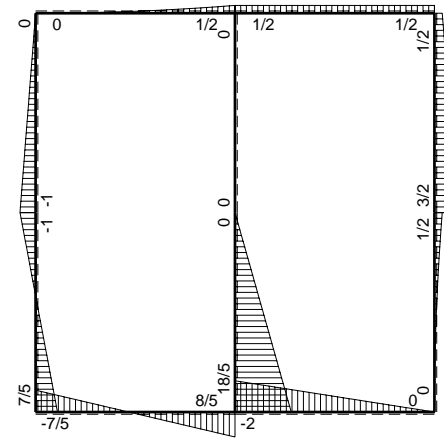


- A = 1104. mm²
- J_u = 286555. mm⁴
- J_v = 69624. mm⁴
- y_g = 24.72 mm
- T_y = 3520. N
- M_x = -2217600. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.28 mm
- σ_m = -Mv/J_u = 218.8 N/mm²
- x_c = 18. mm
- y_c = 40. mm
- v_c = 15.28 mm
- σ_c = -Mv/J_u = 118.2 N/mm²
- τ_c = 6.761 N/mm²
- σ_q = √σ²+3τ² = 118.8 N/mm²
- S = 6605. mm³

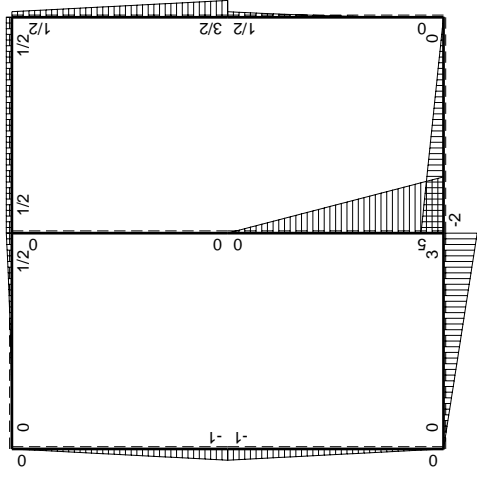
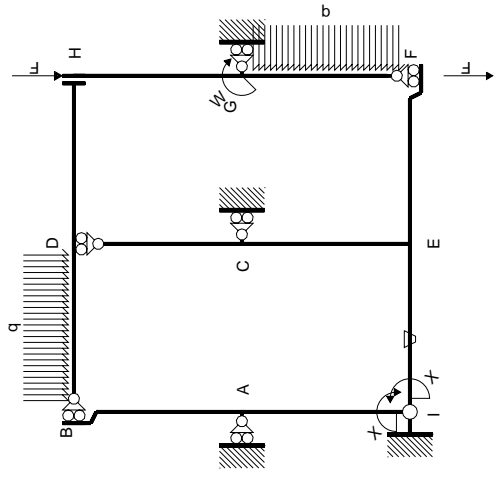


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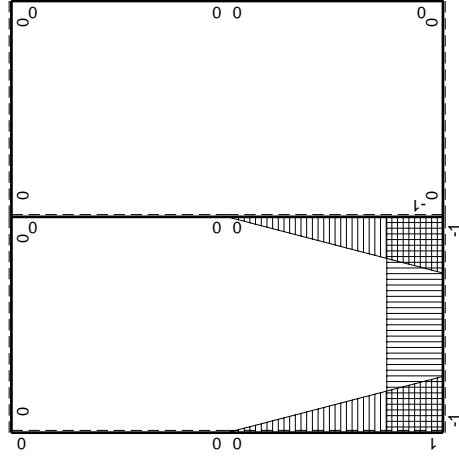


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb-Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 5b - 5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb \frac{1}{EJ} dx = [-5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

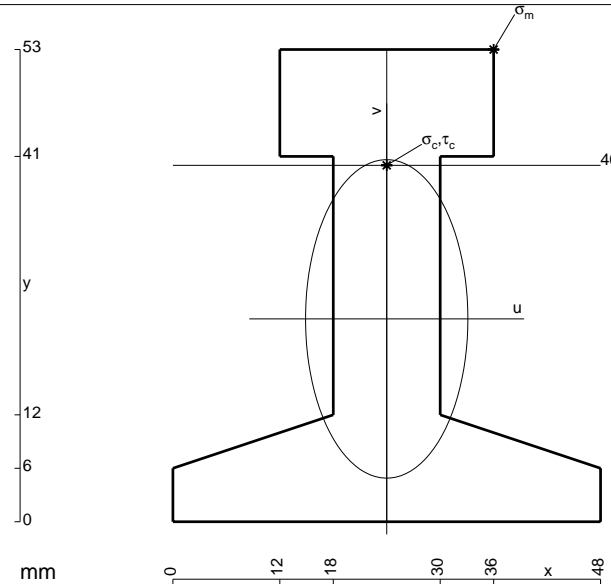
$$= (-5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

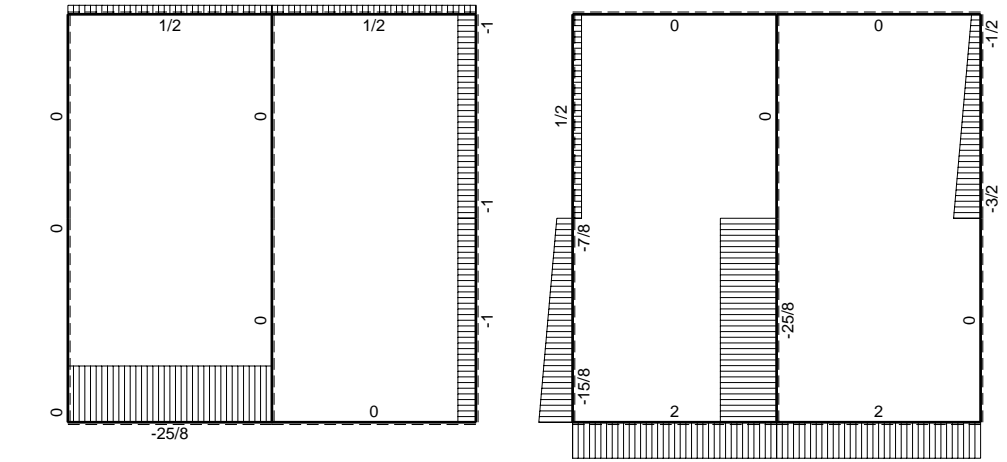
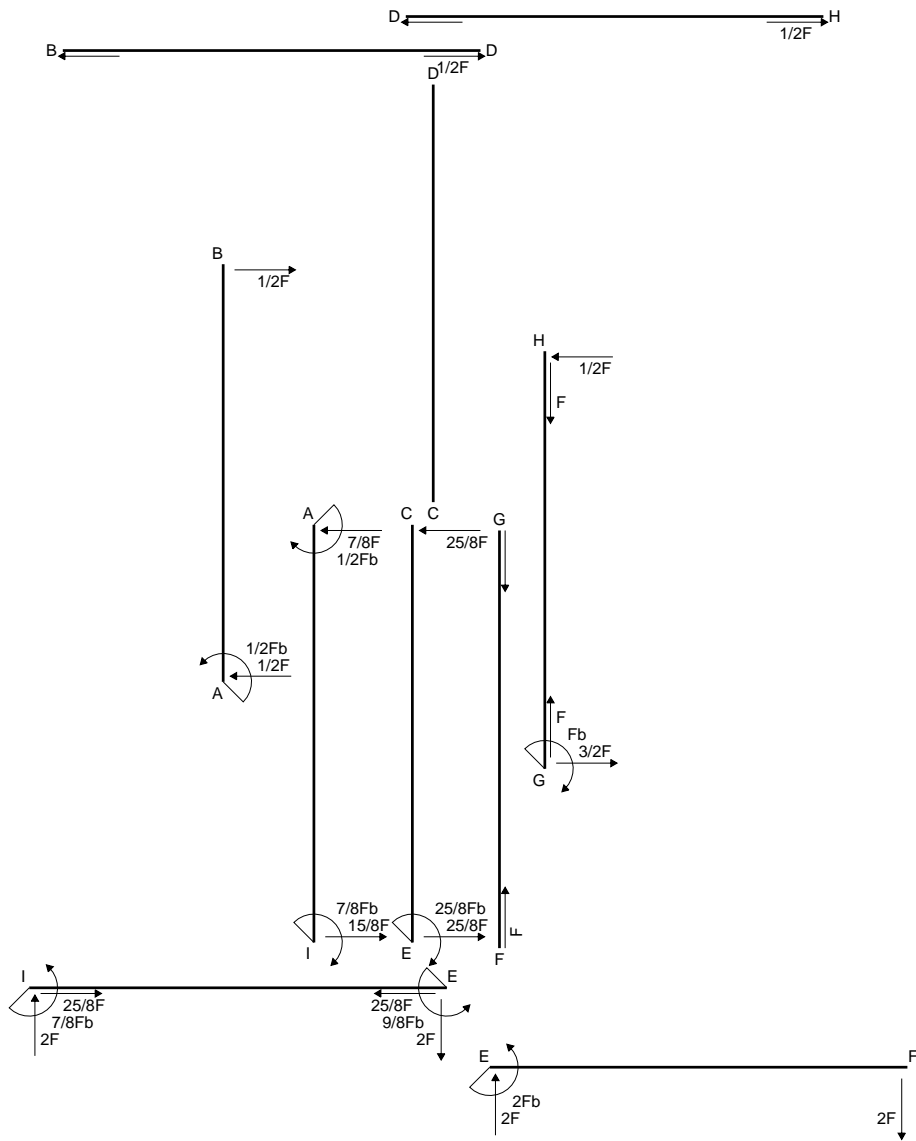
$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

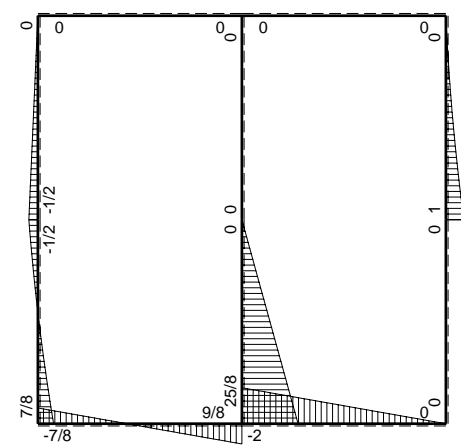


- A = 1104. mm²
- J_u = 352844. mm⁴
- J_v = 91656. mm⁴
- y_g = 22.77 mm
- T_y = 3940. N
- M_x = -2679200. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.23 mm
- σ_m = -Mv/J_u = 229.6 N/mm²
- x_c = 24. mm
- y_c = 40. mm
- v_c = 17.23 mm
- σ_c = -Mv/J_u = 130.9 N/mm²
- τ_c = 6.693 N/mm²
- σ_q = √σ²+3τ² = 131.4 N/mm²
- S = 7192. mm³

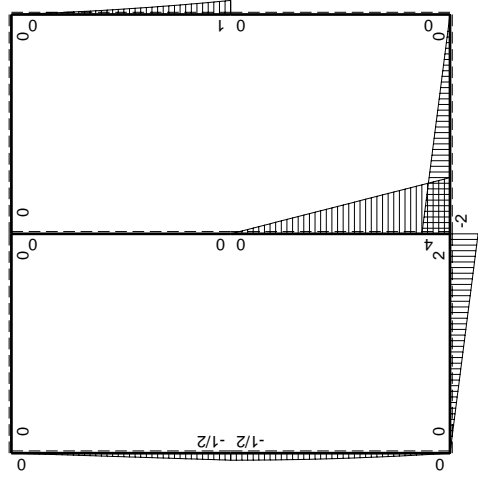
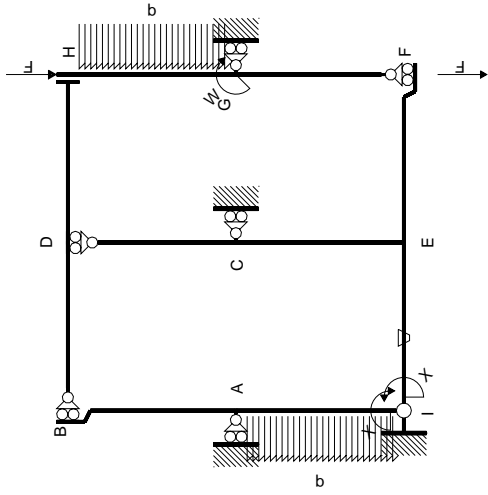


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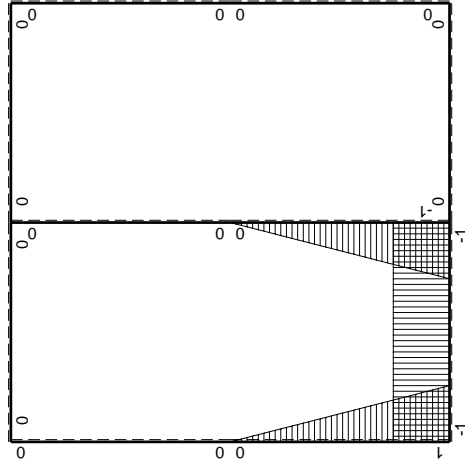


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2qx^2$	0	$-1/2Fx+1/2qx^3/b$	0	x^2/b^2		
	totali						$-35/24Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \cdot 1/EJ \, dx = [x]_0^b \cdot 1/EJ$$

$$= (b) \cdot 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \cdot 1/EJ \, dx = [x]_0^b \cdot 1/EJ$$

$$= (b) \cdot 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \cdot 1/EJ \, dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \cdot 1/EJ$$

$$= (b - b + 1/3 b) \cdot 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \cdot 1/EJ \, dx = [1/3 x^3/b^2]_0^b \cdot 1/EJ$$

$$= (1/3 b) \cdot 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \cdot 1/EJ \, dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \cdot 1/EJ$$

$$= (b - b + 1/3 b) \cdot 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \cdot 1/EJ \, dx = [1/3 x^3/b^2]_0^b \cdot 1/EJ$$

$$= (1/3 b) \cdot 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) \cdot Fb \cdot 1/EJ \, dx + \int_0^b (1) \cdot \theta \, dx = [-x^2/b]_0^b \cdot Fb \cdot 1/EJ + [x]_0^b \cdot \theta$$

$$= (-b) \cdot Fb \cdot 1/EJ + (b) \cdot \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) \cdot Fb \cdot 1/EJ \, dx + \int_0^b (-1) \cdot \theta \, dx = [-2x + x^2/b]_0^b \cdot Fb \cdot 1/EJ + [-x]_0^b \cdot \theta$$

$$= (-2b + b) \cdot Fb \cdot 1/EJ + (-b) \cdot \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 8x/b - 4x^2/b^2) \cdot Fb \cdot 1/EJ \, dx = [-4x + 4x^2/b - 4/3 x^3/b^2]_0^b \cdot Fb \cdot 1/EJ$$

$$= (-4b + 4b - 4/3 b) \cdot Fb \cdot 1/EJ = -4/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-4x^2/b^2) \cdot Fb \cdot 1/EJ \, dx = [-4/3 x^3/b^2]_0^b \cdot Fb \cdot 1/EJ$$

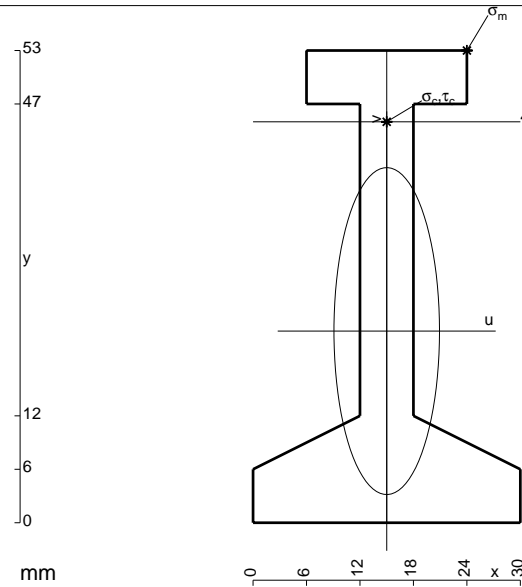
$$= (-4/3 b) \cdot Fb \cdot 1/EJ = -4/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + 3/2 x^2/b^2 - 1/2 x^3/b^3) \cdot Fb \cdot 1/EJ \, dx = [-1/2 x^2/b + 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b \cdot Fb \cdot 1/EJ$$

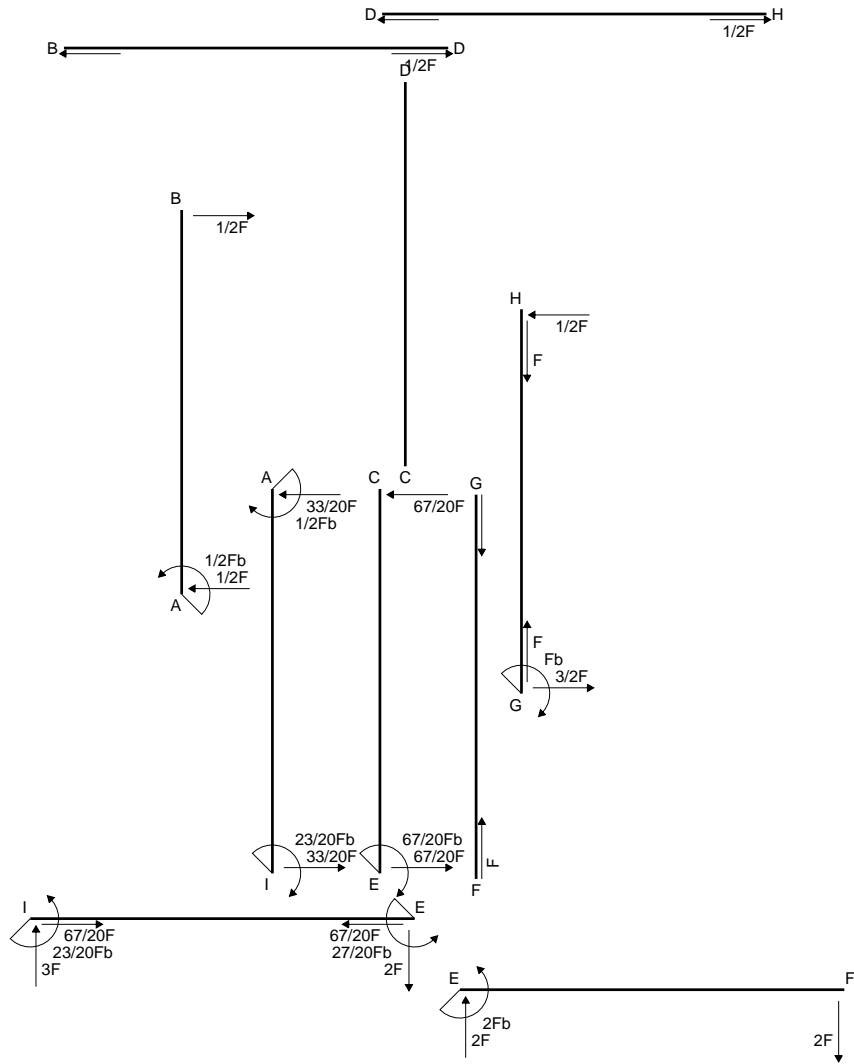
$$= (-1/2 b + 1/2 b - 1/8 b) \cdot Fb \cdot 1/EJ = -1/8 Fb^2/EJ$$

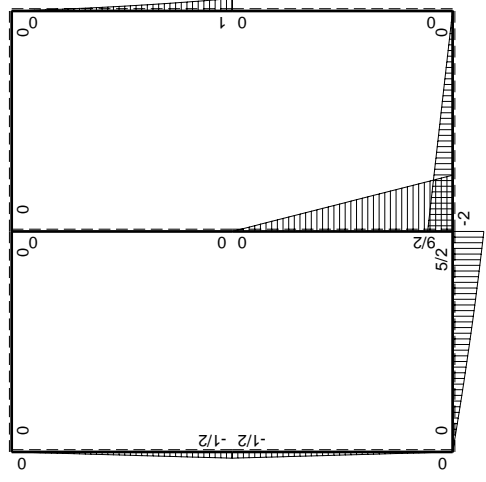
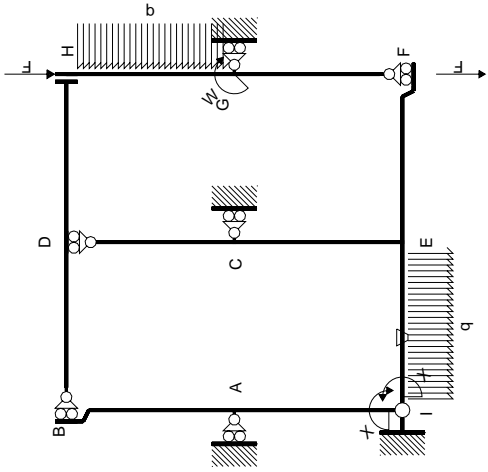
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^3/b^3) \cdot Fb \cdot 1/EJ \, dx = [-1/4 x^2/b + 1/8 x^4/b^3]_0^b \cdot Fb \cdot 1/EJ$$

$$= (-1/4 b + 1/8 b) \cdot Fb \cdot 1/EJ = -1/8 Fb^2/EJ$$



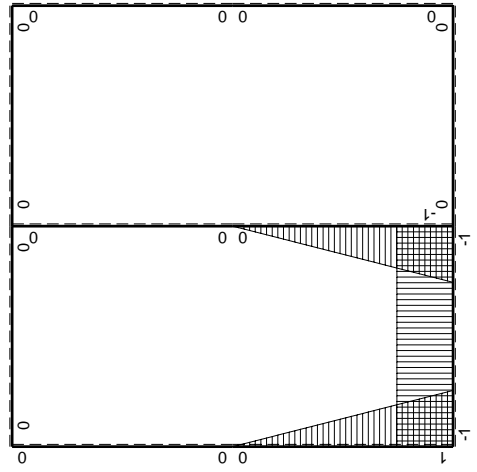
- A = 606. mm²
- J_u = 204068. mm⁴
- J_v = 21258. mm⁴
- y_g = 21.51 mm
- T_y = 2100. N
- M_x = -1554000. Nmm
- x_m = 24. mm
- y_m = 53. mm
- u_m = 9. mm
- v_m = 31.49 mm
- σ_m = -Mv/J_u = 239.8 N/mm²
- x_c = 15. mm
- y_c = 45. mm
- v_c = 23.49 mm
- σ_c = -Mv/J_u = 178.9 N/mm²
- τ_c = 5.781 N/mm²
- σ_q = √σ²+3τ² = 179.2 N/mm²
- S = 3371. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$9/2Fb-9/2Fx$	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-9/2Fx$	0	$-9/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-23/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$23/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -1/3 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-5/2 + 2x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-5/2 b + b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -1/3 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-9/2 + 9x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-9/2 x + 9/2 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-9/2 b + 9/2 b - 3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

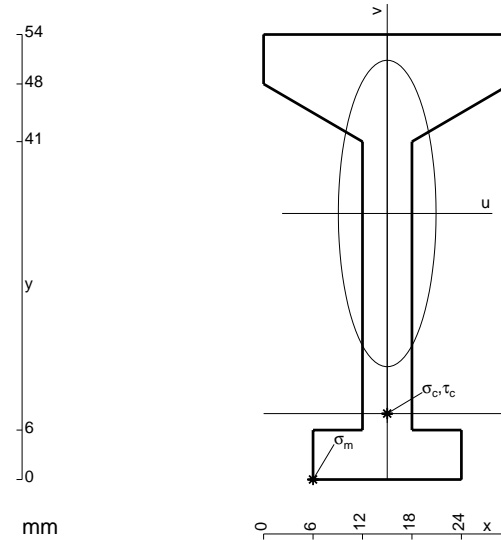
$$= (-3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

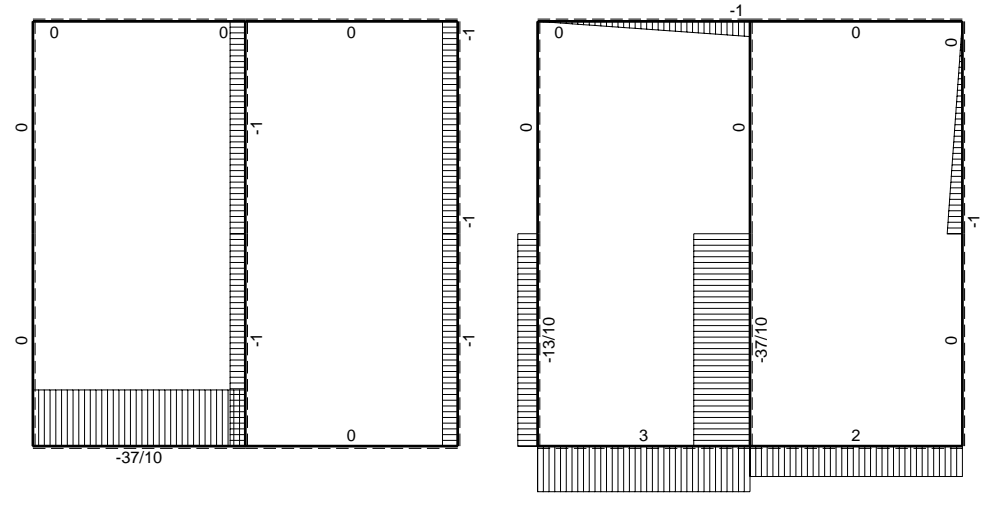
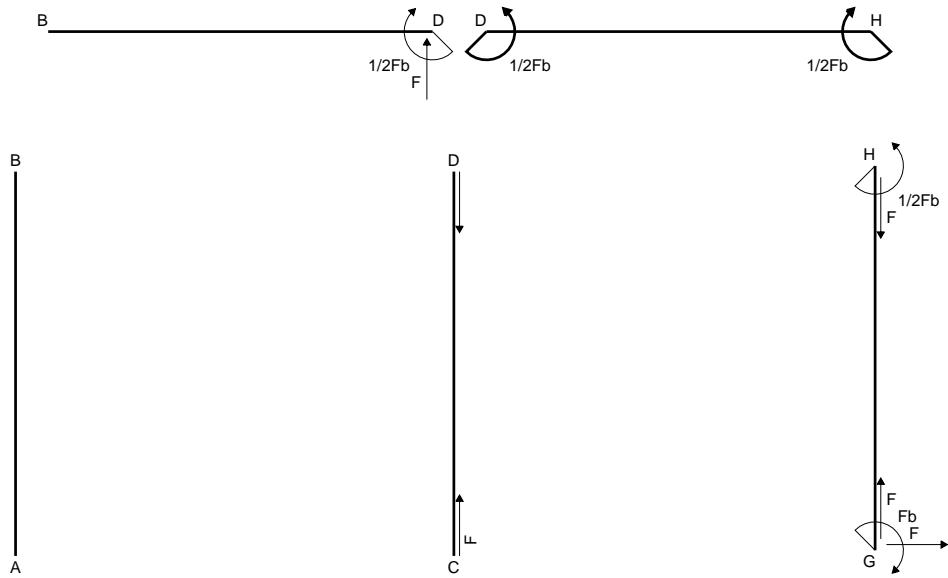
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

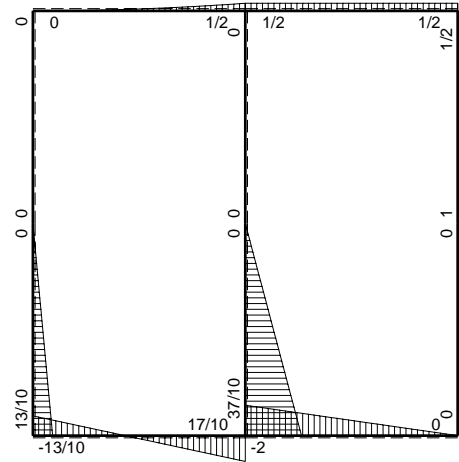
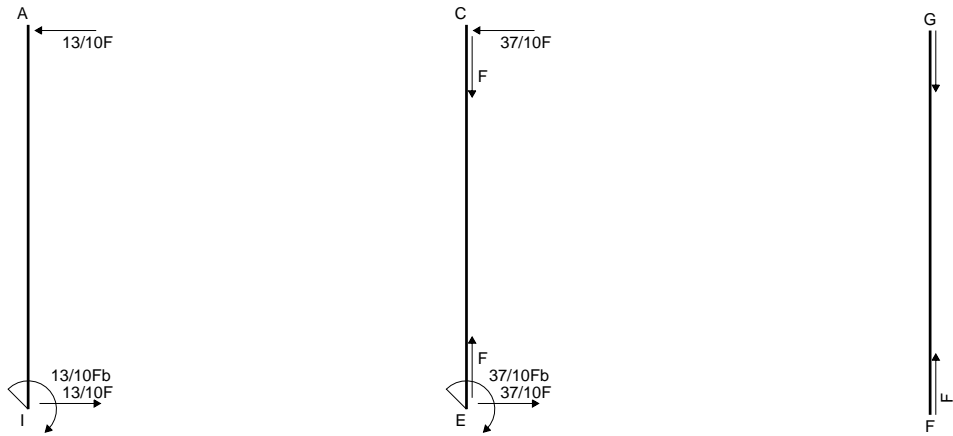


- A = 624. mm²
- J_u = 215884. mm⁴
- J_v = 21960. mm⁴
- y_g = 32.28 mm
- T_y = 1640. N
- M_x = -1328400. Nmm
- x_m = 6. mm
- u_m = -9. mm
- v_m = -32.28 mm
- σ_m = -Mv/J_u = -198.6 N/mm²
- x_c = 15. mm
- y_c = 8. mm
- v_c = -24.28 mm
- σ_c = -Mv/J_u = -149.4 N/mm²
- τ_c = 4.388 N/mm²
- σ_o = √σ²+3τ² = 149.6 N/mm²
- S = 3466. mm³

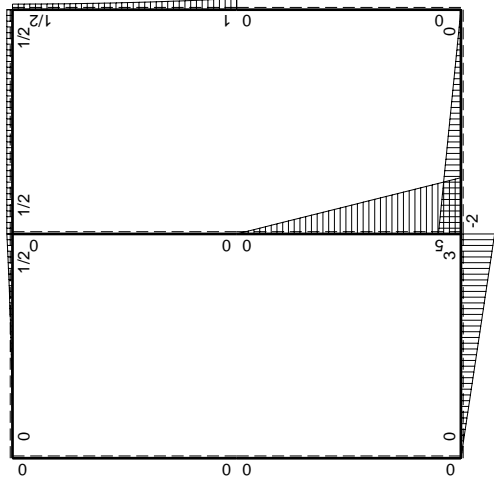
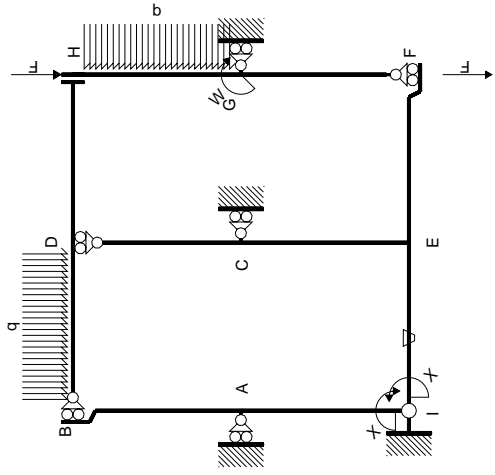


← ⊕ → F

↑ ⊕ ↓ F

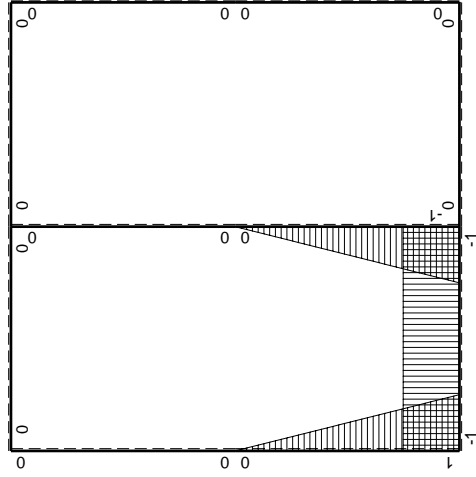


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$13/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

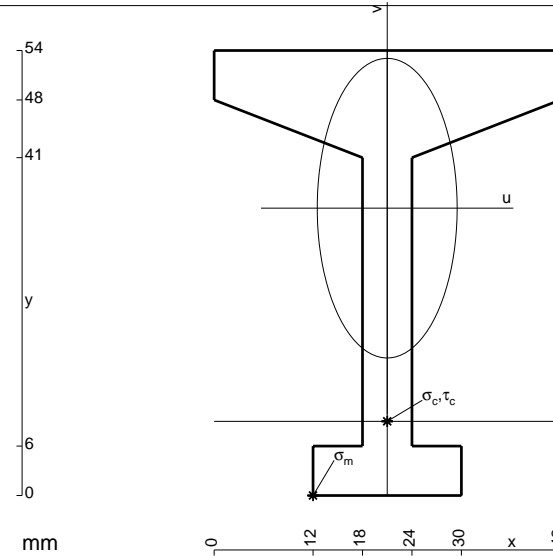
$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

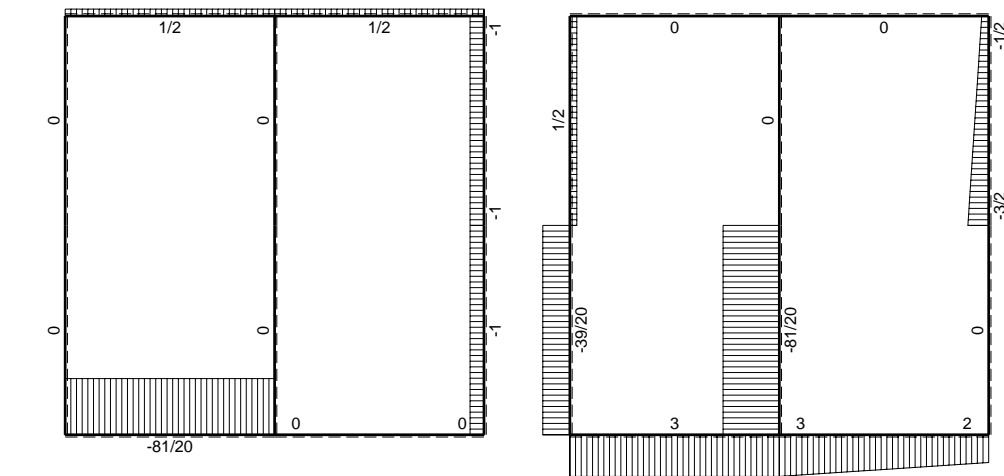
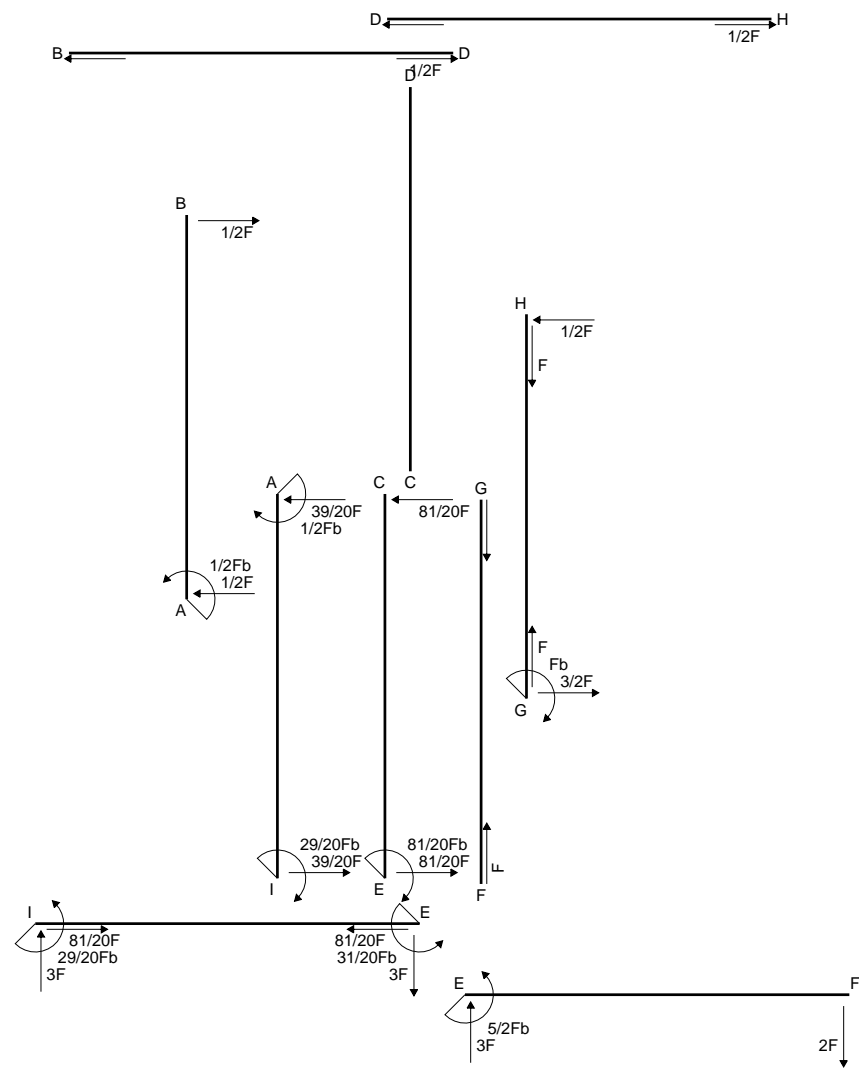
$$= (-5b + 5b - 5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb \frac{1}{EJ} dx = [-5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

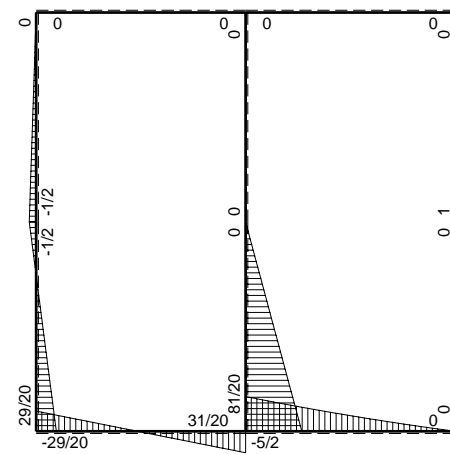


- A = 738. mm²
- J_u = 244023. mm⁴
- J_v = 53190. mm⁴
- y_g = 34.87 mm
- T_y = 1700. N
- M_x = -1462000. Nmm
- x_m = 12. mm
- u_m = -9. mm
- v_m = -34.87 mm
- σ_m = -Mv/J_u = -208.9 N/mm²
- x_c = 21. mm
- y_c = 9. mm
- v_c = -25.87 mm
- σ_c = -Mv/J_u = -155. N/mm²
- τ_c = 4.568 N/mm²
- σ_o = √σ²+3τ² = 155.2 N/mm²
- S = 3935. mm³

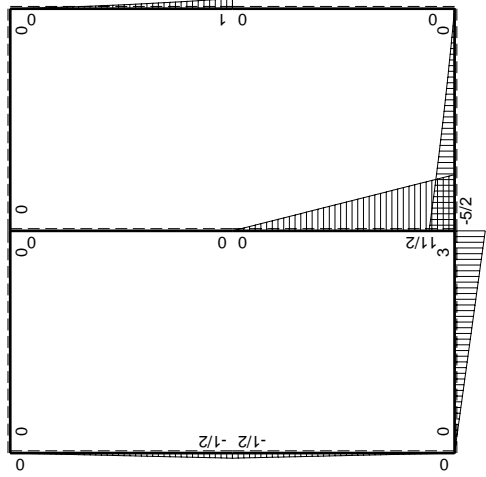
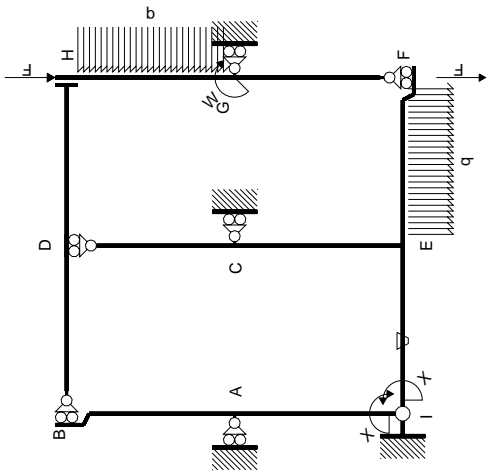


← (+) → F

↑ (+) ↓ F_b

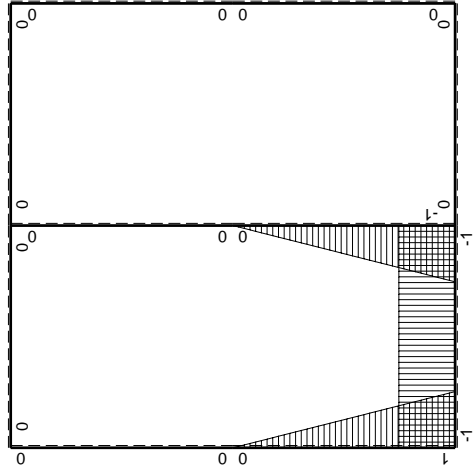


← (+) → F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-29/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$29/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb 1/EJ dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb 1/EJ dx = [-11/6 x^3/b^2]_0^b Fb 1/EJ$$

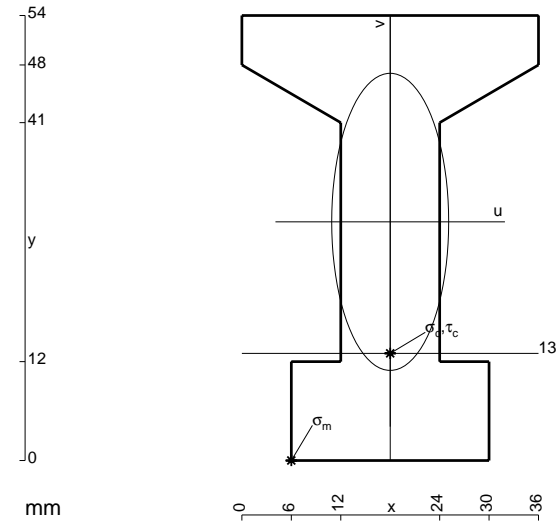
$$= (-11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

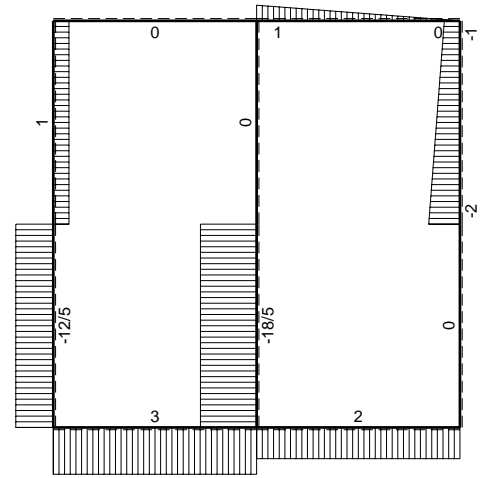
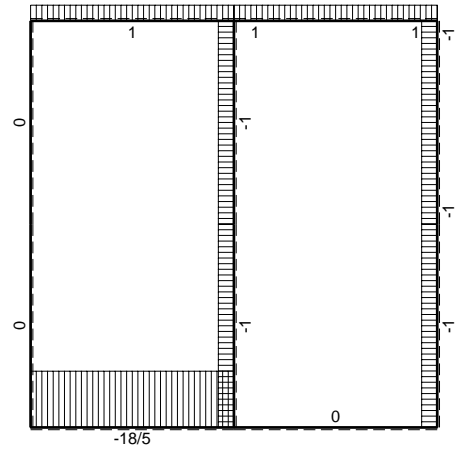
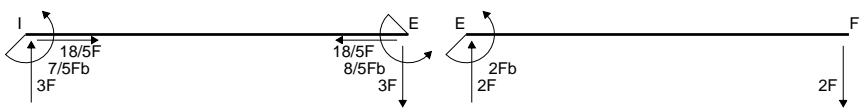
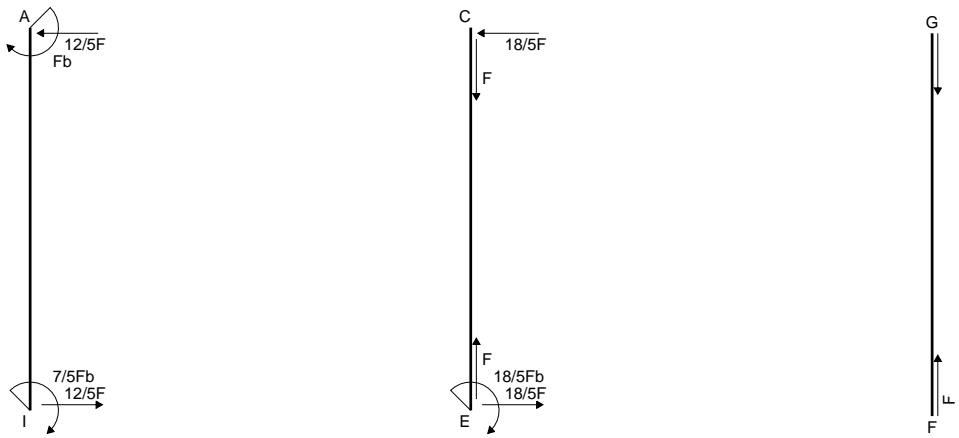
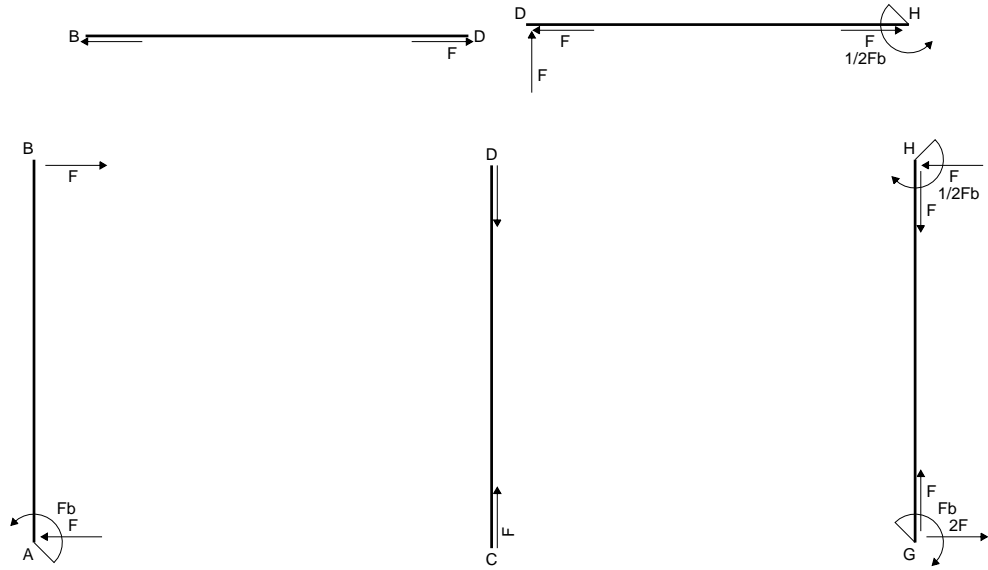
$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

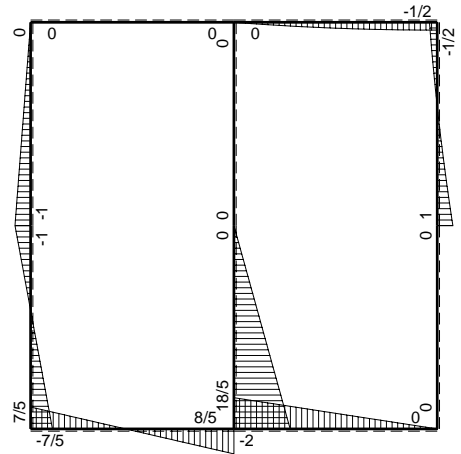


- A = 1020. mm²
- J_u = 331648. mm⁴
- J_v = 51408. mm⁴
- y_g = 28.96 mm
- T_y = 3300. N
- M_x = -2502500. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.96 mm
- σ_m = -Mv/J_u = -218.5 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.96 mm
- σ_c = -Mv/J_u = -120.4 N/mm²
- τ_c = 5.647 N/mm²
- σ_o = √σ² + 3τ² = 120.8 N/mm²
- S = 6810. mm³

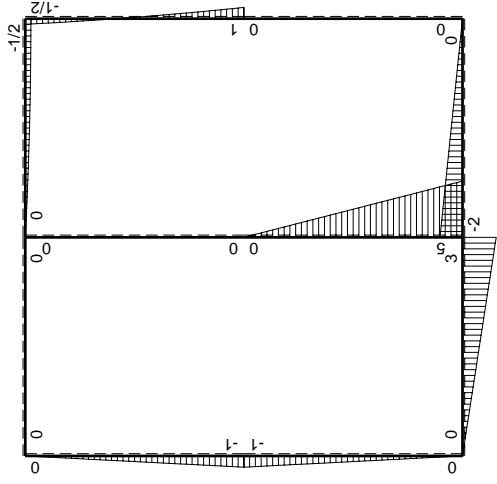
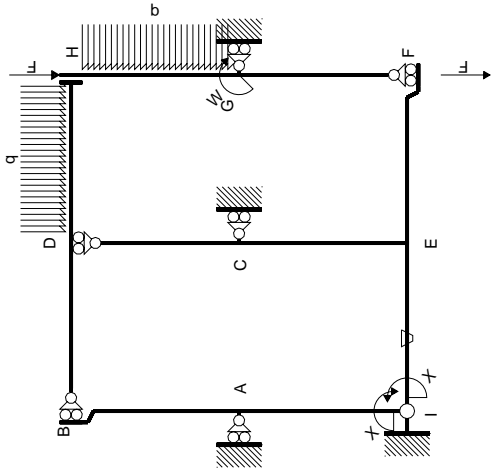


← ⊕ → F

↑ ⊕ ↓ F

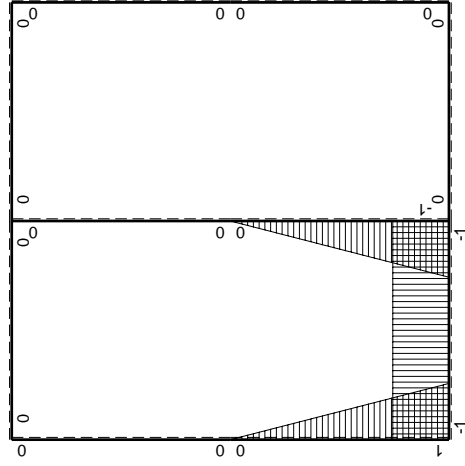


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-Fx-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

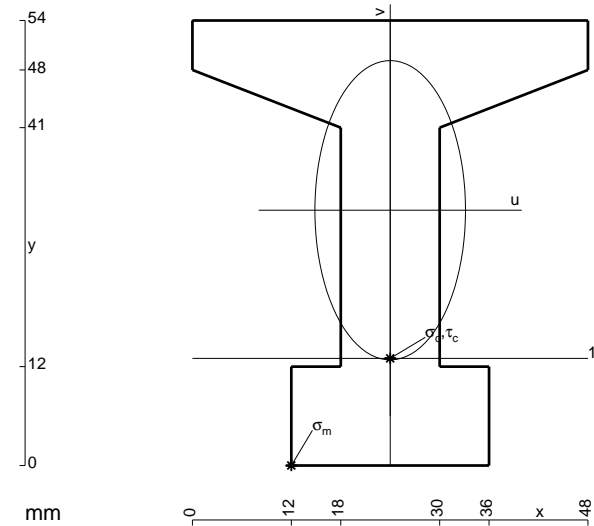
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

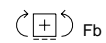
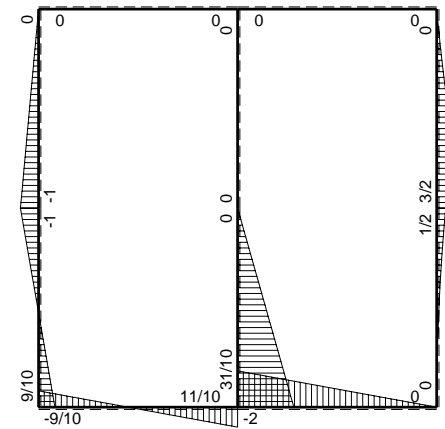
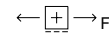
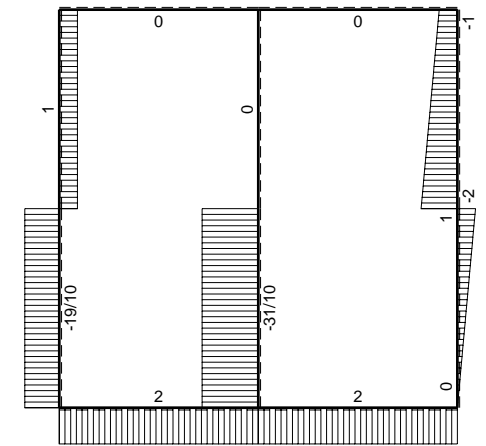
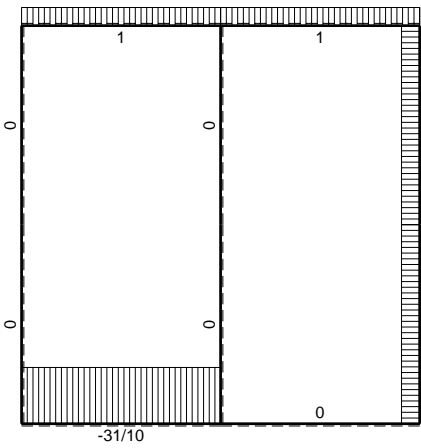
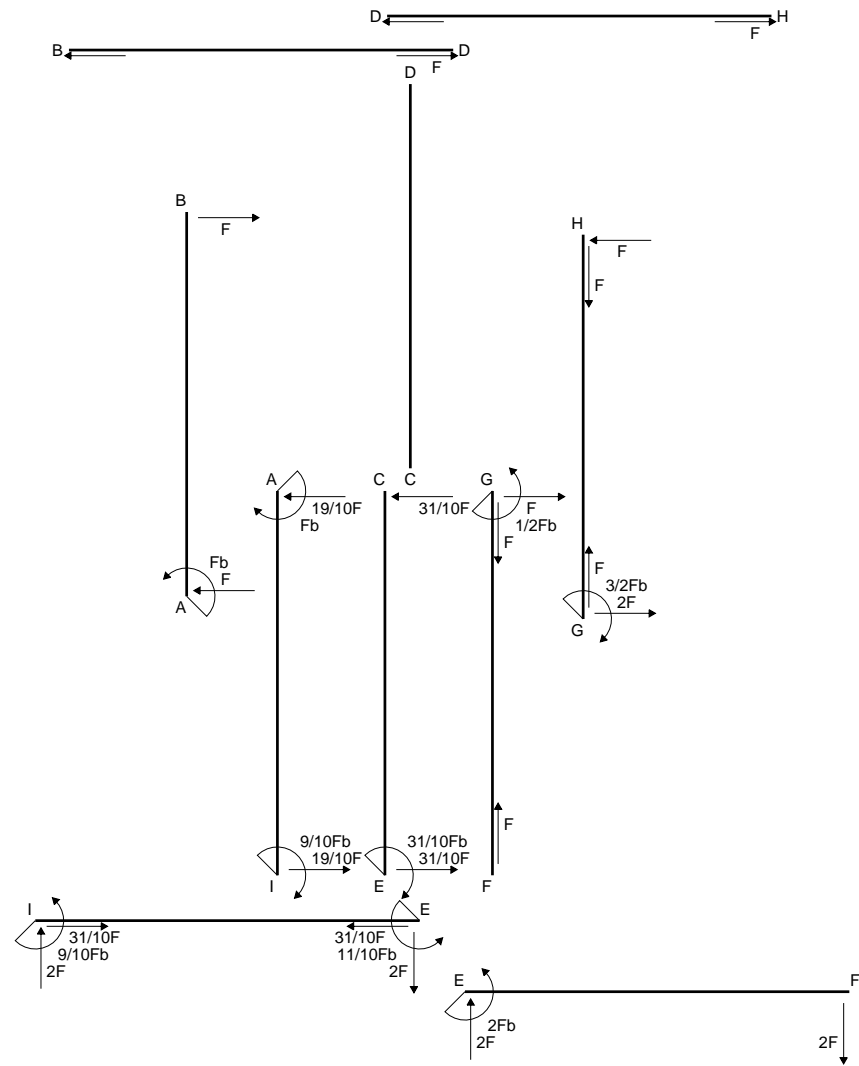
$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

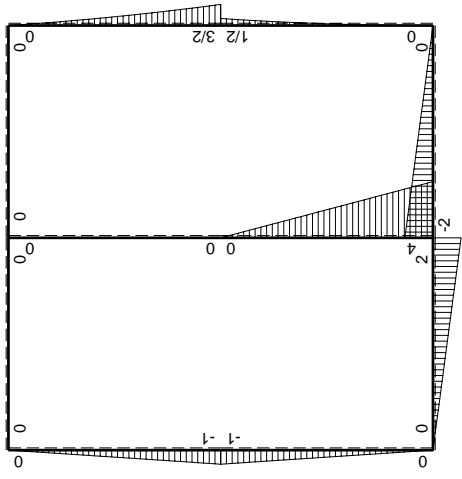
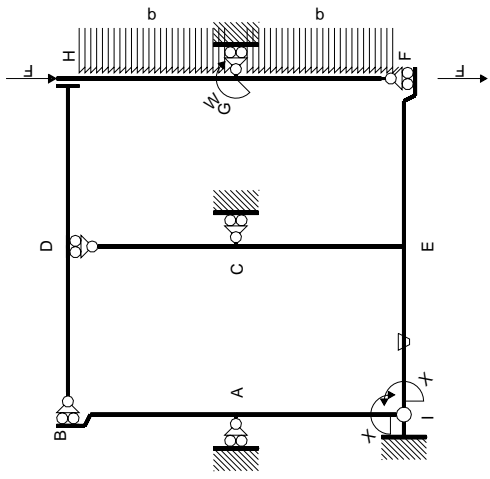
$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$



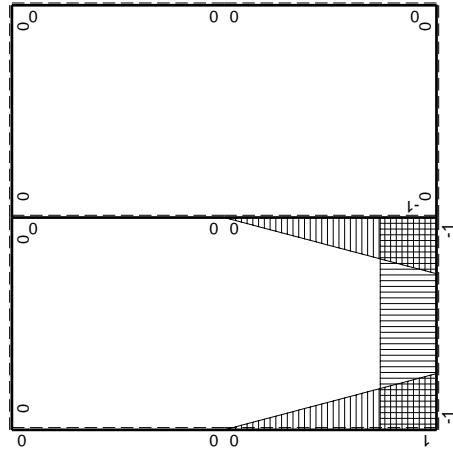
- A = 1134. mm²
- J_u = 374055. mm⁴
- J_v = 94716. mm⁴
- y_g = 30.98 mm
- T_y = 2860. N
- M_x = -2774200. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.98 mm
- σ_m = -Mv/J_u = -229.8 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -17.98 mm
- σ_c = -Mv/J_u = -133.3 N/mm²
- τ_c = 4.725 N/mm²
- σ_ρ = √σ_c² + 3τ_c² = 133.6 N/mm²
- S = 7416. mm³





Schema di calcolo iperstatico

M_0 flexione da carichi assegnati



M_x flexione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$9/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-b) Fb \frac{1}{EJ} + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-2b + b) Fb \frac{1}{EJ} + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 8x/b - 4x^2/b^2) Fb \frac{1}{EJ} dx = [-4x + 4x^2/b - 4/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-4b + 4b - 4/3 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-4x^2/b^2) Fb \frac{1}{EJ} dx = [-4/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

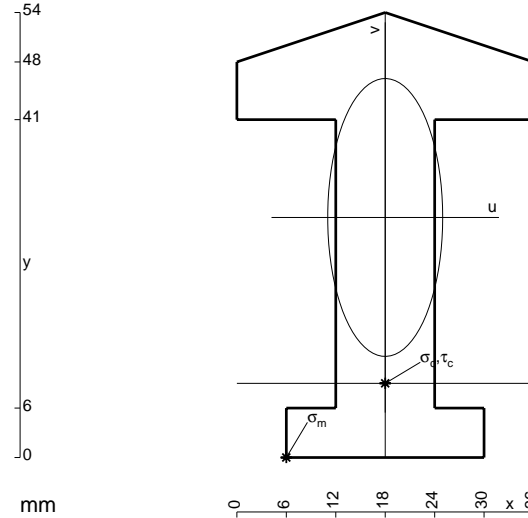
$$= (-4/3 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

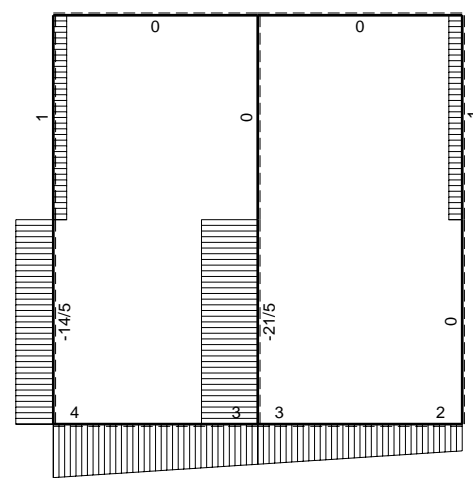
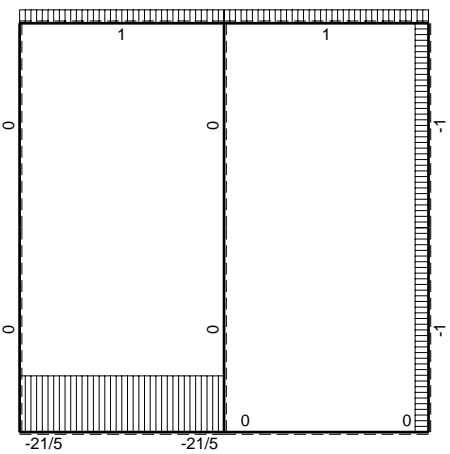
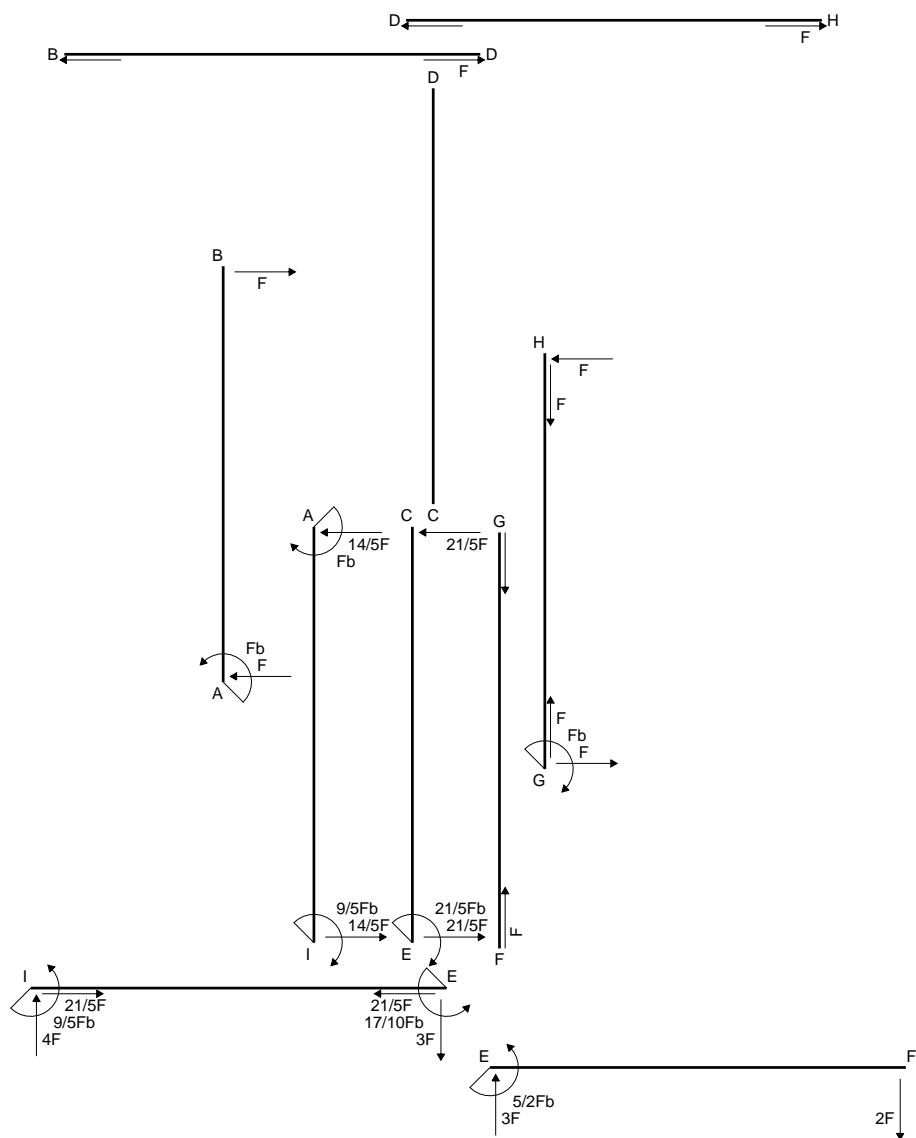
$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

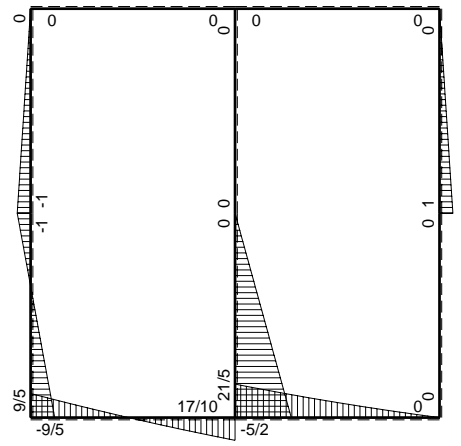


- A = 924. mm²
- J_u = 262756. mm⁴
- J_v = 45000. mm⁴
- y_g = 29.13 mm
- T_y = 2120. N
- M_x = -2162400. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -29.13 mm
- σ_m = -Mv/J_u = -239.7 N/mm²
- x_c = 18. mm
- y_c = 9. mm
- v_c = -20.13 mm
- σ_c = -Mv/J_u = -165.7 N/mm²
- τ_c = 3.053 N/mm²
- σ_g = √σ² + 3τ² = 165.7 N/mm²
- S = 4541. mm³

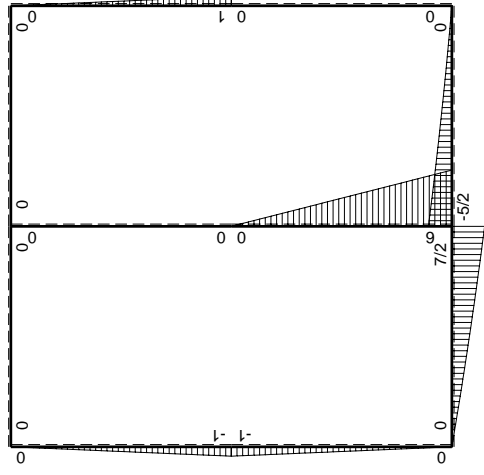
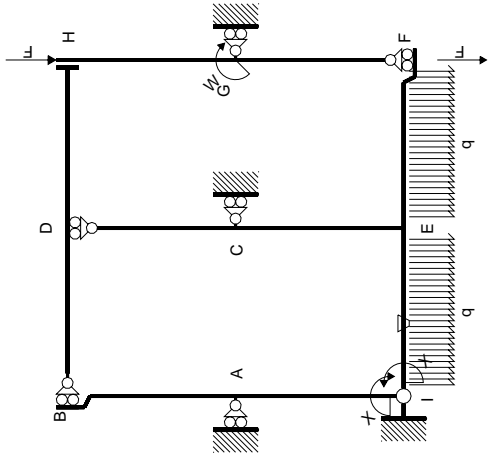


← ⊕ → F

↑ ⊕ ↓ F

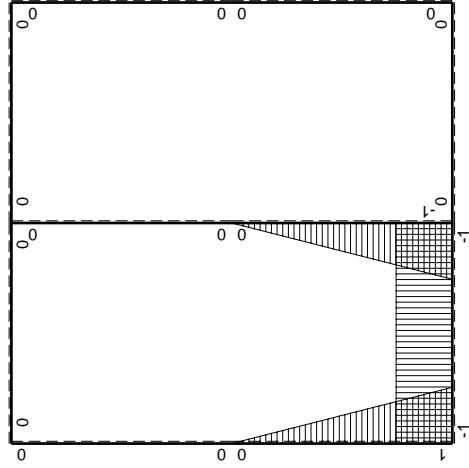


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	0	-Fb+Fx	0	0	0	0	0+0	0	
BA b	0	Fx	0	0	0	0	0+0	0	
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	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	0+0	0	
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0	0+0	0	
GH b	0	Fb-Fx	0	0	0	0	0+0	0	
HG b	0	-Fx	0	0	0	0	0+0	0	
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0	0+0	0	
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0	0+0	0	
IE b	-1	$4Fx-1/2qx^2$	-Fb/EJ	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2			
	totali							$-3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$9/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-6b + 6b - 2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb \frac{1}{EJ} dx = [-2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

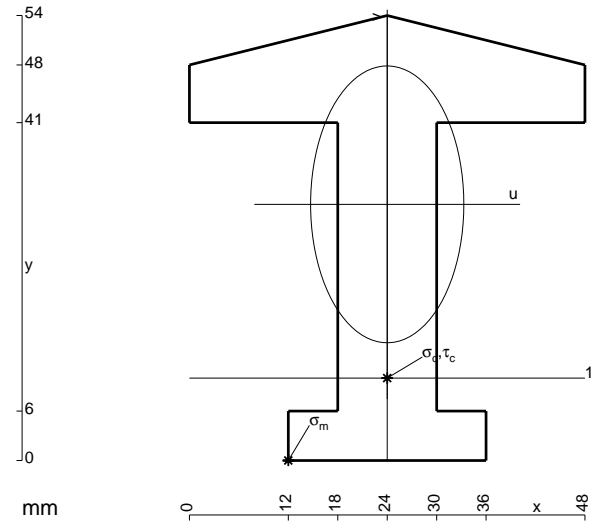
$$= (-2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

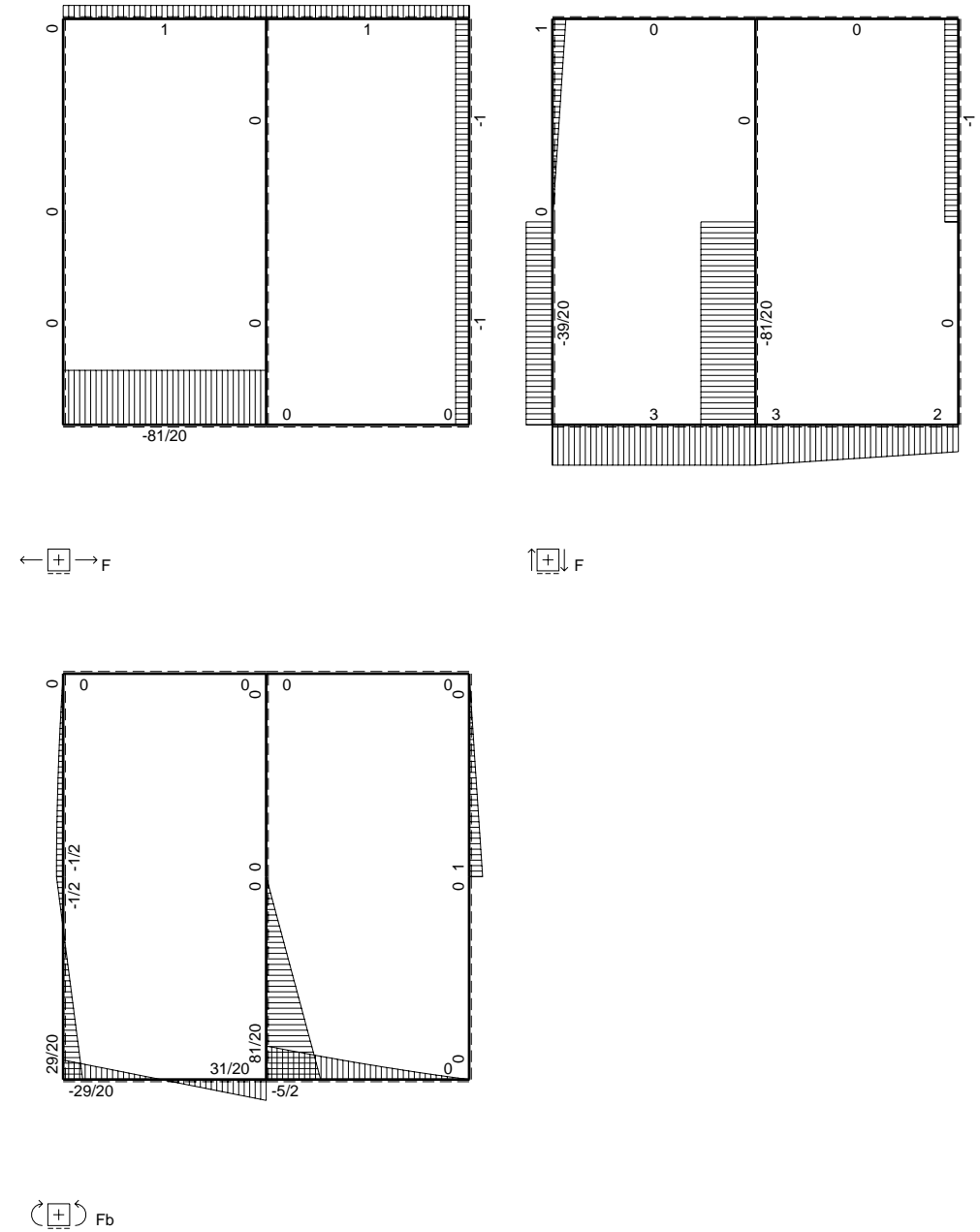
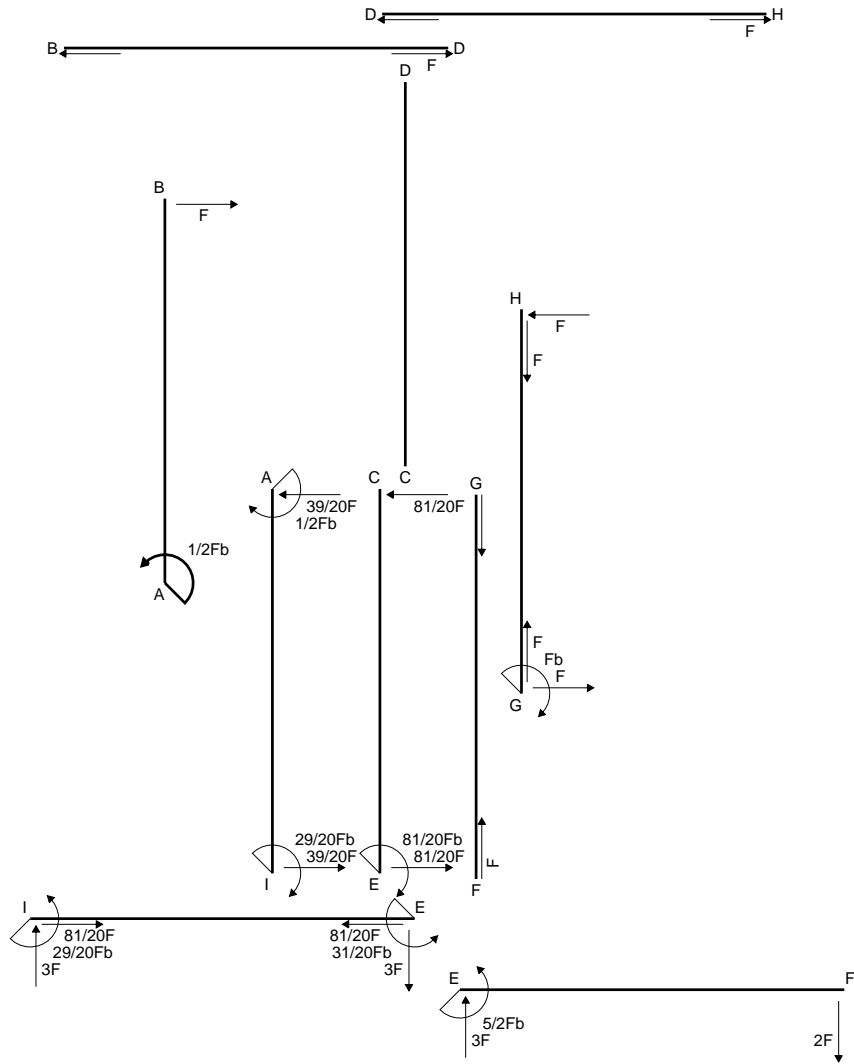
$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

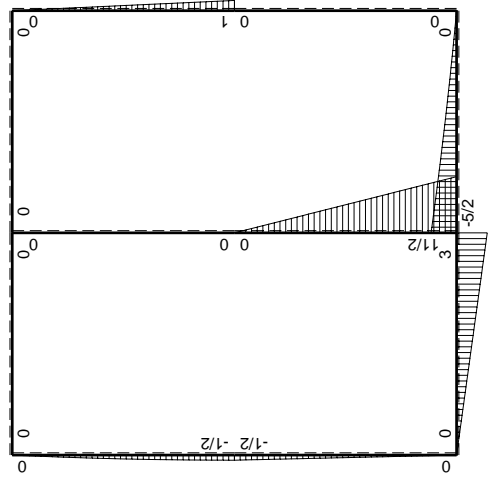
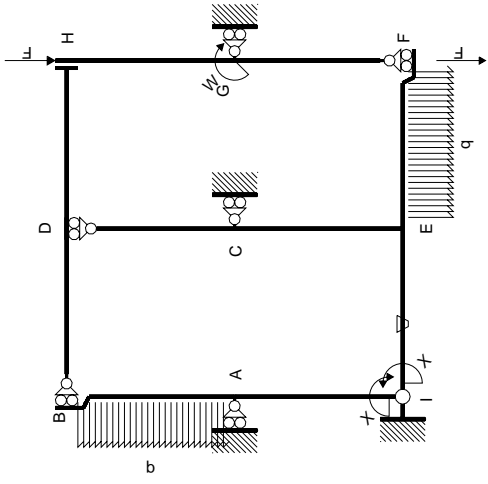
$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$



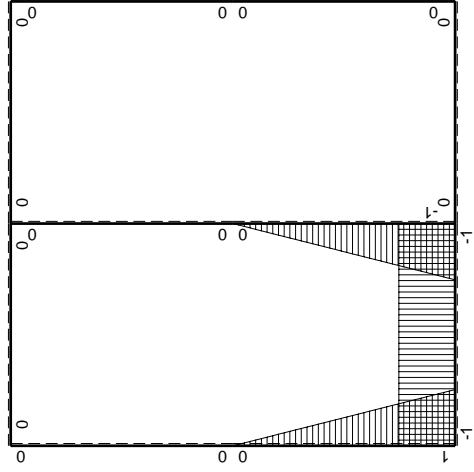
- A = 1044. mm²
- J_u = 294700. mm⁴
- J_v = 90288. mm⁴
- y_g = 31.09 mm
- T_y = 4200. N
- M_x = -1890000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -31.09 mm
- σ_m = -Mv/J_u = -199.4 N/mm²
- x_c = 24. mm
- y_c = 10. mm
- v_c = -21.09 mm
- σ_c = -Mv/J_u = -135.2 N/mm²
- τ_c = 6.119 N/mm²
- σ_o = √σ²+3τ² = 135.6 N/mm²
- S = 5153. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$-Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-29/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$29/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb 1/EJ dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb 1/EJ dx = [-11/6 x^3/b^2]_0^b Fb 1/EJ$$

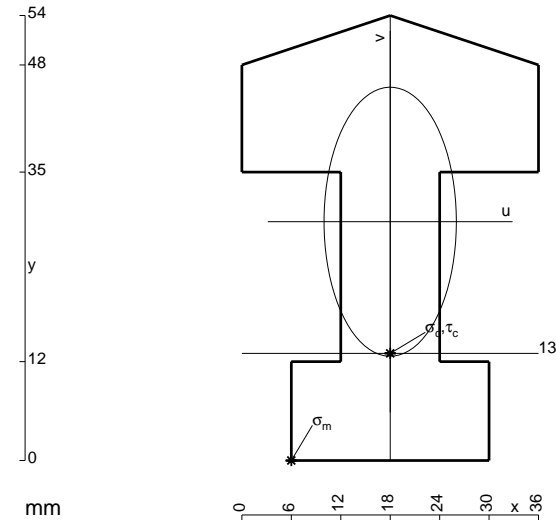
$$= (-11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

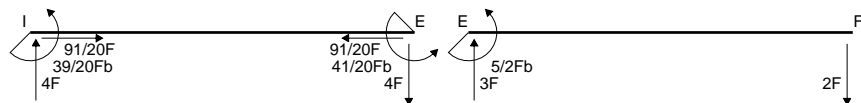
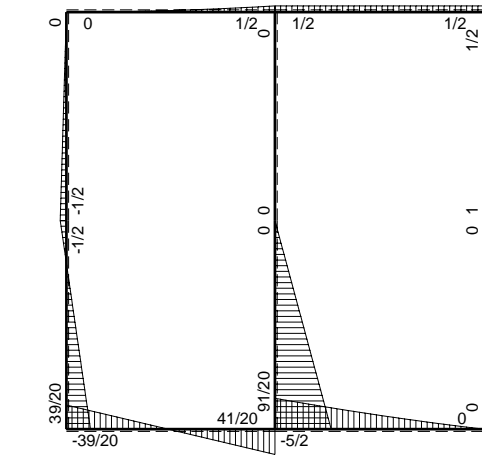
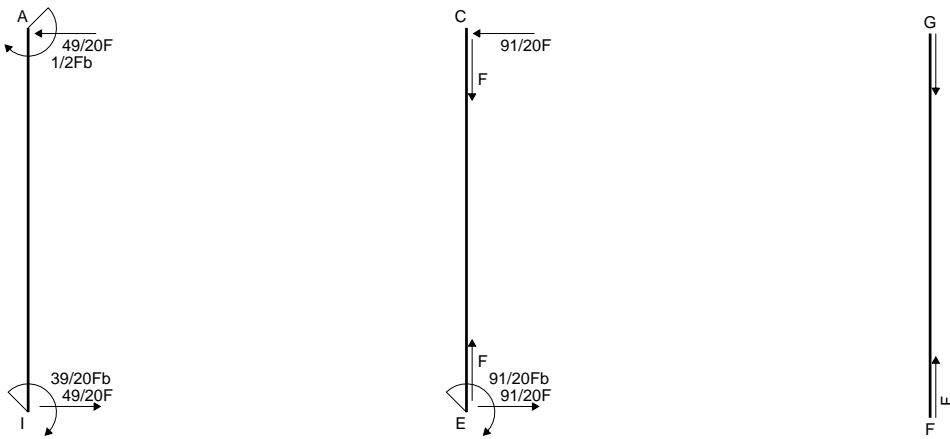
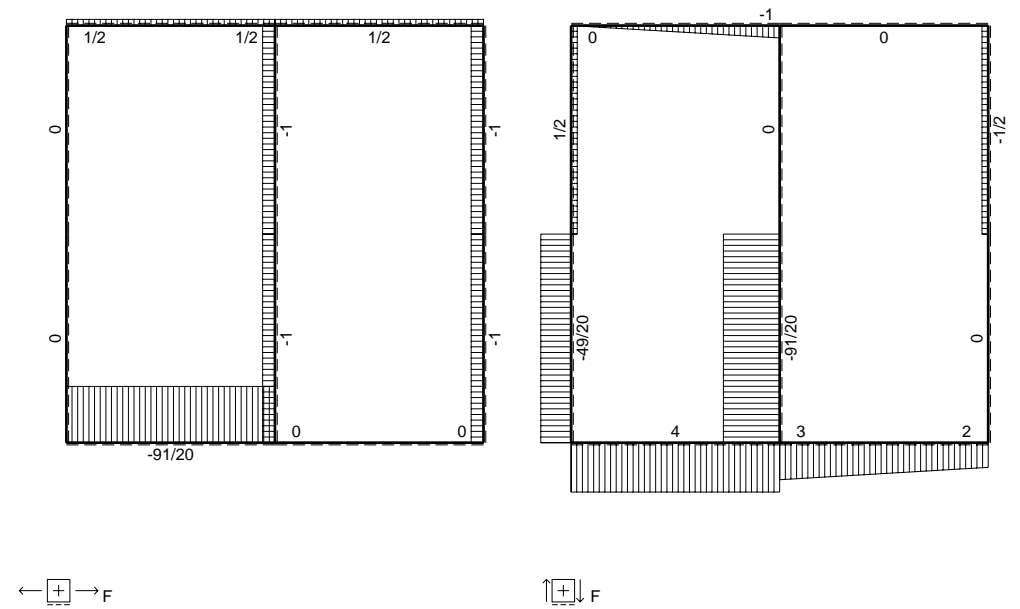
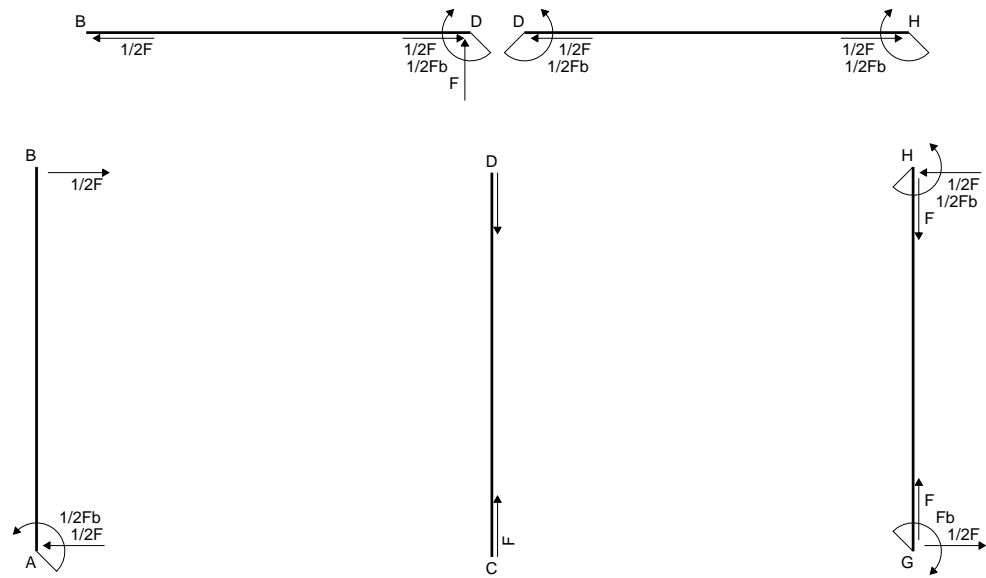
$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

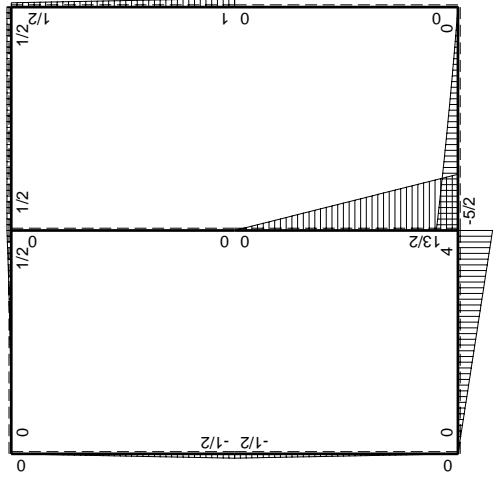
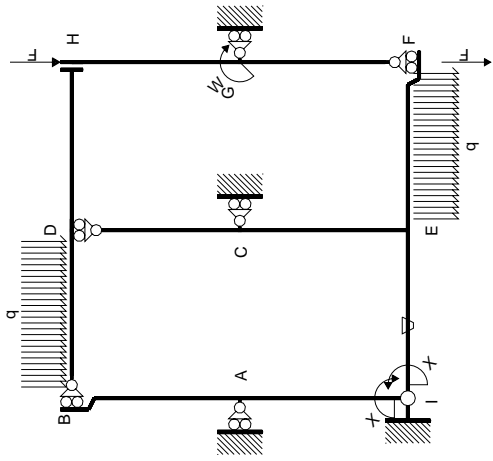
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$



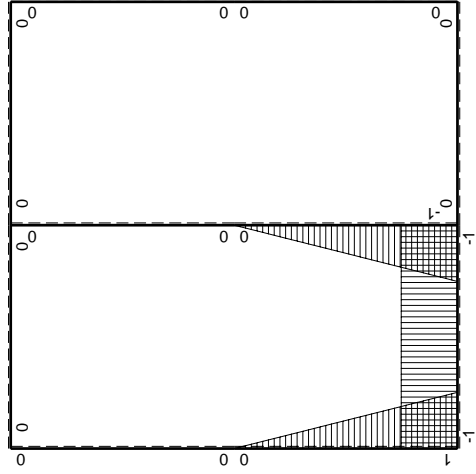
- A = 1140. mm²
- J_u = 303884. mm⁴
- J_v = 73512. mm⁴
- y_g = 28.98 mm
- T_y = 4470. N
- M_x = -2197750. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.98 mm
- σ_m = -Mv/J_u = -209.6 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.98 mm
- σ_c = -Mv/J_u = -115.6 N/mm²
- τ_c = 8.355 N/mm²
- σ_o = √σ²+3τ² = 116.5 N/mm²
- S = 6816. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-13/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$39/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b) Fb \frac{1}{EJ} + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-4 + 4x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-4b + 2b) Fb \frac{1}{EJ} + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

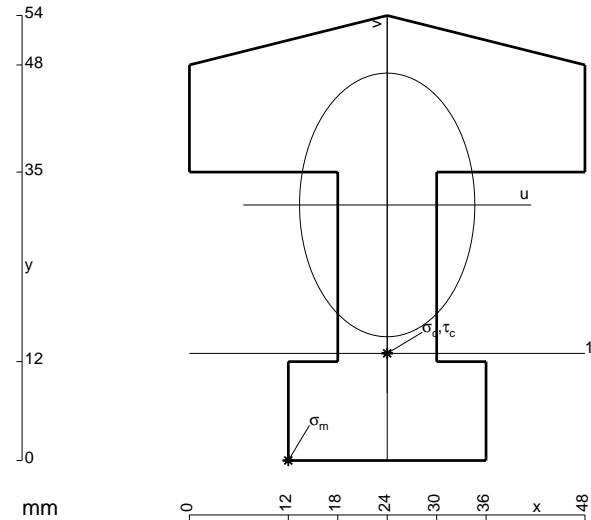
$$= (-13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



$$A = 1332. \text{ mm}^2$$

$$J_u = 341004. \text{ mm}^4$$

$$J_v = 150768. \text{ mm}^4$$

$$y_g = 31.01 \text{ mm}$$

$$T_y = 4530. \text{ N}$$

$$M_x = -2416000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -31.01 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -219.7 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

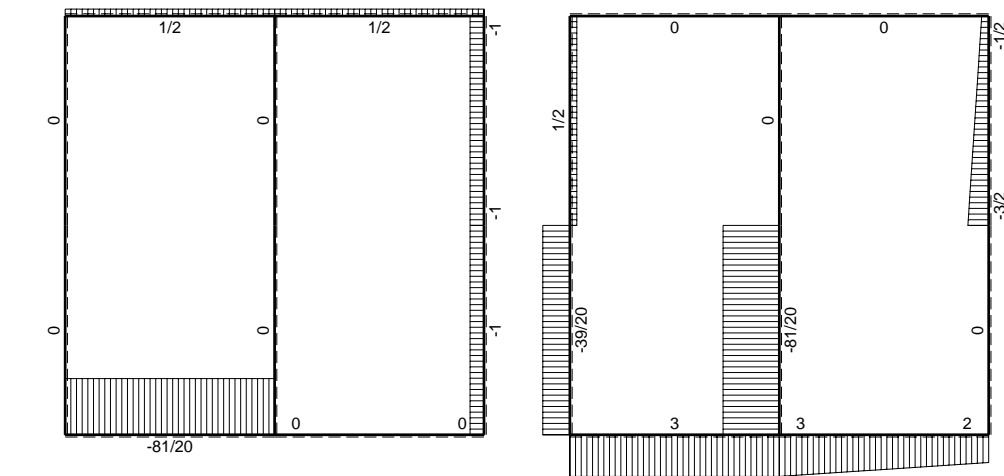
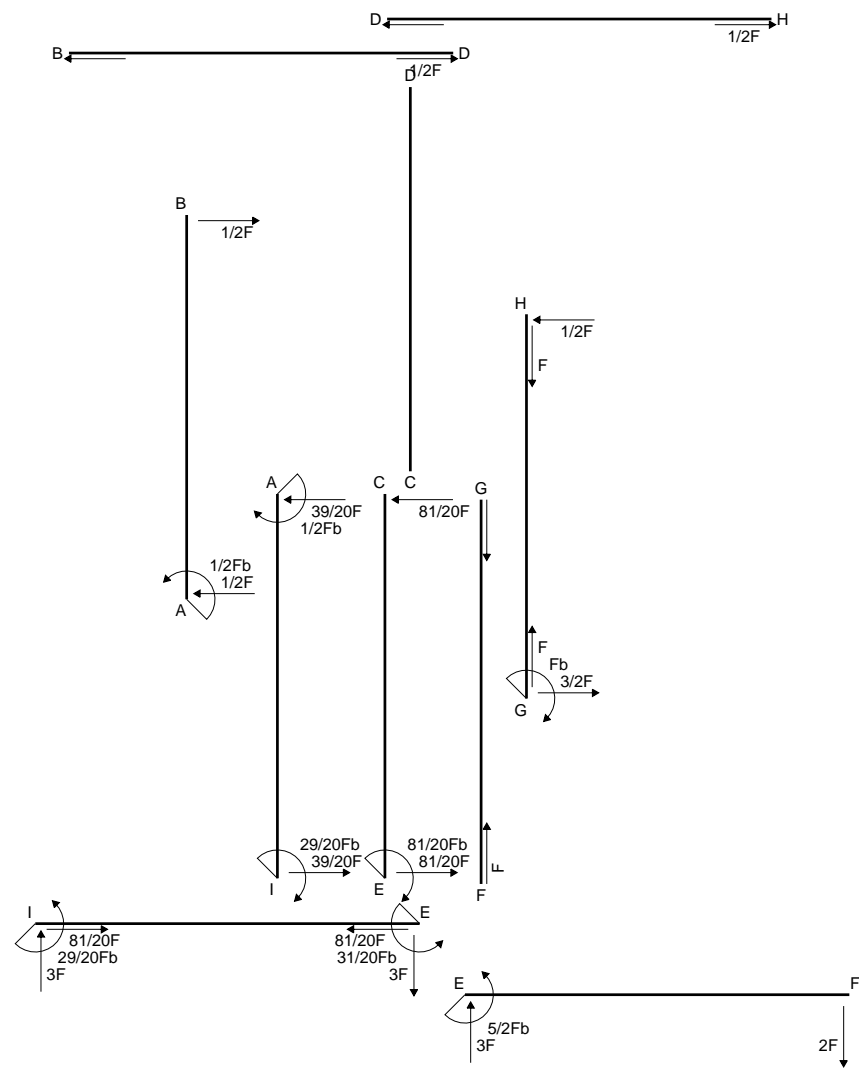
$$v_c = -18.01 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -127.6 \text{ N/mm}^2$$

$$\tau_c = 8.221 \text{ N/mm}^2$$

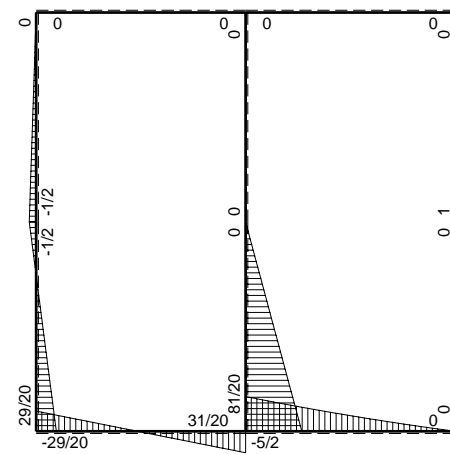
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 128.4 \text{ N/mm}^2$$

$$S = 7426. \text{ mm}^3$$

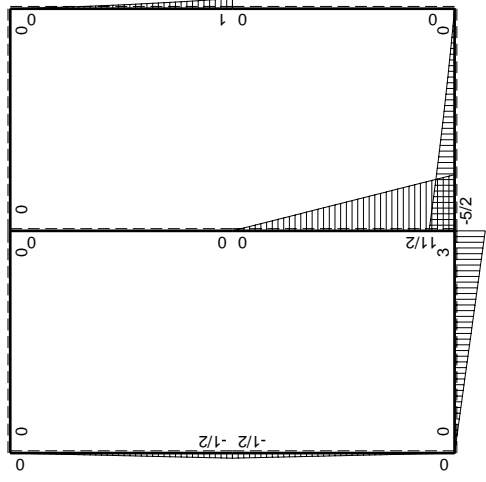
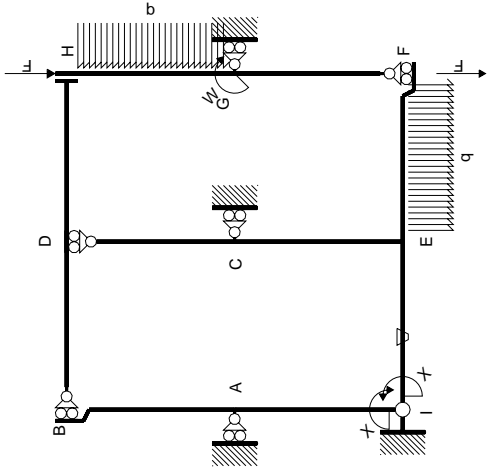


← ⊕ → F

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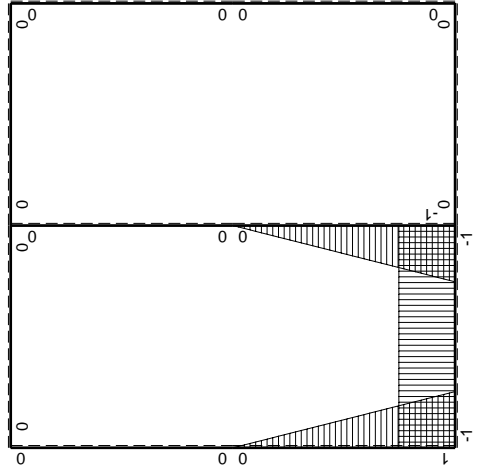


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-29/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$29/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb 1/EJ dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb 1/EJ dx = [-11/6 x^3/b^2]_0^b Fb 1/EJ$$

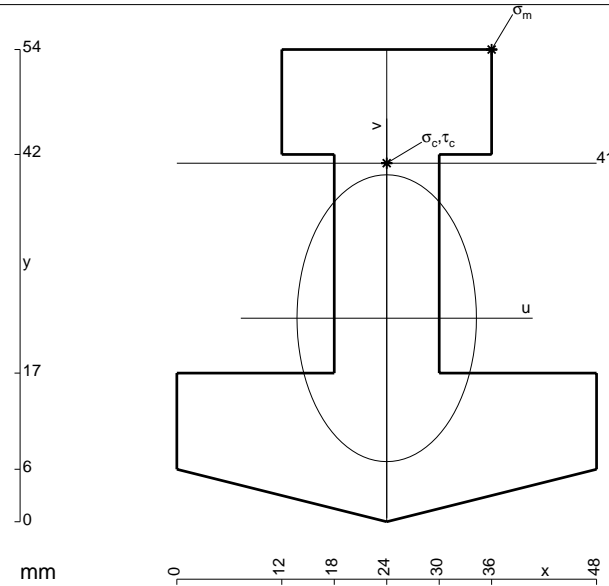
$$= (-11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

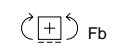
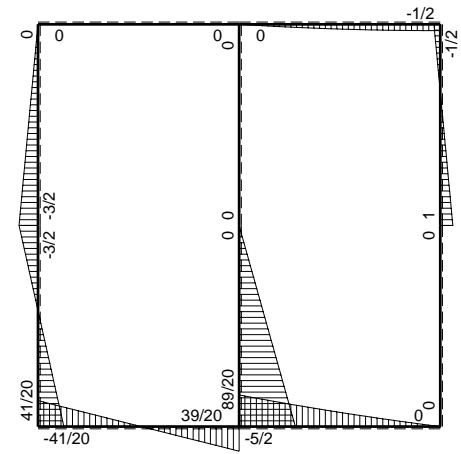
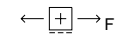
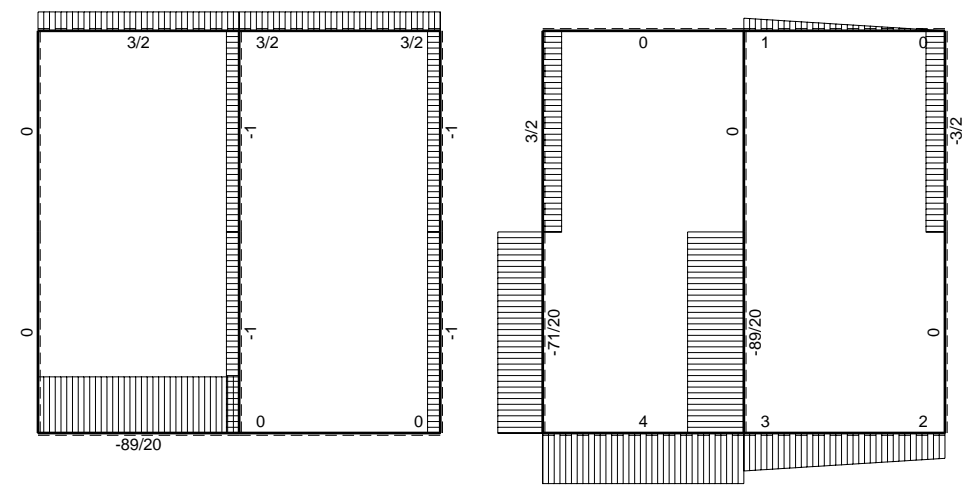
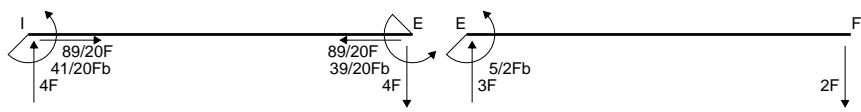
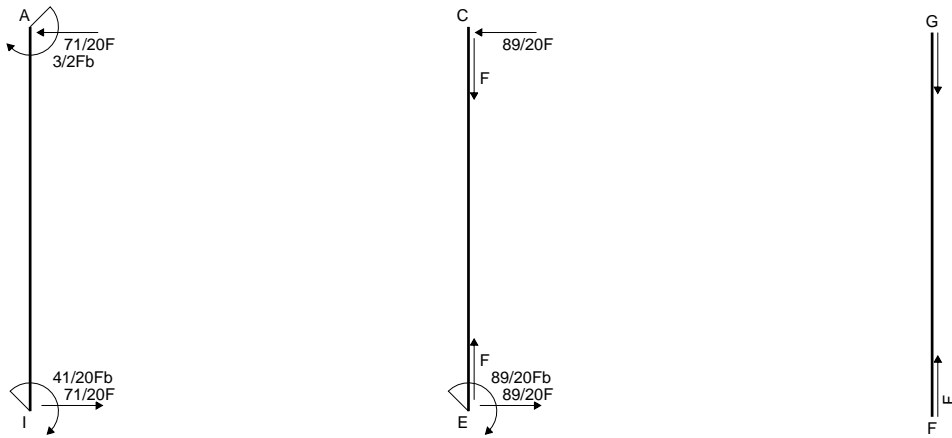
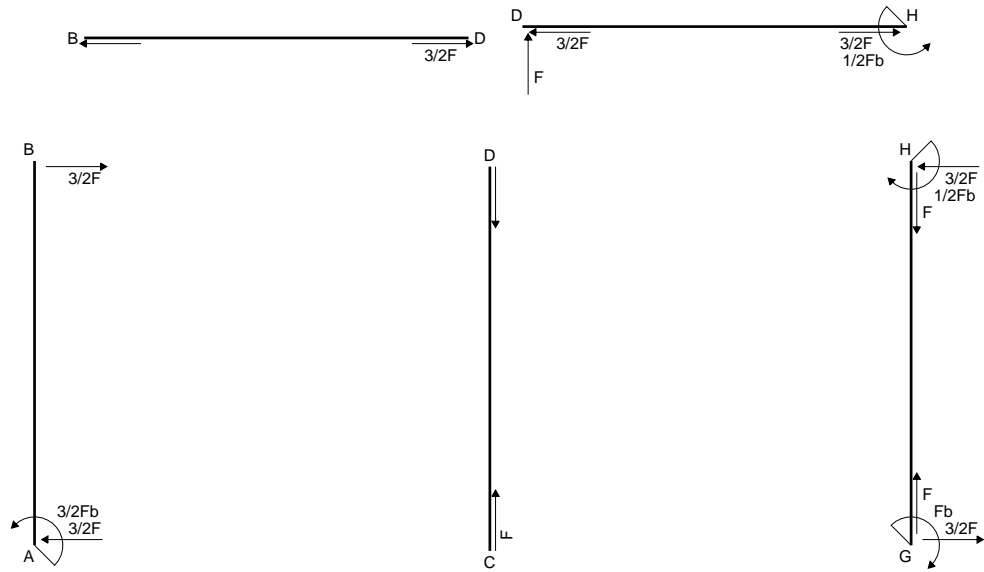
$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

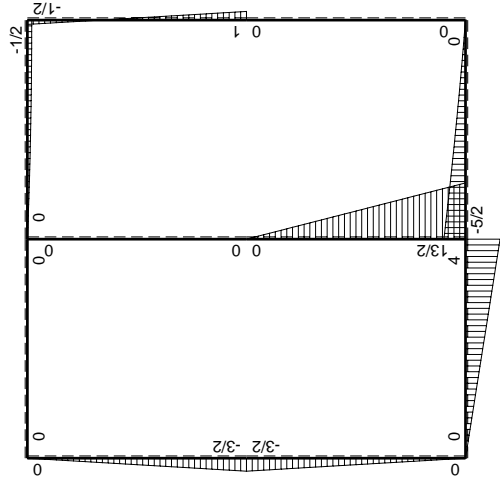
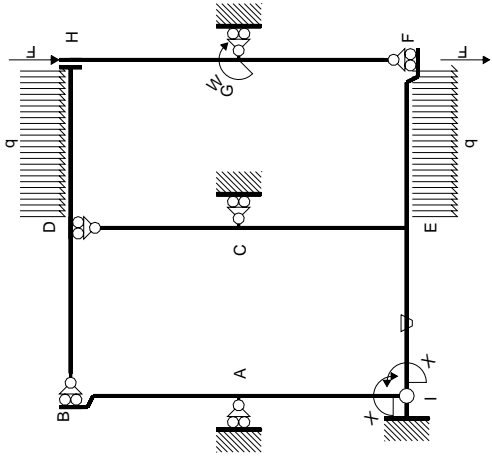
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$



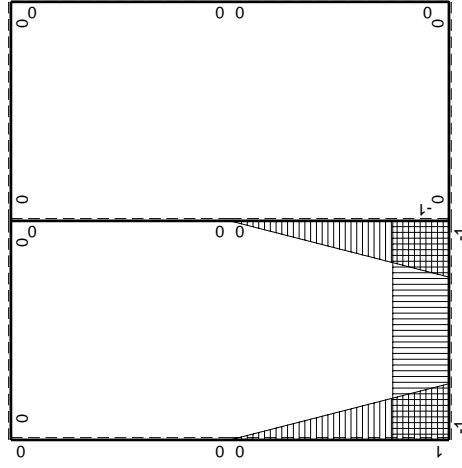
- A = 1260. mm²
- J_u = 339087. mm⁴
- J_v = 132624. mm⁴
- y_g = 23.27 mm
- T_y = 4350. N
- M_x = -2537500. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 30.73 mm
- σ_m = -Mv/J_u = 230. N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 17.73 mm
- σ_c = -Mv/J_u = 132.7 N/mm²
- τ_c = 7.847 N/mm²
- σ_q = √σ²+3τ² = 133.4 N/mm²
- S = 7341. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0
BA b	0	$3/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-3/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-41/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$41/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{x_0} = \int_0^b (-4x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b) Fb \frac{1}{EJ} + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{x_0} = \int_0^b (-4 + 4x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-4b + 2b) Fb \frac{1}{EJ} + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{x_0} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{CE}^{x_0} = \int_0^b (-13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

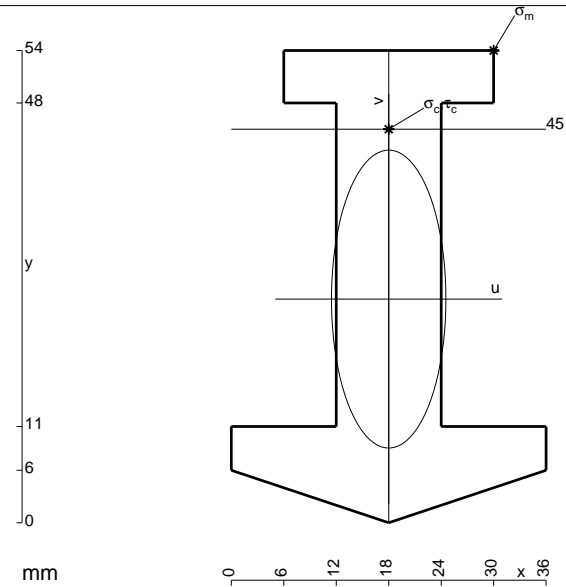
$$= (-13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{IA}^{x_0} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

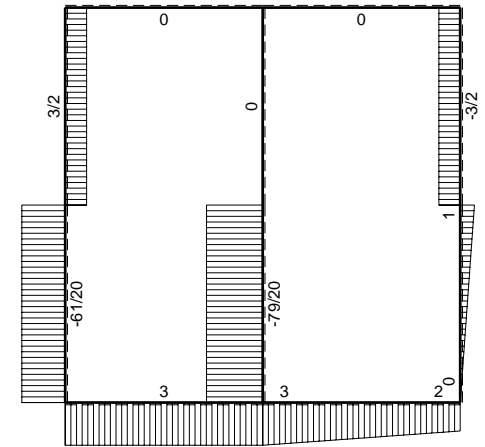
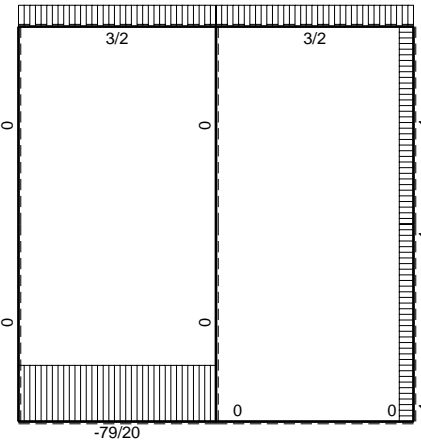
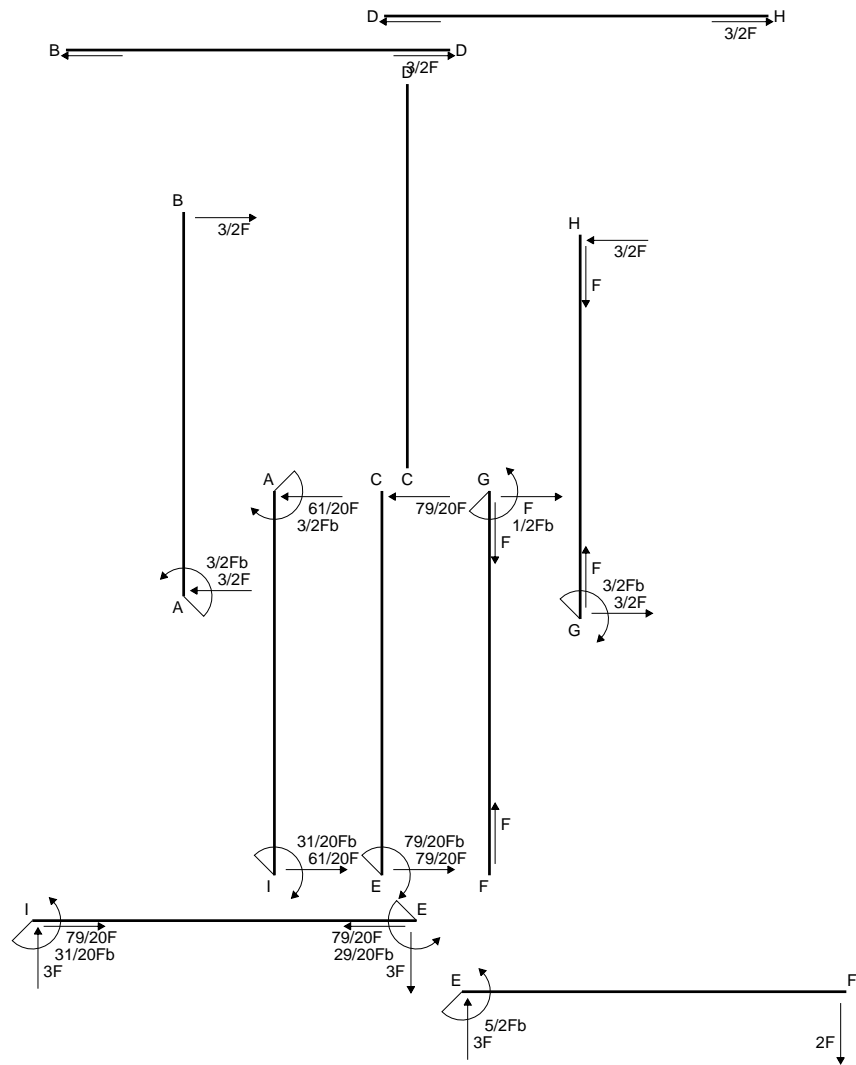
$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

$$L_{AI}^{x_0} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

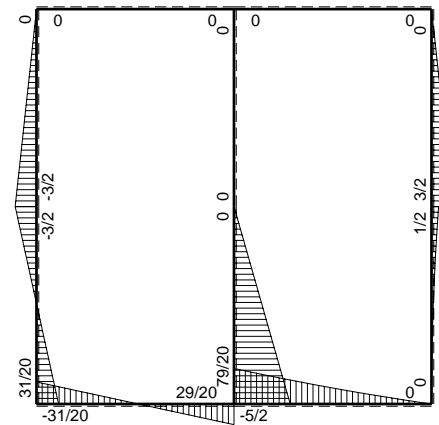


- A = 876. mm²
- J_u = 254354. mm⁴
- J_v = 37512. mm⁴
- y_g = 25.58 mm
- T_y = 3420. N
- M_x = -2137500. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 28.42 mm
- σ_m = -Mv/J_u = 238.9 N/mm²
- x_c = 18. mm
- y_c = 45. mm
- v_c = 19.42 mm
- σ_c = -Mv/J_u = 163.2 N/mm²
- τ_c = 4.946 N/mm²
- σ_q = √σ²+3τ² = 163.5 N/mm²
- S = 4414. mm³

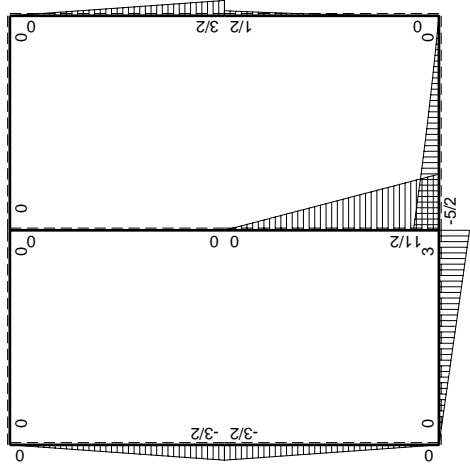
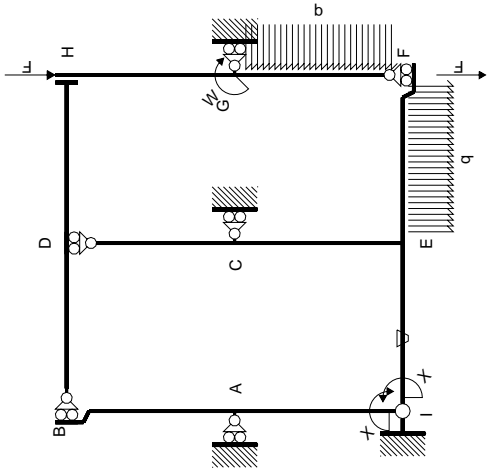


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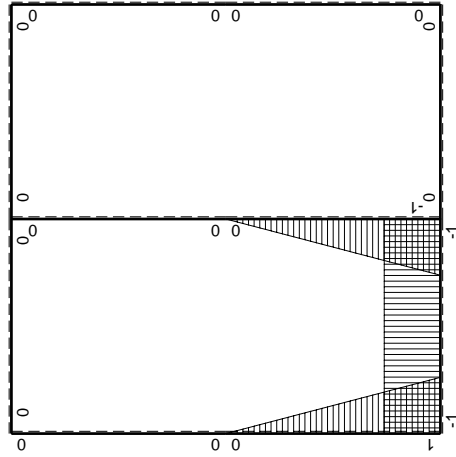


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Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0
BA b	0	$3/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$-3/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-31/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$31/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{x\theta} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{x\theta} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{x\theta} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{x\theta} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

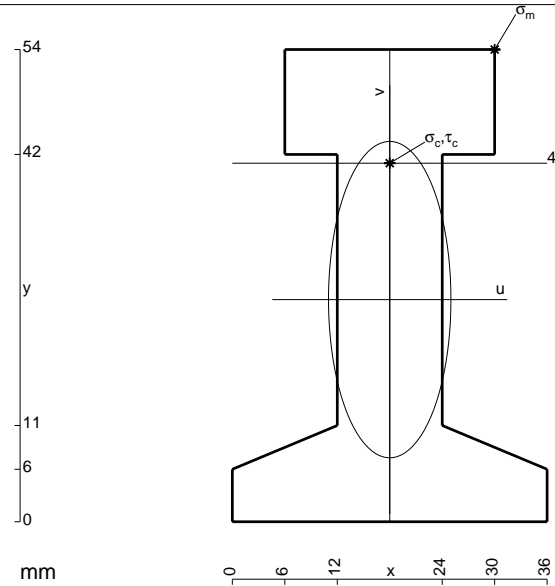
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{IA}^{x\theta} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

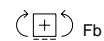
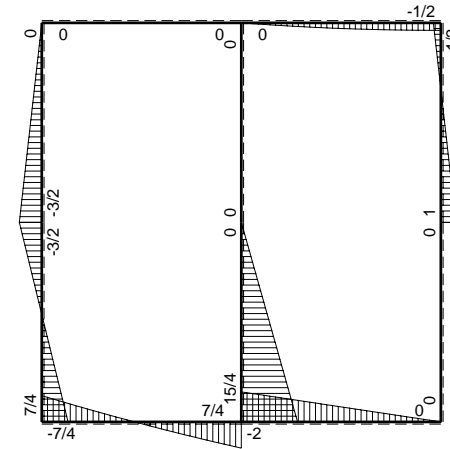
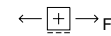
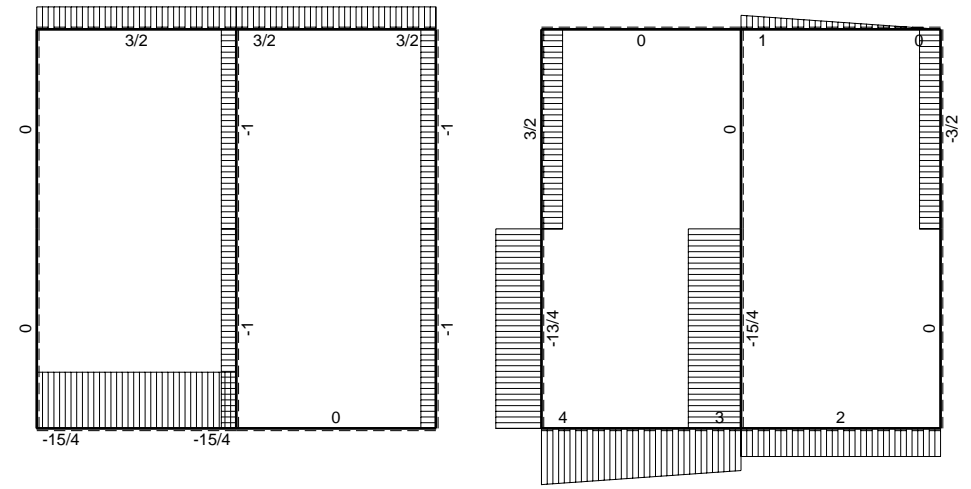
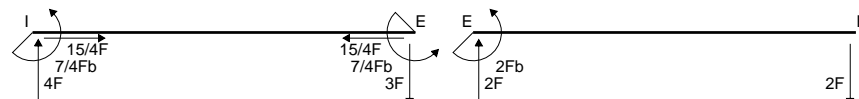
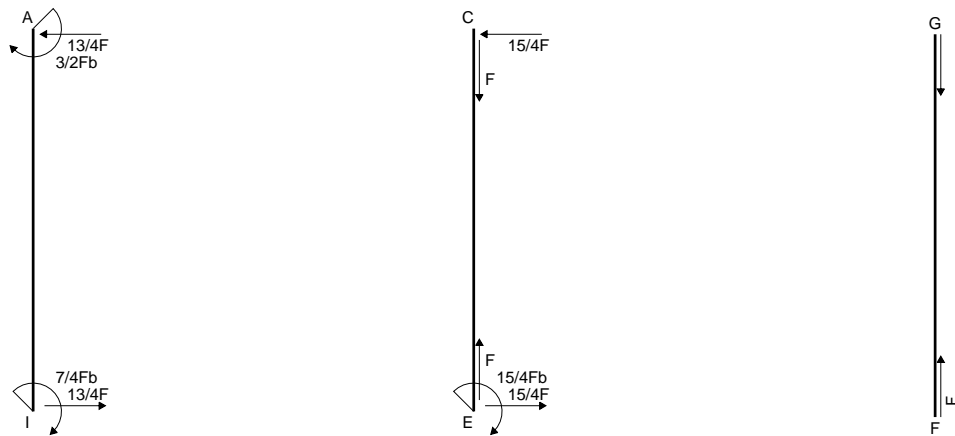
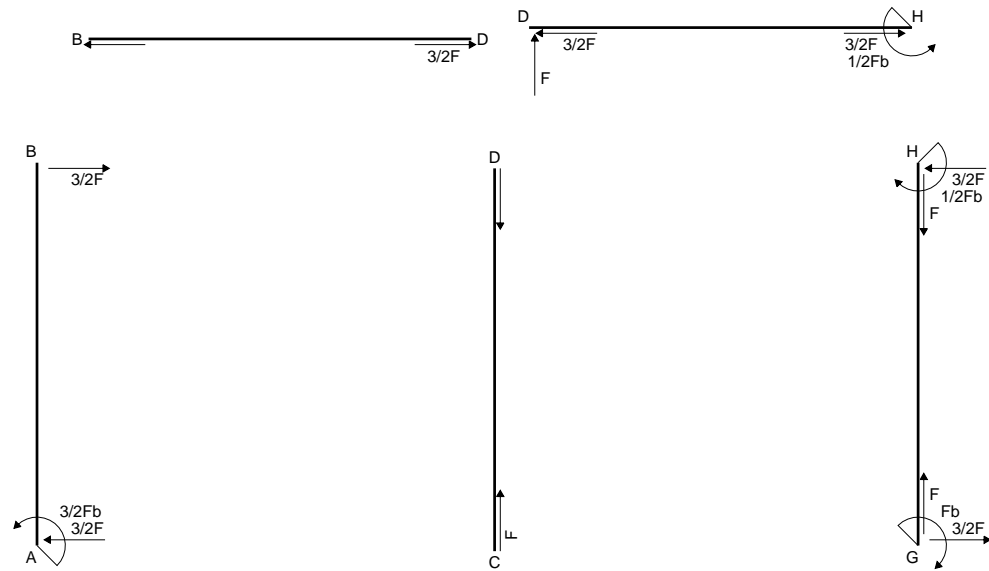
$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

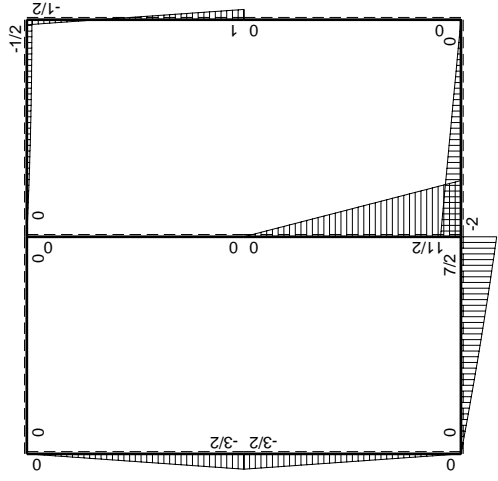
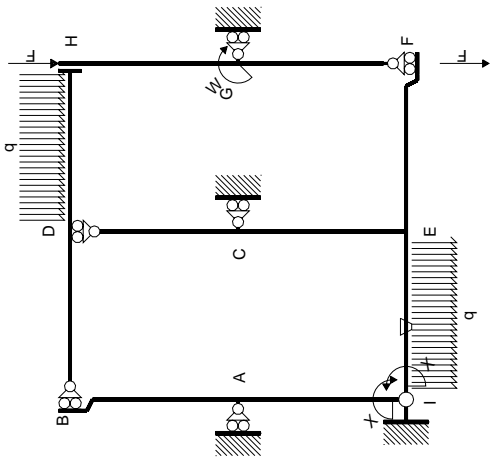
$$L_{AI}^{x\theta} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$



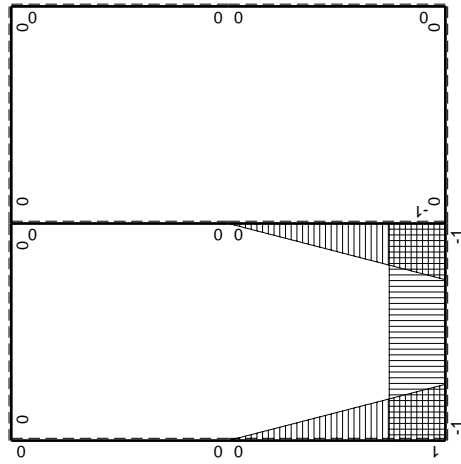
- A = 996. mm²
- J_u = 326037. mm⁴
- J_v = 48816. mm⁴
- y_g = 25.4 mm
- T_y = 3360. N
- M_x = -2268000. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 28.6 mm
- σ_m = -Mv/J_u = 198.9 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 15.6 mm
- σ_c = -Mv/J_u = 108.5 N/mm²
- τ_c = 5.755 N/mm²
- σ_φ = √(σ² + 3τ²) = 109. N/mm²
- S = 6702. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0	
BA b	0	$3/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$Fb-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$1/2Fb-3/2Fx$	0	0	0	0			
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
DH b	0	$Fx-1/2qx^2$	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2			
	totali							$-35/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$7/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb 1/EJ + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb 1/EJ + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb 1/EJ dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb 1/EJ dx = [-11/6 x^3/b^2]_0^b Fb 1/EJ$$

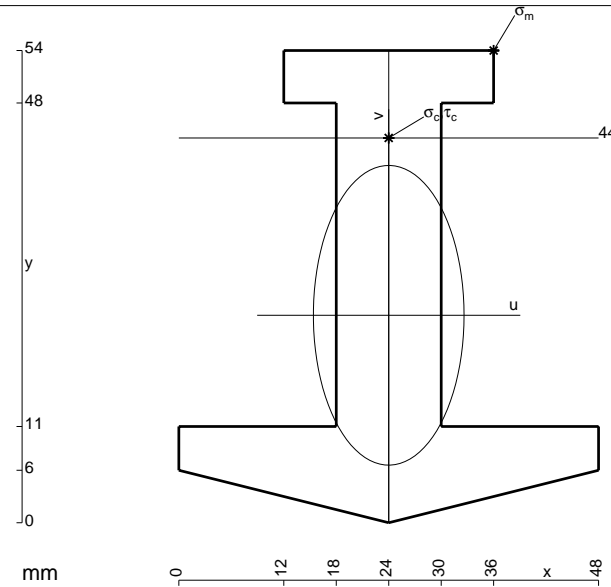
$$= (-11/6 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb 1/EJ dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb 1/EJ$$

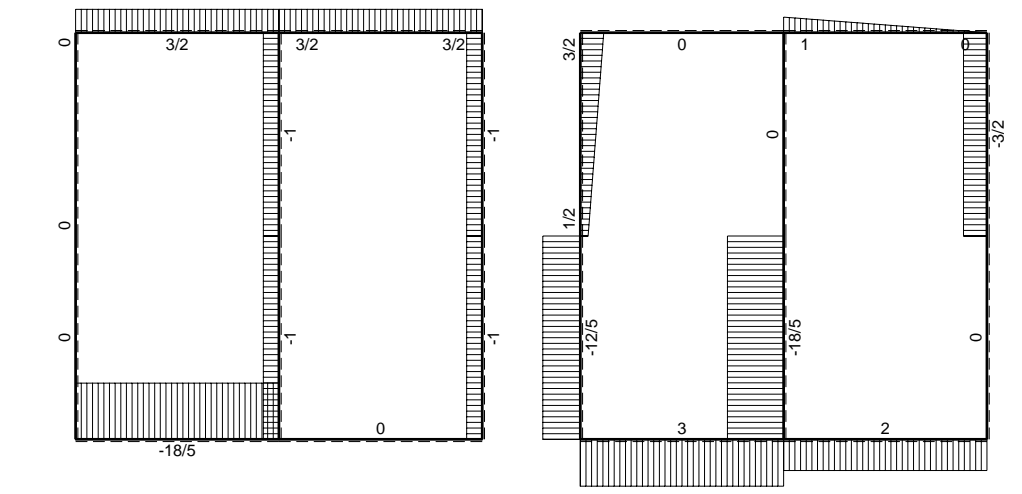
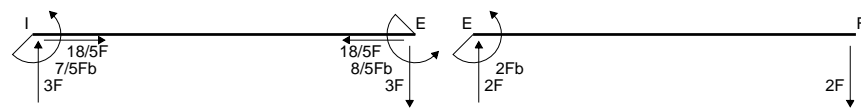
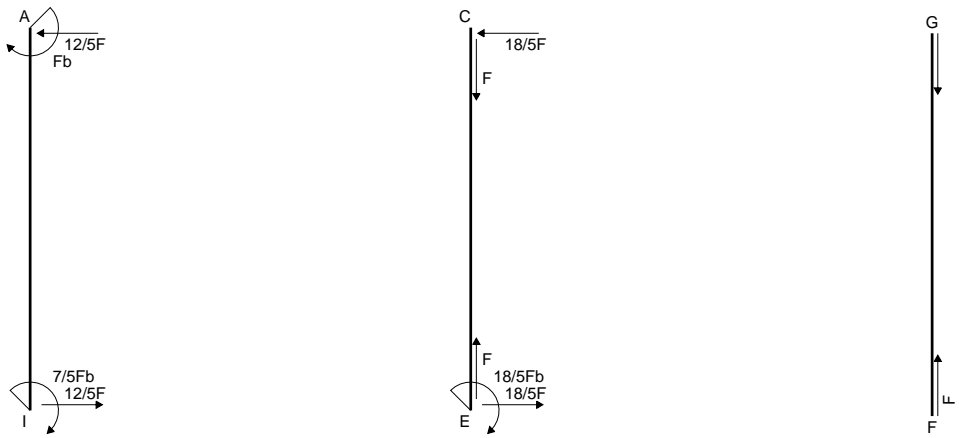
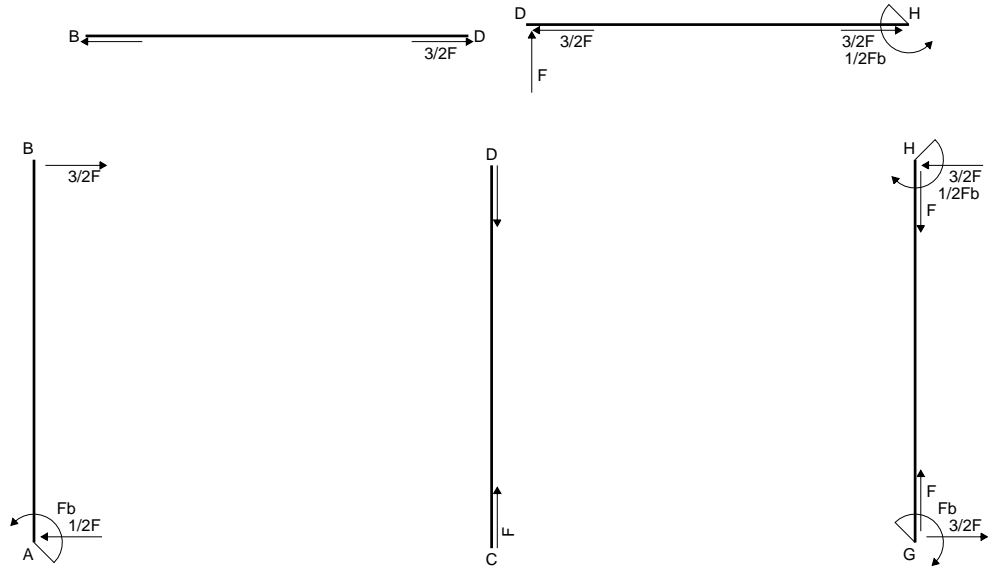
$$= (-3/4 b + 1/2 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb 1/EJ dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/4 b + 1/2 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

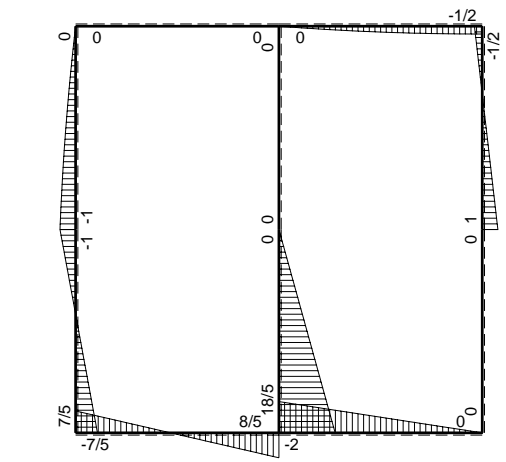


- A = 972. mm²
- J_u = 285465. mm⁴
- J_v = 72144. mm⁴
- y_g = 23.72 mm
- T_y = 2300. N
- M_x = -1978000. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 30.28 mm
- σ_m = -Mv/J_u = 209.8 N/mm²
- x_c = 24. mm
- y_c = 44. mm
- v_c = 20.28 mm
- σ_c = -Mv/J_u = 140.5 N/mm²
- τ_c = 3.355 N/mm²
- σ_q = √σ²+3τ² = 140.6 N/mm²
- S = 4997. mm³

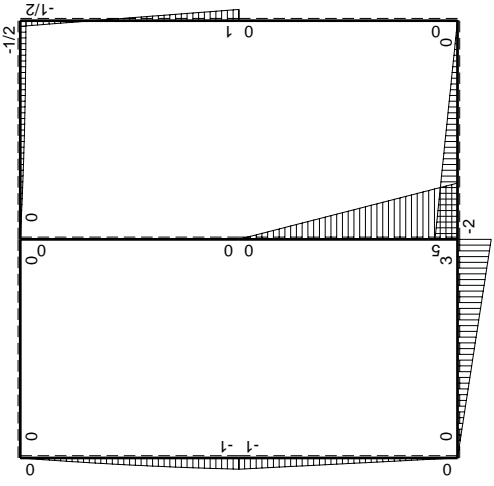
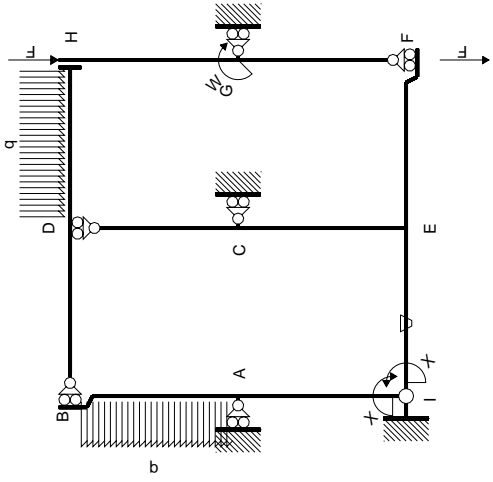


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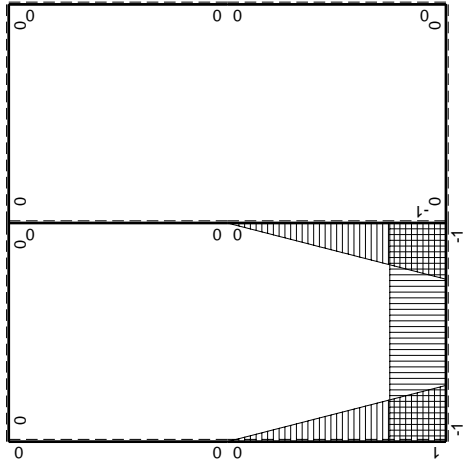


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$3/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-3/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 5b - 5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb \frac{1}{EJ} dx = [-5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

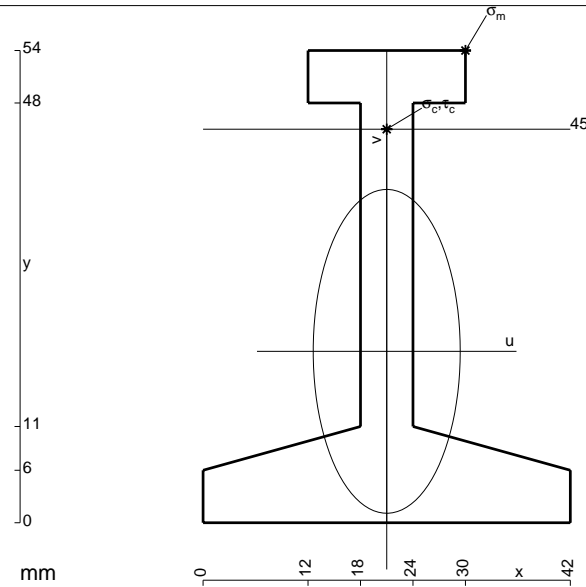
$$= (-5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

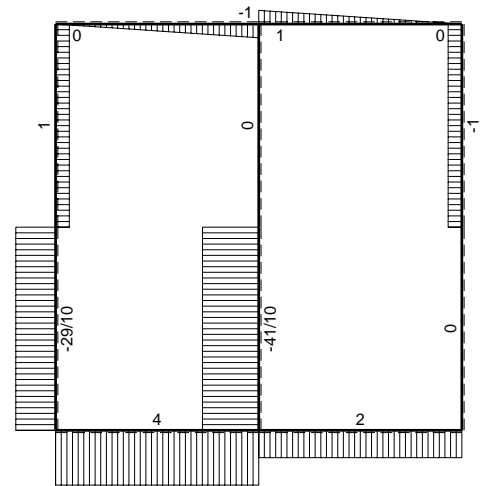
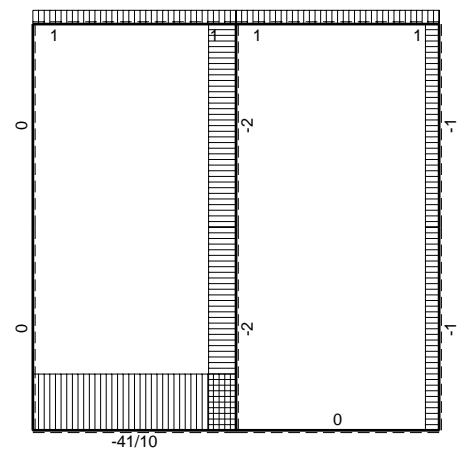
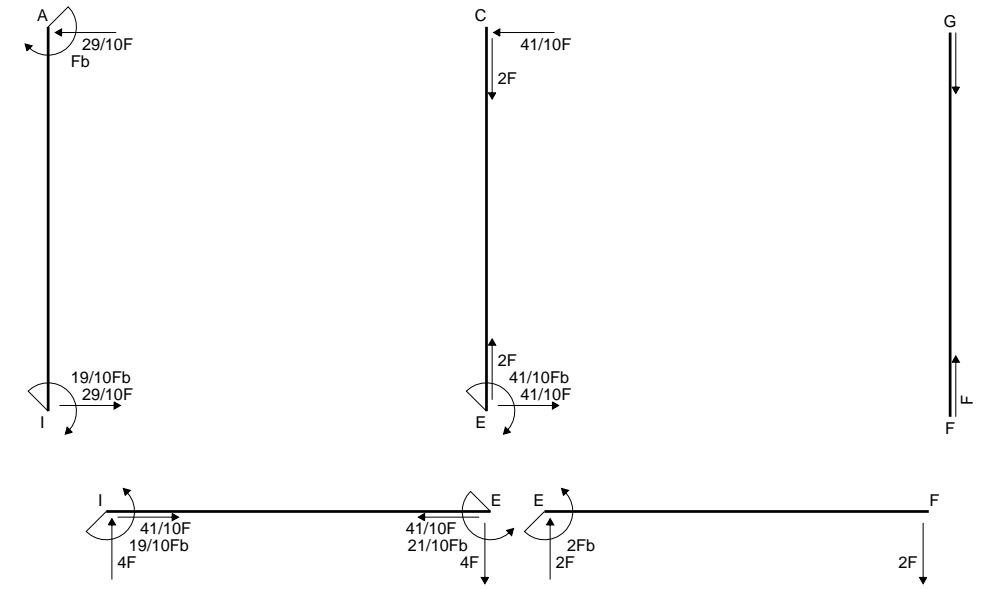
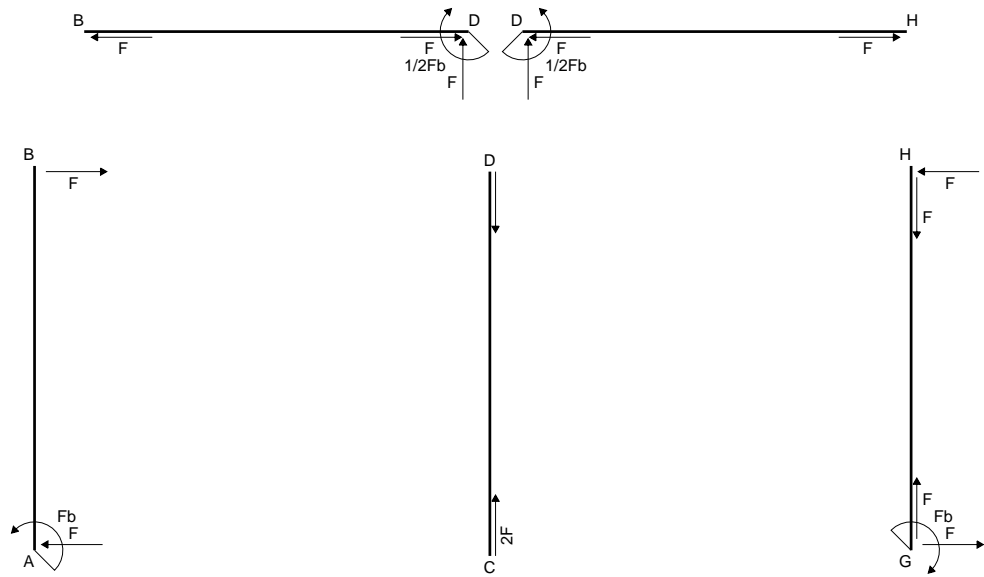
$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

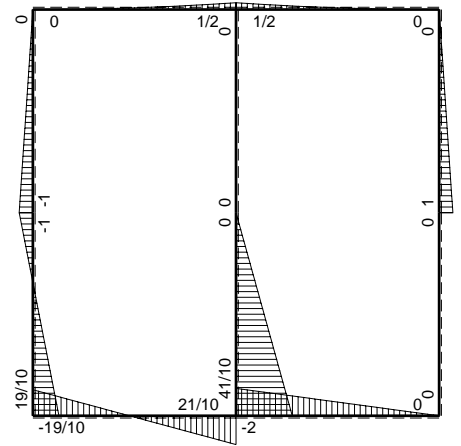


- A = 702. mm²
- J_u = 240790. mm⁴
- J_v = 49626. mm⁴
- y_g = 19.6 mm
- T_y = 1680. N
- M_x = -1528800. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 9. mm
- v_m = 34.4 mm
- σ_m = -Mv/J_u = 218.4 N/mm²
- x_c = 21. mm
- y_c = 45. mm
- v_c = 25.4 mm
- σ_c = -Mv/J_u = 161.3 N/mm²
- τ_c = 4.507 N/mm²
- σ_q = √σ²+3τ² = 161.5 N/mm²
- S = 3876. mm³

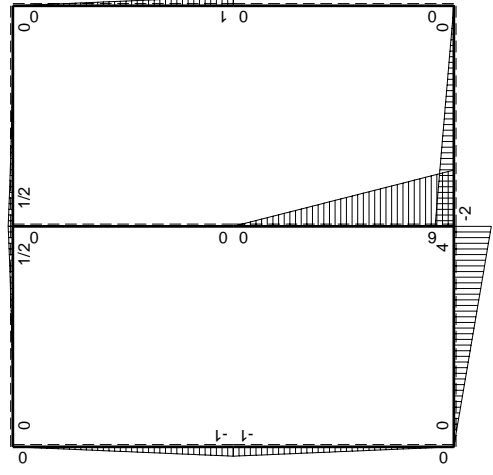
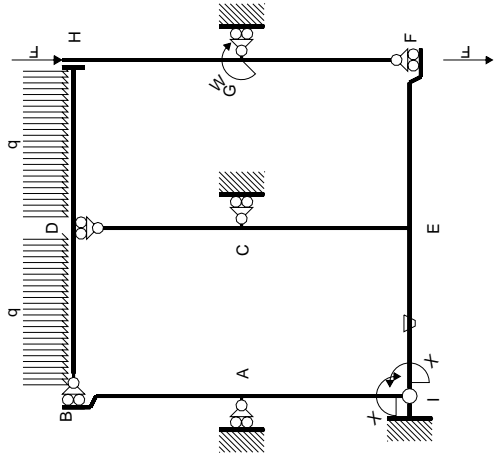


← (+) → F

↑ (+) ↓ F

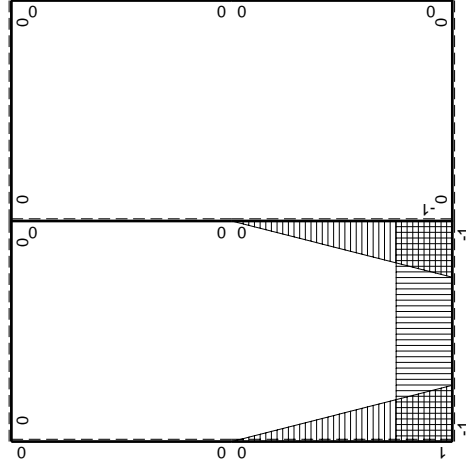


⊙ (+) ⊙ Fb



Schema di calcolo iperstatico

M_0 , flessione da carichi assegnati



M_x , flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-19/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						19/10Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b) Fb 1/EJ + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-4 + 4x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-4b + 2b) Fb 1/EJ + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb 1/EJ dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

$$= (-6b + 6b - 2b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb 1/EJ dx = [-2x^3/b^2]_0^b Fb 1/EJ$$

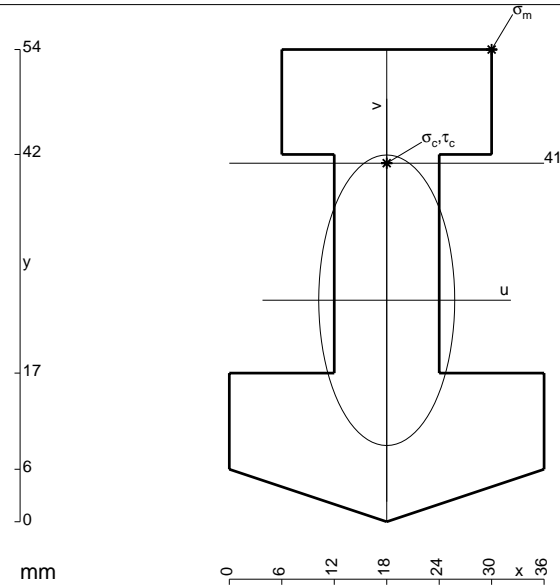
$$= (-2b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

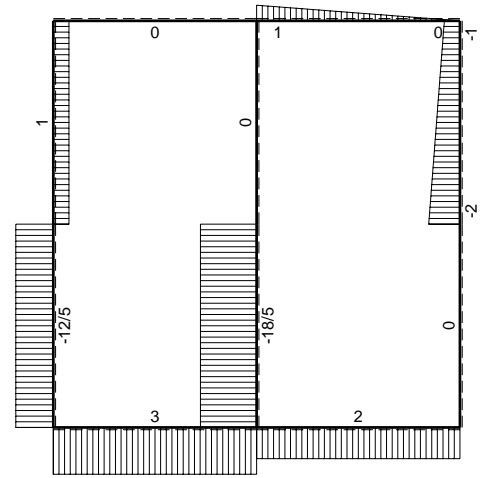
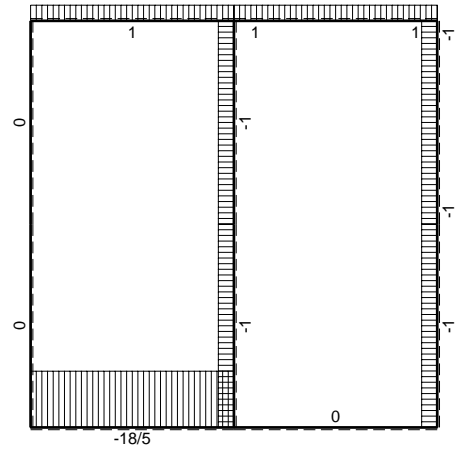
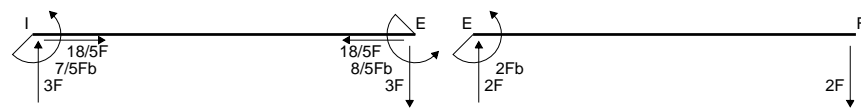
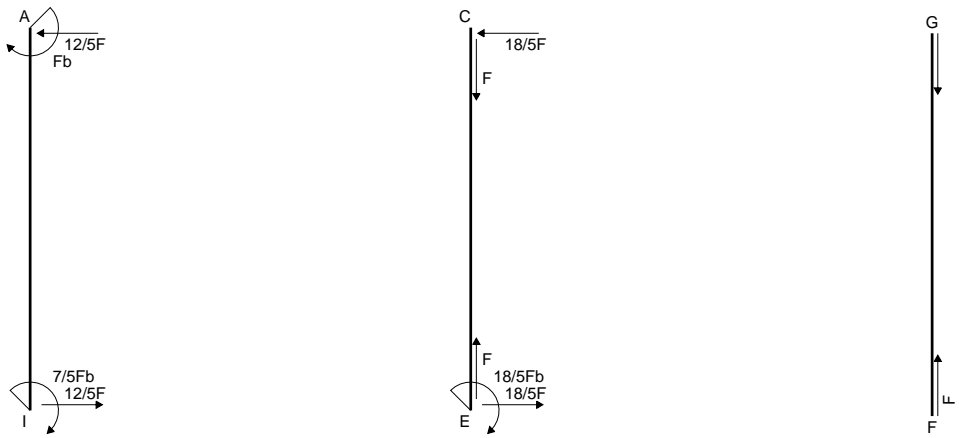
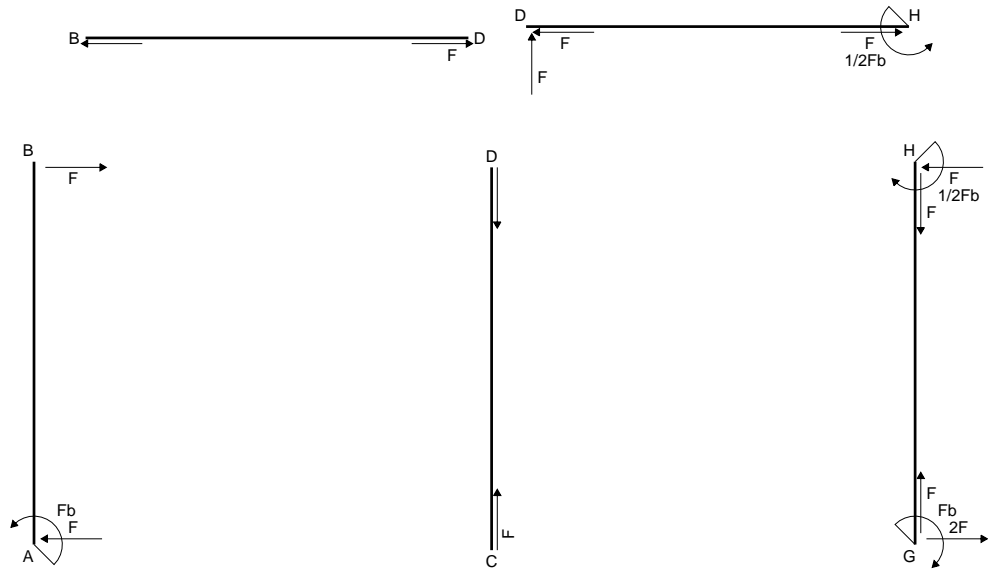
$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

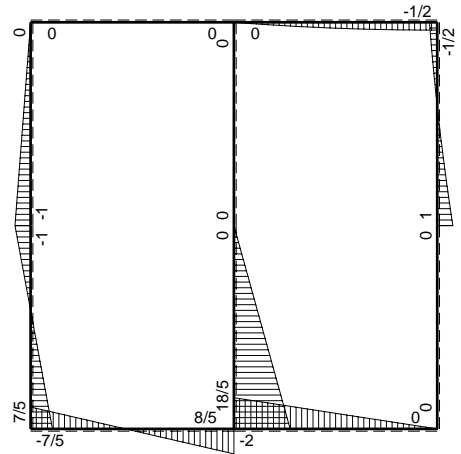


- A = 1092. mm²
- J_u = 301397. mm⁴
- J_v = 66024. mm⁴
- y_g = 25.33 mm
- T_y = 2480. N
- M_x = -2405600. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 28.67 mm
- σ_m = -Mv/J_u = 228.8 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 15.67 mm
- σ_c = -Mv/J_u = 125.1 N/mm²
- τ_c = 4.61 N/mm²
- σ_q = √σ²+3τ² = 125.3 N/mm²
- S = 6723. mm³



← ⊕ → F

↑ ⊕ ↓ F



⊕ ⊖ Fb

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-Fx-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

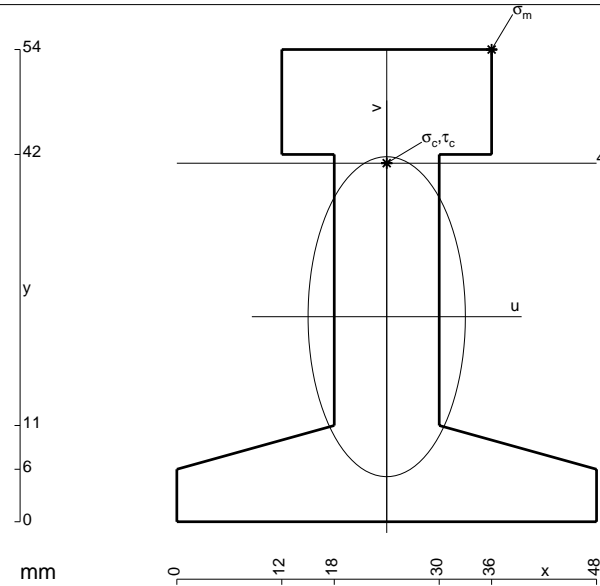
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

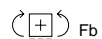
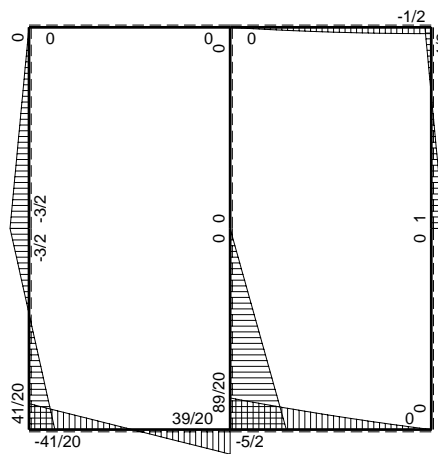
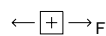
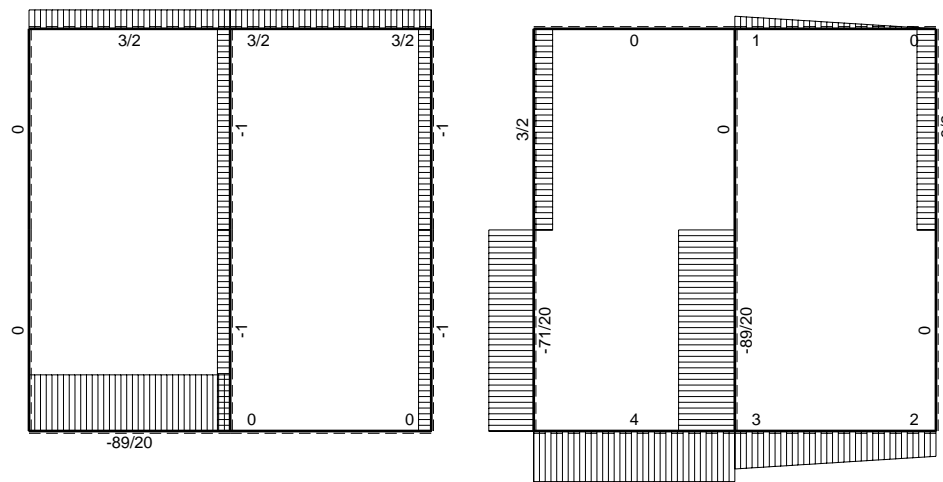
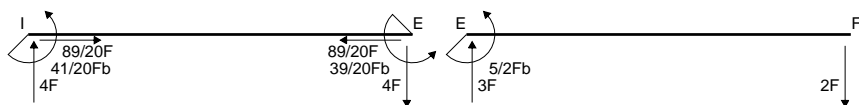
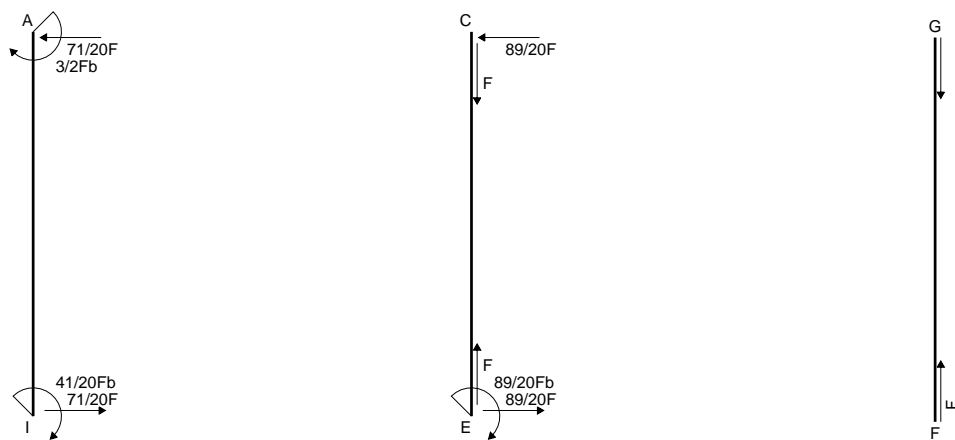
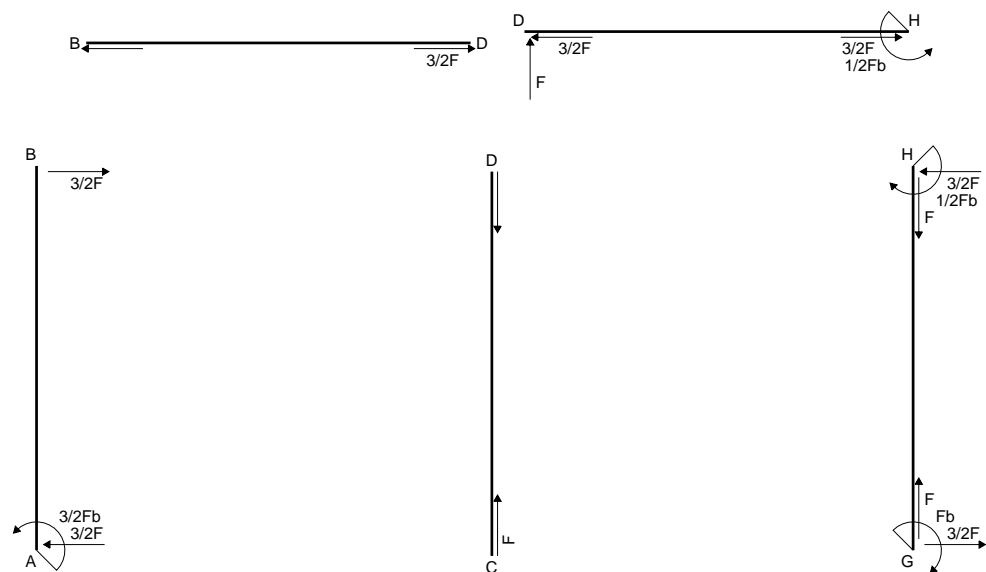
$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

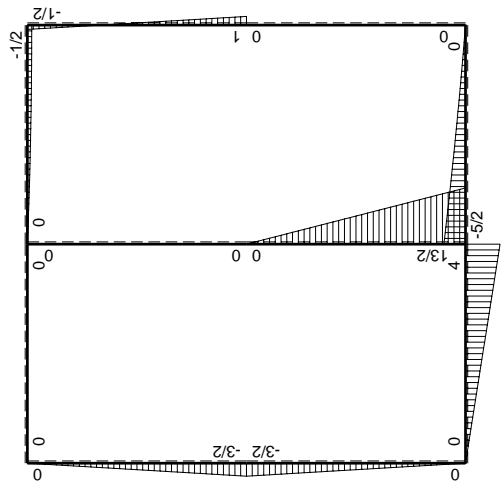
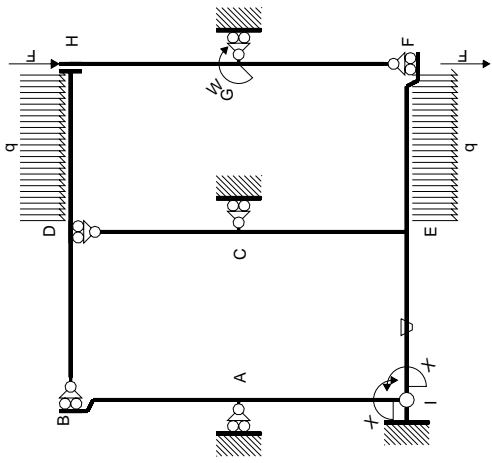
$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$



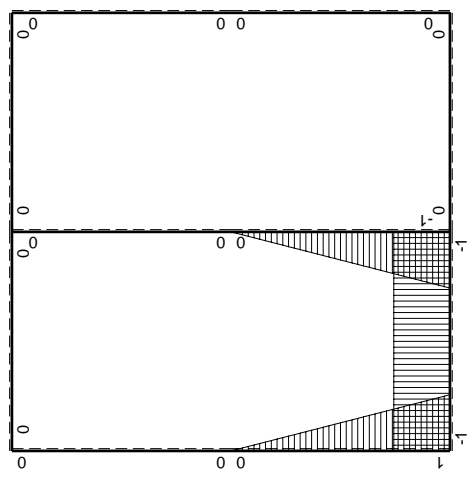
- A = 1098. mm²
- J_u = 367673. mm⁴
- J_v = 88884. mm⁴
- y_g = 23.45 mm
- T_y = 2820. N
- M_x = -2876400. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 30.55 mm
- σ_m = -Mv/J_u = 239. N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 17.55 mm
- σ_c = -Mv/J_u = 137.3 N/mm²
- τ_c = 4.658 N/mm²
- σ_q = √σ²+3τ² = 137.6 N/mm²
- S = 7288. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0
BA b	0	$3/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-3/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-41/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$41/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{x_0} = \int_0^b (-4x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b) Fb \frac{1}{EJ} + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{x_0} = \int_0^b (-4 + 4x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-4b + 2b) Fb \frac{1}{EJ} + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{x_0} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{CE}^{x_0} = \int_0^b (-13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

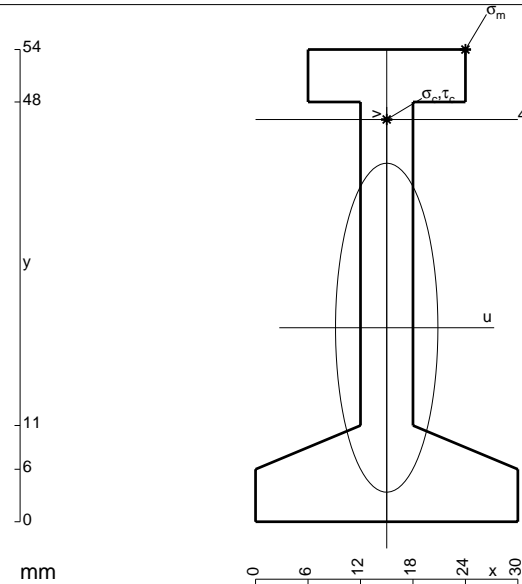
$$= (-13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{IA}^{x_0} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

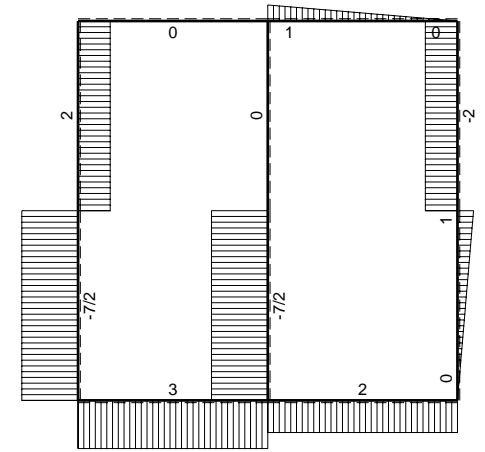
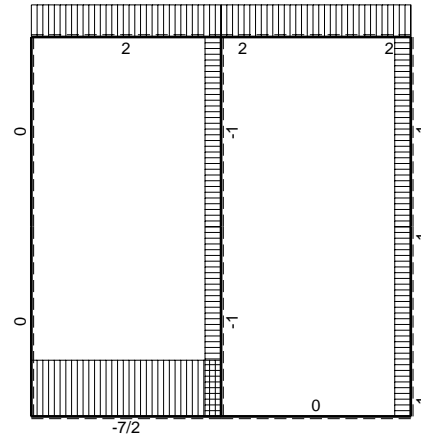
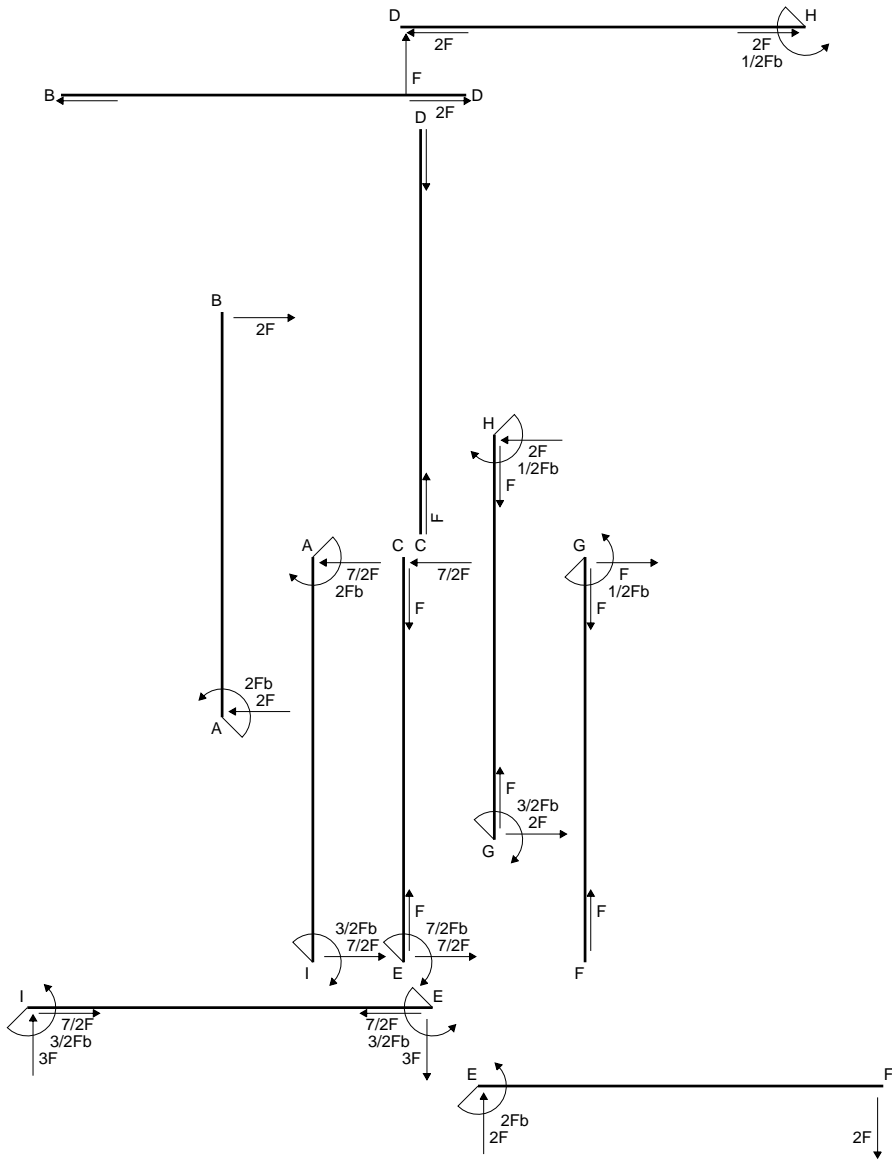
$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

$$L_{AI}^{x_0} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

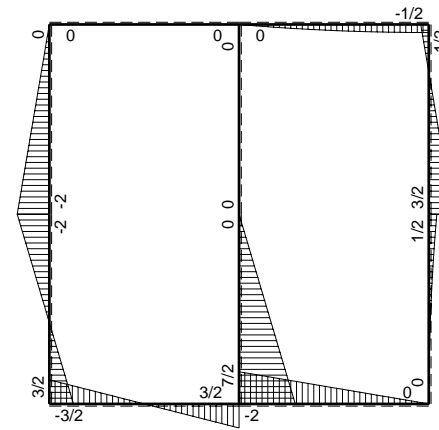


- A = 600. mm²
- J_u = 212405. mm⁴
- J_v = 20592. mm⁴
- y_g = 22.19 mm
- T_y = 2940. N
- M_x = -1323000. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 9. mm
- v_m = 31.81 mm
- σ_m = -Mv/J_u = 198.2 N/mm²
- x_c = 15. mm
- y_c = 46. mm
- v_c = 23.81 mm
- σ_c = -Mv/J_u = 148.3 N/mm²
- τ_c = 7.866 N/mm²
- σ_q = √σ²+3τ² = 148.9 N/mm²
- S = 3410. mm³

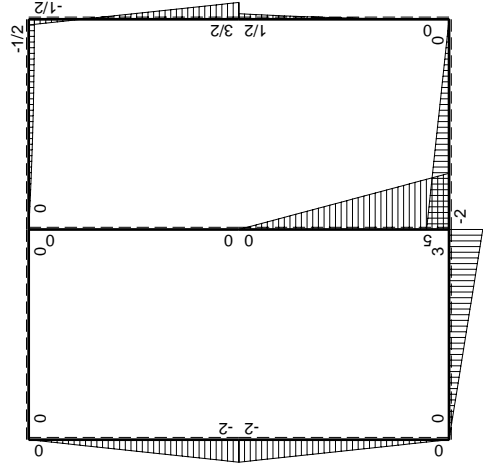
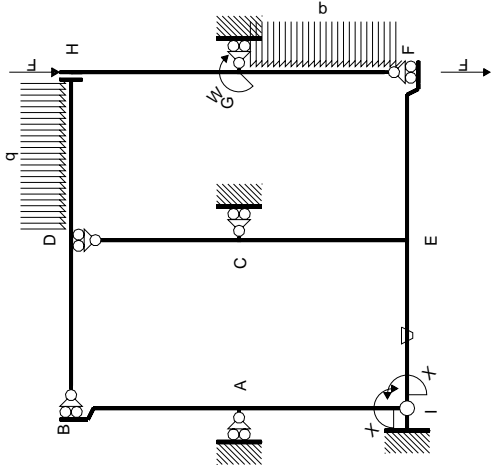


← ⊕ → F

↑ ⊕ ↓ F

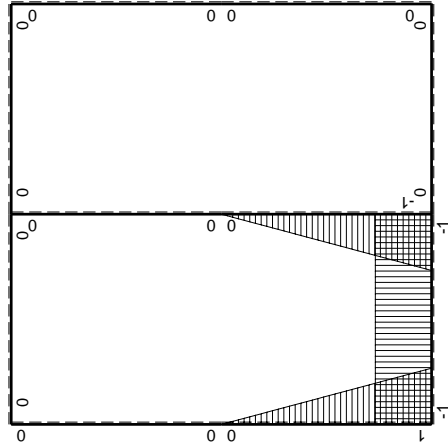


⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-2Fb+2Fx	0	0	0	0	0+0	0
BA b	0	2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-2Fx$	0	$-2Fx+2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$2Fb-2Fx$	0	$-2Fx+2Fx^2/b$	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 5b - 5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb \frac{1}{EJ} dx = [-5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

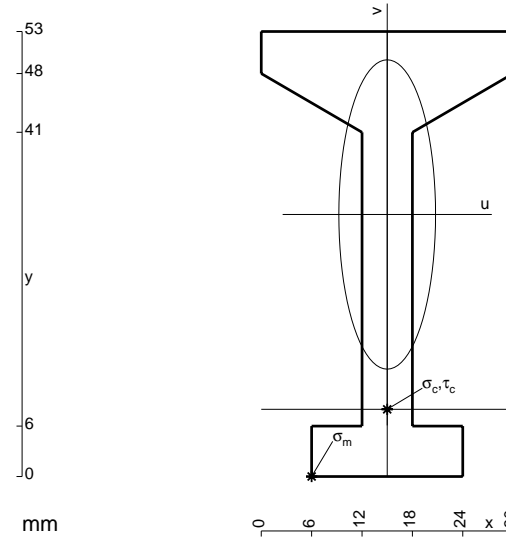
$$= (-5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-2x/b + 2x^2/b^2) Fb \frac{1}{EJ} dx = [-x^2/b + 2/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-b + 2/3 b) Fb \frac{1}{EJ} = -1/3 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-2x/b + 2x^2/b^2) Fb \frac{1}{EJ} dx = [-x^2/b + 2/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-b + 2/3 b) Fb \frac{1}{EJ} = -1/3 Fb^2/EJ$$



$$A = 594. \text{ mm}^2$$

$$J_u = 201694. \text{ mm}^4$$

$$J_v = 19710. \text{ mm}^4$$

$$y_g = 31.21 \text{ mm}$$

$$T_y = 2320. \text{ N}$$

$$M_x = -1345600. \text{ Nmm}$$

$$x_m = 6. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -31.21 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -208.2 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 8. \text{ mm}$$

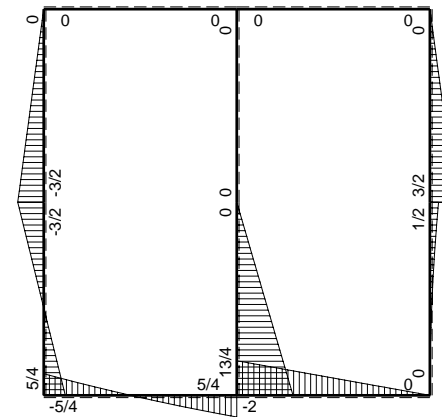
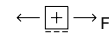
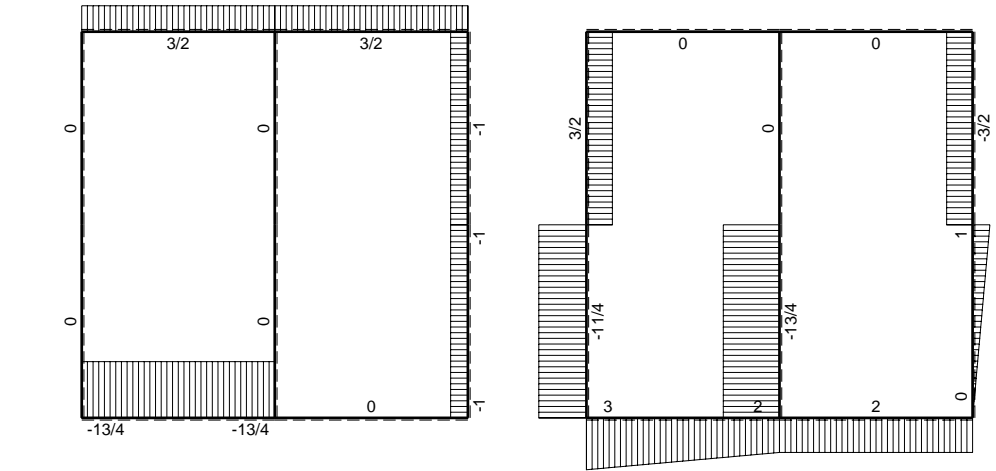
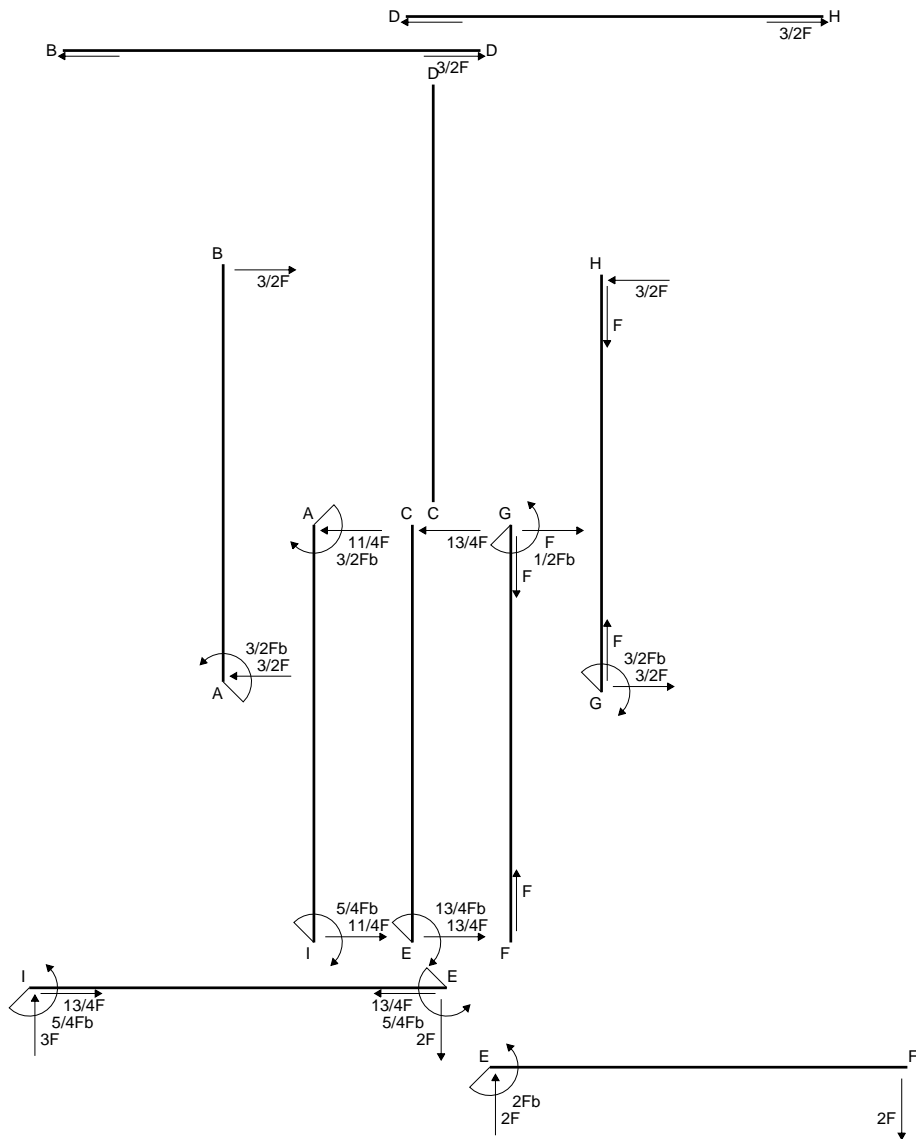
$$v_c = -23.21 \text{ mm}$$

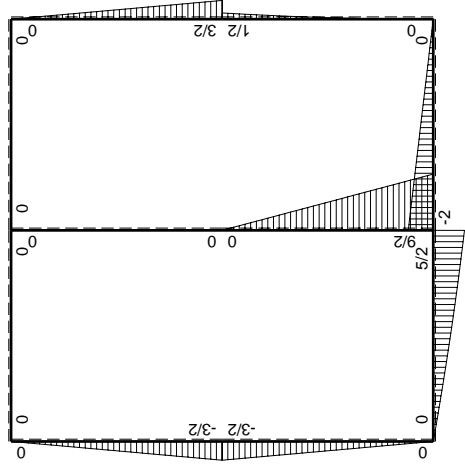
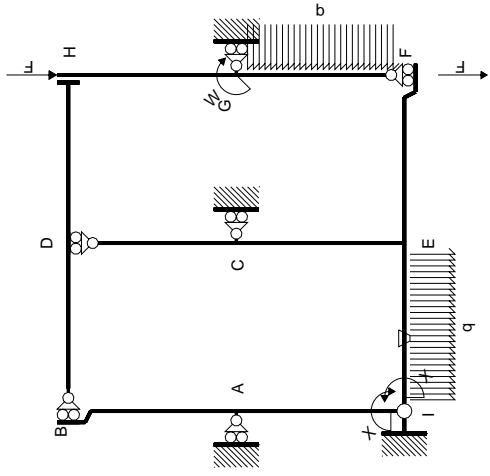
$$\sigma_c = -Mv/J_u = -154.8 \text{ N/mm}^2$$

$$\tau_c = 6.398 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 155.2 \text{ N/mm}^2$$

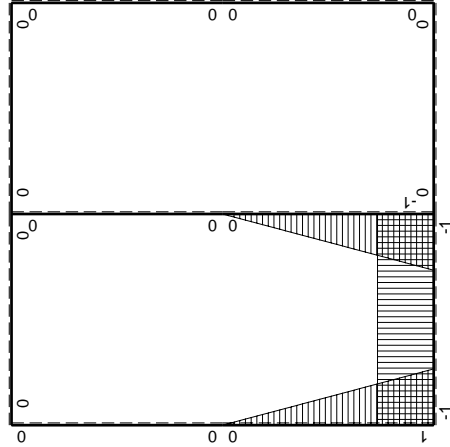
$$S = 3337. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0
BA b	0	$3/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$-3/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$9/2Fb-9/2Fx$	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-9/2Fx$	0	$-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-25/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$5/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -1/3 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-5/2 + 2x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-5/2 b + b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -1/3 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-9/2 + 9x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-9/2 x + 9/2 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-9/2 b + 9/2 b - 3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

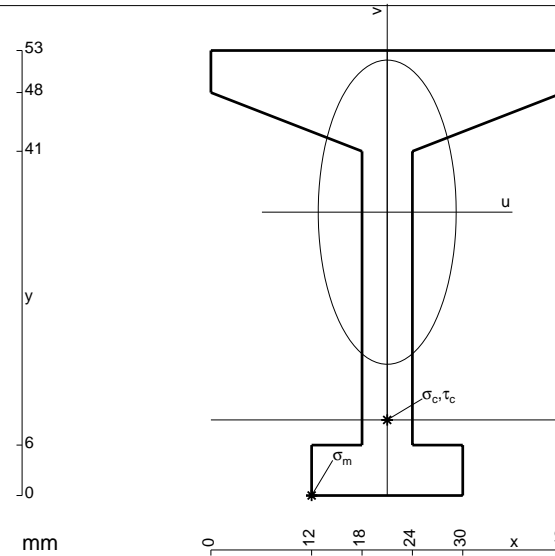
$$= (-3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

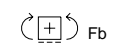
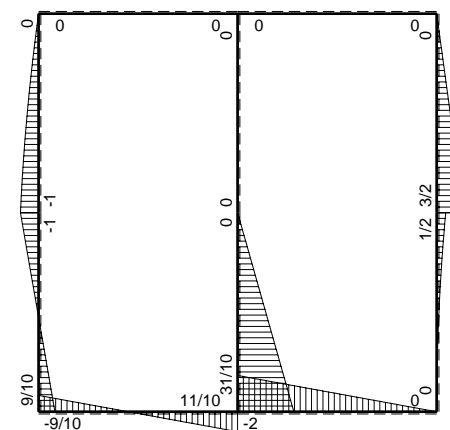
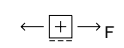
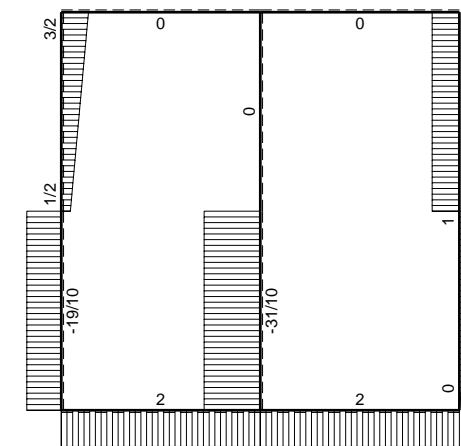
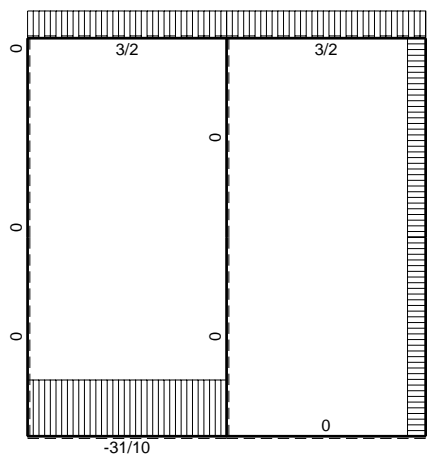
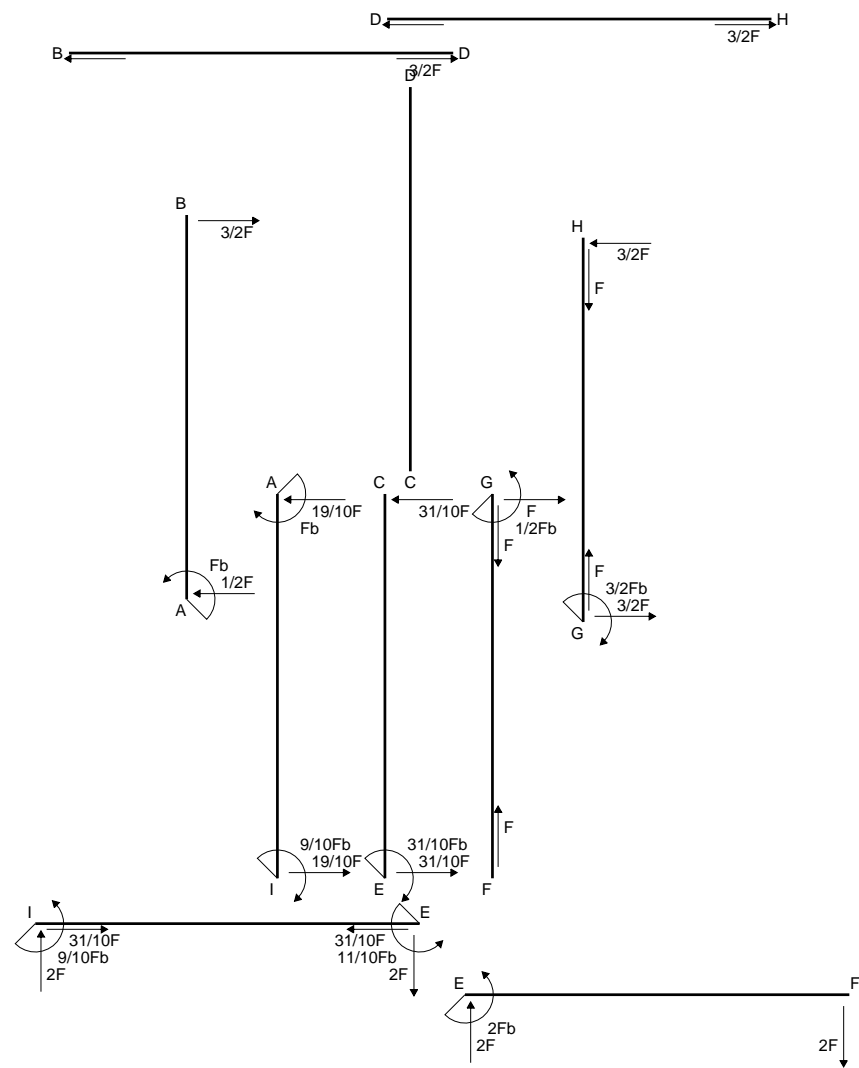
$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

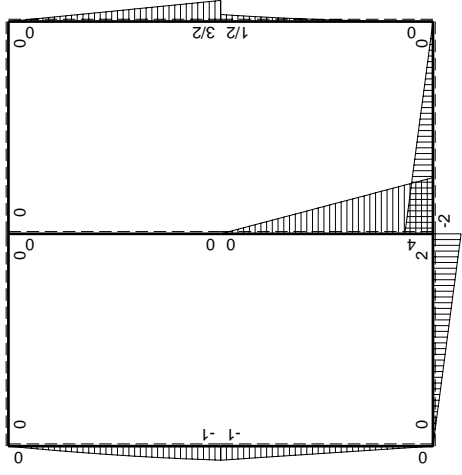
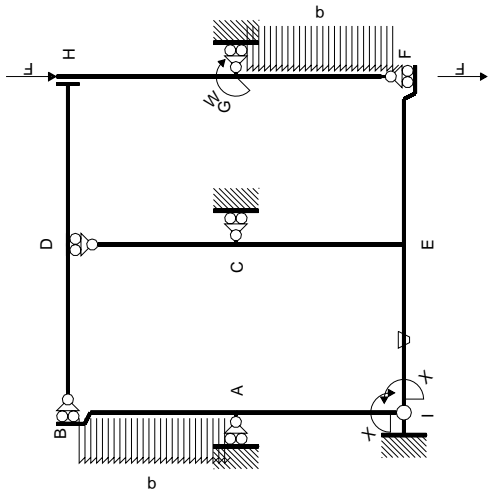
$$L_{AI}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$



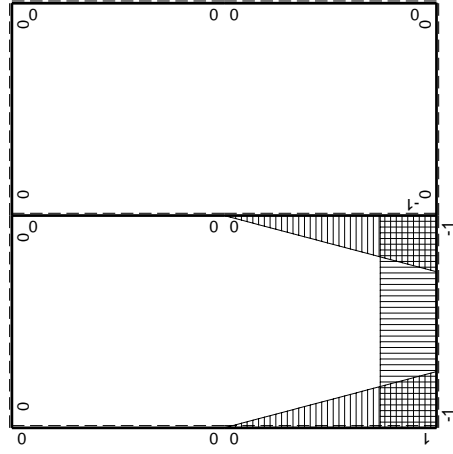
- A = 696. mm²
- J_u = 228562. mm⁴
- J_v = 47016. mm⁴
- y_g = 33.75 mm
- T_y = 2360. N
- M_x = -1486800. Nmm
- x_m = 12. mm
- u_m = -9. mm
- v_m = -33.75 mm
- σ_m = -Mv/J_u = -219.5 N/mm²
- x_c = 21. mm
- y_c = 9. mm
- v_c = -24.75 mm
- σ_c = -Mv/J_u = -161. N/mm²
- τ_c = 6.527 N/mm²
- σ_o = √σ² + 3τ² = 161.4 N/mm²
- S = 3793. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-Fb+1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$3/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$-3/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$9/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-b) Fb \frac{1}{EJ} + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-2b + b) Fb \frac{1}{EJ} + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 8x/b - 4x^2/b^2) Fb \frac{1}{EJ} dx = [-4x + 4x^2/b - 4/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-4b + 4b - 4/3 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-4x^2/b^2) Fb \frac{1}{EJ} dx = [-4/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

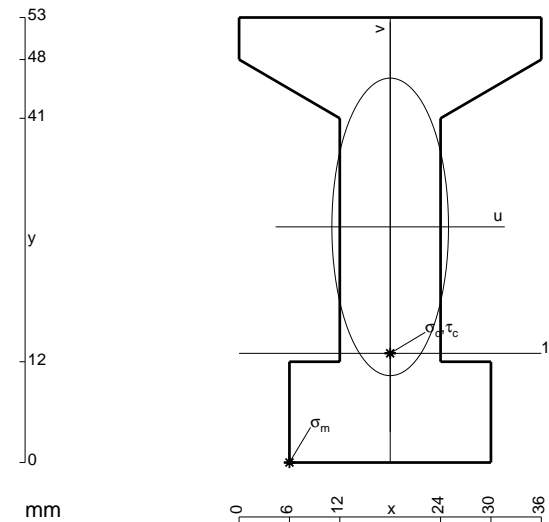
$$= (-4/3 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

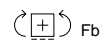
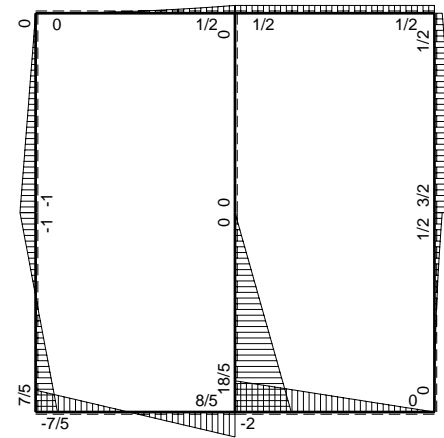
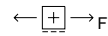
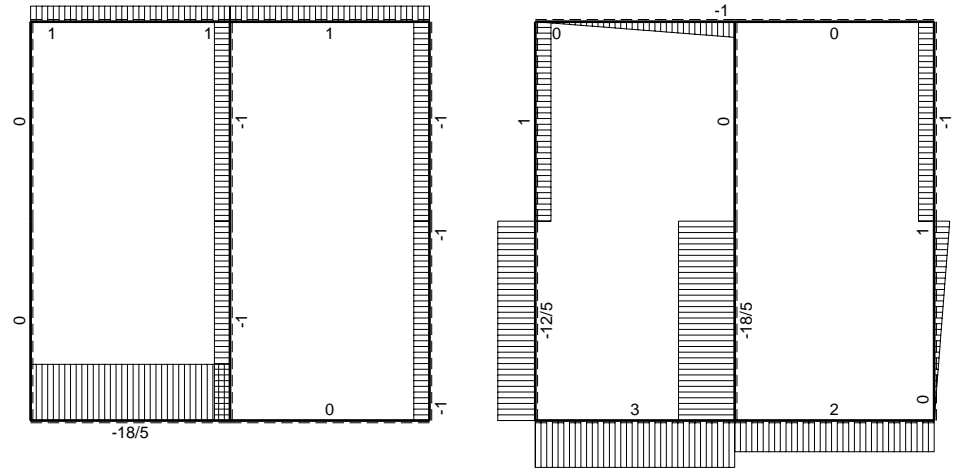
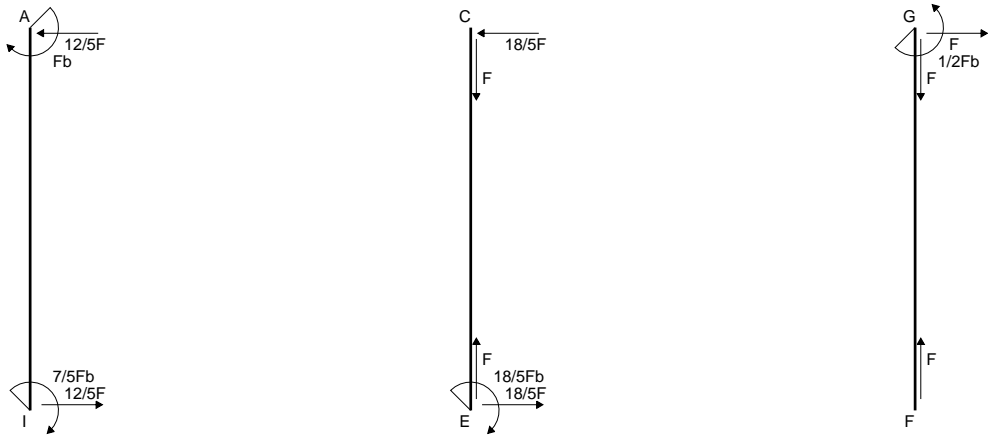
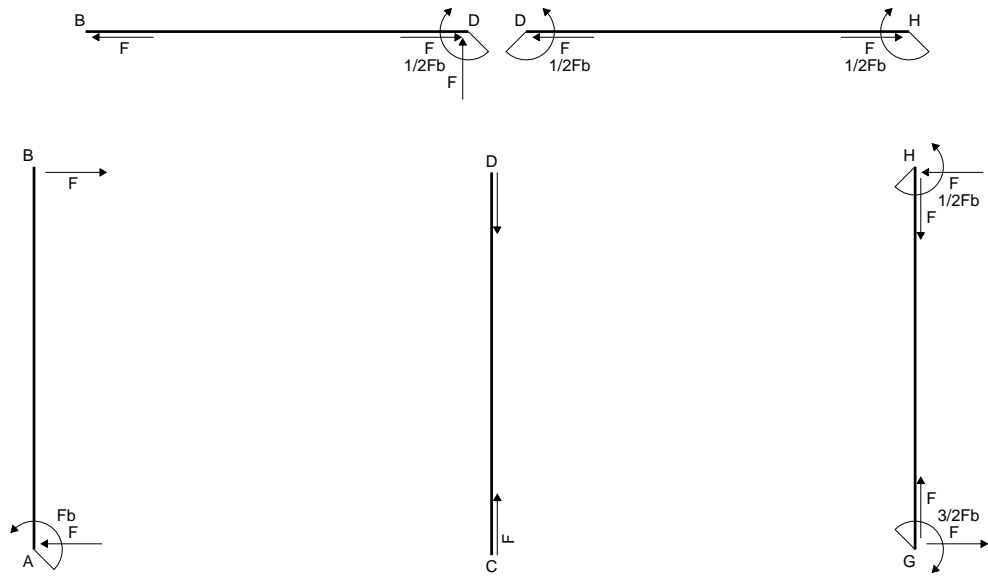
$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

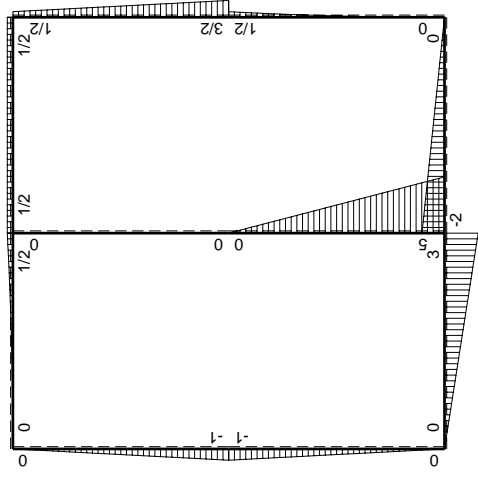
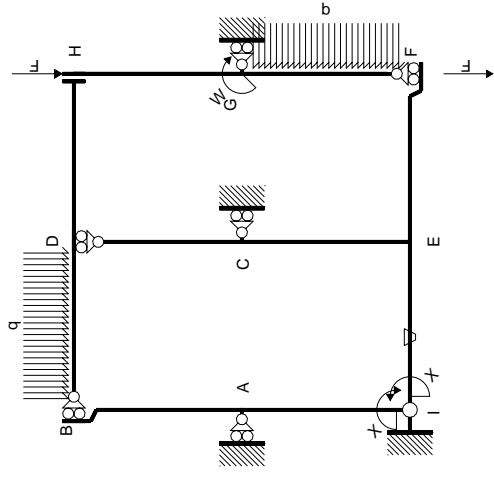
$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$



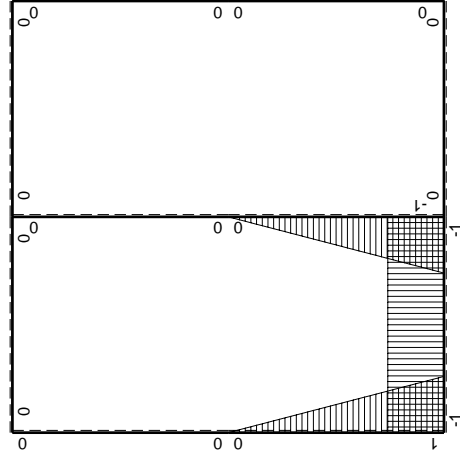
- A = 984. mm²
- J_u = 309174. mm⁴
- J_v = 47520. mm⁴
- y_g = 28.06 mm
- T_y = 3720. N
- M_x = -2529600. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.06 mm
- σ_m = -Mv/J_u = -229.6 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.06 mm
- σ_c = -Mv/J_u = -123.2 N/mm²
- τ_c = 6.558 N/mm²
- σ_o = √σ² + 3τ² = 123.8 N/mm²
- S = 6541. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb-Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

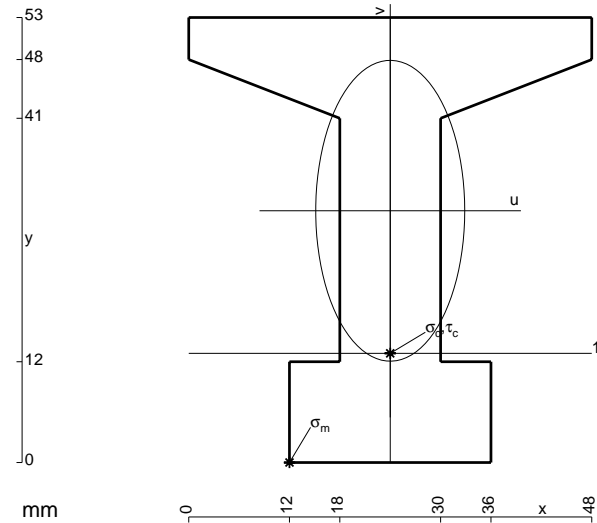
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

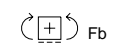
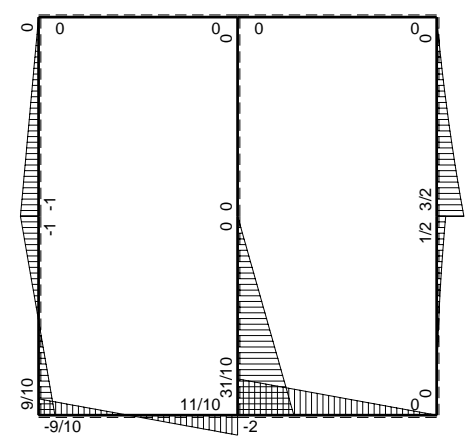
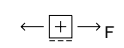
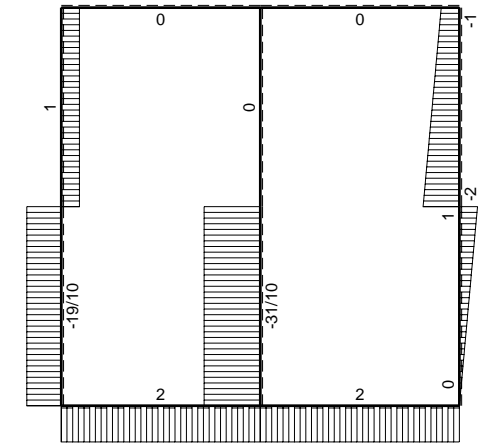
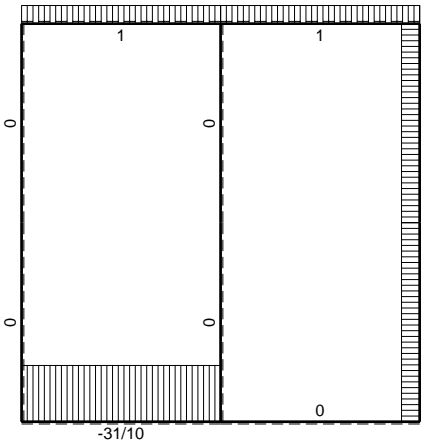
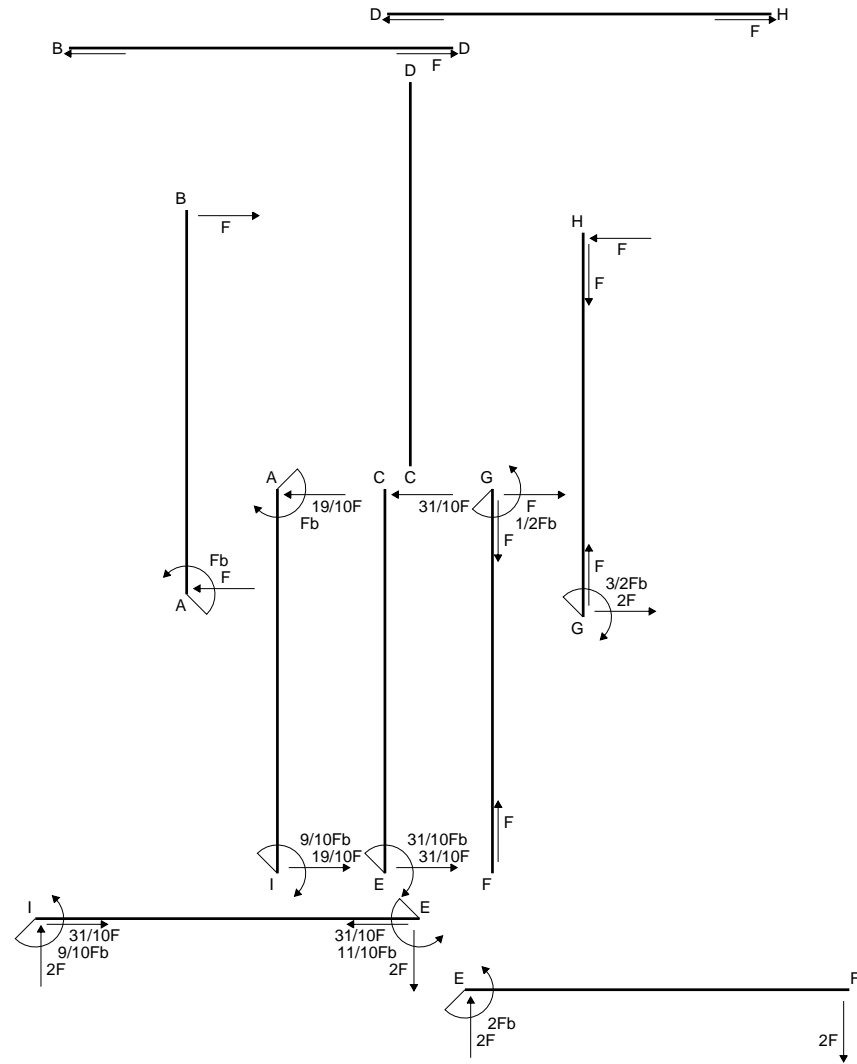
$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

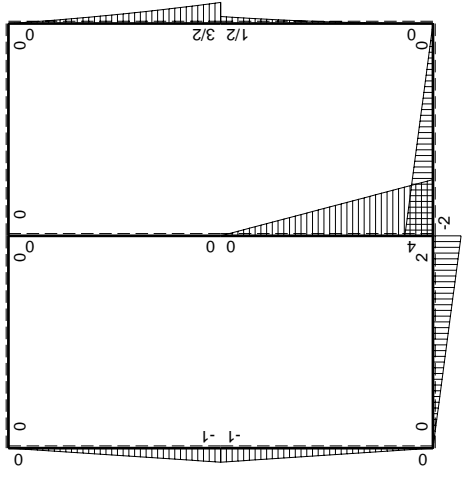
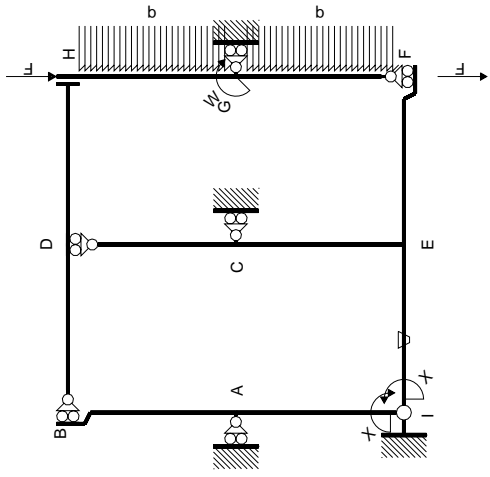
$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$



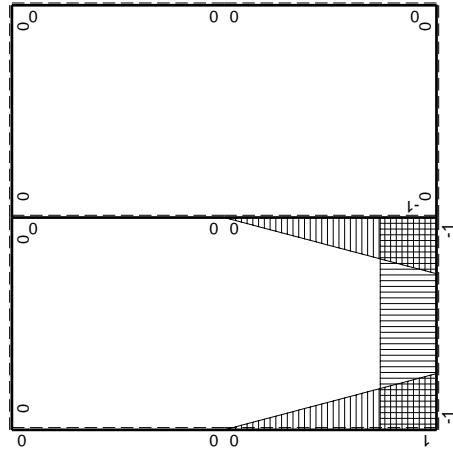
- A = 1086. mm²
- J_u = 348629. mm⁴
- J_v = 85500. mm⁴
- y_g = 29.98 mm
- T_y = 3760. N
- M_x = -2782400. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -29.98 mm
- σ_m = -Mv/J_u = -239.3 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -16.98 mm
- σ_c = -Mv/J_u = -135.5 N/mm²
- τ_c = 6.397 N/mm²
- σ_ρ = √(σ² + 3τ²) = 136. N/mm²
- S = 7117. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$9/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-b) Fb \frac{1}{EJ} + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-2b + b) Fb \frac{1}{EJ} + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 8x/b - 4x^2/b^2) Fb \frac{1}{EJ} dx = [-4x + 4x^2/b - 4/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-4b + 4b - 4/3 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-4x^2/b^2) Fb \frac{1}{EJ} dx = [-4/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

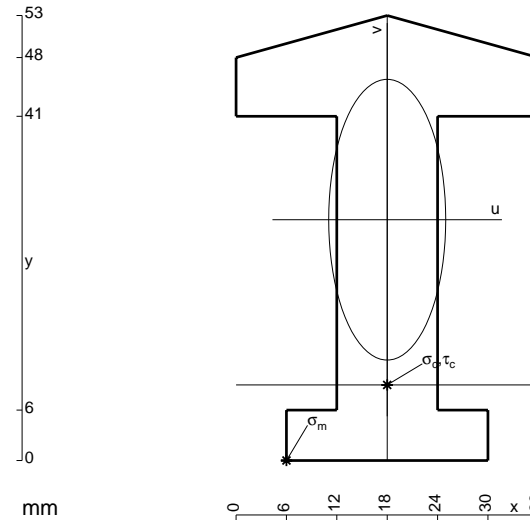
$$= (-4/3 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

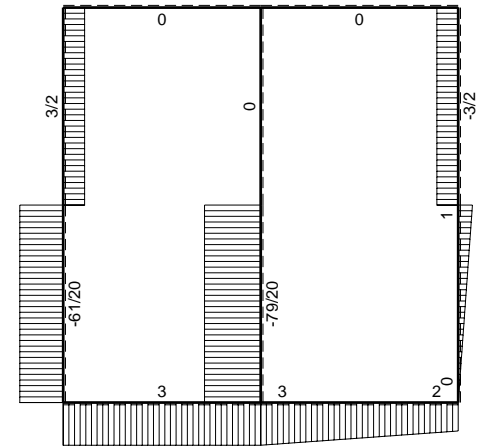
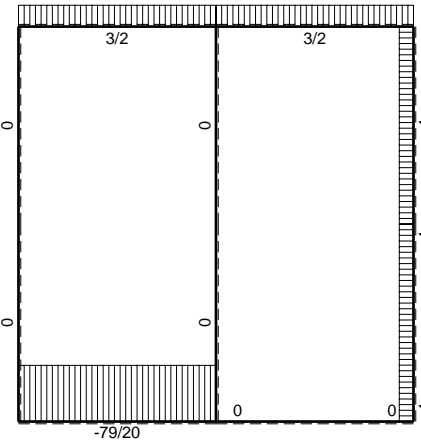
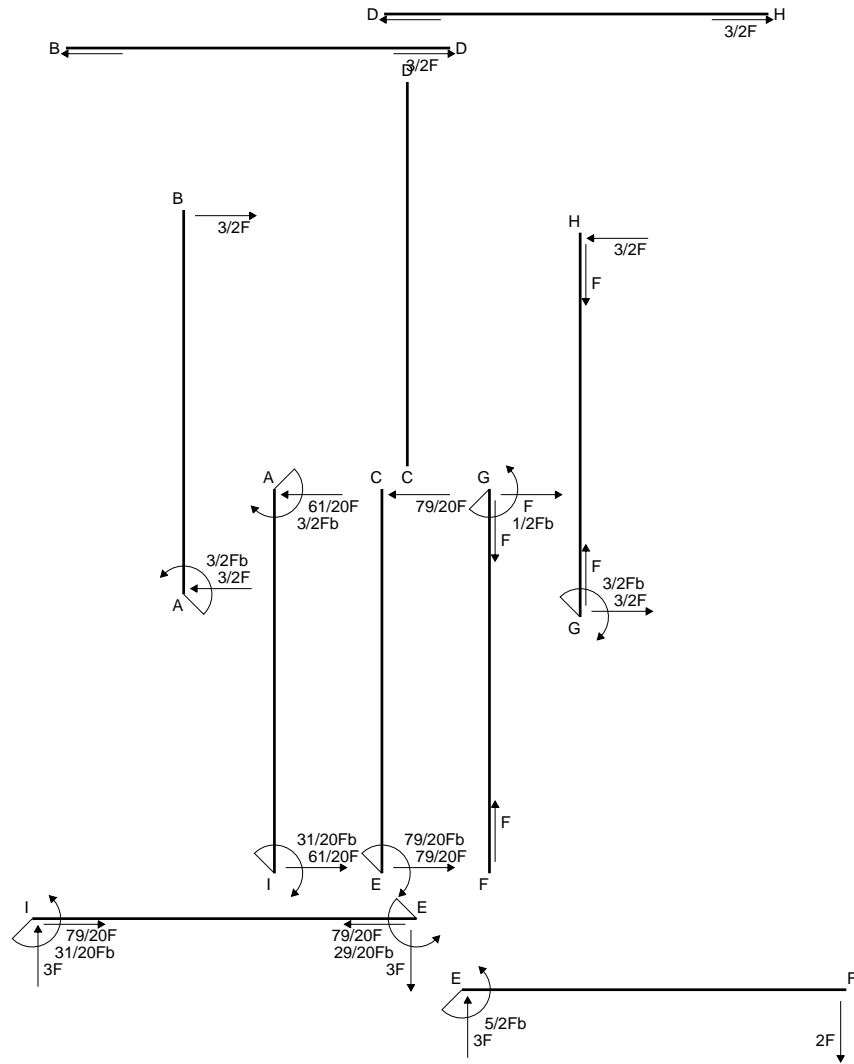
$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

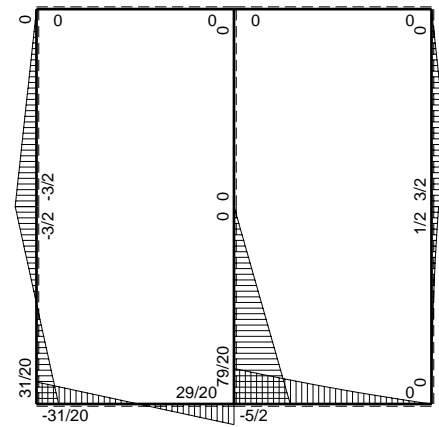


- A = 906. mm²
- J_u = 253401. mm⁴
- J_v = 44028. mm⁴
- y_g = 28.68 mm
- T_y = 2220. N
- M_x = -1753800. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.68 mm
- σ_m = -Mv/J_u = -198.5 N/mm²
- x_c = 18. mm
- y_c = 9. mm
- v_c = -19.68 mm
- σ_c = -Mv/J_u = -136.2 N/mm²
- τ_c = 3.257 N/mm²
- σ_o = √σ²+3τ² = 136.3 N/mm²
- S = 4461. mm³

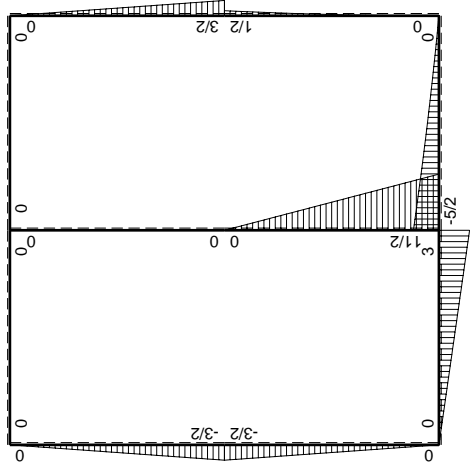
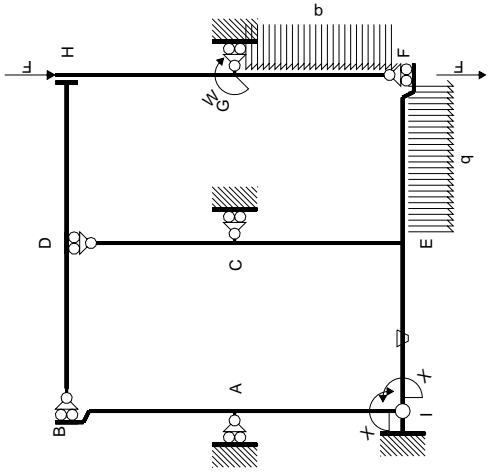


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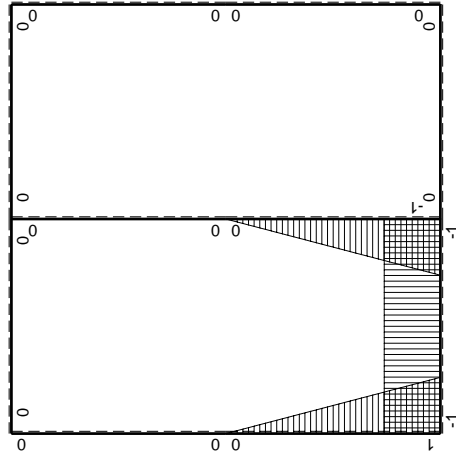


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0	
BA b	0	$3/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC 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			
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
GH b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-3/2Fx$	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1			
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2			
	totali							$-31/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$31/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

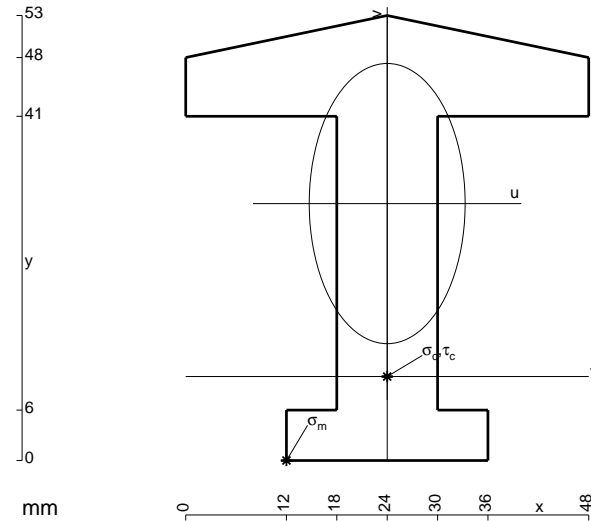
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

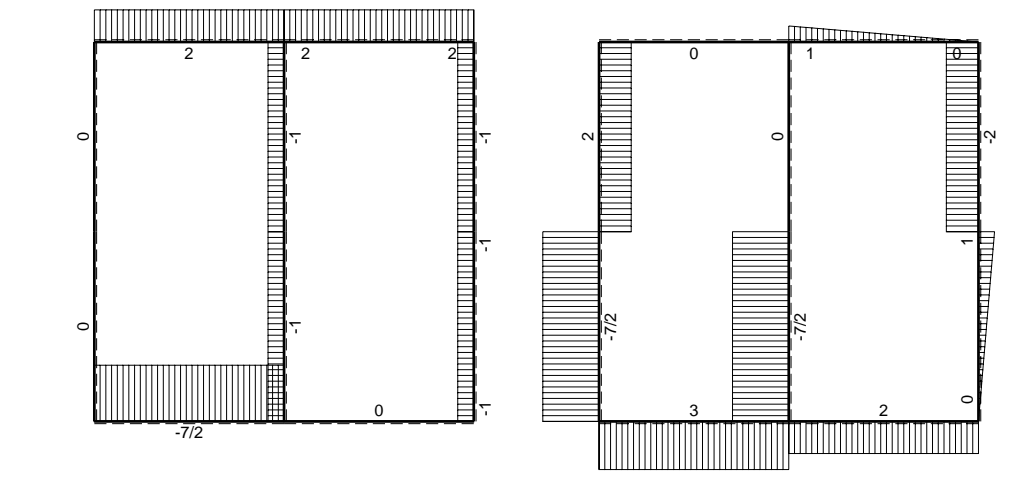
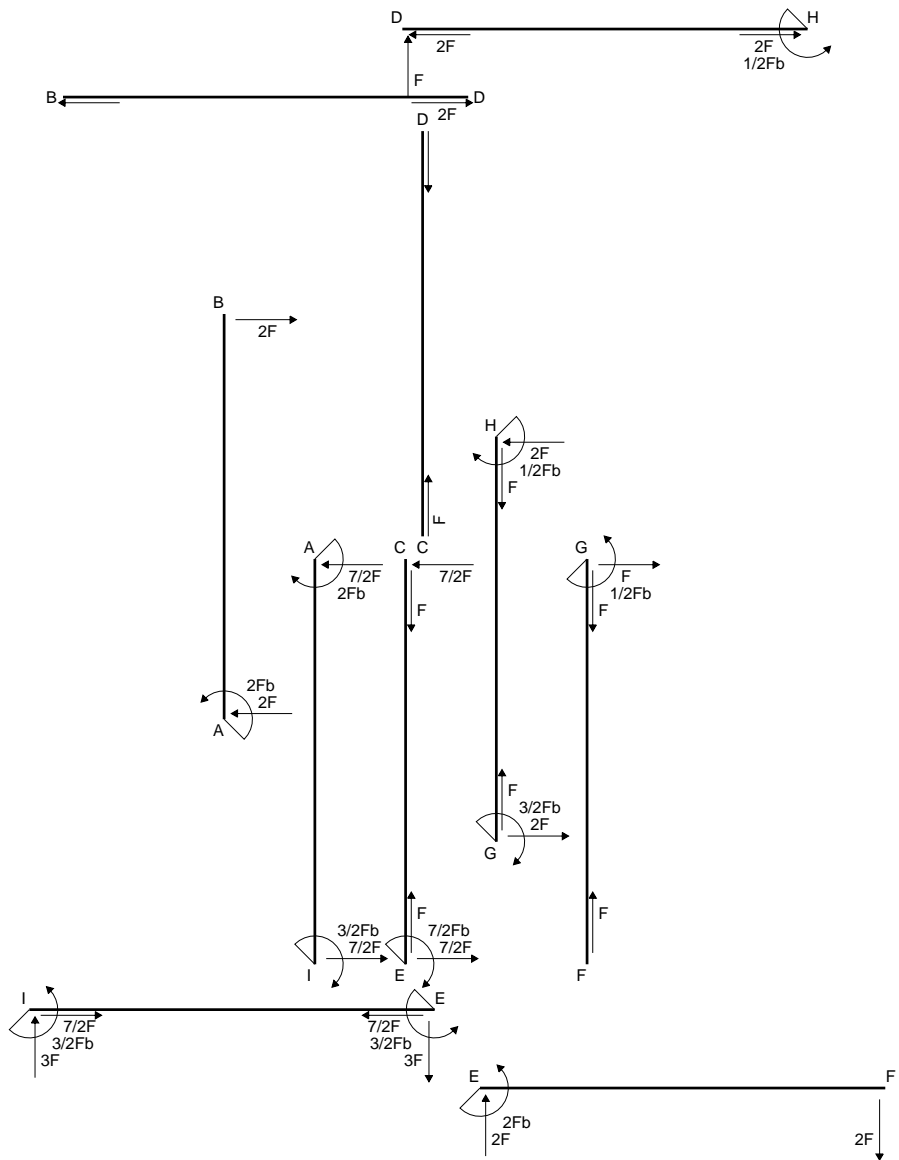
$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

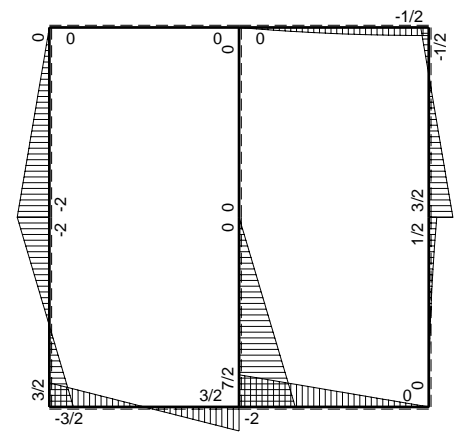


- A = 1020. mm²
- J_u = 284254. mm⁴
- J_v = 87984. mm⁴
- y_g = 30.6 mm
- T_y = 2760. N
- M_x = -1932000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.6 mm
- σ_m = -Mv/J_u = -208. N/mm²
- x_c = 24. mm
- y_c = 10. mm
- v_c = -20.6 mm
- σ_c = -Mv/J_u = -140. N/mm²
- τ_c = 4.094 N/mm²
- σ_o = √σ_c² + 3τ_c² = 140.2 N/mm²
- S = 5060. mm³

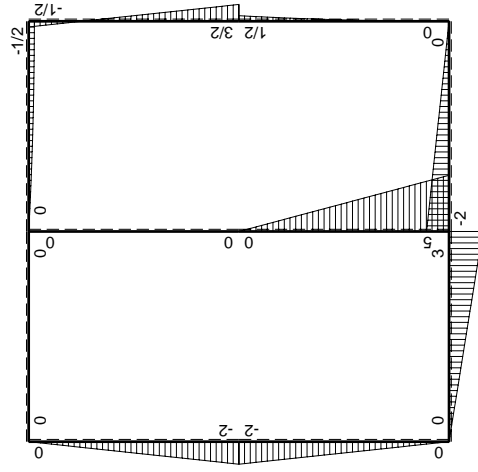
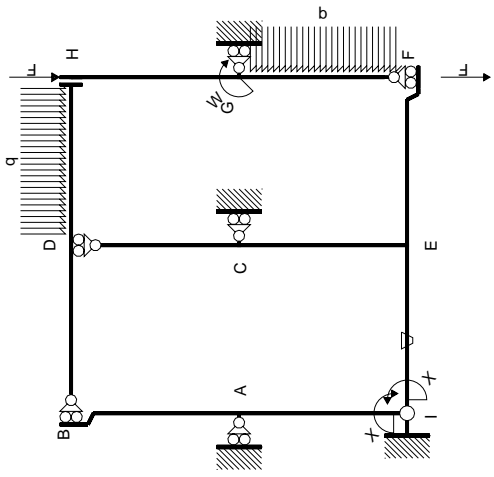


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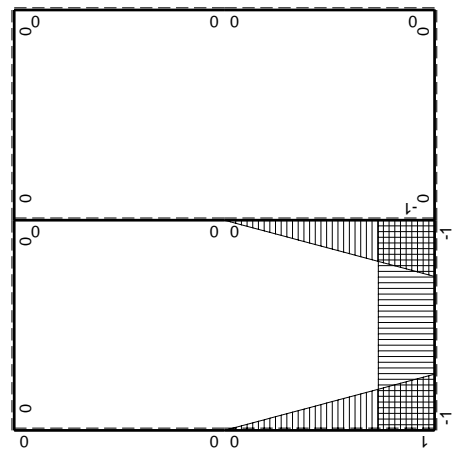


⤵ (+) ⤴ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-2Fb+2Fx	0	0	0	0	0+0	0
BA b	0	2Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-2Fx$	0	$-2Fx+2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/3+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$2Fb-2Fx$	0	$-2Fx+2Fx^2/b$	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

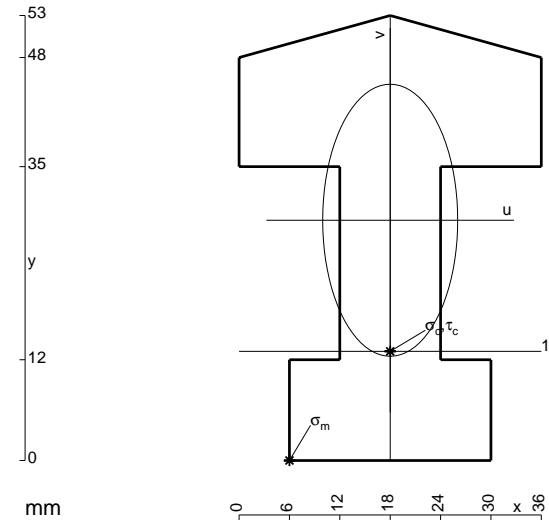
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-2x/b + 2x^2/b^2) Fb 1/EJ dx = [-x^2/b + 2/3 x^3/b^2]_0^b Fb 1/EJ$$

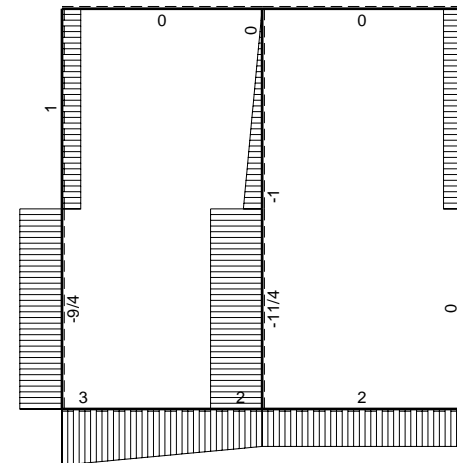
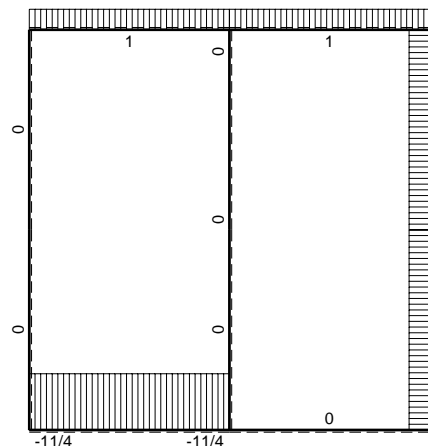
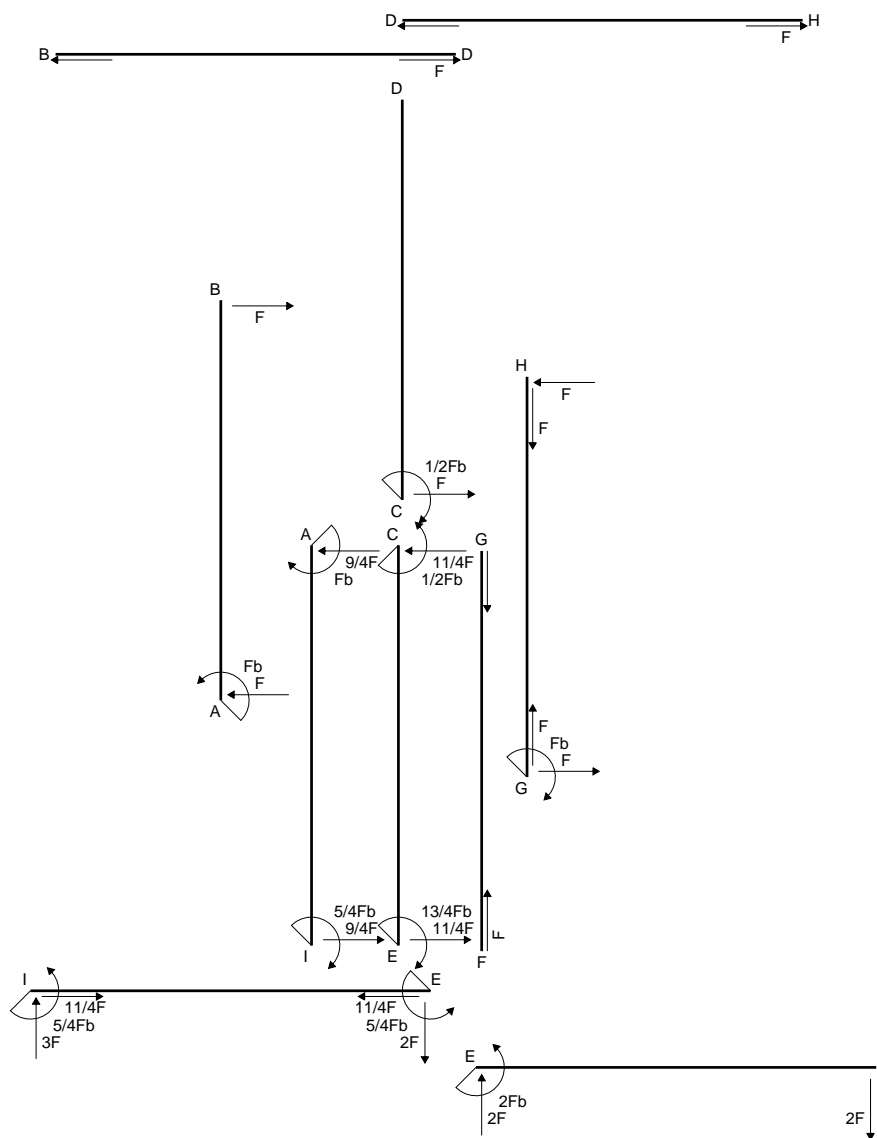
$$= (-b + 2/3 b) Fb 1/EJ = -1/3 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-2x/b + 2x^2/b^2) Fb 1/EJ dx = [-x^2/b + 2/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-b + 2/3 b) Fb 1/EJ = -1/3 Fb^2/EJ$$

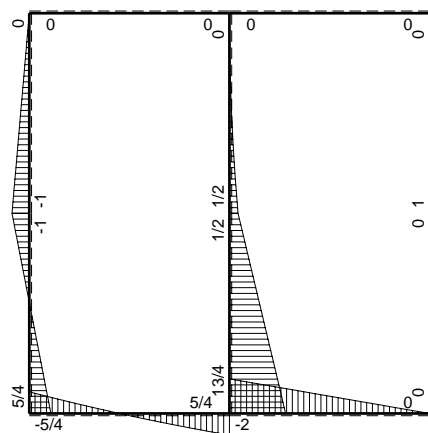


- A = 1122. mm²
- J_u = 294439. mm⁴
- J_v = 72540. mm⁴
- y_g = 28.61 mm
- T_y = 2500. N
- M_x = -2250000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.61 mm
- σ_m = -Mv/J_u = -218.7 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.61 mm
- σ_c = -Mv/J_u = -119.3 N/mm²
- τ_c = 4.745 N/mm²
- σ_o = √σ² + 3τ² = 119.6 N/mm²
- S = 6706. mm³

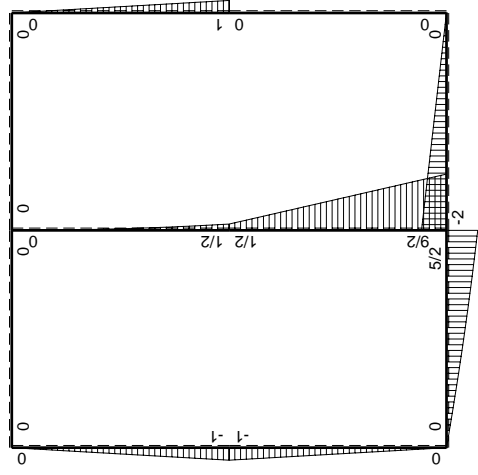
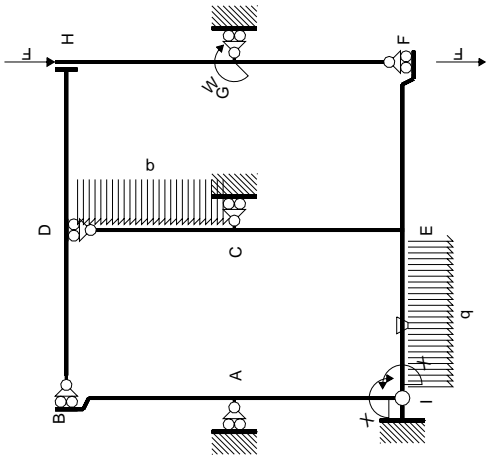


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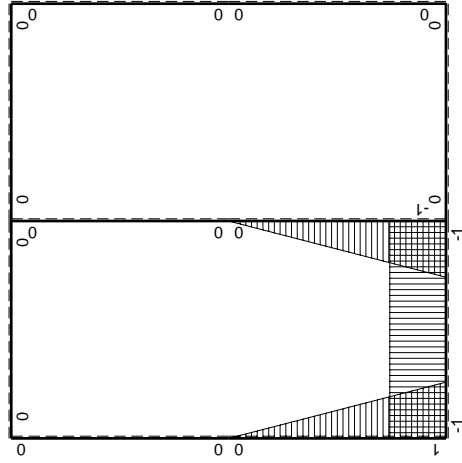


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	0	-Fb+Fx	0	0	0	0	0+0	0	
BA b	0	Fx	0	0	0	0			
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$-1/2qx^2$	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	Fb-Fx	0	0	0	0	0+0	0	
HG b	0	-Fx	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$3Fx-1/2qx^2$	-Fb/EJ	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$9/2Fb-4Fx$	0	$-9/2Fb+17/2Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-19/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-1/2Fb-4Fx$	0	$-1/2Fx-4Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2			
	totali							$-25/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$5/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -1/3 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-5/2 + 2x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-5/2 b + b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -1/3 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-9/2 + 17/2 x/b - 4 x^2/b^2) Fb \frac{1}{EJ} dx = [-9/2 x + 17/4 x^2/b - 4/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-9/2 b + 17/4 b - 4/3 b) Fb \frac{1}{EJ} = -19/12 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 4 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b - 4/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

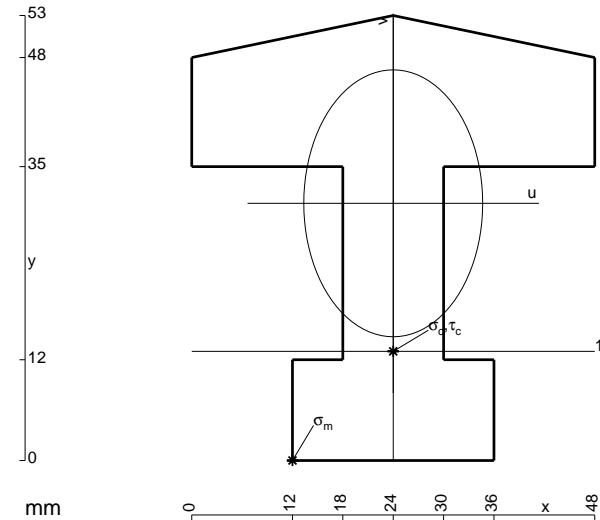
$$= (-1/4 b - 4/3 b) Fb \frac{1}{EJ} = -19/12 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

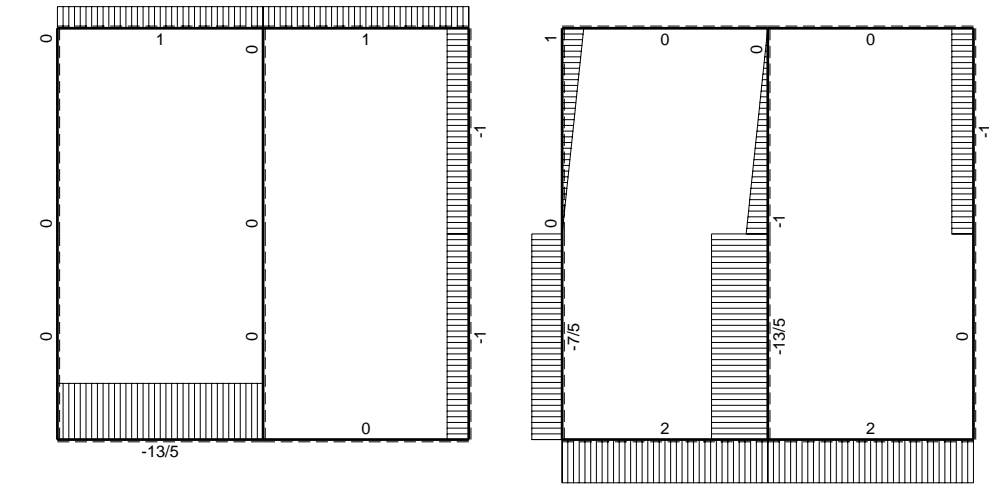
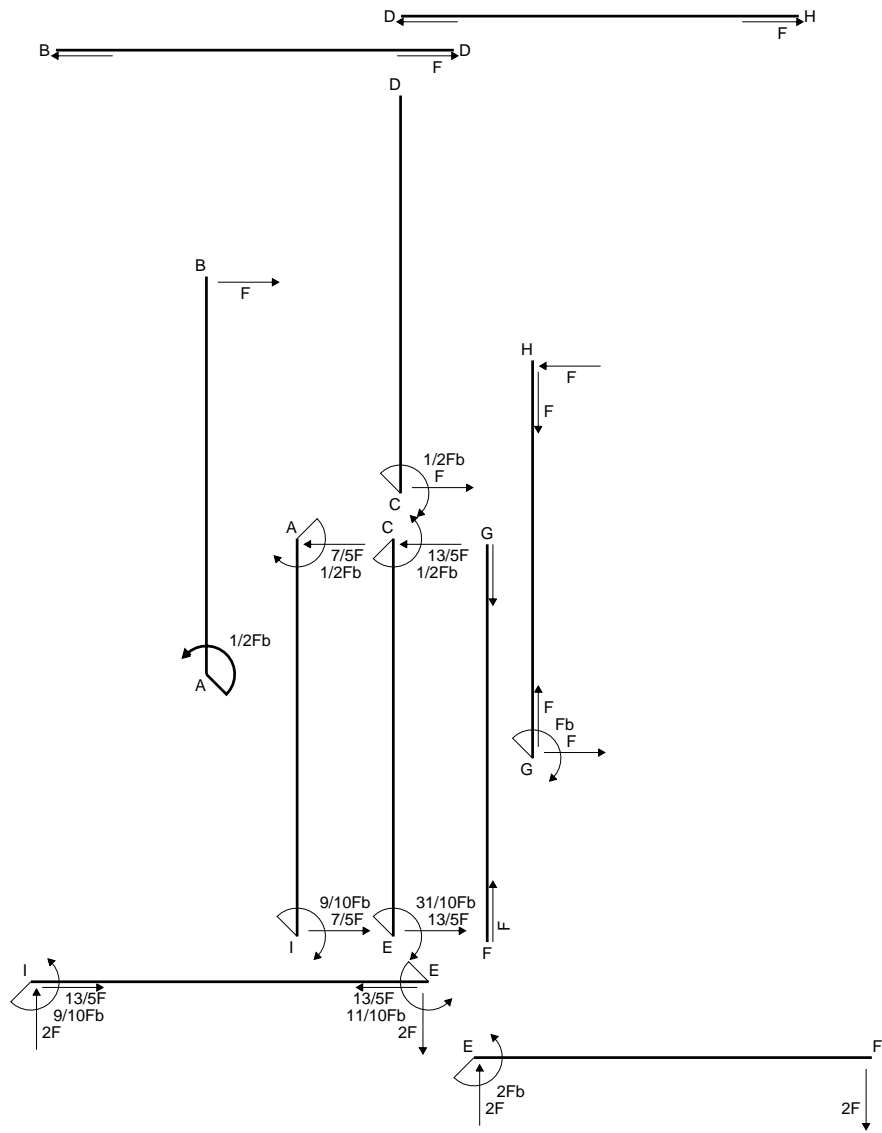
$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

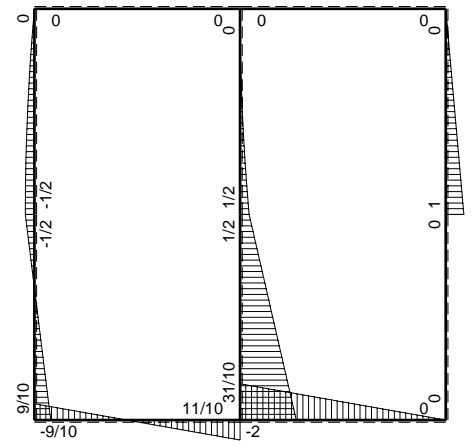


- A = 1308. mm²
- J_u = 330537. mm⁴
- J_v = 148464. mm⁴
- y_g = 30.63 mm
- T_y = 2600. N
- M_x = -2470000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.63 mm
- σ_m = -Mv/J_u = -228.9 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -17.63 mm
- σ_c = -Mv/J_u = -131.8 N/mm²
- τ_c = 4.793 N/mm²
- σ_ρ = √(σ² + 3τ²) = 132. N/mm²
- S = 7312. mm³

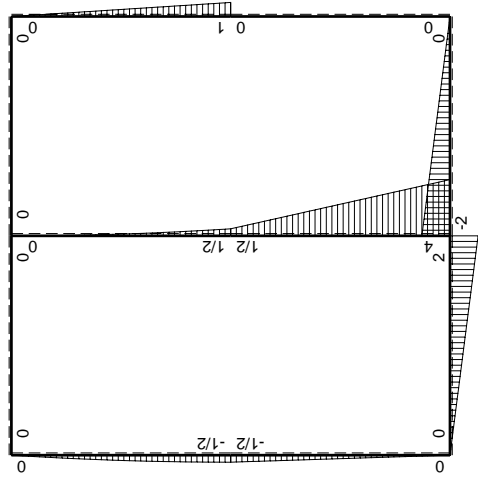
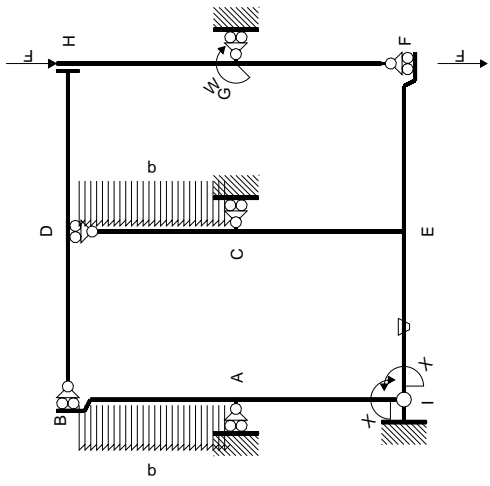


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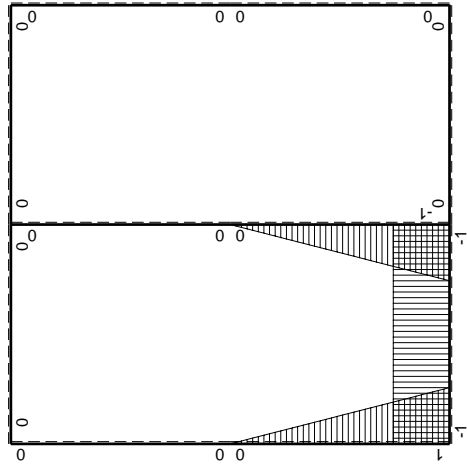


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$Fx-1/2qx^2$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$-Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-7/2Fx$	0	$-4Fb+15/2Fx-7/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-17/12+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-7/2Fx$	0	$-1/2Fx-7/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$9/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-b) Fb \frac{1}{EJ} + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-2b + b) Fb \frac{1}{EJ} + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 15/2 x/b - 7/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-4x + 15/4 x^2/b - 7/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-4b + 15/4 b - 7/6 b) Fb \frac{1}{EJ} = -17/12 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 7/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b - 7/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

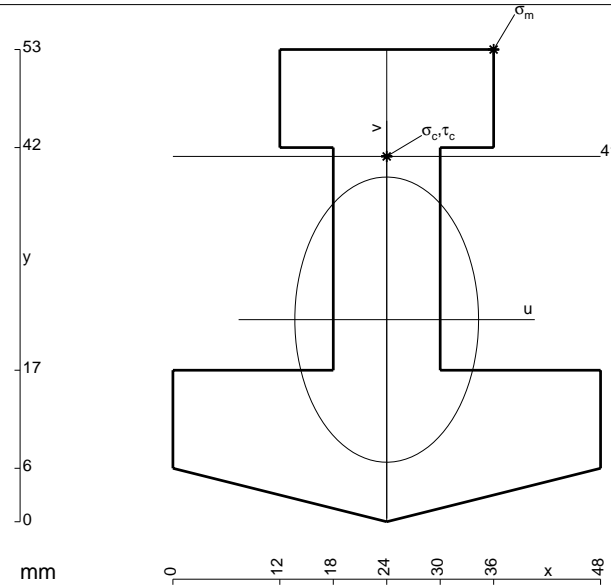
$$= (-1/4 b - 7/6 b) Fb \frac{1}{EJ} = -17/12 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

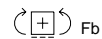
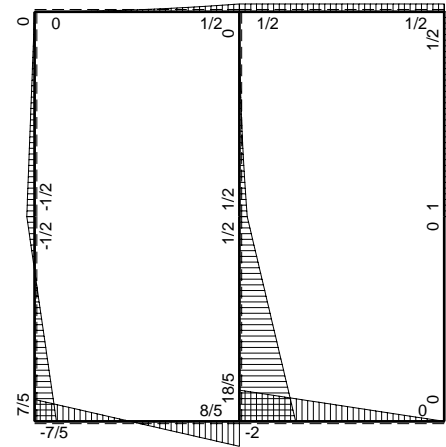
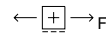
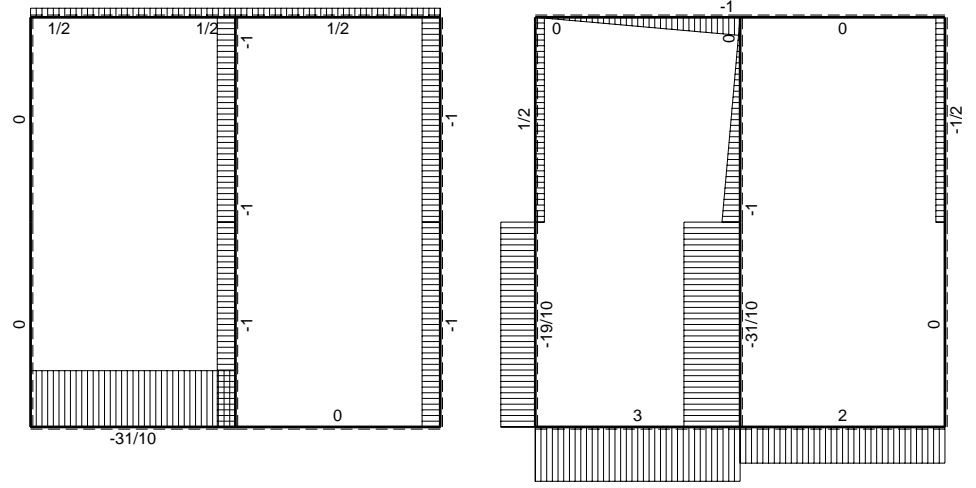
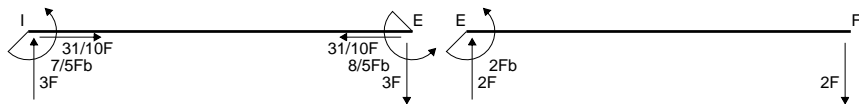
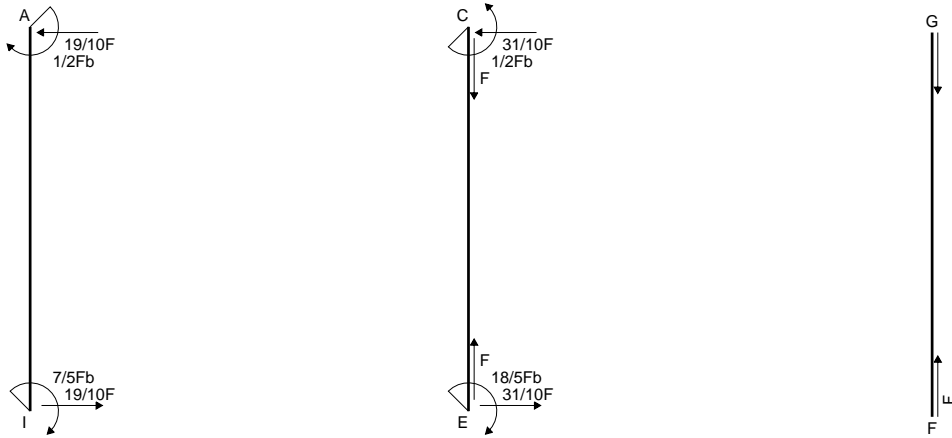
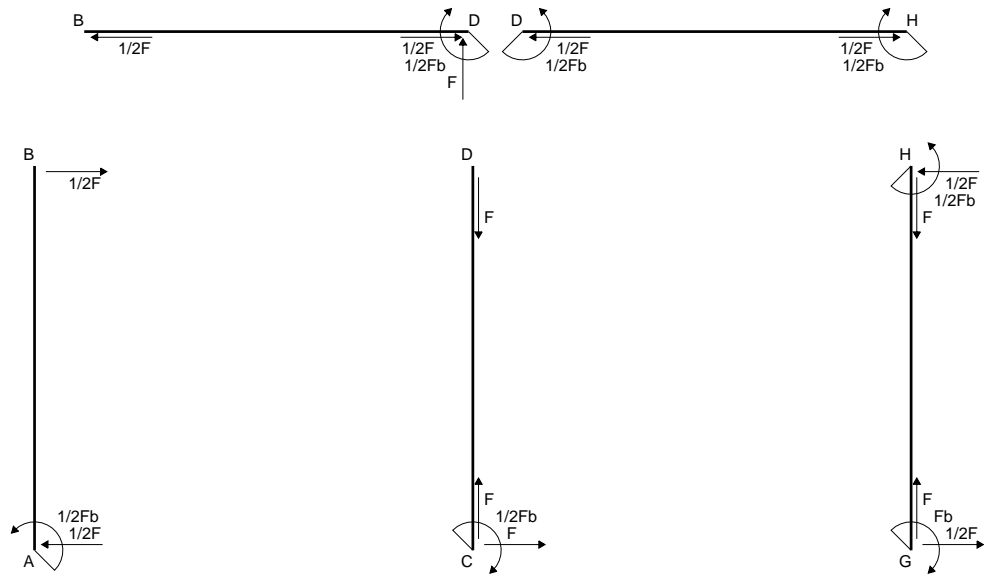
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

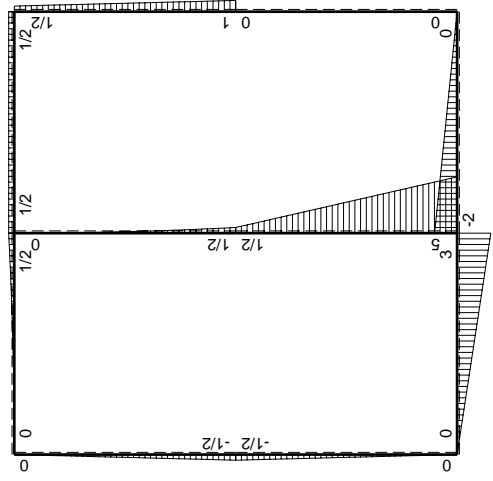
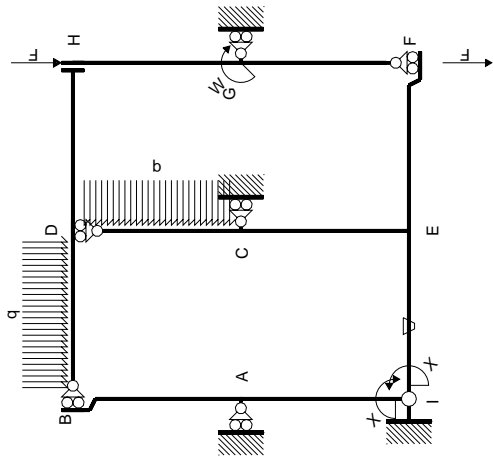
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



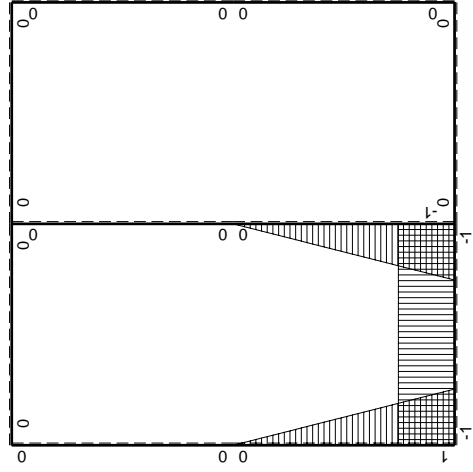
- A = 1236. mm²
- J_u = 316729. mm⁴
- J_v = 131472. mm⁴
- y_g = 22.68 mm
- T_y = 2500. N
- M_x = -2500000. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.32 mm
- σ_m = -Mv/J_u = 239.3 N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 18.32 mm
- σ_c = -Mv/J_u = 144.6 N/mm²
- τ_c = 4.458 N/mm²
- σ_q = √σ²+3τ² = 144.8 N/mm²
- S = 6777. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-9/2Fx$	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 19/2 x/b - 9/2 x^2/b^2) Fb 1/EJ dx = [-5x + 19/4 x^2/b - 3/2 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 19/4 b - 3/2 b) Fb 1/EJ = -7/4 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 9/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b - 3/2 x^3/b^2]_0^b Fb 1/EJ$$

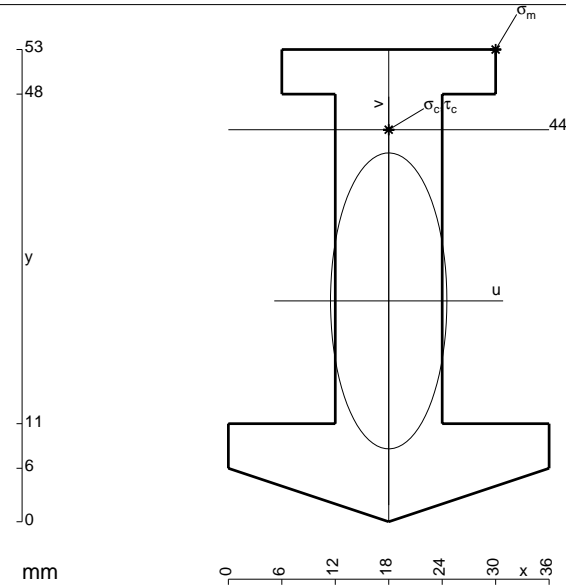
$$= (-1/4 b - 3/2 b) Fb 1/EJ = -7/4 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

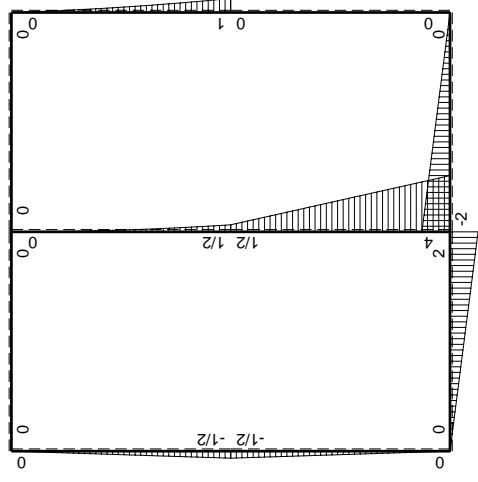
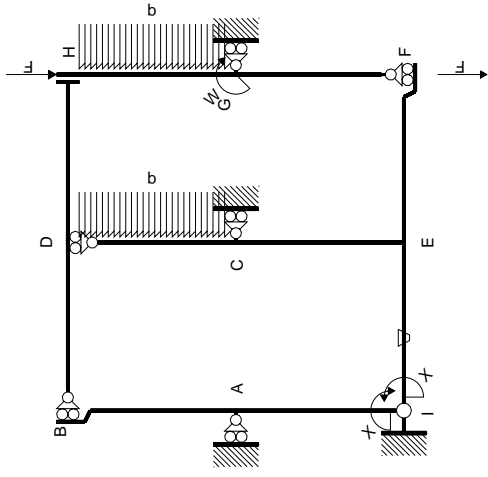
$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

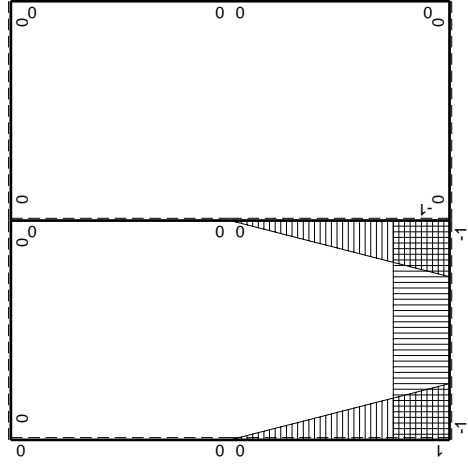


- A = 852. mm²
- J_u = 235110. mm⁴
- J_v = 36360. mm⁴
- y_g = 24.79 mm
- T_y = 3140. N
- M_x = -1664200. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.21 mm
- σ_m = -Mv/J_u = 199.7 N/mm²
- x_c = 18. mm
- y_c = 44. mm
- v_c = 19.21 mm
- σ_c = -Mv/J_u = 136. N/mm²
- τ_c = 4.567 N/mm²
- σ_q = √σ²+3τ² = 136.2 N/mm²
- S = 4103. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-7/2Fx$	0	$-4Fb+15/2Fx-7/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-17/12+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-7/2Fx$	0	$-1/2Fx-7/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$9/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{x_0} = \int_0^b (-2x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-b) Fb \frac{1}{EJ} + (b) \theta = 0$$

$$L_{EI}^{x_0} = \int_0^b (-2 + 2x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-2b + b) Fb \frac{1}{EJ} + (-b) \theta = 0$$

$$L_{EC}^{x_0} = \int_0^b (-4 + 15/2 x/b - 7/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-4x + 15/4 x^2/b - 7/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-4b + 15/4 b - 7/6 b) Fb \frac{1}{EJ} = -17/12 Fb^2/EJ$$

$$L_{CE}^{x_0} = \int_0^b (-1/2 x/b - 7/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b - 7/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

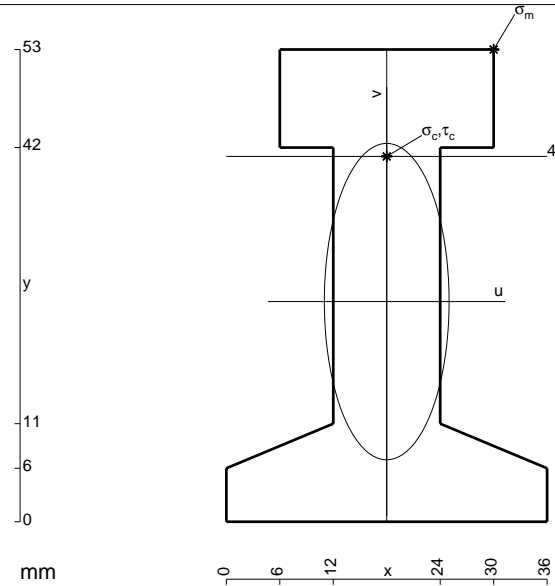
$$= (-1/4 b - 7/6 b) Fb \frac{1}{EJ} = -17/12 Fb^2/EJ$$

$$L_{IA}^{x_0} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

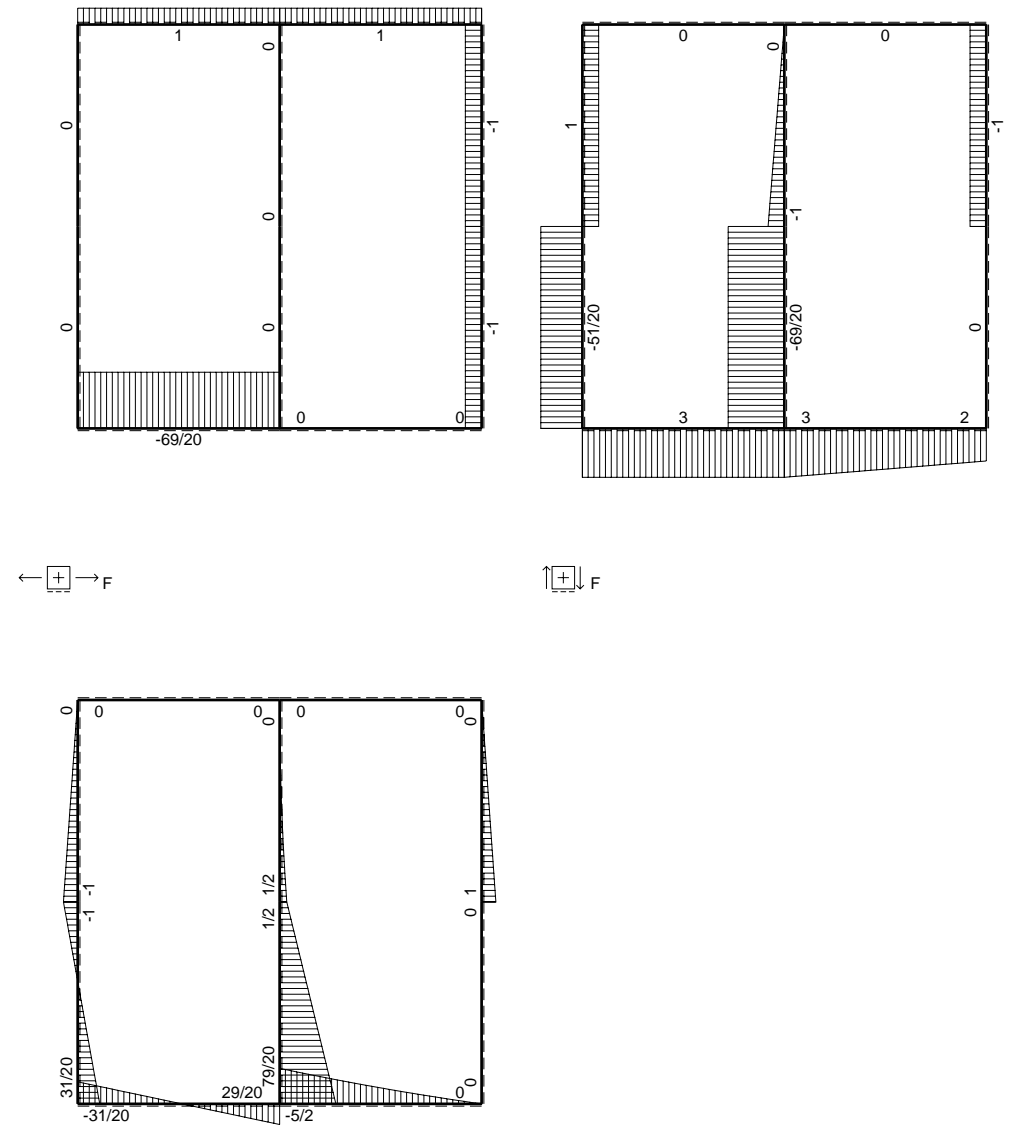
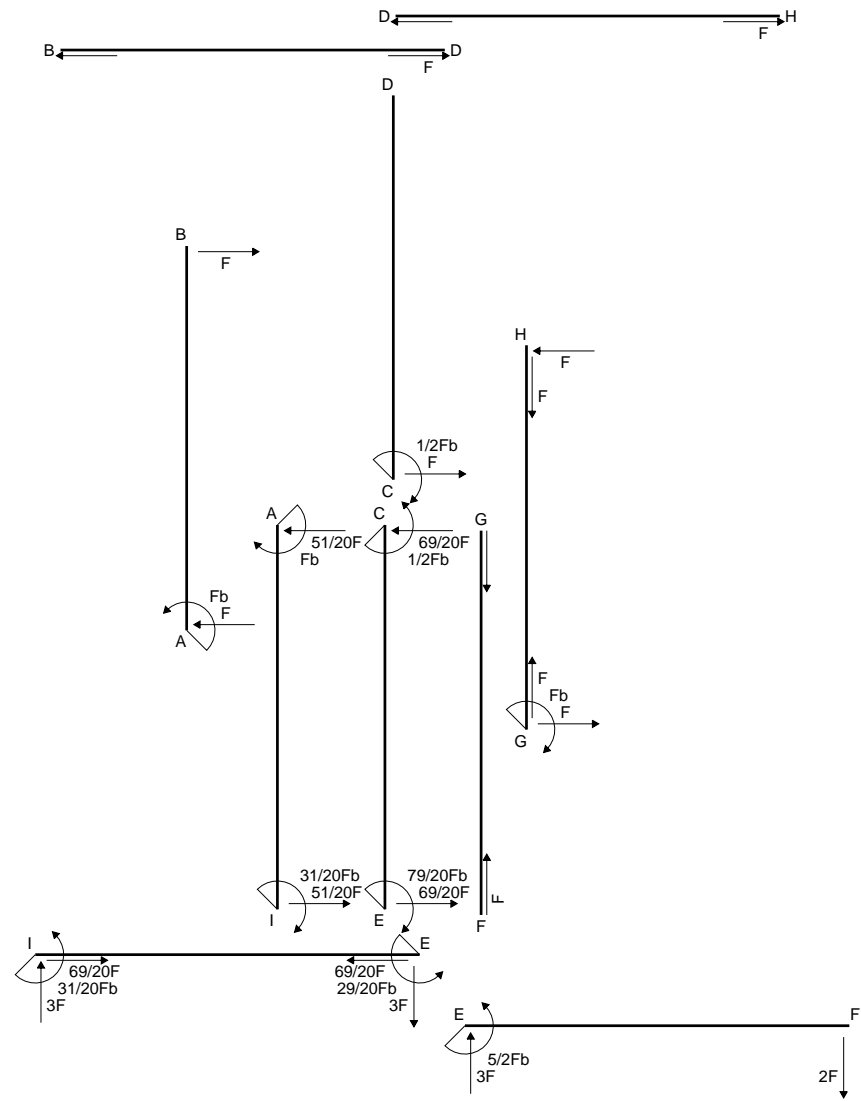
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{x_0} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

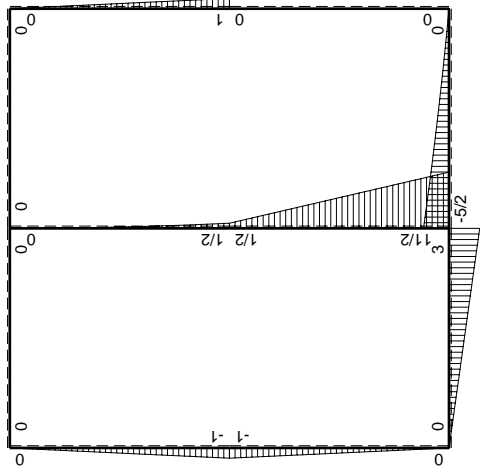
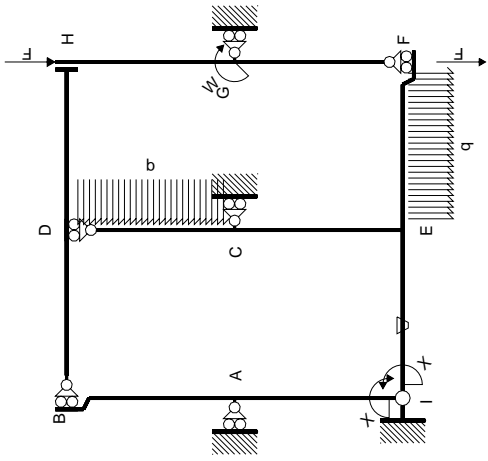
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



- A = 972. mm²
- J_u = 306619. mm⁴
- J_v = 47664. mm⁴
- y_g = 24.71 mm
- T_y = 3920. N
- M_x = -2273600. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.29 mm
- σ_m = -Mv/J_u = 209.8 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 16.29 mm
- σ_c = -Mv/J_u = 120.8 N/mm²
- τ_c = 6.625 N/mm²
- σ_q = √σ²+3τ² = 121.4 N/mm²
- S = 6219. mm³

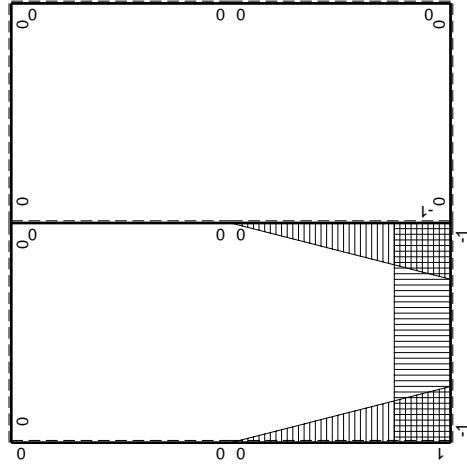


$\left[\begin{matrix} + \\ + \end{matrix} \right] F_b$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	Fb-Fx	0	0	0	0	0+0	0
HG b	0	-Fx	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-5Fx$	0	$-11/2Fb+21/2Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-23/12+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-5Fx$	0	$-1/2Fx-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-31/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$31/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 21/2 x/b - 5x^2/b^2) Fb 1/EJ dx = [-11/2 x + 21/4 x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-11/2 b + 21/4 b - 5/3 b) Fb 1/EJ = -23/12 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 5x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

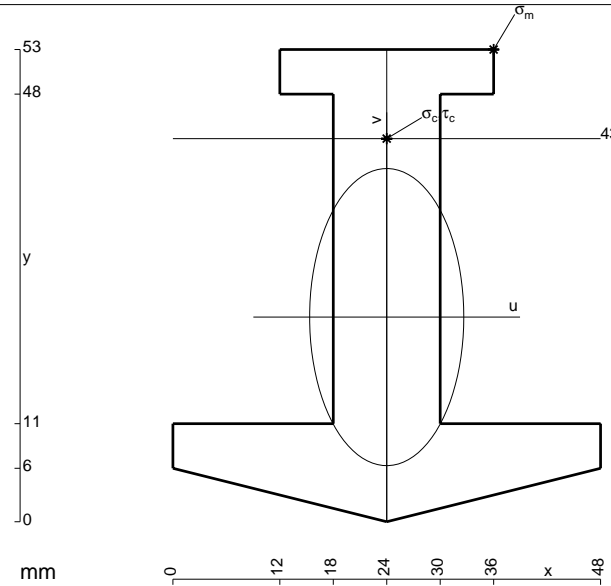
$$= (-1/4 b - 5/3 b) Fb 1/EJ = -23/12 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

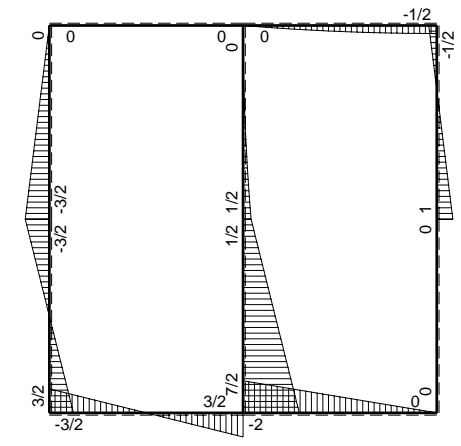
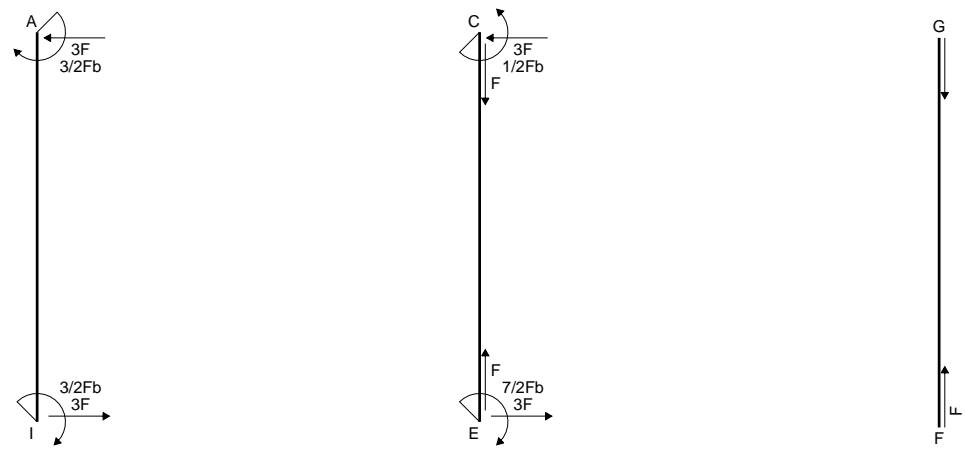
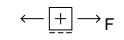
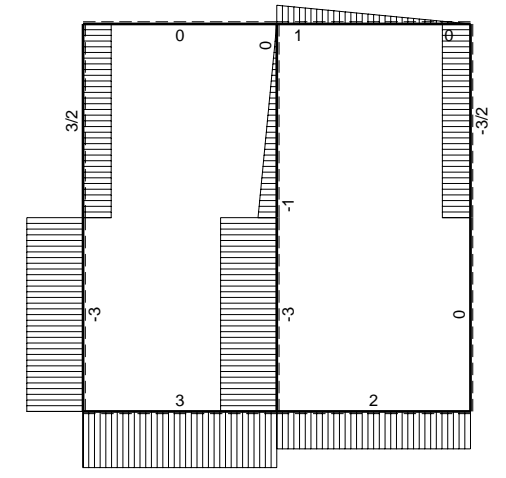
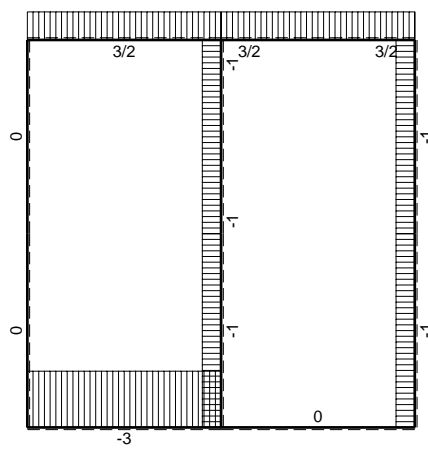
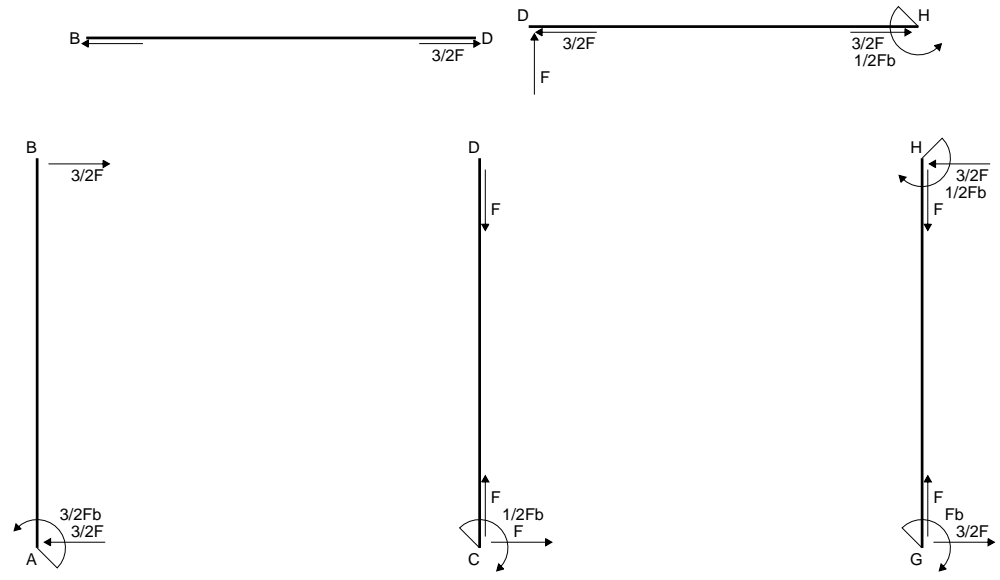
$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

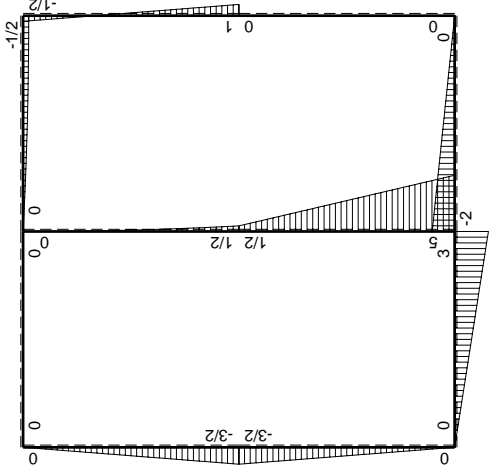
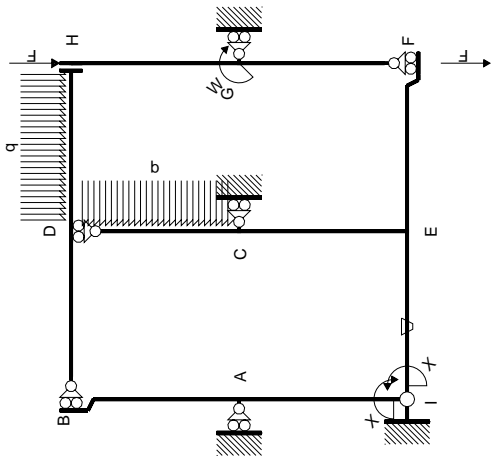
$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$



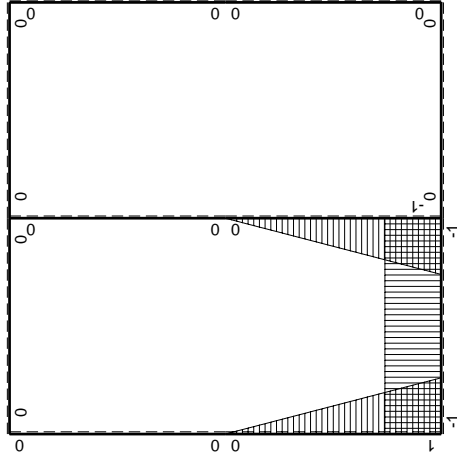
- A = 948. mm²
- J_u = 263643. mm⁴
- J_v = 70992. mm⁴
- y_g = 22.97 mm
- T_y = 3660. N
- M_x = -1921500. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.03 mm
- σ_m = -Mv/J_u = 218.9 N/mm²
- x_c = 24. mm
- y_c = 43. mm
- v_c = 20.03 mm
- σ_c = -Mv/J_u = 146. N/mm²
- τ_c = 5.386 N/mm²
- σ_q = √σ²+3τ² = 146.3 N/mm²
- S = 4656. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0
BA b	0	$3/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-3/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-9/2Fx$	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 19/2 x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 19/4 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 19/4 b - 3/2 b) Fb \frac{1}{EJ} = -7/4 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

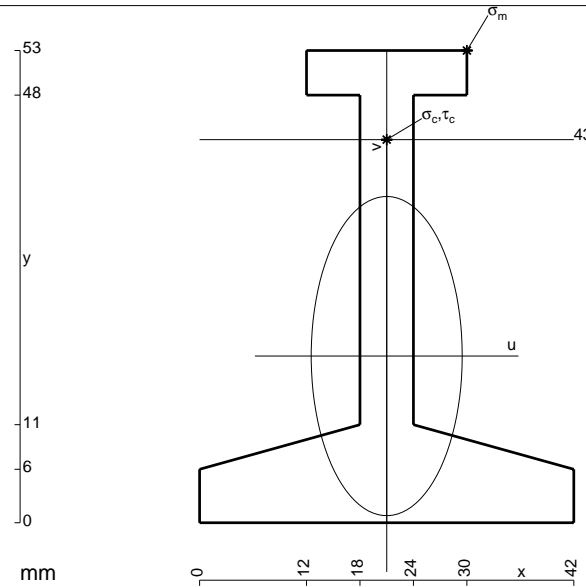
$$= (-1/4 b - 3/2 b) Fb \frac{1}{EJ} = -7/4 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

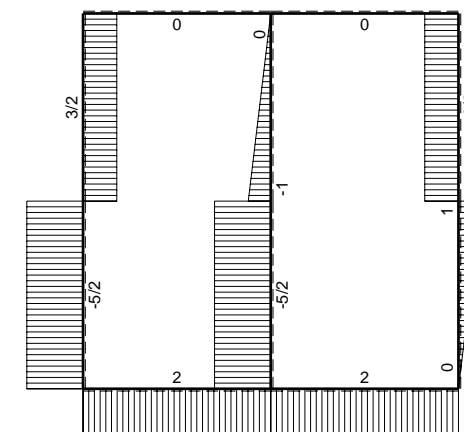
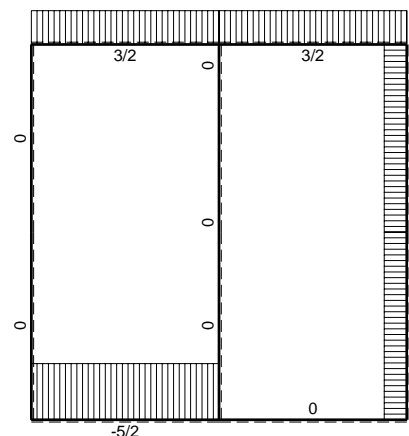
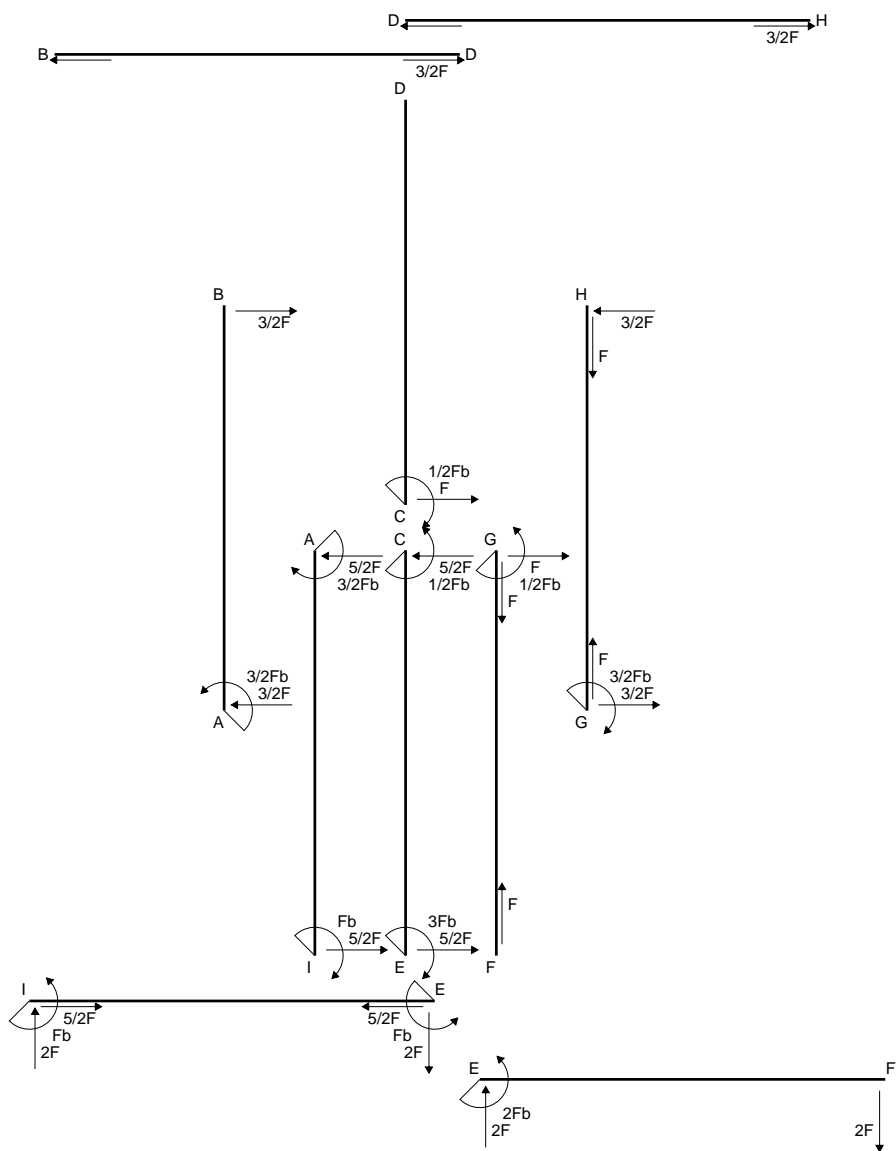
$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

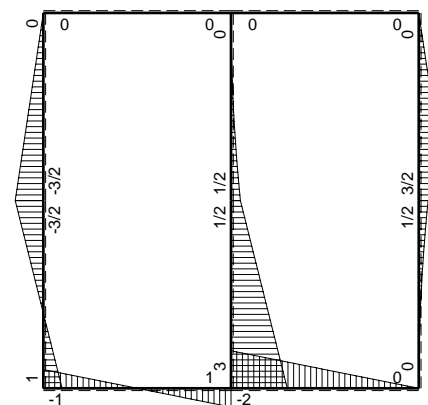


- A = 684. mm²
- J_u = 219556. mm⁴
- J_v = 49140. mm⁴
- y_g = 18.71 mm
- T_y = 2160. N
- M_x = -1468800. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 9. mm
- v_m = 34.29 mm
- σ_m = -Mv/J_u = 229.4 N/mm²
- x_c = 21. mm
- y_c = 43. mm
- v_c = 24.29 mm
- σ_c = -Mv/J_u = 162.5 N/mm²
- τ_c = 6.01 N/mm²
- σ_q = √σ²+3τ² = 162.9 N/mm²
- S = 3665. mm³

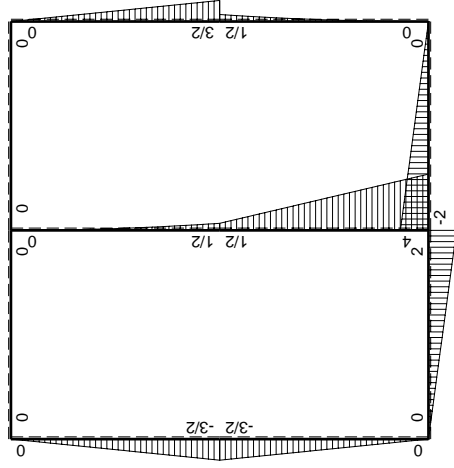
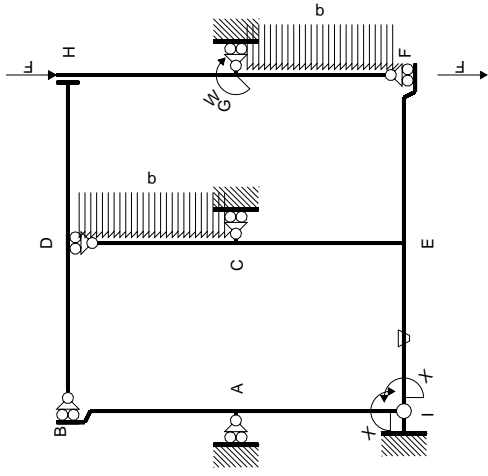


← ⊕ → F

↑ ⊕ ↓ F

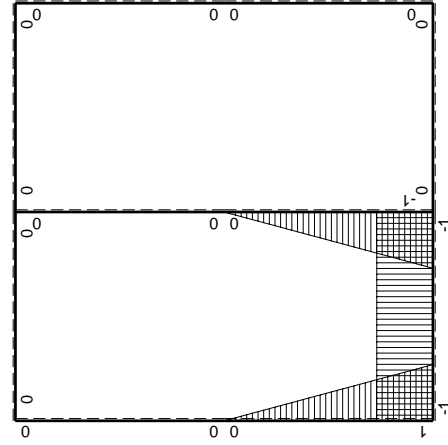


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0
BA b	0	$3/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0
HG b	0	$-3/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-7/2Fx$	0	$-4Fb+15/2Fx-7/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-17/12+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-7/2Fx$	0	$-1/2Fx-7/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{x_0} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{x_0} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{x_0} = \int_0^b (-4 + 15/2 x/b - 7/2 x^2/b^2) Fb 1/EJ dx = [-4x + 15/4 x^2/b - 7/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-4b + 15/4 b - 7/6 b) Fb 1/EJ = -17/12 Fb^2/EJ$$

$$L_{CE}^{x_0} = \int_0^b (-1/2 x/b - 7/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b - 7/6 x^3/b^2]_0^b Fb 1/EJ$$

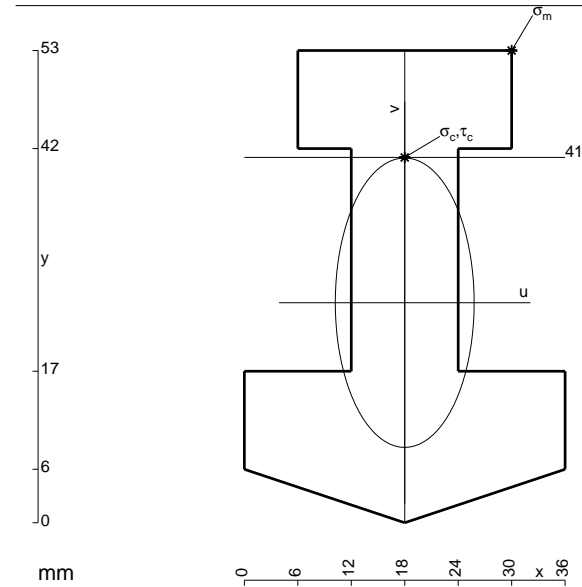
$$= (-1/4 b - 7/6 b) Fb 1/EJ = -17/12 Fb^2/EJ$$

$$L_{IA}^{x_0} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb 1/EJ dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb 1/EJ$$

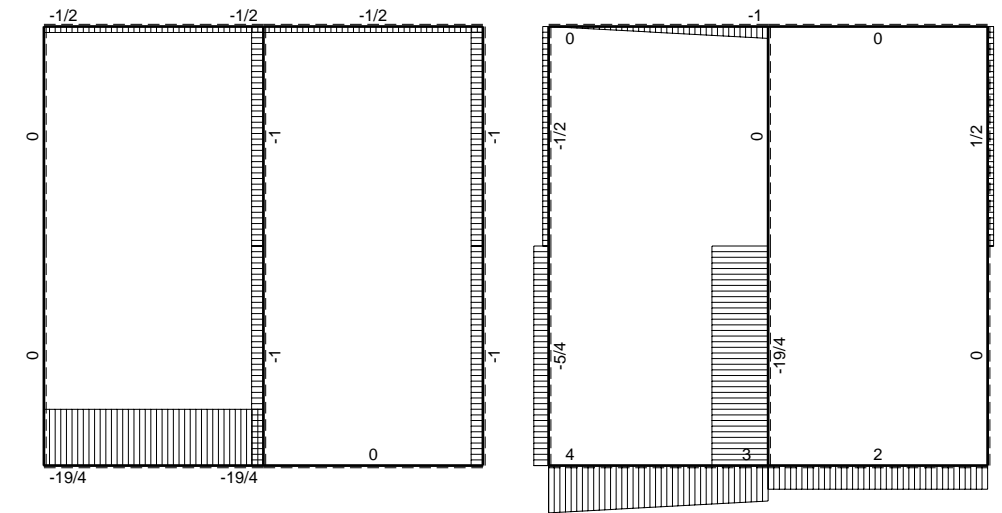
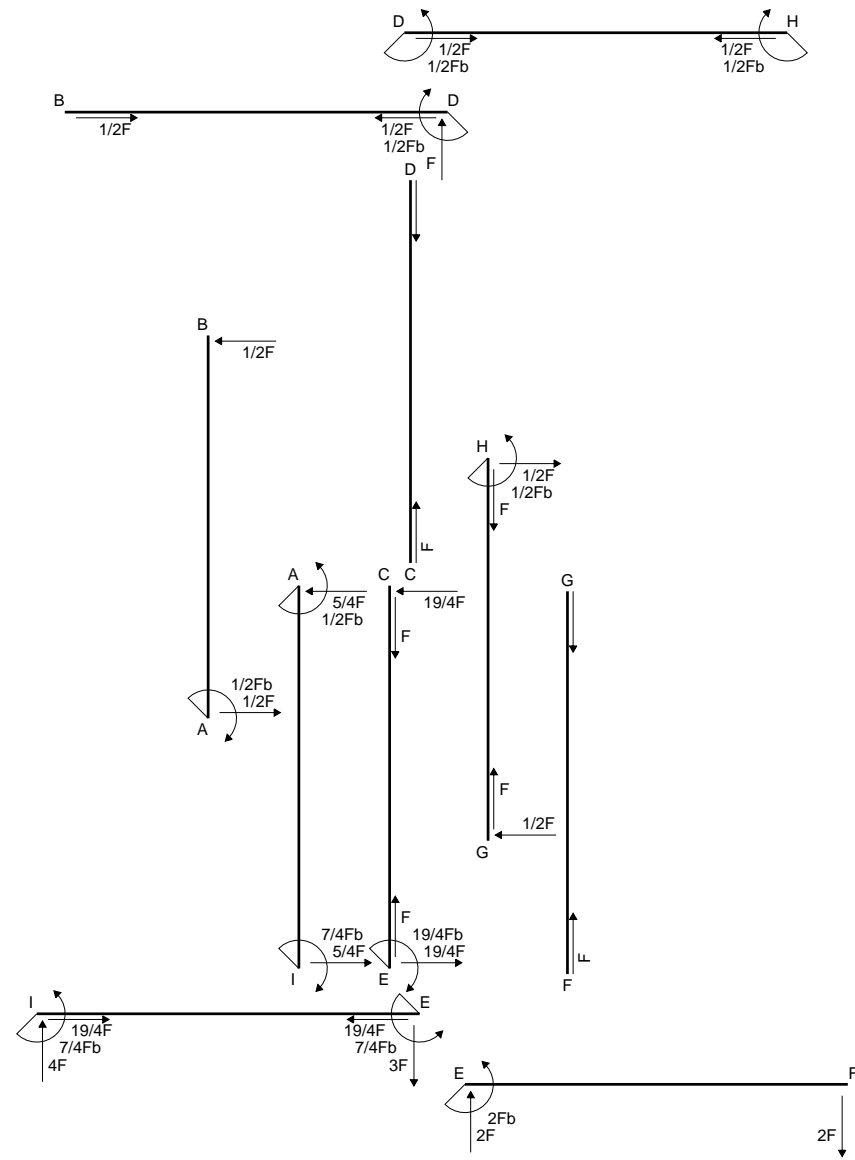
$$= (-3/4 b + 1/2 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{AI}^{x_0} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb 1/EJ dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/4 b + 1/2 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

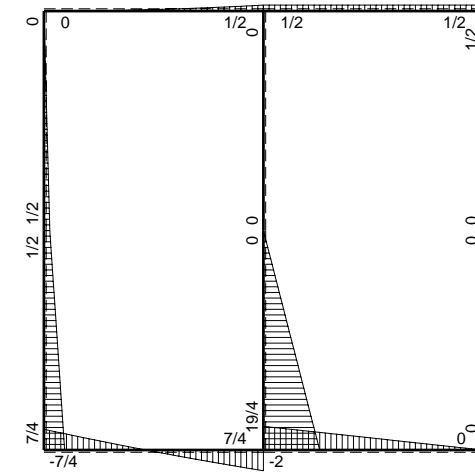


- A = 1068. mm²
- J_u = 281922. mm⁴
- J_v = 64872. mm⁴
- y_g = 24.7 mm
- T_y = 3220. N
- M_x = -2382800. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.3 mm
- σ_m = -Mv/J_u = 239.2 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 16.3 mm
- σ_c = -Mv/J_u = 137.8 N/mm²
- τ_c = 5.922 N/mm²
- σ_q = √σ²+3τ² = 138.2 N/mm²
- S = 6222. mm³

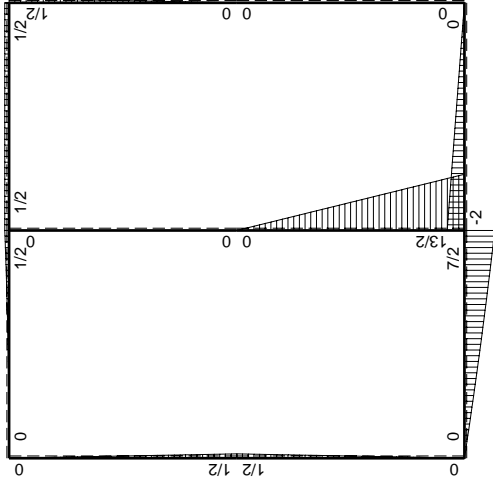
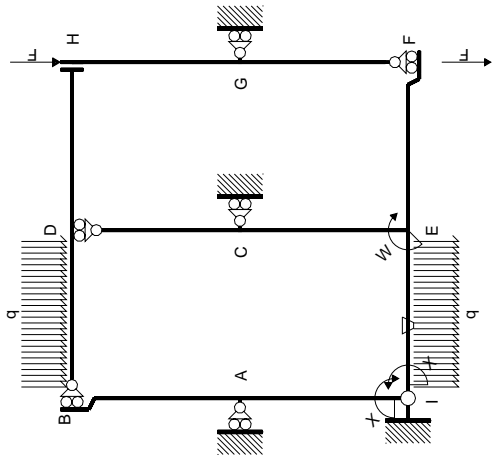


$\leftarrow + \rightarrow F$

$\uparrow + \downarrow F$

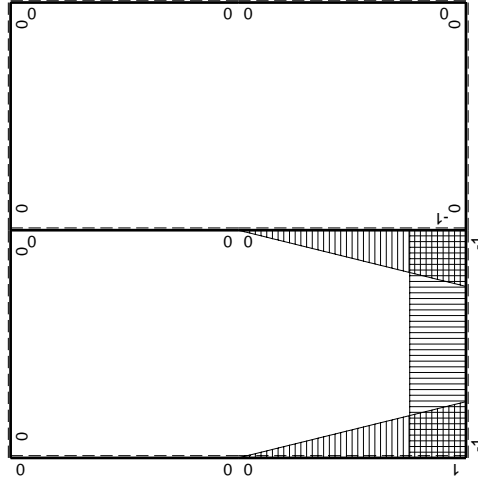


$\leftarrow + \rightarrow F_b$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb 1/EJ + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb 1/EJ + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb 1/EJ dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-13/2 x^2/b^2) Fb 1/EJ dx = [-13/6 x^3/b^2]_0^b Fb 1/EJ$$

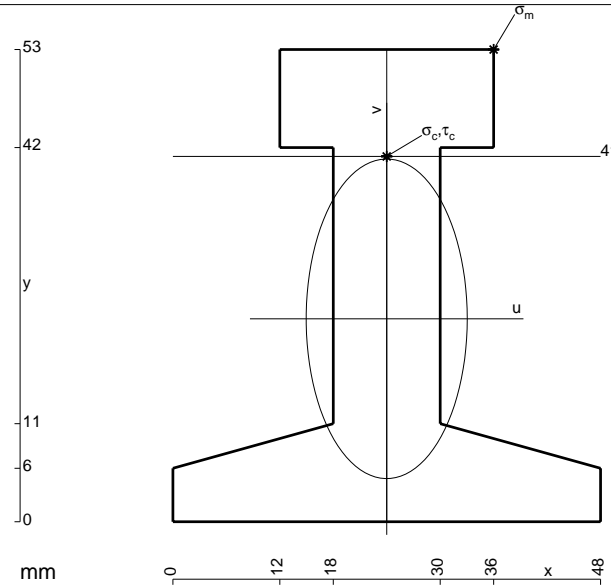
$$= (-13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

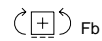
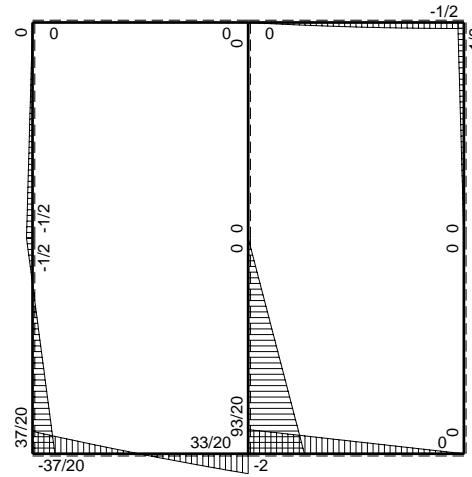
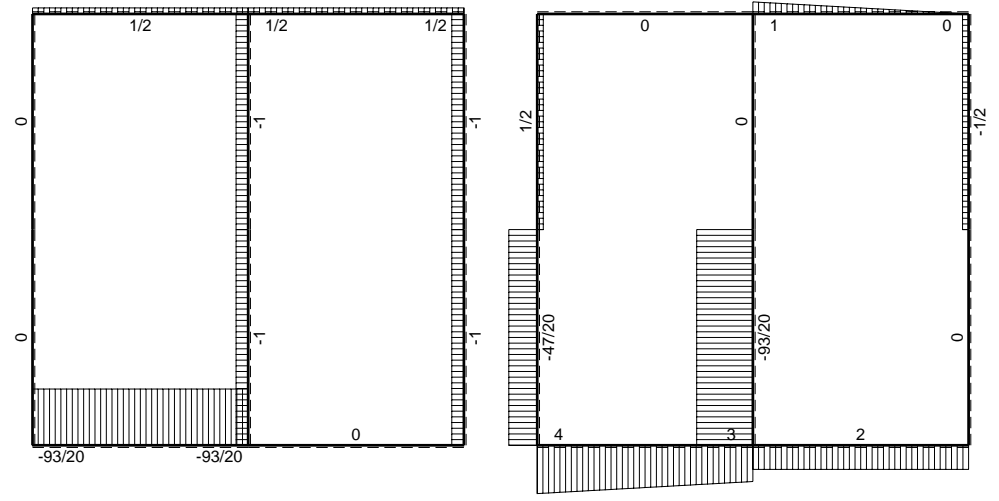
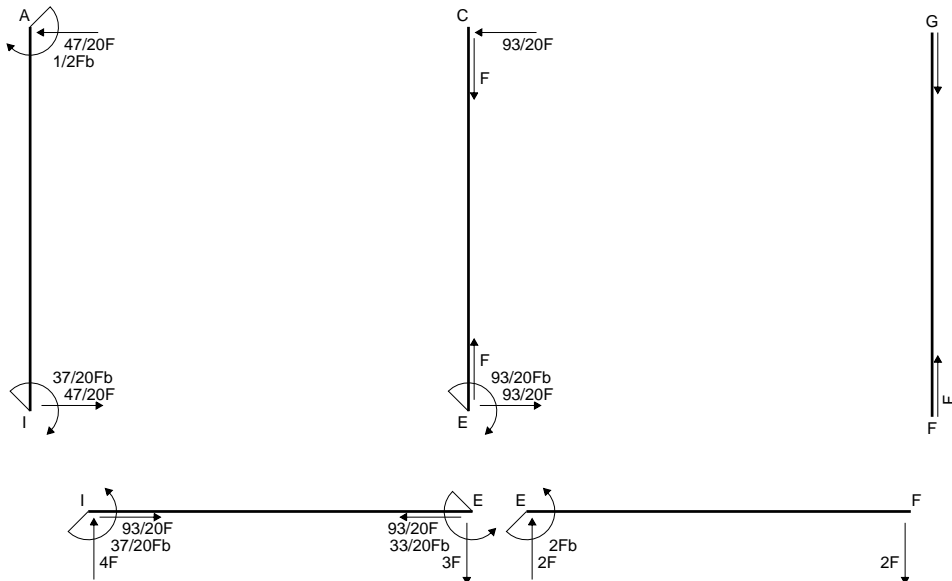
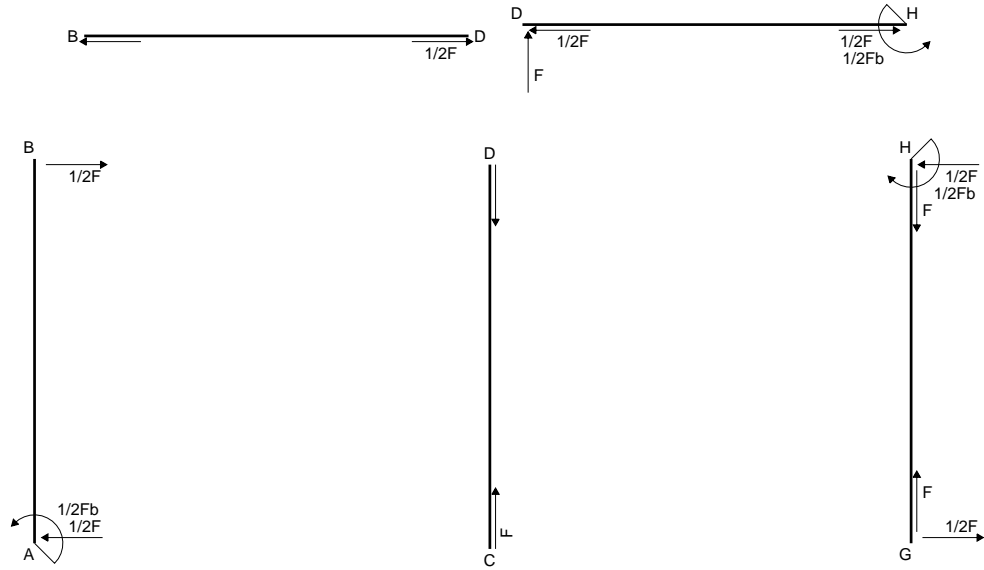
$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

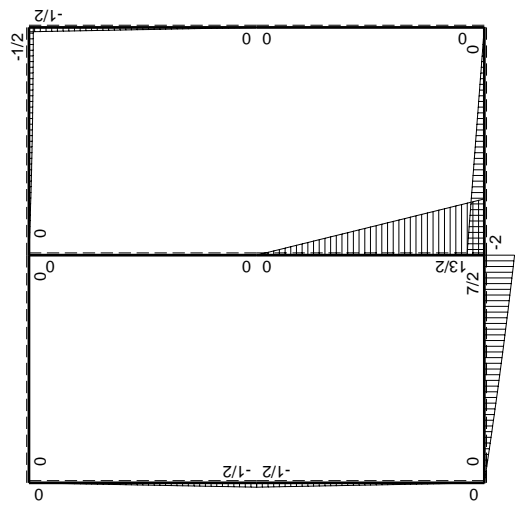
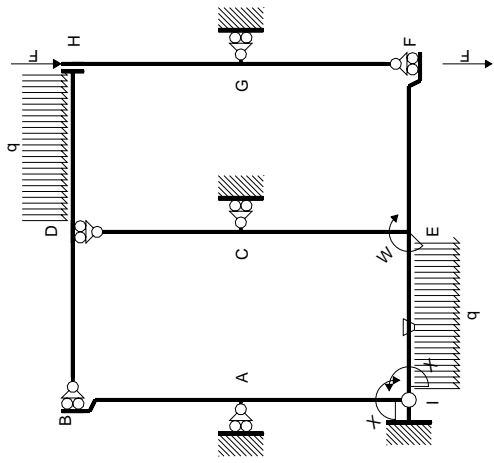
$$L_{AI}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



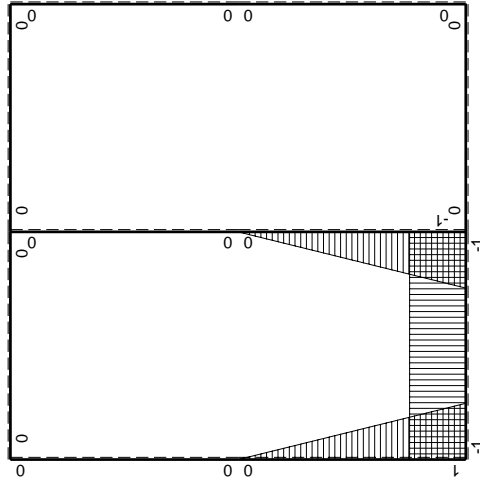
- A = 1074. mm²
- J_u = 345511. mm⁴
- J_v = 87732. mm⁴
- y_g = 22.78 mm
- T_y = 2880. N
- M_x = -2275200. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.22 mm
- σ_m = -Mv/J_u = 199. N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 18.22 mm
- σ_c = -Mv/J_u = 120. N/mm²
- τ_c = 4.69 N/mm²
- σ_q = √σ²+3τ² = 120.3 N/mm²
- S = 6752. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0			
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
DH b	0	$Fx-1/2qx^2$	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-37/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$37/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{x\theta} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb 1/EJ + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{x\theta} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb 1/EJ + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{x\theta} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb 1/EJ dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

$$L_{CE}^{x\theta} = \int_0^b (-13/2 x^2/b^2) Fb 1/EJ dx = [-13/6 x^3/b^2]_0^b Fb 1/EJ$$

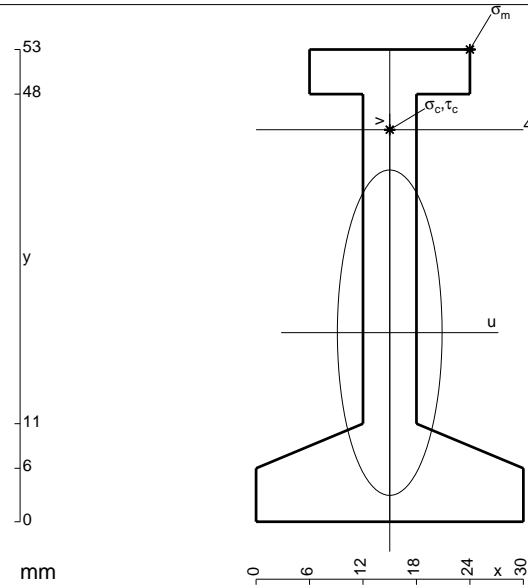
$$= (-13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

$$L_{IA}^{x\theta} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

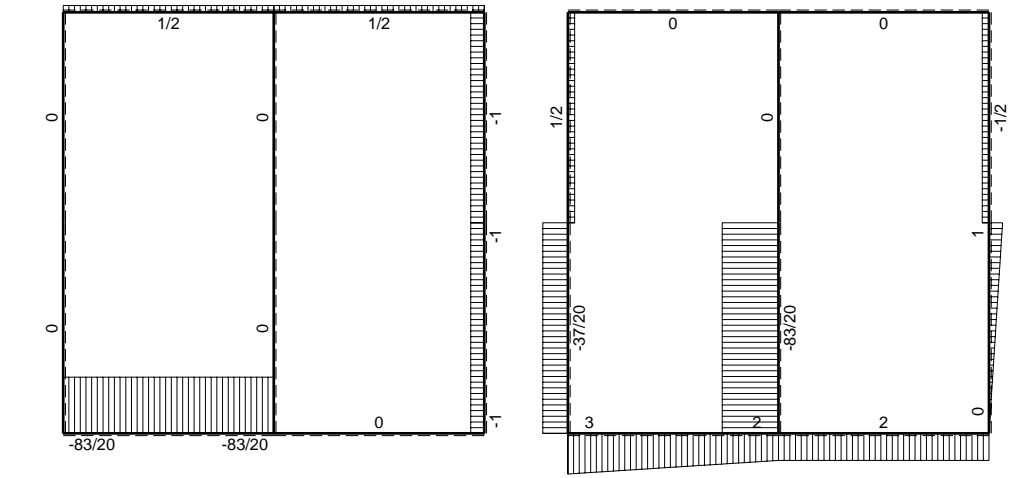
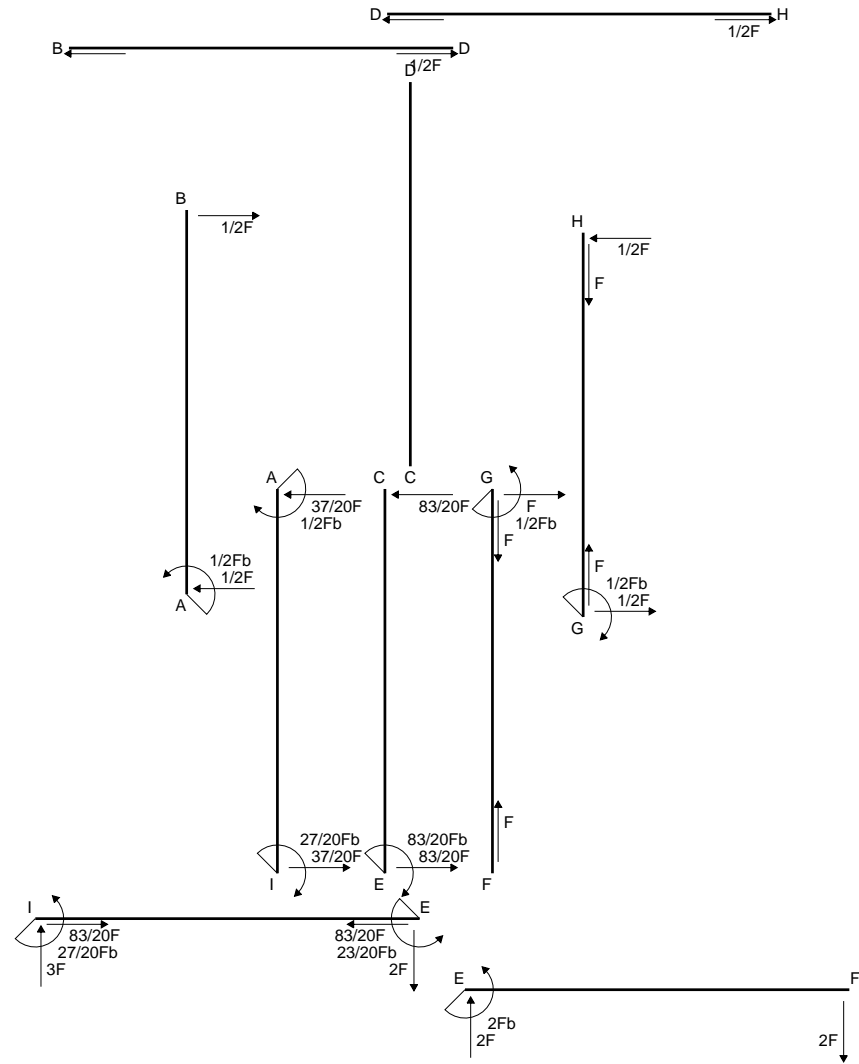
$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{AI}^{x\theta} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

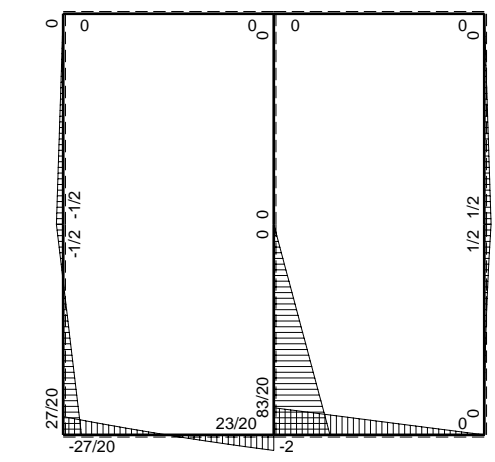


- A = 582. mm²
- J_u = 194208. mm⁴
- J_v = 20106. mm⁴
- y_g = 21.22 mm
- T_y = 1520. N
- M_x = -1276800. Nmm
- x_m = 24. mm
- y_m = 53. mm
- u_m = 9. mm
- v_m = 31.78 mm
- σ_m = -Mv/J_u = 208.9 N/mm²
- x_c = 15. mm
- y_c = 44. mm
- v_c = 22.78 mm
- σ_c = -Mv/J_u = 149.8 N/mm²
- τ_c = 4.214 N/mm²
- σ_q = √σ²+3τ² = 150. N/mm²
- S = 3230. mm³

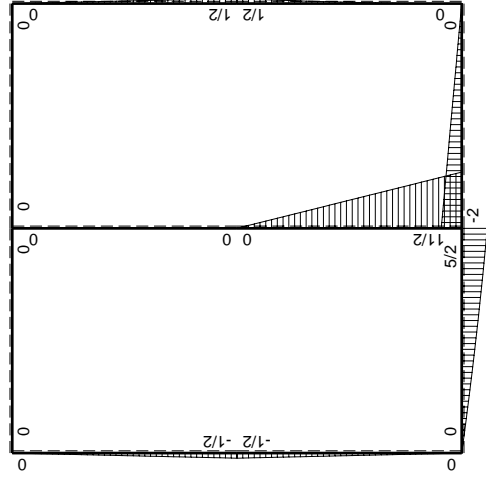
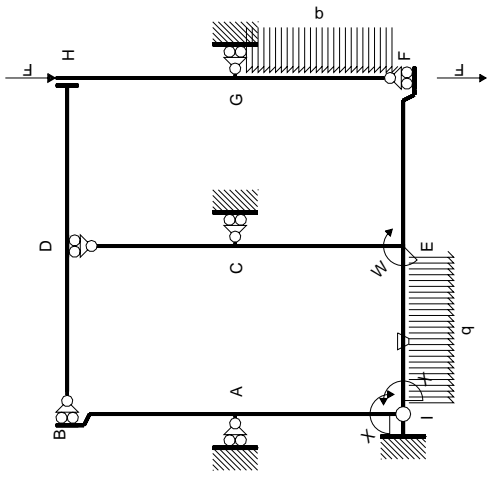


← ⊕ → F

↑ ⊕ ↓ Fb

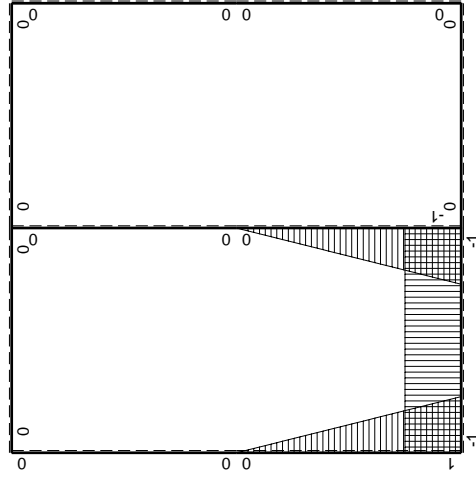


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fx$	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-9/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$27/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -1/3 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-5/2 + 2x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-5/2 b + b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -1/3 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

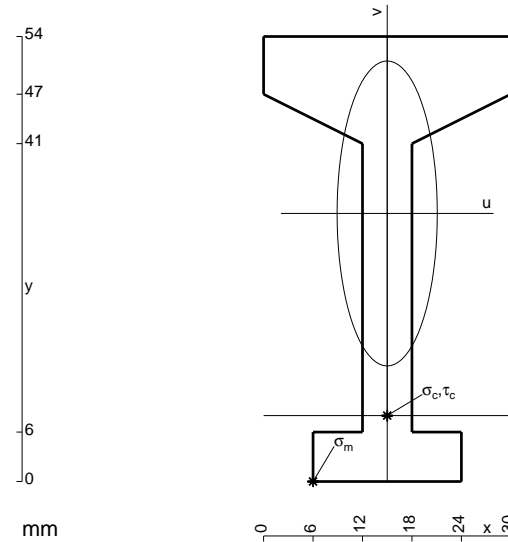
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

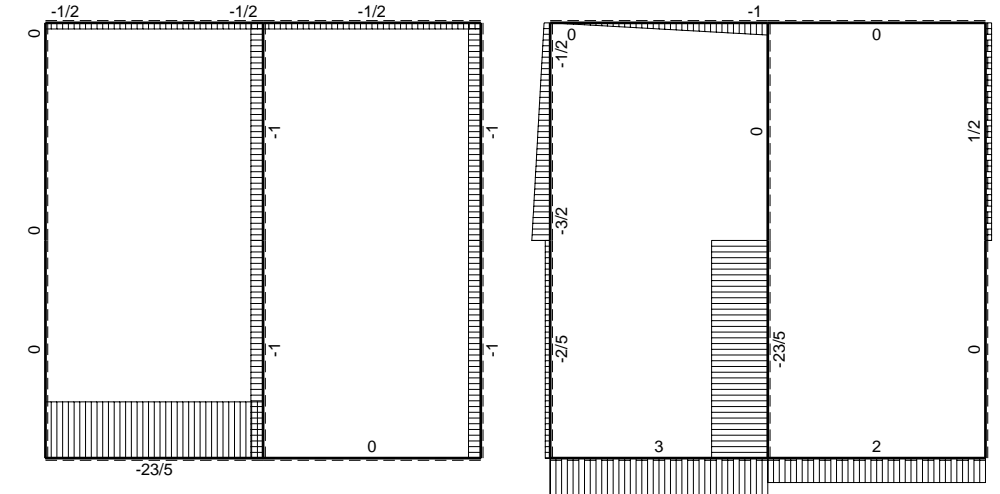
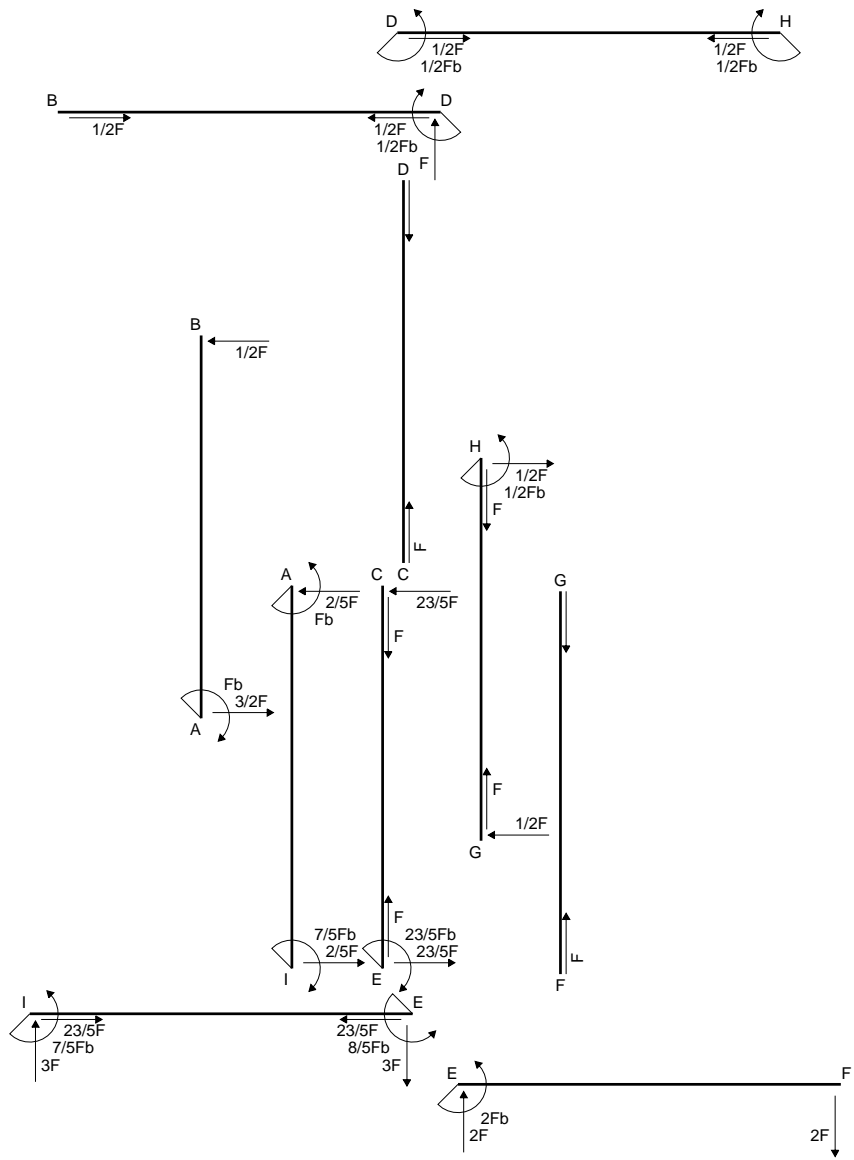
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

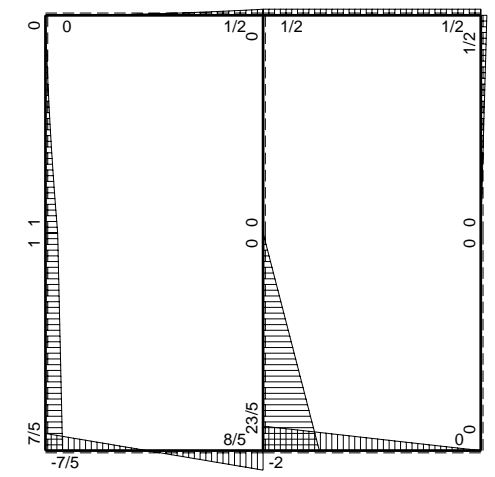


- A = 636. mm²
- J_u = 217919. mm⁴
- J_v = 23508. mm⁴
- y_g = 32.53 mm
- T_y = 1600. N
- M_x = -1456000. Nmm
- x_m = 6. mm
- u_m = -9. mm
- v_m = -32.53 mm
- σ_m = -Mv/J_u = -217.3 N/mm²
- x_c = 15. mm
- y_c = 8. mm
- v_c = -24.53 mm
- σ_c = -Mv/J_u = -163.9 N/mm²
- τ_c = 4.277 N/mm²
- σ_o = √σ²+3τ² = 164.1 N/mm²
- S = 3495. mm³

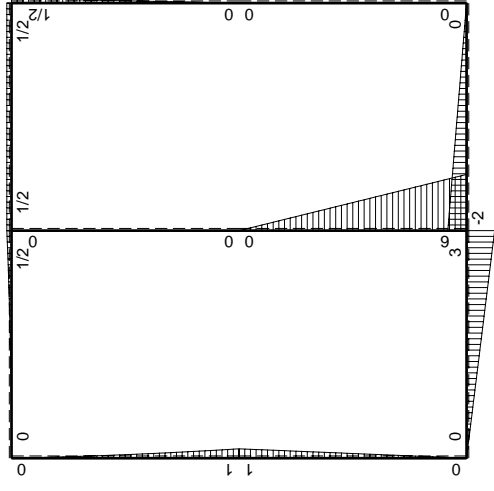
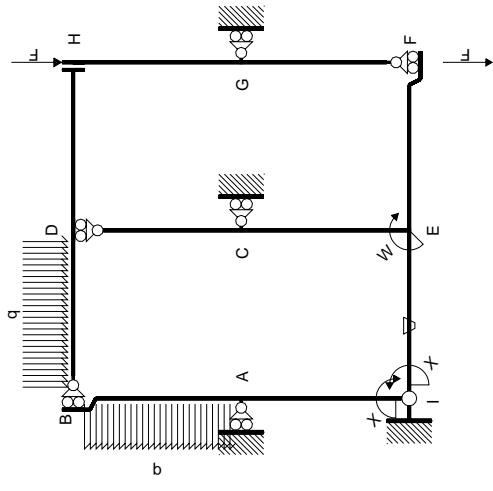


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↑ ⊕ ↓ F

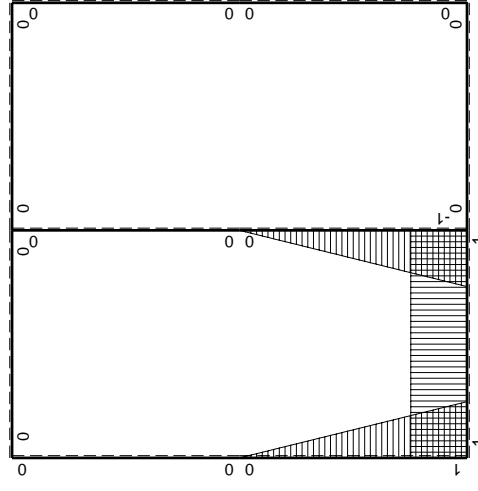


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fb+Fx$	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-6b + 6b - 2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb \frac{1}{EJ} dx = [-2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

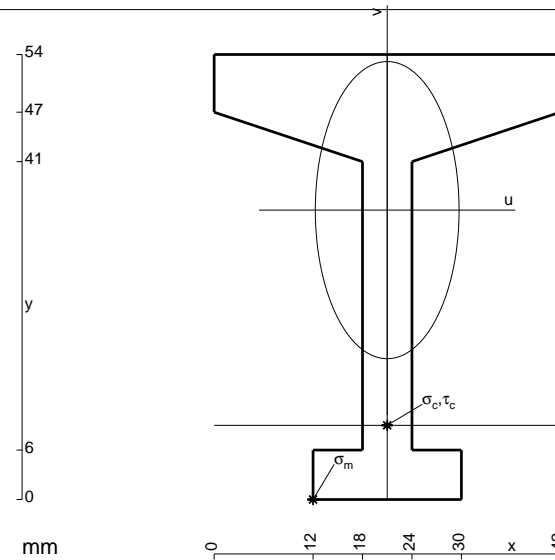
$$= (-2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (x/b - x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

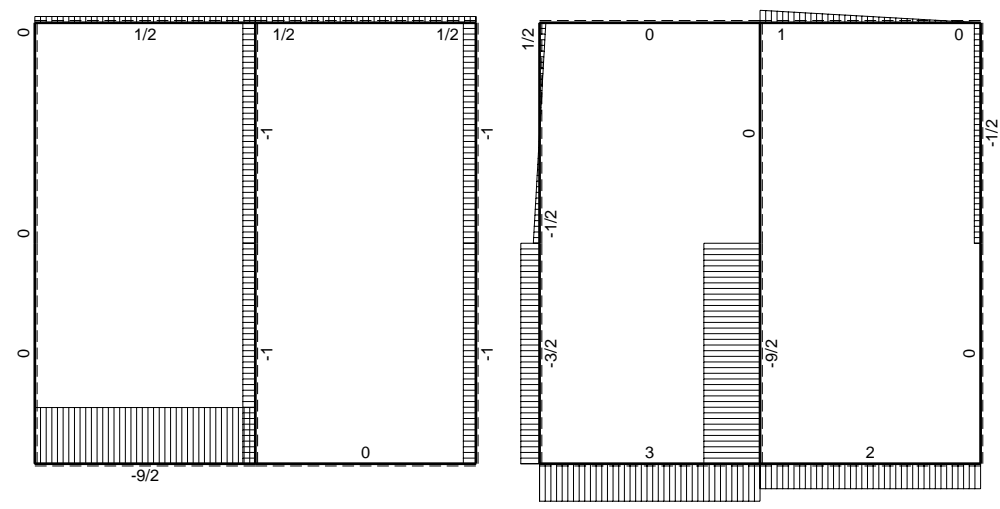
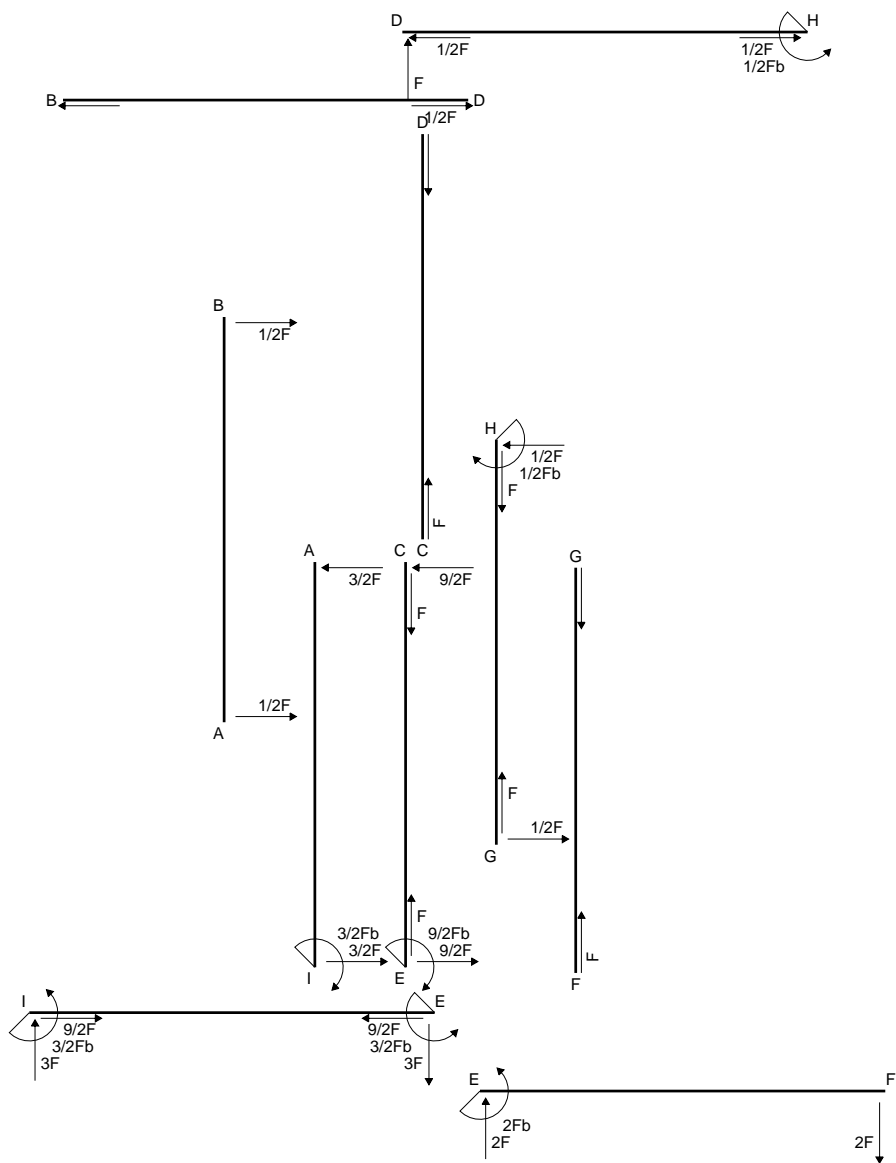
$$= (1/2 b - 1/3 b) Fb \frac{1}{EJ} = 1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (x/b - x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/2 b - 1/3 b) Fb \frac{1}{EJ} = 1/6 Fb^2/EJ$$

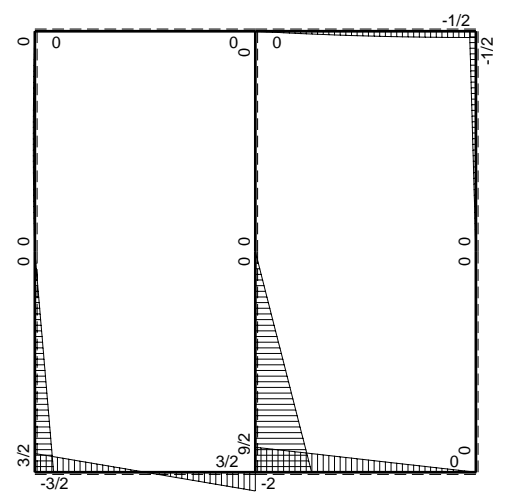


- A = 756. mm²
- J_u = 245989. mm⁴
- J_v = 57564. mm⁴
- y_g = 35.12 mm
- T_y = 1660. N
- M_x = -1610200. Nmm
- x_m = 12. mm
- u_m = -9. mm
- v_m = -35.12 mm
- σ_m = -Mv/J_u = -229.9 N/mm²
- x_c = 21. mm
- y_c = 9. mm
- v_c = -26.12 mm
- σ_c = -Mv/J_u = -171. N/mm²
- τ_c = 4.461 N/mm²
- σ_o = √σ_c² + 3τ_c² = 171.1 N/mm²
- S = 3966. mm³

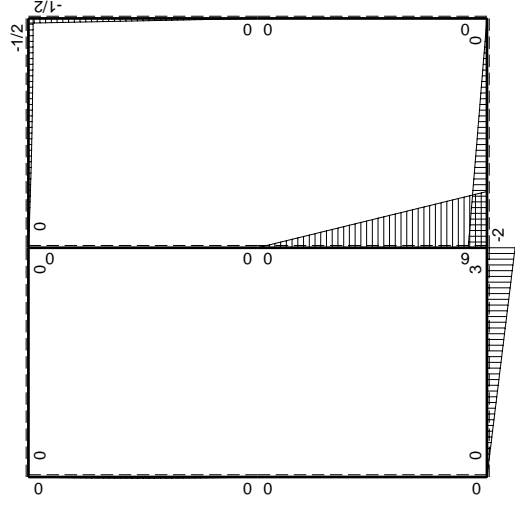
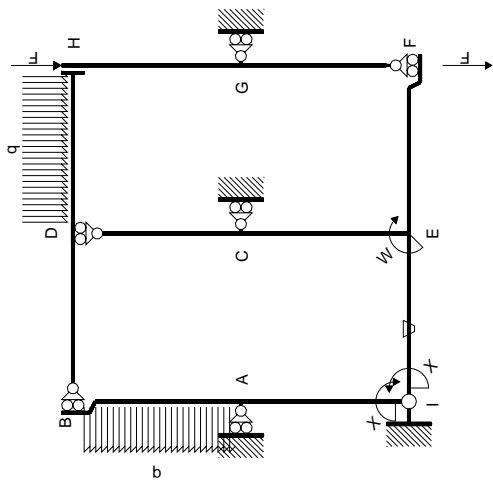


← ⊕ → F

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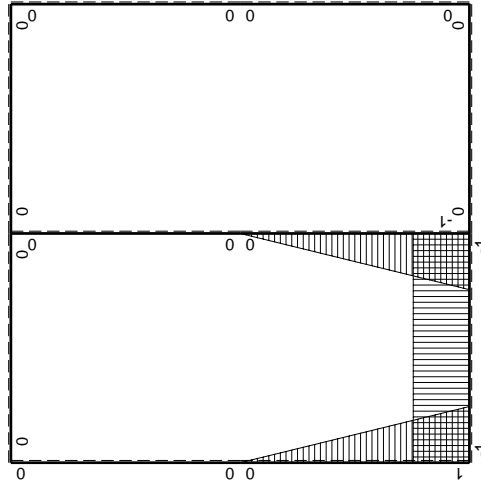


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

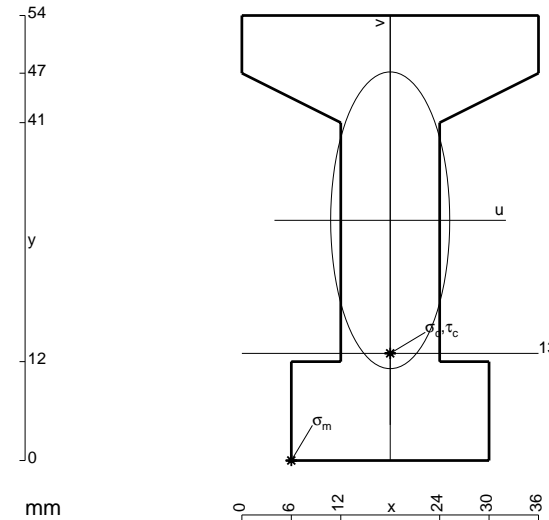
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb 1/EJ dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

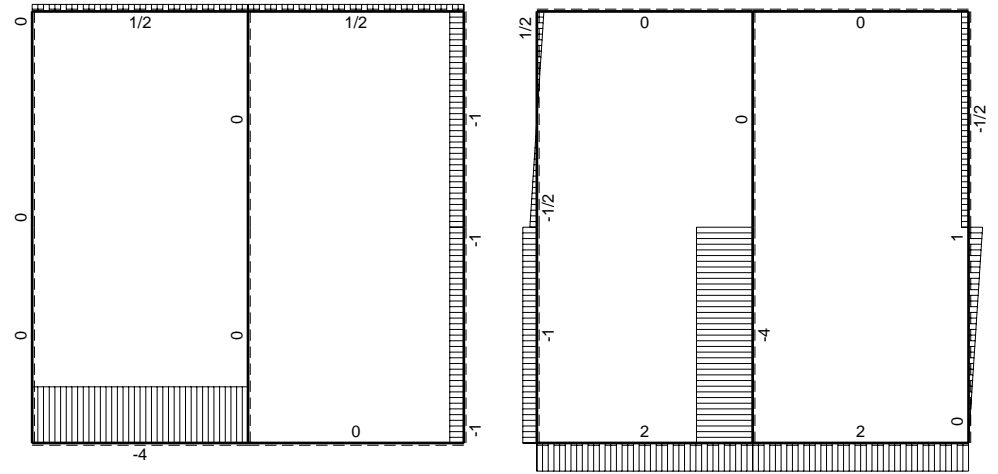
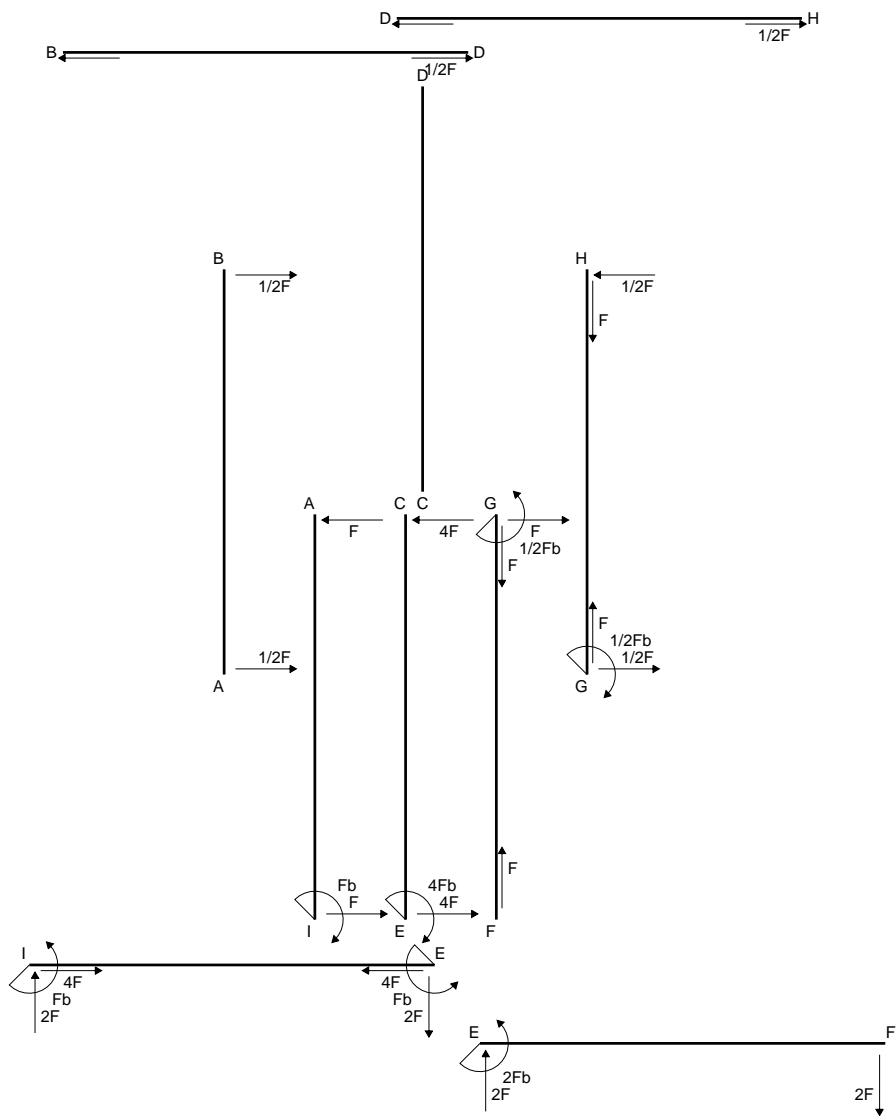
$$= (-6b + 6b - 2b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb 1/EJ dx = [-2x^3/b^2]_0^b Fb 1/EJ$$

$$= (-2b) Fb 1/EJ = -2 Fb^2/EJ$$

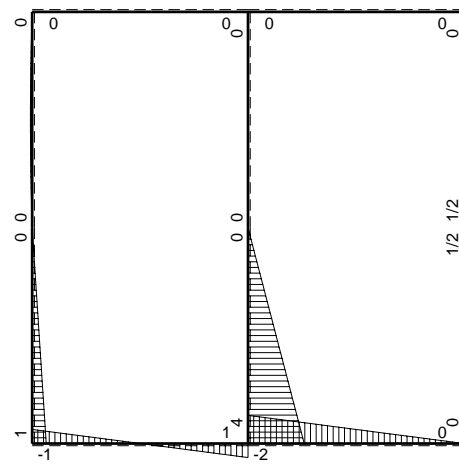


- A = 1032. mm²
- J_u = 334856. mm⁴
- J_v = 53856. mm⁴
- y_g = 29.15 mm
- T_y = 2700. N
- M_x = -2754000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -29.15 mm
- σ_m = -Mv/J_u = -239.8 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -16.15 mm
- σ_c = -Mv/J_u = -132.8 N/mm²
- τ_c = 4.614 N/mm²
- σ_o = √σ²+3τ² = 133.1 N/mm²
- S = 6867. mm³

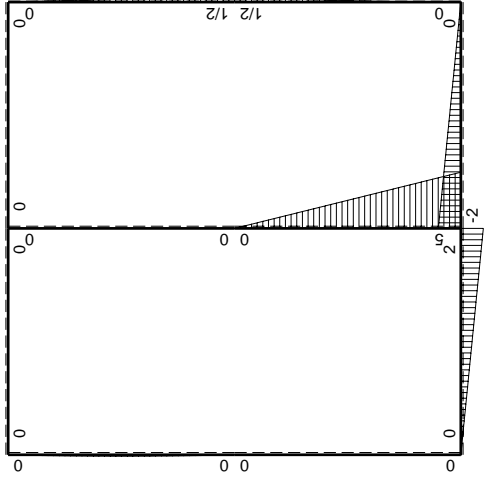
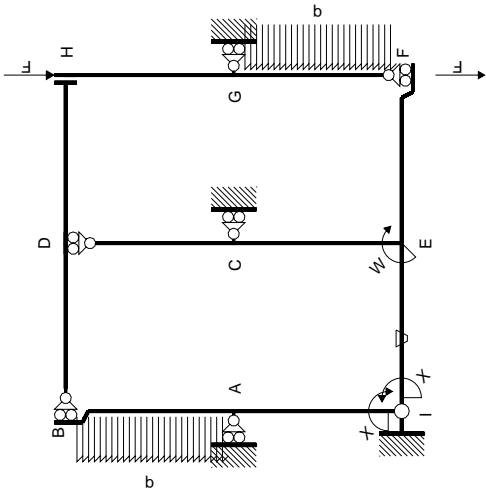


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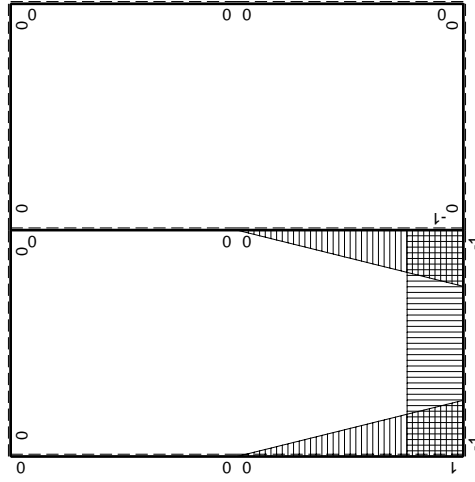


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

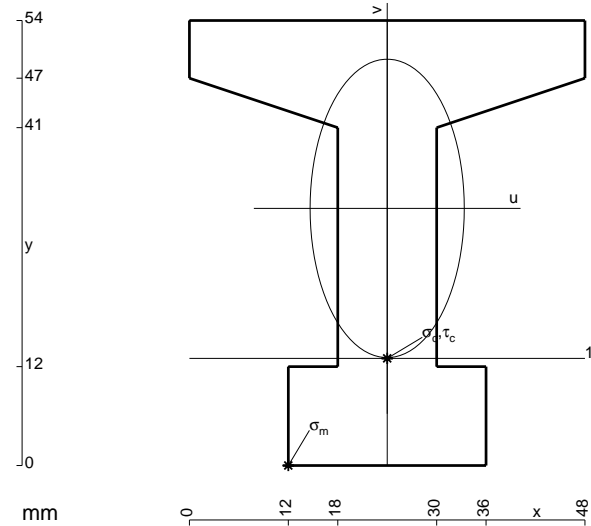
$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

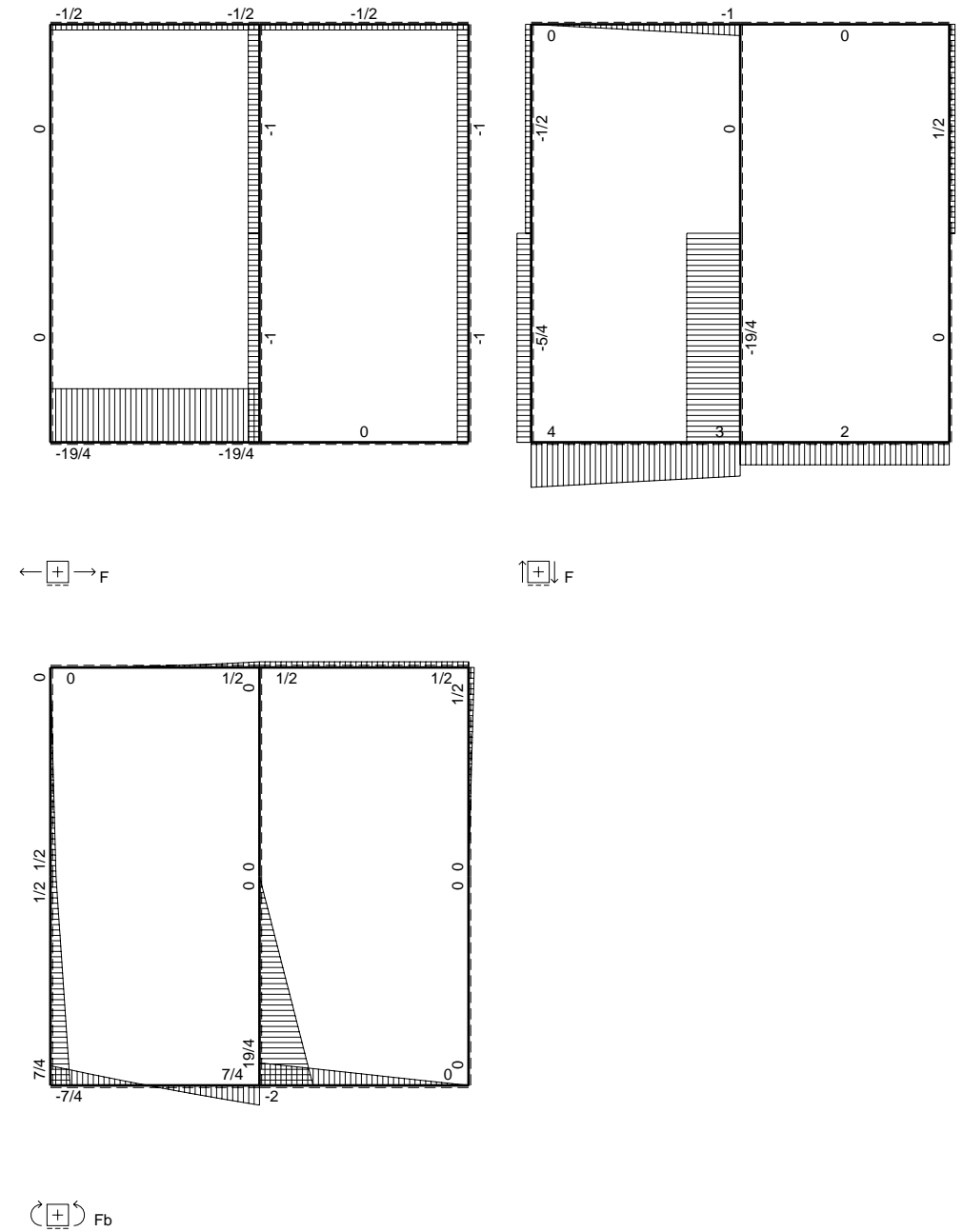
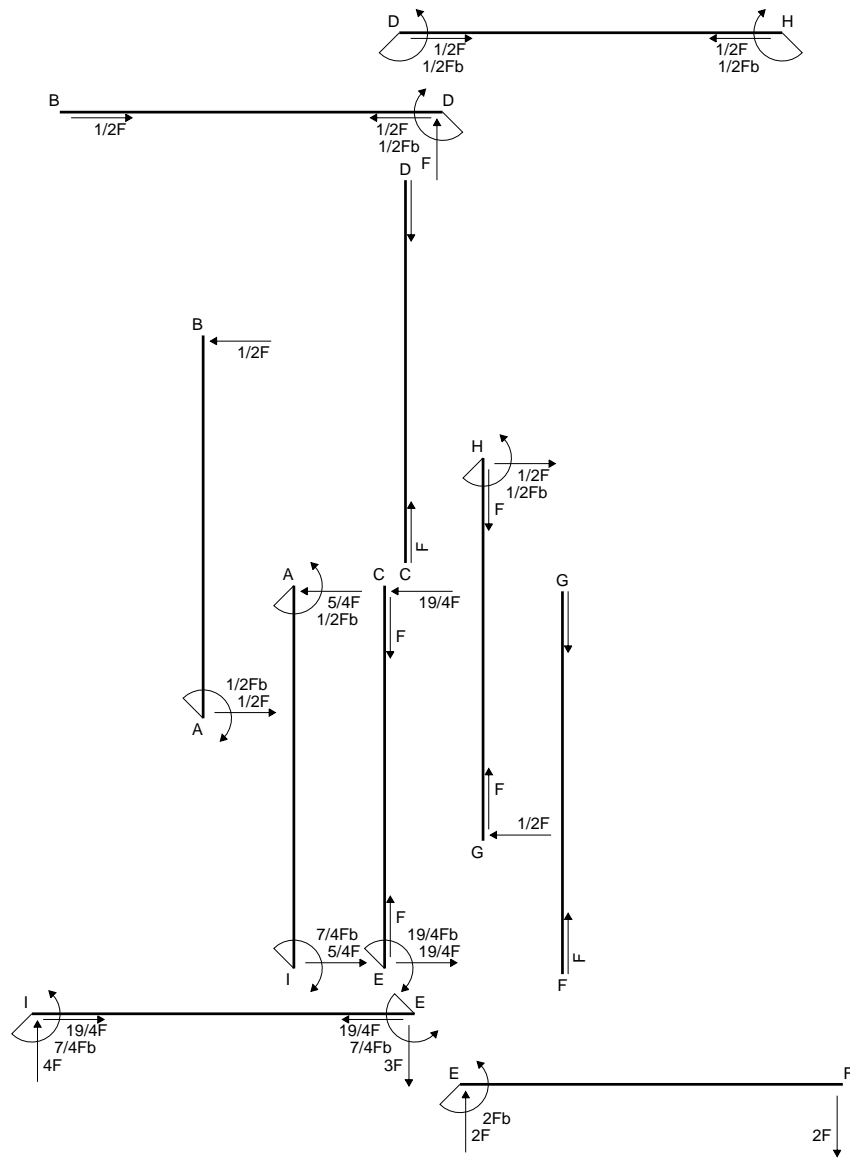
$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

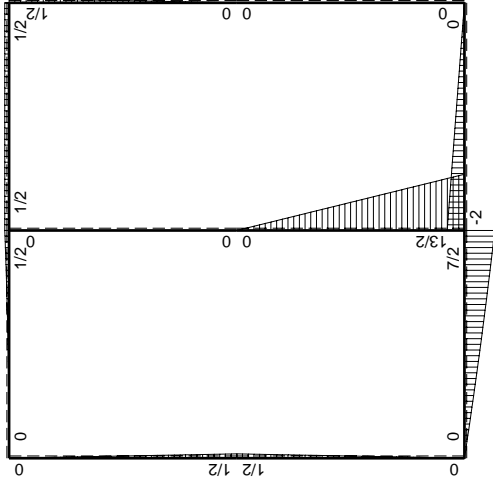
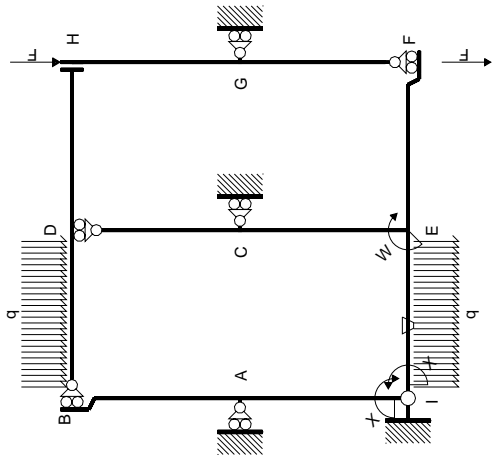
$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$



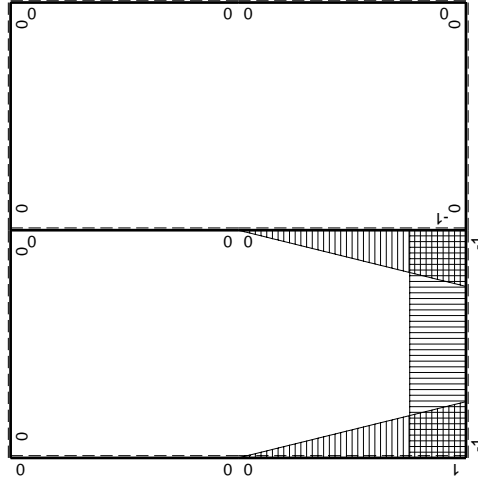
- A = 1152. mm²
- J_u = 377748. mm⁴
- J_v = 100872. mm⁴
- y_g = 31.2 mm
- T_y = 4480. N
- M_x = -2419200. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -31.2 mm
- σ_m = -Mv/J_u = -199.8 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -18.2 mm
- σ_c = -Mv/J_u = -116.6 N/mm²
- τ_c = 7.395 N/mm²
- σ_q = √σ²+3τ² = 117.3 N/mm²
- S = 7483. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

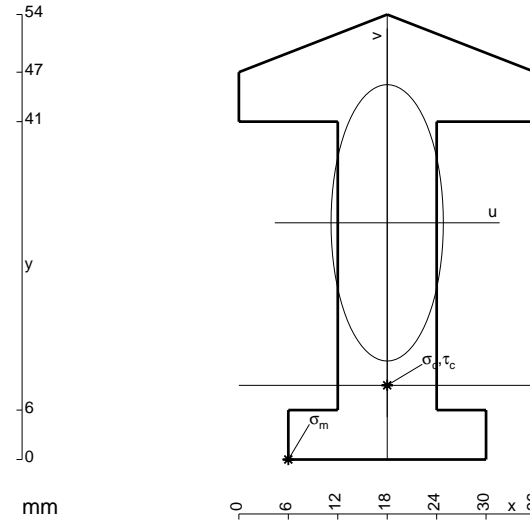
$$= (-13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

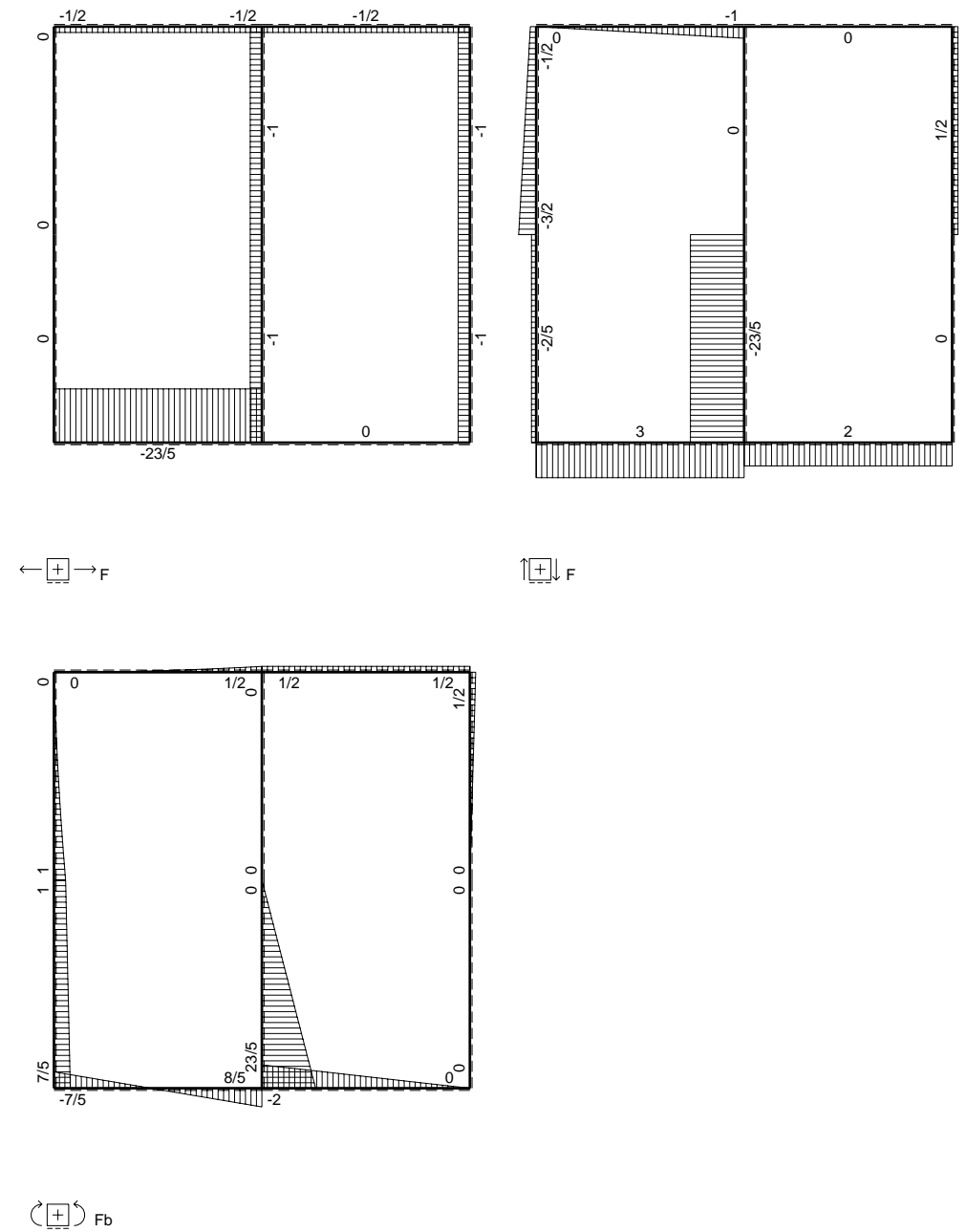
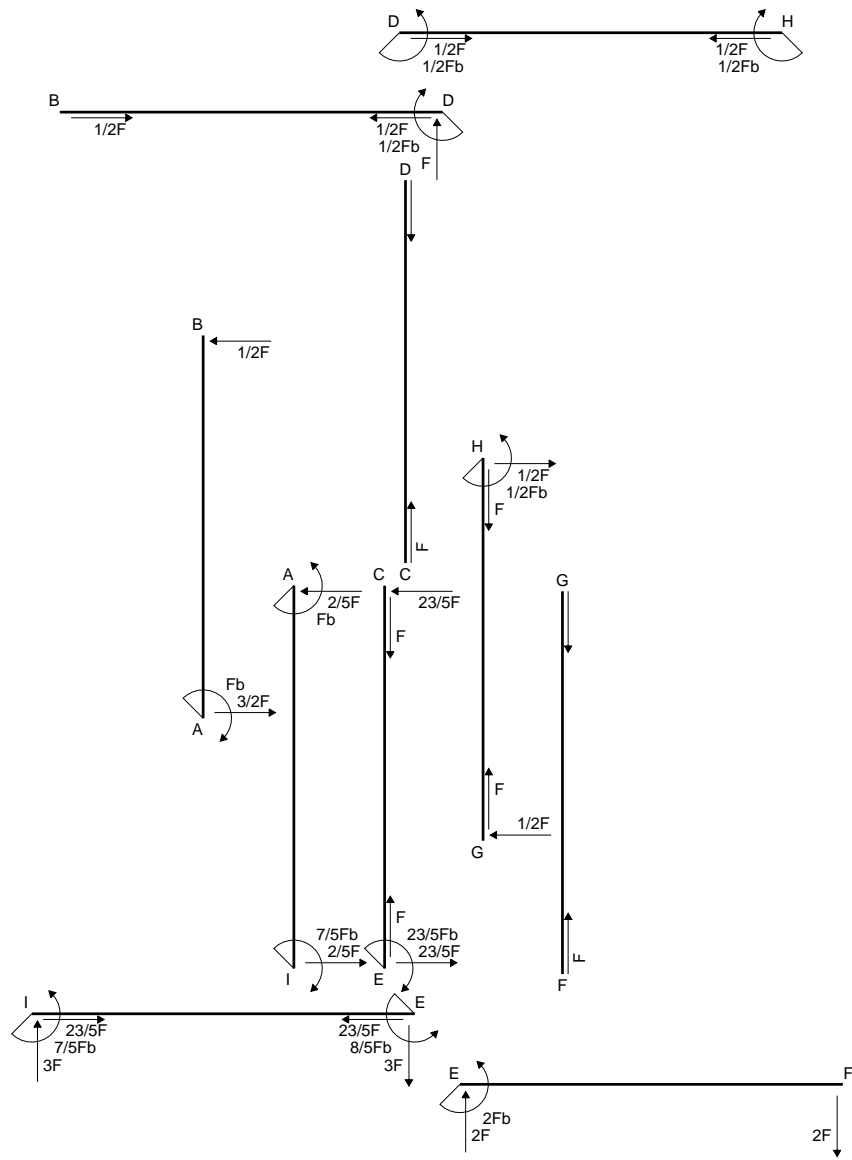
$$= (1/4 b - 1/6 b) Fb \frac{1}{EJ} = 1/12 Fb^2/EJ$$

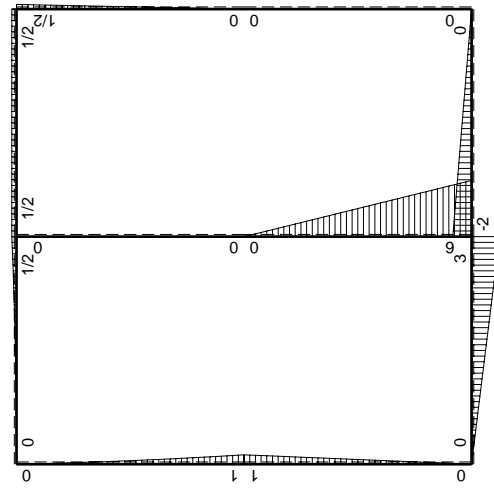
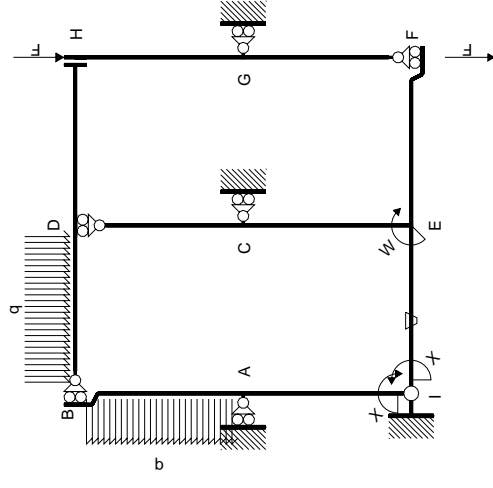
$$L_{AI}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/4 b - 1/6 b) Fb \frac{1}{EJ} = 1/12 Fb^2/EJ$$



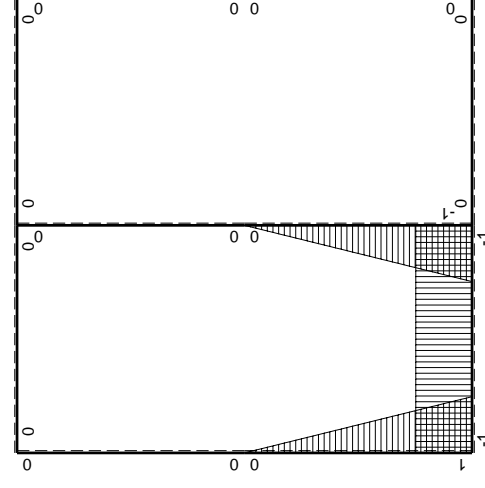
- A = 906. mm²
- J_u = 254971. mm⁴
- J_v = 42084. mm⁴
- y_g = 28.72 mm
- T_y = 3140. N
- M_x = -1852600. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.72 mm
- σ_m = -Mv/J_u = -208.7 N/mm²
- x_c = 18. mm
- y_c = 9. mm
- v_c = -19.72 mm
- σ_c = -Mv/J_u = -143.3 N/mm²
- τ_c = 4.585 N/mm²
- σ_o = √σ² + 3τ² = 143.5 N/mm²
- S = 4468. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fb+Fx$	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-6b + 6b - 2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb \frac{1}{EJ} dx = [-2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

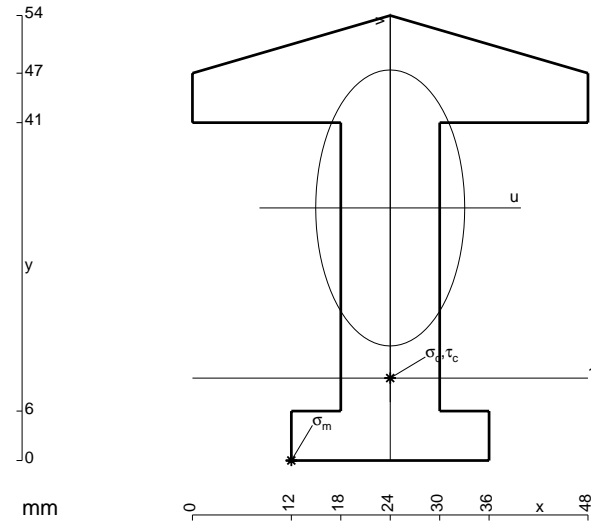
$$= (-2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (x/b - x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

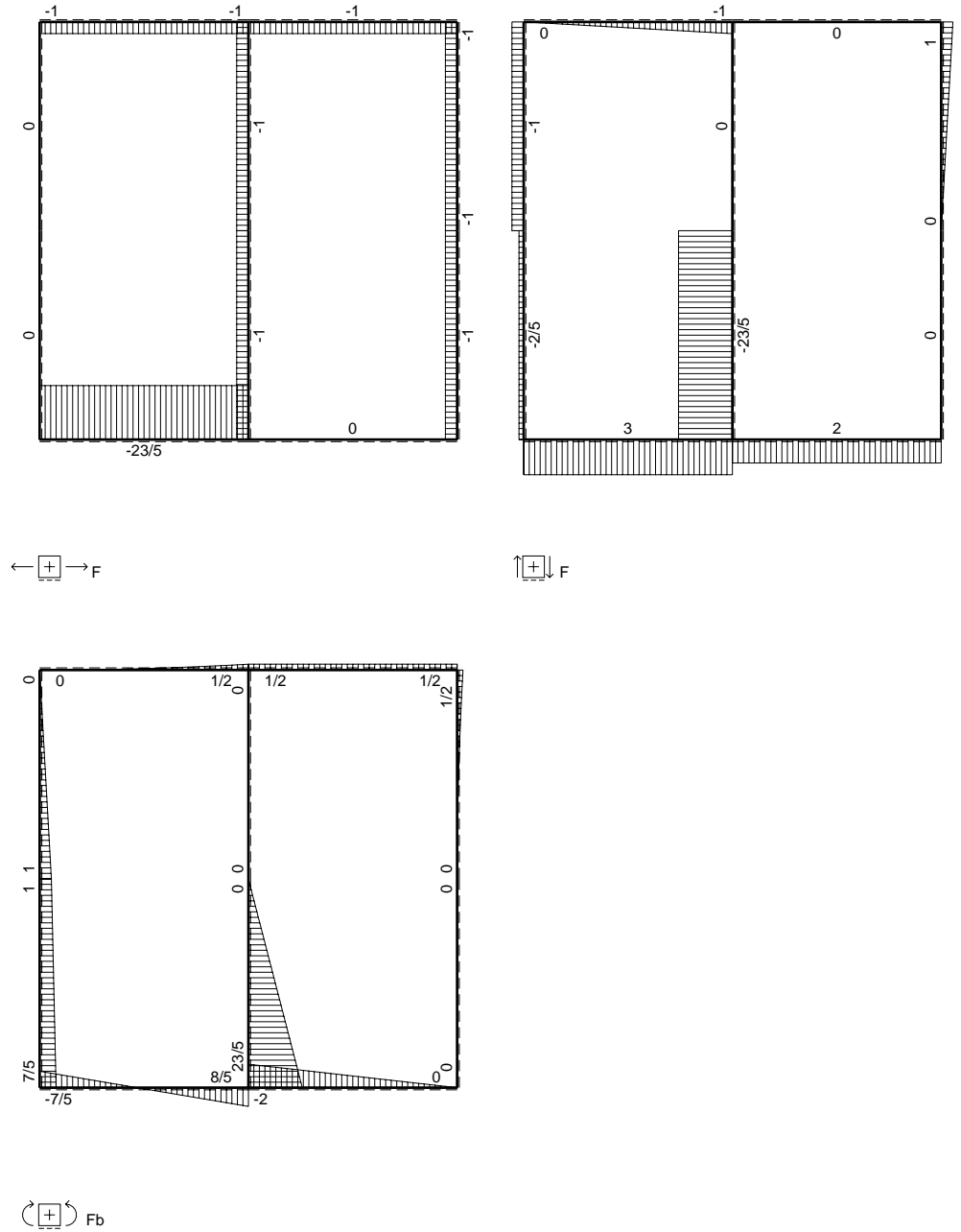
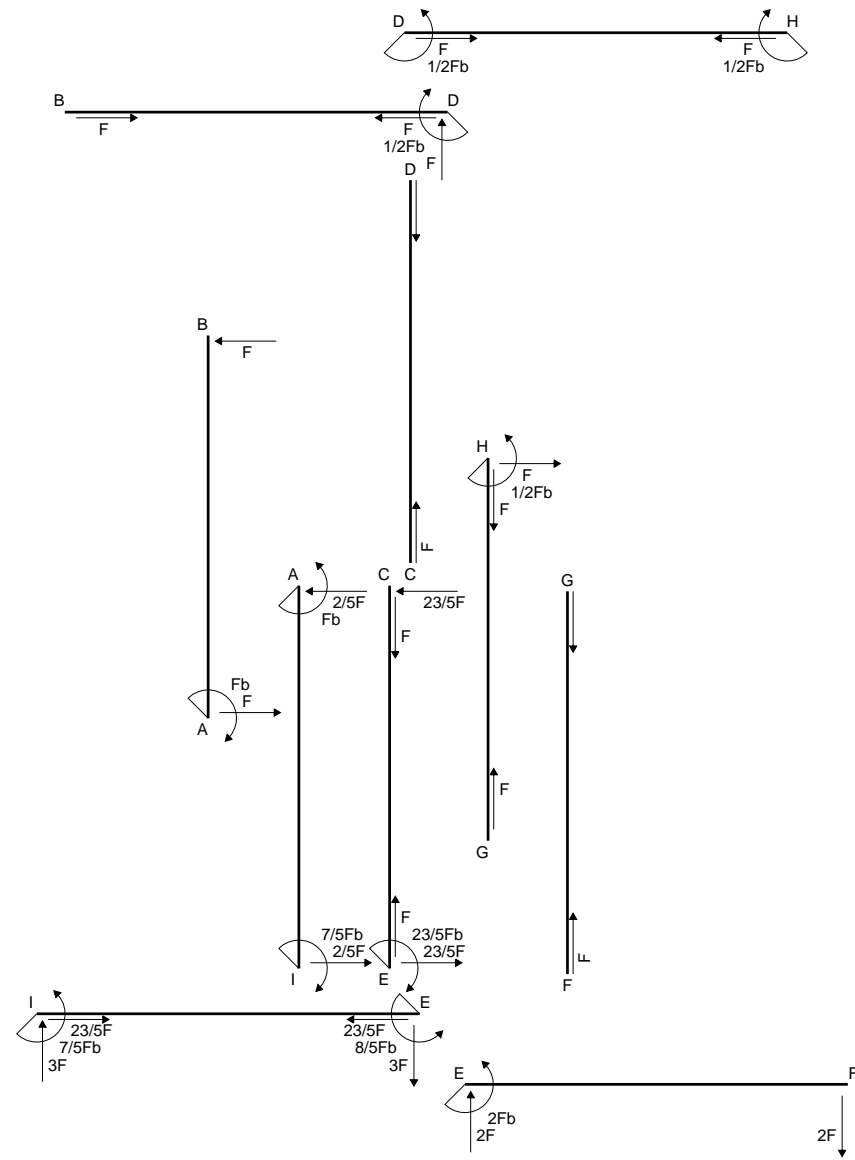
$$= (1/2 b - 1/3 b) Fb \frac{1}{EJ} = 1/6 Fb^2/EJ$$

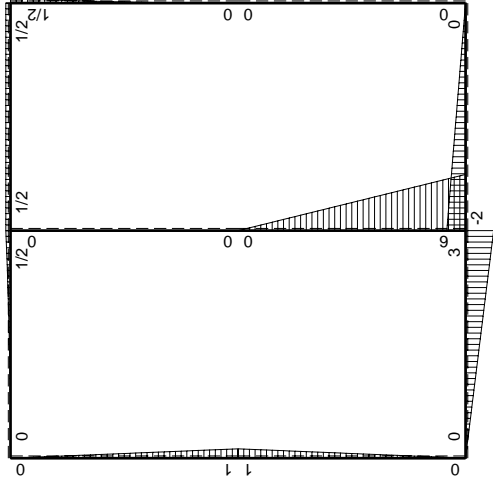
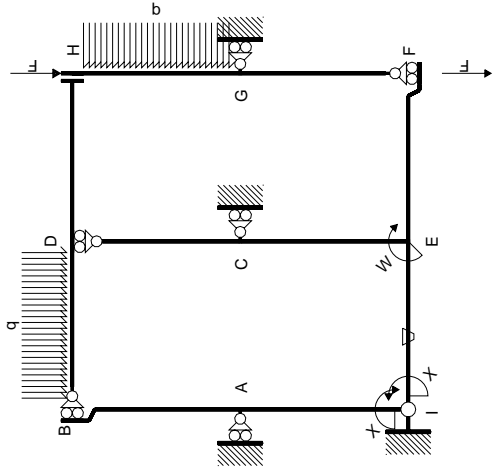
$$L_{AI}^{xo} = \int_0^b (x/b - x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/2 b - 1/3 b) Fb \frac{1}{EJ} = 1/6 Fb^2/EJ$$



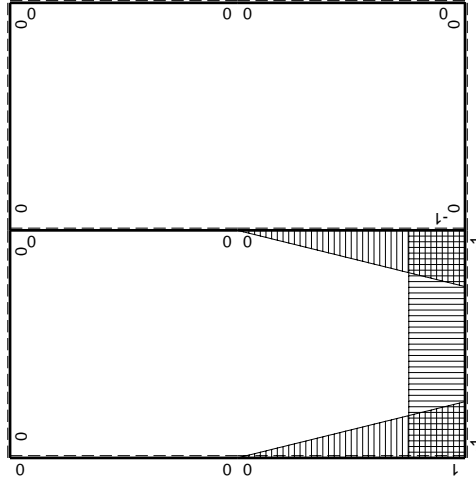
- A = 1020. mm²
- J_u = 286162. mm⁴
- J_v = 83376. mm⁴
- y_g = 30.65 mm
- T_y = 3200. N
- M_x = -2048000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.65 mm
- σ_m = -Mv/J_u = -219.3 N/mm²
- x_c = 24. mm
- y_c = 10. mm
- v_c = -20.65 mm
- σ_c = -Mv/J_u = -147.8 N/mm²
- τ_c = 4.723 N/mm²
- σ_q = √(σ² + 3τ²) = 148. N/mm²
- S = 5069. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	-Fb+Fx	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb 1/EJ dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

$$= (-6b + 6b - 2b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb 1/EJ dx = [-2x^3/b^2]_0^b Fb 1/EJ$$

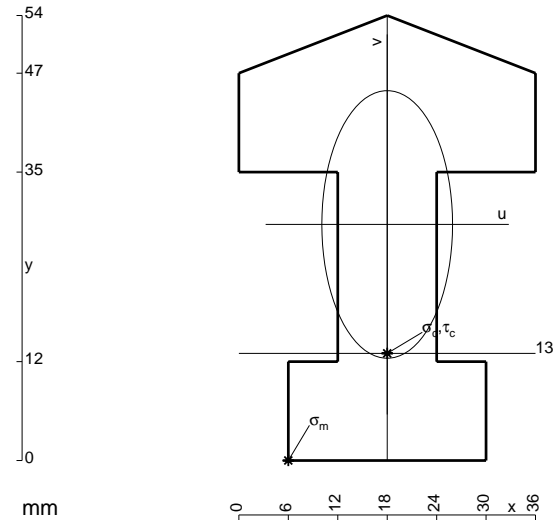
$$= (-2b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (x/b - x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb 1/EJ$$

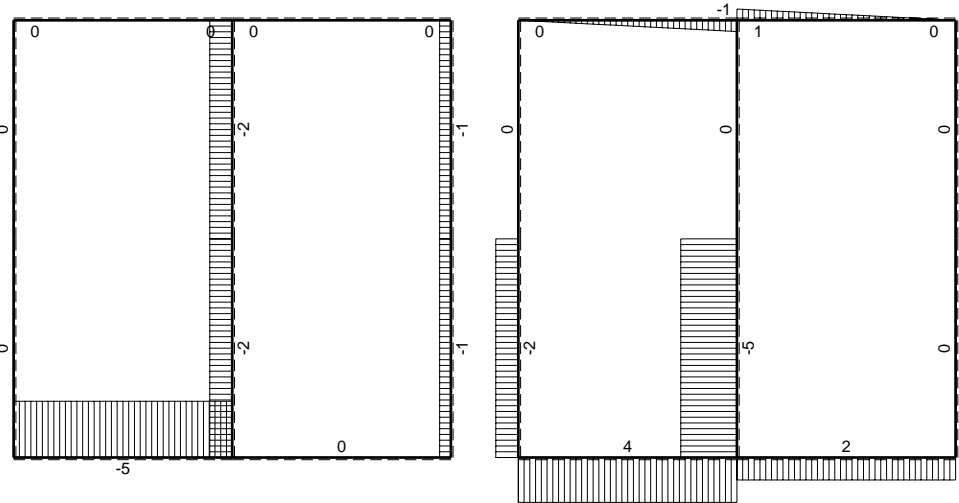
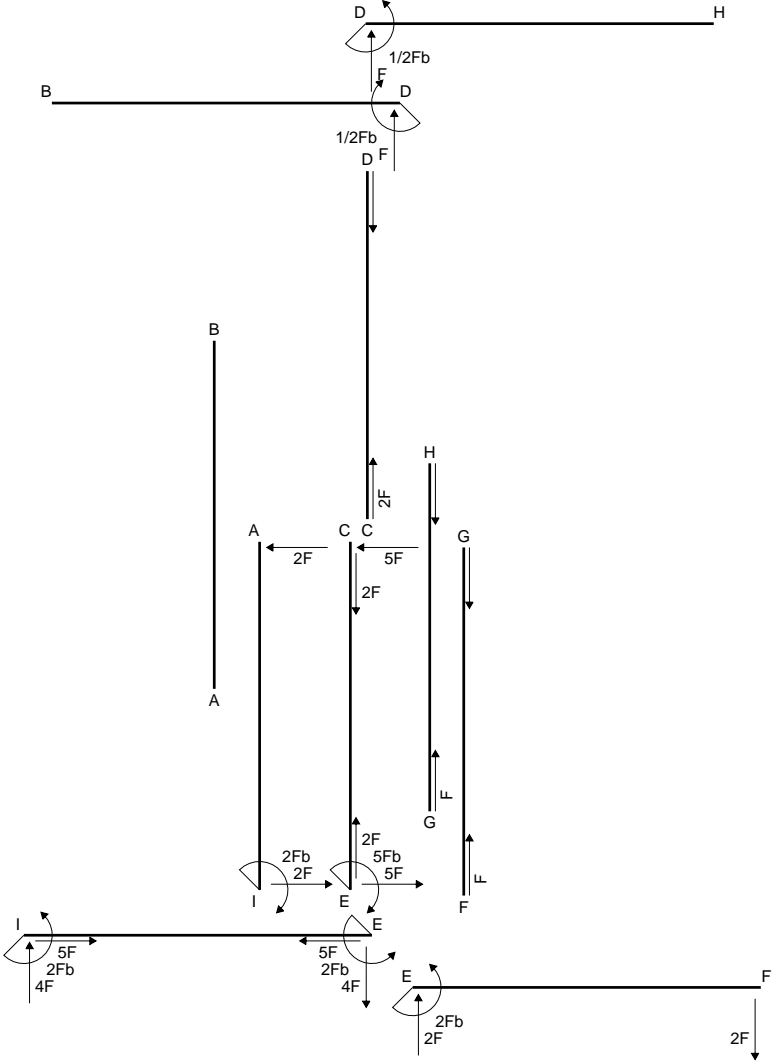
$$= (1/2 b - 1/3 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (x/b - x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/3 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

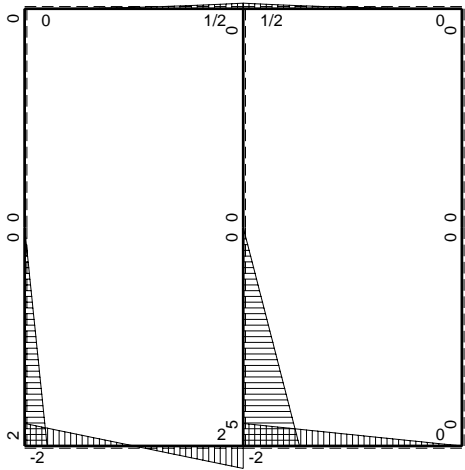


- A = 1122. mm²
- J_u = 296013. mm⁴
- J_v = 70596. mm⁴
- y_g = 28.65 mm
- T_y = 3380. N
- M_x = -2366000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.65 mm
- σ_m = -Mv/J_u = -229. N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.65 mm
- σ_c = -Mv/J_u = -125.1 N/mm²
- τ_c = 6.391 N/mm²
- σ_o = √σ_c² + 3τ_c² = 125.6 N/mm²
- S = 6716. mm³

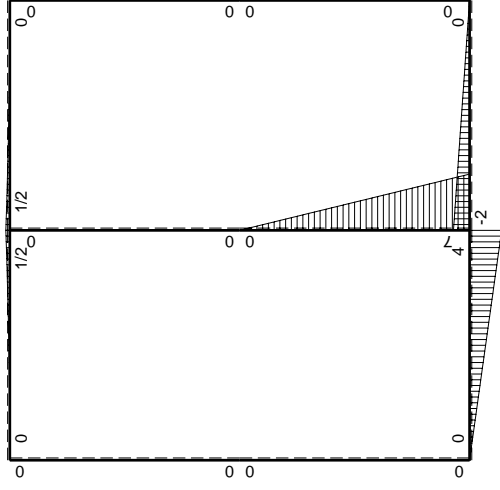
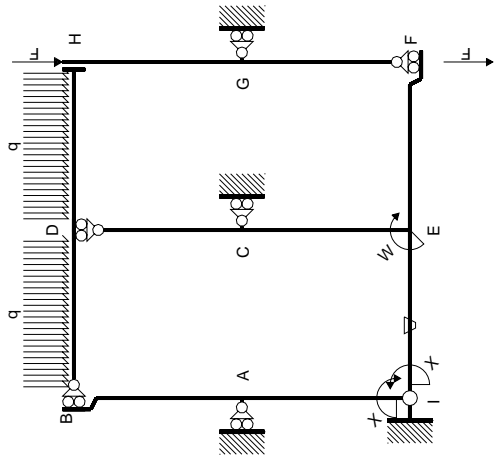


← (+) → F

↑ (+) ↓ F

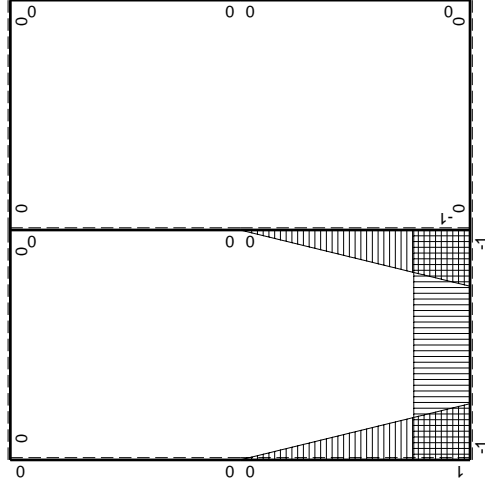


⊙ (+) ⊙ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$7Fb-7Fx$	0	$-7Fb+14Fx-7Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-7Fx$	0	$-7Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-10/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$2Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b) Fb 1/EJ + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-4 + 4x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

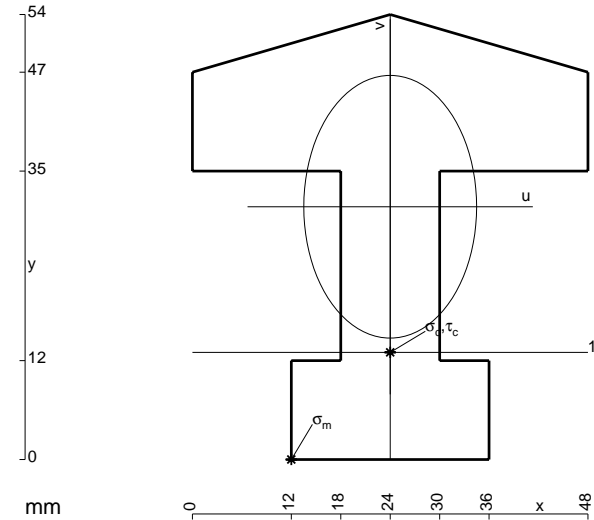
$$= (-4b + 2b) Fb 1/EJ + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-7 + 14x/b - 7x^2/b^2) Fb 1/EJ dx = [-7x + 7x^2/b - 7/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-7b + 7b - 7/3 b) Fb 1/EJ = -7/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-7x^2/b^2) Fb 1/EJ dx = [-7/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-7/3 b) Fb 1/EJ = -7/3 Fb^2/EJ$$



$$A = 1308. \text{ mm}^2$$

$$J_u = 332443. \text{ mm}^4$$

$$J_v = 143856. \text{ mm}^4$$

$$y_g = 30.67 \text{ mm}$$

$$T_y = 3460. \text{ N}$$

$$M_x = -2595000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -30.67 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -239.4 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

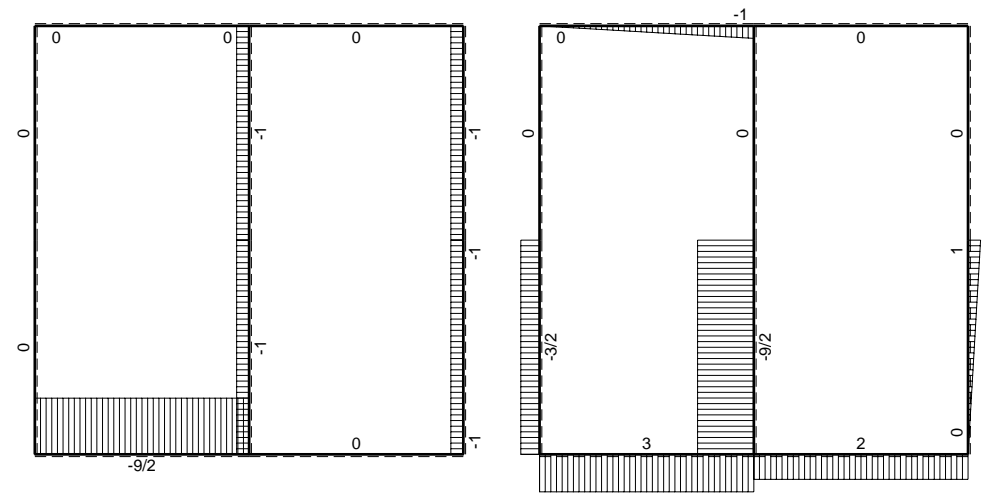
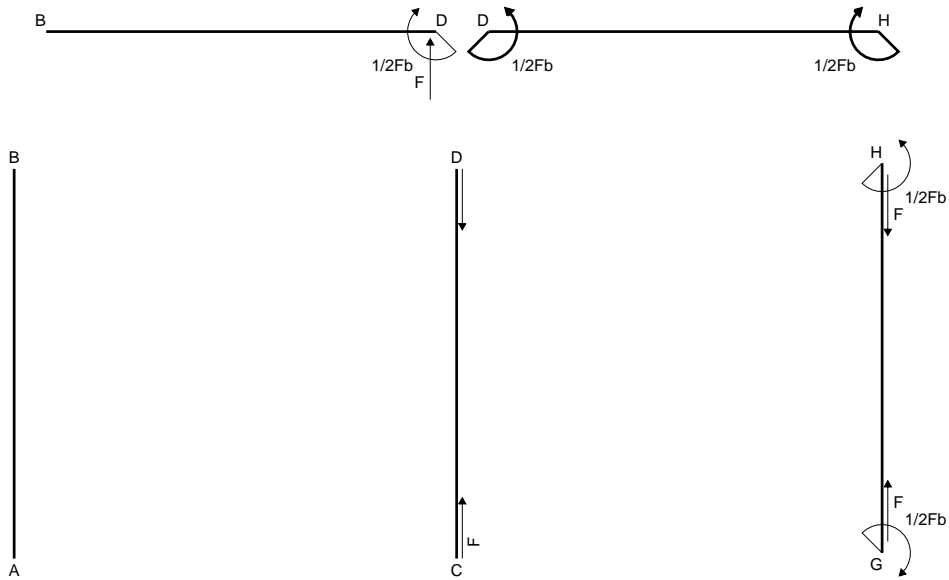
$$v_c = -17.67 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -137.9 \text{ N/mm}^2$$

$$\tau_c = 6.352 \text{ N/mm}^2$$

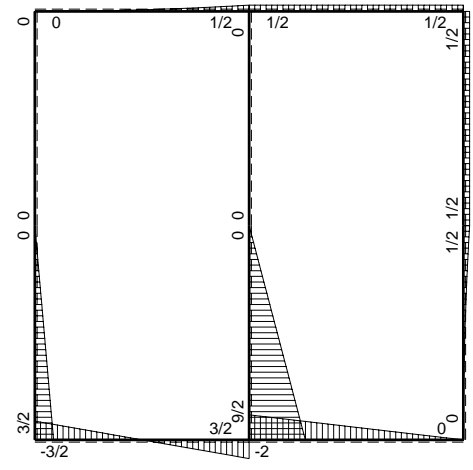
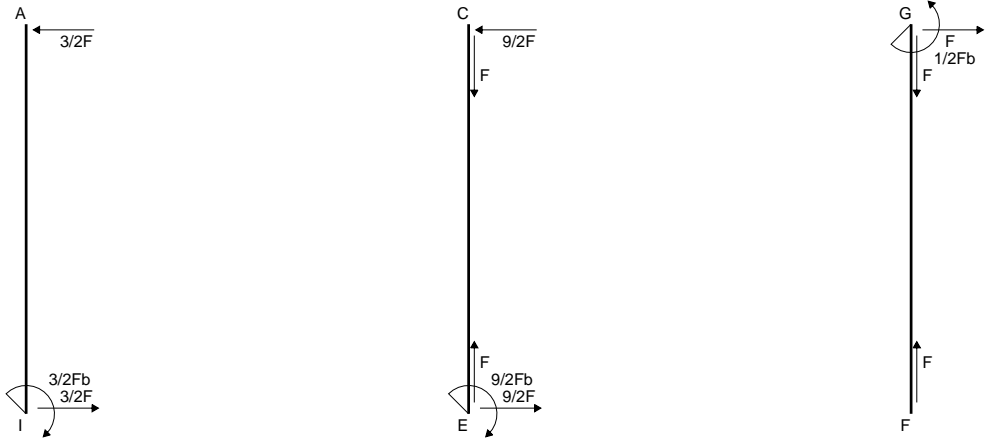
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 138.4 \text{ N/mm}^2$$

$$S = 7323. \text{ mm}^3$$

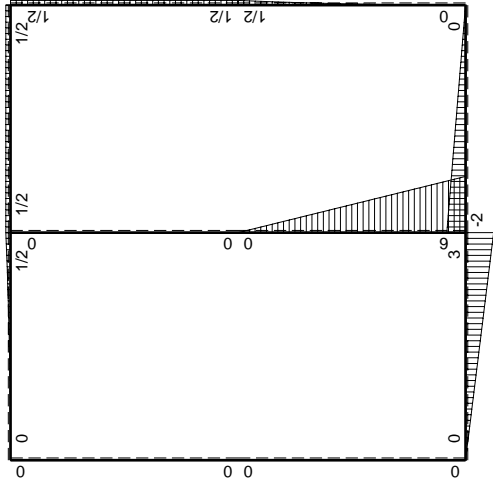
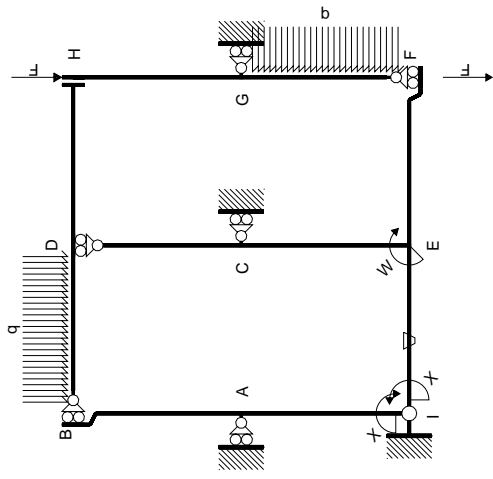


← ⊕ → F

↑ ⊕ ↓ F

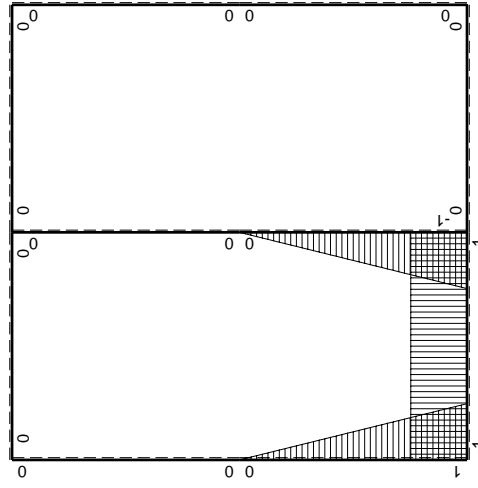


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

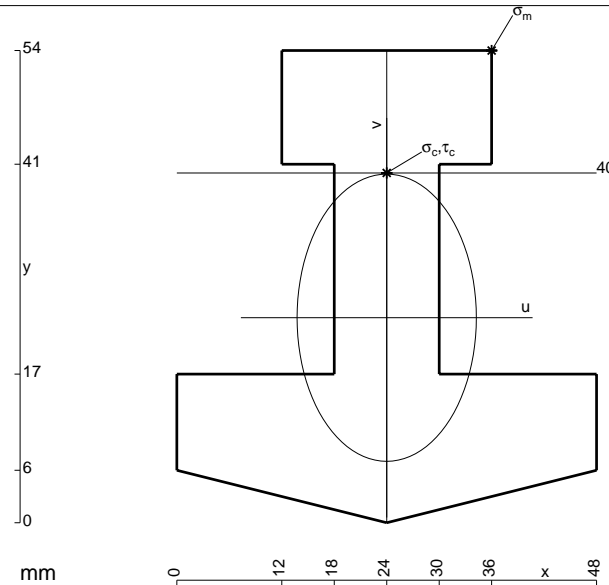
$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

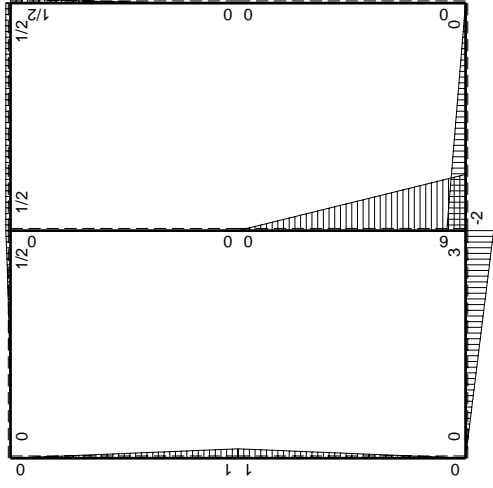
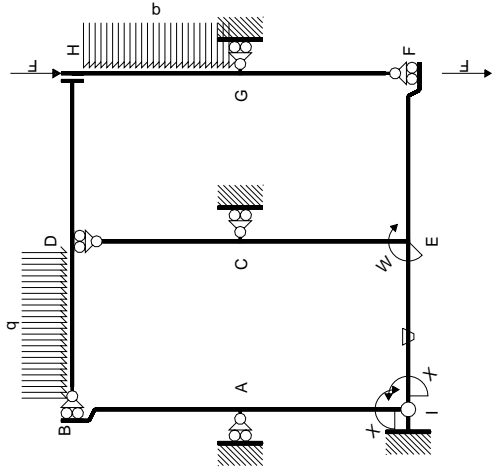
$$= (-6b + 6b - 2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb \frac{1}{EJ} dx = [-2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

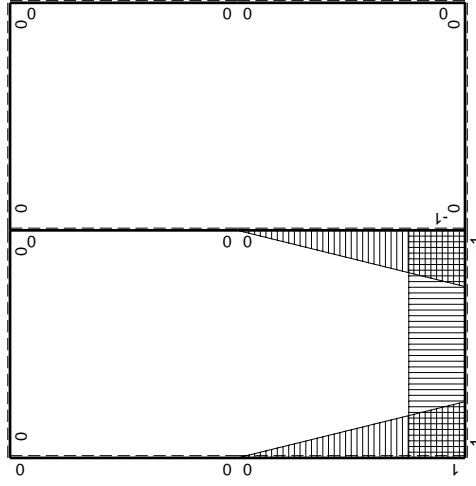


- A = 1272. mm²
- J_u = 343038. mm⁴
- J_v = 133632. mm⁴
- y_g = 23.44 mm
- T_y = 2760. N
- M_x = -2235600. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 30.56 mm
- σ_m = -Mv/J_u = 199.1 N/mm²
- x_c = 24. mm
- y_c = 40. mm
- v_c = 16.56 mm
- σ_c = -Mv/J_u = 107.9 N/mm²
- τ_c = 5.17 N/mm²
- σ_q = √σ²+3τ² = 108.3 N/mm²
- S = 7710. mm³



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	-Fb+Fx	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-6b + 6b - 2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb \frac{1}{EJ} dx = [-2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

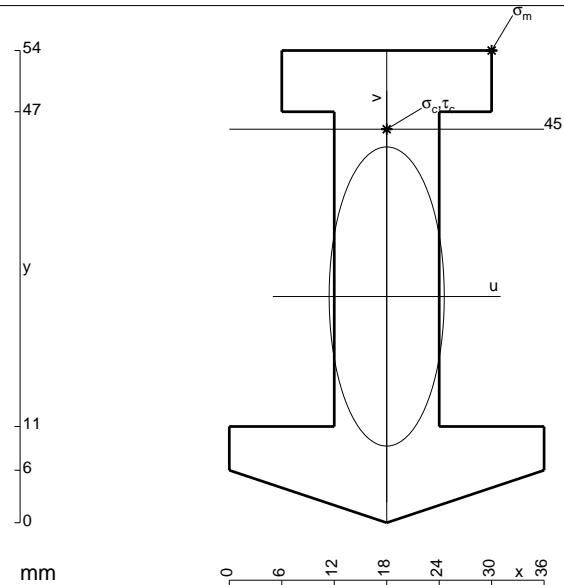
$$= (-2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (x/b - x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

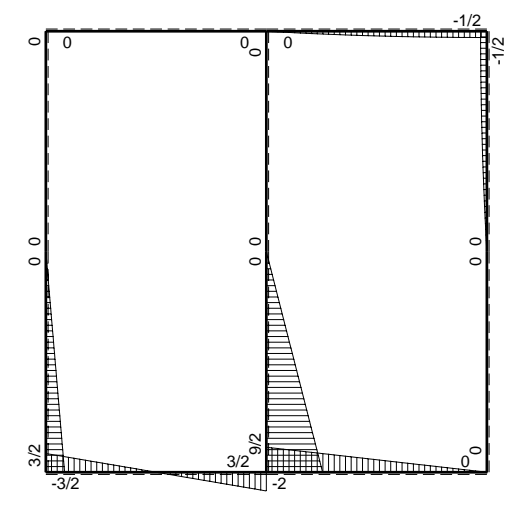
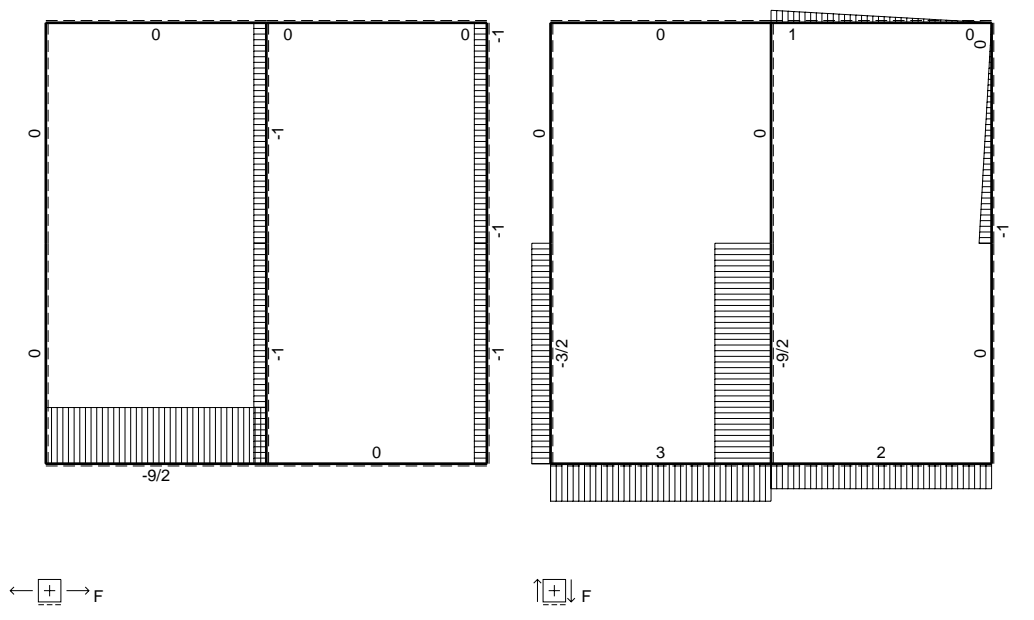
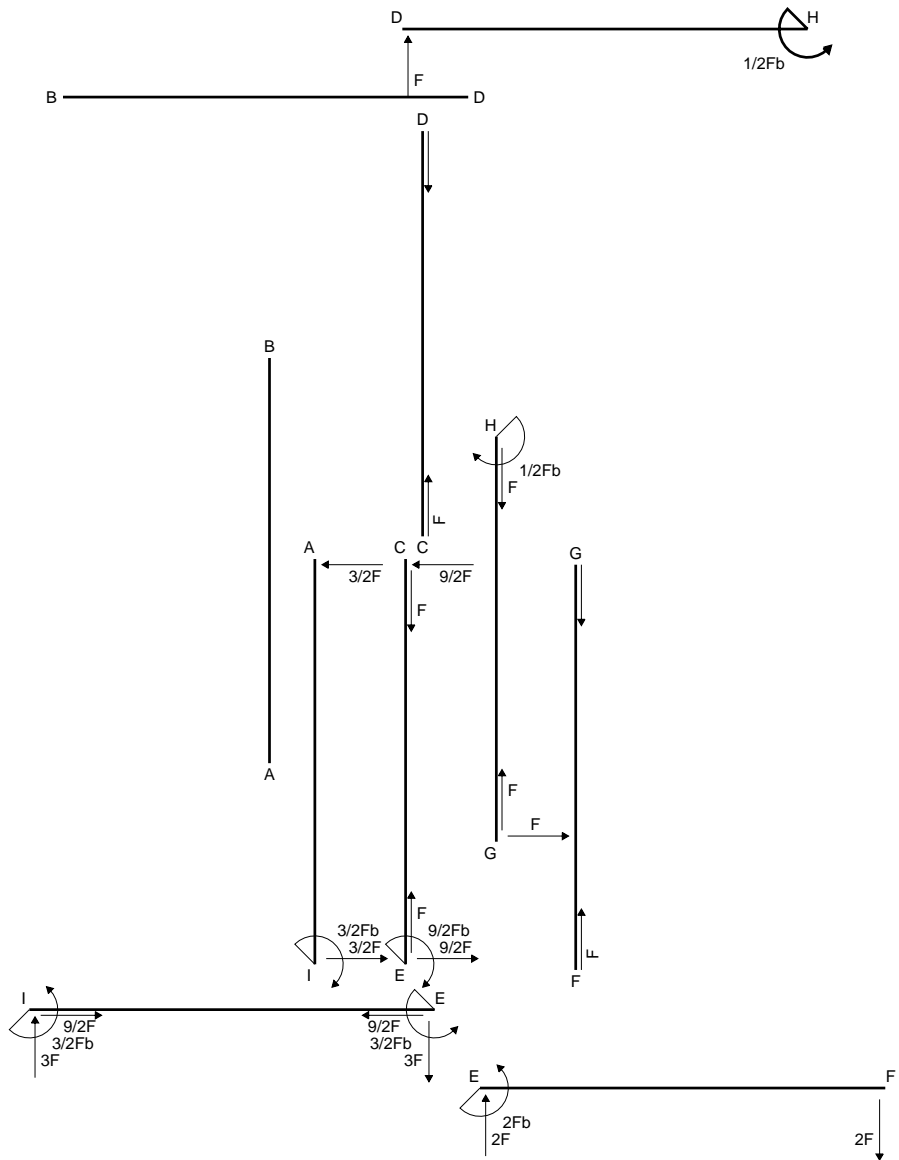
$$= (1/2 b - 1/3 b) Fb \frac{1}{EJ} = 1/6 Fb^2/EJ$$

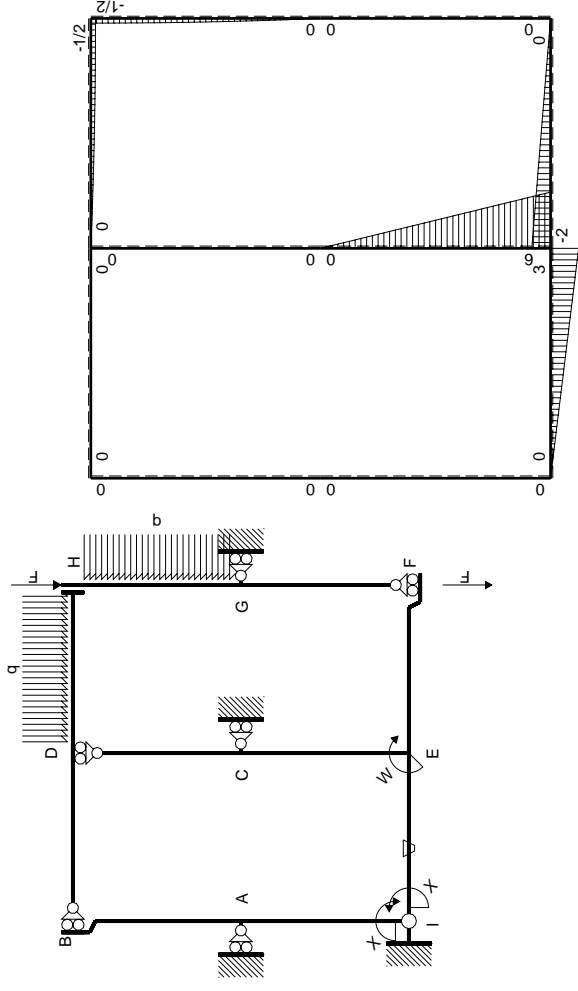
$$L_{AI}^{xo} = \int_0^b (x/b - x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/2 b - 1/3 b) Fb \frac{1}{EJ} = 1/6 Fb^2/EJ$$



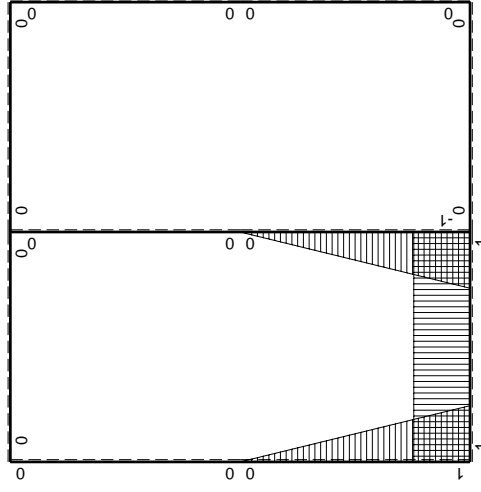
- A = 888. mm²
- J_u = 260045. mm⁴
- J_v = 38520. mm⁴
- y_g = 25.87 mm
- T_y = 2240. N
- M_x = -1926400. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 28.13 mm
- σ_m = -Mv/J_u = 208.4 N/mm²
- x_c = 18. mm
- y_c = 45. mm
- v_c = 19.13 mm
- σ_c = -Mv/J_u = 141.7 N/mm²
- τ_c = 3.317 N/mm²
- σ_q = √σ²+3τ² = 141.8 N/mm²
- S = 4621. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

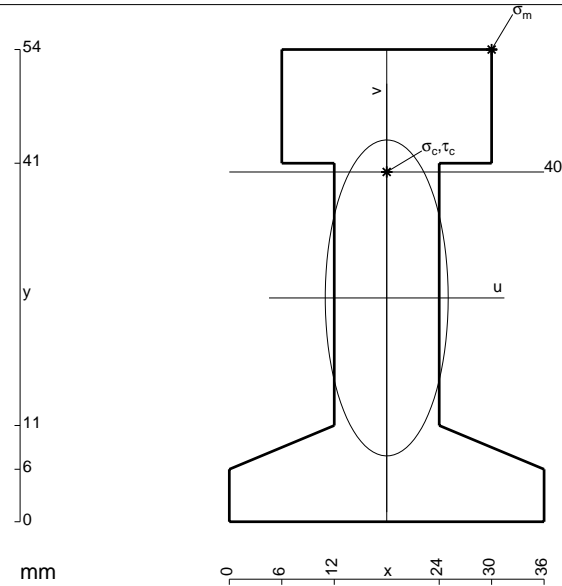
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb 1/EJ dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

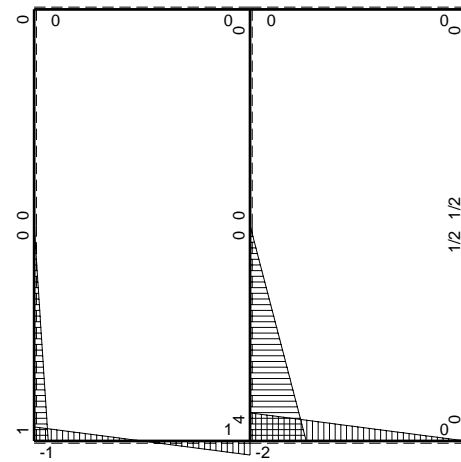
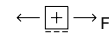
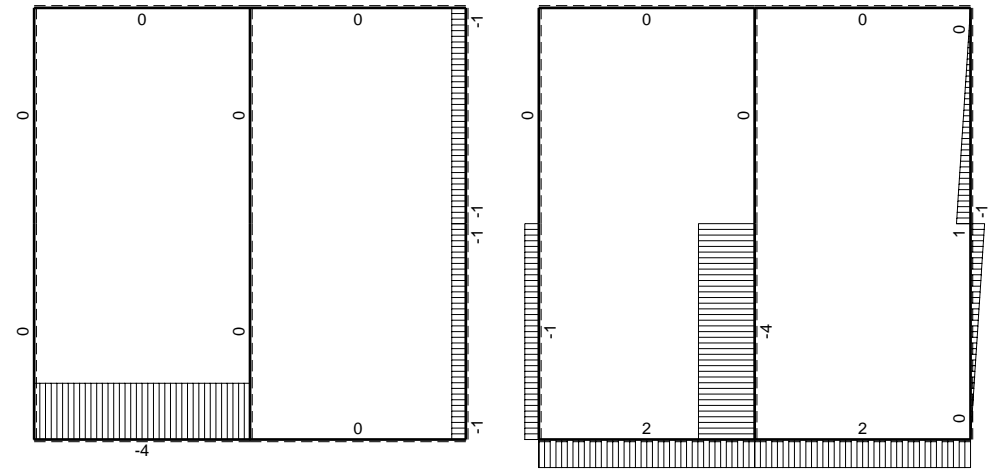
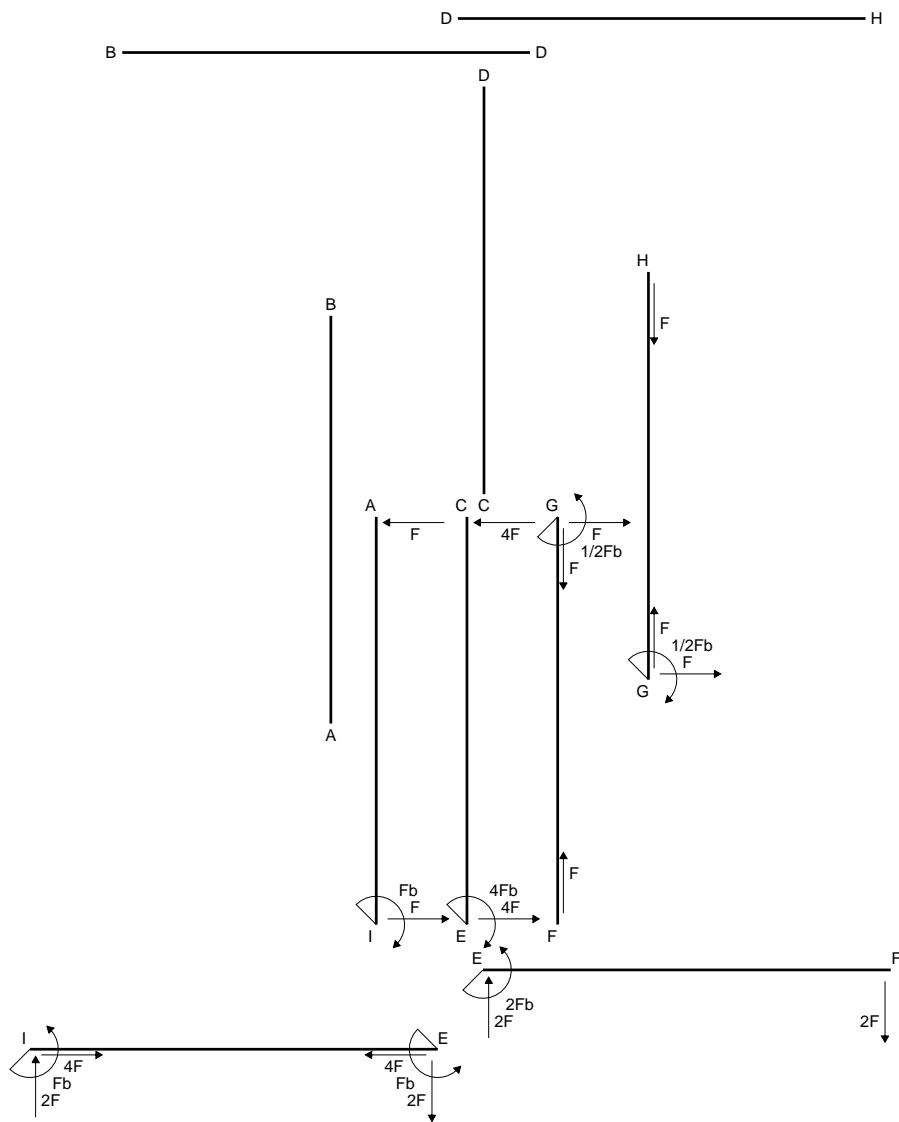
$$= (-6b + 6b - 2b) Fb 1/EJ = -2 Fb^2/EJ$$

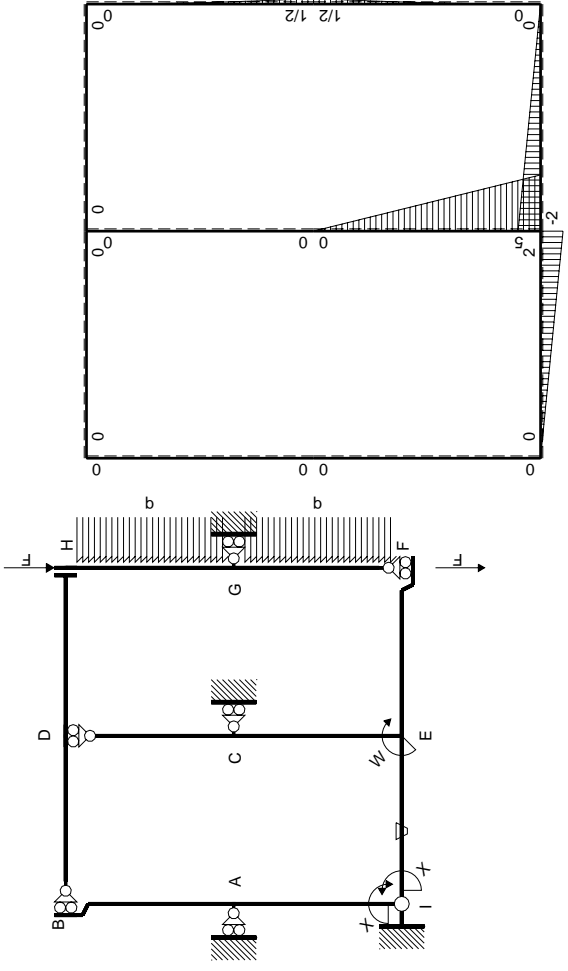
$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb 1/EJ dx = [-2x^3/b^2]_0^b Fb 1/EJ$$

$$= (-2b) Fb 1/EJ = -2 Fb^2/EJ$$



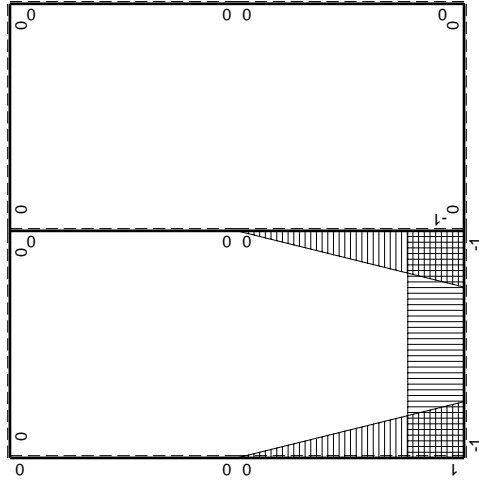
- A = 1008. mm²
- J_u = 329111. mm⁴
- J_v = 49824. mm⁴
- y_g = 25.59 mm
- T_y = 2800. N
- M_x = -2548000. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 28.41 mm
- σ_m = -Mv/J_u = 219.9 N/mm²
- x_c = 18. mm
- y_c = 40. mm
- v_c = 14.41 mm
- σ_c = -Mv/J_u = 111.5 N/mm²
- τ_c = 4.973 N/mm²
- σ_q = √σ²+3τ² = 111.9 N/mm²
- S = 7014. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{x\theta} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{x\theta} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

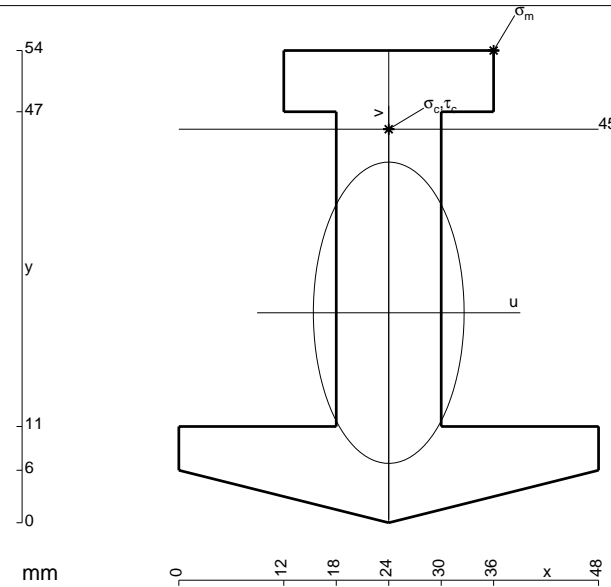
$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{x\theta} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{x\theta} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$



$$A = 984. \text{ mm}^2$$

$$J_u = 292168. \text{ mm}^4$$

$$J_v = 73152. \text{ mm}^4$$

$$y_g = 24.01 \text{ mm}$$

$$T_y = 2300. \text{ N}$$

$$M_x = -2231000. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 54. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 29.99 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 229. \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 45. \text{ mm}$$

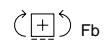
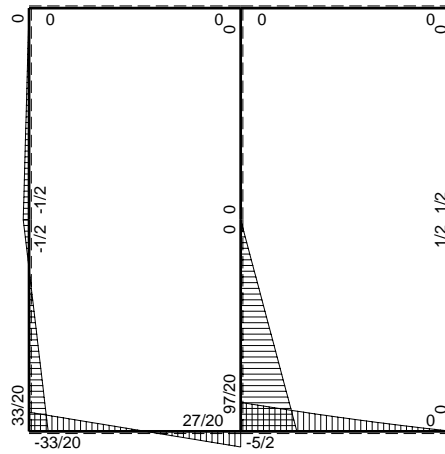
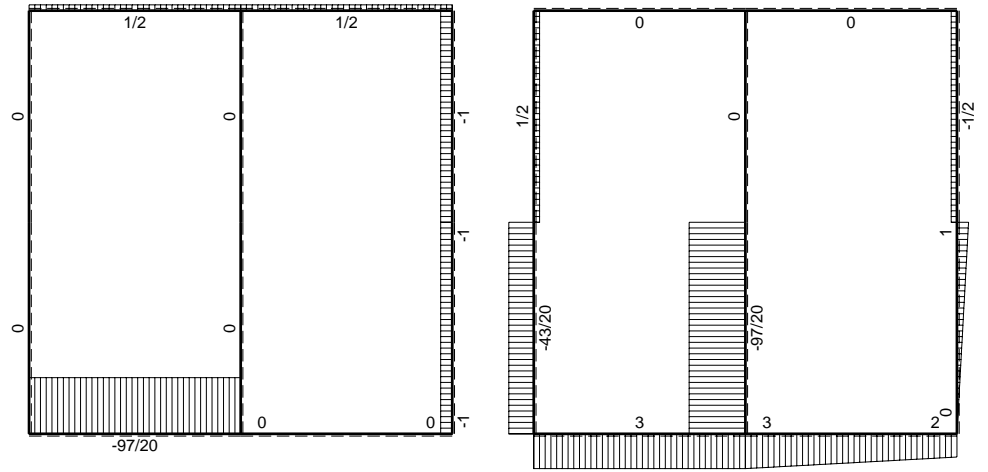
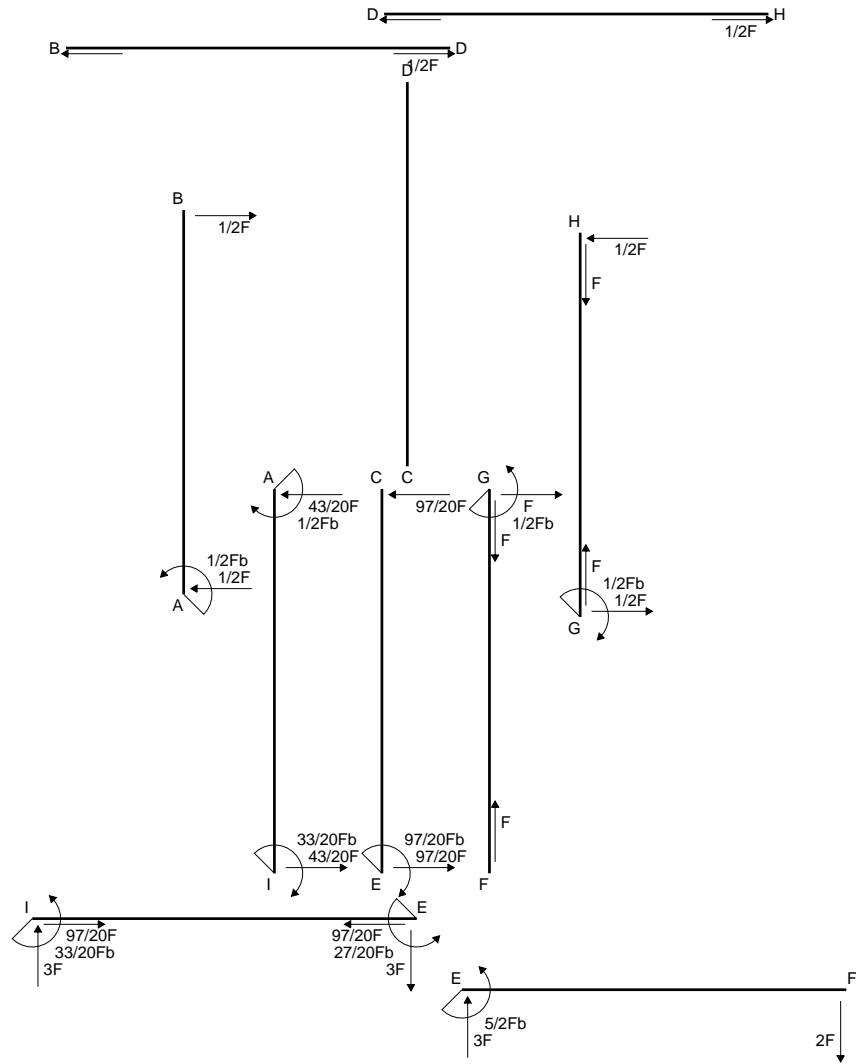
$$v_c = 20.99 \text{ mm}$$

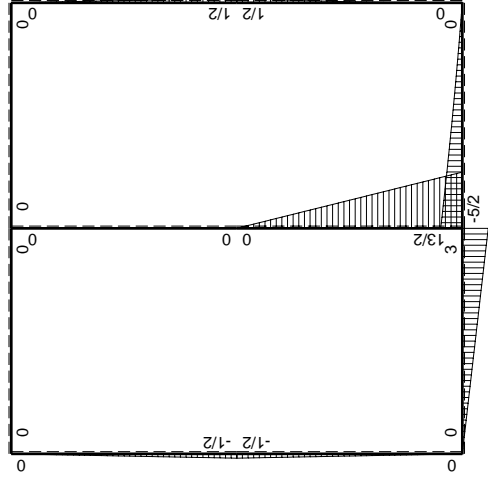
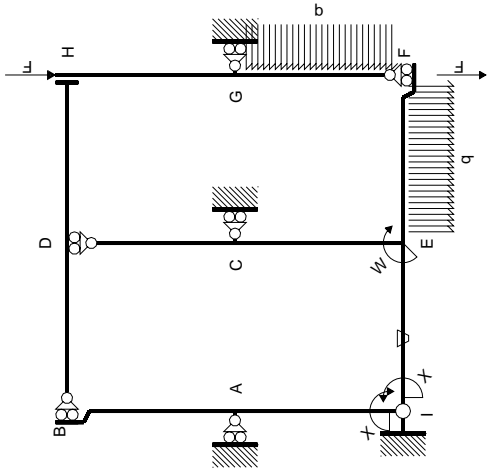
$$\sigma_c = -Mv/J_u = 160.3 \text{ N/mm}^2$$

$$\tau_c = 3.265 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 160.4 \text{ N/mm}^2$$

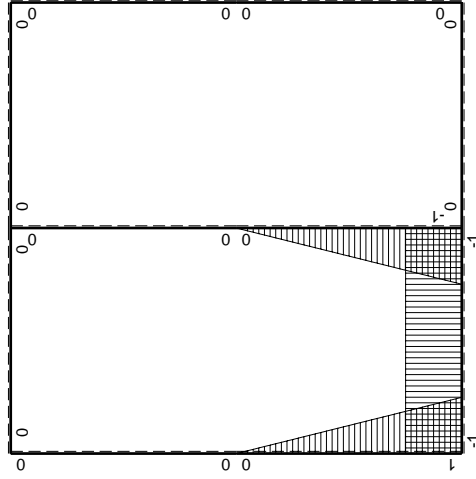
$$S = 4978. \text{ mm}^3$$





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$33/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

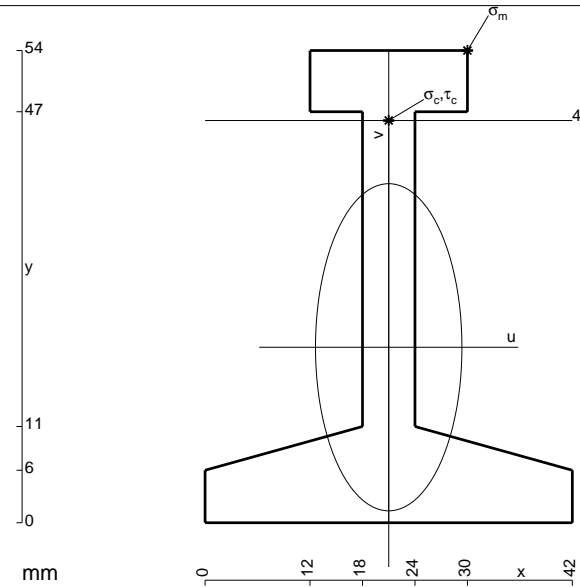
$$= (-13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

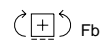
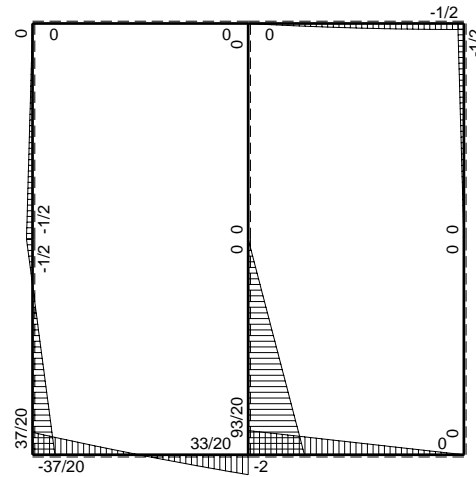
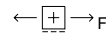
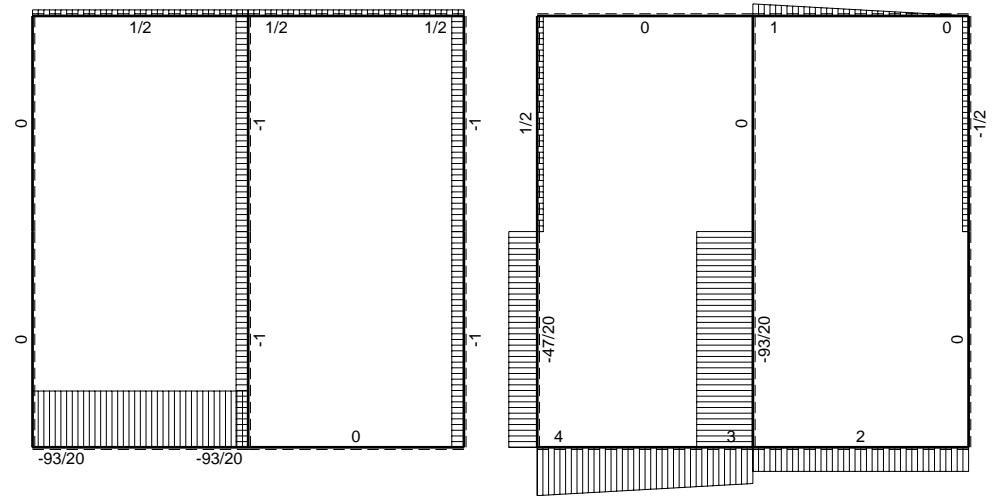
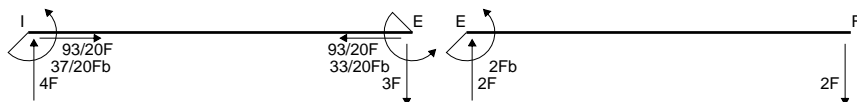
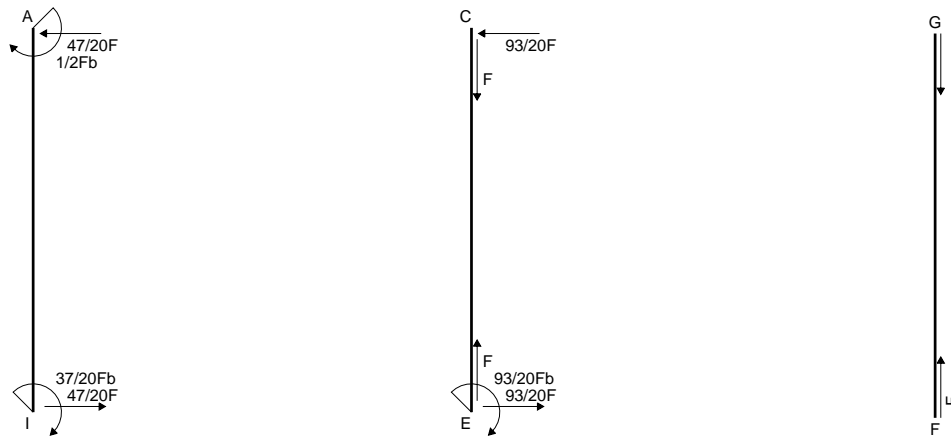
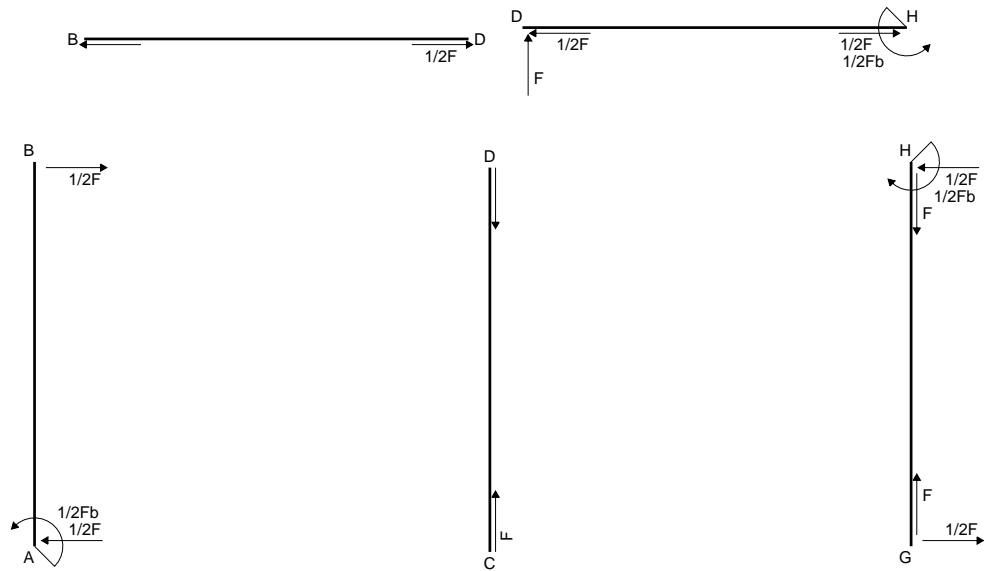
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

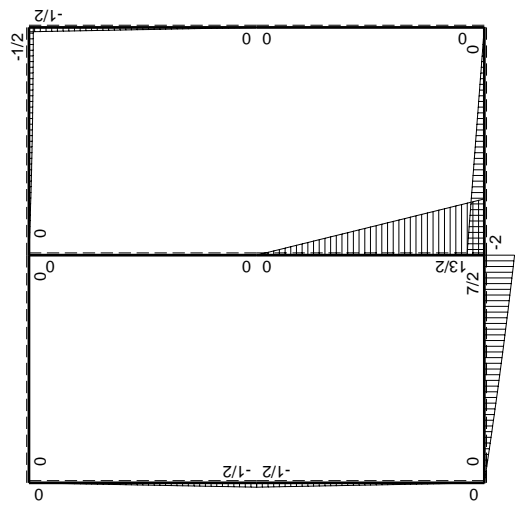
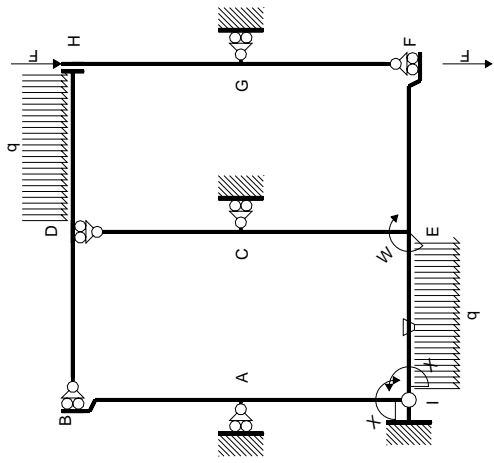
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



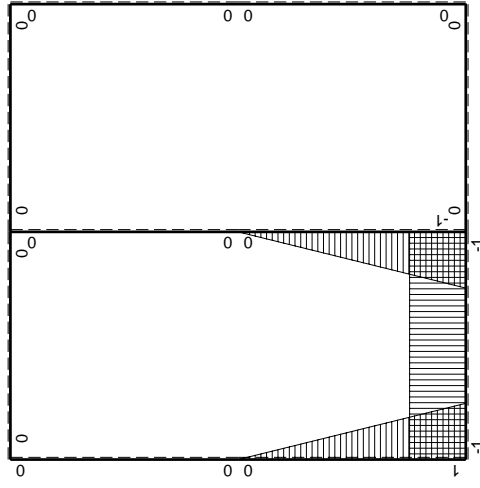
- A = 714. mm²
- J_u = 249976. mm⁴
- J_v = 50094. mm⁴
- y_g = 20.07 mm
- T_y = 2070. N
- M_x = -1759500. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 9. mm
- v_m = 33.93 mm
- σ_m = -Mv/J_u = 238.8 N/mm²
- x_c = 21. mm
- y_c = 46. mm
- v_c = 25.93 mm
- σ_c = -Mv/J_u = 182.5 N/mm²
- τ_c = 5.511 N/mm²
- σ_q = √σ²+3τ² = 182.8 N/mm²
- S = 3993. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0			
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
DH b	0	$Fx-1/2qx^2$	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-37/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$37/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{x\theta} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{x\theta} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{x\theta} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{CE}^{x\theta} = \int_0^b (-13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

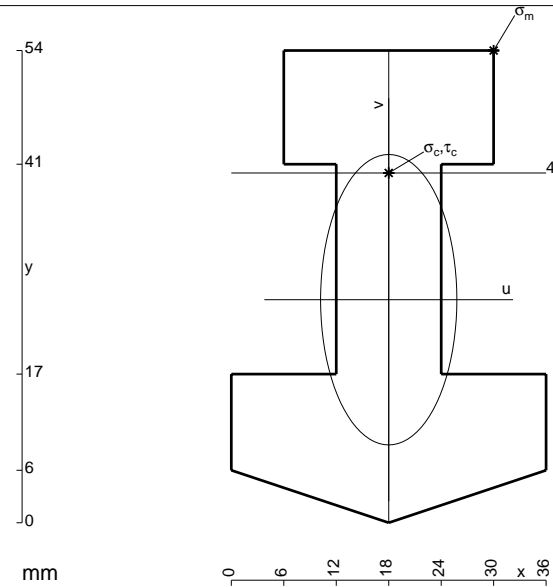
$$= (-13/6 b) Fb \frac{1}{EJ} = -13/6 Fb^2/EJ$$

$$L_{IA}^{x\theta} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

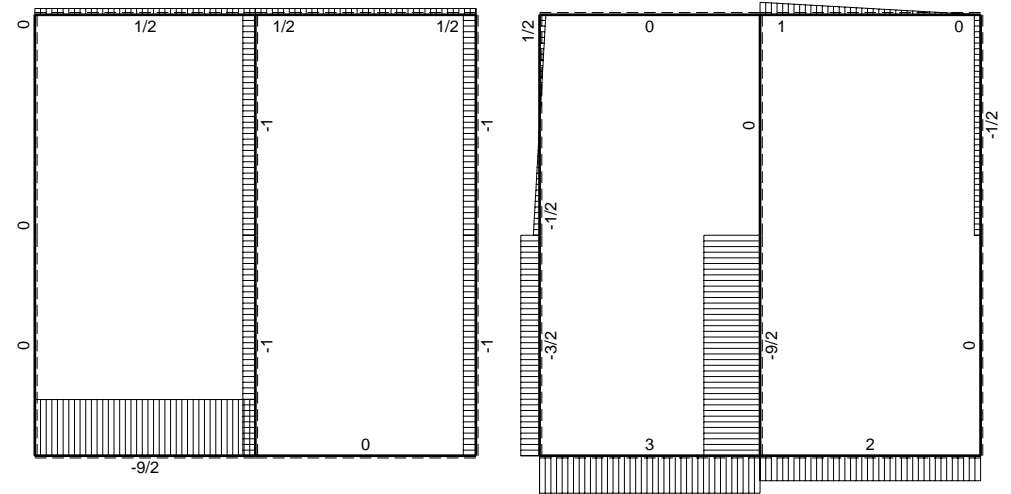
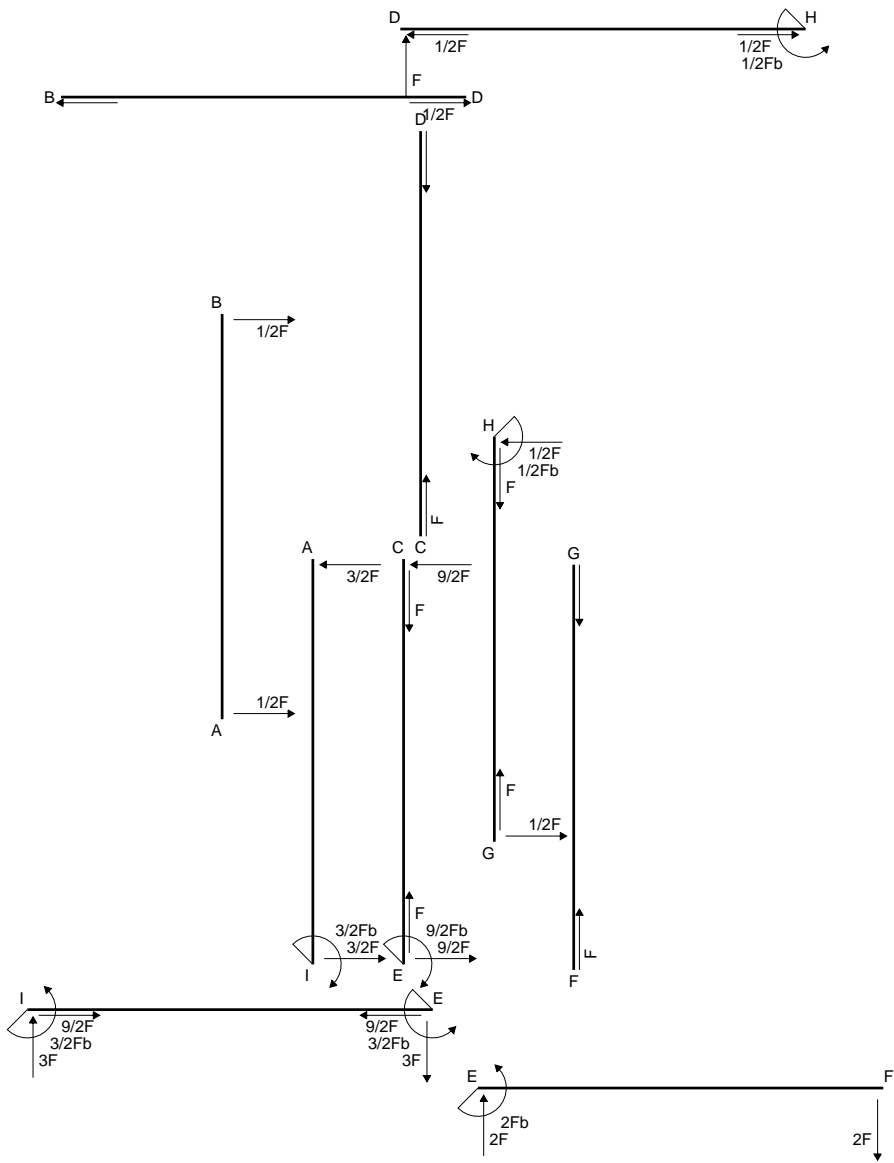
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{x\theta} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

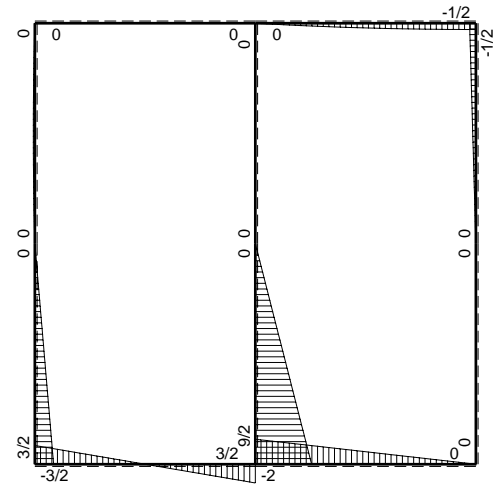


- A = 1104. mm²
- J_u = 304502. mm⁴
- J_v = 67032. mm⁴
- y_g = 25.51 mm
- T_y = 3940. N
- M_x = -2127600. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 28.49 mm
- σ_m = -M_v/J_u = 199.1 N/mm²
- x_c = 18. mm
- y_c = 40. mm
- v_c = 14.49 mm
- σ_c = -M_v/J_u = 101.3 N/mm²
- τ_c = 7.593 N/mm²
- σ_q = √σ² + 3τ² = 102.1 N/mm²
- S = 7042. mm³

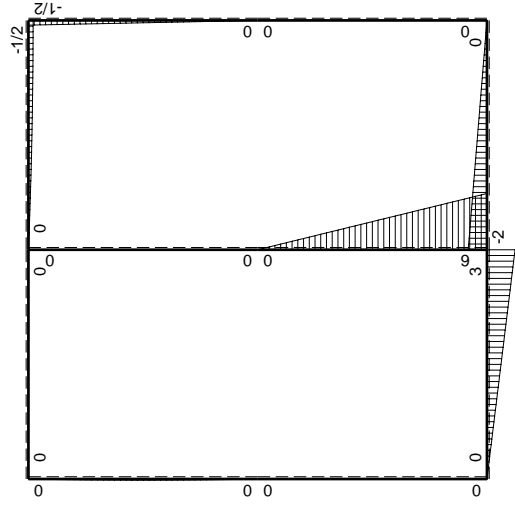
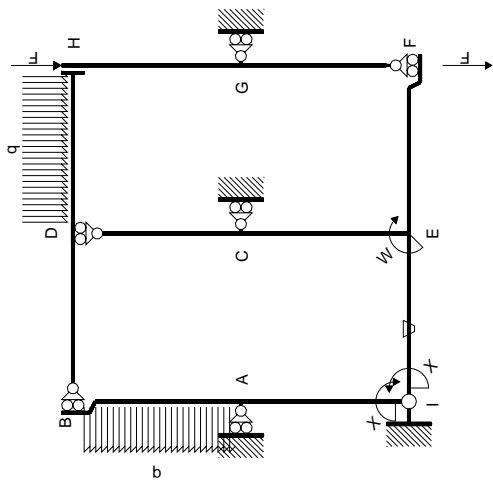


← ⊕ → F

↑ ⊕ ↓ F

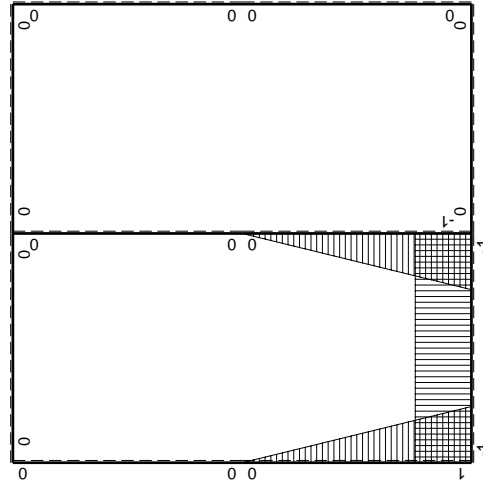


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

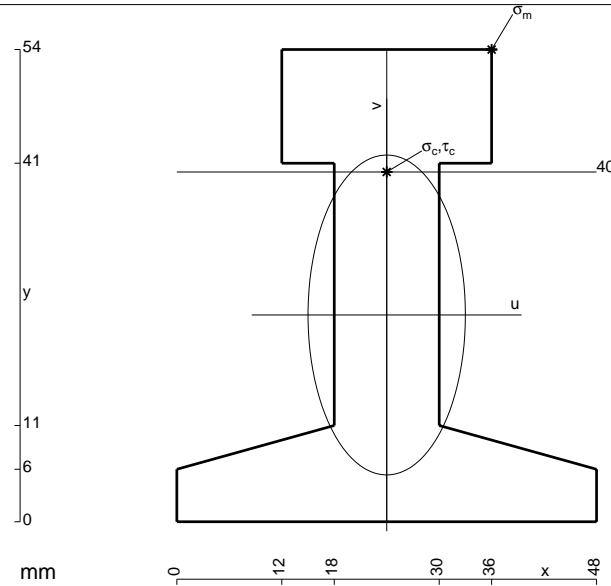
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb 1/EJ dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

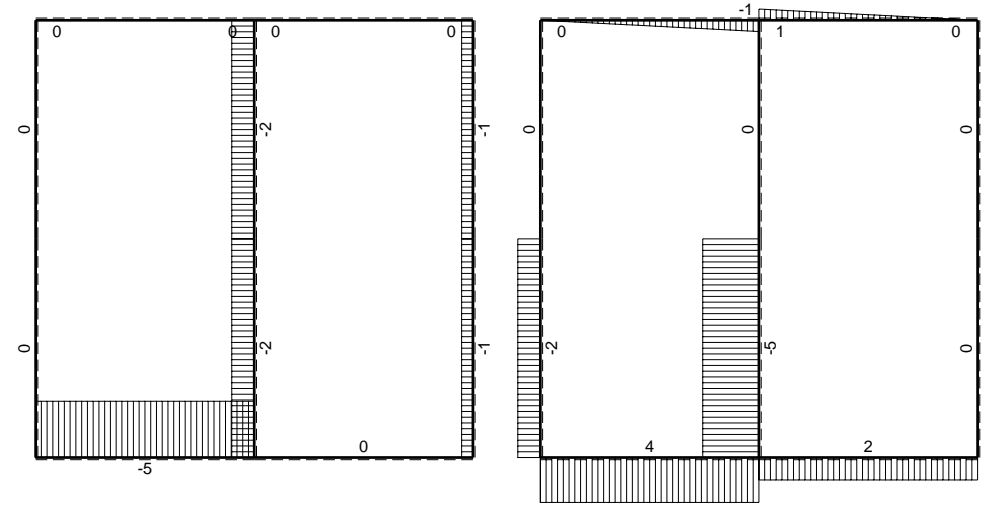
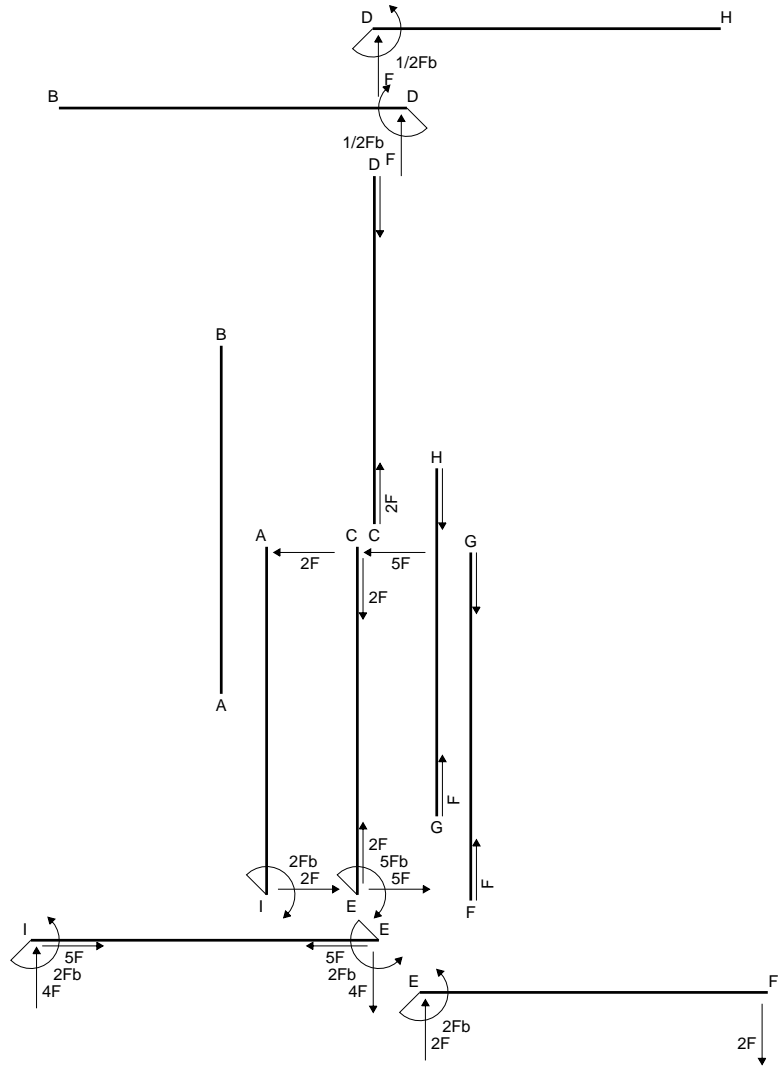
$$= (-6b + 6b - 2b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb 1/EJ dx = [-2x^3/b^2]_0^b Fb 1/EJ$$

$$= (-2b) Fb 1/EJ = -2 Fb^2/EJ$$

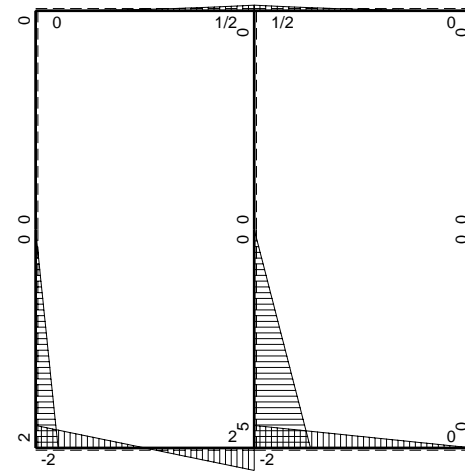


- A = 1110. mm²
- J_u = 371542. mm⁴
- J_v = 89892. mm⁴
- y_g = 23.64 mm
- T_y = 4340. N
- M_x = -2560600. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 30.36 mm
- σ_m = -Mv/J_u = 209.2 N/mm²
- x_c = 24. mm
- y_c = 40. mm
- v_c = 16.36 mm
- σ_c = -Mv/J_u = 112.7 N/mm²
- τ_c = 7.442 N/mm²
- σ_q = √σ²+3τ² = 113.5 N/mm²
- S = 7646. mm³

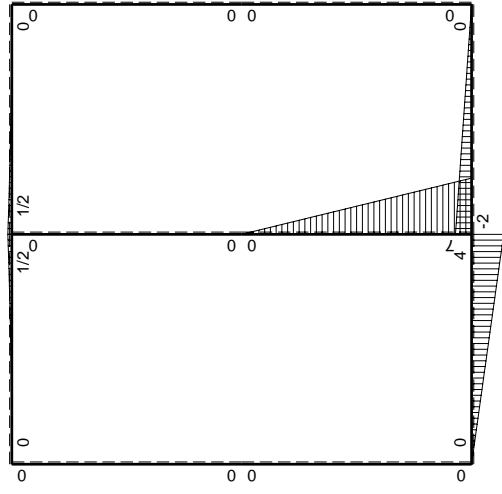
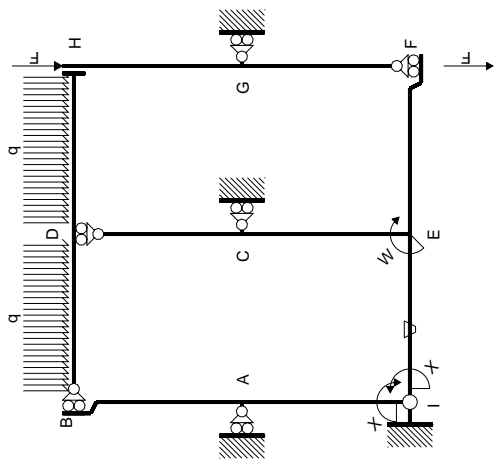


← (+) → F

↑ (+) ↓ F

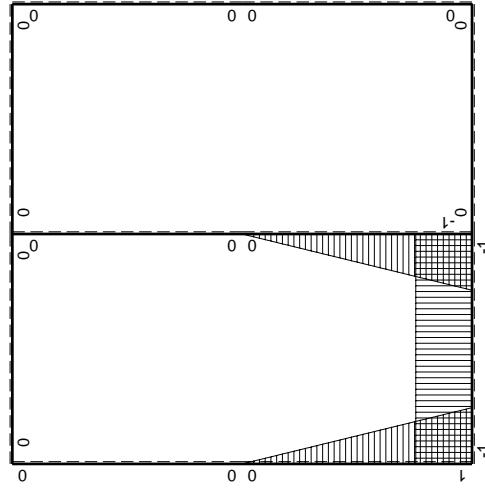


⊕ (+) ⊖ (-) F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	0	0	0	0	0	0+0	0	
BA b	0	0	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	0	0	0	0	0	0+0	0	
HG b	0	0	0	0	0	0			
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0	
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
BD b	0	$-1/2qx^2$	0	0	0	0			
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ	
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1			
EC b	$-1+x/b$	7Fb-7Fx	0	$-7Fb+14Fx-7Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/3+0)Fb^2/EJ$	1/3Xb/EJ	
CE b	x/b	-7Fx	0	$-7Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	1/3Xb/EJ	
AI b	$-x/b$	0	0	0	0	x^2/b^2			
	totali							$-10/3Fb^2/EJ$	5/3Xb/EJ
	iperstatica $X=W_{IE}$							2Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b) Fb 1/EJ + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-4 + 4x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

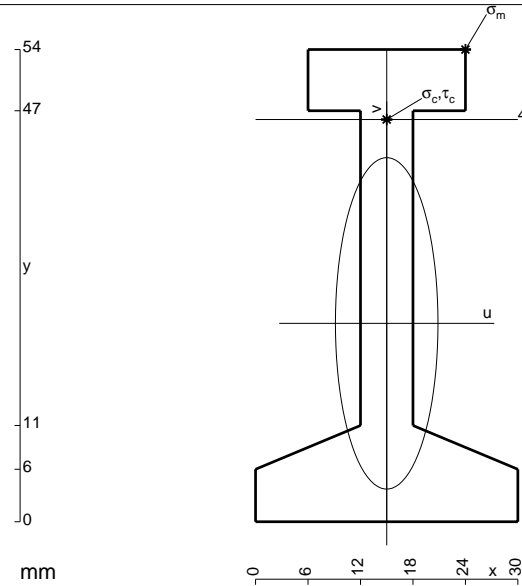
$$= (-4b + 2b) Fb 1/EJ + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-7 + 14x/b - 7x^2/b^2) Fb 1/EJ dx = [-7x + 7x^2/b - 7/3 x^3/b^2]_0^b Fb 1/EJ$$

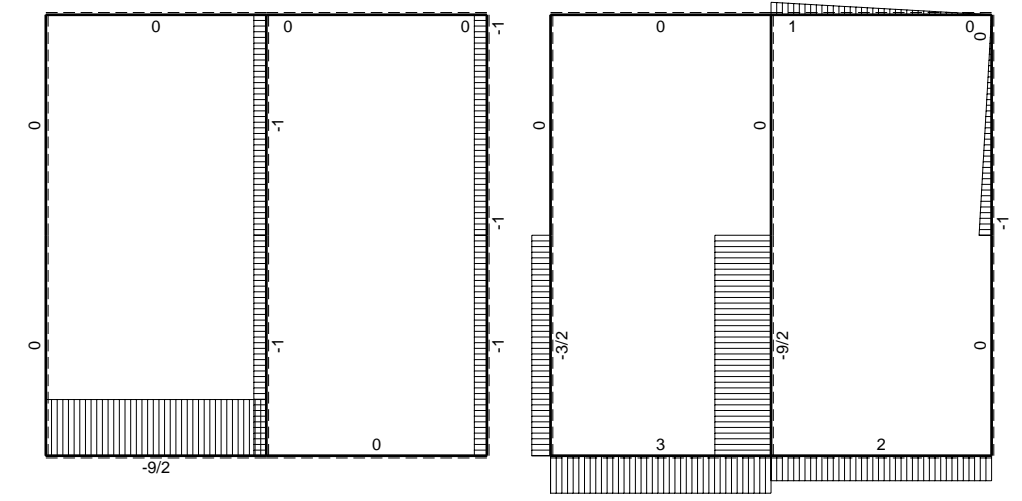
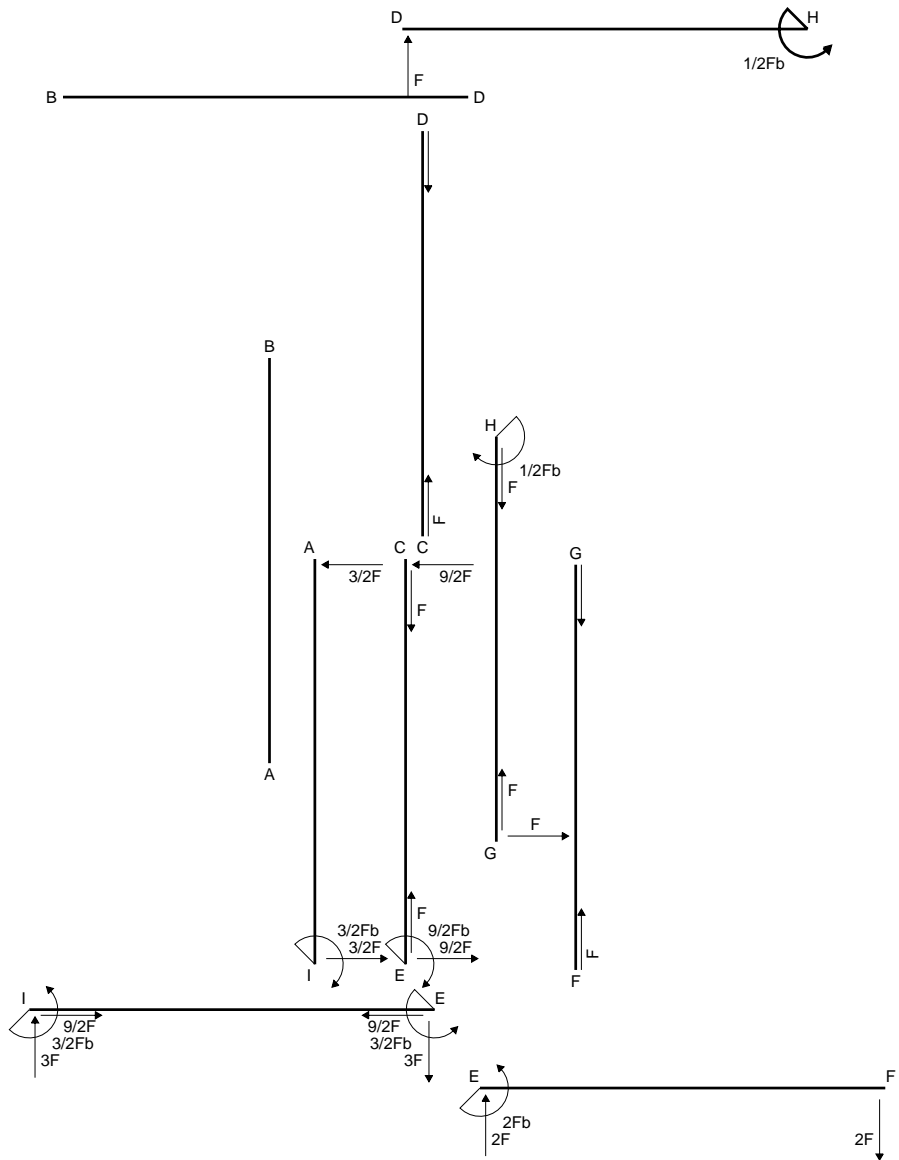
$$= (-7b + 7b - 7/3 b) Fb 1/EJ = -7/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-7x^2/b^2) Fb 1/EJ dx = [-7/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-7/3 b) Fb 1/EJ = -7/3 Fb^2/EJ$$

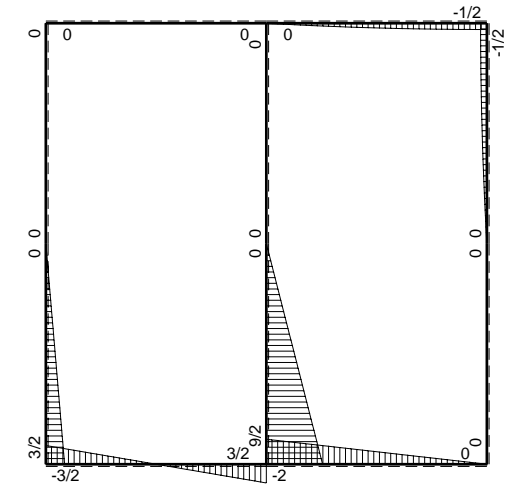


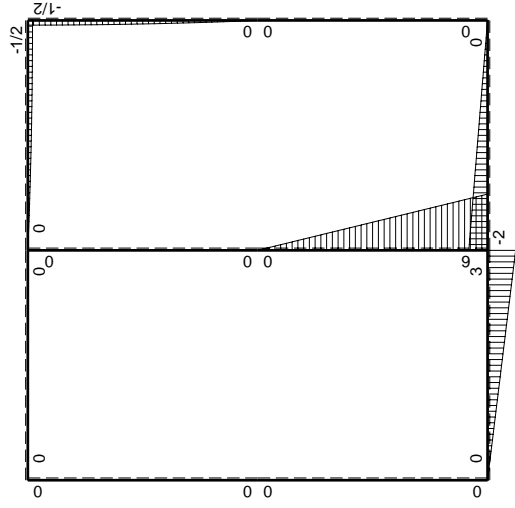
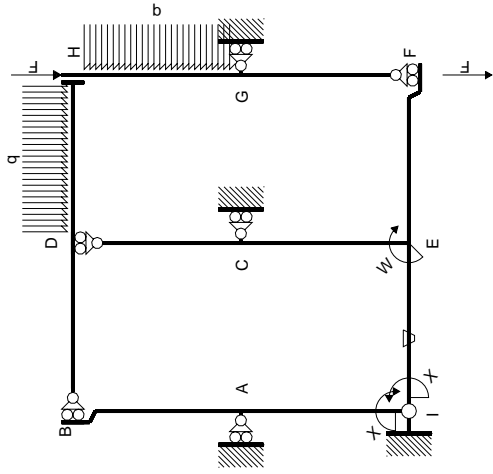
- A = 612. mm²
- J_u = 219945. mm⁴
- J_v = 21060. mm⁴
- y_g = 22.68 mm
- T_y = 2400. N
- M_x = -1536000. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 9. mm
- v_m = 31.32 mm
- σ_m = -Mv/J_u = 218.7 N/mm²
- x_c = 15. mm
- y_c = 46. mm
- v_c = 23.32 mm
- σ_c = -Mv/J_u = 162.8 N/mm²
- τ_c = 6.634 N/mm²
- σ_q = √σ²+3τ² = 163.2 N/mm²
- S = 3648. mm³



← ⊕ → F

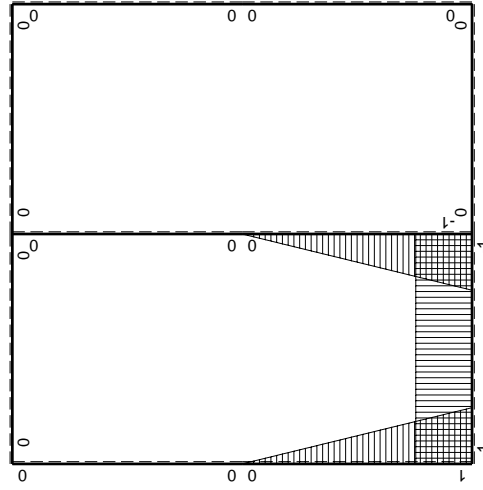
↑ ⊕ ↓ F





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-6Fx$	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

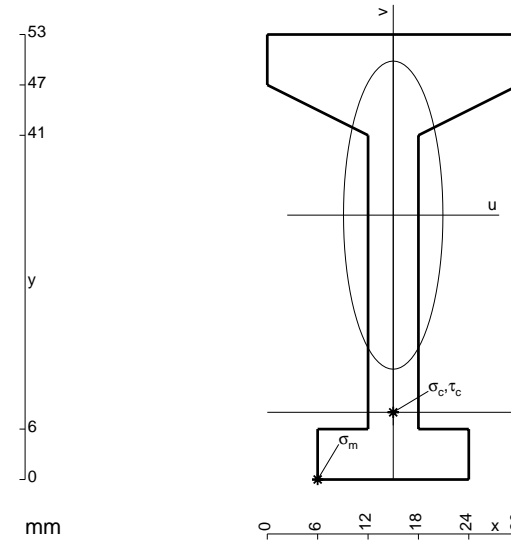
$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

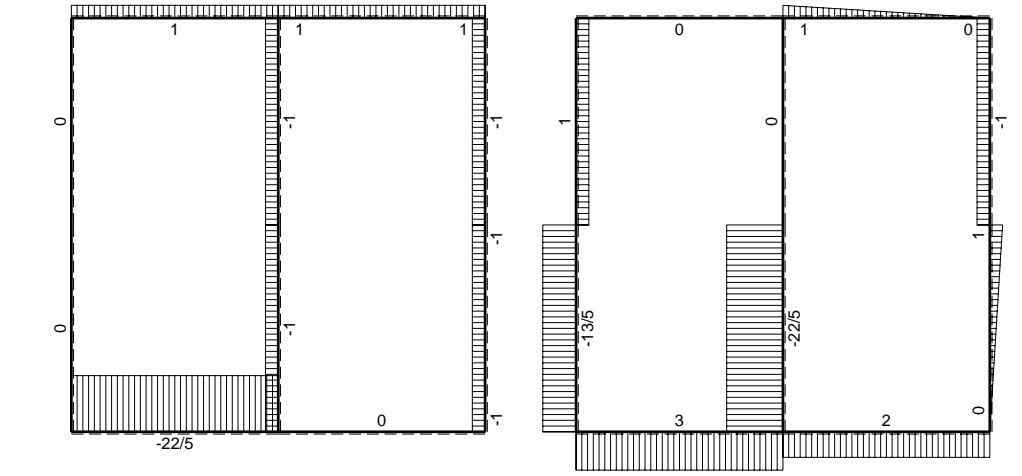
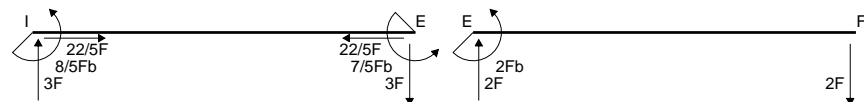
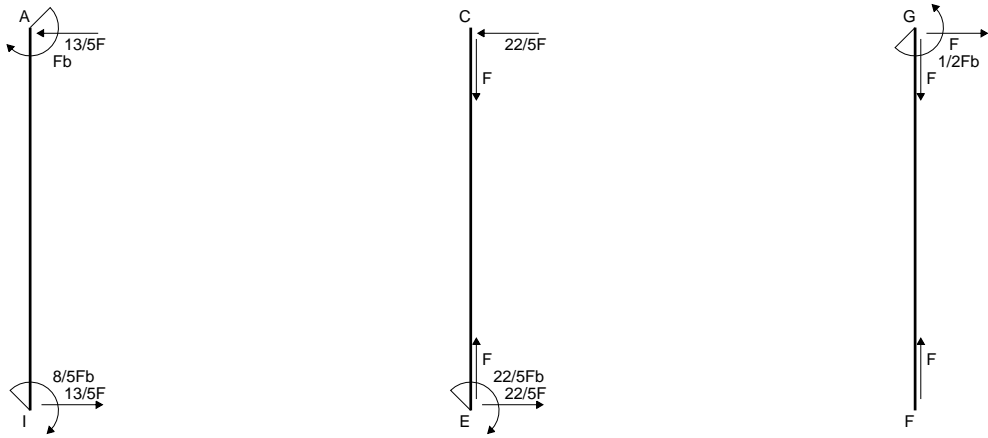
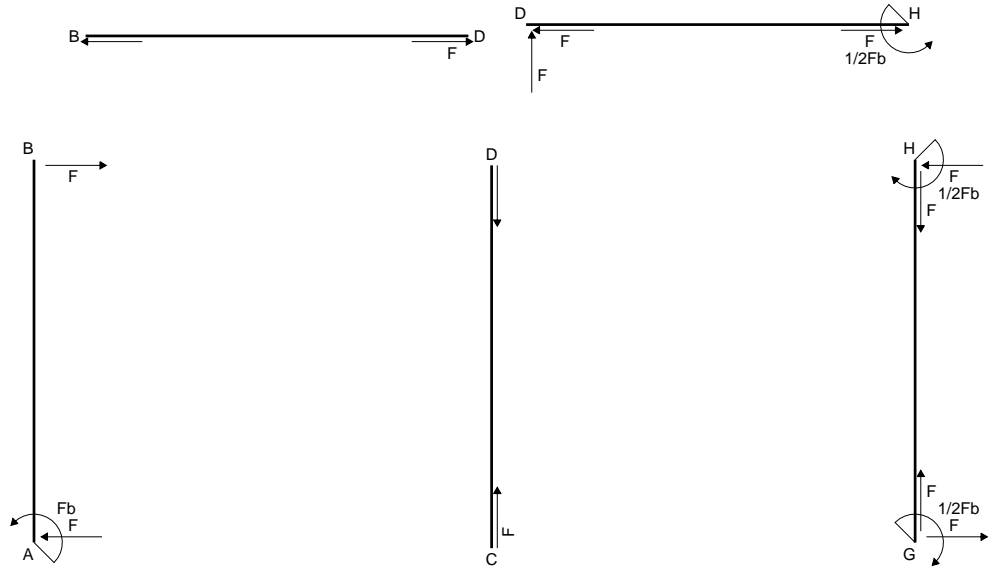
$$= (-6b + 6b - 2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb \frac{1}{EJ} dx = [-2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

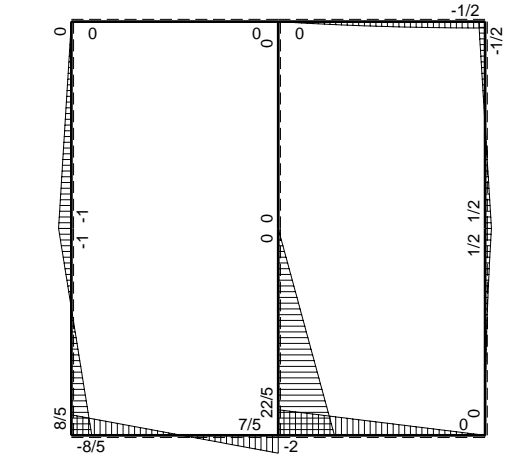


- A = 606. mm²
- J_u = 204068. mm⁴
- J_v = 21258. mm⁴
- y_g = 31.49 mm
- T_y = 2180. N
- M_x = -1482400. Nmm
- x_m = 6. mm
- u_m = -9. mm
- v_m = -31.49 mm
- σ_m = -Mv/J_u = -228.8 N/mm²
- x_c = 15. mm
- y_c = 8. mm
- v_c = -23.49 mm
- σ_c = -Mv/J_u = -170.6 N/mm²
- τ_c = 6.002 N/mm²
- σ_ρ = √(σ² + 3τ²) = 171. N/mm²
- S = 3371. mm³

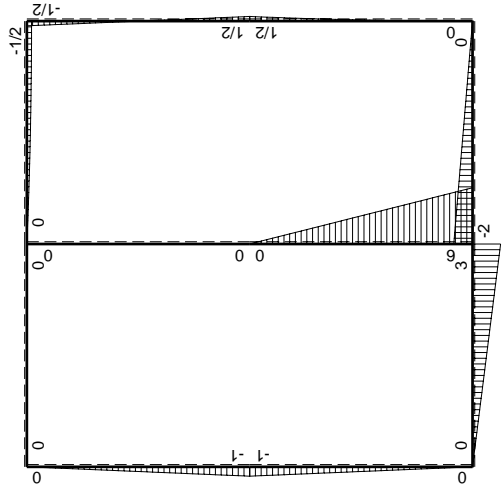
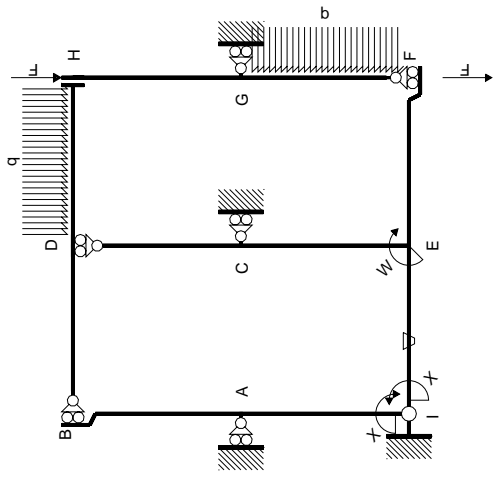


← ⊕ → F

↑ ⊕ ↓ F

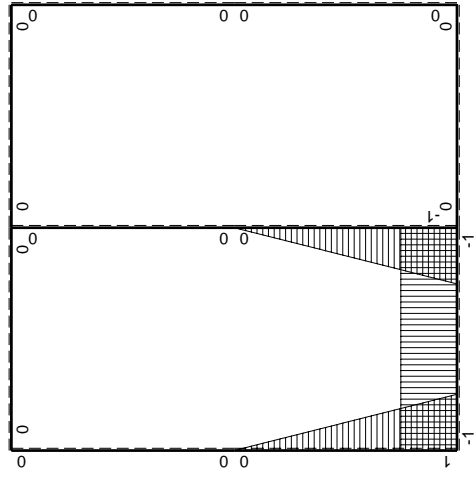


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-6Fx$	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-8/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$8/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-6b + 6b - 2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb \frac{1}{EJ} dx = [-2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

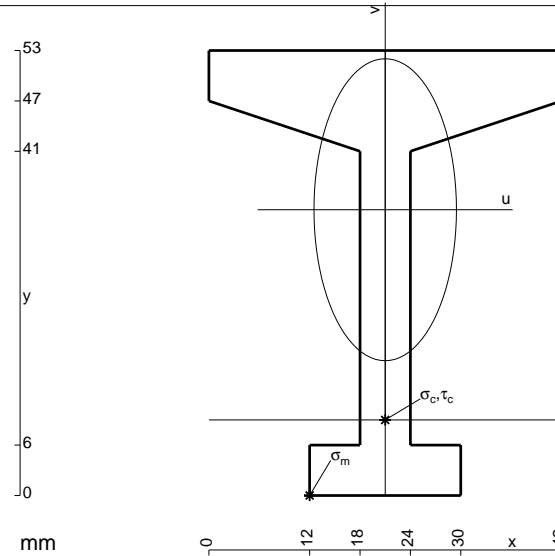
$$= (-2b) Fb \frac{1}{EJ} = -2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

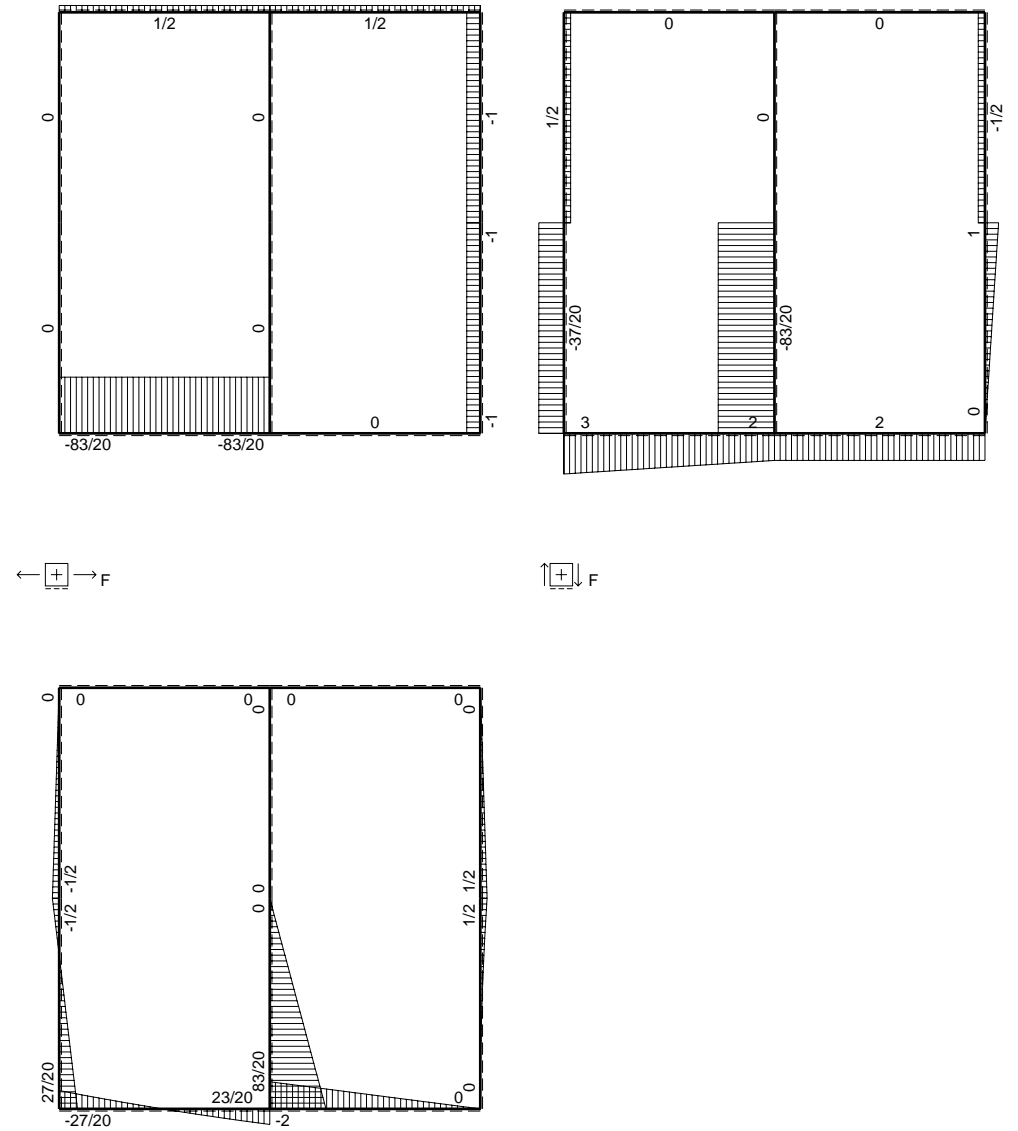
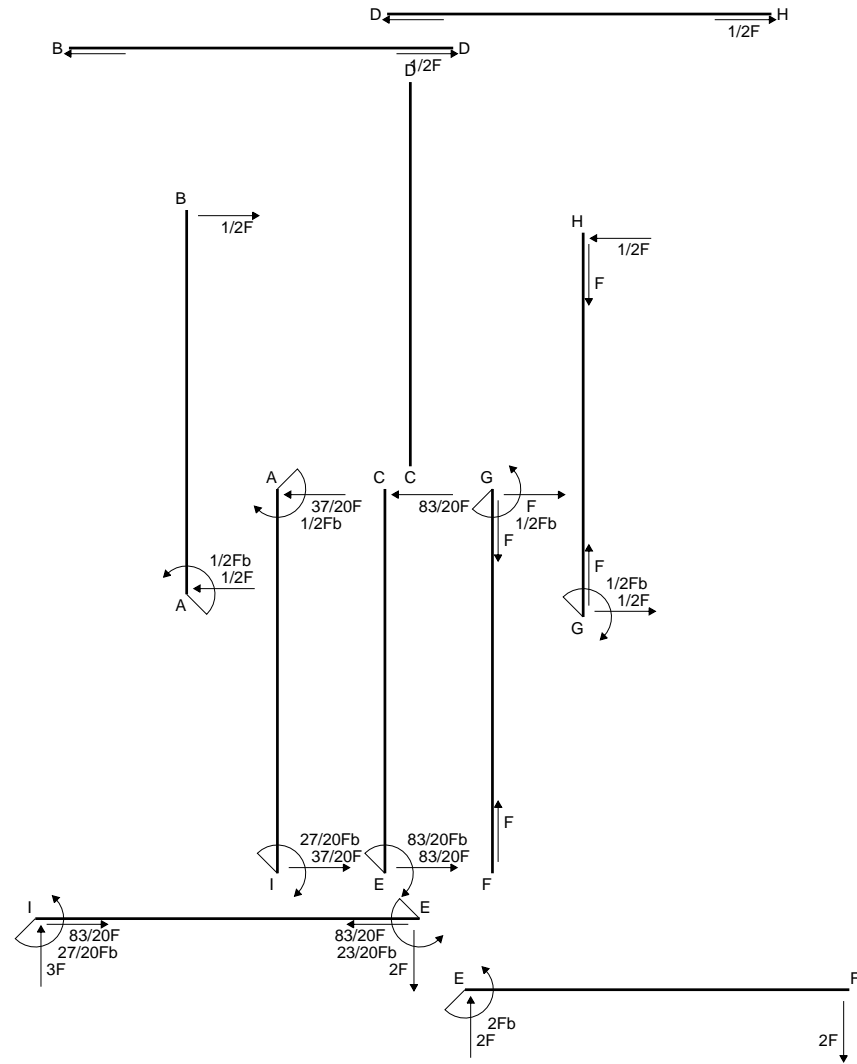
$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

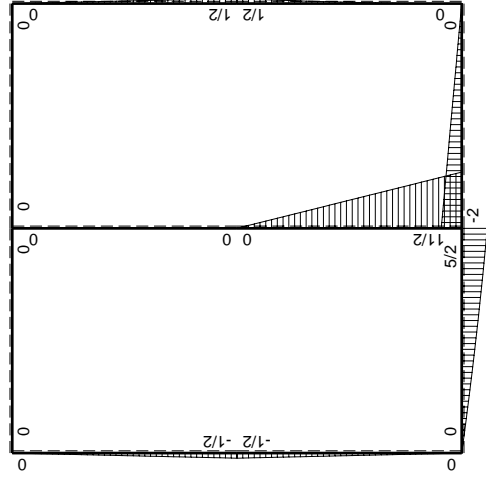
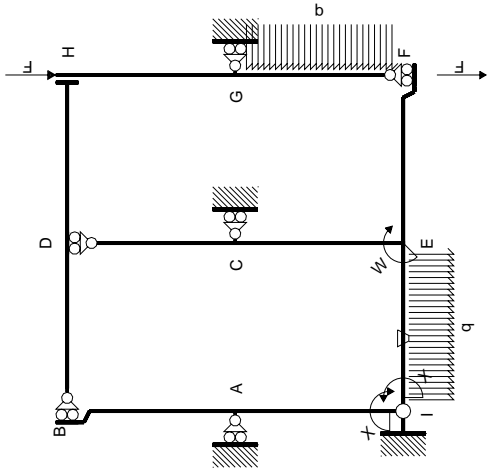
$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$



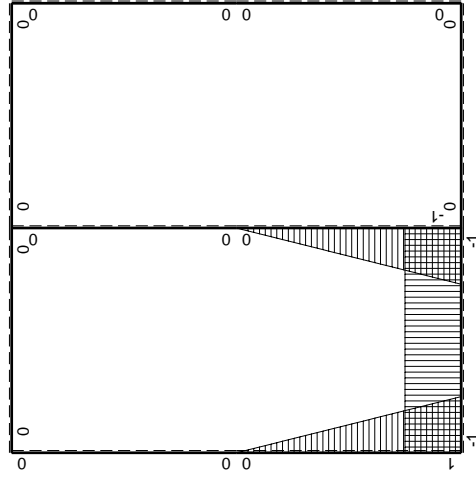
- A = 714. mm²
- J_u = 230961. mm⁴
- J_v = 51390. mm⁴
- y_g = 34.04 mm
- T_y = 2200. N
- M_x = -1628000. Nmm
- x_m = 12. mm
- u_m = -9. mm
- v_m = -34.04 mm
- σ_m = -Mv/J_u = -239.9 N/mm²
- x_c = 21. mm
- y_c = 9. mm
- v_c = -25.04 mm
- σ_c = -Mv/J_u = -176.5 N/mm²
- τ_c = 6.08 N/mm²
- σ_o = √σ²+3τ² = 176.8 N/mm²
- S = 3830. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fx$	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-9/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$27/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -1/3 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-5/2 + 2x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-5/2 b + b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -1/3 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

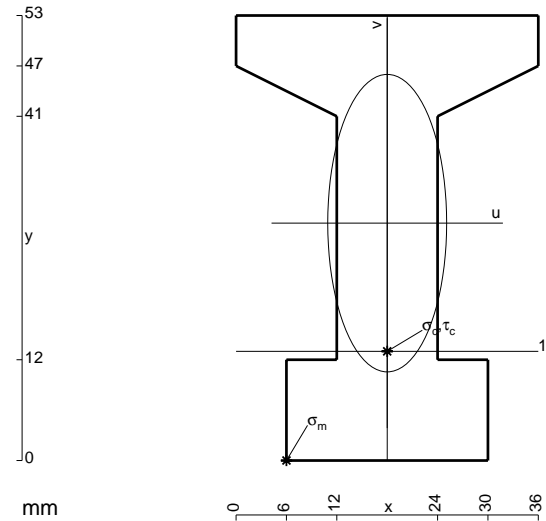
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

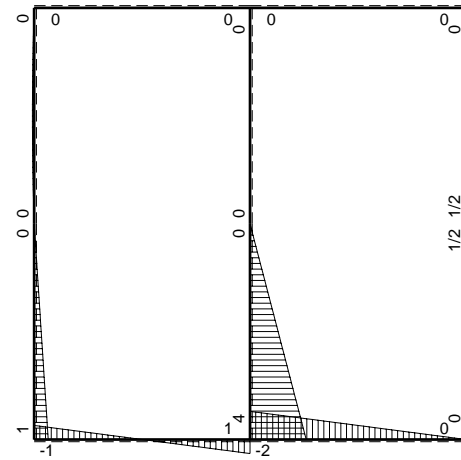
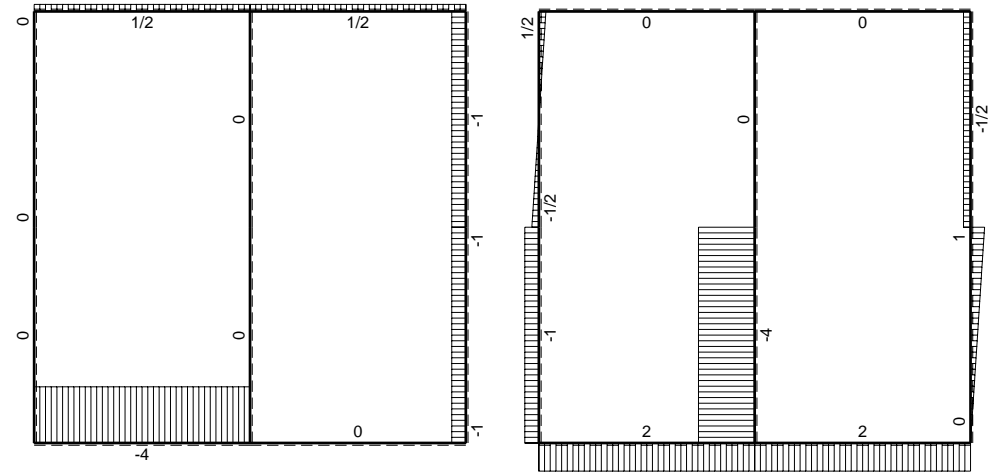
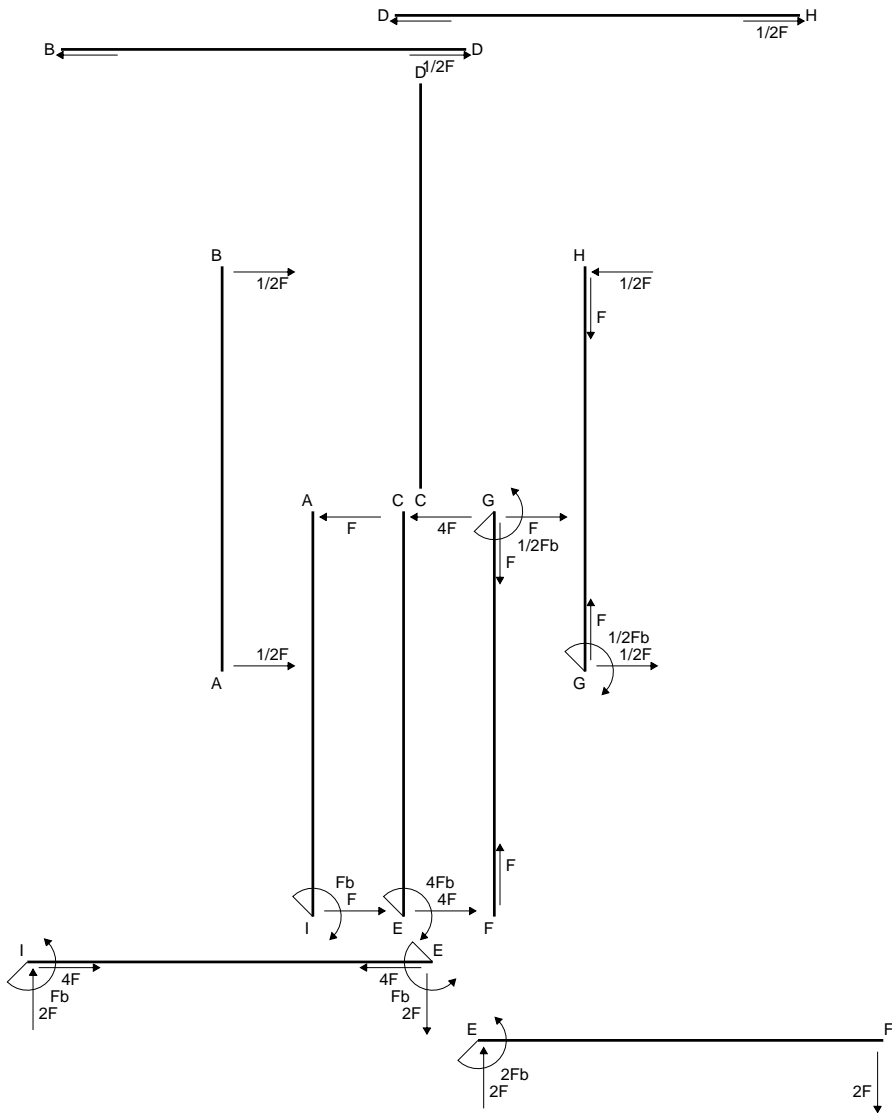
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

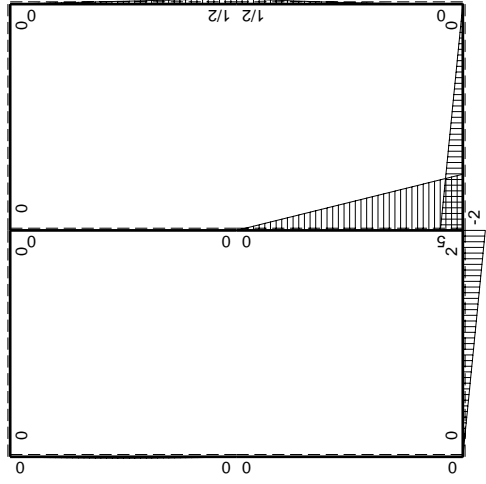
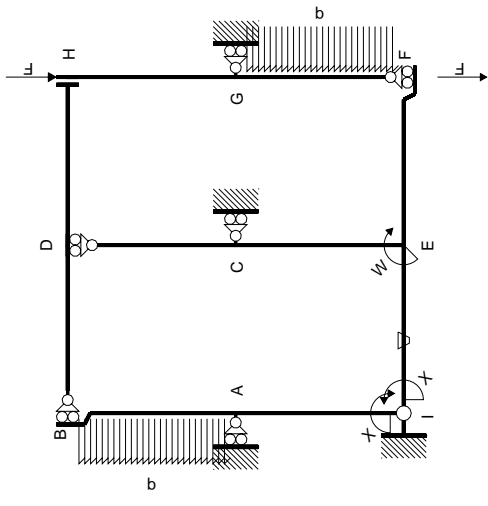
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



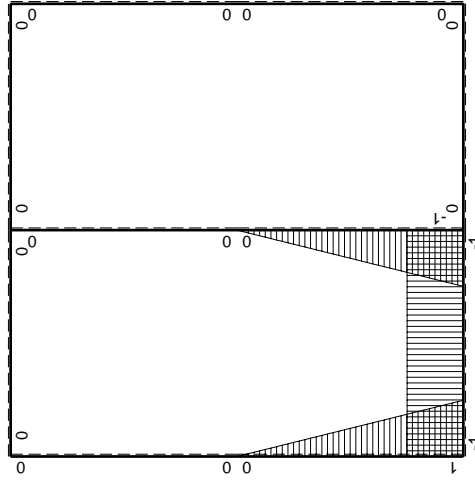
- A = 996. mm²
- J_u = 312739. mm⁴
- J_v = 49968. mm⁴
- y_g = 28.27 mm
- T_y = 2800. N
- M_x = -2212000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.27 mm
- σ_m = -Mv/J_u = -200. N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.27 mm
- σ_c = -Mv/J_u = -108. N/mm²
- τ_c = 4.927 N/mm²
- σ_o = √σ² + 3τ² = 108.3 N/mm²
- S = 6603. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fx$	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1			
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$	
AI b	$-x/b$	0	0	0	0	x^2/b^2			
	totali							$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

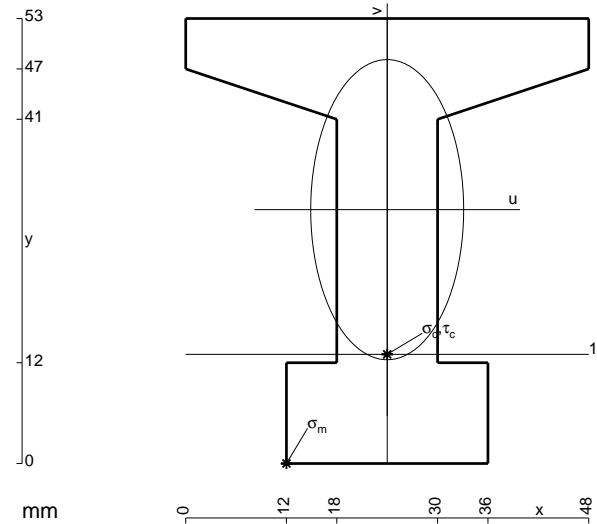
$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

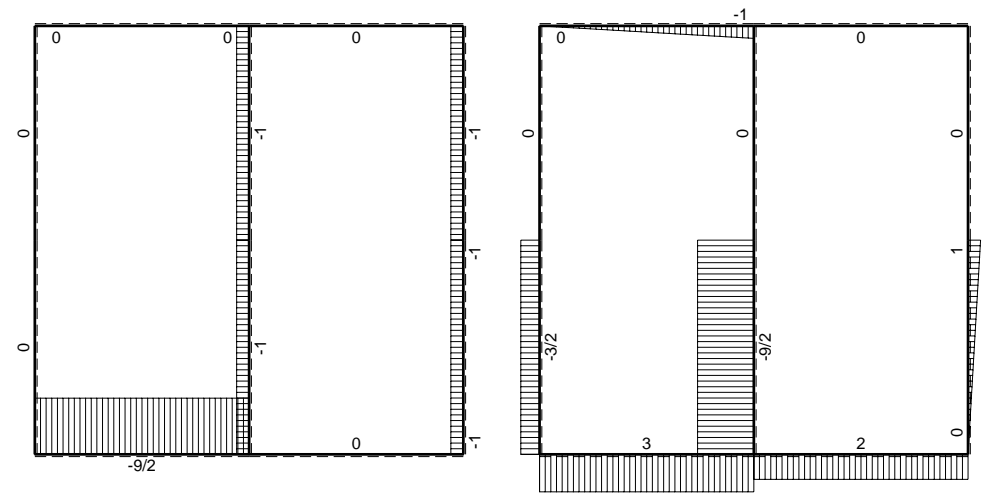
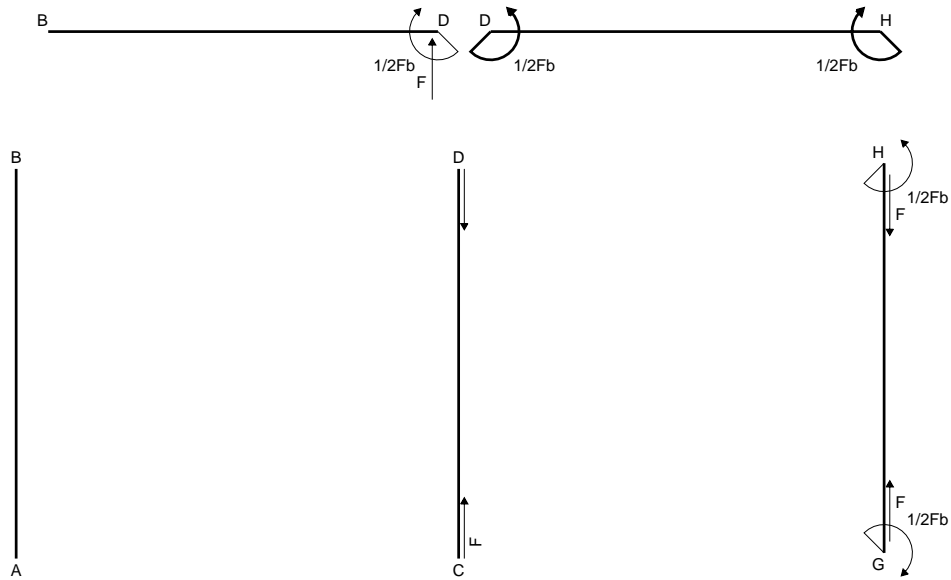
$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

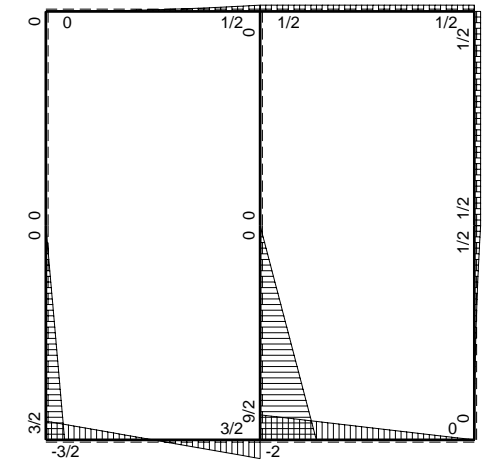
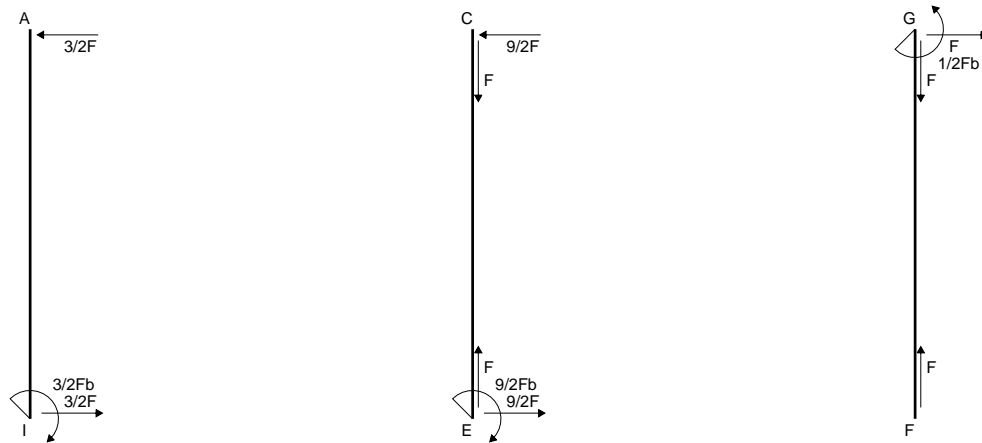


- A = 1104. mm²
- J_u = 352844. mm⁴
- J_v = 91656. mm⁴
- y_g = 30.23 mm
- T_y = 2900. N
- M_x = -2436000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.23 mm
- σ_m = -Mv/J_u = -208.7 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -17.23 mm
- σ_c = -Mv/J_u = -119. N/mm²
- τ_c = 4.926 N/mm²
- σ_o = √σ_c² + 3τ_c² = 119.3 N/mm²
- S = 7192. mm³

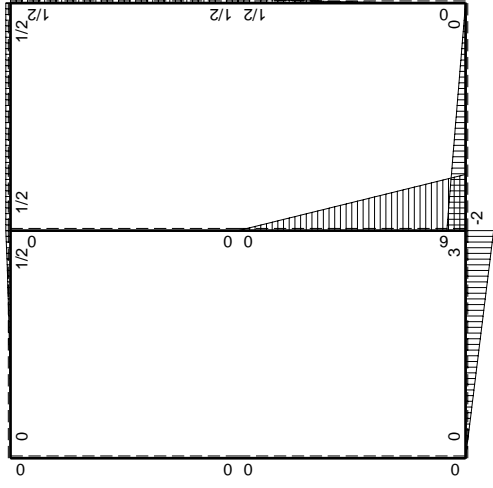
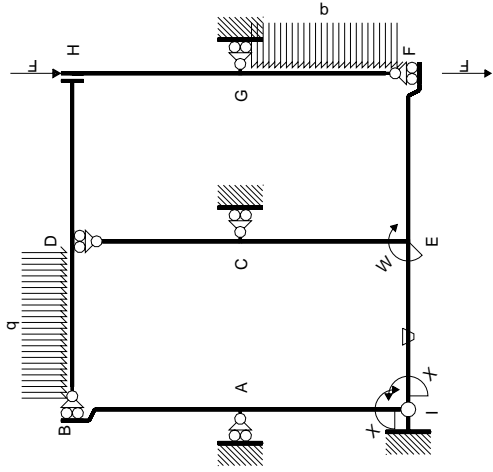


← ⊕ → F

↑ ⊕ ↓ F

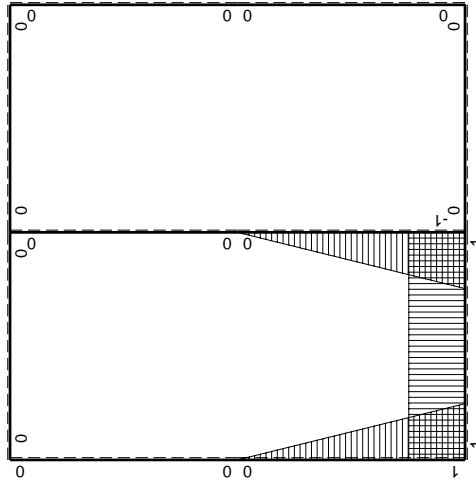


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	0	0	0	0	0	0+0	0	
BA b	0	0	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	1/2qx ²	0	0	0	0	0+0	0	
GF b	0	-1/2Fb+Fx-1/2qx ²	0	0	0	0			
GH b	0	1/2Fb	0	0	0	0	0+0	0	
HG b	0	-1/2Fb	0	0	0	0			
HD b	0	1/2Fb	0	0	0	0	0+0	0	
DH b	0	-1/2Fb	0	0	0	0			
DB b	0	1/2Fb-Fx+1/2qx ²	0	0	0	0	0+0	0	
BD b	0	-1/2qx ²	0	0	0	0			
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	(-3/2+1)Fb ² /EJ	Xb/EJ	
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1			
EC b	-1+x/b	6Fb-6Fx	0	-6Fb+12Fx-6Fx ² /b	0	1-2x/b+x ² /b ²	(-2+0)Fb ² /EJ	1/3Xb/EJ	
CE b	x/b	-6Fx	0	-6Fx ² /b	0	x ² /b ²			
IA b	1-x/b	0	0	0	0	1-2x/b+x ² /b ²	0+0	1/3Xb/EJ	
AI b	-x/b	0	0	0	0	x ² /b ²			
	totali							-5/2Fb ² /EJ	5/3Xb/EJ
	iperstatica $X=W_{IE}$							3/2Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

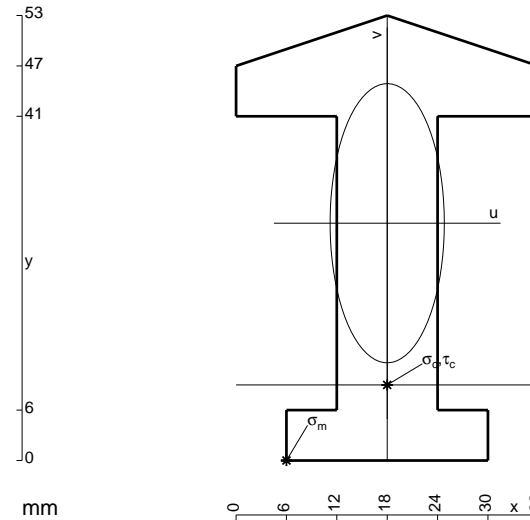
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb 1/EJ dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

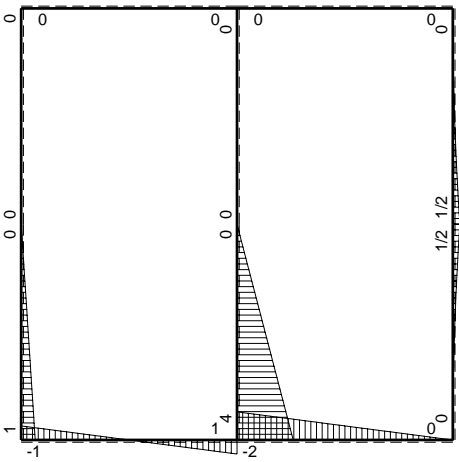
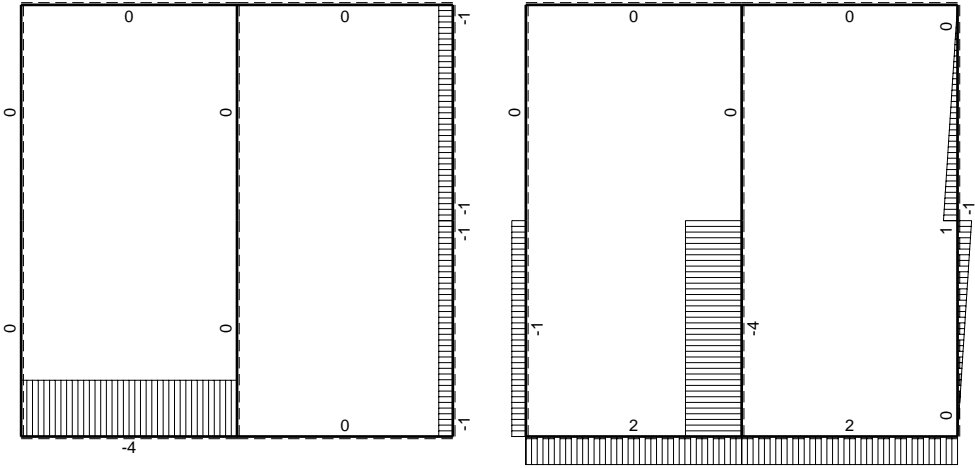
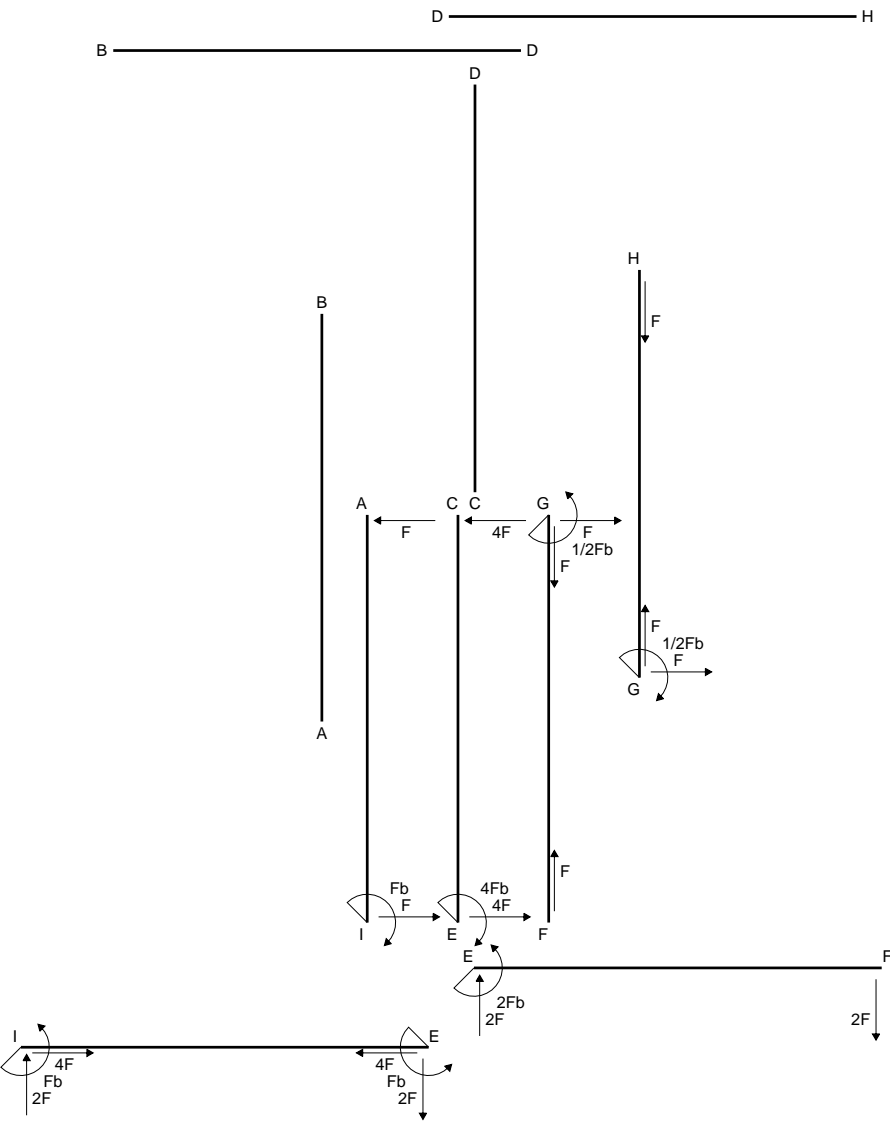
$$= (-6b + 6b - 2b) Fb 1/EJ = -2 Fb^2/EJ$$

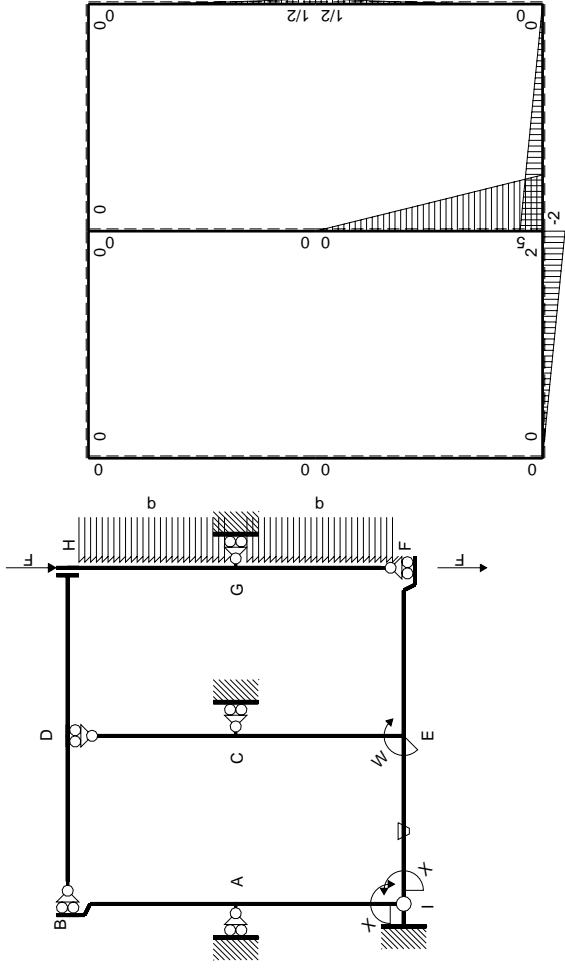
$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb 1/EJ dx = [-2x^3/b^2]_0^b Fb 1/EJ$$

$$= (-2b) Fb 1/EJ = -2 Fb^2/EJ$$



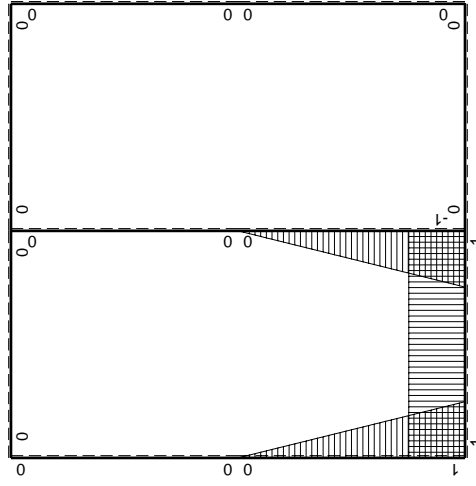
- A = 888. mm²
- J_u = 245538. mm⁴
- J_v = 41112. mm⁴
- y_g = 28.26 mm
- T_y = 2120. N
- M_x = -1908000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.26 mm
- σ_m = -Mv/J_u = -219.6 N/mm²
- x_c = 18. mm
- y_c = 9. mm
- v_c = -19.26 mm
- σ_c = -Mv/J_u = -149.7 N/mm²
- τ_c = 3.155 N/mm²
- σ_o = √σ²+3τ² = 149.8 N/mm²
- S = 4385. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	0	0	0	0	0	0+0	0	
BA b	0	0	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	1/2qx ²	0	0	0	0	0+0	0	
GF b	0	-1/2Fb+Fx-1/2qx ²	0	0	0	0			
GH b	0	1/2Fb-Fx+1/2qx ²	0	0	0	0	0+0	0	
HG b	0	-1/2qx ²	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	(-1+1)Fb ² /EJ	Xb/EJ	
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1			
EC b	-1+x/b	5Fb-5Fx	0	-5Fb+10Fx-5Fx ² /b	0	1-2x/b+x ² /b ²	(-5/3+0)Fb ² /EJ	1/3Xb/EJ	
CE b	x/b	-5Fx	0	-5Fx ² /b	0	x ² /b ²			
IA b	1-x/b	0	0	0	0	1-2x/b+x ² /b ²	0+0	1/3Xb/EJ	
AI b	-x/b	0	0	0	0	x ² /b ²			
	totali							-5/3Fb ² /EJ	5/3Xb/EJ
	iperstatica $X=W_{IE}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

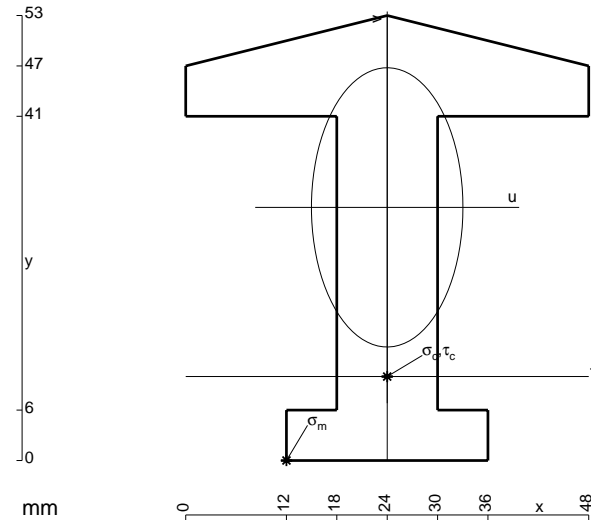
$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$



$$A = 996. \text{ mm}^2$$

$$J_u = 275589. \text{ mm}^4$$

$$J_v = 81072. \text{ mm}^4$$

$$y_g = 30.15 \text{ mm}$$

$$T_y = 2200. \text{ N}$$

$$M_x = -2090000. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -30.15 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -228.7 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 10. \text{ mm}$$

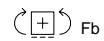
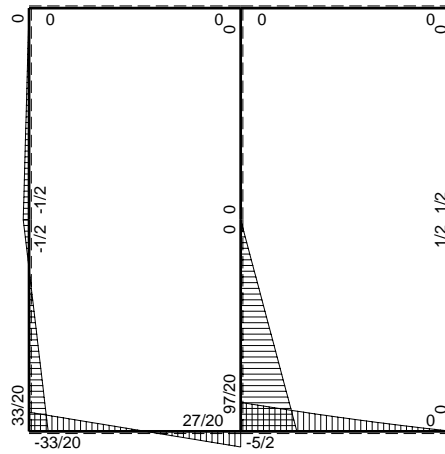
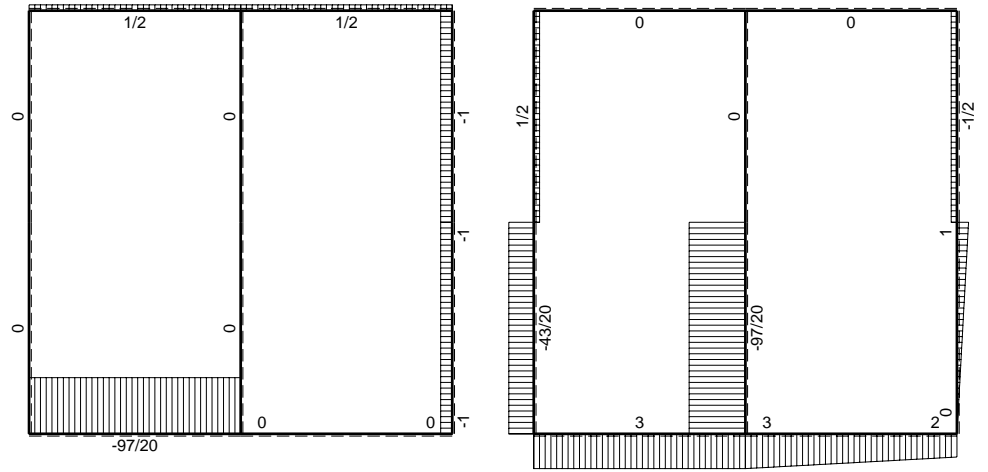
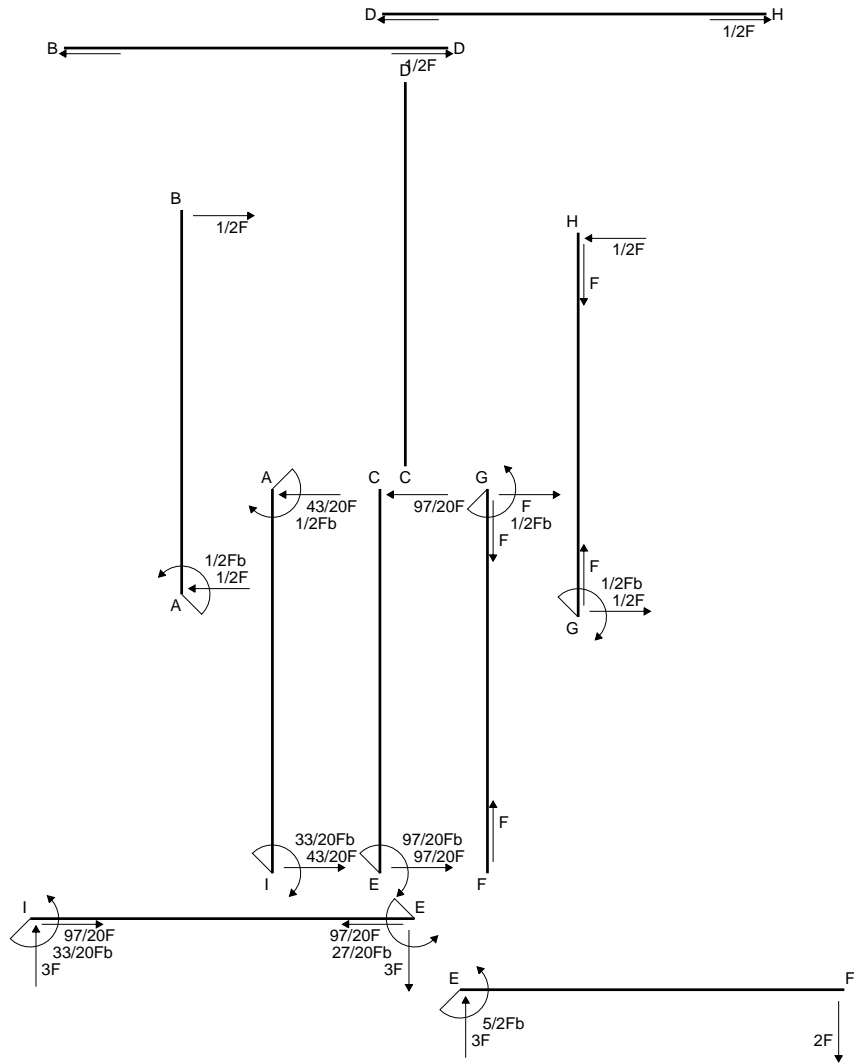
$$v_c = -20.15 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -152.8 \text{ N/mm}^2$$

$$\tau_c = 3.308 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 152.9 \text{ N/mm}^2$$

$$S = 4973. \text{ mm}^3$$



Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$33/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb 1/EJ dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-13/2 x^2/b^2) Fb 1/EJ dx = [-13/6 x^3/b^2]_0^b Fb 1/EJ$$

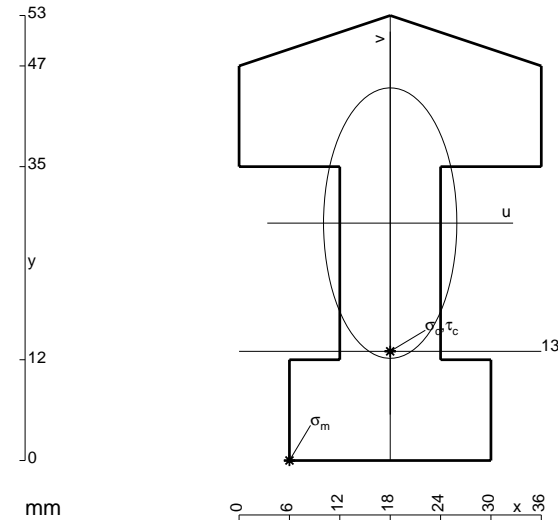
$$= (-13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

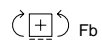
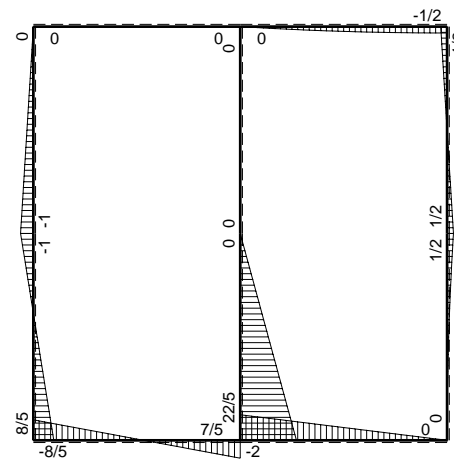
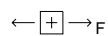
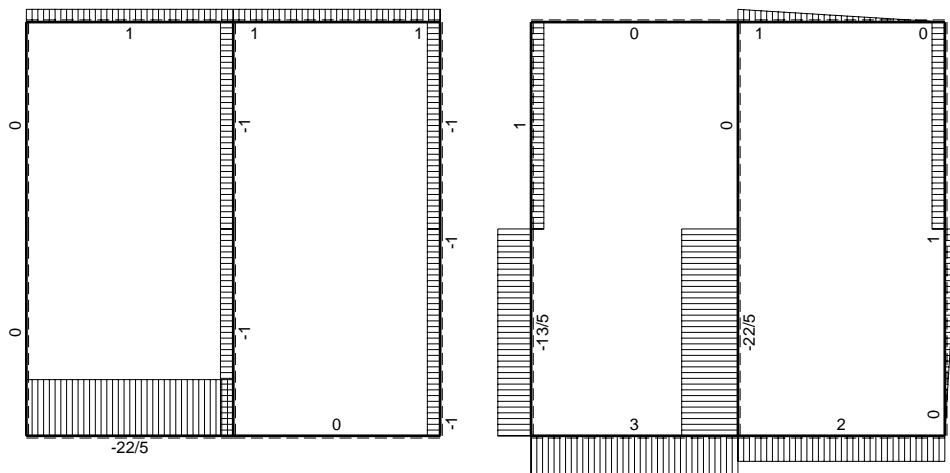
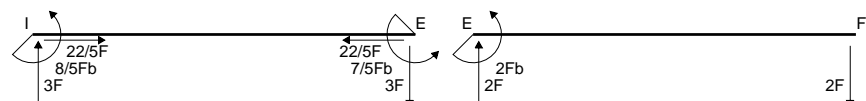
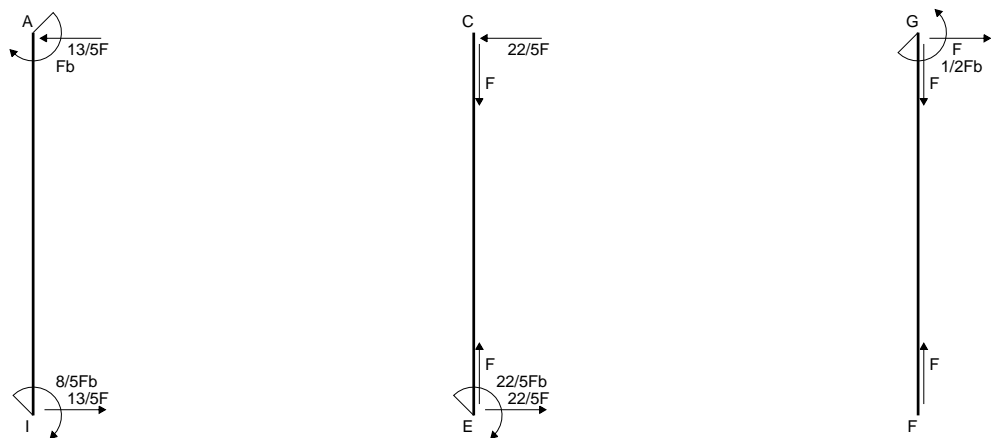
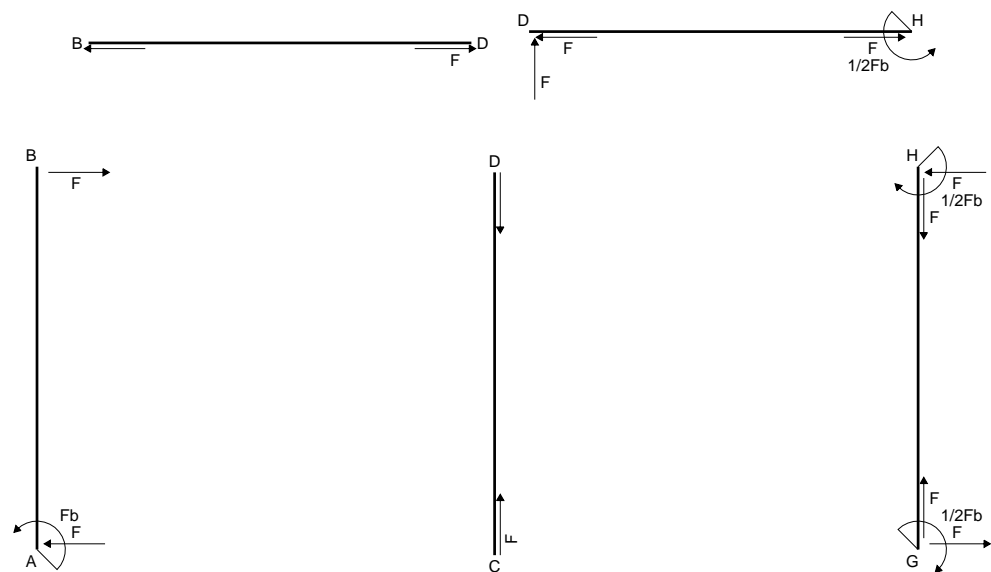
$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

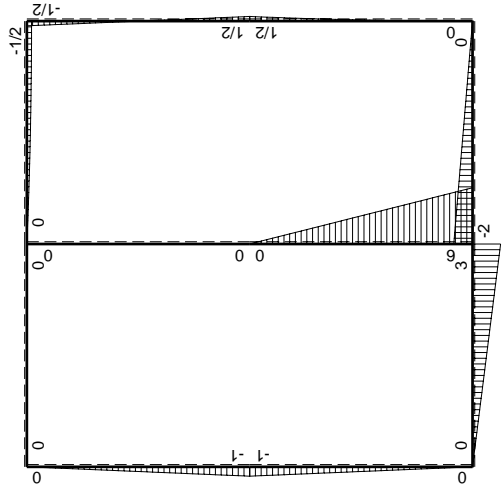
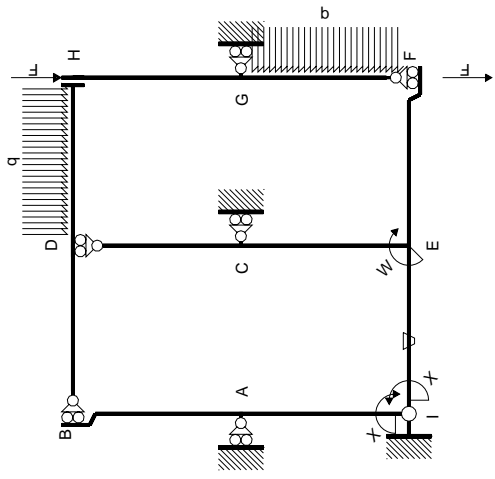
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$



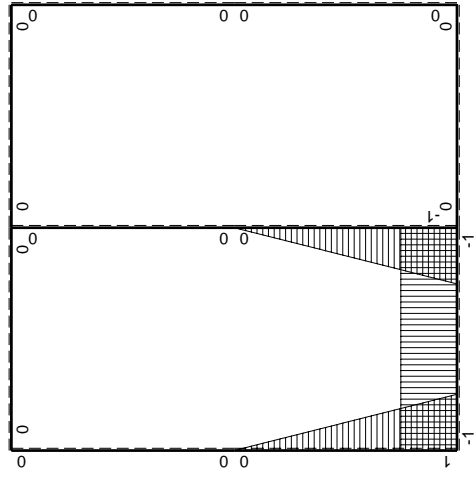
- A = 1104. mm²
- J_u = 286555. mm⁴
- J_v = 69624. mm⁴
- y_g = 28.28 mm
- T_y = 2910. N
- M_x = -2425000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.28 mm
- σ_m = -Mv/J_u = -239.3 N/mm²
- x_c = 18. mm
- y_c = 13. mm
- v_c = -15.28 mm
- σ_c = -Mv/J_u = -129.3 N/mm²
- τ_c = 5.59 N/mm²
- σ_o = √σ_c² + 3τ_c² = 129.6 N/mm²
- S = 6605. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	-Fb+Fx	0	0	0	0	0+0	0	
BA b	0	Fx	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
GH b	0	$1/2Fb-Fx$	0	0	0	0	0+0	0	
HG b	0	$1/2Fb-Fx$	0	0	0	0			
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
DH b	0	$Fx-1/2qx^2$	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ	
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1			
EC b	$-1+x/b$	6Fb-6Fx	0	$-6Fb+12Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	-6Fx	0	$-6Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2			
	totali							$-8/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$8/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 12x/b - 6x^2/b^2) Fb 1/EJ dx = [-6x + 6x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

$$= (-6b + 6b - 2b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-6x^2/b^2) Fb 1/EJ dx = [-2x^3/b^2]_0^b Fb 1/EJ$$

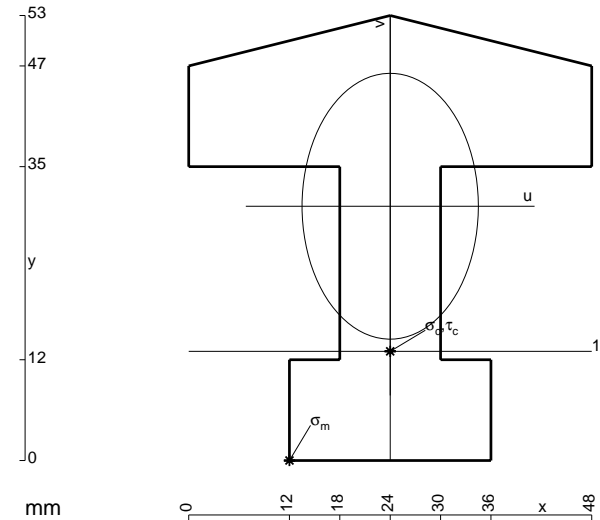
$$= (-2b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

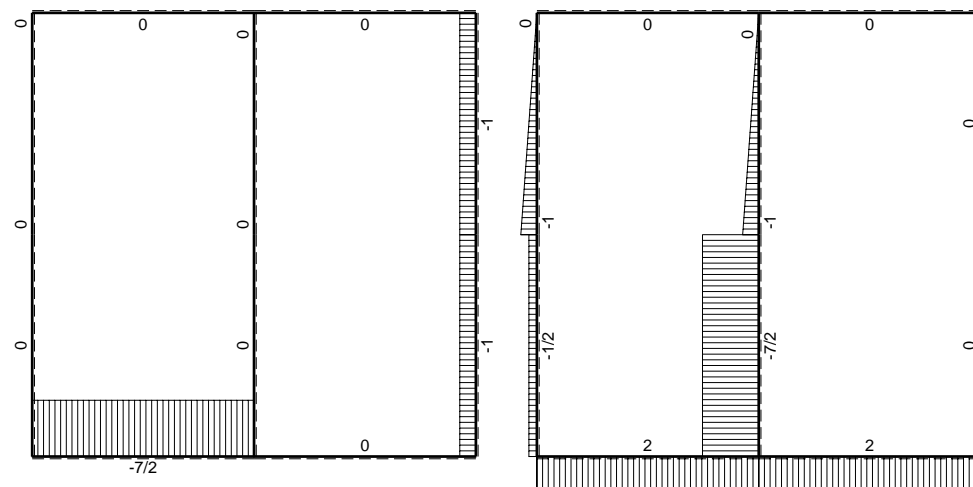
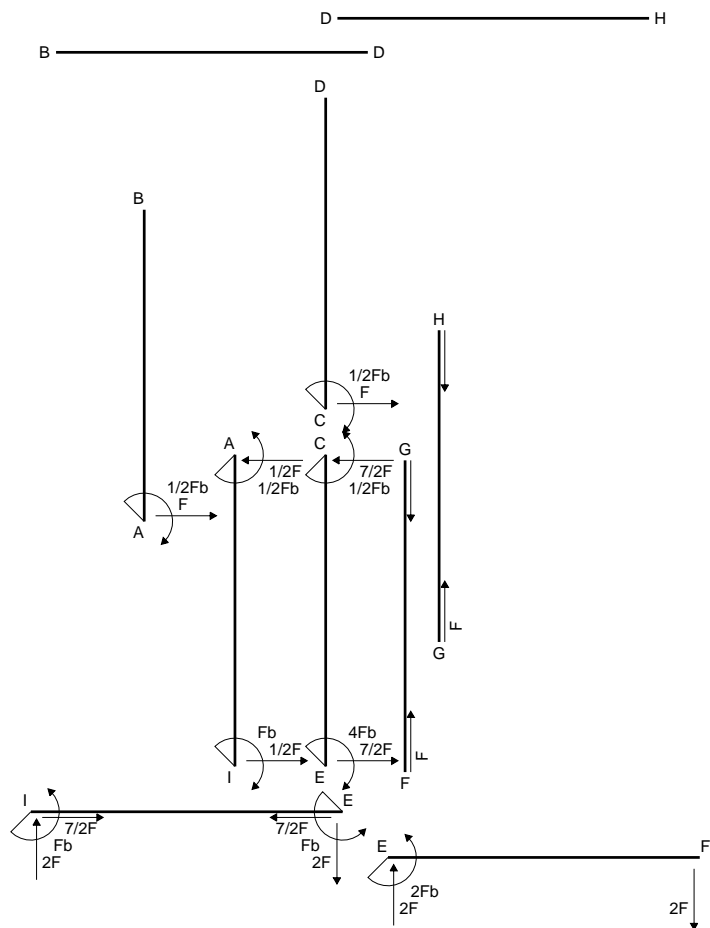
$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

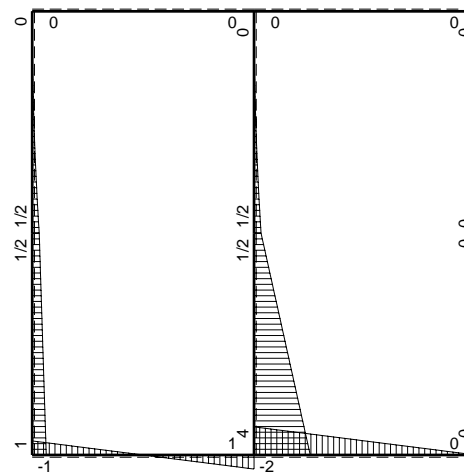


- A = 1284. mm²
- J_u = 321948. mm⁴
- J_v = 141552. mm⁴
- y_g = 30.28 mm
- T_y = 4000. N
- M_x = -2120000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.28 mm
- σ_m = -Mv/J_u = -199.4 N/mm²
- x_c = 24. mm
- y_c = 13. mm
- v_c = -17.28 mm
- σ_c = -Mv/J_u = -113.8 N/mm²
- τ_c = 7.462 N/mm²
- σ_o = √σ²+3τ² = 114.6 N/mm²
- S = 7208. mm³

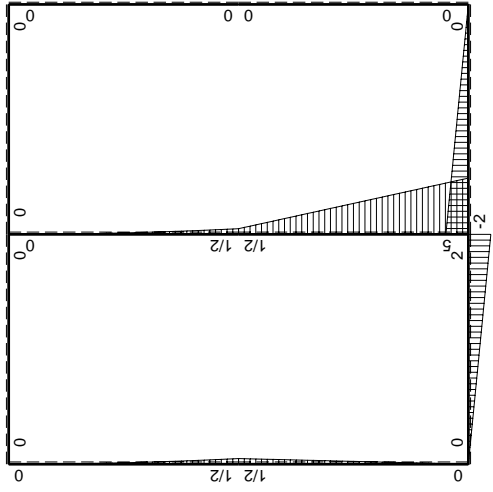
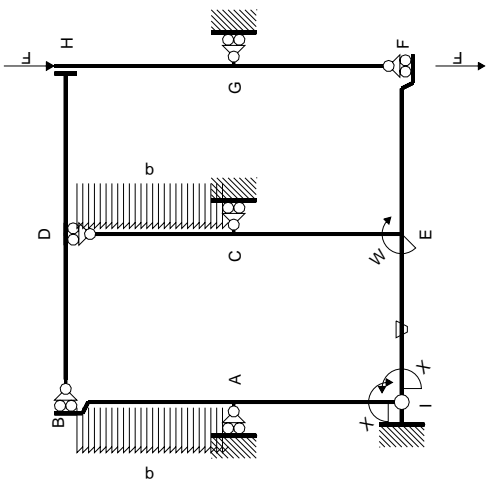


← ⊕ → F

↑ ⊕ ↓ F

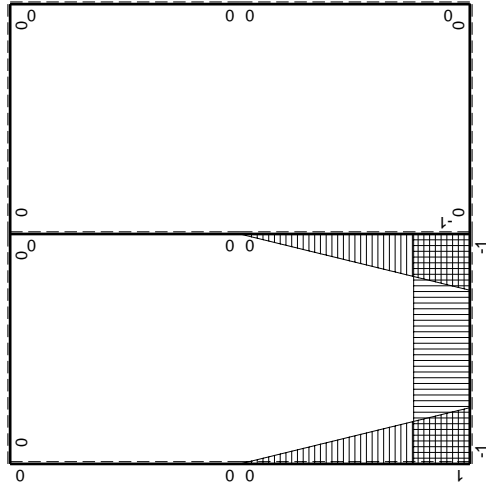


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2qx^2$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-9/2Fx$	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-b) Fb \frac{1}{EJ} + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-2b + b) Fb \frac{1}{EJ} + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-5 + 19/2 x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 19/4 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 19/4 b - 3/2 b) Fb \frac{1}{EJ} = -7/4 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

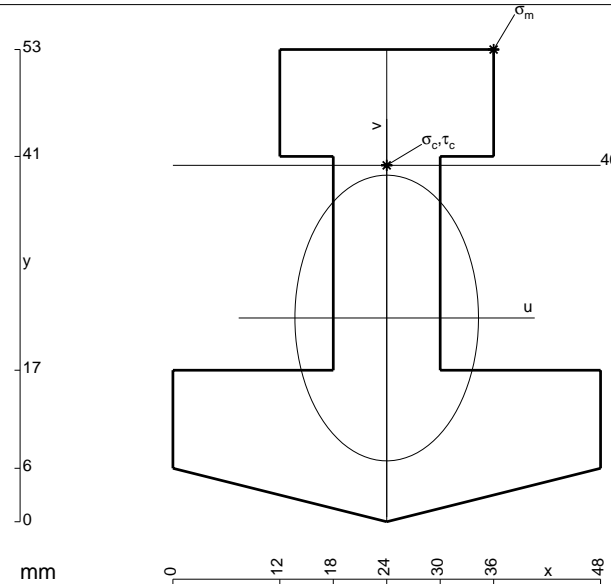
$$= (-1/4 b - 3/2 b) Fb \frac{1}{EJ} = -7/4 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

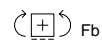
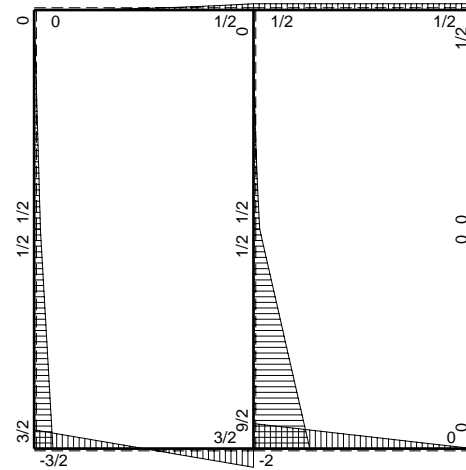
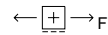
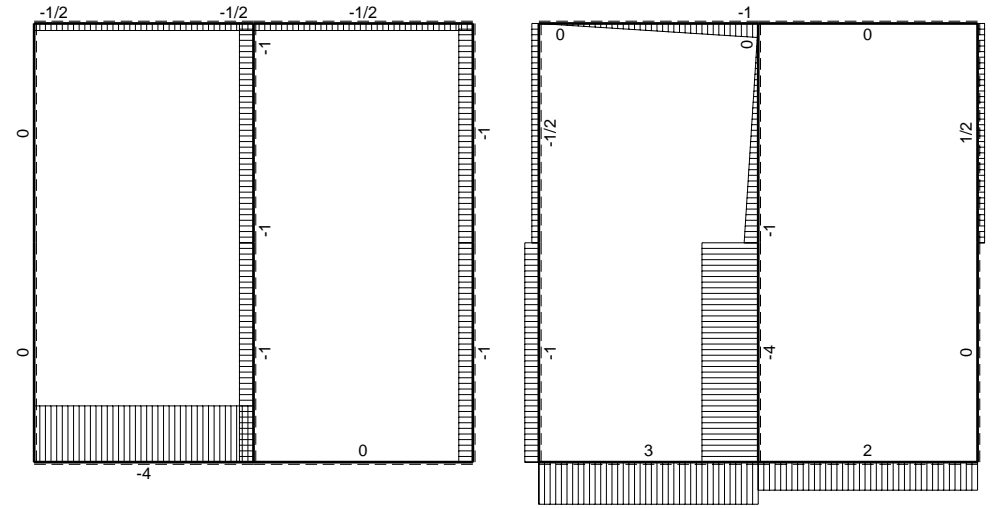
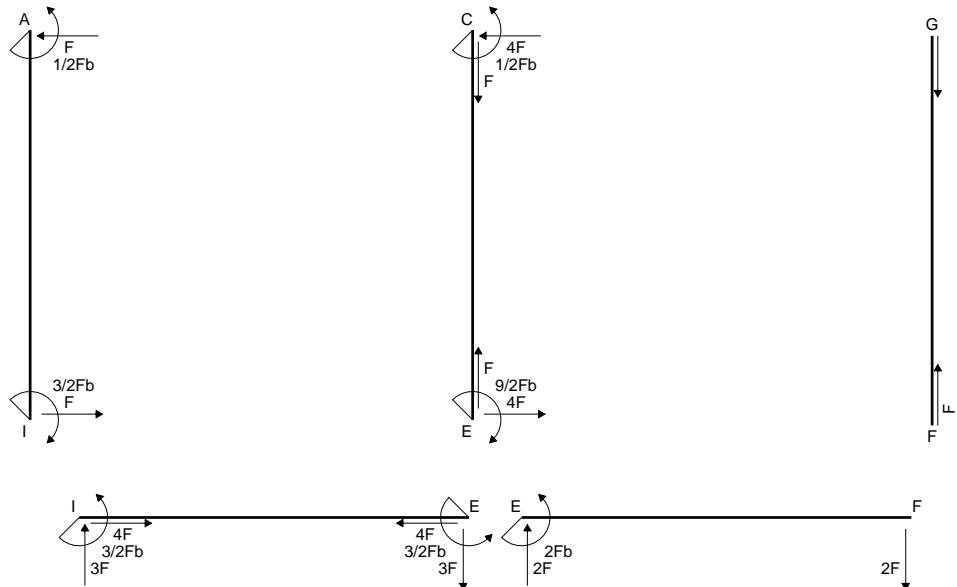
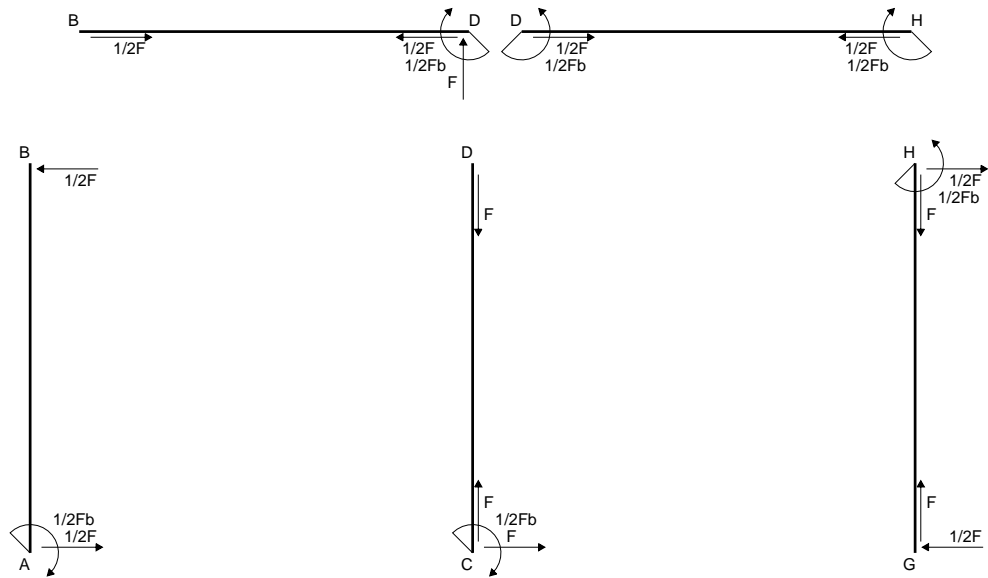
$$= (1/4 b - 1/6 b) Fb \frac{1}{EJ} = 1/12 Fb^2/EJ$$

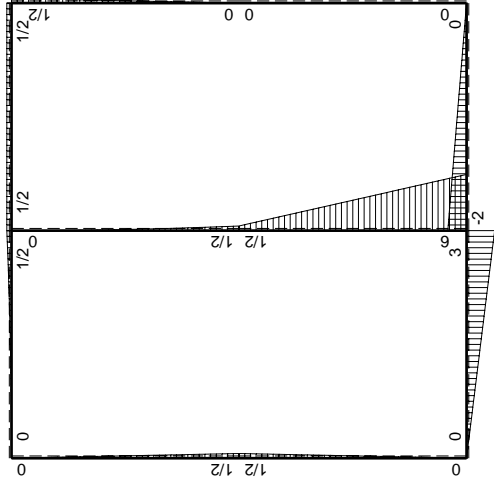
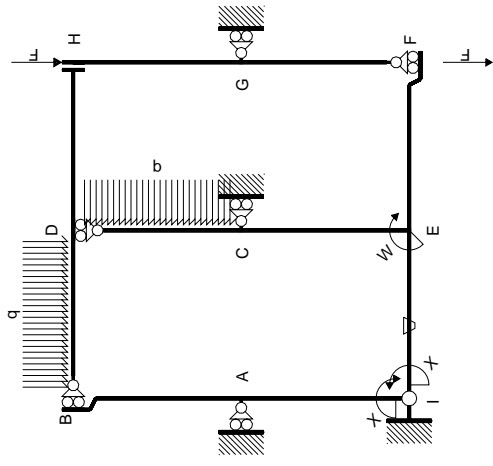
$$L_{AI}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/4 b - 1/6 b) Fb \frac{1}{EJ} = 1/12 Fb^2/EJ$$



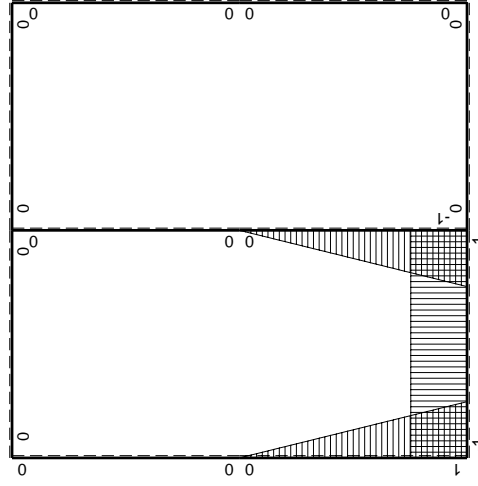
- A = 1248. mm²
- J_u = 320937. mm⁴
- J_v = 132480. mm⁴
- y_g = 22.87 mm
- T_y = 3840. N
- M_x = -2227200. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.13 mm
- σ_m = -Mv/J_u = 209.1 N/mm²
- x_c = 24. mm
- y_c = 40. mm
- v_c = 17.13 mm
- σ_c = -Mv/J_u = 118.9 N/mm²
- τ_c = 7.141 N/mm²
- σ_q = √σ²+3τ² = 119.6 N/mm²
- S = 7162. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-11/2Fx$	0	$-6Fb+23/2Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-25/12+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-11/2Fx$	0	$-1/2Fx-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-5/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$3/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{x_0} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{x_0} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{x_0} = \int_0^b (-6 + 23/2 x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-6x + 23/4 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-6b + 23/4 b - 11/6 b) Fb \frac{1}{EJ} = -25/12 Fb^2/EJ$$

$$L_{CE}^{x_0} = \int_0^b (-1/2 x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

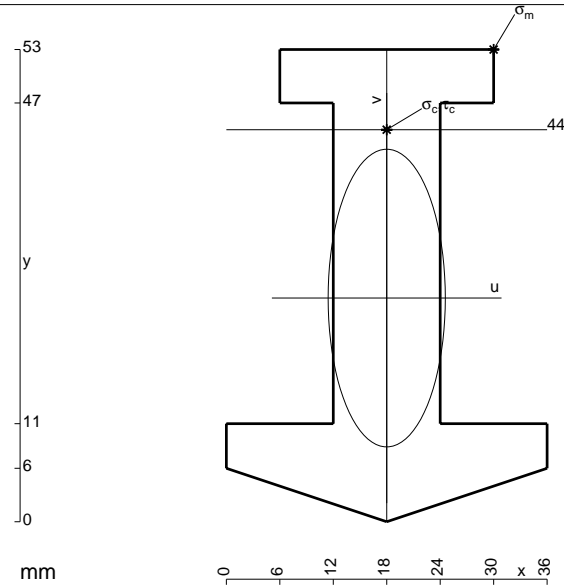
$$= (-1/4 b - 11/6 b) Fb \frac{1}{EJ} = -25/12 Fb^2/EJ$$

$$L_{IA}^{x_0} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

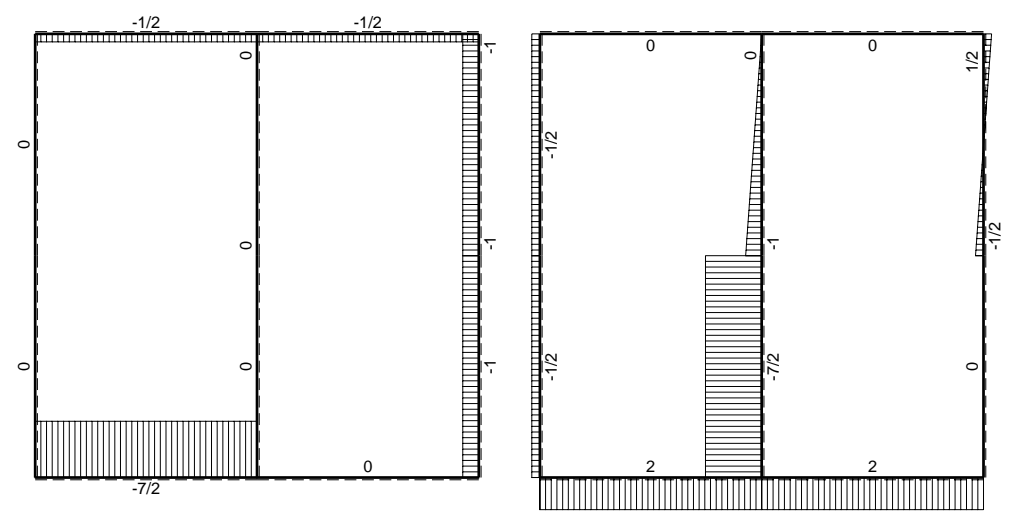
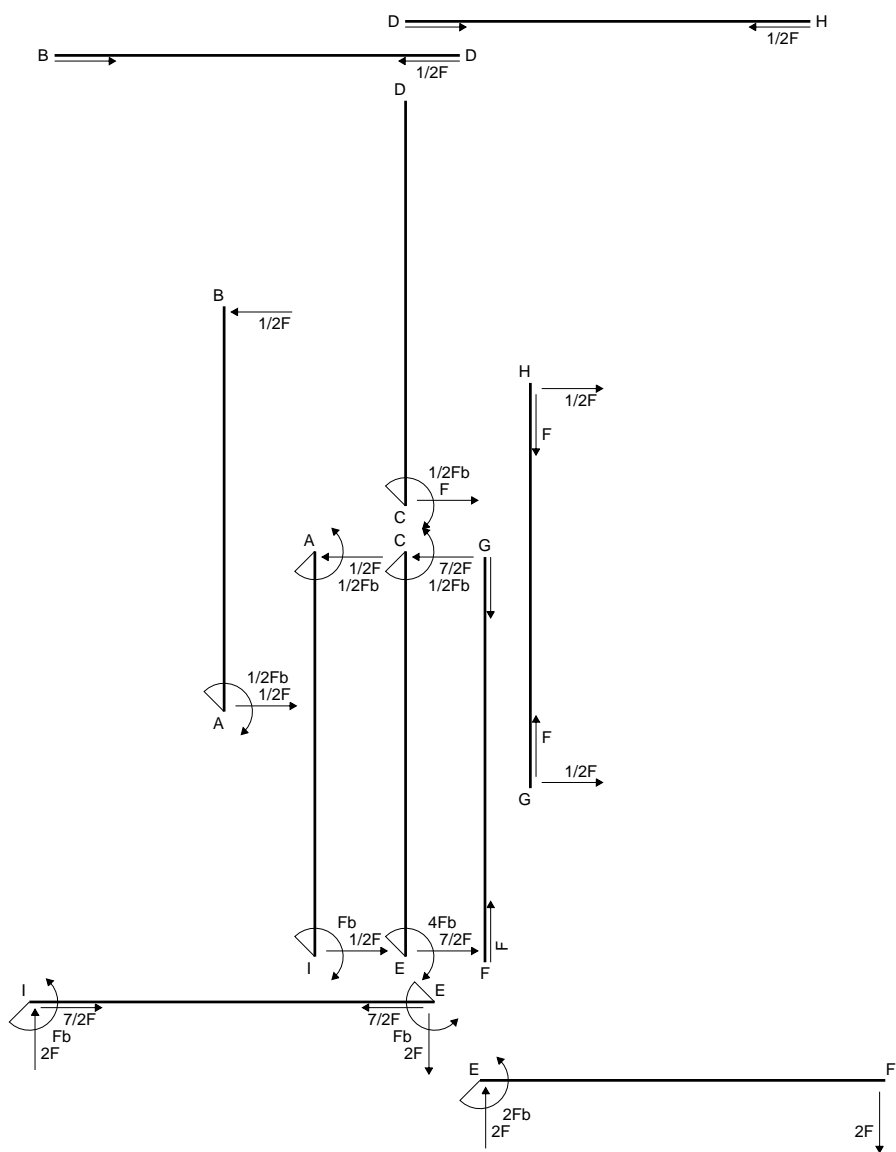
$$= (1/4 b - 1/6 b) Fb \frac{1}{EJ} = 1/12 Fb^2/EJ$$

$$L_{AI}^{x_0} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/4 b - 1/6 b) Fb \frac{1}{EJ} = 1/12 Fb^2/EJ$$

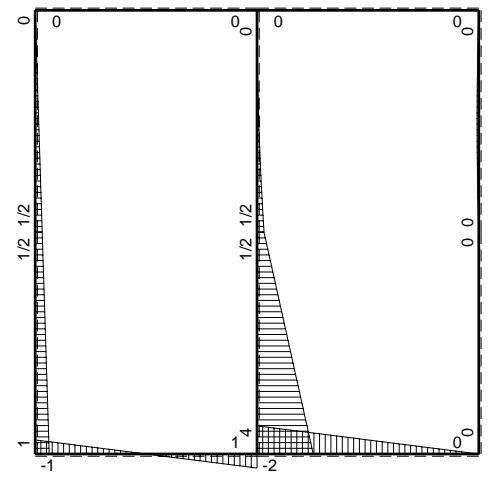


- A = 864. mm²
- J_u = 241215. mm⁴
- J_v = 37368. mm⁴
- y_g = 25.1 mm
- T_y = 3000. N
- M_x = -1890000. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 27.9 mm
- σ_m = -Mv/J_u = 218.6 N/mm²
- x_c = 18. mm
- y_c = 44. mm
- v_c = 18.9 mm
- σ_c = -Mv/J_u = 148.1 N/mm²
- τ_c = 4.477 N/mm²
- σ_q = √σ²+3τ² = 148.3 N/mm²
- S = 4319. mm³

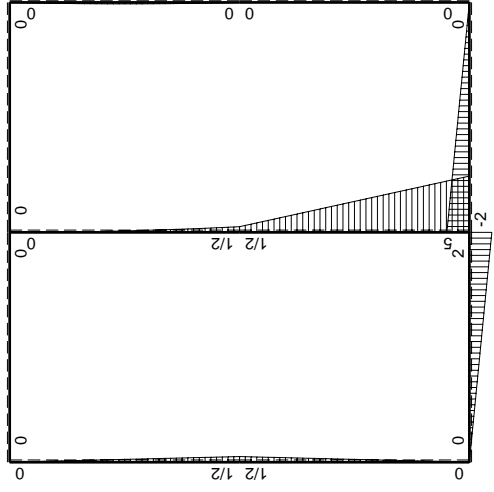
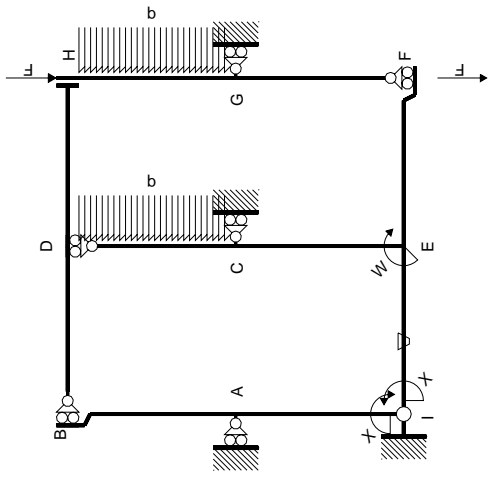


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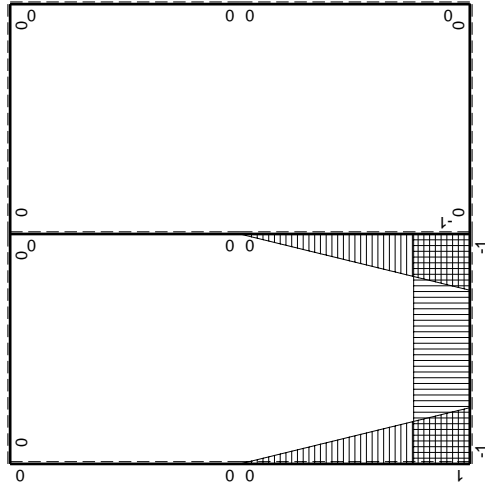


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-9/2Fx$	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-5/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-b) Fb \frac{1}{EJ} + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-2b + b) Fb \frac{1}{EJ} + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-5 + 19/2 x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 19/4 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 19/4 b - 3/2 b) Fb \frac{1}{EJ} = -7/4 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

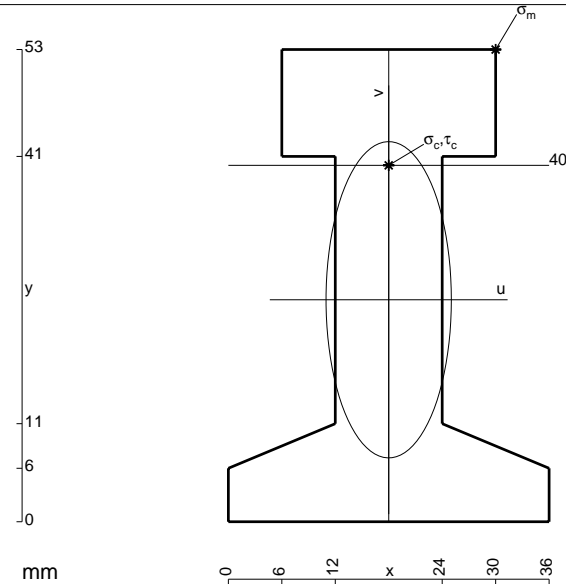
$$= (-1/4 b - 3/2 b) Fb \frac{1}{EJ} = -7/4 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

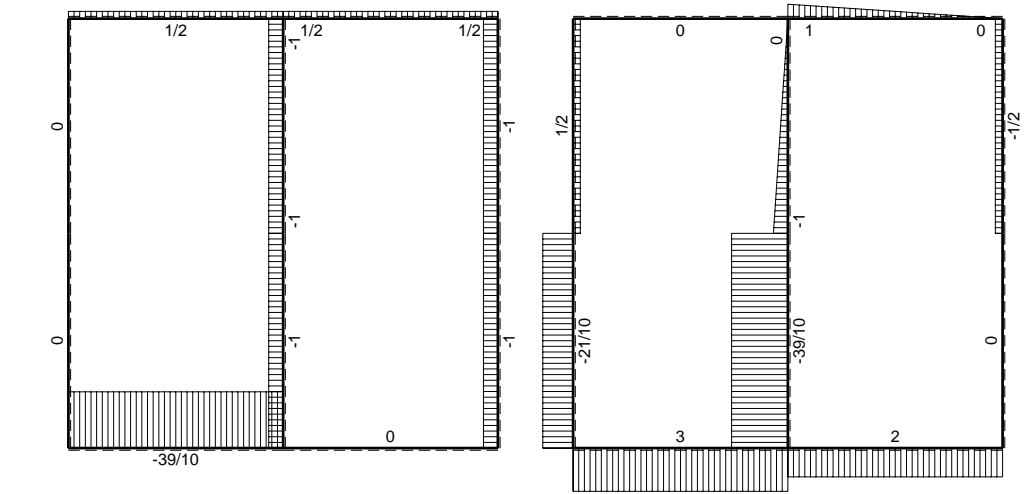
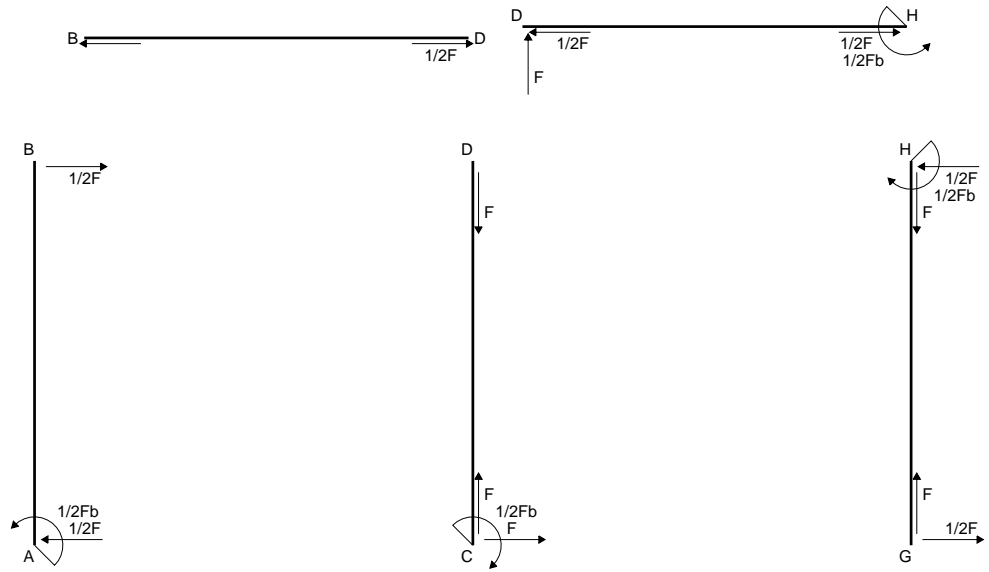
$$= (1/4 b - 1/6 b) Fb \frac{1}{EJ} = 1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/4 b - 1/6 b) Fb \frac{1}{EJ} = 1/12 Fb^2/EJ$$

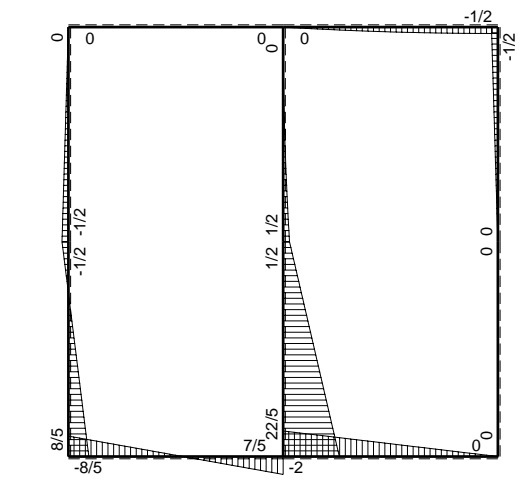
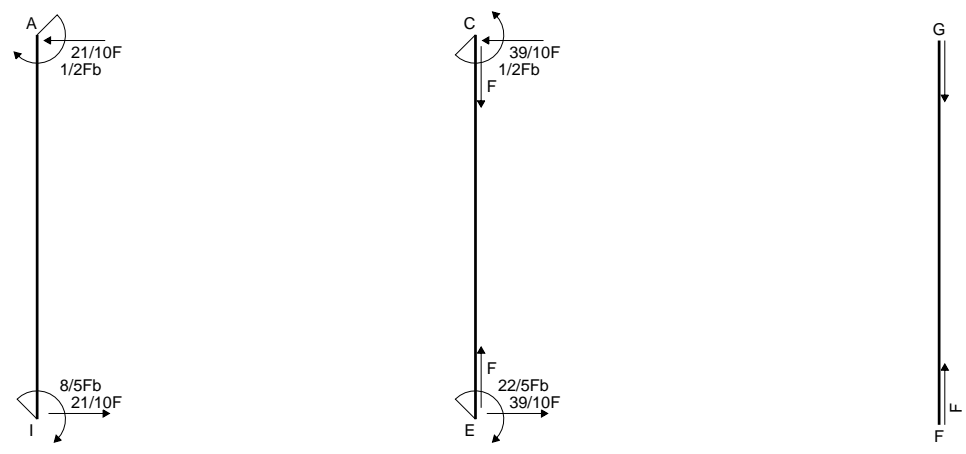


- A = 984. mm²
- J_u = 309963. mm⁴
- J_v = 48672. mm⁴
- y_g = 24.91 mm
- T_y = 3720. N
- M_x = -2529600. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.09 mm
- σ_m = -Mv/J_u = 229.2 N/mm²
- x_c = 18. mm
- y_c = 40. mm
- v_c = 15.09 mm
- σ_c = -Mv/J_u = 123.1 N/mm²
- τ_c = 6.549 N/mm²
- σ_q = √σ²+3τ² = 123.6 N/mm²
- S = 6548. mm³

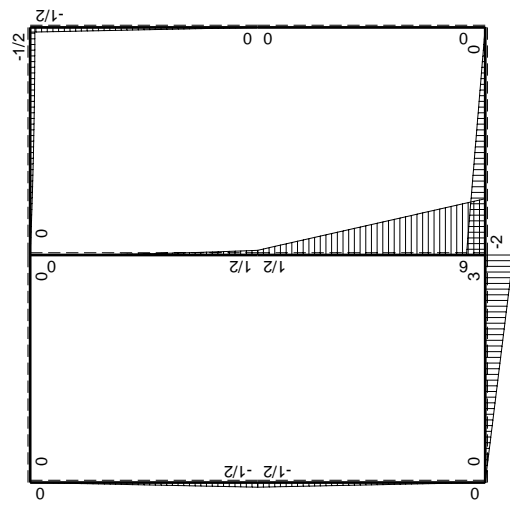
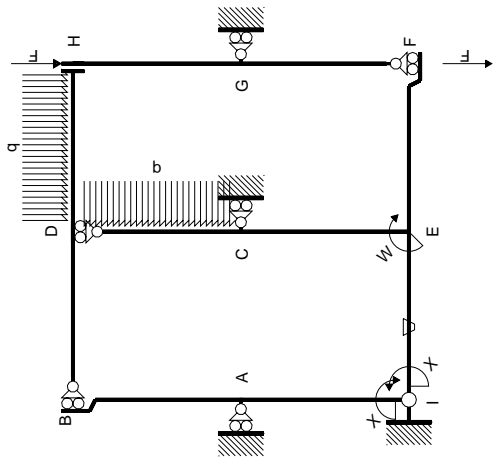


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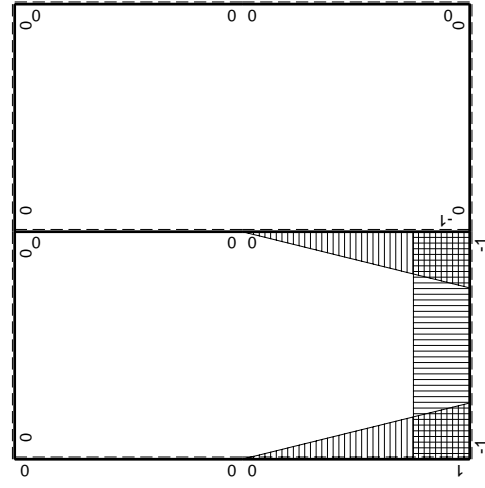


⊕ ⊕ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$6Fb-11/2Fx$	0	$-6Fb+23/2Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-25/12+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-1/2Fb-11/2Fx$	0	$-1/2Fx-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-8/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$8/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 23/2 x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-6x + 23/4 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-6b + 23/4 b - 11/6 b) Fb \frac{1}{EJ} = -25/12 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

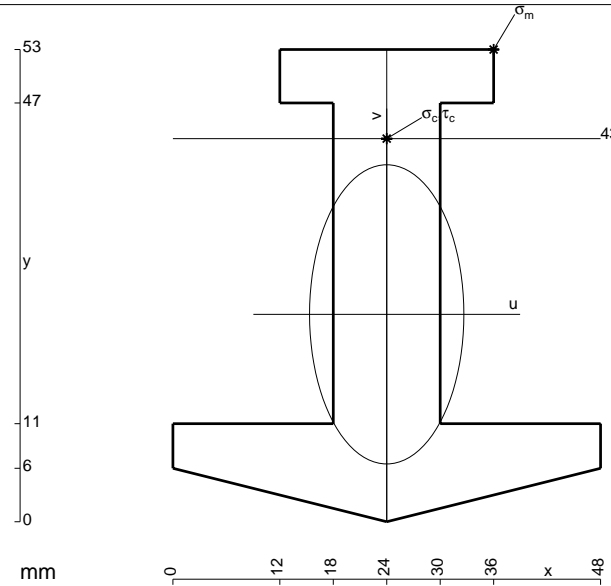
$$= (-1/4 b - 11/6 b) Fb \frac{1}{EJ} = -25/12 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

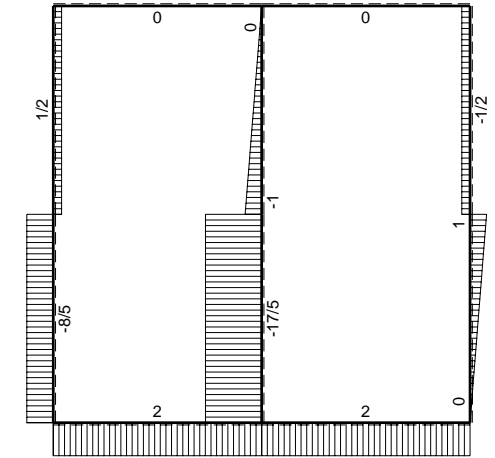
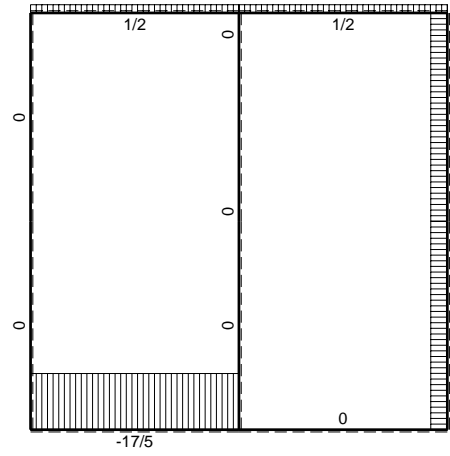
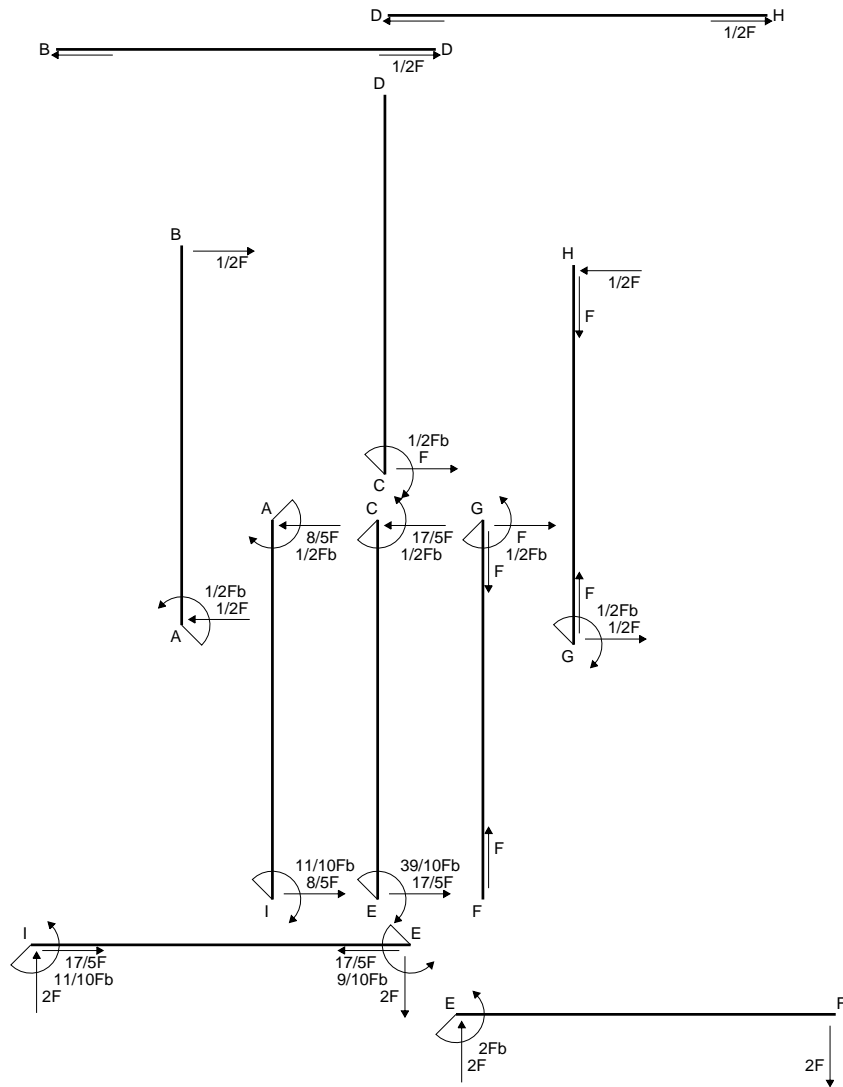
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

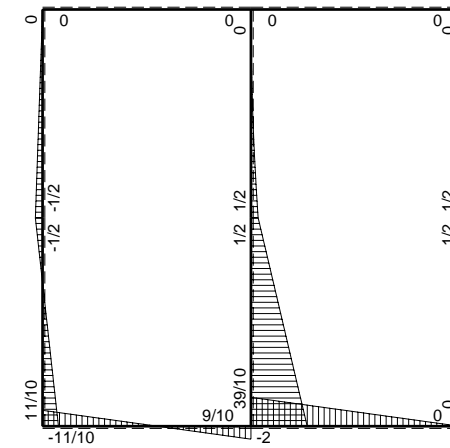


- A = 960. mm²
- J_u = 270775. mm⁴
- J_v = 72000. mm⁴
- y_g = 23.27 mm
- T_y = 2940. N
- M_x = -2175600. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 29.73 mm
- σ_m = -Mv/J_u = 238.8 N/mm²
- x_c = 24. mm
- y_c = 43. mm
- v_c = 19.73 mm
- σ_c = -Mv/J_u = 158.5 N/mm²
- τ_c = 4.426 N/mm²
- σ_q = √σ²+3τ² = 158.7 N/mm²
- S = 4891. mm³

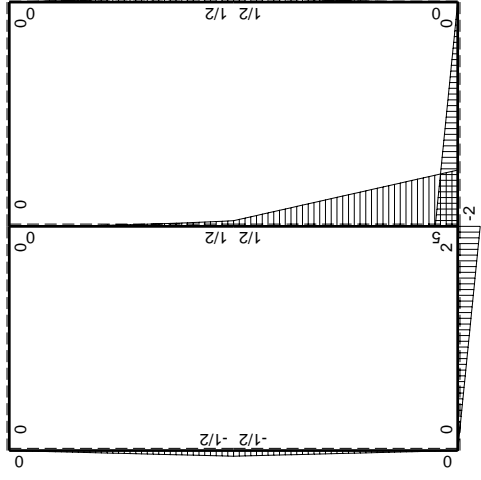
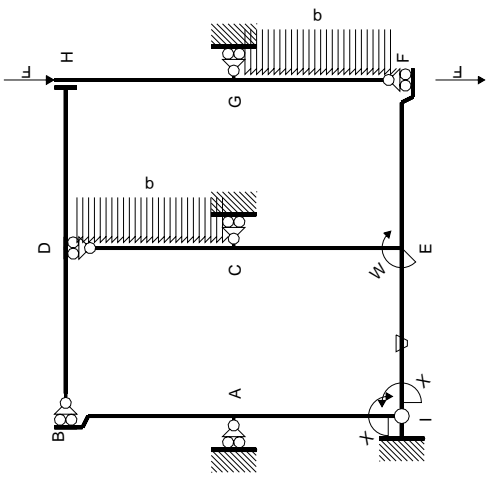


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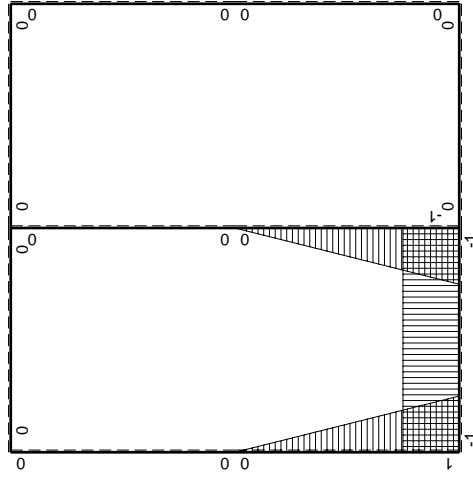


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$-1/2qx^2$	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fx$	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1			
EC b	$-1+x/b$	$5Fb-9/2Fx$	0	$-5Fb+19/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-1/2Fb-9/2Fx$	0	$-1/2Fx-9/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$11/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-5 + 19/2 x/b - 9/2 x^2/b^2) Fb 1/EJ dx = [-5x + 19/4 x^2/b - 3/2 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 19/4 b - 3/2 b) Fb 1/EJ = -7/4 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-1/2 x/b - 9/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b - 3/2 x^3/b^2]_0^b Fb 1/EJ$$

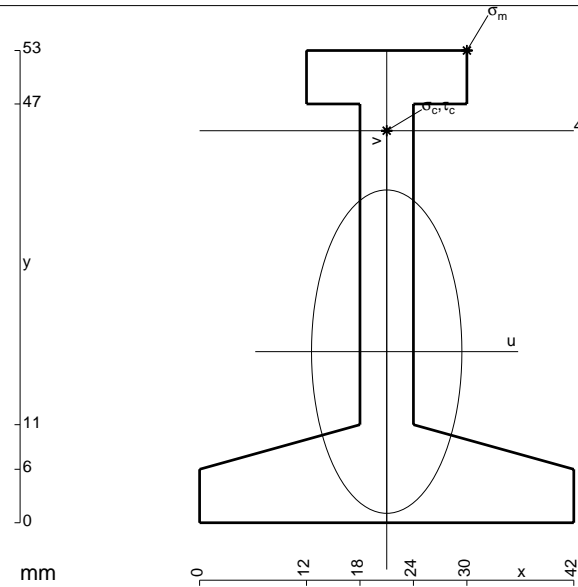
$$= (-1/4 b - 3/2 b) Fb 1/EJ = -7/4 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

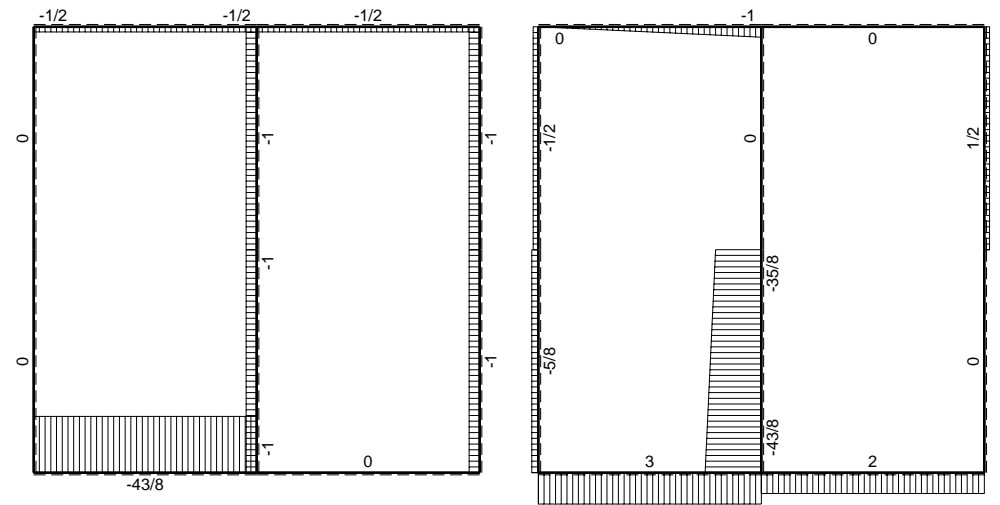
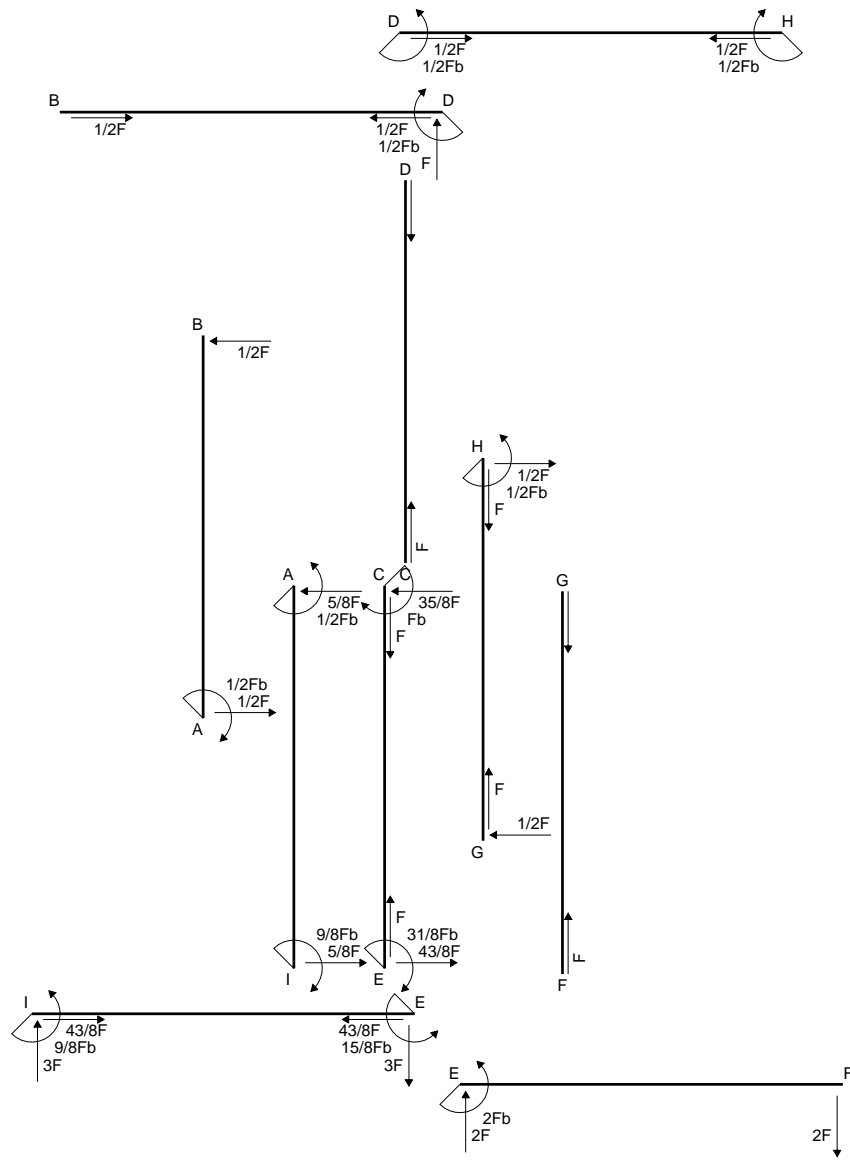
$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

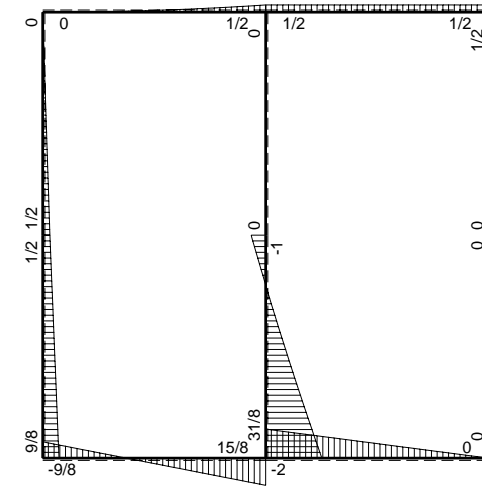


- A = 696. mm²
- J_u = 229334. mm⁴
- J_v = 49608. mm⁴
- y_g = 19.2 mm
- T_y = 1700. N
- M_x = -1343000. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 9. mm
- v_m = 33.8 mm
- σ_m = -Mv/J_u = 197.9 N/mm²
- x_c = 21. mm
- y_c = 44. mm
- v_c = 24.8 mm
- σ_c = -Mv/J_u = 145.2 N/mm²
- τ_c = 4.694 N/mm²
- σ_q = √σ²+3τ² = 145.4 N/mm²
- S = 3799. mm³

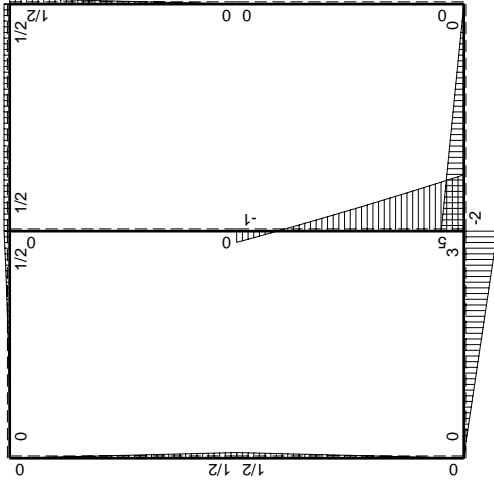
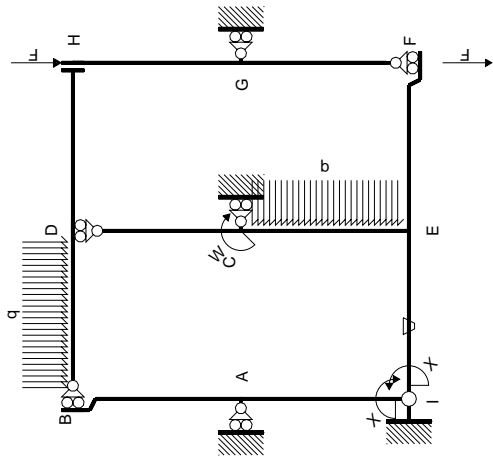


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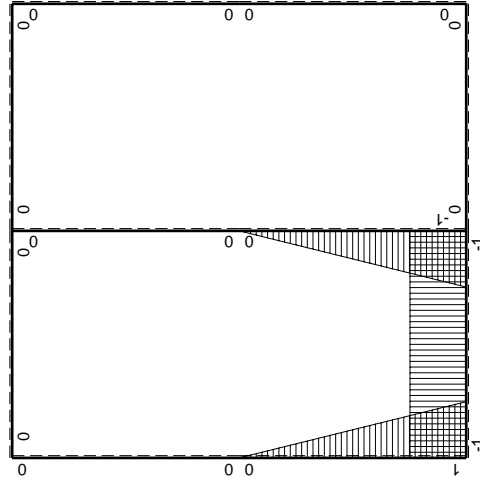


⊕ ⊕ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-13/2Fx+1/2qx^2$	0	$-5Fb+23/2Fx-7Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-35/24+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-11/2Fx-1/2qx^2$	0	$Fx-11/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-15/8Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$9/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 23/2 x/b - 7x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx$$

$$= [-5x + 23/4 x^2/b - 7/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-5b + 23/4 b - 7/3 b + 1/8 b) Fb 1/EJ = -35/24 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 11/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/2 x^2/b - 11/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

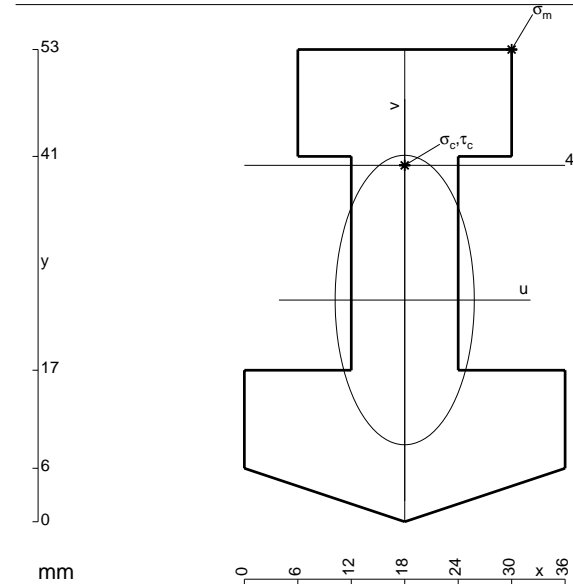
$$= (1/2 b - 11/6 b - 1/8 b) Fb 1/EJ = -35/24 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

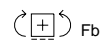
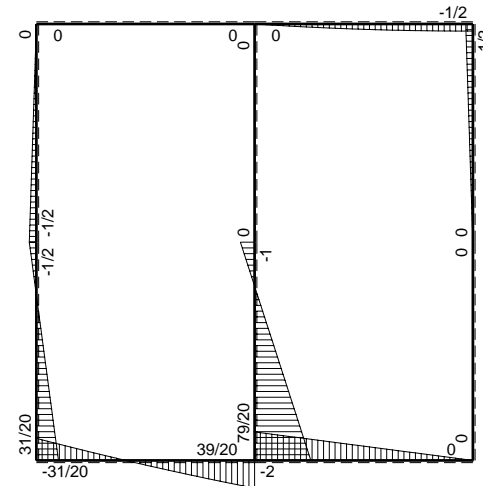
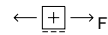
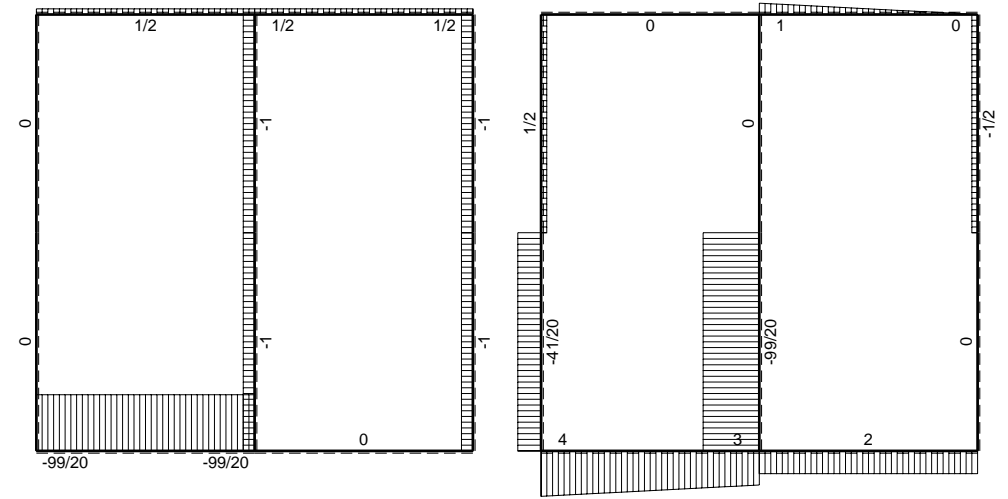
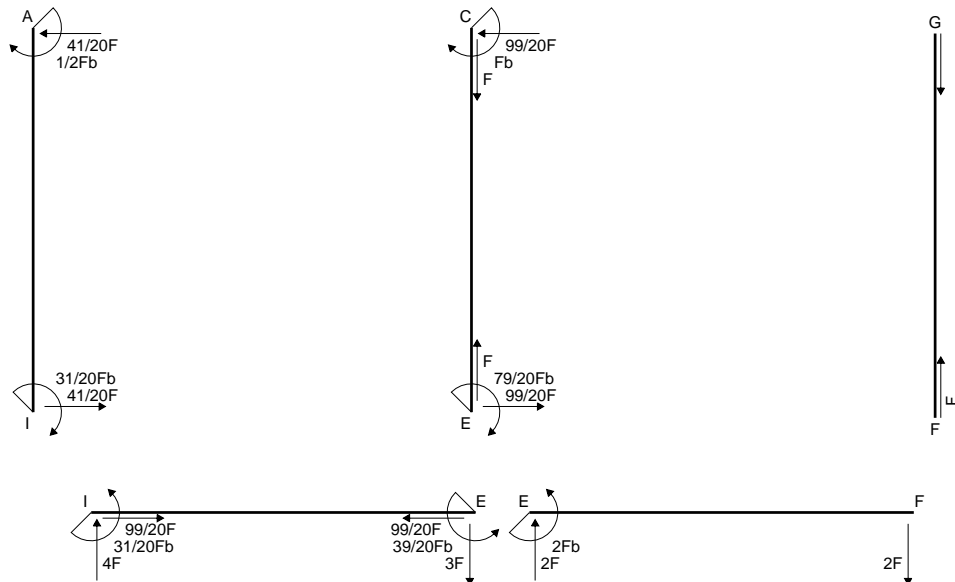
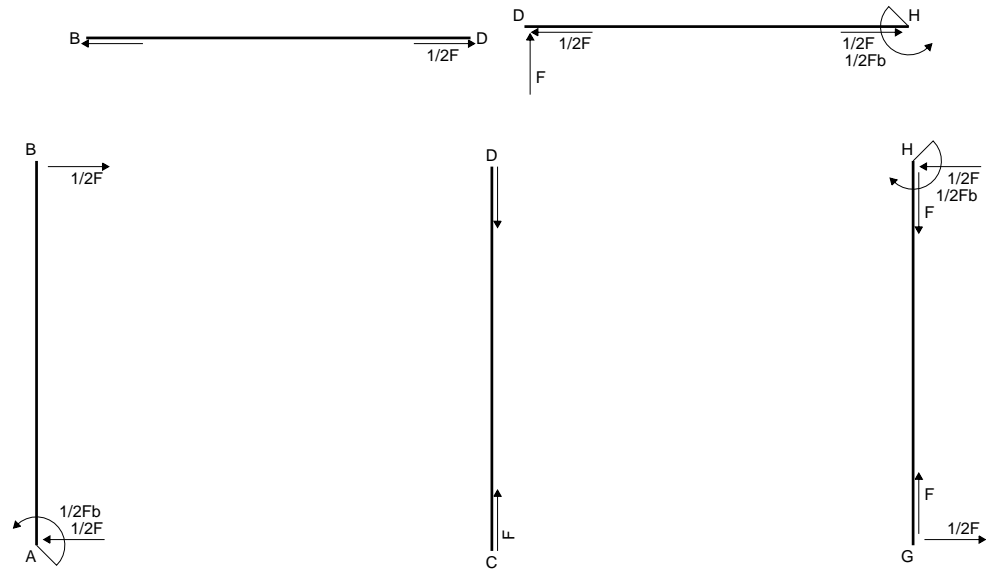
$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

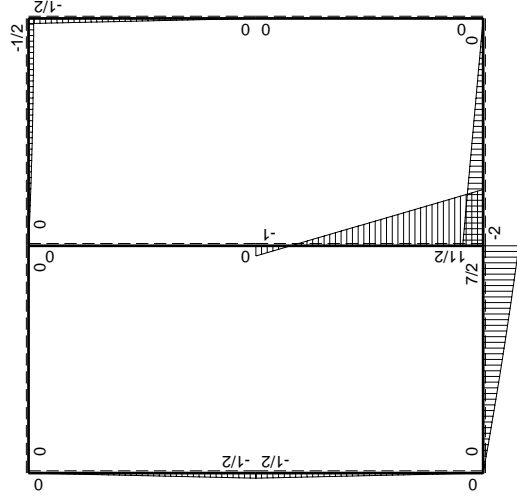
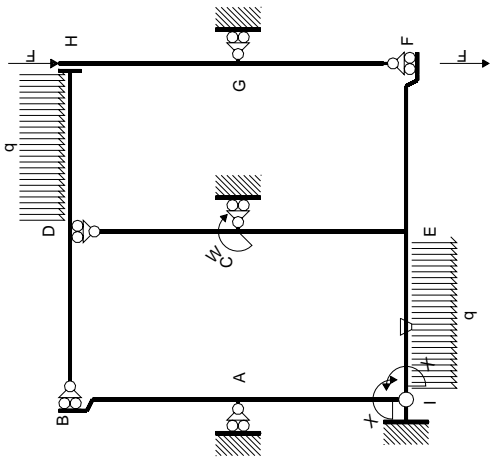
$$L_{AI}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



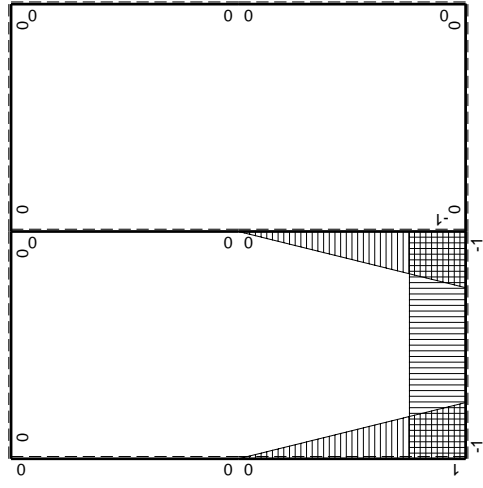
- A = 1080. mm²
- J_u = 285273. mm⁴
- J_v = 65880. mm⁴
- y_g = 24.88 mm
- T_y = 2520. N
- M_x = -2116800. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.12 mm
- σ_m = -Mv/J_u = 208.6 N/mm²
- x_c = 18. mm
- y_c = 40. mm
- v_c = 15.12 mm
- σ_c = -Mv/J_u = 112.2 N/mm²
- τ_c = 4.827 N/mm²
- σ_q = √σ²+3τ² = 112.5 N/mm²
- S = 6557. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-13/2Fx$	0	$-11/2Fb+12Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-13/2Fx$	0	$Fx-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-31/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$31/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 12x/b - 13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 6x^2/b - 13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 6b - 13/6 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

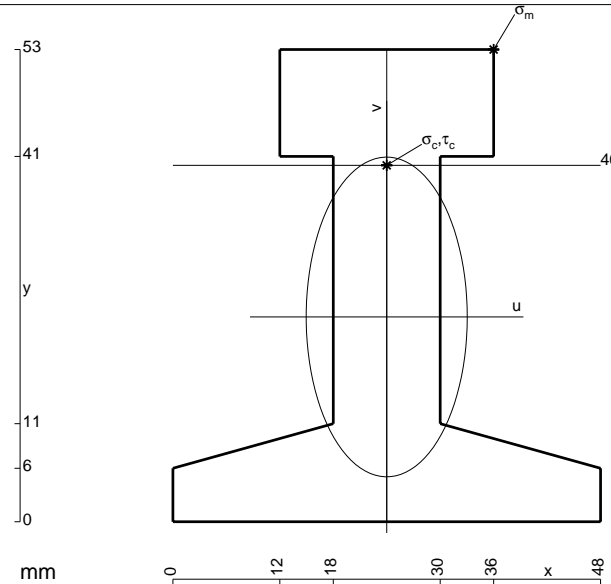
$$= (1/2 b - 13/6 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

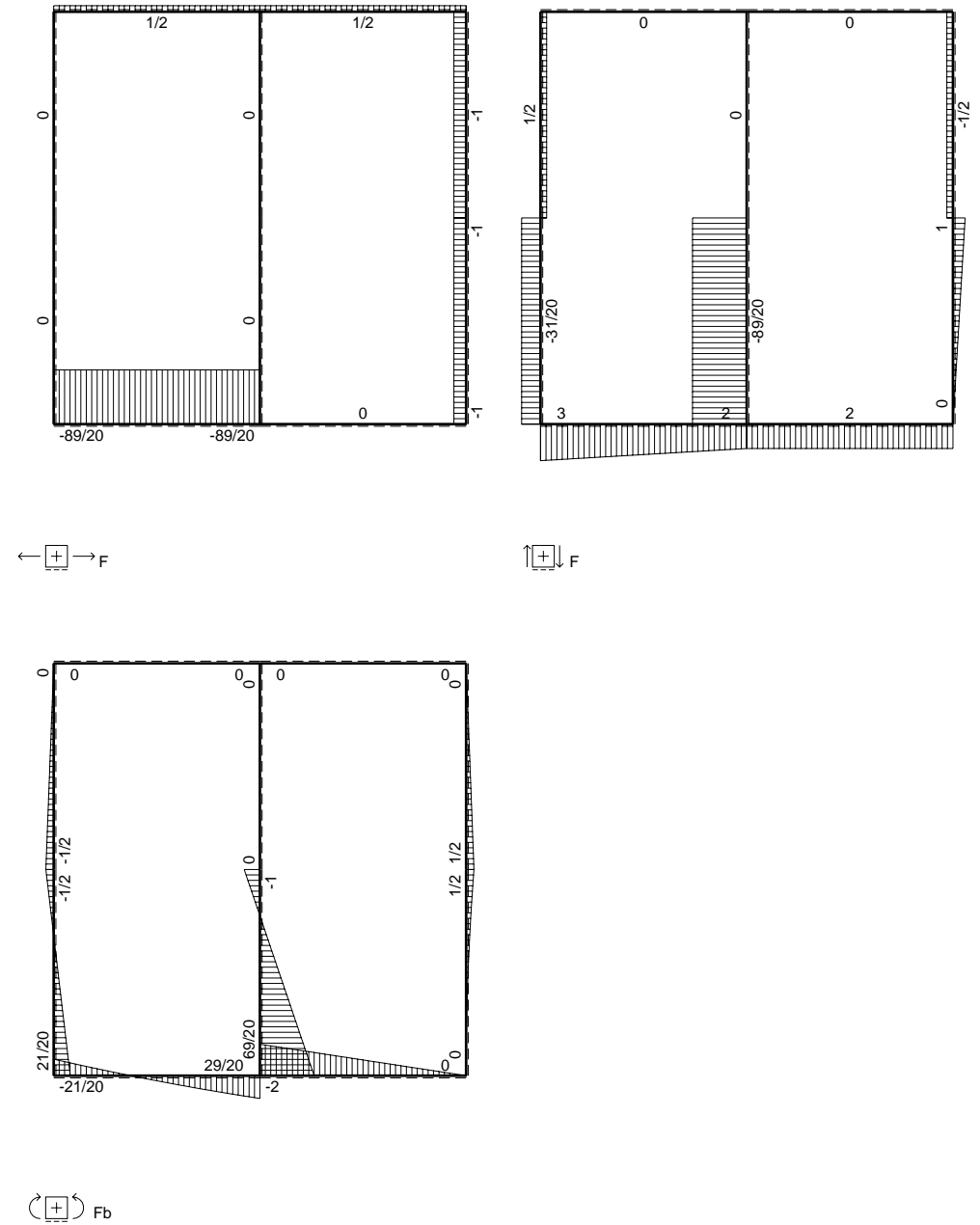
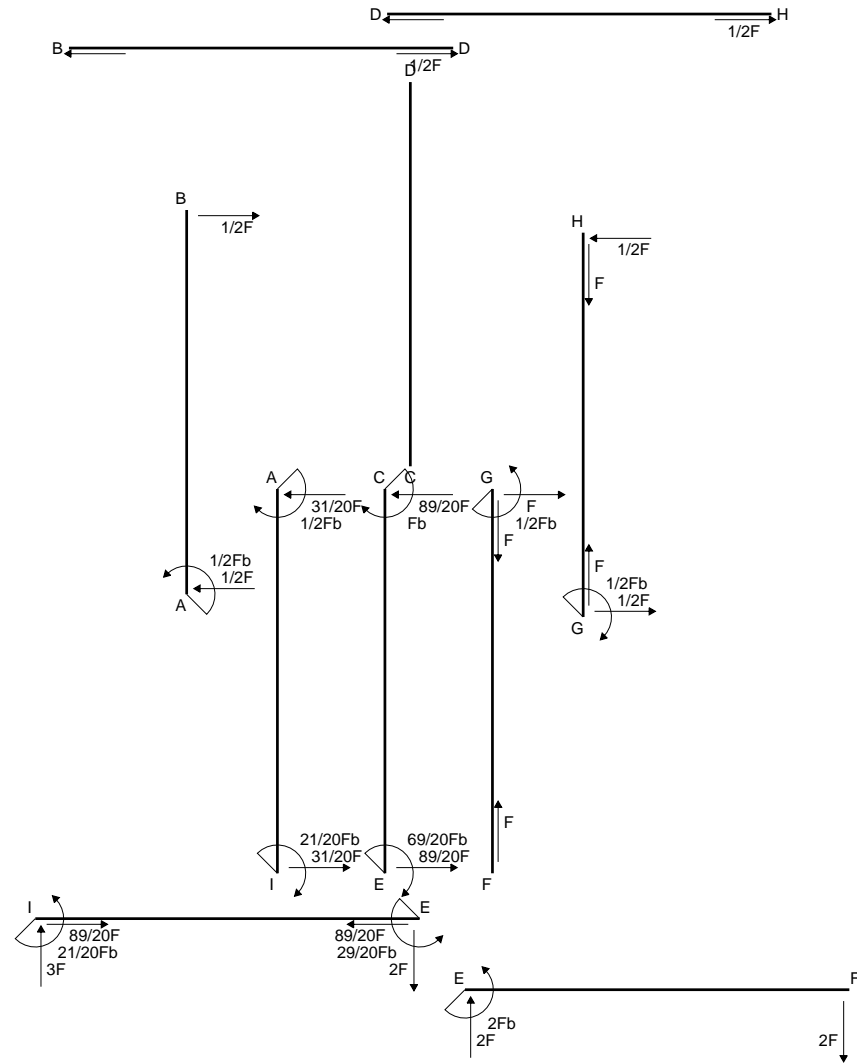
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

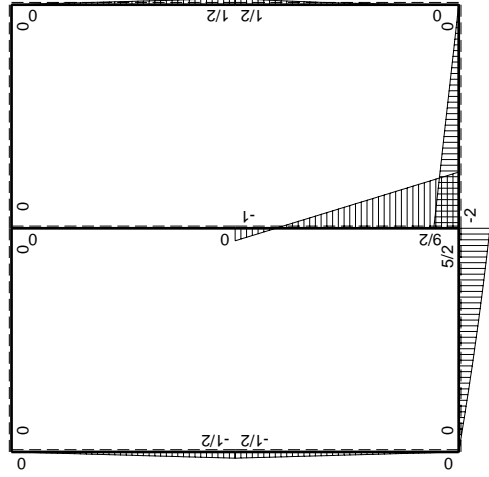
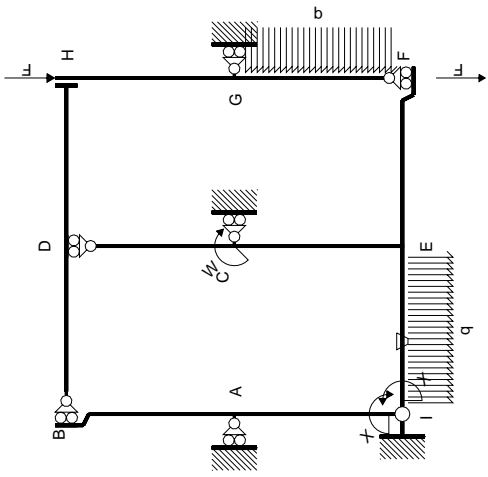
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



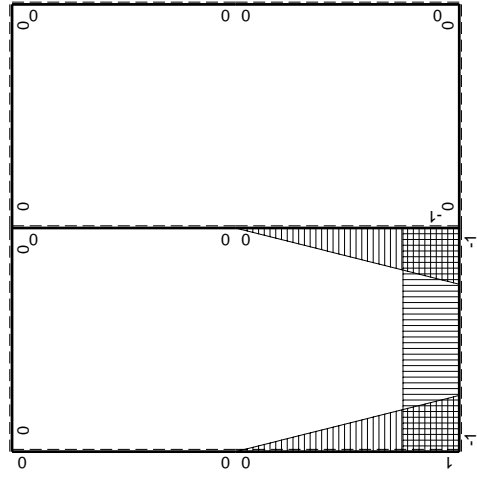
- A = 1086. mm²
- J_u = 349673. mm⁴
- J_v = 88740. mm⁴
- y_g = 22.98 mm
- T_y = 2840. N
- M_x = -2556000. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.02 mm
- σ_m = -Mv/J_u = 219.4 N/mm²
- x_c = 24. mm
- y_c = 40. mm
- v_c = 17.02 mm
- σ_c = -Mv/J_u = 124.4 N/mm²
- τ_c = 4.824 N/mm²
- σ_q = √σ²+3τ² = 124.7 N/mm²
- S = 7127. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fx$	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$9/2Fb-11/2Fx$	0	$-9/2Fb+10Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$Fb-11/2Fx$	0	$Fx-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-7/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$21/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -1/3 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-5/2 + 2x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-5/2 b + b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -1/3 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-9/2 + 10x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-9/2 x + 5x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-9/2 b + 5b - 11/6 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

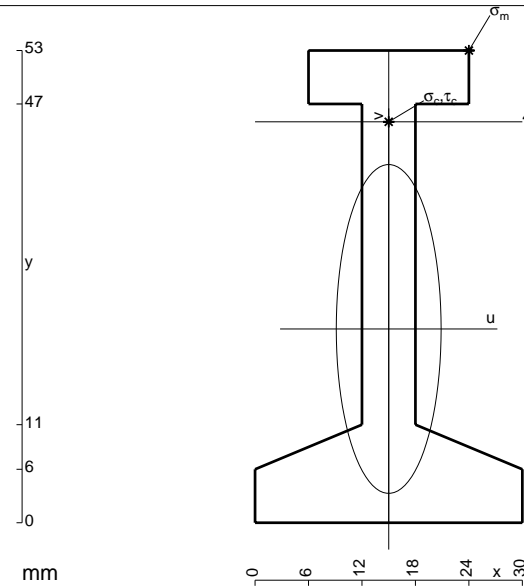
$$= (1/2 b - 11/6 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

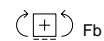
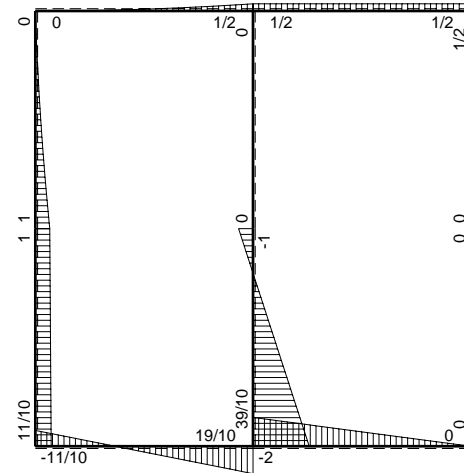
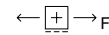
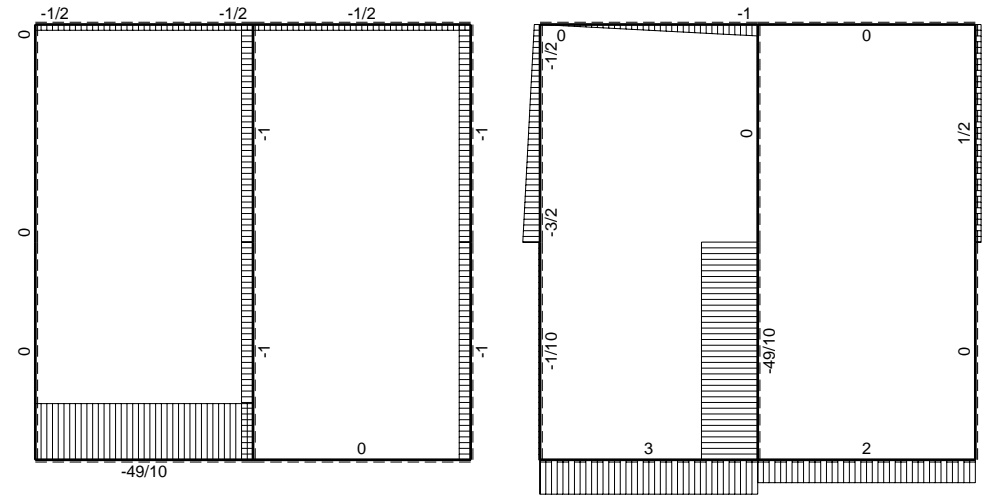
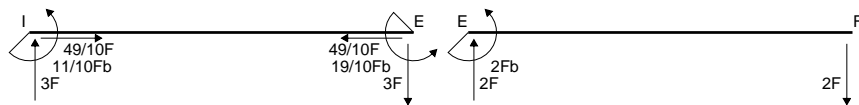
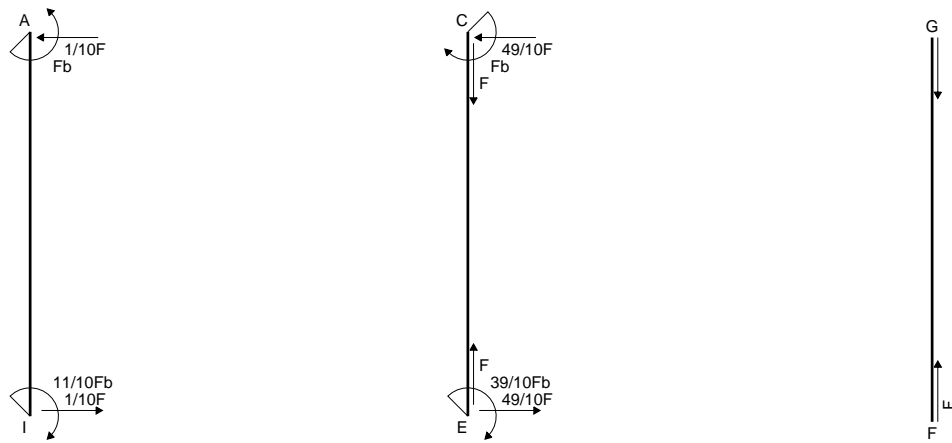
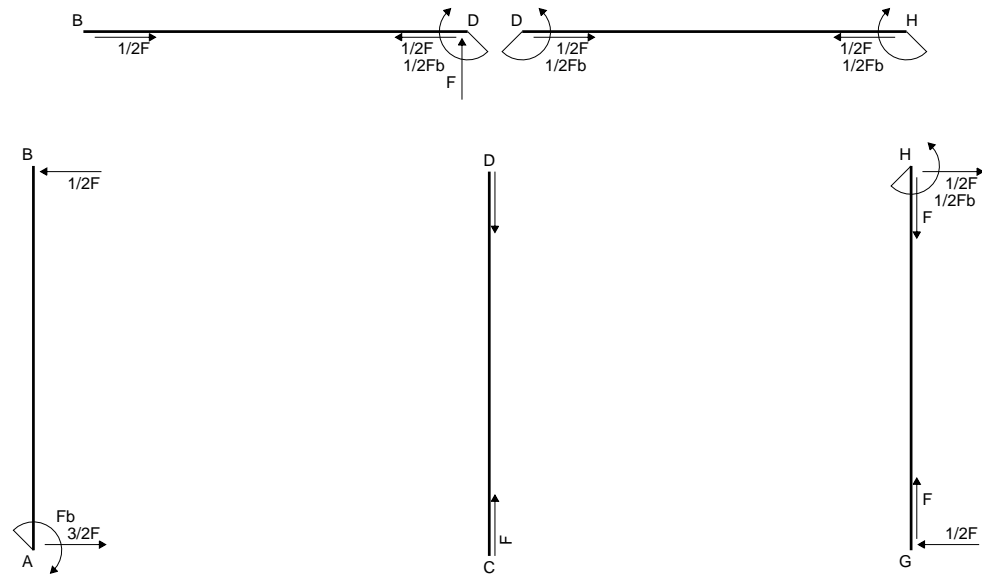
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

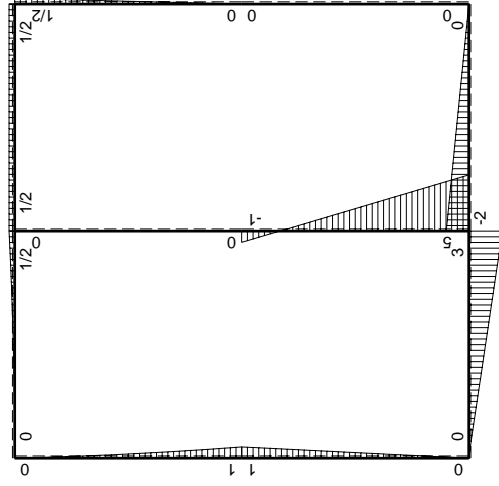
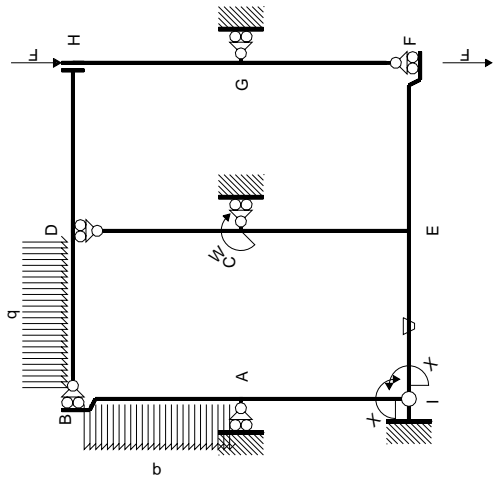
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



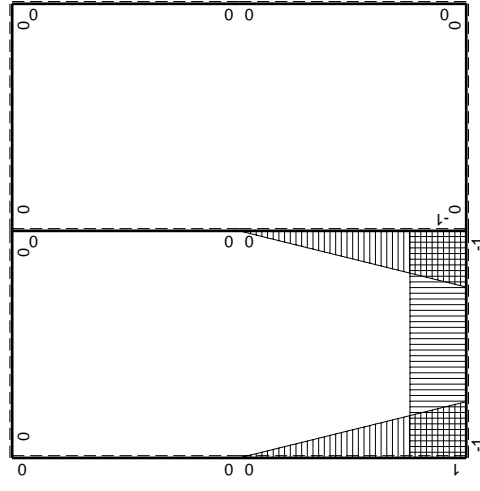
- A = 594. mm²
- J_u = 202331. mm⁴
- J_v = 20574. mm⁴
- y_g = 21.75 mm
- T_y = 1560. N
- M_x = -1482000. Nmm
- x_m = 24. mm
- y_m = 53. mm
- u_m = 9. mm
- v_m = 31.25 mm
- σ_m = -Mv/J_u = 228.9 N/mm²
- x_c = 15. mm
- y_c = 45. mm
- v_c = 23.25 mm
- σ_c = -Mv/J_u = 170.3 N/mm²
- τ_c = 4.295 N/mm²
- σ_q = √σ²+3τ² = 170.5 N/mm²
- S = 3342. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-6Fx$	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-6Fx$	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fb+Fx$	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 11x/b - 6x^2/b^2) Fb 1/EJ dx = [-5x + 11/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 11/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 6x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

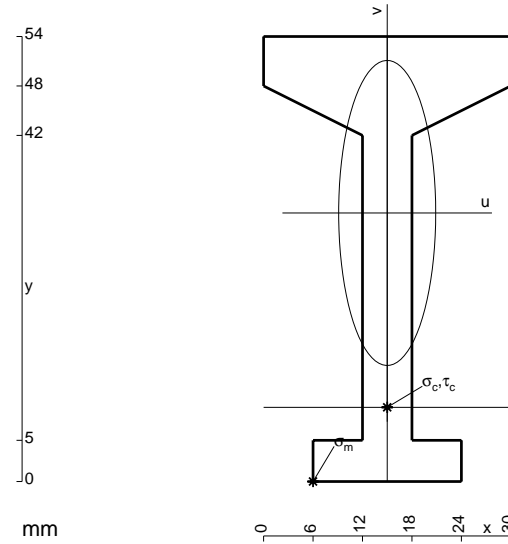
$$= (1/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (x/b - x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb 1/EJ$$

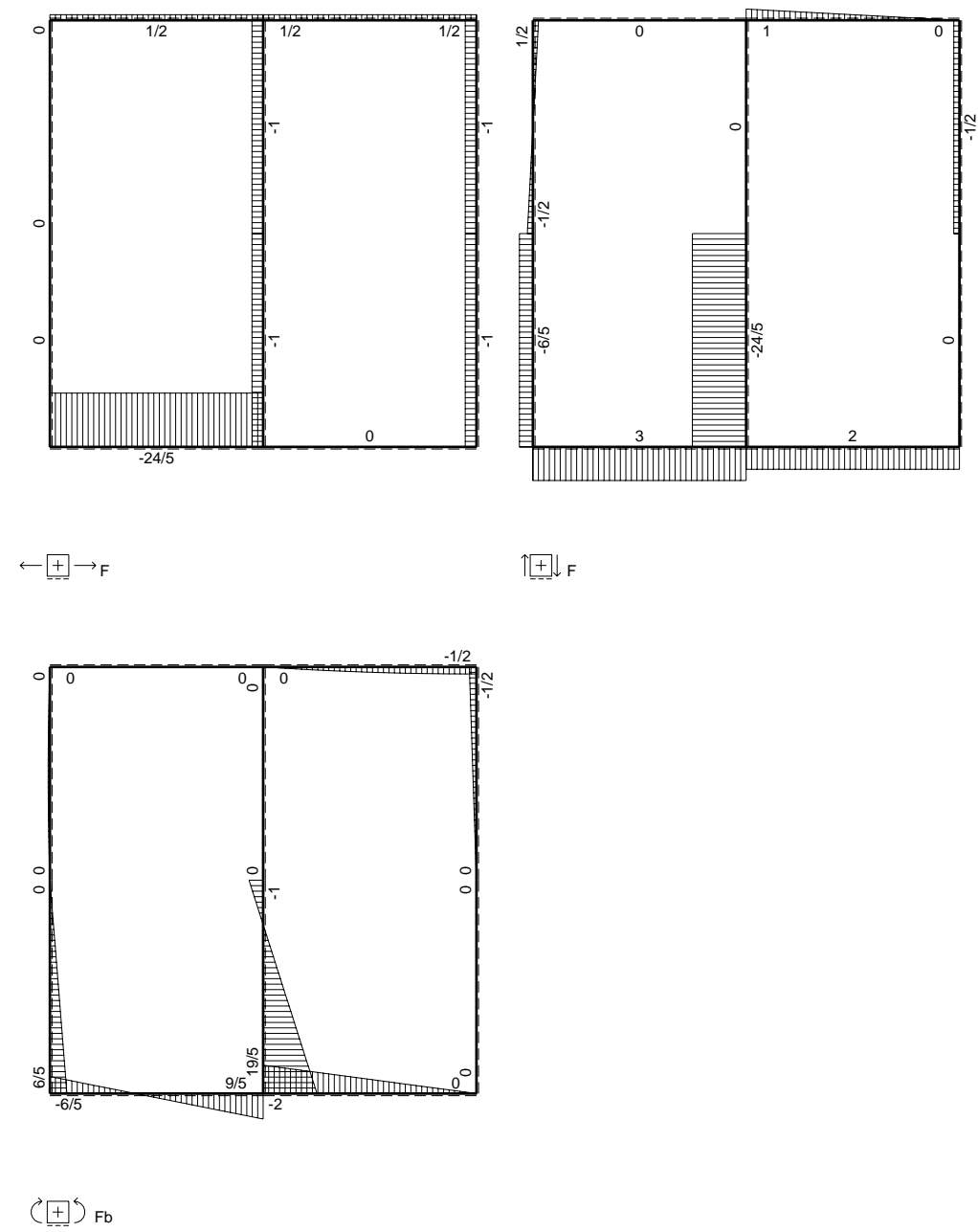
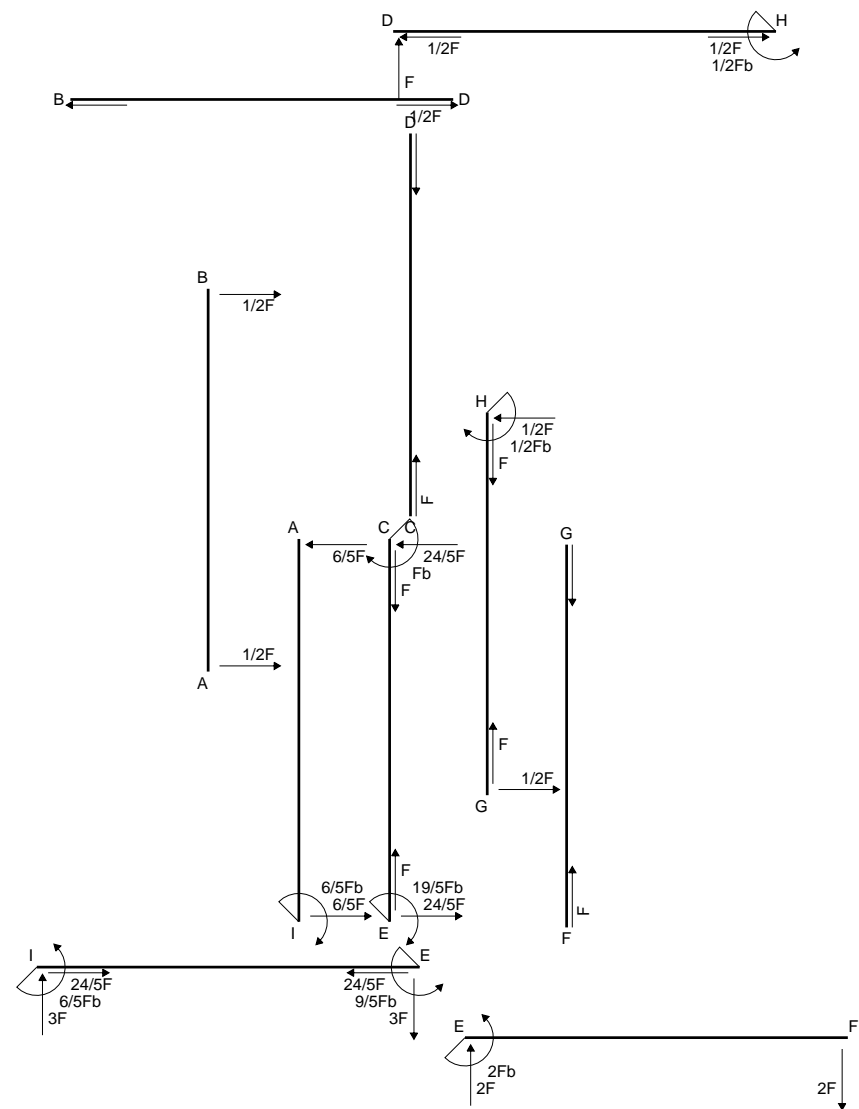
$$= (1/2 b - 1/3 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

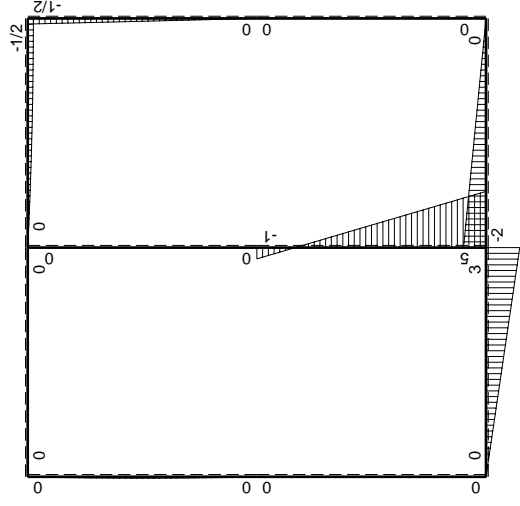
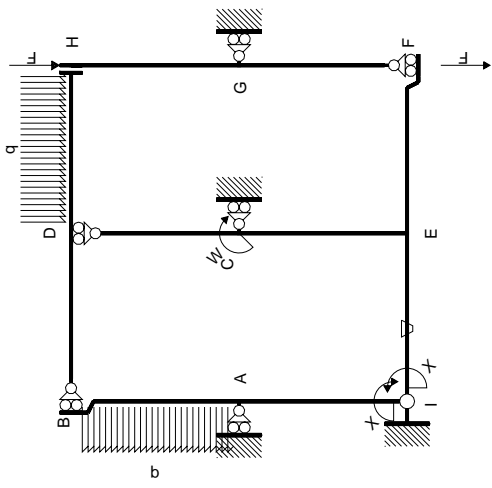
$$L_{AI}^{xo} = \int_0^b (x/b - x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/3 b) Fb 1/EJ = 1/6 Fb^2/EJ$$



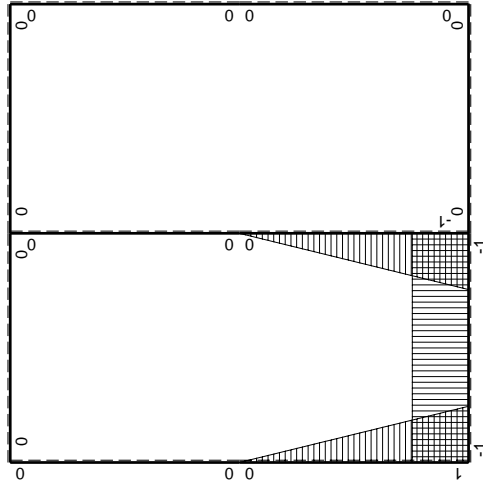
- A = 600. mm²
- J_u = 205635. mm⁴
- J_v = 20808. mm⁴
- y_g = 32.59 mm
- T_y = 1480. N
- M_x = -1509600. Nmm
- x_m = 6. mm
- u_m = -9. mm
- v_m = -32.59 mm
- σ_m = -Mv/J_u = -239.2 N/mm²
- x_c = 15. mm
- y_c = 9. mm
- v_c = -23.59 mm
- σ_c = -Mv/J_u = -173.2 N/mm²
- τ_c = 3.985 N/mm²
- σ_o = √σ_c² + 3τ_c² = 173.3 N/mm²
- S = 3322. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-6Fx$	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-6Fx$	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$6/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

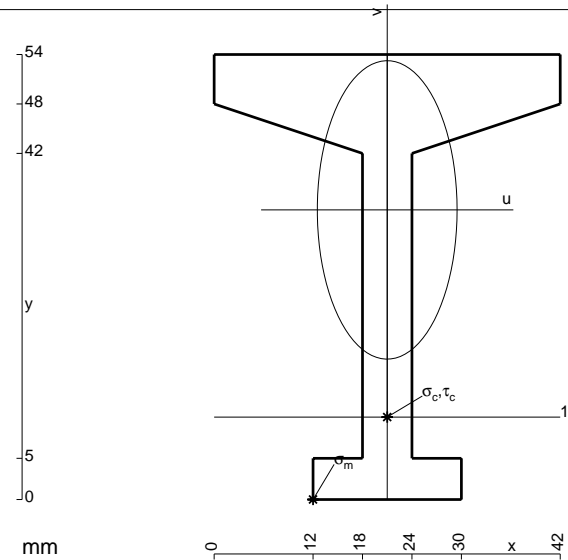
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 11x/b - 6x^2/b^2) Fb 1/EJ dx = [-5x + 11/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

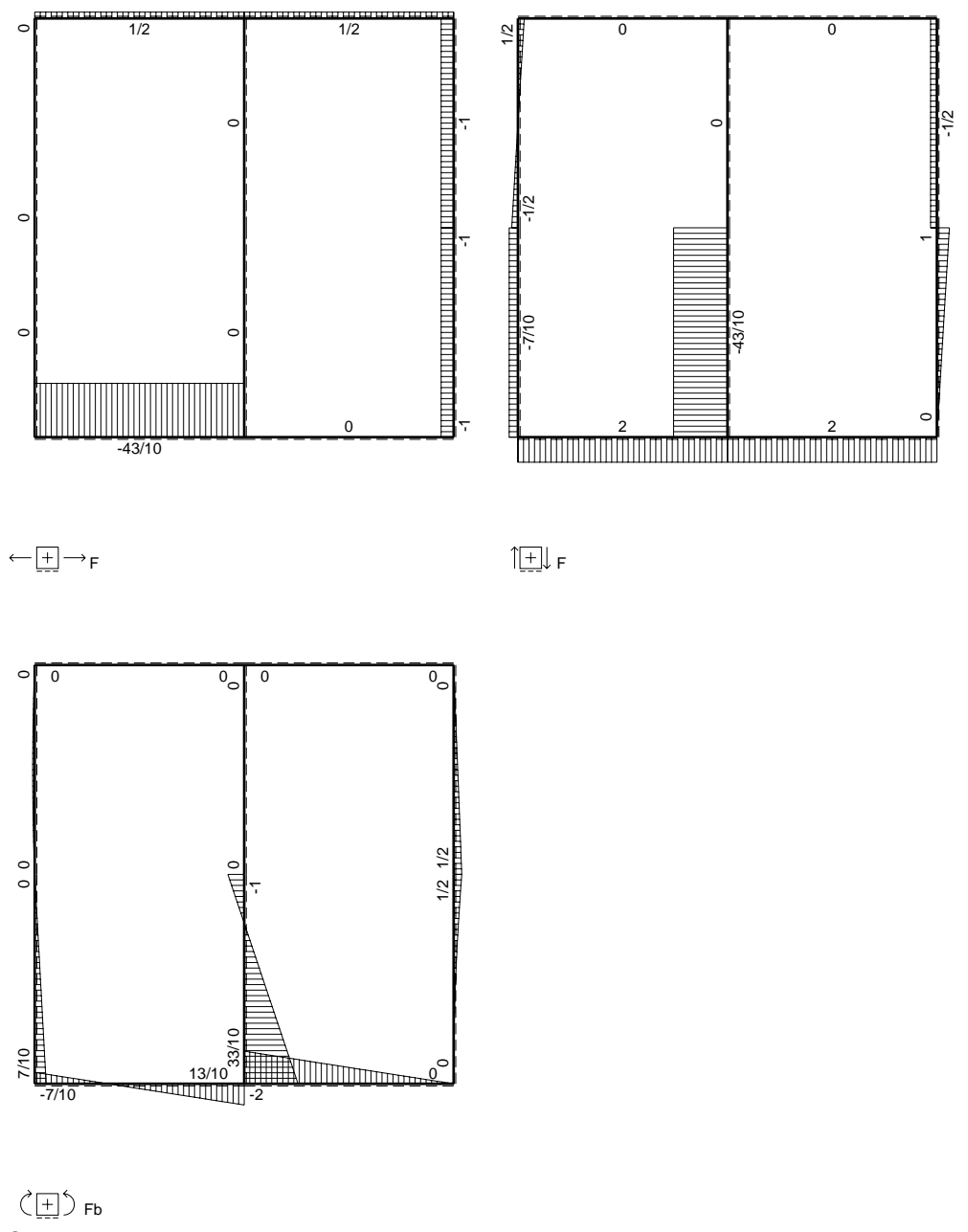
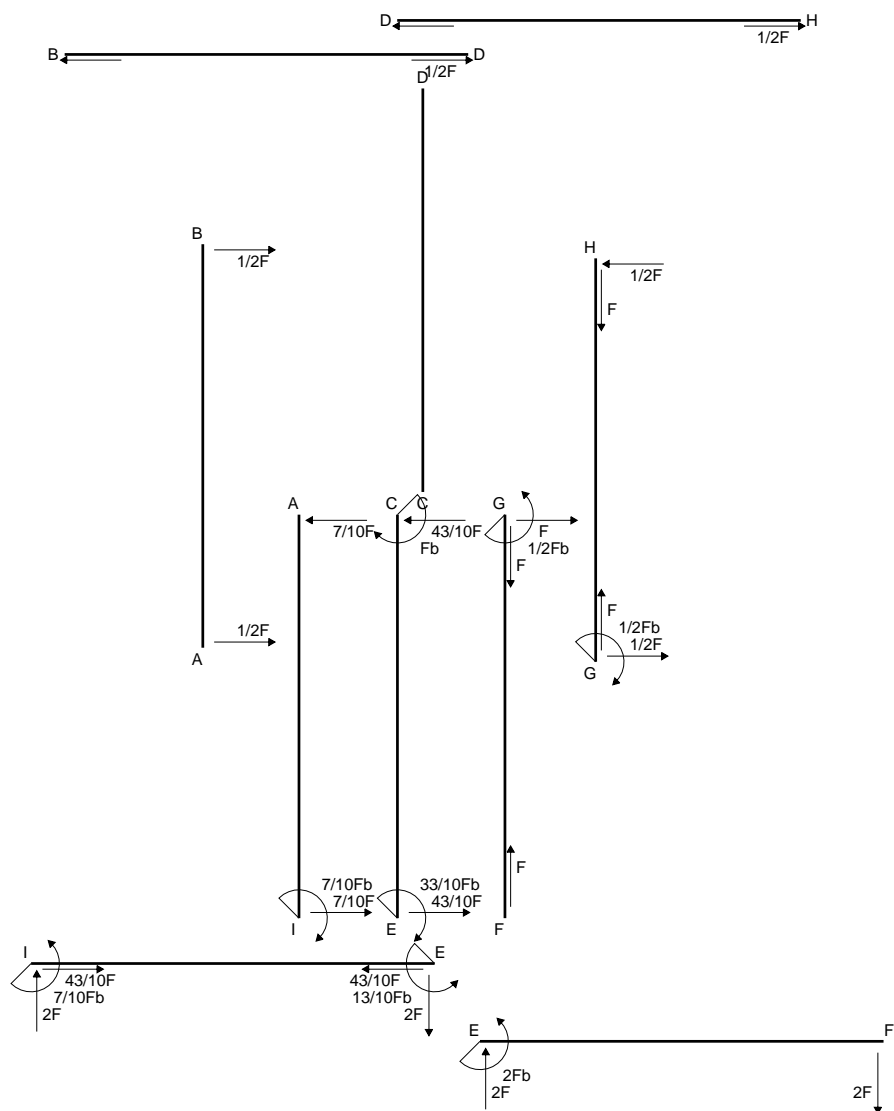
$$= (-5b + 11/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

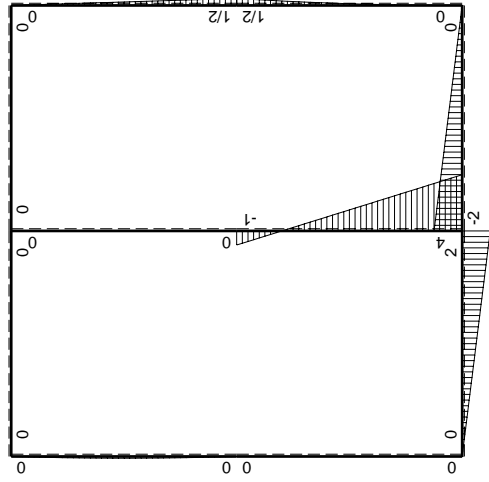
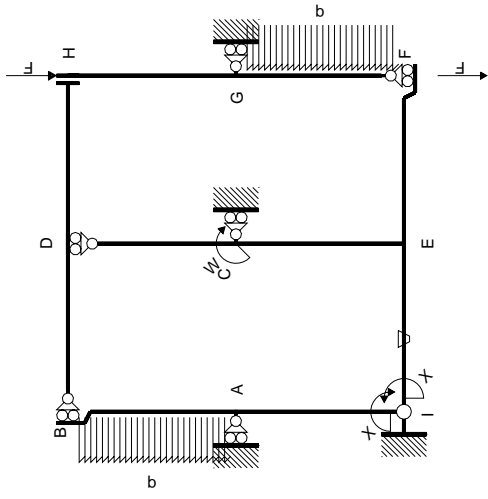
$$L_{CE}^{xo} = \int_0^b (x/b - 6x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$



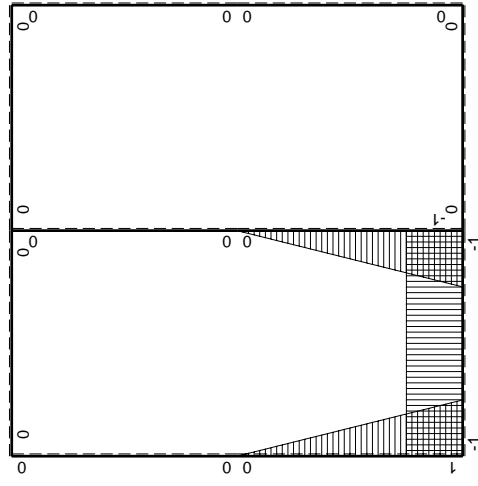
- A = 708. mm²
- J_u = 232181. mm⁴
- J_v = 50940. mm⁴
- y_g = 35.14 mm
- T_y = 2440. N
- M_x = -1317600. Nmm
- x_m = 12. mm
- u_m = -9. mm
- v_m = -35.14 mm
- σ_m = -Mv/J_u = -199.4 N/mm²
- x_c = 21. mm
- y_c = 10. mm
- v_c = -25.14 mm
- σ_c = -Mv/J_u = -142.7 N/mm²
- τ_c = 6.598 N/mm²
- σ_o = √σ²+3τ² = 143.1 N/mm²
- S = 3767. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-5Fx$	0	$-4Fb+9Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-5Fx$	0	$Fx-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-7/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

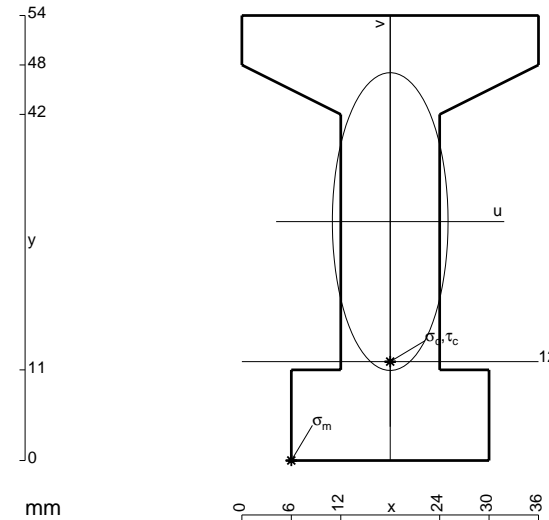
$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 9x/b - 5x^2/b^2) Fb 1/EJ dx = [-4x + 9/2 x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-4b + 9/2 b - 5/3 b) Fb 1/EJ = -7/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 5x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 5/3 b) Fb 1/EJ = -7/6 Fb^2/EJ$$



$$A = 996. \text{ mm}^2$$

$$J_u = 325364. \text{ mm}^4$$

$$J_v = 49104. \text{ mm}^4$$

$$y_g = 28.99 \text{ mm}$$

$$T_y = 3980. \text{ N}$$

$$M_x = -2348200. \text{ Nmm}$$

$$x_m = 6. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -28.99 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -209.3 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 12. \text{ mm}$$

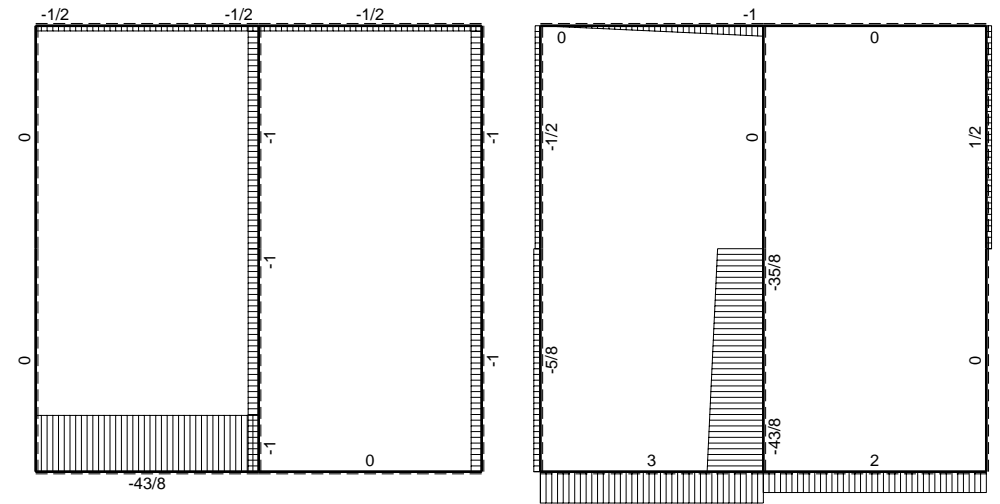
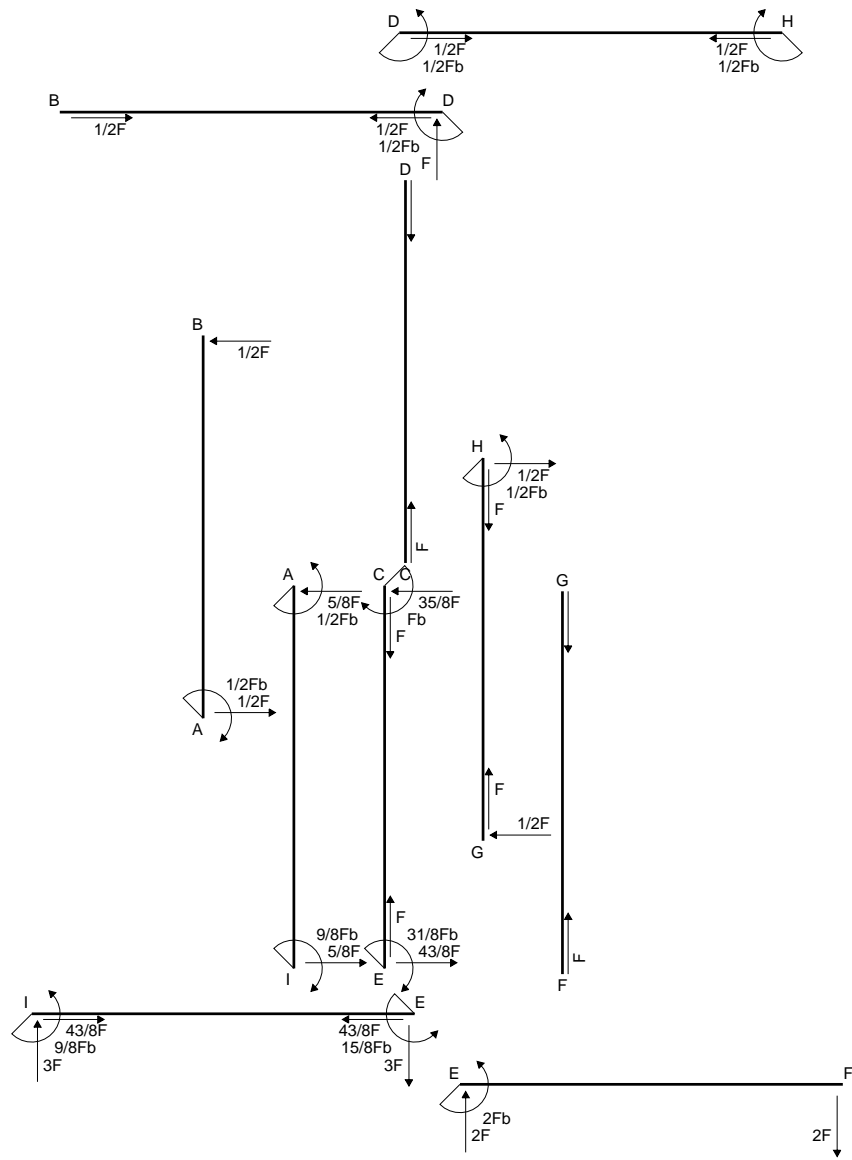
$$v_c = -16.99 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -122.6 \text{ N/mm}^2$$

$$\tau_c = 6.537 \text{ N/mm}^2$$

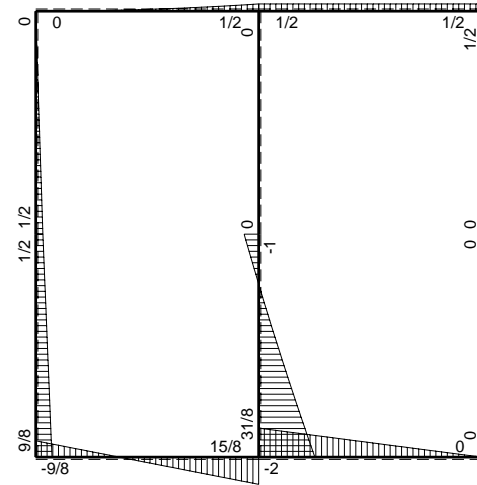
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 123.2 \text{ N/mm}^2$$

$$S = 6412. \text{ mm}^3$$

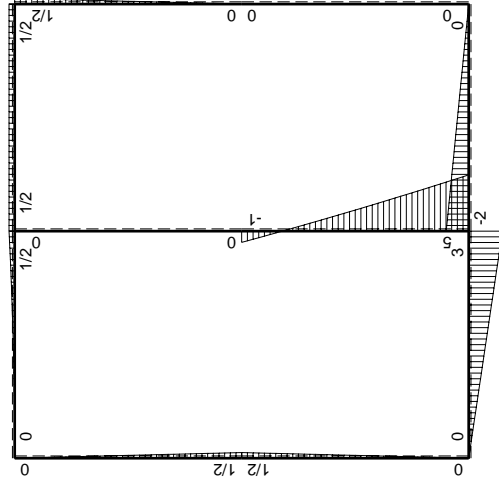
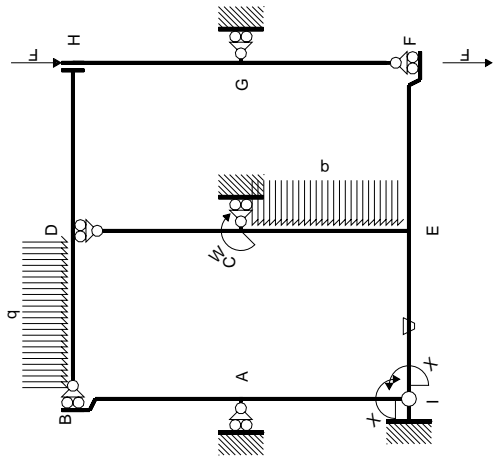


← ⊕ → F

↑ ⊕ ↓ F

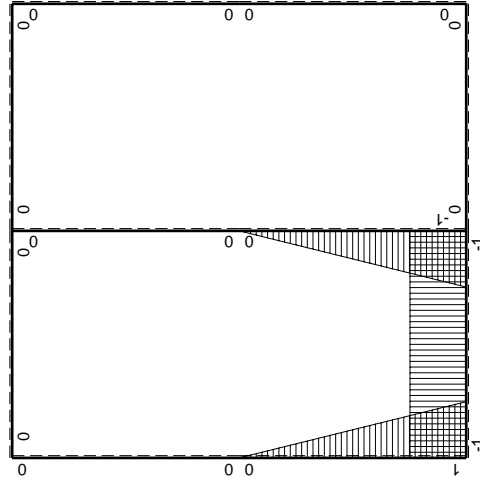


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-13/2Fx+1/2qx^2$	0	$-5Fb+23/2Fx-7Fx^2/b+1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-35/24+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-11/2Fx-1/2qx^2$	0	$Fx-11/2Fx^2/b-1/2qx^3/b$	0	x^2/b^2		
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-15/8Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$9/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 23/2 x/b - 7x^2/b^2 + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx$$

$$= [-5x + 23/4 x^2/b - 7/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 23/4 b - 7/3 b + 1/8 b) Fb \frac{1}{EJ} = -35/24 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 11/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 11/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb \frac{1}{EJ}$$

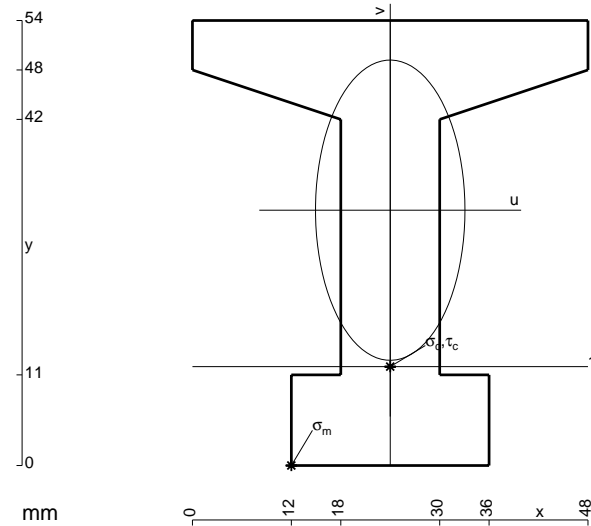
$$= (1/2 b - 11/6 b - 1/8 b) Fb \frac{1}{EJ} = -35/24 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

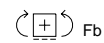
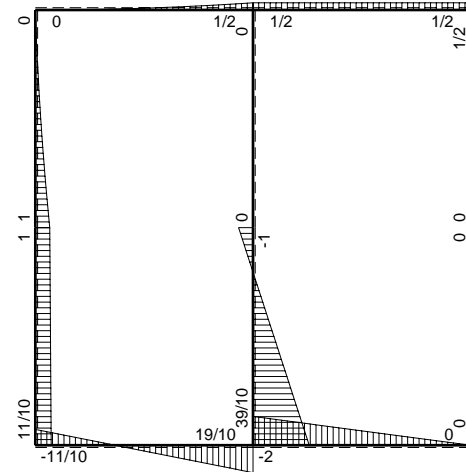
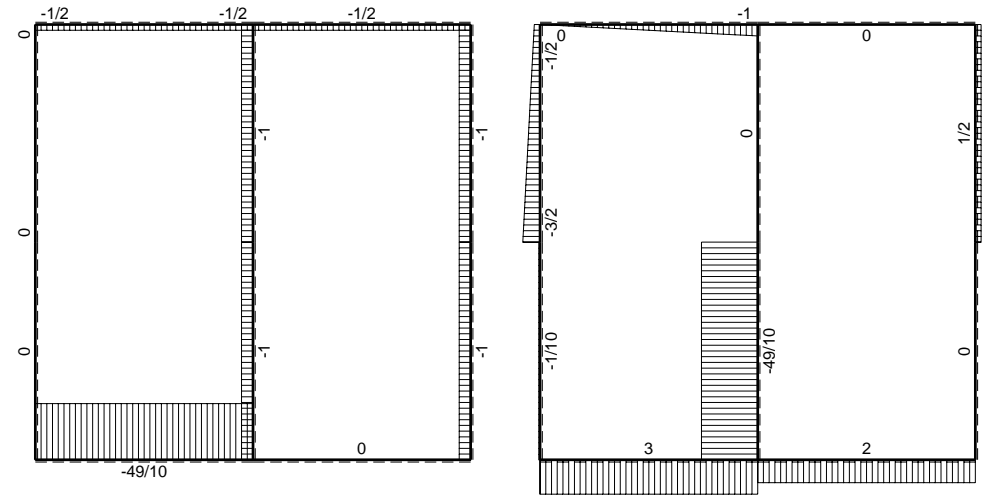
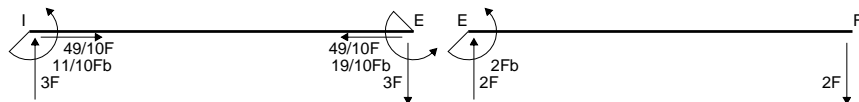
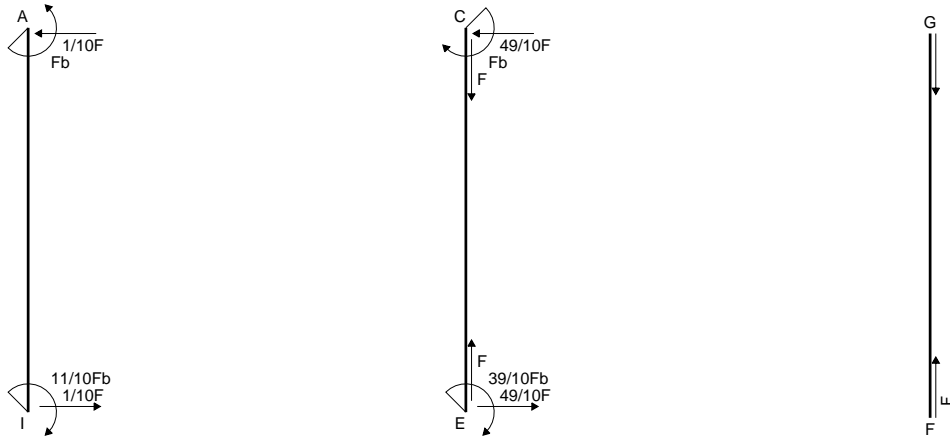
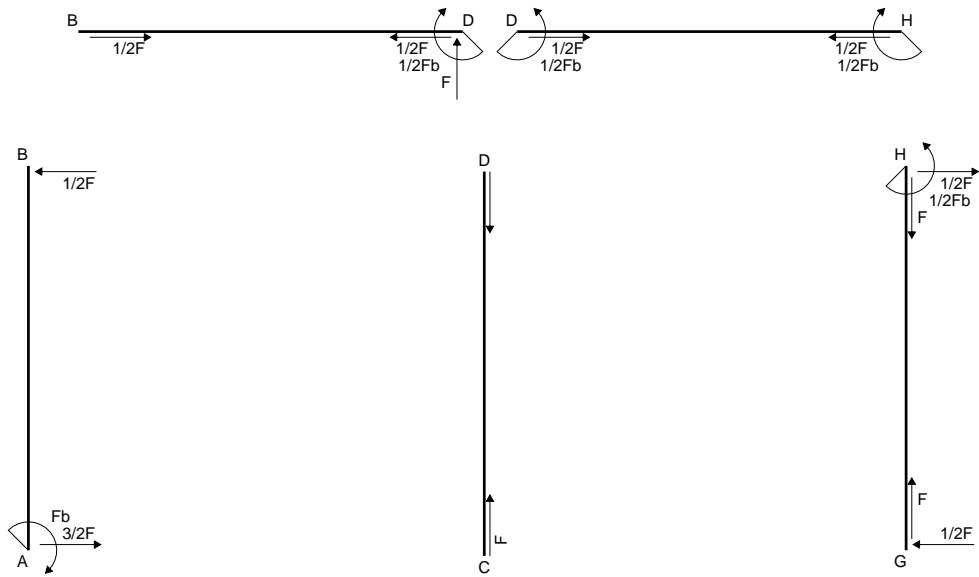
$$= (1/4 b - 1/6 b) Fb \frac{1}{EJ} = 1/12 Fb^2/EJ$$

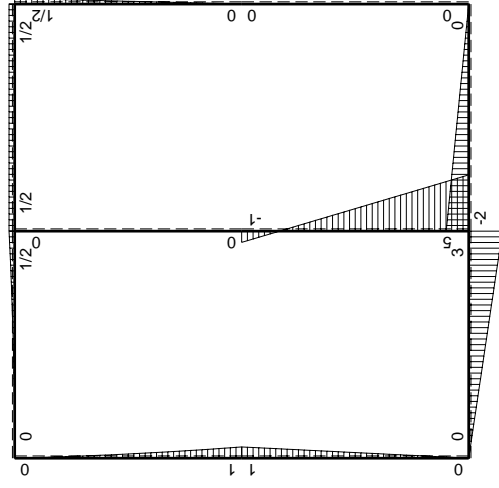
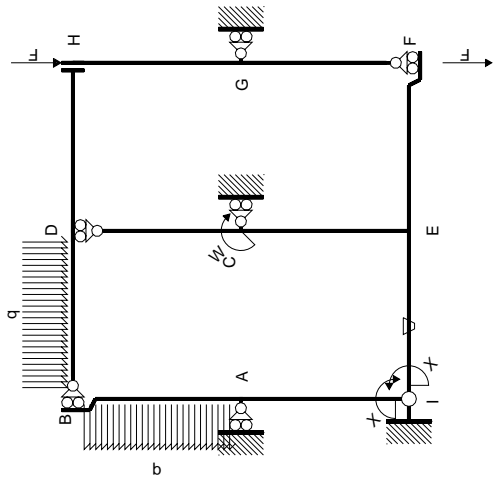
$$L_{AI}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/4 b - 1/6 b) Fb \frac{1}{EJ} = 1/12 Fb^2/EJ$$



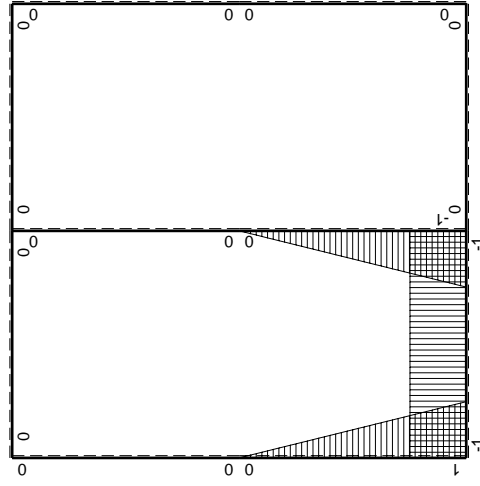
- A = 1104. mm²
- J_u = 366560. mm⁴
- J_v = 90792. mm⁴
- y_g = 30.98 mm
- T_y = 4060. N
- M_x = -2598400. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.98 mm
- σ_m = -Mv/J_u = -219.6 N/mm²
- x_c = 24. mm
- y_c = 12. mm
- v_c = -18.98 mm
- σ_c = -Mv/J_u = -134.6 N/mm²
- τ_c = 6.425 N/mm²
- σ_ρ = √(σ² + 3τ²) = 135. N/mm²
- S = 6962. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-6Fx$	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-6Fx$	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-Fb+Fx$	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 11x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 11/2 x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 11/2 b - 2b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

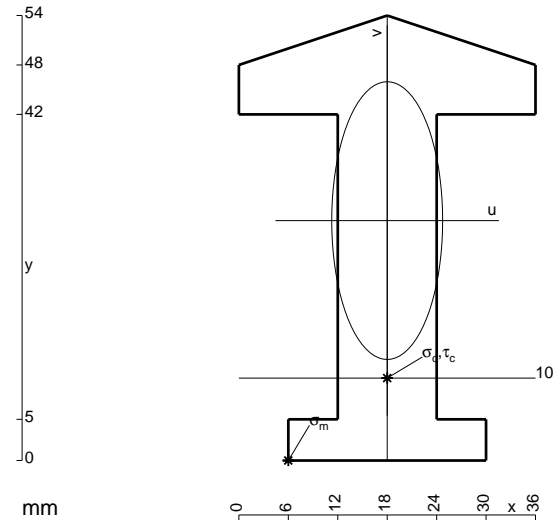
$$= (1/2 b - 2b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (x/b - x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

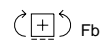
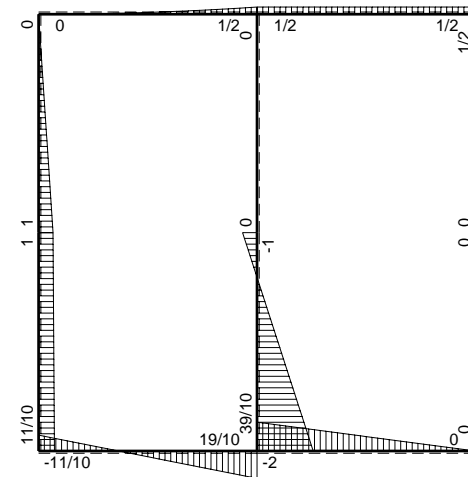
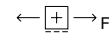
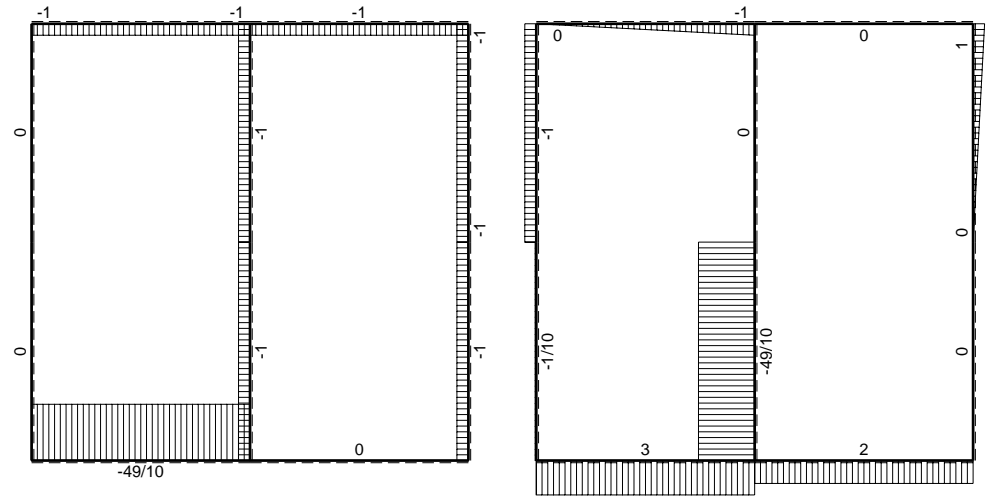
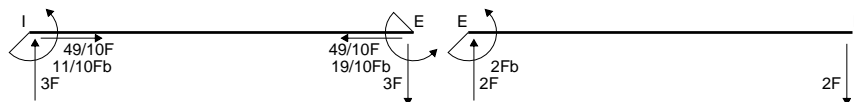
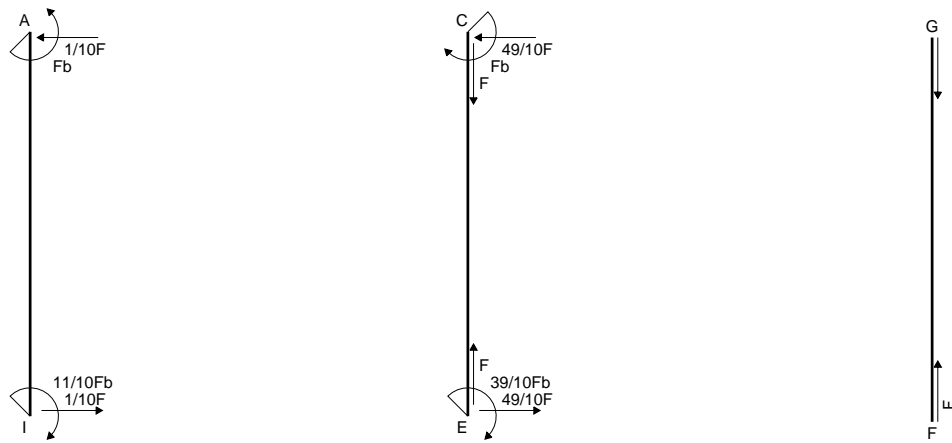
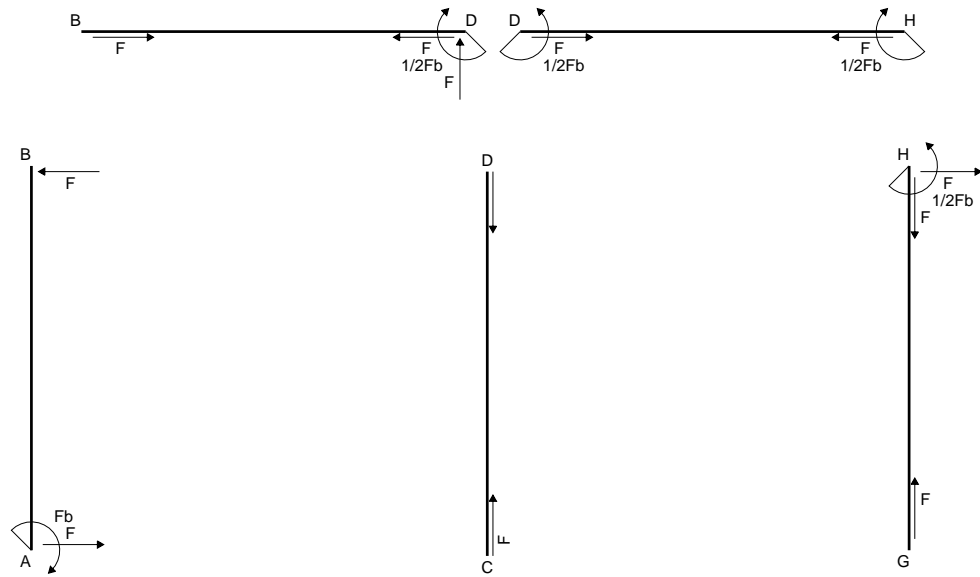
$$= (1/2 b - 1/3 b) Fb \frac{1}{EJ} = 1/6 Fb^2/EJ$$

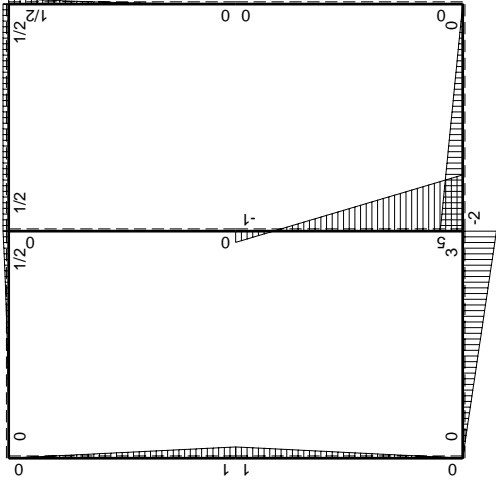
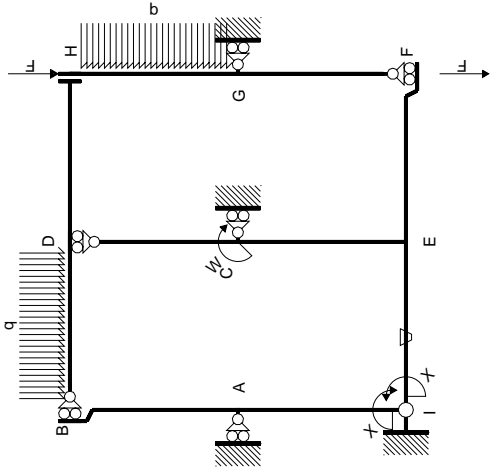
$$L_{AI}^{xo} = \int_0^b (x/b - x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/2 b - 1/3 b) Fb \frac{1}{EJ} = 1/6 Fb^2/EJ$$



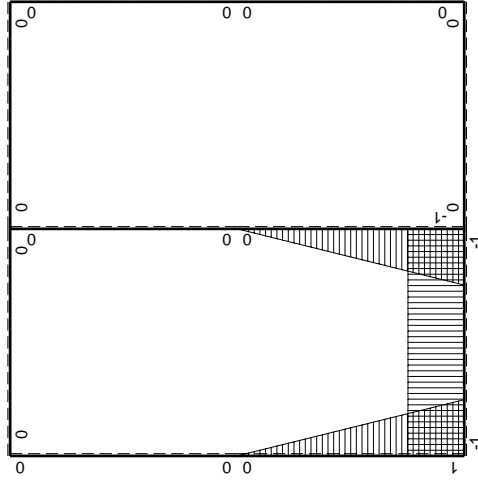
- A = 888. mm²
- J_u = 252380. mm⁴
- J_v = 40248. mm⁴
- y_g = 29.11 mm
- T_y = 2840. N
- M_x = -1988000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -29.11 mm
- σ_m = -Mv/J_u = -229.3 N/mm²
- x_c = 18. mm
- y_c = 10. mm
- v_c = -19.11 mm
- σ_c = -Mv/J_u = -150.6 N/mm²
- τ_c = 4.211 N/mm²
- σ_o = √σ²+3τ² = 150.7 N/mm²
- S = 4491. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-6Fx	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	Fb-6Fx	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	-Fb+Fx	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 11x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 11/2 x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 11/2 b - 2b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

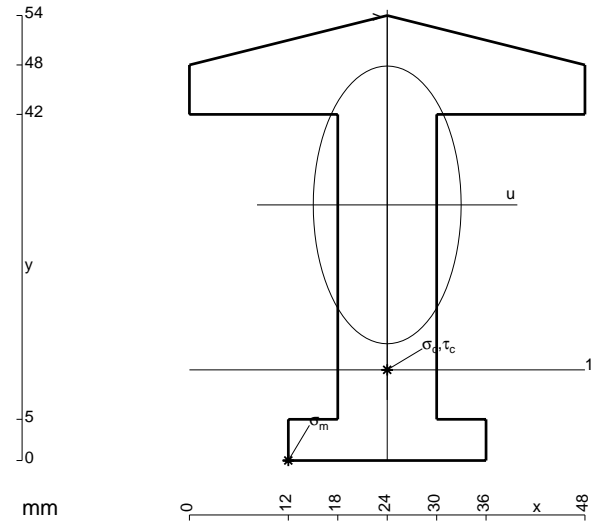
$$= (1/2 b - 2b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (x/b - x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

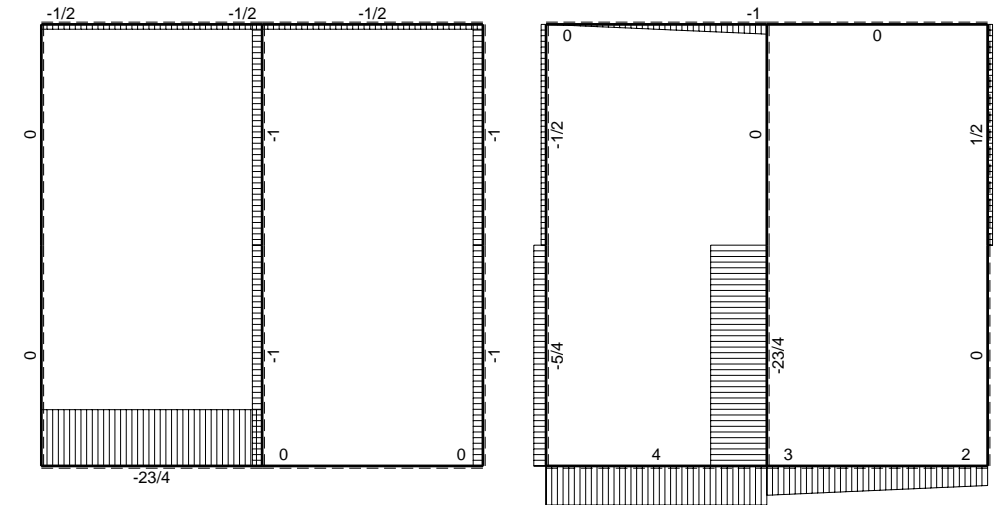
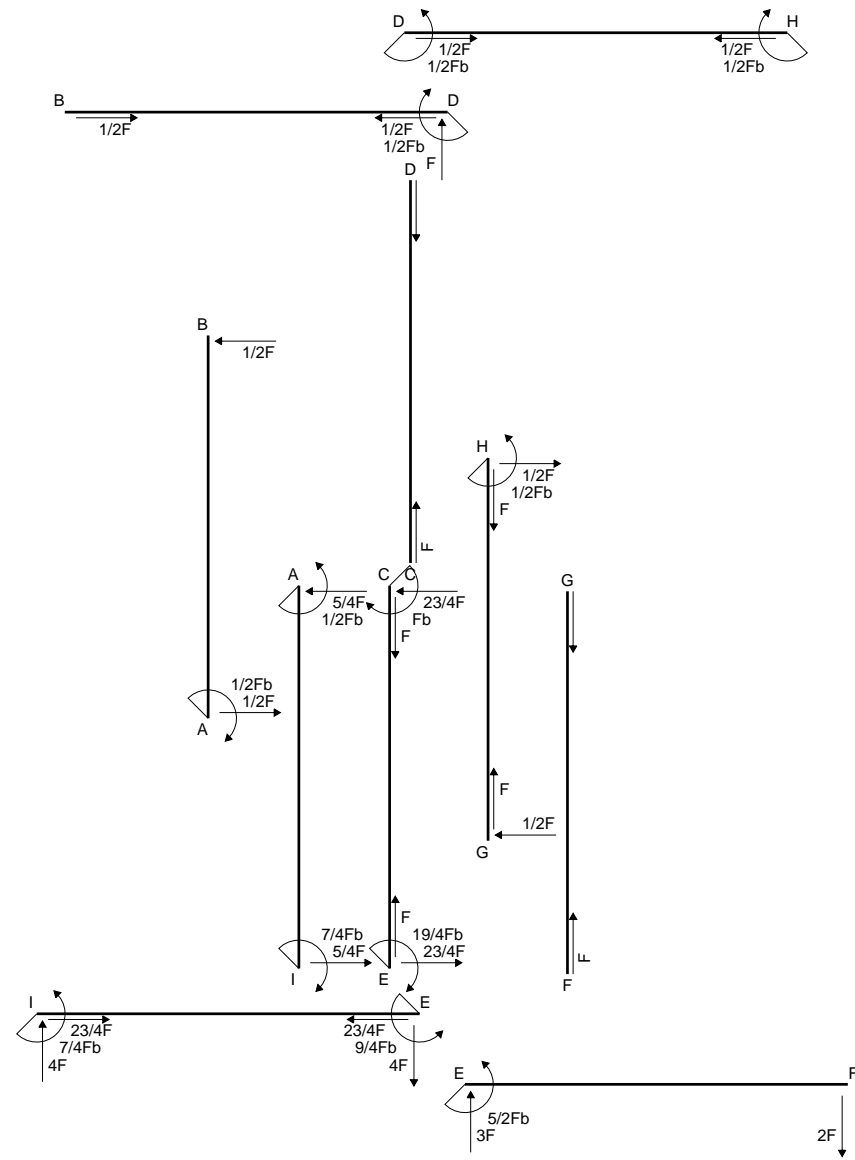
$$= (1/2 b - 1/3 b) Fb \frac{1}{EJ} = 1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (x/b - x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/2 b - 1/3 b) Fb \frac{1}{EJ} = 1/6 Fb^2/EJ$$

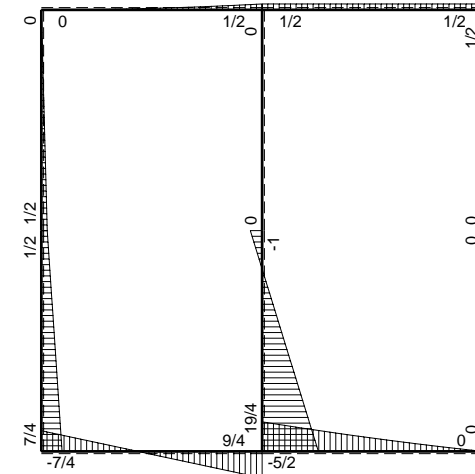


- A = 996. mm²
- J_u = 282932. mm⁴
- J_v = 80208. mm⁴
- y_g = 31.02 mm
- T_y = 2900. N
- M_x = -2175000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -31.02 mm
- σ_m = -Mv/J_u = -238.4 N/mm²
- x_c = 24. mm
- y_c = 11. mm
- v_c = -20.02 mm
- σ_c = -Mv/J_u = -153.9 N/mm²
- τ_c = 4.339 N/mm²
- σ_o = √(σ² + 3τ²) = 154.1 N/mm²
- S = 5079. mm³

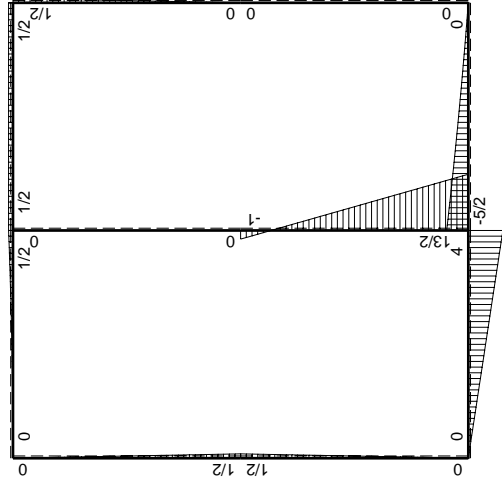
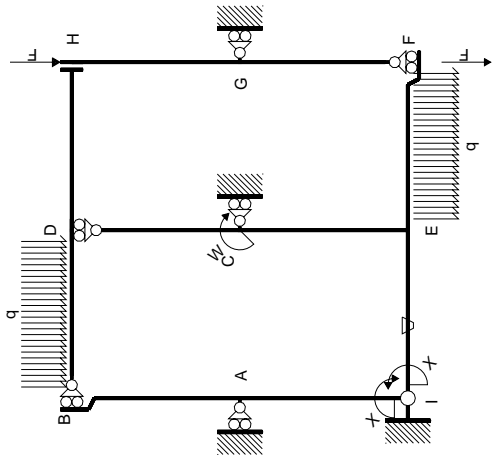


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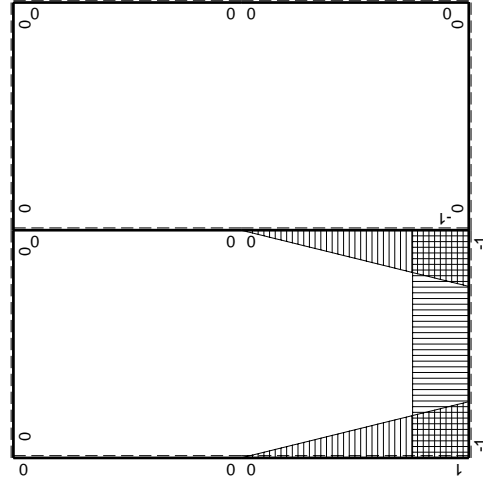


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-15/2Fx$	0	$-13/2Fb+14Fx-15/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-15/2Fx$	0	$Fx-15/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b) Fb 1/EJ + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-4 + 4x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-4b + 2b) Fb 1/EJ + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-13/2 + 14x/b - 15/2 x^2/b^2) Fb 1/EJ dx = [-13/2 x + 7x^2/b - 5/2 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-13/2 b + 7b - 5/2 b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 15/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 5/2 x^3/b^2]_0^b Fb 1/EJ$$

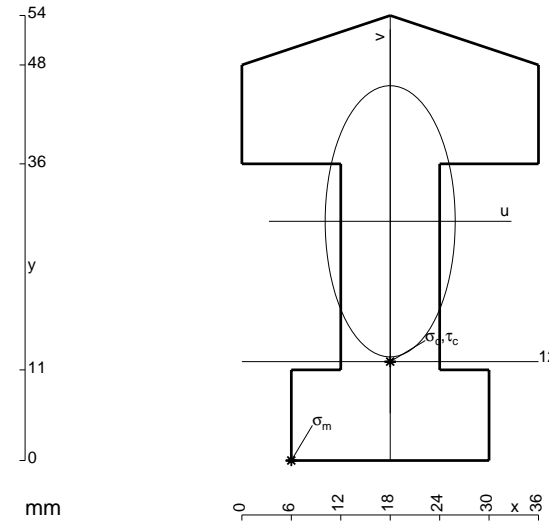
$$= (1/2 b - 5/2 b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

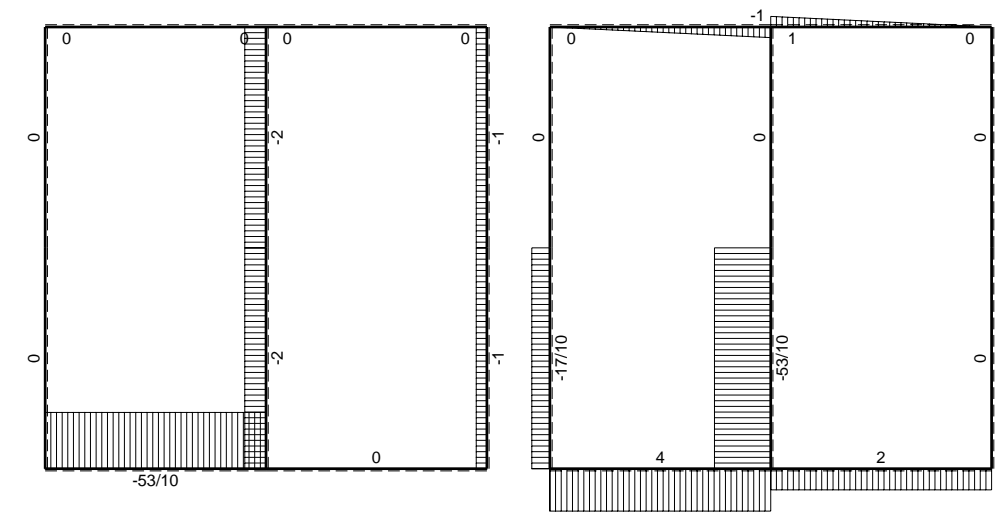
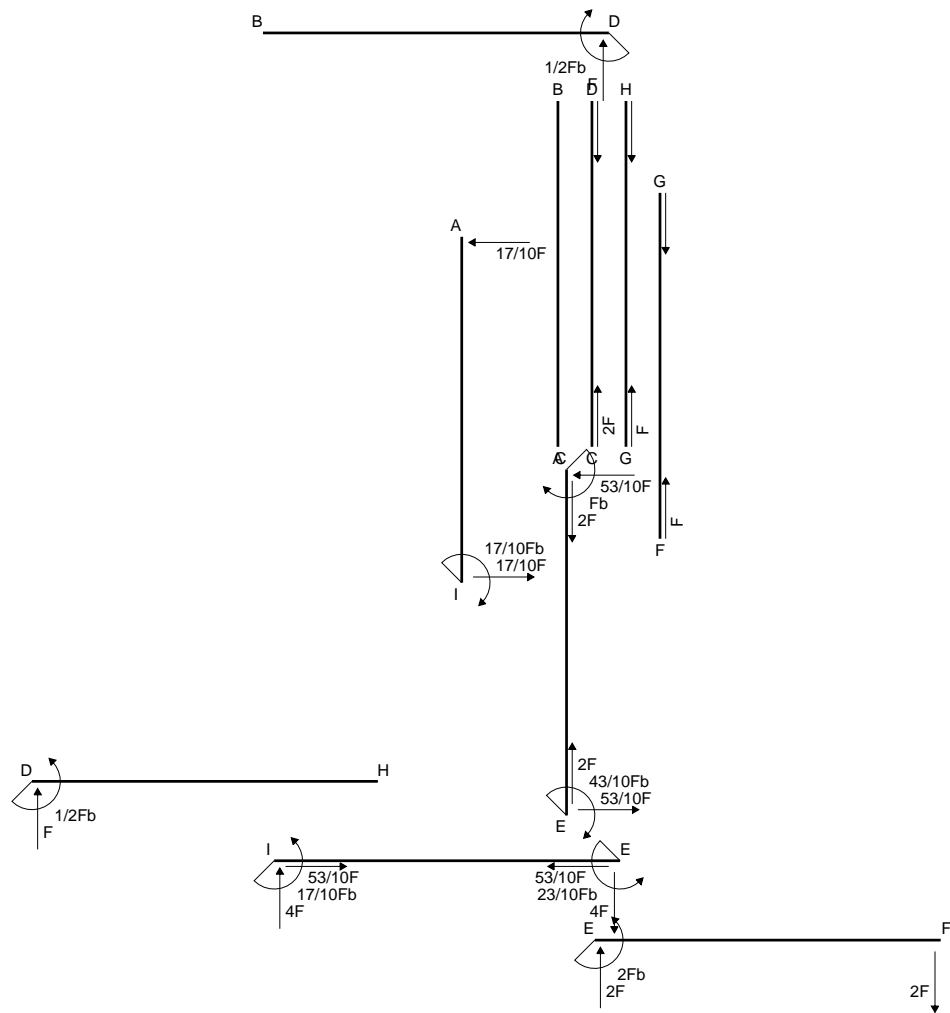
$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

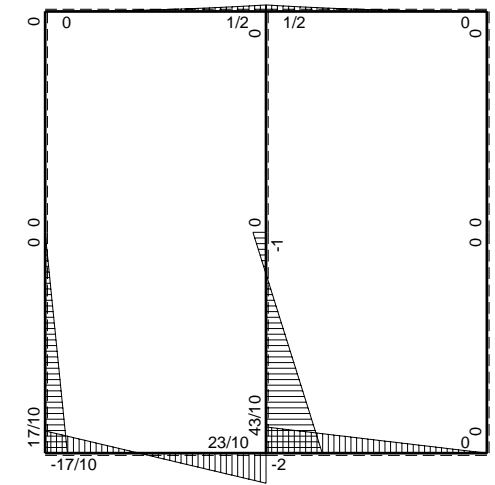


- A = 1104. mm²
- J_u = 299191. mm⁴
- J_v = 68760. mm⁴
- y_g = 29.03 mm
- T_y = 3030. N
- M_x = -2045250. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -29.03 mm
- σ_m = -Mv/J_u = -198.4 N/mm²
- x_c = 18. mm
- y_c = 12. mm
- v_c = -17.03 mm
- σ_c = -Mv/J_u = -116.4 N/mm²
- τ_c = 5.419 N/mm²
- σ_o = √σ²+3τ² = 116.8 N/mm²
- S = 6422. mm³

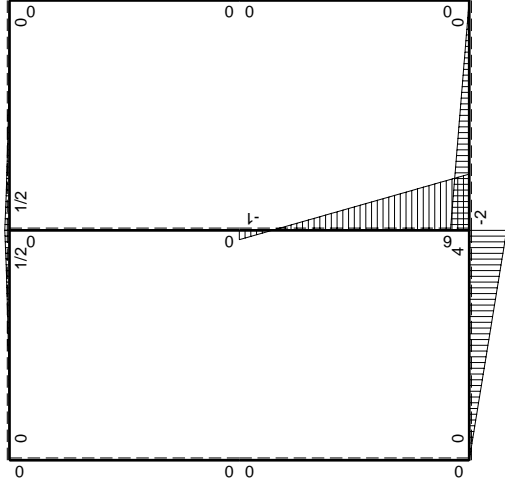
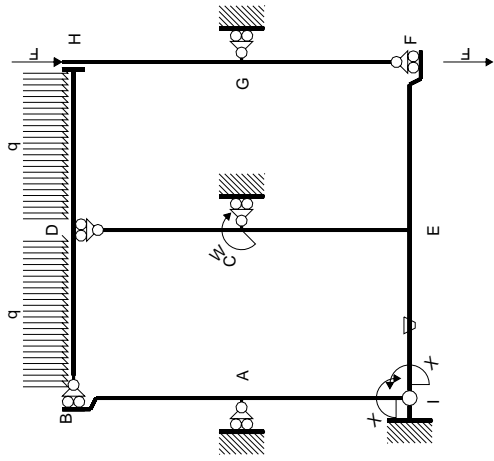


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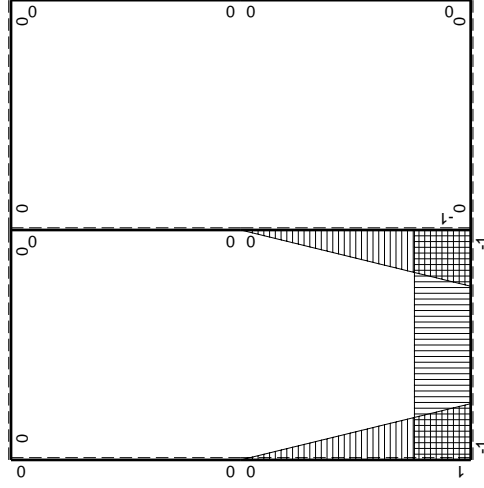


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	0	0	0	0	0	0+0	0	
BA b	0	0	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	0	0	0	0	0	0+0	0	
HG b	0	0	0	0	0	0			
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0	
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
BD b	0	$-1/2qx^2$	0	0	0	0			
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1			
EC b	$-1+x/b$	$6Fb-7Fx$	0	$-6Fb+13Fx-7Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$Fb-7Fx$	0	$Fx-7Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$	
AI b	$-x/b$	0	0	0	0	x^2/b^2			
	totali							$-17/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$17/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b) Fb 1/EJ + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-4 + 4x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

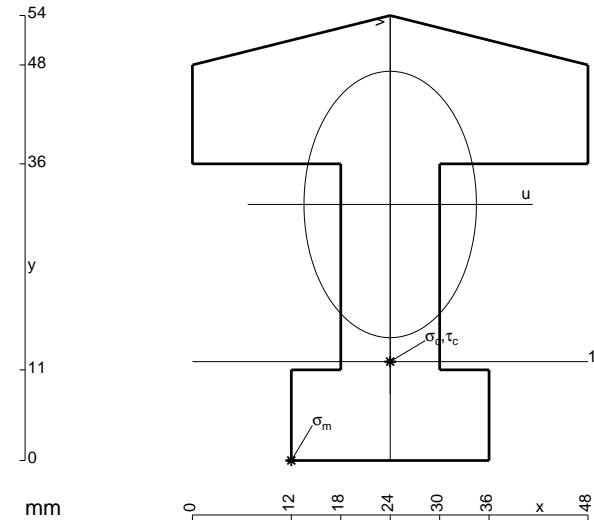
$$= (-4b + 2b) Fb 1/EJ + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 13x/b - 7x^2/b^2) Fb 1/EJ dx = [-6x + 13/2 x^2/b - 7/3 x^3/b^2]_0^b Fb 1/EJ$$

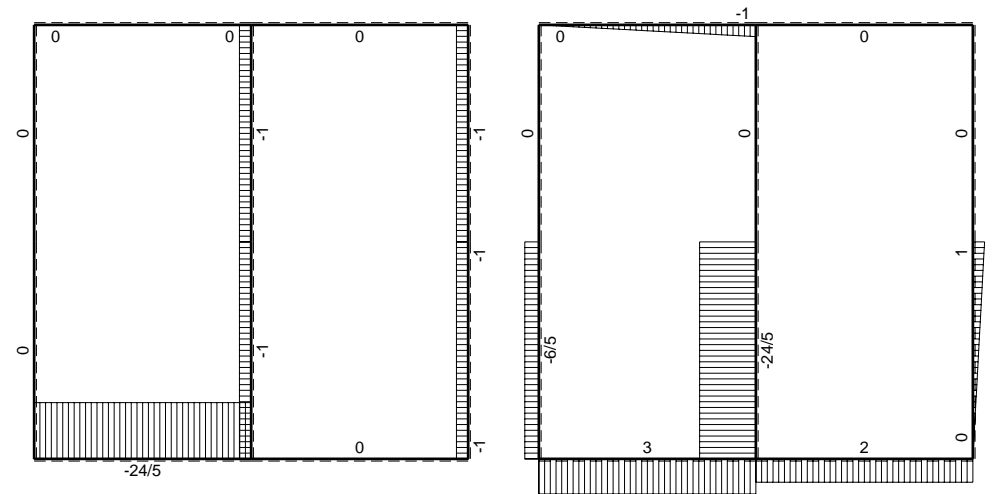
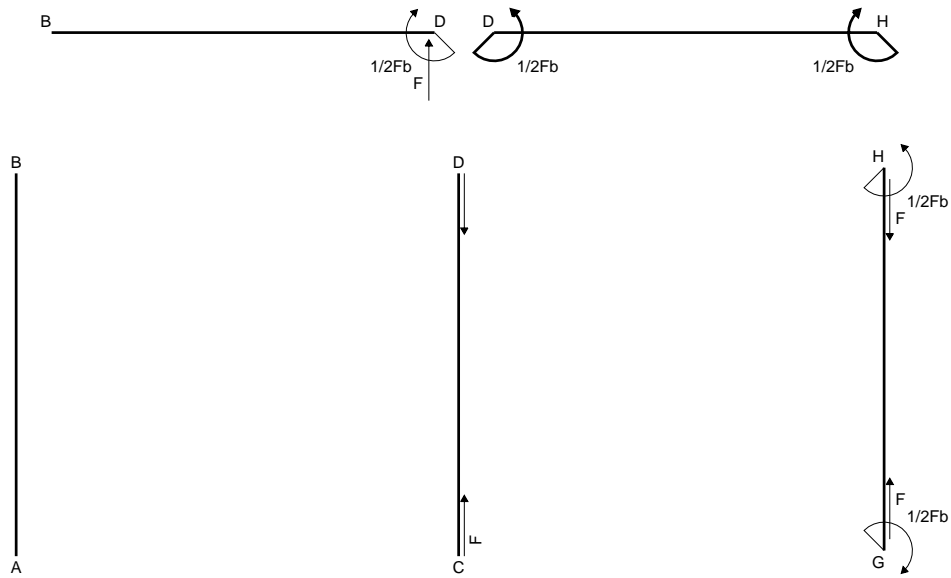
$$= (-6b + 13/2 b - 7/3 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 7x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 7/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 7/3 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

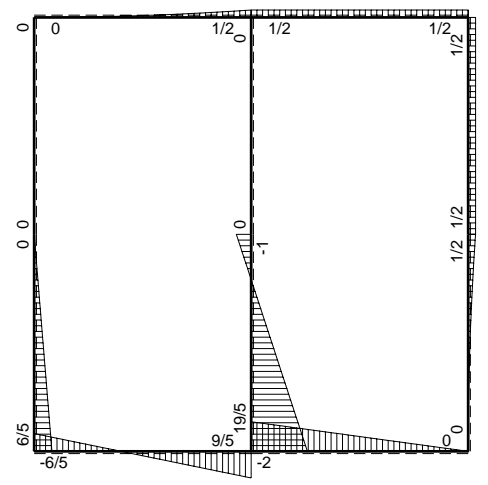
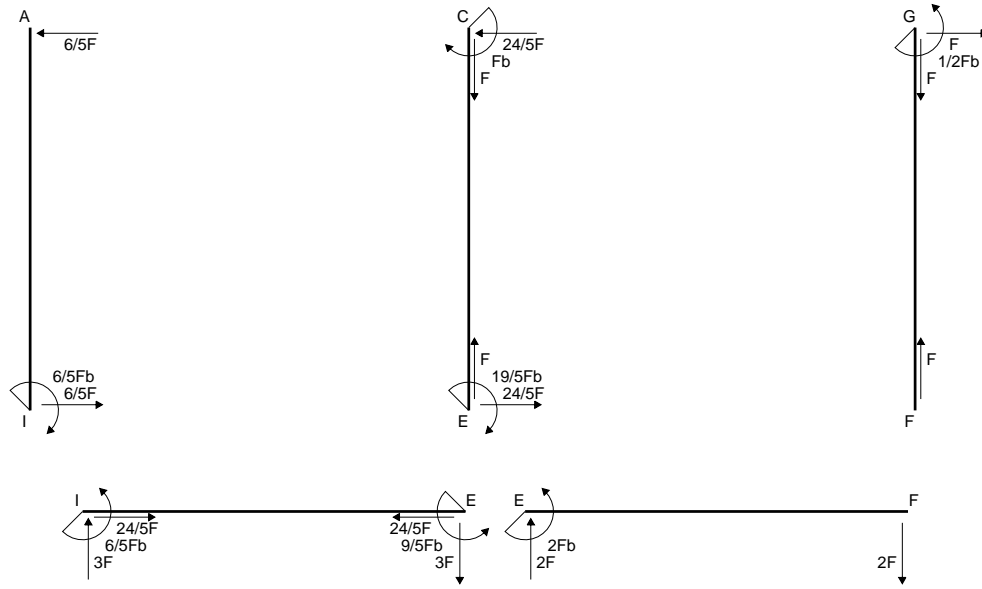


- A = 1284. mm²
- J_u = 335702. mm⁴
- J_v = 140688. mm⁴
- y_g = 31.07 mm
- T_y = 2620. N
- M_x = -2253200. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -31.07 mm
- σ_m = -Mv/J_u = -208.5 N/mm²
- x_c = 24. mm
- y_c = 12. mm
- v_c = -19.07 mm
- σ_c = -Mv/J_u = -128. N/mm²
- τ_c = 4.543 N/mm²
- σ_o = √σ²+3τ² = 128.2 N/mm²
- S = 6985. mm³

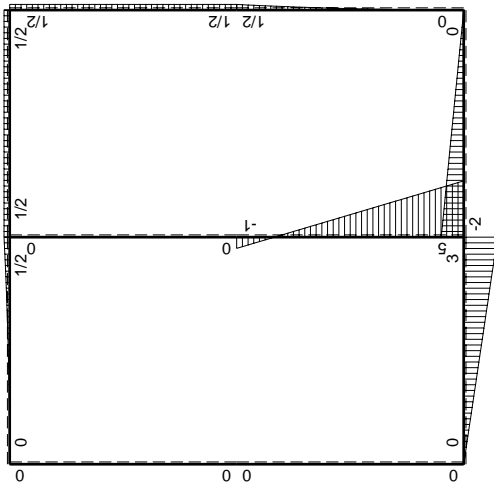
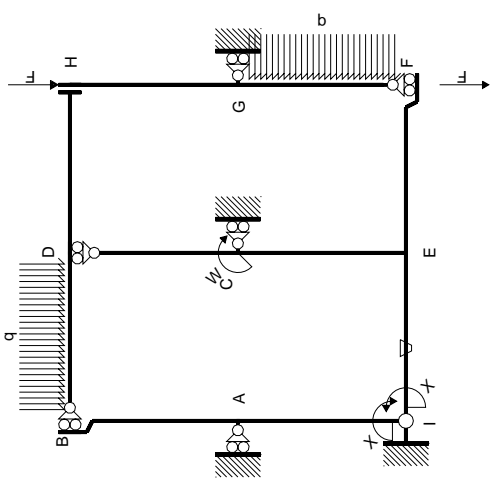


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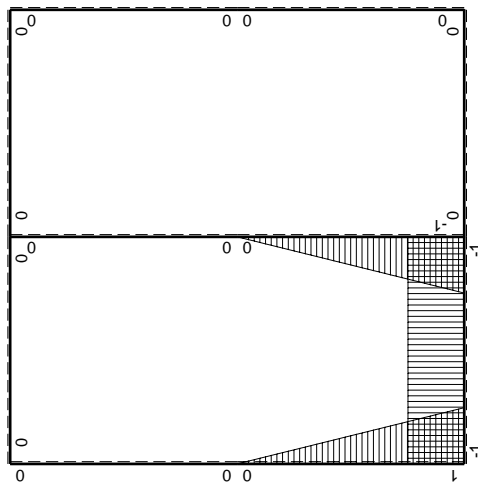


⊕ ⊕ Fb



Schema di calcolo iperstatico

M_0 , flessione da carichi assegnati



M_1 , flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-6Fx$	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-6Fx$	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$6/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

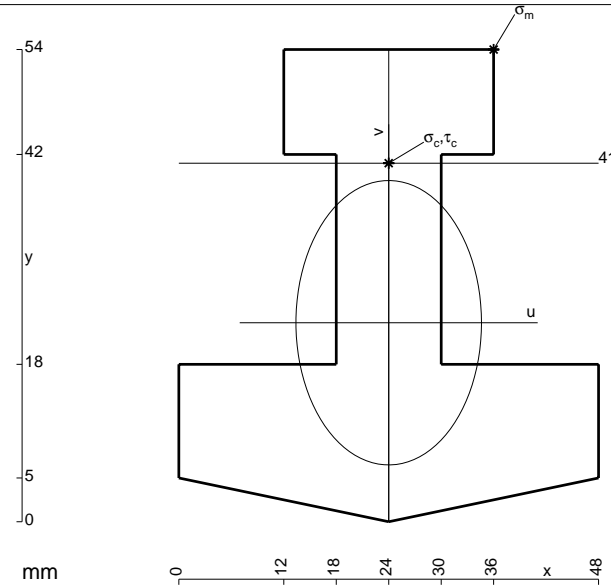
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 11x/b - 6x^2/b^2) Fb 1/EJ dx = [-5x + 11/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

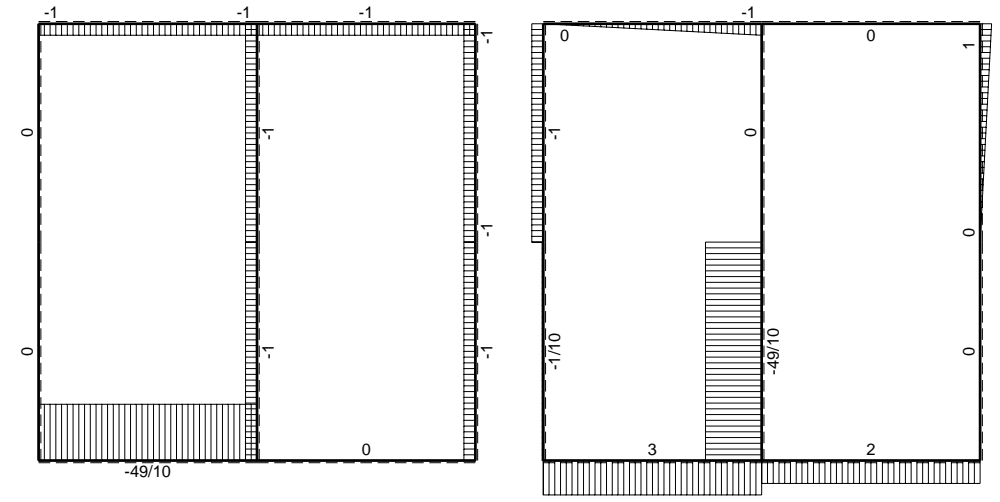
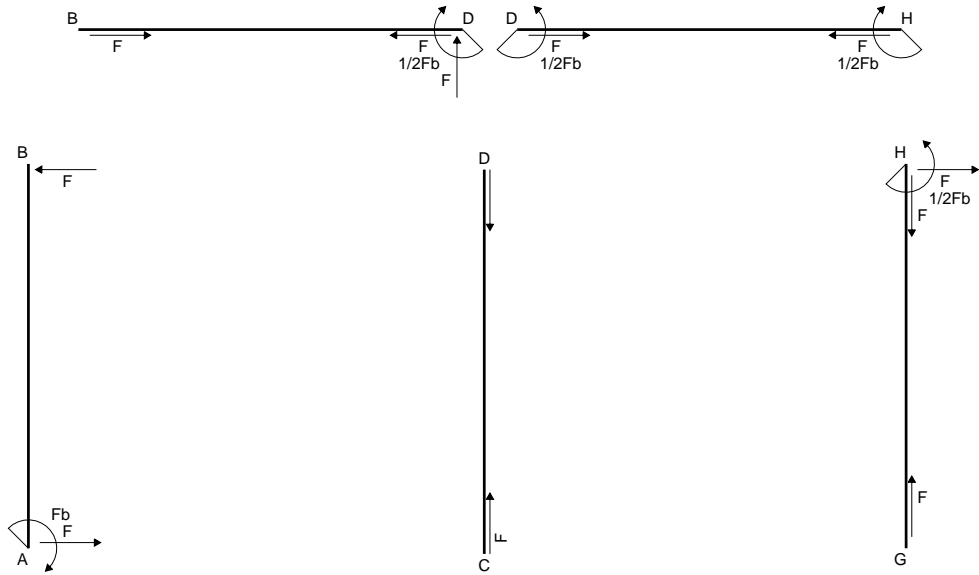
$$= (-5b + 11/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 6x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

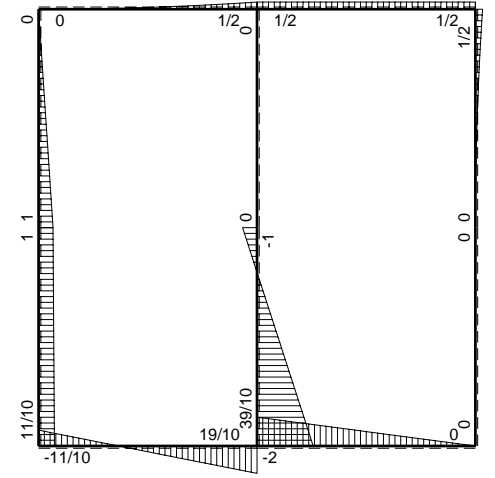
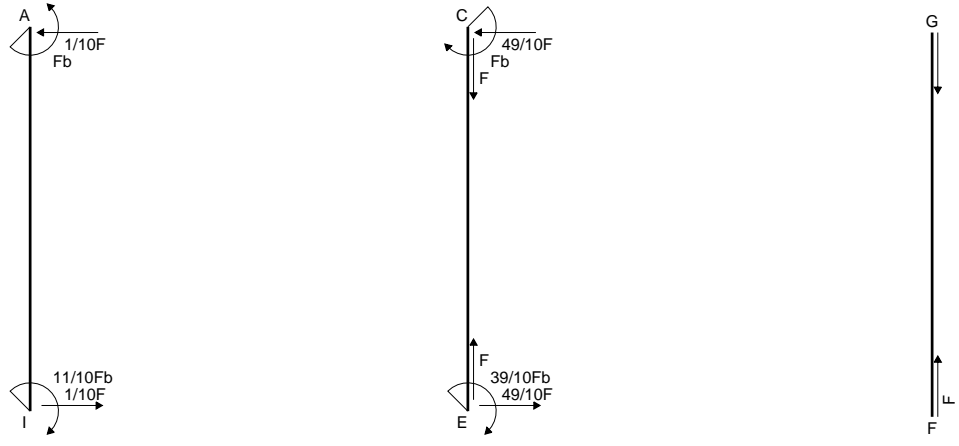


- A = 1320. mm²
- J_u = 349206. mm⁴
- J_v = 148608. mm⁴
- y_g = 22.76 mm
- T_y = 2700. N
- M_x = -2457000. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 31.24 mm
- σ_m = -Mv/J_u = 219.8 N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 18.24 mm
- σ_c = -Mv/J_u = 128.4 N/mm²
- τ_c = 4.829 N/mm²
- σ_q = √σ²+3τ² = 128.6 N/mm²
- S = 7495. mm³

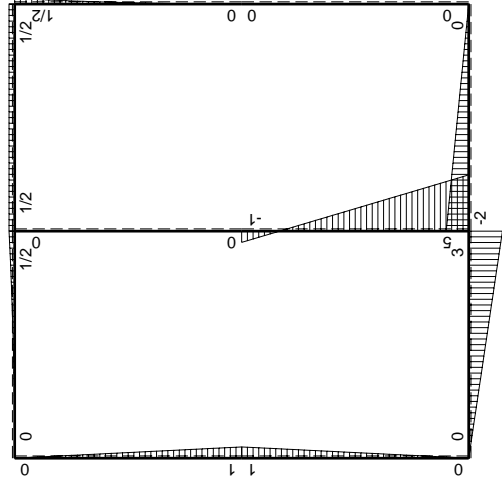
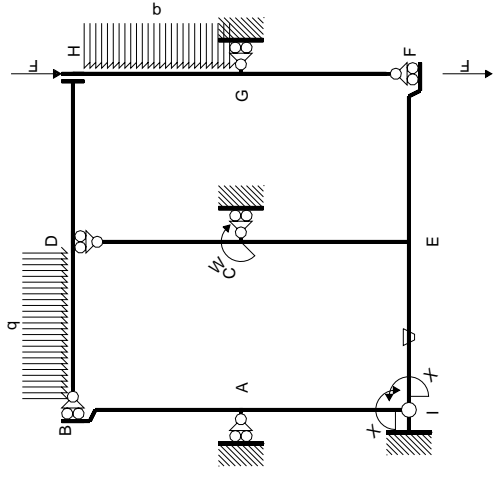


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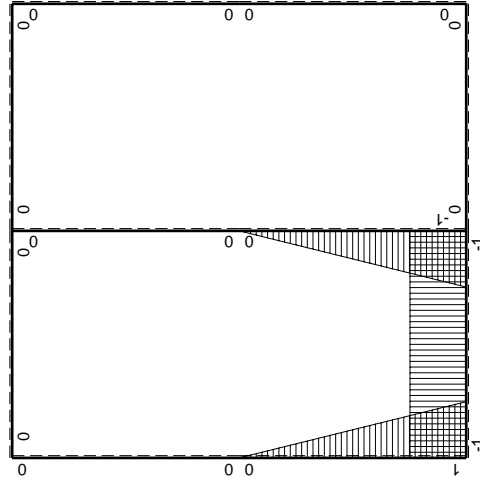


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-6Fx	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	Fb-6Fx	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	Fx	0	$Fx-Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	-Fb+Fx	0	$Fx-Fx^2/b$	0	x^2/b^2		
	totali						$-11/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 11x/b - 6x^2/b^2) Fb 1/EJ dx = [-5x + 11/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 11/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 6x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

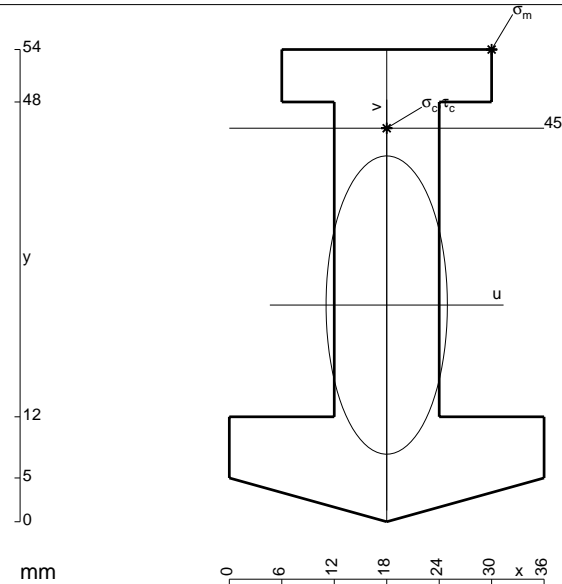
$$= (1/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (x/b - x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb 1/EJ$$

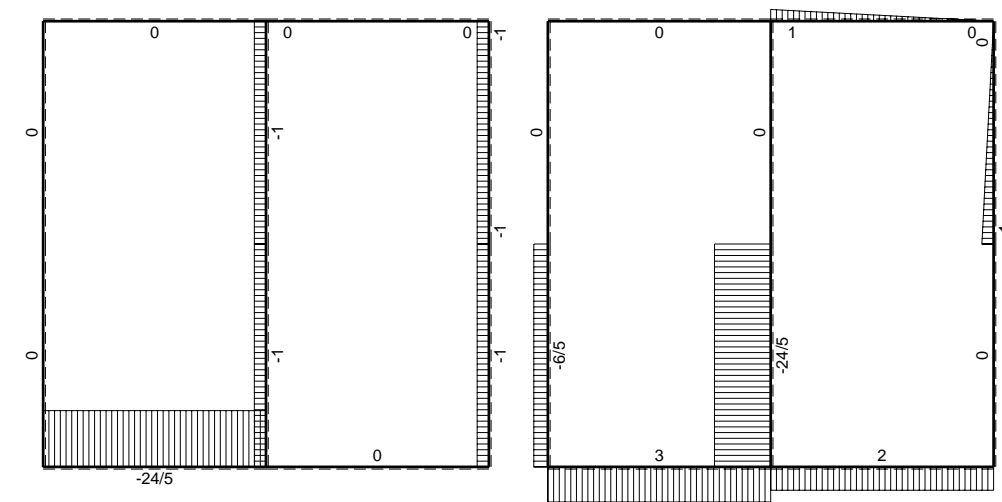
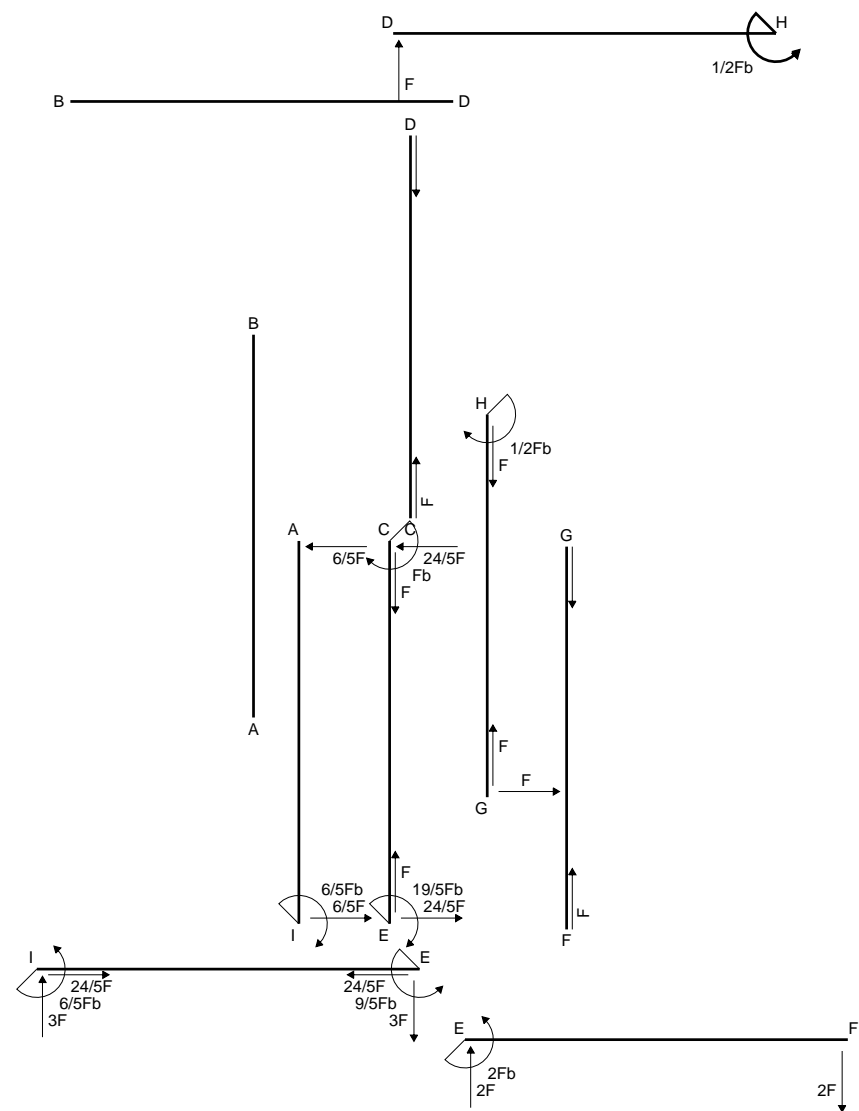
$$= (1/2 b - 1/3 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (x/b - x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/3 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

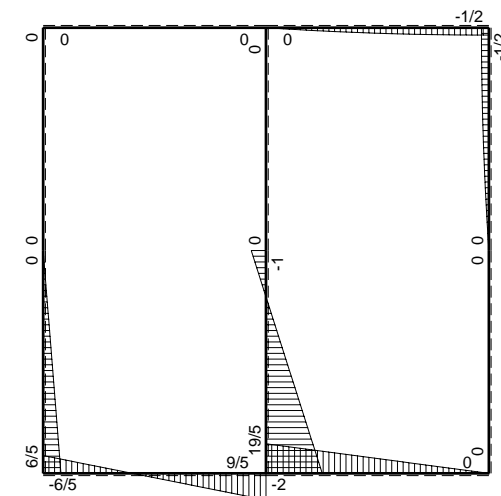


- A = 918. mm²
- J_u = 267198. mm⁴
- J_v = 44172. mm⁴
- y_g = 24.78 mm
- T_y = 2160. N
- M_x = -2095200. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 29.22 mm
- σ_m = -Mv/J_u = 229.1 N/mm²
- x_c = 18. mm
- y_c = 45. mm
- v_c = 20.22 mm
- σ_c = -Mv/J_u = 158.6 N/mm²
- τ_c = 3.071 N/mm²
- σ_q = √σ²+3τ² = 158.7 N/mm²
- S = 4558. mm³

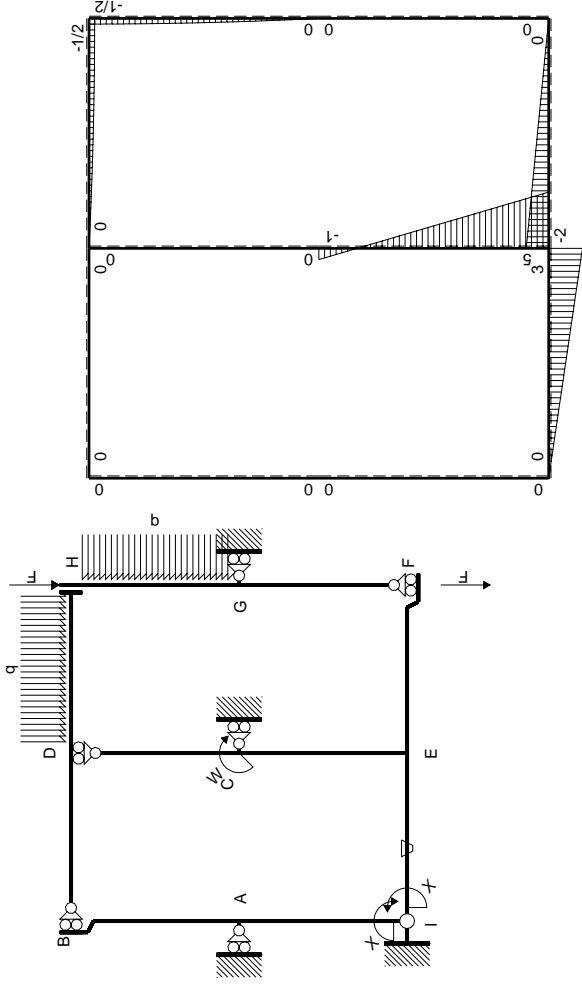


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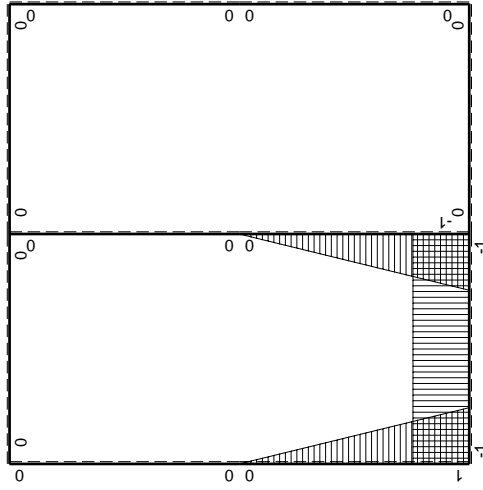


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2qx^2$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-6Fx$	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-6Fx$	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$6/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

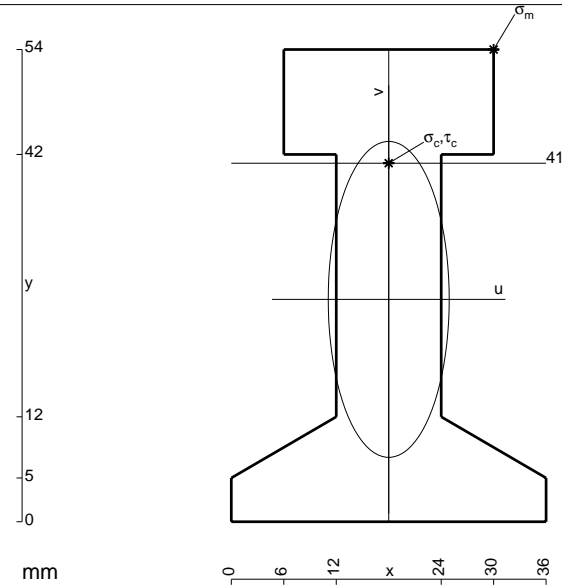
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 11x/b - 6x^2/b^2) Fb 1/EJ dx = [-5x + 11/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

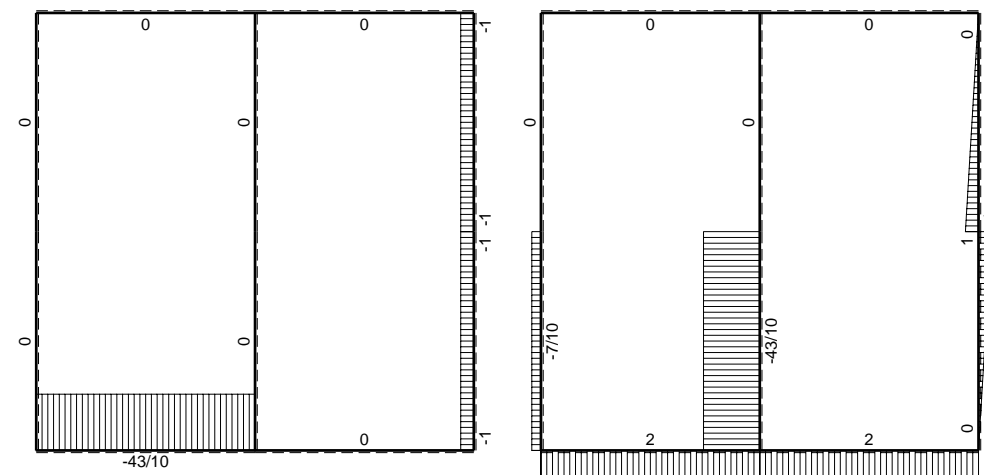
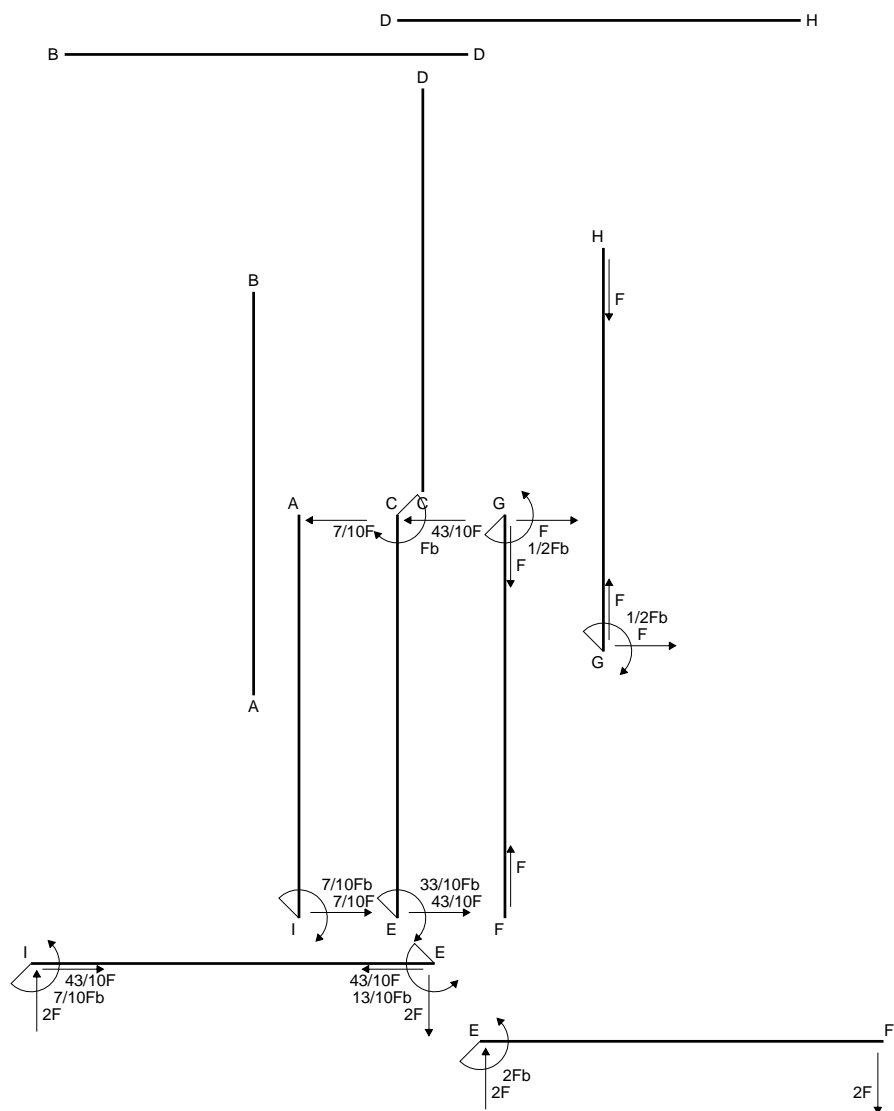
$$= (-5b + 11/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 6x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

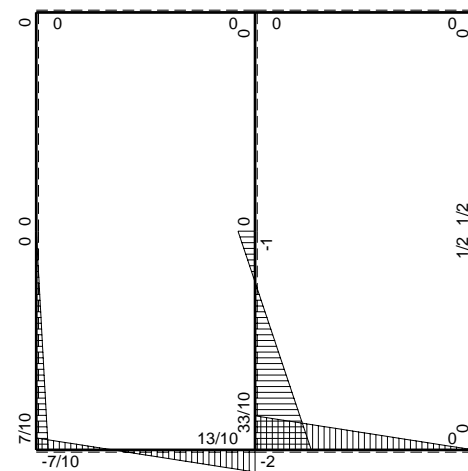


- A = 996. mm²
- J_u = 325226. mm⁴
- J_v = 47664. mm⁴
- y_g = 25.43 mm
- T_y = 2660. N
- M_x = -2713200. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 28.57 mm
- σ_m = -Mv/J_u = 238.4 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 15.57 mm
- σ_c = -Mv/J_u = 129.9 N/mm²
- τ_c = 4.563 N/mm²
- σ_q = √σ²+3τ² = 130.2 N/mm²
- S = 6694. mm³

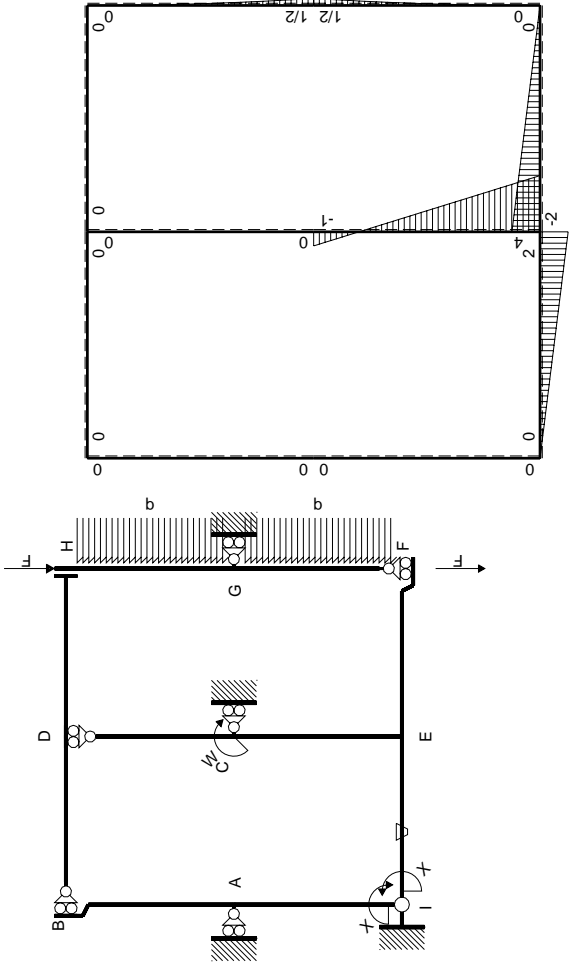


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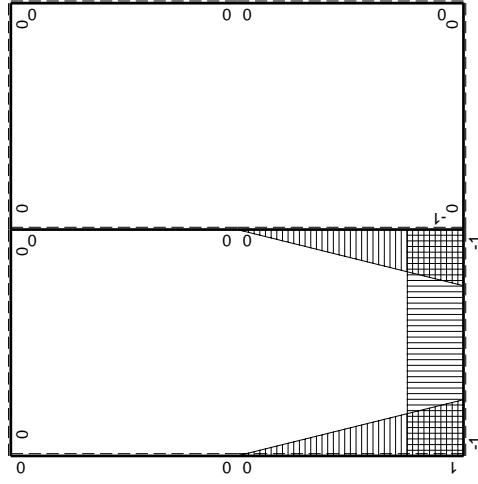


⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	0	0	0	0	0	0+0	0	
BA b	0	0	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	1/2qx ²	0	0	0	0	0+0	0	
GF b	0	-1/2Fb+Fx-1/2qx ²	0	0	0	0			
GH b	0	1/2Fb-Fx+1/2qx ²	0	0	0	0	0+0	0	
HG b	0	-1/2qx ²	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	2Fx	-Fb/EJ	-2Fx	Fb/EJ	1	(-1+1)Fb ² /EJ	Xb/EJ	
EI b	1	-2Fb+2Fx	Fb/EJ	-2Fb+2Fx	Fb/EJ	1			
EC b	-1+x/b	4Fb-5Fx	0	-4Fb+9Fx-5Fx ² /b	0	1-2x/b+x ² /b ²	(-7/6+0)Fb ² /EJ	1/3Xb/EJ	
CE b	x/b	Fb-5Fx	0	Fx-5Fx ² /b	0	x ² /b ²			
IA b	1-x/b	0	0	0	0	1-2x/b+x ² /b ²	0+0	1/3Xb/EJ	
AI b	-x/b	0	0	0	0	x ² /b ²			
	totali							-7/6Fb ² /EJ	5/3Xb/EJ
	iperstatica $X=W_{IE}$							7/10Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

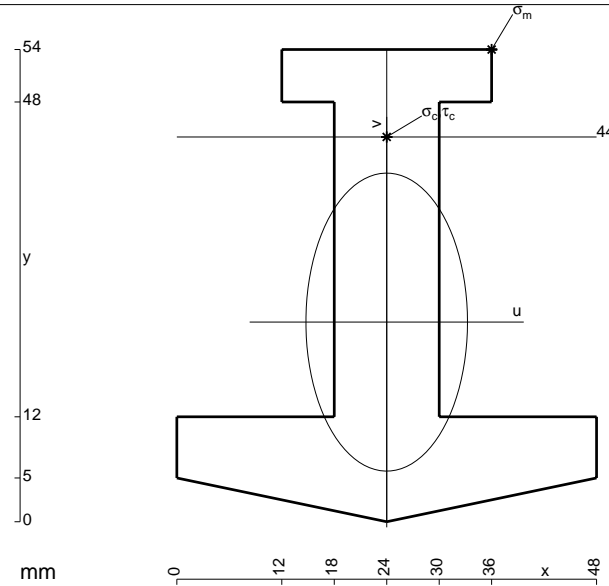
$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 9x/b - 5x^2/b^2) Fb 1/EJ dx = [-4x + 9/2 x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

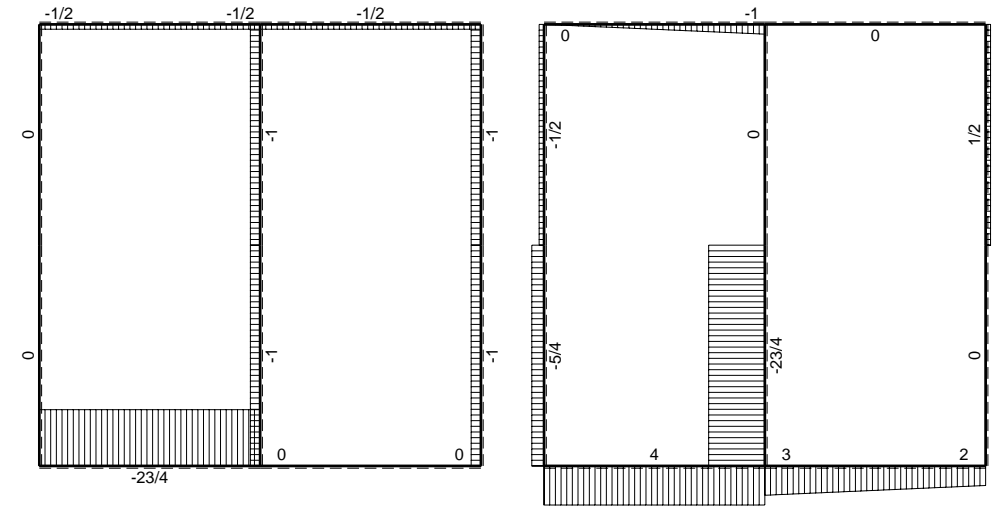
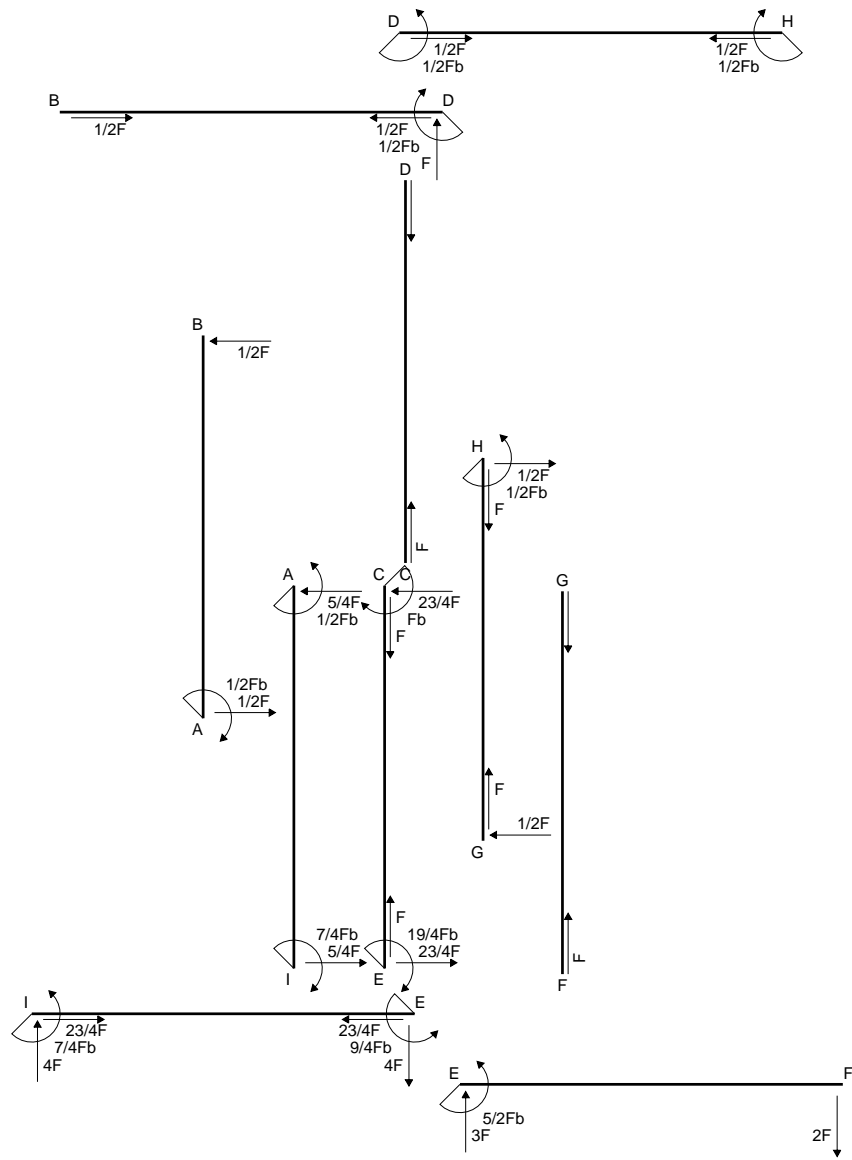
$$= (-4b + 9/2 b - 5/3 b) Fb 1/EJ = -7/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 5x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 5/3 b) Fb 1/EJ = -7/6 Fb^2/EJ$$

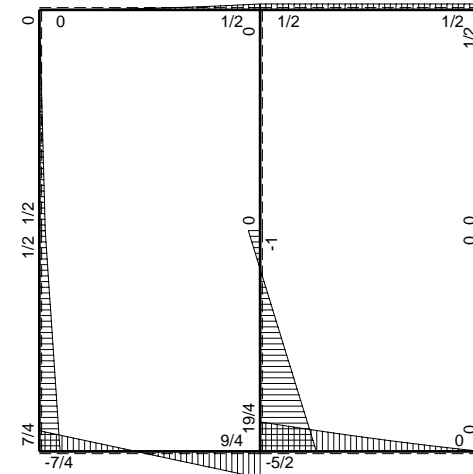


- A = 1032. mm²
- J_u = 299718. mm⁴
- J_v = 88128. mm⁴
- y_g = 22.83 mm
- T_y = 3560. N
- M_x = -1922400. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 31.17 mm
- σ_m = -Mv/J_u = 199.9 N/mm²
- x_c = 24. mm
- y_c = 44. mm
- v_c = 21.17 mm
- σ_c = -Mv/J_u = 135.8 N/mm²
- τ_c = 5.116 N/mm²
- σ_q = √σ²+3τ² = 136.1 N/mm²
- S = 5169. mm³

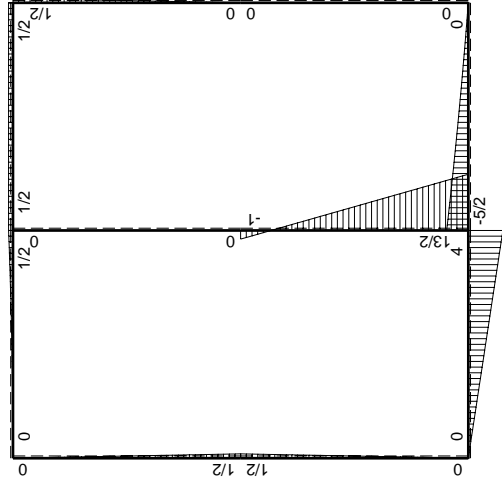
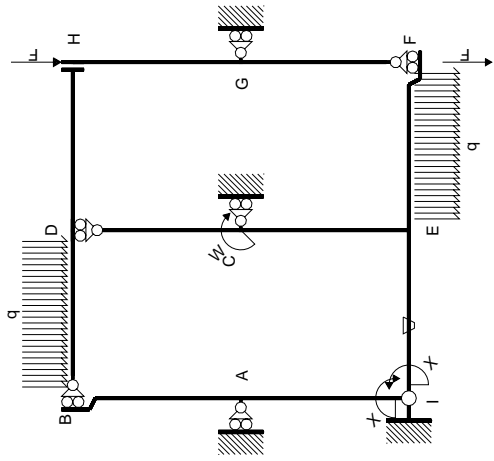


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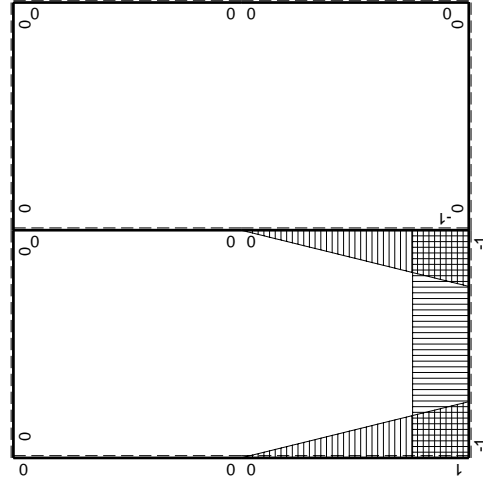


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-15/2Fx$	0	$-13/2Fb+14Fx-15/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-15/2Fx$	0	$Fx-15/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-35/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b) Fb 1/EJ + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-4 + 4x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-4b + 2b) Fb 1/EJ + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-13/2 + 14x/b - 15/2 x^2/b^2) Fb 1/EJ dx = [-13/2 x + 7x^2/b - 5/2 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-13/2 b + 7b - 5/2 b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 15/2 x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 5/2 x^3/b^2]_0^b Fb 1/EJ$$

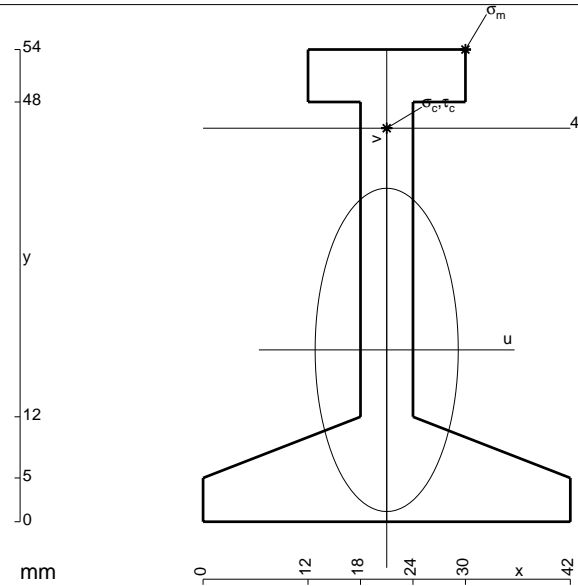
$$= (1/2 b - 5/2 b) Fb 1/EJ = -2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

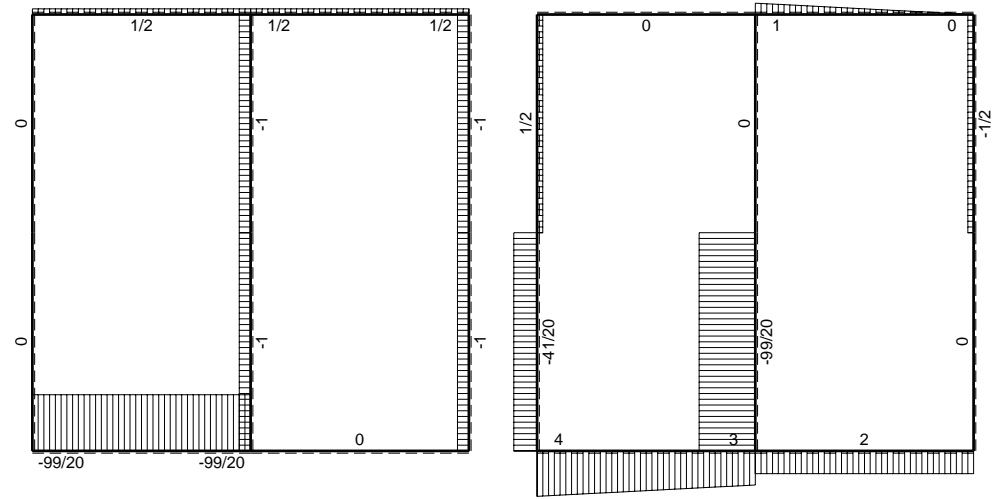
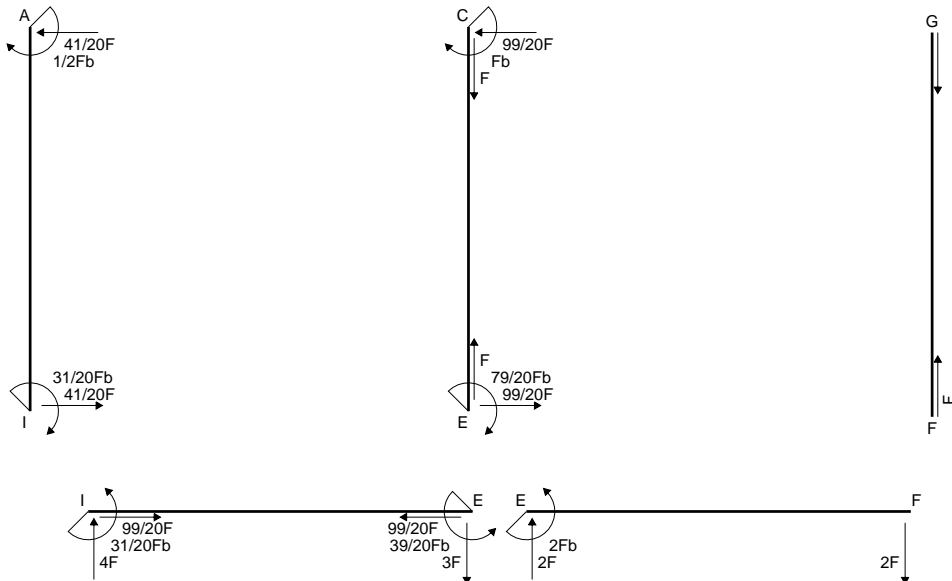
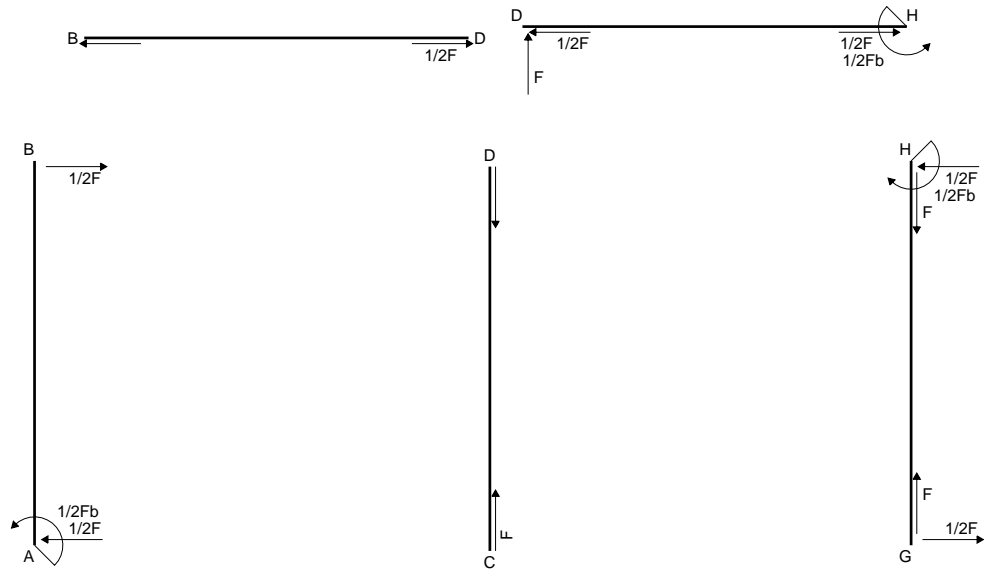
$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

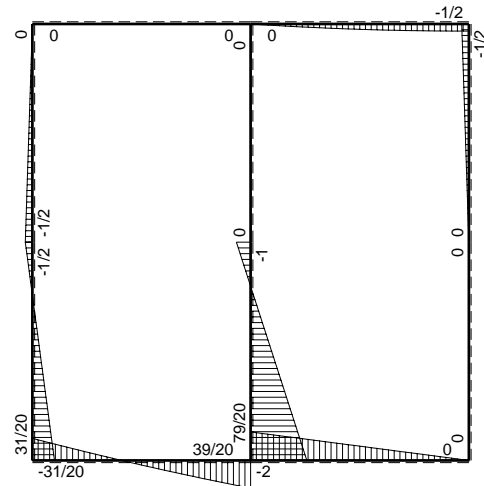


- A = 702. mm²
- J_u = 239989. mm⁴
- J_v = 47034. mm⁴
- y_g = 19.65 mm
- T_y = 2970. N
- M_x = -1460250. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 9. mm
- v_m = 34.35 mm
- σ_m = -Mv/J_u = 209. N/mm²
- x_c = 21. mm
- y_c = 45. mm
- v_c = 25.35 mm
- σ_c = -Mv/J_u = 154.2 N/mm²
- τ_c = 7.981 N/mm²
- σ_q = √σ²+3τ² = 154.9 N/mm²
- S = 3869. mm³

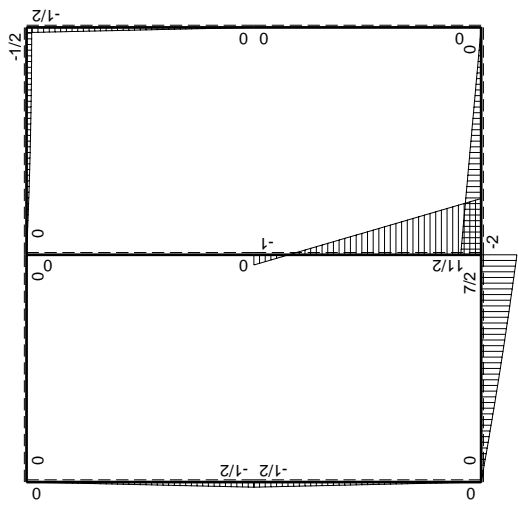
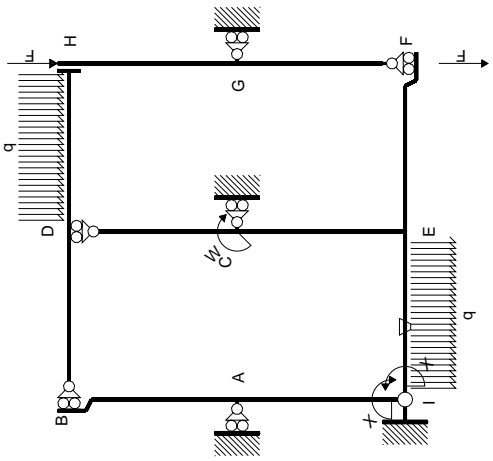


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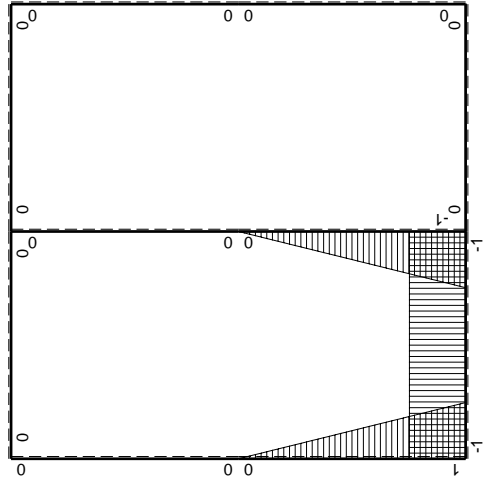
↑ ⊕ ↓ F



⊕ ⊖ Fb



Schema di calcolo iperstatico



M_0 flessione da carichi assegnati

M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-13/2Fx$	0	$-11/2Fb+12Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-13/2Fx$	0	$Fx-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-31/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$31/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 12x/b - 13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 6x^2/b - 13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 6b - 13/6 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 13/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 13/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

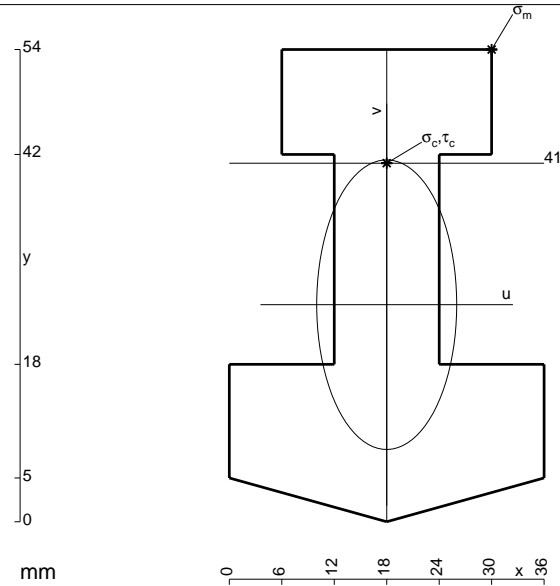
$$= (1/2 b - 13/6 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

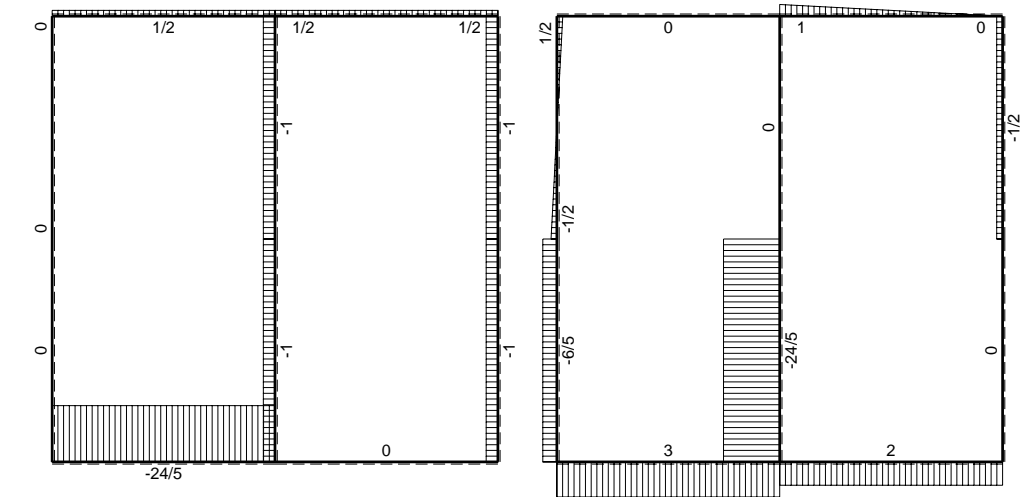
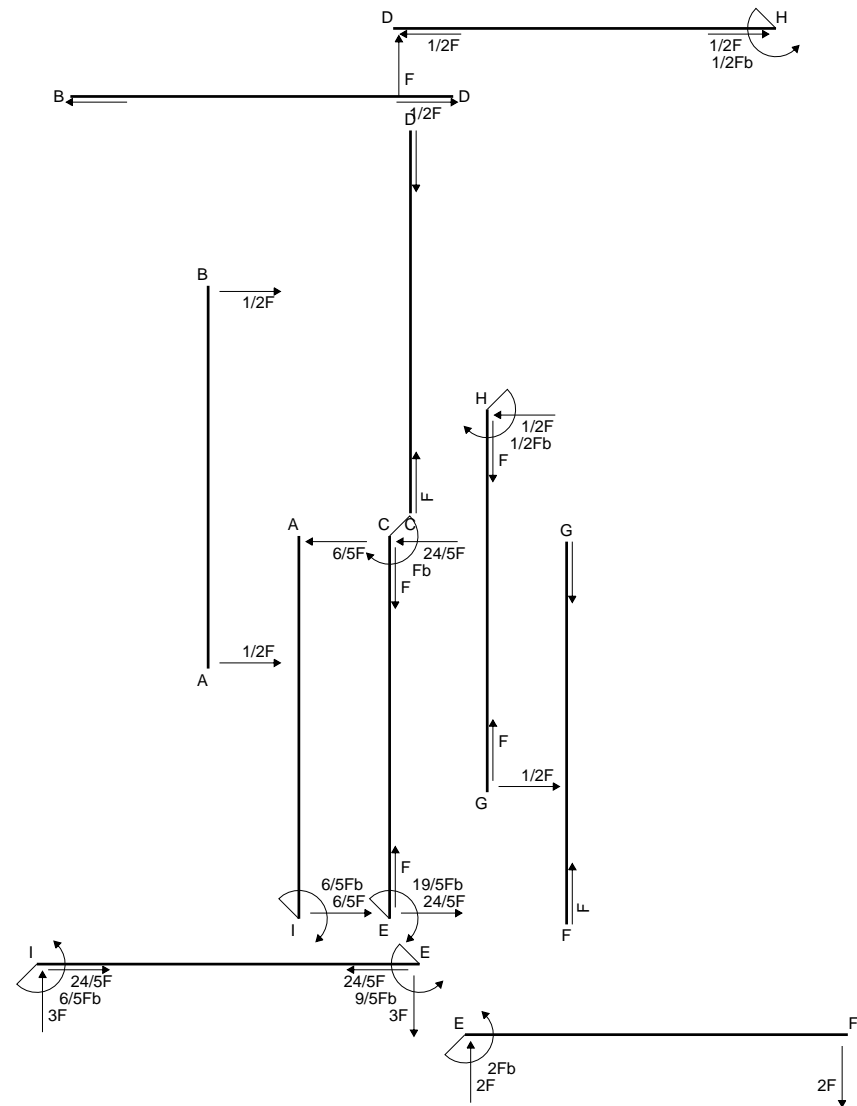
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

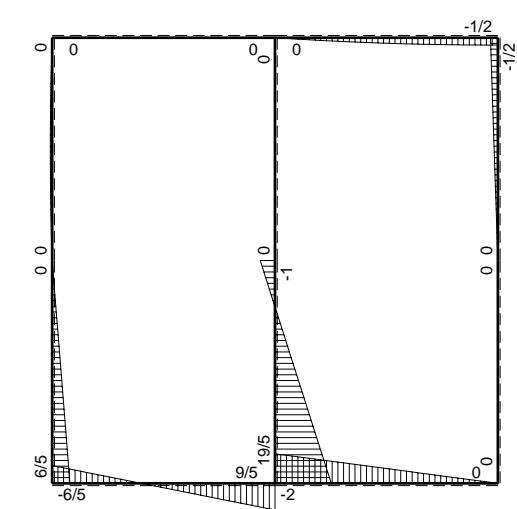


- A = 1134. mm²
- J_u = 311054. mm⁴
- J_v = 72684. mm⁴
- y_g = 24.82 mm
- T_y = 3660. N
- M_x = -2342400. Nmm
- x_m = 30. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 29.18 mm
- σ_m = -Mv/J_u = 219.7 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 16.18 mm
- σ_c = -Mv/J_u = 121.8 N/mm²
- τ_c = 6.742 N/mm²
- σ_q = √σ²+3τ² = 122.4 N/mm²
- S = 6876. mm³

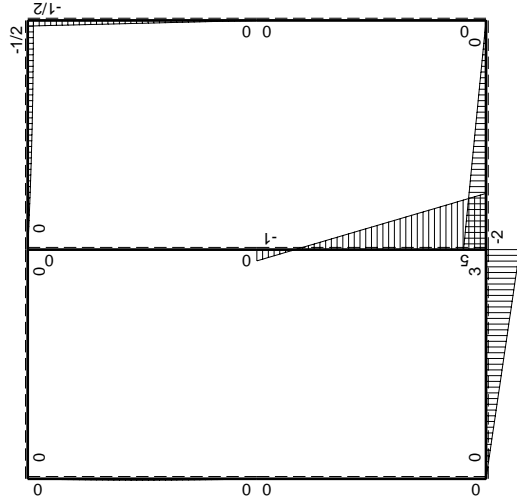
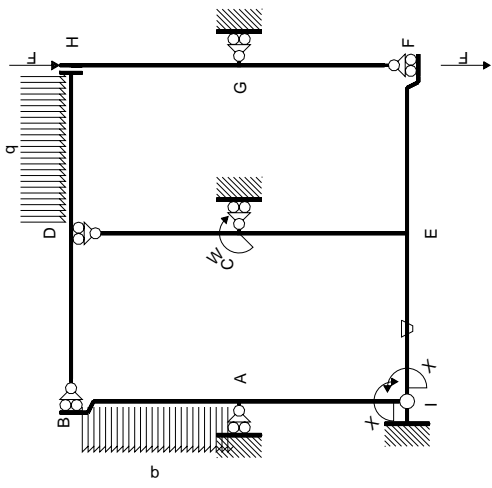


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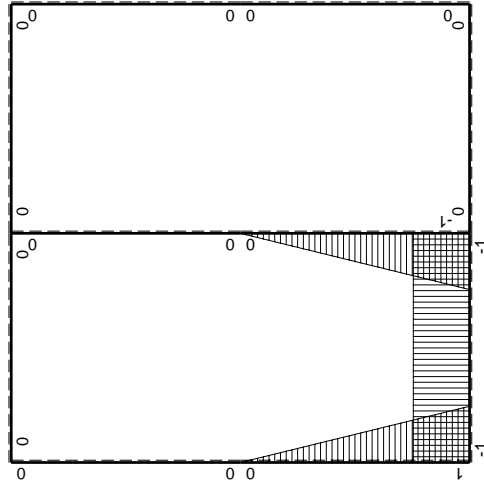


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-6Fx$	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-6Fx$	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$6/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{x\theta} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{x\theta} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

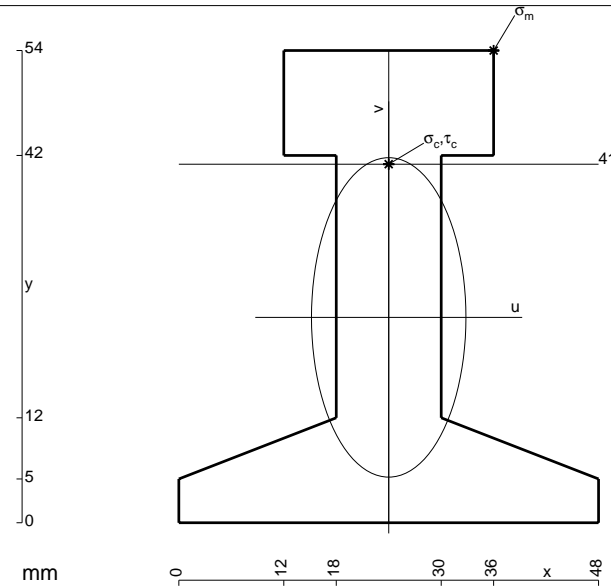
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{x\theta} = \int_0^b (-5 + 11x/b - 6x^2/b^2) Fb 1/EJ dx = [-5x + 11/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

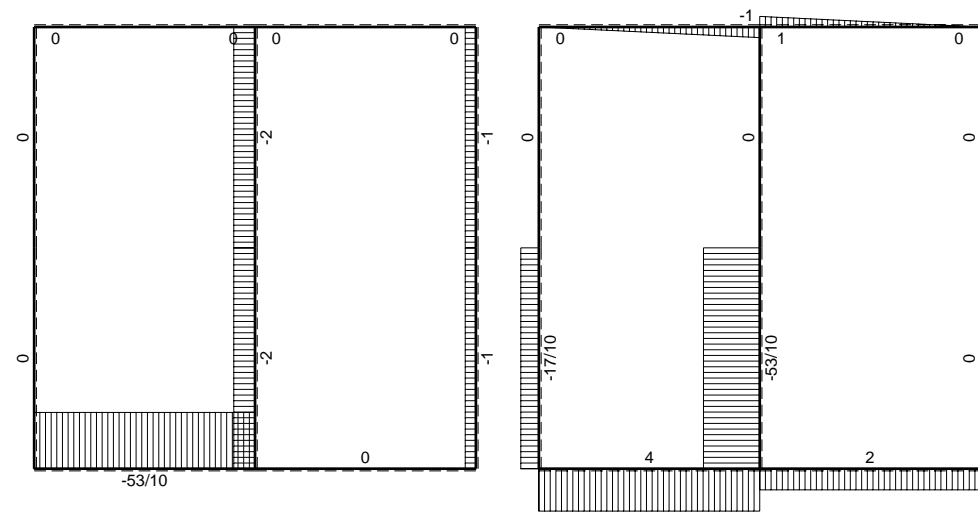
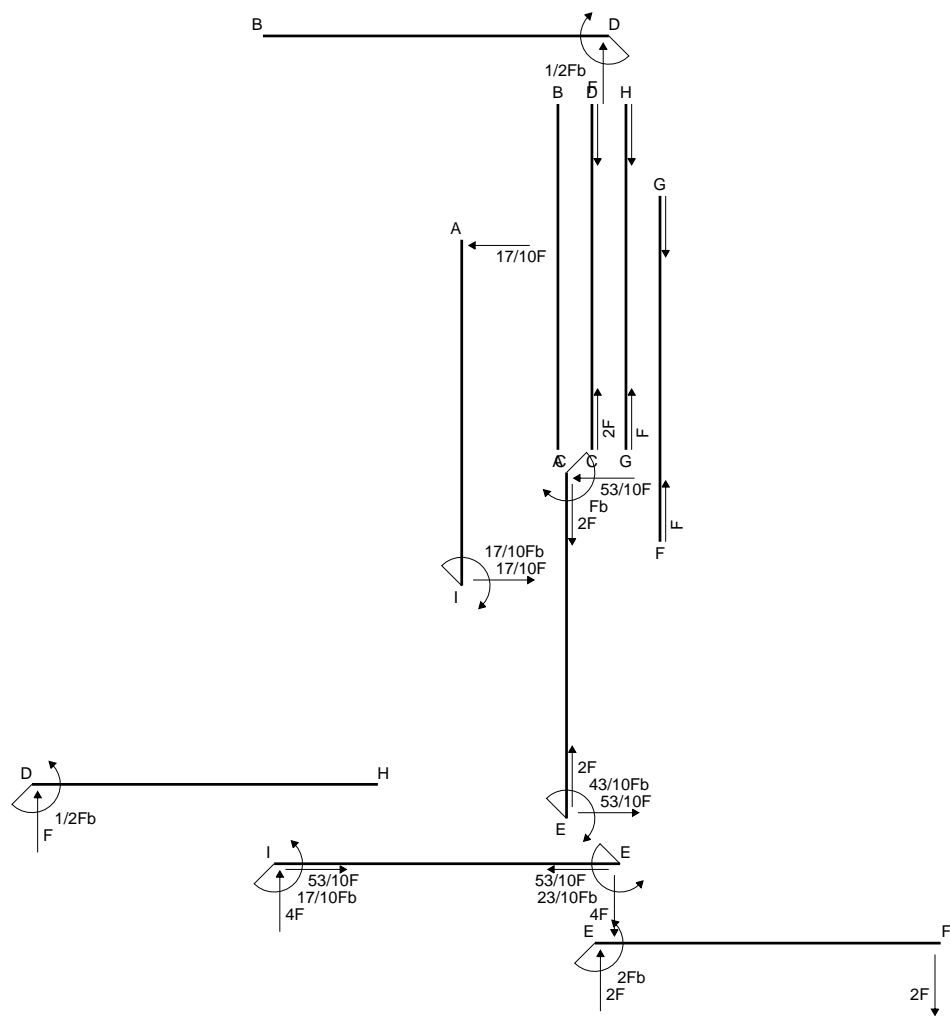
$$= (-5b + 11/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

$$L_{CE}^{x\theta} = \int_0^b (x/b - 6x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

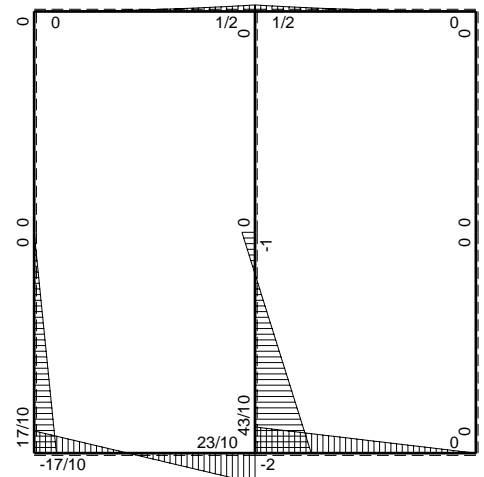


- A = 1098. mm²
- J_u = 366595. mm⁴
- J_v = 85644. mm⁴
- y_g = 23.48 mm
- T_y = 3940. N
- M_x = -2758000. Nmm
- x_m = 36. mm
- y_m = 54. mm
- u_m = 12. mm
- v_m = 30.52 mm
- σ_m = -Mv/J_u = 229.6 N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 17.52 mm
- σ_c = -Mv/J_u = 131.8 N/mm²
- τ_c = 6.518 N/mm²
- σ_q = √σ²+3τ² = 132.3 N/mm²
- S = 7278. mm³

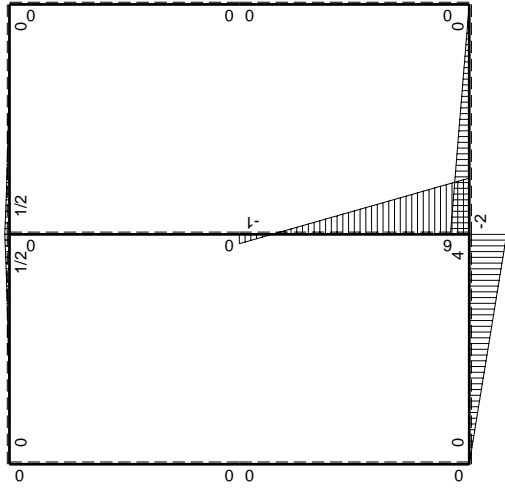
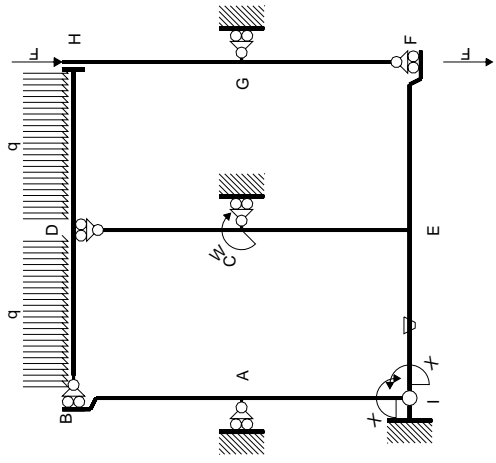


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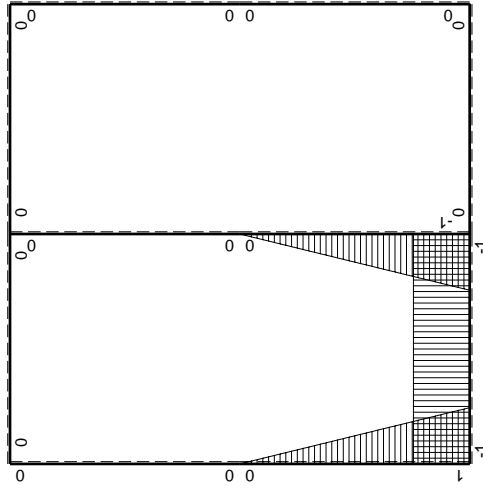


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	0	0	0	0	0	0+0	0	
BA b	0	0	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	0	0	0	0	0	0+0	0	
HG b	0	0	0	0	0	0			
HD b	0	$1/2qx^2$	0	0	0	0	0+0	0	
DH b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
BD b	0	$-1/2qx^2$	0	0	0	0			
IE b	-1	4Fx	-Fb/EJ	-4Fx	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ	
EI b	1	-4Fb+4Fx	Fb/EJ	-4Fb+4Fx	Fb/EJ	1			
EC b	$-1+x/b$	$6Fb-7Fx$	0	$-6Fb+13Fx-7Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$Fb-7Fx$	0	$Fx-7Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$	
AI b	$-x/b$	0	0	0	0	x^2/b^2			
	totali							$-17/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$17/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b) Fb 1/EJ + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-4 + 4x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

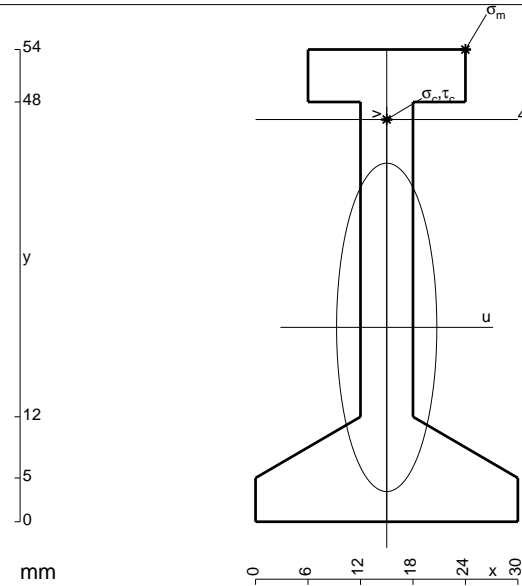
$$= (-4b + 2b) Fb 1/EJ + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-6 + 13x/b - 7x^2/b^2) Fb 1/EJ dx = [-6x + 13/2 x^2/b - 7/3 x^3/b^2]_0^b Fb 1/EJ$$

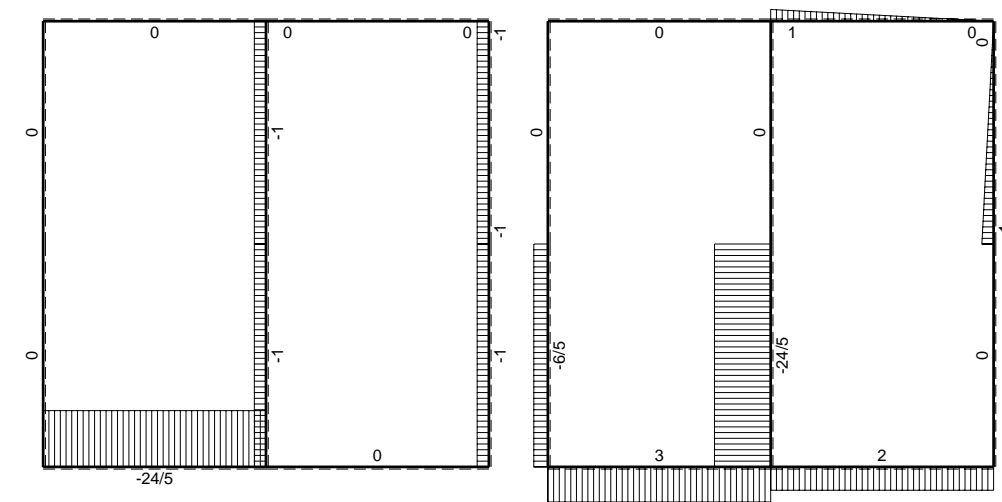
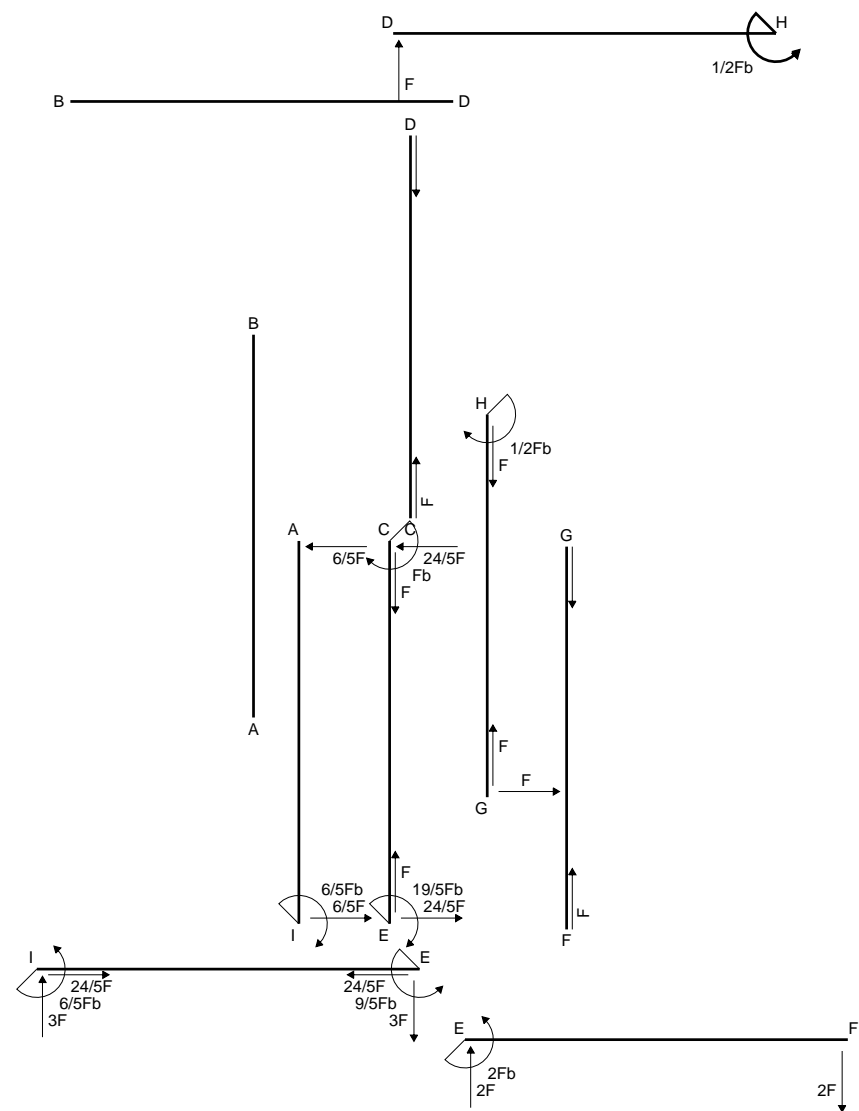
$$= (-6b + 13/2 b - 7/3 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 7x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 7/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 7/3 b) Fb 1/EJ = -11/6 Fb^2/EJ$$

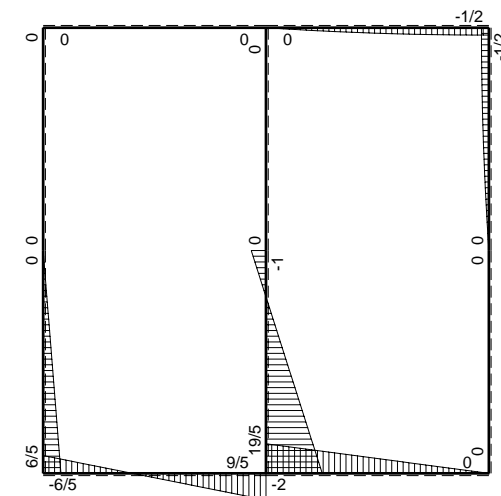


- A = 600. mm²
- J_u = 211747. mm⁴
- J_v = 19728. mm⁴
- y_g = 22.23 mm
- T_y = 2120. N
- M_x = -1590000. Nmm
- x_m = 24. mm
- y_m = 54. mm
- u_m = 9. mm
- v_m = 31.77 mm
- σ_m = -Mv/J_u = 238.6 N/mm²
- x_c = 15. mm
- y_c = 46. mm
- v_c = 23.77 mm
- σ_c = -Mv/J_u = 178.5 N/mm²
- τ_c = 5.681 N/mm²
- σ_q = √σ²+3τ² = 178.8 N/mm²
- S = 3405. mm³

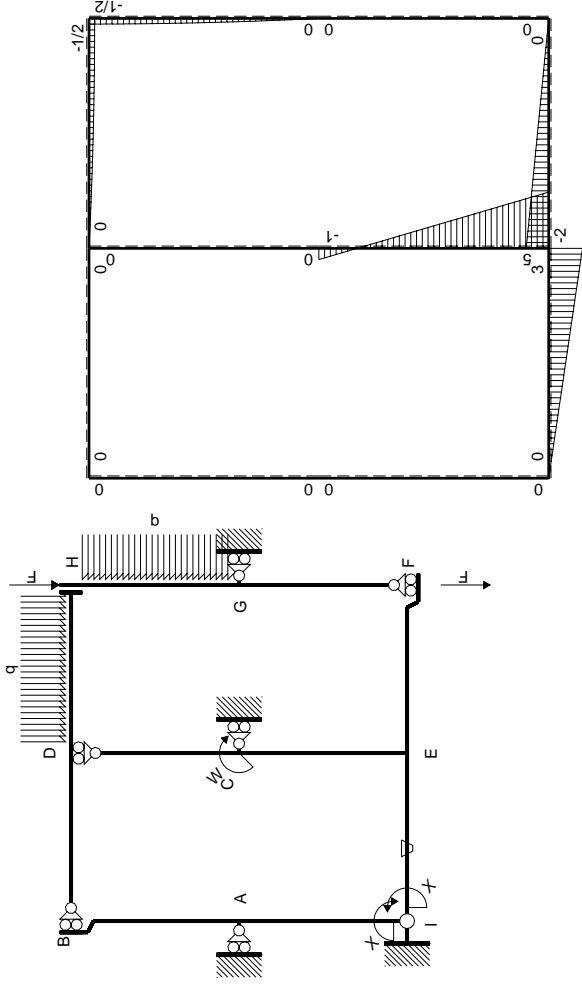


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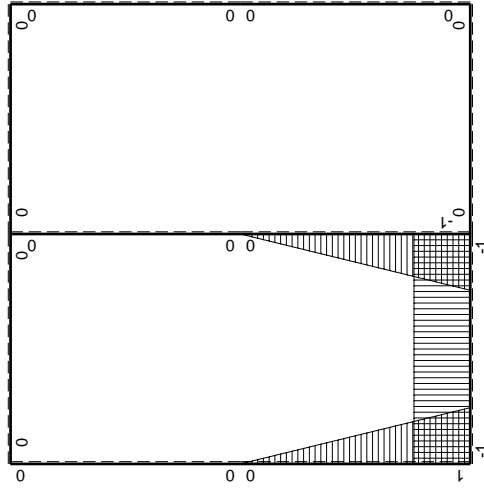


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	0	0	0	0	0	0+0	0	
BA b	0	0	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0	
FE b	0	2Fx	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	-Fx+1/2qx ²	0	0	0	0	0+0	0	
HG b	0	1/2Fb-1/2qx ²	0	0	0	0			
HD b	0	-1/2Fb+1/2qx ²	0	0	0	0	0+0	0	
DH b	0	Fx-1/2qx ²	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	(-3/2+1)Fb ² /EJ	Xb/EJ	
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1			
EC b	-1+x/b	5Fb-6Fx	0	-5Fb+11Fx-6Fx ² /b	0	1-2x/b+x ² /b ²	(-3/2+0)Fb ² /EJ	1/3Xb/EJ	
CE b	x/b	Fb-6Fx	0	Fx-6Fx ² /b	0	x ² /b ²			
IA b	1-x/b	0	0	0	0	1-2x/b+x ² /b ²	0+0	1/3Xb/EJ	
AI b	-x/b	0	0	0	0	x ² /b ²			
	totali							-2Fb ² /EJ	5/3Xb/EJ
	iperstatica $X=W_{IE}$							6/5Fb	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

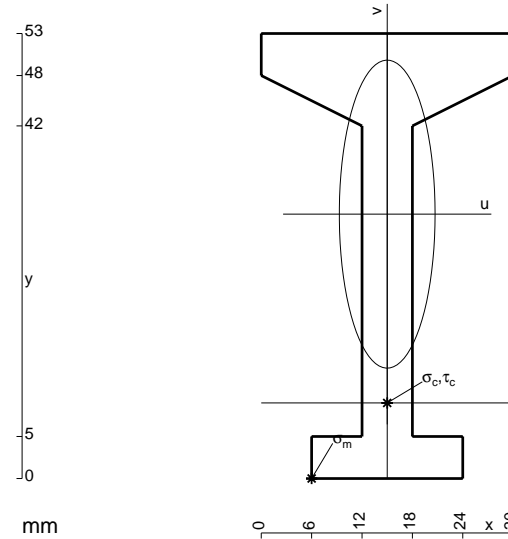
$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 11x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 11/2 x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

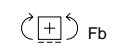
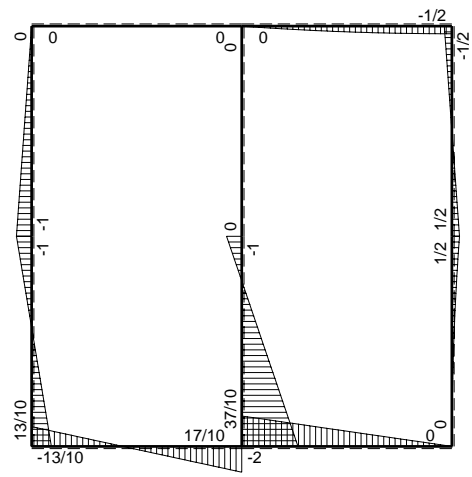
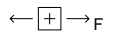
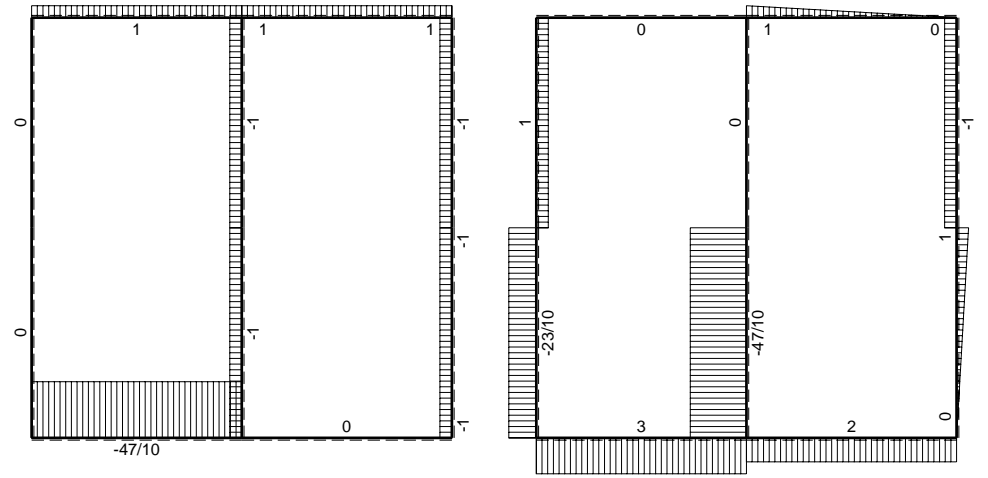
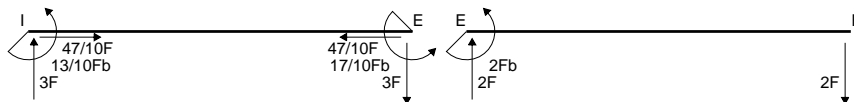
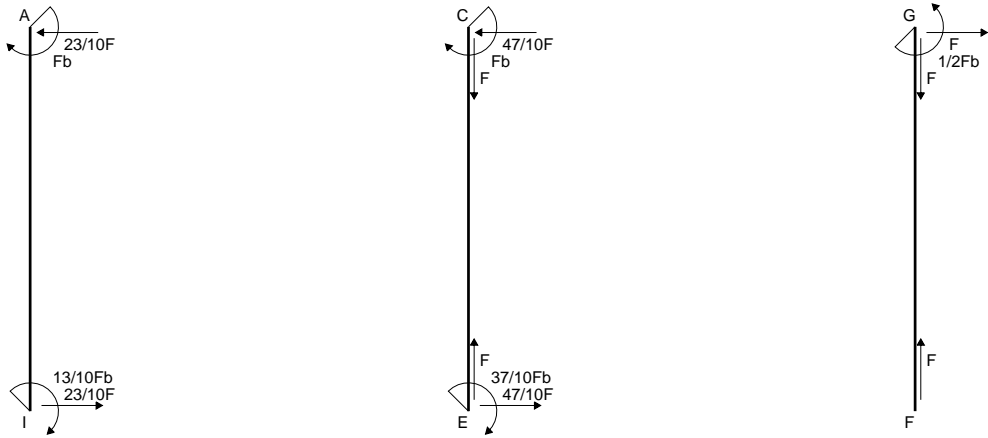
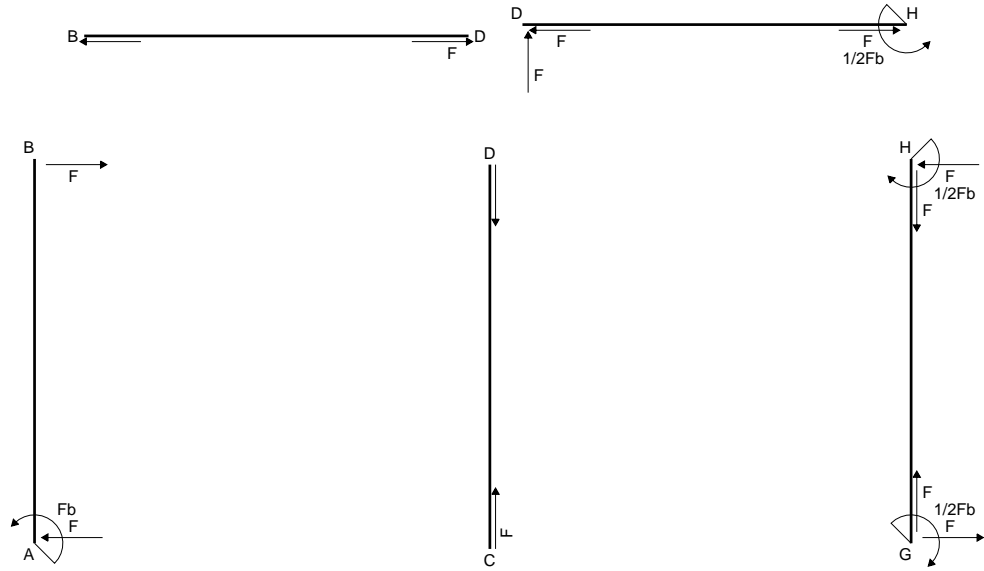
$$= (-5b + 11/2 b - 2b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/2 b - 2b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$



- A = 570. mm²
- J_u = 191825. mm⁴
- J_v = 18558. mm⁴
- y_g = 31.49 mm
- T_y = 1540. N
- M_x = -1216600. Nmm
- x_m = 6. mm
- u_m = -9. mm
- v_m = -31.49 mm
- σ_m = -Mv/J_u = -199.7 N/mm²
- x_c = 15. mm
- y_c = 9. mm
- v_c = -22.49 mm
- σ_c = -Mv/J_u = -142.6 N/mm²
- τ_c = 4.277 N/mm²
- σ_o = √σ_c² + 3τ_c² = 142.8 N/mm²
- S = 3197. mm³



Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-6Fx	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	Fb-6Fx	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$13/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 11x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 11/2 x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 11/2 b - 2b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

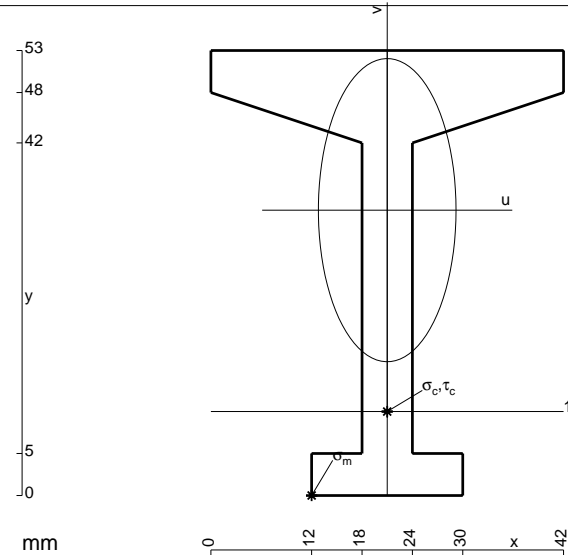
$$= (1/2 b - 2b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

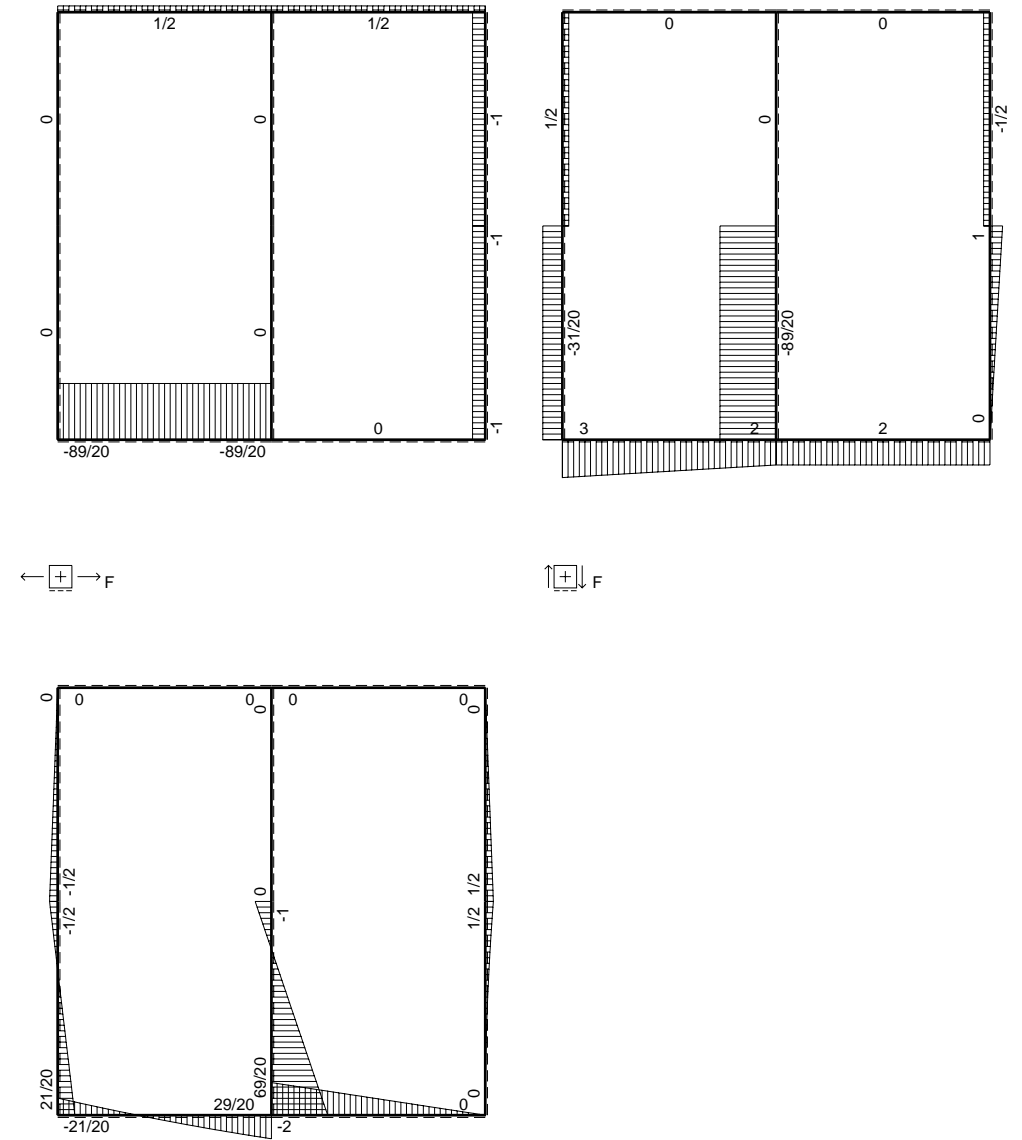
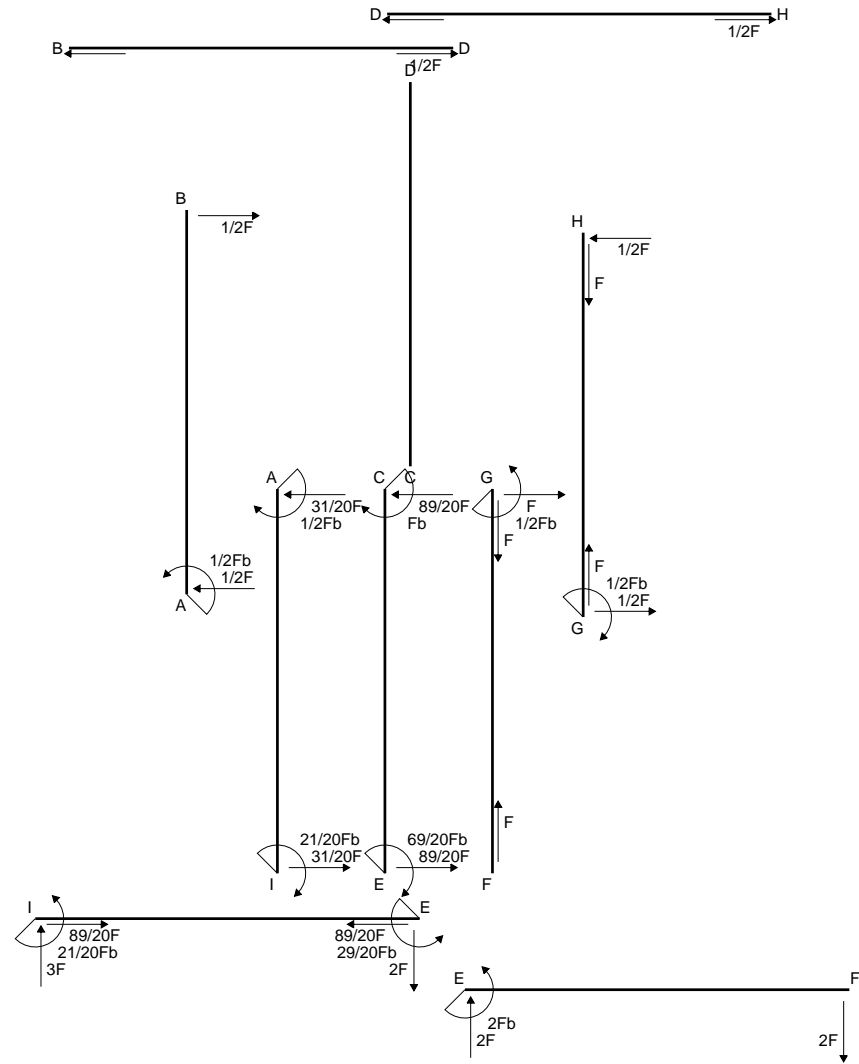
$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

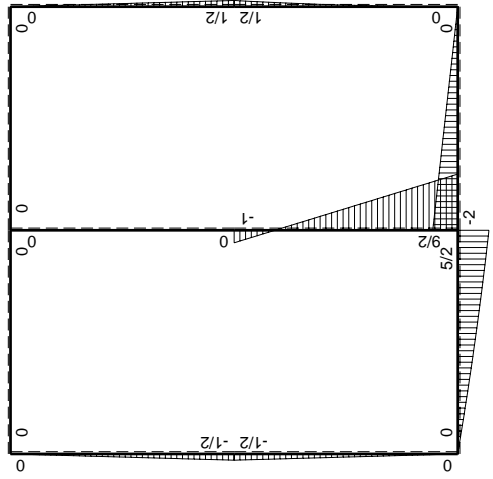
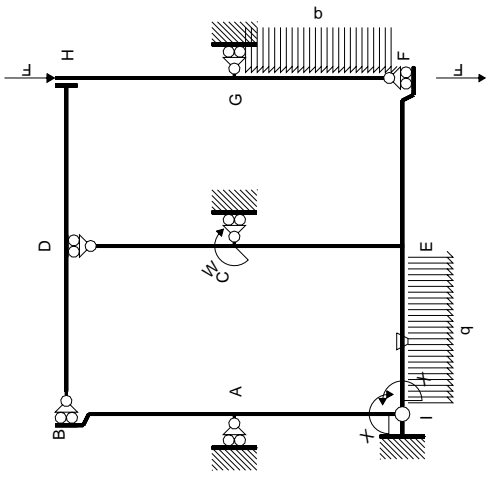
$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$



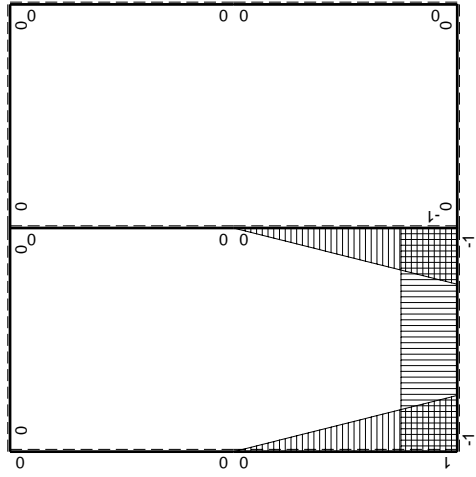
- A = 666. mm²
- J_u = 217134. mm⁴
- J_v = 44766. mm⁴
- y_g = 33.99 mm
- T_y = 1580. N
- M_x = -1327200. Nmm
- x_m = 12. mm
- u_m = -9. mm
- v_m = -33.99 mm
- σ_m = -Mv/J_u = -207.7 N/mm²
- x_c = 21. mm
- y_c = 10. mm
- v_c = -23.99 mm
- σ_c = -Mv/J_u = -146.6 N/mm²
- τ_c = 4.4 N/mm²
- σ_o = √σ_c² + 3τ_c² = 146.8 N/mm²
- S = 3628. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fx$	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$9/2Fb-11/2Fx$	0	$-9/2Fb+10Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$Fb-11/2Fx$	0	$Fx-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-7/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$21/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -1/3 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-5/2 + 2x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-5/2 b + b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -1/3 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-9/2 + 10x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-9/2 x + 5x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-9/2 b + 5b - 11/6 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

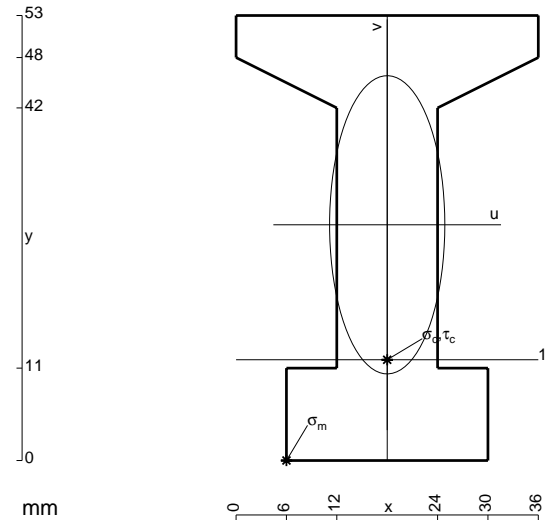
$$= (1/2 b - 11/6 b) Fb \frac{1}{EJ} = -4/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

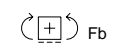
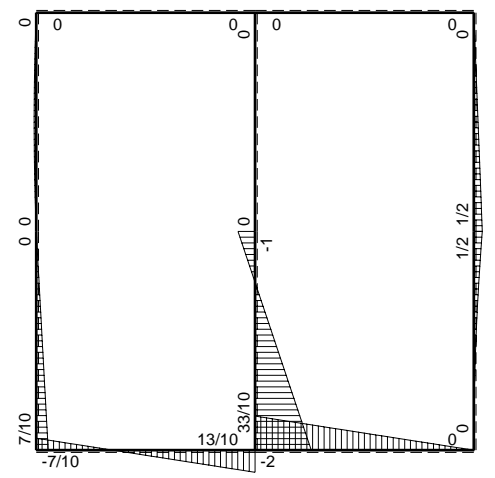
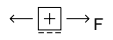
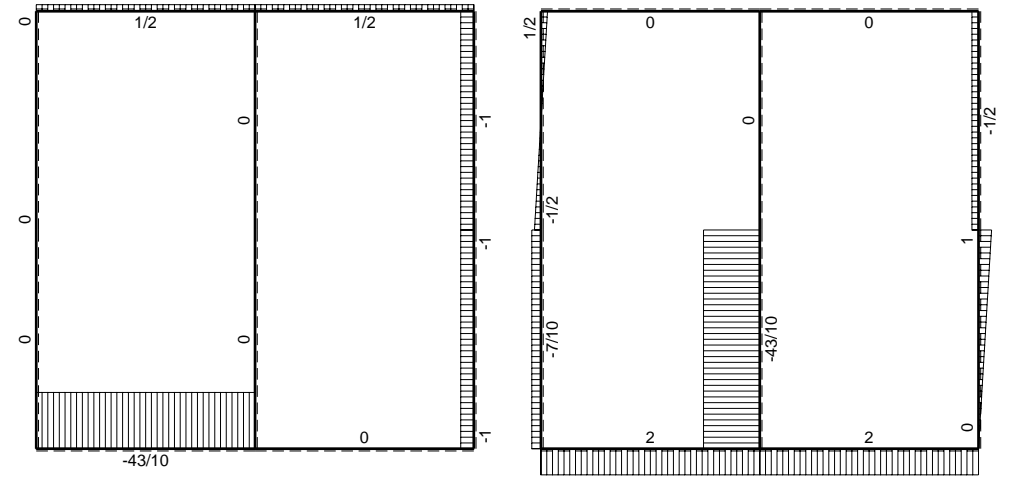
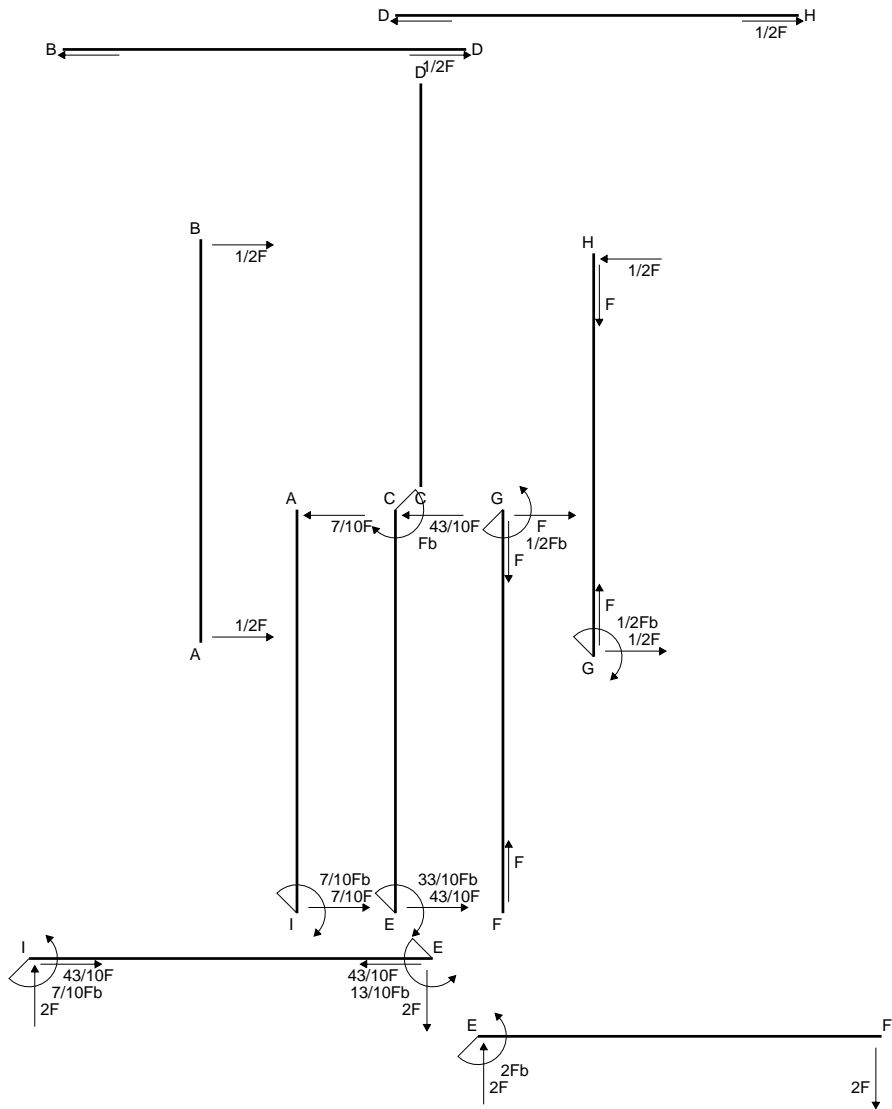
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

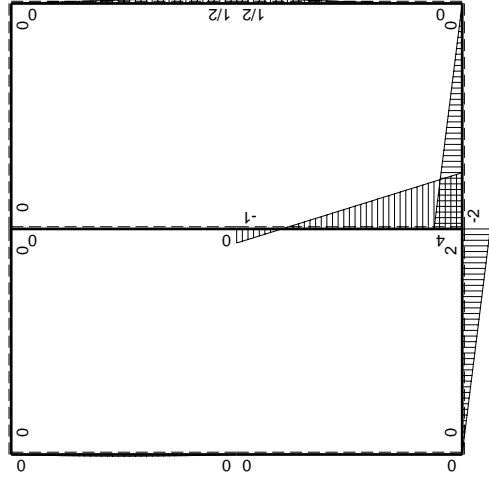
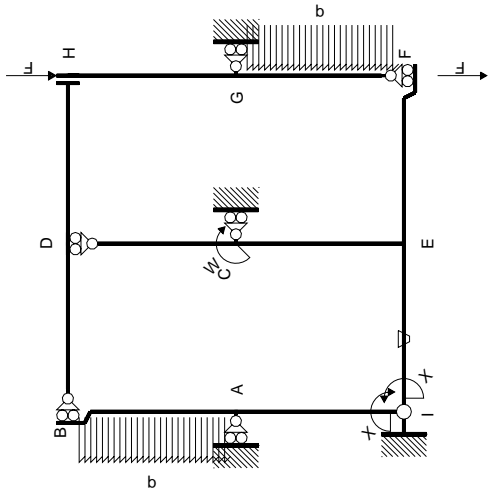
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



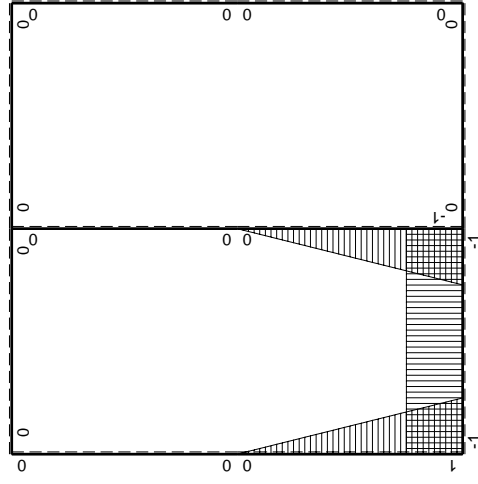
- A = 960. mm²
- J_u = 302931. mm⁴
- J_v = 45216. mm⁴
- y_g = 28.08 mm
- T_y = 2620. N
- M_x = -2358000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.08 mm
- σ_m = -Mv/J_u = -218.5 N/mm²
- x_c = 18. mm
- y_c = 12. mm
- v_c = -16.08 mm
- σ_c = -Mv/J_u = -125.1 N/mm²
- τ_c = 4.439 N/mm²
- σ_o = √σ²+3τ² = 125.4 N/mm²
- S = 6159. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fx$	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1			
EC b	$-1+x/b$	$4Fb-5Fx$	0	$-4Fb+9Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$Fb-5Fx$	0	$Fx-5Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$	
AI b	$-x/b$	0	0	0	0	x^2/b^2			
	totali							$-7/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$7/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

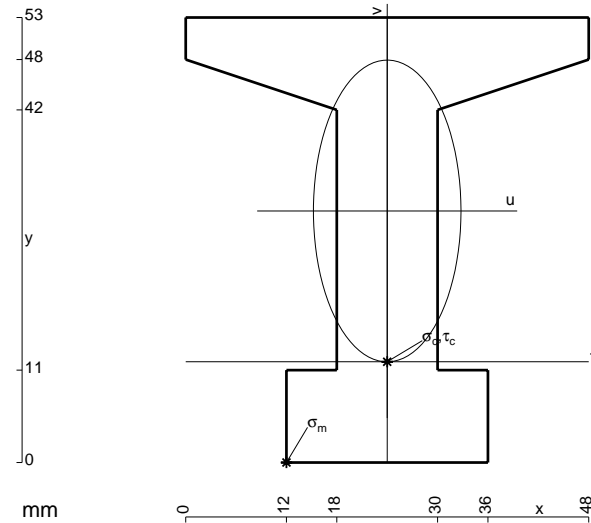
$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 9x/b - 5x^2/b^2) Fb 1/EJ dx = [-4x + 9/2 x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

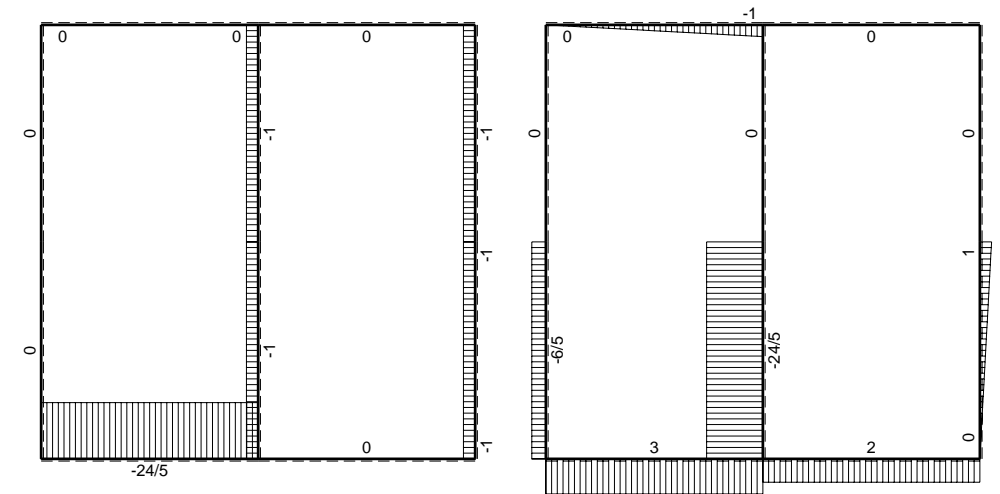
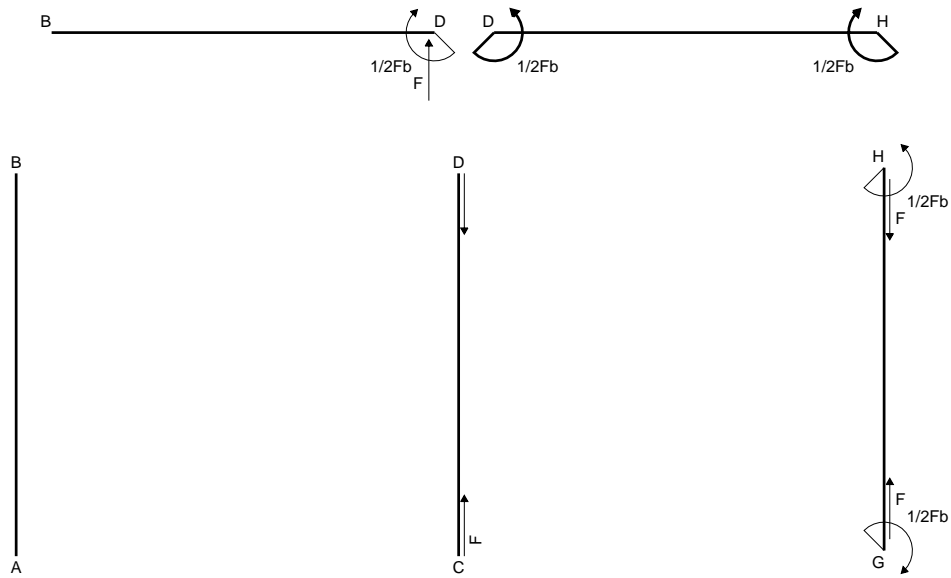
$$= (-4b + 9/2 b - 5/3 b) Fb 1/EJ = -7/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 5x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 5/3 b) Fb 1/EJ = -7/6 Fb^2/EJ$$

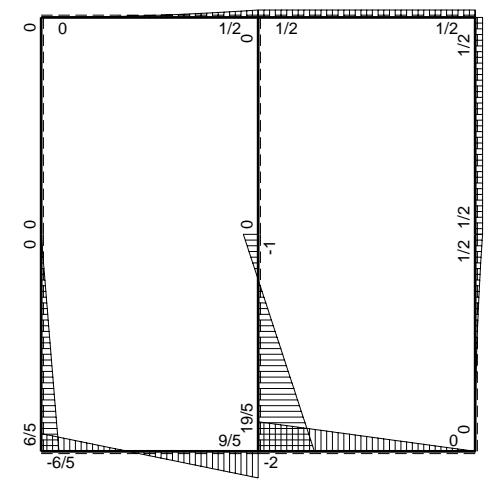
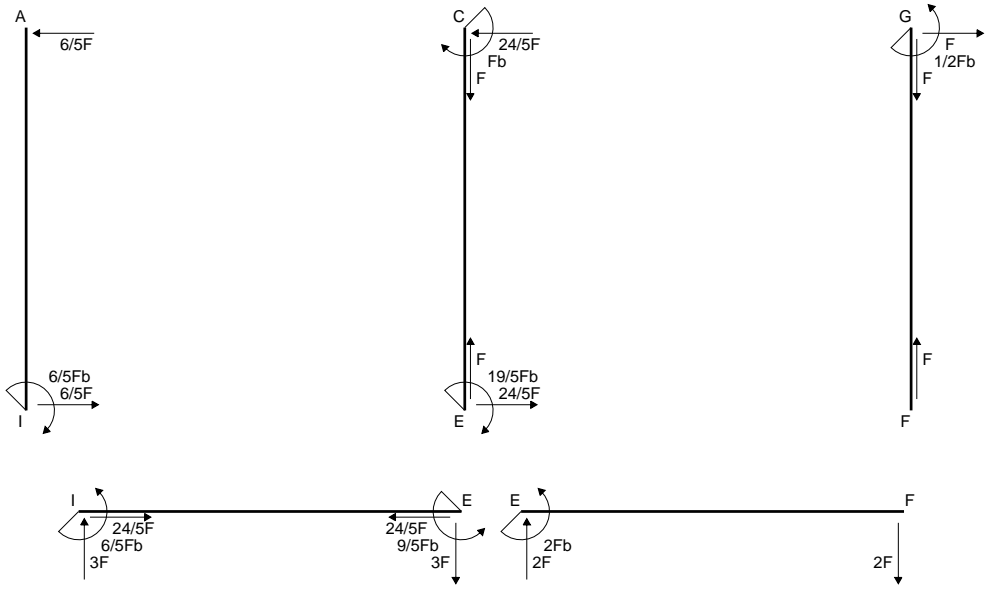


- A = 1056. mm²
- J_u = 341114. mm⁴
- J_v = 81576. mm⁴
- y_g = 29.96 mm
- T_y = 2740. N
- M_x = -2603000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -29.96 mm
- σ_m = -Mv/J_u = -228.6 N/mm²
- x_c = 24. mm
- y_c = 12. mm
- v_c = -17.96 mm
- σ_c = -Mv/J_u = -137.1 N/mm²
- τ_c = 4.471 N/mm²
- σ_o = √σ² + 3τ² = 137.3 N/mm²
- S = 6679. mm³

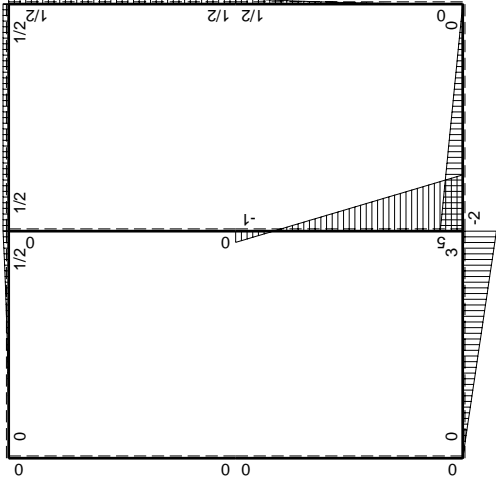
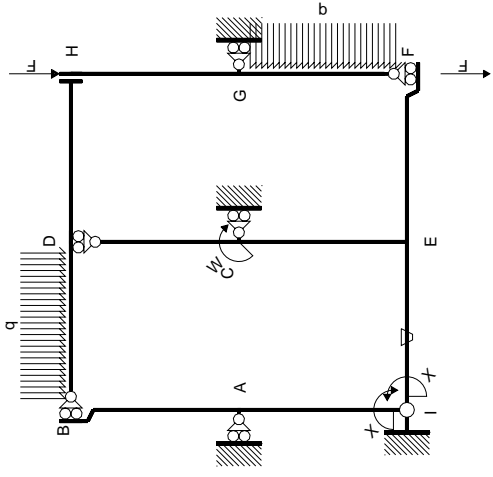


← ⊕ → F

↑ ⊕ ↓ F

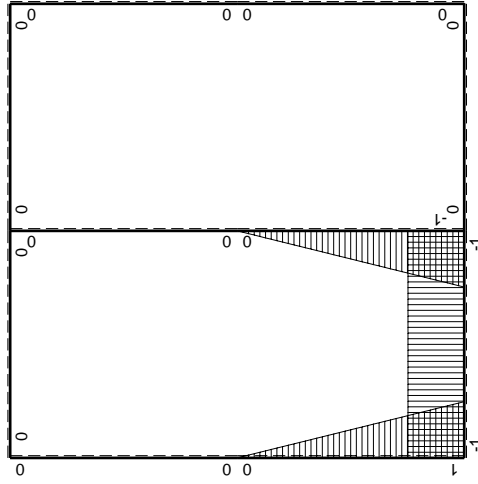


⊕ ⊕ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-6Fx$	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-6Fx$	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$6/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

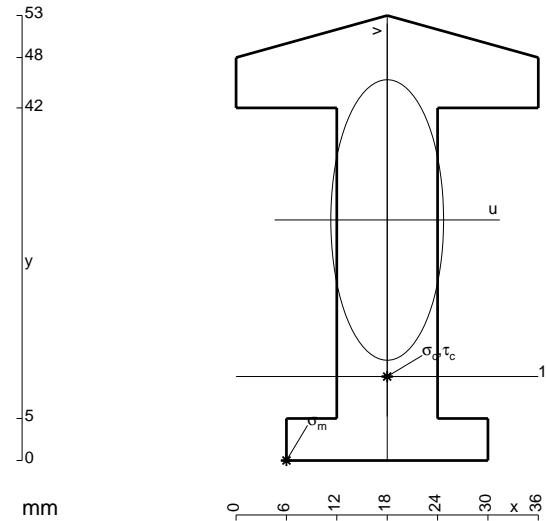
$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 11x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 11/2 x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

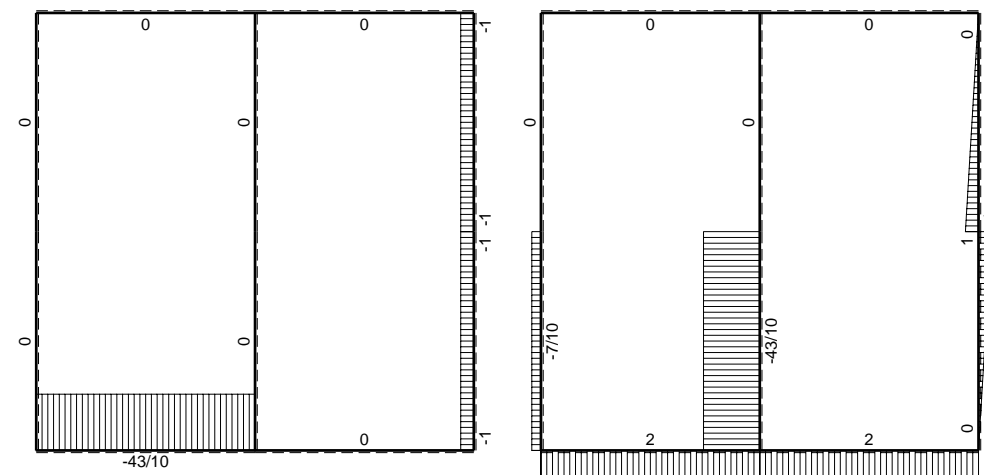
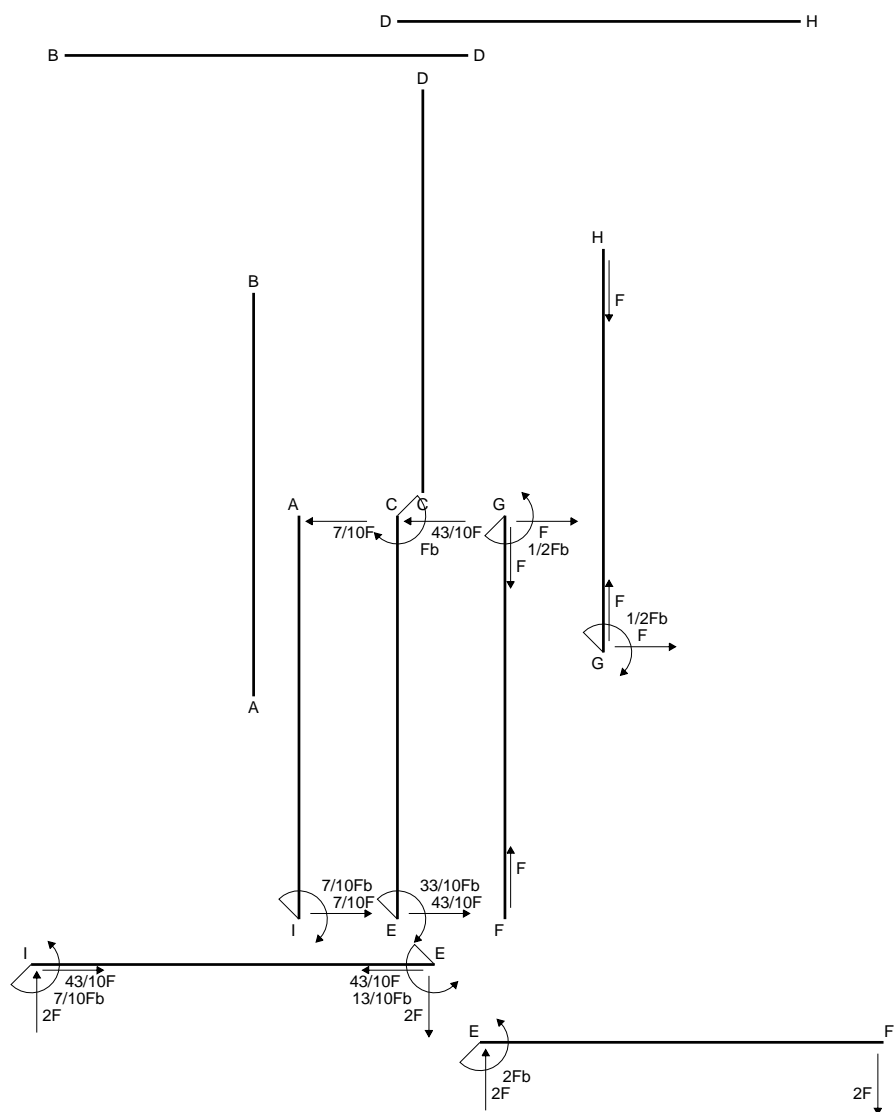
$$= (-5b + 11/2 b - 2b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 6x^2/b^2) Fb \frac{1}{EJ} dx = [1/2 x^2/b - 2x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (1/2 b - 2b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

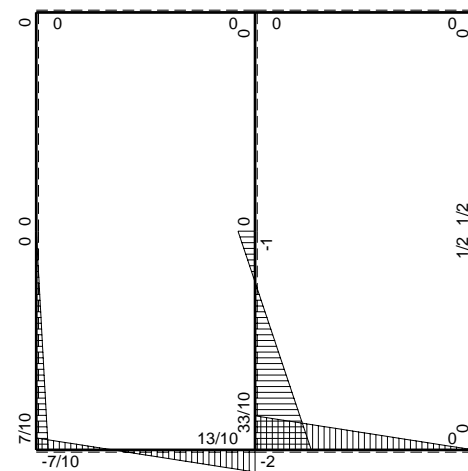


- A = 870. mm²
- J_u = 243005. mm⁴
- J_v = 39276. mm⁴
- y_g = 28.65 mm
- T_y = 2020. N
- M_x = -2020000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.65 mm
- σ_m = -Mv/J_u = -238.1 N/mm²
- x_c = 18. mm
- y_c = 10. mm
- v_c = -18.65 mm
- σ_c = -Mv/J_u = -155. N/mm²
- τ_c = 3.053 N/mm²
- σ_o = √σ² + 3τ² = 155.1 N/mm²
- S = 4407. mm³

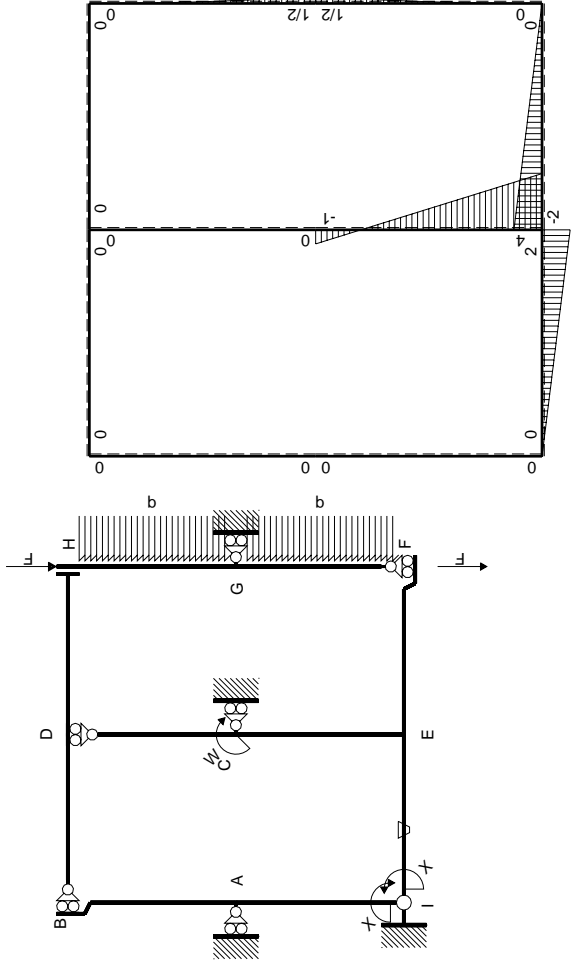


← ⊕ → F

↑ ⊕ ↓ F

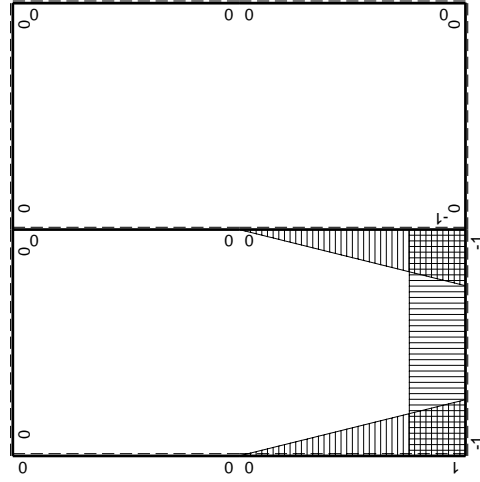


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	0	0	0	0	0	0+0	0
BA b	0	0	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-5Fx$	0	$-4Fb+9Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-7/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$Fb-5Fx$	0	$Fx-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-7/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

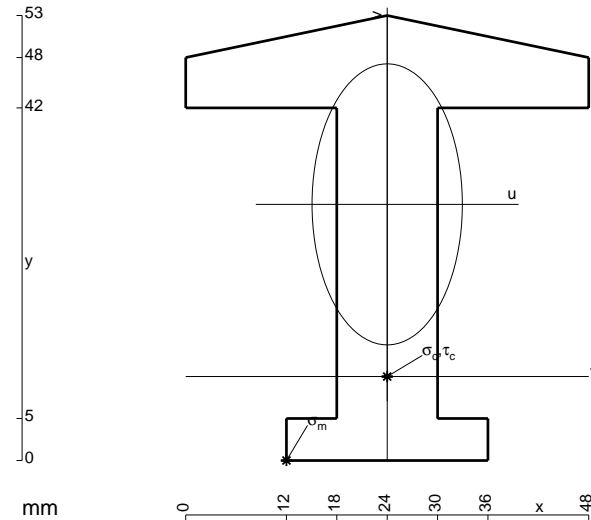
$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 9x/b - 5x^2/b^2) Fb 1/EJ dx = [-4x + 9/2 x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

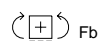
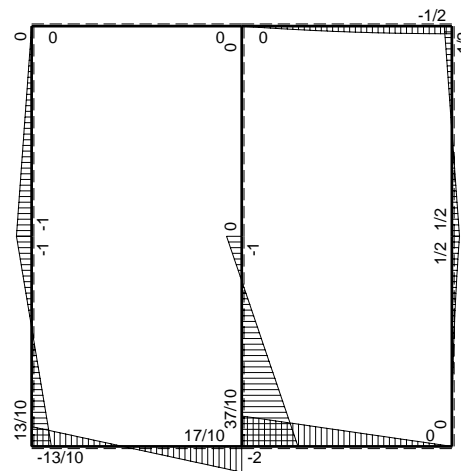
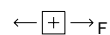
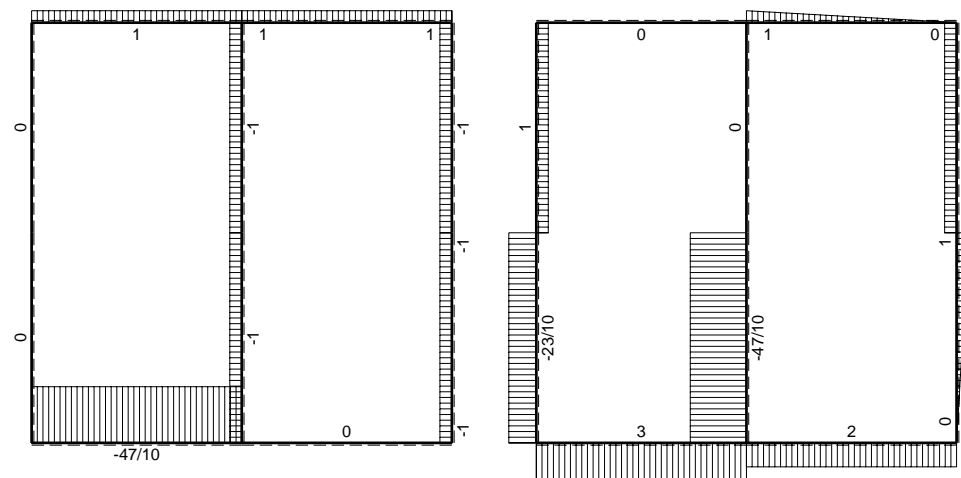
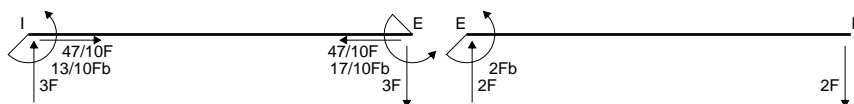
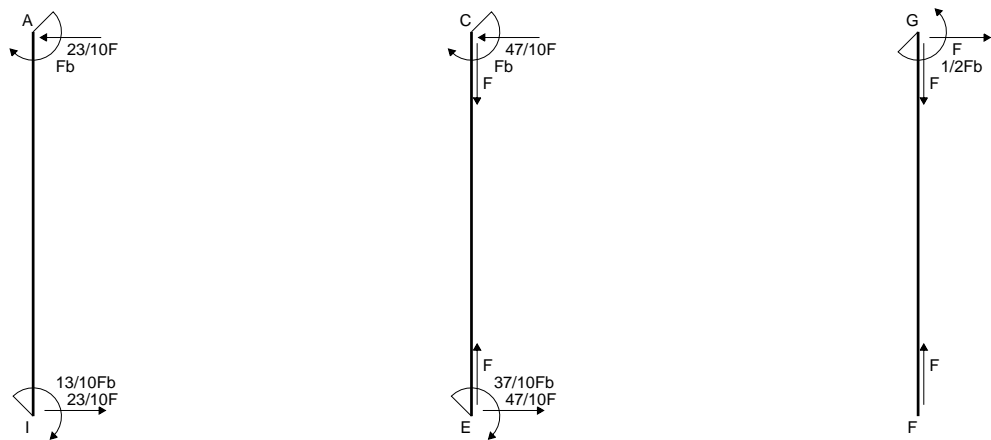
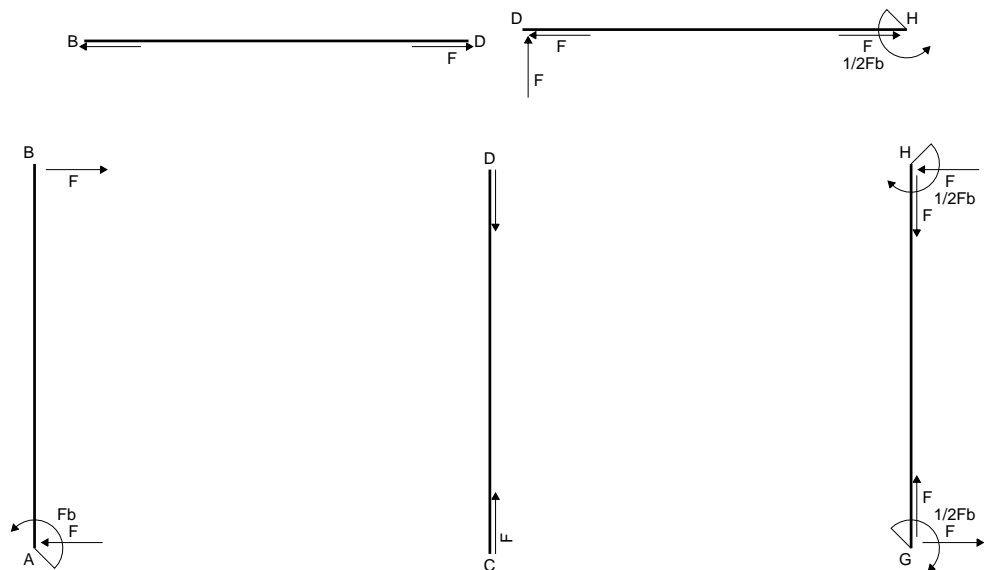
$$= (-4b + 9/2 b - 5/3 b) Fb 1/EJ = -7/6 Fb^2/EJ$$

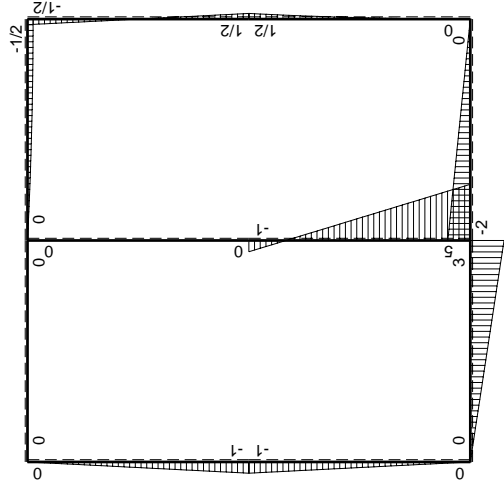
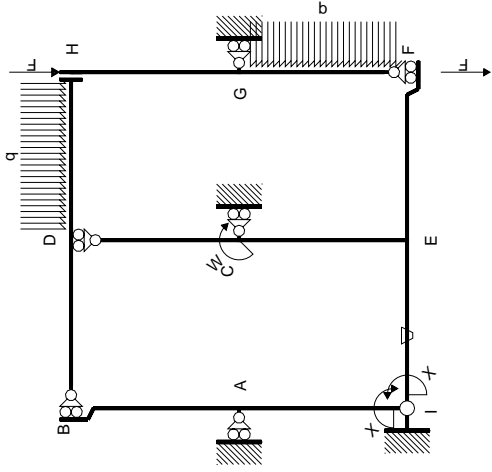
$$L_{CE}^{xo} = \int_0^b (x/b - 5x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/2 b - 5/3 b) Fb 1/EJ = -7/6 Fb^2/EJ$$



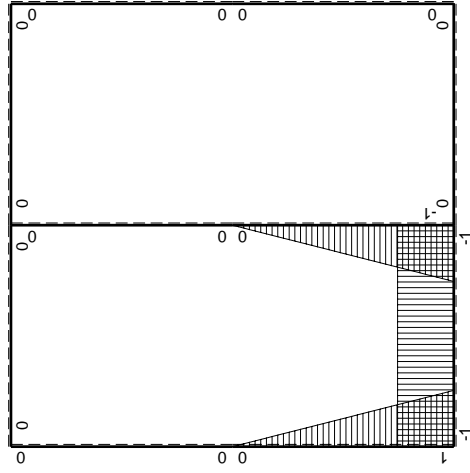
- A = 972. mm²
- J_u = 272405. mm⁴
- J_v = 77904. mm⁴
- y_g = 30.51 mm
- T_y = 3360. N
- M_x = -1780800. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.51 mm
- σ_m = -Mv/J_u = -199.4 N/mm²
- x_c = 24. mm
- y_c = 10. mm
- v_c = -20.51 mm
- σ_c = -Mv/J_u = -134.1 N/mm²
- τ_c = 4.874 N/mm²
- σ₀ = √σ_c² + 3τ_c² = 134.3 N/mm²
- S = 4741. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0	0+0	0
BA b	0	Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-6Fx	0	$-5Fb+11Fx-6Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	Fb-6Fx	0	$Fx-6Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	-Fx	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	Fb-Fx	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$13/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 11x/b - 6x^2/b^2) Fb 1/EJ dx = [-5x + 11/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 11/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (x/b - 6x^2/b^2) Fb 1/EJ dx = [1/2 x^2/b - 2x^3/b^2]_0^b Fb 1/EJ$$

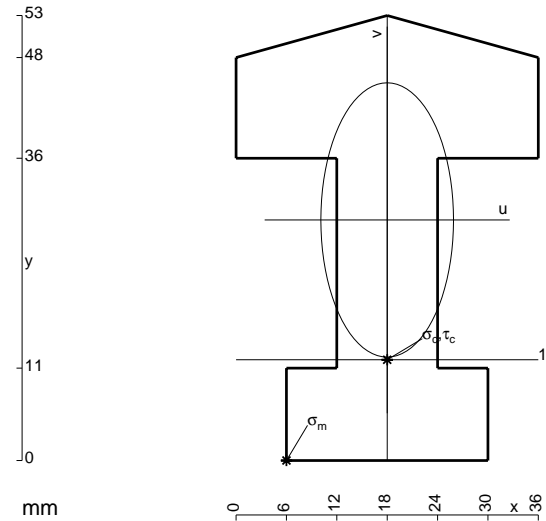
$$= (1/2 b - 2b) Fb 1/EJ = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

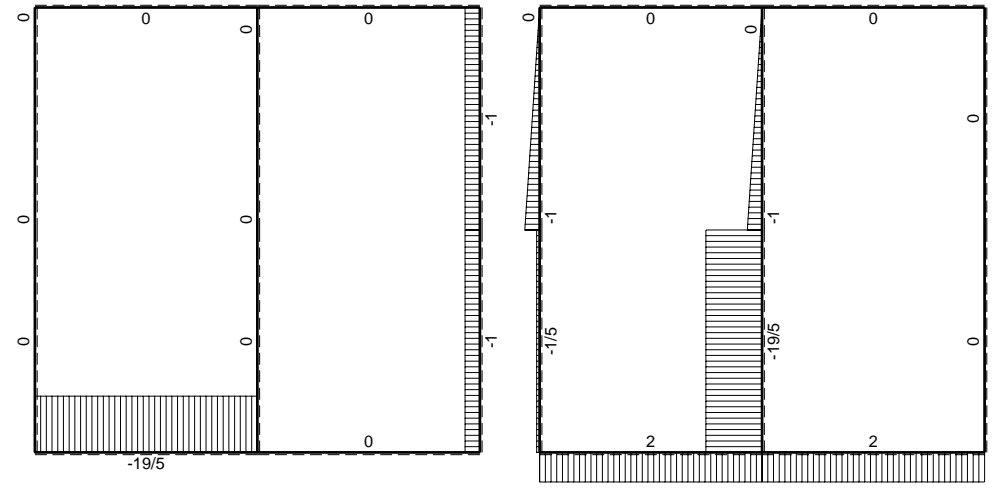
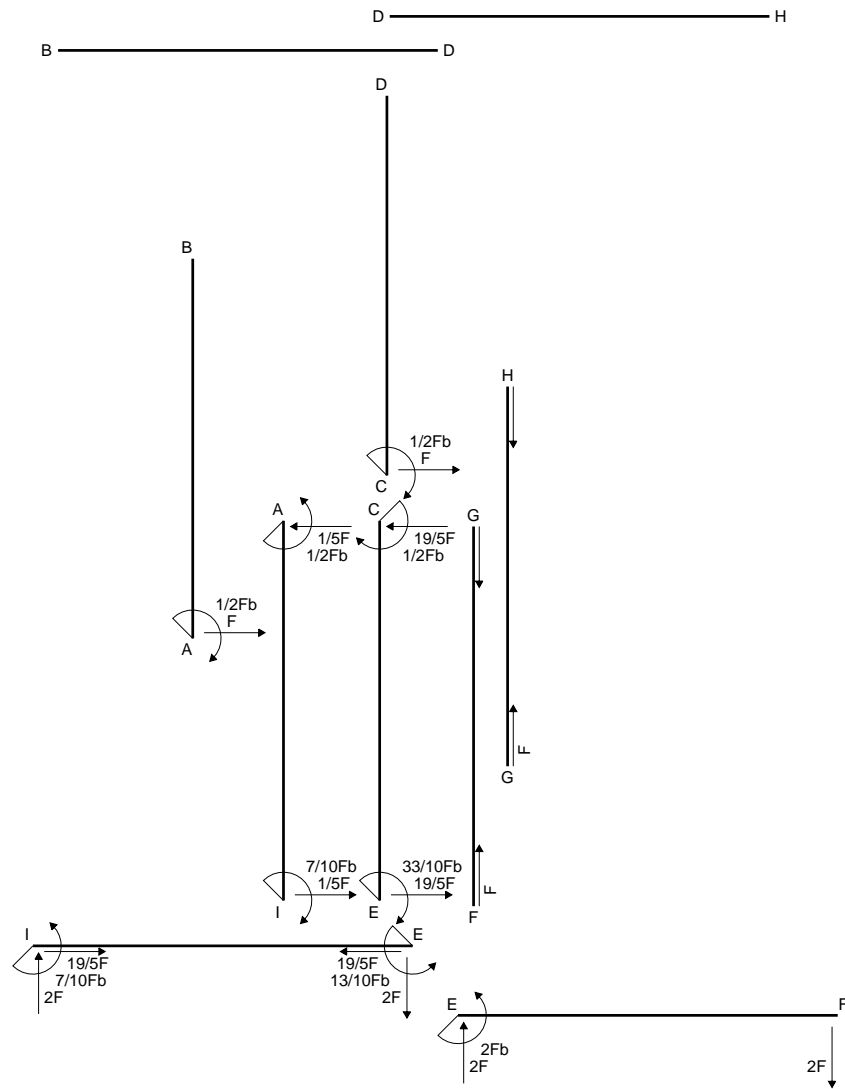
$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

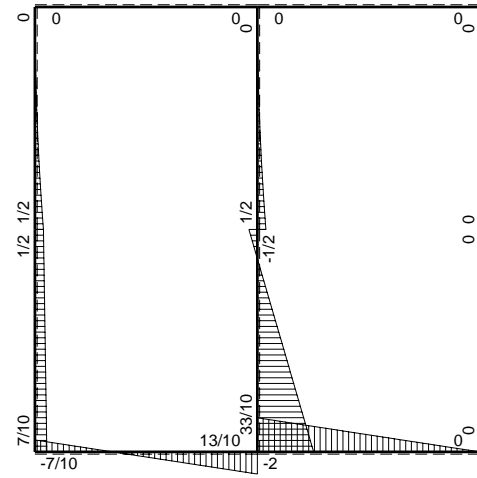


- A = 1086. mm²
- J_u = 289781. mm⁴
- J_v = 67788. mm⁴
- y_g = 28.65 mm
- T_y = 3660. N
- M_x = -2122800. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.65 mm
- σ_m = -Mv/J_u = -209.9 N/mm²
- x_c = 18. mm
- y_c = 12. mm
- v_c = -16.65 mm
- σ_c = -Mv/J_u = -122. N/mm²
- τ_c = 6.65 N/mm²
- σ_o = √σ²+3τ² = 122.5 N/mm²
- S = 6318. mm³

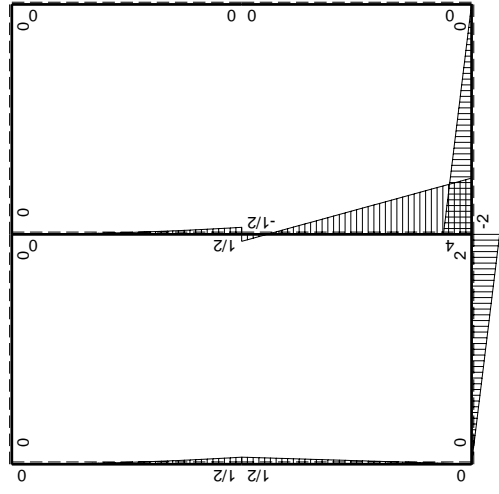
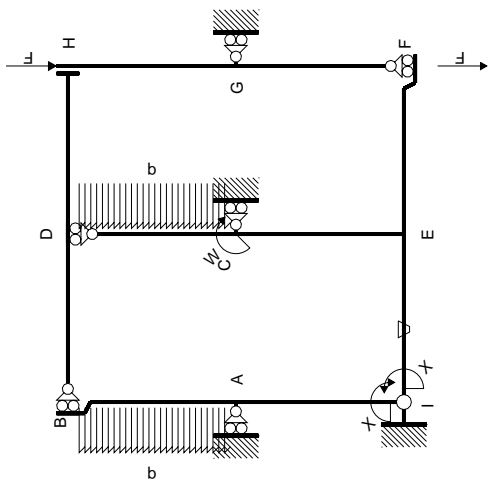


← ⊕ → F

↑ ⊕ ↓ F_b

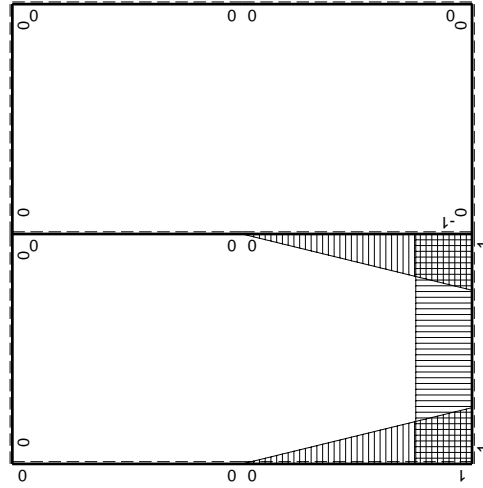


⊕ ⊖ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2qx^2$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	0	0	0	0	0	0+0	0
HG b	0	0	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-9/2Fx$	0	$-4Fb+17/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/4+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$1/2Fb-9/2Fx$	0	$1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-7/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 17/2 x/b - 9/2 x^2/b^2) Fb 1/EJ dx = [-4x + 17/4 x^2/b - 3/2 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-4b + 17/4 b - 3/2 b) Fb 1/EJ = -5/4 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (1/2 x/b - 9/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 3/2 x^3/b^2]_0^b Fb 1/EJ$$

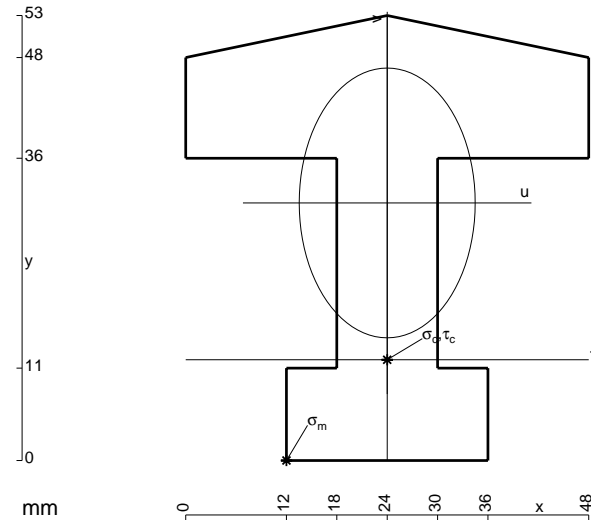
$$= (1/4 b - 3/2 b) Fb 1/EJ = -5/4 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

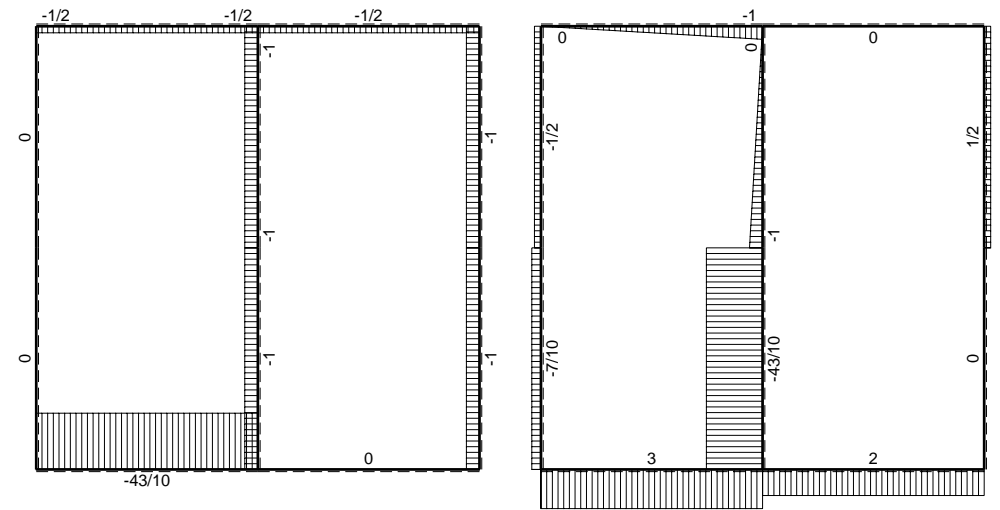
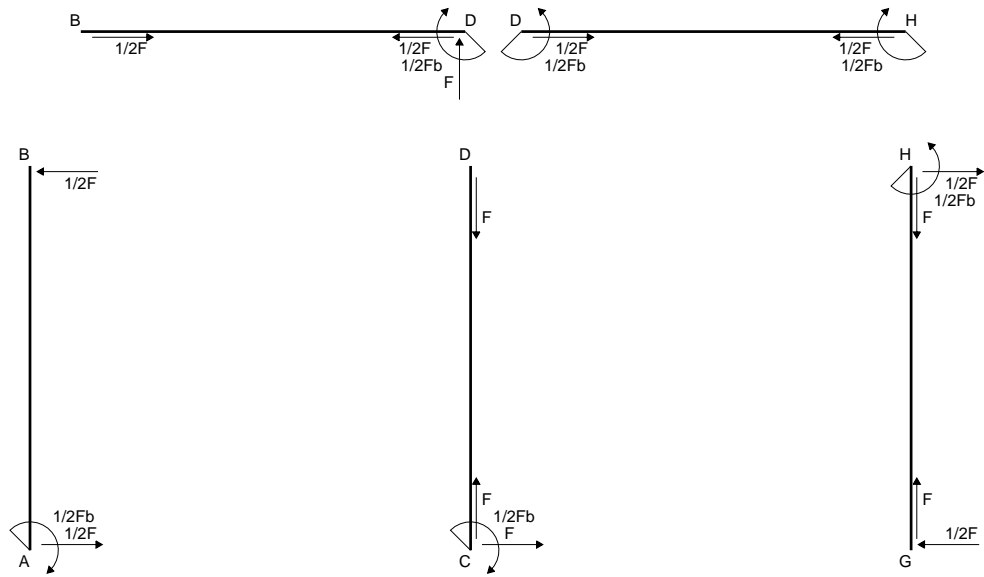
$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

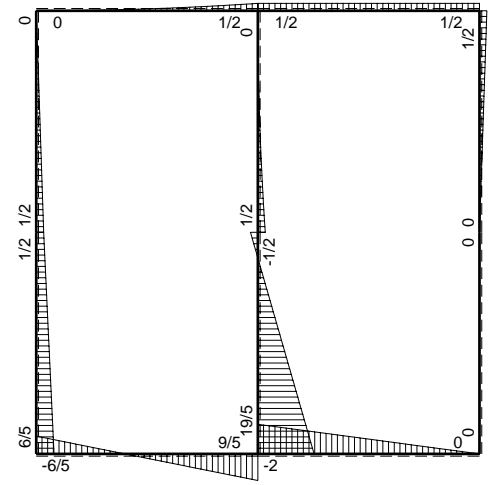
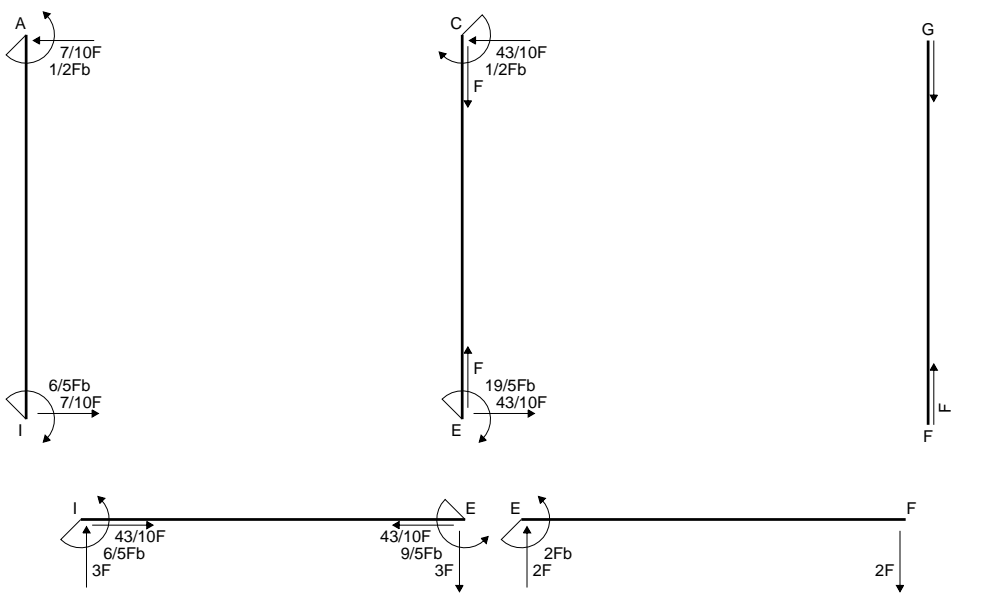


- A = 1260. mm²
- J_u = 325285. mm⁴
- J_v = 138384. mm⁴
- y_g = 30.68 mm
- T_y = 3700. N
- M_x = -2331000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.68 mm
- σ_m = -Mv/J_u = -219.8 N/mm²
- x_c = 24. mm
- y_c = 12. mm
- v_c = -18.68 mm
- σ_c = -Mv/J_u = -133.8 N/mm²
- τ_c = 6.519 N/mm²
- σ_o = √σ²+3τ² = 134.3 N/mm²
- S = 6877. mm³

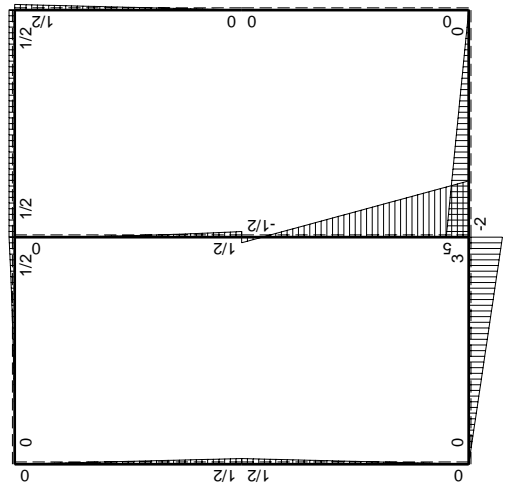
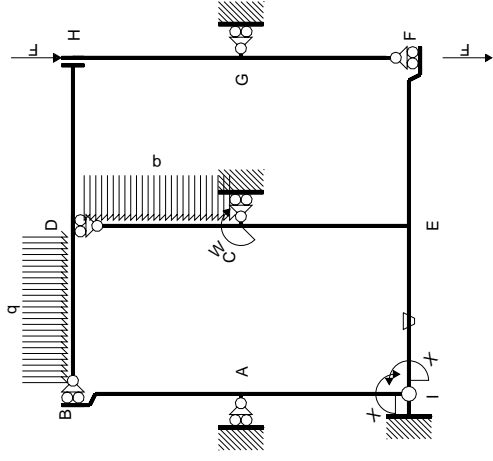


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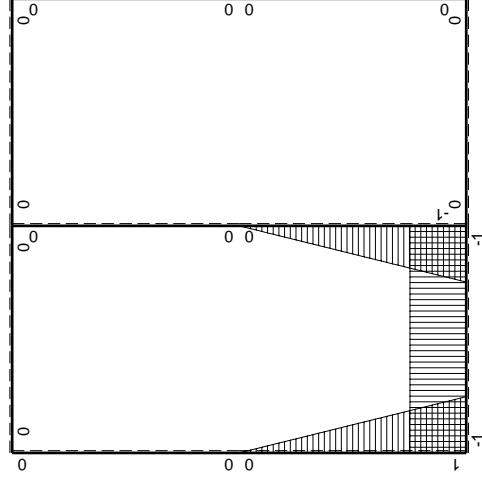


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$-1/2Fx$	0	0	0	0			
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$-1/2qx^2$	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0			
HD b	0	$1/2Fb$	0	0	0	0	0+0	0	
DH b	0	$-1/2Fb$	0	0	0	0			
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
BD b	0	$-1/2qx^2$	0	0	0	0			
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1			
EC b	$-1+x/b$	$5Fb-11/2Fx$	0	$-5Fb+21/2Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-19/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$1/2Fb-11/2Fx$	0	$1/2Fx-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2			
	totali							$-2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$6/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{x_0} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{x_0} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{x_0} = \int_0^b (-5 + 21/2 x/b - 11/2 x^2/b^2) Fb 1/EJ dx = [-5x + 21/4 x^2/b - 11/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 21/4 b - 11/6 b) Fb 1/EJ = -19/12 Fb^2/EJ$$

$$L_{CE}^{x_0} = \int_0^b (1/2 x/b - 11/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 11/6 x^3/b^2]_0^b Fb 1/EJ$$

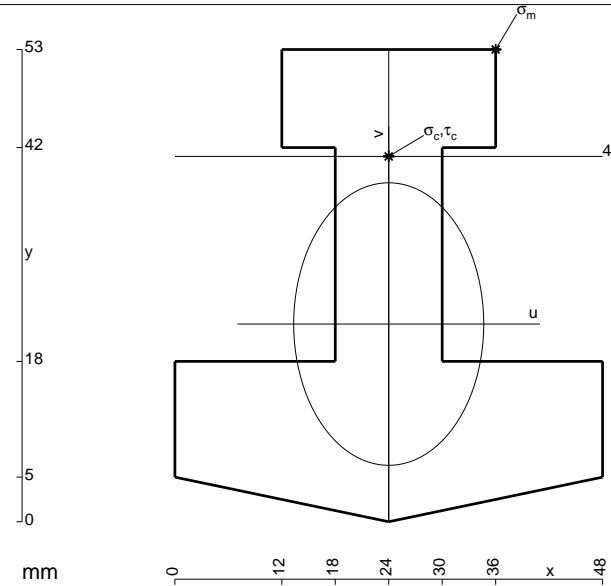
$$= (1/4 b - 11/6 b) Fb 1/EJ = -19/12 Fb^2/EJ$$

$$L_{IA}^{x_0} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

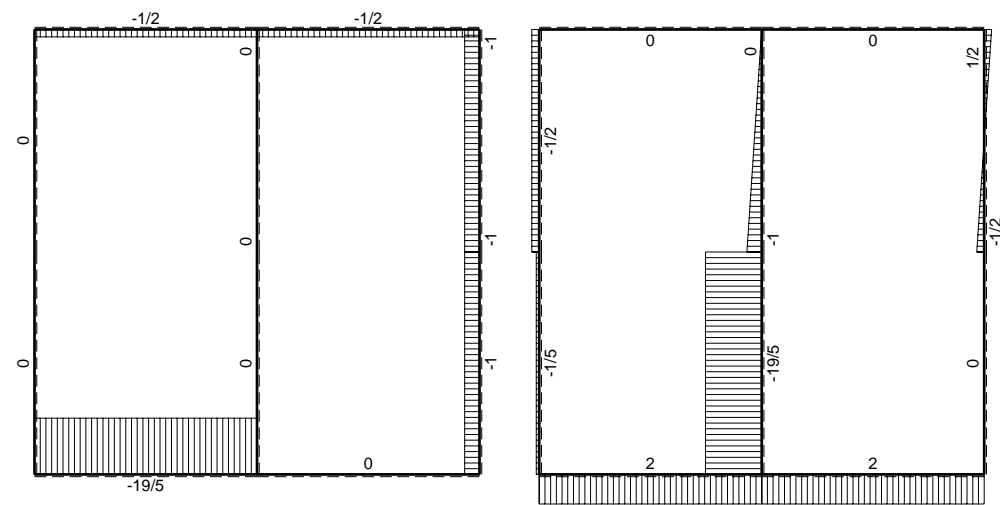
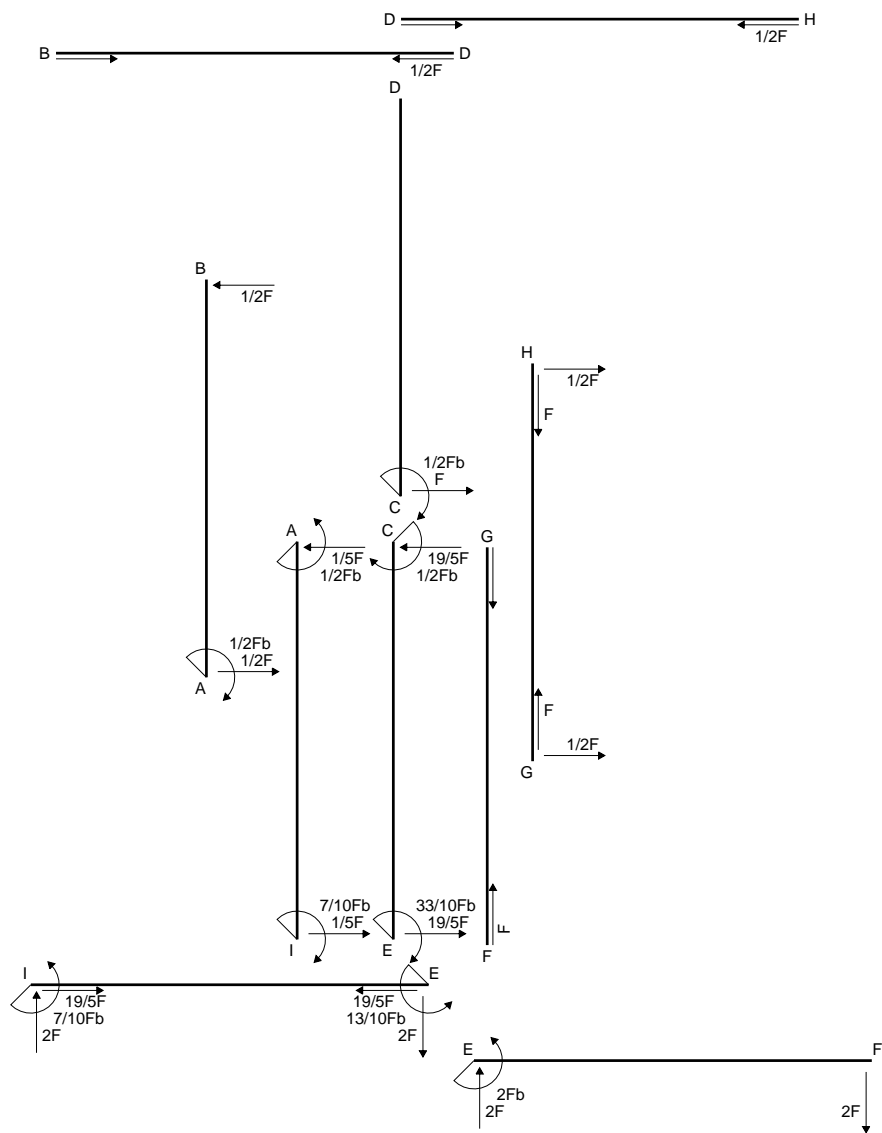
$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

$$L_{AI}^{x_0} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

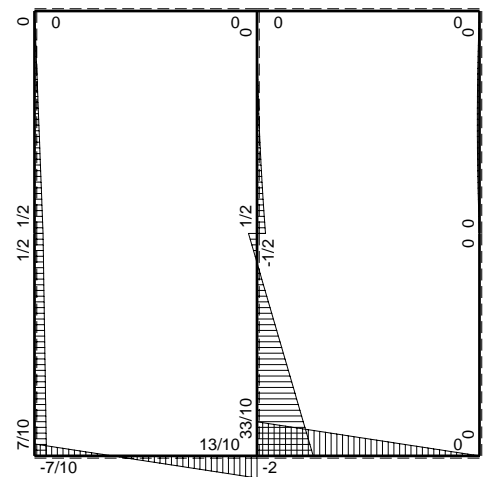


- A = 1296. mm²
- J_u = 326102. mm⁴
- J_v = 147456. mm⁴
- y_g = 22.19 mm
- T_y = 3560. N
- M_x = -2420800. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.81 mm
- σ_m = -Mv/J_u = 228.7 N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 18.81 mm
- σ_c = -Mv/J_u = 139.6 N/mm²
- τ_c = 6.29 N/mm²
- σ_q = √σ²+3τ² = 140.1 N/mm²
- S = 6914. mm³

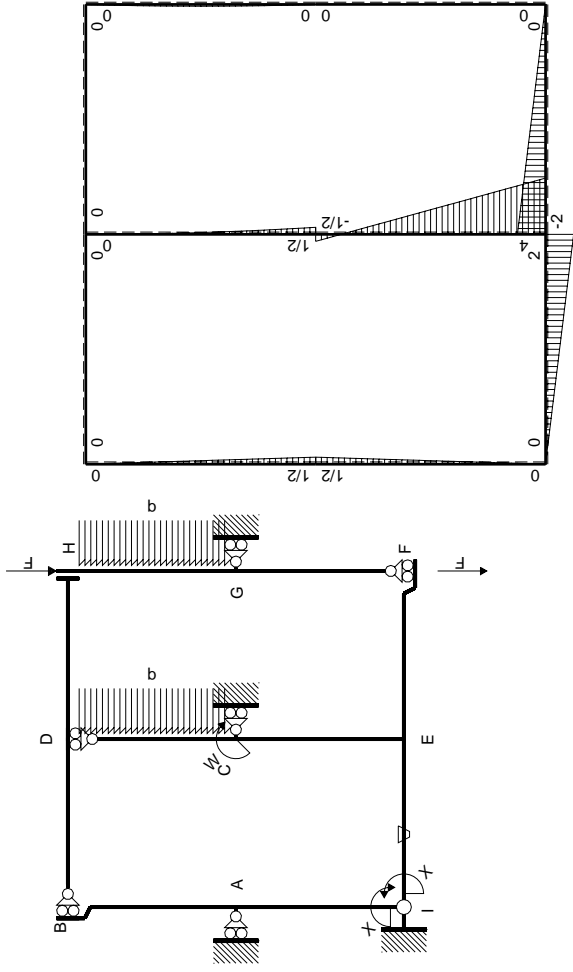


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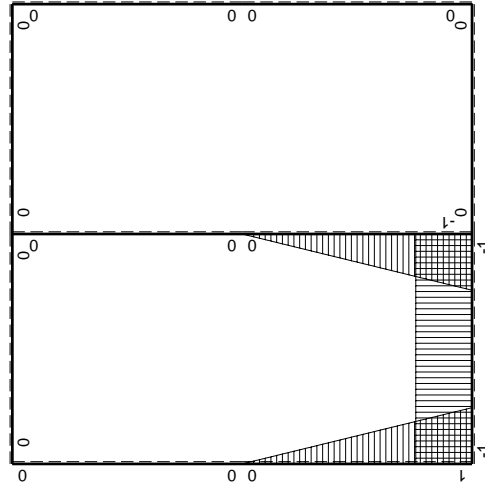


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-9/2Fx$	0	$-4Fb+17/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/4+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$1/2Fb-9/2Fx$	0	$1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$-1/2Fb+1/2Fx$	0	$1/2Fx-1/2Fx^2/b$	0	x^2/b^2		
	totali						$-7/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 17/2 x/b - 9/2 x^2/b^2) Fb 1/EJ dx = [-4x + 17/4 x^2/b - 3/2 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-4b + 17/4 b - 3/2 b) Fb 1/EJ = -5/4 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (1/2 x/b - 9/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 3/2 x^3/b^2]_0^b Fb 1/EJ$$

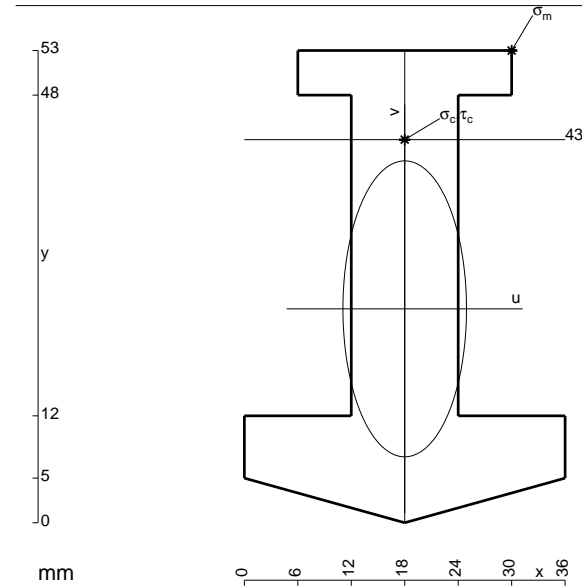
$$= (1/4 b - 3/2 b) Fb 1/EJ = -5/4 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

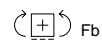
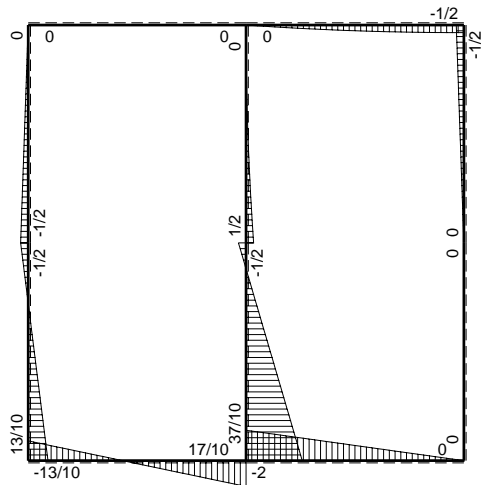
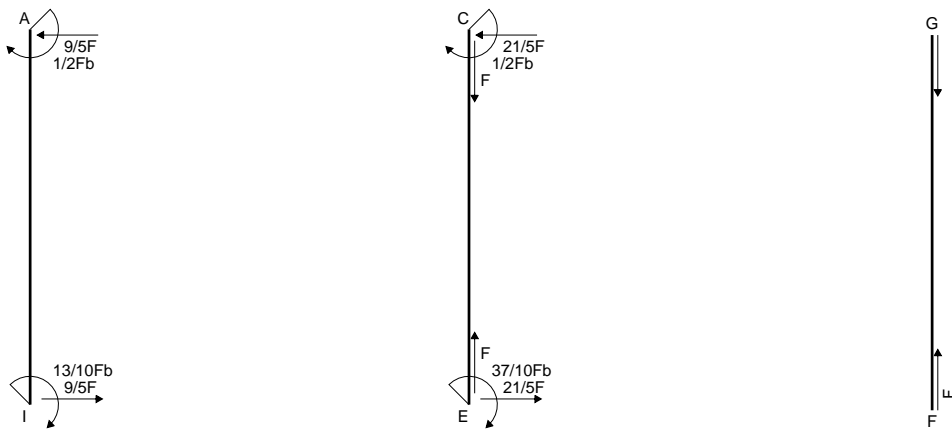
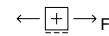
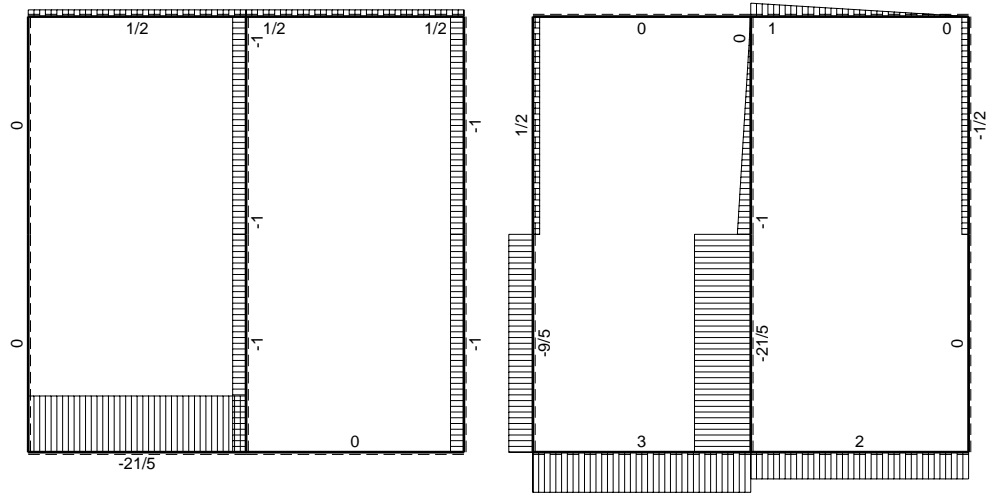
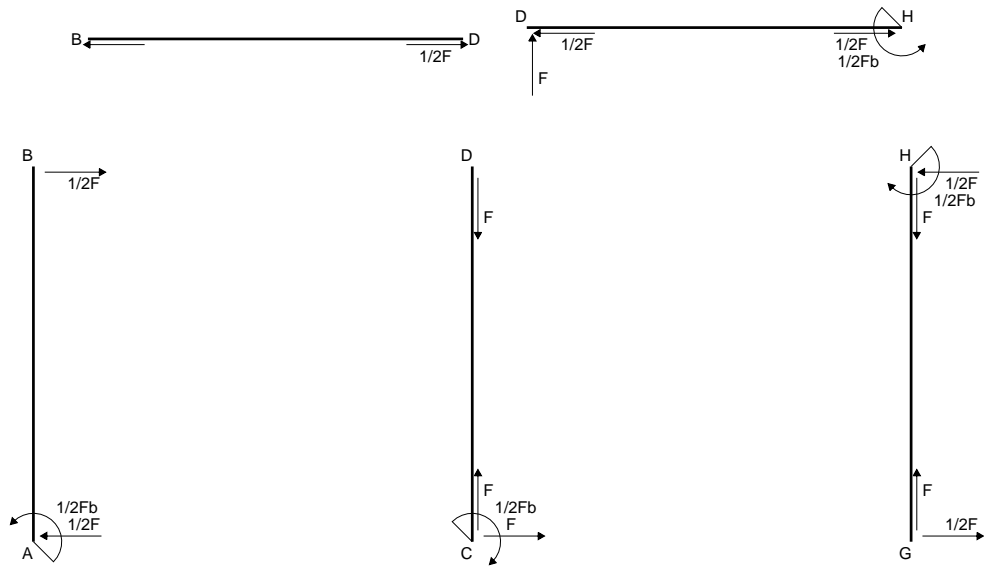
$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$

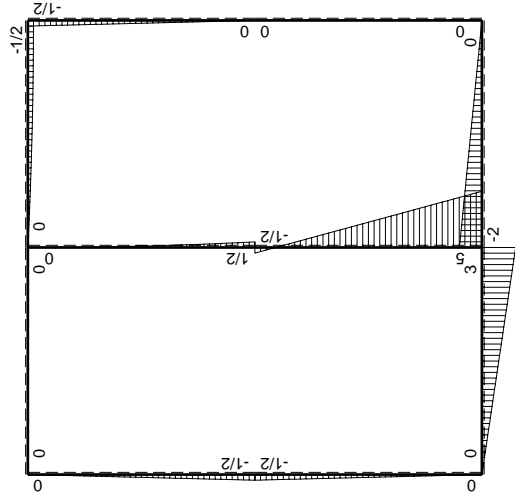
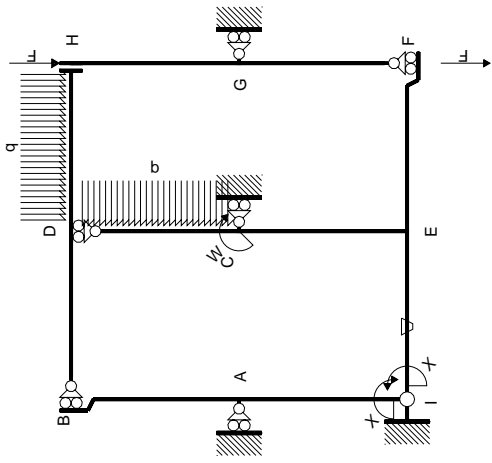
$$L_{AI}^{xo} = \int_0^b (1/2 x/b - 1/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (1/4 b - 1/6 b) Fb 1/EJ = 1/12 Fb^2/EJ$$



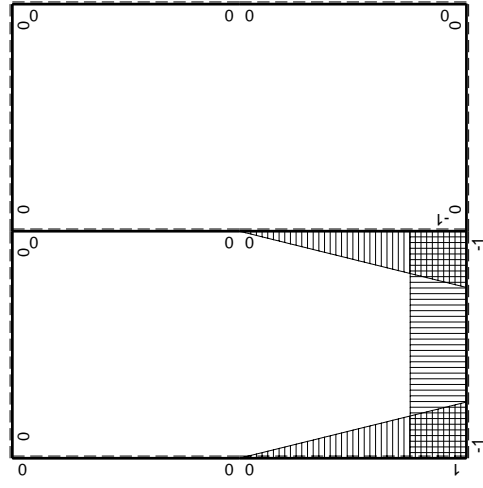
- A = 894. mm²
- J_u = 246865. mm⁴
- J_v = 43020. mm⁴
- y_g = 24.01 mm
- T_y = 2760. N
- M_x = -2042400. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.99 mm
- σ_m = -Mv/J_u = 239.9 N/mm²
- x_c = 18. mm
- y_c = 43. mm
- v_c = 18.99 mm
- σ_c = -Mv/J_u = 157.1 N/mm²
- τ_c = 4.163 N/mm²
- σ_q = √σ²+3τ² = 157.3 N/mm²
- S = 4469. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-11/2Fx$	0	$-5Fb+21/2Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-19/12+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$1/2Fb-11/2Fx$	0	$1/2Fx-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$13/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = \left[x \right]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = \left[x \right]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = \left[x - x^2/b + 1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = \left[1/3 x^3/b^2 \right]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = \left[-3/2 x^2/b \right]_0^b Fb \frac{1}{EJ} + \left[x \right]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = \left[-3x + 3/2 x^2/b \right]_0^b Fb \frac{1}{EJ} + \left[-x \right]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 21/2 x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-5x + 21/4 x^2/b - 11/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 21/4 b - 11/6 b) Fb \frac{1}{EJ} = -19/12 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (1/2 x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[1/4 x^2/b - 11/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

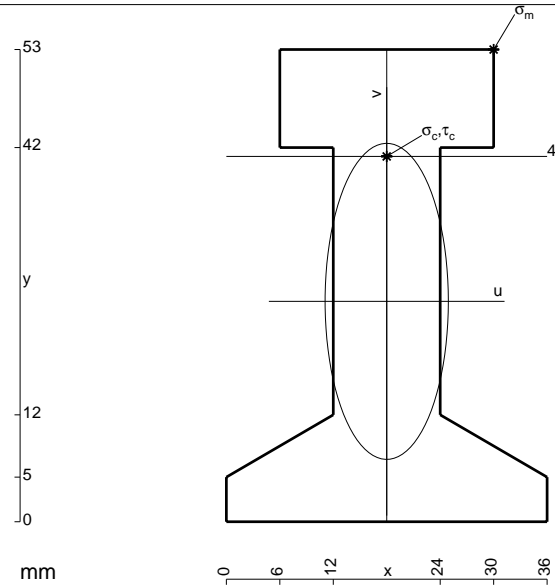
$$= (1/4 b - 11/6 b) Fb \frac{1}{EJ} = -19/12 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

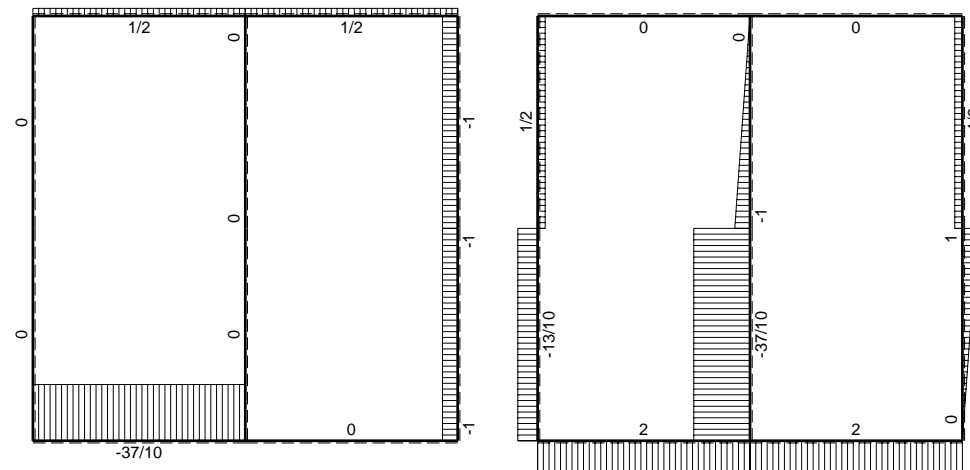
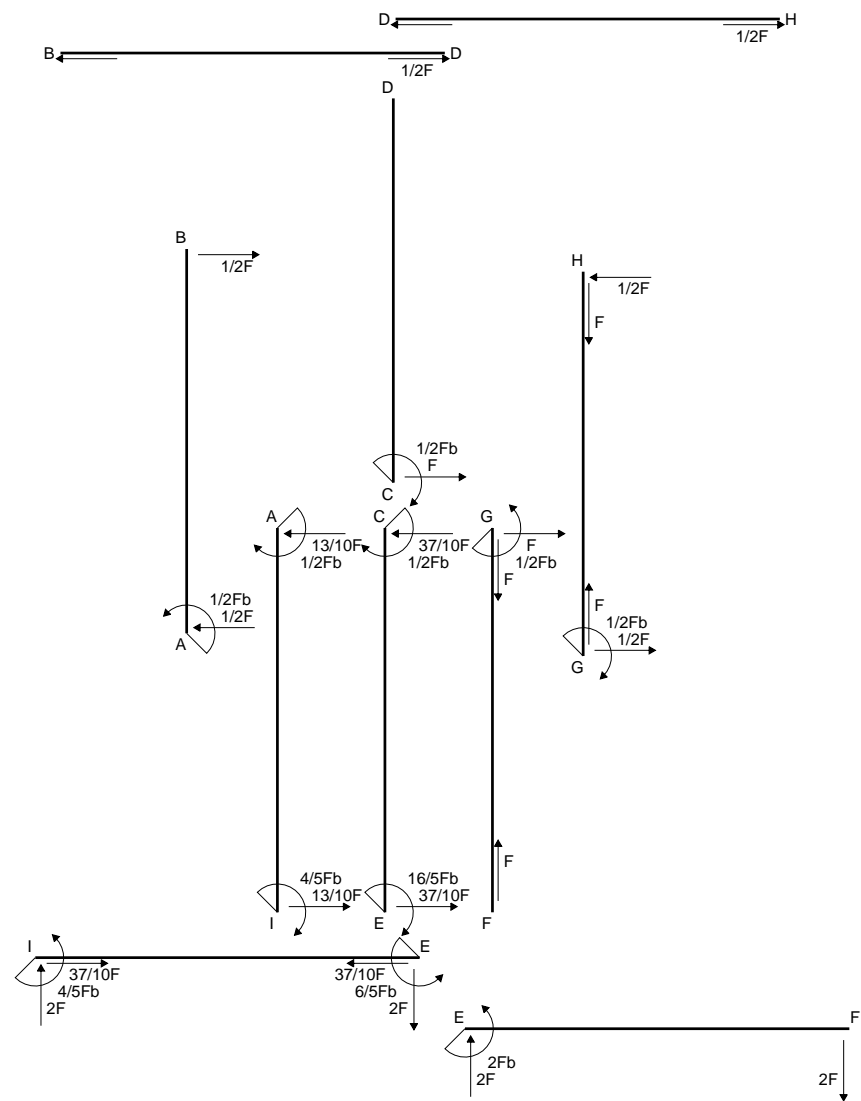
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = \left[-1/4 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

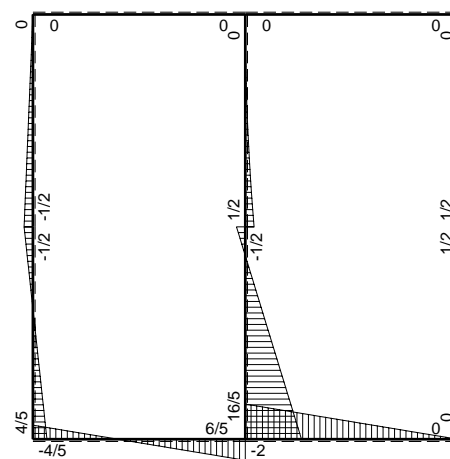


- A = 972. mm²
- J_u = 305841. mm⁴
- J_v = 46512. mm⁴
- y_g = 24.73 mm
- T_y = 2720. N
- M_x = -2148800. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.27 mm
- σ_m = -Mv/J_u = 198.6 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 16.27 mm
- σ_c = -Mv/J_u = 114.3 N/mm²
- τ_c = 4.604 N/mm²
- σ_q = √σ²+3τ² = 114.6 N/mm²
- S = 6212. mm³

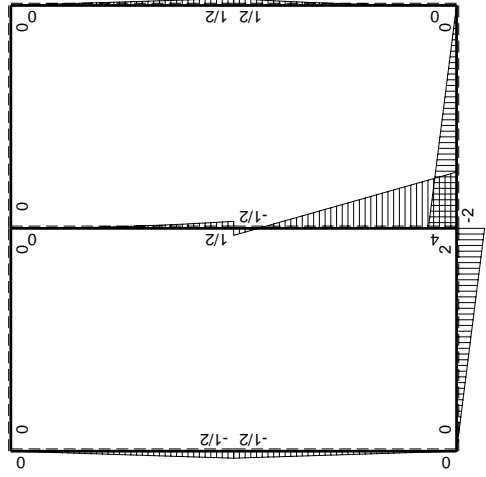
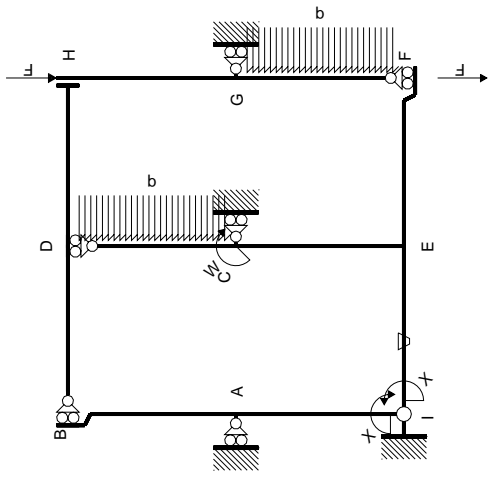


← ⊕ → F

↑ ⊕ ↓ F

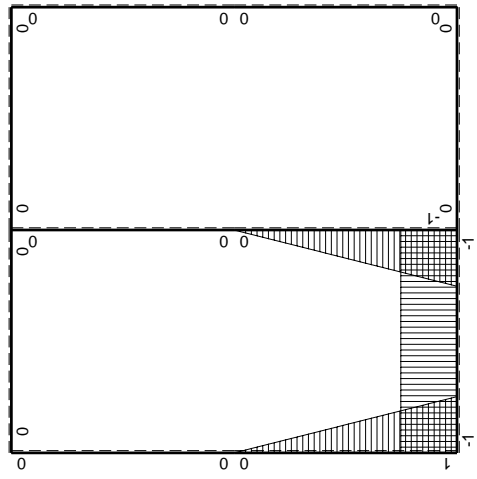


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0
BA b	0	$1/2Fx$	0	0	0	0		
CD b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
DC b	0	$-1/2qx^2$	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-9/2Fx$	0	$-4Fb+17/2Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/4+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$1/2Fb-9/2Fx$	0	$1/2Fx-9/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-4/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$4/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 17/2 x/b - 9/2 x^2/b^2) Fb 1/EJ dx = [-4x + 17/4 x^2/b - 3/2 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-4b + 17/4 b - 3/2 b) Fb 1/EJ = -5/4 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (1/2 x/b - 9/2 x^2/b^2) Fb 1/EJ dx = [1/4 x^2/b - 3/2 x^3/b^2]_0^b Fb 1/EJ$$

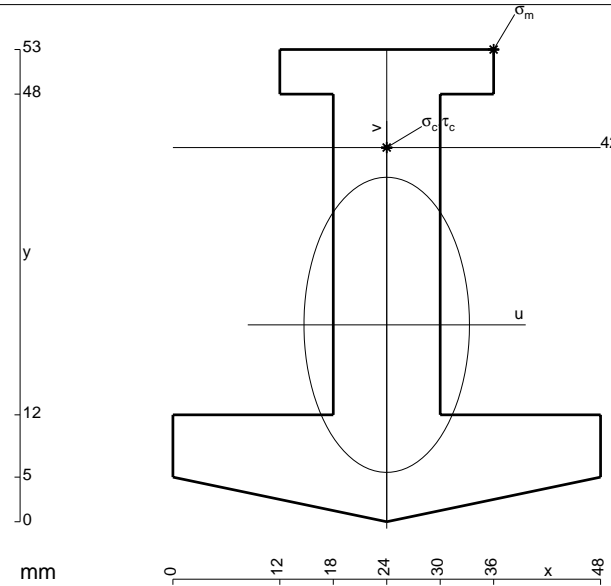
$$= (1/4 b - 3/2 b) Fb 1/EJ = -5/4 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

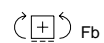
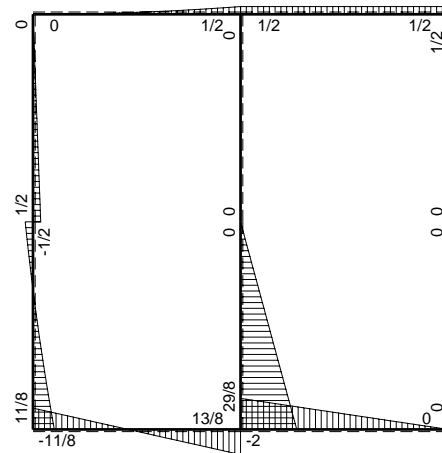
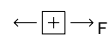
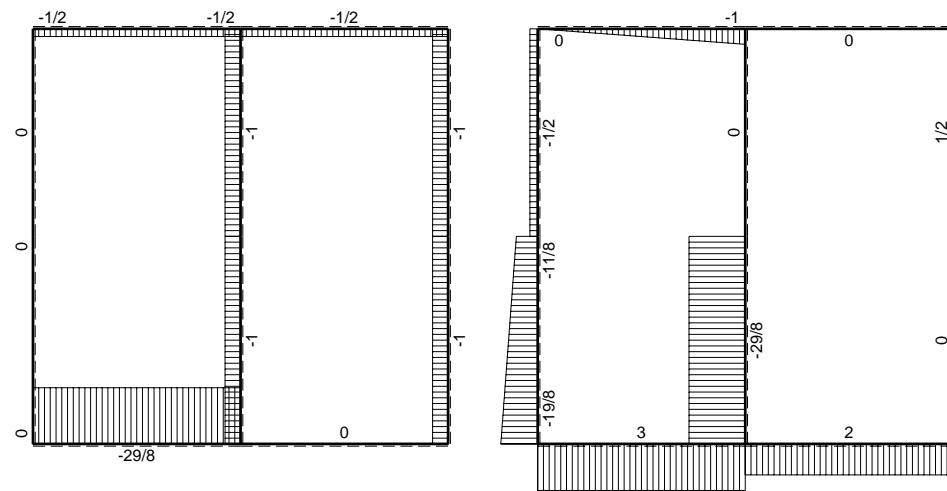
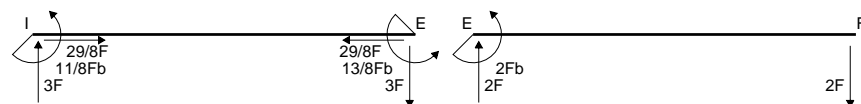
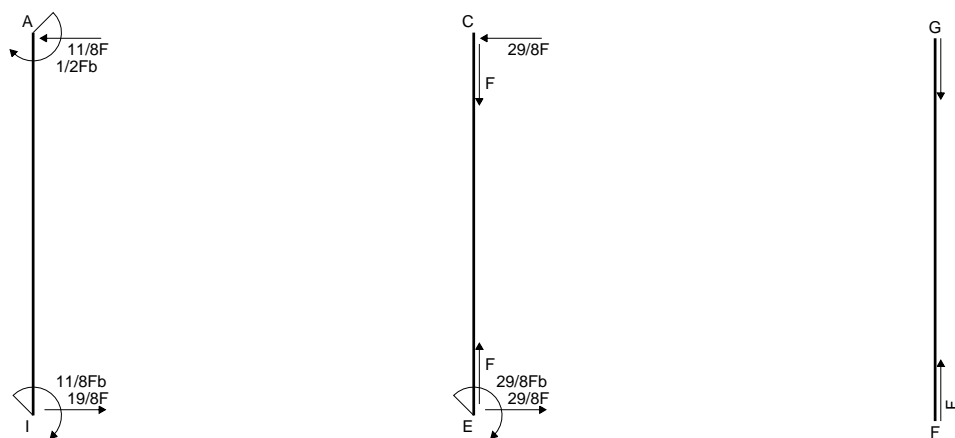
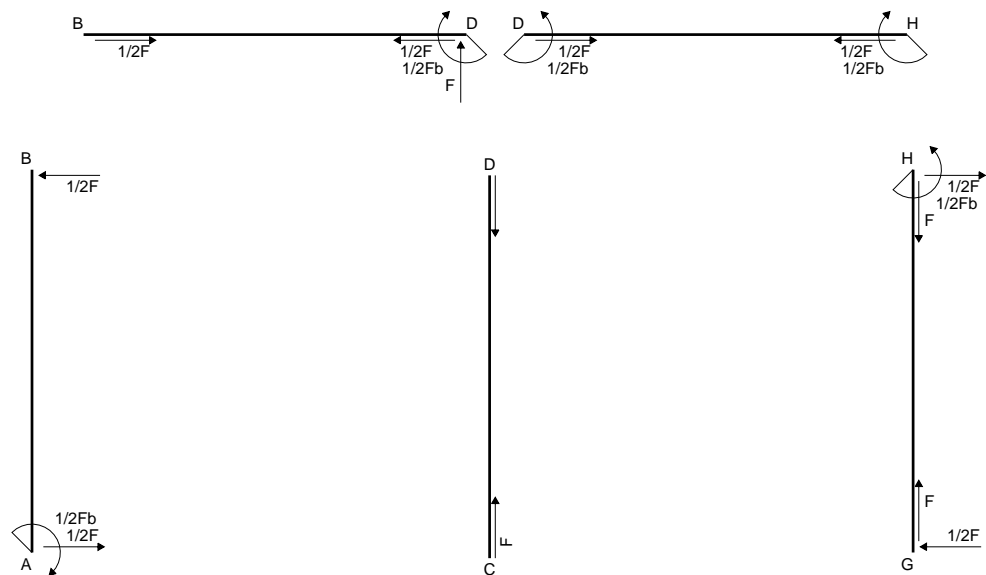
$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

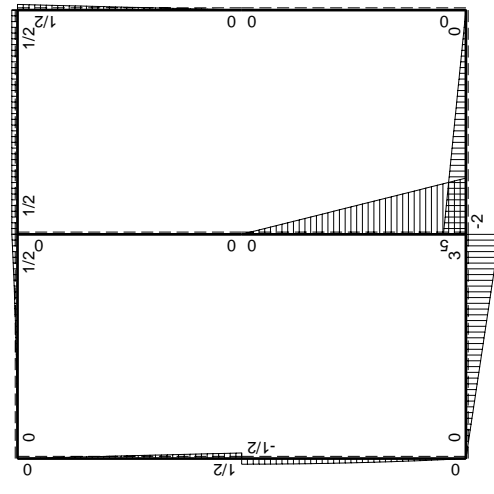
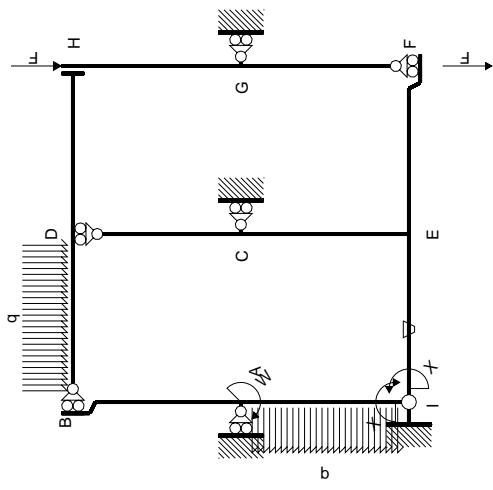
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$



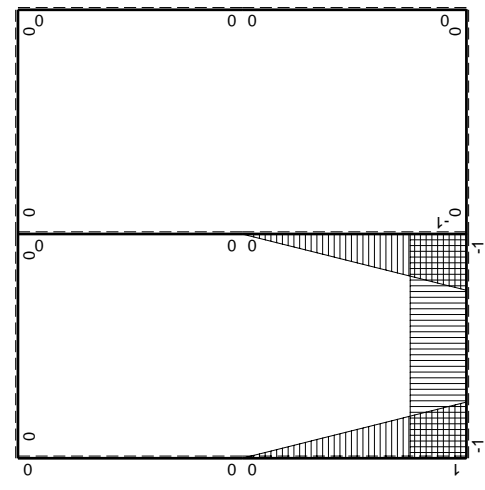
- A = 1008. mm²
- J_u = 276602. mm⁴
- J_v = 86976. mm⁴
- y_g = 22.1 mm
- T_y = 2220. N
- M_x = -1864800. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.9 mm
- σ_m = -Mv/J_u = 208.3 N/mm²
- x_c = 24. mm
- y_c = 42. mm
- v_c = 19.9 mm
- σ_c = -Mv/J_u = 134.2 N/mm²
- τ_c = 3.382 N/mm²
- σ_q = √σ²+3τ² = 134.3 N/mm²
- S = 5057. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2qx^2$	0	$-1/2Fb+1/2qx^3/b$	0	x^2/b^2		
	totali						$-55/24Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{x_0} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{x_0} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{x_0} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{x_0} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

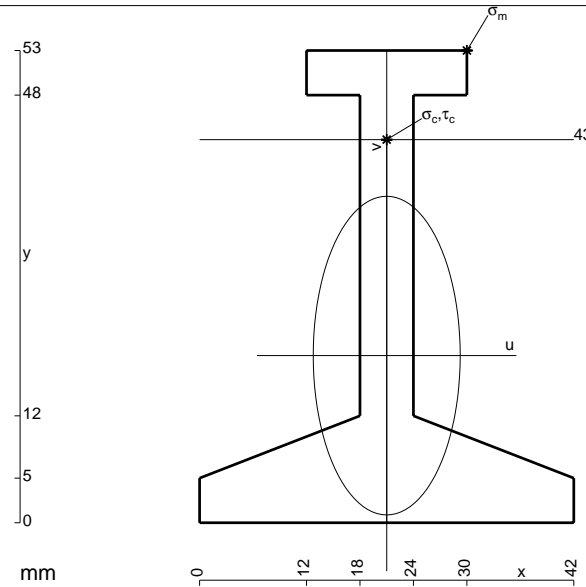
$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{IA}^{x_0} = \int_0^b (-x/b + 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [-1/2 x^2/b + 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

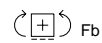
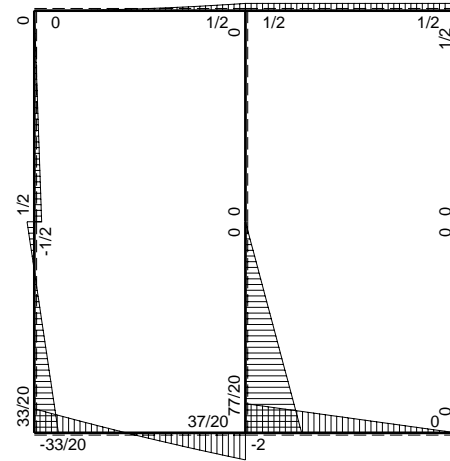
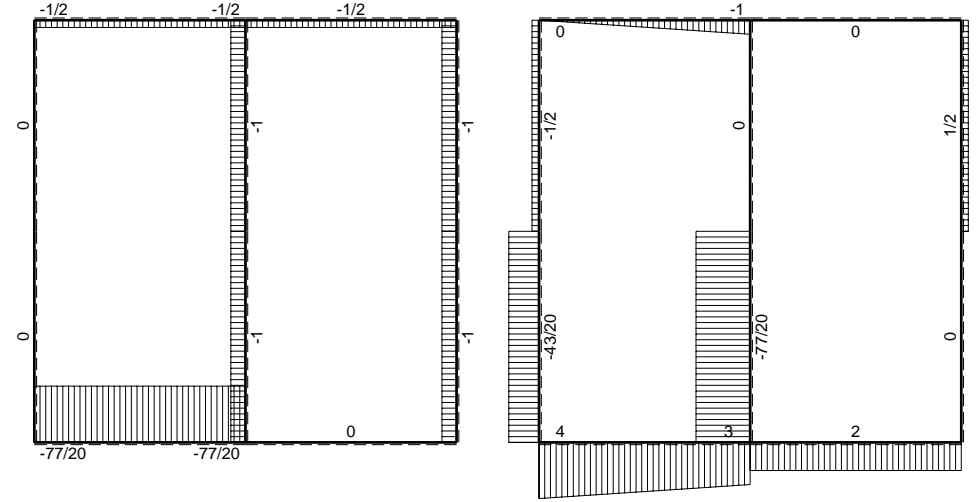
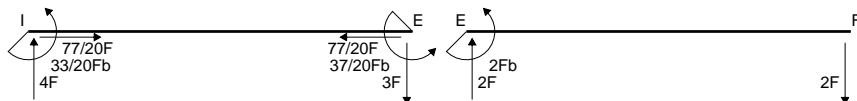
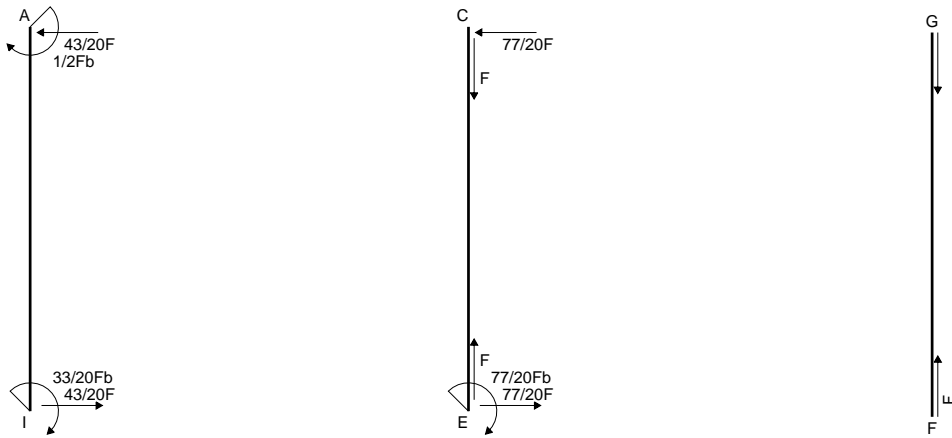
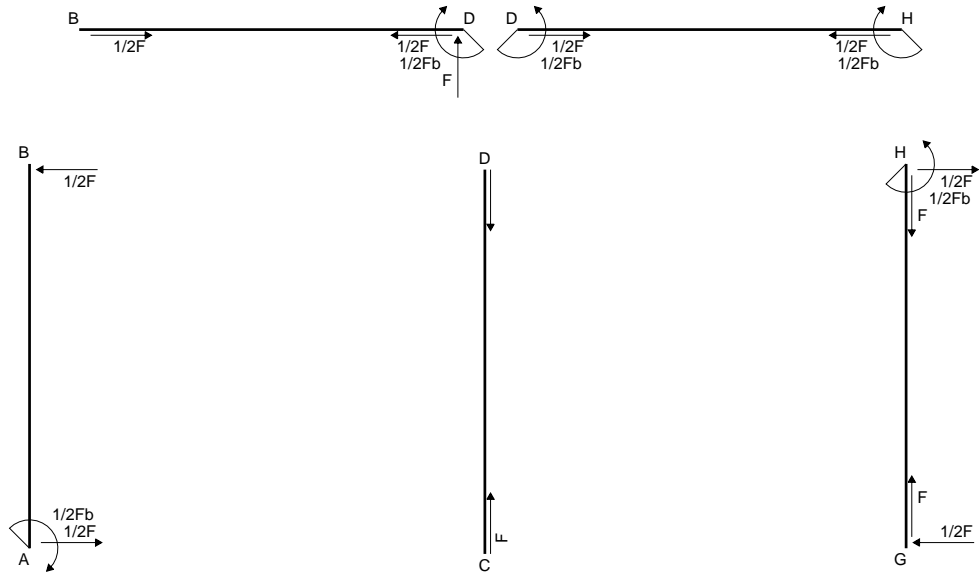
$$= (-1/2 b + 1/2 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

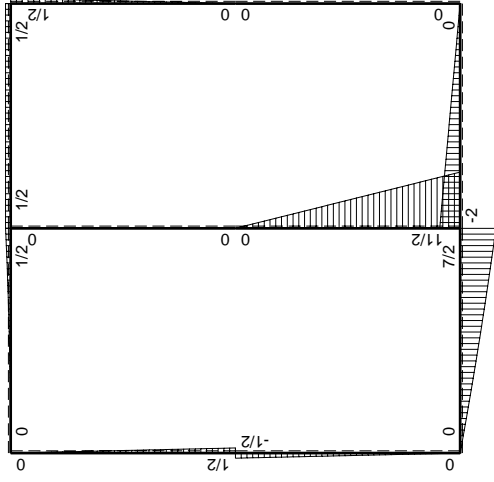
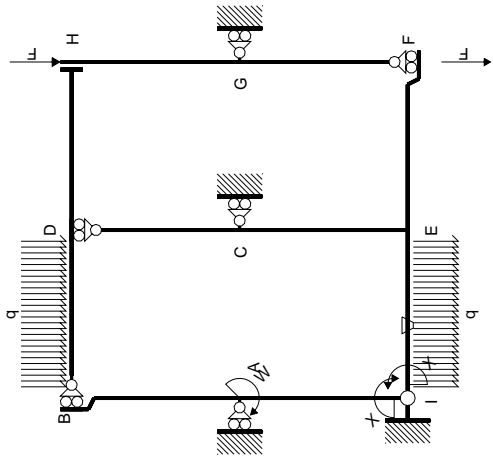
$$L_{AI}^{x_0} = \int_0^b (-1/2 x/b + 1/2 x^3/b^3) Fb 1/EJ dx = [-1/4 x^2/b + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$



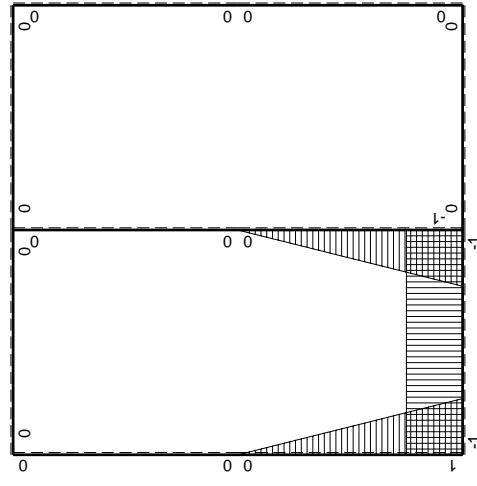
- A = 684. mm²
- J_u = 218819. mm⁴
- J_v = 46548. mm⁴
- y_g = 18.76 mm
- T_y = 1560. N
- M_x = -1404000. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 9. mm
- v_m = 34.24 mm
- σ_m = -Mv/J_u = 219.7 N/mm²
- x_c = 21. mm
- y_c = 43. mm
- v_c = 24.24 mm
- σ_c = -Mv/J_u = 155.5 N/mm²
- τ_c = 4.348 N/mm²
- σ_q = √σ²+3τ² = 155.7 N/mm²
- S = 3659. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$-1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0			
HD b	0	$1/2Fb$	0	0	0	0	0+0	0	
DH b	0	$-1/2Fb$	0	0	0	0			
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0	
BD b	0	$-1/2qx^2$	0	0	0	0			
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2			
	totali							$-11/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$33/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

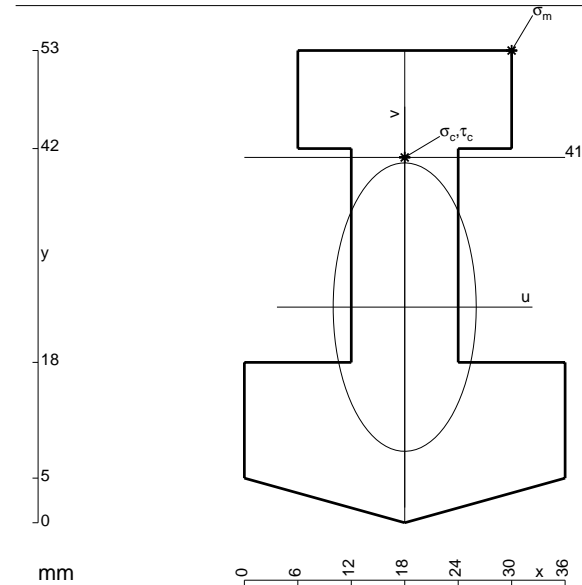
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

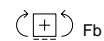
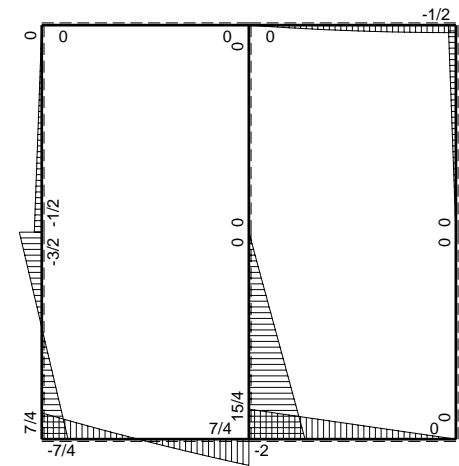
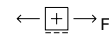
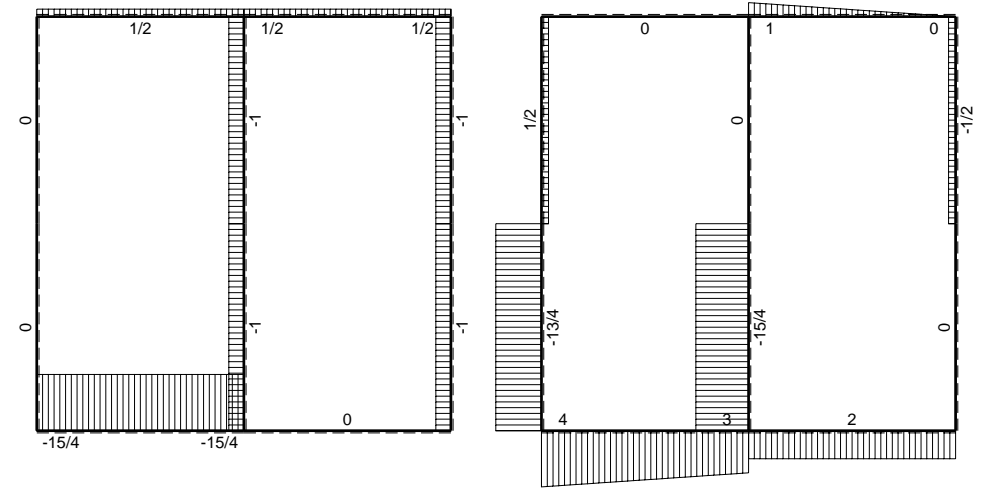
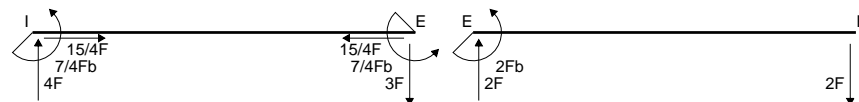
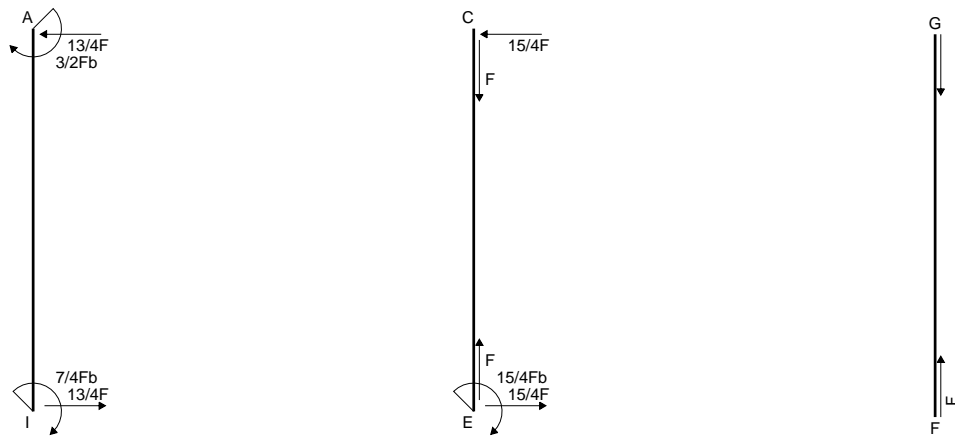
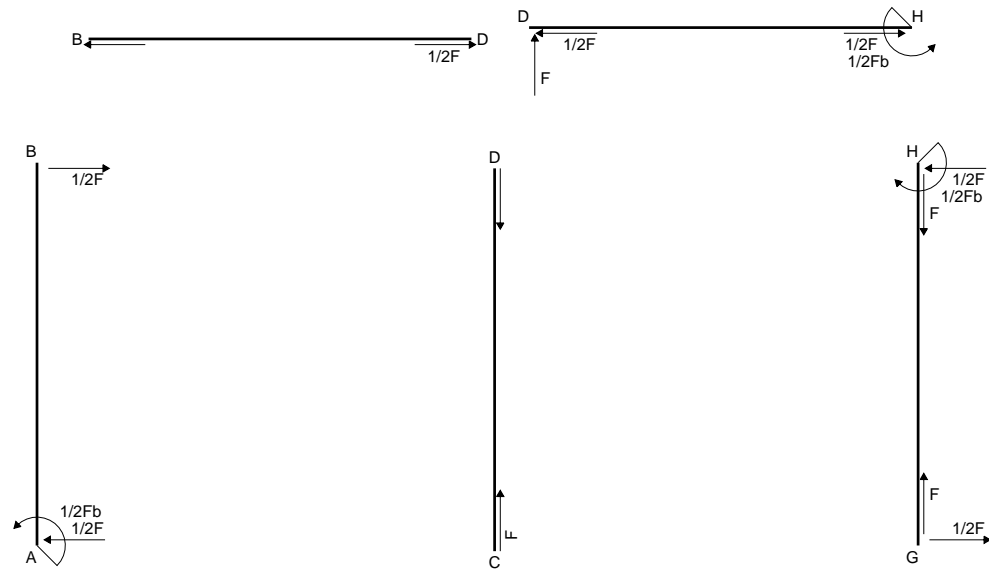
$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

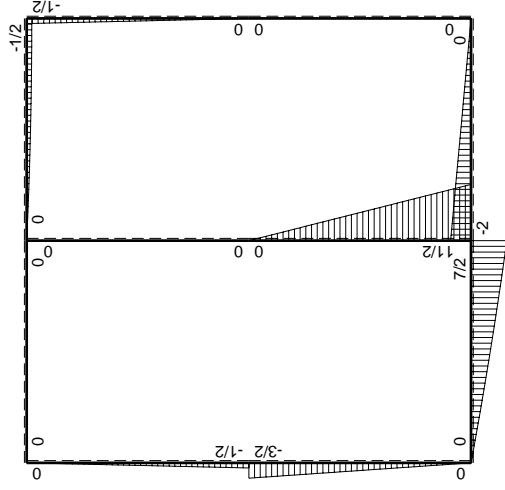
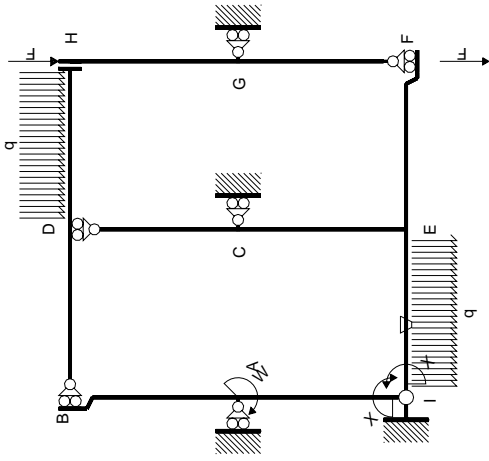
$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



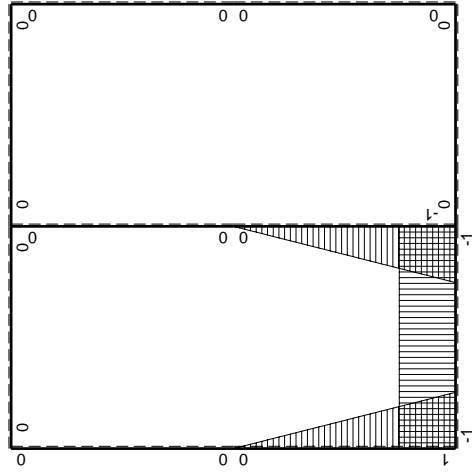
- A = 1110. mm²
- J_u = 290885. mm⁴
- J_v = 71532. mm⁴
- y_g = 24.2 mm
- T_y = 2440. N
- M_x = -2318000. Nmm
- x_m = 30. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 28.8 mm
- σ_m = -Mv/J_u = 229.5 N/mm²
- x_c = 18. mm
- y_c = 41. mm
- v_c = 16.8 mm
- σ_c = -Mv/J_u = 133.9 N/mm²
- τ_c = 4.445 N/mm²
- σ_q = √σ²+3τ² = 134.1 N/mm²
- S = 6359. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_X flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0			
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
DH b	0	$Fx-1/2qx^2$	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2			
	totali							$-35/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$7/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

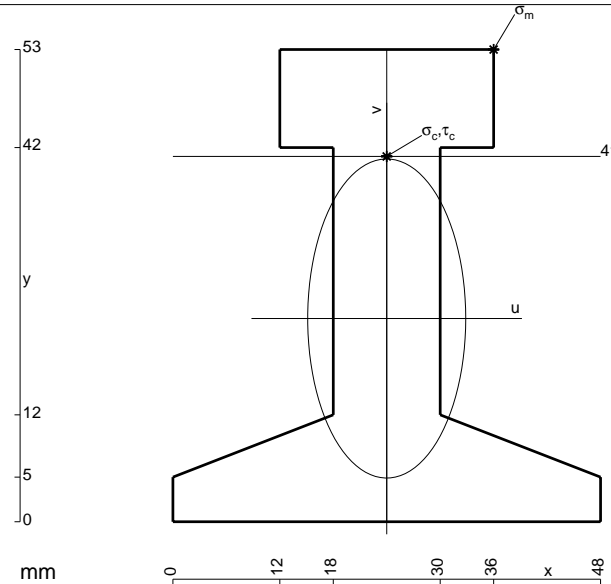
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

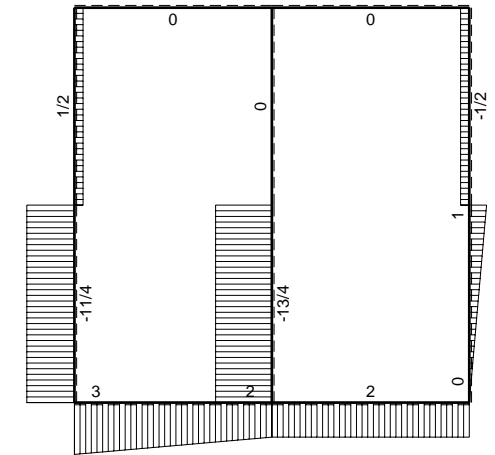
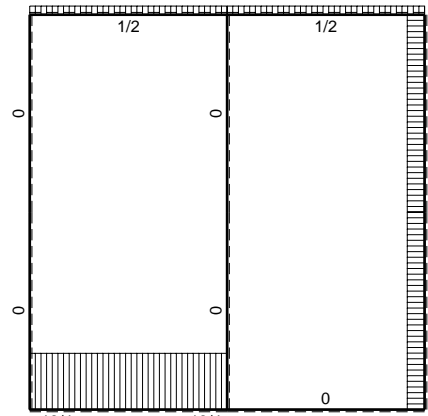
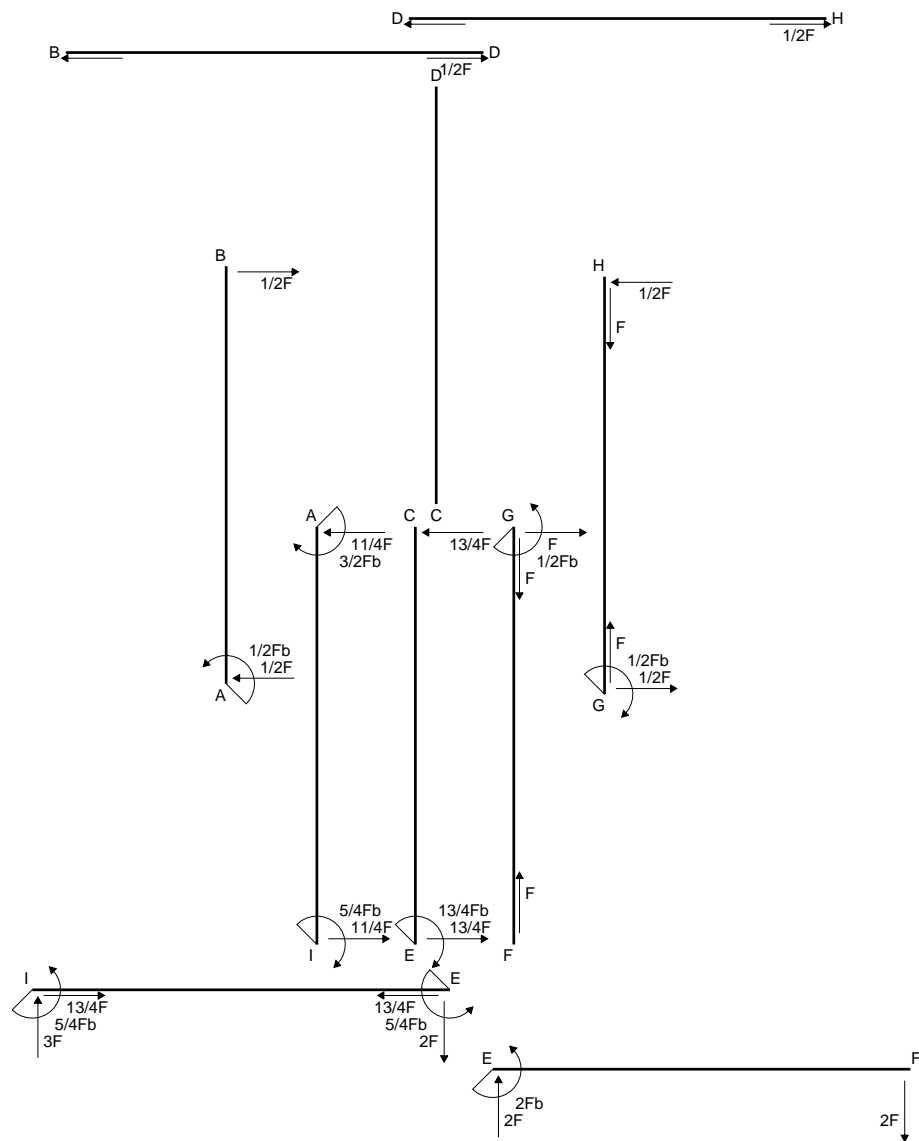
$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

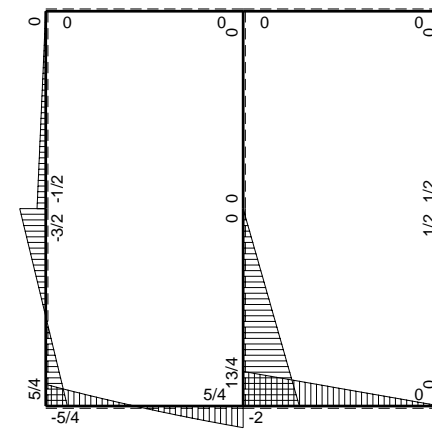


- A = 1074. mm²
- J_u = 344482. mm⁴
- J_v = 84492. mm⁴
- y_g = 22.81 mm
- T_y = 2720. N
- M_x = -2720000. Nmm
- x_m = 36. mm
- y_m = 53. mm
- u_m = 12. mm
- v_m = 30.19 mm
- σ_m = -Mv/J_u = 238.4 N/mm²
- x_c = 24. mm
- y_c = 41. mm
- v_c = 18.19 mm
- σ_c = -Mv/J_u = 143.6 N/mm²
- τ_c = 4.436 N/mm²
- σ_q = √σ²+3τ² = 143.8 N/mm²
- S = 6742. mm³

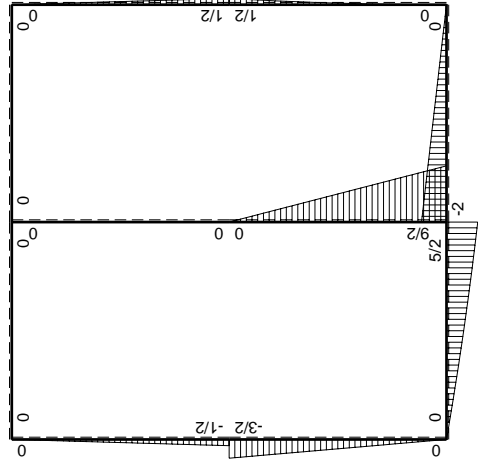
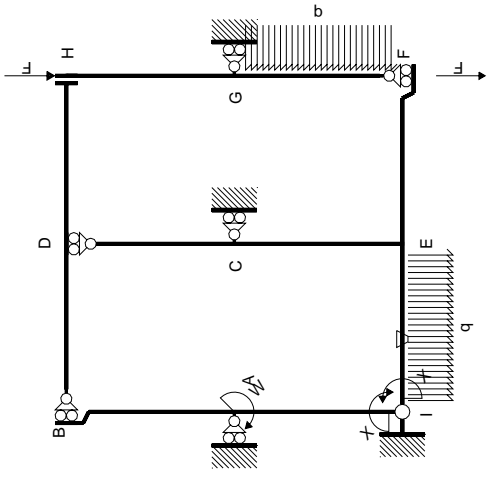


← ⊕ → F

↑ ⊕ ↓ F

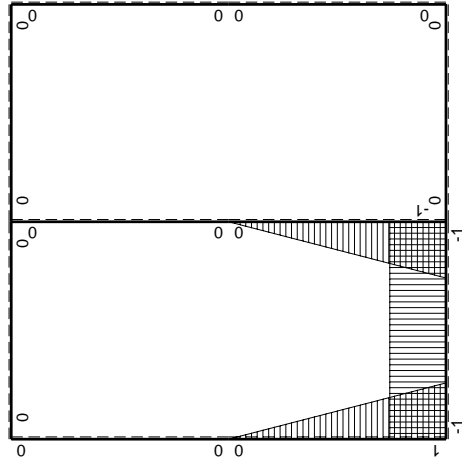


⊕ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0	0+0	0	
BA b	0	$1/2Fx$	0	0	0	0			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0	
FE b	0	$2Fx$	0	0	0	0			
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0			
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0	
HG b	0	$-1/2Fx$	0	0	0	0			
HD b	0	0	0	0	0	0	0+0	0	
DH b	0	0	0	0	0	0			
DB b	0	0	0	0	0	0	0+0	0	
BD b	0	0	0	0	0	0			
IE b	-1	$3Fx-1/2qx^2$	$-Fb/EJ$	$-3Fx+1/2Fx^2/b$	Fb/EJ	1	$(-4/3+1)Fb^2/EJ$	Xb/EJ	
EI b	1	$-5/2Fb+2Fx+1/2qx^2$	Fb/EJ	$-5/2Fb+2Fx+1/2Fx^2/b$	Fb/EJ	1			
EC b	$-1+x/b$	$9/2Fb-9/2Fx$	0	$-9/2Fb+9Fx-9/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-3/2+0)Fb^2/EJ$	$1/3Xb/EJ$	
CE b	x/b	$-9/2Fx$	0	$-9/2Fx^2/b$	0	x^2/b^2			
IA b	$1-x/b$	$-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AI b	$-x/b$	$3/2Fb-3/2Fx$	0	$-3/2Fx+3/2Fx^2/b$	0	x^2/b^2			
	totali							$-25/12Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$							$5/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -1/3 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-5/2 + 2x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-5/2 x + x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-5/2 b + b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -1/3 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-9/2 + 9x/b - 9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-9/2 x + 9/2 x^2/b - 3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-9/2 b + 9/2 b - 3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-9/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

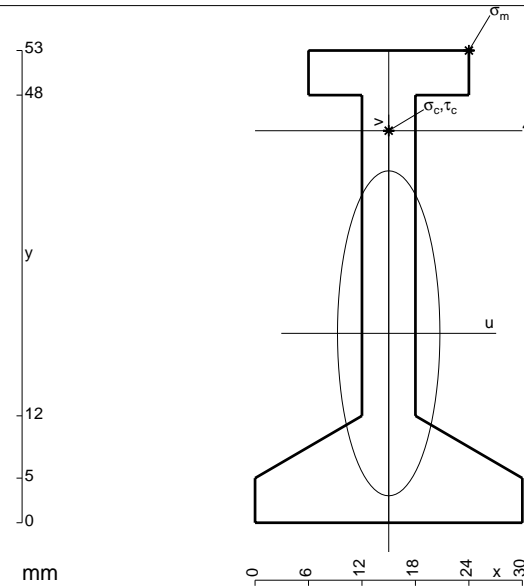
$$= (-3/2 b) Fb \frac{1}{EJ} = -3/2 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

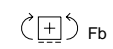
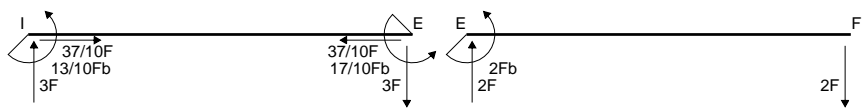
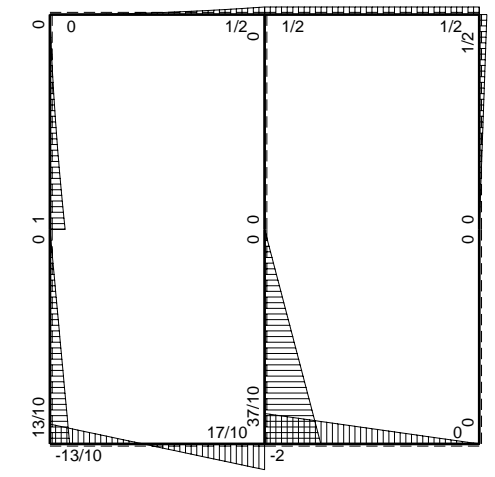
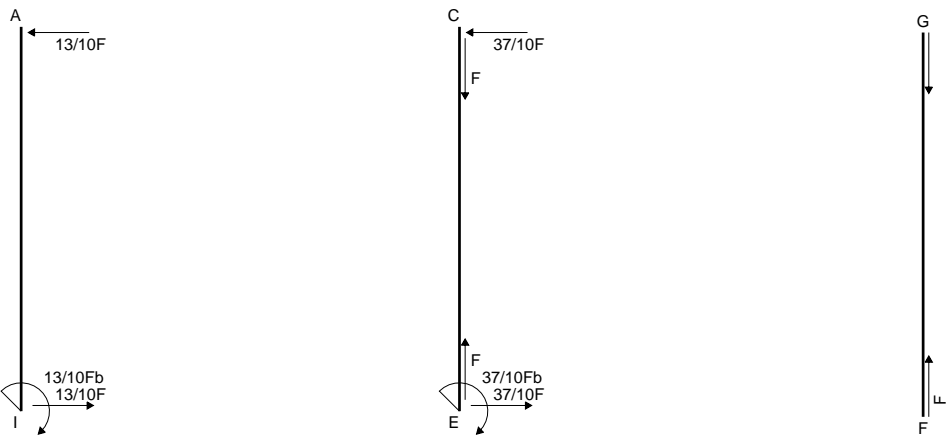
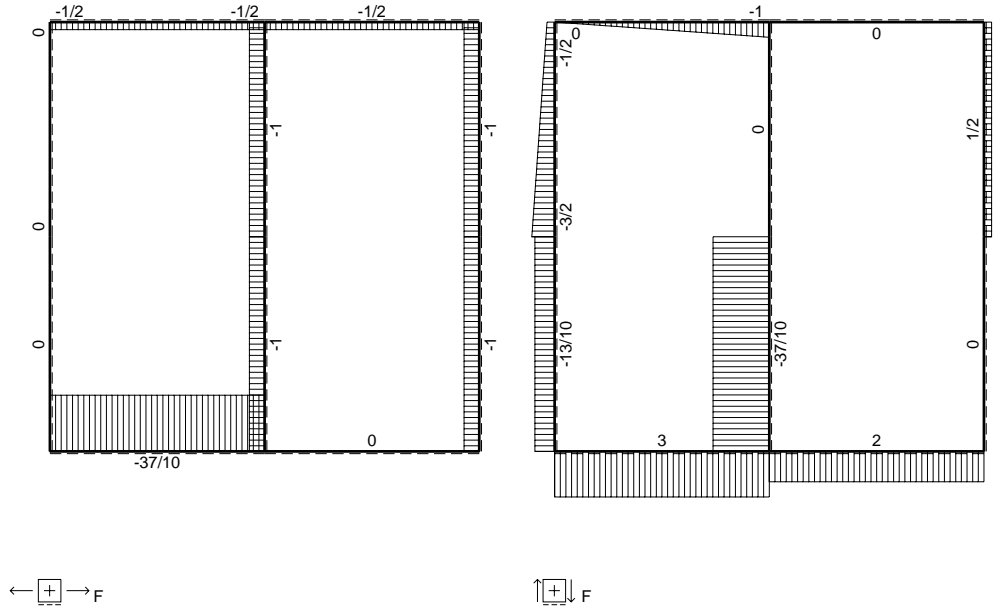
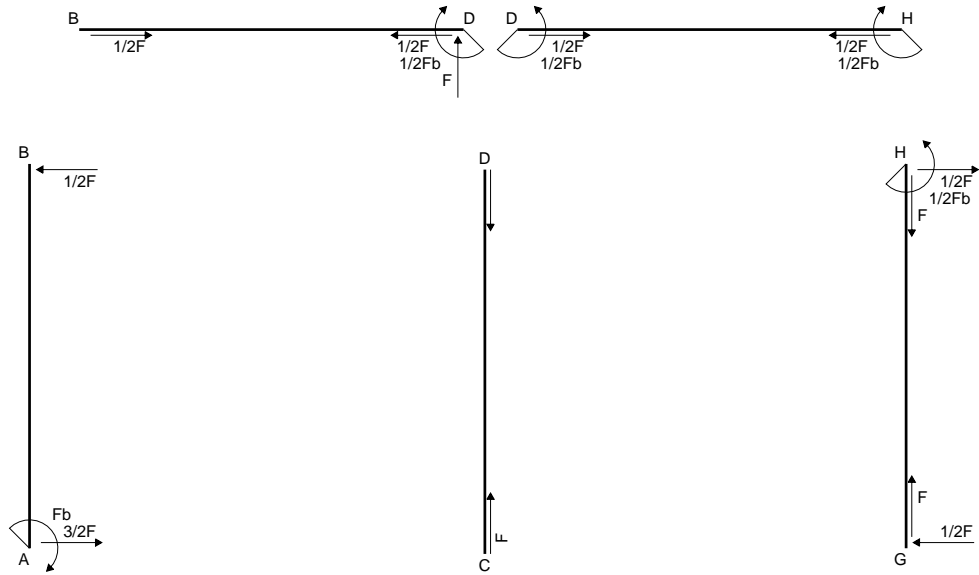
$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$

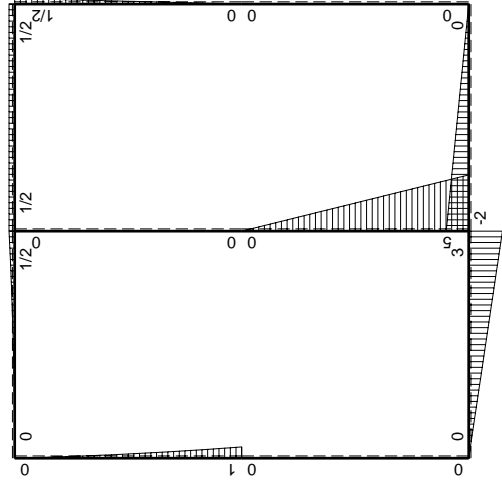
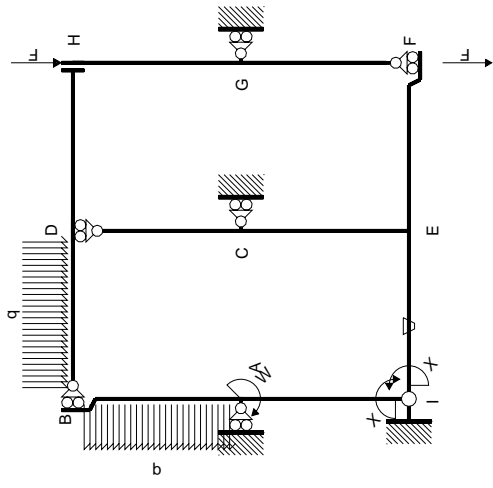
$$L_{AI}^{xo} = \int_0^b (-3/2 x/b + 3/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-3/4 x^2/b + 1/2 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-3/4 b + 1/2 b) Fb \frac{1}{EJ} = -1/4 Fb^2/EJ$$



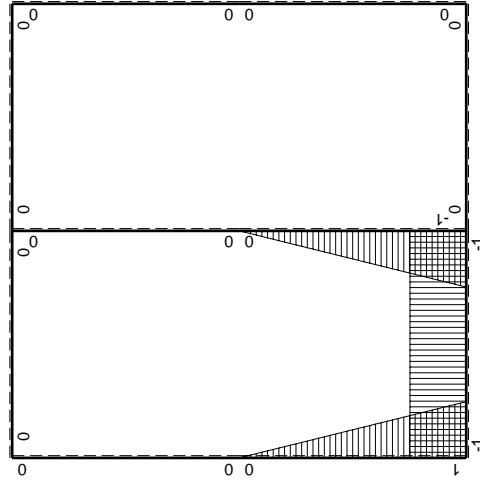
- A = 582. mm²
- J_u = 193597. mm⁴
- J_v = 19242. mm⁴
- y_g = 21.26 mm
- T_y = 2300. N
- M_x = -1219000. Nmm
- x_m = 24. mm
- y_m = 53. mm
- u_m = 9. mm
- v_m = 31.74 mm
- σ_m = -Mv/J_u = 199.9 N/mm²
- x_c = 15. mm
- y_c = 44. mm
- v_c = 22.74 mm
- σ_c = -Mv/J_u = 143.2 N/mm²
- τ_c = 6.387 N/mm²
- σ_q = √σ²+3τ² = 143.6 N/mm²
- S = 3225. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$13/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

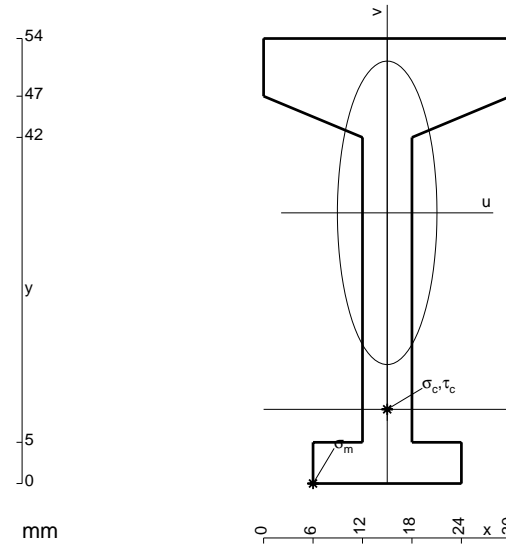
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$



$$A = 612. \text{ mm}^2$$

$$J_u = 207668. \text{ mm}^4$$

$$J_v = 22356. \text{ mm}^4$$

$$y_g = 32.85 \text{ mm}$$

$$T_y = 2240. \text{ N}$$

$$M_x = -1321600. \text{ Nmm}$$

$$x_m = 6. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -32.85 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -209. \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 9. \text{ mm}$$

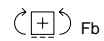
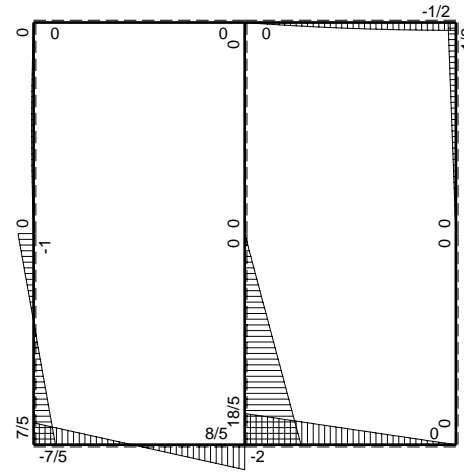
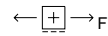
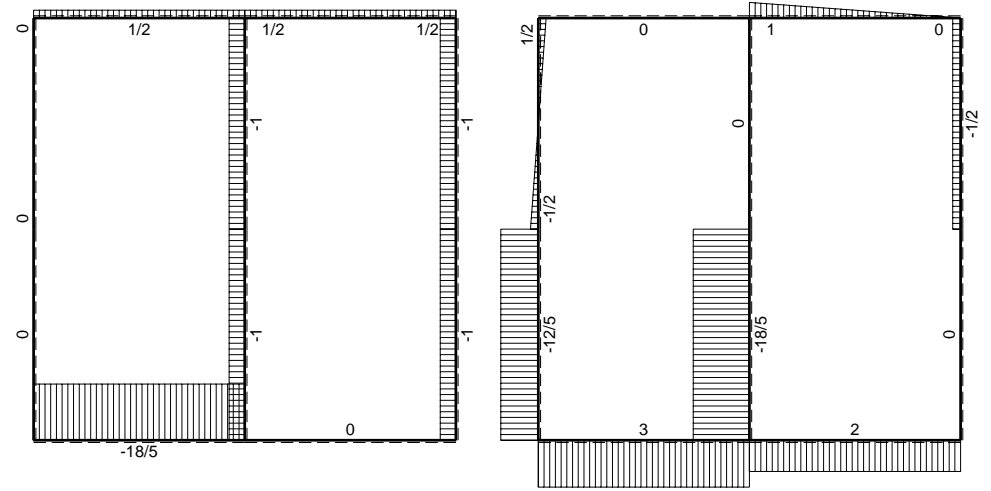
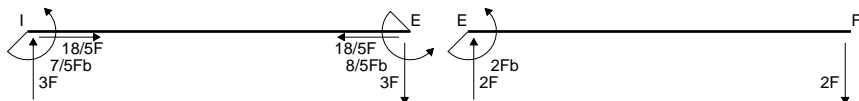
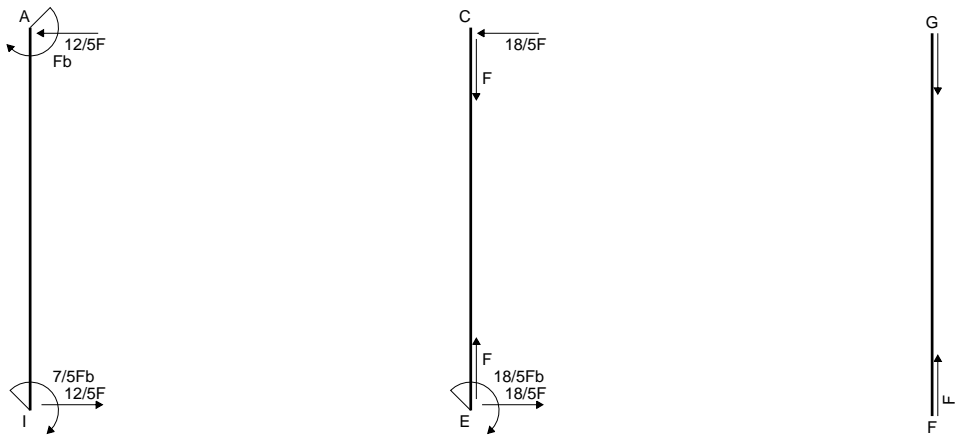
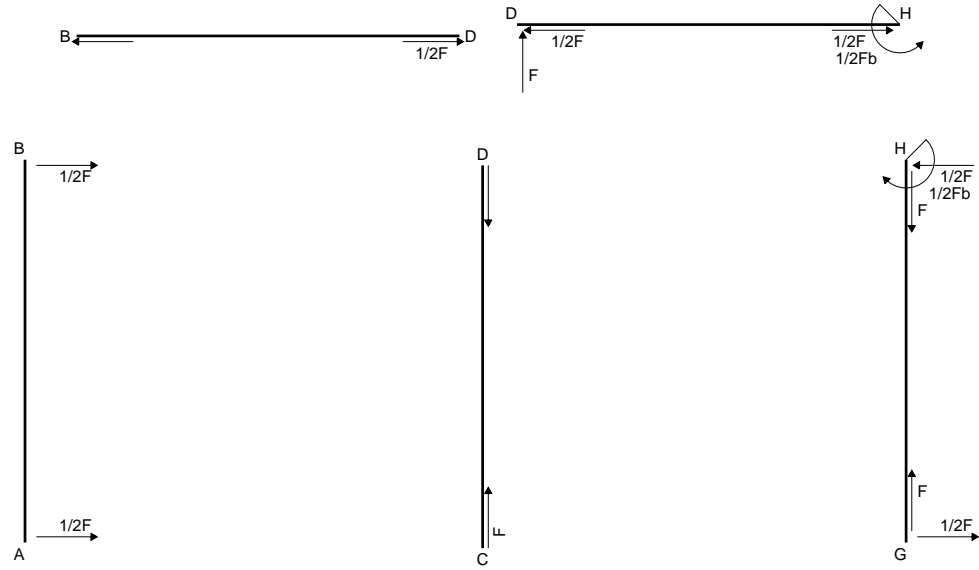
$$v_c = -23.85 \text{ mm}$$

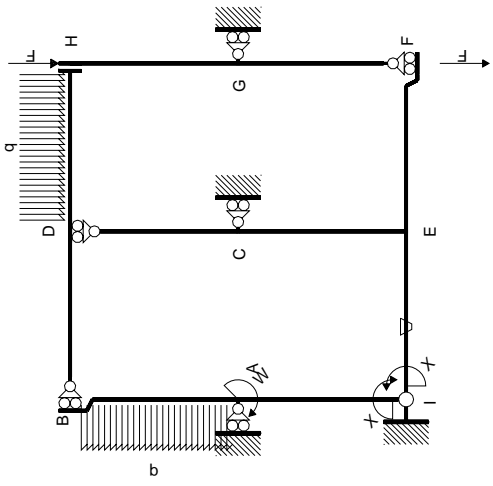
$$\sigma_c = -Mv/J_u = -151.8 \text{ N/mm}^2$$

$$\tau_c = 6.025 \text{ N/mm}^2$$

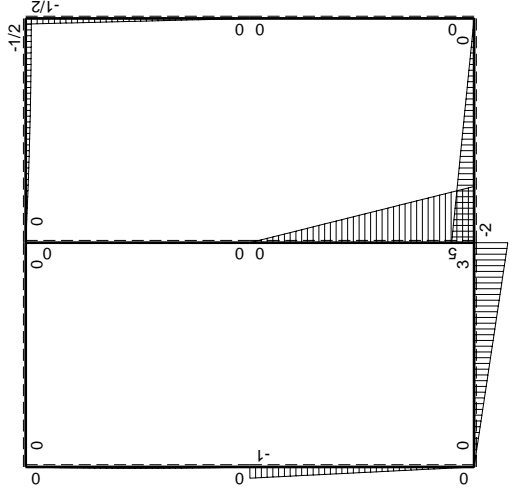
$$\sigma_0 = \sqrt{\sigma^2 + 3\tau^2} = 152.1 \text{ N/mm}^2$$

$$S = 3351. \text{ mm}^3$$

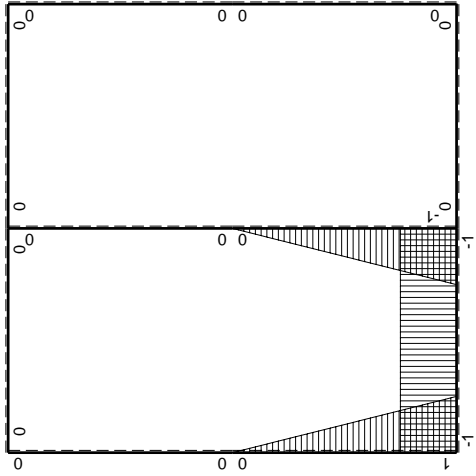




Schema di calcolo iperstatico



M_0 flessione da carichi assegnati



M_1 flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$1/2Fb-1/2Fx$	0	0	0	0		
HD b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0
DH b	0	$Fx-1/2qx^2$	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-7/3Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$7/5Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 5b - 5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb \frac{1}{EJ} dx = [-5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

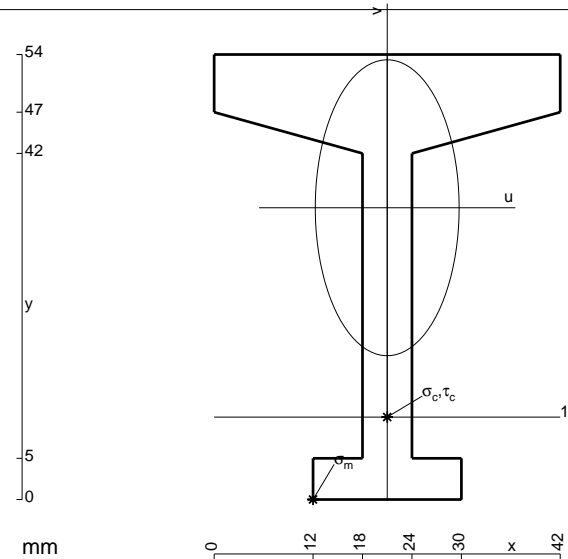
$$= (-5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

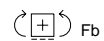
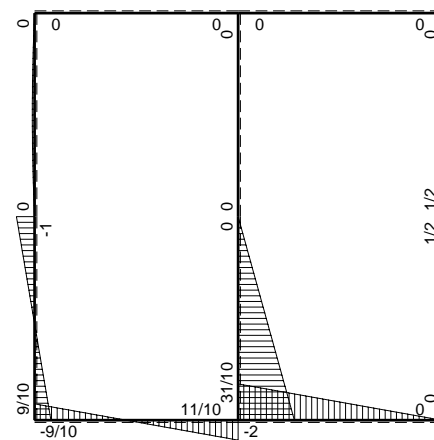
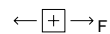
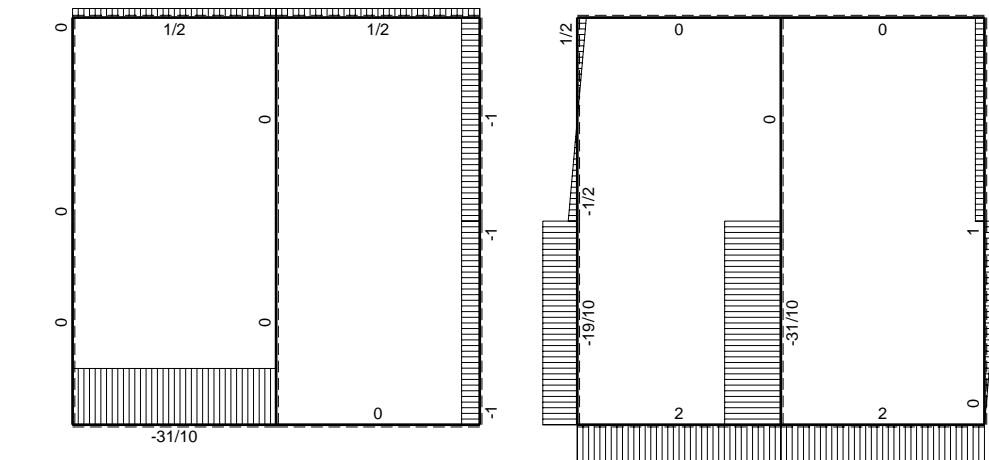
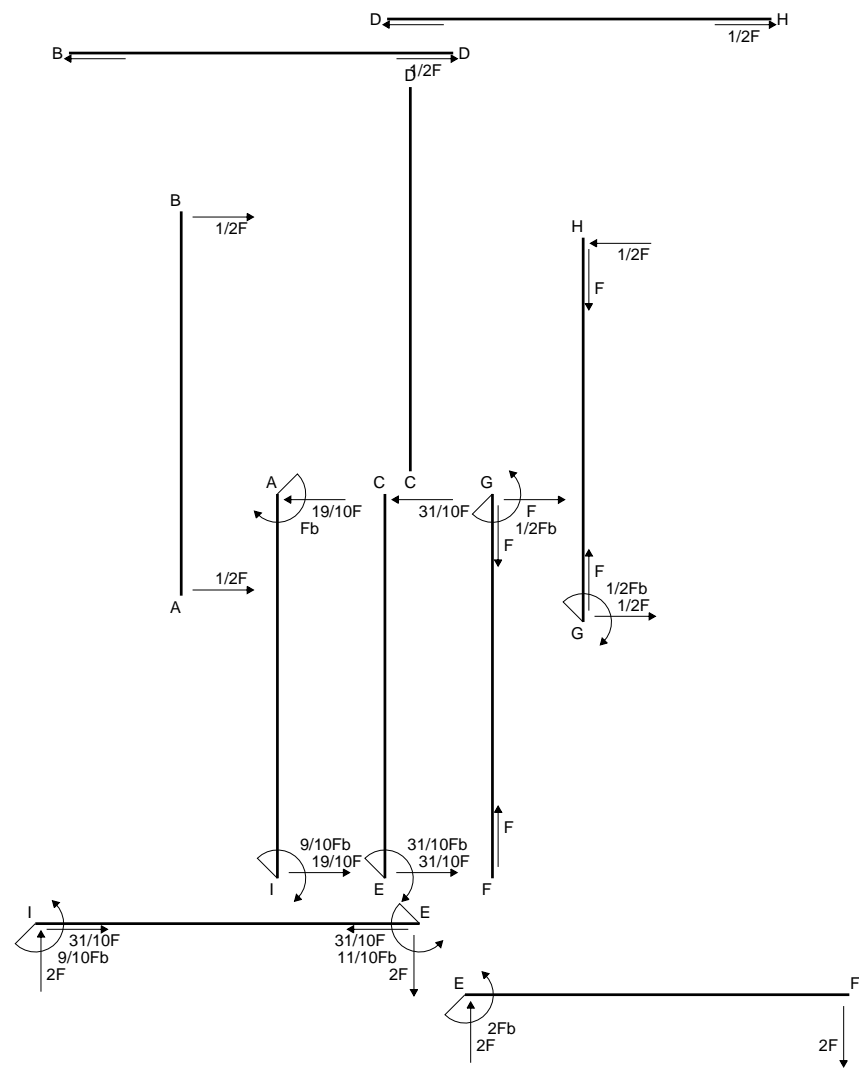
$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$

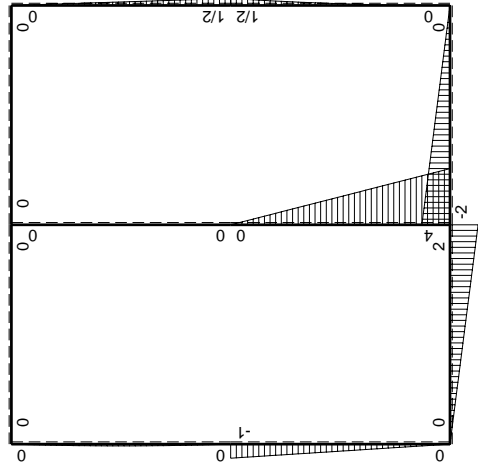
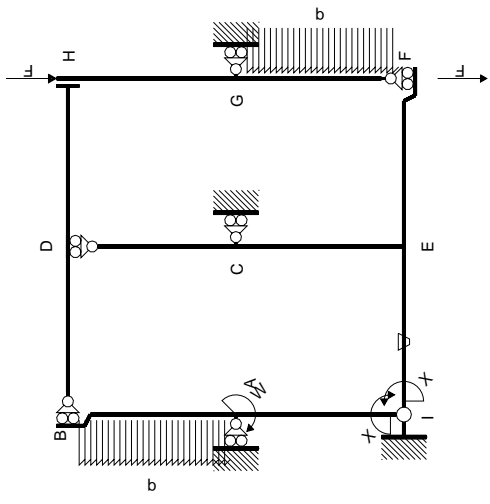
$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/2 b + 1/3 b) Fb \frac{1}{EJ} = -1/6 Fb^2/EJ$$



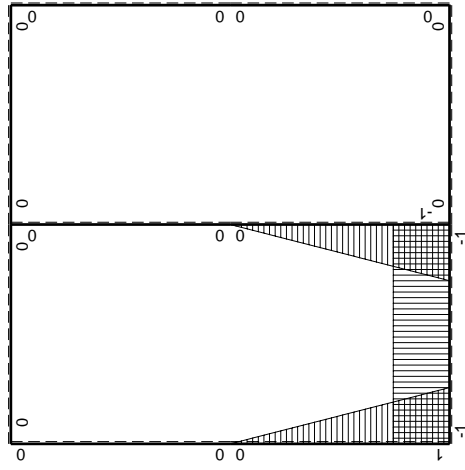
- A = 726. mm²
- J_u = 234156. mm⁴
- J_v = 55314. mm⁴
- y_g = 35.4 mm
- T_y = 2260. N
- M_x = -1446400. Nmm
- x_m = 12. mm
- u_m = -9. mm
- v_m = -35.4 mm
- σ_m = -Mv/J_u = -218.7 N/mm²
- x_c = 21. mm
- y_c = 10. mm
- v_c = -25.41 mm
- σ_c = -Mv/J_u = -156.9 N/mm²
- τ_c = 6.11 N/mm²
- σ_o = √σ_c² + 3τ_c² = 157.3 N/mm²
- S = 3799. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	$1/2qx^2$	0	0	0	0	0+0	0
GF b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
GH b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fx$	0	0	0	0		
HD b	0	0	0	0	0	0	0+0	0
DH b	0	0	0	0	0	0		
DB b	0	0	0	0	0	0	0+0	0
BD b	0	0	0	0	0	0		
IE b	-1	$2Fx$	$-Fb/EJ$	$-2Fx$	Fb/EJ	1	$(-1+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-2Fb+2Fx$	Fb/EJ	$-2Fb+2Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$4Fb-4Fx$	0	$-4Fb+8Fx-4Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-4/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-4Fx$	0	$-4Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx$	0	$-Fx+Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$Fb-Fx$	0	$-Fx+Fx^2/b$	0	x^2/b^2		
	totali						$-3/2Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$9/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-2x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-b) Fb 1/EJ + (b) \theta = 0$$

$$L_{EI}^{xo} = \int_0^b (-2 + 2x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-2x + x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-2b + b) Fb 1/EJ + (-b) \theta = 0$$

$$L_{EC}^{xo} = \int_0^b (-4 + 8x/b - 4x^2/b^2) Fb 1/EJ dx = [-4x + 4x^2/b - 4/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-4b + 4b - 4/3 b) Fb 1/EJ = -4/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-4x^2/b^2) Fb 1/EJ dx = [-4/3 x^3/b^2]_0^b Fb 1/EJ$$

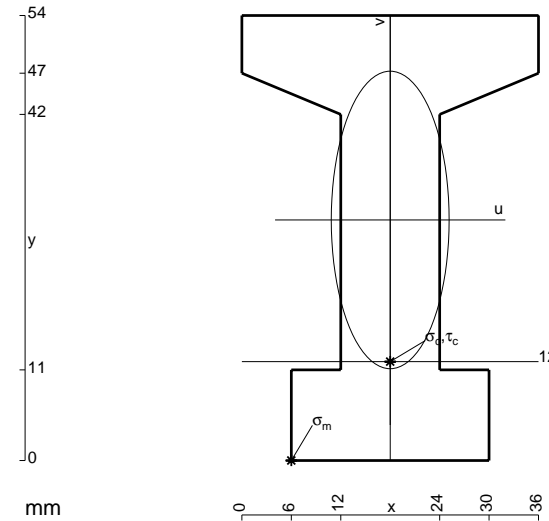
$$= (-4/3 b) Fb 1/EJ = -4/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

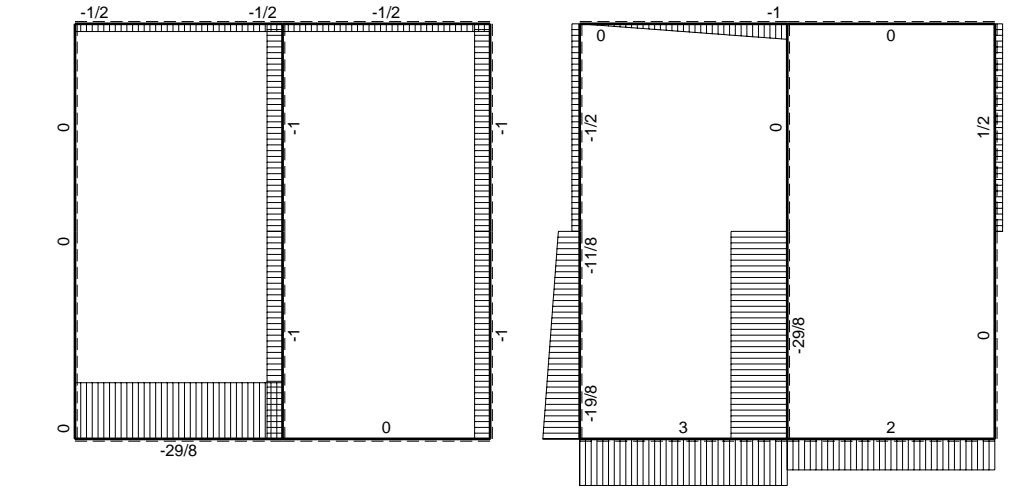
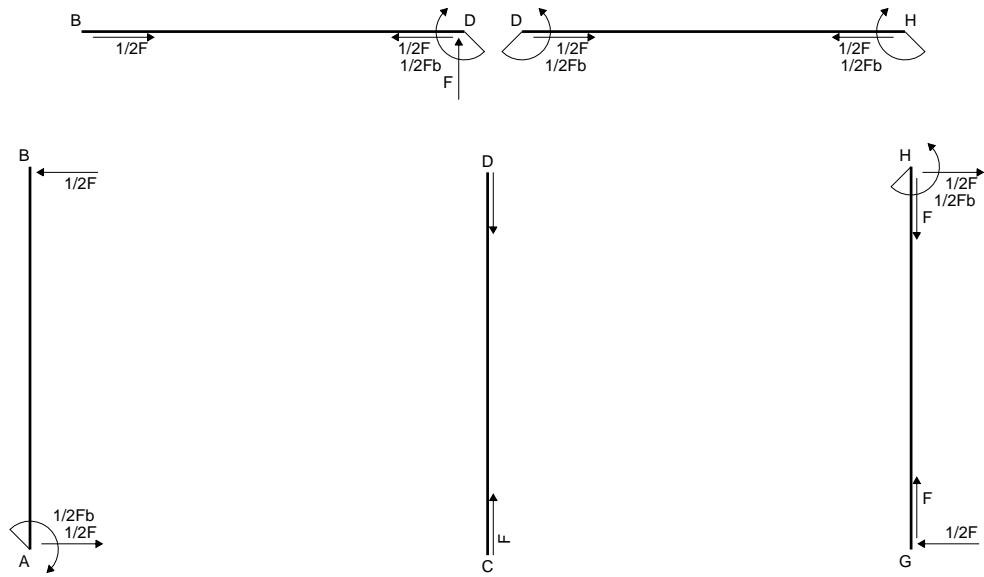
$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-x/b + x^2/b^2) Fb 1/EJ dx = [-1/2 x^2/b + 1/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/2 b + 1/3 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

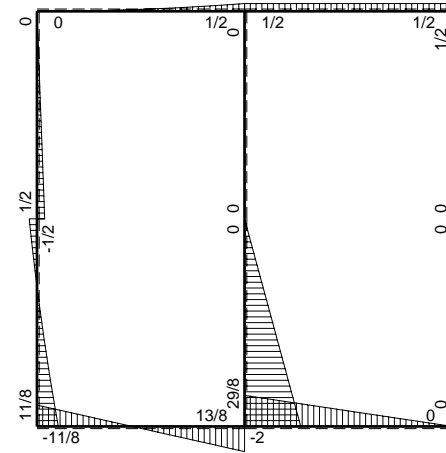
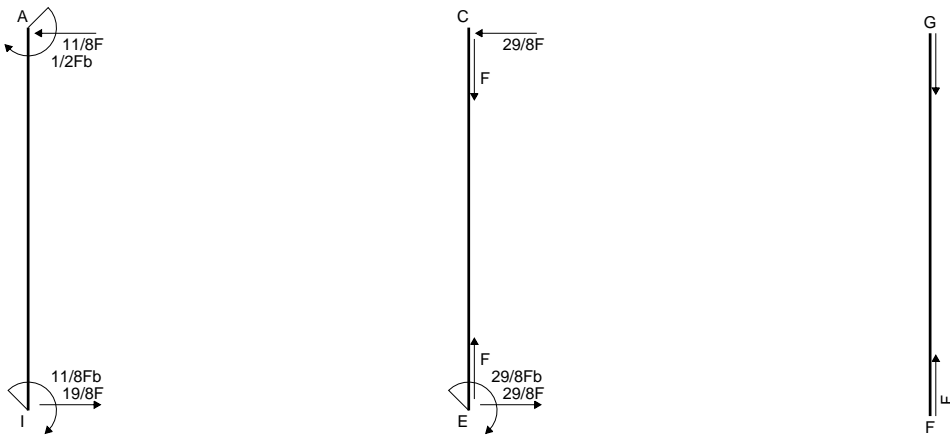


- A = 1008. mm²
- J_u = 328681. mm⁴
- J_v = 51552. mm⁴
- y_g = 29.19 mm
- T_y = 3680. N
- M_x = -2576000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -29.19 mm
- σ_m = -Mv/J_u = -228.8 N/mm²
- x_c = 18. mm
- y_c = 12. mm
- v_c = -17.19 mm
- σ_c = -Mv/J_u = -134.7 N/mm²
- τ_c = 6.034 N/mm²
- σ_o = √σ²+3τ² = 135.1 N/mm²
- S = 6467. mm³

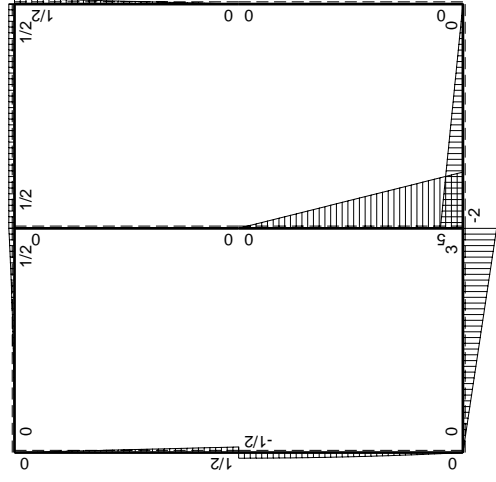
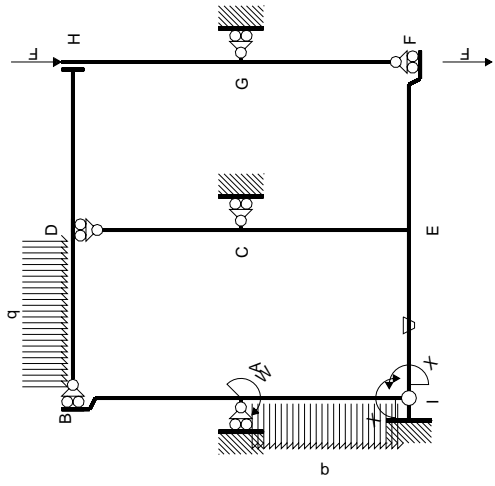


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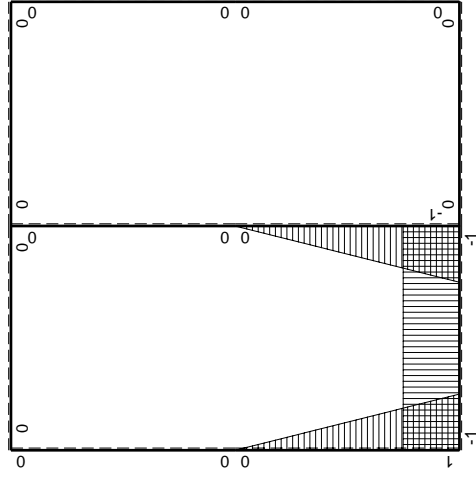


⊕ ⊕ F_b



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-Fx+1/2qx^2$	0	$-Fx+3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2qx^2$	0	$-1/2Fb+1/2qx^3/b$	0	x^2/b^2		
	totali						$-55/24Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$11/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-3/2 b) Fb \frac{1}{EJ} + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-3b + 3/2 b) Fb \frac{1}{EJ} + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb \frac{1}{EJ} dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-5b + 5b - 5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb \frac{1}{EJ} dx = [-5/3 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

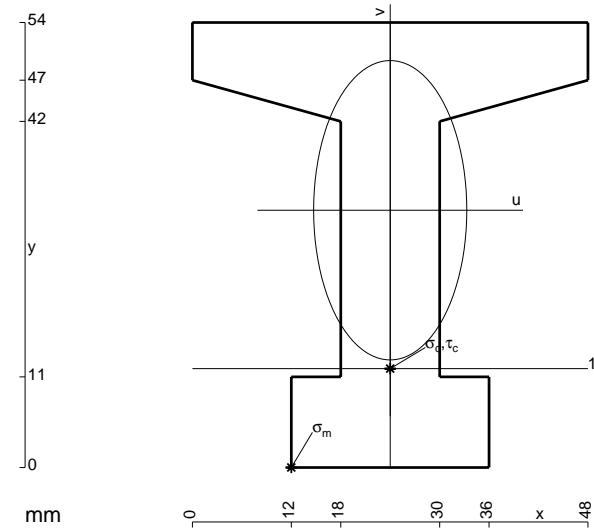
$$= (-5/3 b) Fb \frac{1}{EJ} = -5/3 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-x/b + 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb \frac{1}{EJ} dx = [-1/2 x^2/b + 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb \frac{1}{EJ}$$

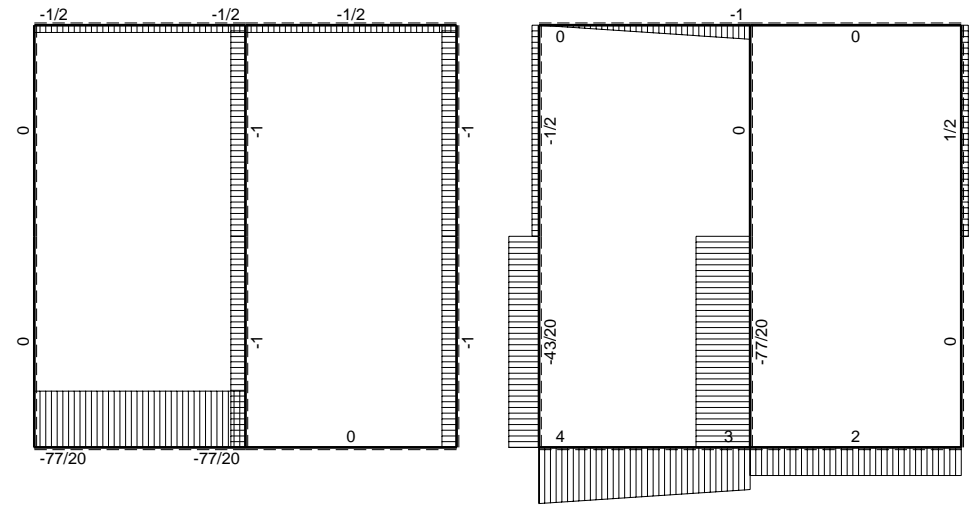
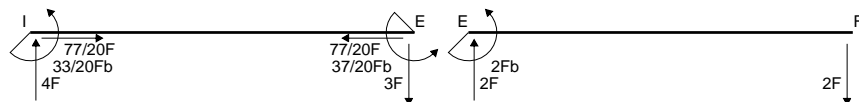
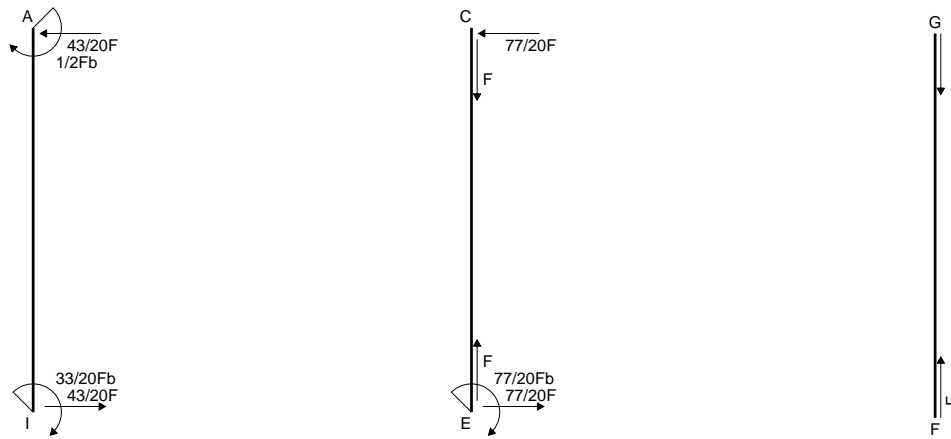
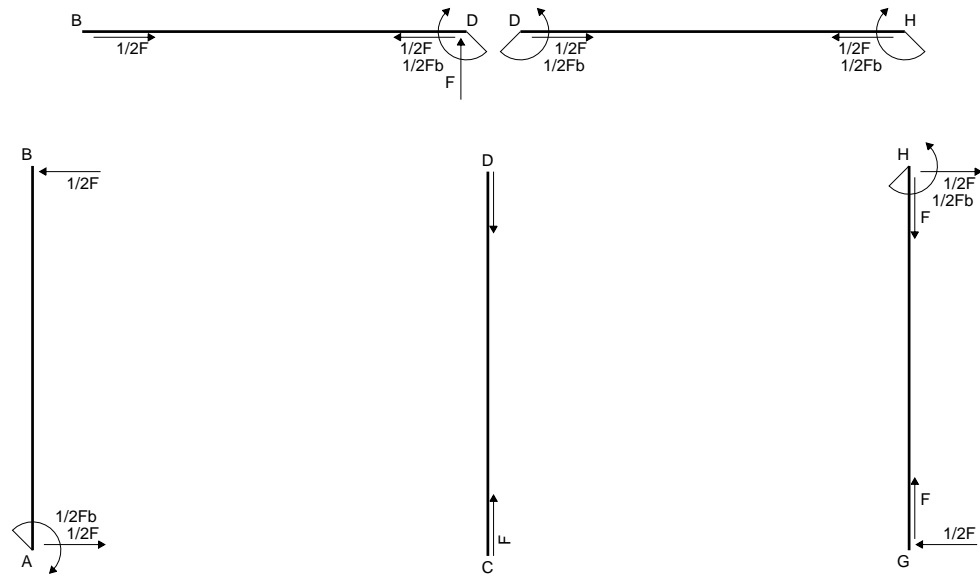
$$= (-1/2 b + 1/2 b - 1/8 b) Fb \frac{1}{EJ} = -1/8 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^3/b^3) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/8 x^4/b^3]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/8 b) Fb \frac{1}{EJ} = -1/8 Fb^2/EJ$$

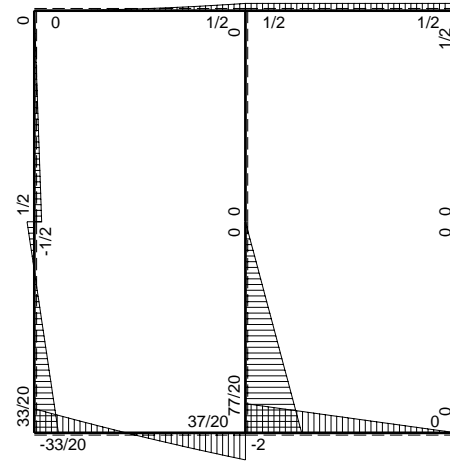


- A = 1122. mm²
- J_u = 370409. mm⁴
- J_v = 96948. mm⁴
- y_g = 31.22 mm
- T_y = 3780. N
- M_x = -2835000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -31.22 mm
- σ_m = -Mv/J_u = -238.9 N/mm²
- x_c = 24. mm
- y_c = 12. mm
- v_c = -19.22 mm
- σ_c = -Mv/J_u = -147.1 N/mm²
- τ_c = 5.975 N/mm²
- σ_o = √σ²+3τ² = 147.5 N/mm²
- S = 7027. mm³

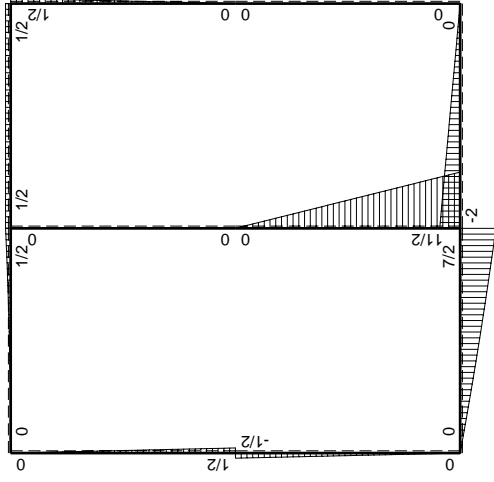
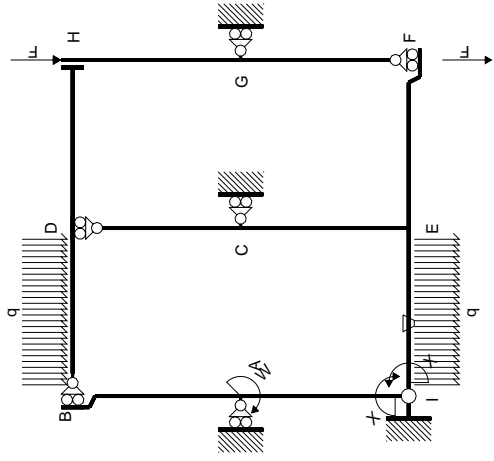


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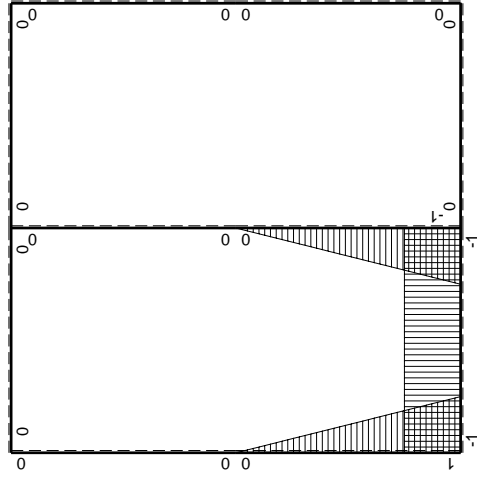


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx-1/2qx^2$	$-Fb/EJ$	$-4Fx+1/2Fx^2/b$	Fb/EJ	1	$(-11/6+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-7/2Fb+3Fx+1/2qx^2$	Fb/EJ	$-7/2Fb+3Fx+1/2Fx^2/b$	Fb/EJ	1		
EC b	$-1+x/b$	$11/2Fb-11/2Fx$	0	$-11/2Fb+11Fx-11/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-11/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-11/2Fx$	0	$-11/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-11/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$33/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) \frac{1}{EJ} dx = [x]_0^b \frac{1}{EJ}$$

$$= (b) \frac{1}{EJ} = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) \frac{1}{EJ} dx = [x - x^2/b + 1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (b - b + 1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) \frac{1}{EJ} dx = [1/3 x^3/b^2]_0^b \frac{1}{EJ}$$

$$= (1/3 b) \frac{1}{EJ} = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (1) \theta dx = [-2x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [x]_0^b \theta$$

$$= (-2b + 1/6 b) Fb \frac{1}{EJ} + (b) \theta = -5/6 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-7/2 + 3x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx + \int_0^b (-1) \theta dx$$

$$= [-7/2 x + 3/2 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ} + [-x]_0^b \theta$$

$$= (-7/2 b + 3/2 b + 1/6 b) Fb \frac{1}{EJ} + (-b) \theta = -5/6 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-11/2 + 11x/b - 11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/2 x + 11/2 x^2/b - 11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-11/2 b + 11/2 b - 11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-11/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-11/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

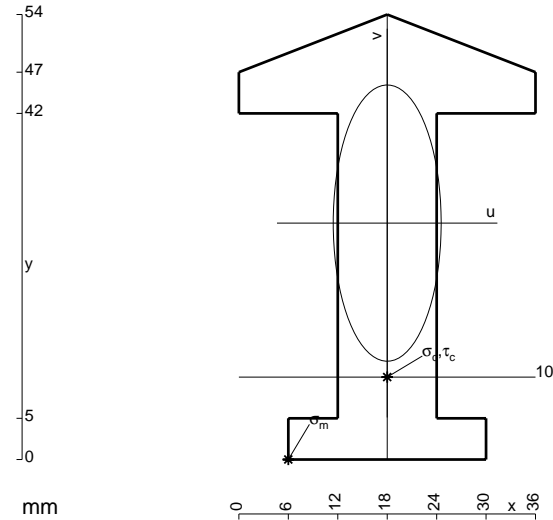
$$= (-11/6 b) Fb \frac{1}{EJ} = -11/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb \frac{1}{EJ} dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb \frac{1}{EJ}$$

$$= (-1/4 b + 1/6 b) Fb \frac{1}{EJ} = -1/12 Fb^2/EJ$$



$$A = 870. \text{ mm}^2$$

$$J_u = 244577. \text{ mm}^4$$

$$J_v = 37332. \text{ mm}^4$$

$$y_g = 28.69 \text{ mm}$$

$$T_y = 2100. \text{ N}$$

$$M_x = -1701000. \text{ Nmm}$$

$$x_m = 6. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -28.69 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -199.5 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 10. \text{ mm}$$

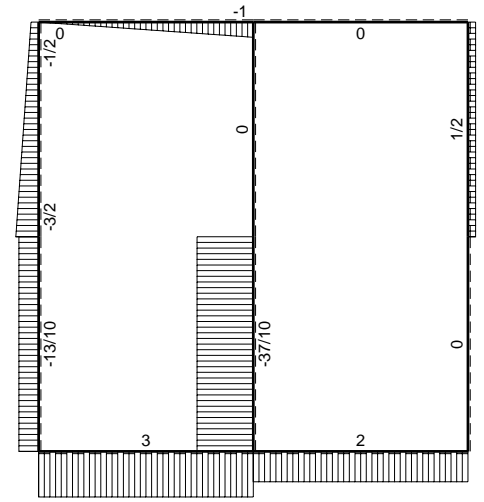
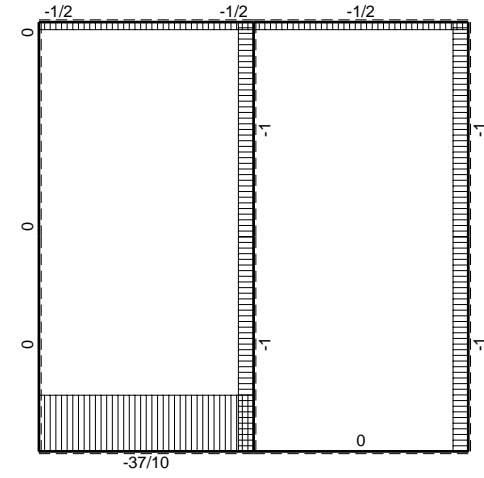
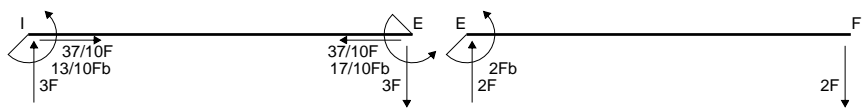
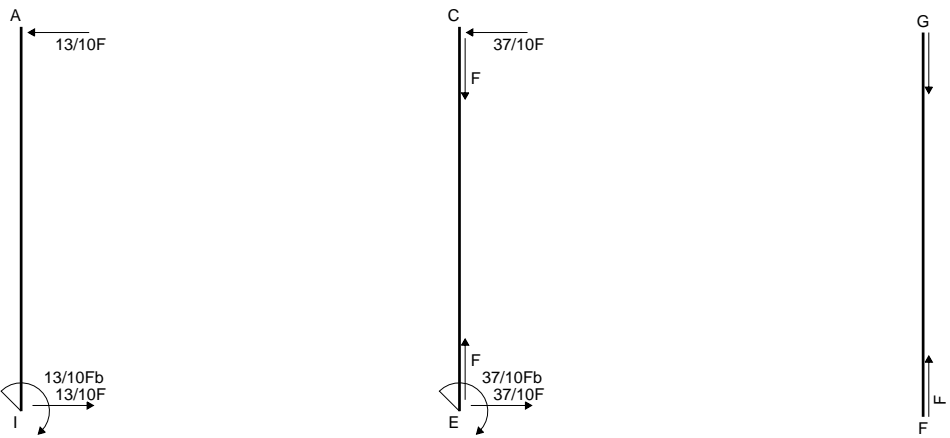
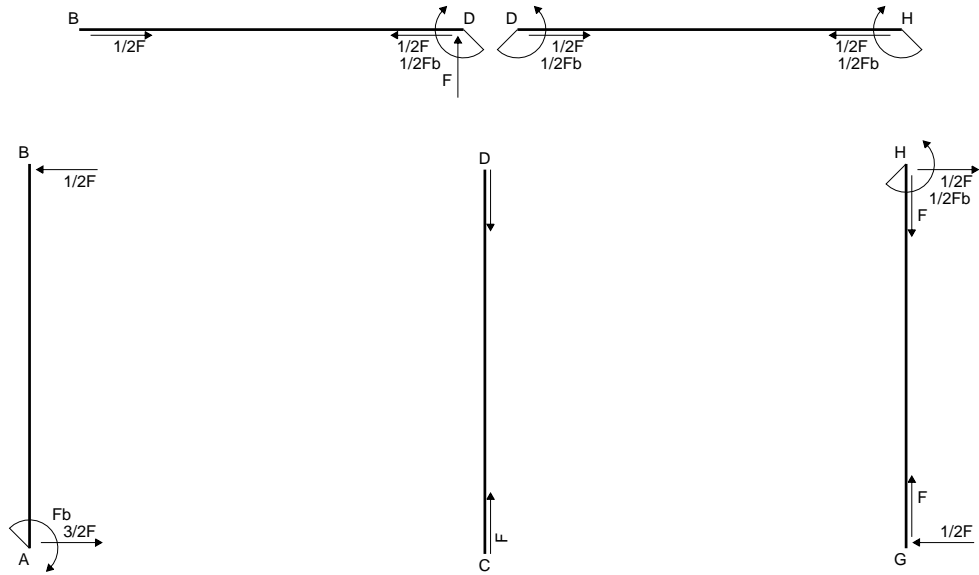
$$v_c = -18.69 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -130. \text{ N/mm}^2$$

$$\tau_c = 3.158 \text{ N/mm}^2$$

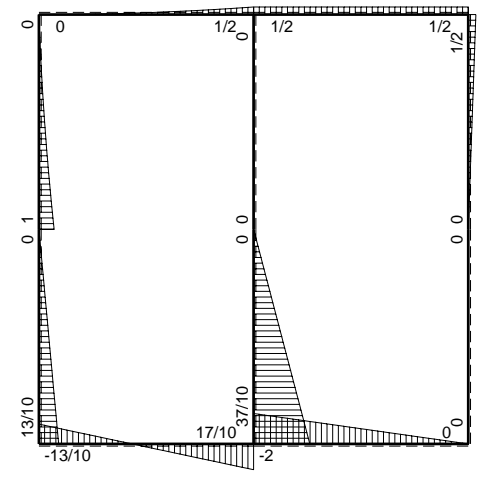
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 130.1 \text{ N/mm}^2$$

$$S = 4414. \text{ mm}^3$$

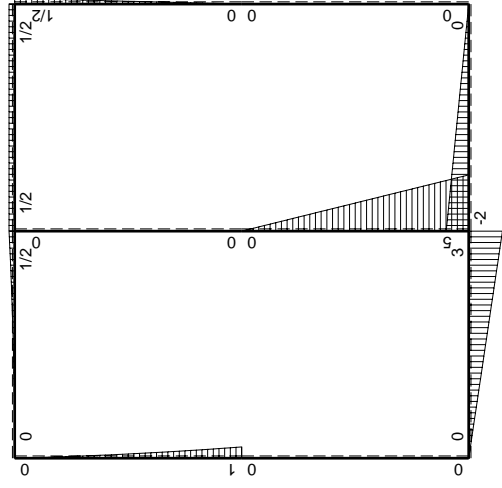
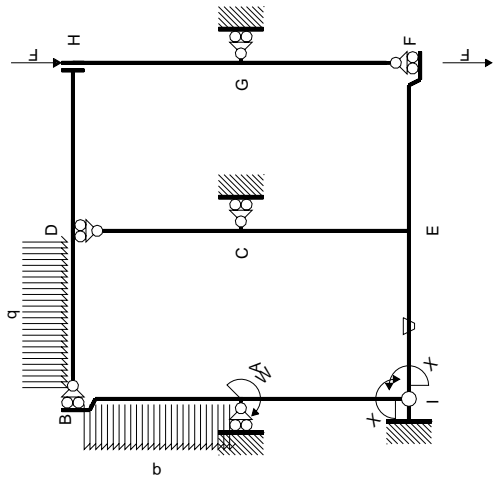


← ⊕ → F

↑ ⊕ ↓ F

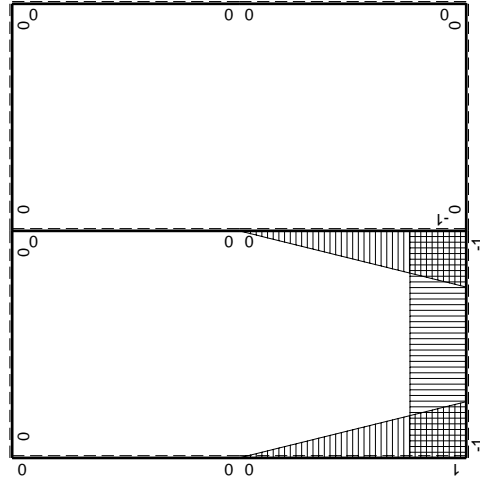


⊕ ⊖ Fb



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx-1/2qx^2$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	$-2Fb+2Fx$	0	0	0	0	0+0	0
FE b	0	$2Fx$	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$3Fx$	$-Fb/EJ$	$-3Fx$	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-3Fb+3Fx$	Fb/EJ	$-3Fb+3Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$5Fb-5Fx$	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-5Fx$	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$13/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

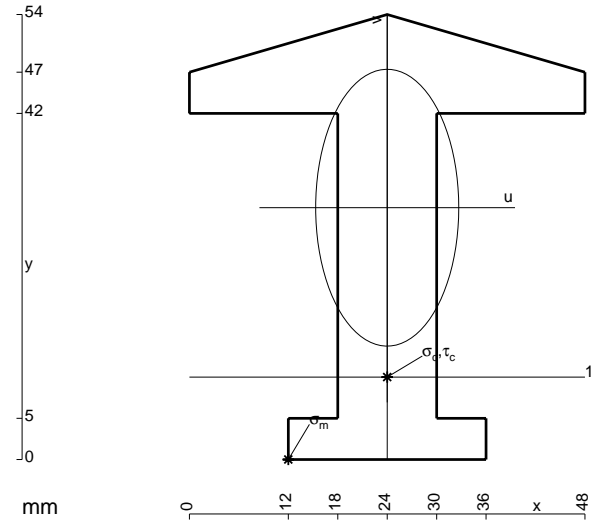
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

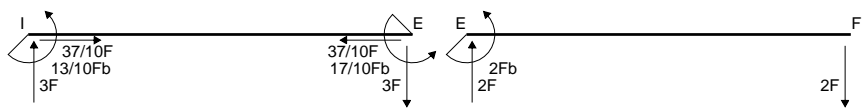
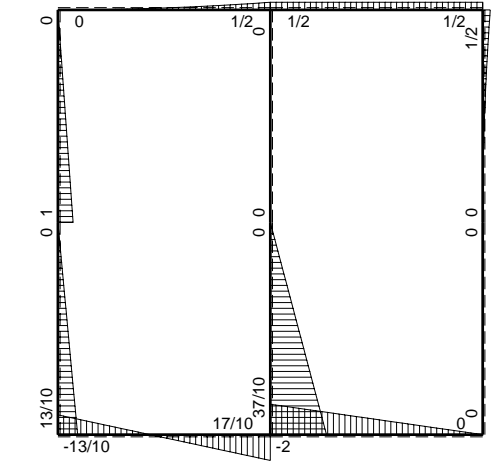
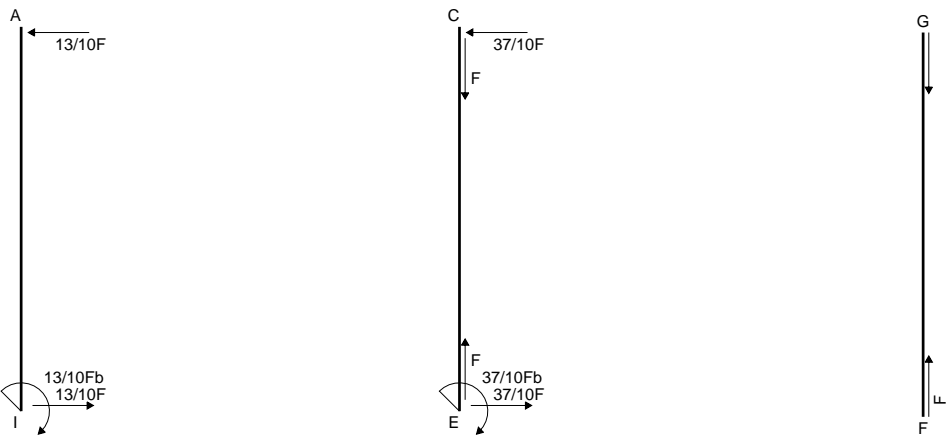
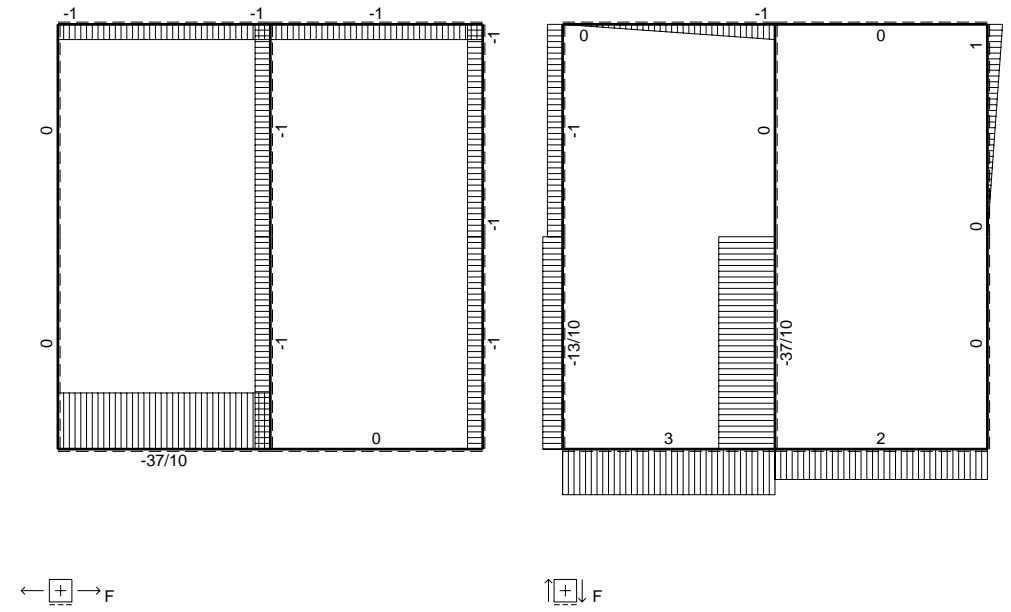
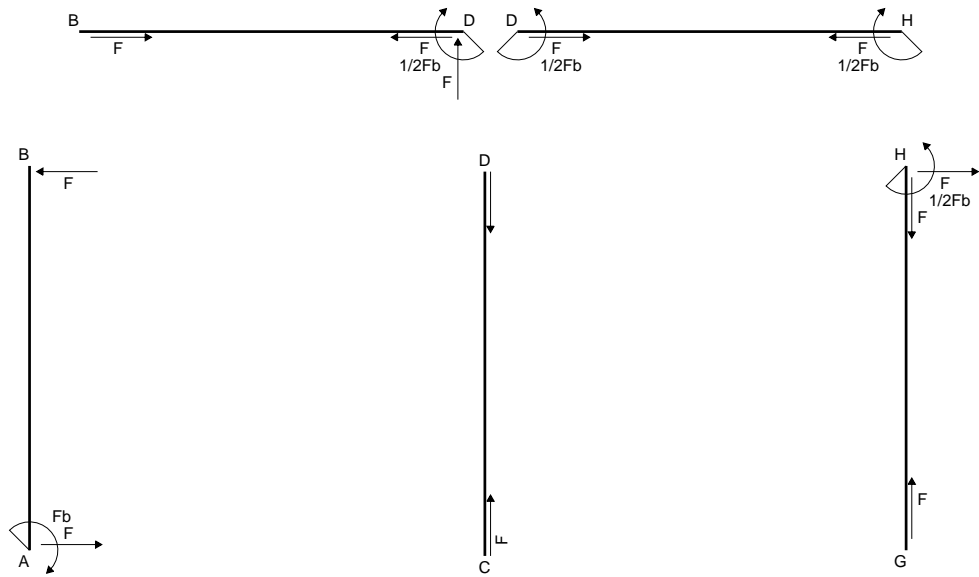
$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

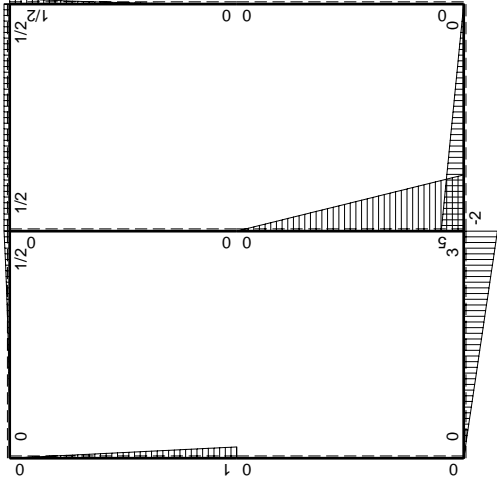
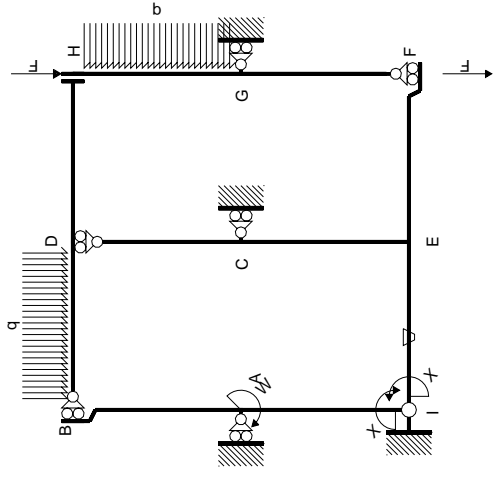
$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$



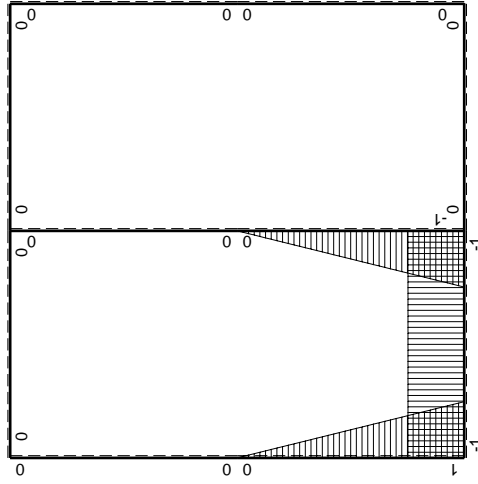
- A = 972. mm²
- J_u = 274322. mm⁴
- J_v = 73296. mm⁴
- y_g = 30.56 mm
- T_y = 2180. N
- M_x = -1874800. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -30.56 mm
- σ_m = -Mv/J_u = -208.8 N/mm²
- x_c = 24. mm
- y_c = 10. mm
- v_c = -20.56 mm
- σ_c = -Mv/J_u = -140.5 N/mm²
- τ_c = 3.146 N/mm²
- σ_o = √σ_c² + 3τ_c² = 140.6 N/mm²
- S = 4750. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	Fb-Fx	0	0	0	0	0+0	0
BA b	0	-Fx	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
EF b	0	-2Fb+2Fx	0	0	0	0	0+0	0
FE b	0	2Fx	0	0	0	0		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	3Fx	-Fb/EJ	-3Fx	Fb/EJ	1	$(-3/2+1)Fb^2/EJ$	Xb/EJ
EI b	1	-3Fb+3Fx	Fb/EJ	-3Fb+3Fx	Fb/EJ	1		
EC b	$-1+x/b$	5Fb-5Fx	0	$-5Fb+10Fx-5Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-5/3+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	-5Fx	0	$-5Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	0	0	0	0	$1-2x/b+x^2/b^2$	0+0	$1/3Xb/EJ$
AI b	$-x/b$	0	0	0	0	x^2/b^2		
	totali						$-13/6Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$13/10Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-3x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-3/2 x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-3/2 b) Fb 1/EJ + (b) \theta = -1/2 Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-3 + 3x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-3x + 3/2 x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

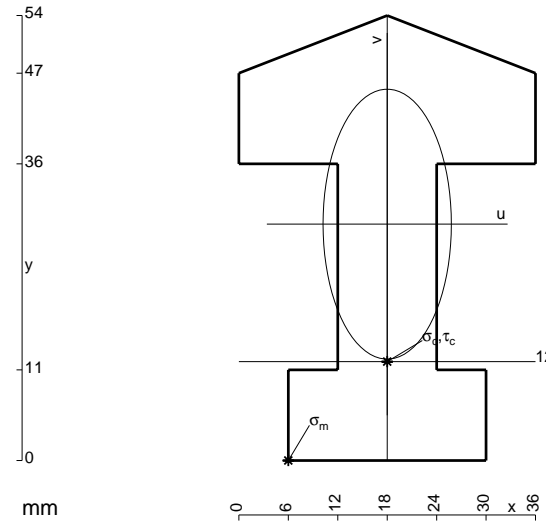
$$= (-3b + 3/2 b) Fb 1/EJ + (-b) \theta = -1/2 Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-5 + 10x/b - 5x^2/b^2) Fb 1/EJ dx = [-5x + 5x^2/b - 5/3 x^3/b^2]_0^b Fb 1/EJ$$

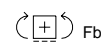
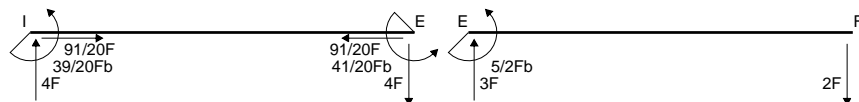
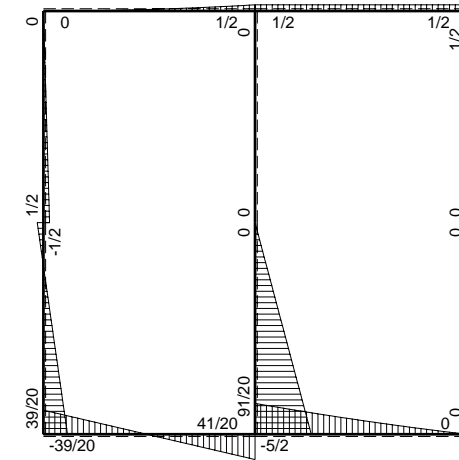
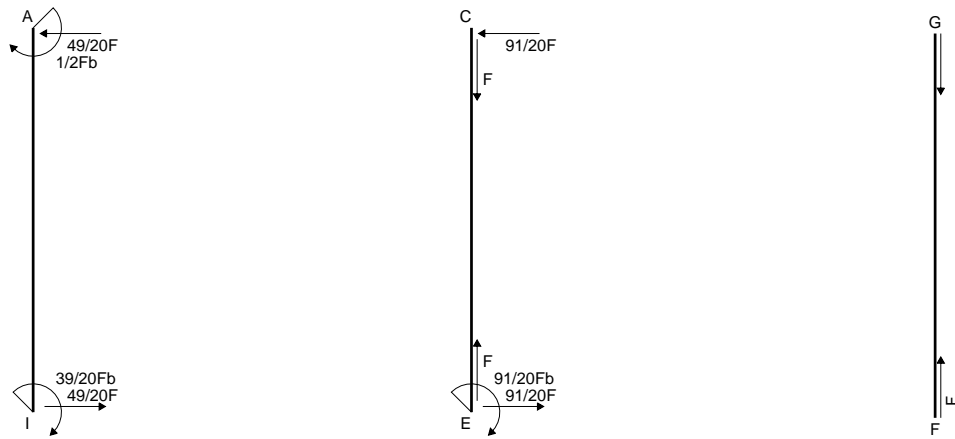
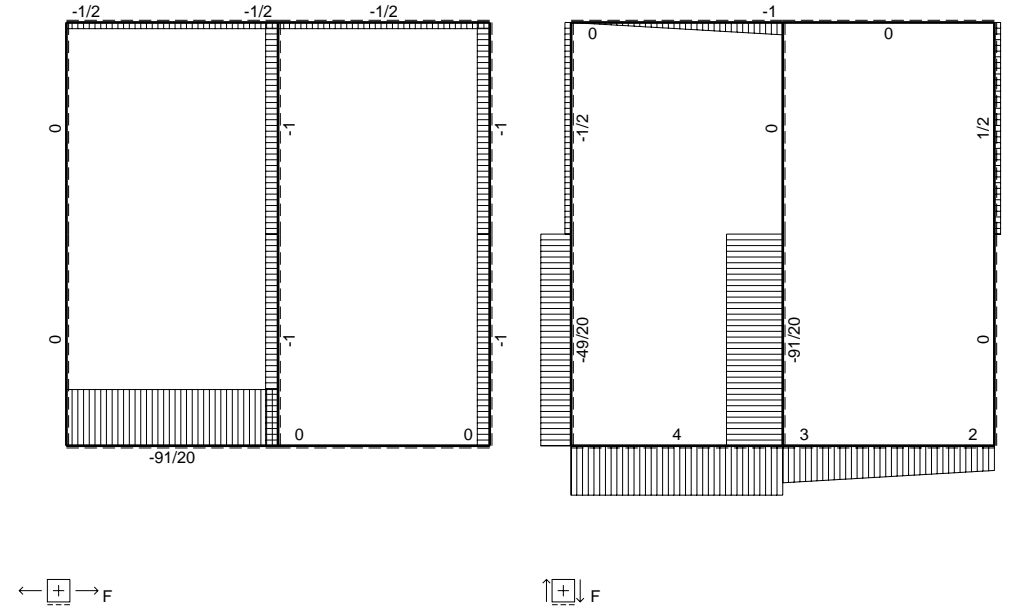
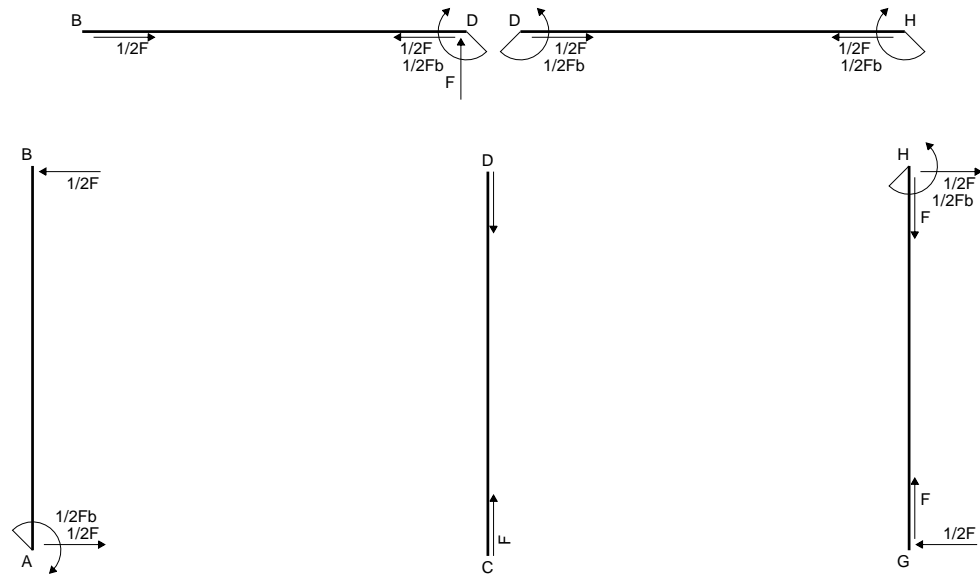
$$= (-5b + 5b - 5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$

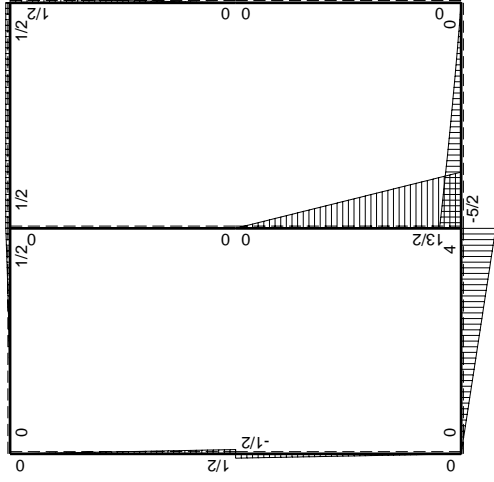
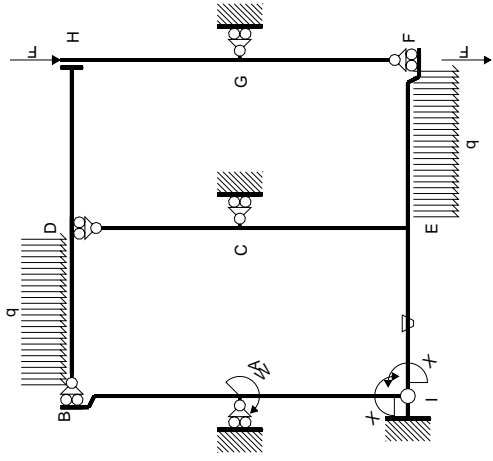
$$L_{CE}^{xo} = \int_0^b (-5x^2/b^2) Fb 1/EJ dx = [-5/3 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/3 b) Fb 1/EJ = -5/3 Fb^2/EJ$$



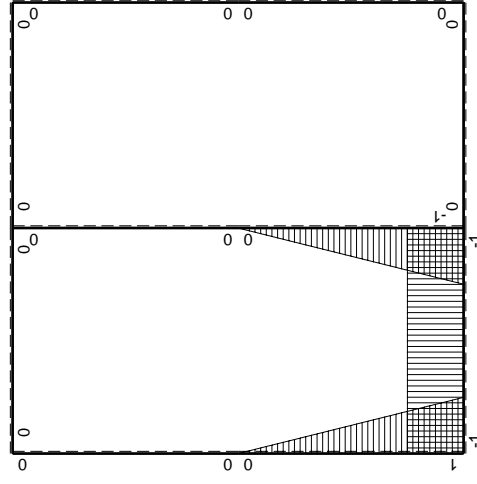
- A = 1086. mm²
- J_u = 291353. mm⁴
- J_v = 65844. mm⁴
- y_g = 28.69 mm
- T_y = 2440. N
- M_x = -2220400. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -28.69 mm
- σ_m = -Mv/J_u = -218.6 N/mm²
- x_c = 18. mm
- y_c = 12. mm
- v_c = -16.69 mm
- σ_c = -Mv/J_u = -127.2 N/mm²
- τ_c = 4.416 N/mm²
- σ_o = √σ²+3τ² = 127.4 N/mm²
- S = 6327. mm³





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_1 flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=W_{IE}$

→	$M_x(x)$	$M_o(x)$	θ	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	0	$1/2Fb-1/2Fx$	0	0	0	0	0+0	0
BA b	0	$-1/2Fx$	0	0	0	0		
CD b	0	0	0	0	0	0	0+0	0
DC 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		
FG b	0	0	0	0	0	0	0+0	0
GF b	0	0	0	0	0	0		
GH b	0	$1/2Fx$	0	0	0	0	0+0	0
HG b	0	$-1/2Fb+1/2Fx$	0	0	0	0		
HD b	0	$1/2Fb$	0	0	0	0	0+0	0
DH b	0	$-1/2Fb$	0	0	0	0		
DB b	0	$1/2Fb-Fx+1/2qx^2$	0	0	0	0	0+0	0
BD b	0	$-1/2qx^2$	0	0	0	0		
IE b	-1	$4Fx$	$-Fb/EJ$	$-4Fx$	Fb/EJ	1	$(-2+1)Fb^2/EJ$	Xb/EJ
EI b	1	$-4Fb+4Fx$	Fb/EJ	$-4Fb+4Fx$	Fb/EJ	1		
EC b	$-1+x/b$	$13/2Fb-13/2Fx$	0	$-13/2Fb+13Fx-13/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-13/6+0)Fb^2/EJ$	$1/3Xb/EJ$
CE b	x/b	$-13/2Fx$	0	$-13/2Fx^2/b$	0	x^2/b^2		
IA b	$1-x/b$	$-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	$1-2x/b+x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/3Xb/EJ$
AI b	$-x/b$	$1/2Fb-1/2Fx$	0	$-1/2Fx+1/2Fx^2/b$	0	x^2/b^2		
	totali						$-13/4Fb^2/EJ$	$5/3Xb/EJ$
	iperstatica $X=W_{IE}$						$39/20Fb$	

Sviluppi di calcolo iperstatica

$$L_{IE}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EI}^{xx} = \int_0^b (1) 1/EJ dx = [x]_0^b 1/EJ$$

$$= (b) 1/EJ = b/EJ$$

$$L_{EC}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{CE}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IA}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AI}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{IE}^{xo} = \int_0^b (-4x/b) Fb 1/EJ dx + \int_0^b (1) \theta dx = [-2x^2/b]_0^b Fb 1/EJ + [x]_0^b \theta$$

$$= (-2b) Fb 1/EJ + (b) \theta = -Fb^2/EJ$$

$$L_{EI}^{xo} = \int_0^b (-4 + 4x/b) Fb 1/EJ dx + \int_0^b (-1) \theta dx = [-4x + 2x^2/b]_0^b Fb 1/EJ + [-x]_0^b \theta$$

$$= (-4b + 2b) Fb 1/EJ + (-b) \theta = -Fb^2/EJ$$

$$L_{EC}^{xo} = \int_0^b (-13/2 + 13x/b - 13/2 x^2/b^2) Fb 1/EJ dx = [-13/2 x + 13/2 x^2/b - 13/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-13/2 b + 13/2 b - 13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

$$L_{CE}^{xo} = \int_0^b (-13/2 x^2/b^2) Fb 1/EJ dx = [-13/6 x^3/b^2]_0^b Fb 1/EJ$$

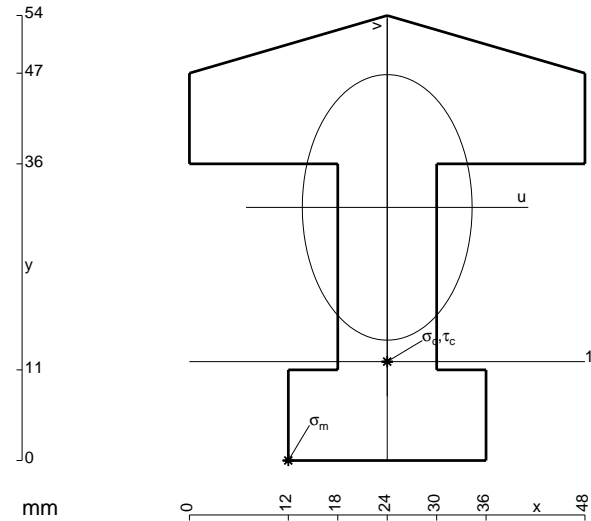
$$= (-13/6 b) Fb 1/EJ = -13/6 Fb^2/EJ$$

$$L_{IA}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{AI}^{xo} = \int_0^b (-1/2 x/b + 1/2 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/6 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/6 b) Fb 1/EJ = -1/12 Fb^2/EJ$$



$$A = 1260. \text{ mm}^2$$

$$J_u = 327186. \text{ mm}^4$$

$$J_v = 133776. \text{ mm}^4$$

$$y_g = 30.72 \text{ mm}$$

$$T_y = 3030. \text{ N}$$

$$M_x = -2449250. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -30.72 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -229.9 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 12. \text{ mm}$$

$$v_c = -18.72 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -140.1 \text{ N/mm}^2$$

$$\tau_c = 5.315 \text{ N/mm}^2$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 140.4 \text{ N/mm}^2$$

$$S = 6888. \text{ mm}^3$$