



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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	$-Fb/EJ$	$-1/4Fx+1/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-1/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	$Fb/EJ$	$-1/8Fb+1/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/12Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

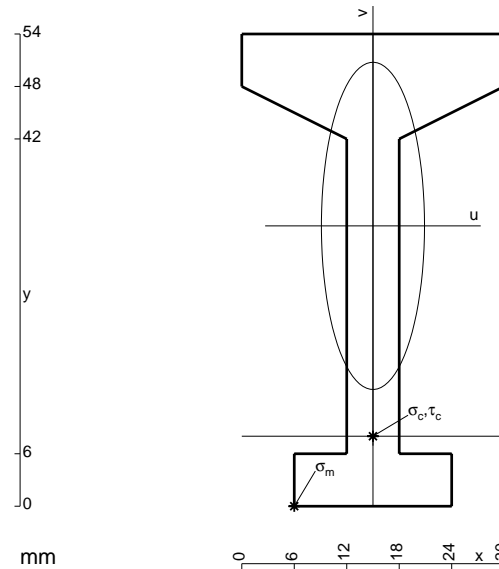
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

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

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

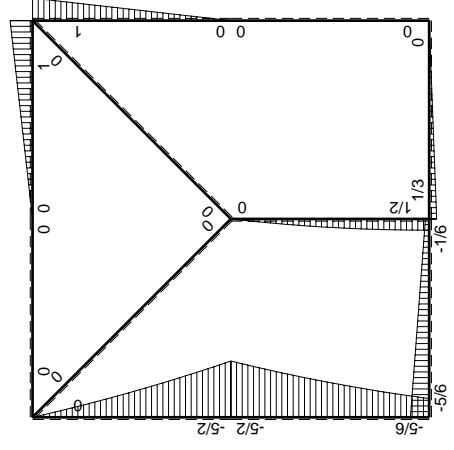
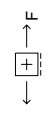
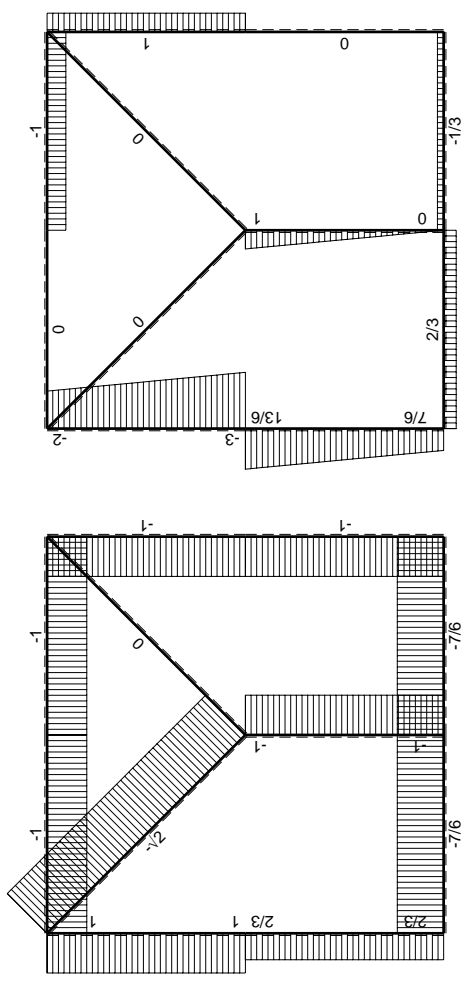
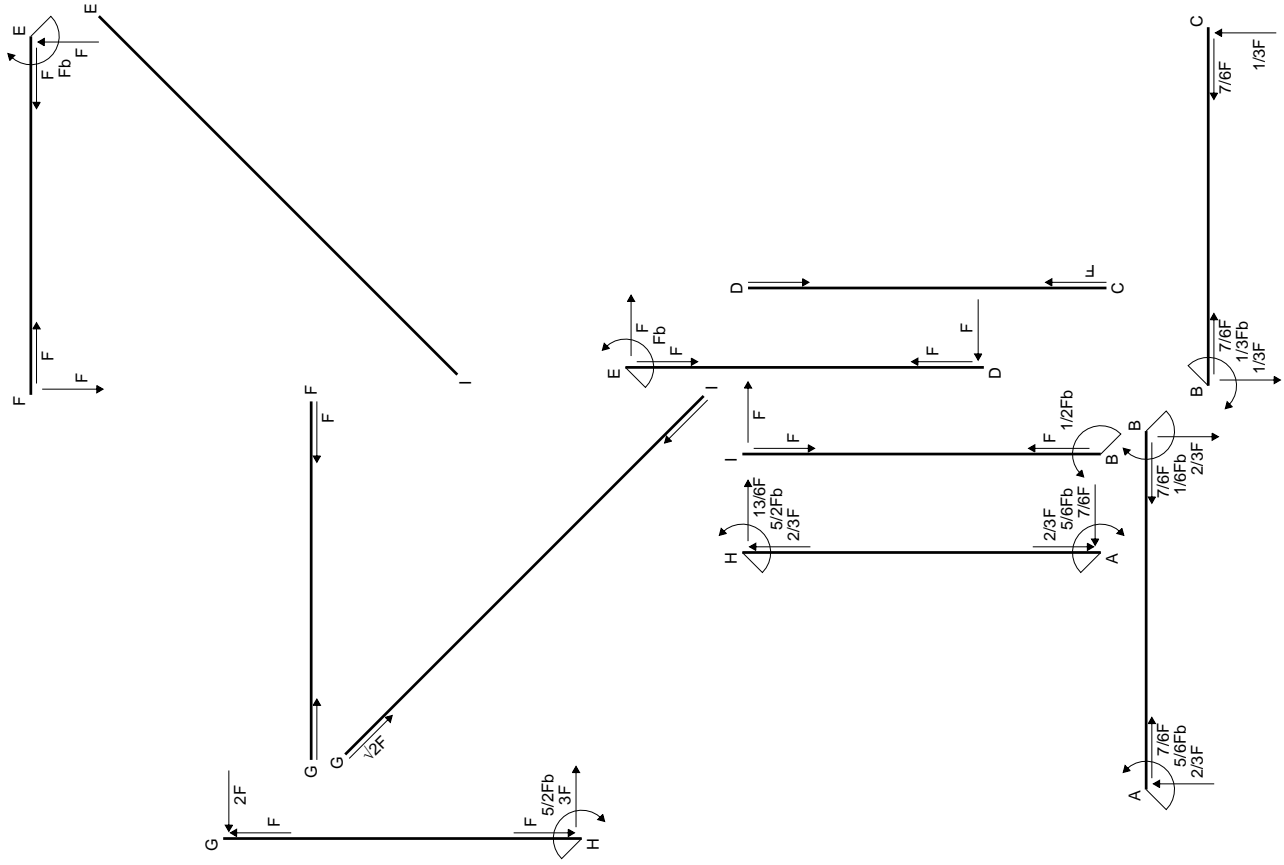
$$L_{AH}^{x\theta} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

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



- A = 612. mm<sup>2</sup>
- J<sub>u</sub> = 214270. mm<sup>4</sup>
- J<sub>v</sub> = 21276. mm<sup>4</sup>
- y<sub>g</sub> = 32.06 mm
- N = 1020. N
- T<sub>y</sub> = -3060. N
- M<sub>x</sub> = -1402500. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -32.06 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -208.2 N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 8. mm
- v<sub>c</sub> = -24.06 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -155.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.186 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 156.5 N/mm<sup>2</sup>
- S = 3439. mm<sup>3</sup>







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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

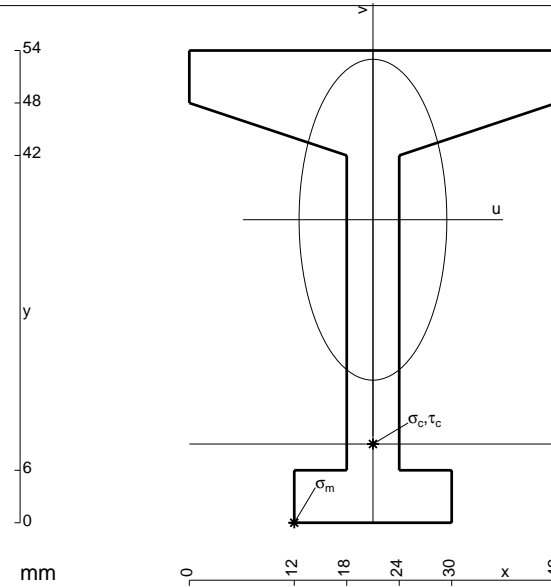
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

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

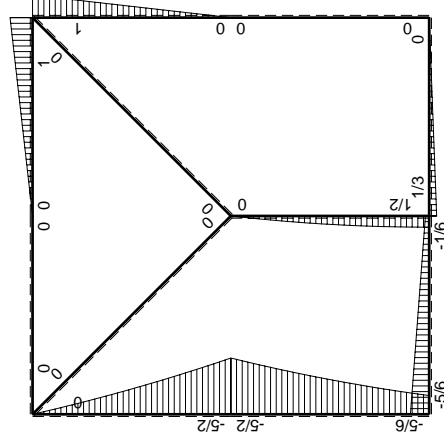
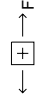
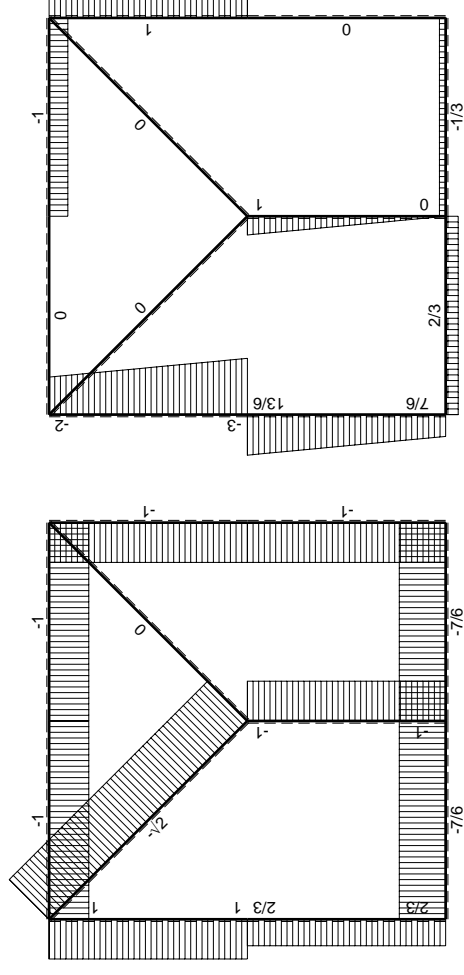
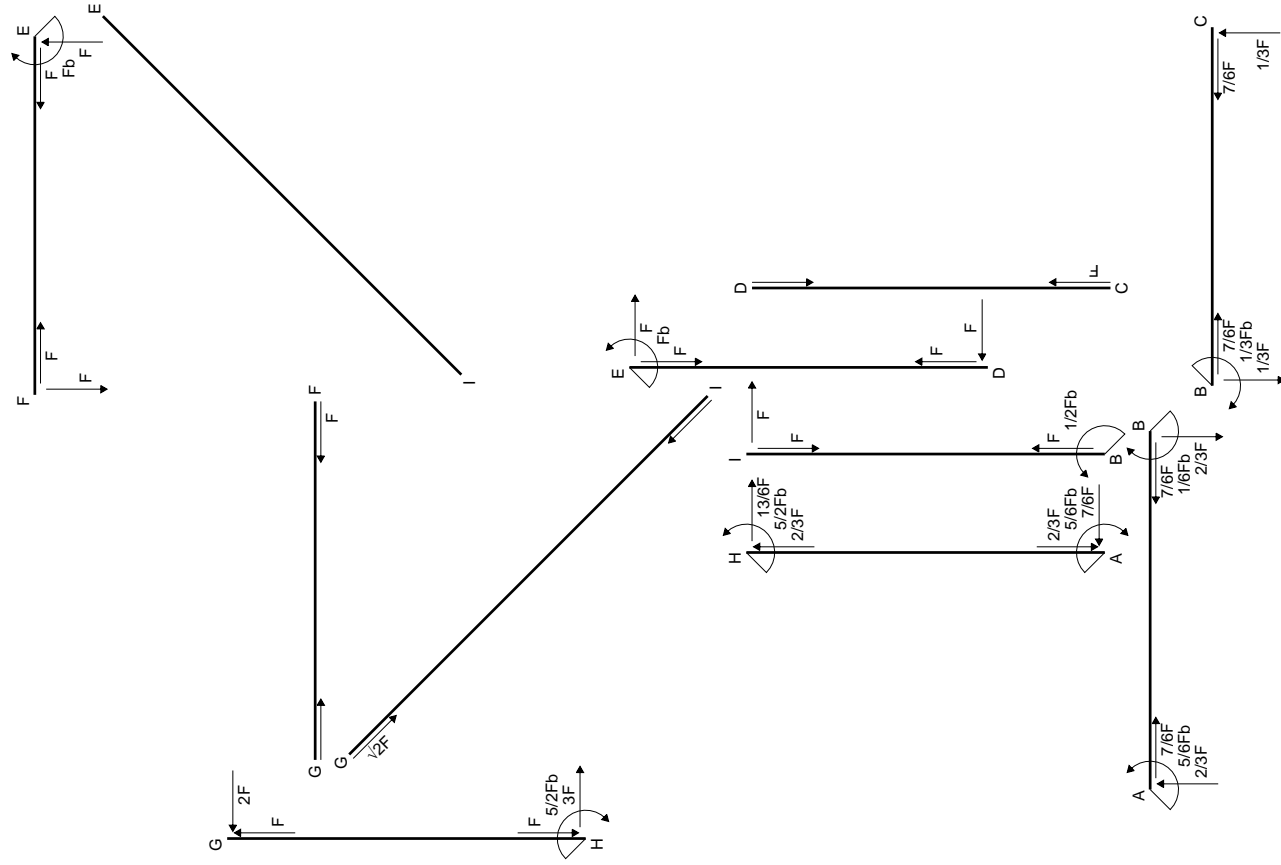
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

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

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



- A = 720. mm<sup>2</sup>
- J<sub>u</sub> = 242552. mm<sup>4</sup>
- J<sub>v</sub> = 51408. mm<sup>4</sup>
- y<sub>g</sub> = 34.65 mm
- N = 1030. N
- T<sub>y</sub> = -3090. N
- M<sub>x</sub> = -1545000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -34.65 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -219.3 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -25.65 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -162. N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.295 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 162.6 N/mm<sup>2</sup>
- S = 3907. mm<sup>3</sup>





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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

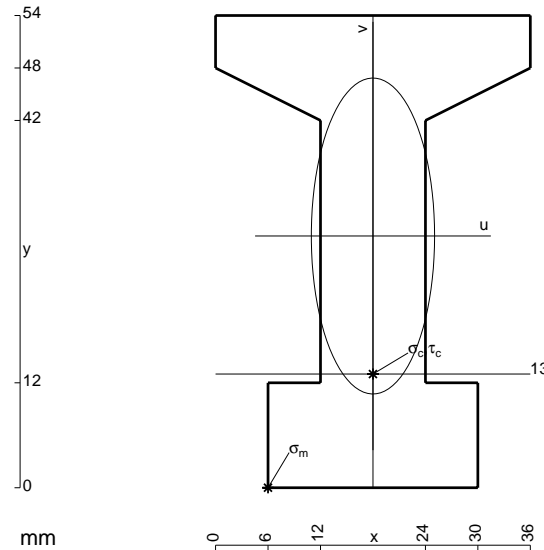
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

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

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

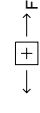
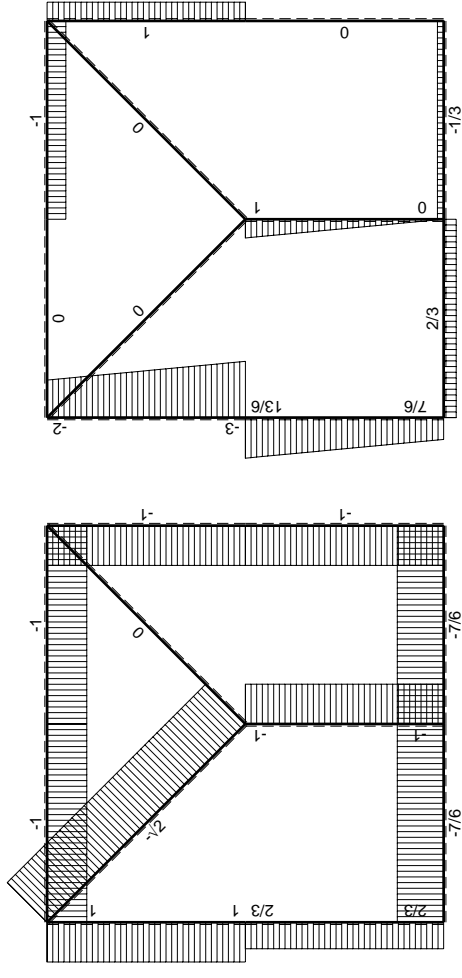
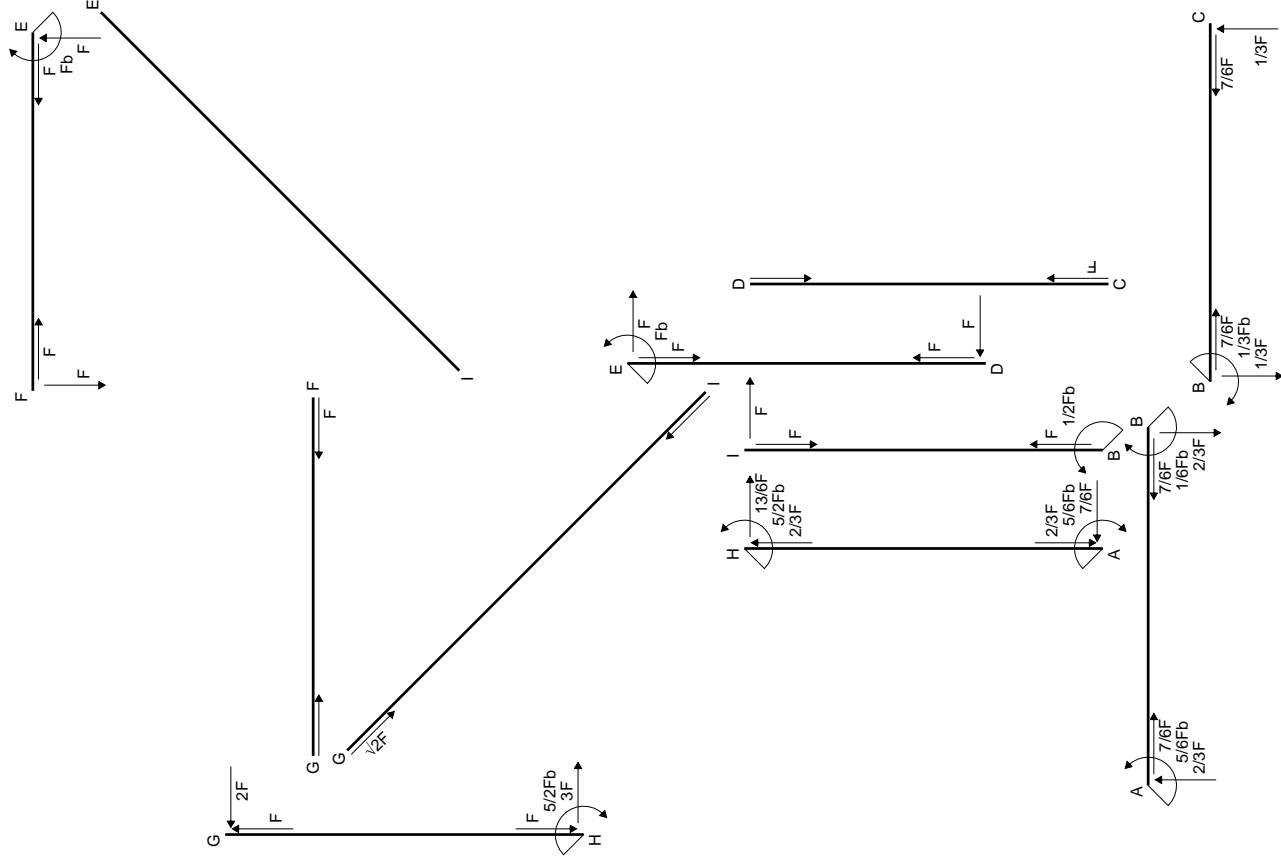
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

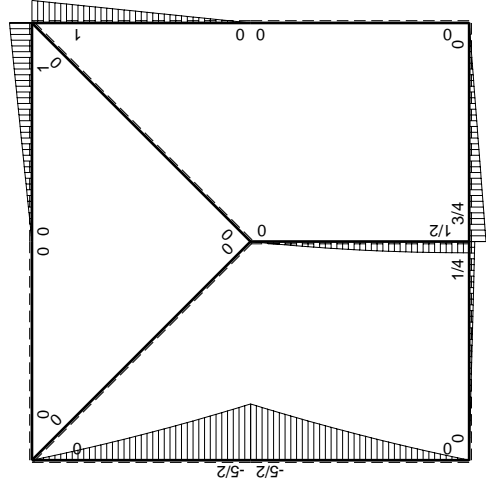
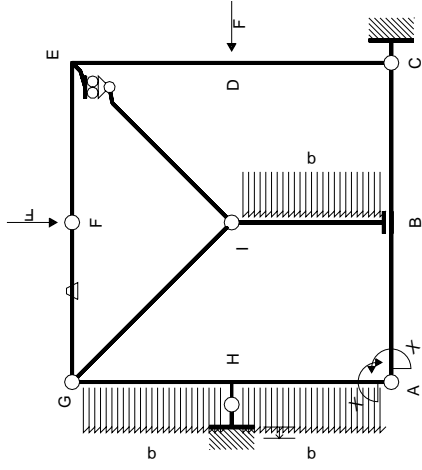
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



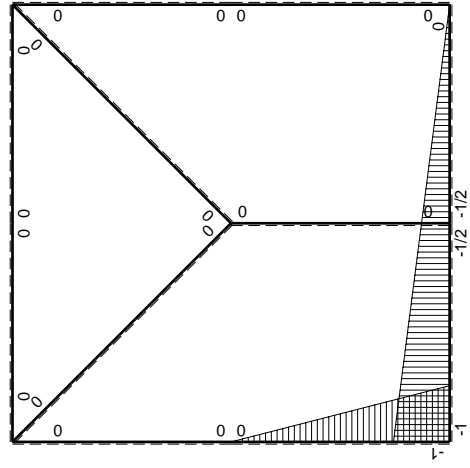
- A = 1008. mm<sup>2</sup>
- J<sub>u</sub> = 328994. mm<sup>4</sup>
- J<sub>v</sub> = 50112. mm<sup>4</sup>
- y<sub>g</sub> = 28.79 mm
- N = 1620. N
- T<sub>y</sub> = -4860. N
- M<sub>x</sub> = -2632500. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.79 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -228.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.79 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -124.7 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.319 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 125.5 N/mm<sup>2</sup>
- S = 6758. mm<sup>3</sup>







$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	0	0	0	0			
FG b	0	0	-Fb/EJ	0	0	0	0+0	0	
GF b	0	0	Fb/EJ	0	0	0			
GH b	0	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

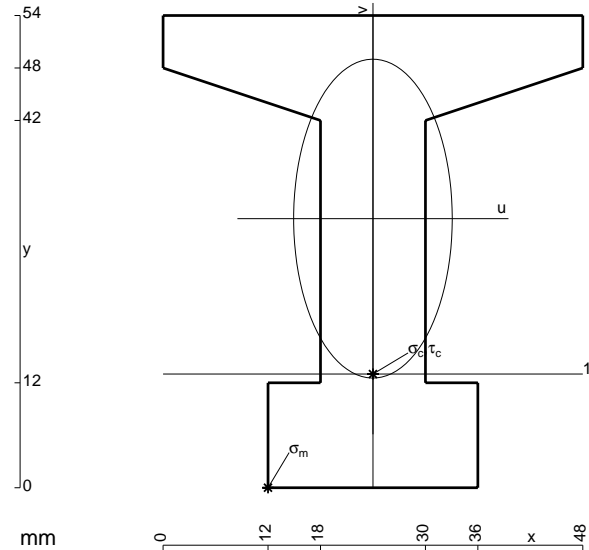
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

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

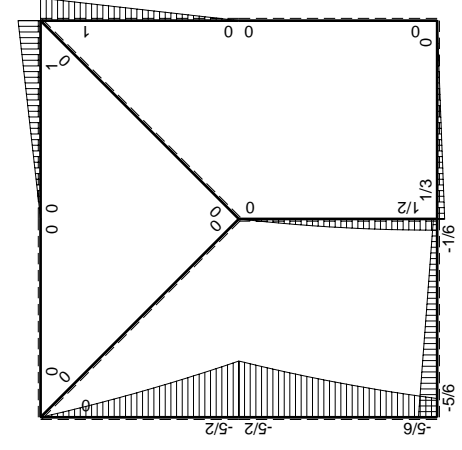
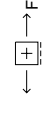
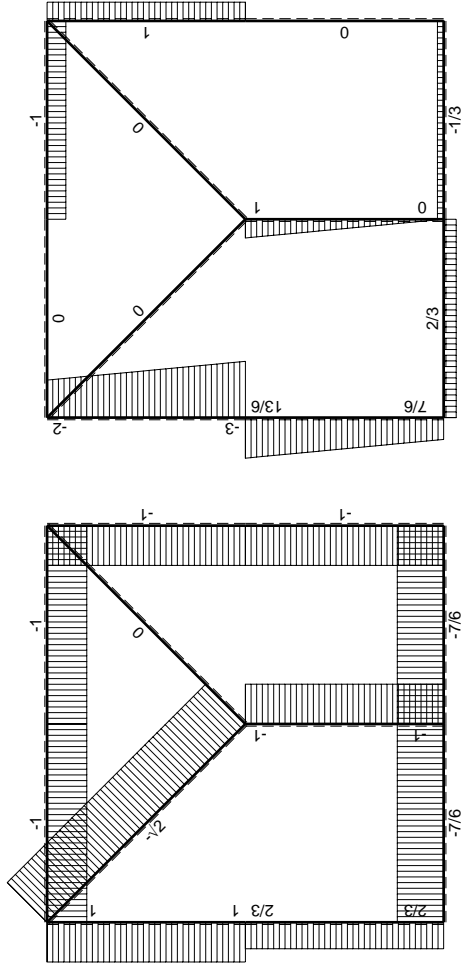
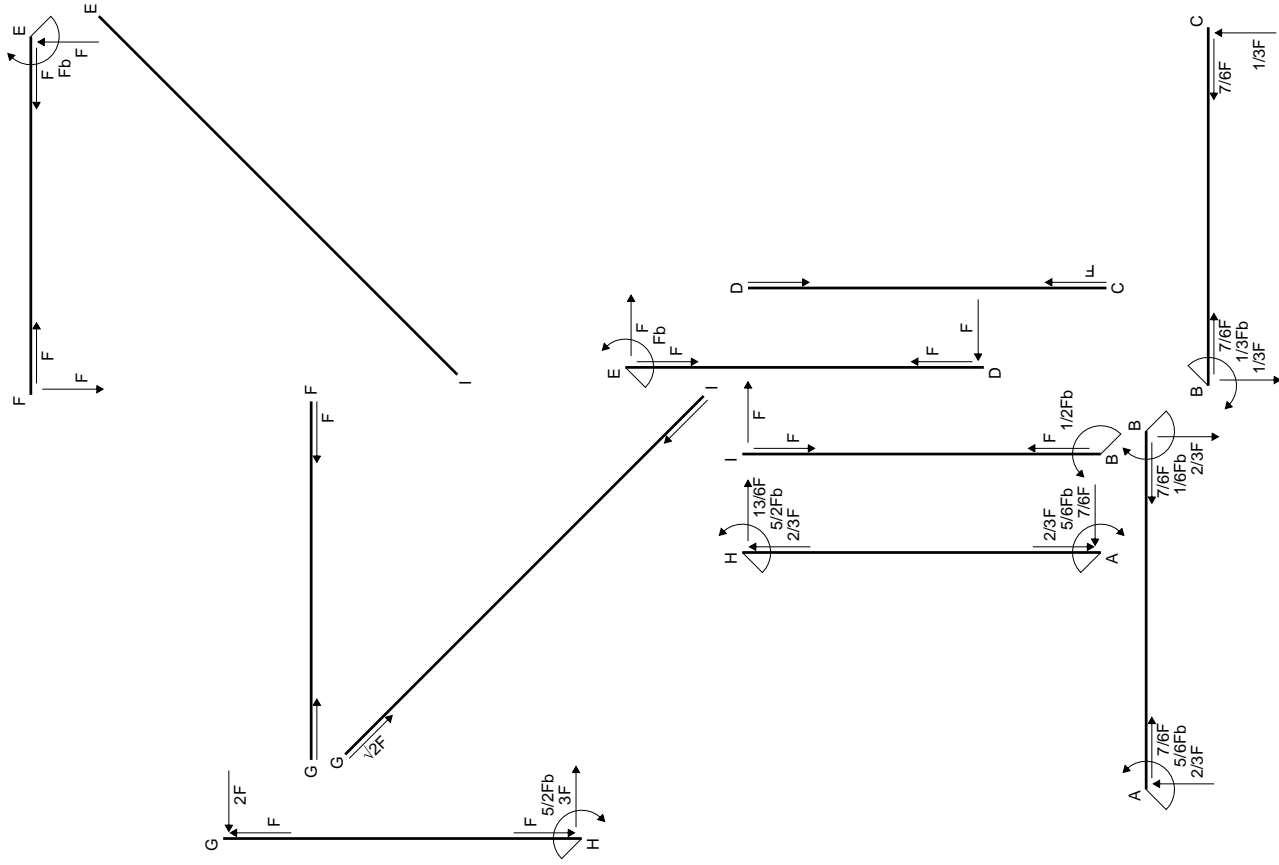
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

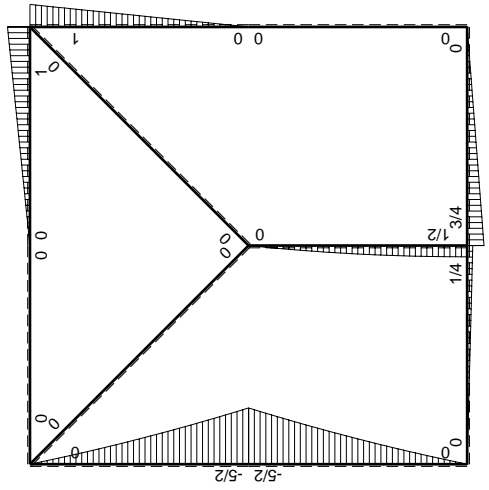
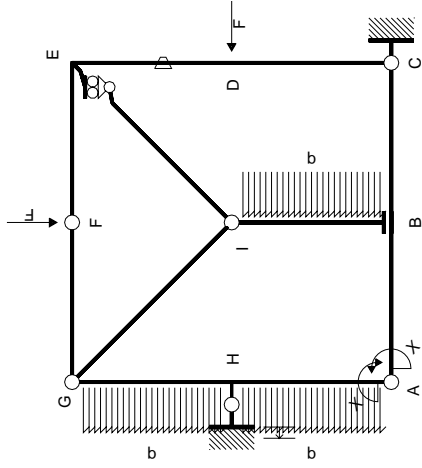
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

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

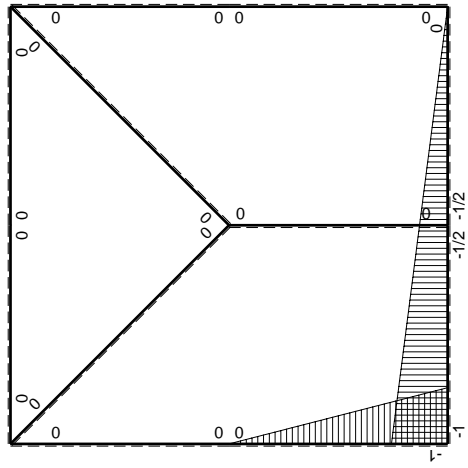


- A = 1116. mm<sup>2</sup>
- J<sub>u</sub> = 371067. mm<sup>4</sup>
- J<sub>v</sub> = 91800. mm<sup>4</sup>
- y<sub>g</sub> = 30.77 mm
- N = 1660. N
- T<sub>y</sub> = -4980. N
- M<sub>x</sub> = -2905000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.77 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -239.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -17.77 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -137.7 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.225 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 138.4 N/mm<sup>2</sup>
- S = 7354. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	$Fb/EJ$	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

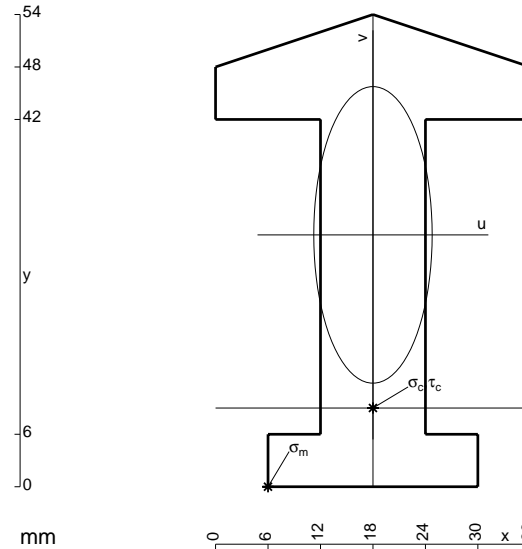
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

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

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

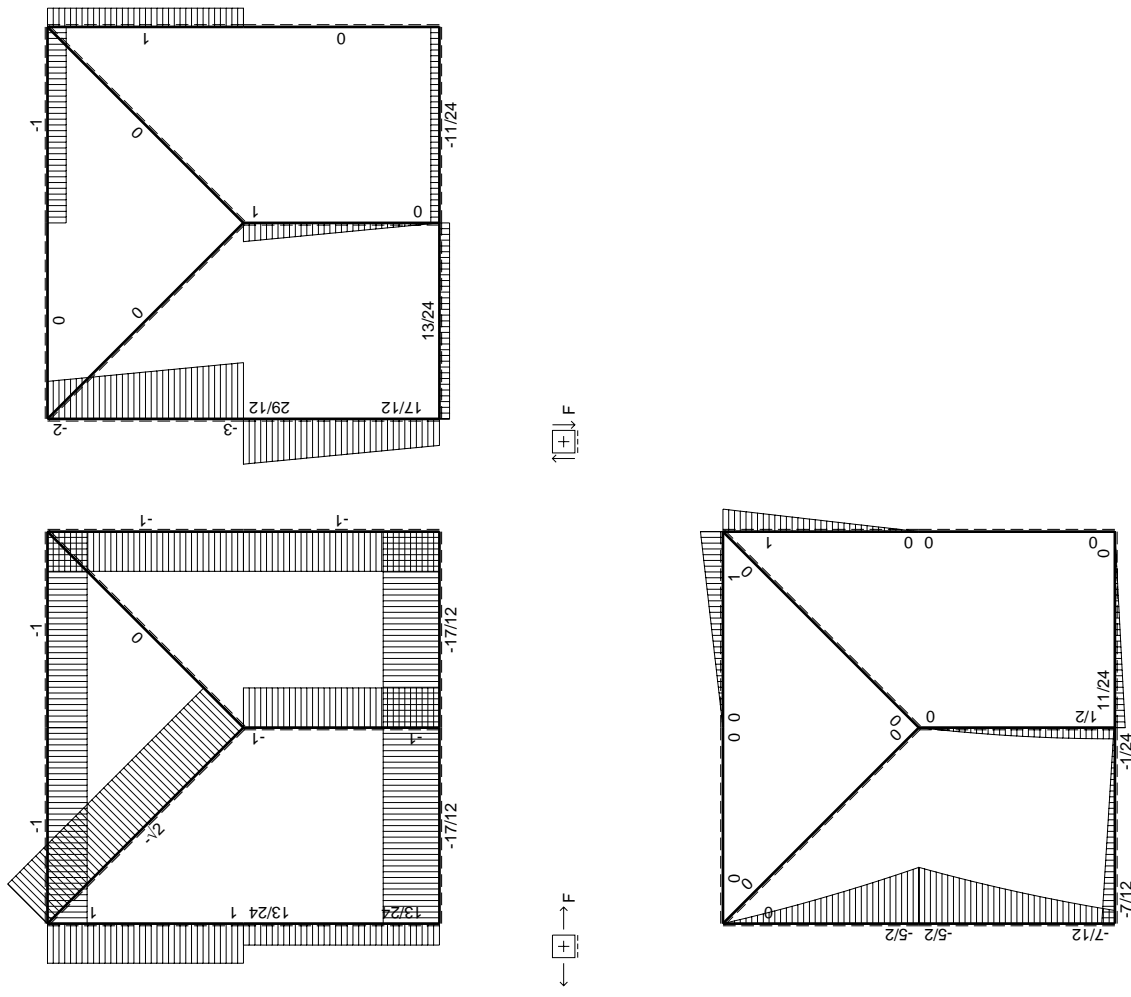
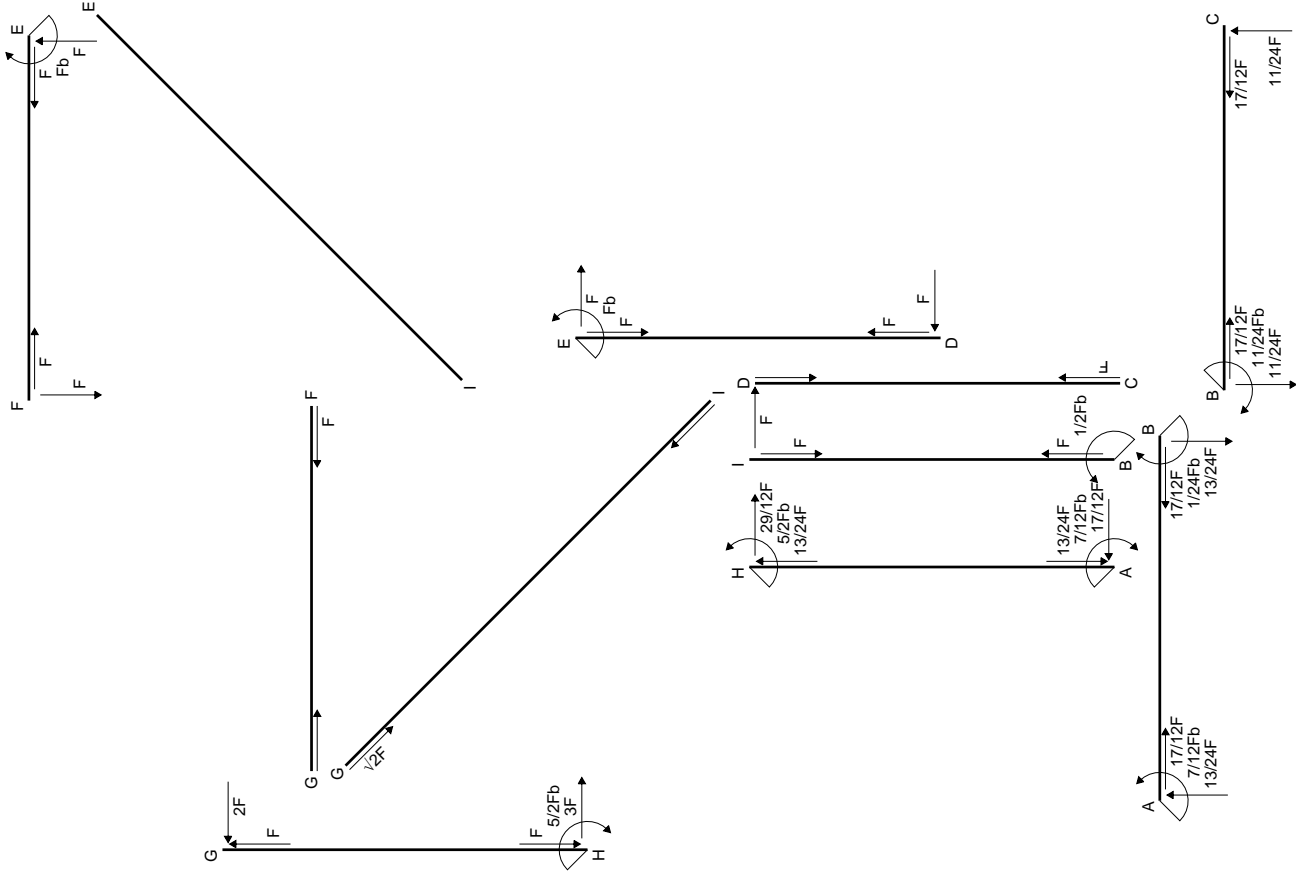
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

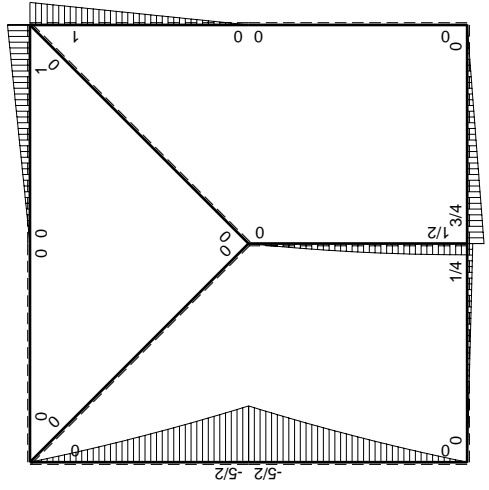
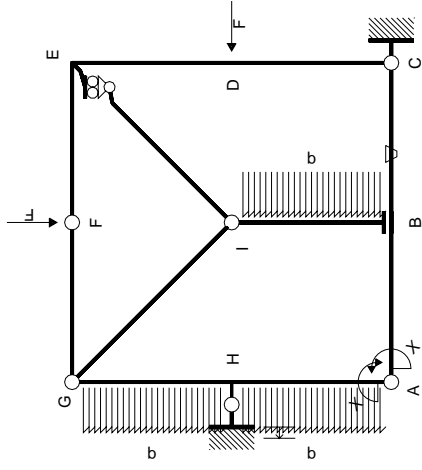
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



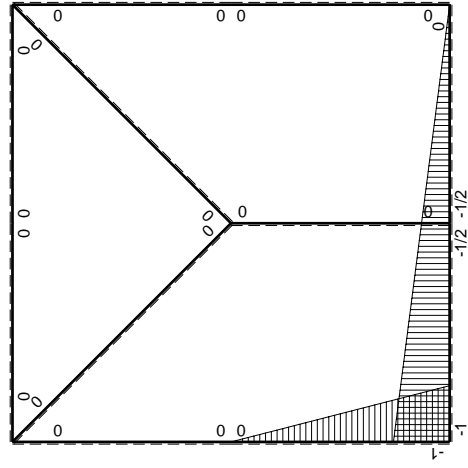
- A = 900. mm<sup>2</sup>
- J<sub>u</sub> = 258984. mm<sup>4</sup>
- J<sub>v</sub> = 41256. mm<sup>4</sup>
- y<sub>g</sub> = 28.8 mm
- N = 960. N
- T<sub>y</sub> = -2880. N
- M<sub>x</sub> = -1800000. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.8 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -199.1 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -19.8 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -136.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.153 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 136.7 N/mm<sup>2</sup>
- S = 4482. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_0(x)$	$\theta$	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	$-Fb/EJ$	$-3/8Fb+3/4Fx-3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$
CB b	$1/2x/b$	$-3/4Fx$	$Fb/EJ$	$-3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
DE b	0	Fx	0	0	0	0	0+0	0
ED b	0	$-Fb+Fx$	0	0	0	0		
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0
FE b	0	$-Fx$	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0		
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0		
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
H	cedimento nodo $-H_{1H}u_H$						$-Fb^2/EJ$	
	totali						$-7/12Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$						$7/12Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

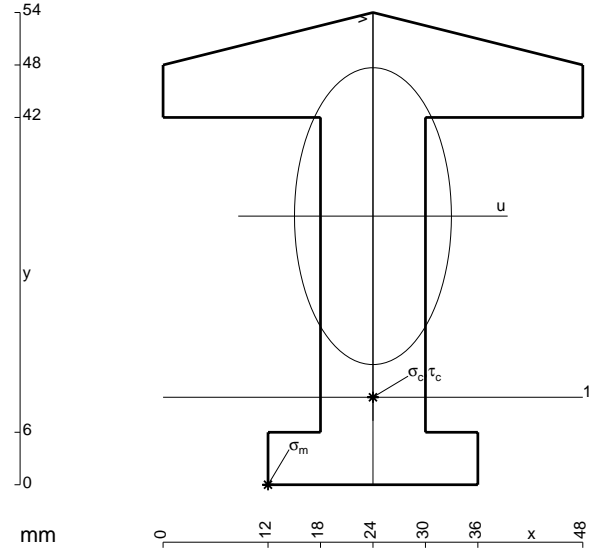
$$= (-1/8 b) Fb 1/EJ + (-1/4 b) \theta = 1/8 Fb^2/EJ$$

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

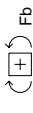
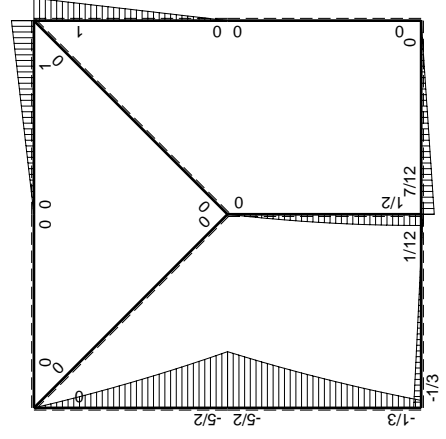
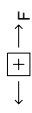
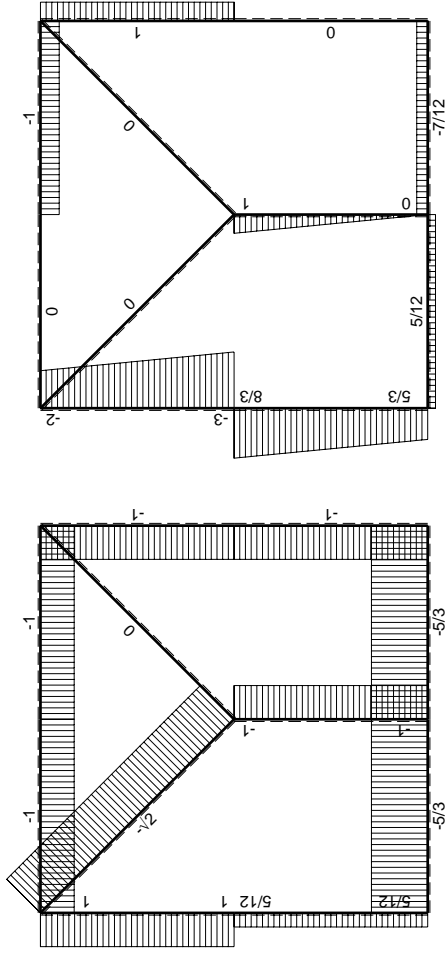
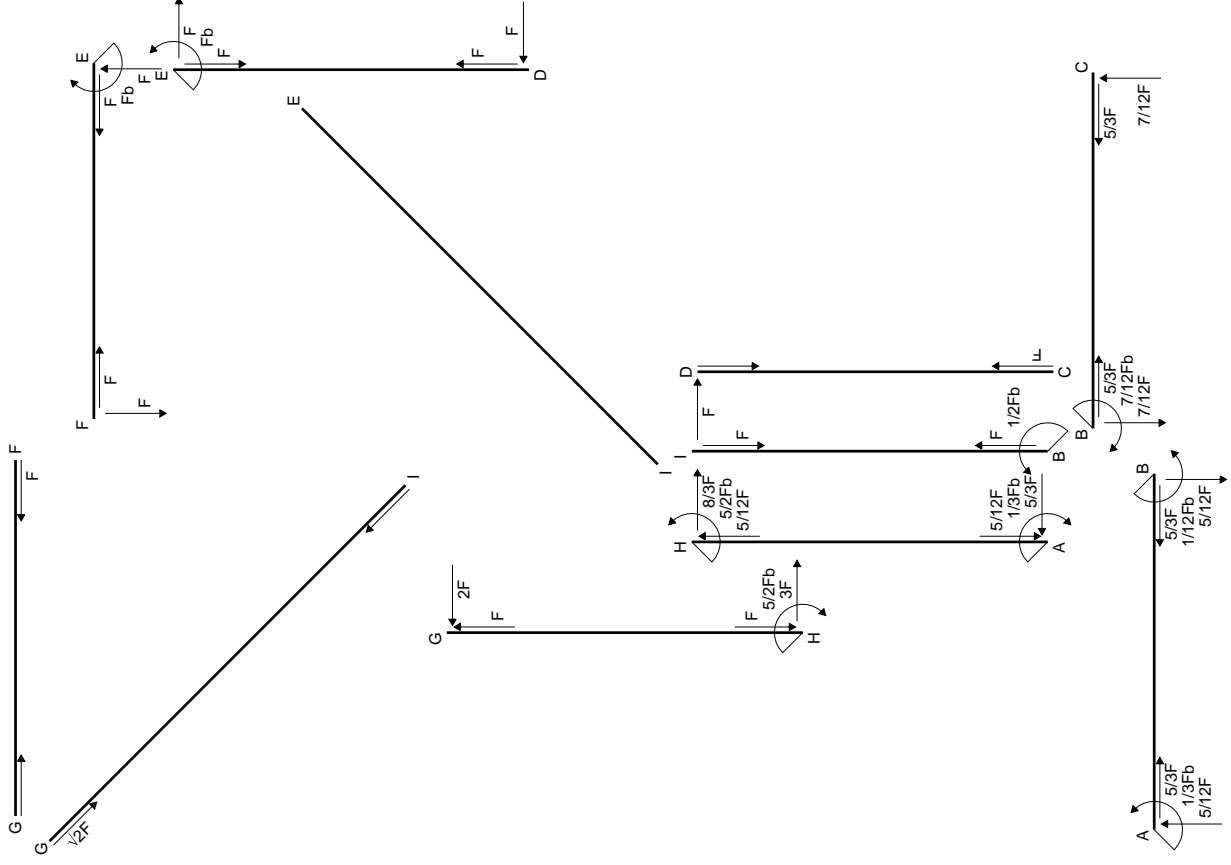
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

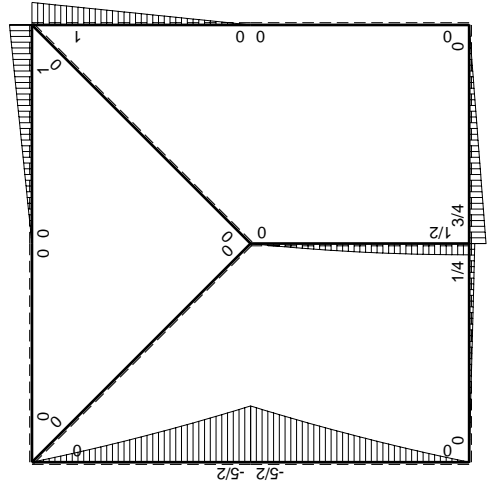
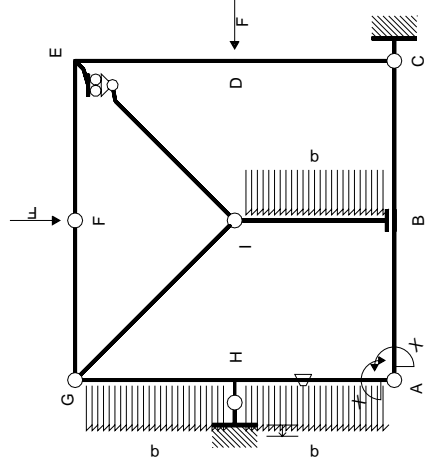
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

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

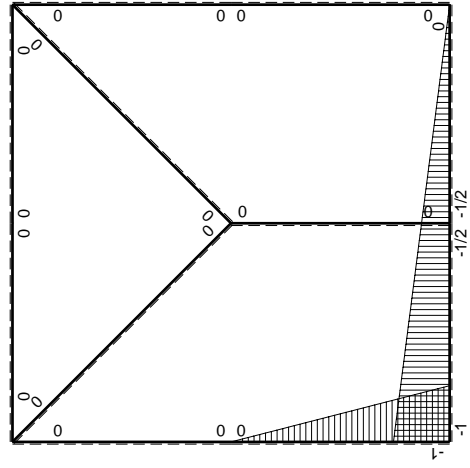


- A = 1008. mm<sup>2</sup>
- J<sub>u</sub> = 290654. mm<sup>4</sup>
- J<sub>v</sub> = 81216. mm<sup>4</sup>
- y<sub>g</sub> = 30.71 mm
- N = 990. N
- T<sub>y</sub> = -2970. N
- M<sub>x</sub> = -1980000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.71 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -208.3 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -20.71 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -140.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.327 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 140.3 N/mm<sup>2</sup>
- S = 5081. mm<sup>3</sup>





$M_x$  flessione da carichi assegnati



$M_y$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	-Fb/EJ	$5/2Fx-3Fx^2/b+1/2qx^3/b$	Fx/EJ	$x^2/b^2$	$(3/8+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	Fb/EJ	$2Fx-3/2Fx^2/b-1/2qx^3/b$	Fb/EJ-Fx/EJ	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/3Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/3Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

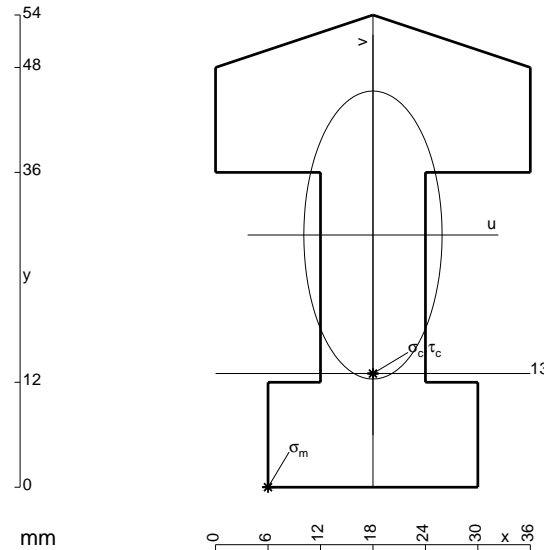
$$= [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

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

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

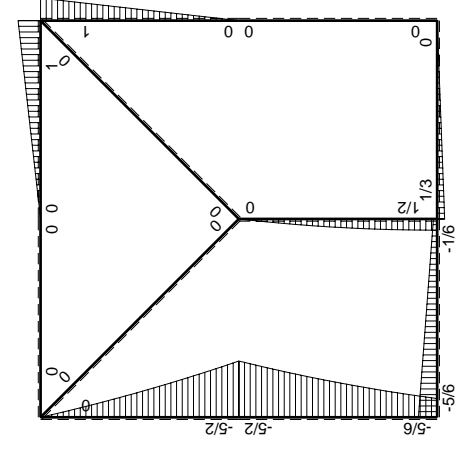
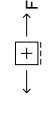
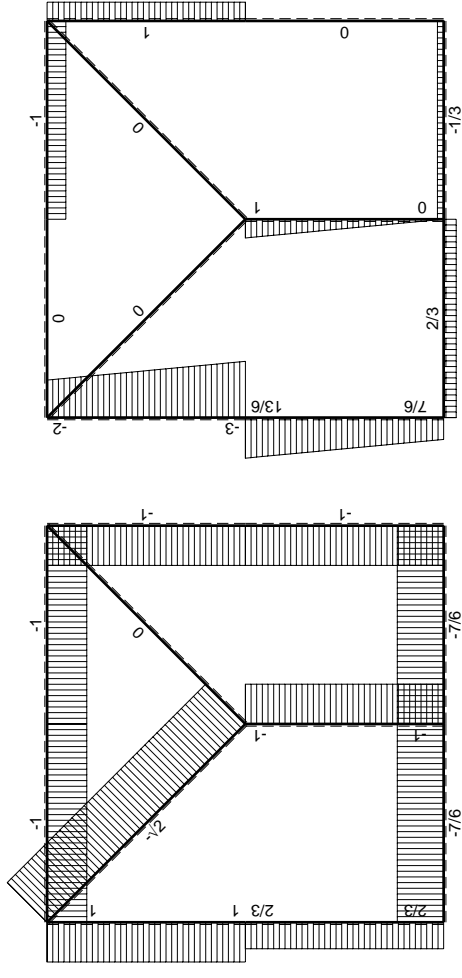
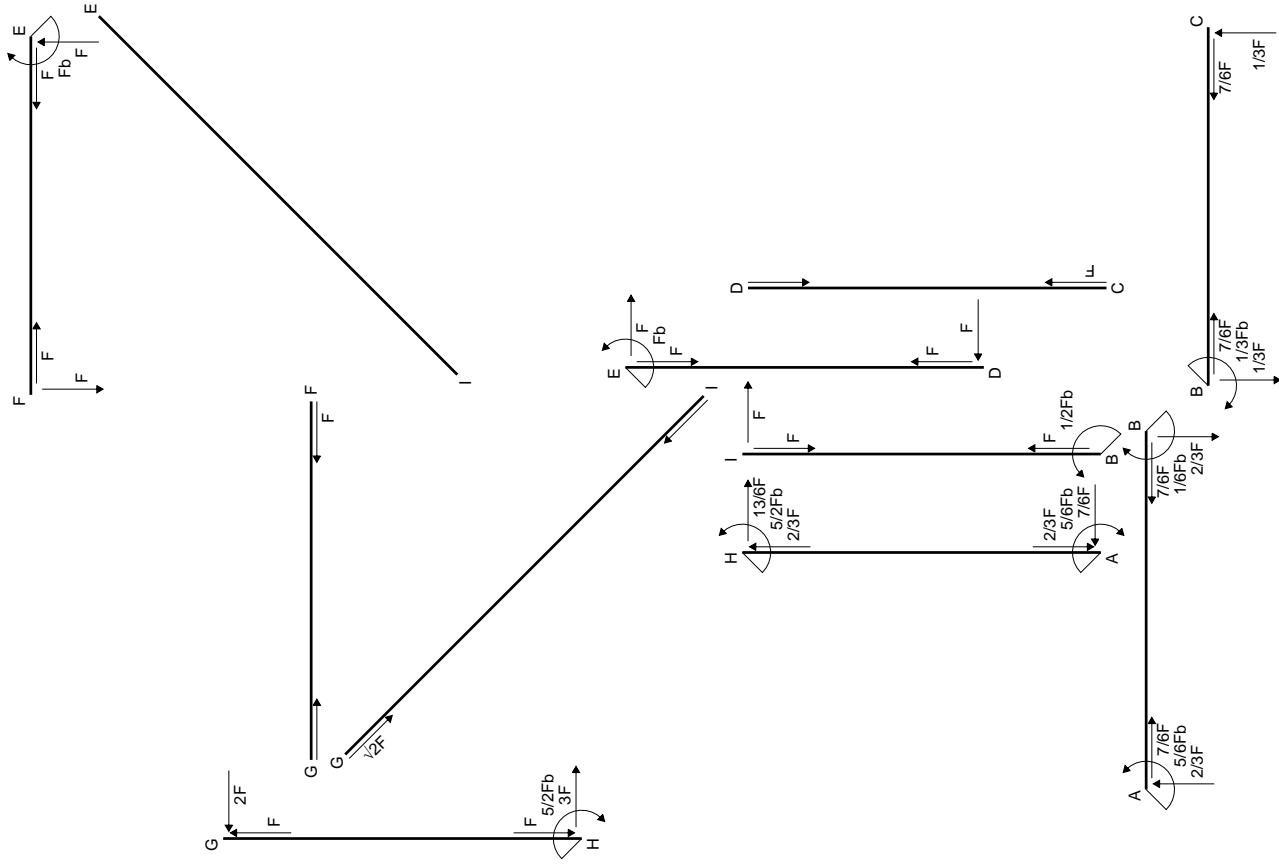
$$= [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

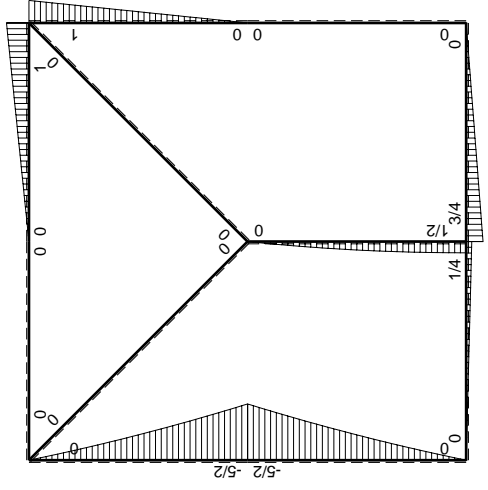
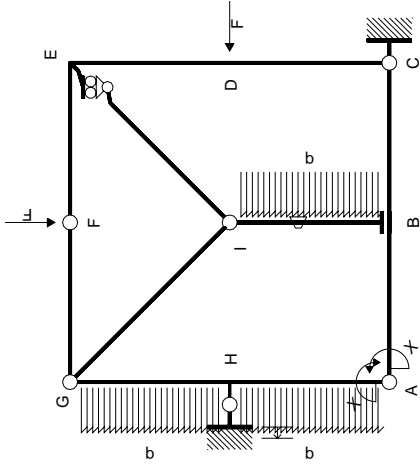
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 7/8 Fb^2/EJ$$



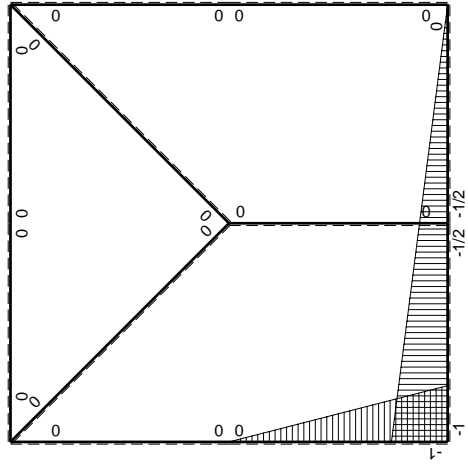
- A = 1116. mm<sup>2</sup>
- J<sub>u</sub> = 302839. mm<sup>4</sup>
- J<sub>v</sub> = 69768. mm<sup>4</sup>
- y<sub>g</sub> = 28.84 mm
- N = 1090. N
- T<sub>y</sub> = -3270. N
- M<sub>x</sub> = -2316250. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.84 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -219.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.84 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -120.2 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.095 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 120.6 N/mm<sup>2</sup>
- S = 6774. mm<sup>3</sup>







$M_y$  flessione da carichi assegnati



$M_x$  flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	-Fb/EJ	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	Fb/EJ	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

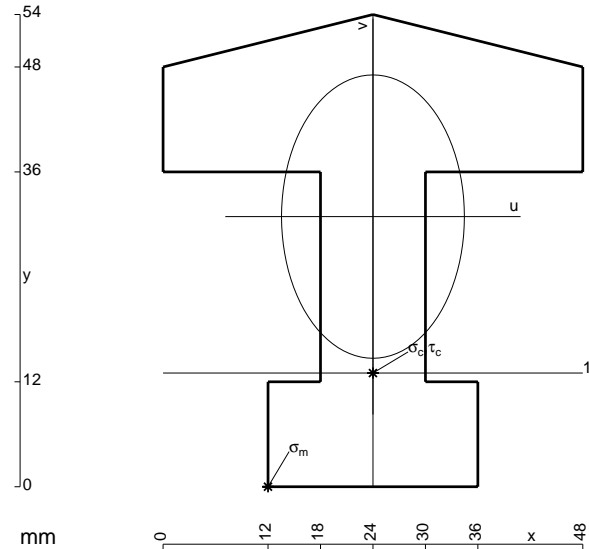
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

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

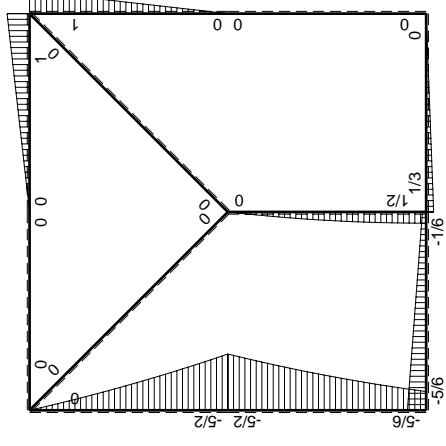
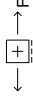
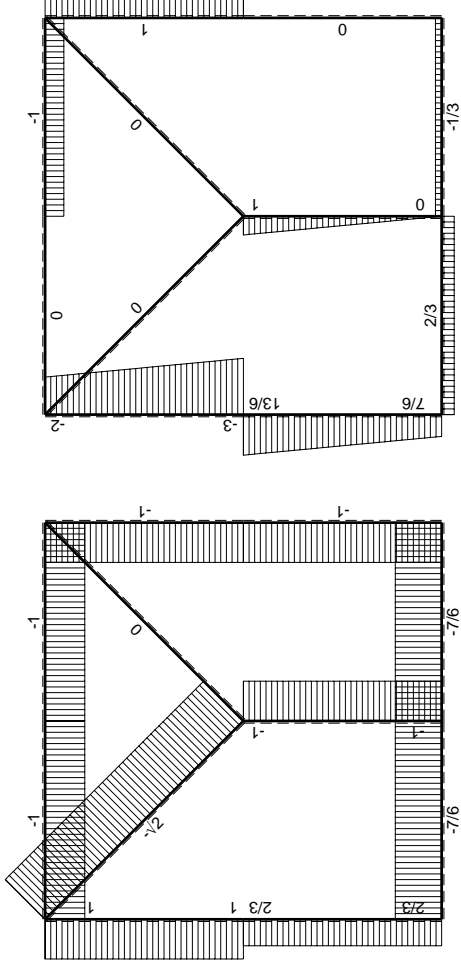
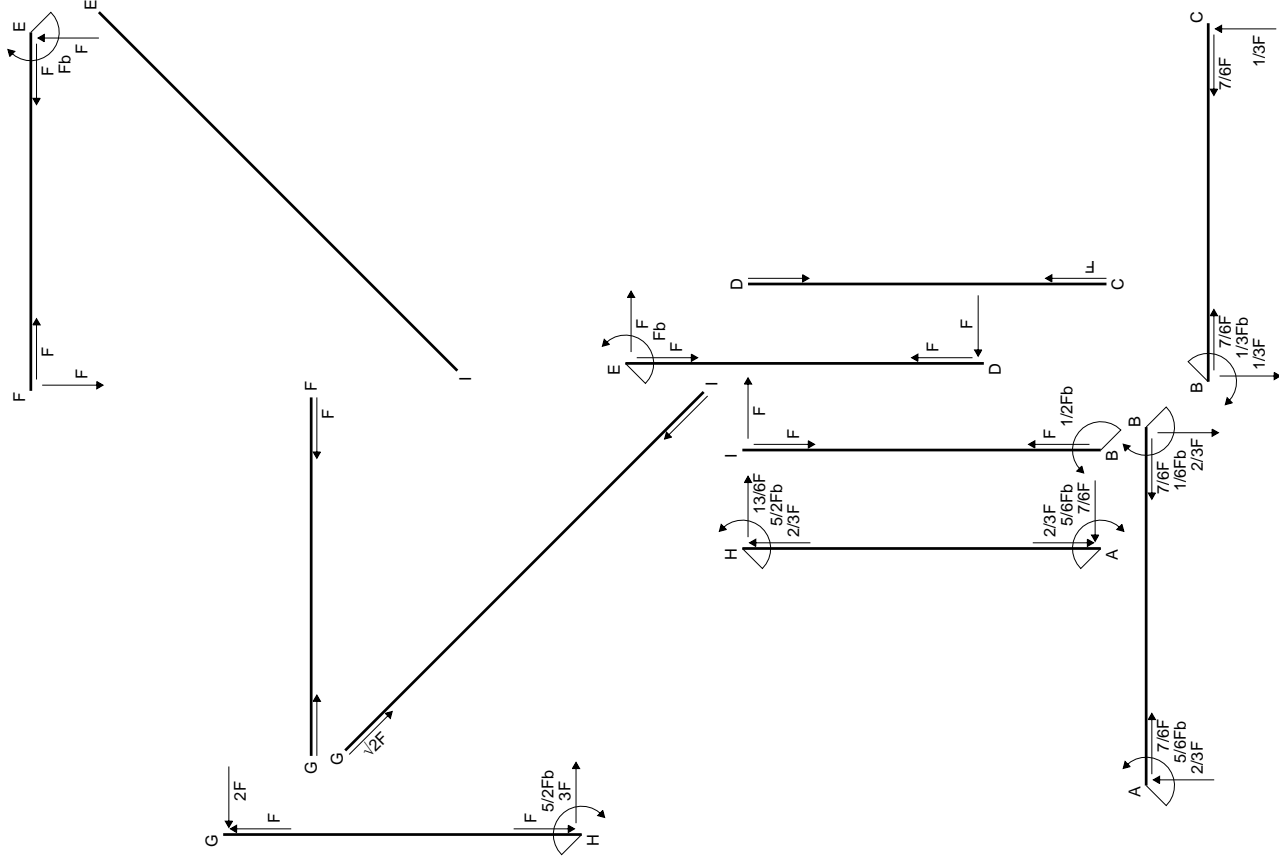
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

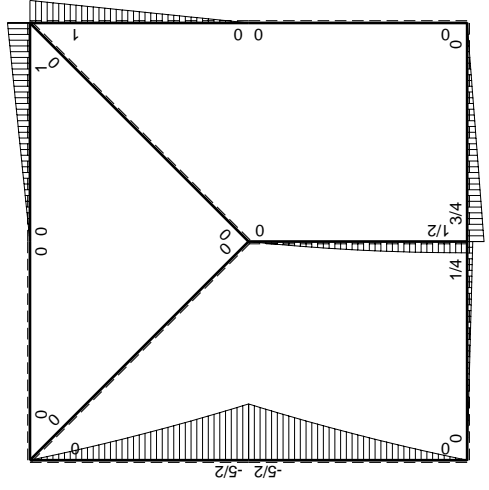
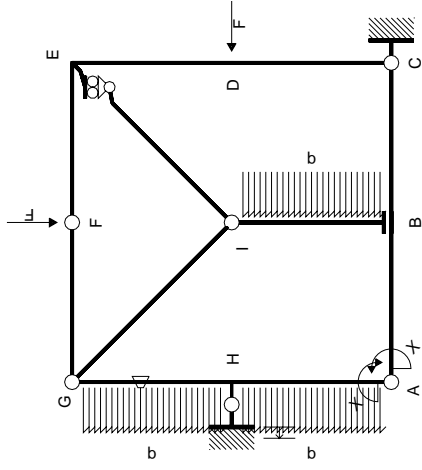
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

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

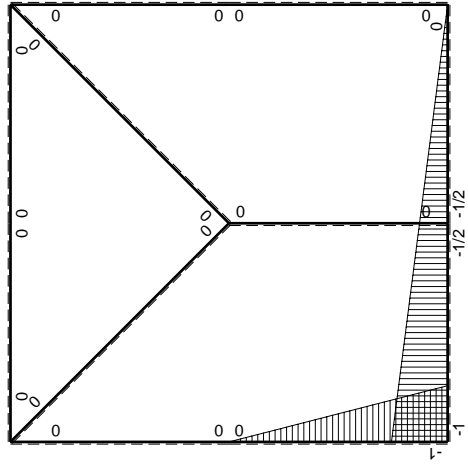


- A = 1296. mm<sup>2</sup>
- J<sub>u</sub> = 340256. mm<sup>4</sup>
- J<sub>v</sub> = 141696. mm<sup>4</sup>
- y<sub>g</sub> = 30.89 mm
- N = 1130. N
- T<sub>y</sub> = -3390. N
- M<sub>x</sub> = -2542500. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.89 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -229.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -17.89 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -132.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.134 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 133.2 N/mm<sup>2</sup>
- S = 7389. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	-Fb/EJ	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	Fb/EJ	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{AB}^{x_0} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

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

$$L_{BA}^{x_0} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

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

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

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

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

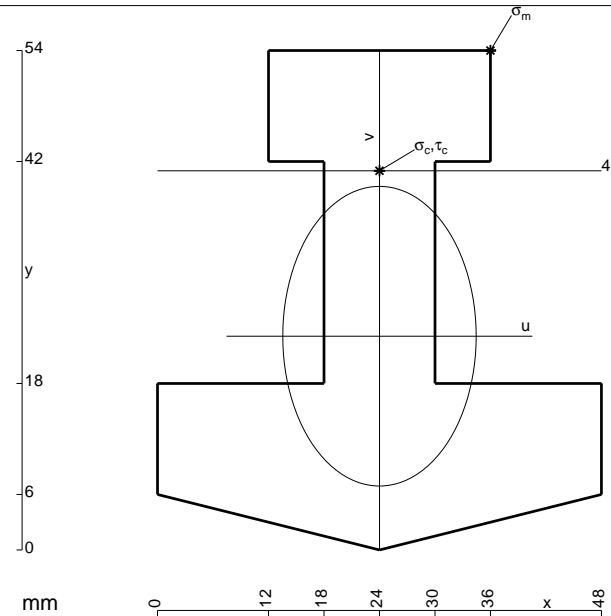
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

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

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

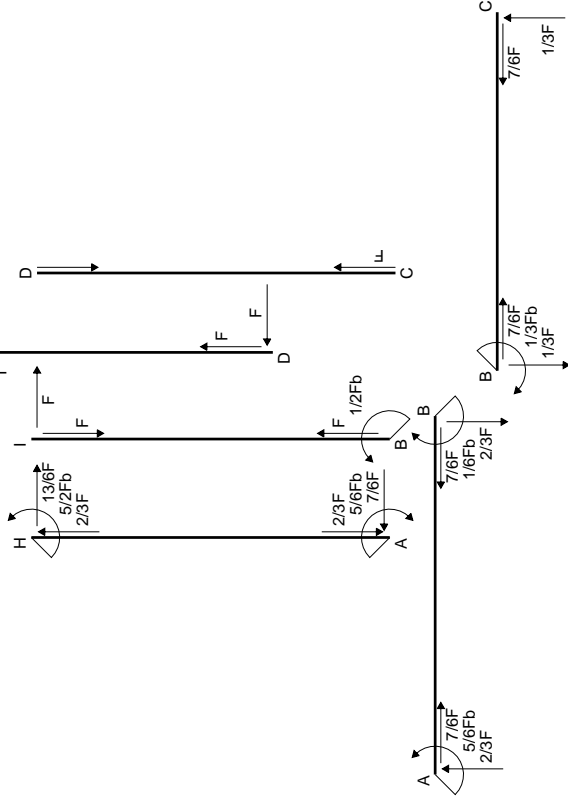
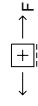
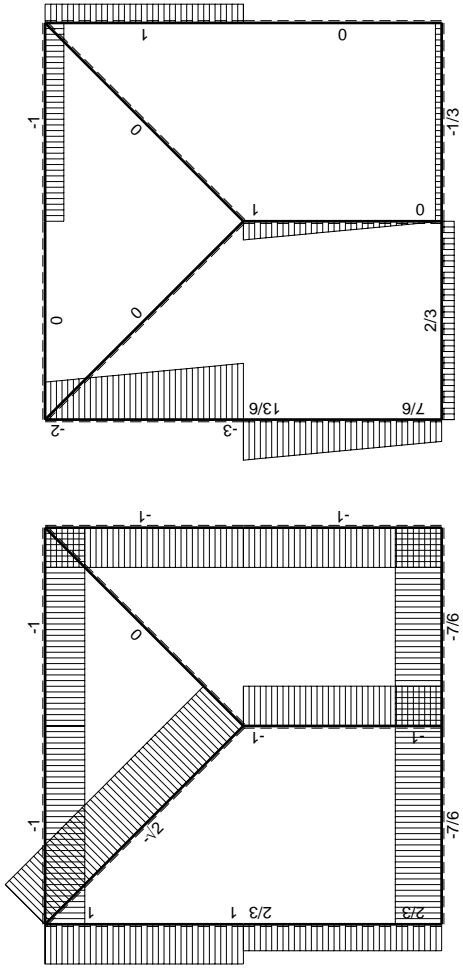
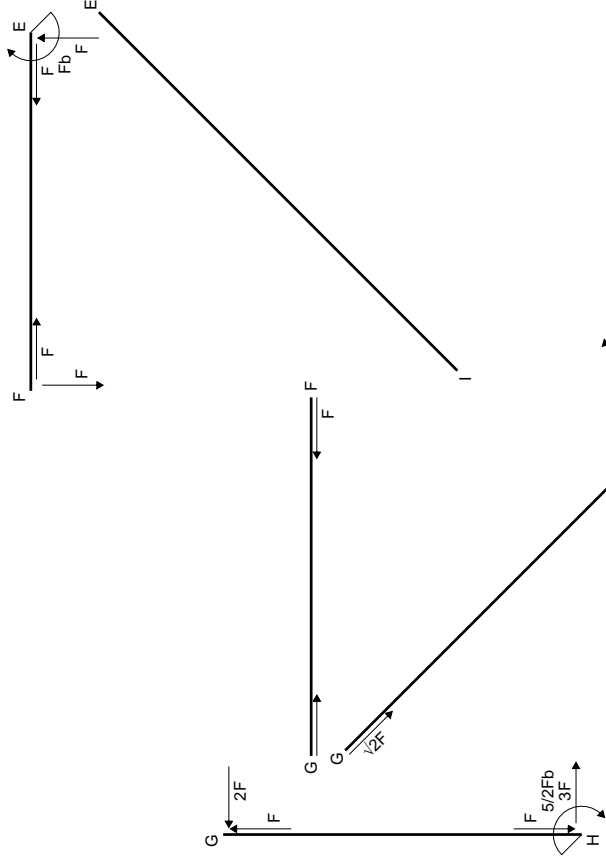
$$L_{AH}^{x_0} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

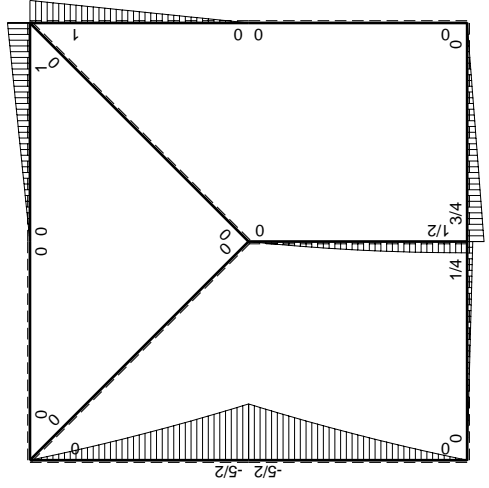
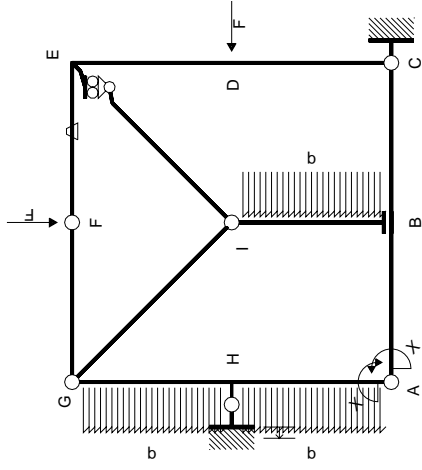
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



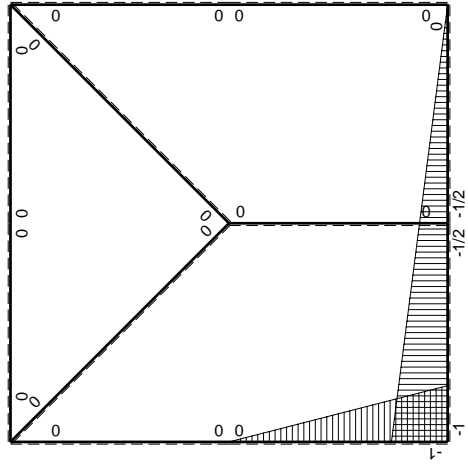
- A = 1296. mm<sup>2</sup>
- J<sub>u</sub> = 340256. mm<sup>4</sup>
- J<sub>v</sub> = 141696. mm<sup>4</sup>
- y<sub>g</sub> = 23.11 mm
- N = 1100. N
- T<sub>y</sub> = -3300. N
- M<sub>x</sub> = -2612500. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.89 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 238. N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 17.89 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 138.2 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.972 N/mm<sup>2</sup>
- σ<sub>g</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 138.6 N/mm<sup>2</sup>
- S = 7389. mm<sup>3</sup>







$M_0$ , flessione da carichi assegnati



$M_1$ , flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_0(x)$	$\theta$	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	-Fb/EJ	0	0	0	0+0	0	
FE b	0	-Fx	Fb/EJ	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

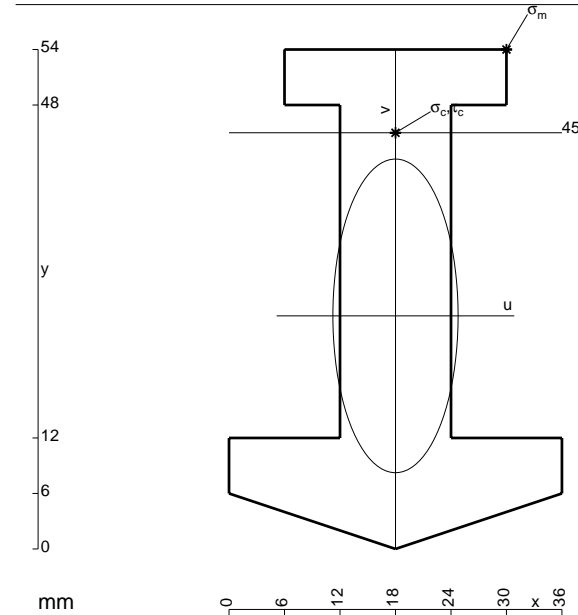
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

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

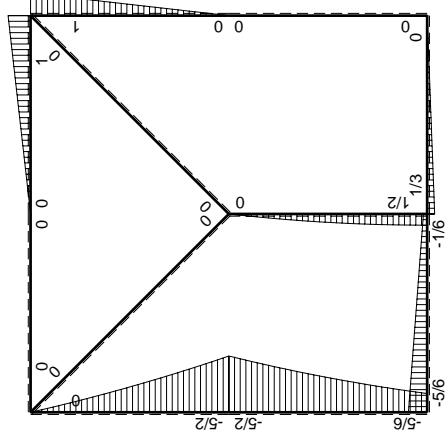
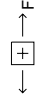
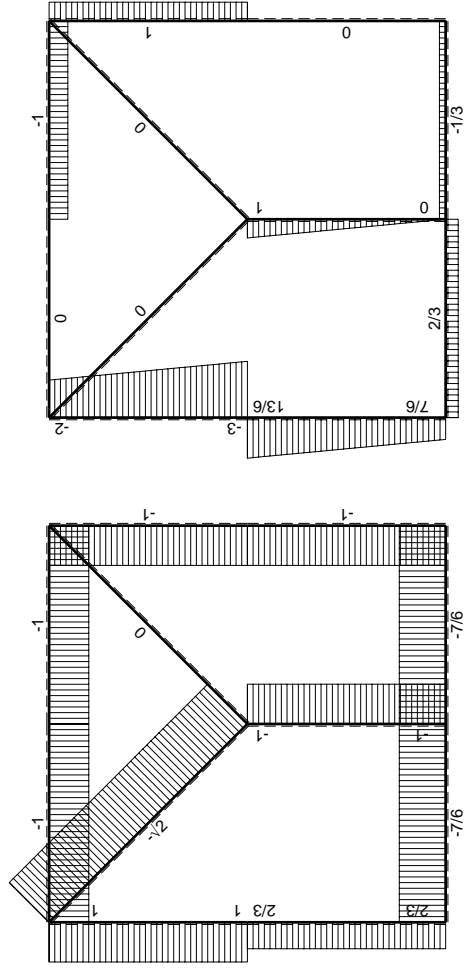
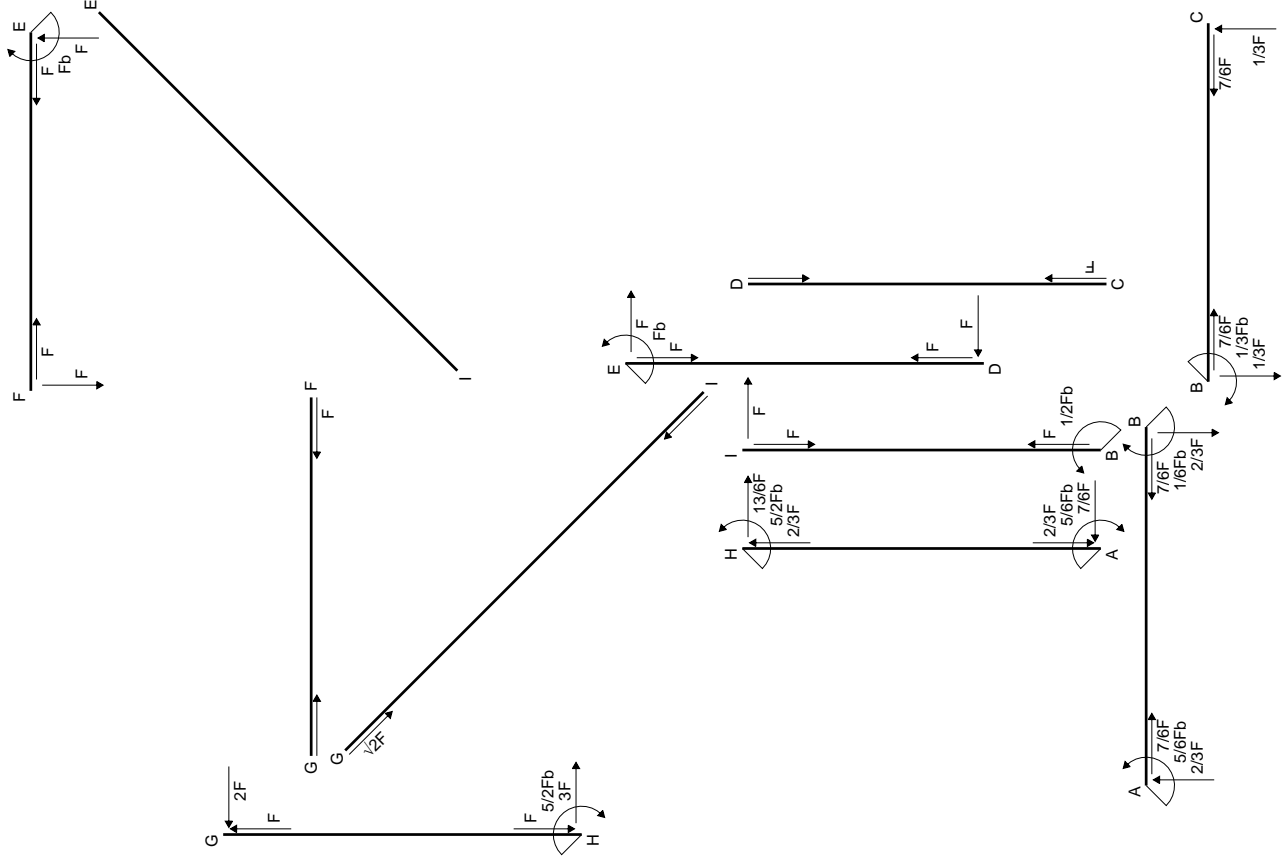
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

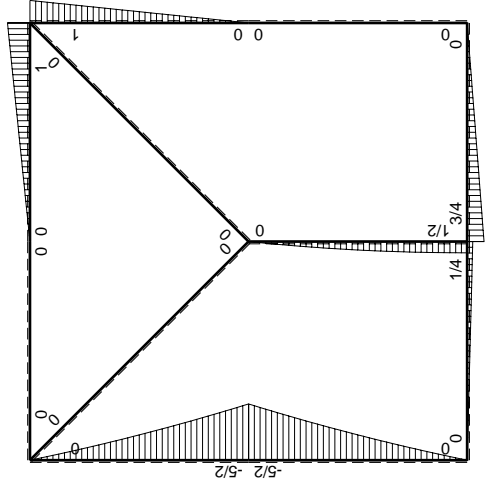
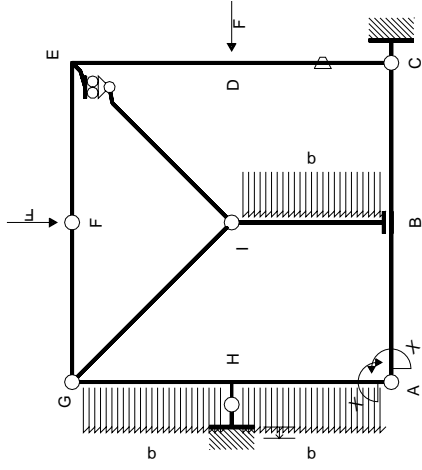
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

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

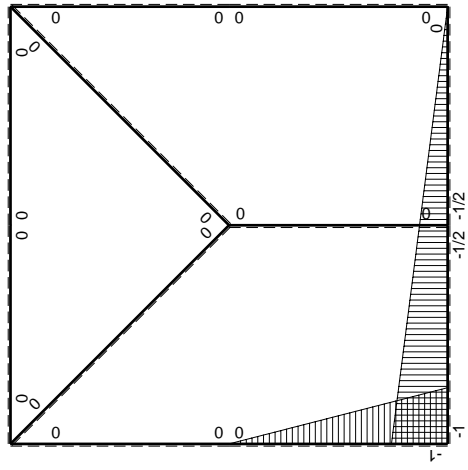


- A = 900. mm<sup>2</sup>
- J<sub>u</sub> = 258984. mm<sup>4</sup>
- J<sub>v</sub> = 41256. mm<sup>4</sup>
- y<sub>g</sub> = 25.2 mm
- N = 1420. N
- T<sub>y</sub> = -4260. N
- M<sub>x</sub> = -1775000. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.8 mm
- σ<sub>m</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = 199. N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 45. mm
- v<sub>c</sub> = 19.8 mm
- σ<sub>c</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = 137.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.144 N/mm<sup>2</sup>
- σ<sub>g</sub> = √σ<sup>2</sup> + 3τ<sup>2</sup> = 137.7 N/mm<sup>2</sup>
- S = 4482. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	0	$Fb/EJ$	0	0	0			
DE b	0	$Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

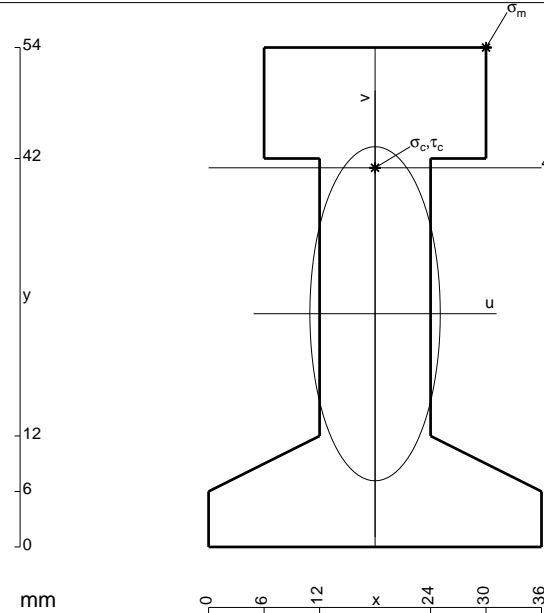
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

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

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

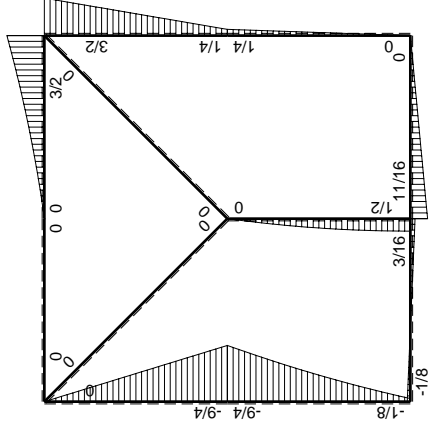
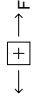
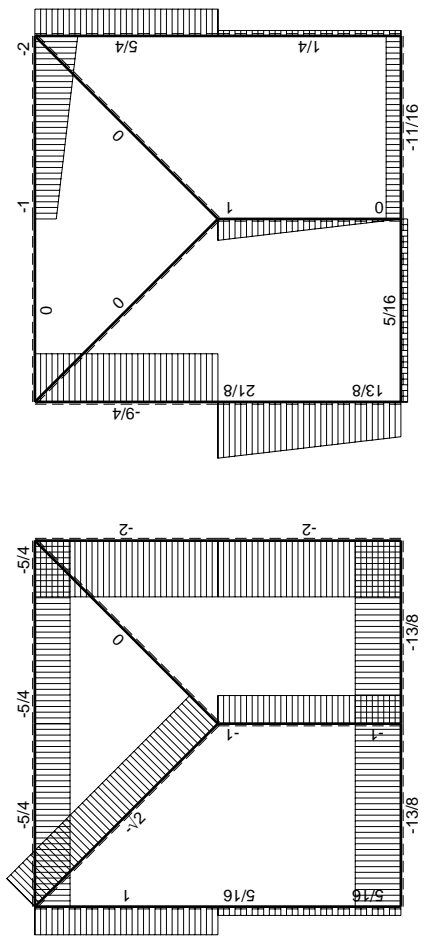
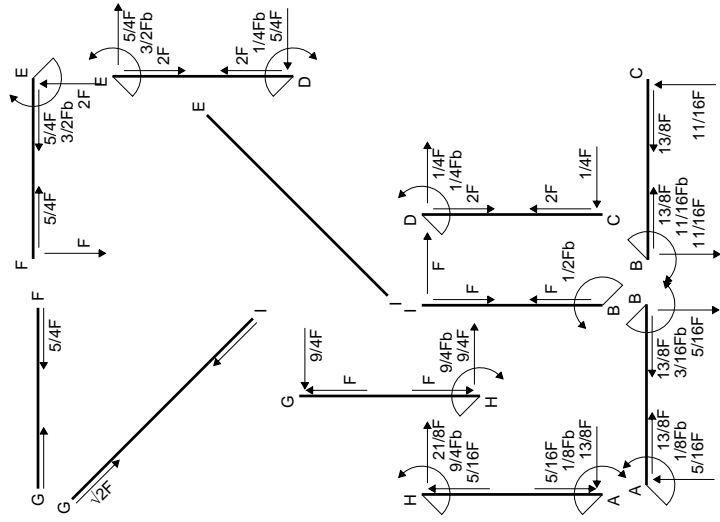
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

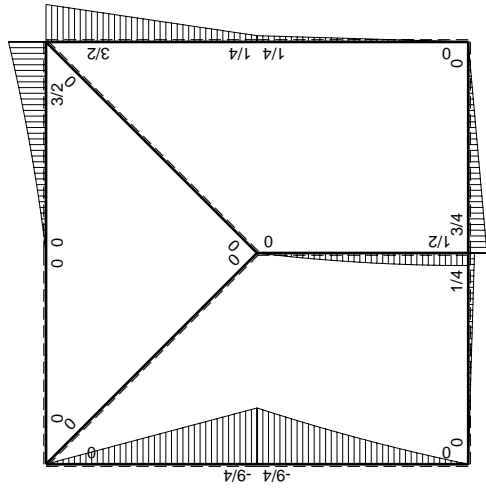
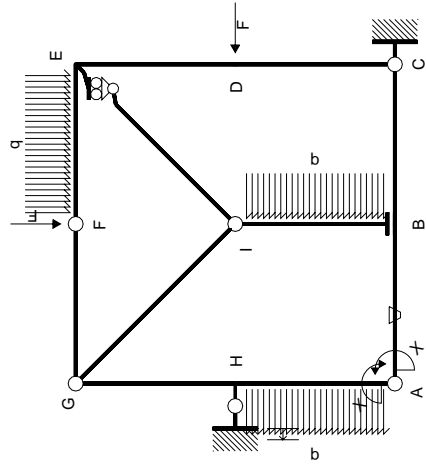
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



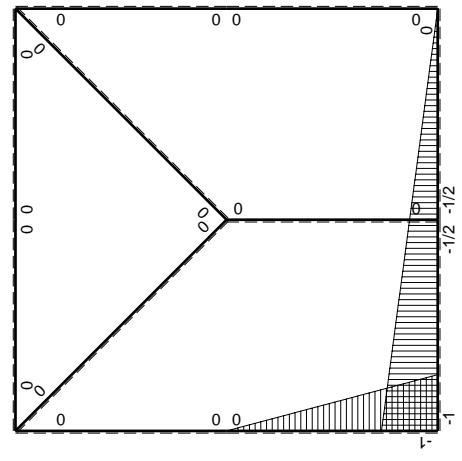
- A = 1008. mm<sup>2</sup>
- J<sub>u</sub> = 328994. mm<sup>4</sup>
- J<sub>v</sub> = 50112. mm<sup>4</sup>
- y<sub>g</sub> = 25.21 mm
- N = 1730. N
- T<sub>y</sub> = -5190. N
- M<sub>x</sub> = -2378750. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.79 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 209.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 15.79 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 115.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.884 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 116.9 N/mm<sup>2</sup>
- S = 6758. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	$-Fb/EJ$	$-1/4Fx+1/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-1/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	$Fb/EJ$	$-1/8Fb+1/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

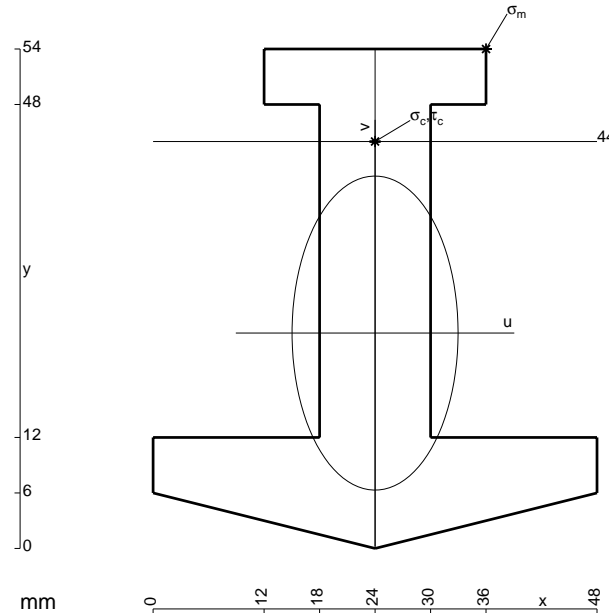
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

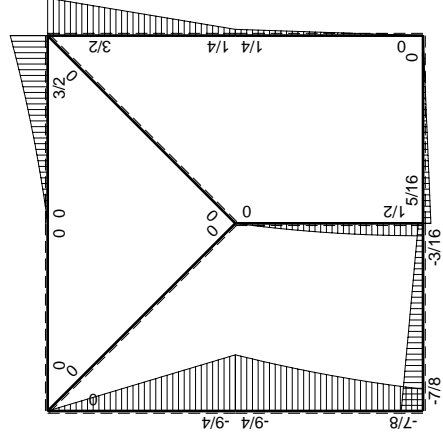
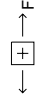
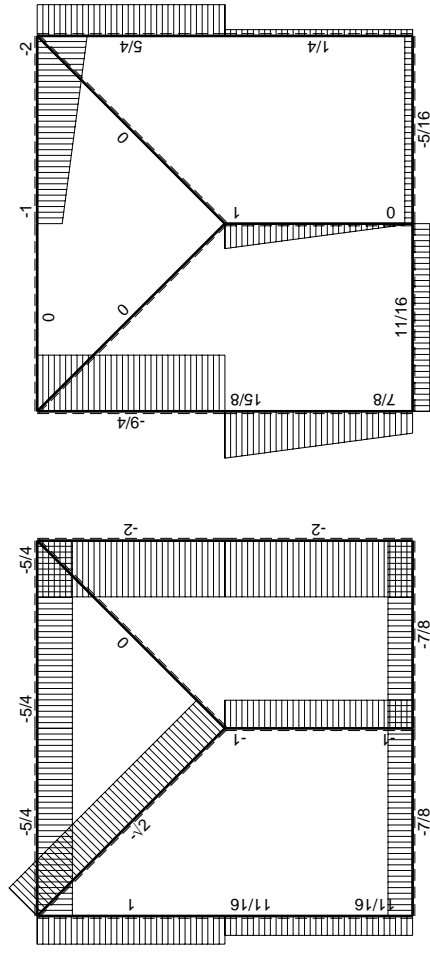
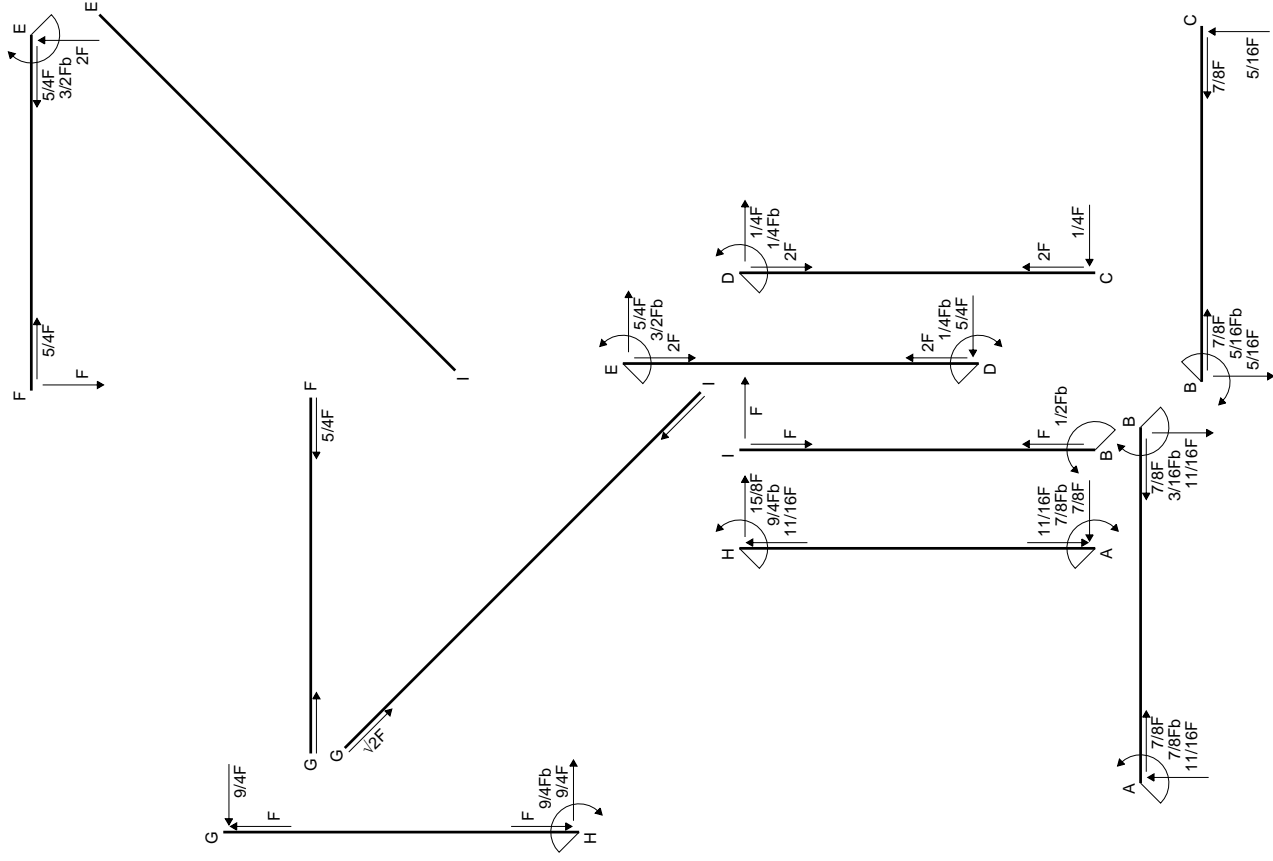
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

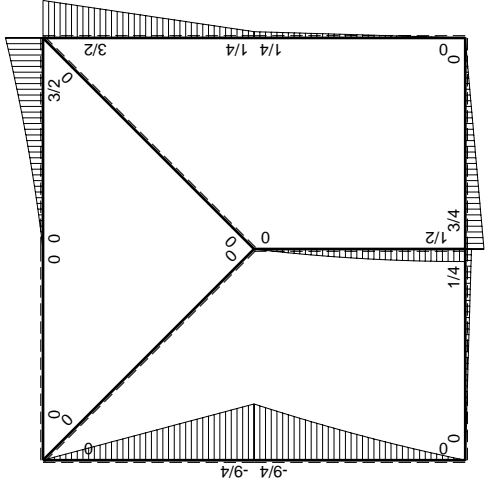
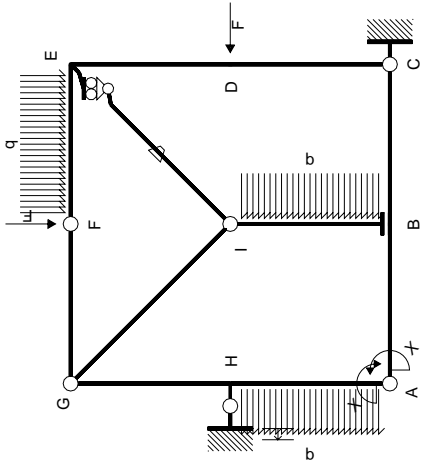
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

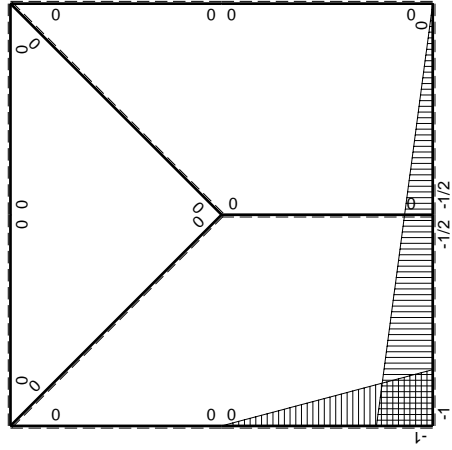


- A = 1008. mm<sup>2</sup>
- J<sub>u</sub> = 290654. mm<sup>4</sup>
- J<sub>v</sub> = 81216. mm<sup>4</sup>
- y<sub>g</sub> = 23.29 mm
- N = 1530. N
- T<sub>y</sub> = -3443. N
- M<sub>x</sub> = -2065500. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.71 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 219.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 44. mm
- v<sub>c</sub> = 20.71 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 148.7 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.015 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 149. N/mm<sup>2</sup>
- S = 5081. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{AB}^{x_0} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

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

$$L_{BA}^{x_0} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

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

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

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

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

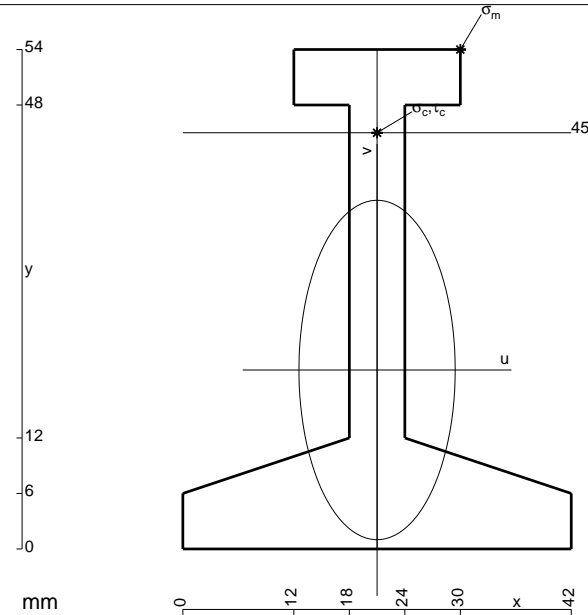
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{x_0} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

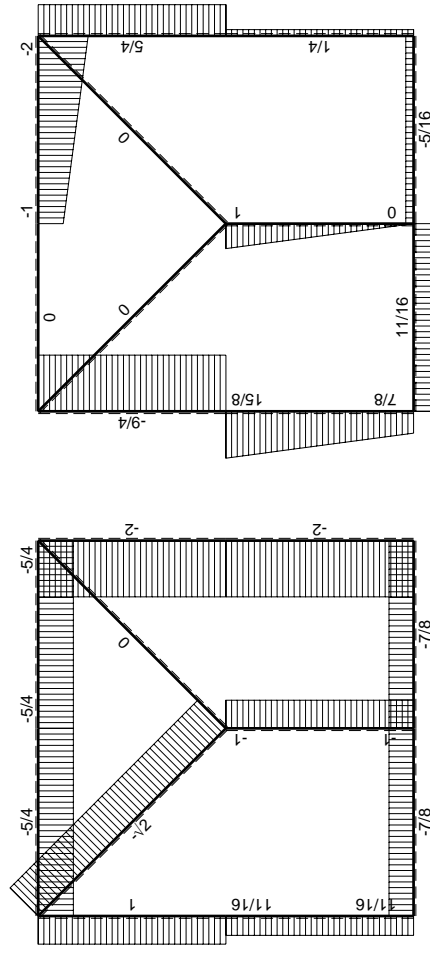
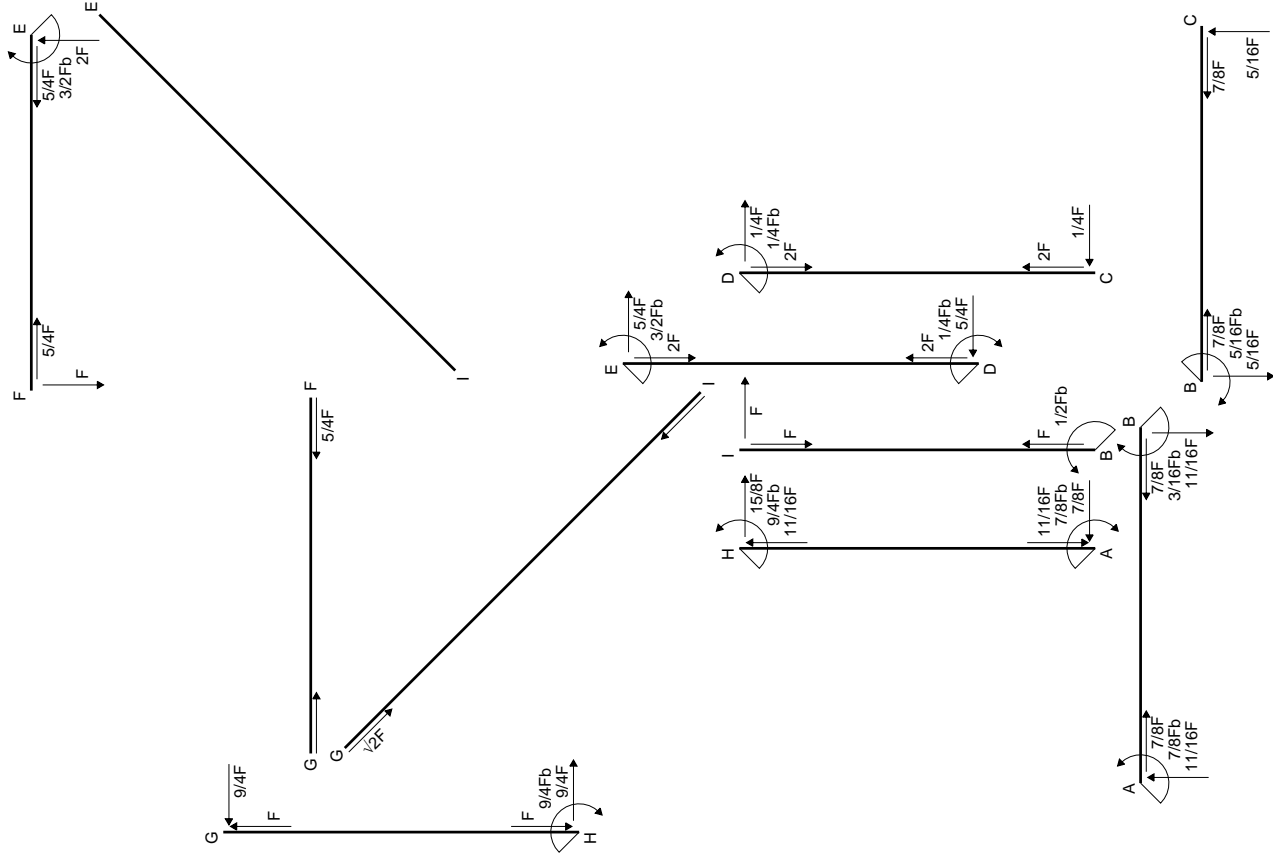
$$L_{AH}^{x_0} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



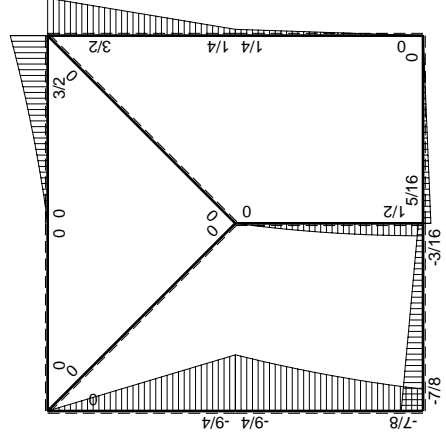
- A = 720. mm<sup>2</sup>
- J<sub>u</sub> = 242552. mm<sup>4</sup>
- J<sub>v</sub> = 51408. mm<sup>4</sup>
- y<sub>g</sub> = 19.35 mm
- N = 1090. N
- T<sub>y</sub> = -2453. N
- M<sub>x</sub> = -1594130. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 34.65 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 229.2 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 45. mm
- v<sub>c</sub> = 25.65 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 170.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.584 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 170.5 N/mm<sup>2</sup>
- S = 3907. mm<sup>3</sup>



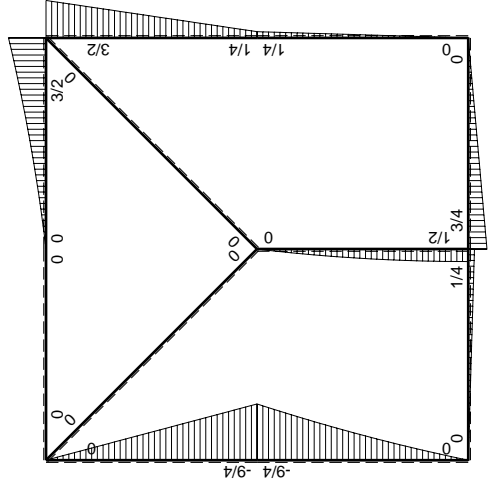
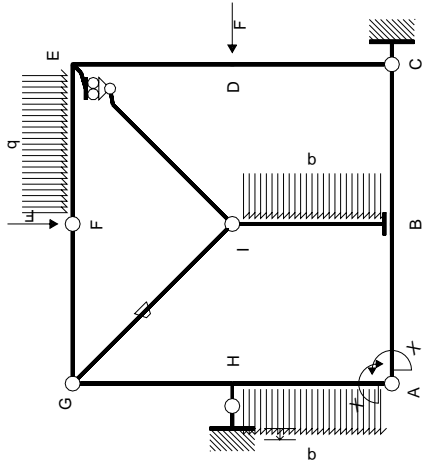


← ⊕ → F

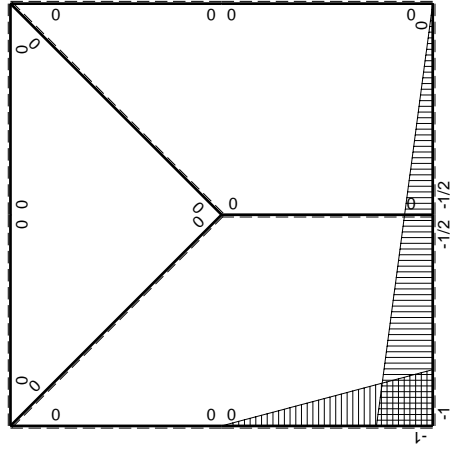
↑ ⊕ ↓ F



← ⊕ → Fb



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

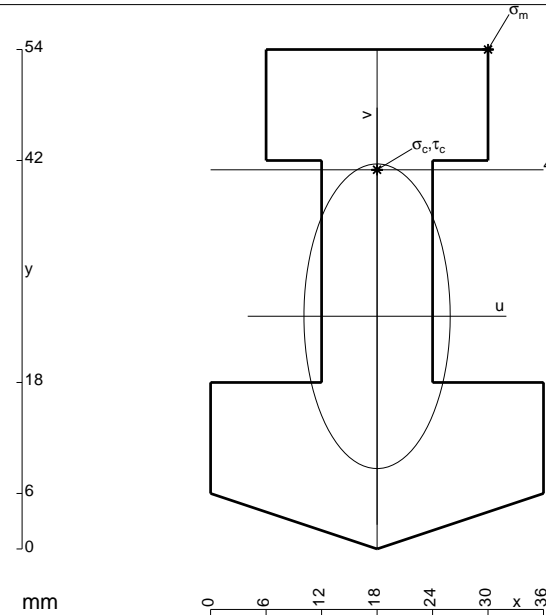
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

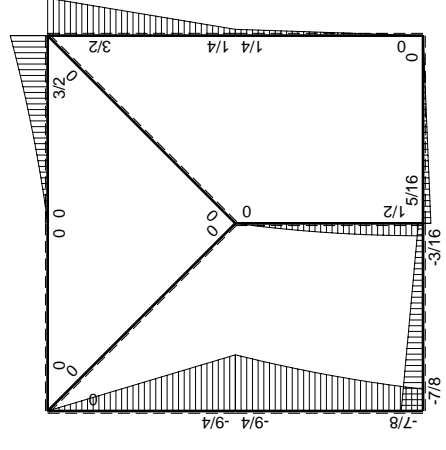
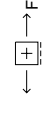
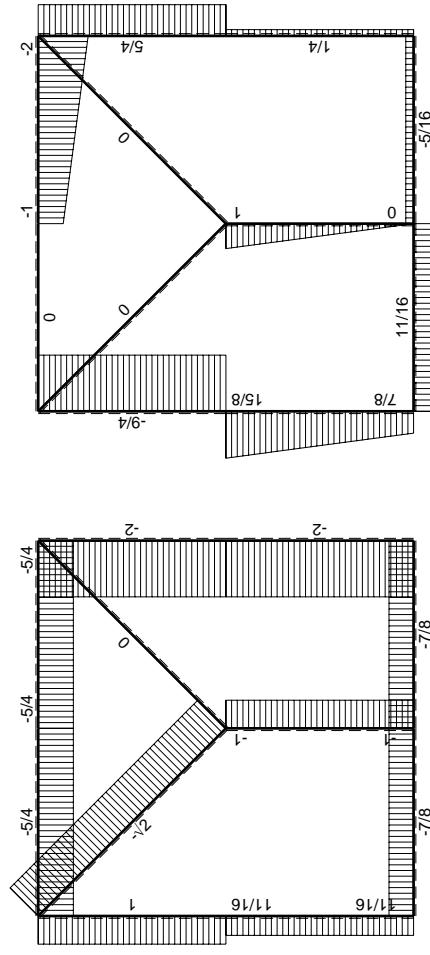
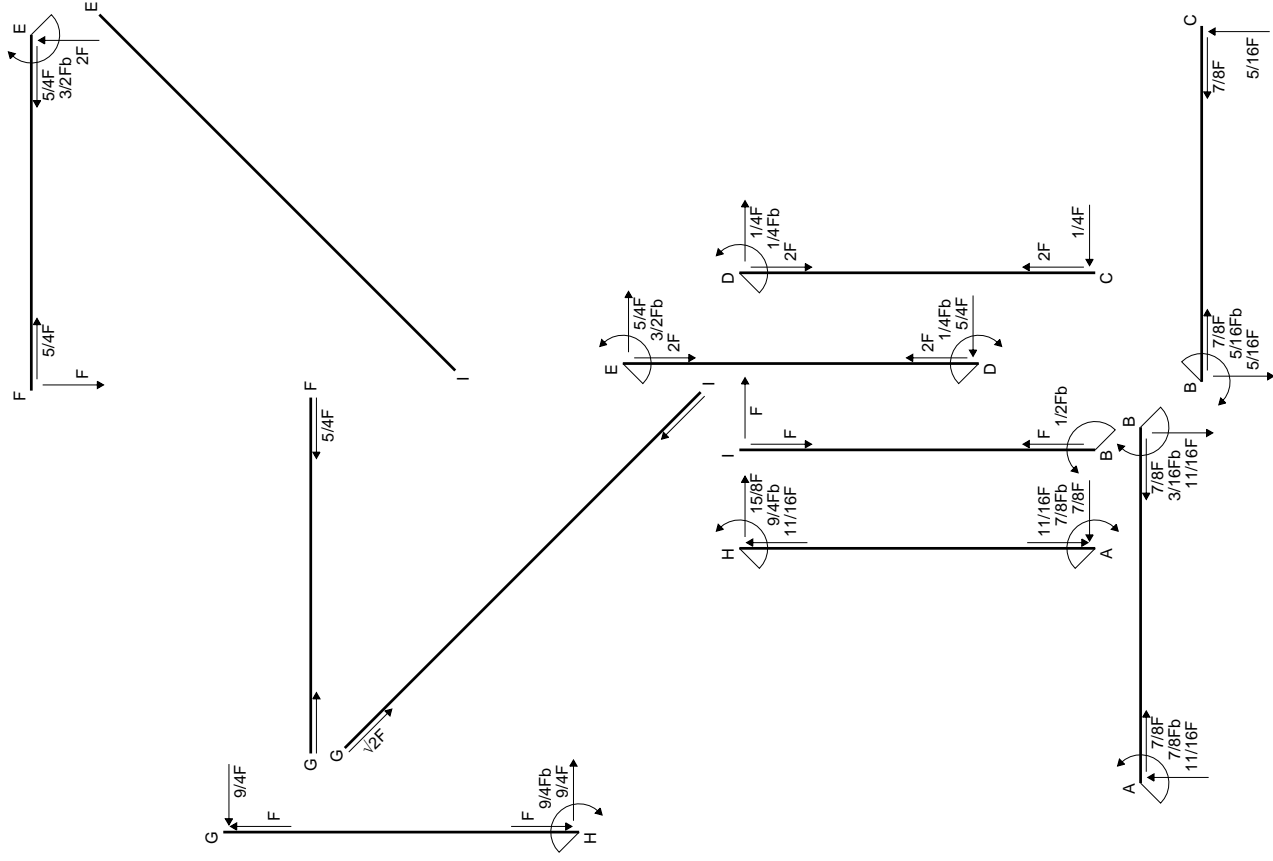
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

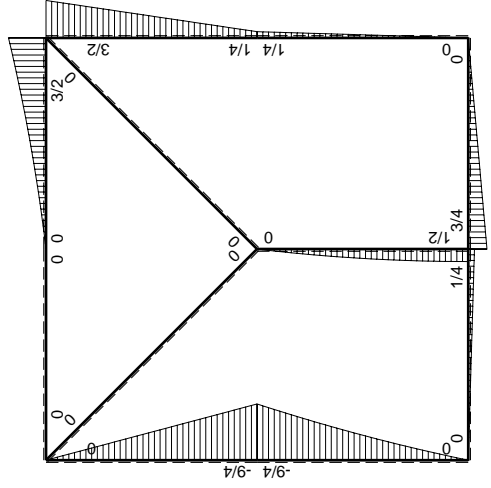
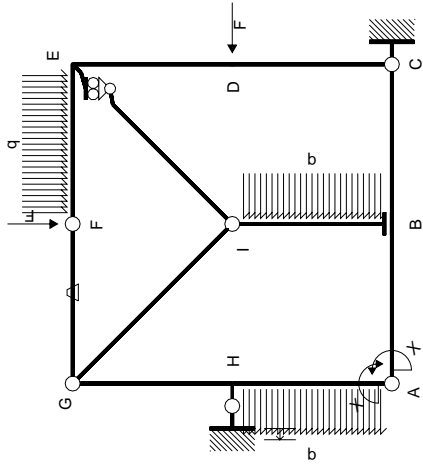
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

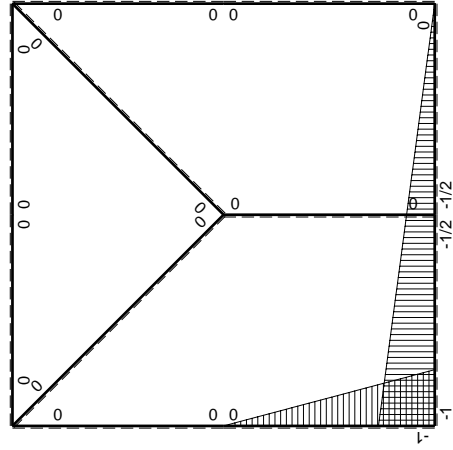


- A = 1116. mm<sup>2</sup>
- J<sub>u</sub> = 302839. mm<sup>4</sup>
- J<sub>v</sub> = 69768. mm<sup>4</sup>
- y<sub>g</sub> = 25.16 mm
- N = 1590. N
- T<sub>y</sub> = -3578. N
- M<sub>x</sub> = -2504250. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.84 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 239.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 15.84 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 132.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.668 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 132.9 N/mm<sup>2</sup>
- S = 6774. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	0	0	0	0			
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
GF b	0	0	$Fb/EJ$	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

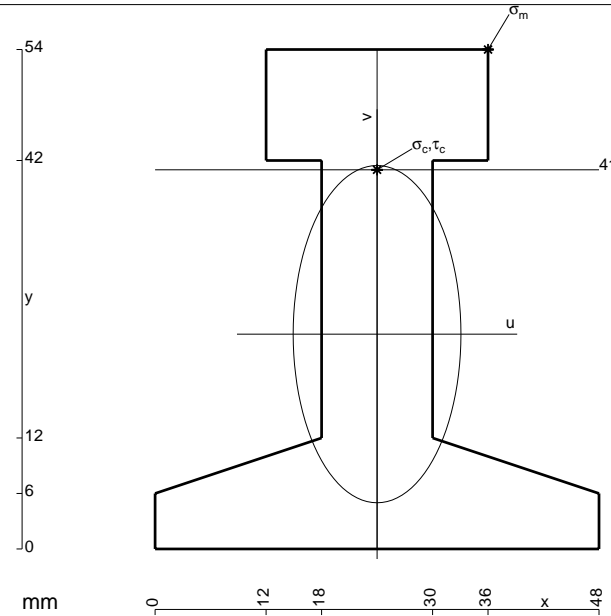
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

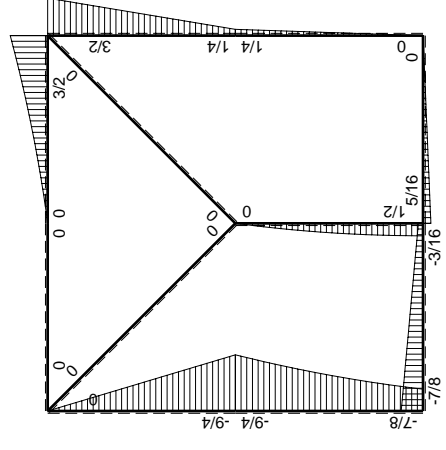
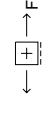
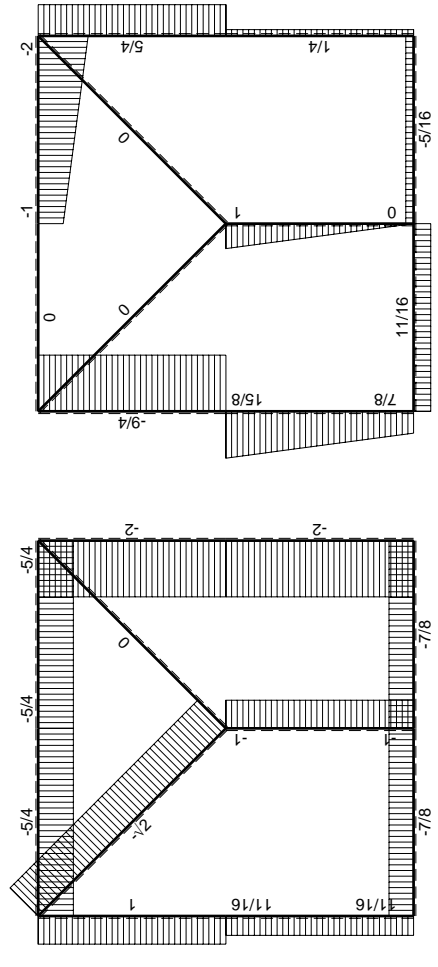
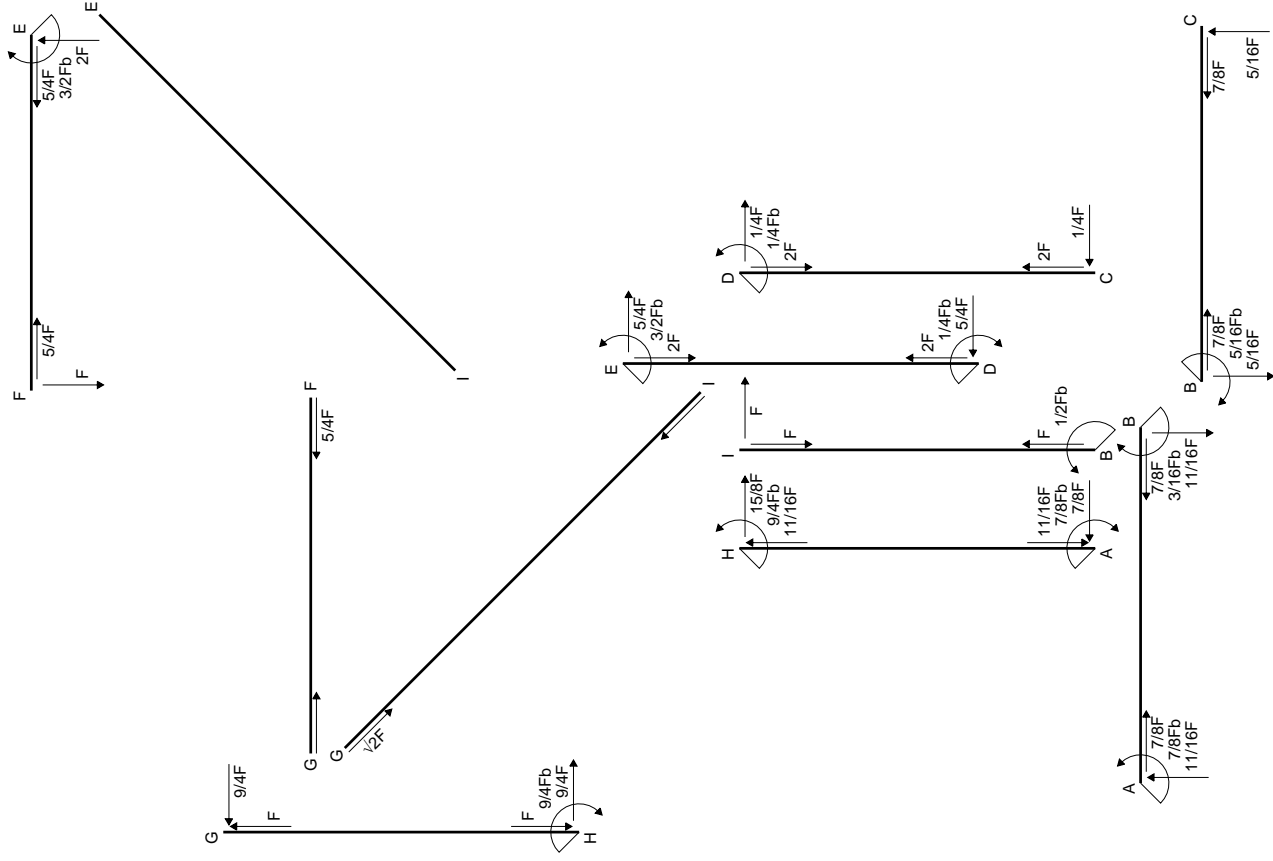
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

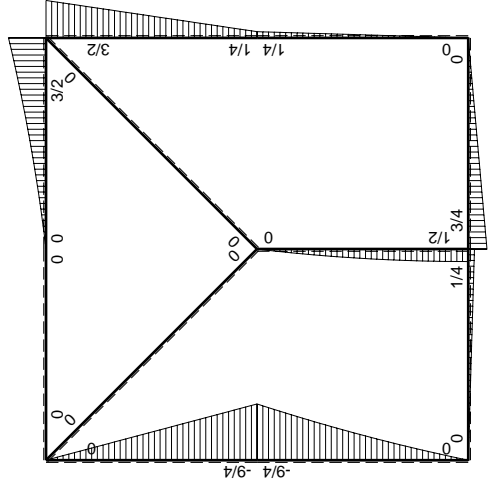
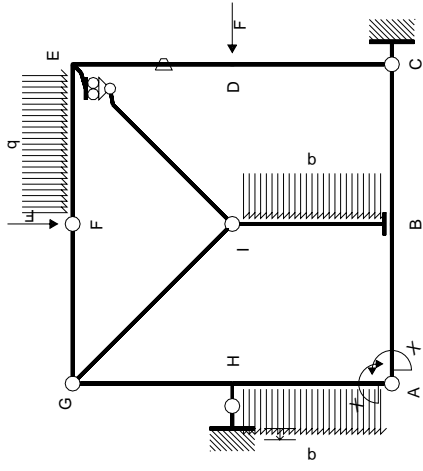
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



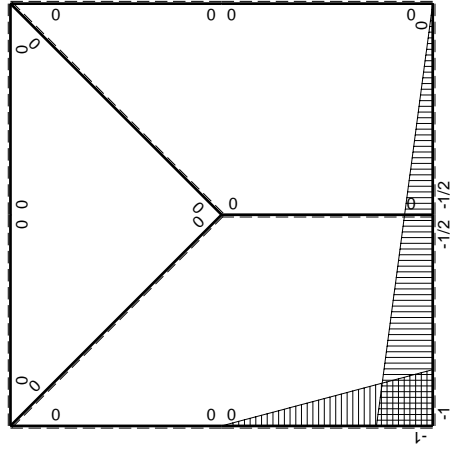
- A = 1116. mm<sup>2</sup>
- J<sub>u</sub> = 371067. mm<sup>4</sup>
- J<sub>v</sub> = 91800. mm<sup>4</sup>
- y<sub>g</sub> = 23.23 mm
- N = 1410. N
- T<sub>y</sub> = -3173. N
- M<sub>x</sub> = -2379380. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.77 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 198.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 17.77 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 115.2 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.24 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 115.6 N/mm<sup>2</sup>
- S = 7354. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	$Fb/EJ$	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

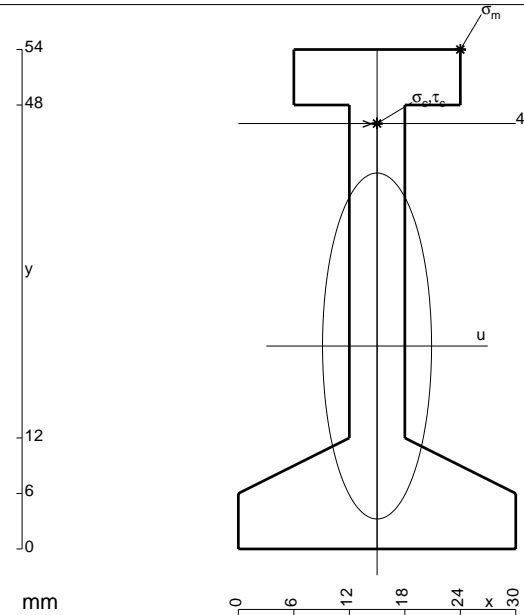
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



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

$$J_u = 214270. \text{ mm}^4$$

$$J_v = 21276. \text{ mm}^4$$

$$y_g = 21.94 \text{ mm}$$

$$N = 770. \text{ N}$$

$$T_y = -1733. \text{ N}$$

$$M_x = -1386000. \text{ Nmm}$$

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

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

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

$$v_m = 32.06 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = 208.6 \text{ N/mm}^2$$

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

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

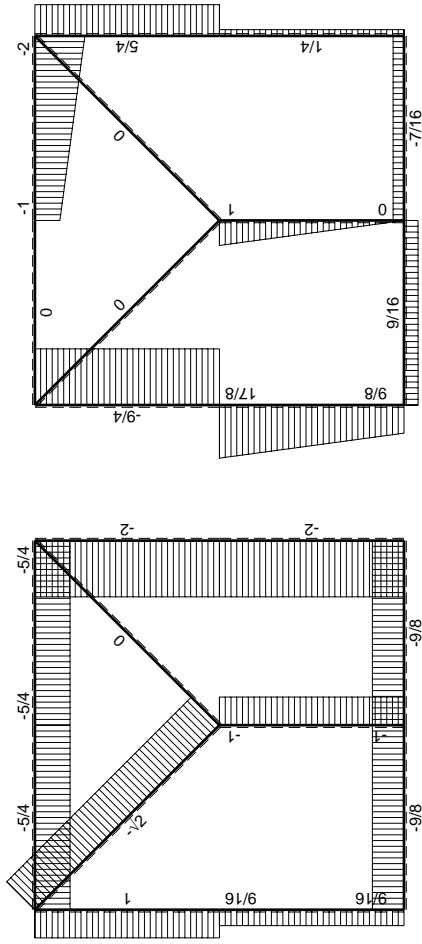
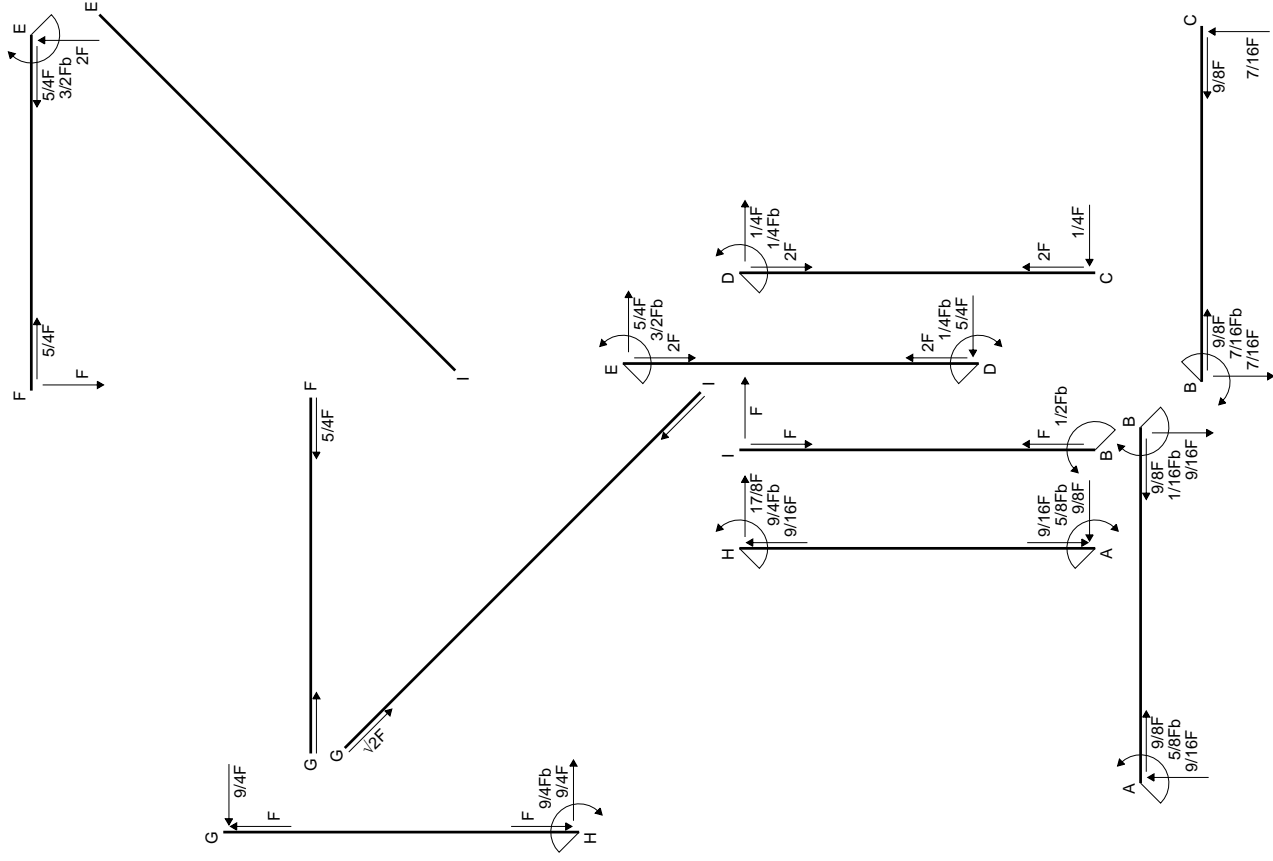
$$v_c = 24.06 \text{ mm}$$

$$\sigma_c = N/A - Mv/J_u = 156.9 \text{ N/mm}^2$$

$$\tau_c = 4.634 \text{ N/mm}^2$$

$$\sigma_\rho = \sqrt{\sigma^2 + 3\tau^2} = 157.1 \text{ N/mm}^2$$

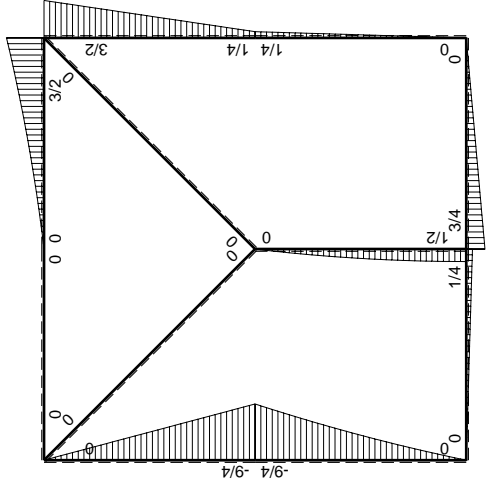
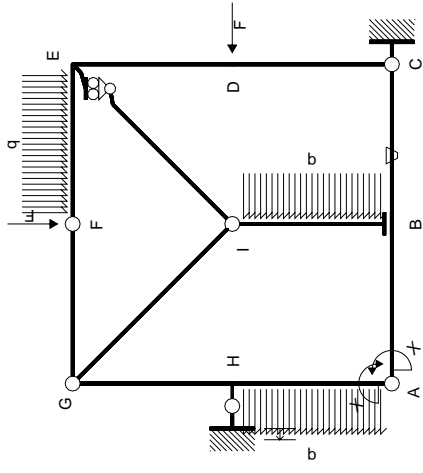
$$S = 3439. \text{ mm}^3$$



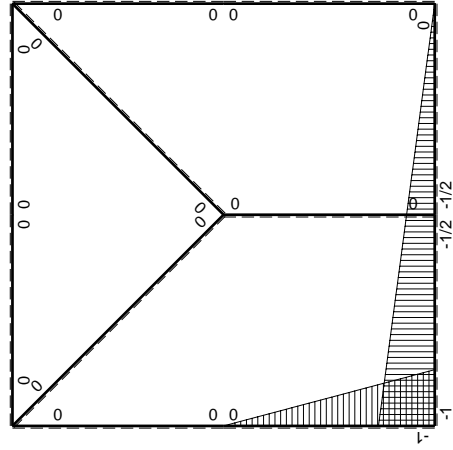
← ⊕ → F

↑ ⊕ ↓ F

⊕ Fb



$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	$-Fb/EJ$	$-3/8Fb+3/4Fx-3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	$Fb/EJ$	$-3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{AB}^{x_0} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = \left[ -1/8 x^2/b + 1/24 x^3/b^2 \right]_0^b Fb 1/EJ$$

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

$$L_{BA}^{x_0} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = \left[ -1/8 x + 1/24 x^3/b^2 \right]_0^b Fb 1/EJ$$

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

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

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

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

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

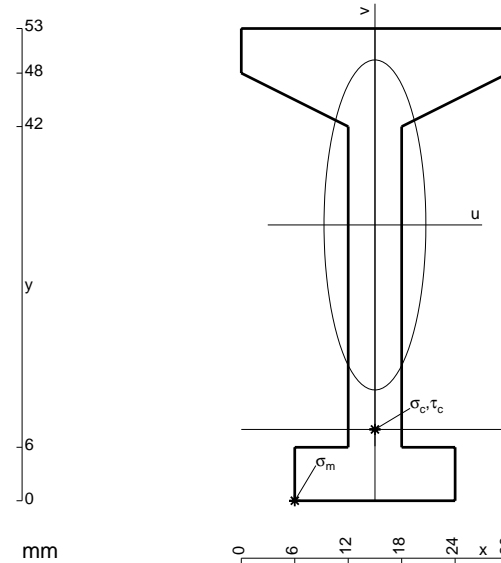
$$= (-1/8 b) Fb 1/EJ + (-1/4 b) \theta = 1/8 Fb^2/EJ$$

$$L_{HA}^{x_0} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{AH}^{x_0} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



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

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

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

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

$$N = 760. \text{ N}$$

$$T_y = -1710. \text{ N}$$

$$M_x = -1419300. \text{ Nmm}$$

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

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

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

$$\sigma_m = N/A - Mv/J_u = -218.6 \text{ N/mm}^2$$

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

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

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

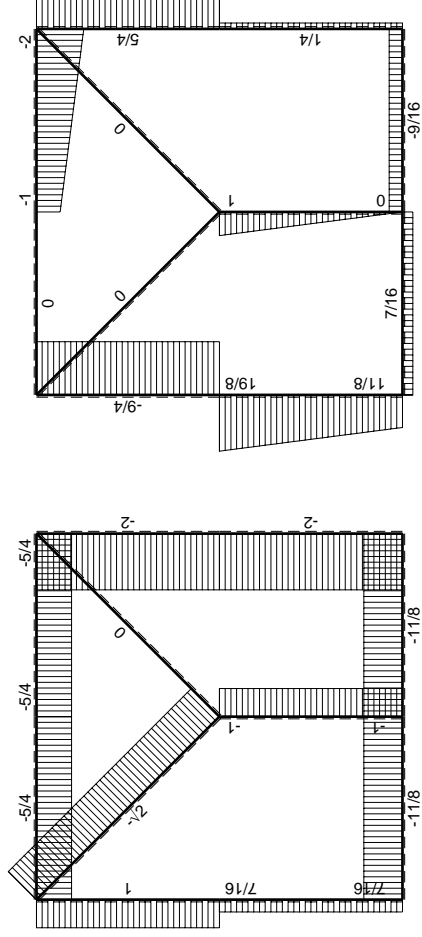
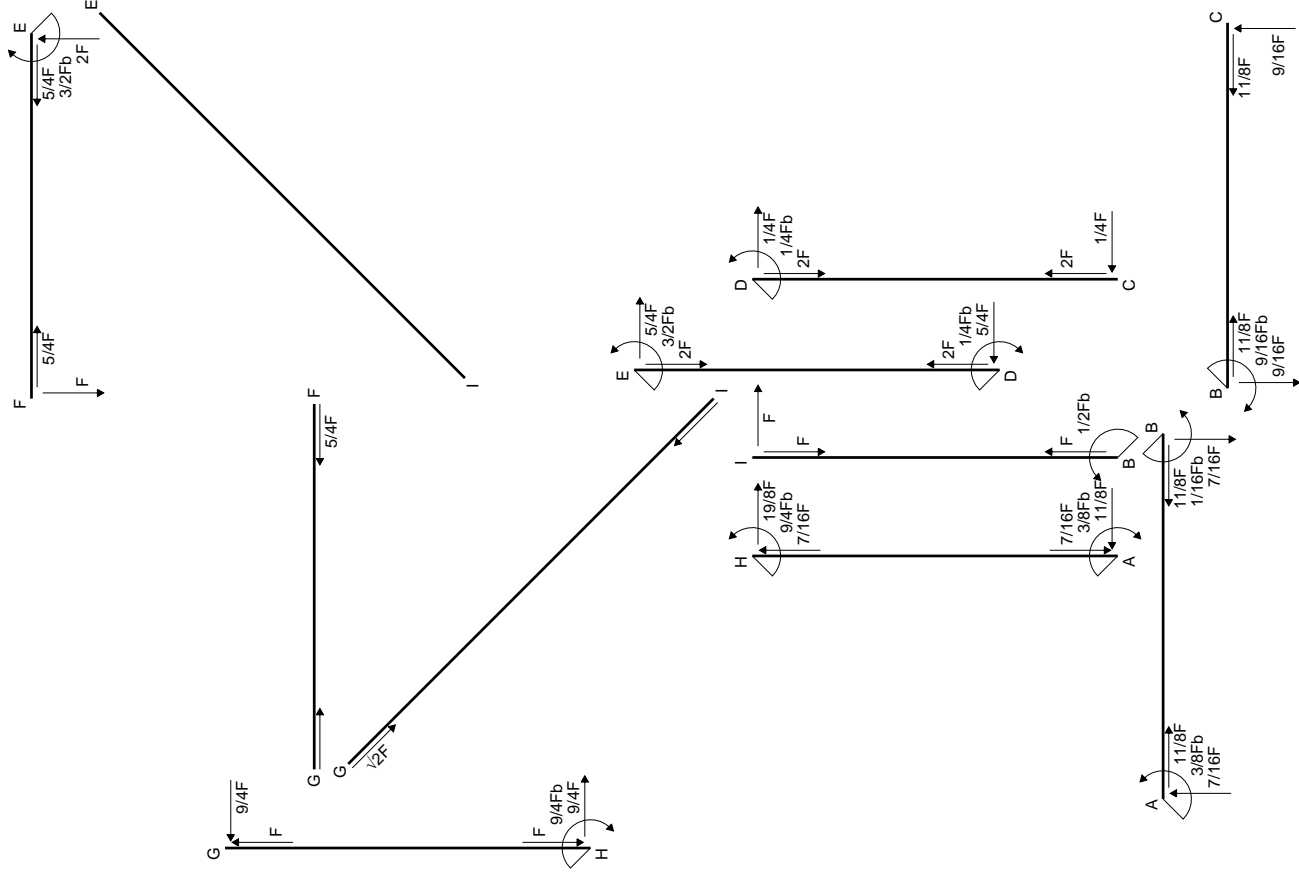
$$\sigma_c = N/A - Mv/J_u = -161.8 \text{ N/mm}^2$$

$$\tau_c = 4.717 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 162. \text{ N/mm}^2$$

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

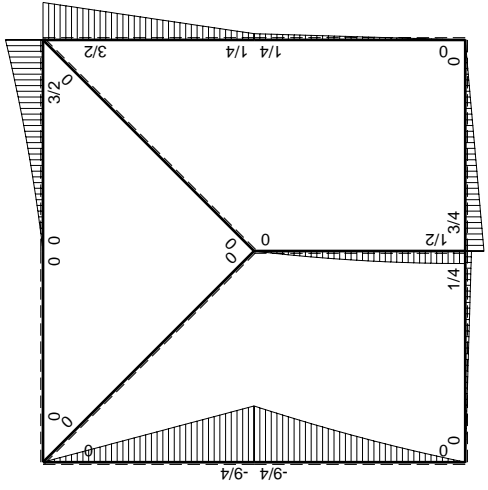
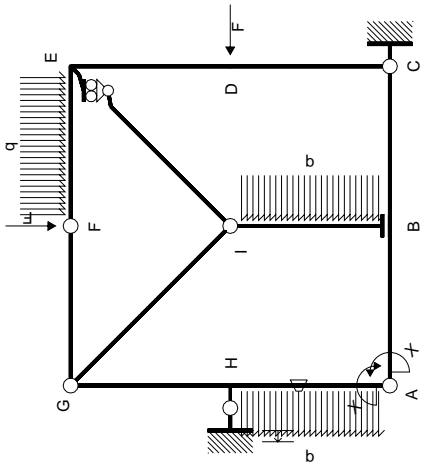




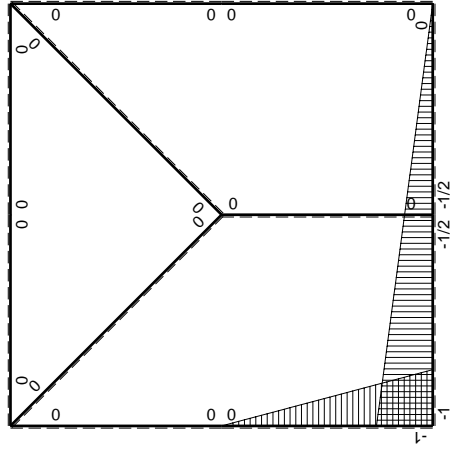
← ⊕ → F

⊕ ↓ F

⊕ ⊕ Fb



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	$-Fb/EJ$	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	$Fx/EJ$	$x^2/b^2$	$(1/3+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	$Fb/EJ$	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

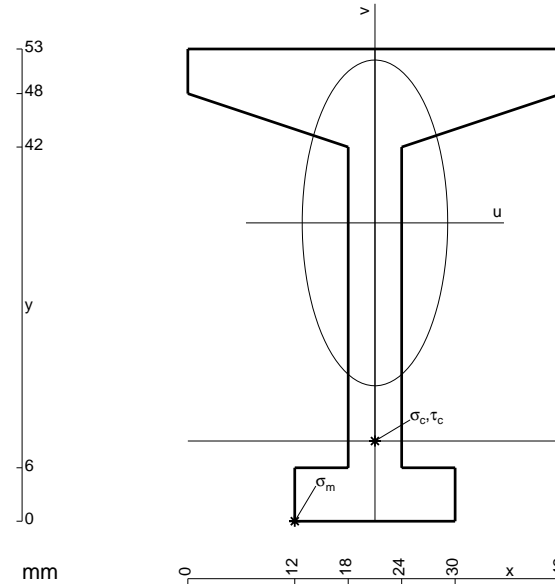
$$= \left[ 9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ + \left[ 1/2 x^2/b \right]_0^b \theta$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 5/6 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= \left[ 7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ + \left[ -x + 1/2 x^2/b \right]_0^b \theta$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 5/6 Fb^2/EJ$$



$$A = 678. \text{ mm}^2$$

$$J_u = 226700. \text{ mm}^4$$

$$J_v = 45234. \text{ mm}^4$$

$$y_g = 33.48 \text{ mm}$$

$$N = 790. \text{ N}$$

$$T_y = -1778. \text{ N}$$

$$M_x = -1564200. \text{ Nmm}$$

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

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

$$v_m = -33.48 \text{ mm}$$

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

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

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

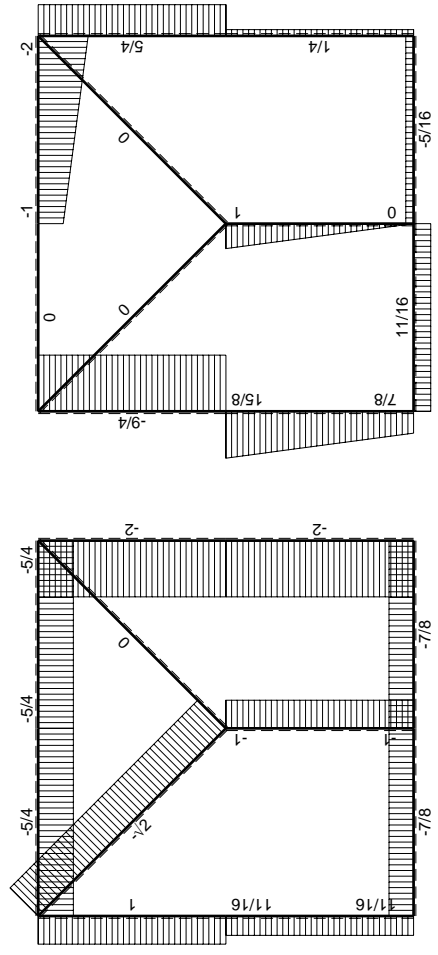
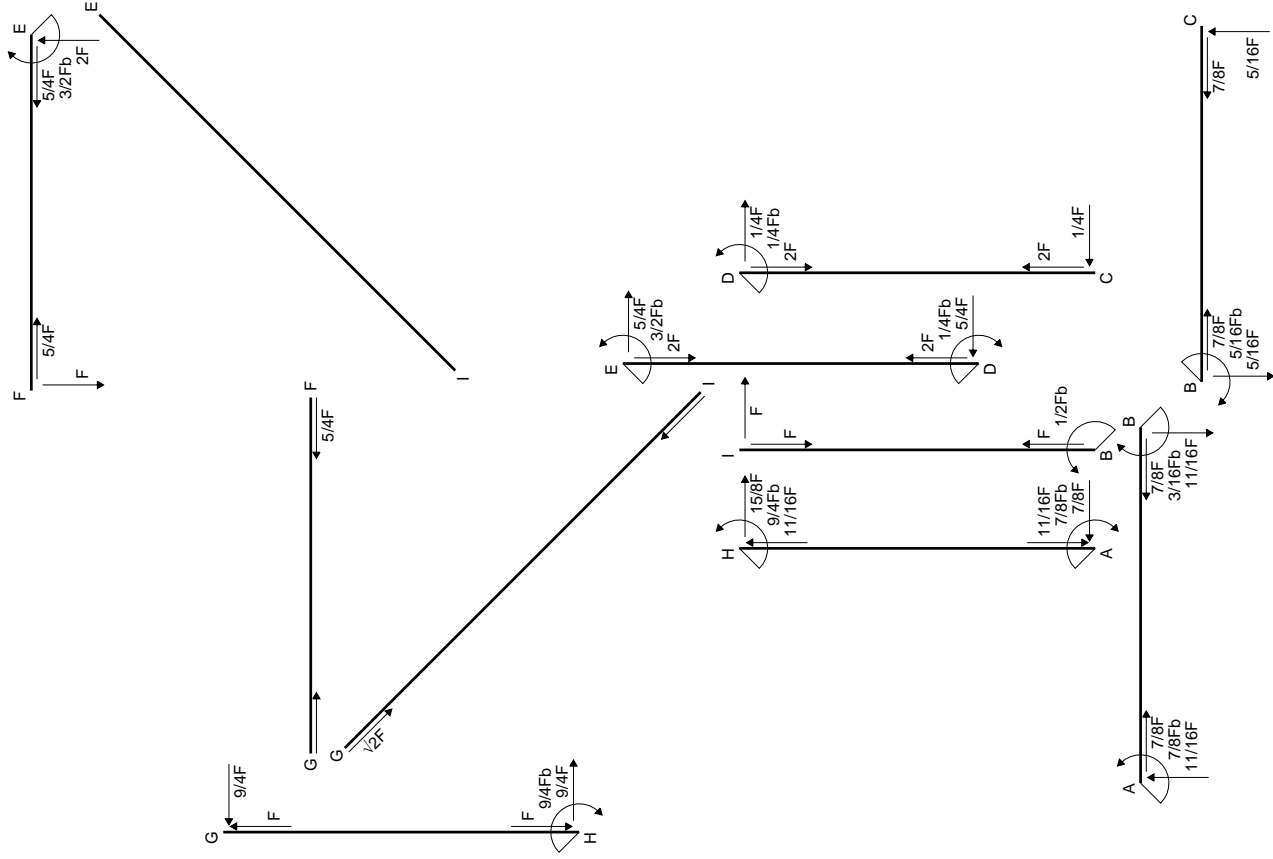
$$v_c = -24.48 \text{ mm}$$

$$\sigma_c = N/A - Mv/J_u = -167.8 \text{ N/mm}^2$$

$$\tau_c = 4.913 \text{ N/mm}^2$$

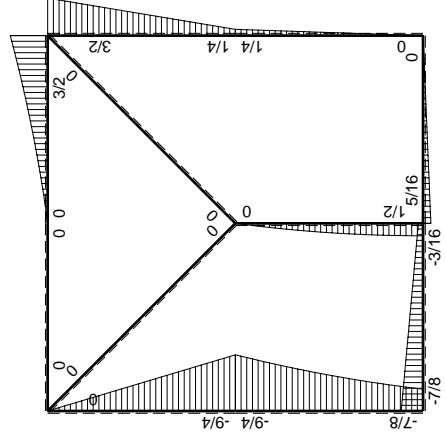
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 168. \text{ N/mm}^2$$

$$S = 3760. \text{ mm}^3$$

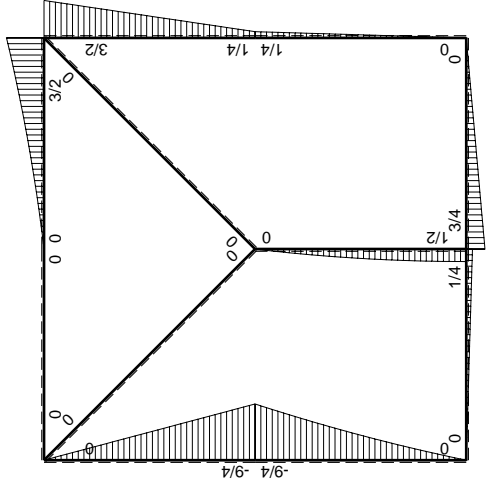
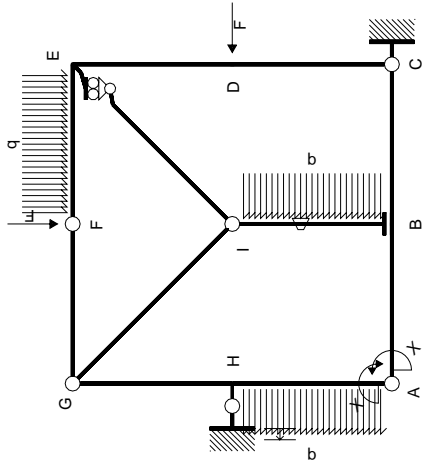


$\left[ \begin{array}{c} + \\ - \end{array} \right] \rightarrow F$

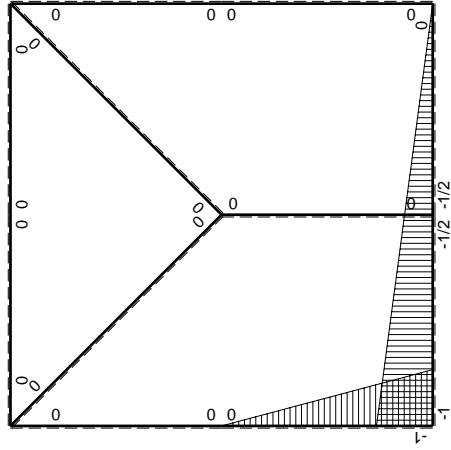
$\left[ \begin{array}{c} + \\ - \end{array} \right] \rightarrow F$



$\left[ \begin{array}{c} + \\ - \end{array} \right] F_b$



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	$Fb/EJ$	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

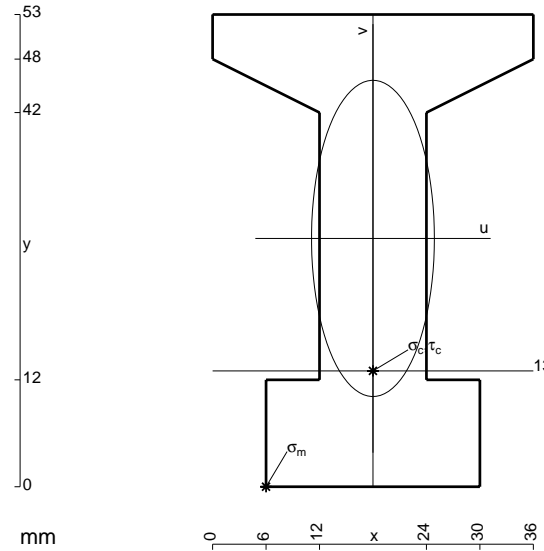
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

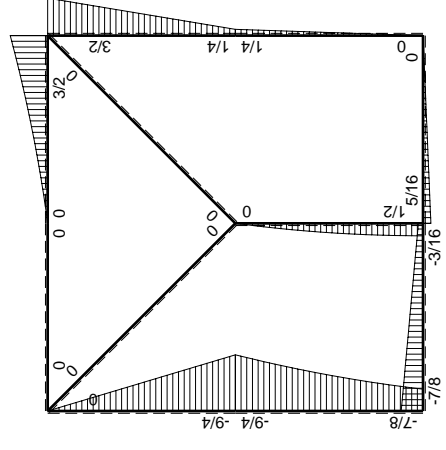
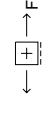
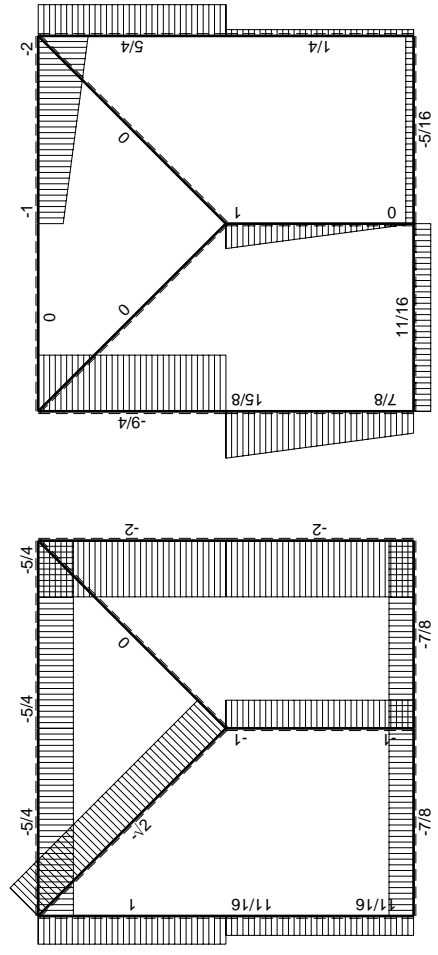
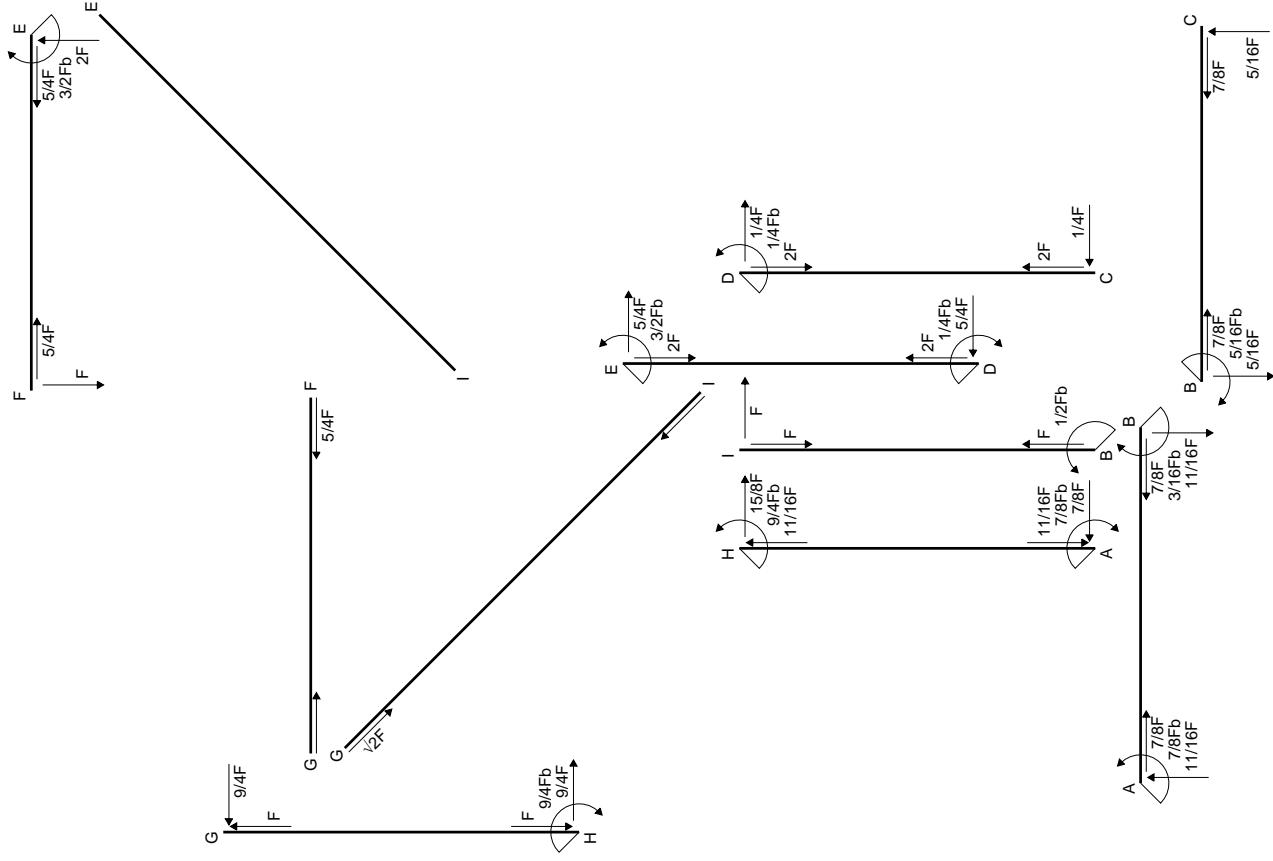
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

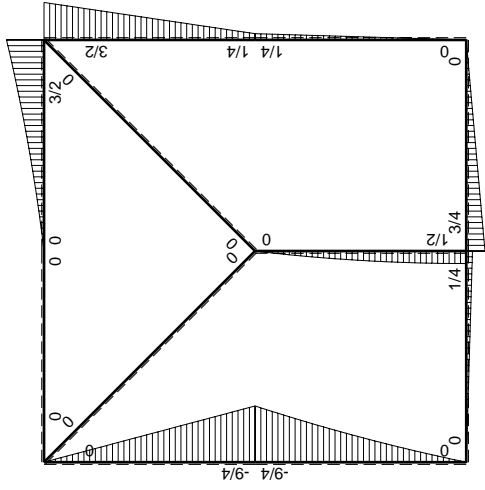
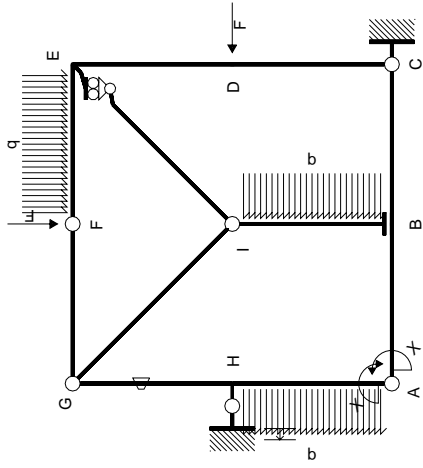
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



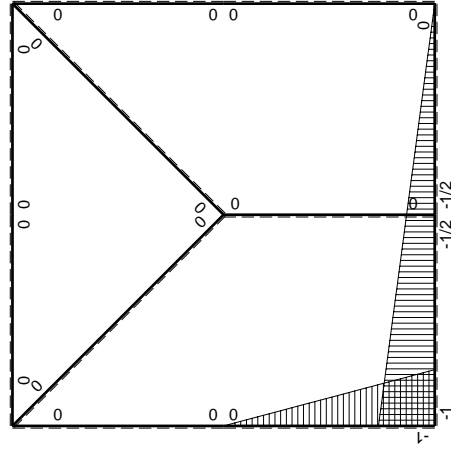
- A = 972. mm<sup>2</sup>
- J<sub>u</sub> = 306188. mm<sup>4</sup>
- J<sub>v</sub> = 46224. mm<sup>4</sup>
- y<sub>g</sub> = 27.87 mm
- N = 1260. N
- T<sub>y</sub> = -2835. N
- M<sub>x</sub> = -2636550. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -27.87 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -238.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -14.87 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -126.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.002 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 127. N/mm<sup>2</sup>
- S = 6483. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	$Fb/EJ$	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

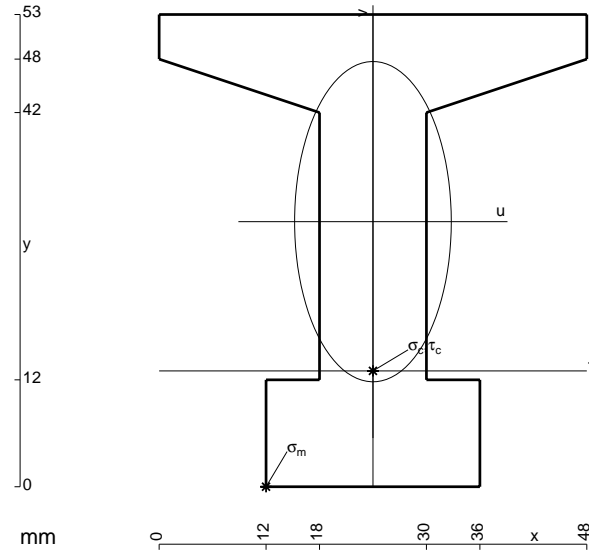
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

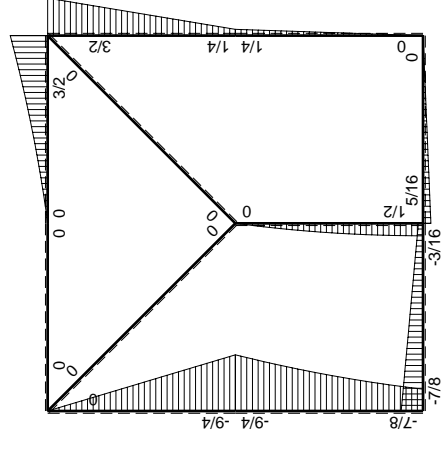
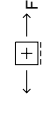
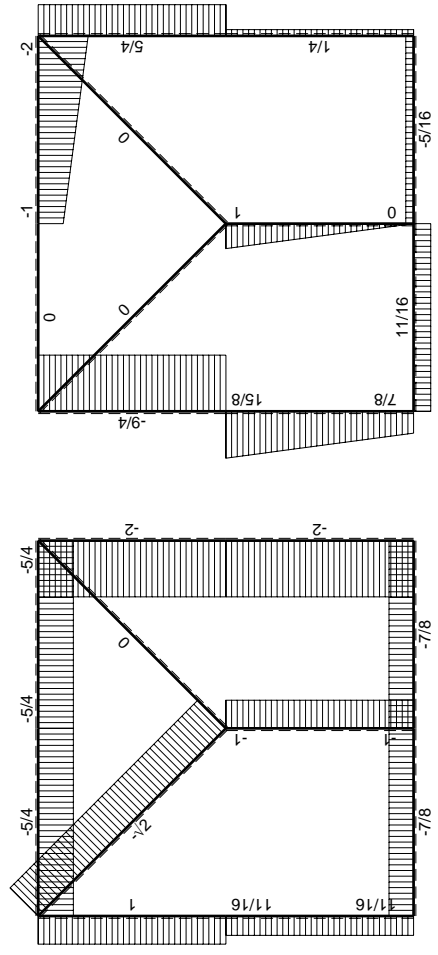
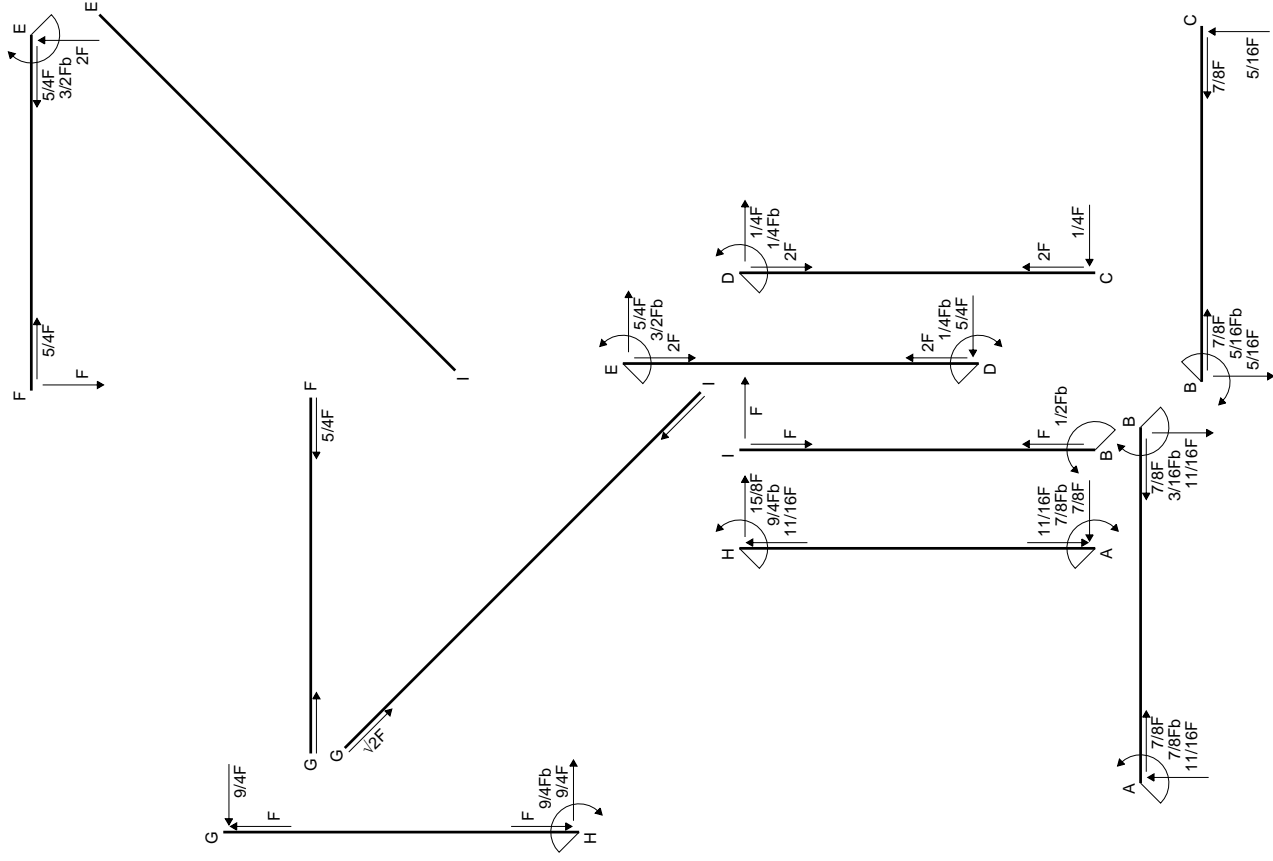
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

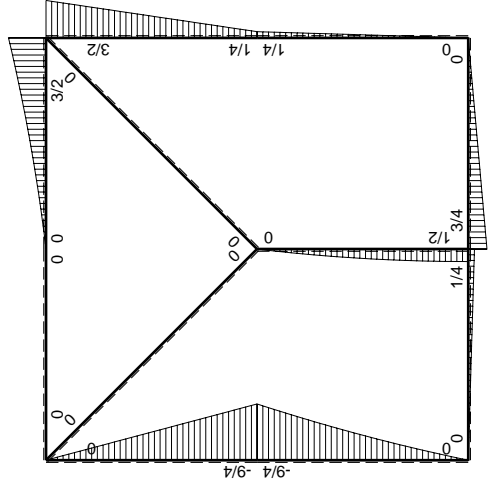
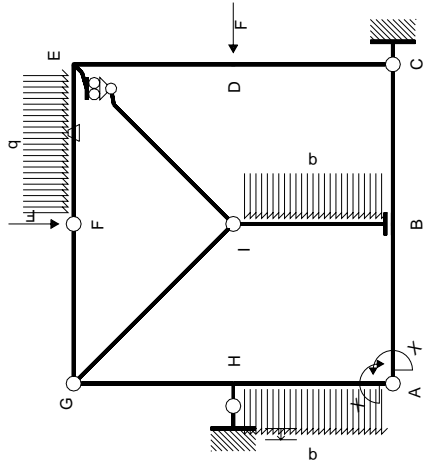
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

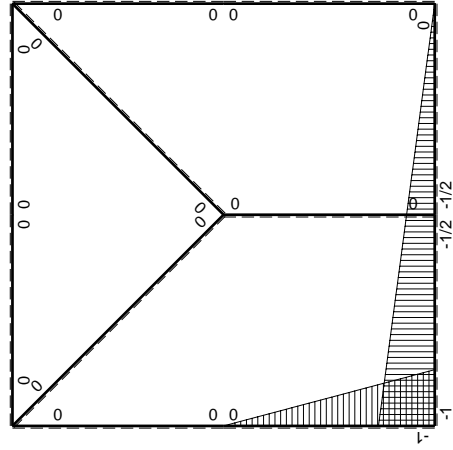


- A = 1068. mm<sup>2</sup>
- J<sub>u</sub> = 345159. mm<sup>4</sup>
- J<sub>v</sub> = 82584. mm<sup>4</sup>
- y<sub>g</sub> = 29.75 mm
- N = 2120. N
- T<sub>y</sub> = -4770. N
- M<sub>x</sub> = -2337300. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -29.75 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -199.5 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -16.75 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -111.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.117 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 112.3 N/mm<sup>2</sup>
- S = 7048. mm<sup>3</sup>





M<sub>0</sub> flessione da carichi assegnati



M<sub>x</sub> flessione da iperstatica X=1

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	$Fb/EJ$	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

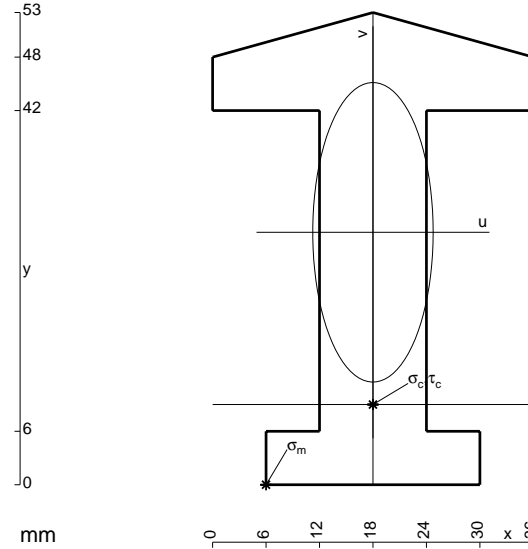
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

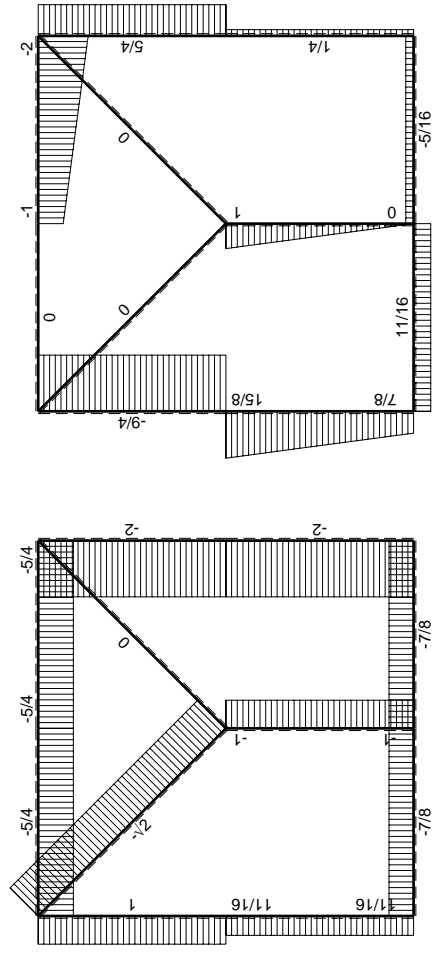
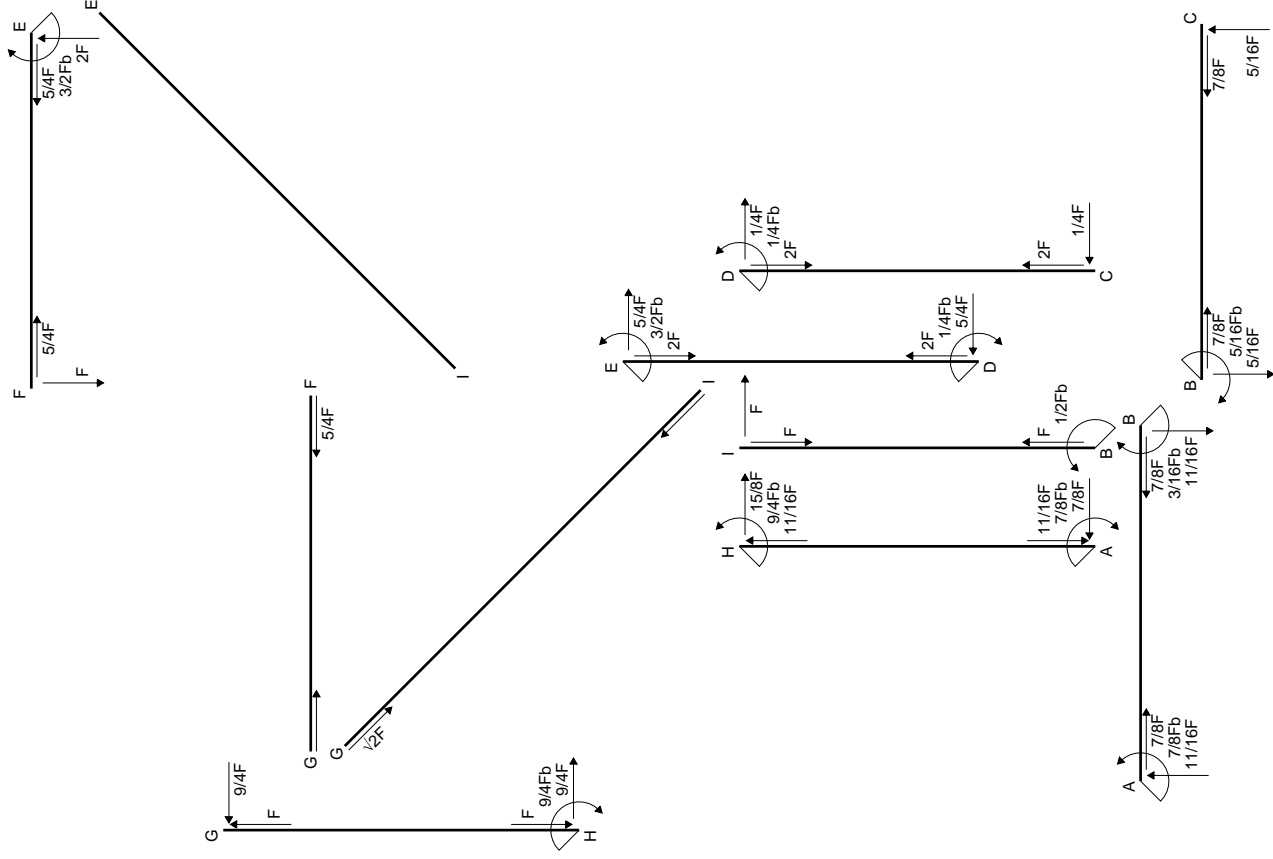
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



- A = 882. mm<sup>2</sup>
- J<sub>u</sub> = 249349. mm<sup>4</sup>
- J<sub>v</sub> = 40284. mm<sup>4</sup>
- y<sub>g</sub> = 28.33 mm
- N = 1560. N
- T<sub>y</sub> = -3510. N
- M<sub>x</sub> = -1860300. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.33 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -209.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -19.33 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -142.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.159 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 142.8 N/mm<sup>2</sup>
- S = 4398. mm<sup>3</sup>

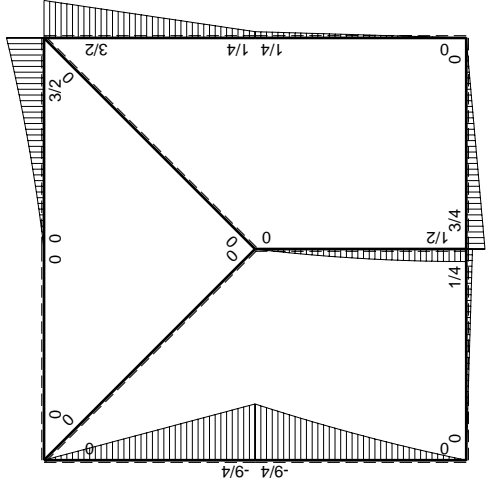
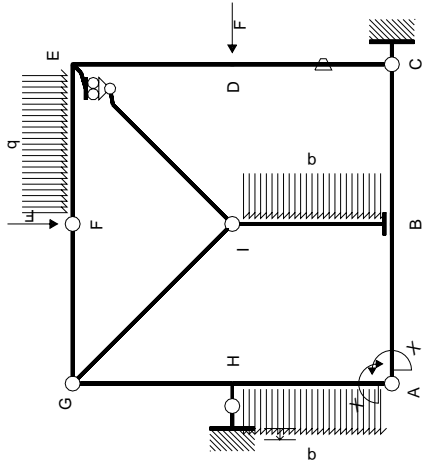




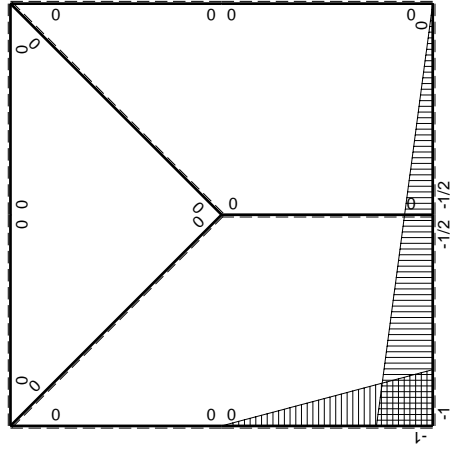
$\left[ \begin{array}{c} + \\ - \end{array} \right] \rightarrow F$

$\left[ \begin{array}{c} + \\ - \end{array} \right] \rightarrow F$

$\left[ \begin{array}{c} + \\ - \end{array} \right] F_b$



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	$Fb/EJ$	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

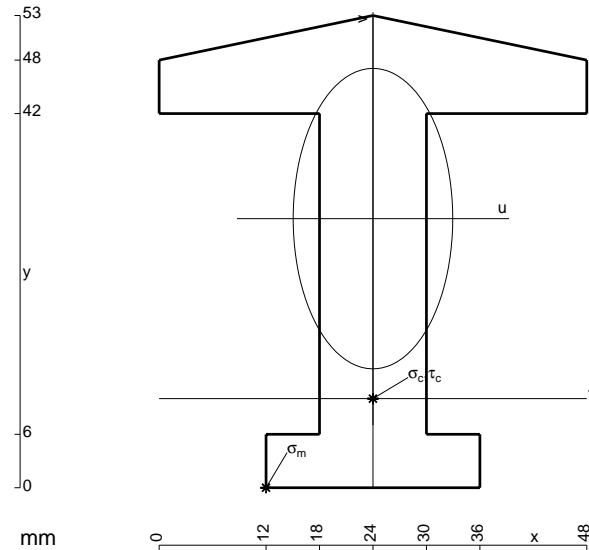
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

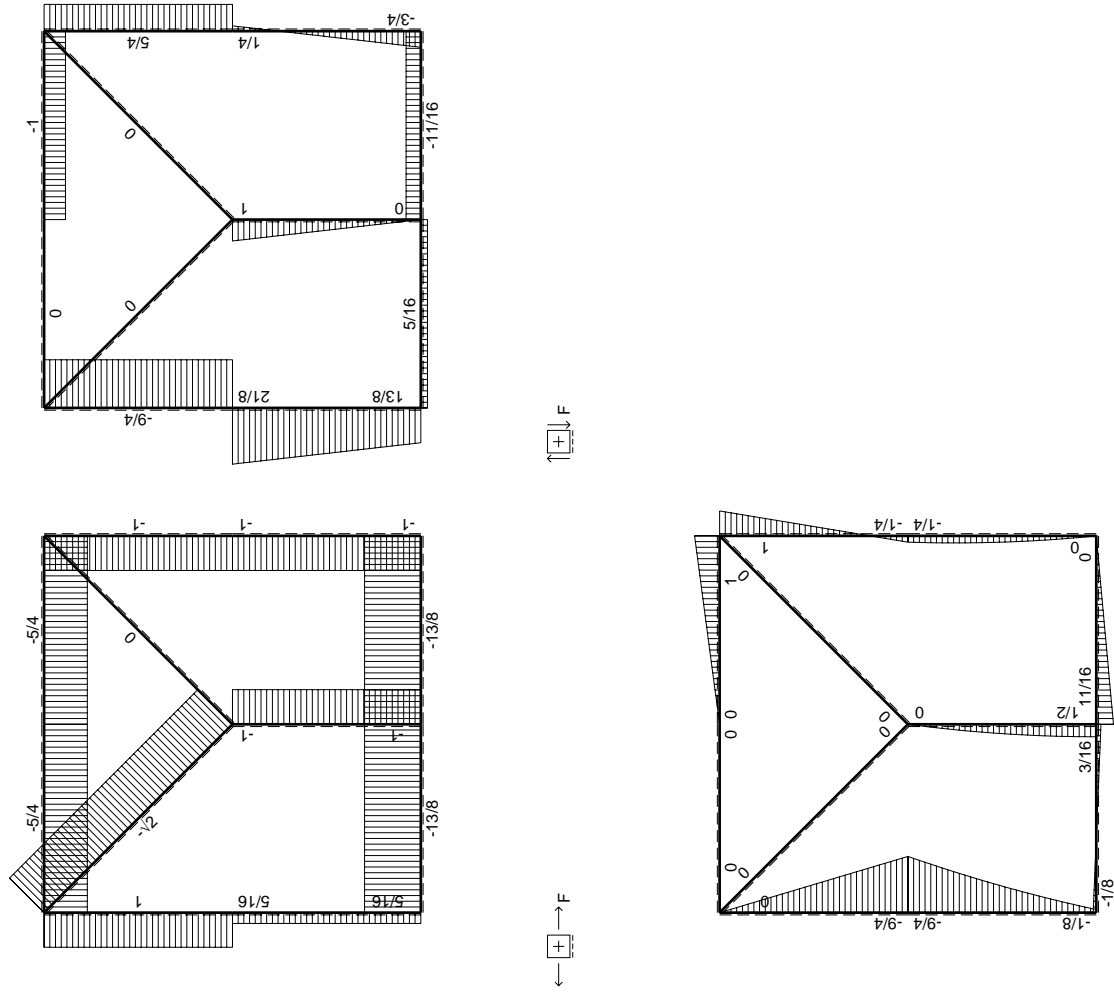
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

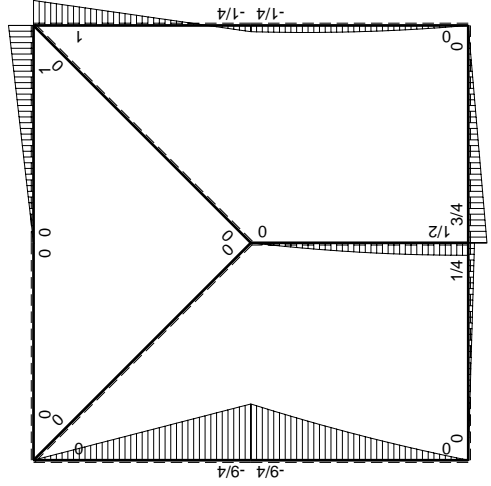
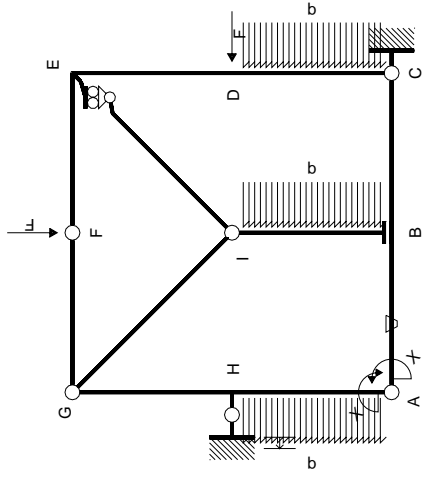
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

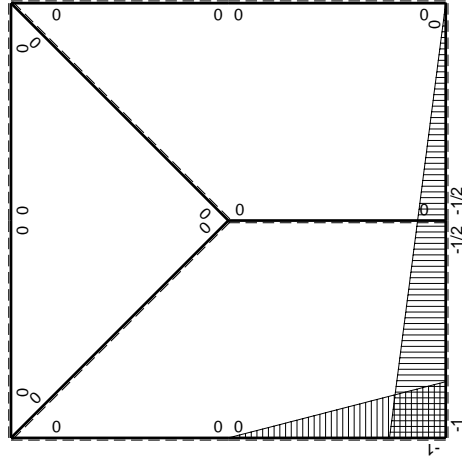


- A = 984. mm<sup>2</sup>
- J<sub>u</sub> = 279819. mm<sup>4</sup>
- J<sub>v</sub> = 78912. mm<sup>4</sup>
- y<sub>g</sub> = 30.2 mm
- N = 1570. N
- T<sub>y</sub> = -3533. N
- M<sub>x</sub> = -2048850. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.2 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -219.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -20.2 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -146.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.242 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 146.6 N/mm<sup>2</sup>
- S = 4983. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	$-Fb/EJ$	$-1/4Fx+1/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-1/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	$Fb/EJ$	$-1/8Fb+1/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

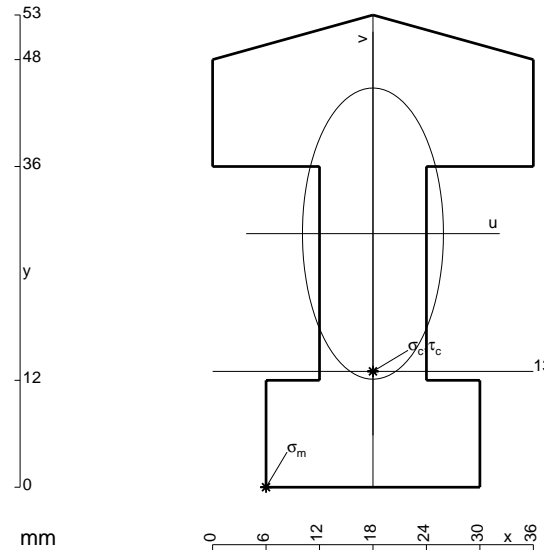
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{x\theta} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

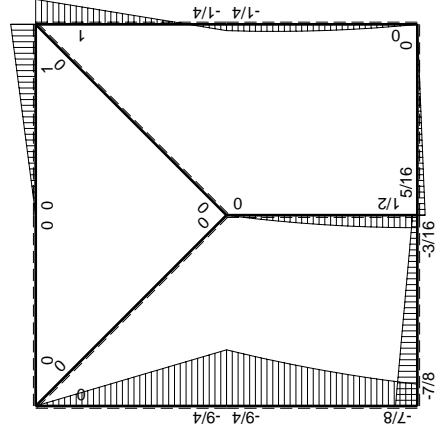
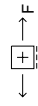
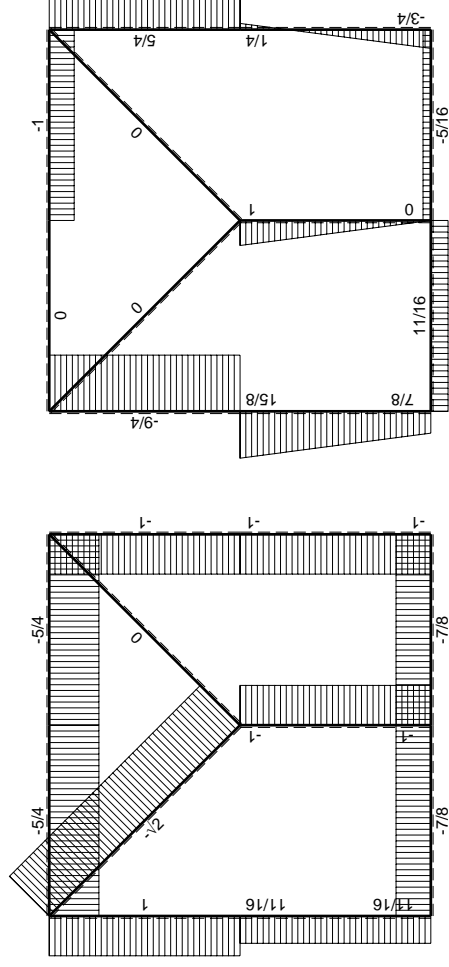
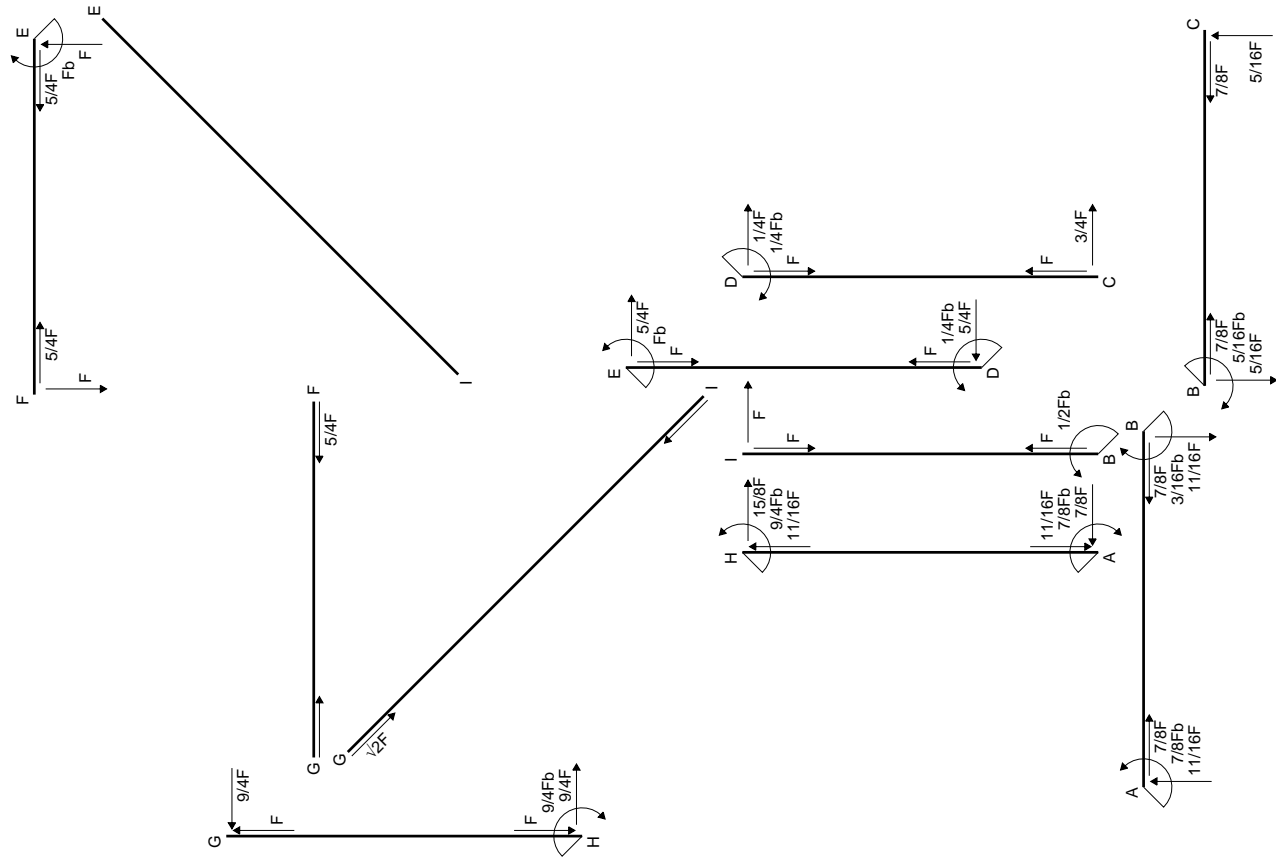
$$L_{AH}^{x\theta} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

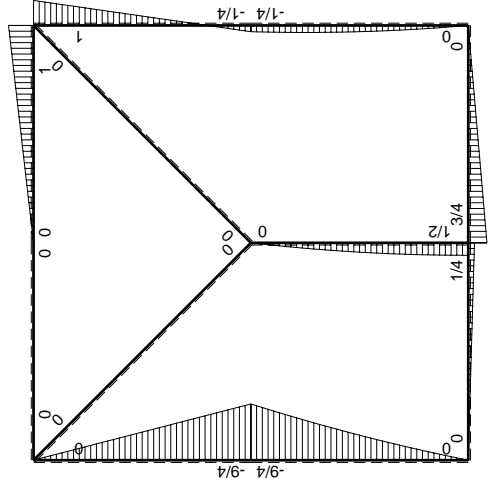
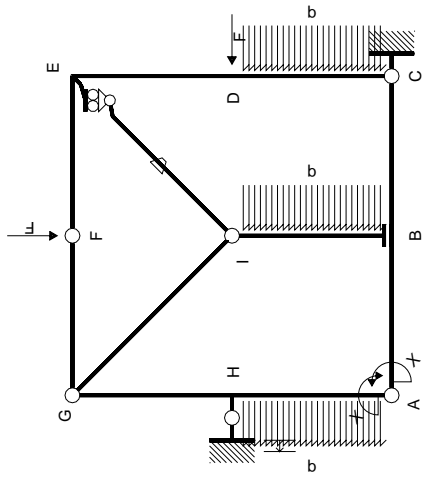
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



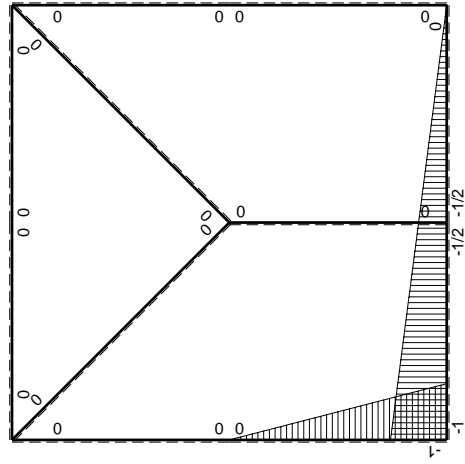
- A = 1098. mm<sup>2</sup>
- J<sub>u</sub> = 293274. mm<sup>4</sup>
- J<sub>v</sub> = 68796. mm<sup>4</sup>
- y<sub>g</sub> = 28.46 mm
- N = 1680. N
- T<sub>y</sub> = -3780. N
- M<sub>x</sub> = -2381400. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.46 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -229.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.46 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -124. N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.155 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 124.7 N/mm<sup>2</sup>
- S = 6661. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

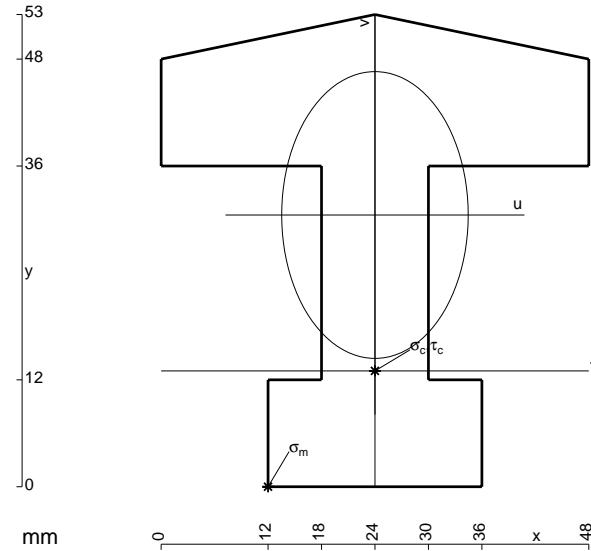
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

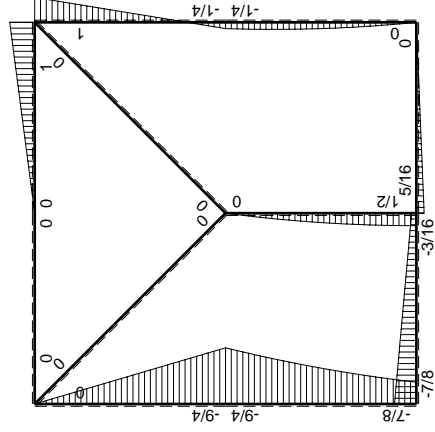
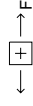
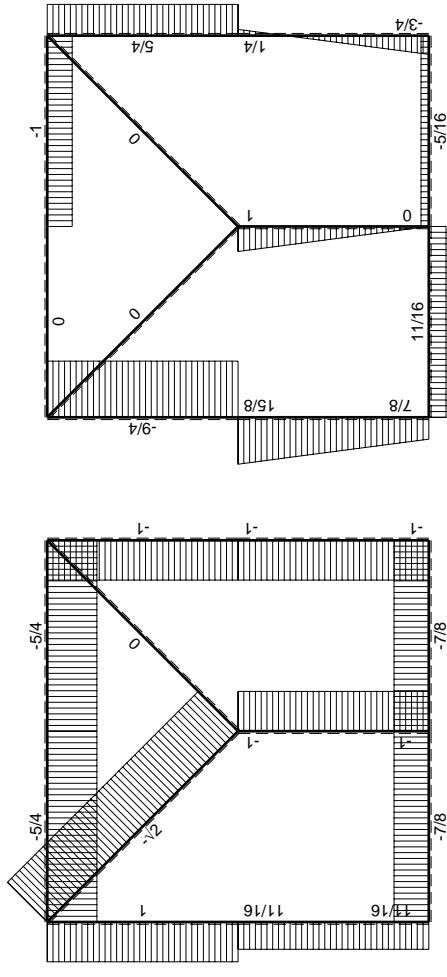
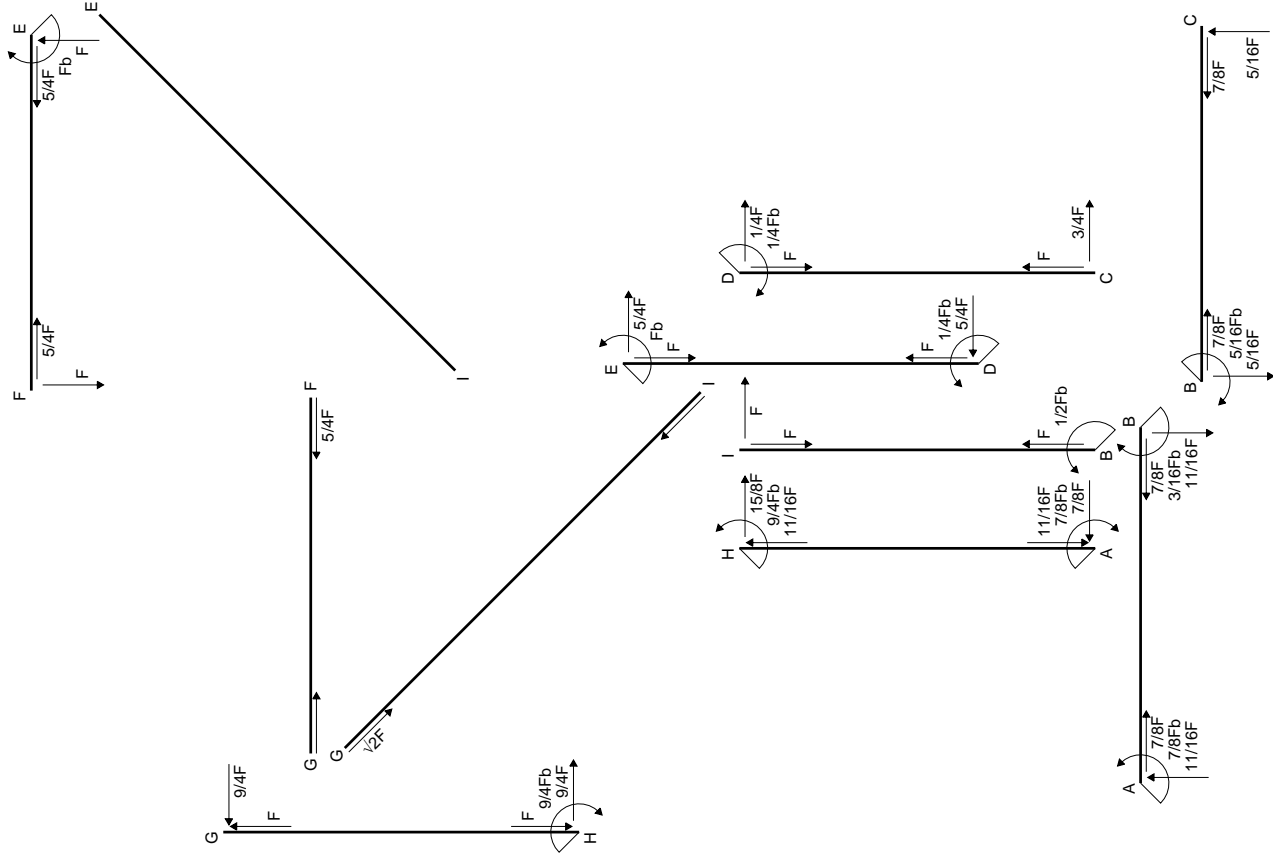
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

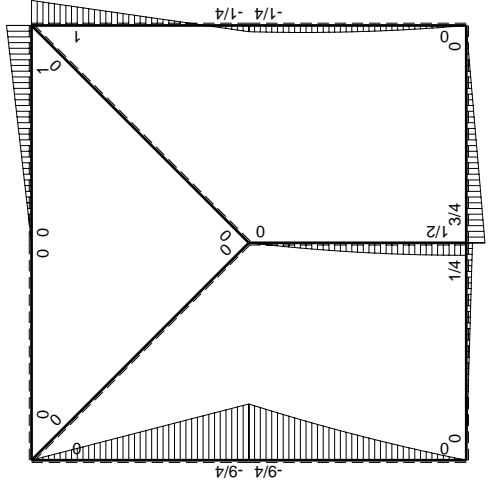
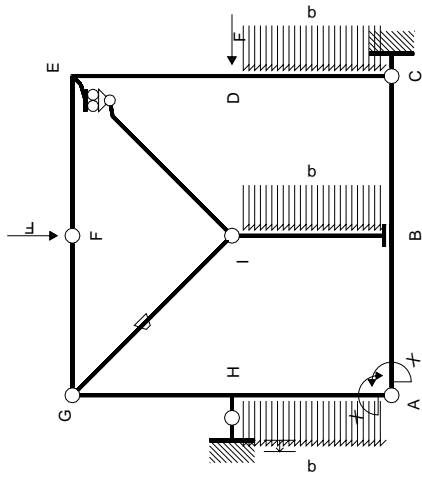
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

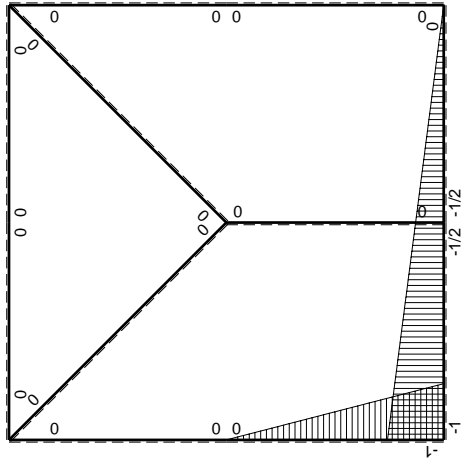


- A = 1272. mm<sup>2</sup>
- J<sub>u</sub> = 329658. mm<sup>4</sup>
- J<sub>v</sub> = 139392. mm<sup>4</sup>
- y<sub>g</sub> = 30.5 mm
- N = 1700. N
- T<sub>y</sub> = -3825. N
- M<sub>x</sub> = -2601000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.5 mm
- σ<sub>m</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = -239.3 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -17.5 mm
- σ<sub>c</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = -136.7 N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.03 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 137.3 N/mm<sup>2</sup>
- S = 7271. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{AB}^{x_0} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = \left[ -1/8 x^2/b + 1/24 x^3/b^2 \right]_0^b Fb 1/EJ$$

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

$$L_{BA}^{x_0} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = \left[ -1/8 x + 1/24 x^3/b^2 \right]_0^b Fb 1/EJ$$

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

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

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

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

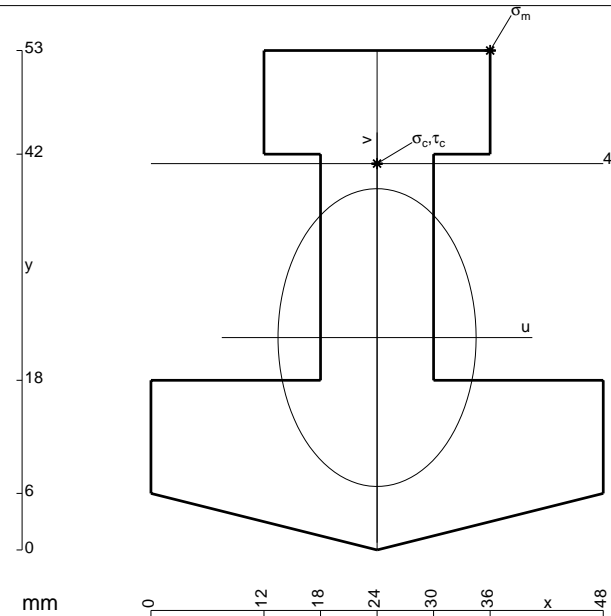
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{x_0} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{AH}^{x_0} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



$$A = 1272. \text{ mm}^2$$

$$J_u = 317672. \text{ mm}^4$$

$$J_v = 140544. \text{ mm}^4$$

$$y_g = 22.54 \text{ mm}$$

$$N = 1260. \text{ N}$$

$$T_y = -2835. \text{ N}$$

$$M_x = -2069550. \text{ Nmm}$$

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

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

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

$$v_m = 30.46 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = 199.4 \text{ N/mm}^2$$

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

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

$$v_c = 18.46 \text{ mm}$$

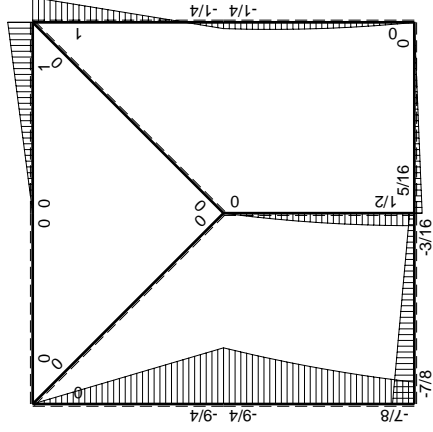
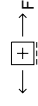
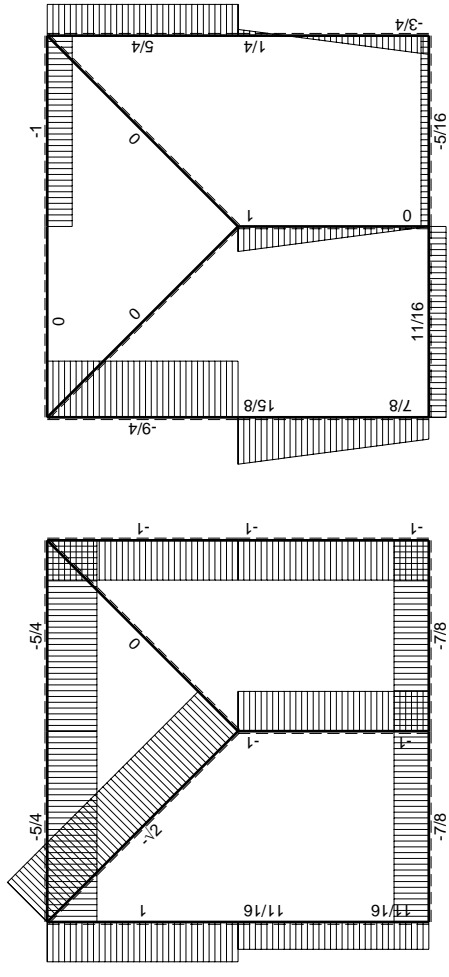
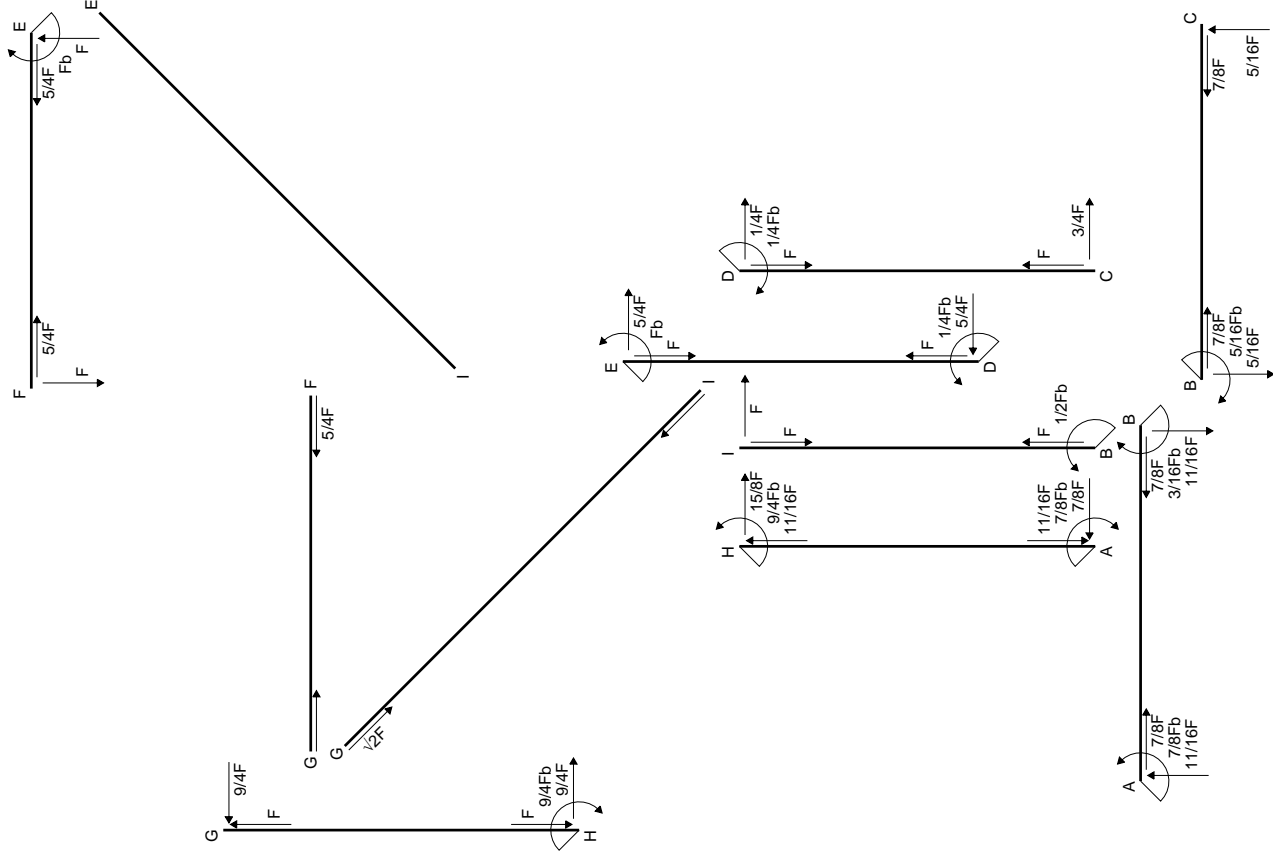
$$\sigma_c = N/A - Mv/J_u = 121.3 \text{ N/mm}^2$$

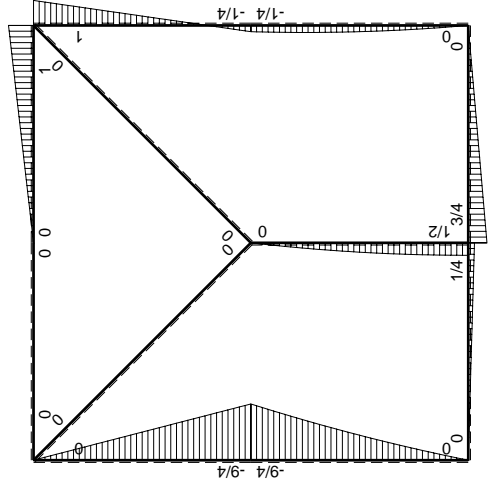
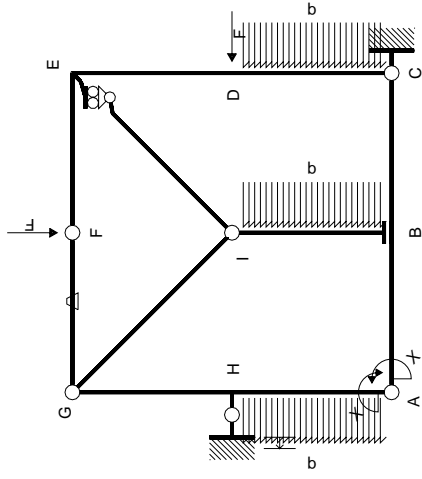
$$\tau_c = 5.07 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 121.6 \text{ N/mm}^2$$

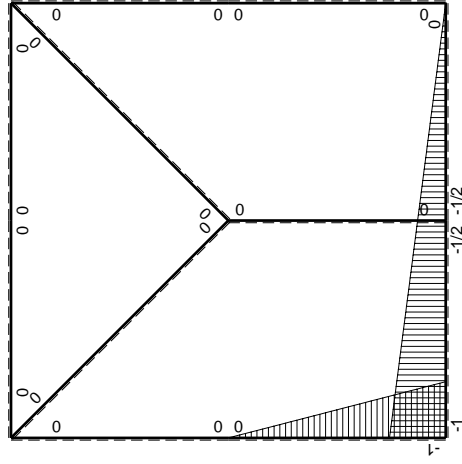
$$S = 6818. \text{ mm}^3$$







$M_0$  flessione da carichi assegnati



$M_X$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	0	0	0	0			
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
GF b	0	0	$Fb/EJ$	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

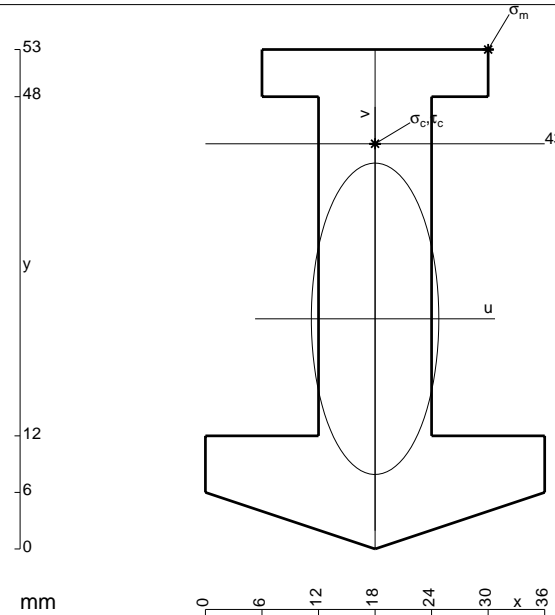
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

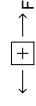
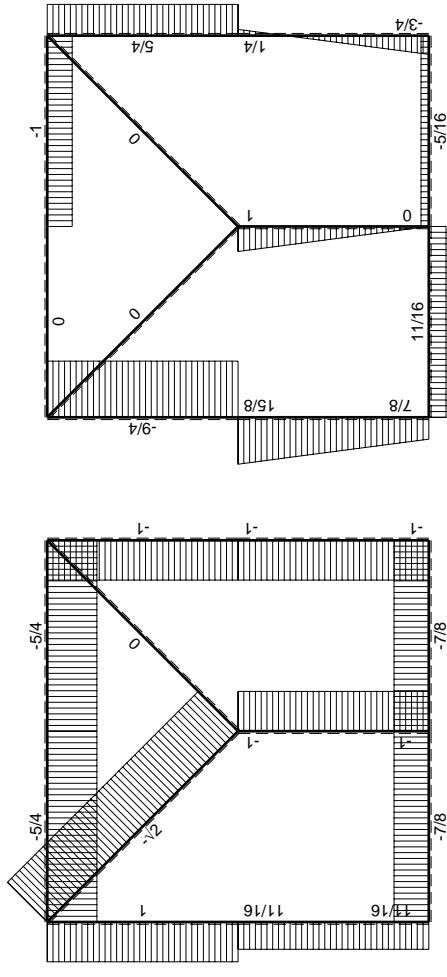
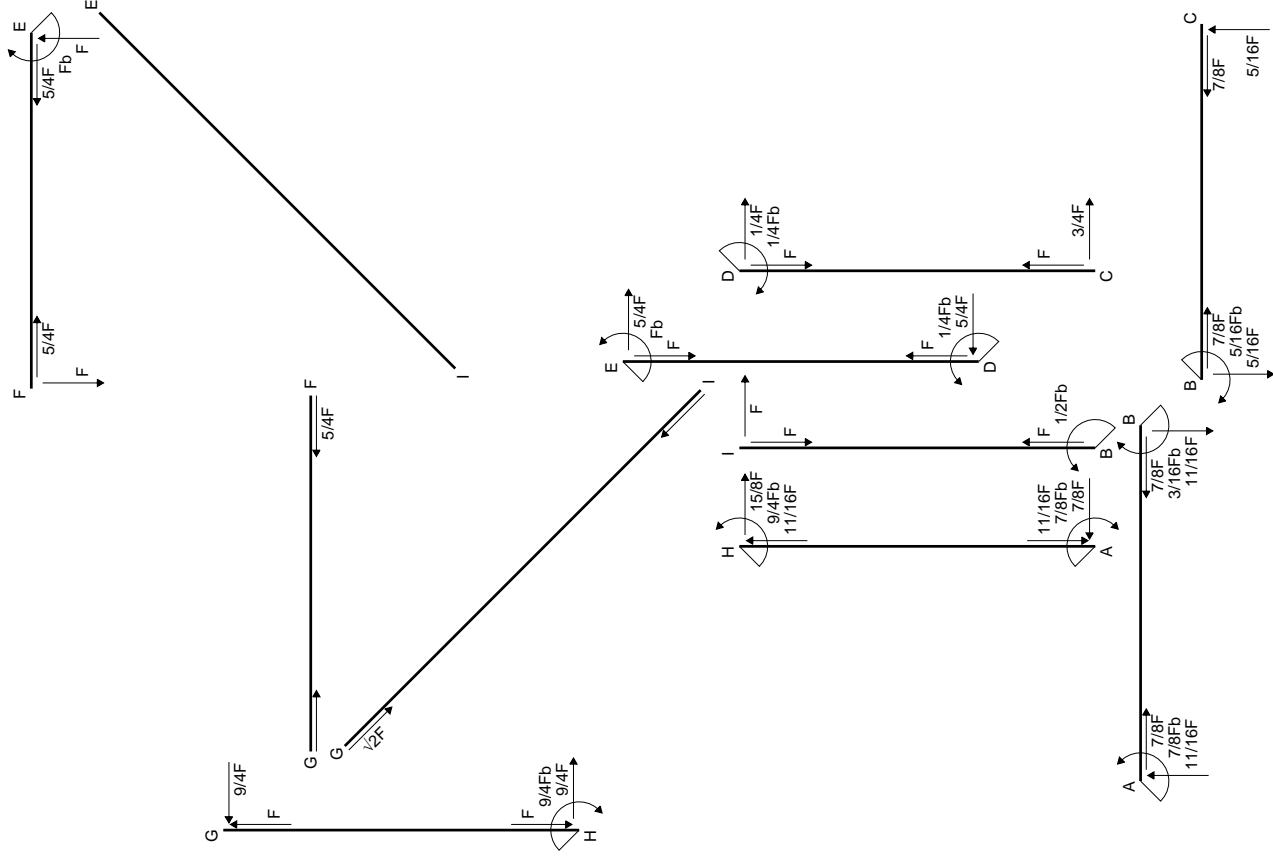
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

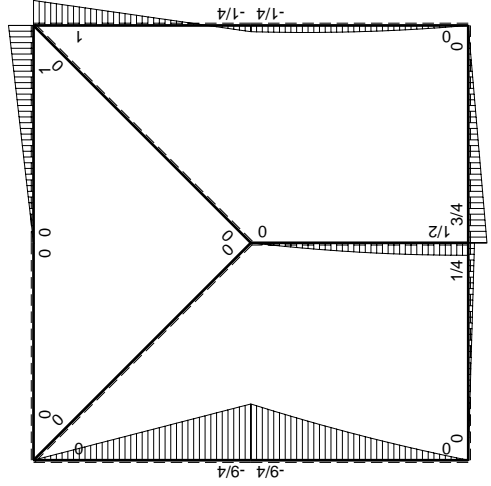
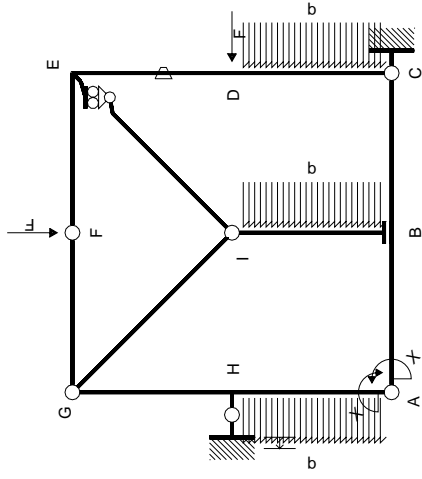
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

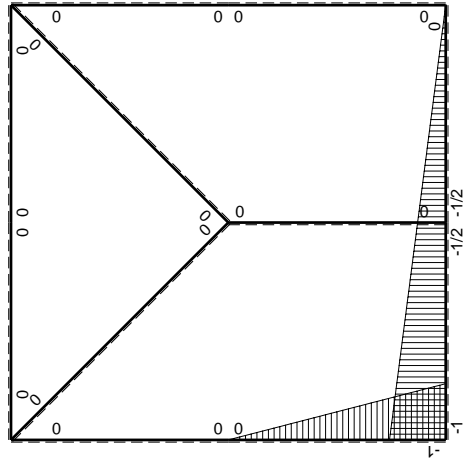


- A = 876. mm<sup>2</sup>
- J<sub>u</sub> = 239234. mm<sup>4</sup>
- J<sub>v</sub> = 40104. mm<sup>4</sup>
- y<sub>g</sub> = 24.42 mm
- N = 990. N
- T<sub>y</sub> = -2228. N
- M<sub>x</sub> = -1737450. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.58 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 208.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 43. mm
- v<sub>c</sub> = 18.58 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 136. N/mm<sup>2</sup>
- τ<sub>c</sub> = 3.409 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 136.2 N/mm<sup>2</sup>
- S = 4394. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_X$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	$Fb/EJ$	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0			
FE b	0	$-Fx$	0	0	0	0	0+0	0	
FG b	0	0	0	0	0	0			
GF b	0	0	0	0	0	0	0+0	0	
GH b	0	$-9/4Fx$	0	0	0	0			
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0	0+0	0	
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0			
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

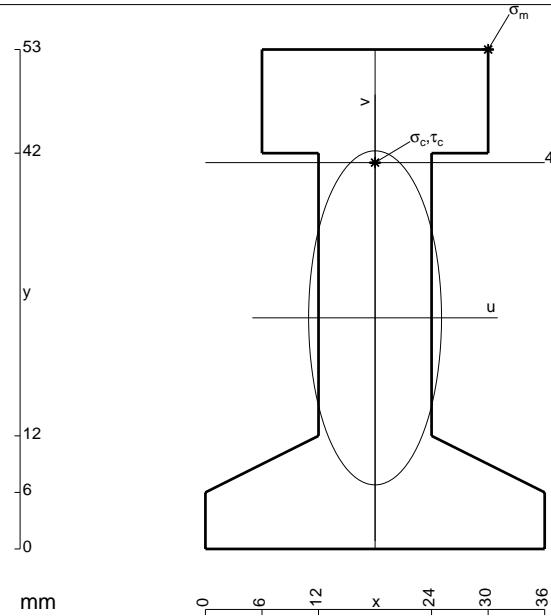
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

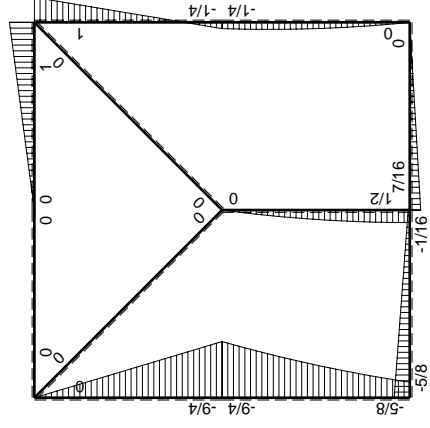
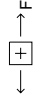
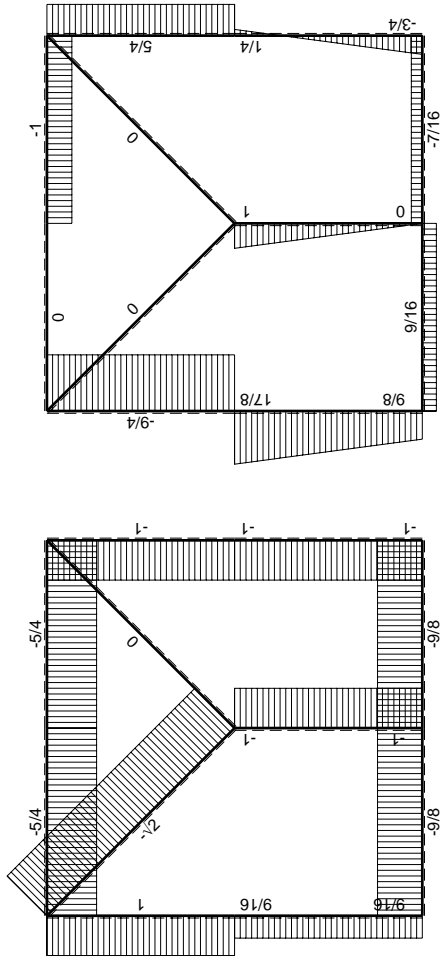
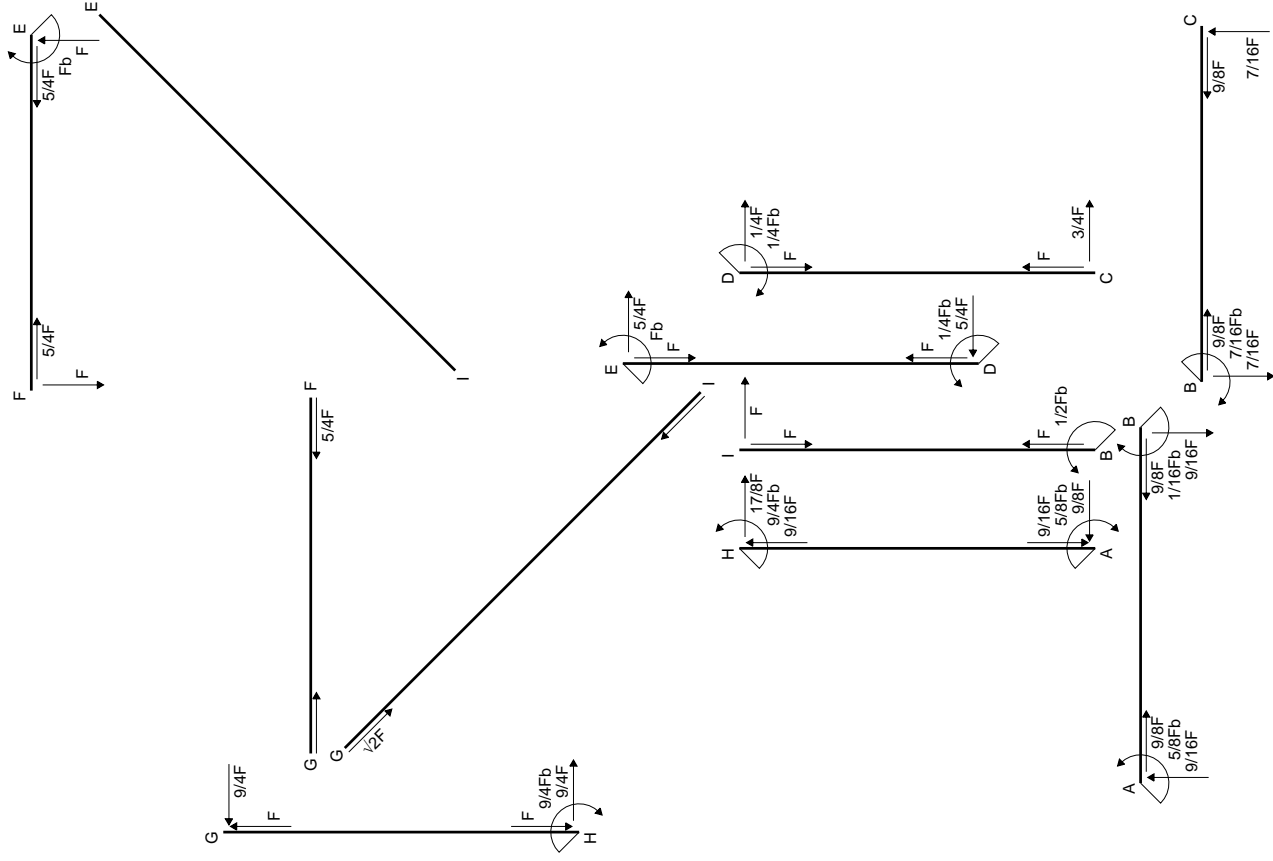
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

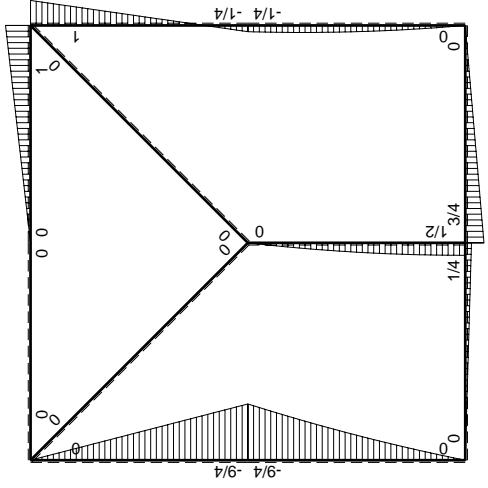
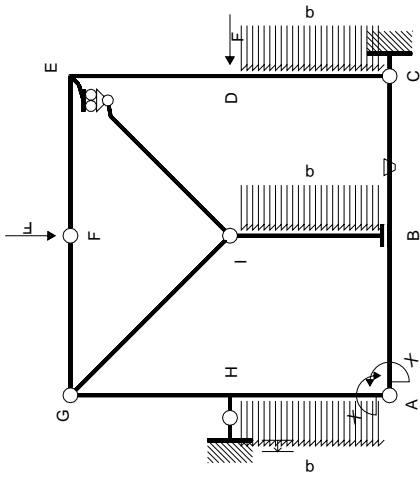
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



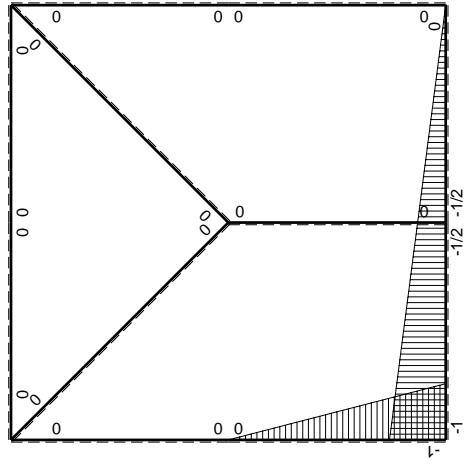
- A = 984. mm<sup>2</sup>
- J<sub>u</sub> = 309321. mm<sup>4</sup>
- J<sub>v</sub> = 48960. mm<sup>4</sup>
- y<sub>g</sub> = 24.52 mm
- N = 1270. N
- T<sub>y</sub> = -2858. N
- M<sub>x</sub> = -2371730. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.48 mm
- σ<sub>m</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = 219.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 16.48 mm
- σ<sub>c</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = 127.6 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.826 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup> + 3τ<sup>2</sup> = 127.9 N/mm<sup>2</sup>
- S = 6269. mm<sup>3</sup>







  $M_0$  flessione da carichi assegnati



  $M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	$-Fb/EJ$	$-3/8Fb+3/4Fx-3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	$Fb/EJ$	$-3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

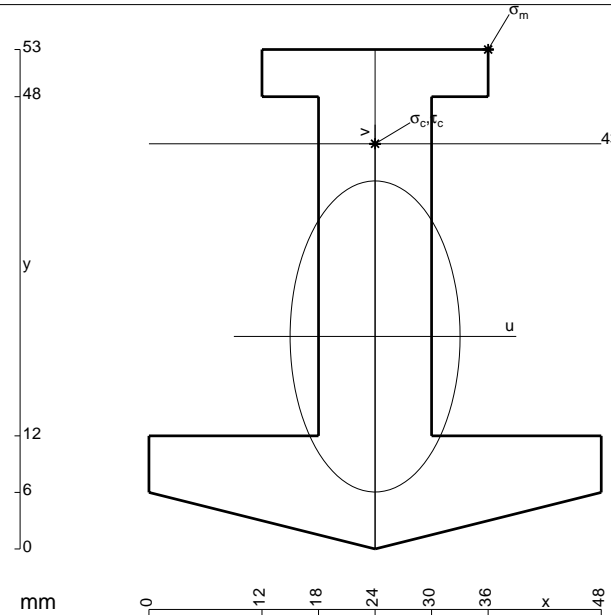
$$= (-1/8 b) Fb 1/EJ + (-1/4 b) \theta = 1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

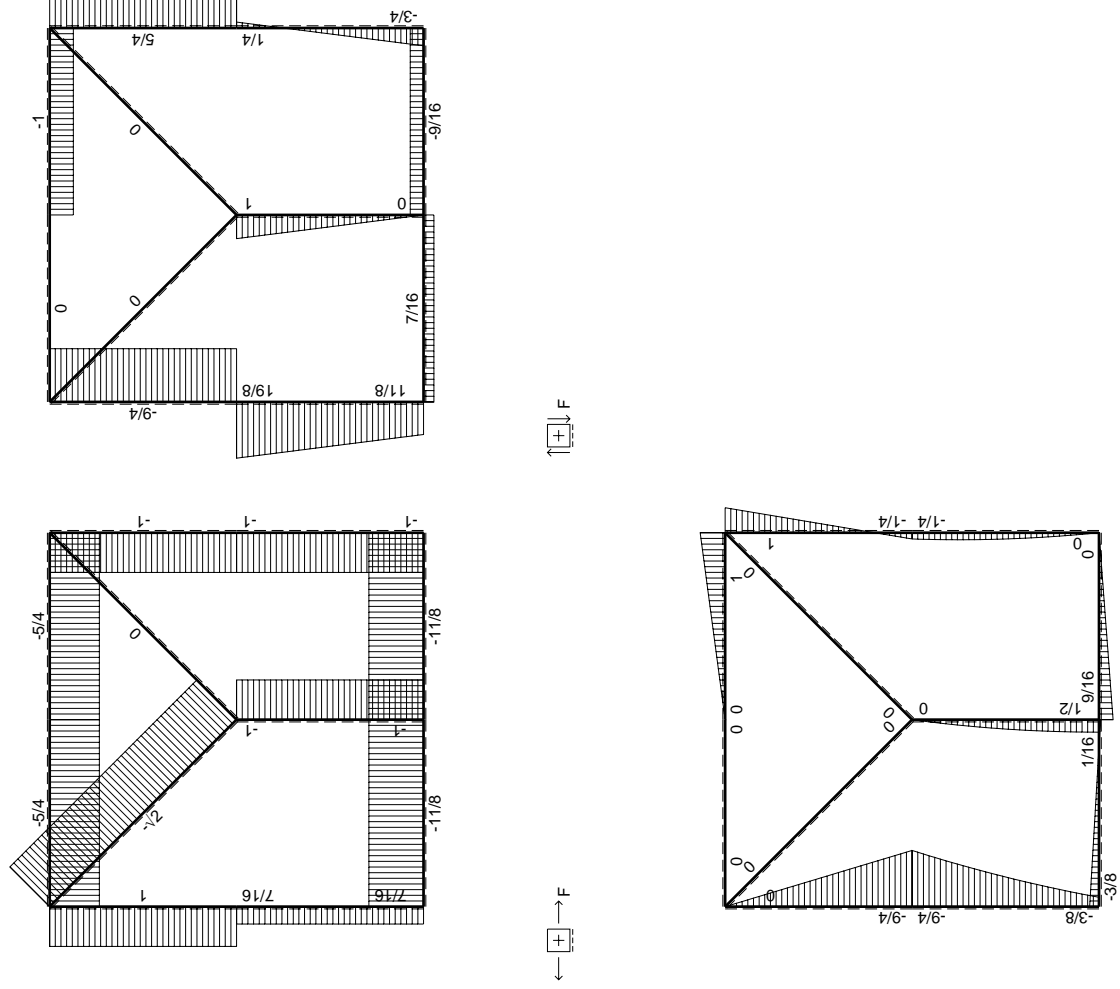
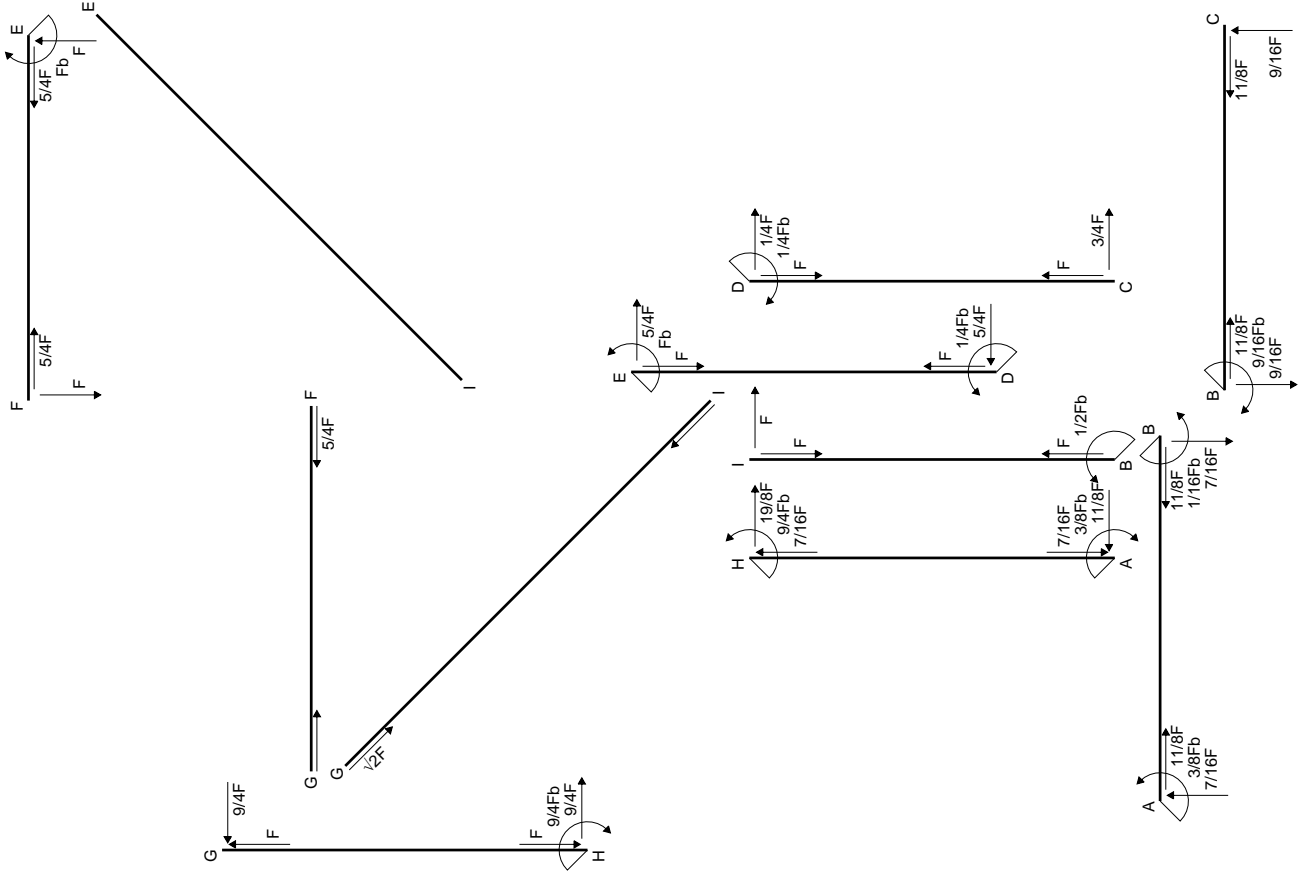
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

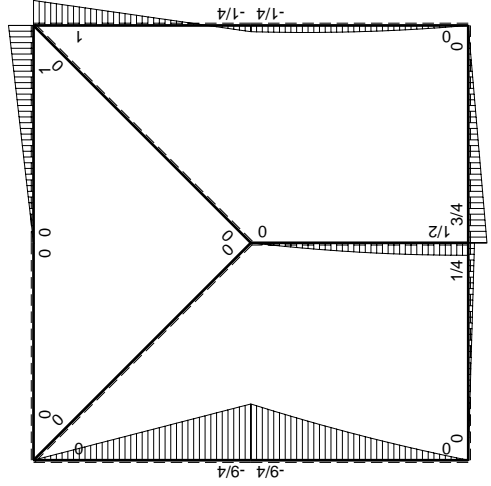
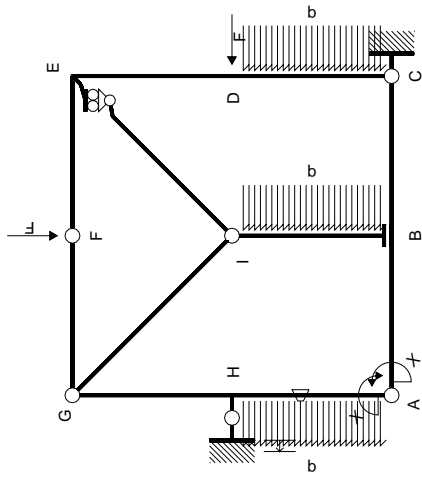
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

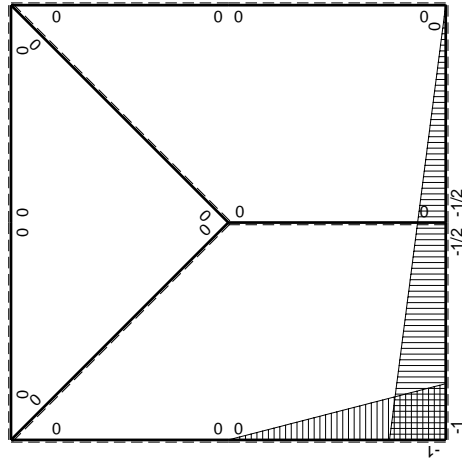


- A = 984. mm<sup>2</sup>
- J<sub>u</sub> = 268208. mm<sup>4</sup>
- J<sub>v</sub> = 80064. mm<sup>4</sup>
- y<sub>g</sub> = 22.55 mm
- N = 1010. N
- T<sub>y</sub> = -2273. N
- M<sub>x</sub> = -1999800. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.45 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 228.1 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 43. mm
- v<sub>c</sub> = 20.45 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 153.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 3.341 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 153.6 N/mm<sup>2</sup>
- S = 4731. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_X$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	$-Fb/EJ$	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	$Fx/EJ$	$x^2/b^2$	$(1/3+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	$Fb/EJ$	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

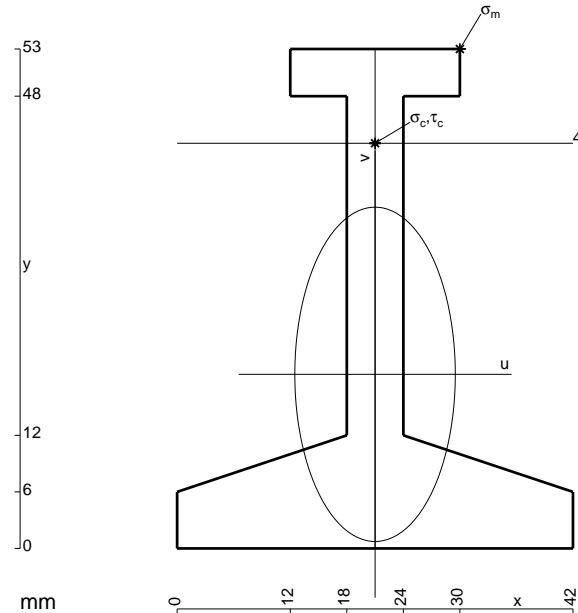
$$= [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 5/6 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

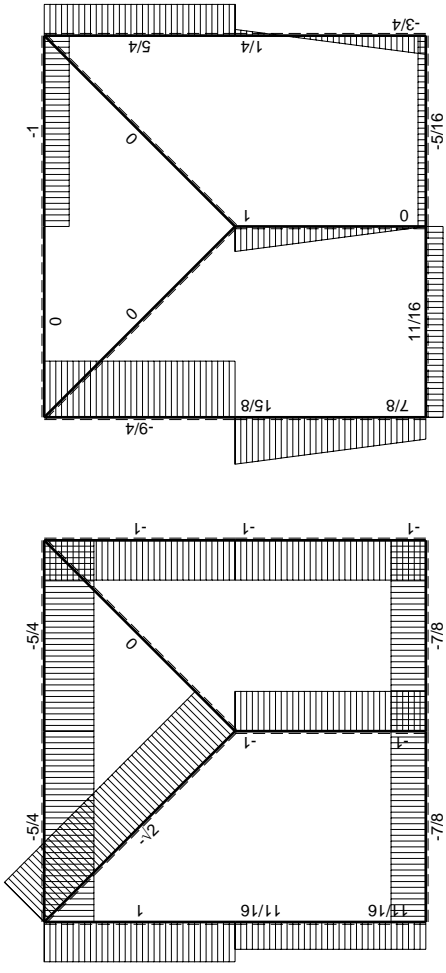
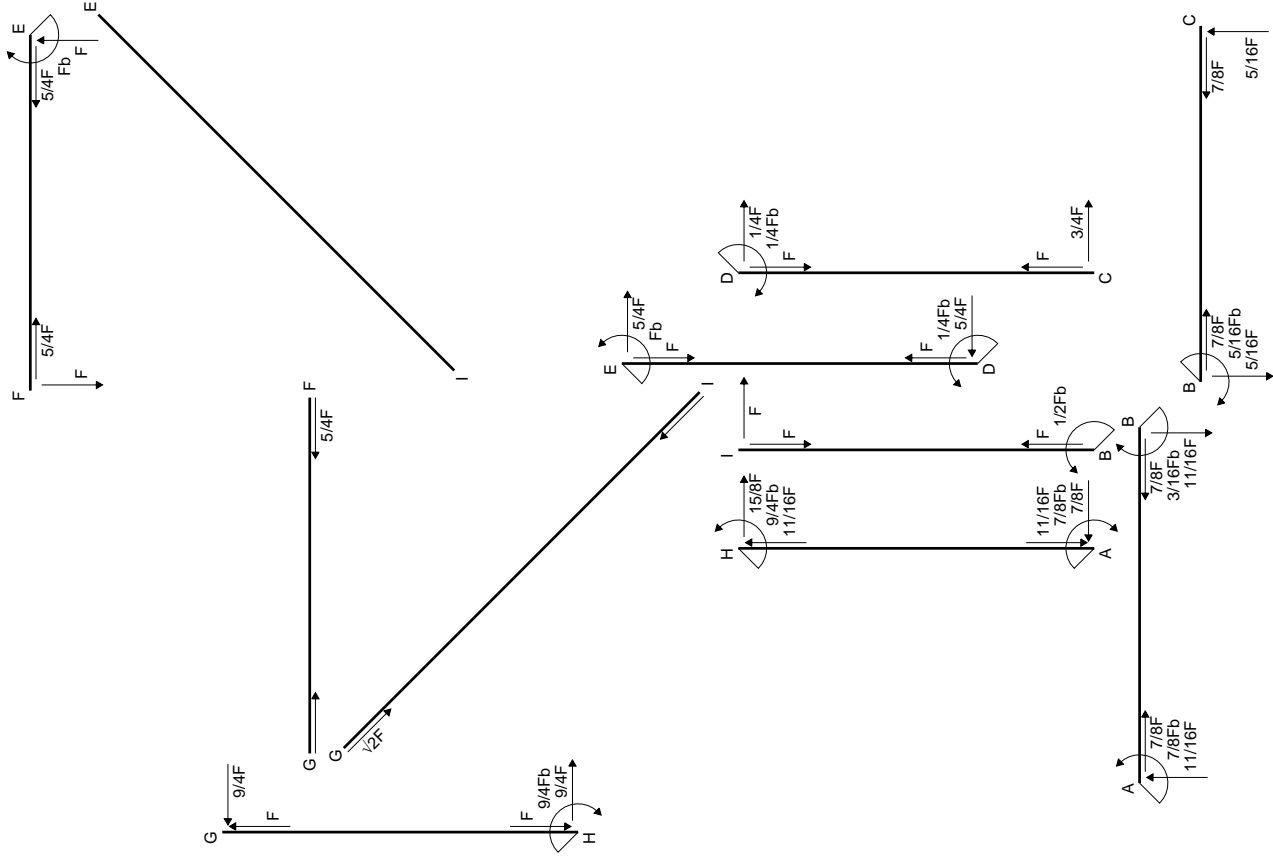
$$= [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

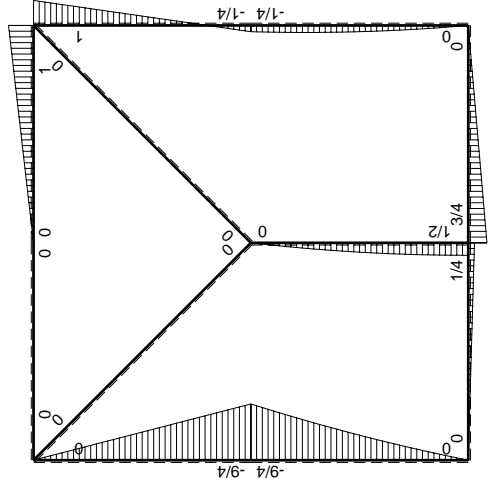
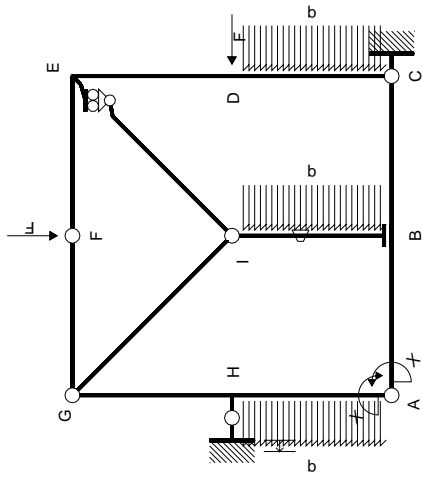
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 5/6 Fb^2/EJ$$



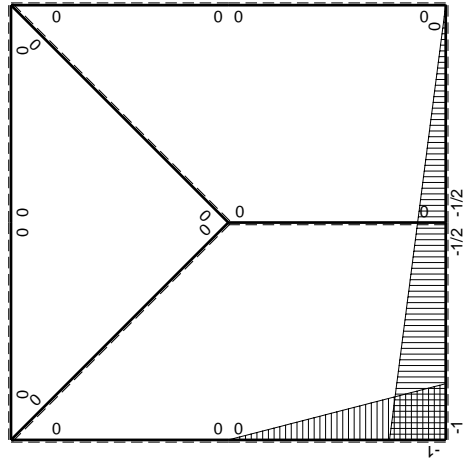
- A = 702. mm<sup>2</sup>
- J<sub>u</sub> = 221020. mm<sup>4</sup>
- J<sub>v</sub> = 50922. mm<sup>4</sup>
- y<sub>g</sub> = 18.47 mm
- N = 730. N
- T<sub>y</sub> = -1643. N
- M<sub>x</sub> = -1527530. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 34.53 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 239.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 43. mm
- v<sub>c</sub> = 24.53 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 170.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.574 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 170.7 N/mm<sup>2</sup>
- S = 3693. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	$Fb/EJ$	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

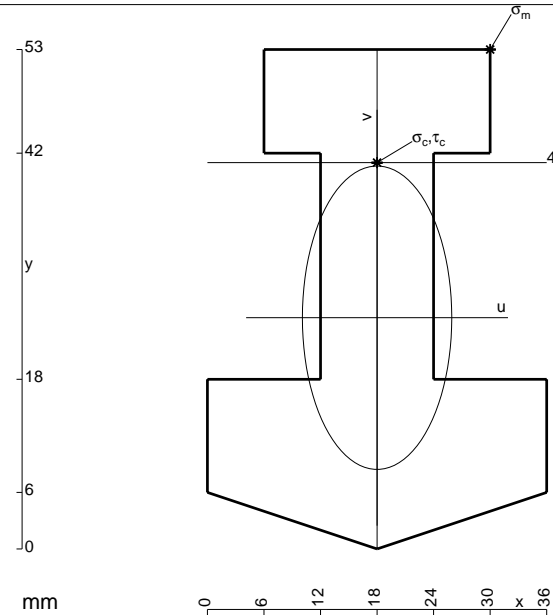
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

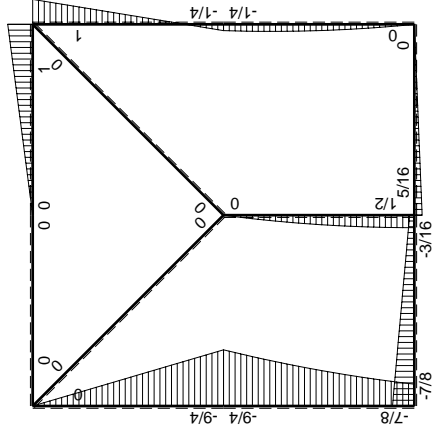
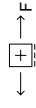
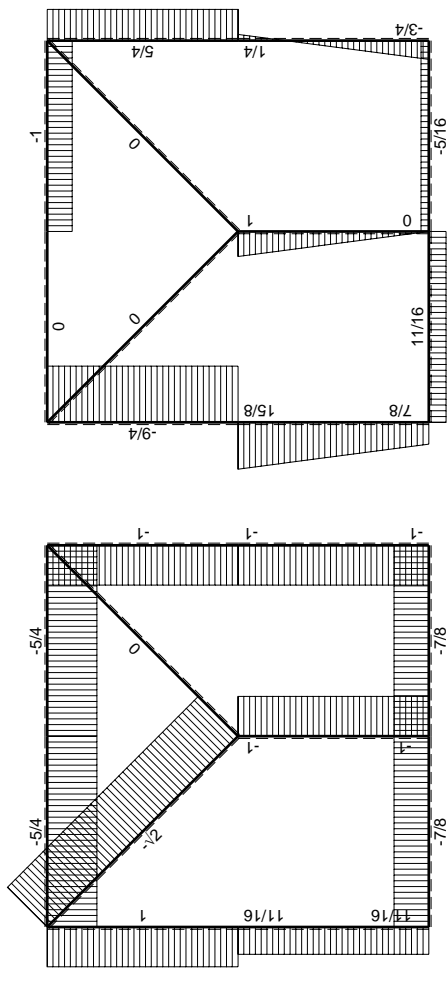
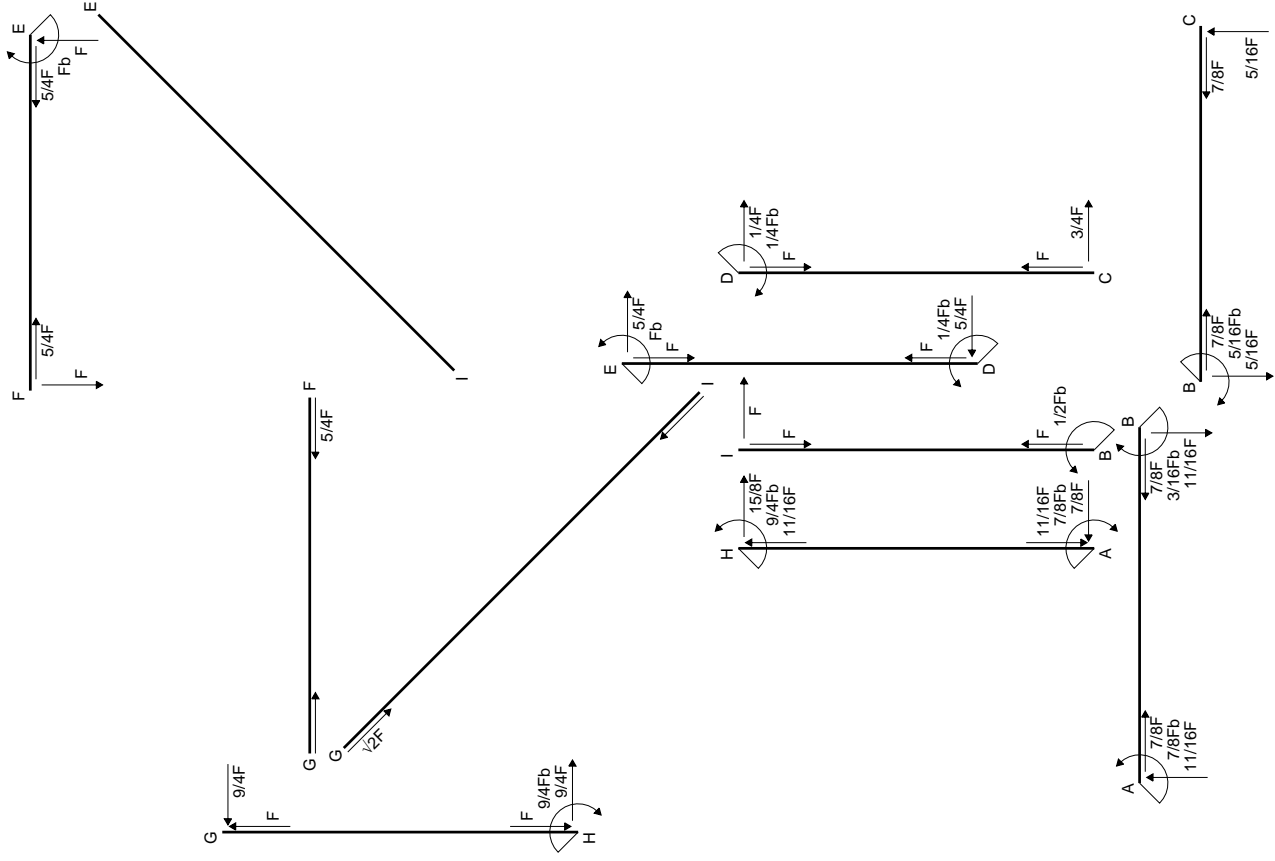
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

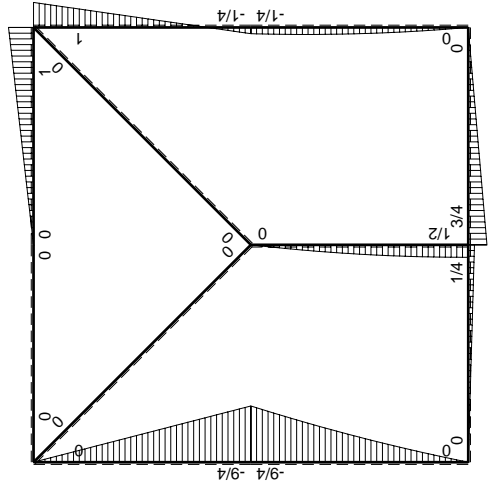
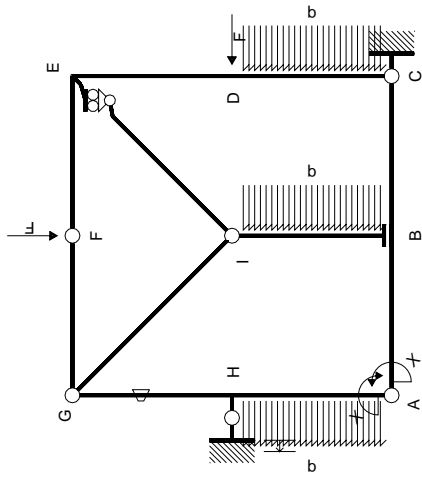
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

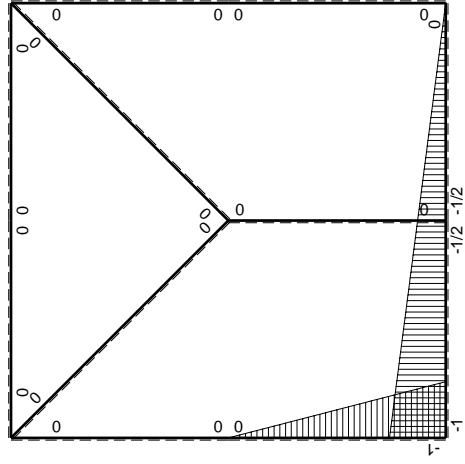


- A = 1092. mm<sup>2</sup>
- J<sub>u</sub> = 283139. mm<sup>4</sup>
- J<sub>v</sub> = 68616. mm<sup>4</sup>
- y<sub>g</sub> = 24.54 mm
- N = 1780. N
- T<sub>y</sub> = -4005. N
- M<sub>x</sub> = -1962450. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.46 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 198.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 16.46 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 115.7 N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.385 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 116.4 N/mm<sup>2</sup>
- S = 6265. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-9/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	$Fb/EJ$	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{AB}^{x_0} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

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

$$L_{BA}^{x_0} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

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

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

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

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

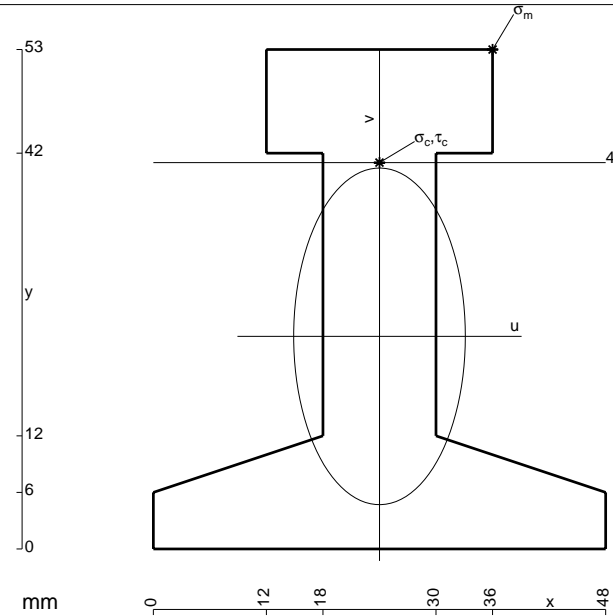
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{x_0} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

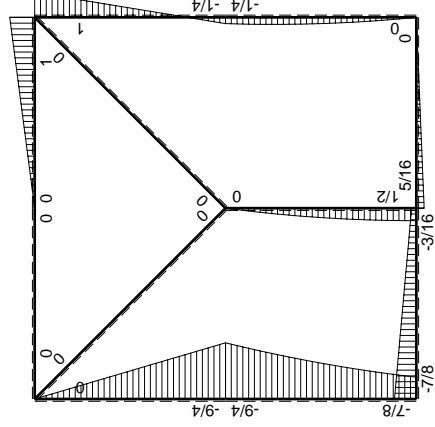
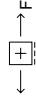
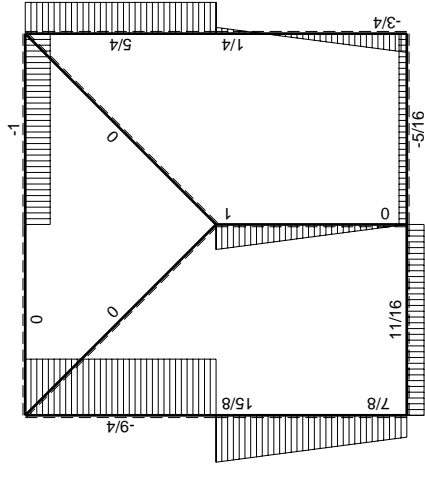
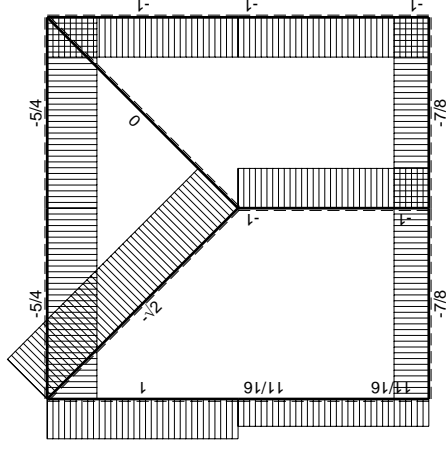
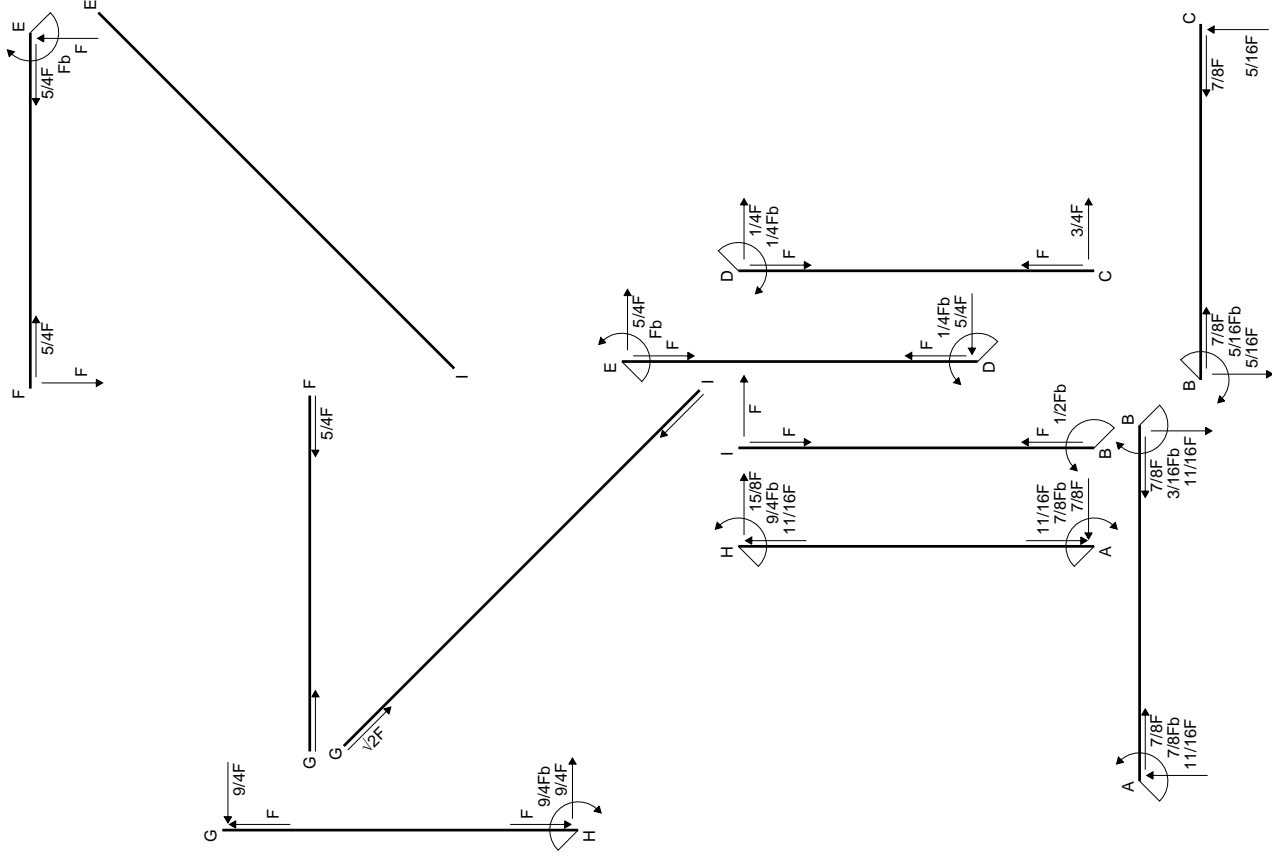
$$L_{AH}^{x_0} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

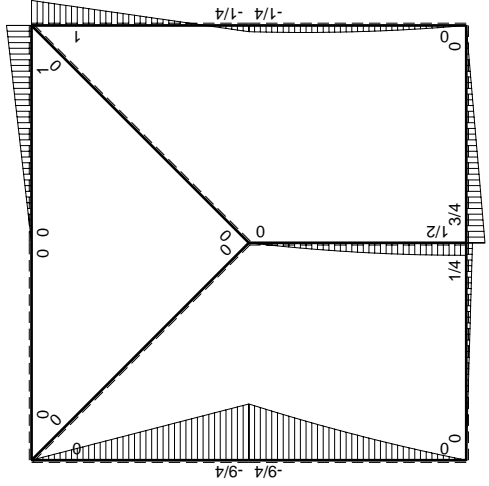
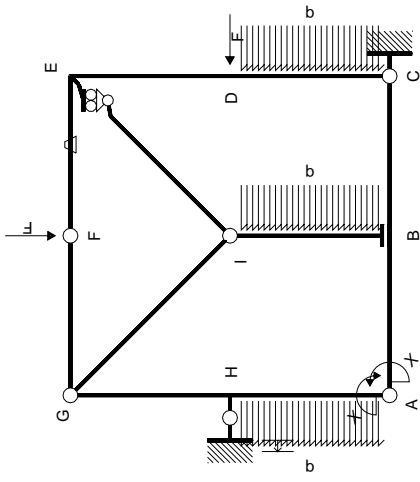
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



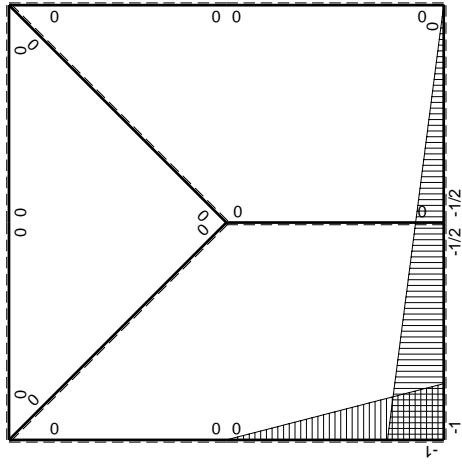
- A = 1092. mm<sup>2</sup>
- J<sub>u</sub> = 348585. mm<sup>4</sup>
- J<sub>v</sub> = 90648. mm<sup>4</sup>
- y<sub>g</sub> = 22.56 mm
- N = 1990. N
- T<sub>y</sub> = -4478. N
- M<sub>x</sub> = -2373080. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.44 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 209. N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 18.44 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>v</sub> = 127.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.291 N/mm<sup>2</sup>
- σ<sub>0</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 128. N/mm<sup>2</sup>
- S<sup>+</sup> = 6811. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_X$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	$-Fb/EJ$	0	0	0	0+0	0	
FE b	0	$-Fx$	$Fb/EJ$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

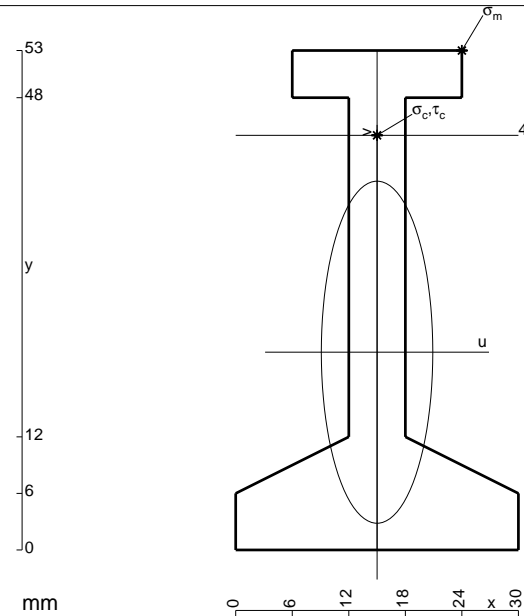
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

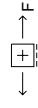
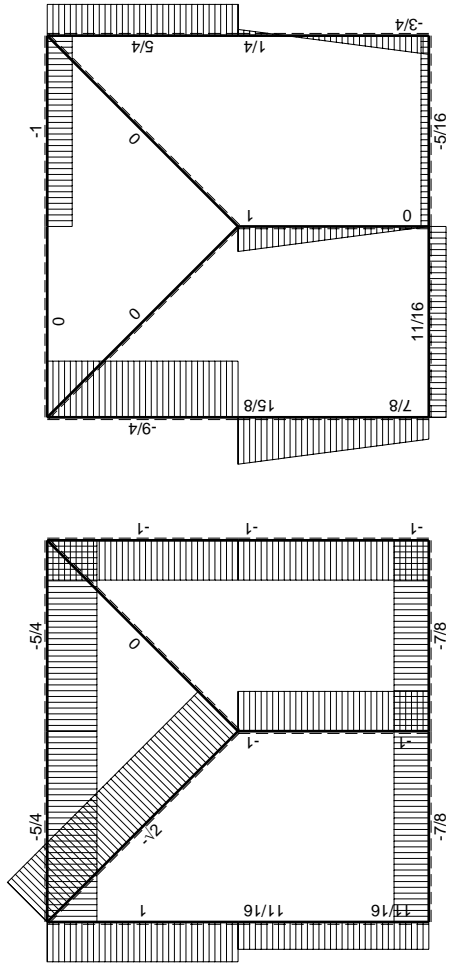
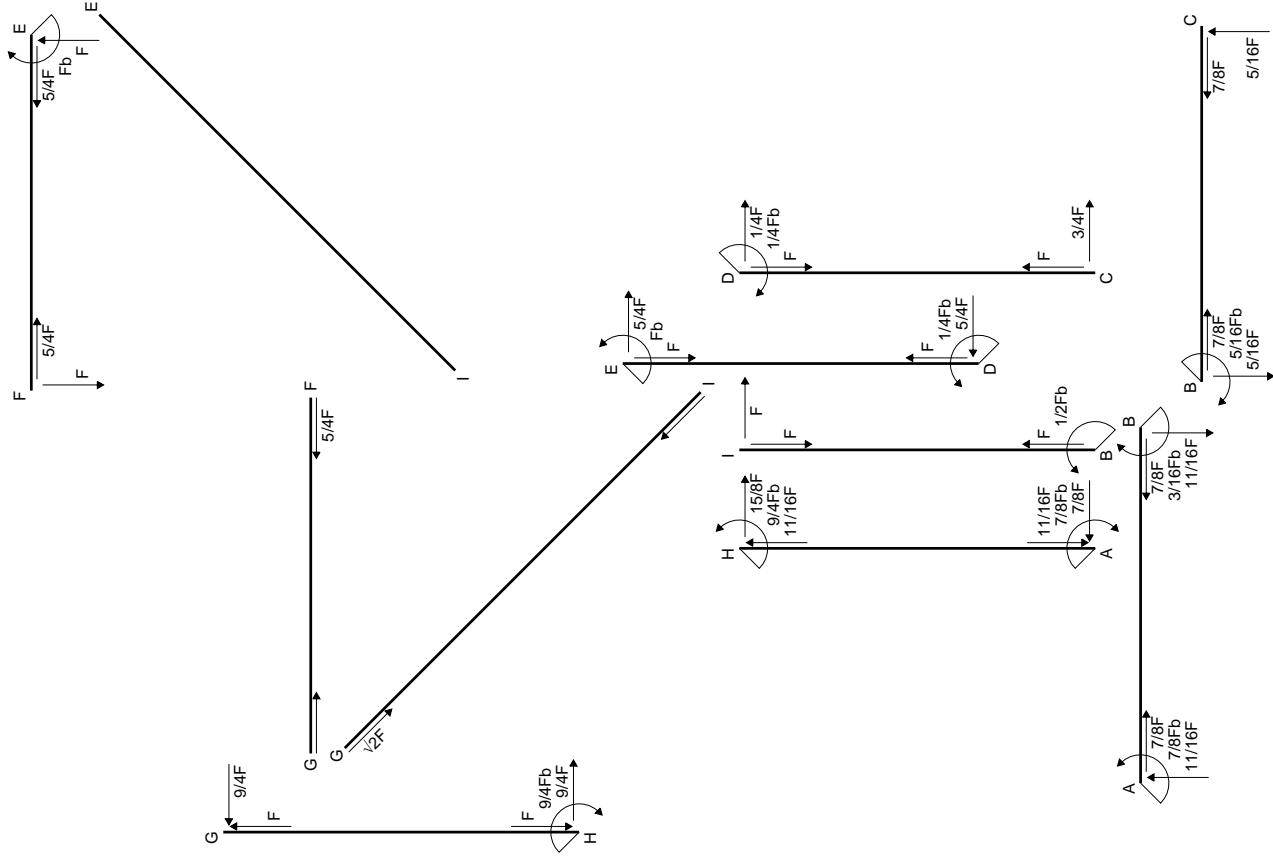
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

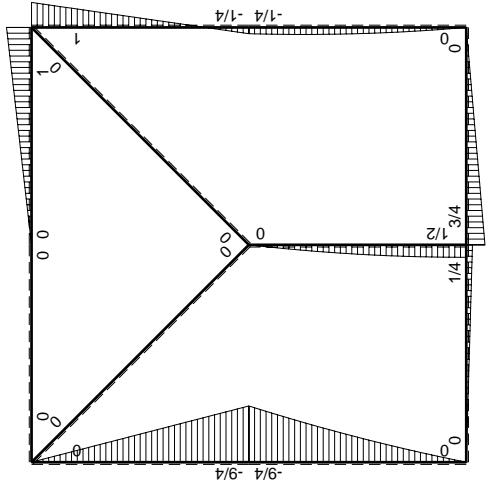
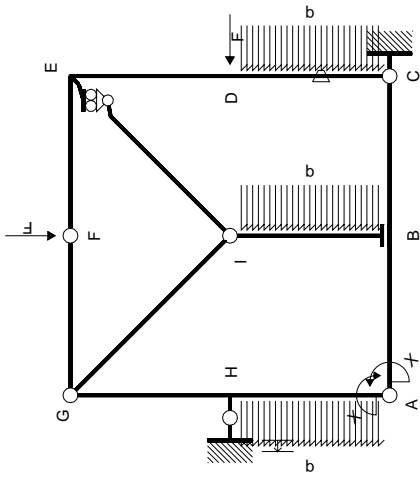
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

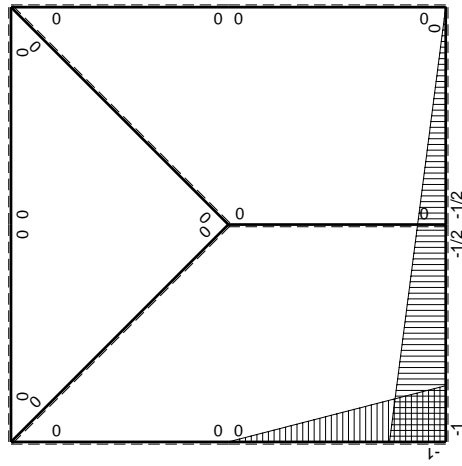


- A = 594. mm<sup>2</sup>
- J<sub>u</sub> = 195798. mm<sup>4</sup>
- J<sub>v</sub> = 20790. mm<sup>4</sup>
- y<sub>g</sub> = 20.98 mm
- N = 1020. N
- T<sub>y</sub> = -2295. N
- M<sub>x</sub> = -1331100. Nmm
- x<sub>m</sub> = 24. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 32.02 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 219.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 44. mm
- v<sub>c</sub> = 23.02 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 158.2 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.362 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 158.6 N/mm<sup>2</sup>
- S = 3257. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	$Fb/EJ$	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

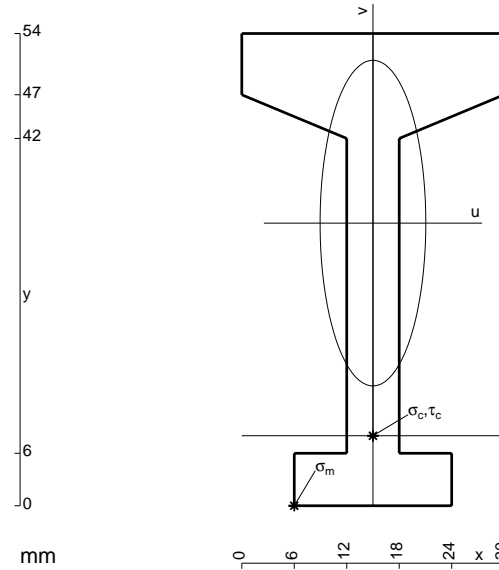
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

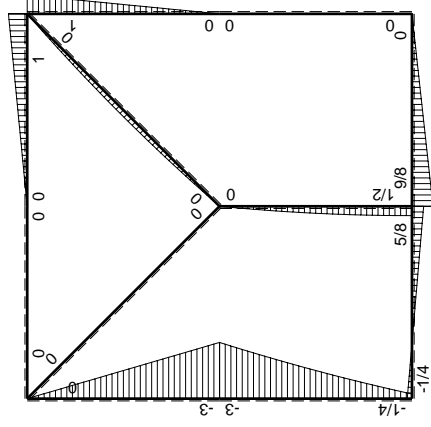
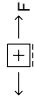
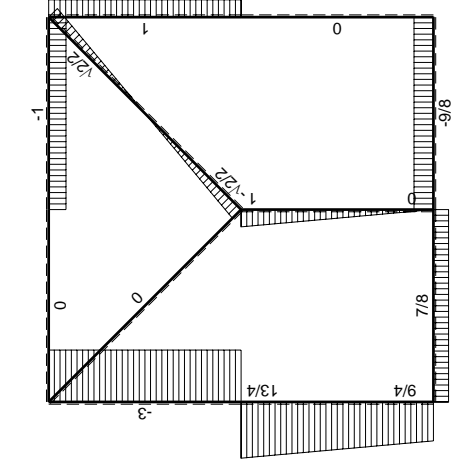
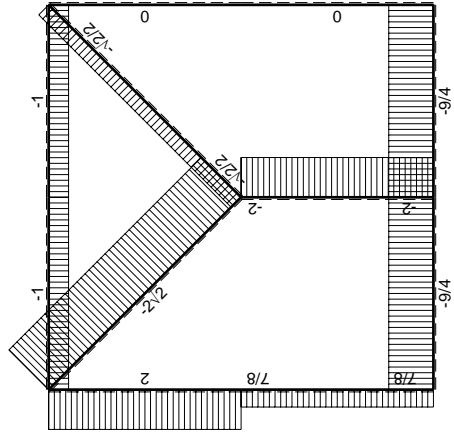
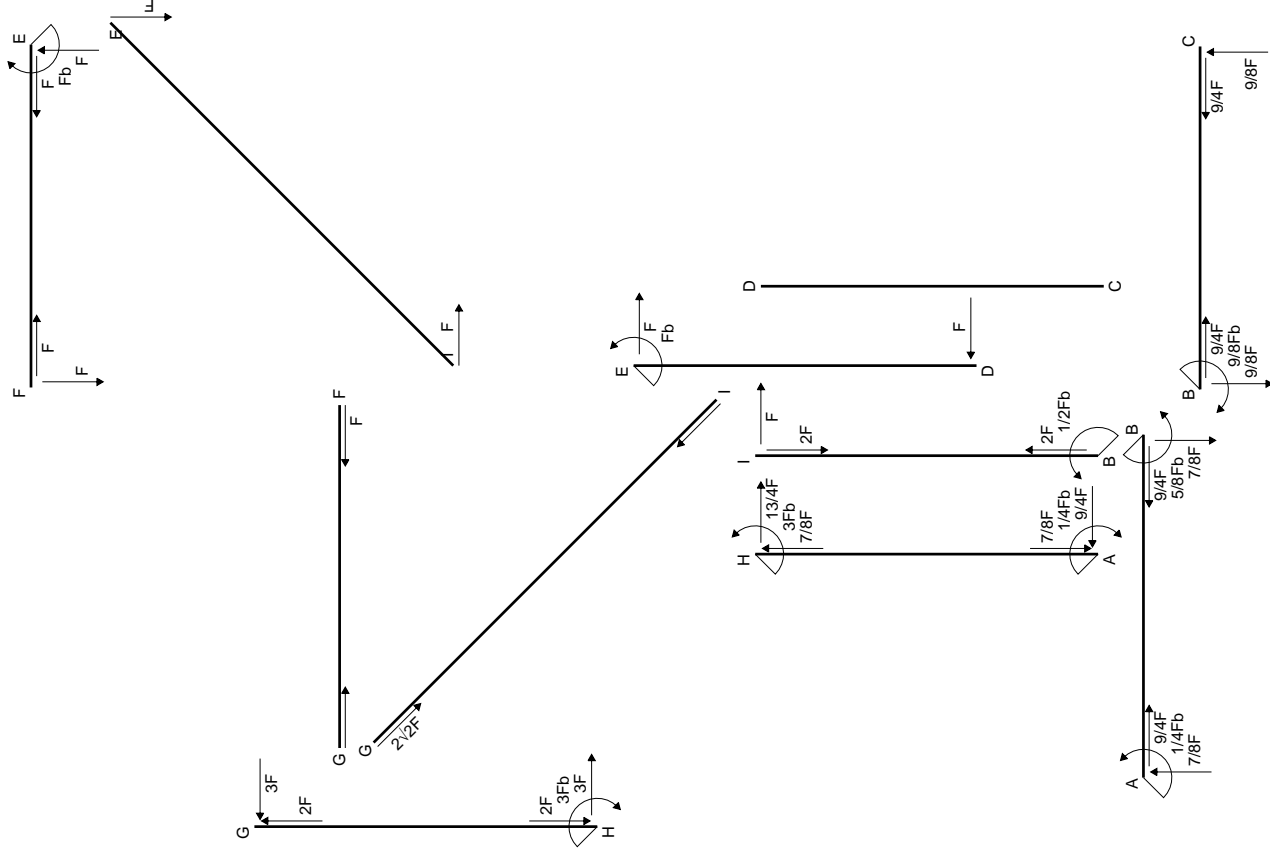
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

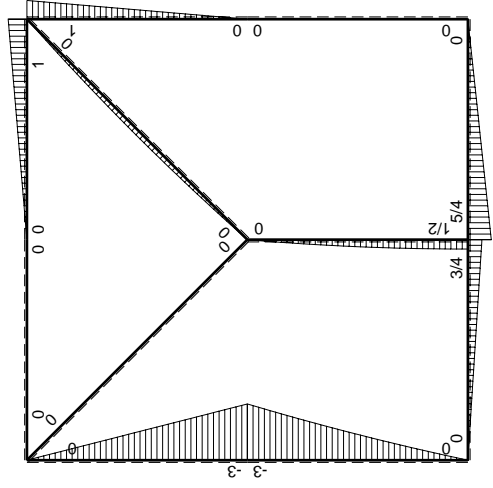
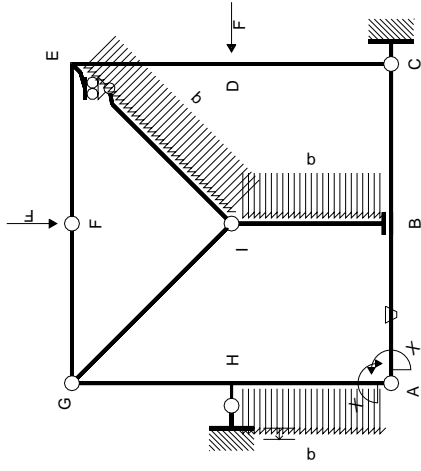
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



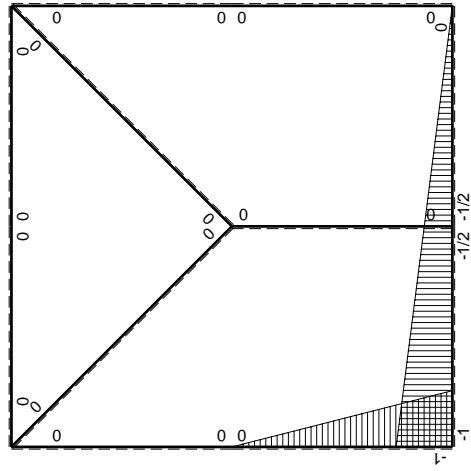
- A = 624. mm<sup>2</sup>
- J<sub>u</sub> = 216470. mm<sup>4</sup>
- J<sub>v</sub> = 22824. mm<sup>4</sup>
- y<sub>g</sub> = 32.32 mm
- N = 1060. N
- T<sub>y</sub> = -2385. N
- M<sub>x</sub> = -1550250. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -32.32 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -229.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 8. mm
- v<sub>c</sub> = -24.32 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -172.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.373 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 172.8 N/mm<sup>2</sup>
- S = 3470. mm<sup>3</sup>







$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	$-Fb/EJ$	$-3/4Fx+3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$Fb/EJ$	$-3/8Fb+3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-3Fx$	0	0	0	0	0+0	0	
HG b	0	$3Fb-3Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/4Fb$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

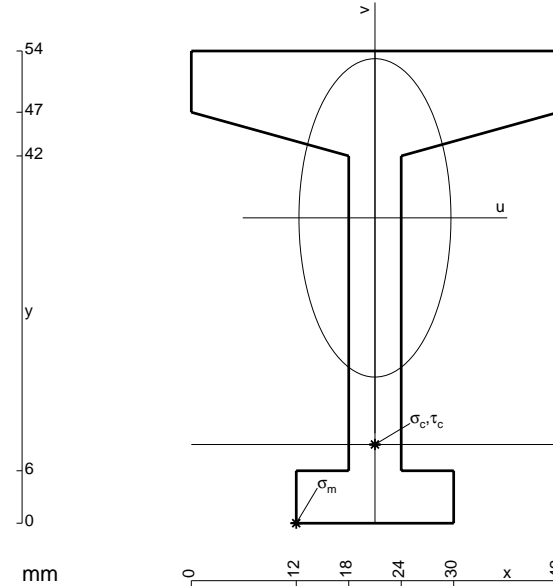
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

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

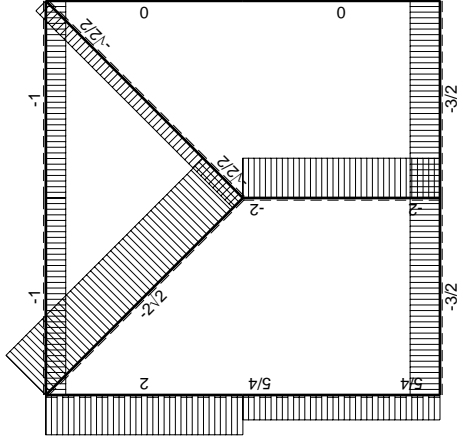
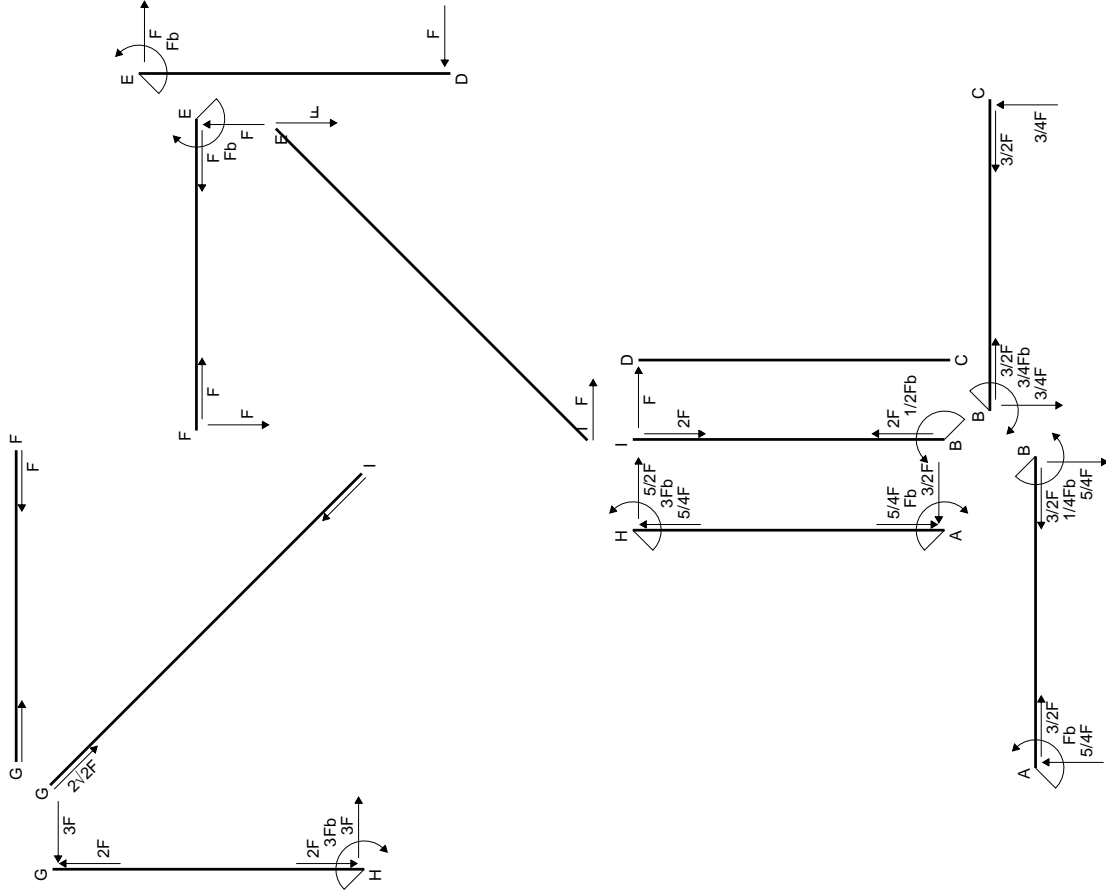
$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

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

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

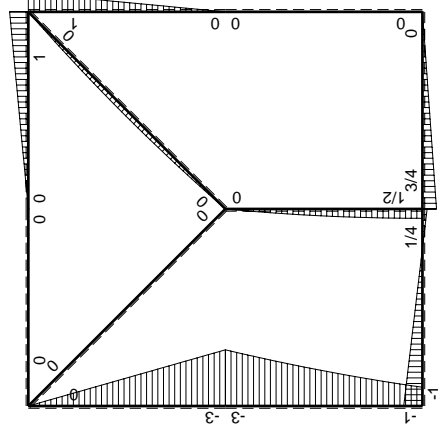


- A = 738. mm<sup>2</sup>
- J<sub>u</sub> = 244714. mm<sup>4</sup>
- J<sub>v</sub> = 55782. mm<sup>4</sup>
- y<sub>g</sub> = 34.92 mm
- N = 1600. N
- T<sub>y</sub> = -2400. N
- M<sub>x</sub> = -1680000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -34.92 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -237.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -25.92 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -175.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.441 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 176.1 N/mm<sup>2</sup>
- S = 3941. mm<sup>3</sup>

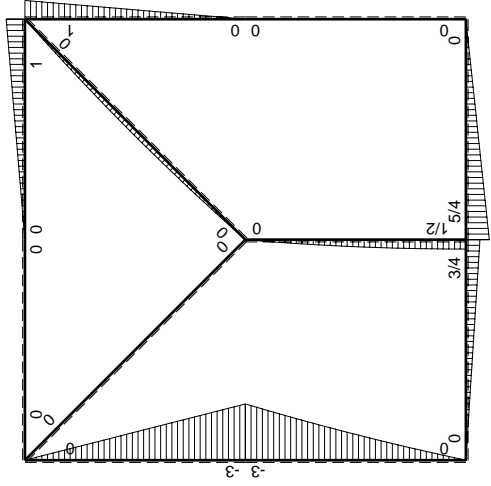
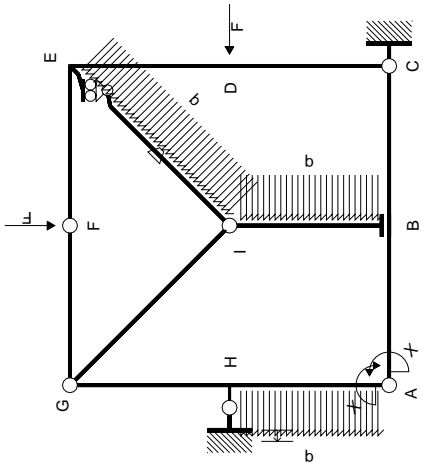


$\left[ \begin{array}{c} + \\ - \end{array} \right] \rightarrow F$

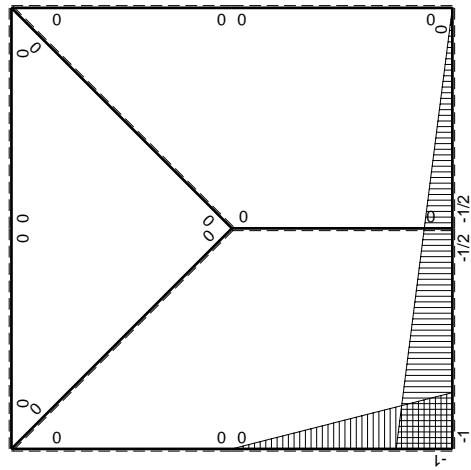
$\left[ \begin{array}{c} + \\ - \end{array} \right] \rightarrow F$



$\left[ \begin{array}{c} + \\ - \end{array} \right] \rightarrow F_b$



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

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

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	-Fb/EJ	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

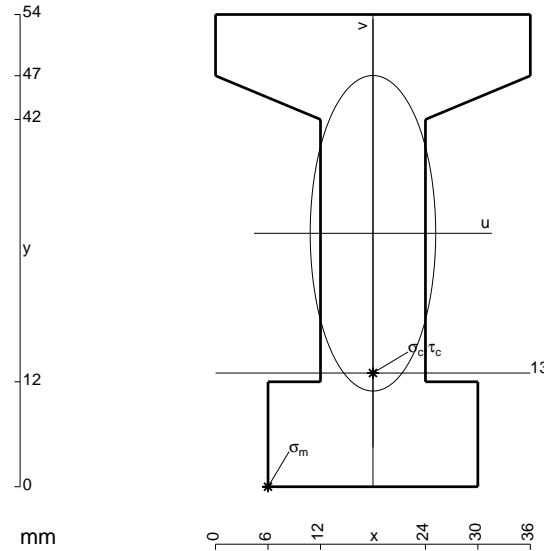
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

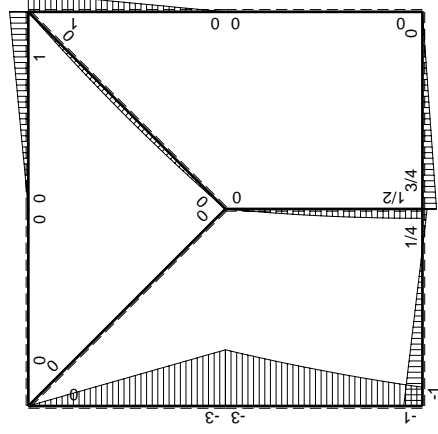
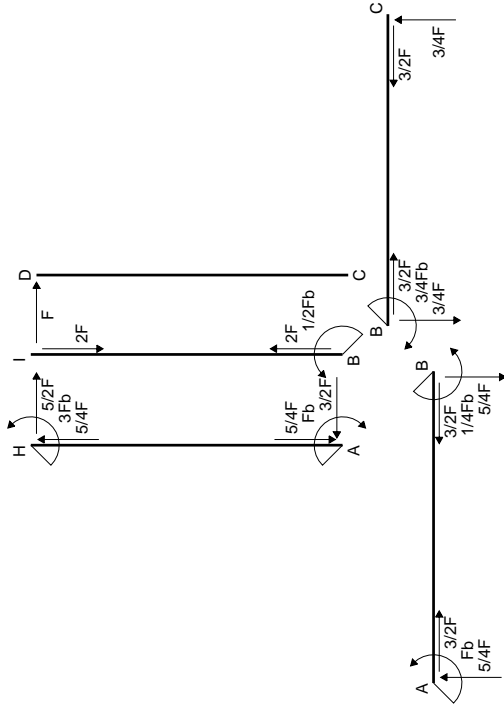
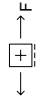
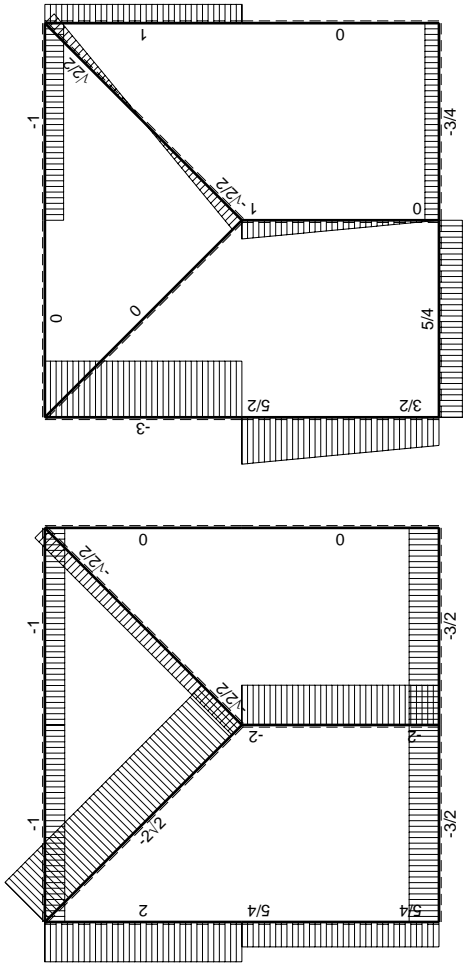
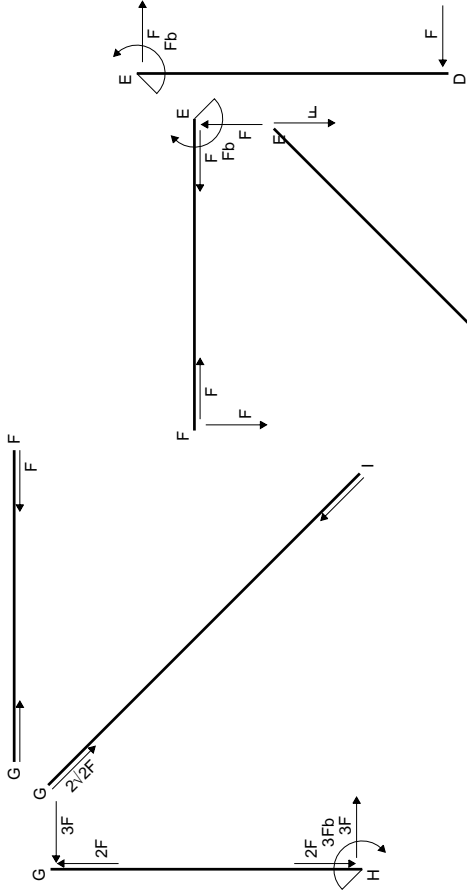
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

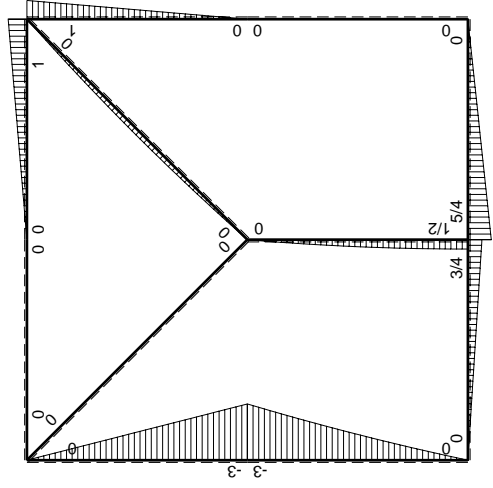
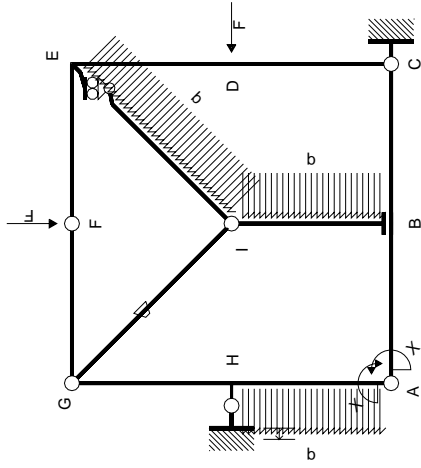
$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$



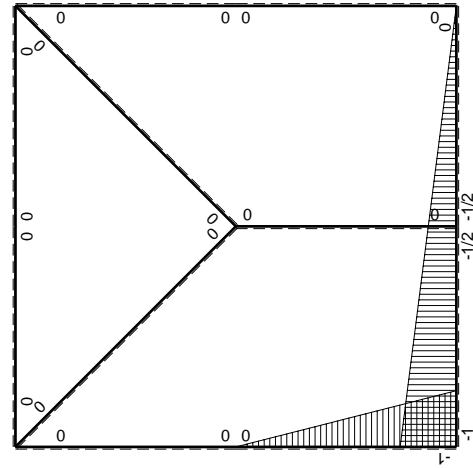
- A = 1020. mm<sup>2</sup>
- J<sub>u</sub> = 332394. mm<sup>4</sup>
- J<sub>v</sub> = 52560. mm<sup>4</sup>
- y<sub>g</sub> = 28.98 mm
- N = 2040. N
- T<sub>y</sub> = -3060. N
- M<sub>x</sub> = -2295000. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.98 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -198.1 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.98 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -108.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.23 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 108.7 N/mm<sup>2</sup>
- S = 6817. mm<sup>3</sup>







$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	0	-Fb/EJ	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

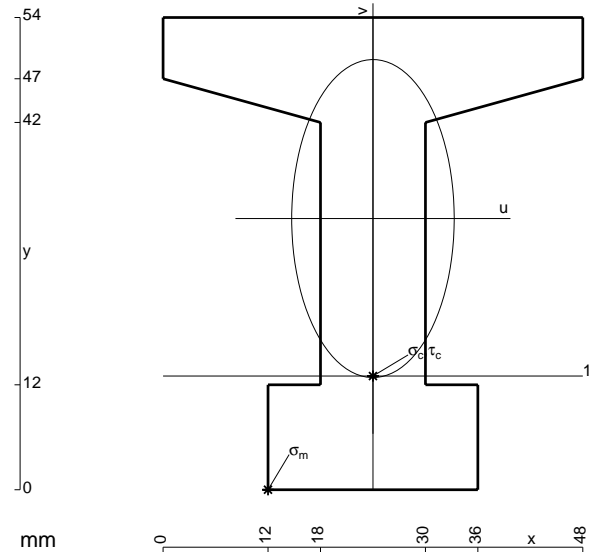
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

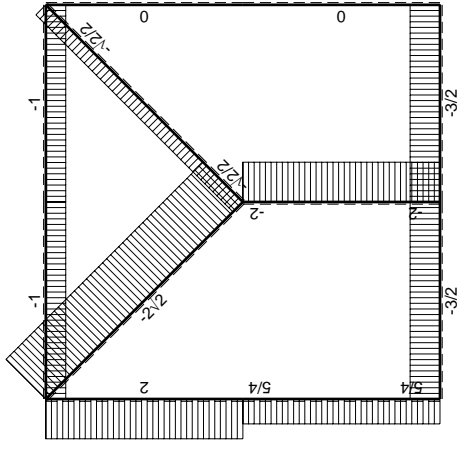
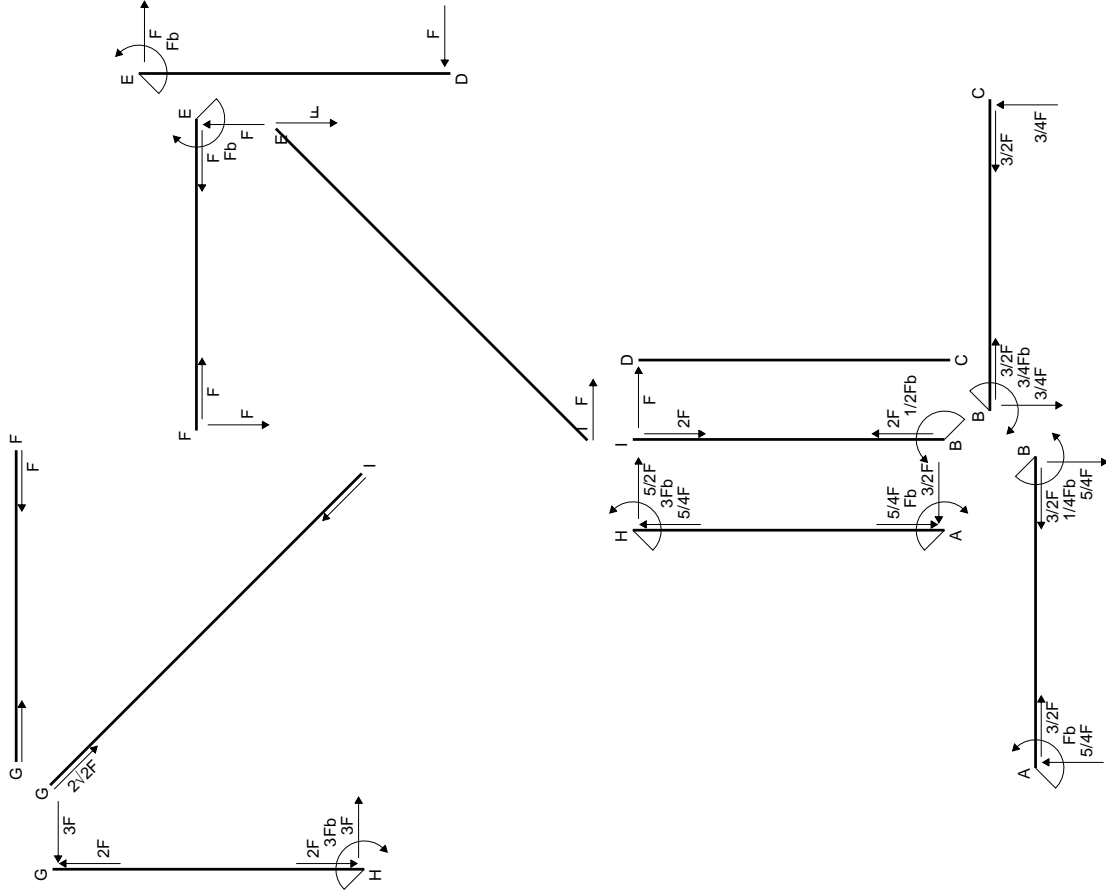
$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

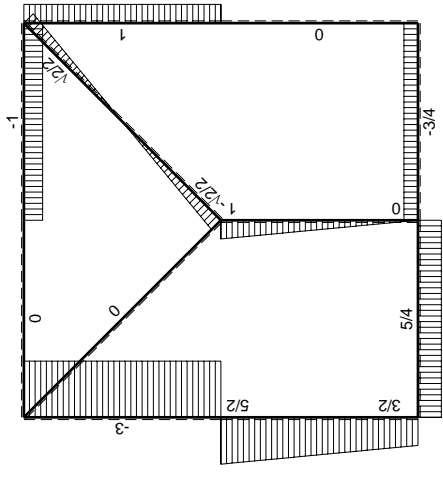
$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$



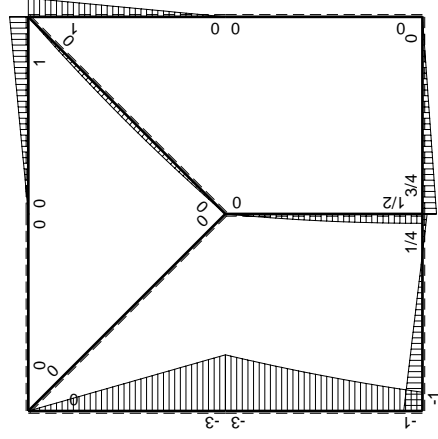
- A = 1134. mm<sup>2</sup>
- J<sub>u</sub> = 375027. mm<sup>4</sup>
- J<sub>v</sub> = 97956. mm<sup>4</sup>
- y<sub>g</sub> = 31.01 mm
- N = 2120. N
- T<sub>y</sub> = -3180. N
- M<sub>x</sub> = -2544000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -31.01 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -208.5 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -18.01 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -120.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.247 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 120.6 N/mm<sup>2</sup>
- S = 7425. mm<sup>3</sup>



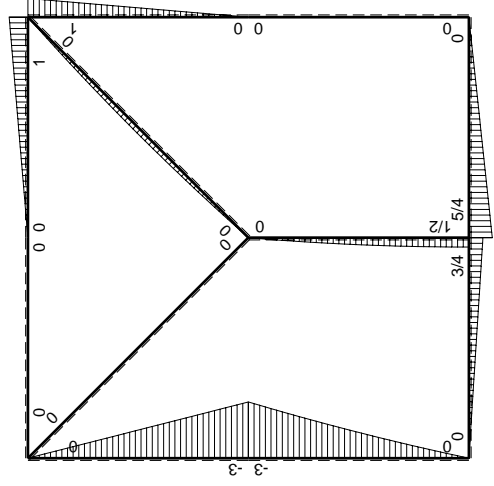
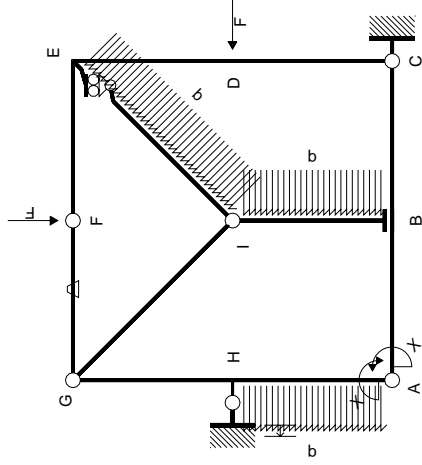
$\left[ \begin{array}{c} + \\ - \end{array} \right] \rightarrow F$



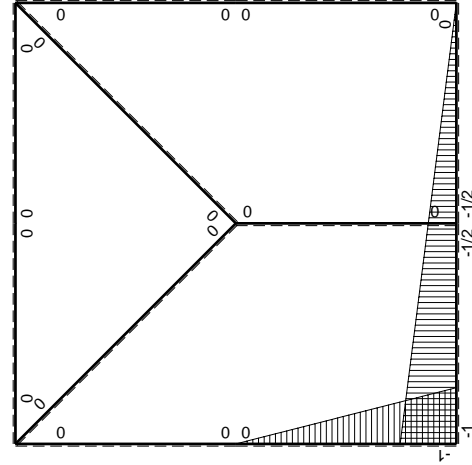
$\left[ \begin{array}{c} + \\ - \end{array} \right] \rightarrow F$



$\left[ \begin{array}{c} + \\ - \end{array} \right] \rightarrow F_b$



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	0	0	0	0			
FG b	0	0	-Fb/EJ	0	0	0	0+0	0	
GF b	0	0	Fb/EJ	0	0	0			
GH b	0	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

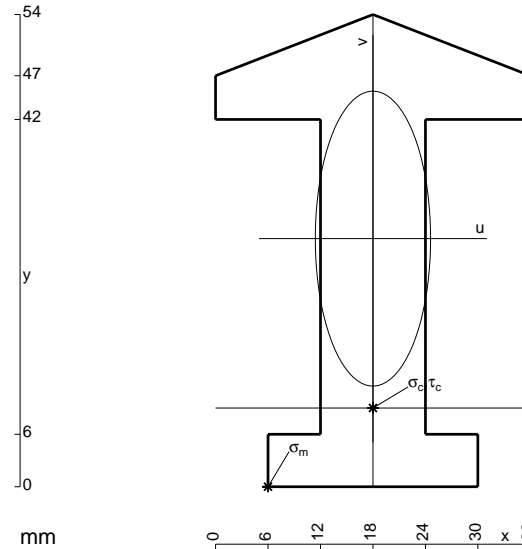
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

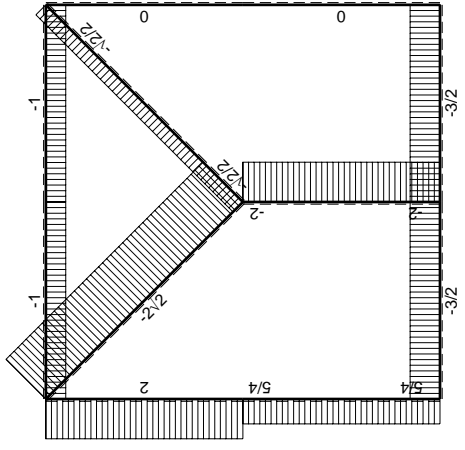
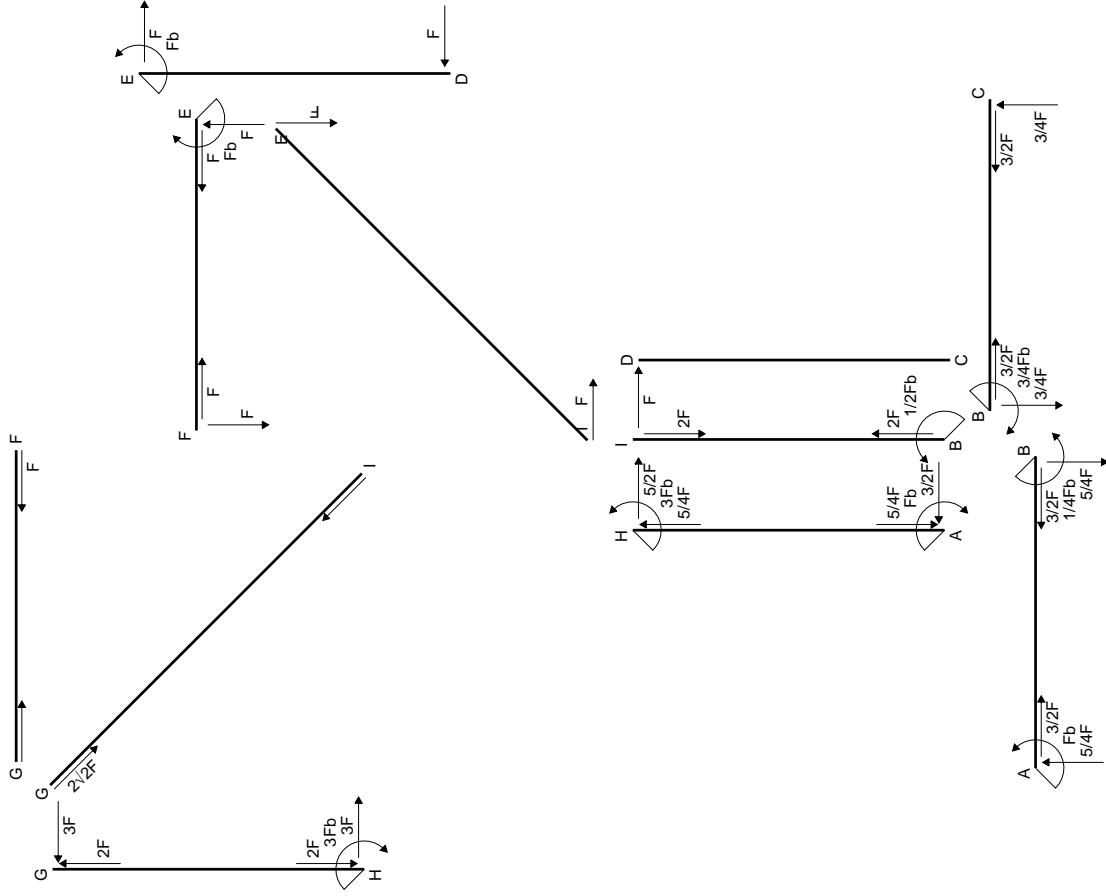
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

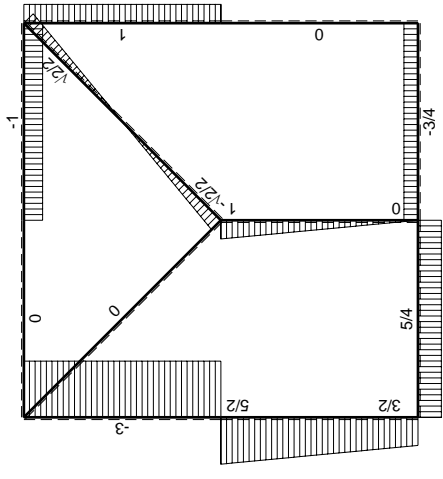


- A = 882. mm<sup>2</sup>
- J<sub>u</sub> = 250944. mm<sup>4</sup>
- J<sub>v</sub> = 38340. mm<sup>4</sup>
- y<sub>g</sub> = 28.37 mm
- N = 1520. N
- T<sub>y</sub> = -2280. N
- M<sub>x</sub> = -1938000. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.37 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -217.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -19.37 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -147.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 3.335 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 148. N/mm<sup>2</sup>
- S = 4405. mm<sup>3</sup>

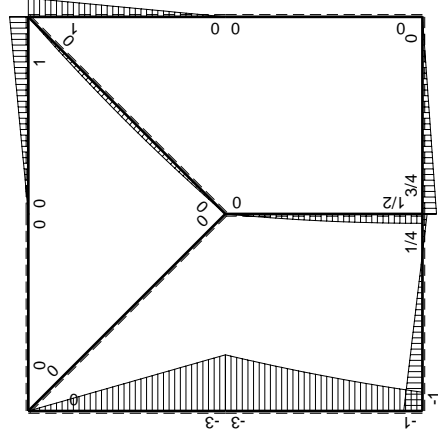




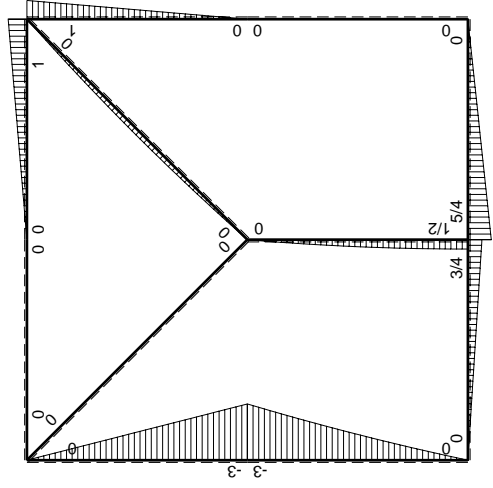
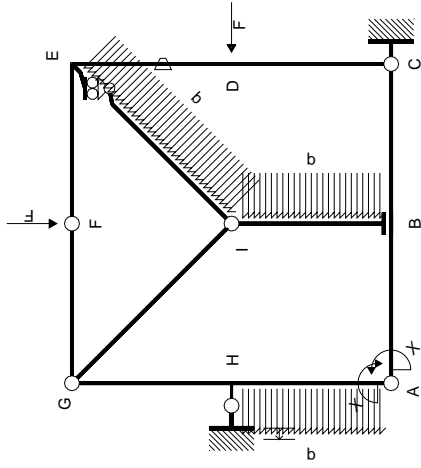
$\leftarrow \rightarrow F$



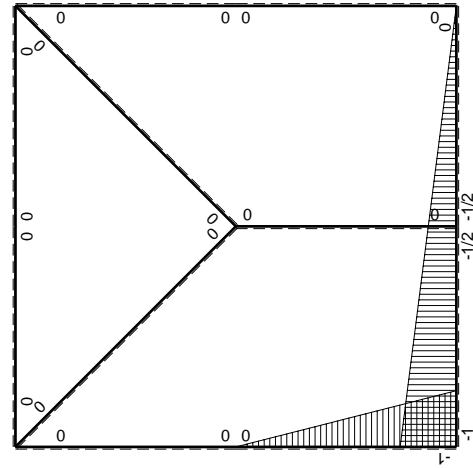
$\leftarrow \rightarrow F$



$\leftarrow \rightarrow F_b$



$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	$Fb/EJ$	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0			
FE b	0	$-Fx$	0	0	0	0	0+0	0	
FG b	0	0	0	0	0	0			
GF b	0	0	0	0	0	0	0+0	0	
GH b	0	$-3Fx$	0	0	0	0			
HG b	0	$3Fb-3Fx$	0	0	0	0	0+0	0	
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0			
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

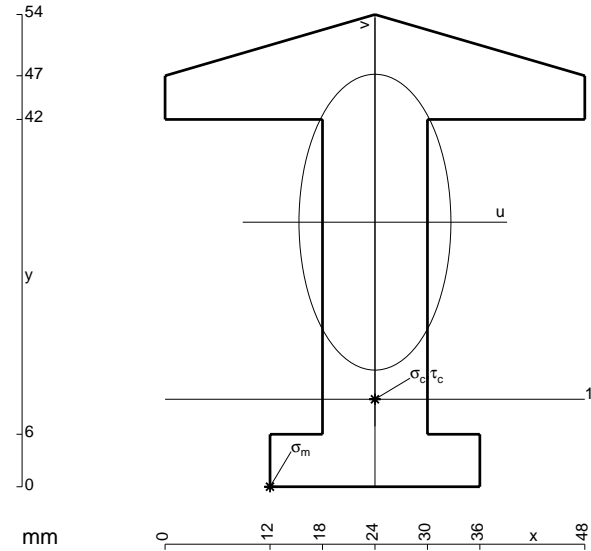
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

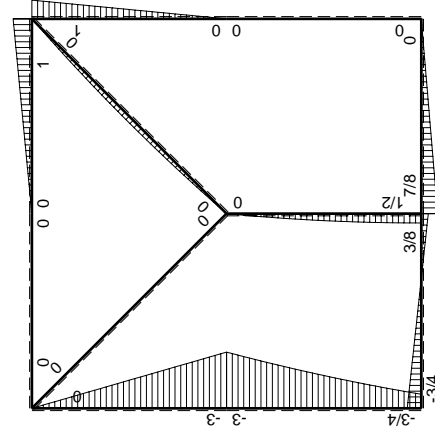
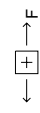
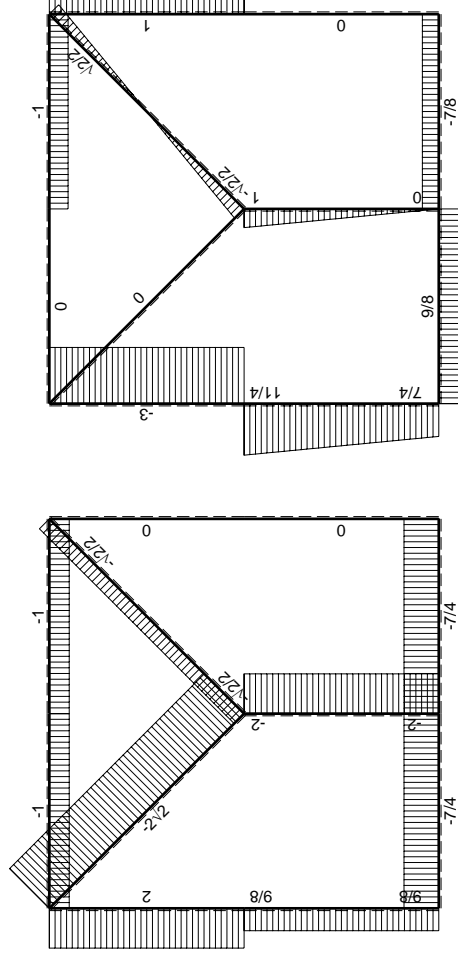
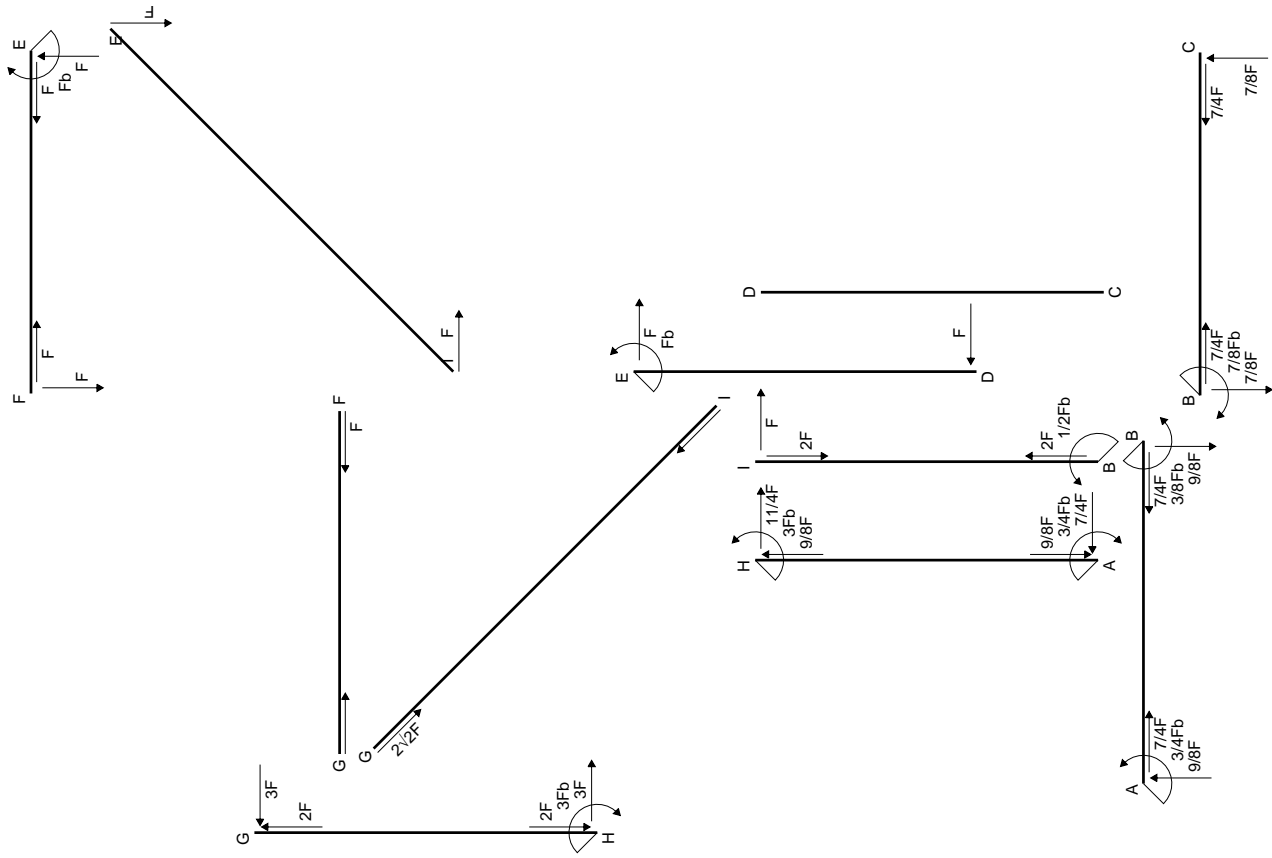
$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

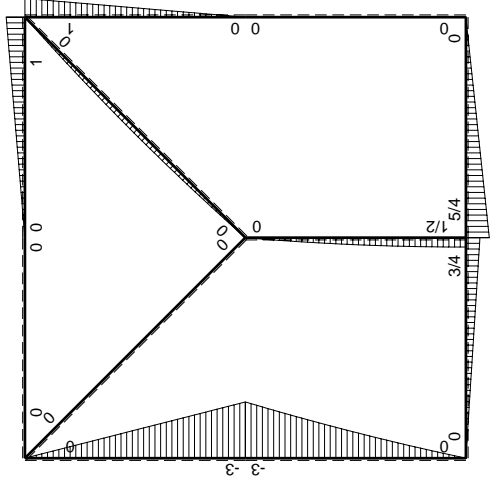
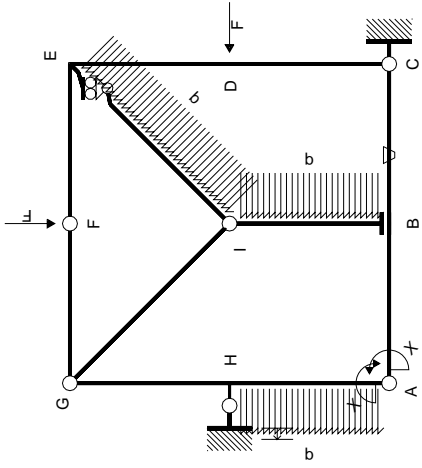
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

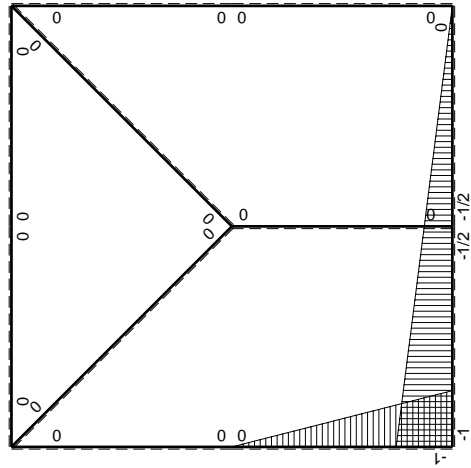


- A = 984. mm<sup>2</sup>
- J<sub>u</sub> = 281765. mm<sup>4</sup>
- J<sub>v</sub> = 74304. mm<sup>4</sup>
- y<sub>g</sub> = 30.25 mm
- N = 1580. N
- T<sub>y</sub> = -2370. N
- M<sub>x</sub> = -2133000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.25 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -227.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -20.25 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -151.7 N/mm<sup>2</sup>
- τ<sub>c</sub> = 3.499 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 151.8 N/mm<sup>2</sup>
- S = 4992. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	$-Fb/EJ$	$-5/8Fb+5/4Fx-5/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	$Fb/EJ$	$-5/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-3Fx$	0	0	0	0	0+0	0	
HG b	0	$3Fb-3Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

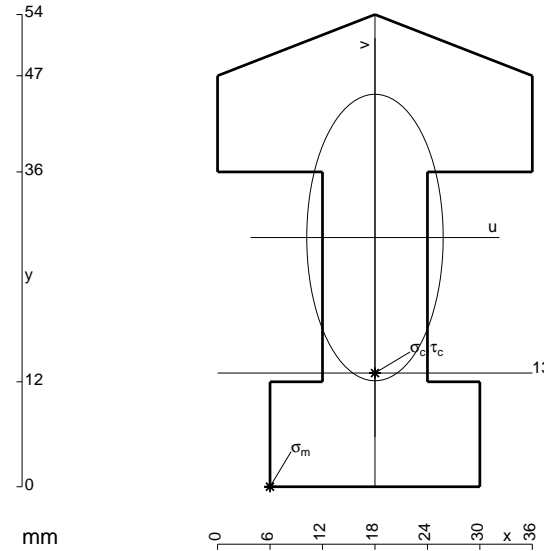
$$= (-5/24 b) Fb 1/EJ + (-1/4 b) \theta = 1/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$



$$A = 1098. \text{ mm}^2$$

$$J_u = 294859. \text{ mm}^4$$

$$J_v = 66852. \text{ mm}^4$$

$$y_g = 28.5 \text{ mm}$$

$$N = 1740. \text{ N}$$

$$T_y = -2610. \text{ N}$$

$$M_x = -2479500. \text{ Nmm}$$

$$x_m = 6. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -28.5 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = -238.1 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

$$v_c = -15.5 \text{ mm}$$

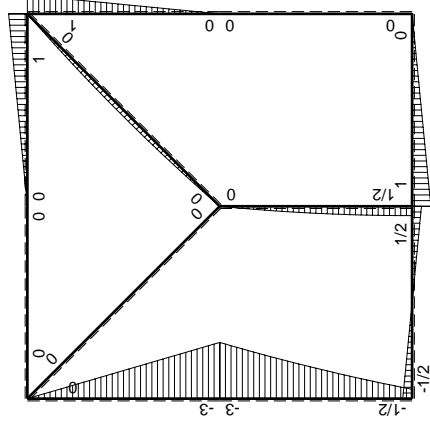
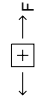
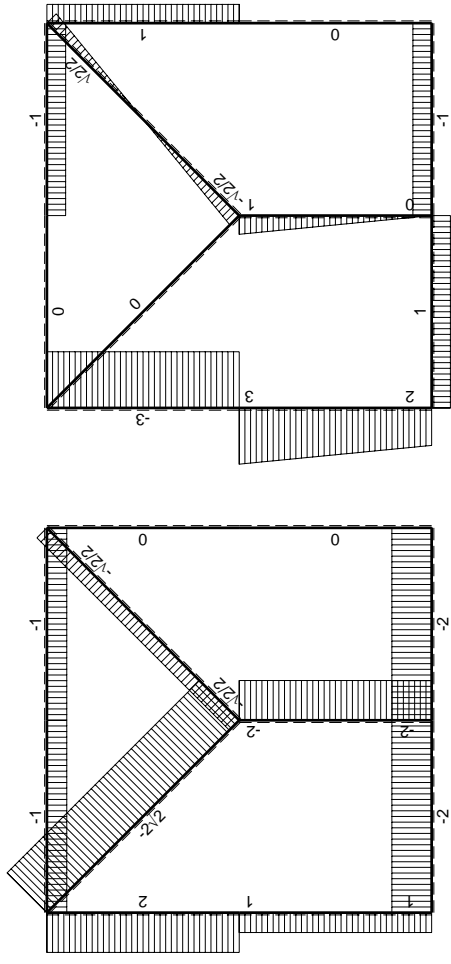
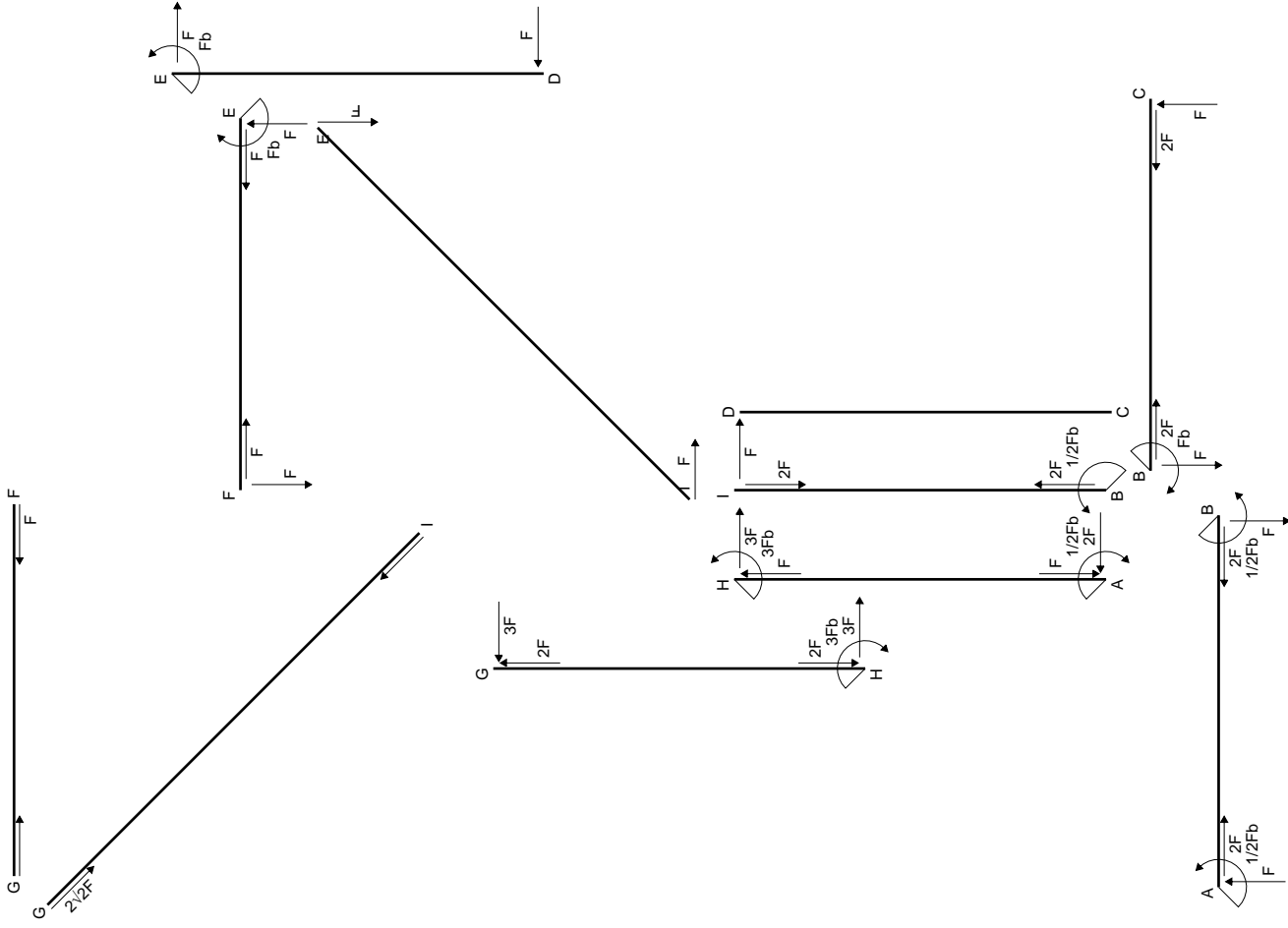
$$\sigma_c = N/A - Mv/J_u = -128.7 \text{ N/mm}^2$$

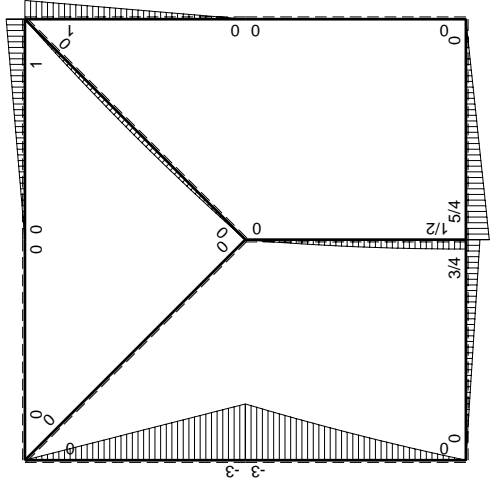
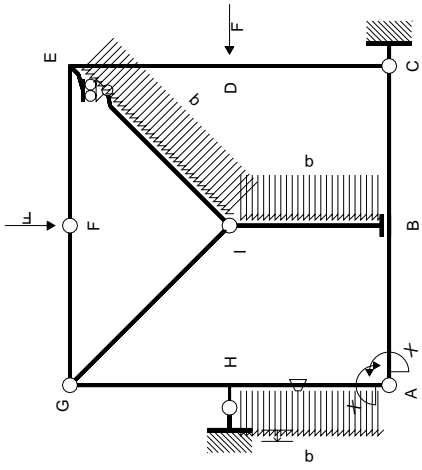
$$\tau_c = 4.921 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 129. \text{ N/mm}^2$$

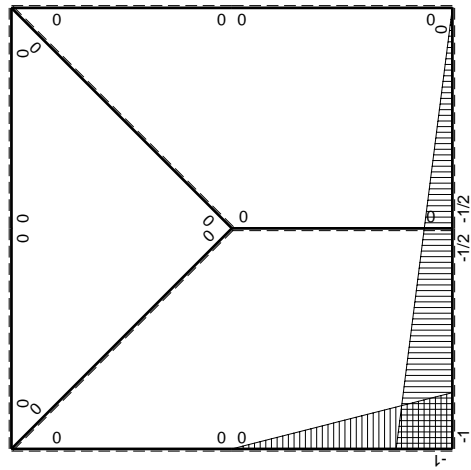
$$S = 6671. \text{ mm}^3$$







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$			
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	-Fb/EJ	$3Fx-7/2Fx^2/b+1/2qx^3/b$	Fx/EJ	$x^2/b^2$	$(11/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	Fb/EJ	$5/2Fx-2Fx^2/b-1/2qx^3/b$	Fb/EJ-Fx/EJ	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/2Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

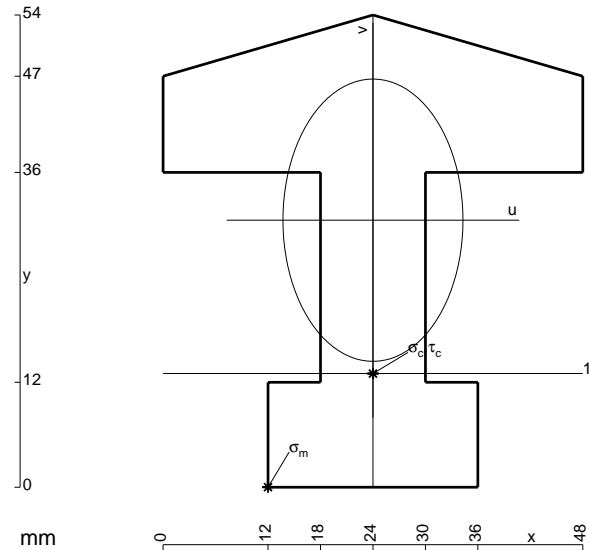
$$= [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 23/24 Fb^2/EJ$$

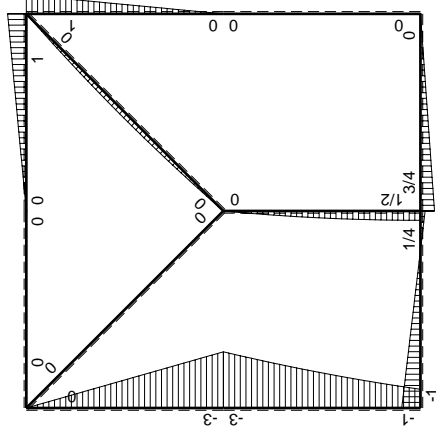
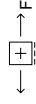
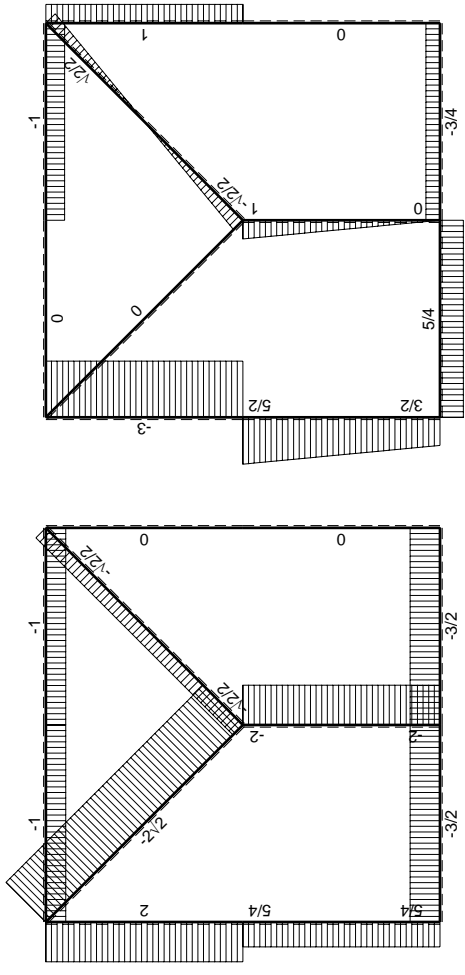
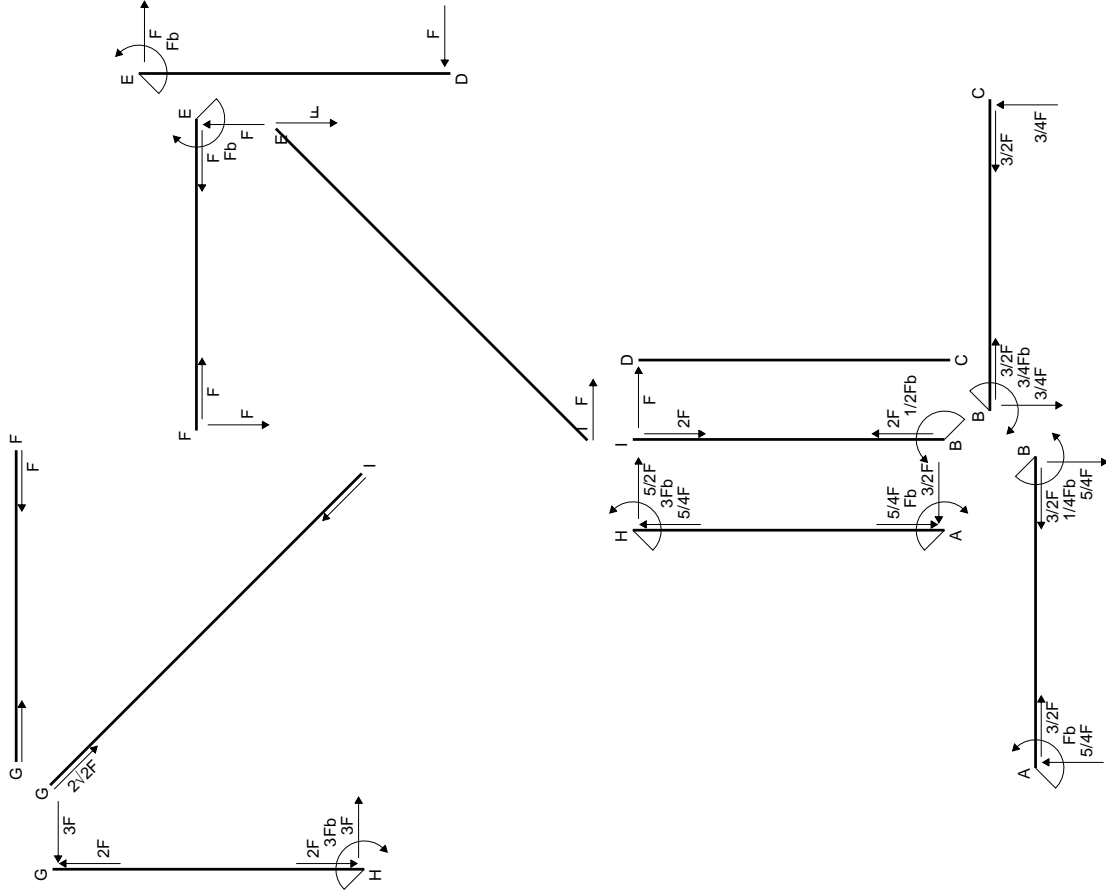
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

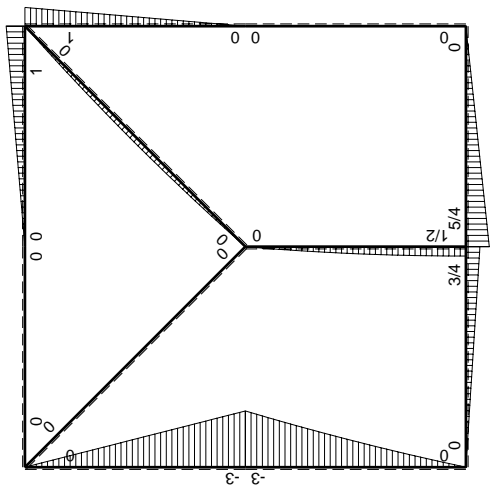
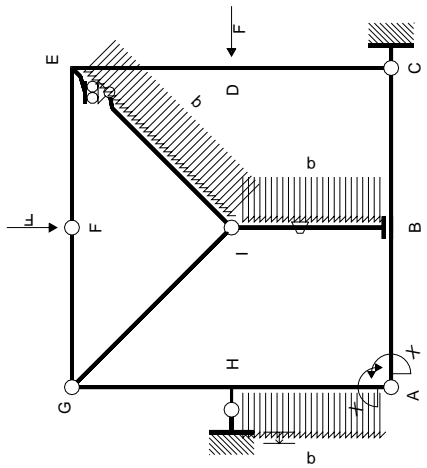
$$= [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 23/24 Fb^2/EJ$$

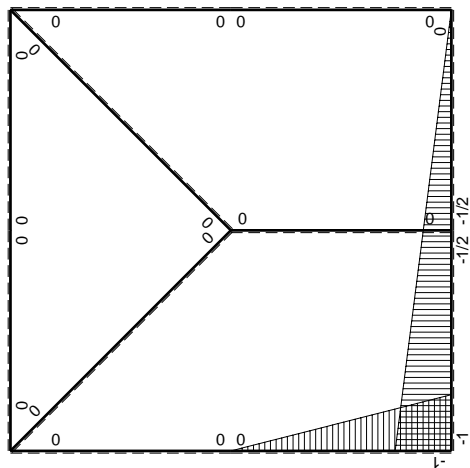


- A = 1272. mm<sup>2</sup>
- J<sub>u</sub> = 331576. mm<sup>4</sup>
- J<sub>v</sub> = 134784. mm<sup>4</sup>
- y<sub>g</sub> = 30.53 mm
- N = 2920. N
- T<sub>y</sub> = -4380. N
- M<sub>x</sub> = -2190000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.53 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -199.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -17.53 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -113.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.016 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 114.4 N/mm<sup>2</sup>
- S = 7282. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	$Fb/EJ$	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{x_0} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{x_0} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{x_0} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{x_0} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

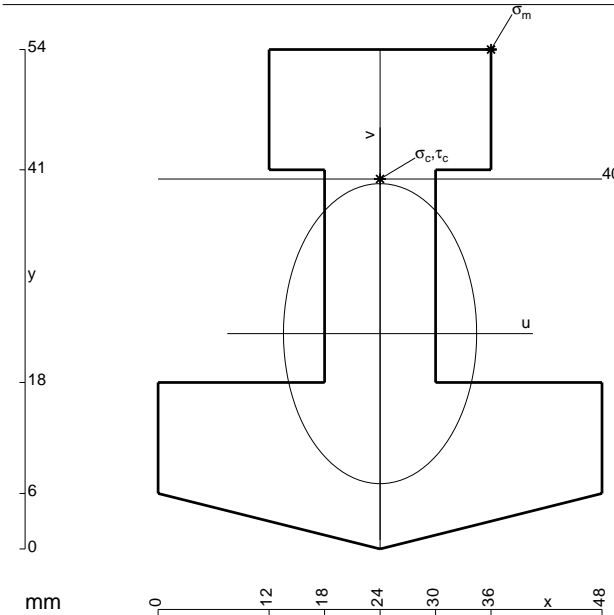
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{x_0} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

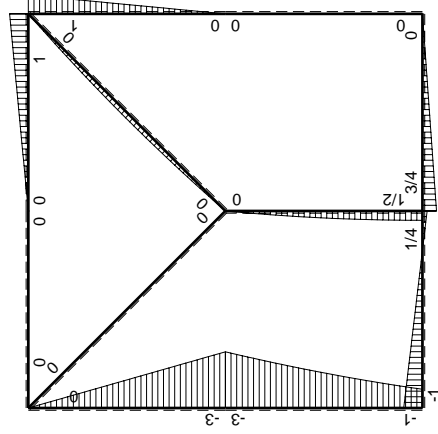
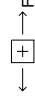
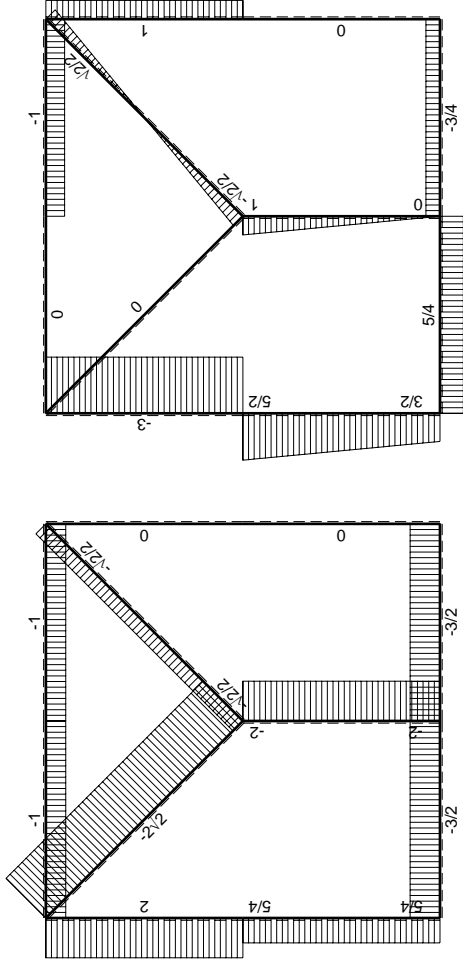
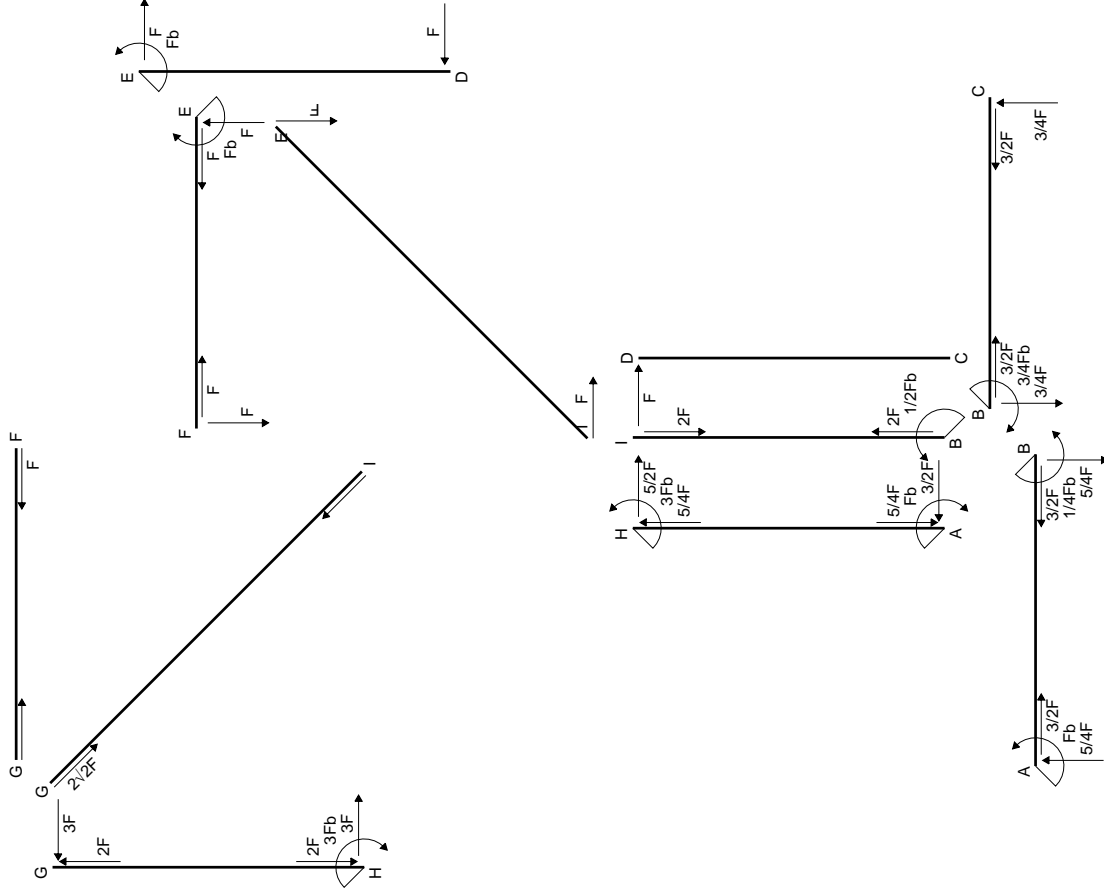
$$L_{AH}^{x_0} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

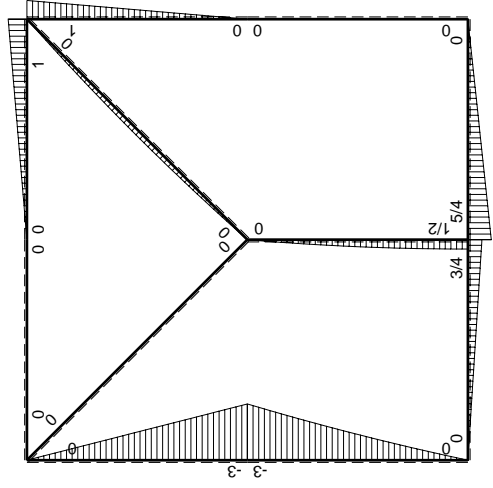
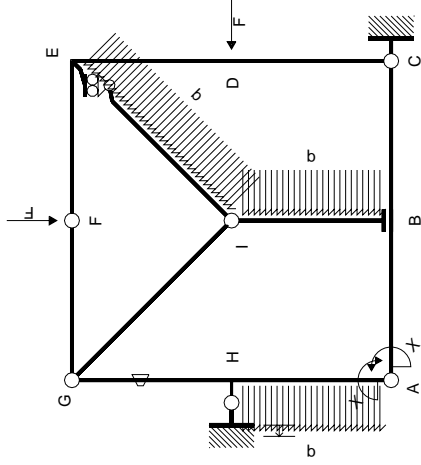
$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$



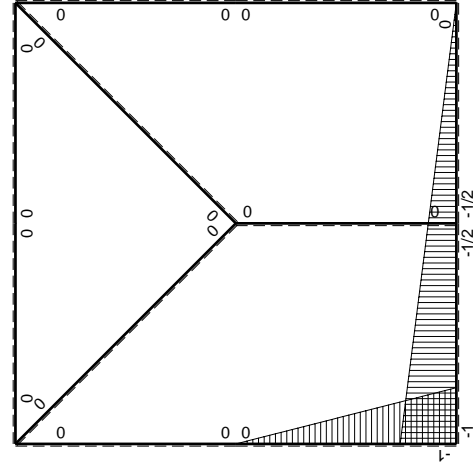
- A = 1308. mm<sup>2</sup>
- J<sub>u</sub> = 344278. mm<sup>4</sup>
- J<sub>v</sub> = 142704. mm<sup>4</sup>
- y<sub>g</sub> = 23.28 mm
- N = 2820. N
- T<sub>y</sub> = -4230. N
- M<sub>x</sub> = -2326500. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.72 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 209.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 16.72 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 115.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.949 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 116. N/mm<sup>2</sup>
- S = 7763. mm<sup>3</sup>







$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	-3Fx	-Fb/EJ	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	Fb/EJ	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

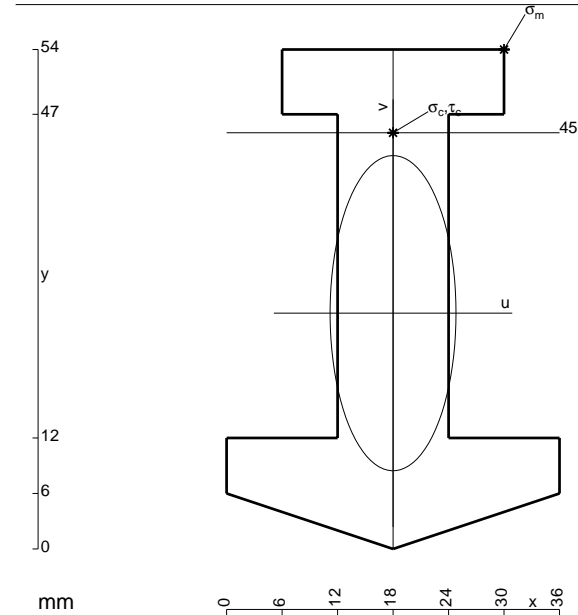
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

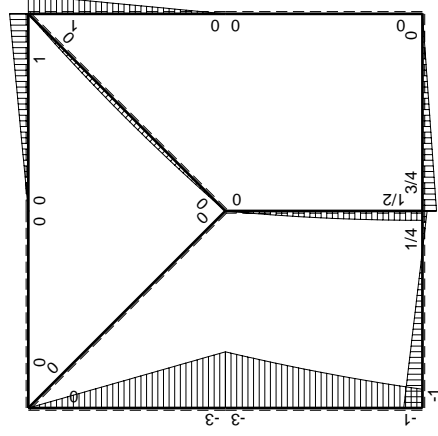
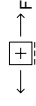
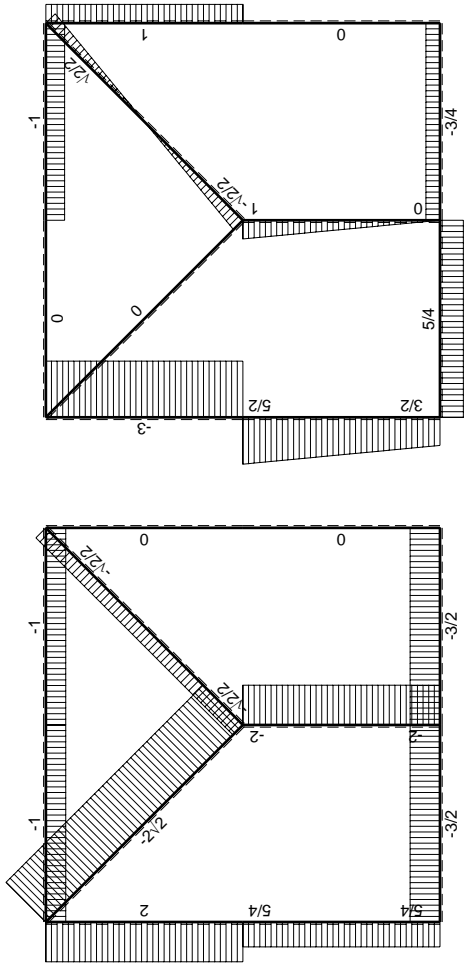
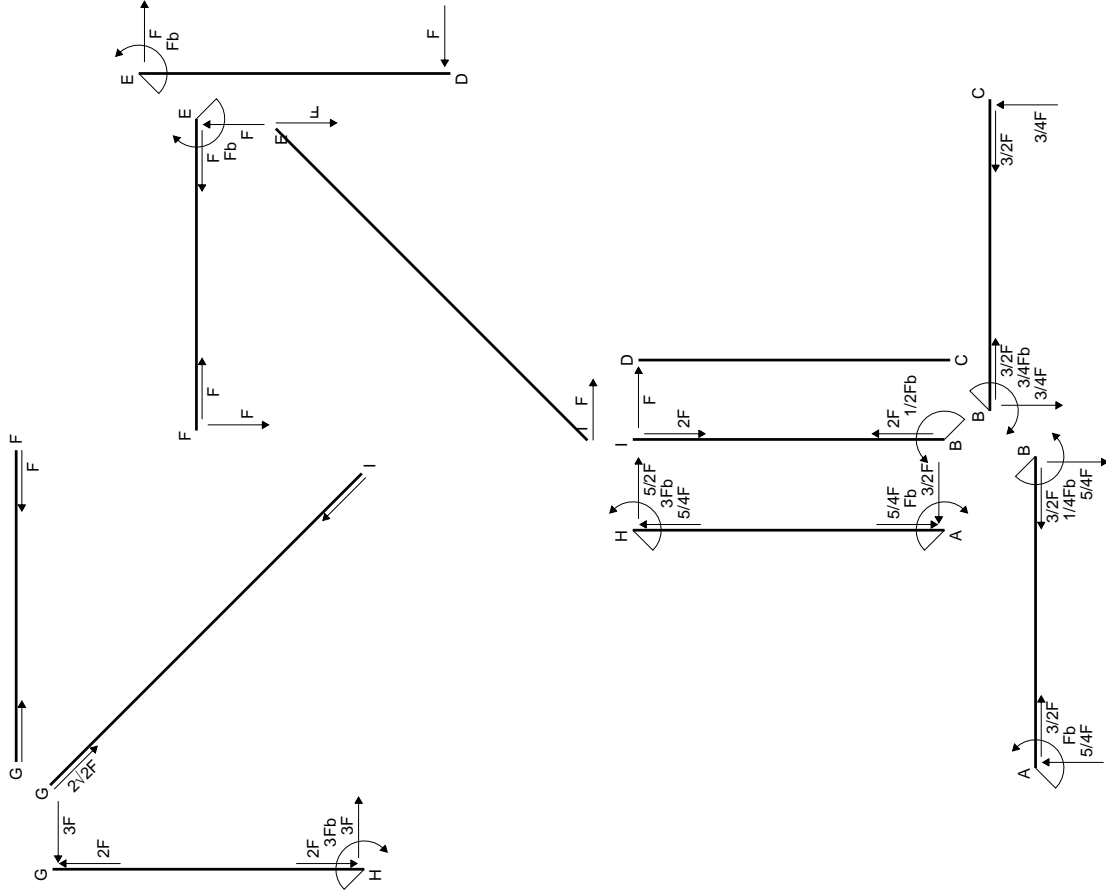
$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

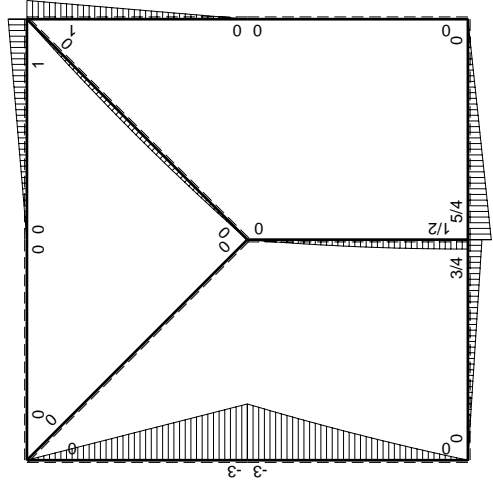
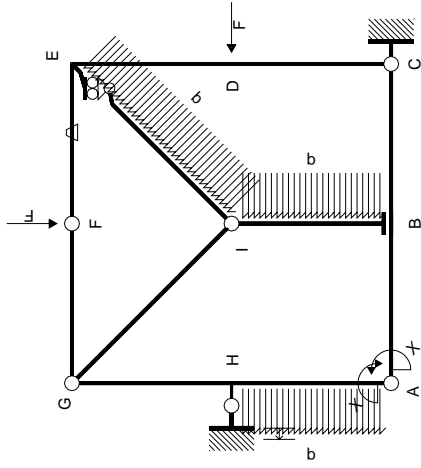
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

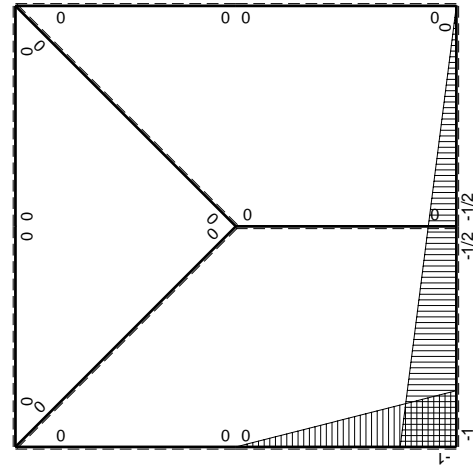


- A = 912. mm<sup>2</sup>
- J<sub>u</sub> = 264874. mm<sup>4</sup>
- J<sub>v</sub> = 42264. mm<sup>4</sup>
- y<sub>g</sub> = 25.49 mm
- N = 2240. N
- T<sub>y</sub> = -3360. N
- M<sub>x</sub> = -2016000. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.51 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 219.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 45. mm
- v<sub>c</sub> = 19.51 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 150.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.961 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 151.2 N/mm<sup>2</sup>
- S = 4693. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	-Fb/EJ	0	0	0	0+0	0	
FE b	0	-Fx	Fb/EJ	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	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

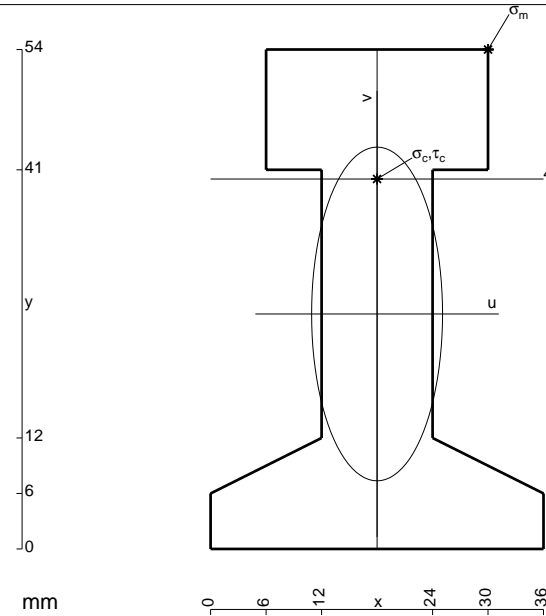
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

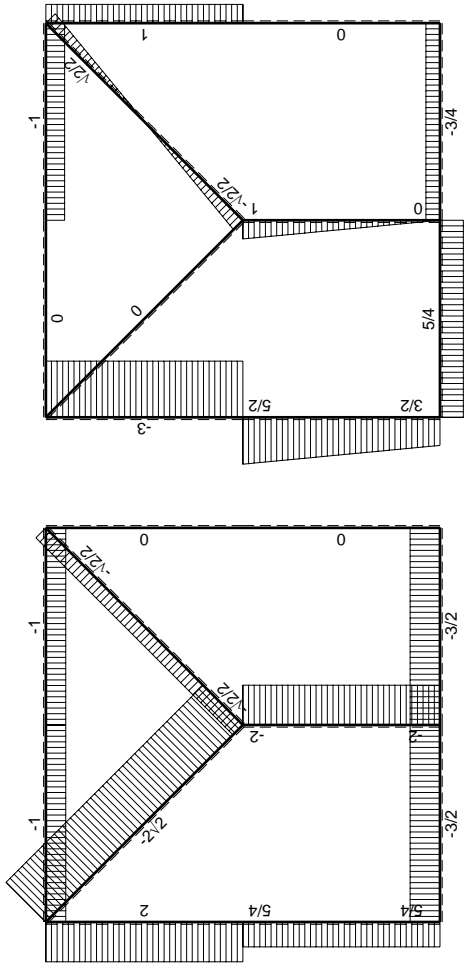
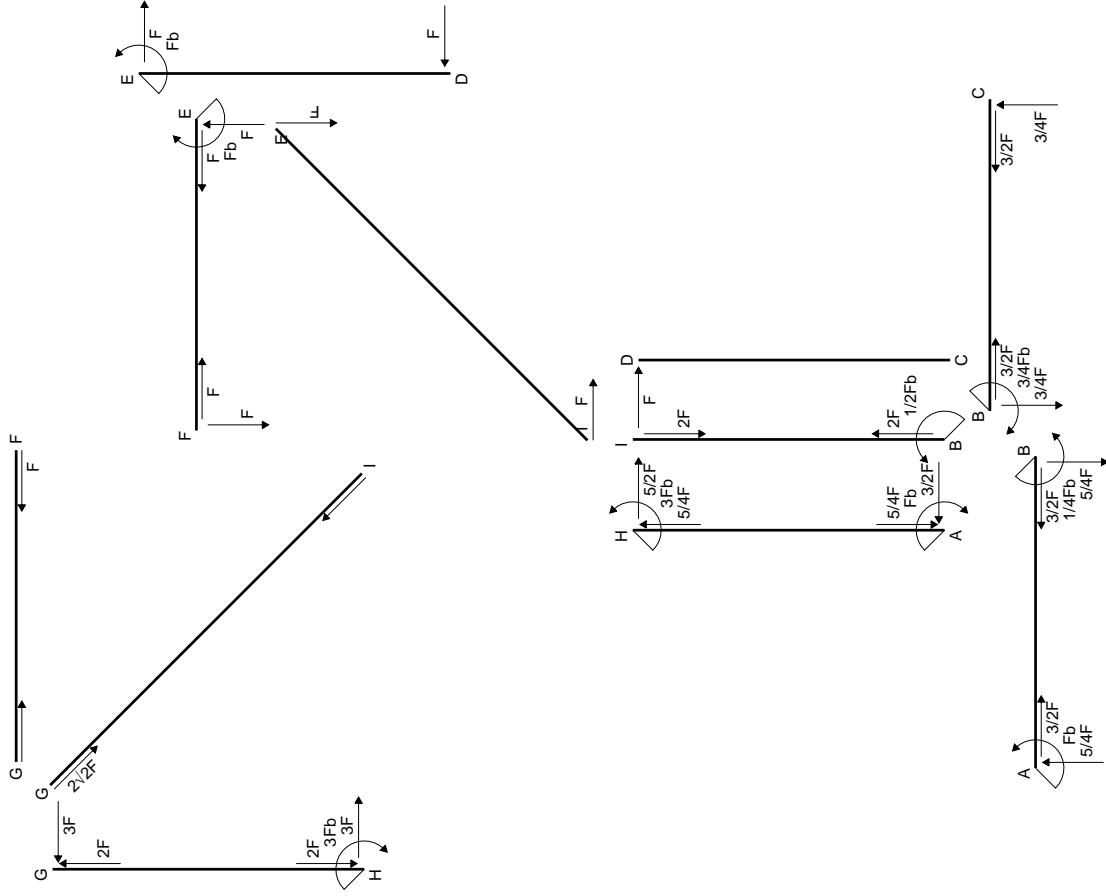
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$



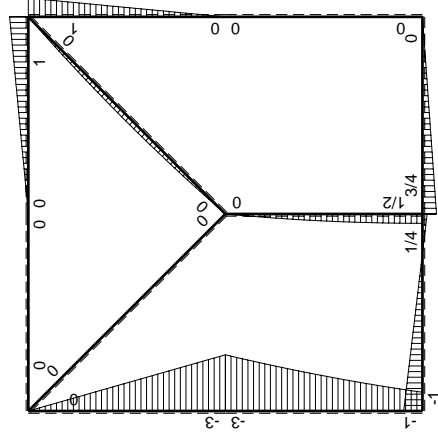
- A = 1020. mm<sup>2</sup>
- J<sub>u</sub> = 332140. mm<sup>4</sup>
- J<sub>v</sub> = 51120. mm<sup>4</sup>
- y<sub>g</sub> = 25.41 mm
- N = 2700. N
- T<sub>y</sub> = -4050. N
- M<sub>x</sub> = -2632500. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.59 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 229.3 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 14.59 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 118.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.189 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 119. N/mm<sup>2</sup>
- S = 7074. mm<sup>3</sup>



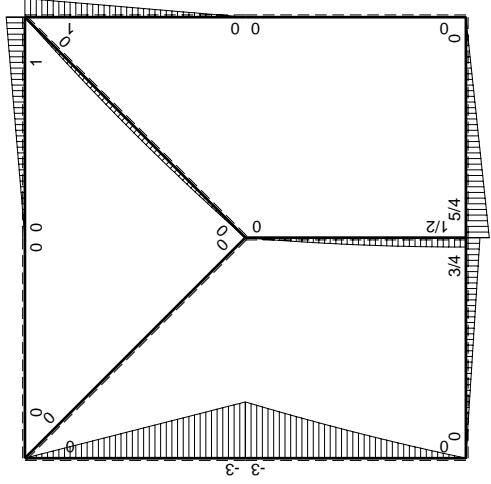
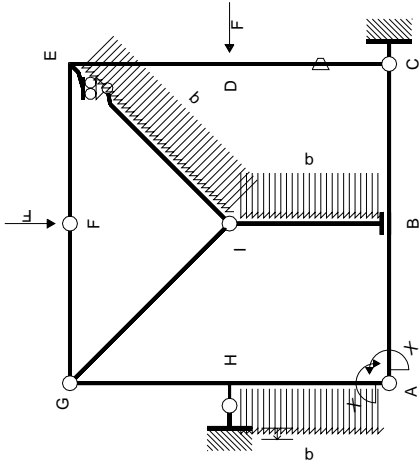


← ⊕ → F

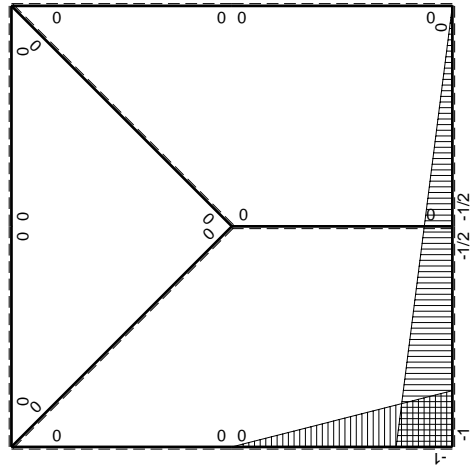
↑ ⊕ ↓ F



← ⊕ → F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	0	$Fb/EJ$	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-3Fx$	0	0	0	0	0+0	0	
HG b	0	$3Fb-3Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

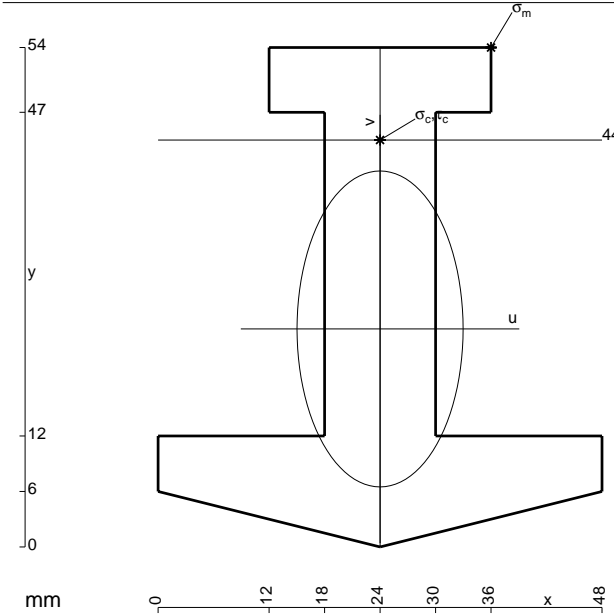
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

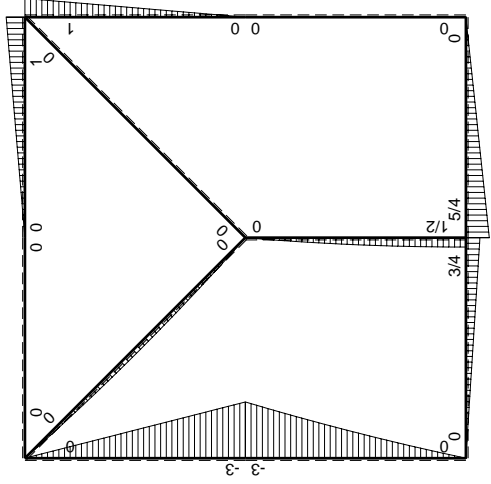
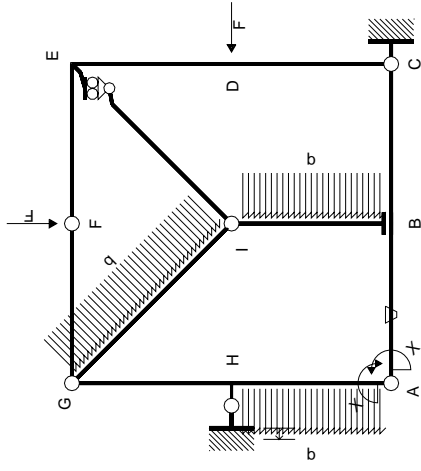
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

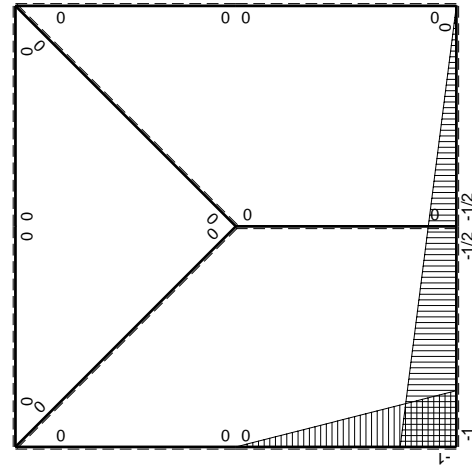


- A = 1020. mm<sup>2</sup>
- J<sub>u</sub> = 297608. mm<sup>4</sup>
- J<sub>v</sub> = 82224. mm<sup>4</sup>
- y<sub>g</sub> = 23.57 mm
- N = 2200. N
- T<sub>y</sub> = -3300. N
- M<sub>x</sub> = -2310000. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.43 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 238.3 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 44. mm
- v<sub>c</sub> = 20.43 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 160.7 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.91 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 161. N/mm<sup>2</sup>
- S = 5314. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	$-Fb/EJ$	$-3/4Fx+3/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-1/4+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	$Fb/EJ$	$-3/8Fb+3/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	$Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-3Fx$	0	0	0	0	0+0	0	
HG b	0	$3Fb-3Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ + (b - 1/4 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 1/2 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

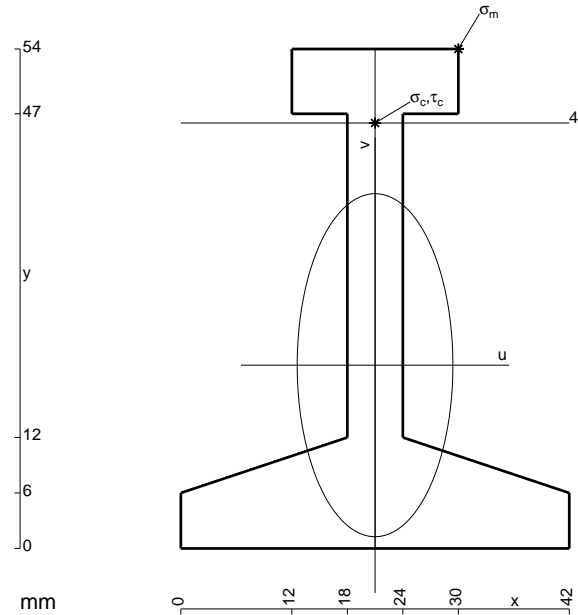
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

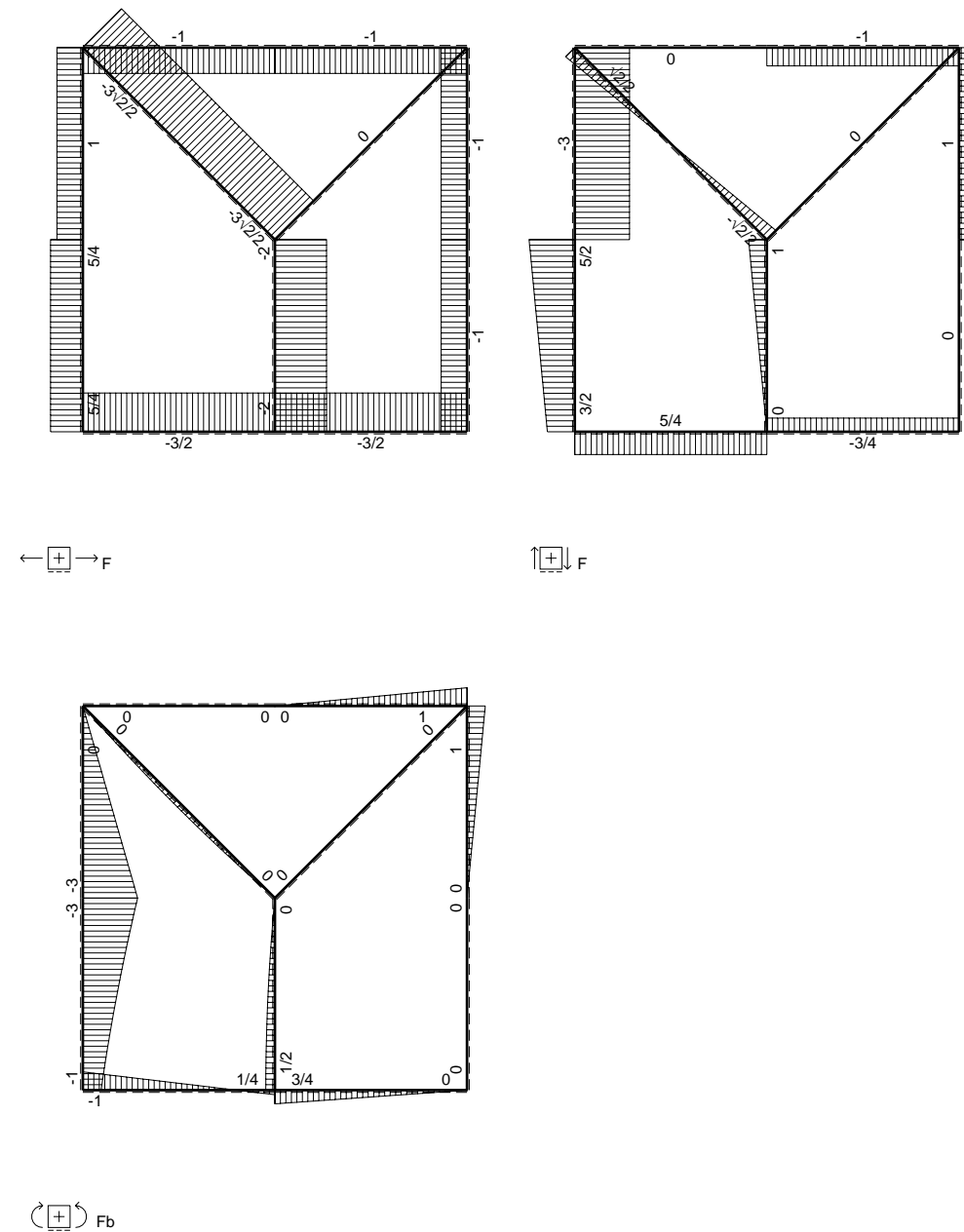
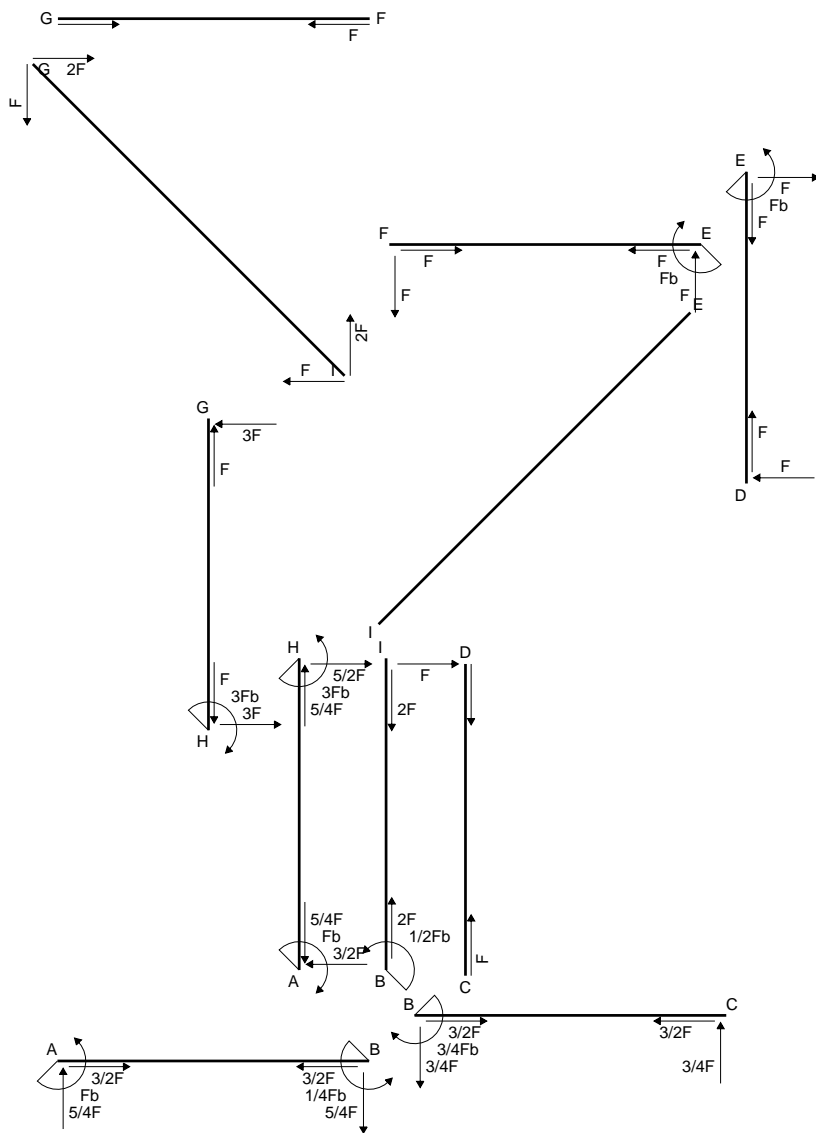
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

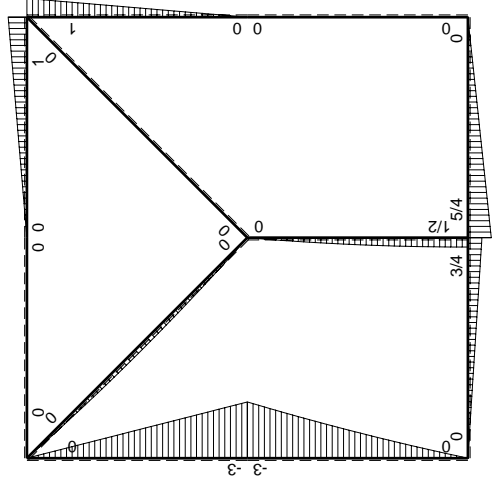
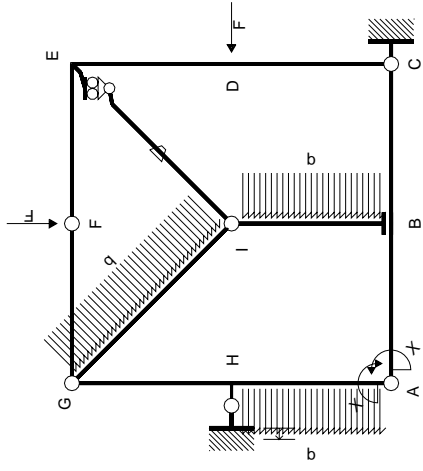
$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$



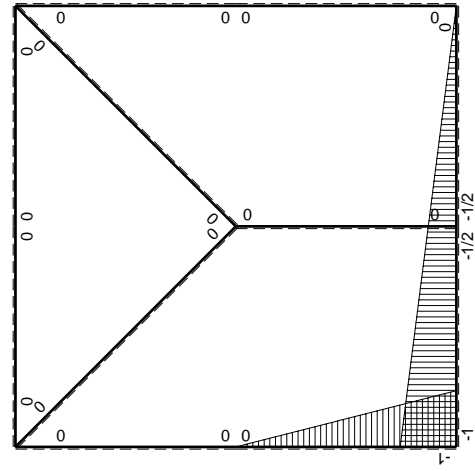
- A = 732. mm<sup>2</sup>
- J<sub>u</sub> = 251906. mm<sup>4</sup>
- J<sub>v</sub> = 51876. mm<sup>4</sup>
- y<sub>g</sub> = 19.81 mm
- N = 650. N
- T<sub>y</sub> = -1950. N
- M<sub>x</sub> = -1462500. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 34.19 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 199.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 46. mm
- v<sub>c</sub> = 26.19 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 152.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.195 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 153.2 N/mm<sup>2</sup>
- S = 4027. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	-Fb/EJ	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							-Fb <sup>2</sup> /EJ	
	totali							-Fb <sup>2</sup> /EJ	Xb/EJ
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

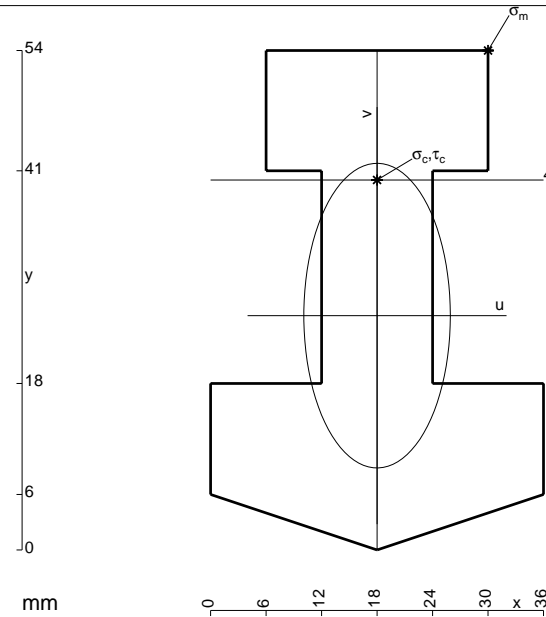
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

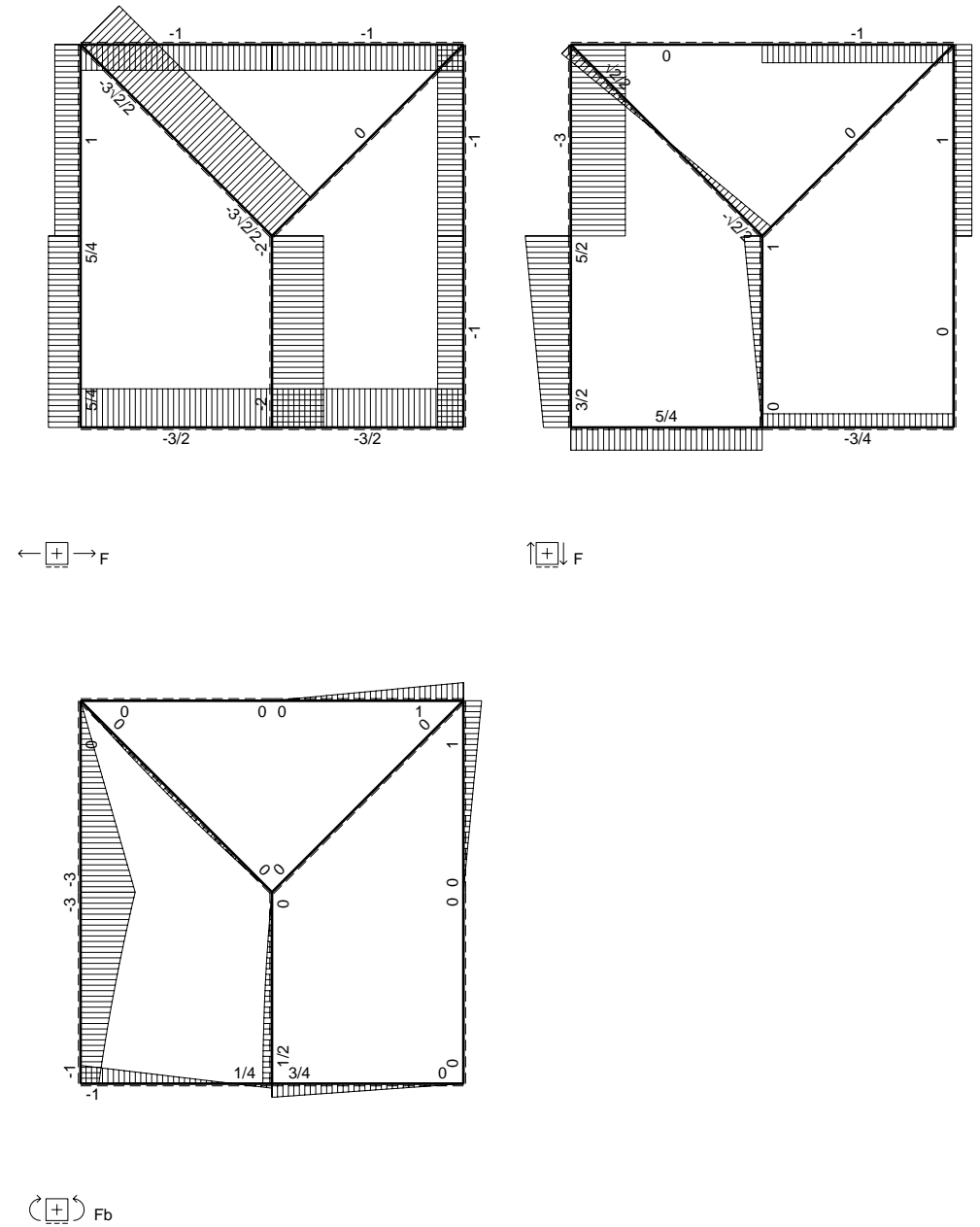
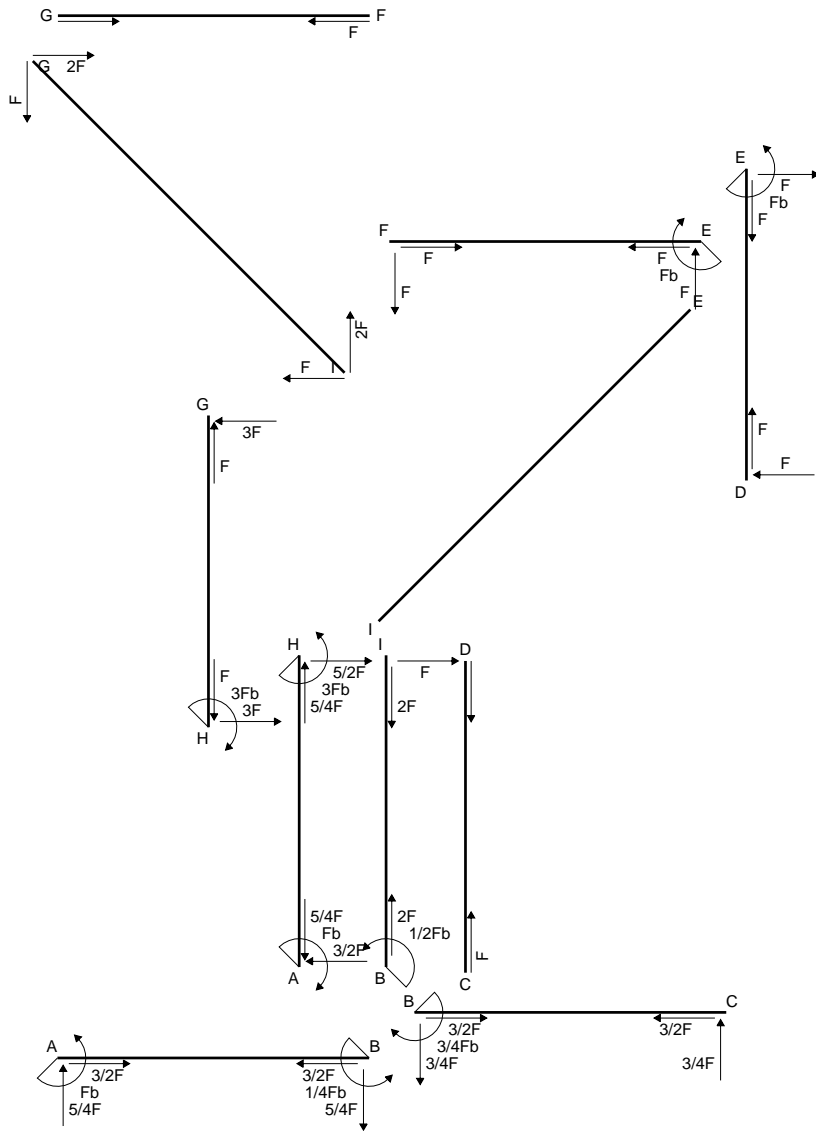
$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

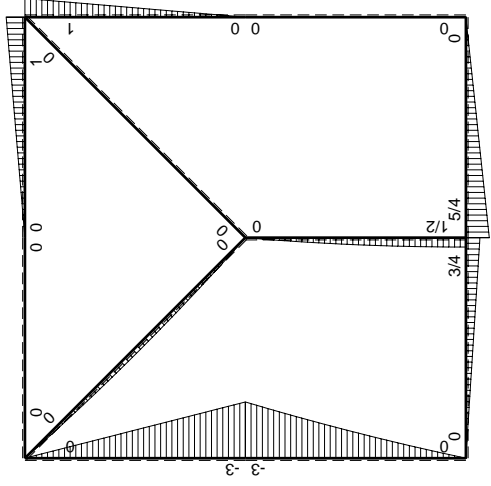
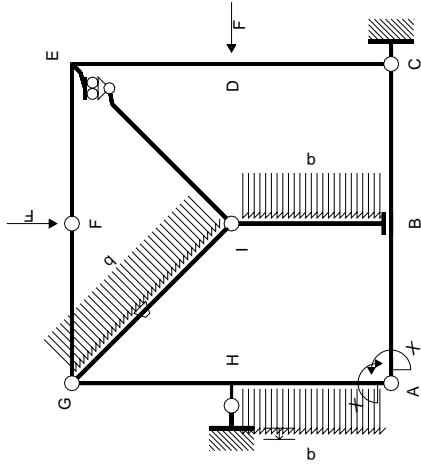
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

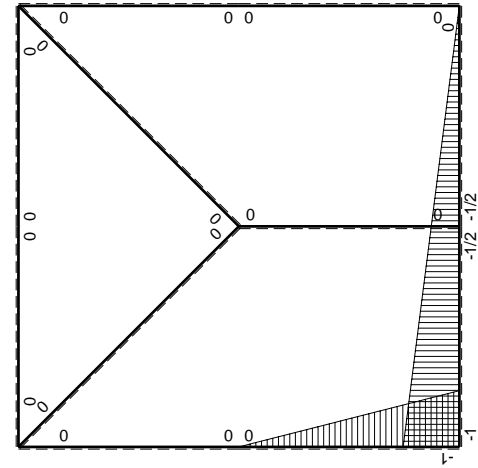


- A = 1128. mm<sup>2</sup>
- J<sub>u</sub> = 306009. mm<sup>4</sup>
- J<sub>v</sub> = 70776. mm<sup>4</sup>
- y<sub>g</sub> = 25.34 mm
- N = 930. N
- T<sub>y</sub> = -2790. N
- M<sub>x</sub> = -2232000. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.66 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 209.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 14.66 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 107.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.392 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 108.2 N/mm<sup>2</sup>
- S = 7097. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	-Fb/EJ	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

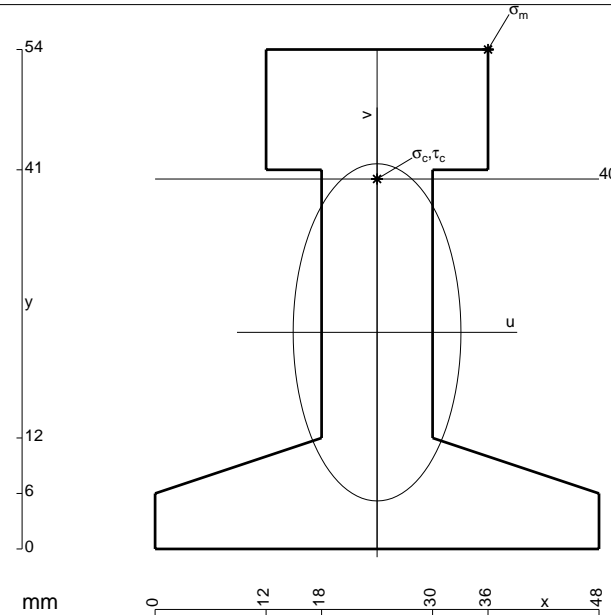
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

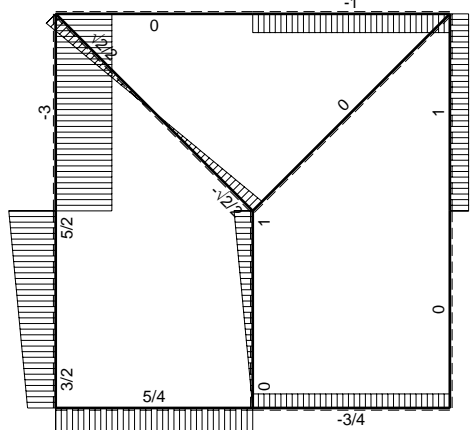
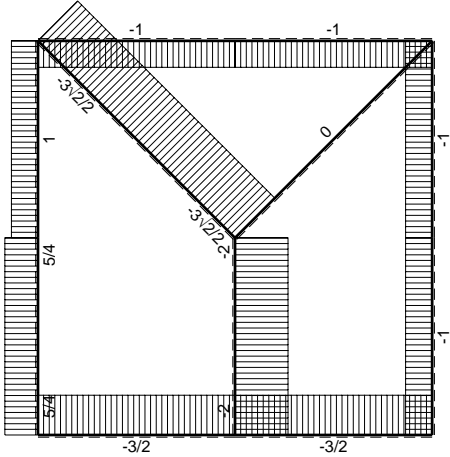
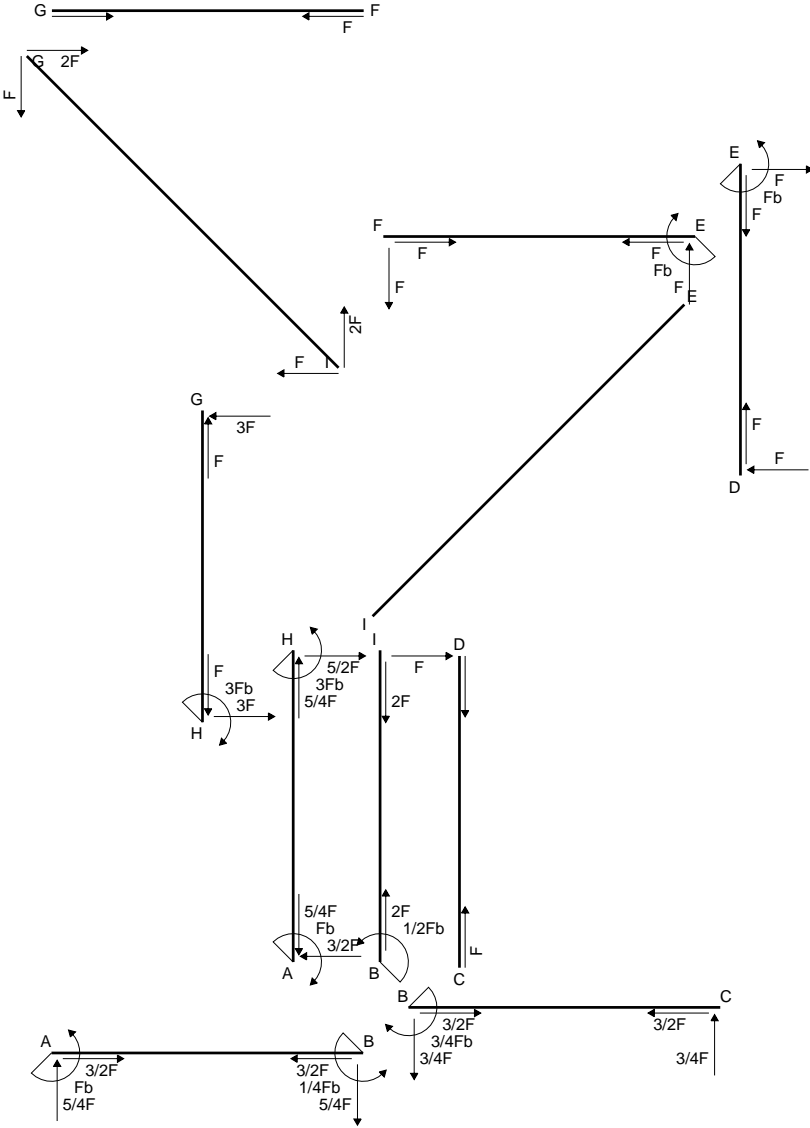
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$



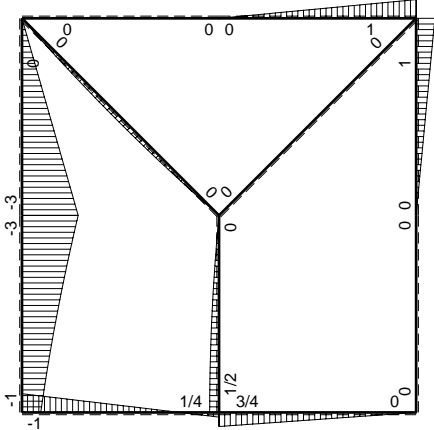
- A = 1128. mm<sup>2</sup>
- J<sub>u</sub> = 375033. mm<sup>4</sup>
- J<sub>v</sub> = 92808. mm<sup>4</sup>
- y<sub>g</sub> = 23.42 mm
- N = 1050. N
- T<sub>y</sub> = -3150. N
- M<sub>x</sub> = -2677500. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.58 mm
- σ<sub>m</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = 219.3 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 16.58 mm
- σ<sub>c</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = 119.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.402 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 119.7 N/mm<sup>2</sup>
- S = 7718. mm<sup>3</sup>



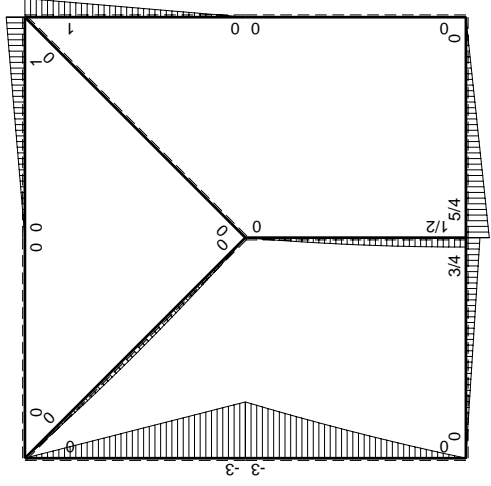
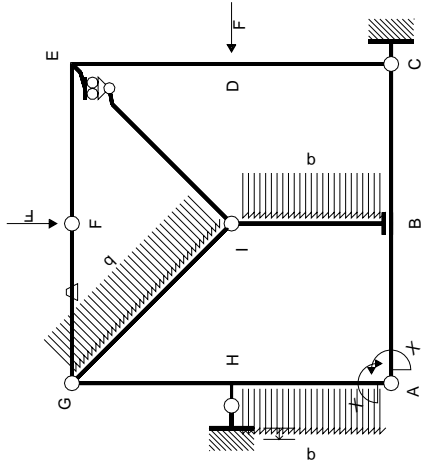


← ⊕ → F

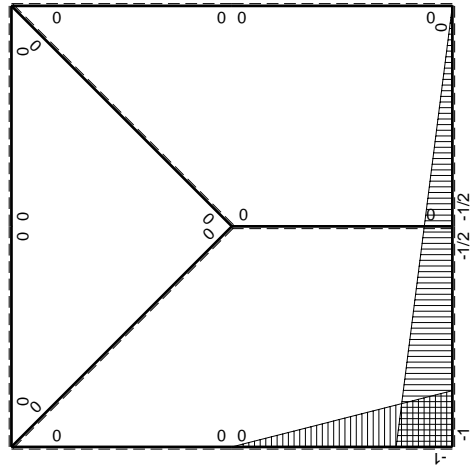
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	0	0	0	0			
FG b	0	0	-Fb/EJ	0	0	0	0+0	0	
GF b	0	0	Fb/EJ	0	0	0			
GH b	0	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

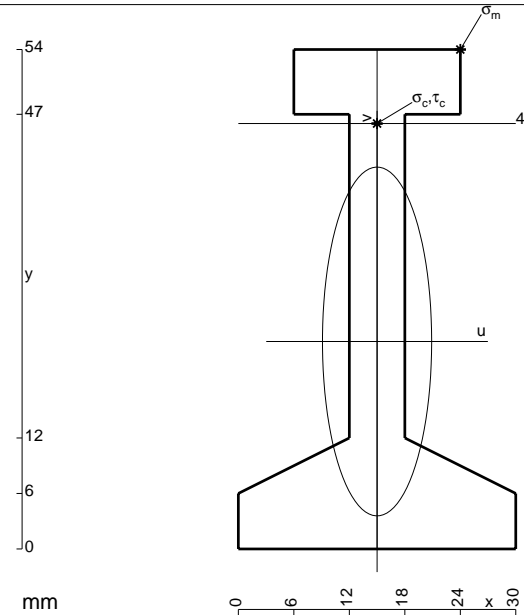
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

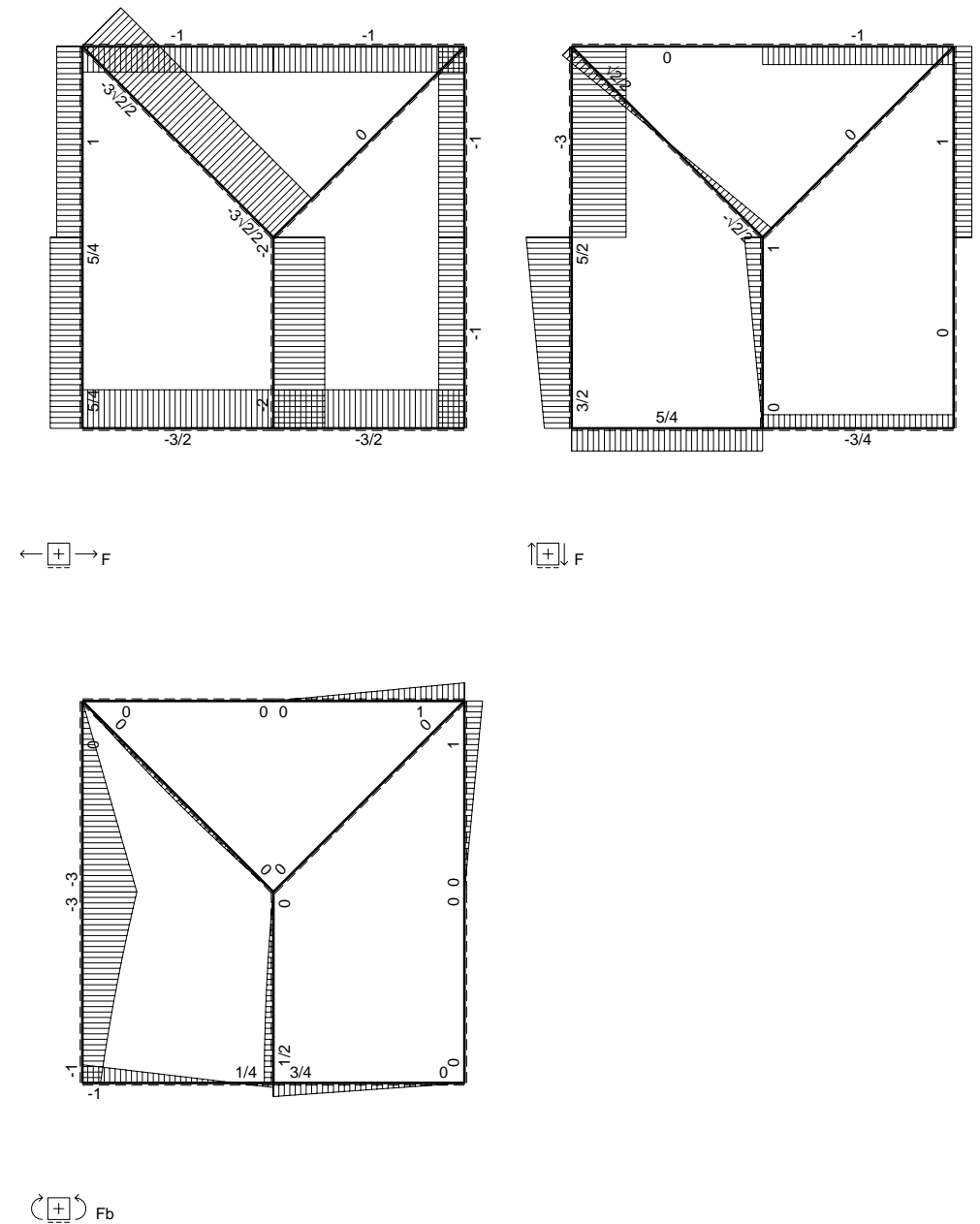
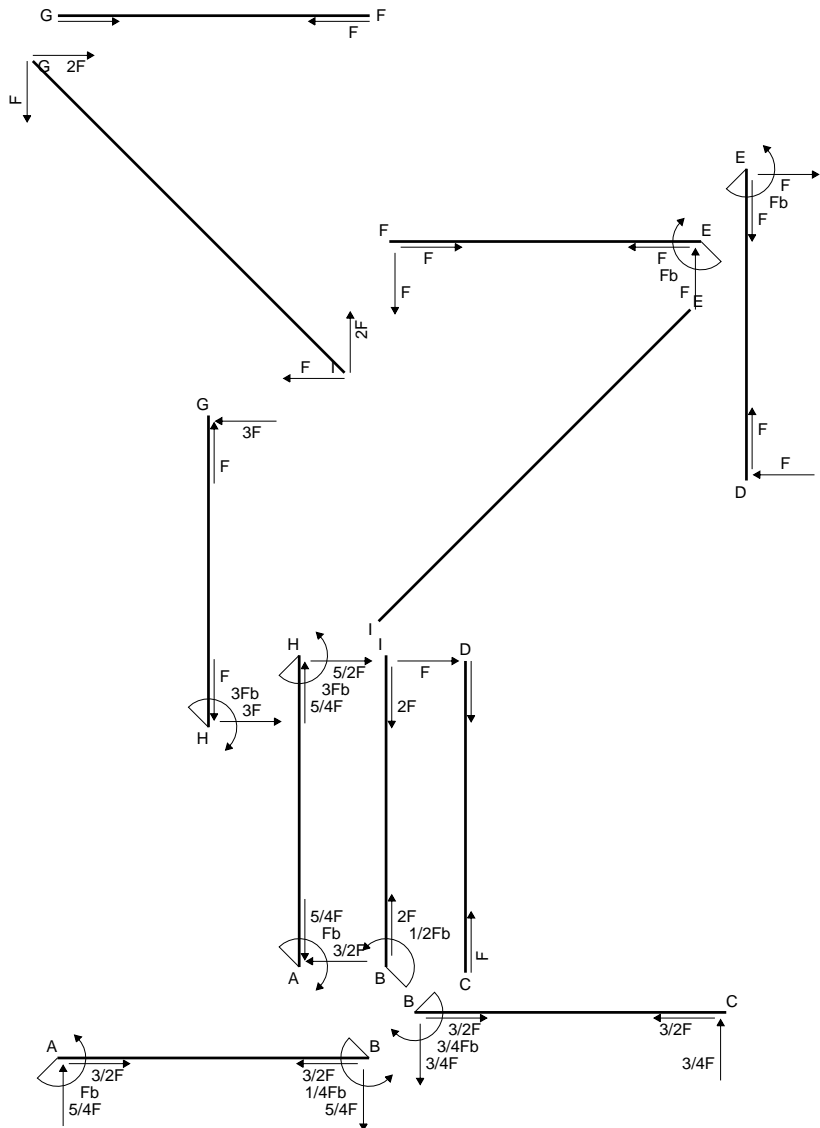
$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

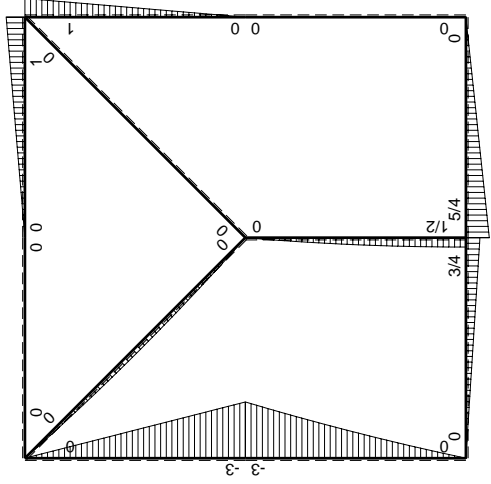
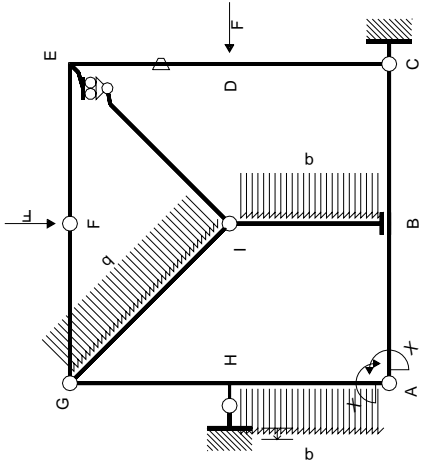
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

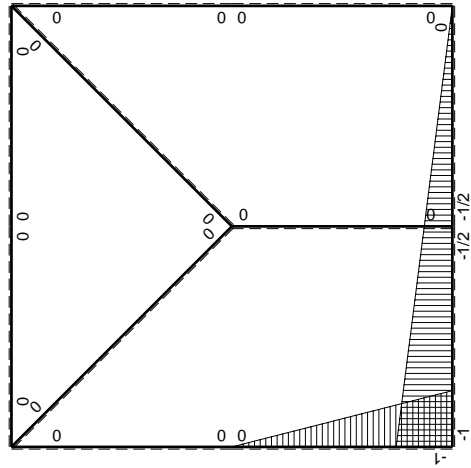


- A = 624. mm<sup>2</sup>
- J<sub>u</sub> = 221959. mm<sup>4</sup>
- J<sub>v</sub> = 21744. mm<sup>4</sup>
- y<sub>g</sub> = 22.43 mm
- N = 590. N
- T<sub>y</sub> = -1770. N
- M<sub>x</sub> = -1593000. Nmm
- x<sub>m</sub> = 24. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 31.57 mm
- σ<sub>m</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = 227.5 N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 46. mm
- v<sub>c</sub> = 23.57 mm
- σ<sub>c</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = 170.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.892 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 170.3 N/mm<sup>2</sup>
- S = 3681. mm<sup>3</sup>





$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	$Fb/EJ$	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0			
FE b	0	$-Fx$	0	0	0	0	0+0	0	
FG b	0	0	0	0	0	0			
GF b	0	0	0	0	0	0	0+0	0	
GH b	0	$-3Fx$	0	0	0	0			
HG b	0	$3Fb-3Fx$	0	0	0	0	0+0	0	
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0			
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0	0+0	0	
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

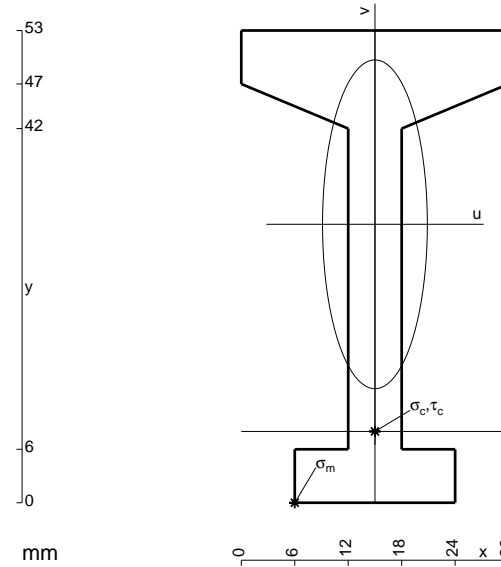
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

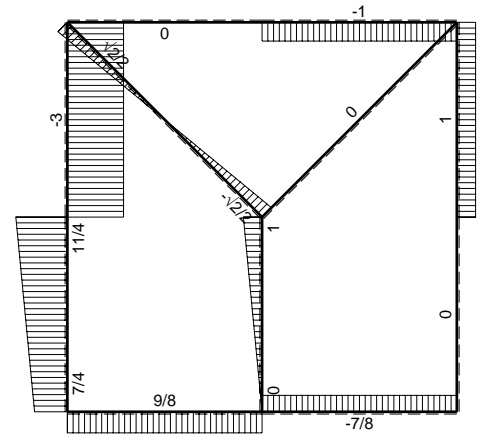
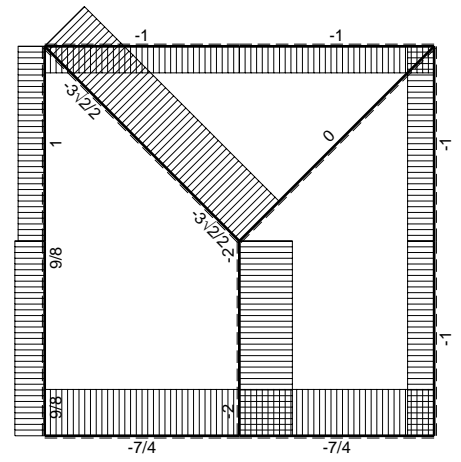
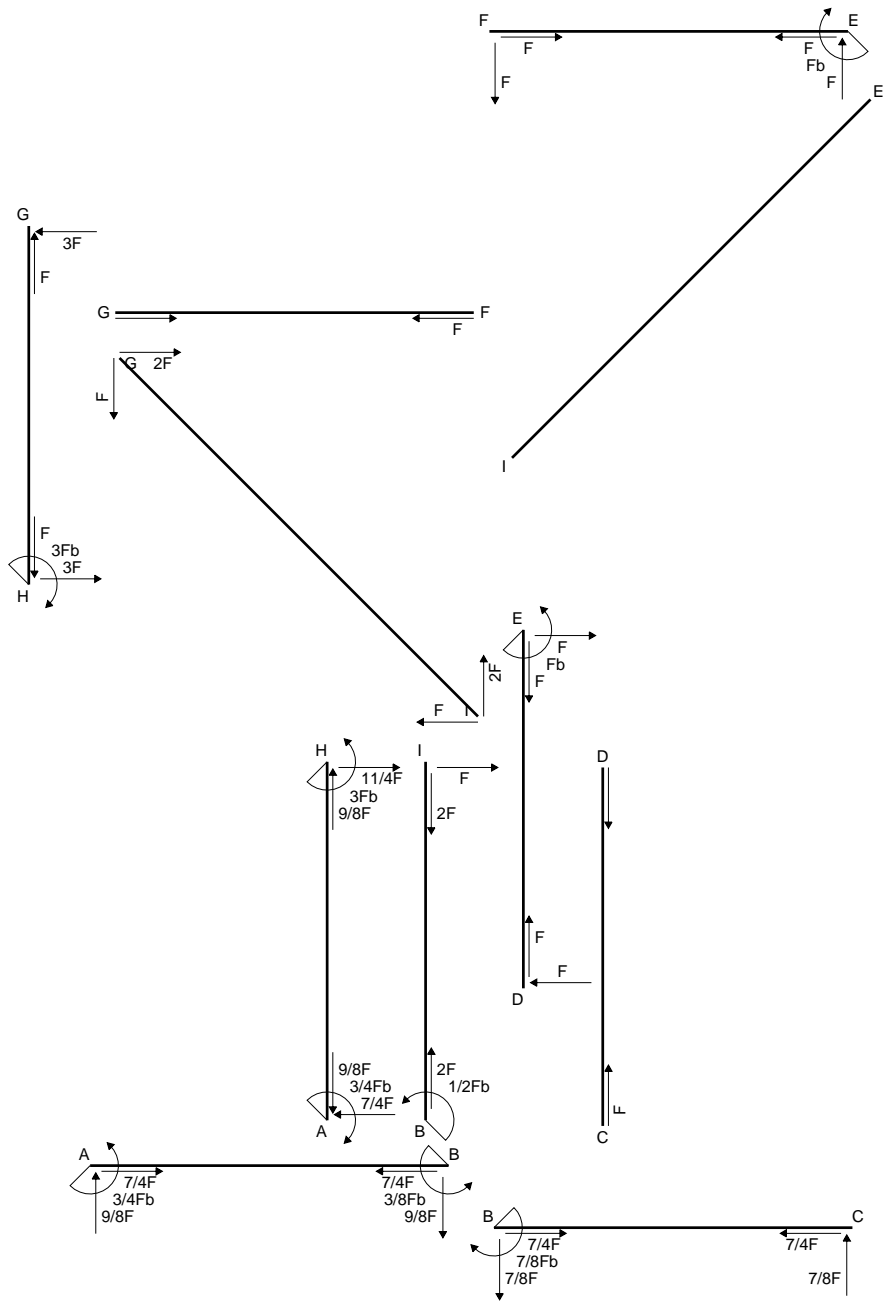
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$



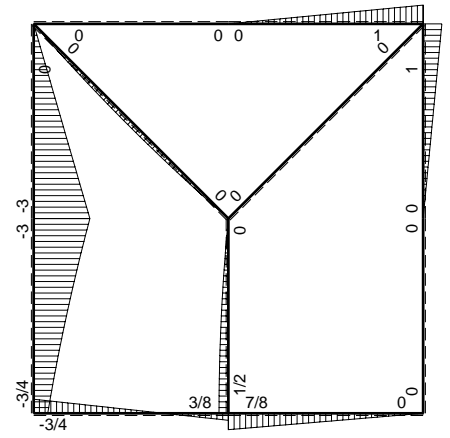
- A = 594. mm<sup>2</sup>
- J<sub>u</sub> = 202331. mm<sup>4</sup>
- J<sub>v</sub> = 20574. mm<sup>4</sup>
- y<sub>g</sub> = 31.25 mm
- N = 550. N
- T<sub>y</sub> = -1650. N
- M<sub>x</sub> = -1534500. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -31.25 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -236.1 N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 8. mm
- v<sub>c</sub> = -23.25 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -175.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.542 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 175.6 N/mm<sup>2</sup>
- S = 3342. mm<sup>3</sup>



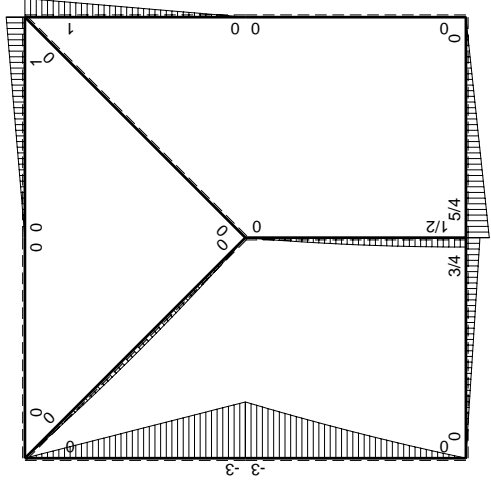
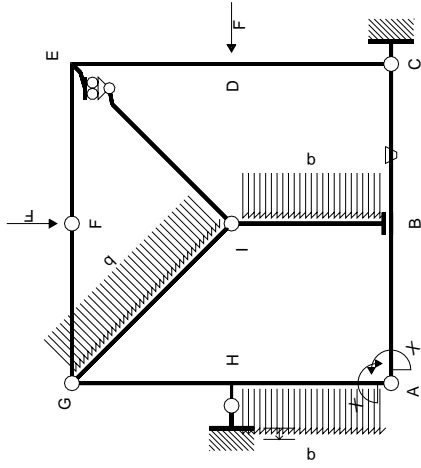


← ⊕ → F

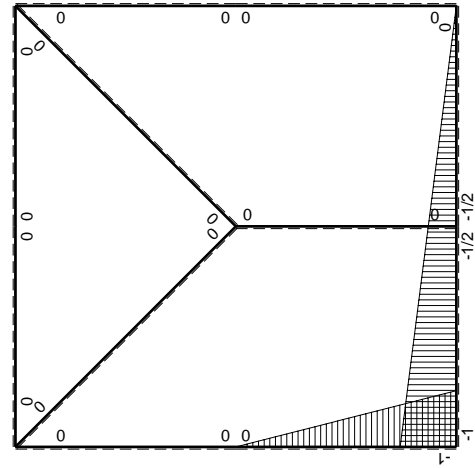
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	$-Fb/EJ$	$-5/8Fb+5/4Fx-5/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	$Fb/EJ$	$-5/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ x - 1/2 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x + 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x - 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = \left[ 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = \left[ 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = \left[ x - x^2/b + 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = \left[ -3/8 x^2/b + 1/8 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = \left[ -3/8 x + 1/8 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= \left[ -5/8 x + 5/8 x^2/b - 5/24 x^3/b^2 \right]_0^b Fb 1/EJ + \left[ 1/2 x - 1/4 x^2/b \right]_0^b \theta$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = \left[ -5/24 x^3/b^2 \right]_0^b Fb 1/EJ + \left[ -1/4 x^2/b \right]_0^b \theta$$

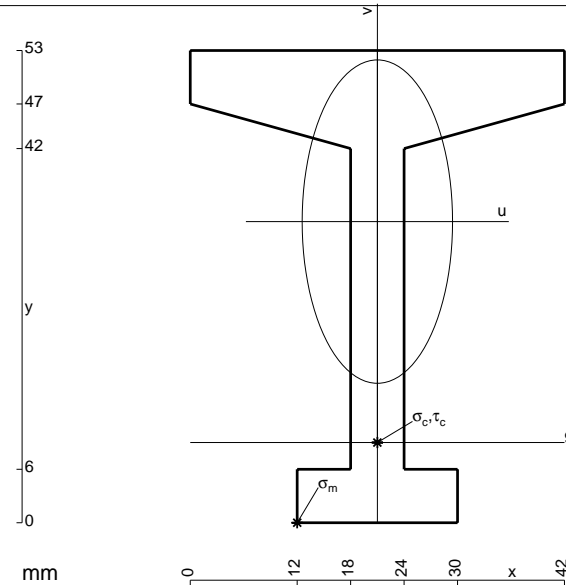
$$= (-5/24 b) Fb 1/EJ + (-1/4 b) \theta = 1/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$



$$A = 696. \text{ mm}^2$$

$$J_u = 229334. \text{ mm}^4$$

$$J_v = 49608. \text{ mm}^4$$

$$y_g = 33.8. \text{ mm}$$

$$N = 920. \text{ N}$$

$$T_y = -2760. \text{ N}$$

$$M_x = -1352400. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -33.8. \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = -198. \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 9. \text{ mm}$$

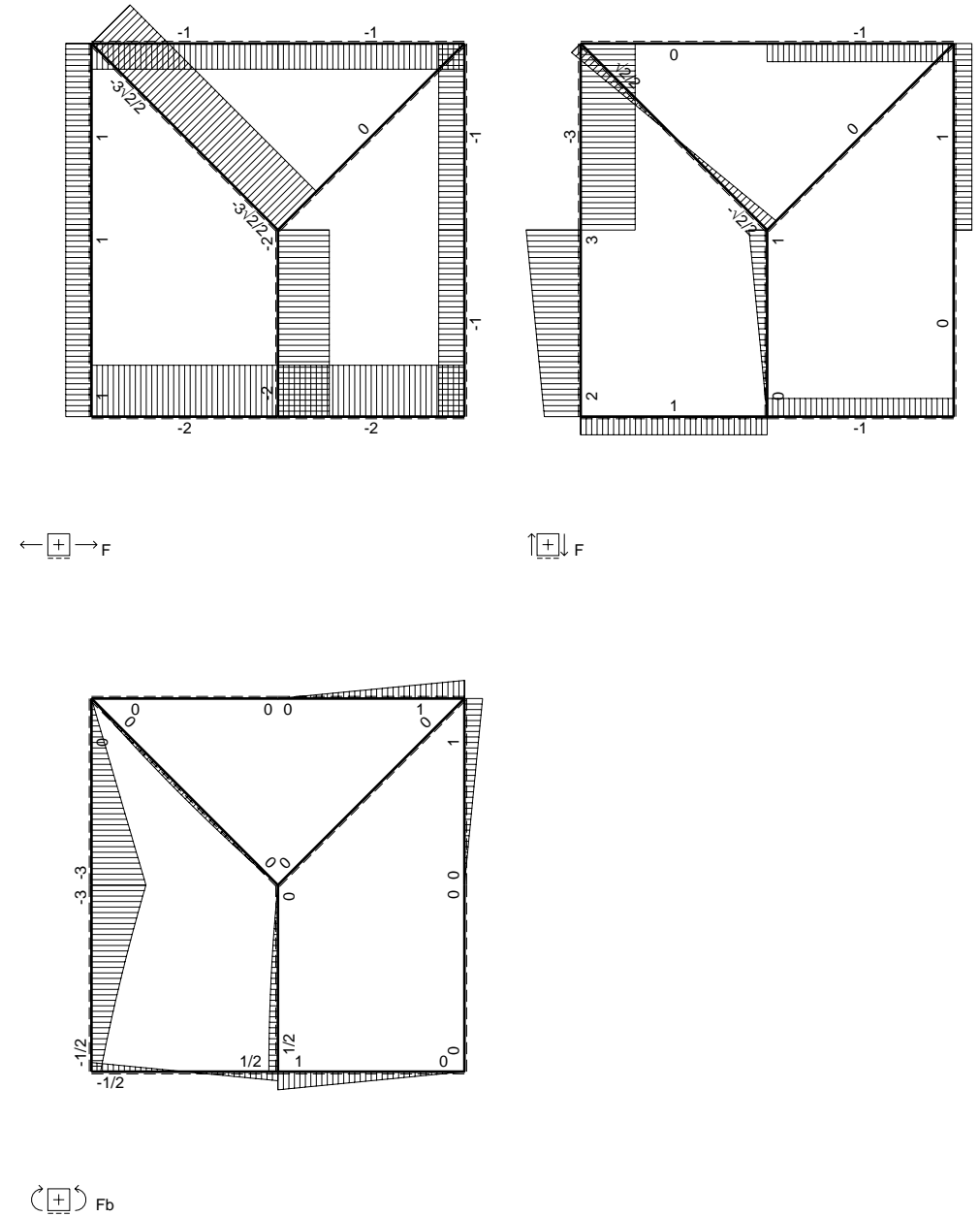
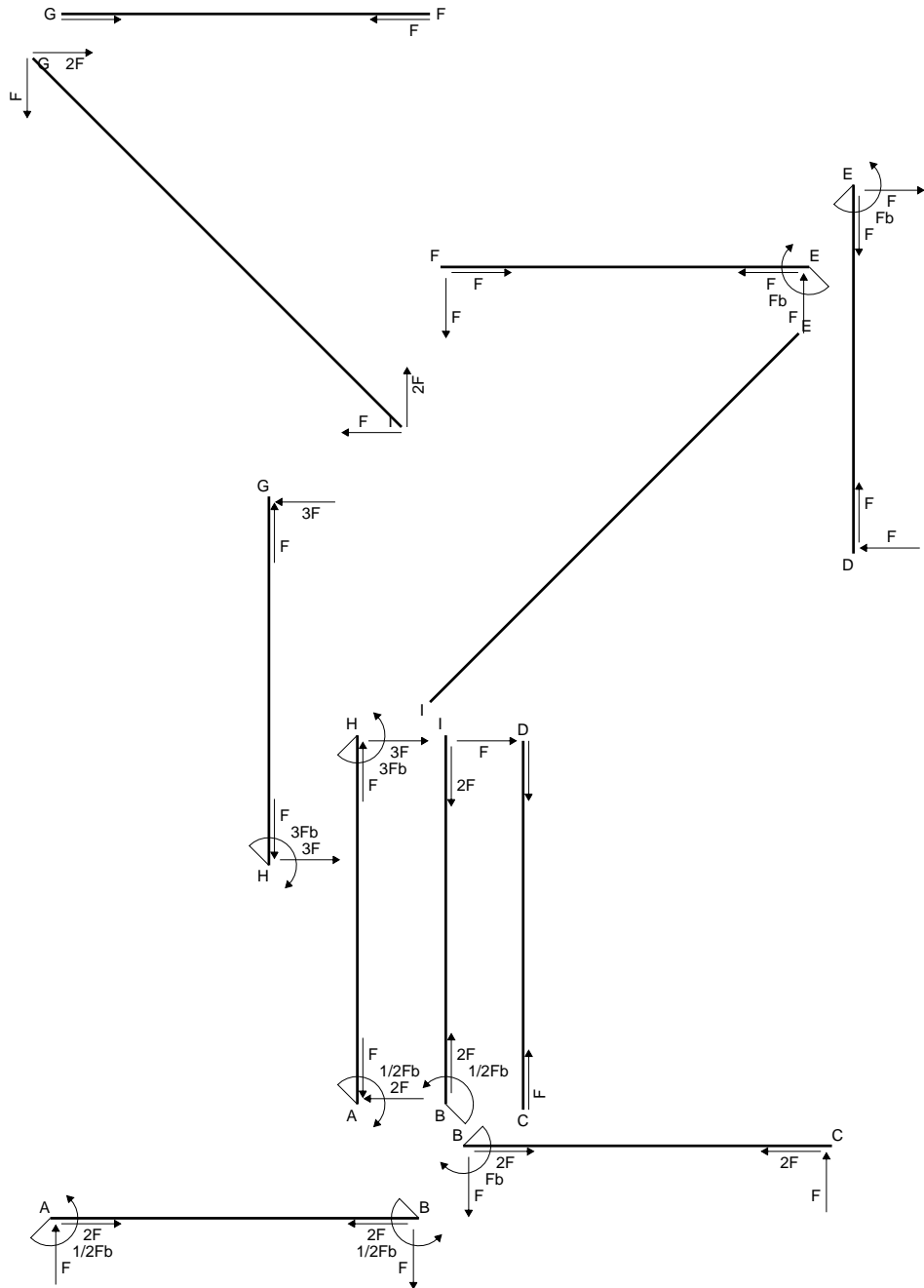
$$v_c = -24.8. \text{ mm}$$

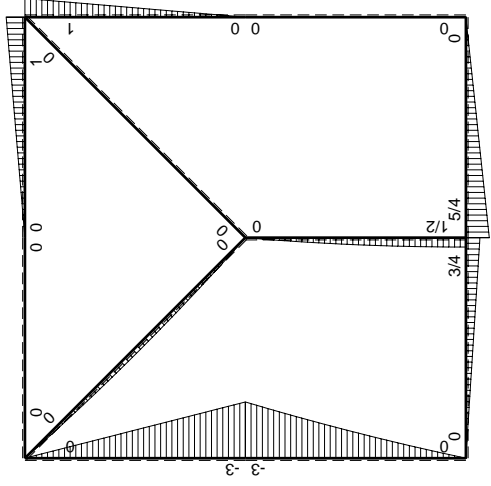
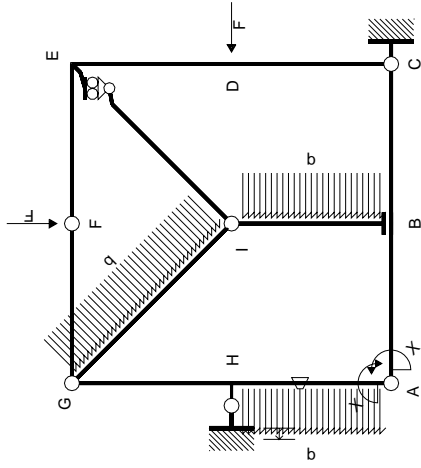
$$\sigma_c = N/A - Mv/J_u = -144.9. \text{ N/mm}^2$$

$$\tau_c = 7.621. \text{ N/mm}^2$$

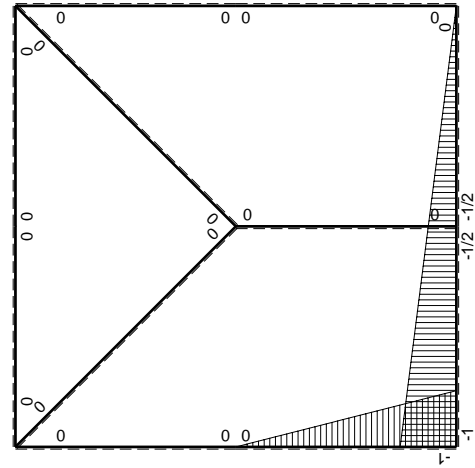
$$\sigma_g = \sqrt{\sigma^2 + 3\tau^2} = 145.5. \text{ N/mm}^2$$

$$S = 3799. \text{ mm}^3$$





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	-Fb/EJ	$3Fx-7/2Fx^2/b+1/2qx^3/b$	Fx/EJ	$x^2/b^2$	$(11/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	Fb/EJ	$5/2Fx-2Fx^2/b-1/2qx^3/b$	Fb/EJ-Fx/EJ	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/2Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

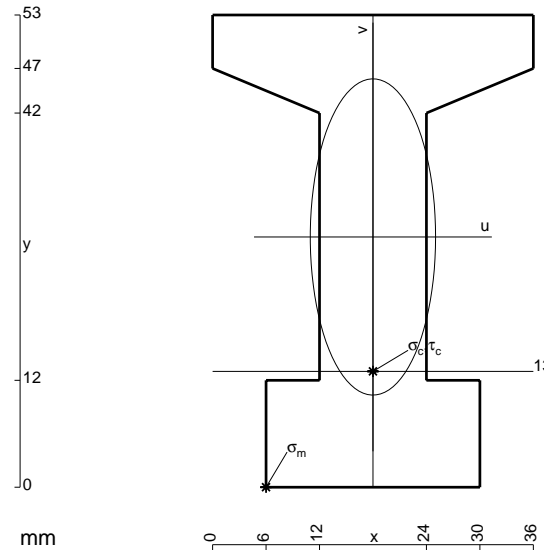
$$= [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 23/24 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

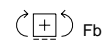
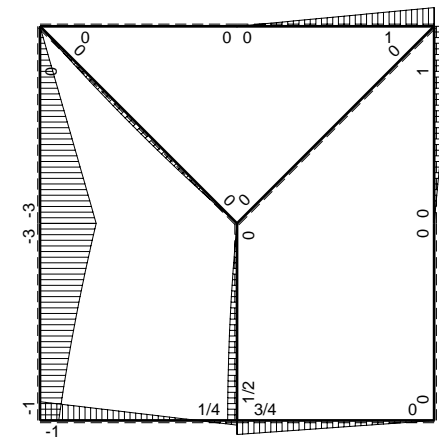
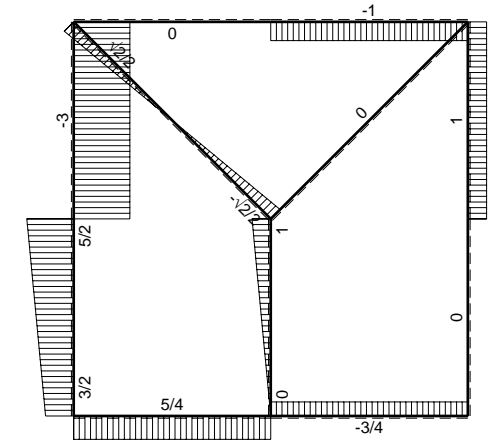
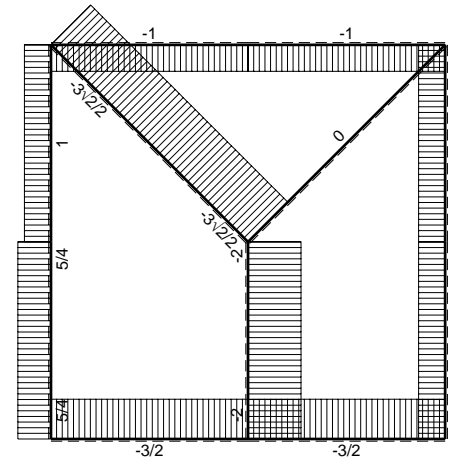
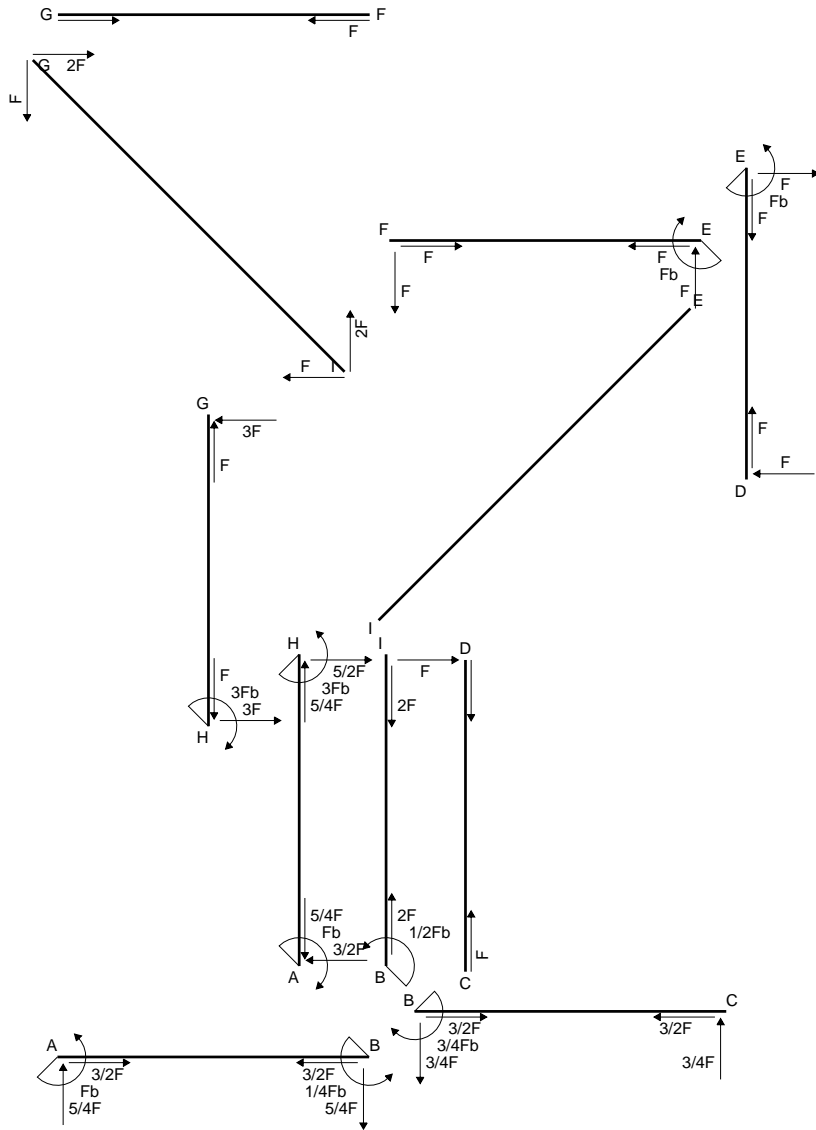
$$= [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

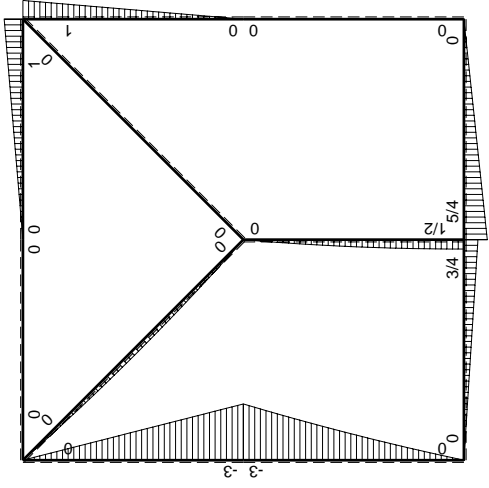
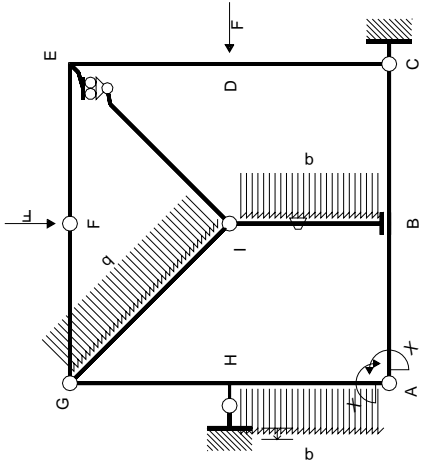
$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 23/24 Fb^2/EJ$$



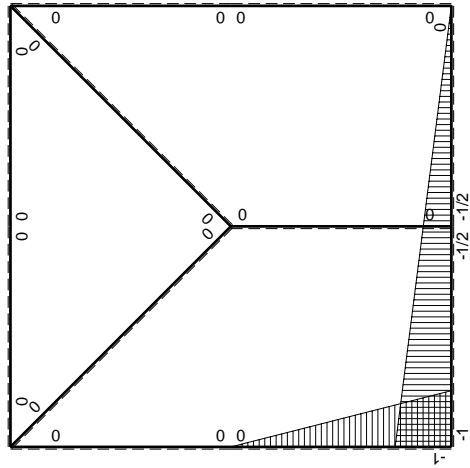
- A = 984. mm<sup>2</sup>
- J<sub>u</sub> = 309962. mm<sup>4</sup>
- J<sub>v</sub> = 48672. mm<sup>4</sup>
- y<sub>g</sub> = 28.09 mm
- N = 1460. N
- T<sub>y</sub> = -4380. N
- M<sub>x</sub> = -2321400. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.09 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -208.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.09 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -111.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.711 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 112.3 N/mm<sup>2</sup>
- S = 6548. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	-Fb/EJ	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	Fb/EJ	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

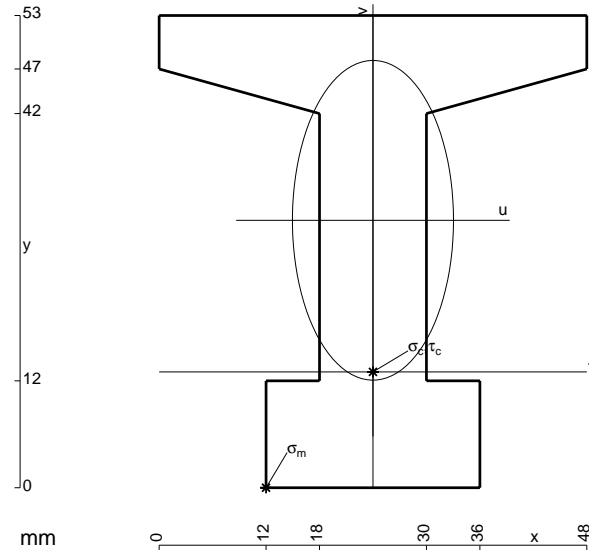
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

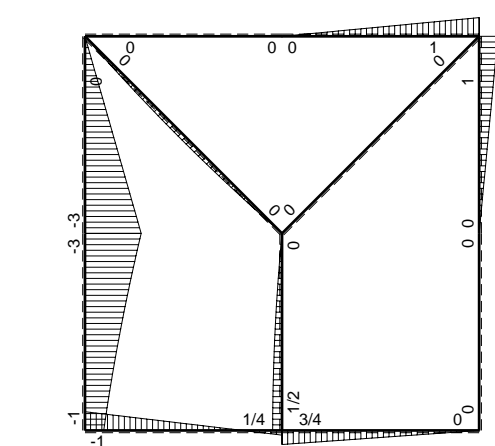
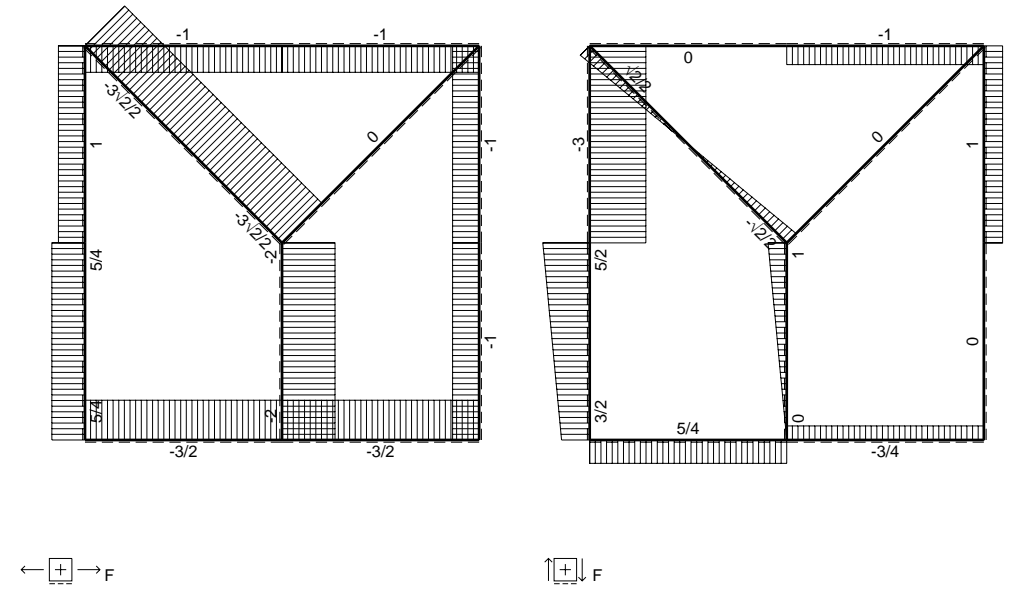
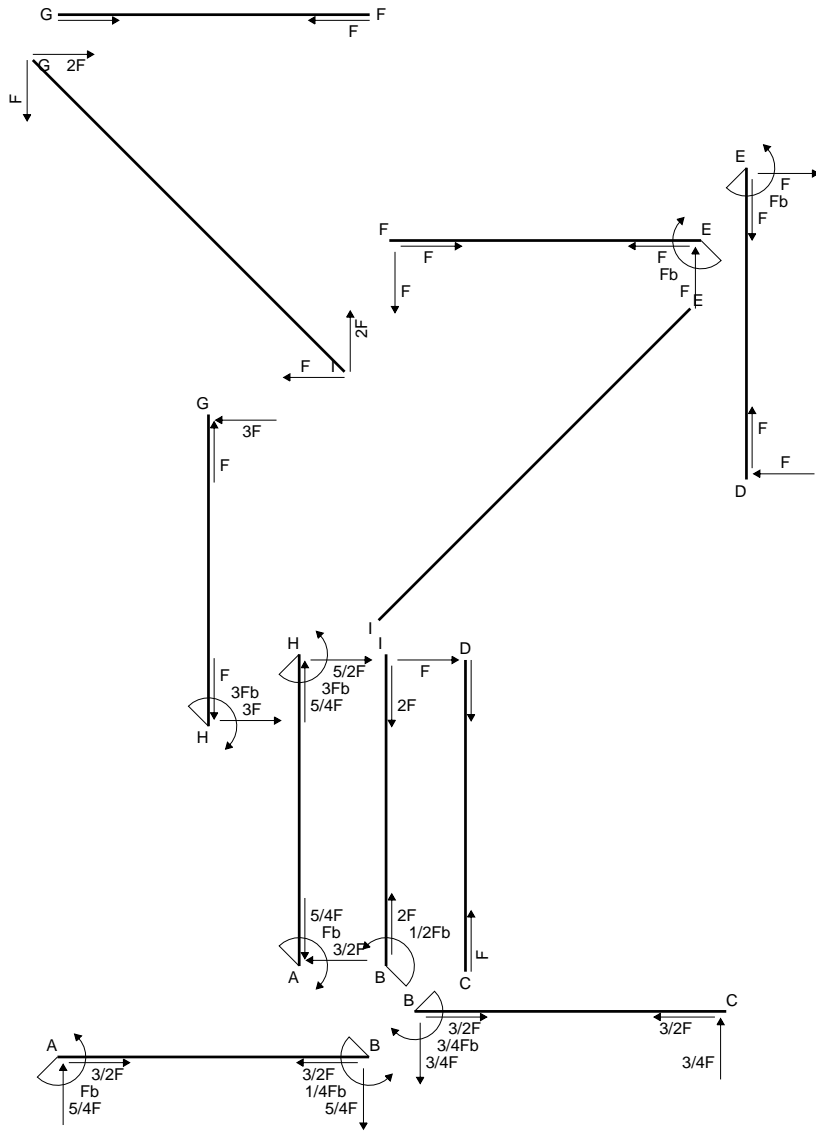
$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

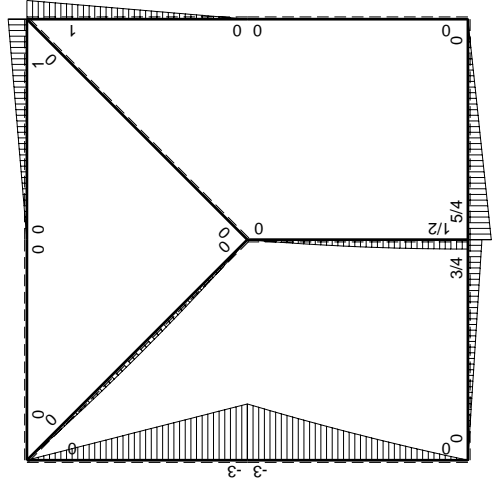
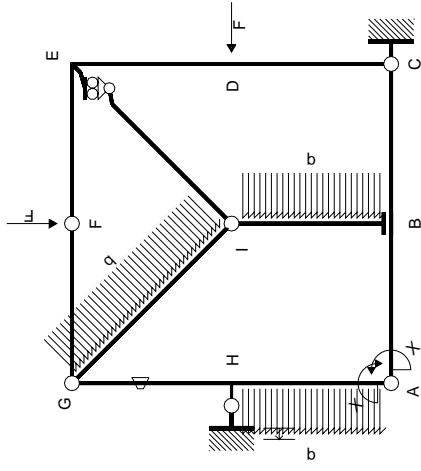
$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$




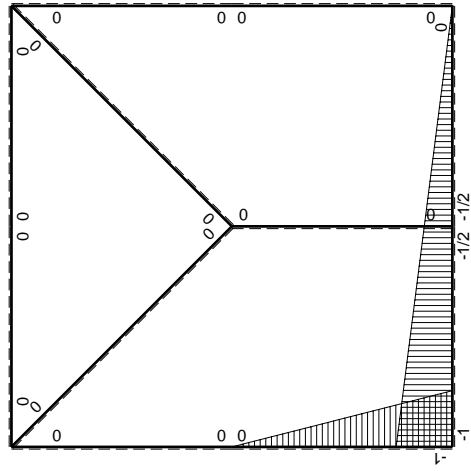
- A = 1086. mm<sup>2</sup>
- J<sub>u</sub> = 349673. mm<sup>4</sup>
- J<sub>v</sub> = 88740. mm<sup>4</sup>
- y<sub>g</sub> = 30.02 mm
- N = 1480. N
- T<sub>y</sub> = -4440. N
- M<sub>x</sub> = -2575200. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.02 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -219.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -17.02 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -124. N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.541 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 124.6 N/mm<sup>2</sup>
- S = 7127. mm<sup>3</sup>




$\curvearrowright \boxed{+} \curvearrowleft F_b$



  $M_0$  flessione da carichi assegnati



  $M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	-3Fx	-Fb/EJ	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	Fb/EJ	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

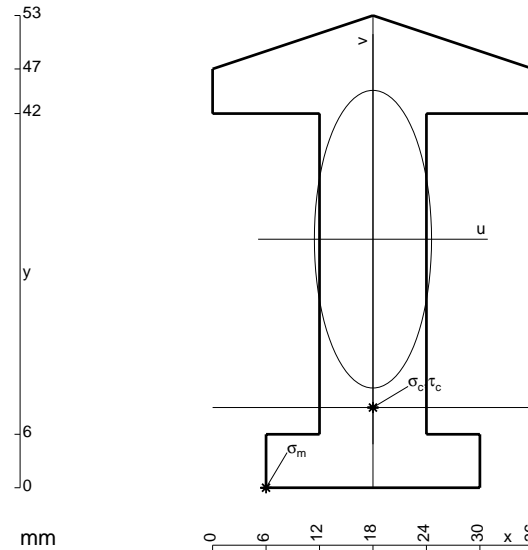
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

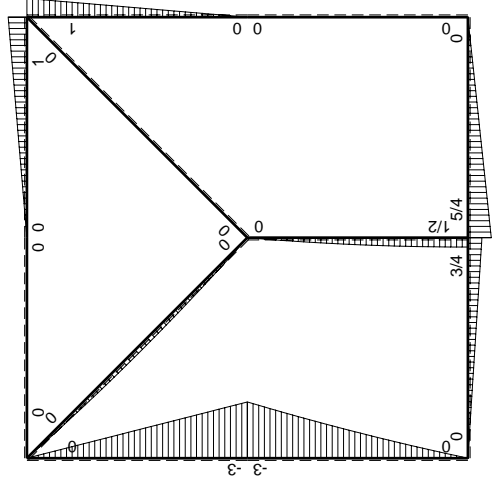
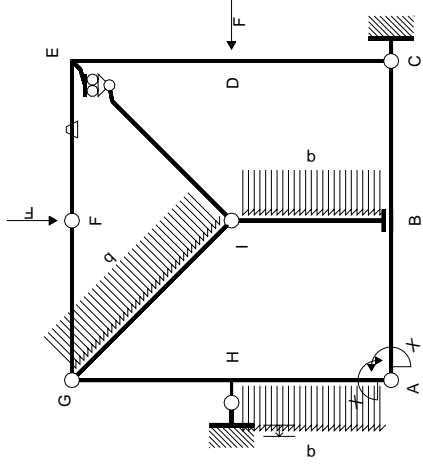
$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$



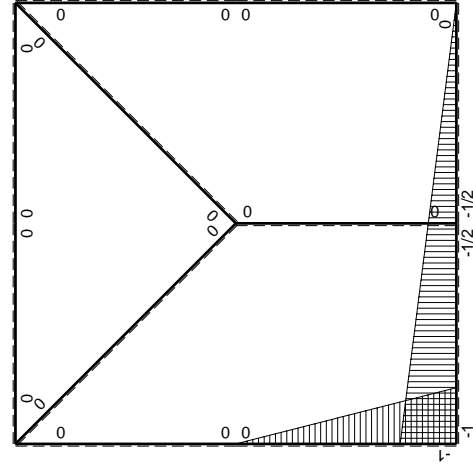
$A = 864. \text{ mm}^2$   
 $J_u = 241215. \text{ mm}^4$   
 $J_v = 37368. \text{ mm}^4$   
 $y_g = 27.9 \text{ mm}$   
 $N = 1050. \text{ N}$   
 $T_y = -3150. \text{ N}$   
 $M_x = -1984500. \text{ Nmm}$   
 $x_m = 6. \text{ mm}$   
 $u_m = -12. \text{ mm}$   
 $v_m = -27.9 \text{ mm}$   
 $\sigma_m = N/A - Mv/J_u = -228.3 \text{ N/mm}^2$   
 $x_c = 18. \text{ mm}$   
 $y_c = 9. \text{ mm}$   
 $v_c = -18.9 \text{ mm}$   
 $\sigma_c = N/A - Mv/J_u = -154.2 \text{ N/mm}^2$   
 $\tau_c = 4.7 \text{ N/mm}^2$   
 $\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 154.5 \text{ N/mm}^2$   
 $S = 4319. \text{ mm}^3$







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	-Fb/EJ	0	0	0	0+0	0	
FE b	0	-Fx	Fb/EJ	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	-3Fx	0	0	0	0	0+0	0	
HG b	0	3Fb-3Fx	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2 x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

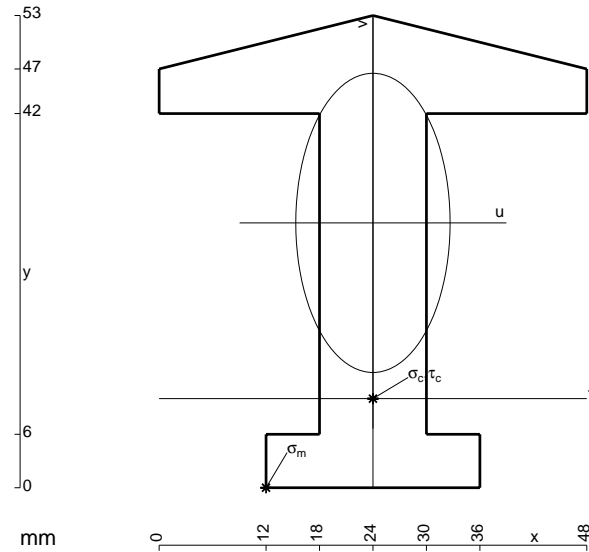
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3 x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

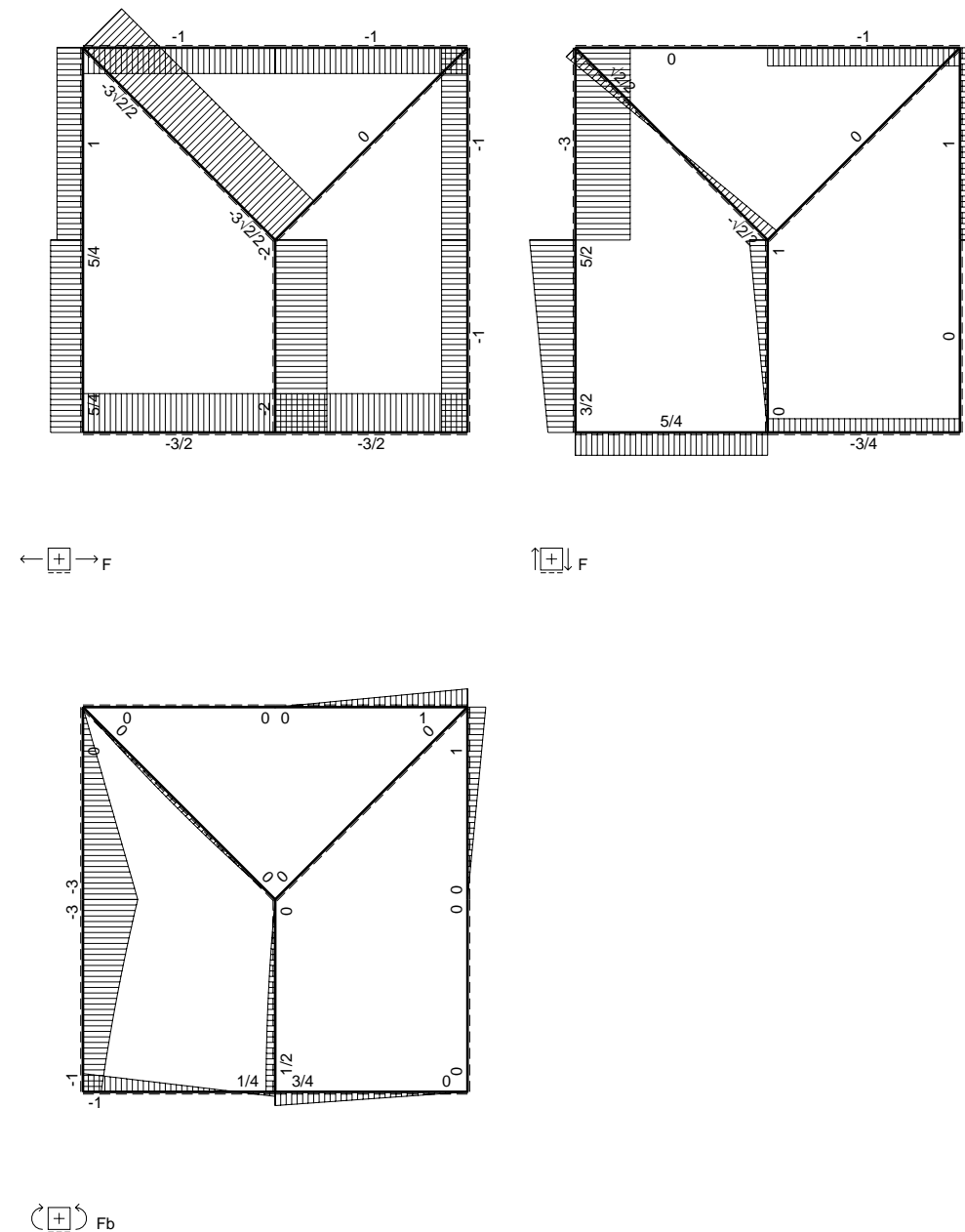
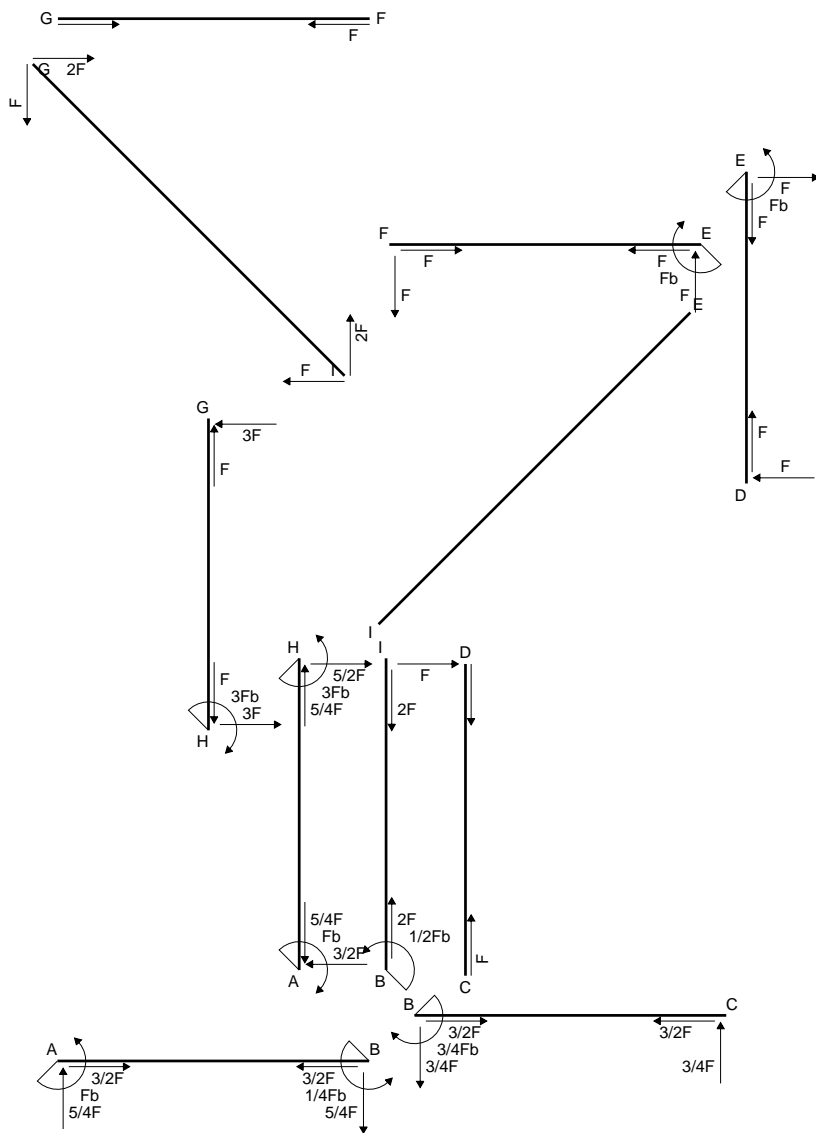
$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

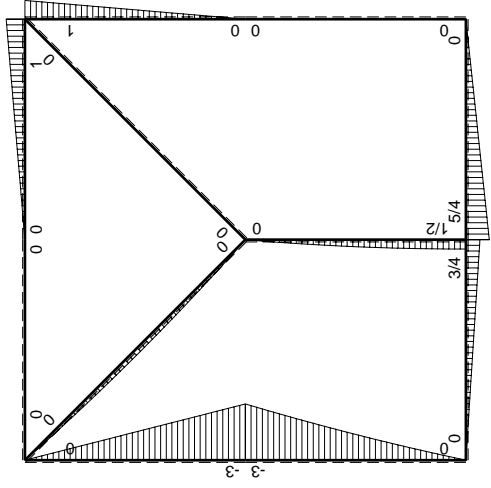
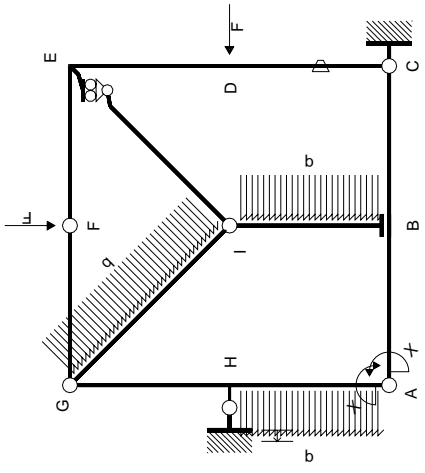
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

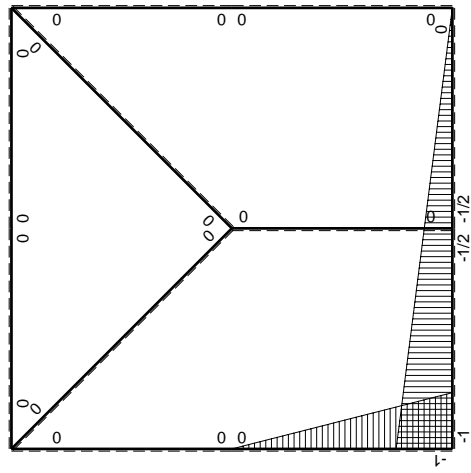


$A = 960. \text{ mm}^2$   
 $J_u = 270775. \text{ mm}^4$   
 $J_v = 72000. \text{ mm}^4$   
 $y_g = 29.73 \text{ mm}$   
 $N = 1070. \text{ N}$   
 $T_y = -3210. \text{ N}$   
 $M_x = -2182800. \text{ Nmm}$   
 $x_m = 12. \text{ mm}$   
 $u_m = -12. \text{ mm}$   
 $v_m = -29.73 \text{ mm}$   
 $\sigma_m = N/A - Mv/J_u = -238.5 \text{ N/mm}^2$   
 $x_c = 24. \text{ mm}$   
 $y_c = 10. \text{ mm}$   
 $v_c = -19.73 \text{ mm}$   
 $\sigma_c = N/A - Mv/J_u = -157.9 \text{ N/mm}^2$   
 $\tau_c = 4.832 \text{ N/mm}^2$   
 $\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 158.1 \text{ N/mm}^2$   
 $S = 4891. \text{ mm}^3$





$(\oplus)$   $M_0$  flessione da carichi assegnati



$(\oplus)$   $M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx$	0	$-3/4Fx+3/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/4+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-3/4Fb+3/4Fx$	0	$-3/8Fb+3/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$5/4Fb-5/4Fx$	0	$-5/8Fb+5/4Fx-5/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-5/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-5/4Fx$	0	$-5/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	0	$Fb/EJ$	0	0	0			
DE b	0	$Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-3Fx$	0	0	0	0	0+0	0	
HG b	0	$3Fb-3Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3Fb+7/2Fx-1/2qx^2$	0	$3Fx-7/2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(11/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/2Fx+1/2qx^2$	0	$5/2Fx-2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x^2/b + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-3/8 + 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 1/8 b) Fb 1/EJ = -1/4 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-5/8 + 5/4 x/b - 5/8 x^2/b^2) Fb 1/EJ dx = [-5/8 x + 5/8 x^2/b - 5/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-5/8 b + 5/8 b - 5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-5/8 x^2/b^2) Fb 1/EJ dx = [-5/24 x^3/b^2]_0^b Fb 1/EJ$$

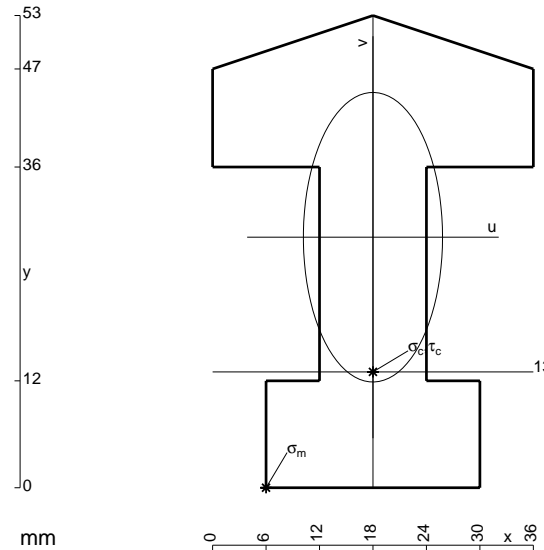
$$= (-5/24 b) Fb 1/EJ = -5/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3x/b - 7/2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/2 x^2/b - 7/6 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/2 b - 7/6 b + 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$

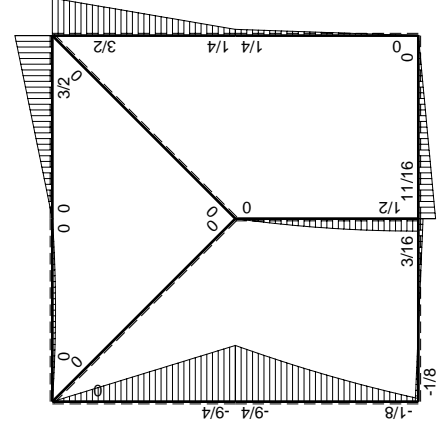
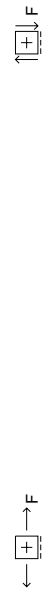
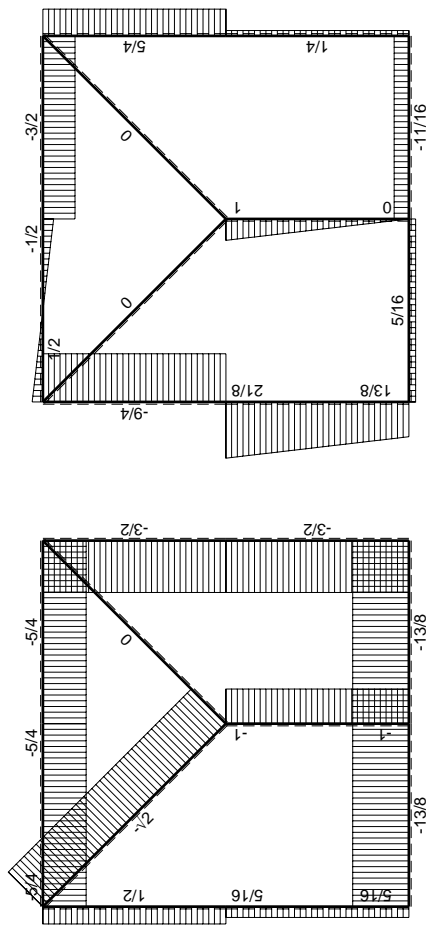
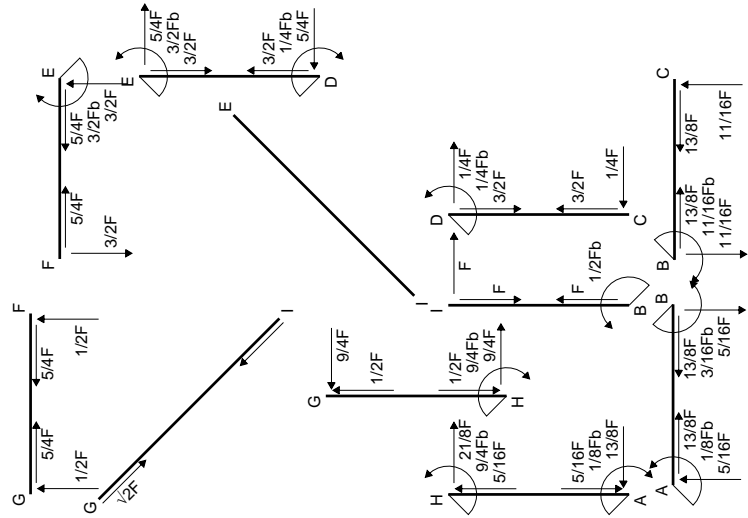
$$L_{AH}^{xo} = \int_0^b (5/2 x/b - 2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - 2/3 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

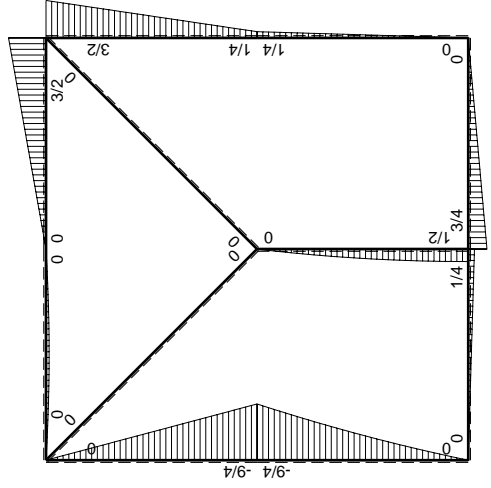
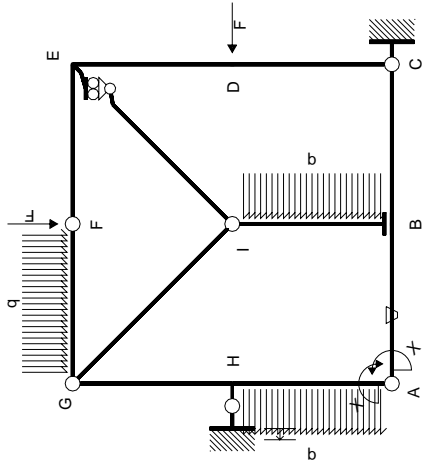
$$= (5/4 b - 2/3 b - 1/8 b) Fb 1/EJ = 11/24 Fb^2/EJ$$



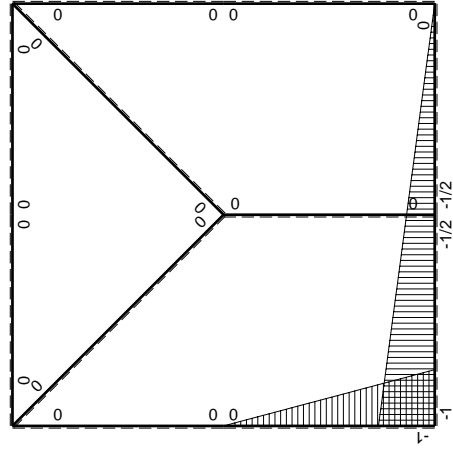
- A = 1080. mm<sup>2</sup>
- J<sub>u</sub> = 285273. mm<sup>4</sup>
- J<sub>v</sub> = 65880. mm<sup>4</sup>
- y<sub>g</sub> = 28.12 mm
- N = 930. N
- T<sub>y</sub> = -2790. N
- M<sub>x</sub> = -2036700. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.12 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -199.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.12 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -107.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.344 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 107.5 N/mm<sup>2</sup>
- S = 6557. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	$-Fb/EJ$	$-1/4Fx+1/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-1/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	$Fb/EJ$	$-1/8Fb+1/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/2 x^2/b]_0^b \theta$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ + (b - 1/2 b) \theta = 2/3 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 2/3 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

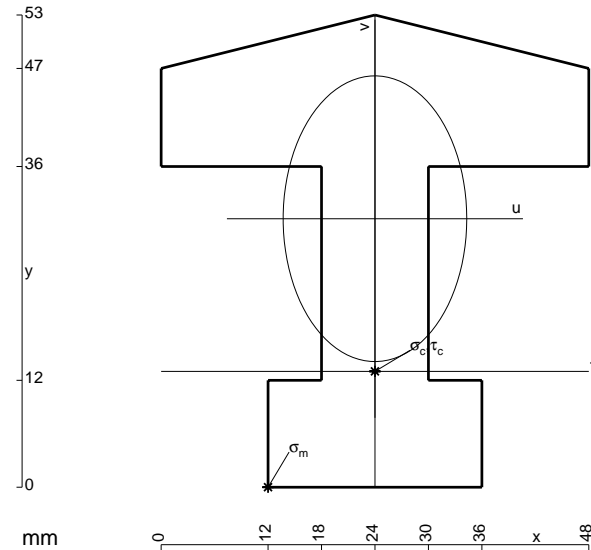
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

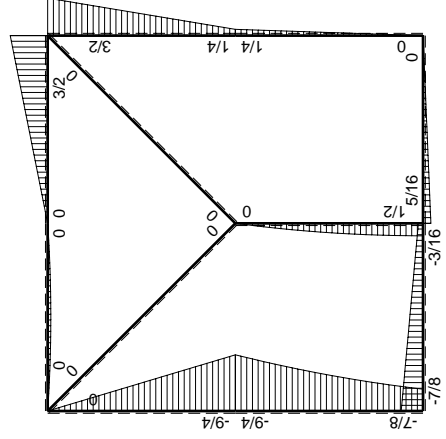
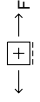
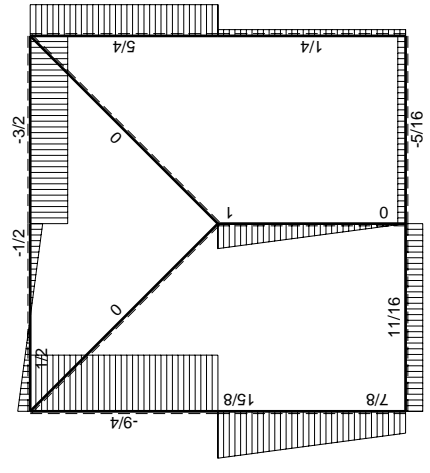
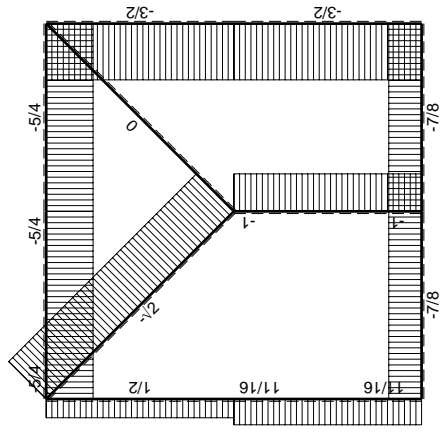
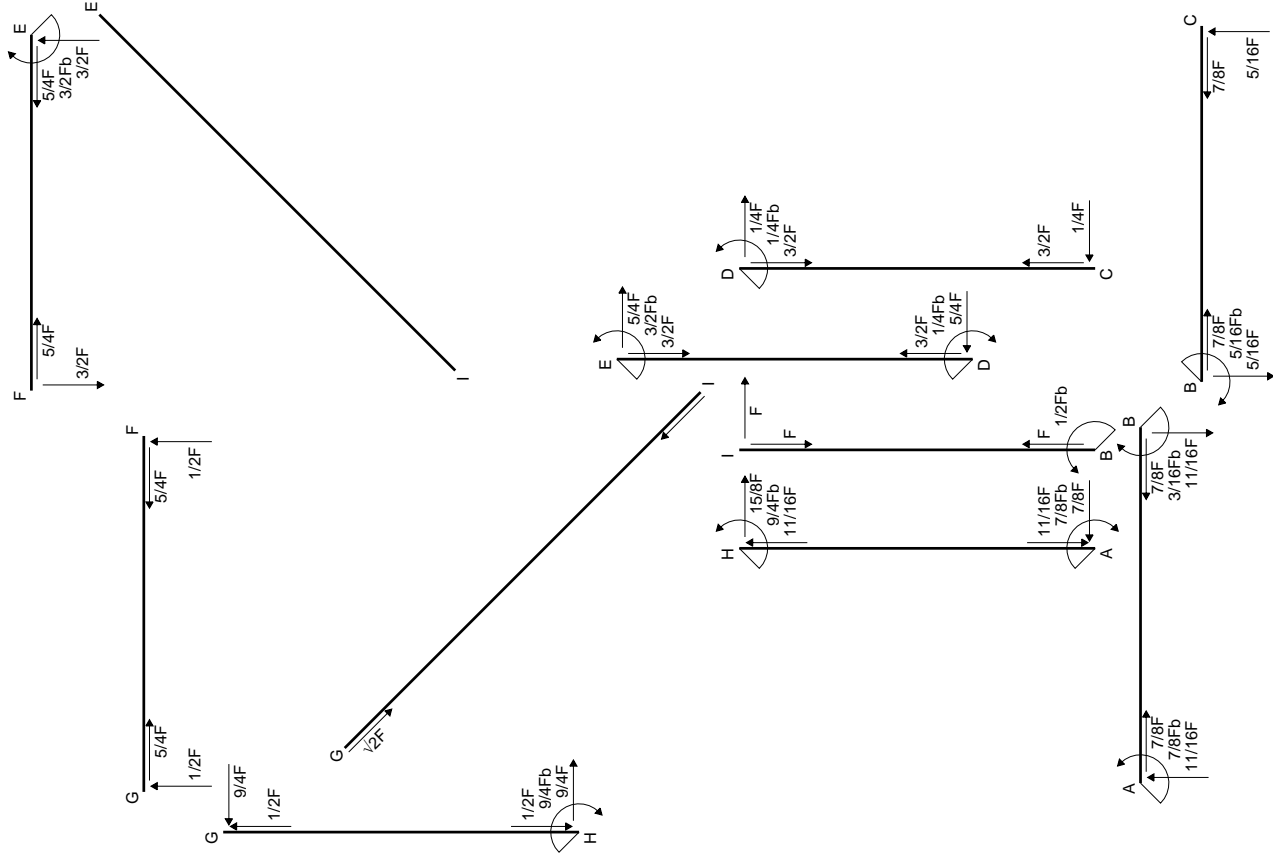
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

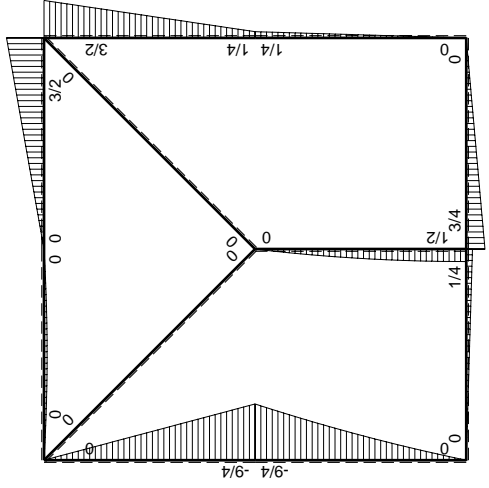
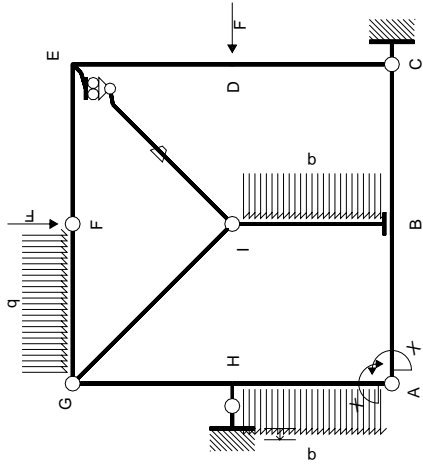
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

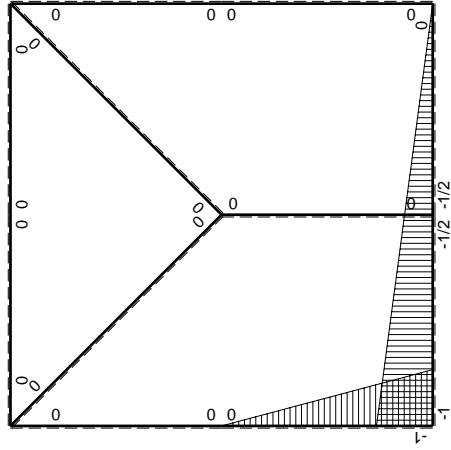


- A = 1248. mm<sup>2</sup>
- J<sub>u</sub> = 320937. mm<sup>4</sup>
- J<sub>v</sub> = 132480. mm<sup>4</sup>
- y<sub>g</sub> = 30.13 mm
- N = 635. N
- T<sub>y</sub> = -2858. N
- M<sub>x</sub> = -2228850. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.13 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -208.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -17.13 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -118.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.314 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 118.8 N/mm<sup>2</sup>
- S = 7162. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

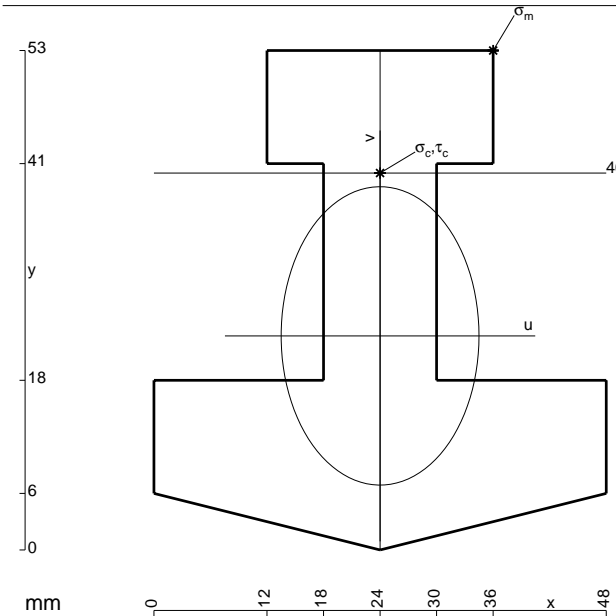
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

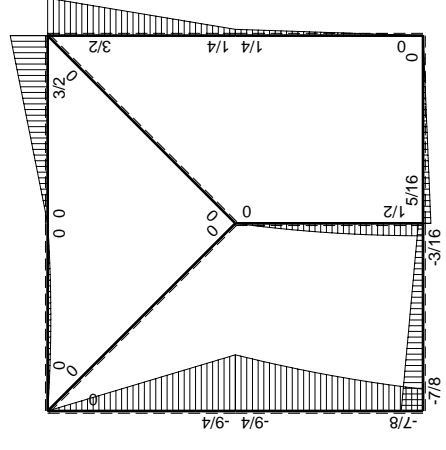
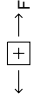
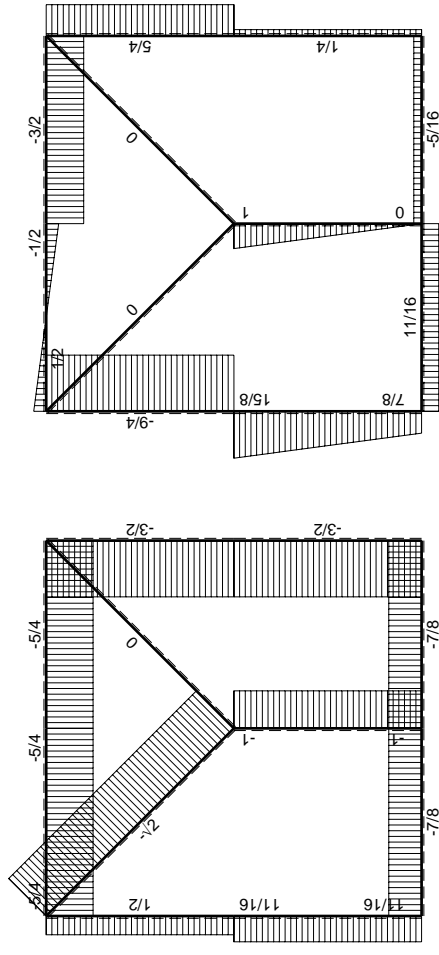
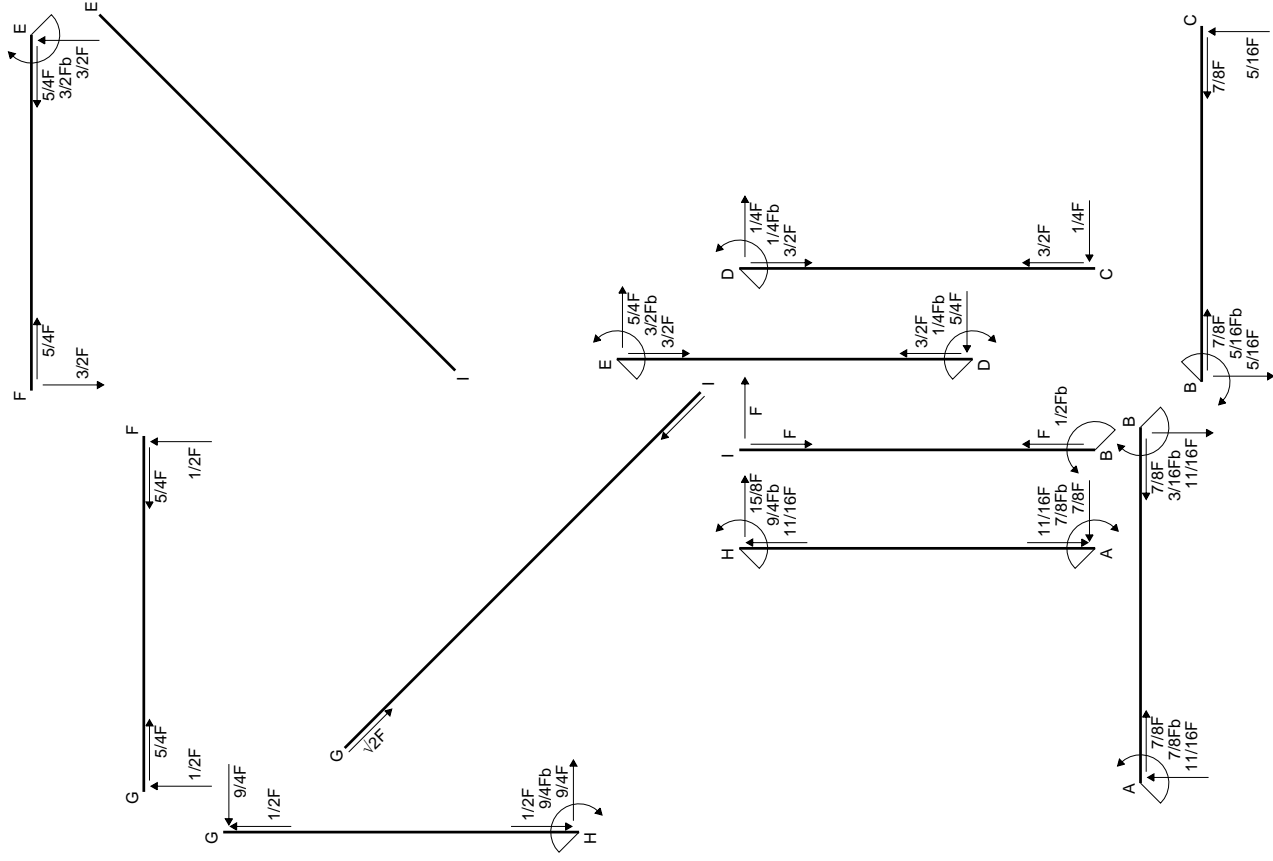
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



- A = 1284. mm<sup>2</sup>
- J<sub>u</sub> = 321948. mm<sup>4</sup>
- J<sub>v</sub> = 141552. mm<sup>4</sup>
- y<sub>g</sub> = 22.72 mm
- N = 620. N
- T<sub>y</sub> = -2790. N
- M<sub>x</sub> = -2315700. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.28 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 218.3 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 17.28 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 124.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.205 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 125.1 N/mm<sup>2</sup>
- S = 7208. mm<sup>3</sup>







Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{x_0} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{x_0} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{x_0} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{x_0} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

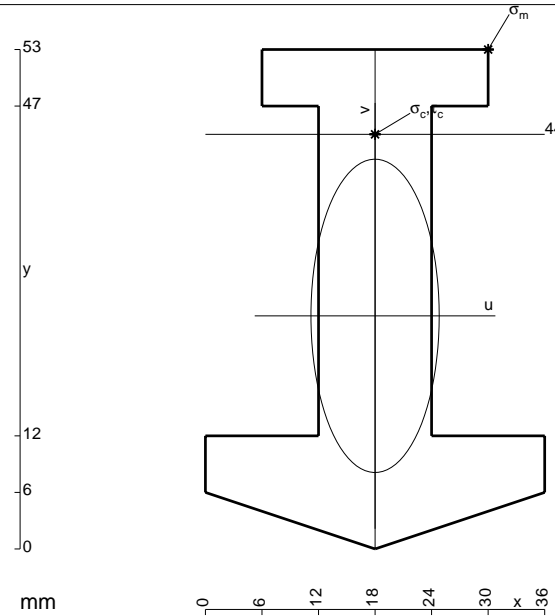
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{x_0} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

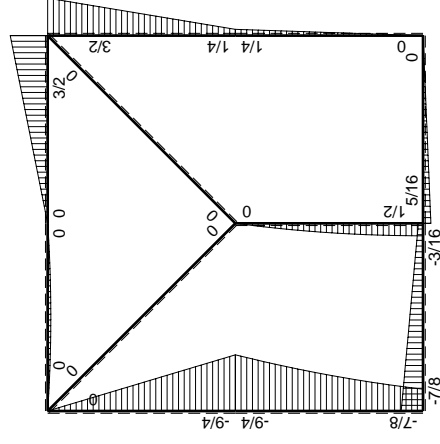
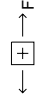
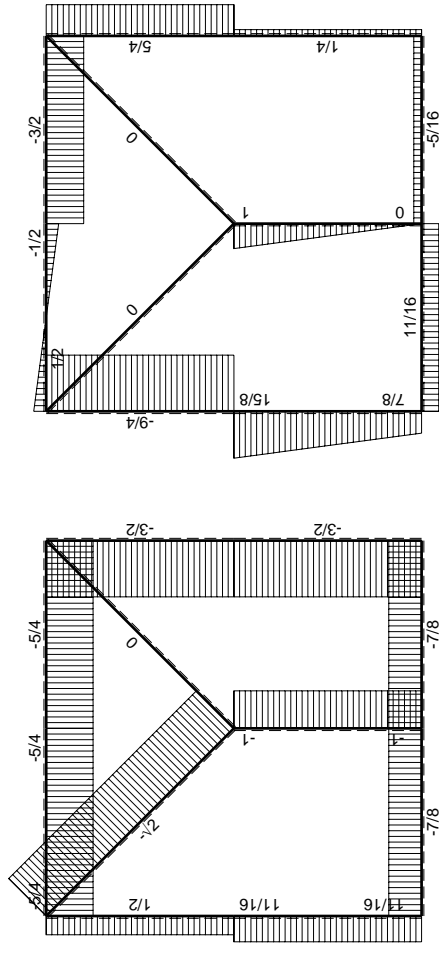
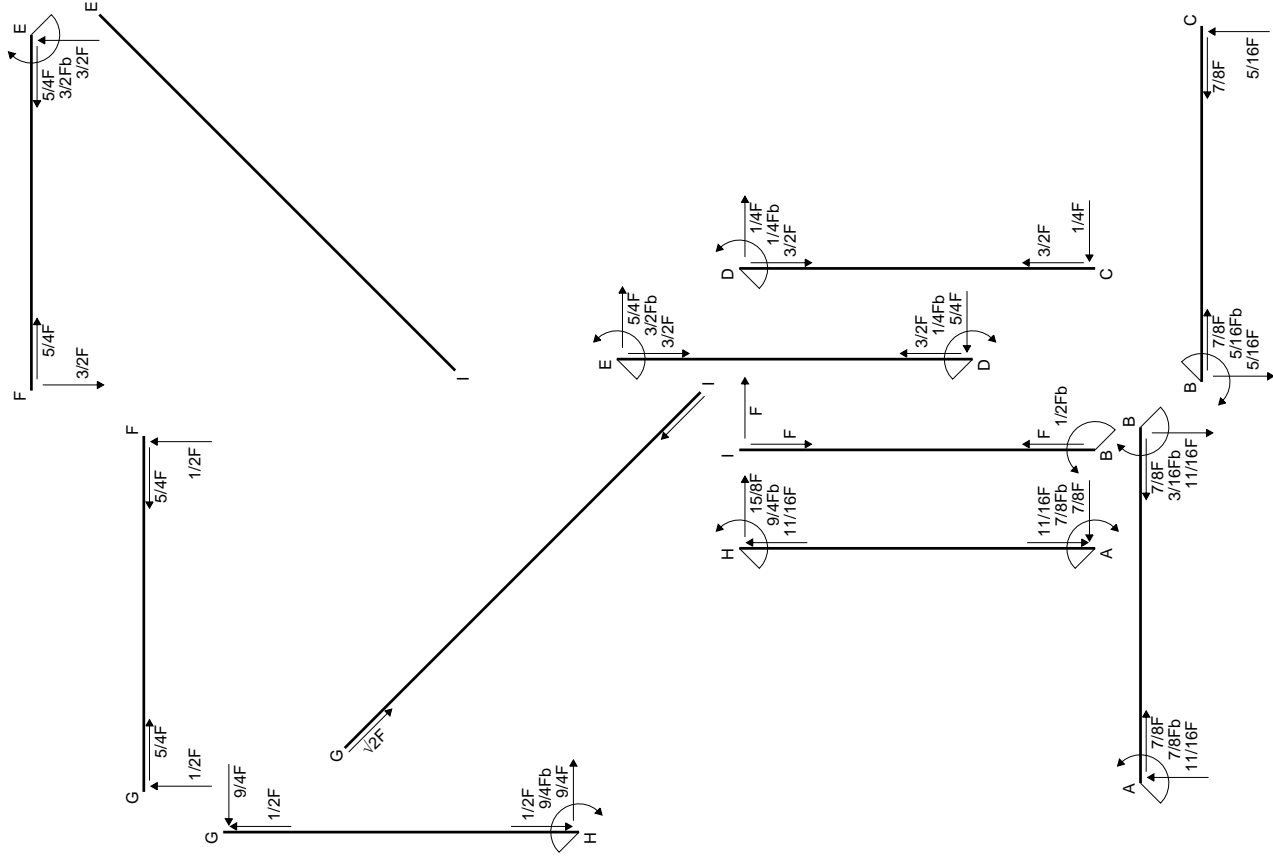
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

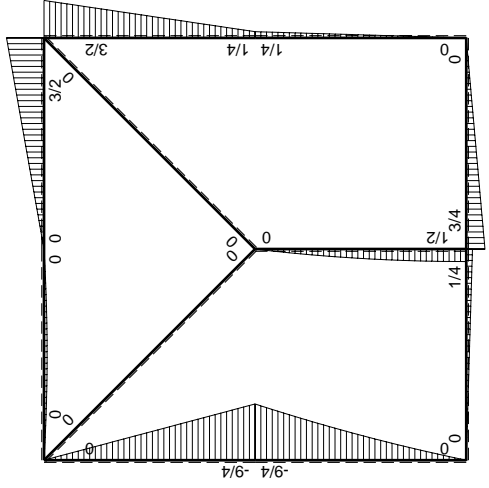
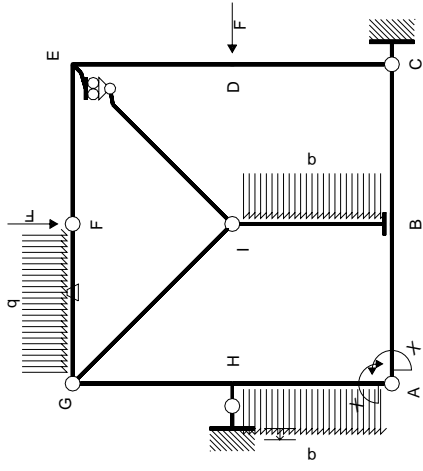
$$L_{AH}^{x_0} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

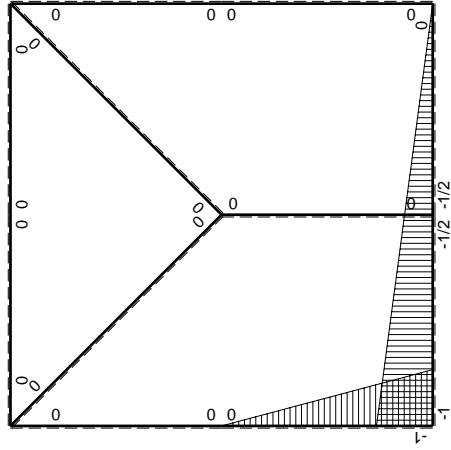


- A = 888. mm<sup>2</sup>
- J<sub>u</sub> = 245538. mm<sup>4</sup>
- J<sub>v</sub> = 41112. mm<sup>4</sup>
- y<sub>g</sub> = 24.74 mm
- N = 500. N
- T<sub>y</sub> = -2250. N
- M<sub>x</sub> = -1980000. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.26 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 228.5 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 44. mm
- v<sub>c</sub> = 19.26 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 155.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 3.349 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 156. N/mm<sup>2</sup>
- S = 4385. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	$Fb/EJ$	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

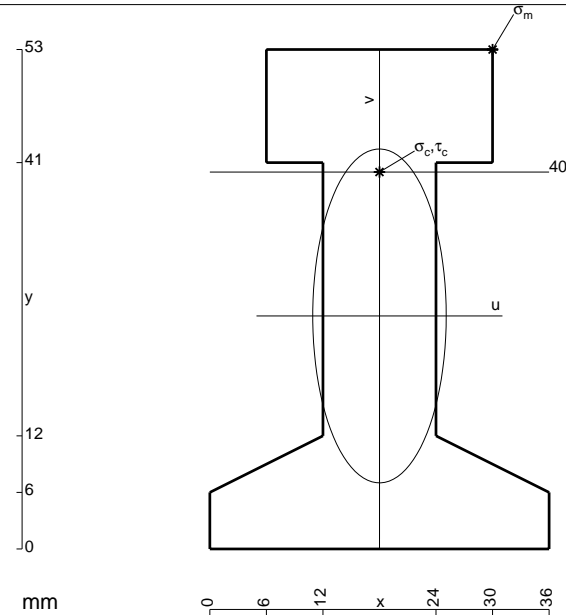
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

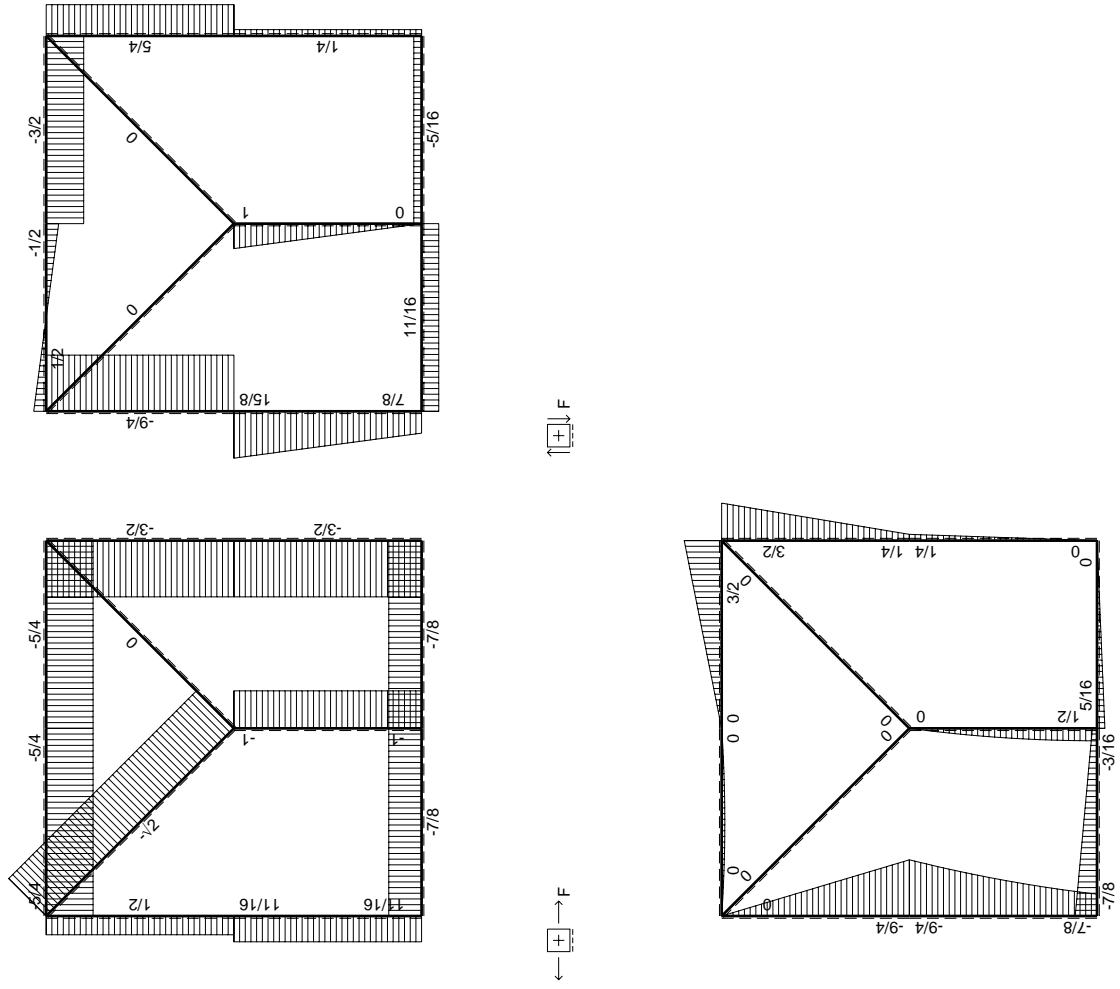
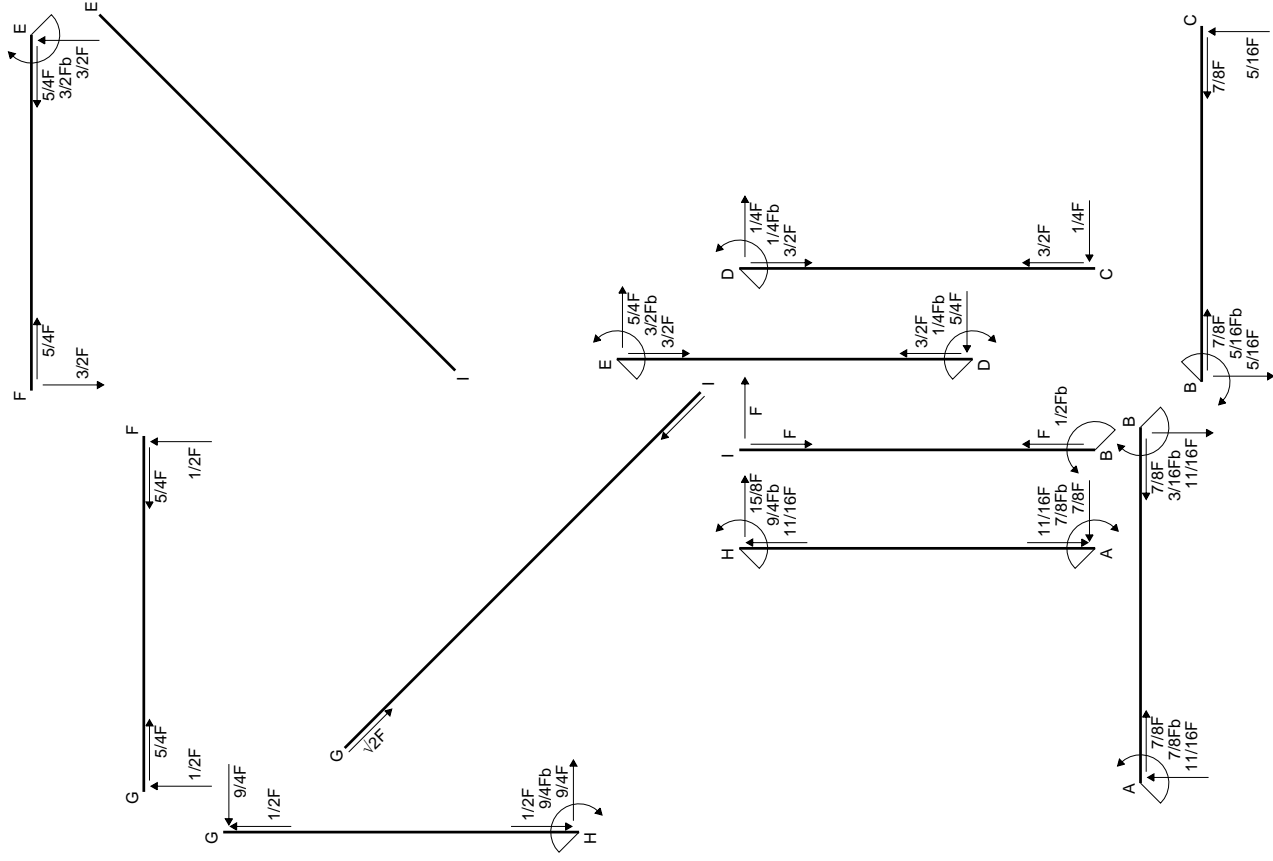
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

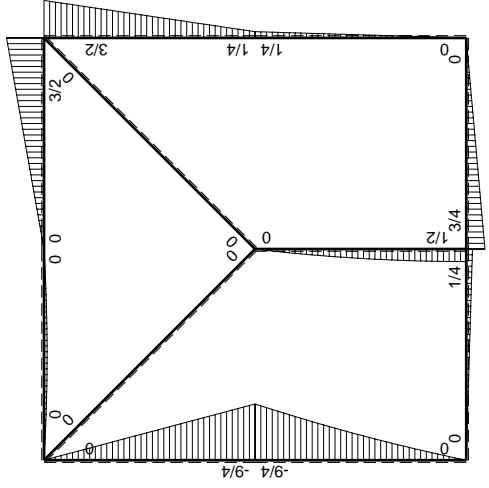
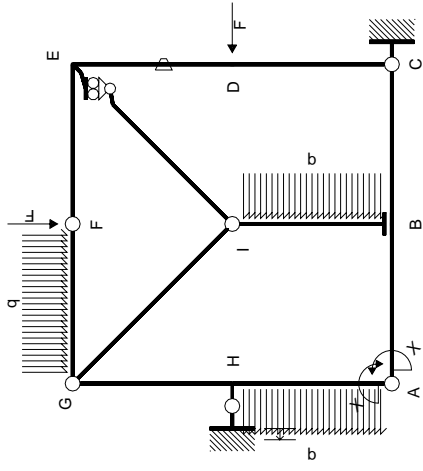
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



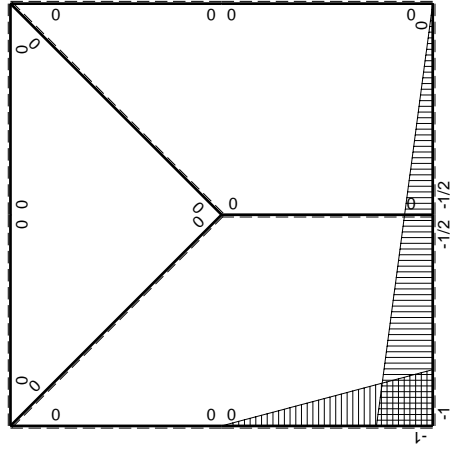
- A = 996. mm<sup>2</sup>
- J<sub>u</sub> = 312739. mm<sup>4</sup>
- J<sub>v</sub> = 49968. mm<sup>4</sup>
- y<sub>g</sub> = 24.73 mm
- N = 630. N
- T<sub>y</sub> = -2835. N
- M<sub>x</sub> = -2636550. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 12. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.27 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 239. N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 15.27 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 129.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.988 N/mm<sup>2</sup>
- σ<sub>g</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 129.7 N/mm<sup>2</sup>
- S = 6603. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	$Fb/EJ$	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

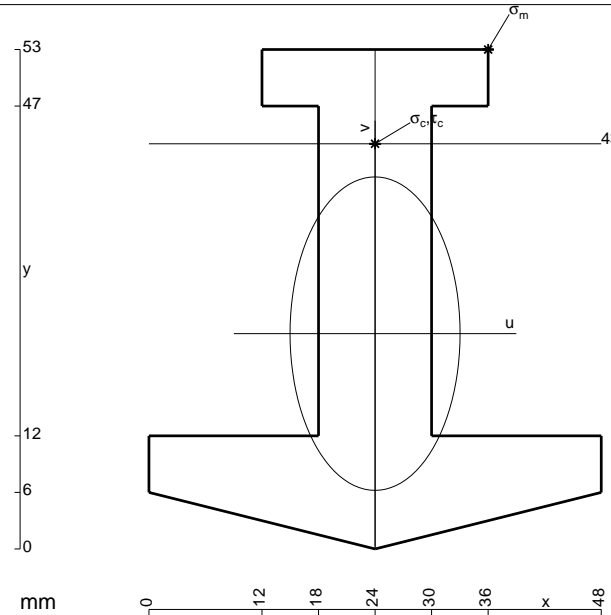
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

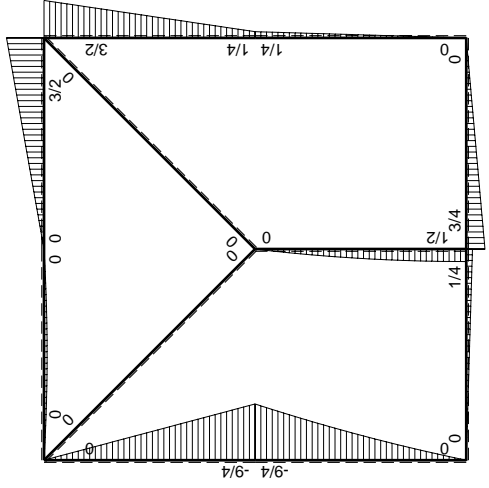
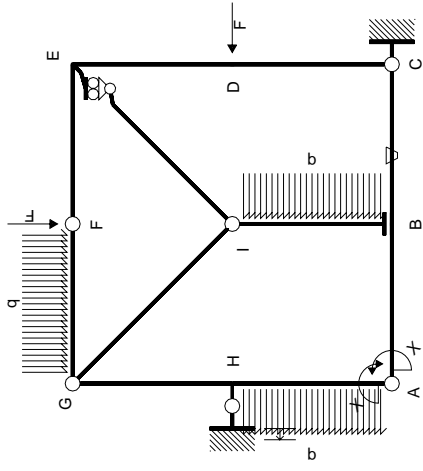
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

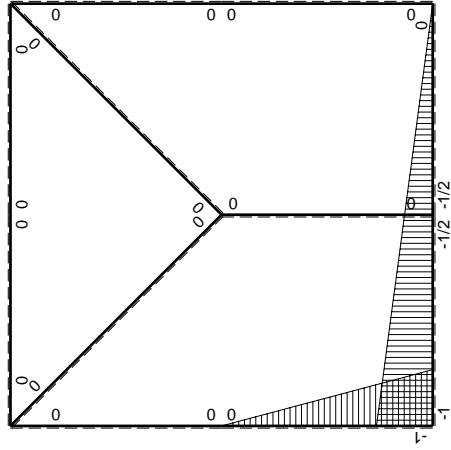


- A = 996. mm<sup>2</sup>
- J<sub>u</sub> = 275589. mm<sup>4</sup>
- J<sub>v</sub> = 81072. mm<sup>4</sup>
- y<sub>g</sub> = 22.85 mm
- N = 825. N
- T<sub>y</sub> = -3713. N
- M<sub>x</sub> = -1819130. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.15 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 199.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 43. mm
- v<sub>c</sub> = 20.15 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 133.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.583 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 134.2 N/mm<sup>2</sup>
- S = 4973. mm<sup>3</sup>





$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	$-Fb/EJ$	$-3/8Fb+3/4Fx-3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	$Fb/EJ$	$-3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

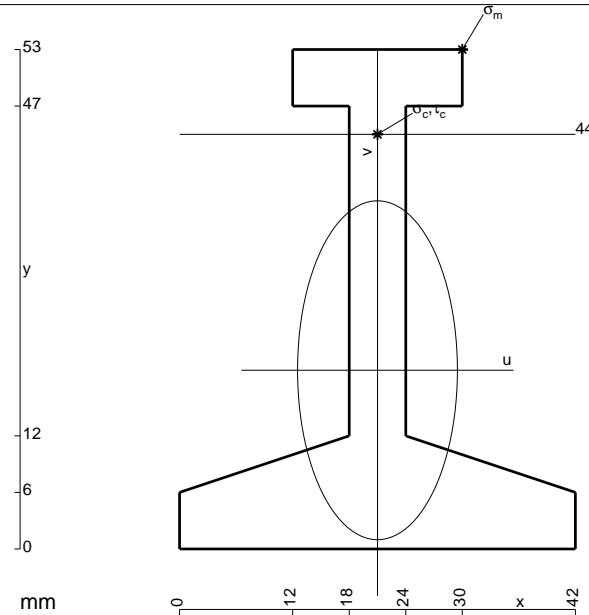
$$= (-1/8 b) Fb 1/EJ + (-1/4 b) \theta = 1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

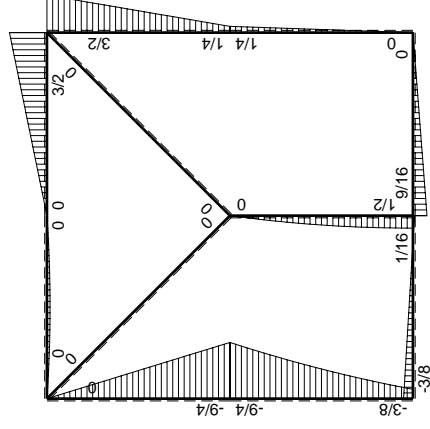
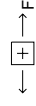
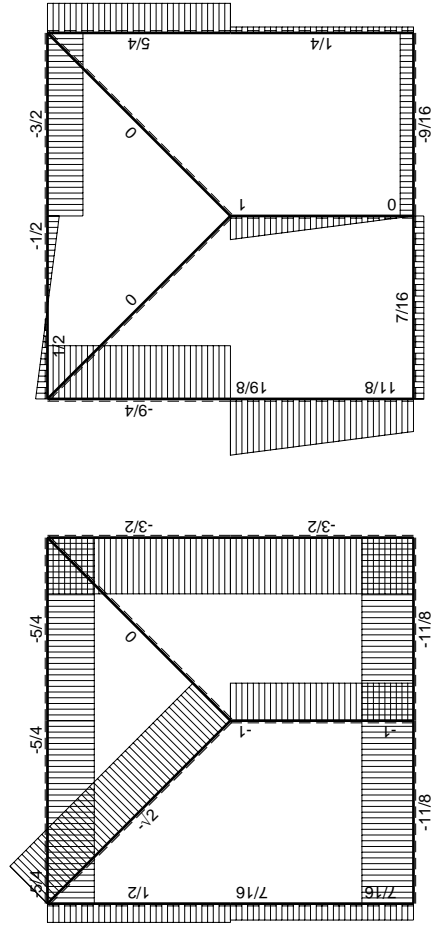
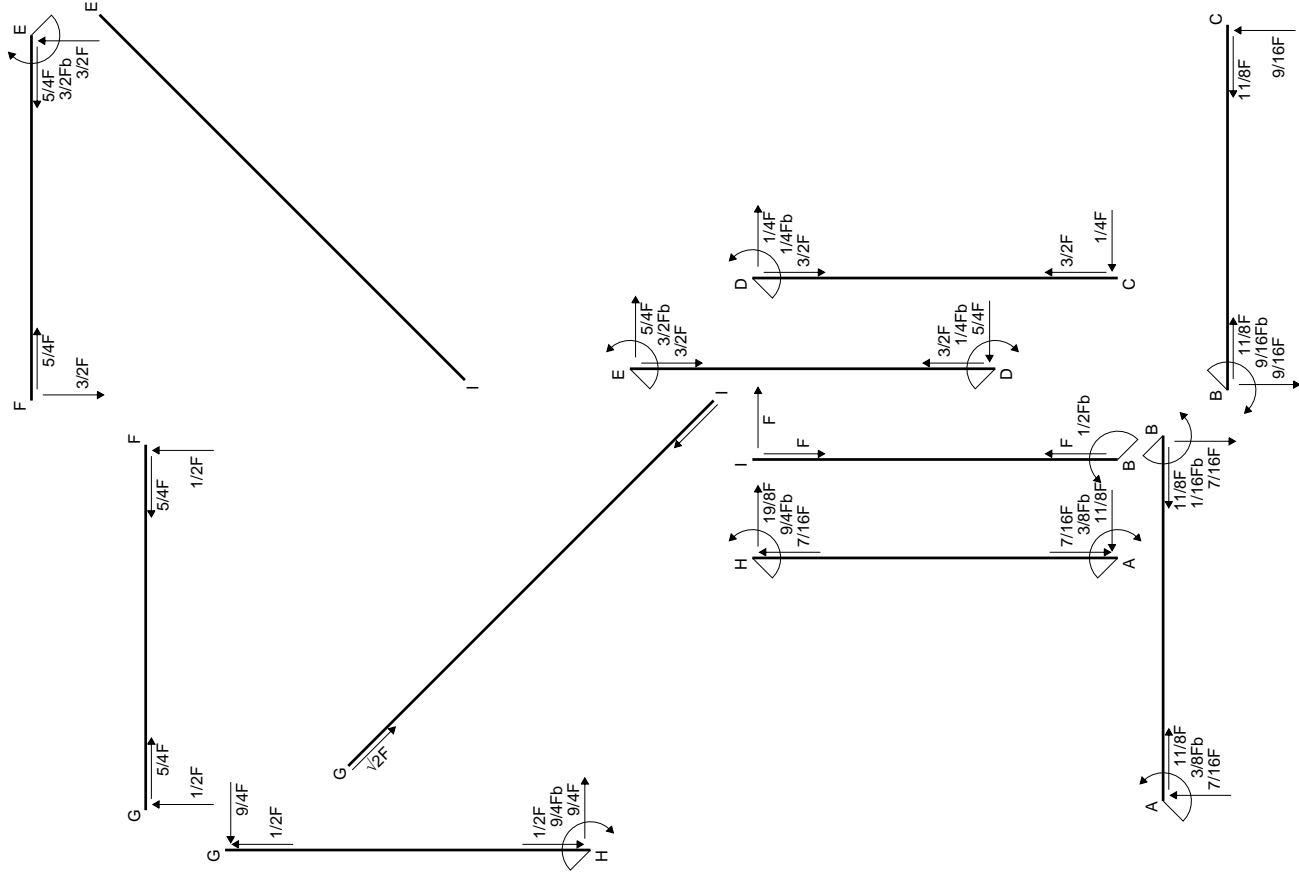
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

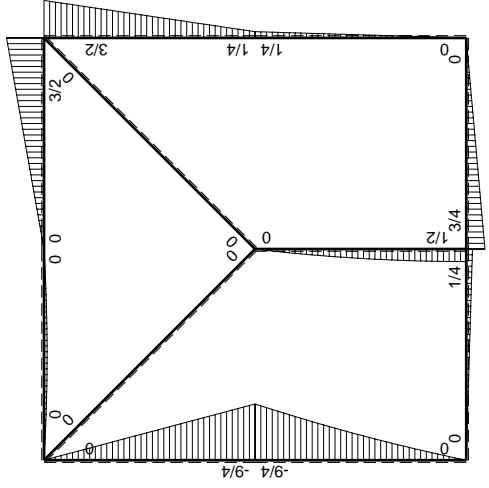
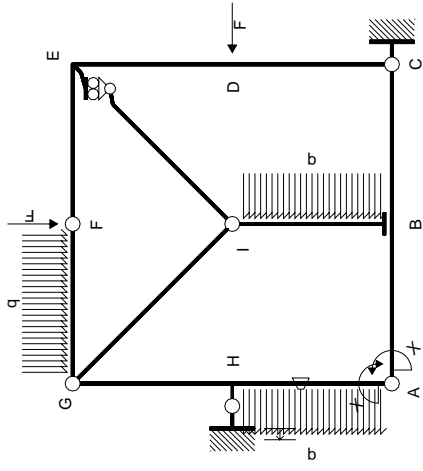
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



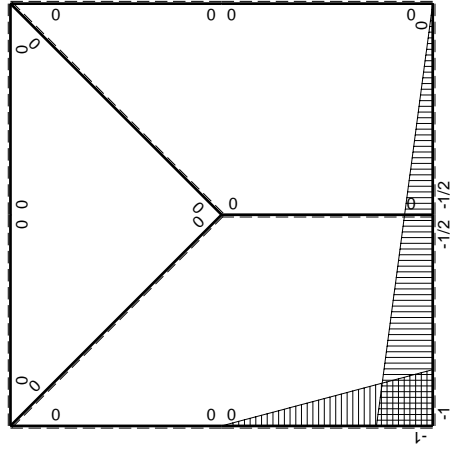
- A = 714. mm<sup>2</sup>
- J<sub>u</sub> = 230961. mm<sup>4</sup>
- J<sub>v</sub> = 51390. mm<sup>4</sup>
- y<sub>g</sub> = 18.96 mm
- N = 595. N
- T<sub>y</sub> = -2678. N
- M<sub>x</sub> = -1419080. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 34.04 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 210. N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 44. mm
- v<sub>c</sub> = 25.04 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 154.7 N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.4 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 155.2 N/mm<sup>2</sup>
- S = 3830. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	$-Fb/EJ$	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	$Fx/EJ$	$x^2/b^2$	$(1/3+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	$Fb/EJ$	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

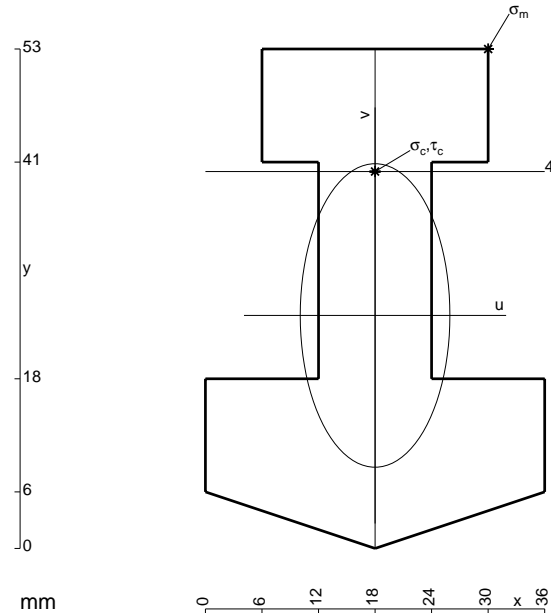
$$= [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 5/6 Fb^2/EJ$$

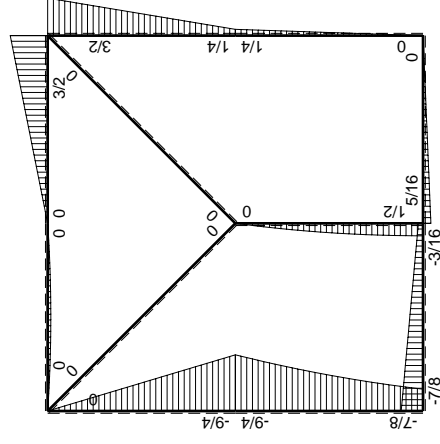
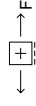
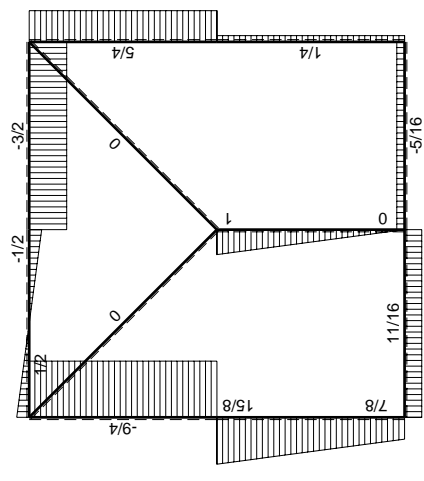
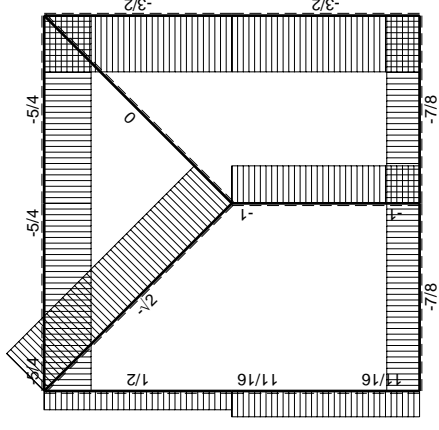
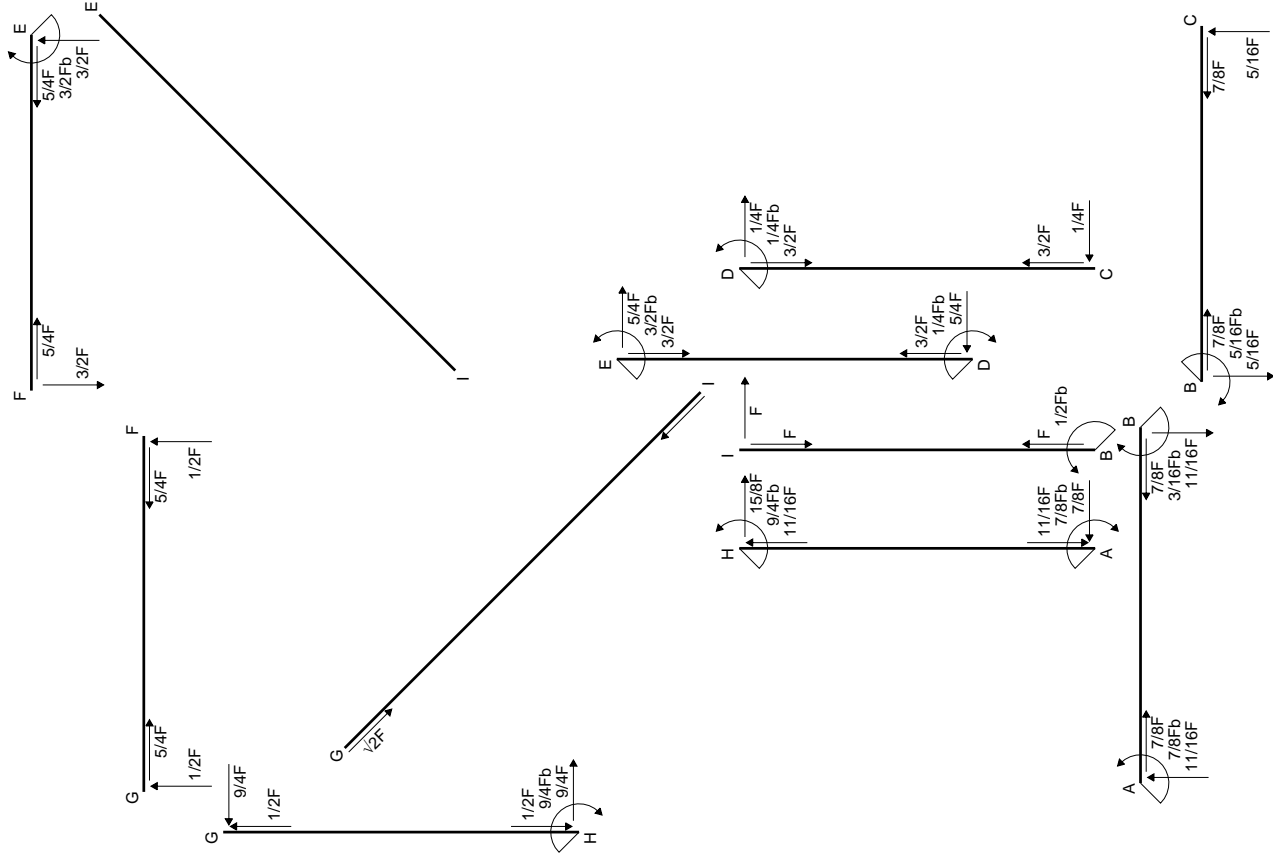
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

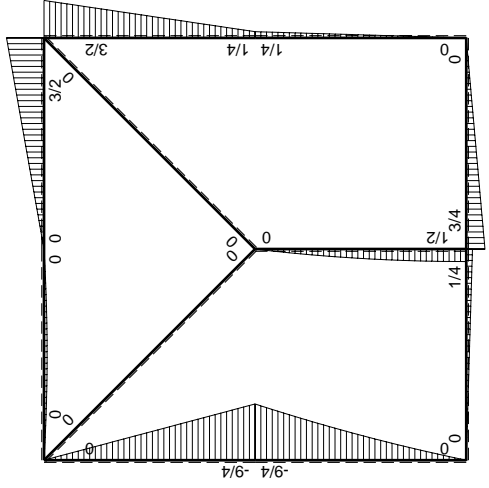
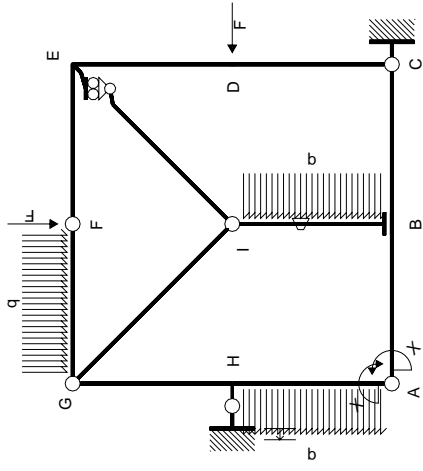
$$= [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 5/6 Fb^2/EJ$$

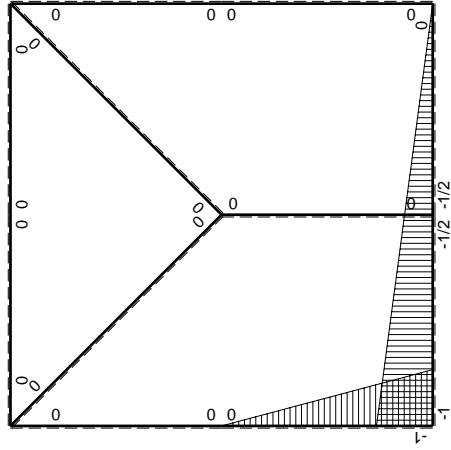


- A = 1104. mm<sup>2</sup>
- J<sub>u</sub> = 286555. mm<sup>4</sup>
- J<sub>v</sub> = 69624. mm<sup>4</sup>
- y<sub>g</sub> = 24.72 mm
- N = 850. N
- T<sub>y</sub> = -3825. N
- M<sub>x</sub> = -2218500. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.28 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 219.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 15.28 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 119. N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.347 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 119.7 N/mm<sup>2</sup>
- S = 6605. mm<sup>3</sup>





$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	$Fb/EJ$	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ x - 1/2 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x + 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x - 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = \left[ 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = \left[ 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = \left[ x - x^2/b + 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{x_0} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = \left[ -1/8 x^2/b + 1/24 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{x_0} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = \left[ -1/8 x + 1/24 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{x_0} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = \left[ -3/8 x + 3/8 x^2/b - 1/8 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{x_0} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = \left[ -1/8 x^3/b^2 \right]_0^b Fb 1/EJ$$

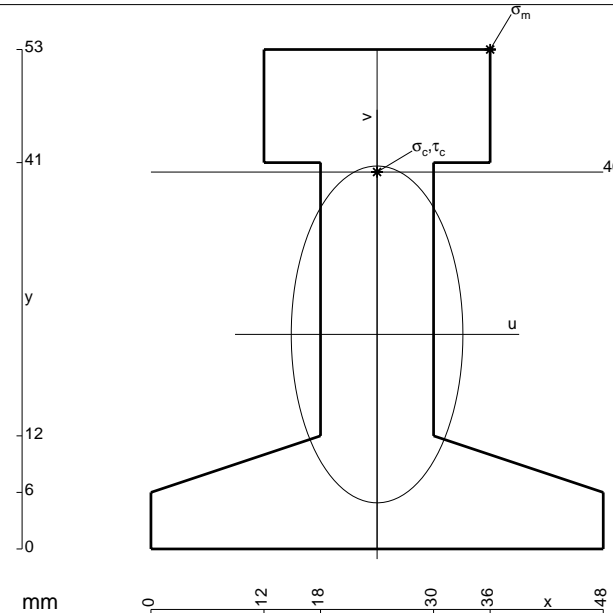
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{x_0} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{AH}^{x_0} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



$$A = 1104. \text{ mm}^2$$

$$J_u = 352844. \text{ mm}^4$$

$$J_v = 91656. \text{ mm}^4$$

$$y_g = 22.77 \text{ mm}$$

$$N = 940. \text{ N}$$

$$T_y = -4230. \text{ N}$$

$$M_x = -2664900. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 30.23 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = 229.2 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

$$v_c = 17.23 \text{ mm}$$

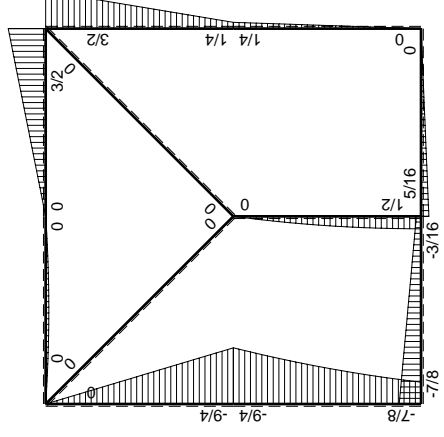
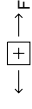
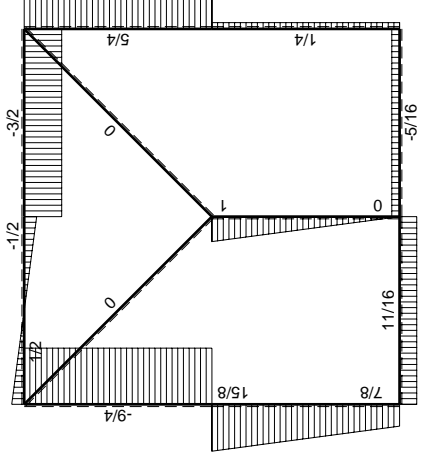
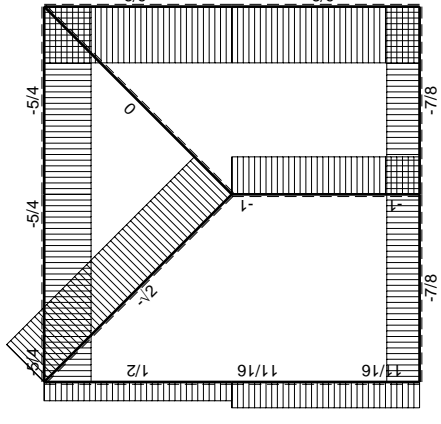
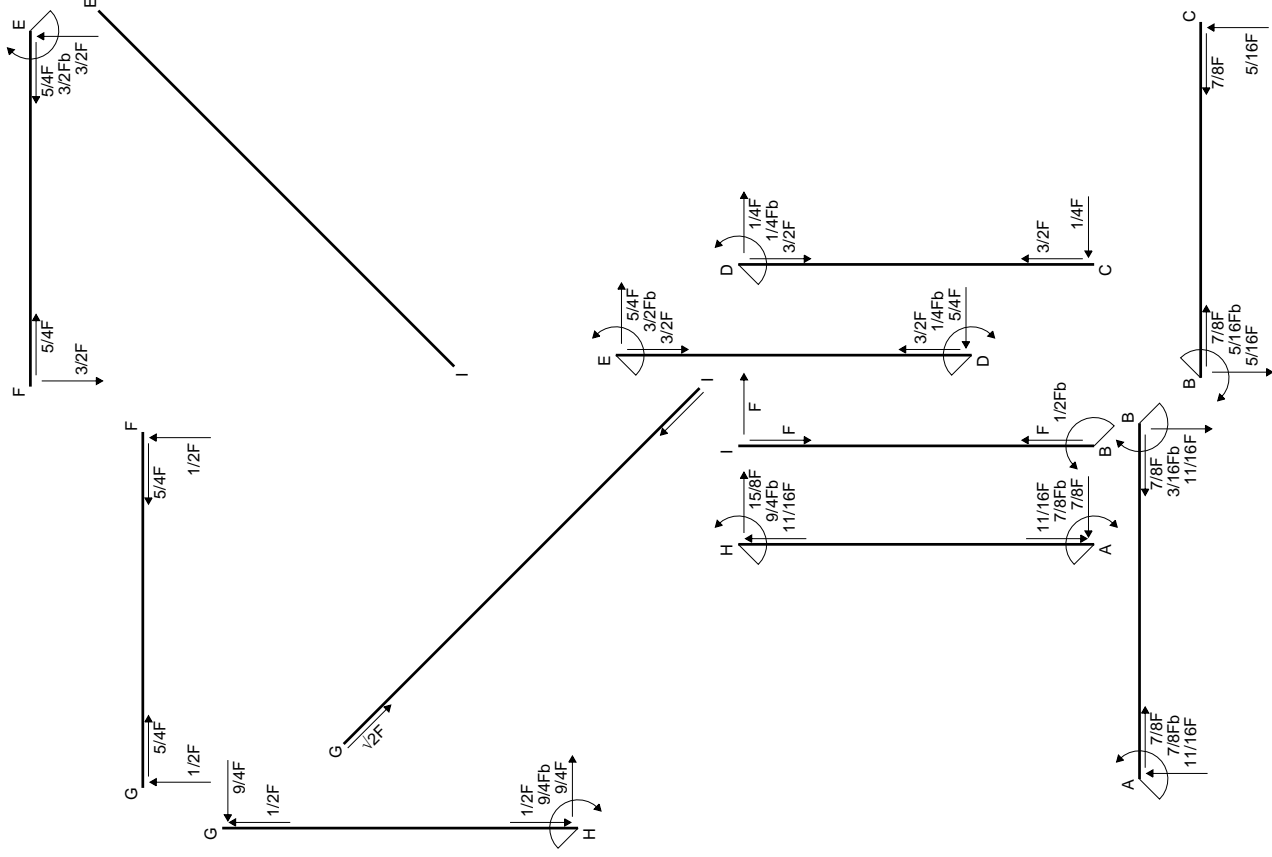
$$\sigma_c = N/A - Mv/J_u = 131. \text{ N/mm}^2$$

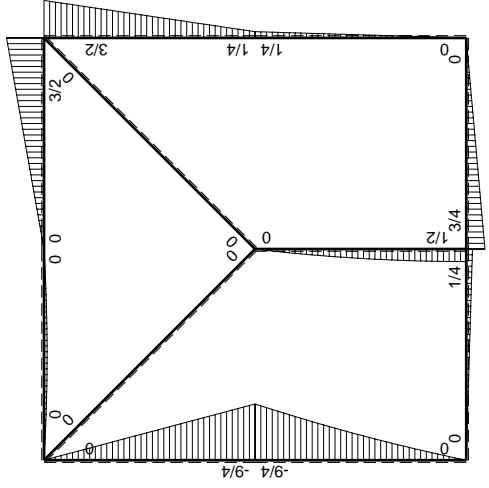
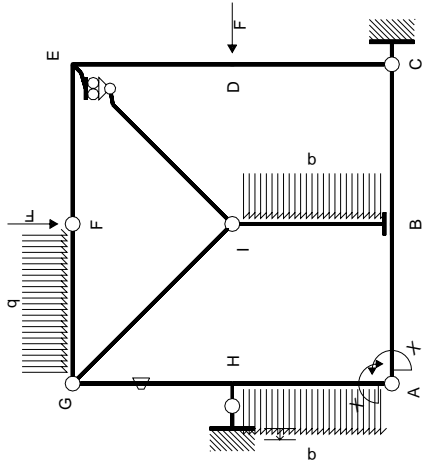
$$\tau_c = 7.185 \text{ N/mm}^2$$

$$\sigma_\varphi = \sqrt{\sigma^2 + 3\tau^2} = 131.6 \text{ N/mm}^2$$

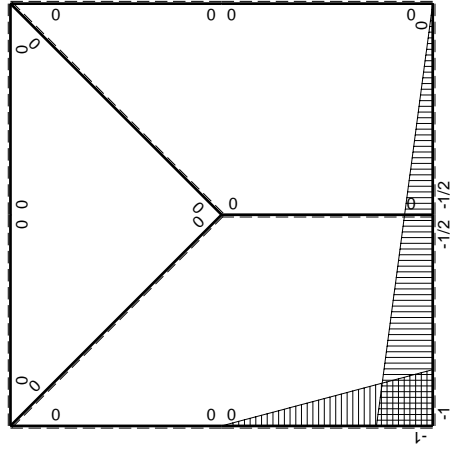
$$S = 7192. \text{ mm}^3$$







$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica X=1

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-9/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	$Fb/EJ$	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

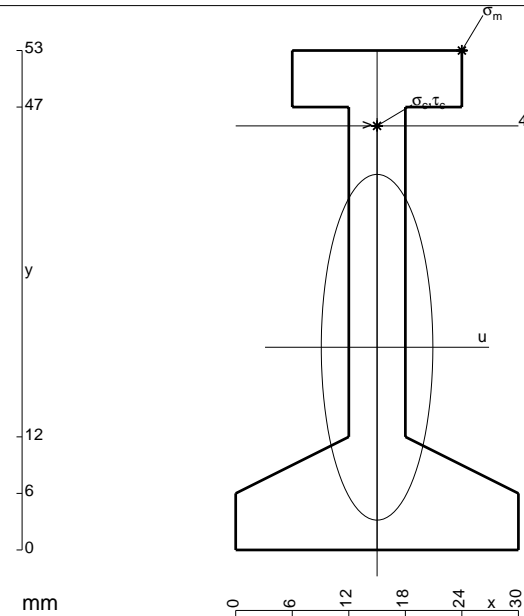
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



$$A = 606. \text{ mm}^2$$

$$J_u = 204068. \text{ mm}^4$$

$$J_v = 21258. \text{ mm}^4$$

$$y_g = 21.51 \text{ mm}$$

$$N = 505. \text{ N}$$

$$T_y = -2273. \text{ N}$$

$$M_x = -1545300. \text{ Nmm}$$

$$x_m = 24. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 31.49 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = 239.3 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 45. \text{ mm}$$

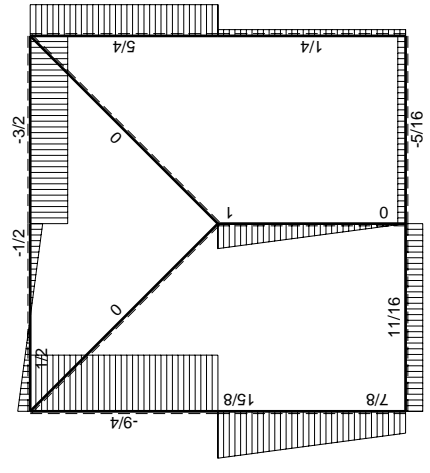
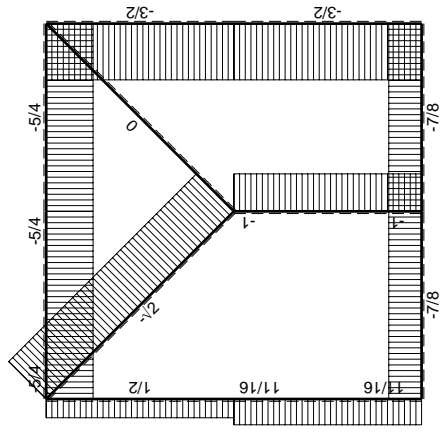
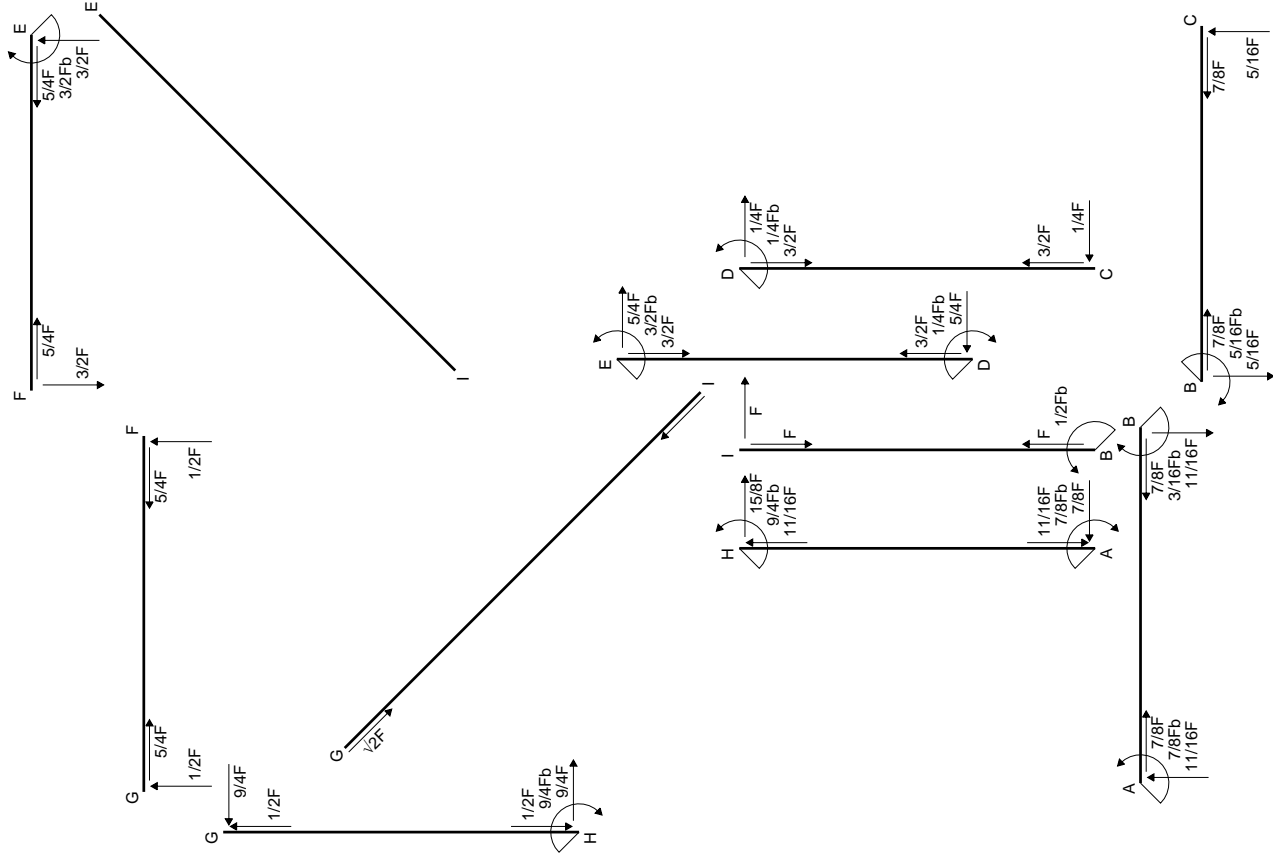
$$v_c = 23.49 \text{ mm}$$

$$\sigma_c = N/A - Mv/J_u = 178.7 \text{ N/mm}^2$$

$$\tau_c = 6.256 \text{ N/mm}^2$$

$$\sigma_\rho = \sqrt{\sigma^2 + 3\tau^2} = 179. \text{ N/mm}^2$$

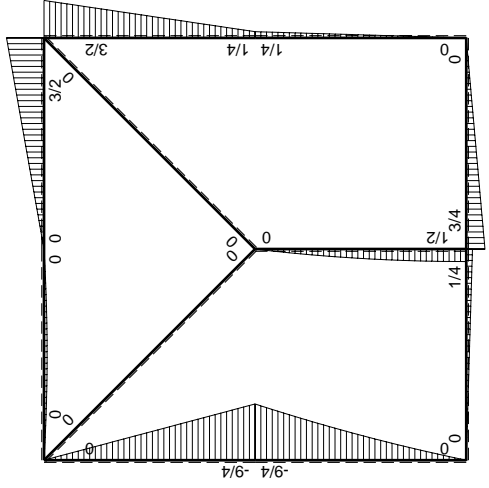
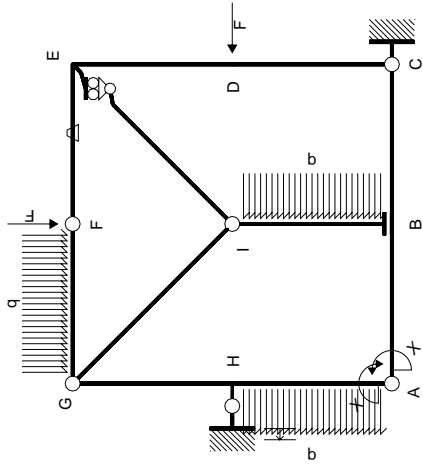
$$S = 3371. \text{ mm}^3$$



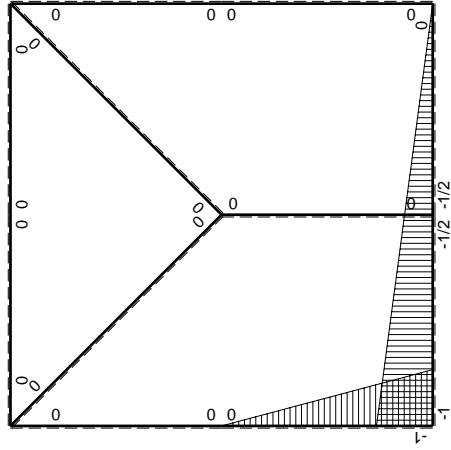
$\left[ \begin{matrix} + \\ - \end{matrix} \right] \rightarrow F$

$\left[ \begin{matrix} + \\ - \end{matrix} \right] \rightarrow F$

$\left[ \begin{matrix} + \\ - \end{matrix} \right] \rightarrow Fb$



$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	$-Fb/EJ$	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	$Fb/EJ$	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

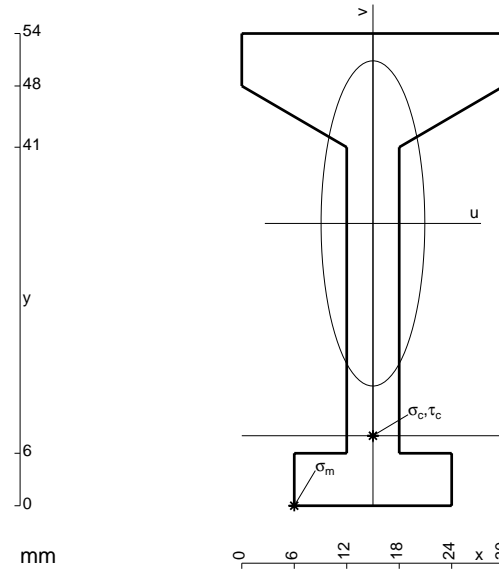
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

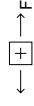
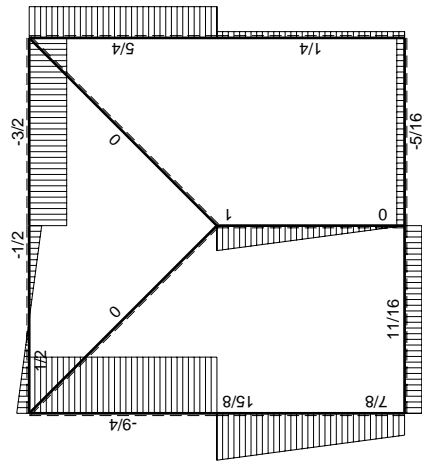
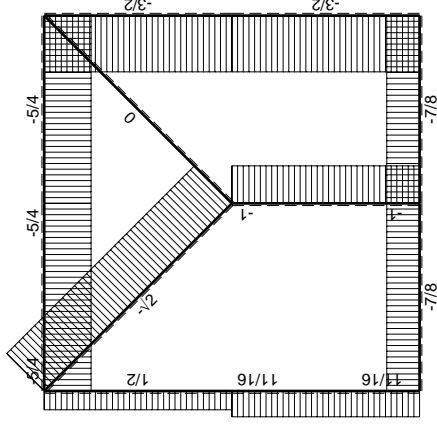
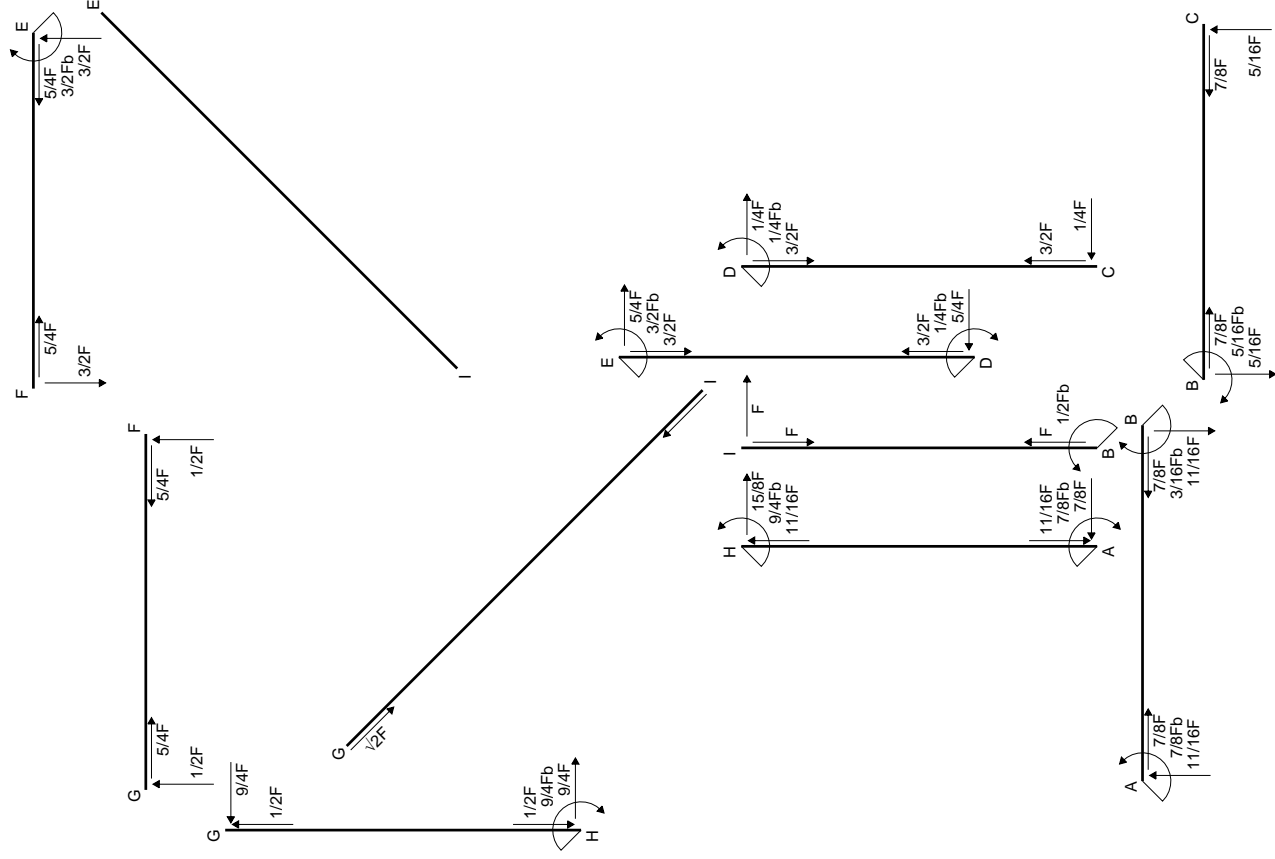
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

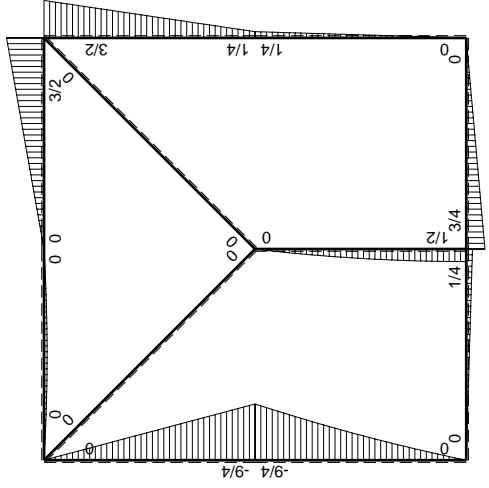
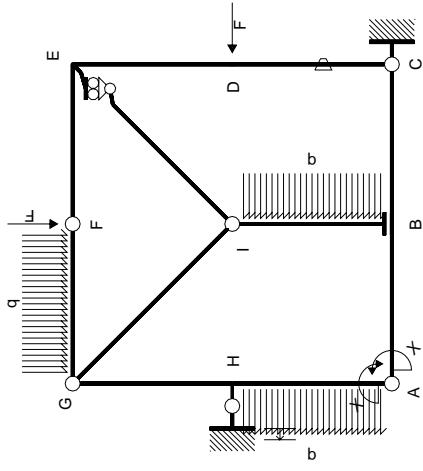
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



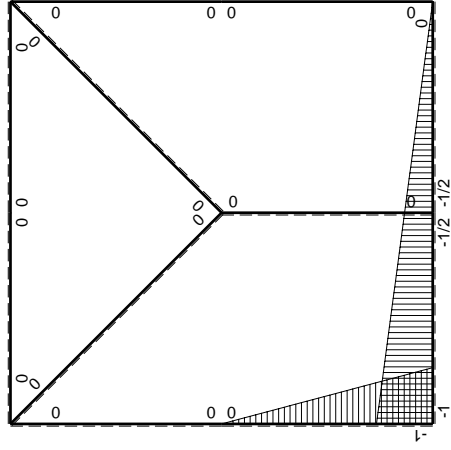
- A = 624. mm<sup>2</sup>
- J<sub>u</sub> = 215884. mm<sup>4</sup>
- J<sub>v</sub> = 21960. mm<sup>4</sup>
- y<sub>g</sub> = 32.28 mm
- N = 395. N
- T<sub>y</sub> = -1778. N
- M<sub>x</sub> = -1333130. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -32.28 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -198.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 8. mm
- v<sub>c</sub> = -24.28 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -149.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.756 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 149.5 N/mm<sup>2</sup>
- S = 3466. mm<sup>3</sup>







$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	$Fb/EJ$	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

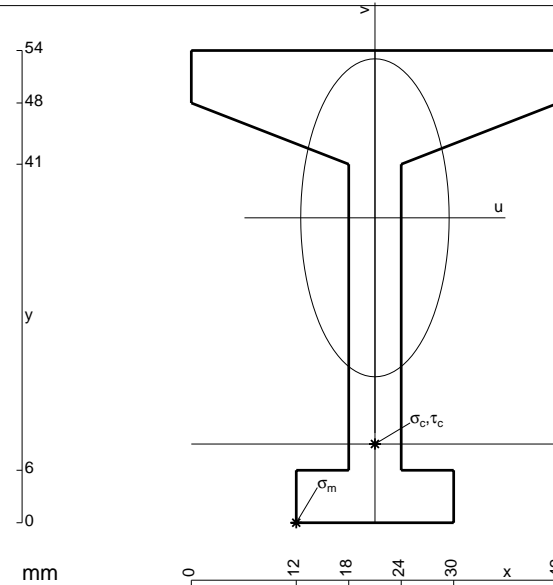
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

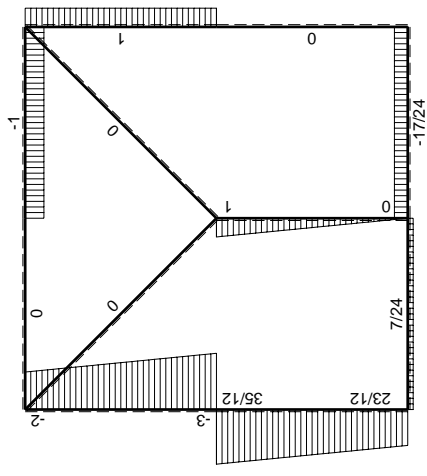
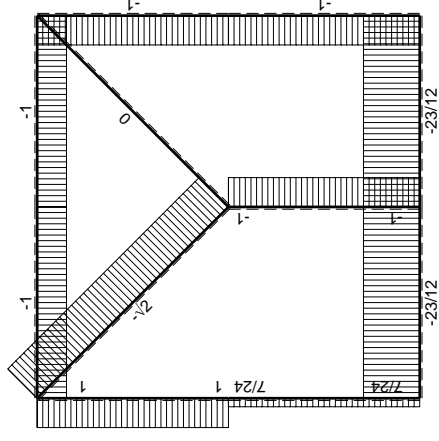
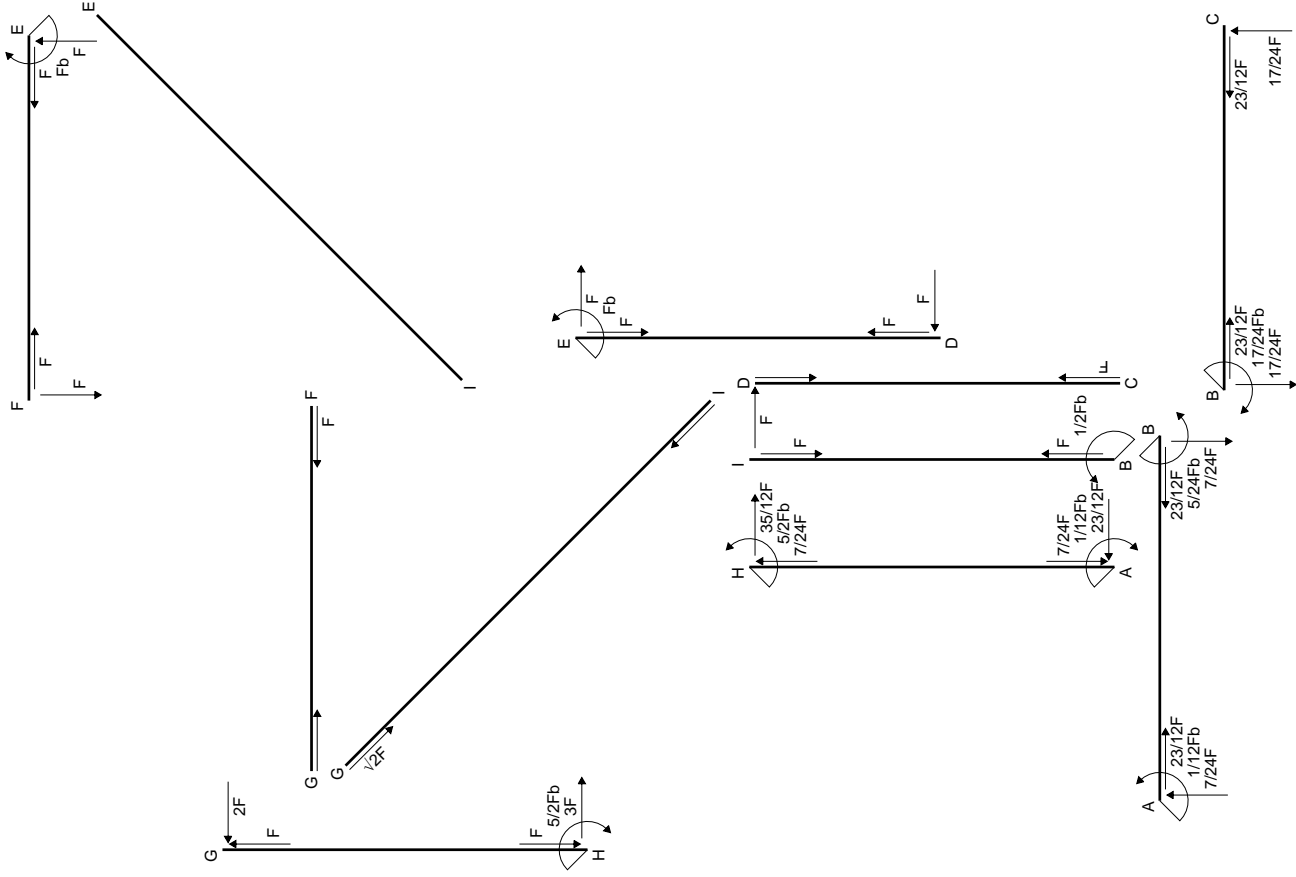
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

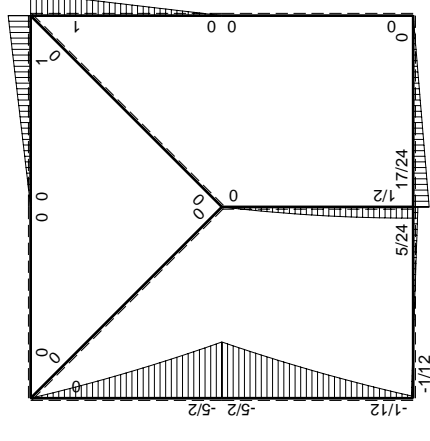


- A = 738. mm<sup>2</sup>
- J<sub>u</sub> = 244023. mm<sup>4</sup>
- J<sub>v</sub> = 53190. mm<sup>4</sup>
- y<sub>g</sub> = 34.87 mm
- N = 405. N
- T<sub>y</sub> = -1823. N
- M<sub>x</sub> = -1458000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -34.87 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -207.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -25.87 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -154. N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.898 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 154.3 N/mm<sup>2</sup>
- S = 3935. mm<sup>3</sup>

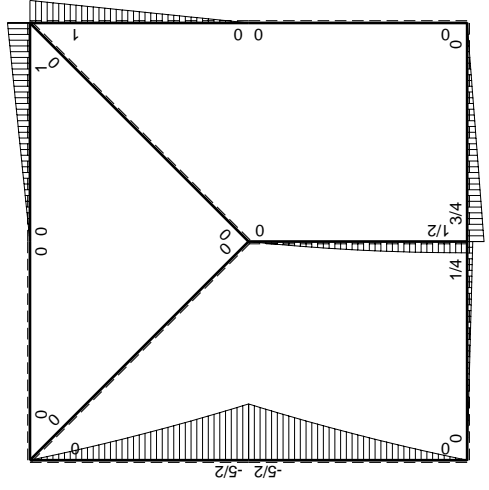
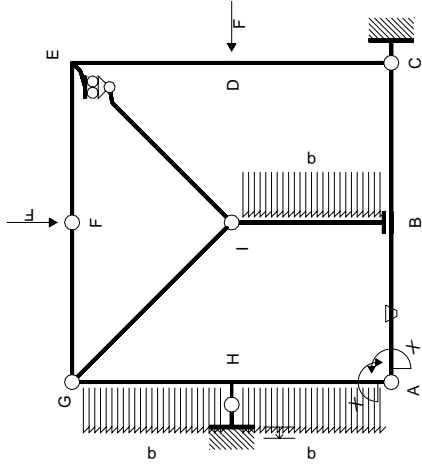


← ⊕ → F

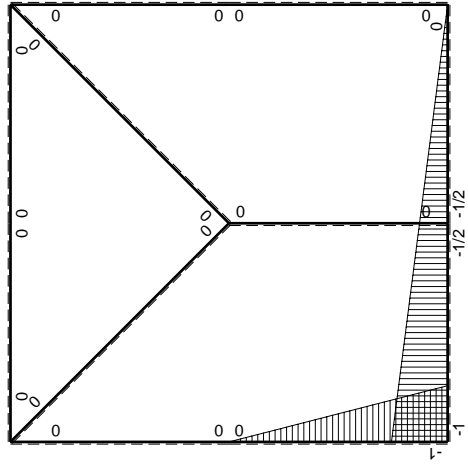
↑ ⊕ ↓ F



← ⊕ → Fb



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	$-Fb/EJ$	$-1/4Fx+1/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-1/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	$Fb/EJ$	$-1/8Fb+1/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/12Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{x\theta} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/2 x^2/b]_0^b \theta$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ + (b - 1/2 b) \theta = 2/3 Fb^2/EJ$$

$$L_{BA}^{x\theta} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 2/3 Fb^2/EJ$$

$$L_{BC}^{x\theta} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{x\theta} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

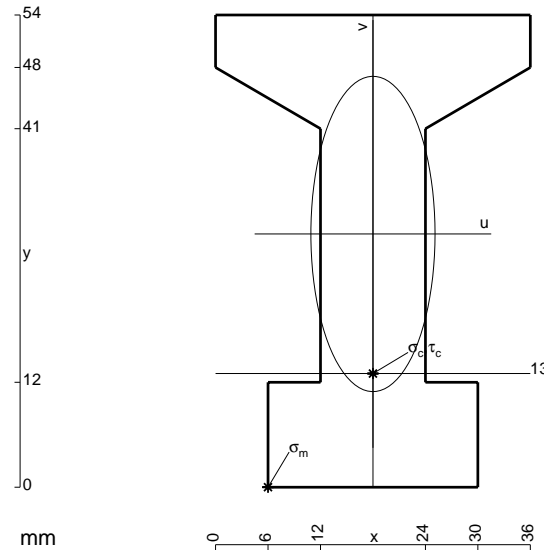
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{x\theta} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

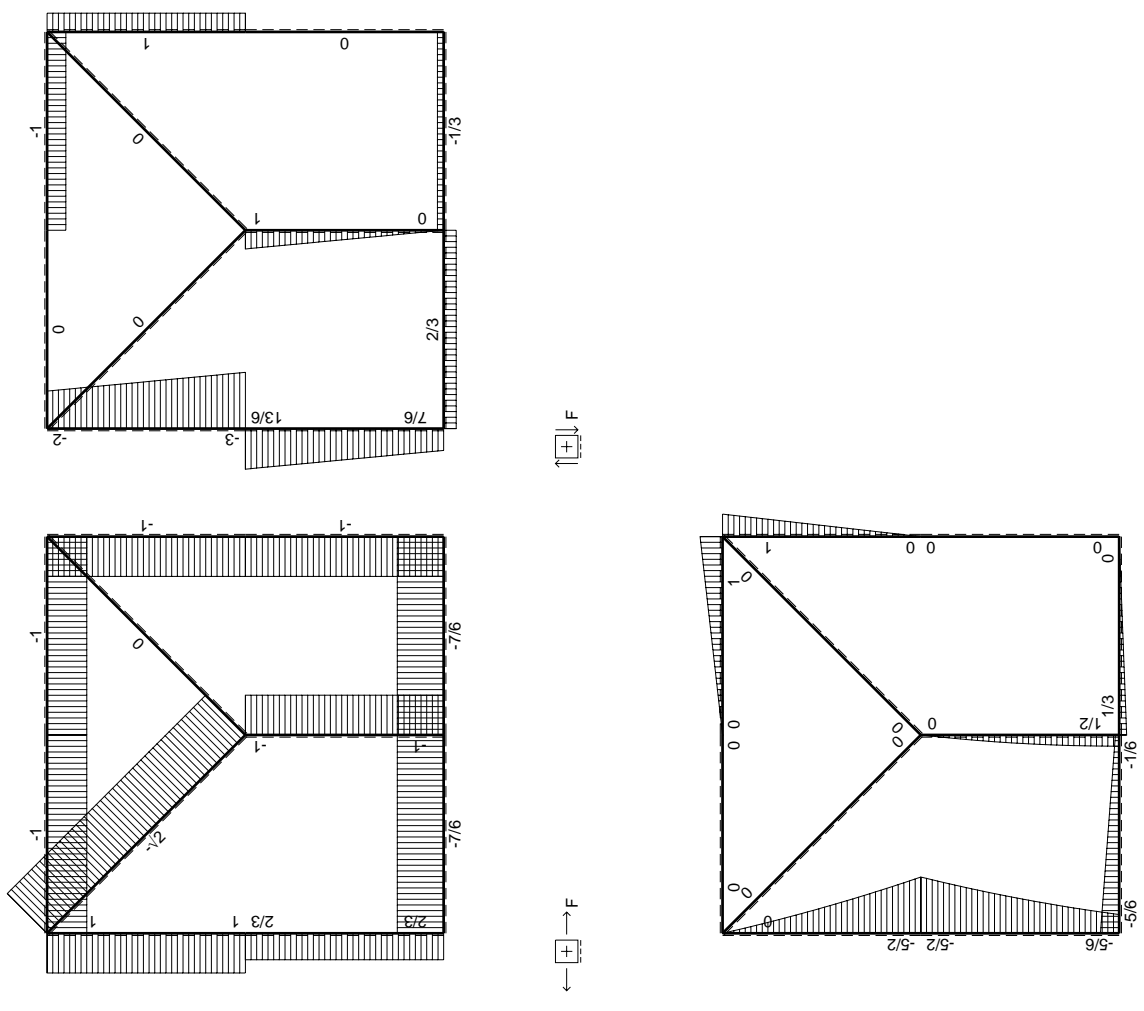
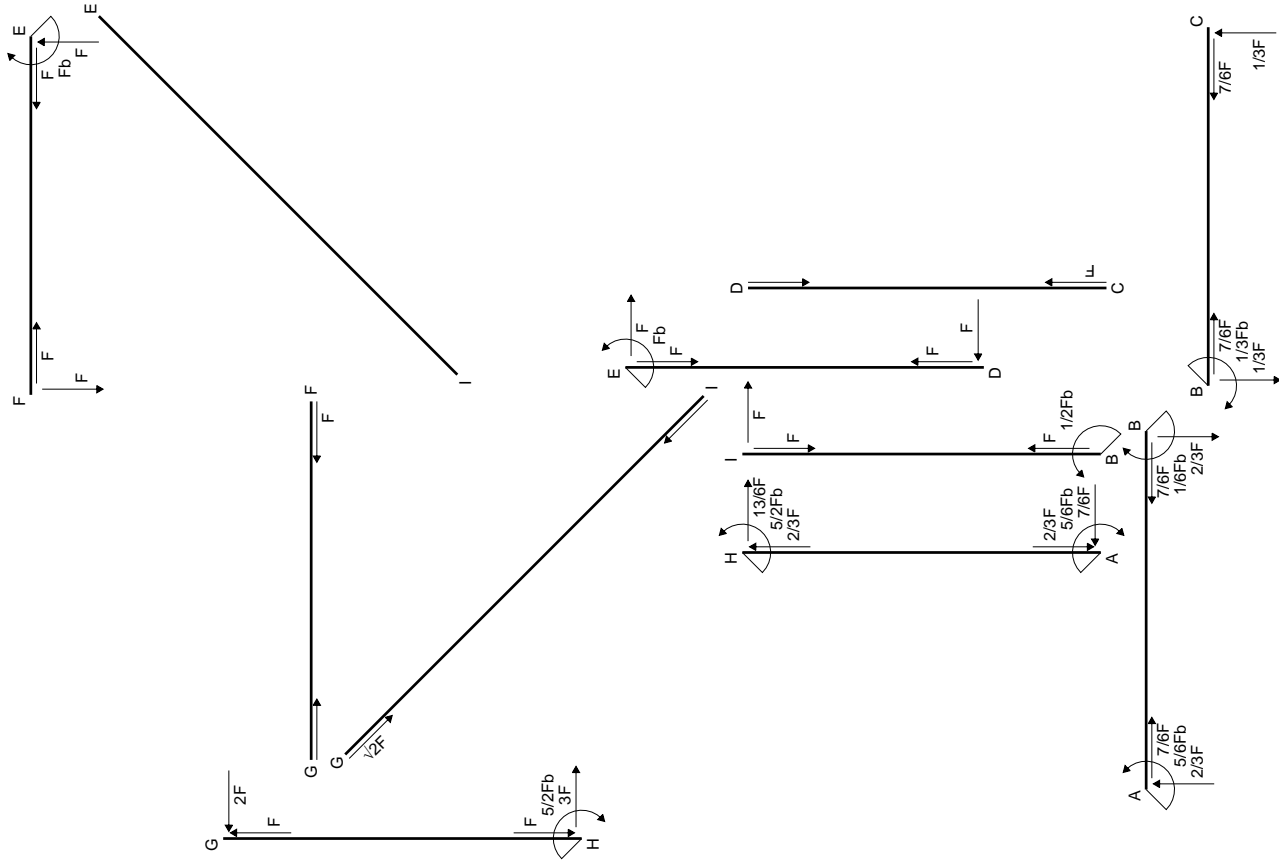
$$L_{AH}^{x\theta} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

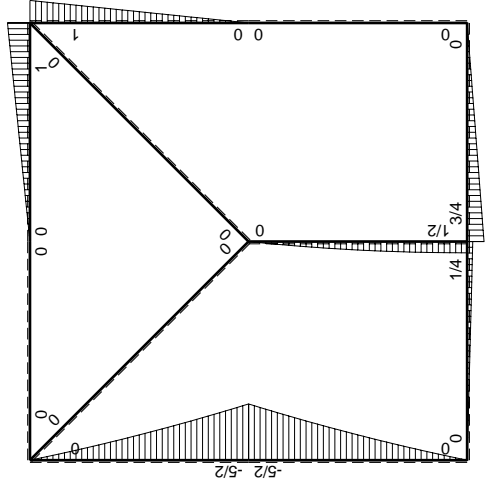
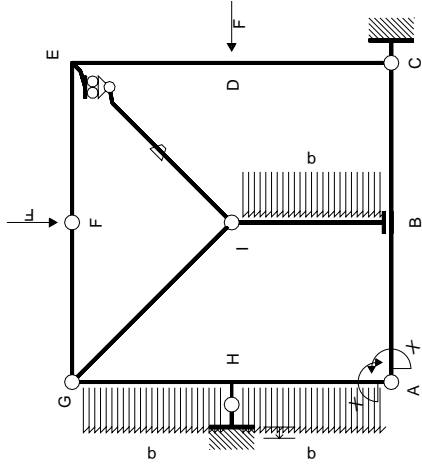
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



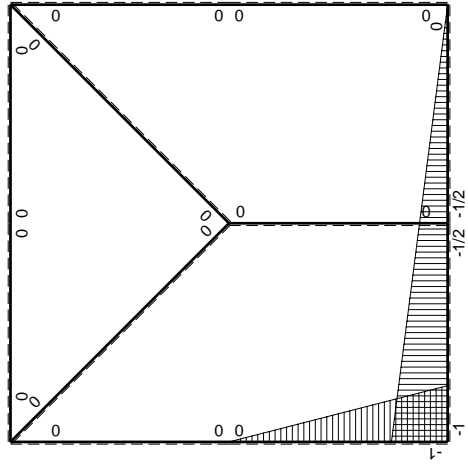
- A = 1020. mm<sup>2</sup>
- J<sub>u</sub> = 331648. mm<sup>4</sup>
- J<sub>v</sub> = 51408. mm<sup>4</sup>
- y<sub>g</sub> = 28.96 mm
- N = 1190. N
- T<sub>y</sub> = -3570. N
- M<sub>x</sub> = -2528750. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.96 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -219.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.96 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -120.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.109 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup> + 3τ<sup>2</sup> = 121. N/mm<sup>2</sup>
- S = 6810. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica X=1

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

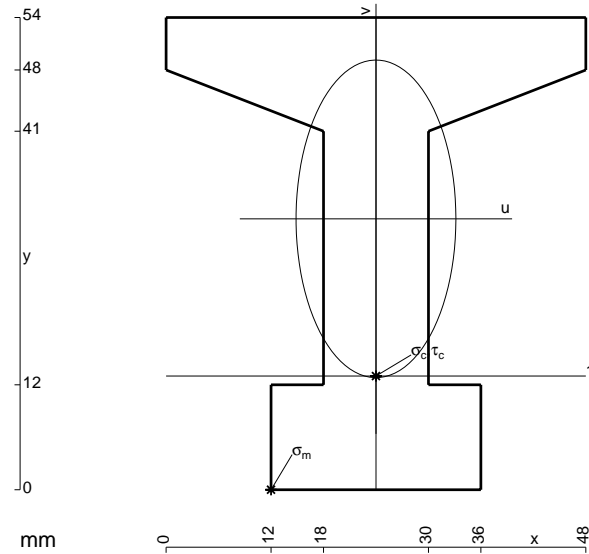
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

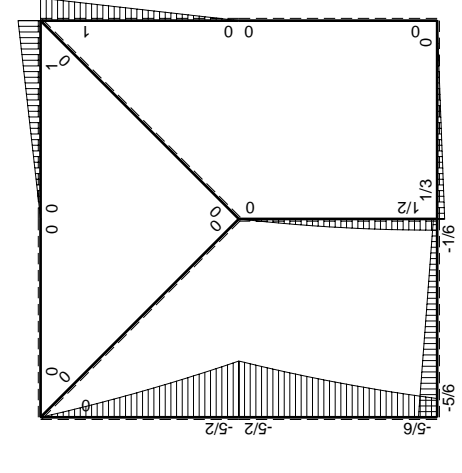
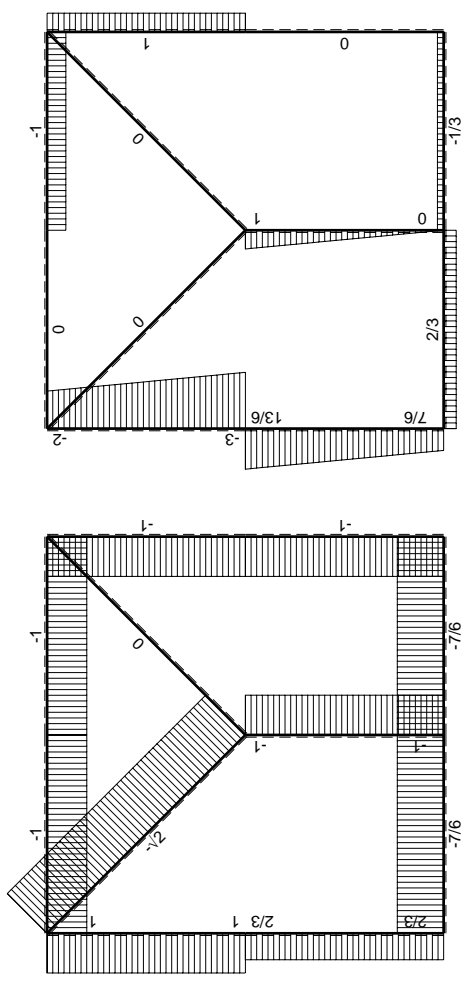
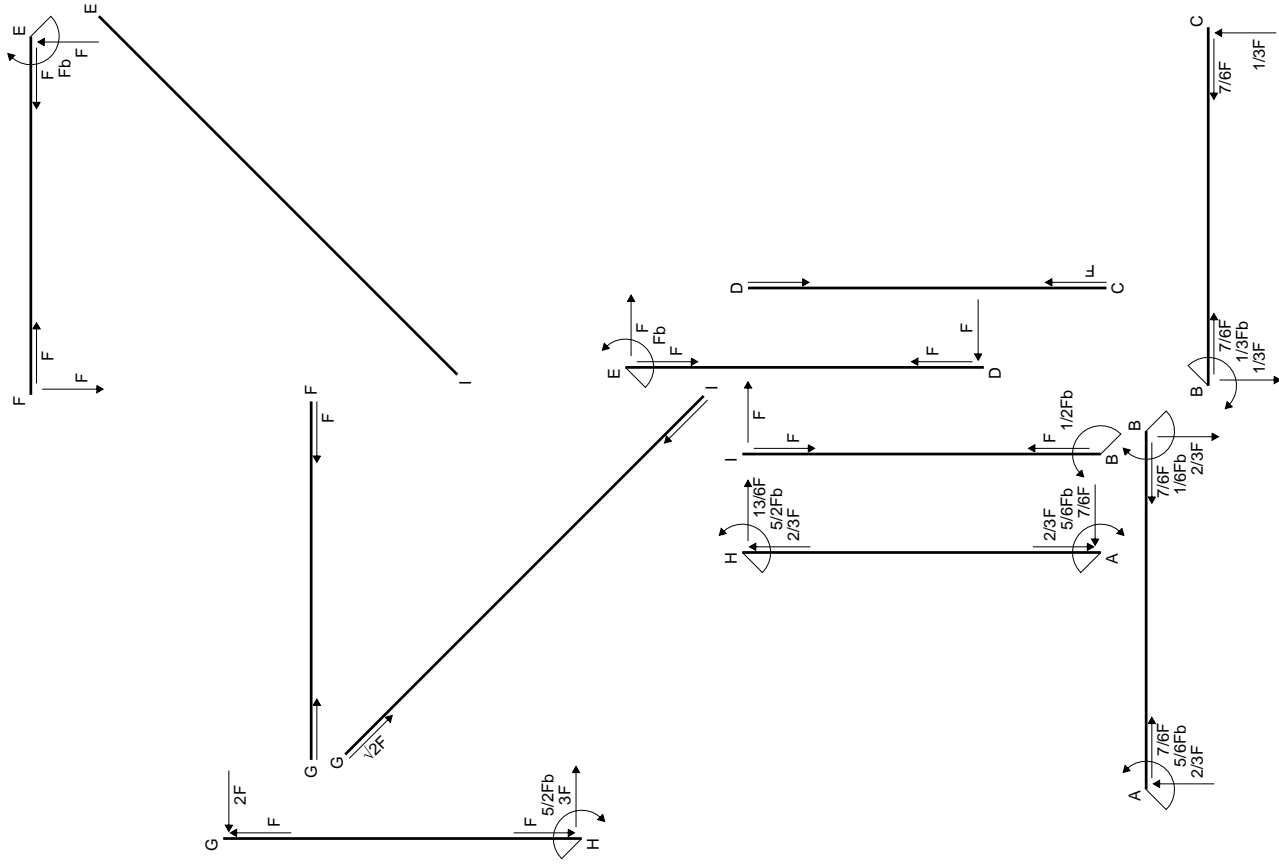
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

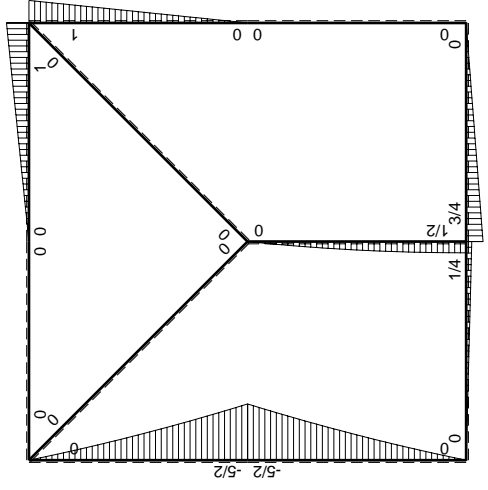
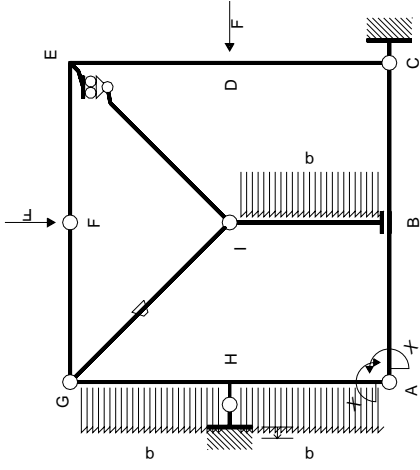
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

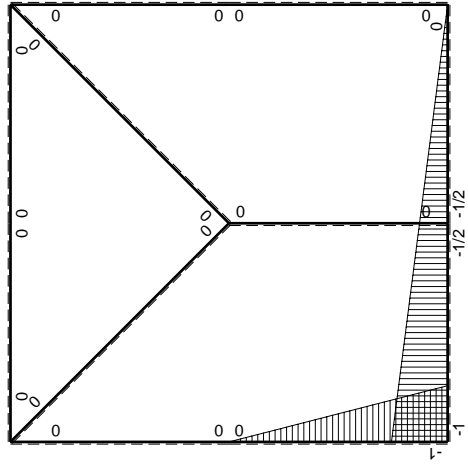


- A = 1134. mm<sup>2</sup>
- J<sub>u</sub> = 374055. mm<sup>4</sup>
- J<sub>v</sub> = 94716. mm<sup>4</sup>
- y<sub>g</sub> = 30.98 mm
- N = 1240. N
- T<sub>y</sub> = -3720. N
- M<sub>x</sub> = -2790000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.98 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -230. N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -17.98 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -133. N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.146 N/mm<sup>2</sup>
- σ<sub>g</sub> = √σ<sup>2</sup> + 3τ<sup>2</sup> = 133.4 N/mm<sup>2</sup>
- S = 7416. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

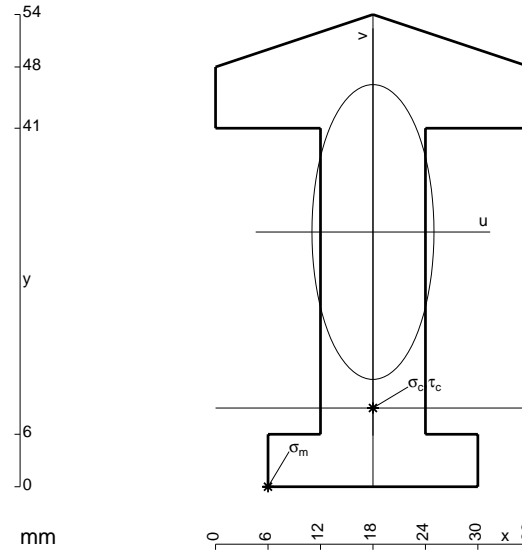
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

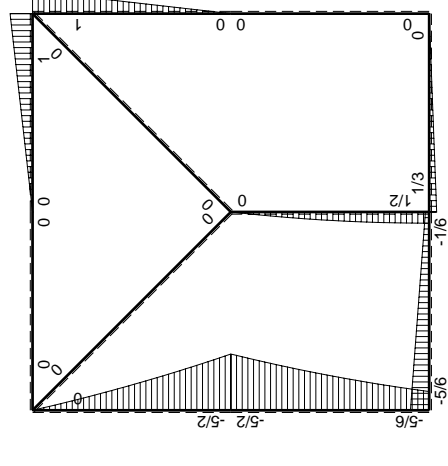
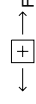
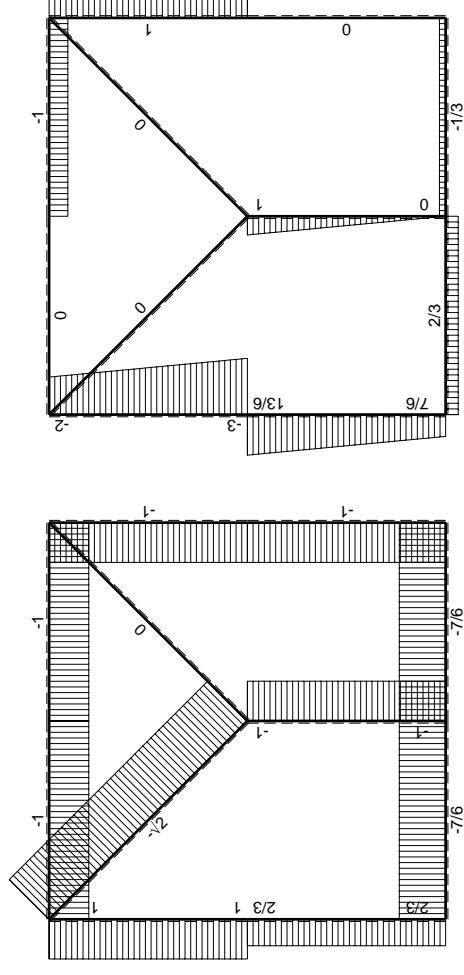
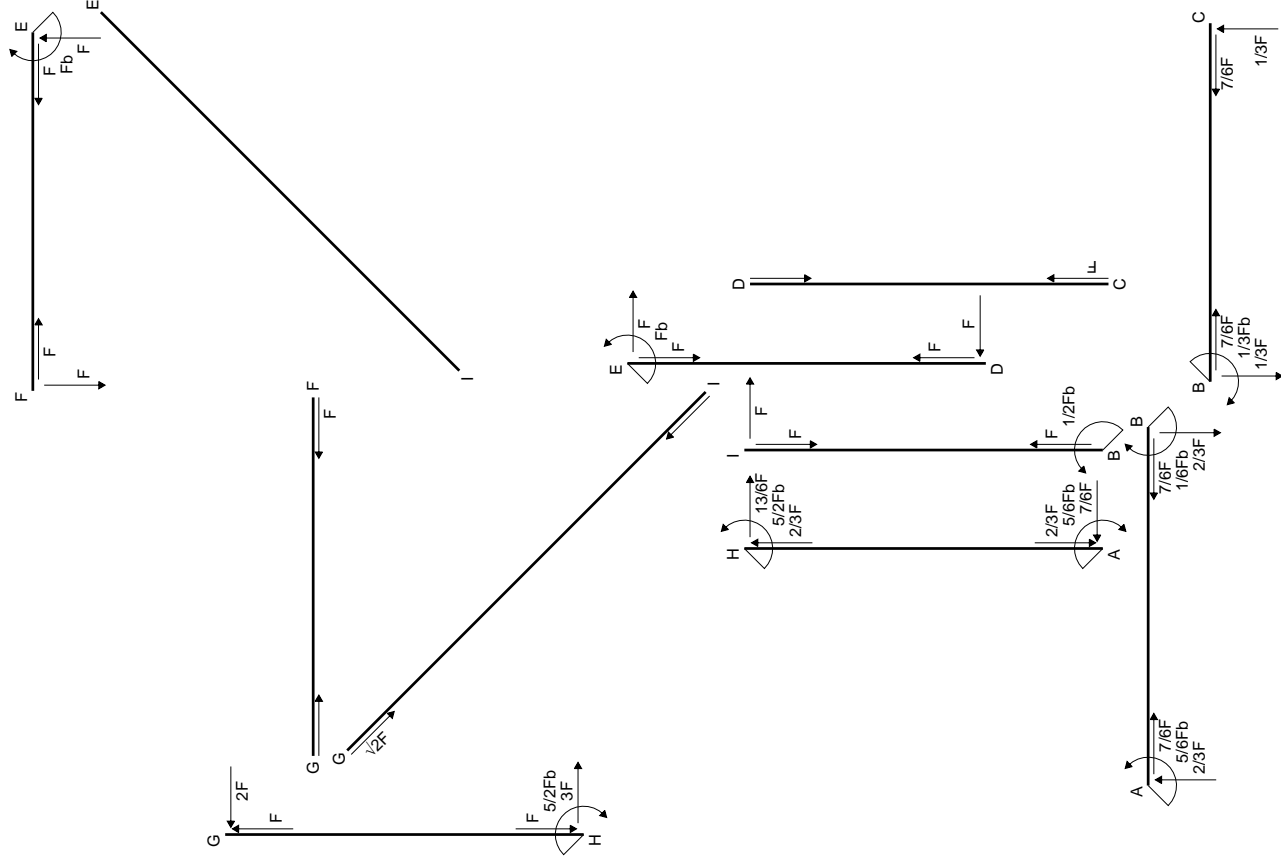
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

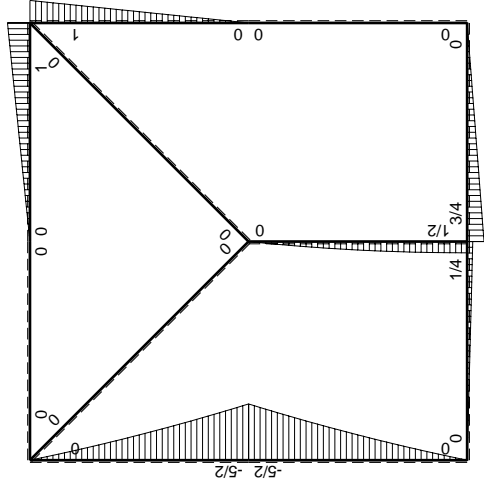
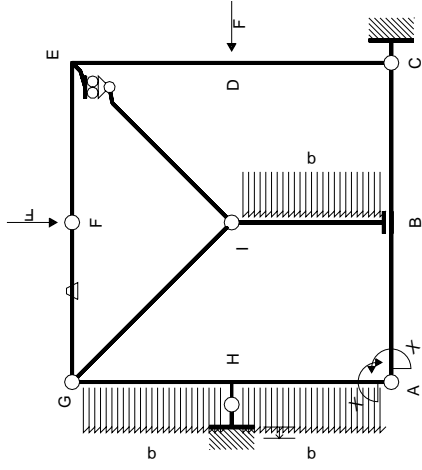
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



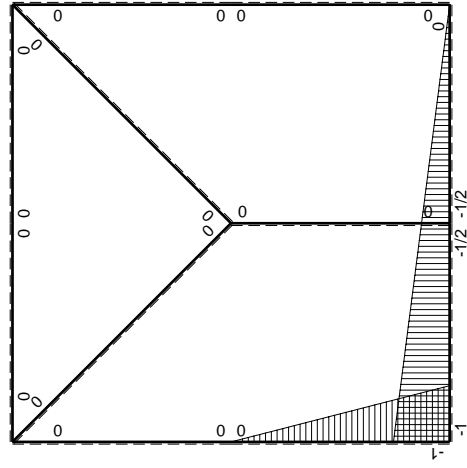
- A = 924. mm<sup>2</sup>
- J<sub>u</sub> = 262756. mm<sup>4</sup>
- J<sub>v</sub> = 45000. mm<sup>4</sup>
- y<sub>g</sub> = 29.13 mm
- N = 910. N
- T<sub>y</sub> = -2730. N
- M<sub>x</sub> = -2161250. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -29.13 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -238.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -20.13 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -164.6 N/mm<sup>2</sup>
- τ<sub>c</sub> = 3.932 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 164.7 N/mm<sup>2</sup>
- S = 4541. mm<sup>3</sup>







$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	0	0	0	0			
FG b	0	0	-Fb/EJ	0	0	0	0+0	0	
GF b	0	0	Fb/EJ	0	0	0			
GH b	0	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

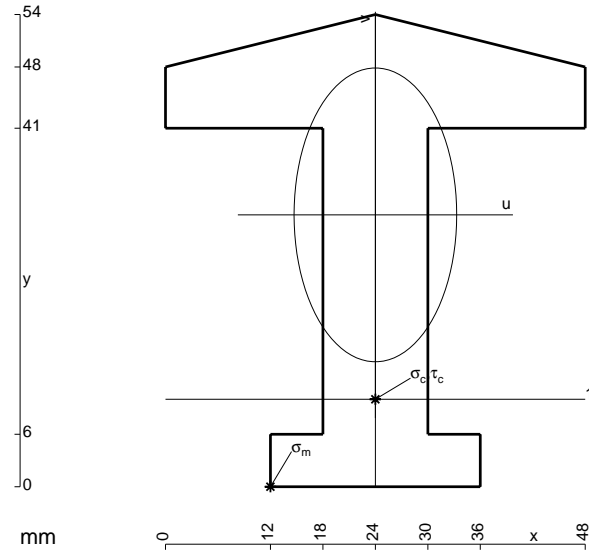
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

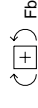
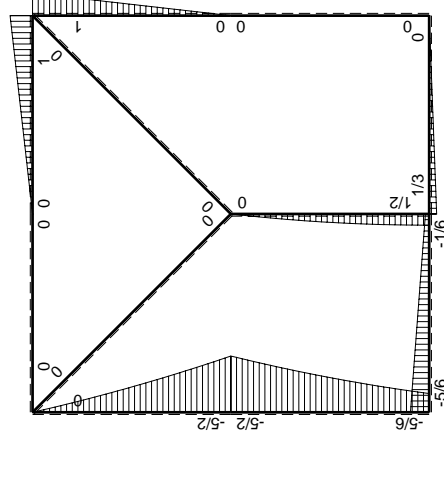
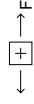
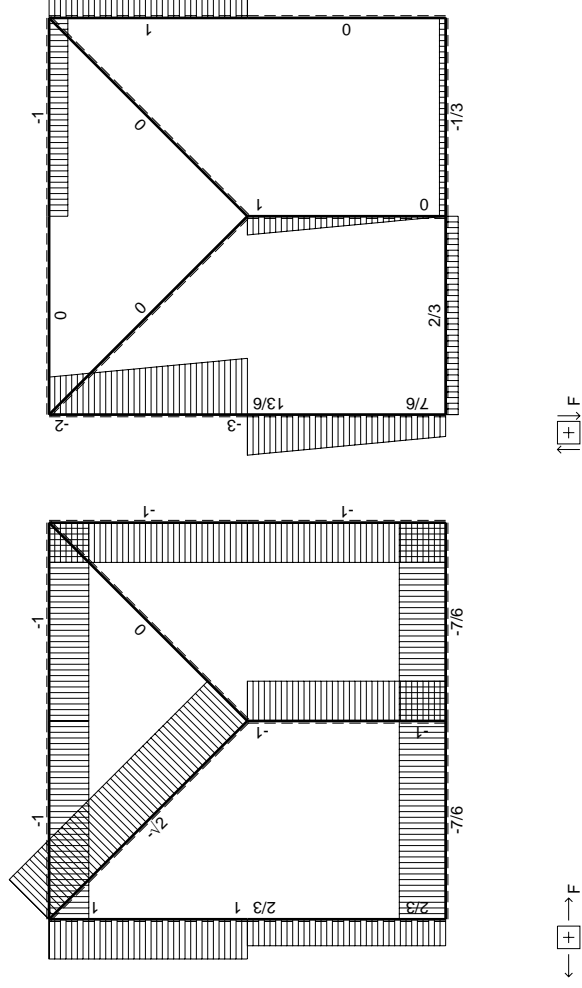
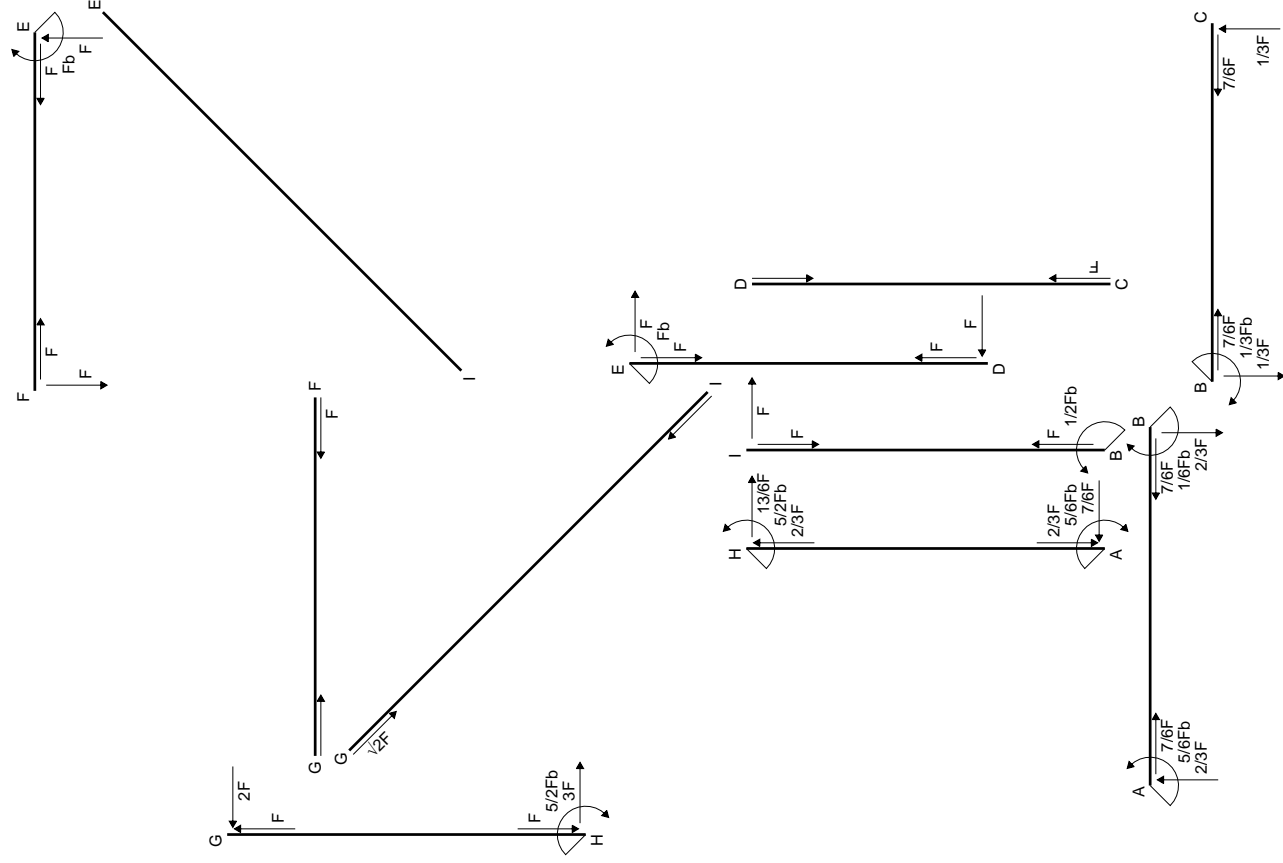
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

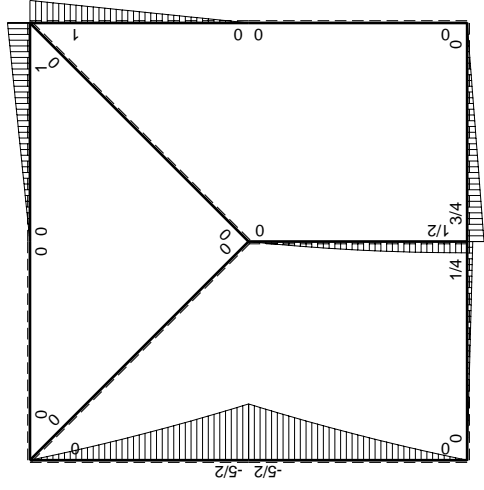
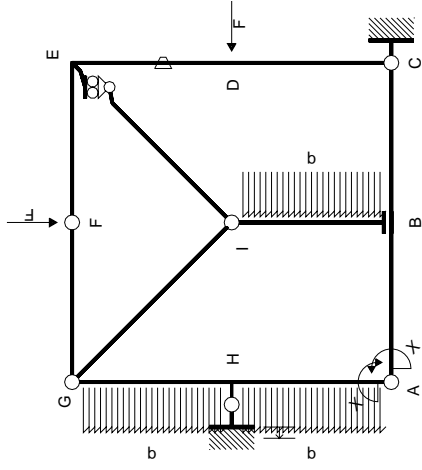
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

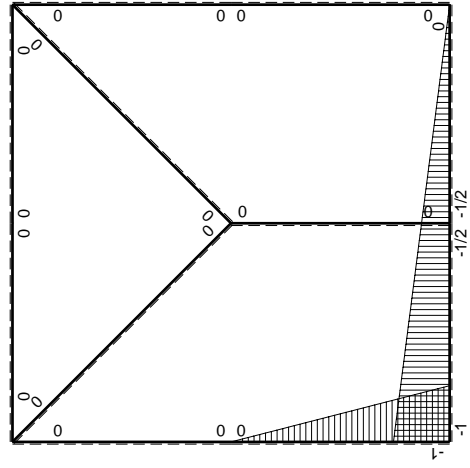


- A = 1044. mm<sup>2</sup>
- J<sub>u</sub> = 294700. mm<sup>4</sup>
- J<sub>v</sub> = 90288. mm<sup>4</sup>
- y<sub>g</sub> = 31.09 mm
- N = 1520. N
- T<sub>y</sub> = -4560. N
- M<sub>x</sub> = -1900000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -31.09 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -199. N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -21.09 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -134.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.644 N/mm<sup>2</sup>
- σ<sub>g</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 135. N/mm<sup>2</sup>
- S = 5153. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	$Fb/EJ$	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

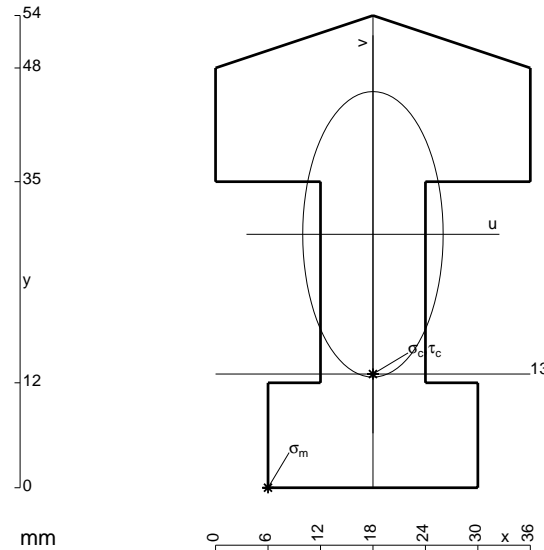
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

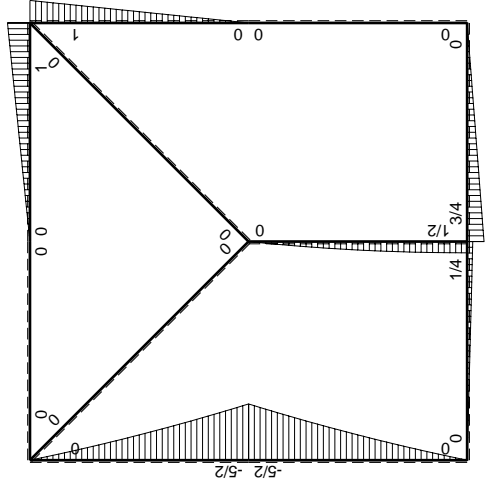
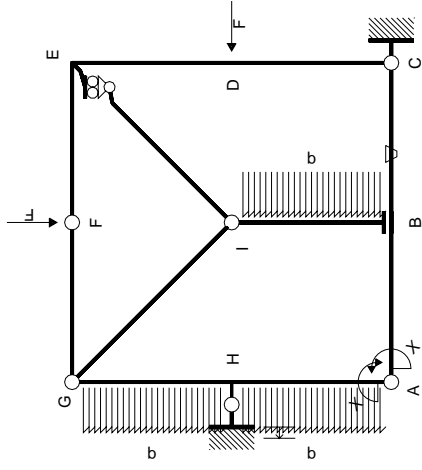
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



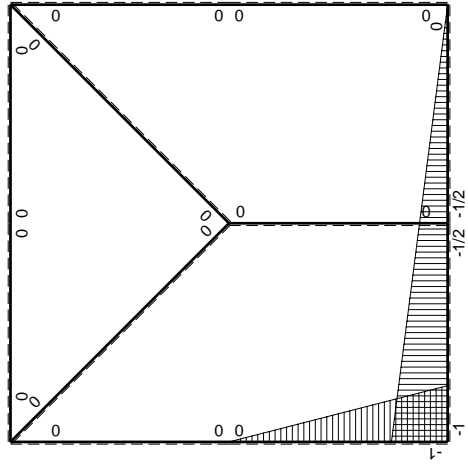
- A = 1140. mm<sup>2</sup>
- J<sub>u</sub> = 303884. mm<sup>4</sup>
- J<sub>v</sub> = 73512. mm<sup>4</sup>
- y<sub>g</sub> = 28.98 mm
- N = 1610. N
- T<sub>y</sub> = -4830. N
- M<sub>x</sub> = -2213750. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.98 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -209.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.98 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -115. N/mm<sup>2</sup>
- τ<sub>c</sub> = 9.028 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 116.1 N/mm<sup>2</sup>
- S = 6816. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_0(x)$	$\theta$	$M_x M_0$	$M_x \theta$	$M_x M_x$	$\int M_x(M_0/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$		
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	$-Fb/EJ$	$-3/8Fb+3/4Fx-3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$
CB b	$1/2x/b$	$-3/4Fx$	$Fb/EJ$	$-3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$		
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0		
DE b	0	Fx	0	0	0	0	0+0	0
ED b	0	$-Fb+Fx$	0	0	0	0		
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0
FE b	0	$-Fx$	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0		
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0		
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$		
H	cedimento nodo $-H_{1H}u_H$						$-Fb^2/EJ$	
	totali						$-7/12Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$						$7/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

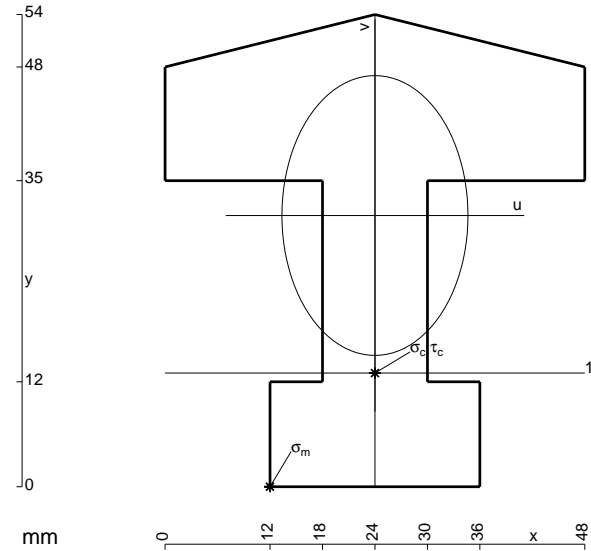
$$= (-1/8 b) Fb 1/EJ + (-1/4 b) \theta = 1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

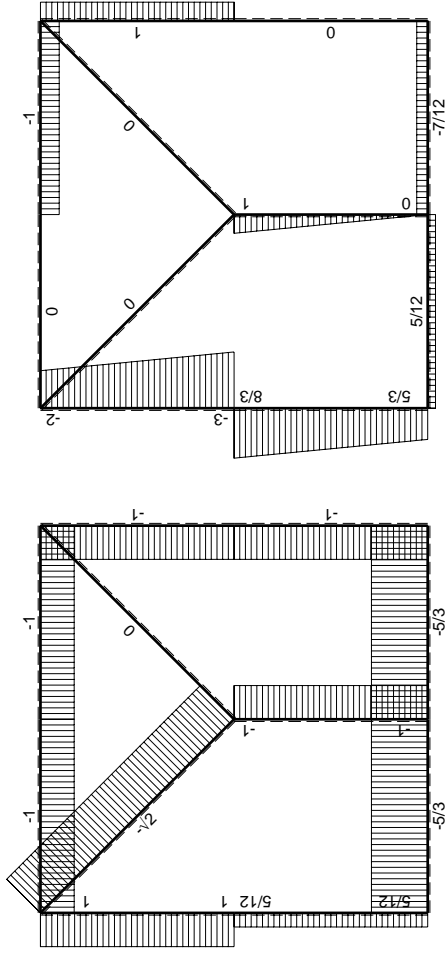
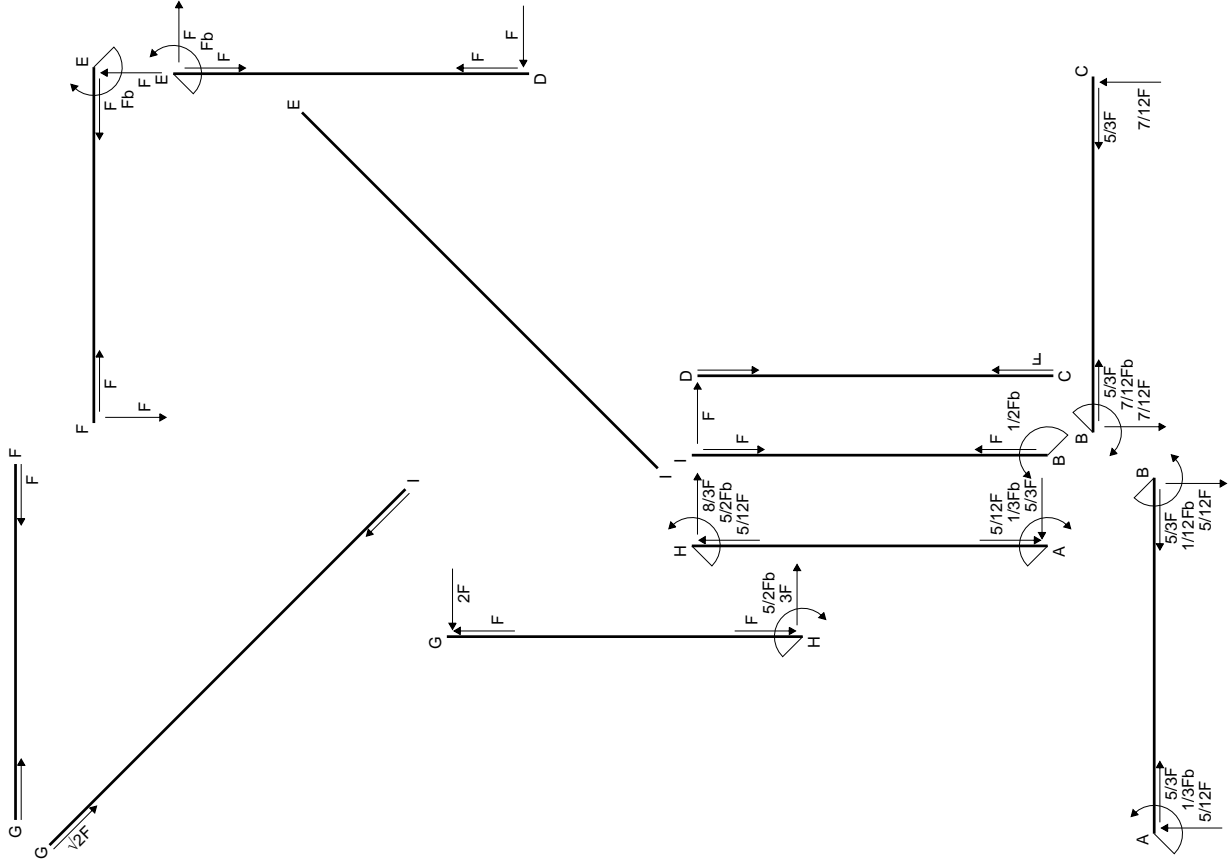
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



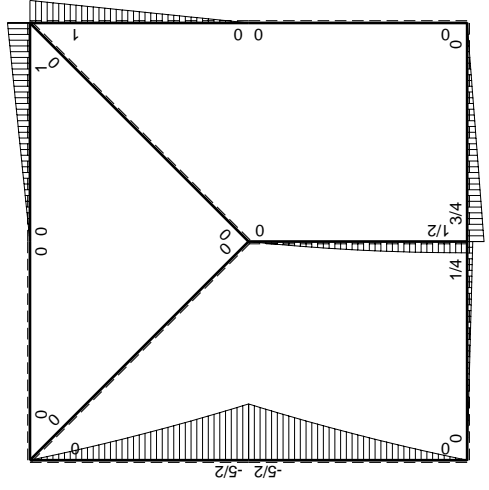
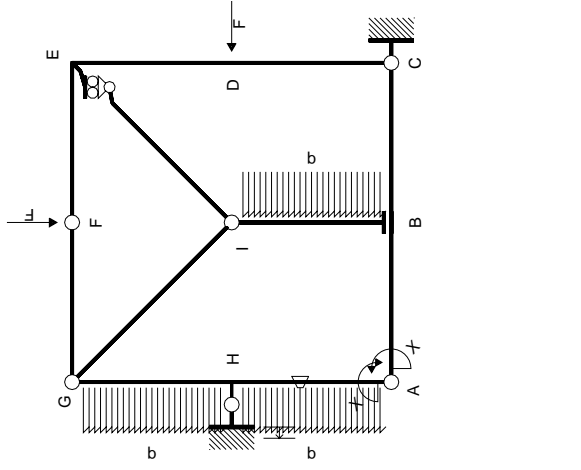
$A = 1332. \text{ mm}^2$   
 $J_u = 341004. \text{ mm}^4$   
 $J_v = 150768. \text{ mm}^4$   
 $y_g = 31.01 \text{ mm}$   
 $N = 1620. \text{ N}$   
 $T_y = -4860. \text{ N}$   
 $M_x = -2430000. \text{ Nmm}$   
 $x_m = 12. \text{ mm}$   
 $u_m = -12. \text{ mm}$   
 $v_m = -31.01 \text{ mm}$   
 $\sigma_m = N/A - Mv/J_u = -219.8 \text{ N/mm}^2$   
 $x_c = 24. \text{ mm}$   
 $y_c = 13. \text{ mm}$   
 $v_c = -18.01 \text{ mm}$   
 $\sigma_c = N/A - Mv/J_u = -127.1 \text{ N/mm}^2$   
 $\tau_c = 8.82 \text{ N/mm}^2$   
 $\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 128.1 \text{ N/mm}^2$   
 $S = 7426. \text{ mm}^3$



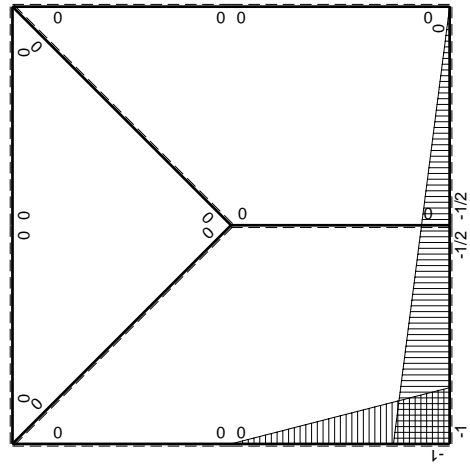
$\left[ \begin{matrix} + \\ - \end{matrix} \right] F$

$\left[ \begin{matrix} + \\ - \end{matrix} \right] F$

$\left[ \begin{matrix} + \\ - \end{matrix} \right] F_b$



$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	-Fb/EJ	$5/2Fx-3Fx^2/b+1/2qx^3/b$	Fx/EJ	$x^2/b^2$	$(3/8+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	Fb/EJ	$2Fx-3/2Fx^2/b-1/2qx^3/b$	Fb/EJ-Fx/EJ	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/3Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/3Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

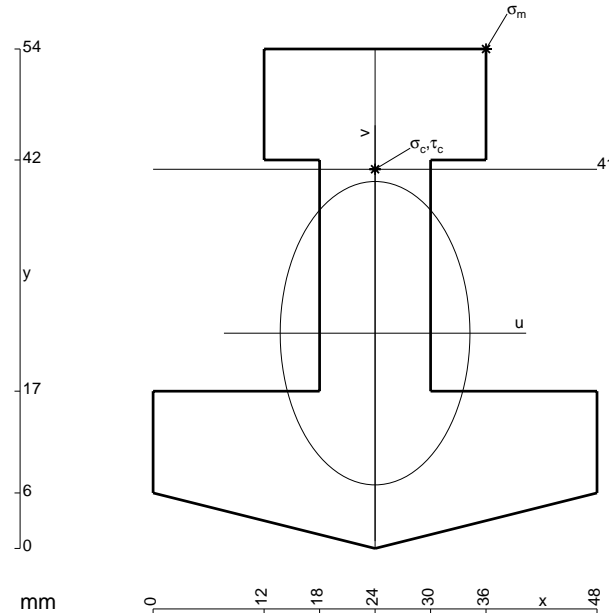
$$= [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 7/8 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

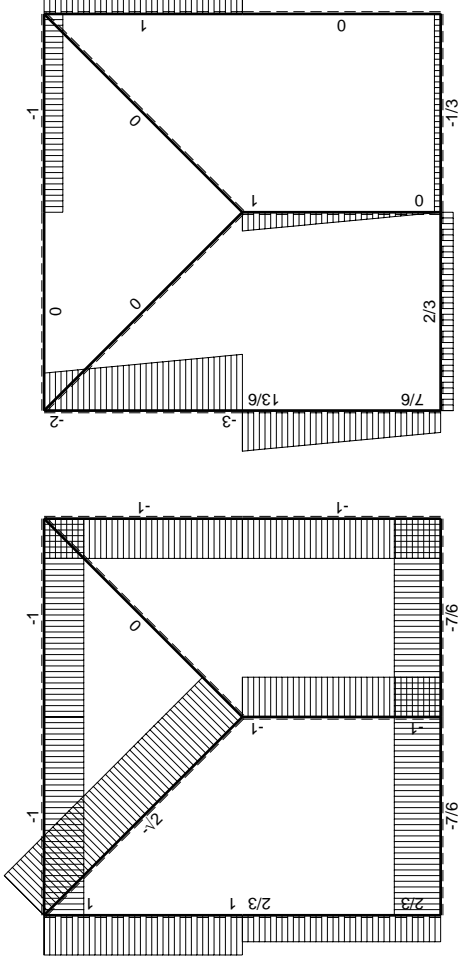
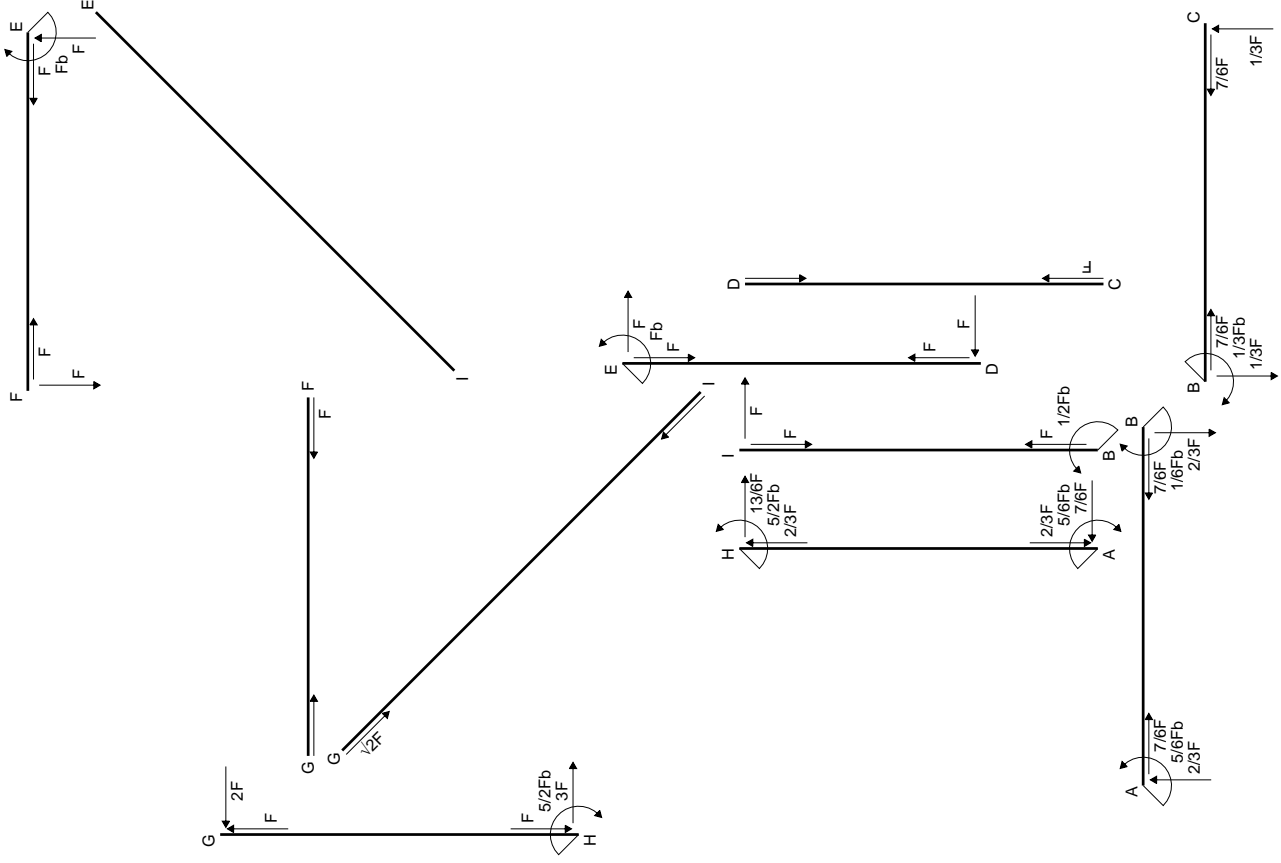
$$= [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 7/8 Fb^2/EJ$$



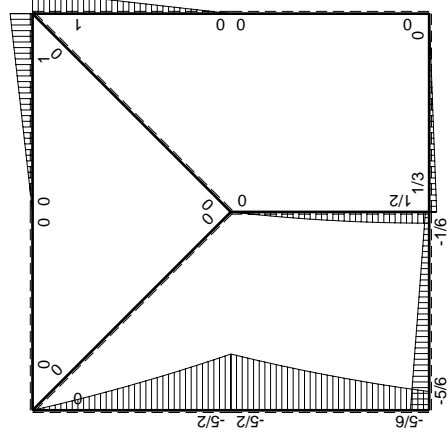
- A = 1260. mm<sup>2</sup>
- J<sub>u</sub> = 339087. mm<sup>4</sup>
- J<sub>v</sub> = 132624. mm<sup>4</sup>
- y<sub>g</sub> = 23.27 mm
- N = 1550. N
- T<sub>y</sub> = -4650. N
- M<sub>x</sub> = -2518750. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.73 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 229.5 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 17.73 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 132.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.389 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 133.7 N/mm<sup>2</sup>
- S = 7341. mm<sup>3</sup>



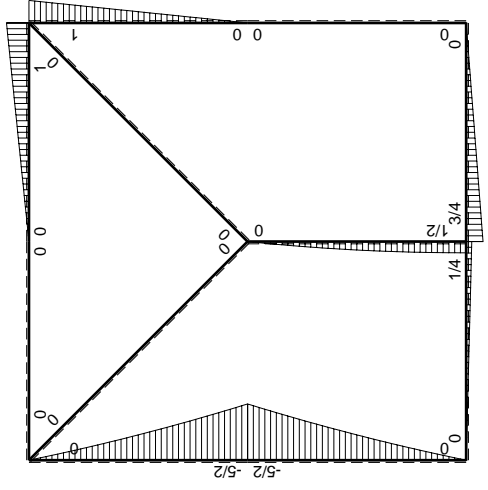
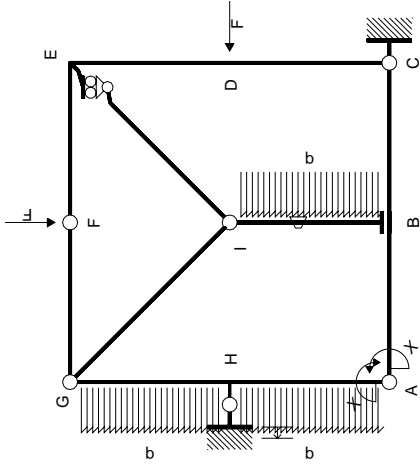


← ⊕ → F

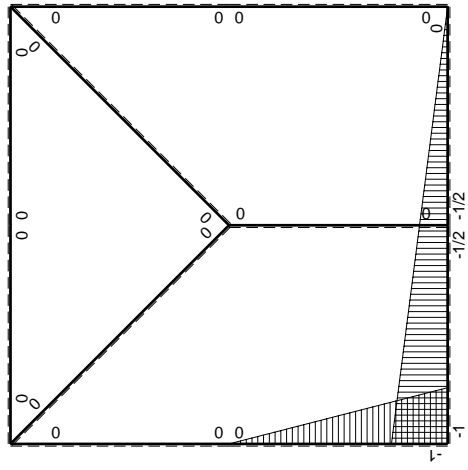
⊕ ↓ F



⊕ ⊕ Fb



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica X=1

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	-Fb/EJ	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	Fb/EJ	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

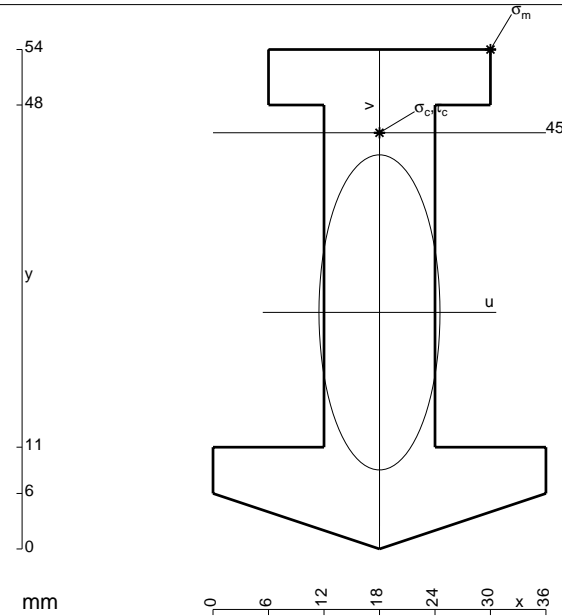
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

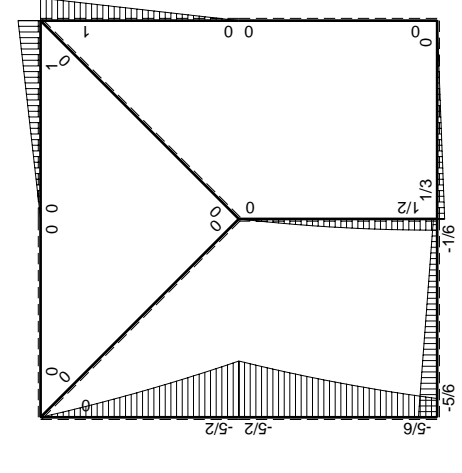
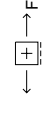
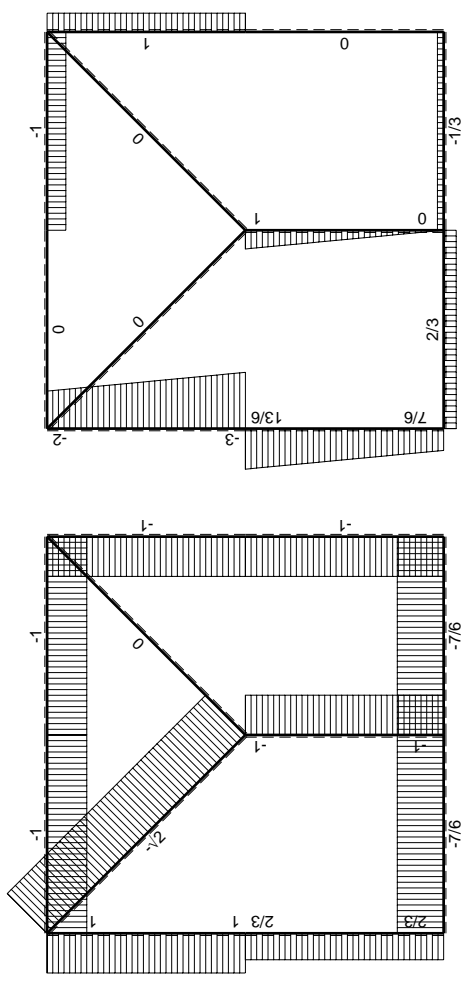
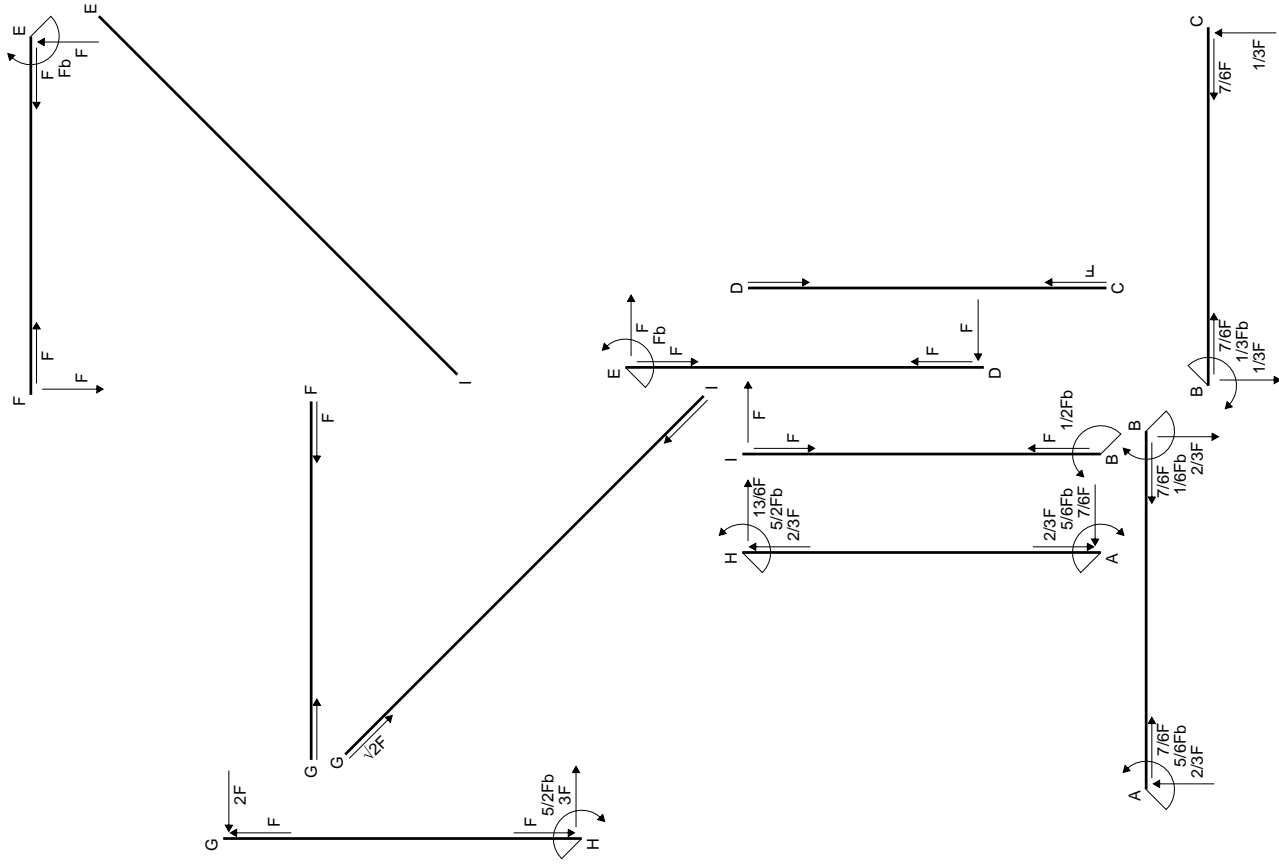
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

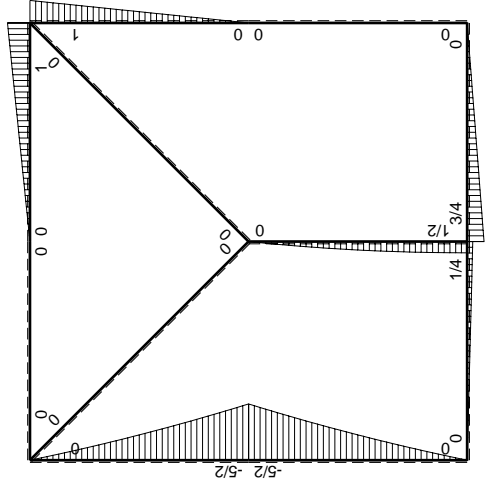
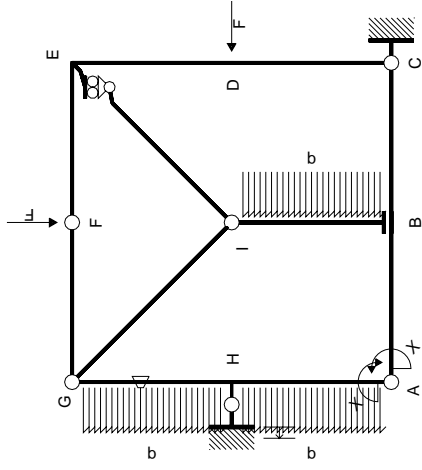
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

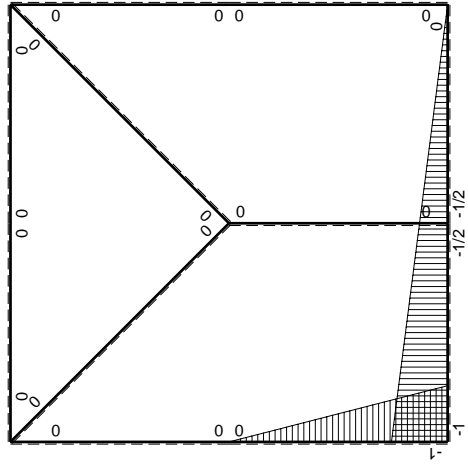


- A = 876. mm<sup>2</sup>
- J<sub>u</sub> = 254354. mm<sup>4</sup>
- J<sub>v</sub> = 37512. mm<sup>4</sup>
- y<sub>g</sub> = 25.58 mm
- N = 1220. N
- T<sub>y</sub> = -3660. N
- M<sub>x</sub> = -2135000. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.42 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 240. N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 45. mm
- v<sub>c</sub> = 19.42 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 164.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.293 N/mm<sup>2</sup>
- σ<sub>g</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 164.7 N/mm<sup>2</sup>
- S = 4414. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	-Fb/EJ	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	Fb/EJ	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

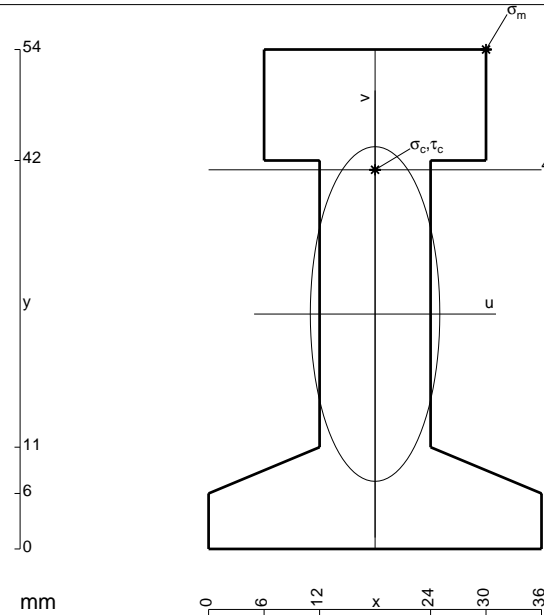
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

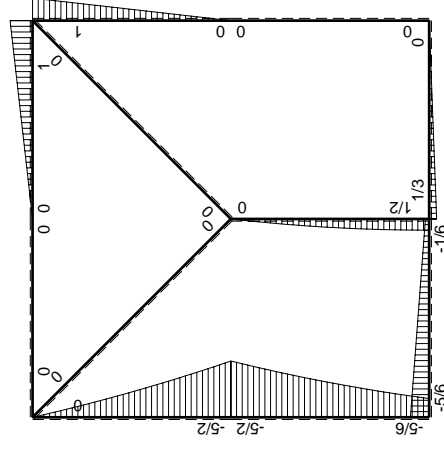
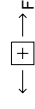
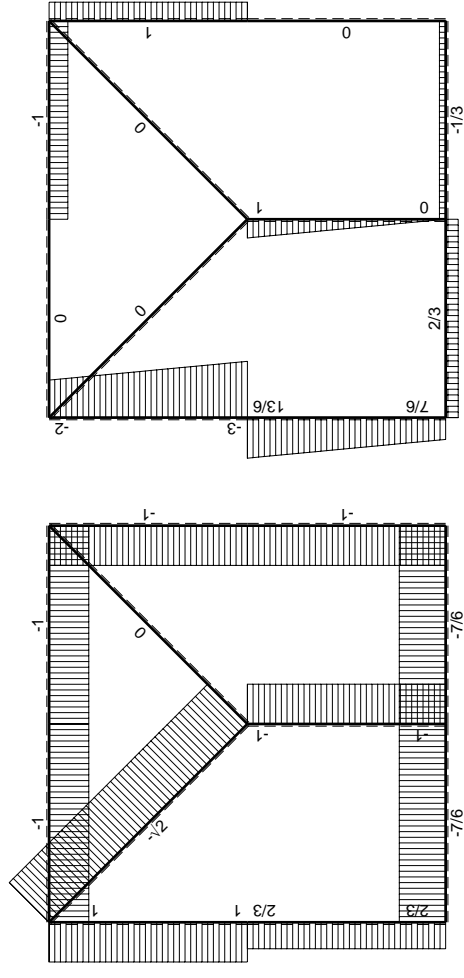
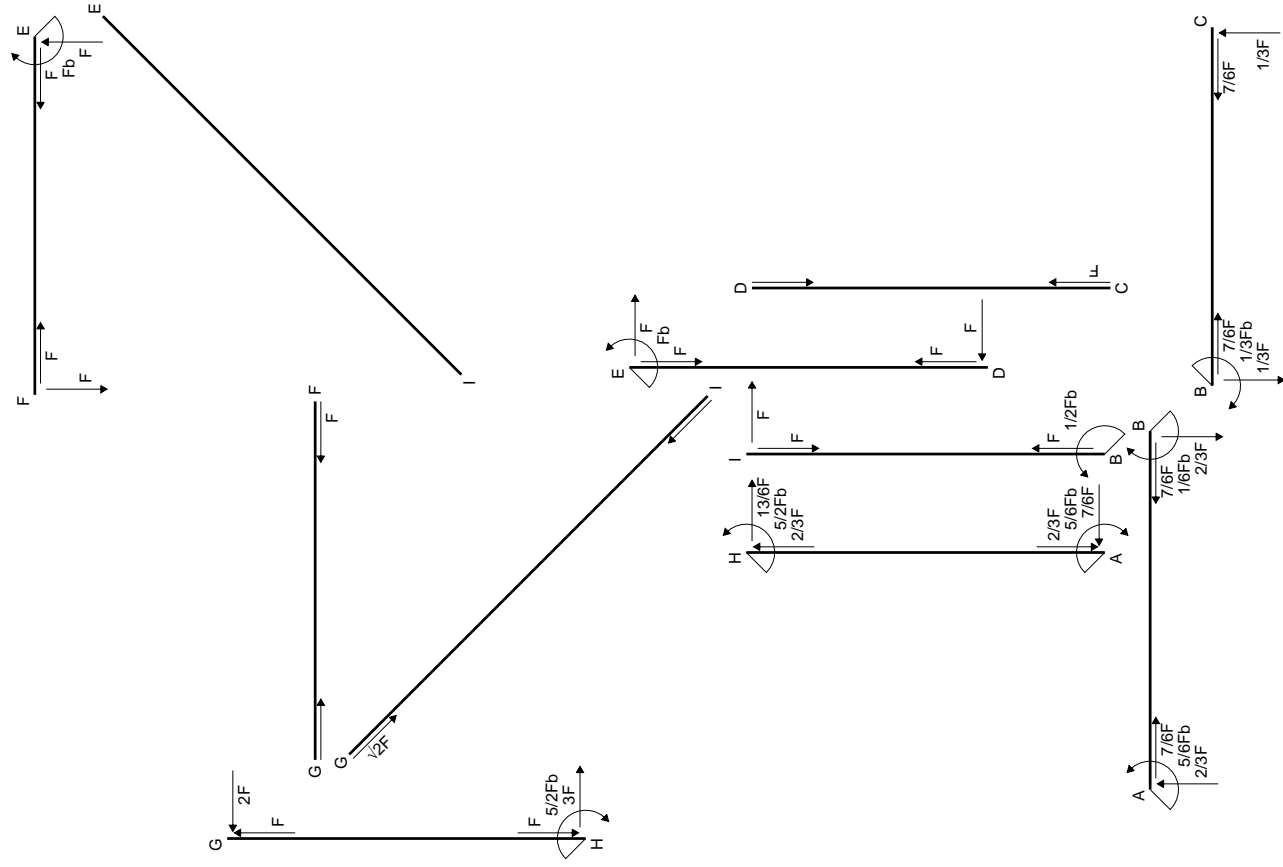
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

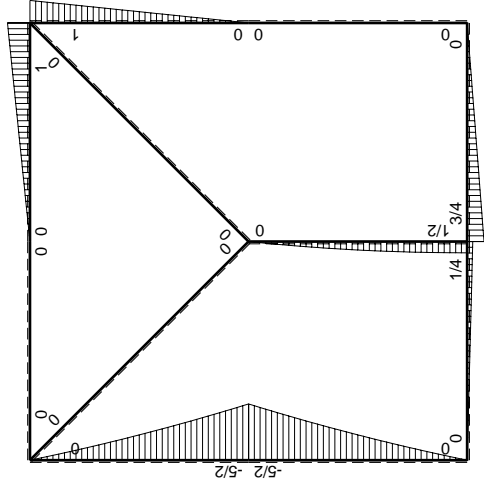
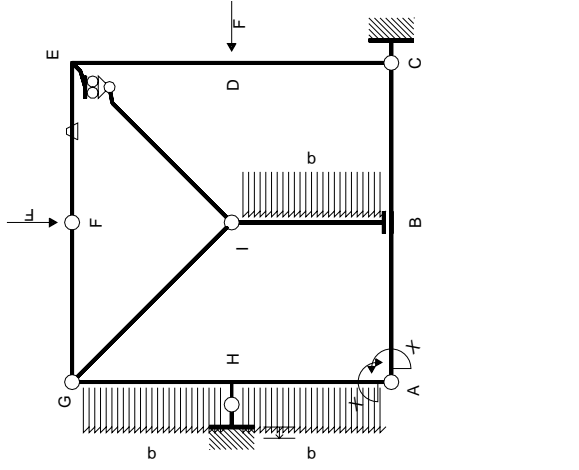
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



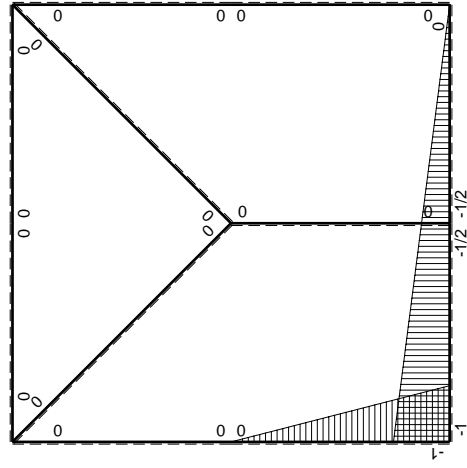
- A = 996. mm<sup>2</sup>
- J<sub>u</sub> = 326037. mm<sup>4</sup>
- J<sub>v</sub> = 48816. mm<sup>4</sup>
- y<sub>g</sub> = 25.4 mm
- N = 1200. N
- T<sub>y</sub> = -3600. N
- M<sub>x</sub> = -2250000. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.6 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 198.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 15.6 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 108.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.166 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 109.4 N/mm<sup>2</sup>
- S = 6702. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	-Fb/EJ	0	0	0	0+0	0	
FE b	0	-Fx	Fb/EJ	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

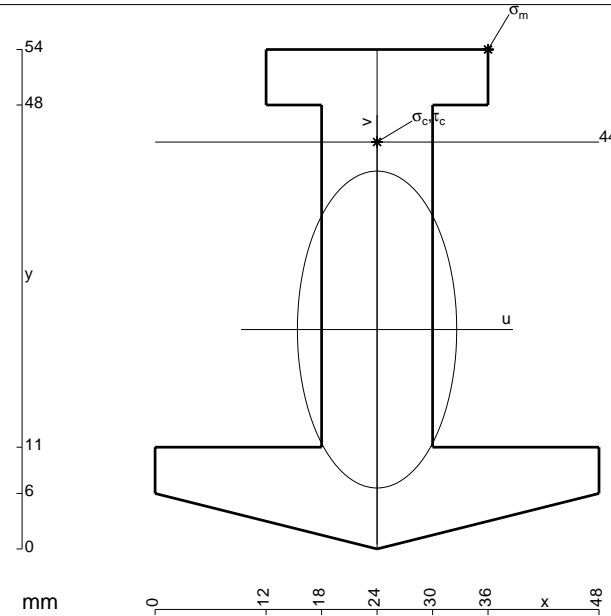
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

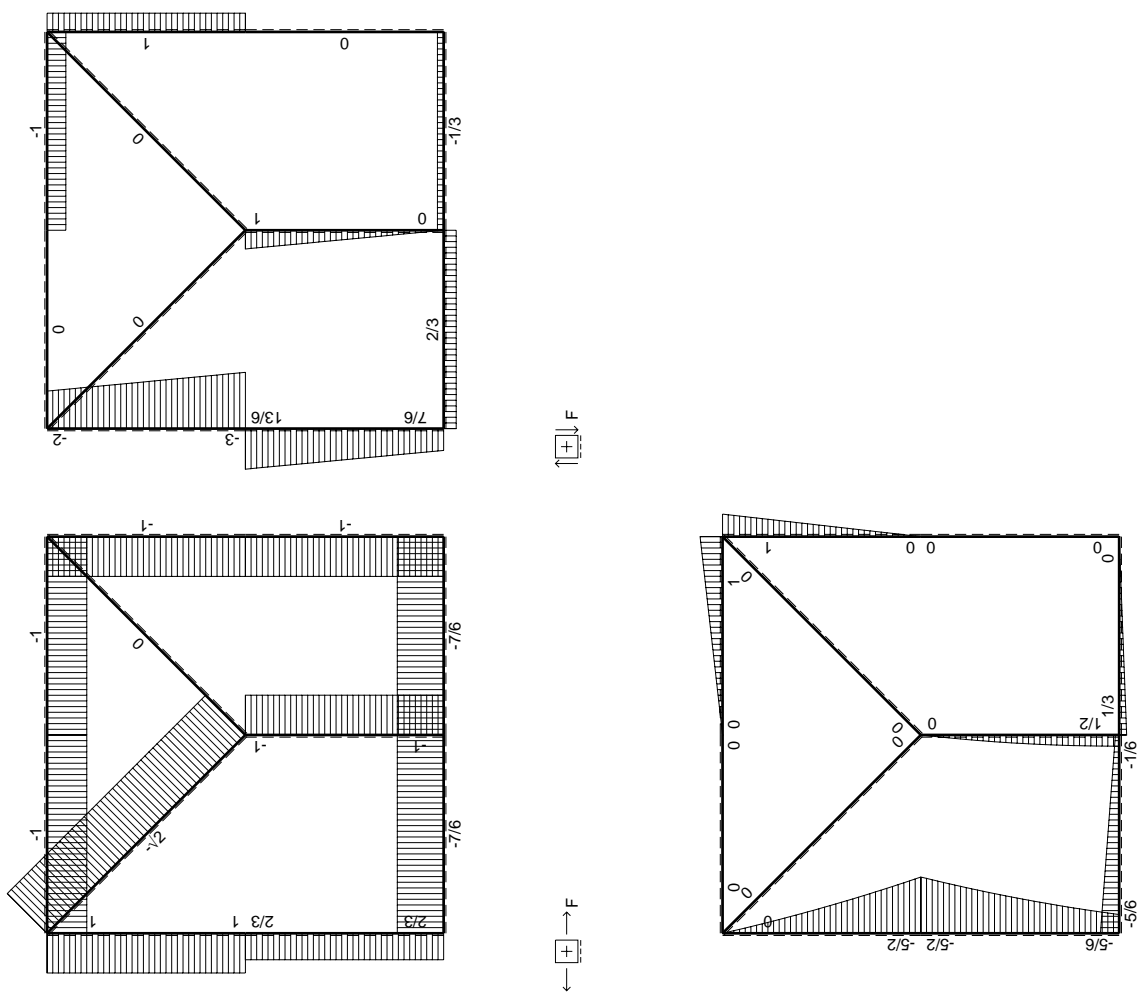
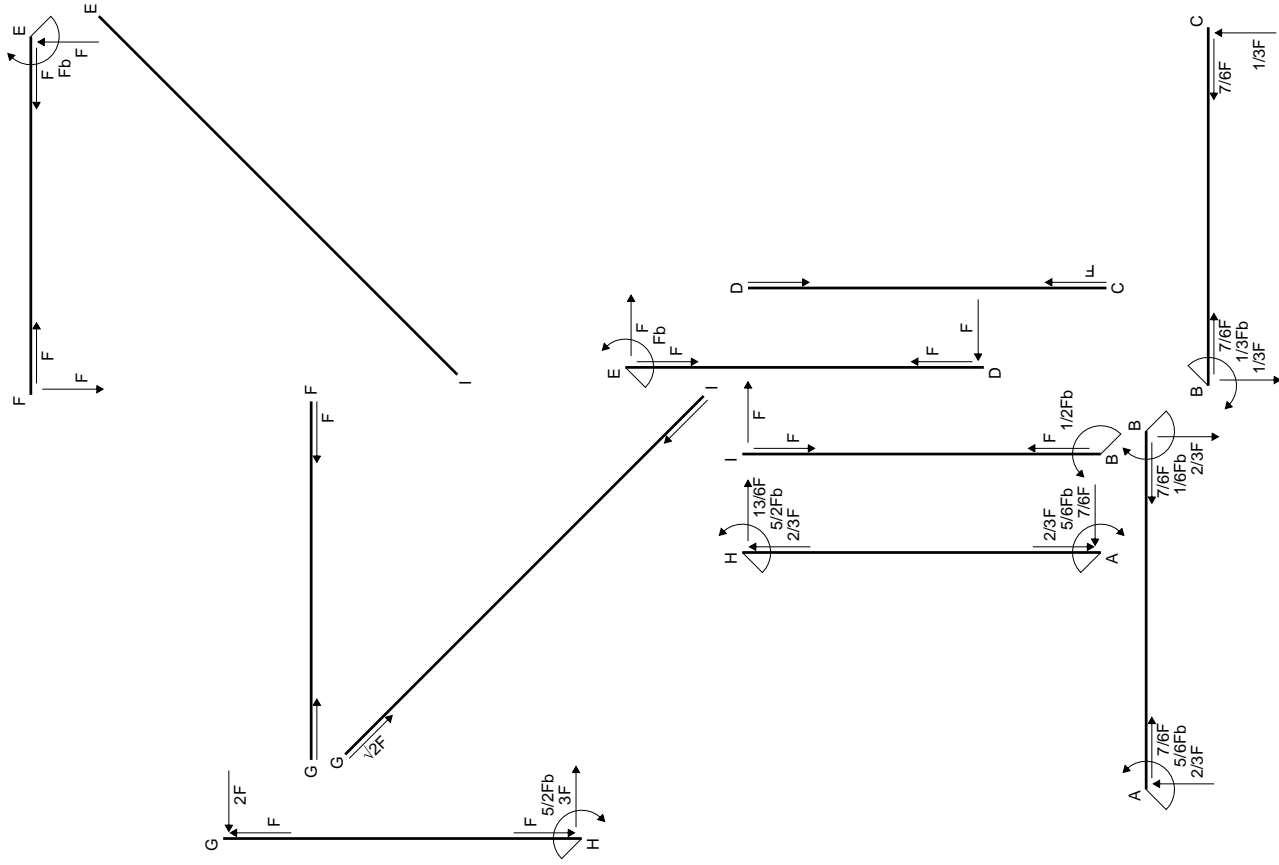
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

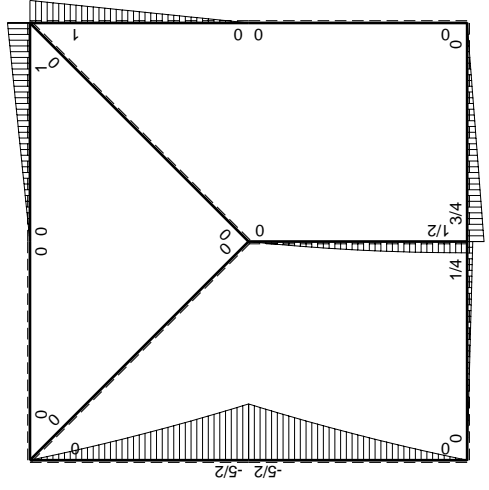
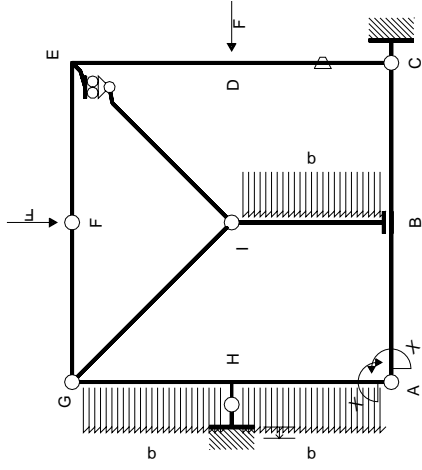
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

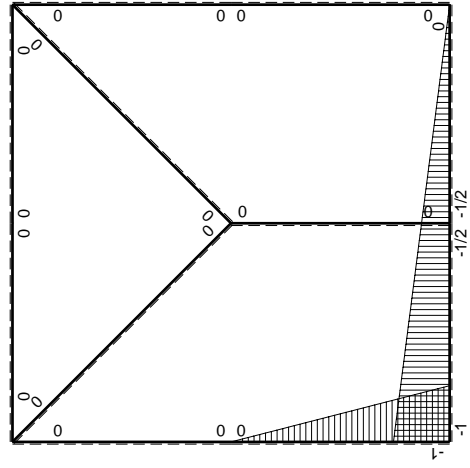


- A = 972. mm<sup>2</sup>
- J<sub>u</sub> = 285465. mm<sup>4</sup>
- J<sub>v</sub> = 72144. mm<sup>4</sup>
- y<sub>g</sub> = 23.72 mm
- N = 980. N
- T<sub>y</sub> = -2940. N
- M<sub>x</sub> = -1960000. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.28 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 208.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 44. mm
- v<sub>c</sub> = 20.28 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 140.2 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.289 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 140.4 N/mm<sup>2</sup>
- S = 4997. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	0	$Fb/EJ$	0	0	0			
DE b	0	$Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

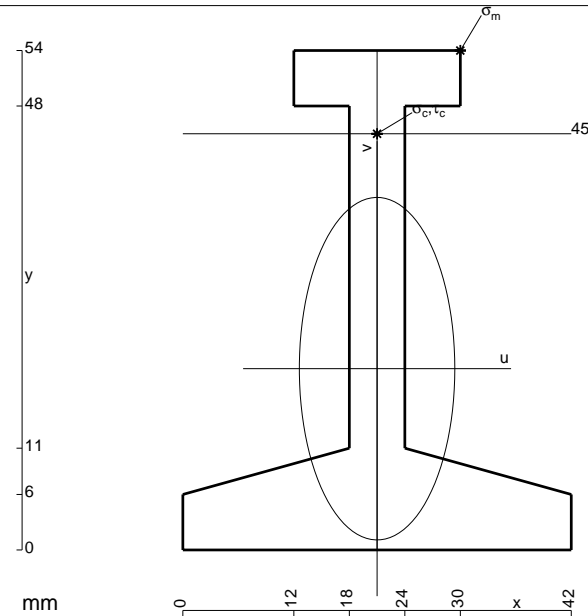
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

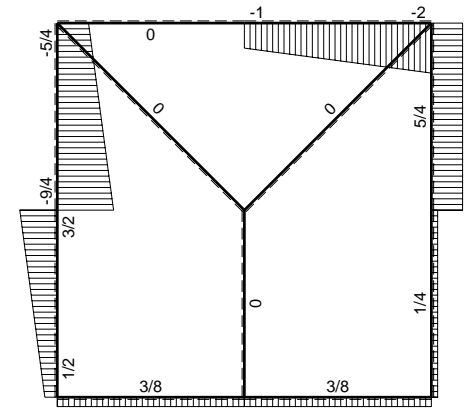
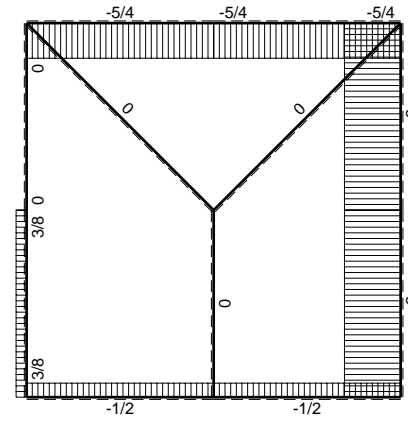
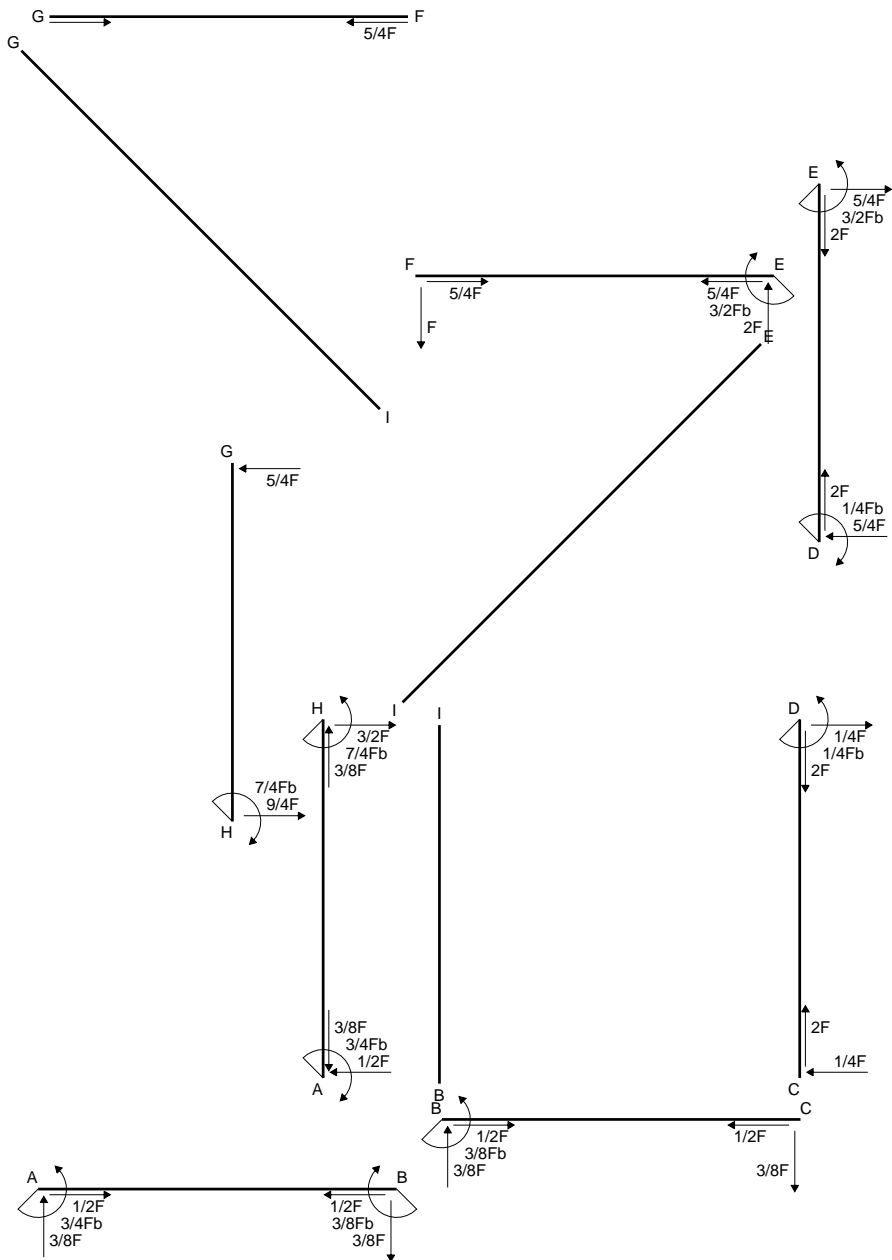
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



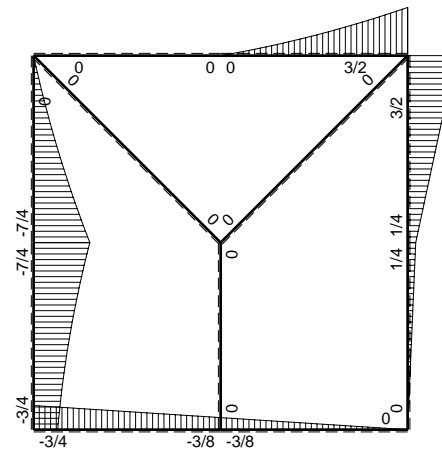
- A = 702. mm<sup>2</sup>
- J<sub>u</sub> = 240790. mm<sup>4</sup>
- J<sub>v</sub> = 49626. mm<sup>4</sup>
- y<sub>g</sub> = 19.6 mm
- N = 720. N
- T<sub>y</sub> = -2160. N
- M<sub>x</sub> = -1530000. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 34.4 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 219.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 45. mm
- v<sub>c</sub> = 25.4 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 162.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.794 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 162.7 N/mm<sup>2</sup>
- S = 3876. mm<sup>3</sup>



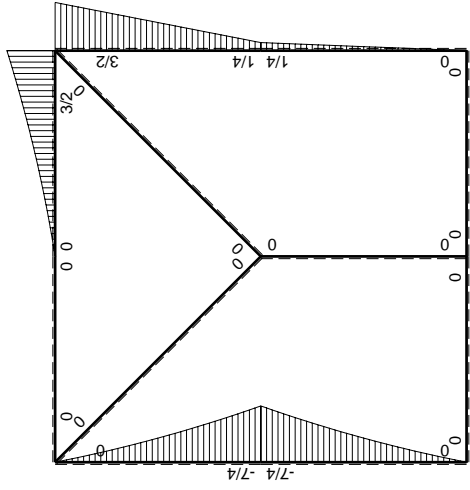
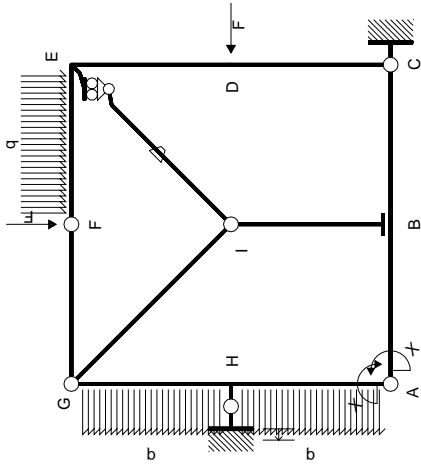


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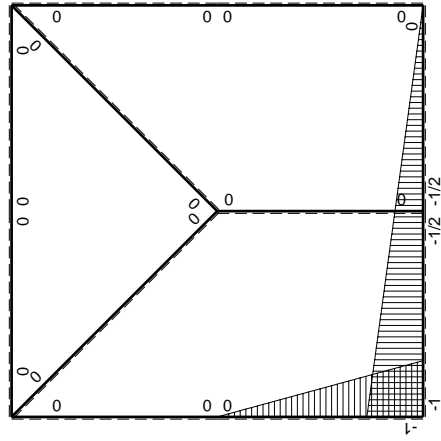
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

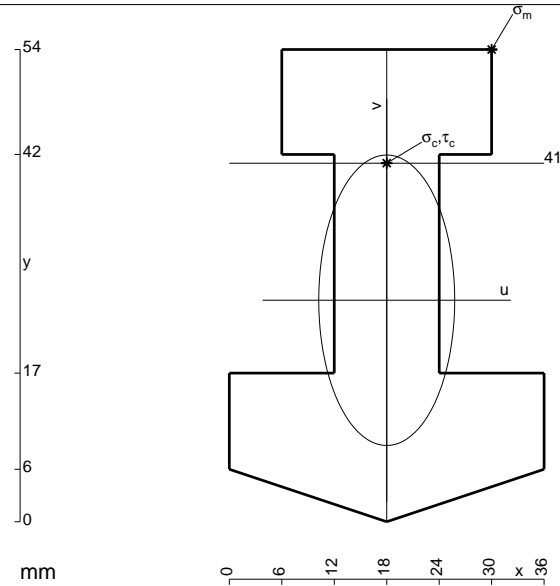
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

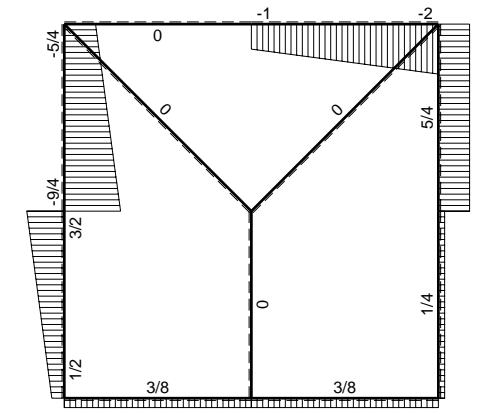
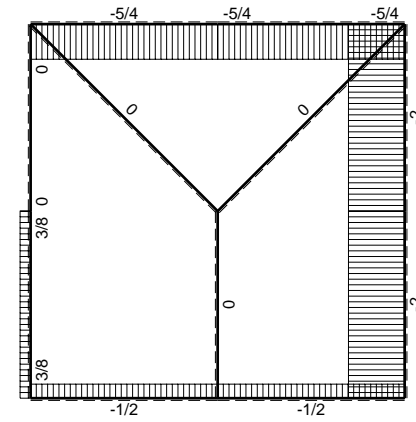
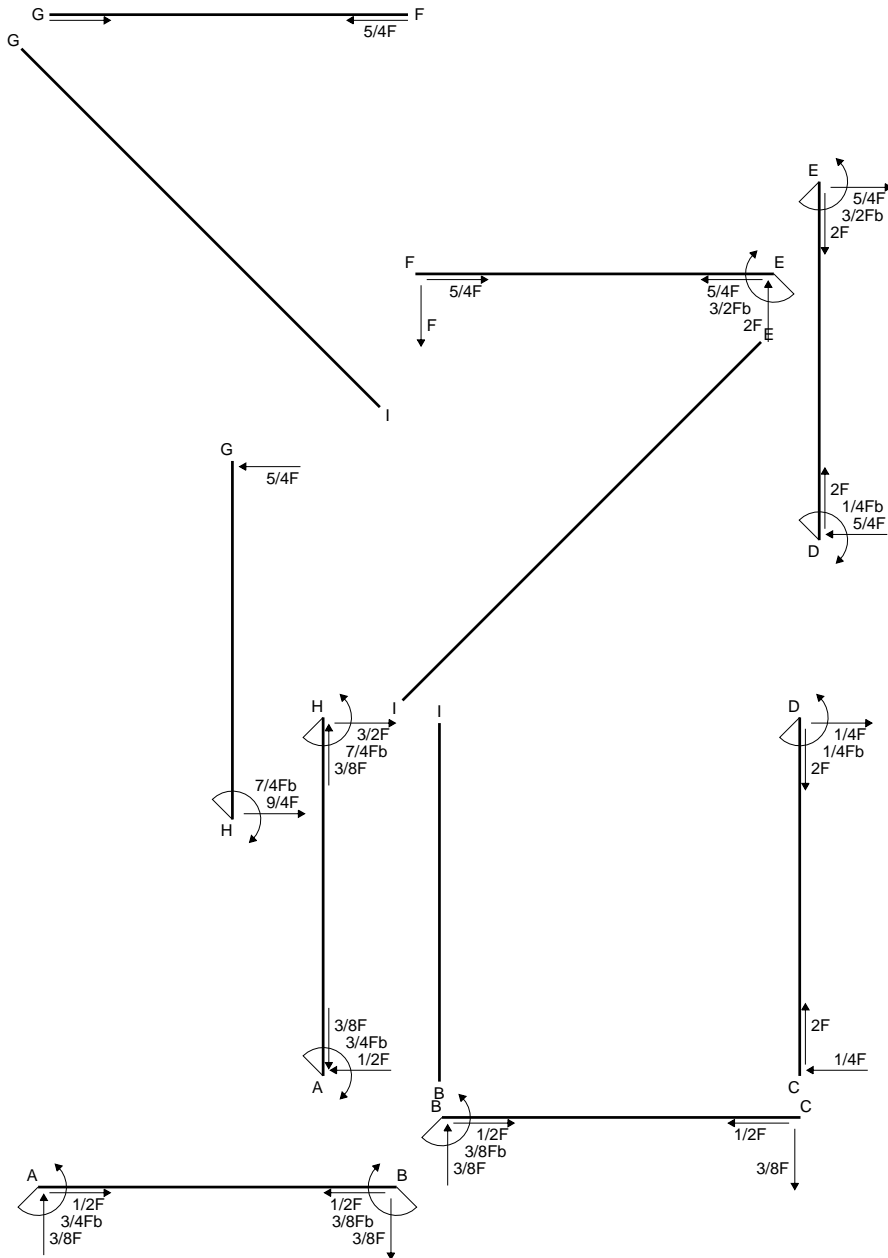
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

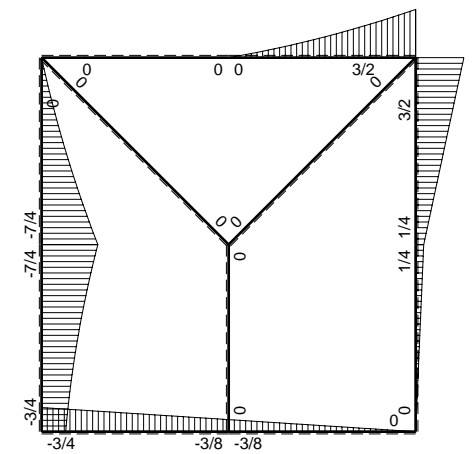


- A = 1092. mm<sup>2</sup>
- J<sub>u</sub> = 301397. mm<sup>4</sup>
- J<sub>v</sub> = 66024. mm<sup>4</sup>
- y<sub>g</sub> = 25.33 mm
- T<sub>y</sub> = -3443. N
- M<sub>x</sub> = -2409750. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.67 mm
- σ<sub>m</sub> = -M<sub>v</sub>/J<sub>u</sub> = 229.2 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 15.67 mm
- σ<sub>c</sub> = -M<sub>v</sub>/J<sub>u</sub> = 125.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.399 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 125.8 N/mm<sup>2</sup>
- S = 6723. mm<sup>3</sup>

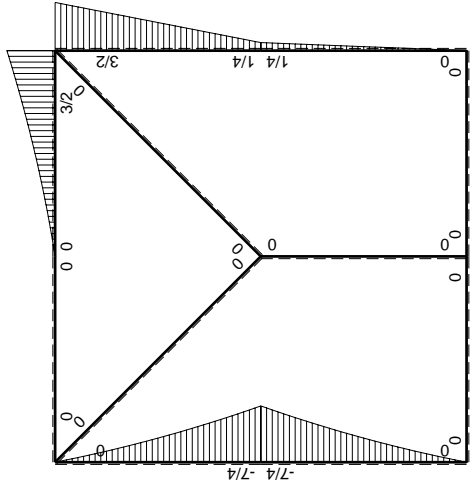
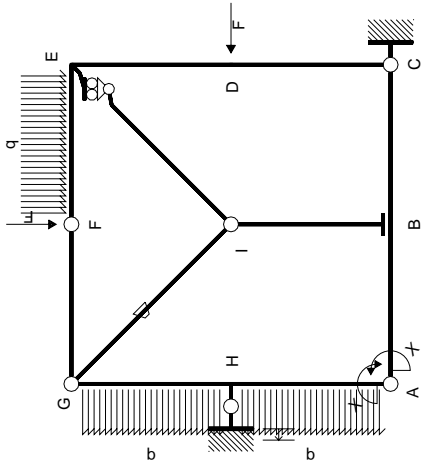


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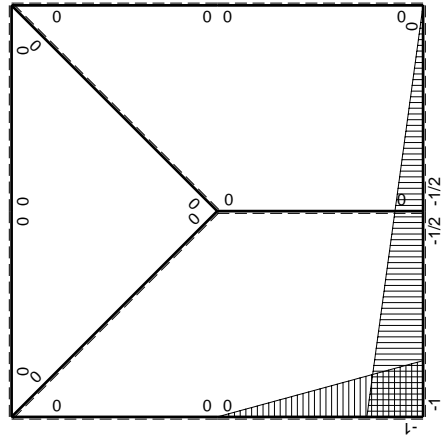
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

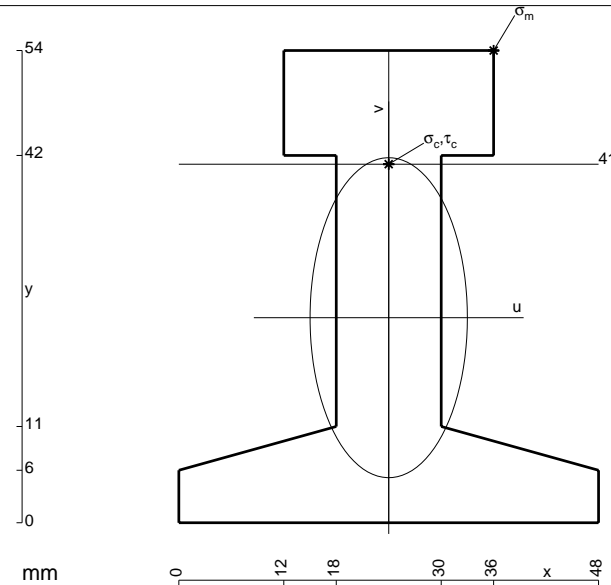
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

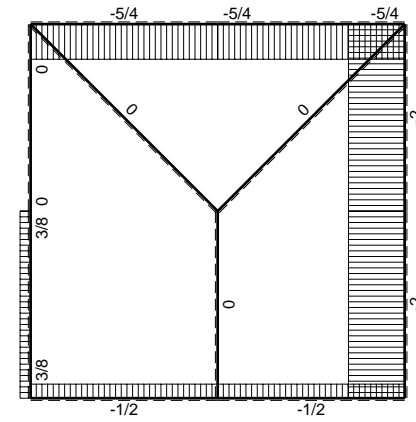
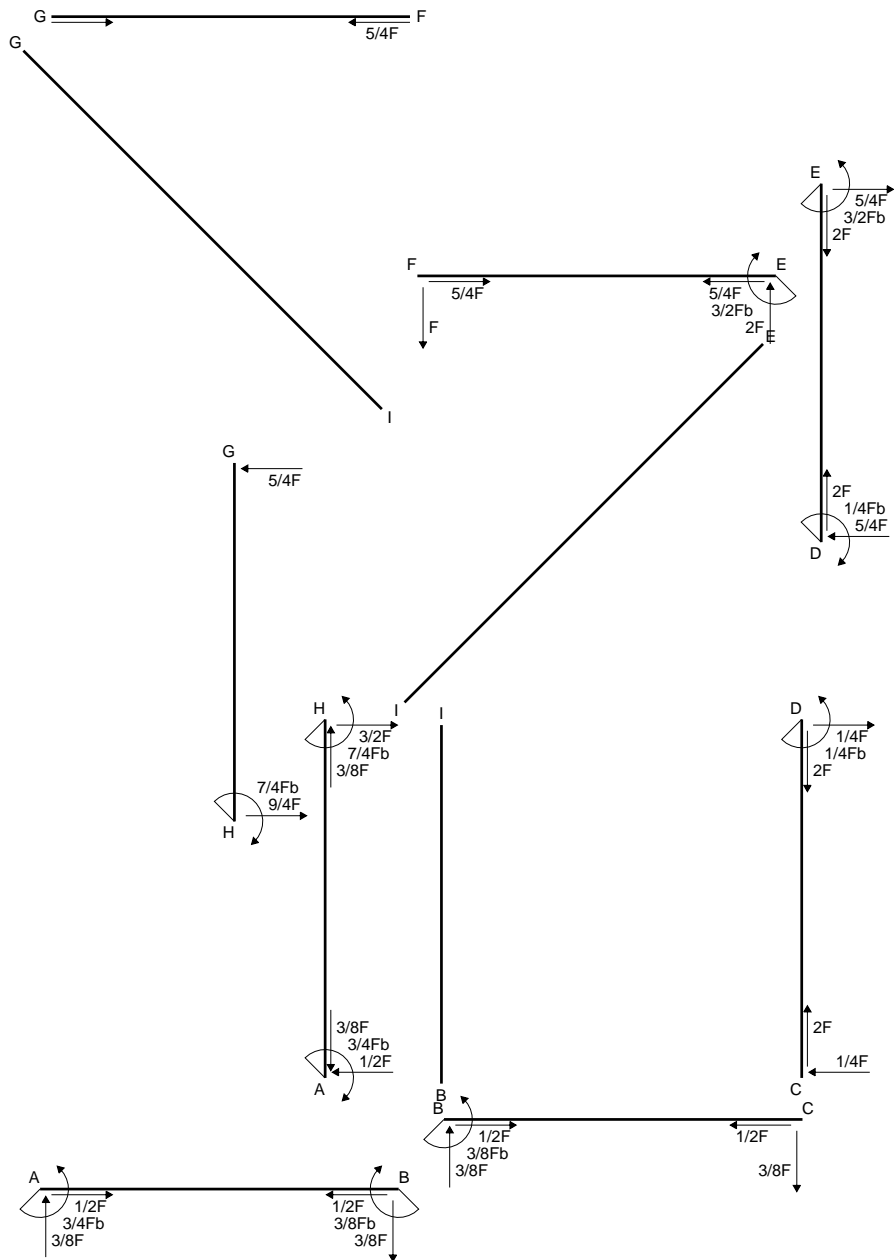
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

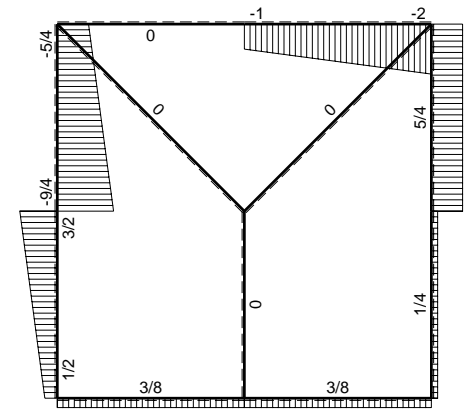


- A = 1098. mm<sup>2</sup>
- J<sub>u</sub> = 367673. mm<sup>4</sup>
- J<sub>v</sub> = 88884. mm<sup>4</sup>
- y<sub>g</sub> = 23.45 mm
- T<sub>y</sub> = -3893. N
- M<sub>x</sub> = -2876130. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.55 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = 239. N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 17.55 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = 137.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.429 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 137.8 N/mm<sup>2</sup>
- S = 7288. mm<sup>3</sup>

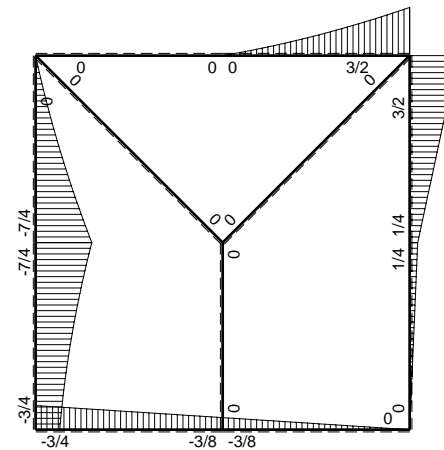




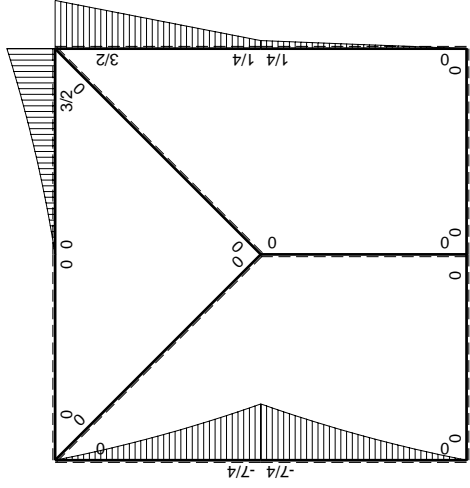
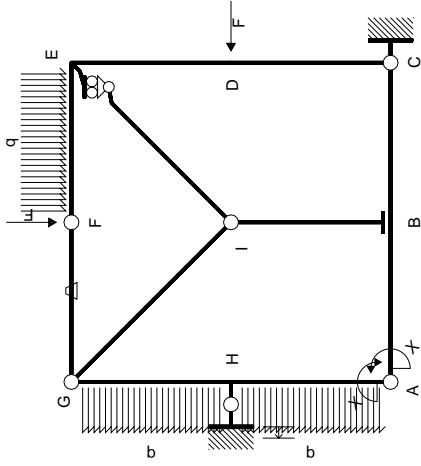
← ⊕ → F



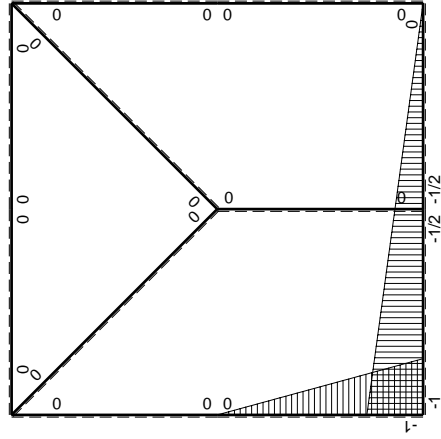
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	0	0	0	0			
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
GF b	0	0	$Fb/EJ$	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

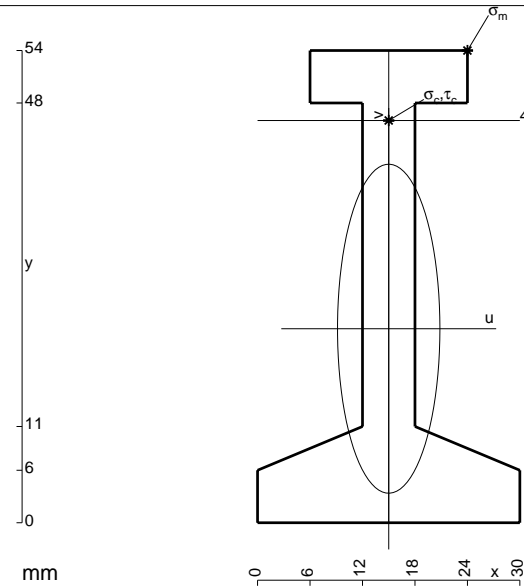
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

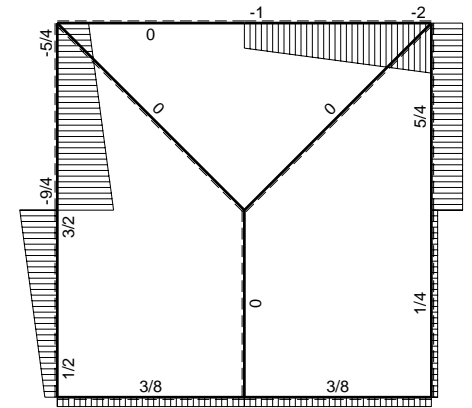
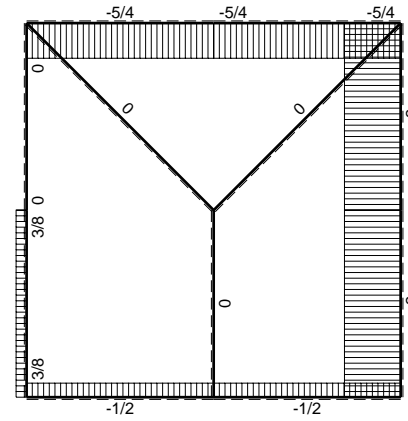
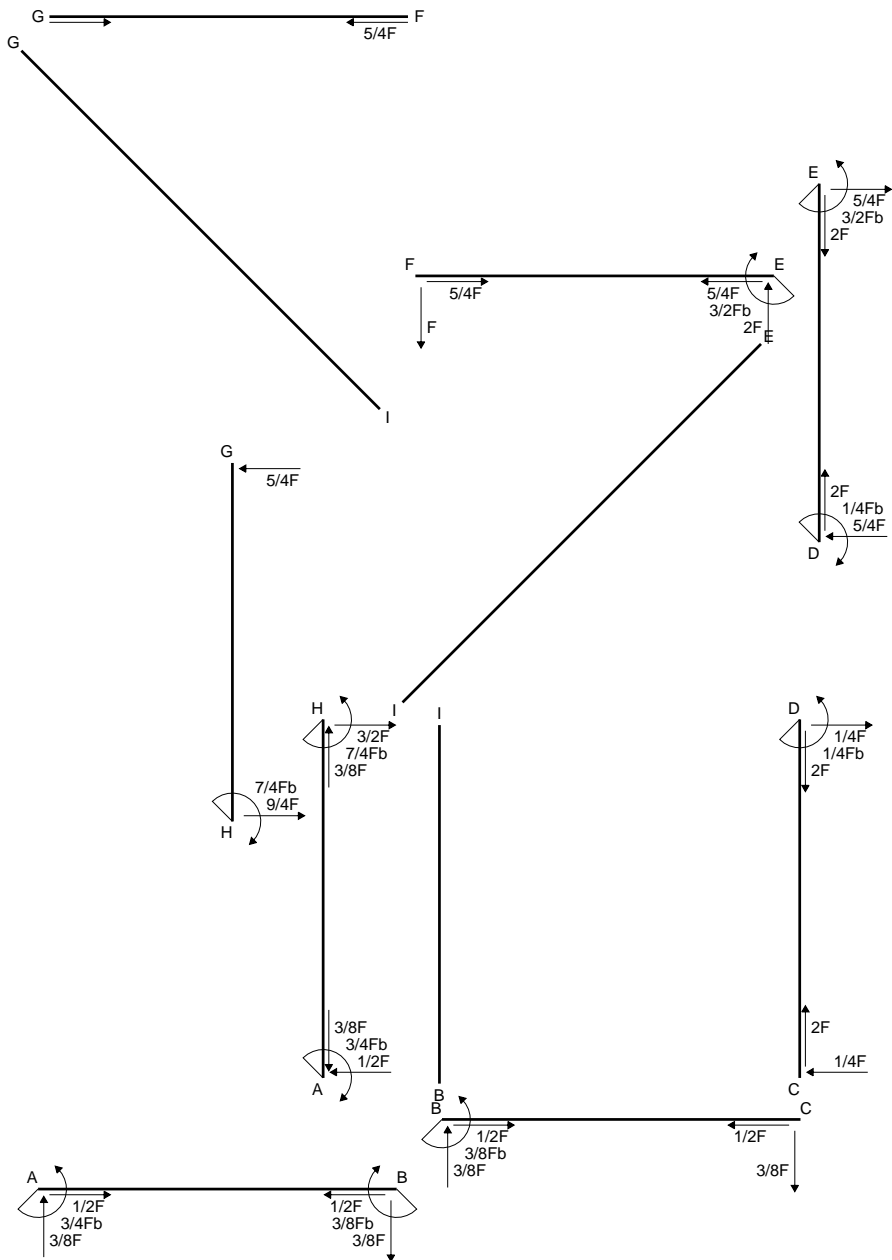
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

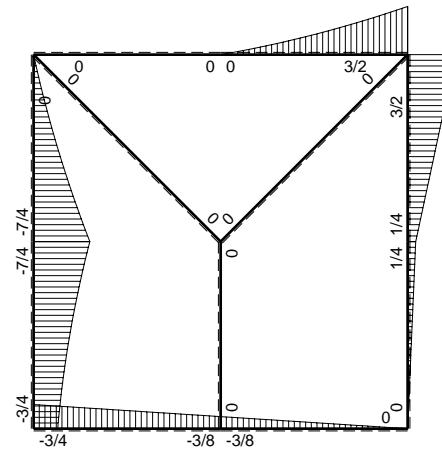


- A = 600. mm<sup>2</sup>
- J<sub>u</sub> = 212405. mm<sup>4</sup>
- J<sub>v</sub> = 20592. mm<sup>4</sup>
- y<sub>g</sub> = 22.19 mm
- T<sub>y</sub> = -3420. N
- M<sub>x</sub> = -1330000. Nmm
- x<sub>m</sub> = 24. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 31.81 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = 199.2 N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 46. mm
- v<sub>c</sub> = 23.81 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = 149.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 9.15 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 149.9 N/mm<sup>2</sup>
- S = 3410. mm<sup>3</sup>

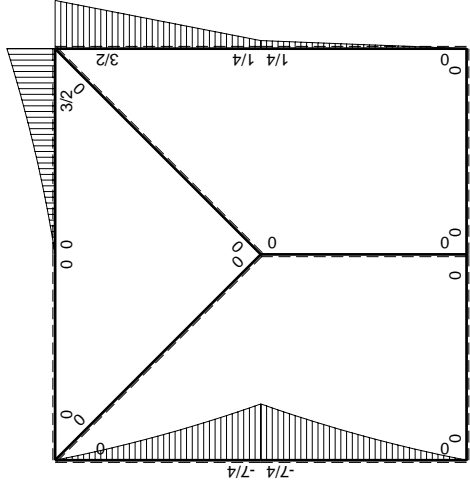
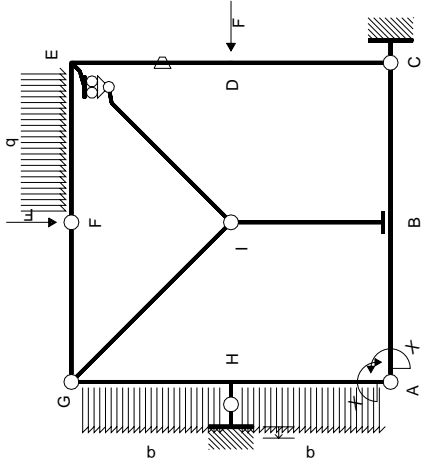


← ⊕ → F

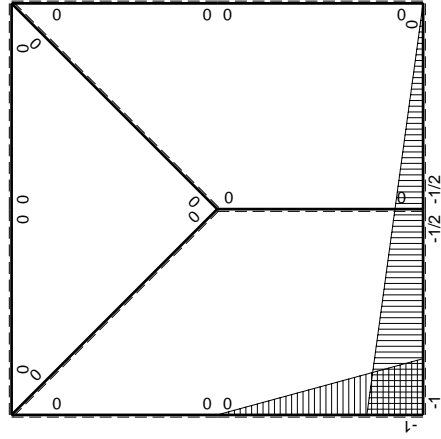
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	$Fb/EJ$	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

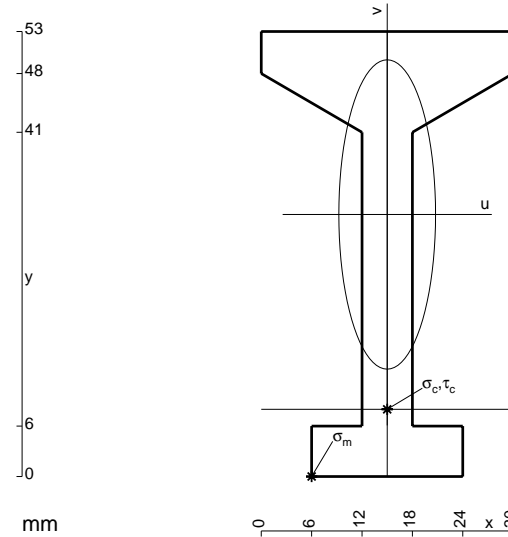
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

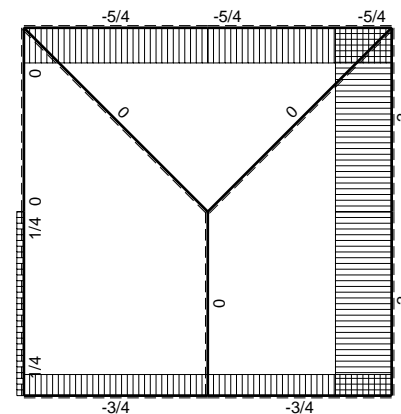
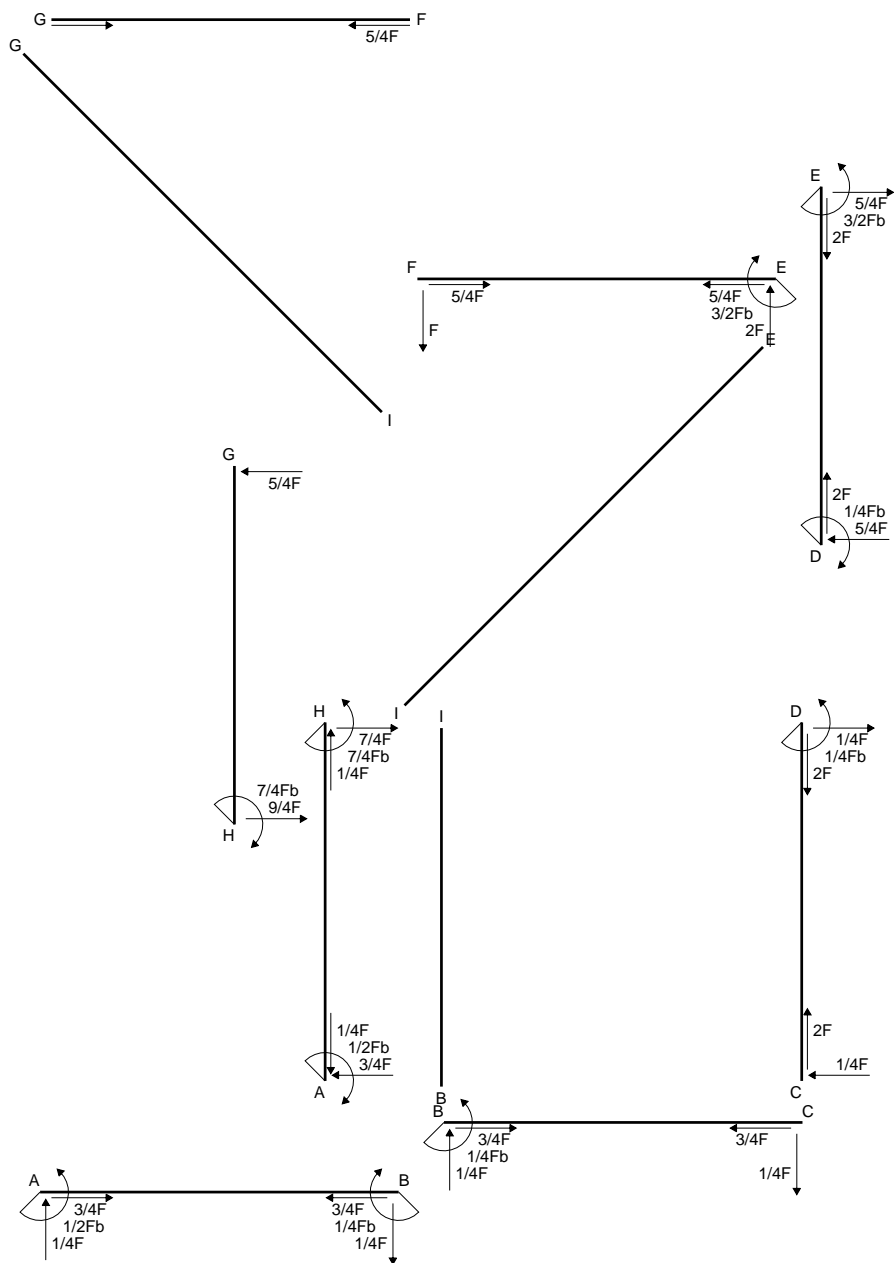
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

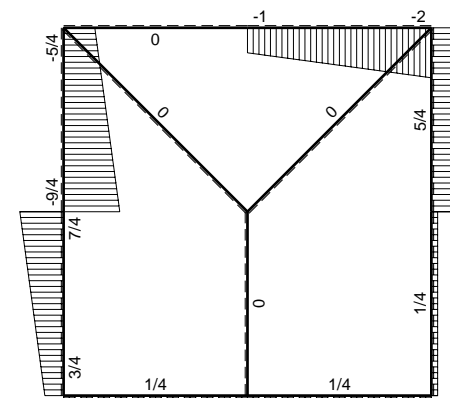


- A = 594. mm<sup>2</sup>
- J<sub>u</sub> = 201694. mm<sup>4</sup>
- J<sub>v</sub> = 19710. mm<sup>4</sup>
- y<sub>g</sub> = 31.21 mm
- T<sub>y</sub> = -3285. N
- M<sub>x</sub> = -1354150. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -31.21 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -209.5 N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 8. mm
- v<sub>c</sub> = -23.21 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -155.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 9.059 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 156.6 N/mm<sup>2</sup>
- S = 3337. mm<sup>3</sup>

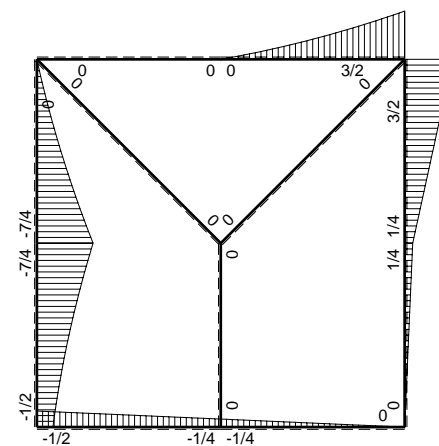




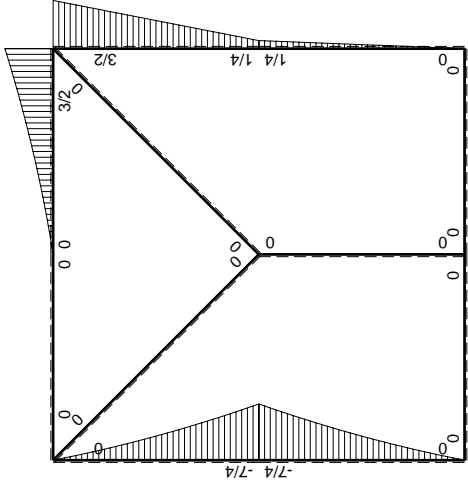
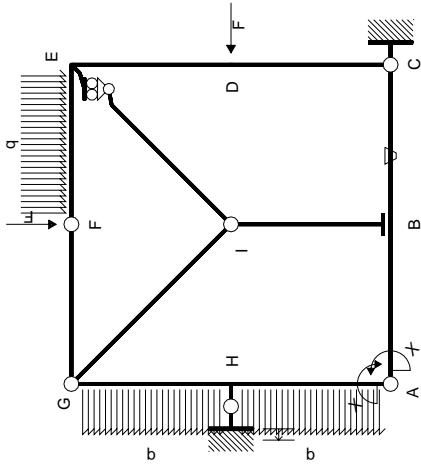
← ⊕ → F



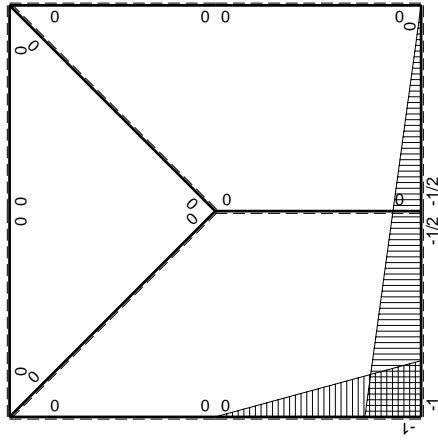
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



M<sub>0</sub> flessione da carichi assegnati



M<sub>x</sub> flessione da iperstatica X=1

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	$-Fb/EJ$	0	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(0+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	$Fb/EJ$	0	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/2Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ x - 1/2 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x + 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x - 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = \left[ 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = \left[ 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = \left[ x - x^2/b + 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 - 1/2 x/b) \theta dx = \left[ 1/2 x - 1/4 x^2/b \right]_0^b \theta$$

$$= (1/2 b - 1/4 b) \theta = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/2 x/b) \theta dx = \left[ -1/4 x^2/b \right]_0^b \theta$$

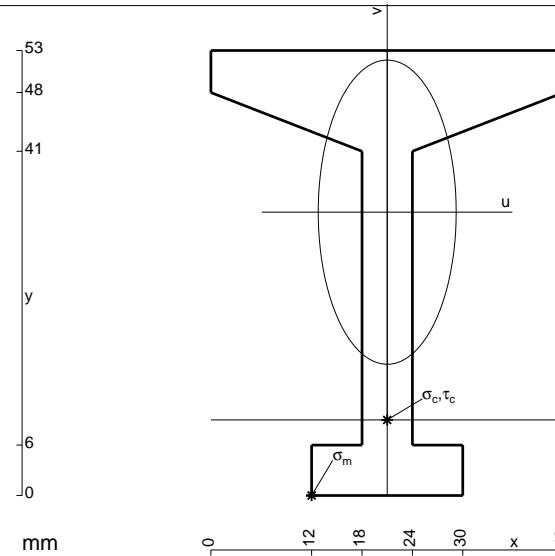
$$= (-1/4 b) \theta = 1/4 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



$$A = 696. \text{ mm}^2$$

$$J_u = 228562. \text{ mm}^4$$

$$J_v = 47016. \text{ mm}^4$$

$$y_g = 33.75 \text{ mm}$$

$$T_y = -3285. \text{ N}$$

$$M_x = -1481900. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -33.75 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -218.8 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 9. \text{ mm}$$

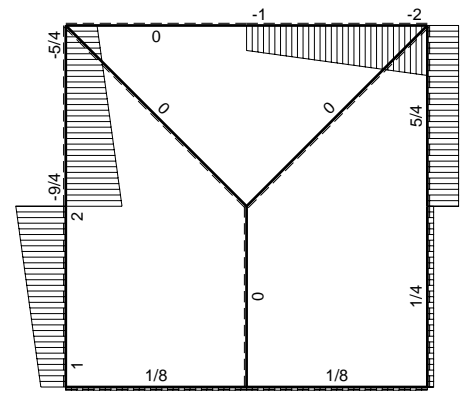
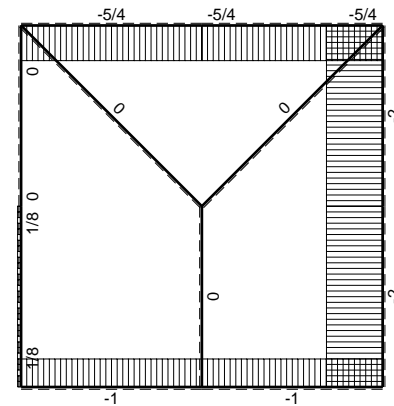
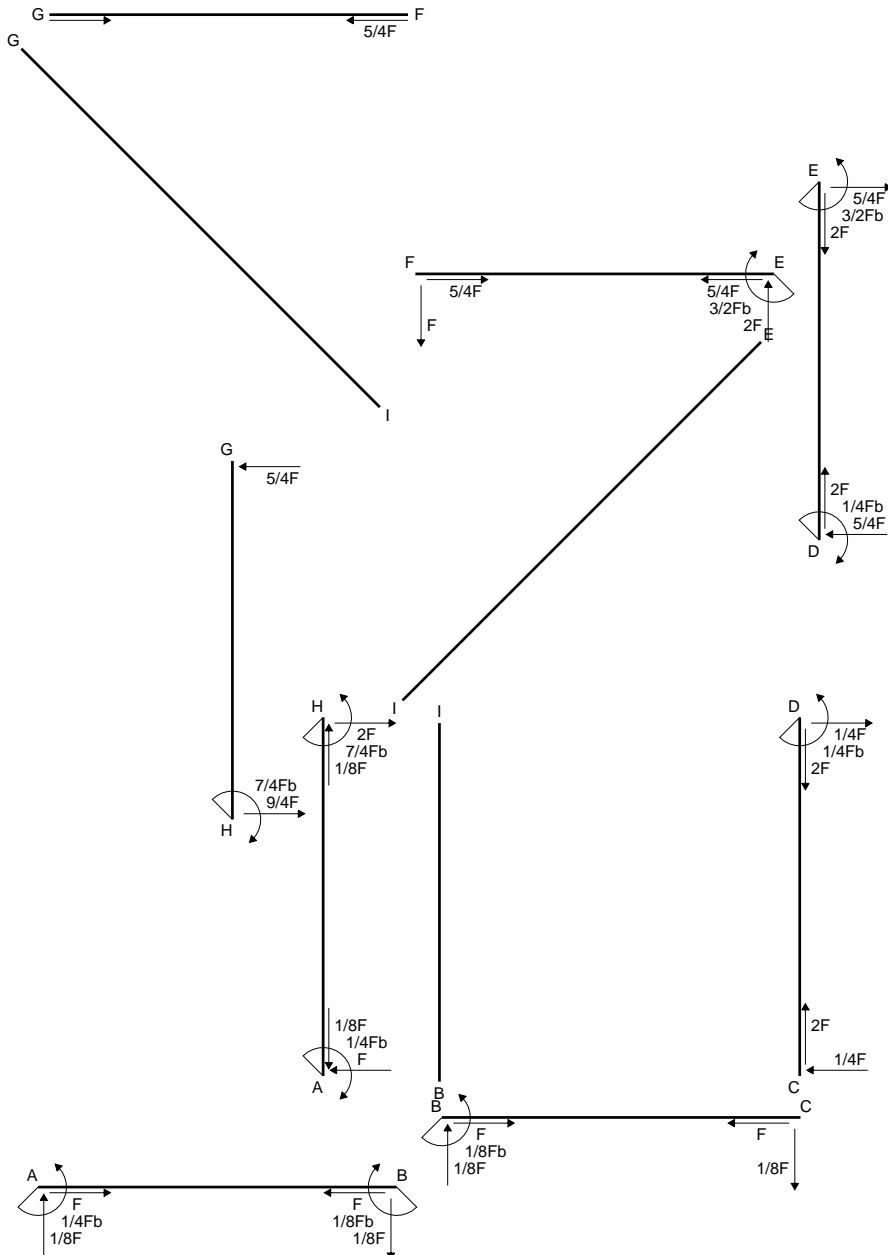
$$v_c = -24.75 \text{ mm}$$

$$\sigma_c = -Mv/J_u = -160.4 \text{ N/mm}^2$$

$$\tau_c = 9.086 \text{ N/mm}^2$$

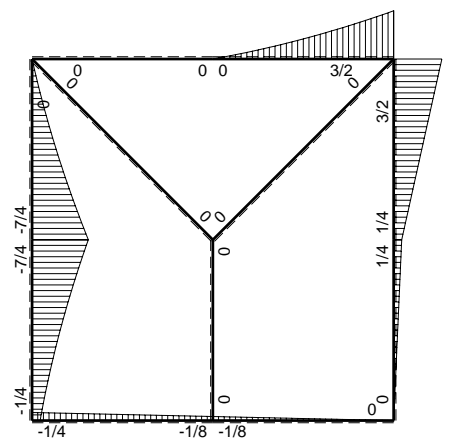
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 161.2 \text{ N/mm}^2$$

$$S = 3793. \text{ mm}^3$$

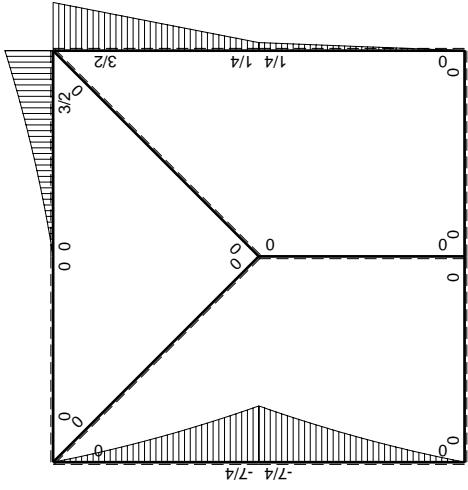
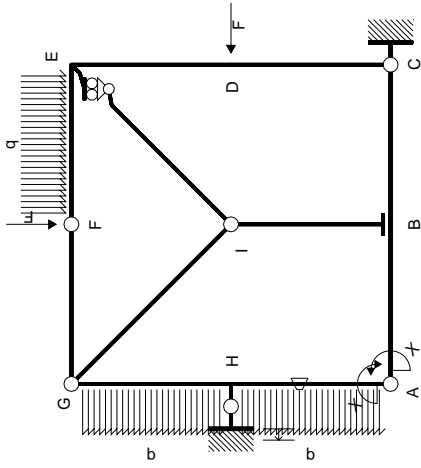


← ⊕ → F

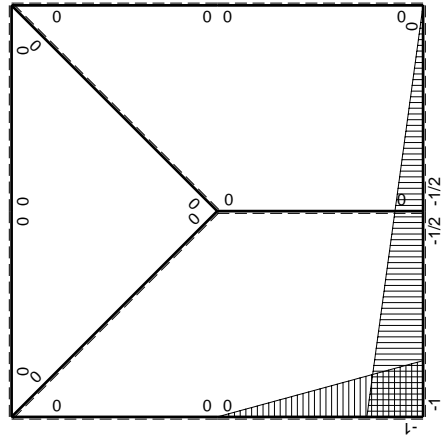
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	$-Fb/EJ$	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	$Fx/EJ$	$x^2/b^2$	$(1/4+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	$Fb/EJ$	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

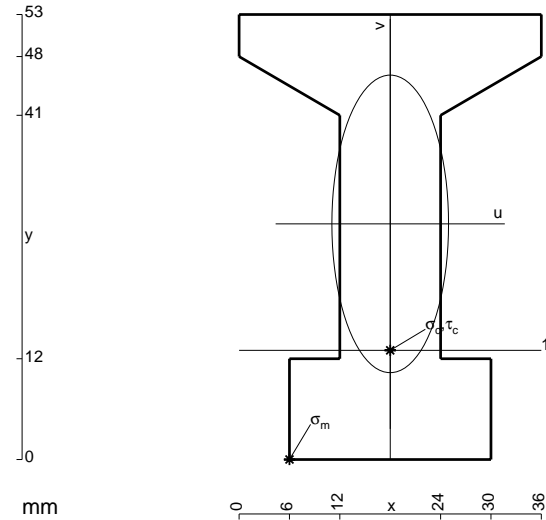
$$= [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 3/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

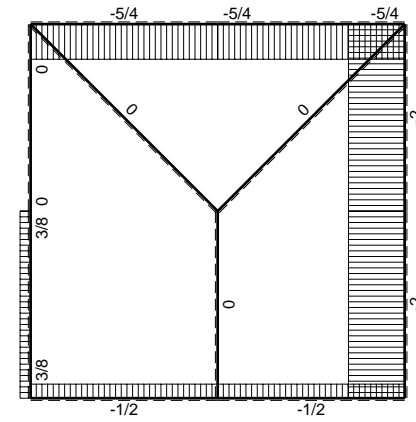
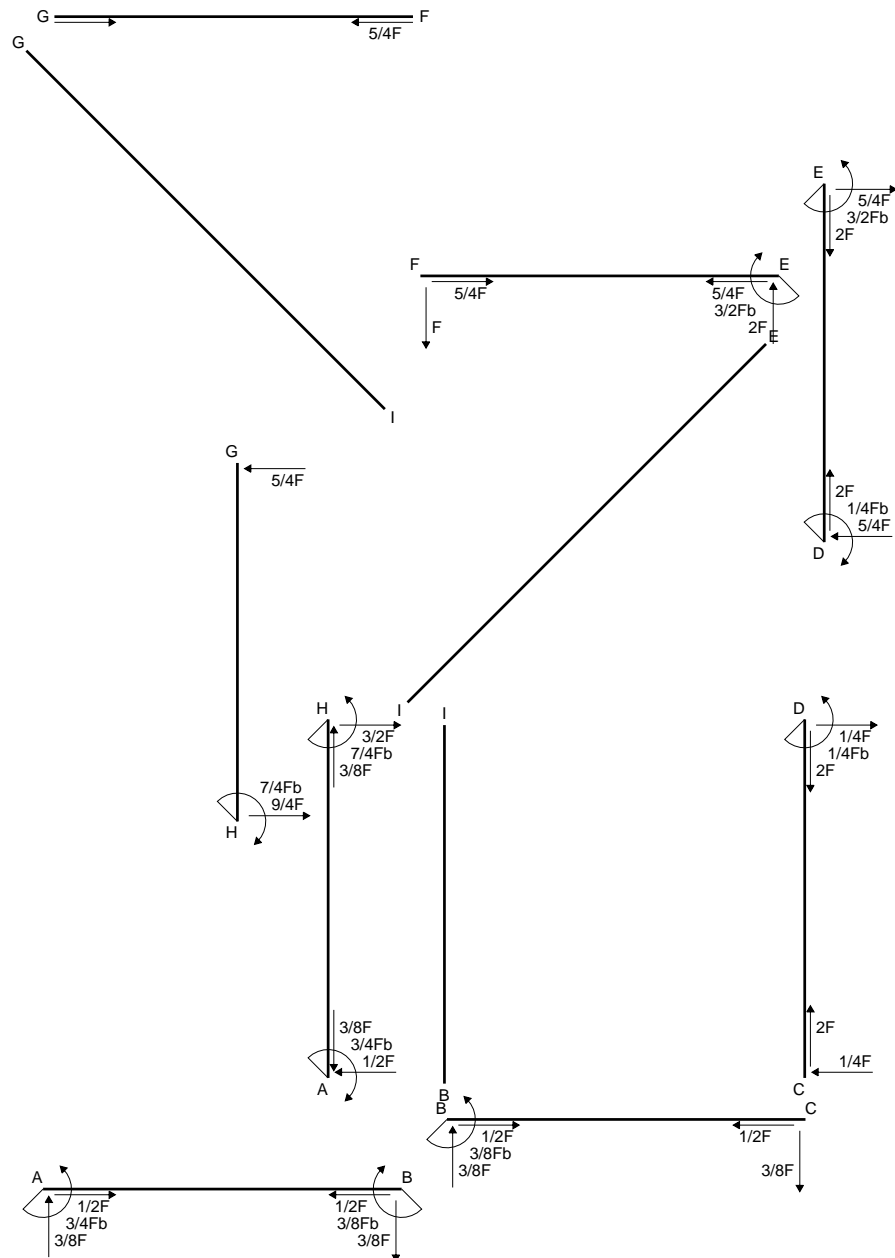
$$= [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 3/4 Fb^2/EJ$$

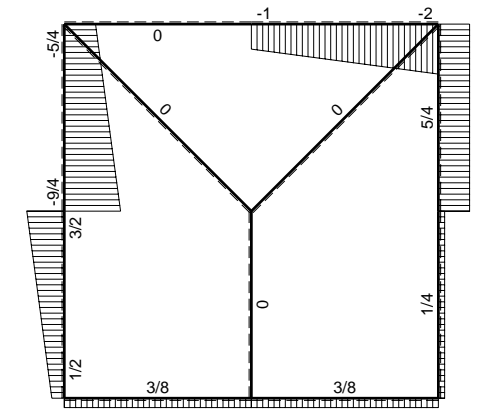


- A = 984. mm<sup>2</sup>
- J<sub>u</sub> = 309174. mm<sup>4</sup>
- J<sub>v</sub> = 47520. mm<sup>4</sup>
- y<sub>g</sub> = 28.06 mm
- T<sub>y</sub> = -5153. N
- M<sub>x</sub> = -2524730. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.06 mm
- σ<sub>m</sub> = -M<sub>v</sub>/J<sub>u</sub> = -229.2 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.06 mm
- σ<sub>c</sub> = -M<sub>v</sub>/J<sub>u</sub> = -123. N/mm<sup>2</sup>
- τ<sub>c</sub> = 9.084 N/mm<sup>2</sup>
- σ<sub>ρ</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 124. N/mm<sup>2</sup>
- S = 6541. mm<sup>3</sup>

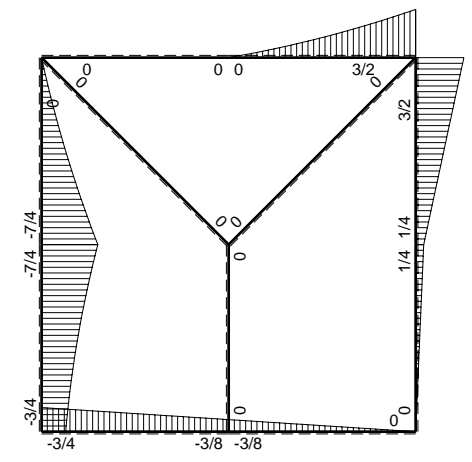




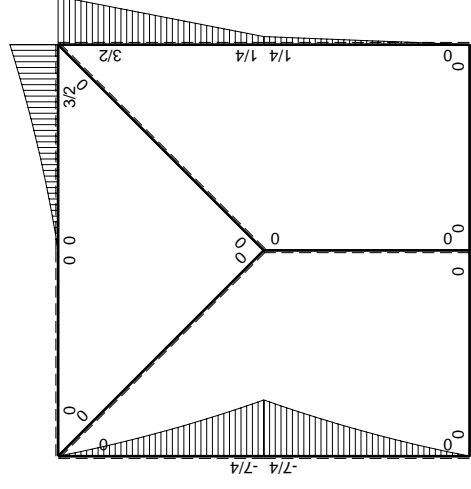
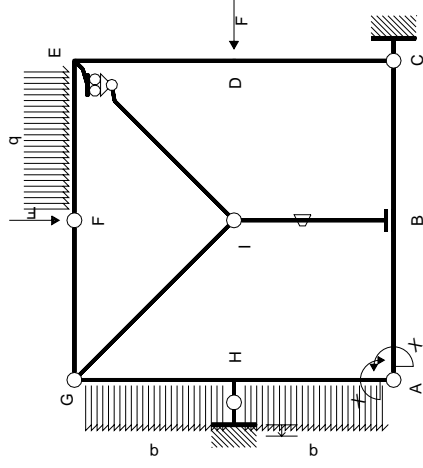
← ⊕ → F



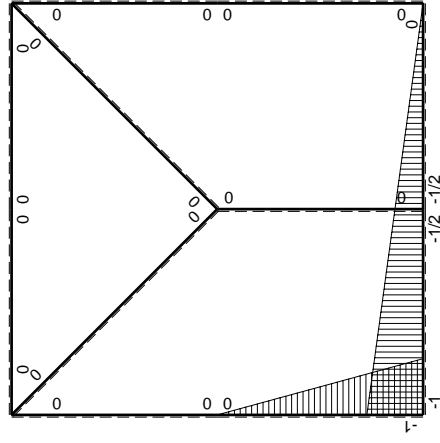
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
BI b	0	0	$Fb/EJ$	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

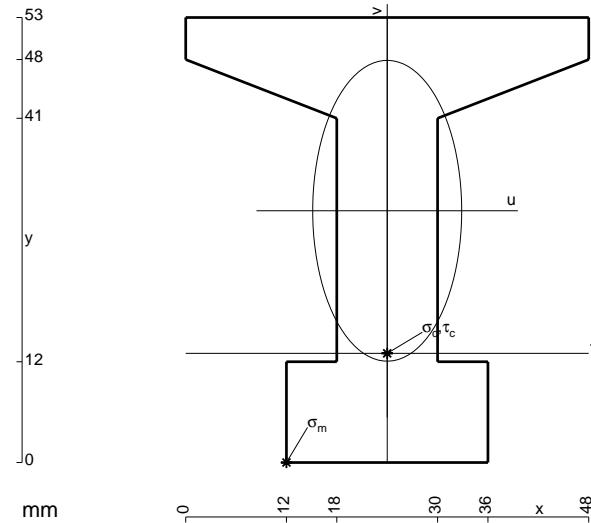
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

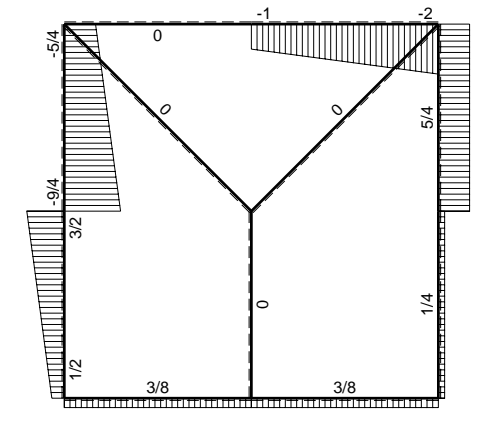
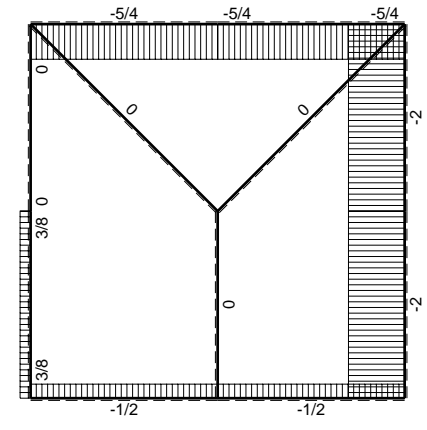
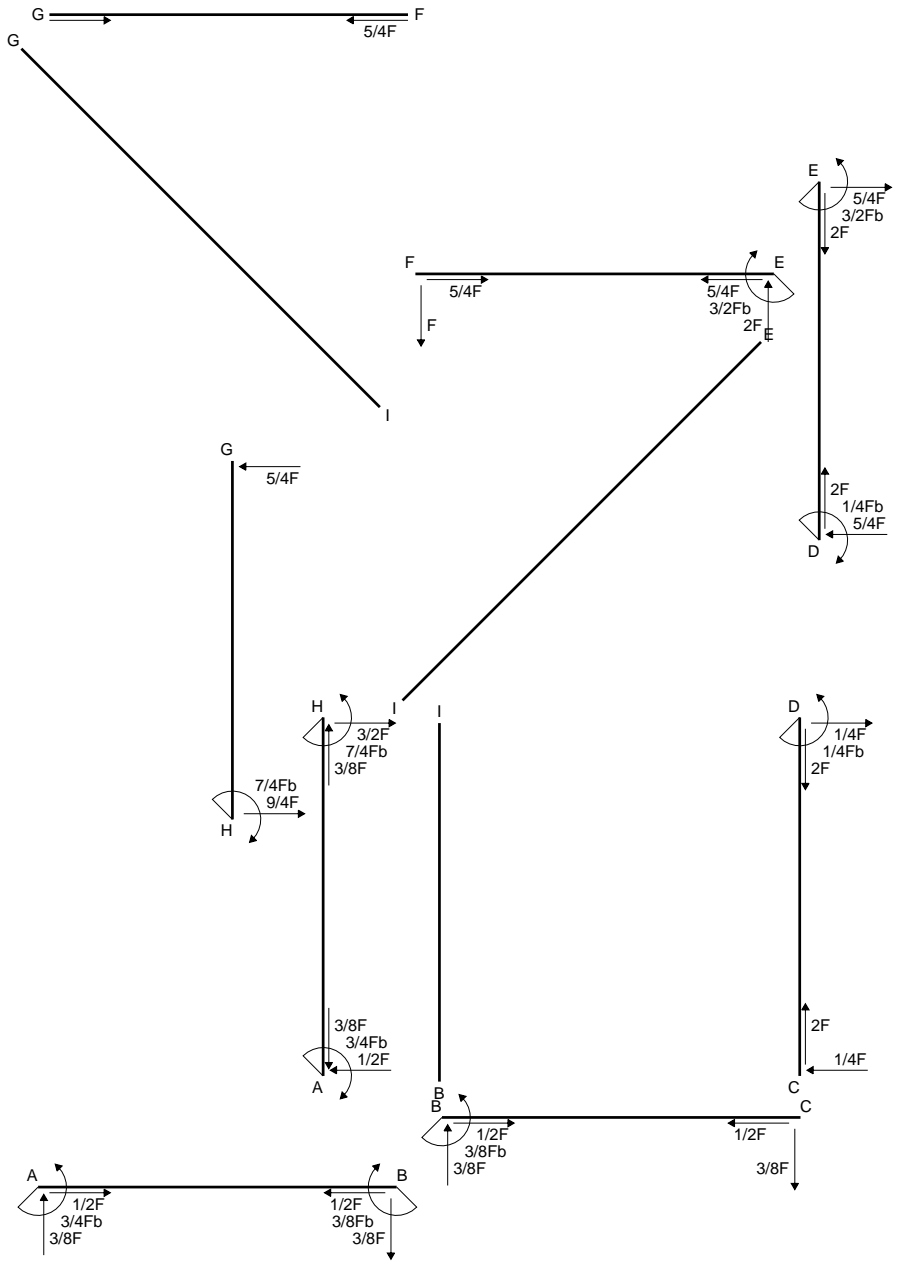
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

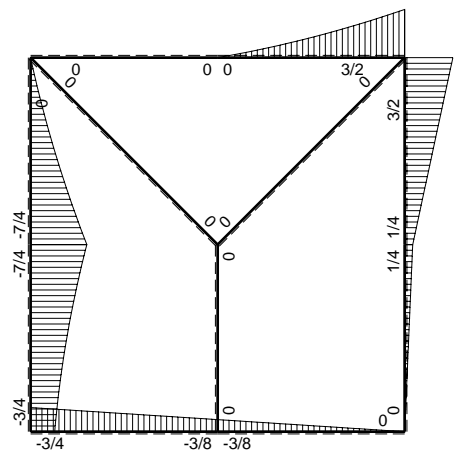


- A = 1086. mm<sup>2</sup>
- J<sub>u</sub> = 348629. mm<sup>4</sup>
- J<sub>v</sub> = 85500. mm<sup>4</sup>
- y<sub>g</sub> = 29.98 mm
- T<sub>y</sub> = -5265. N
- M<sub>x</sub> = -2784600. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -29.98 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -239.5 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -16.98 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -135.7 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.957 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 136.5 N/mm<sup>2</sup>
- S = 7117. mm<sup>3</sup>

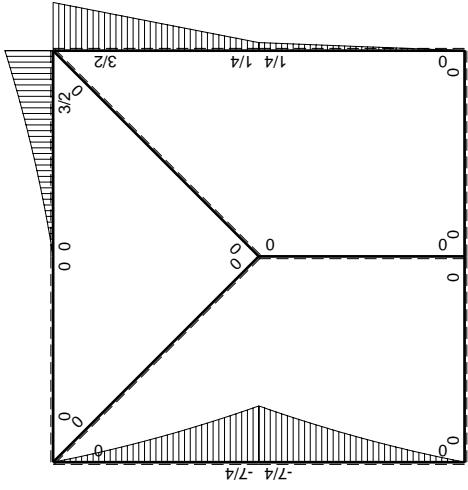
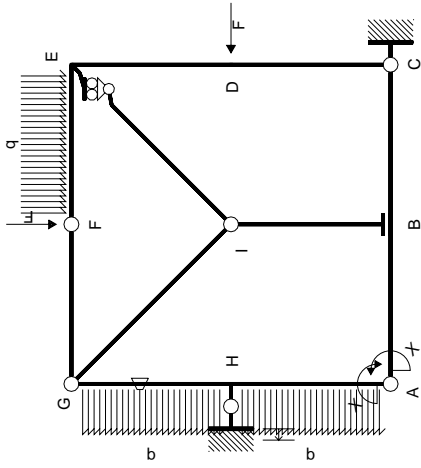


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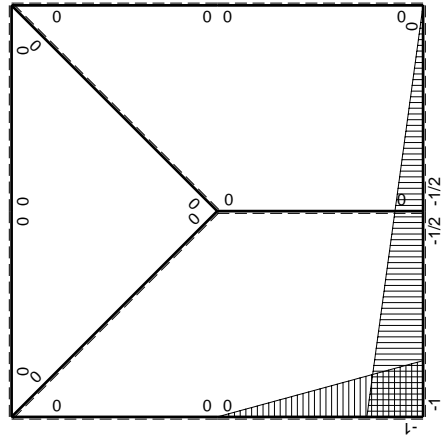
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	$Fb/EJ$	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

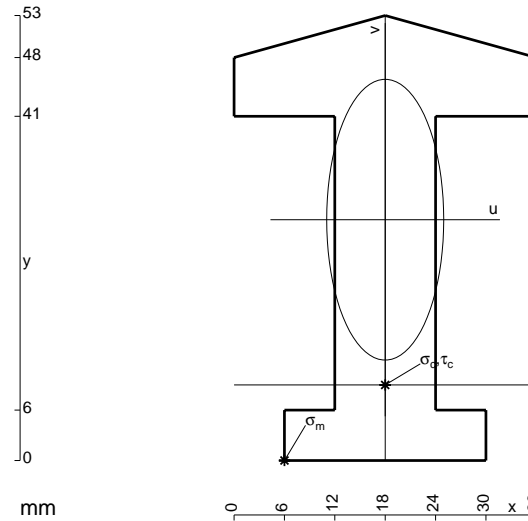
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

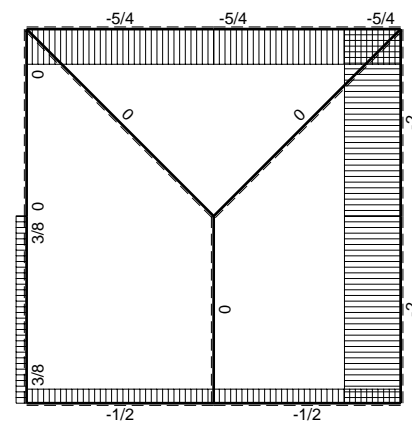
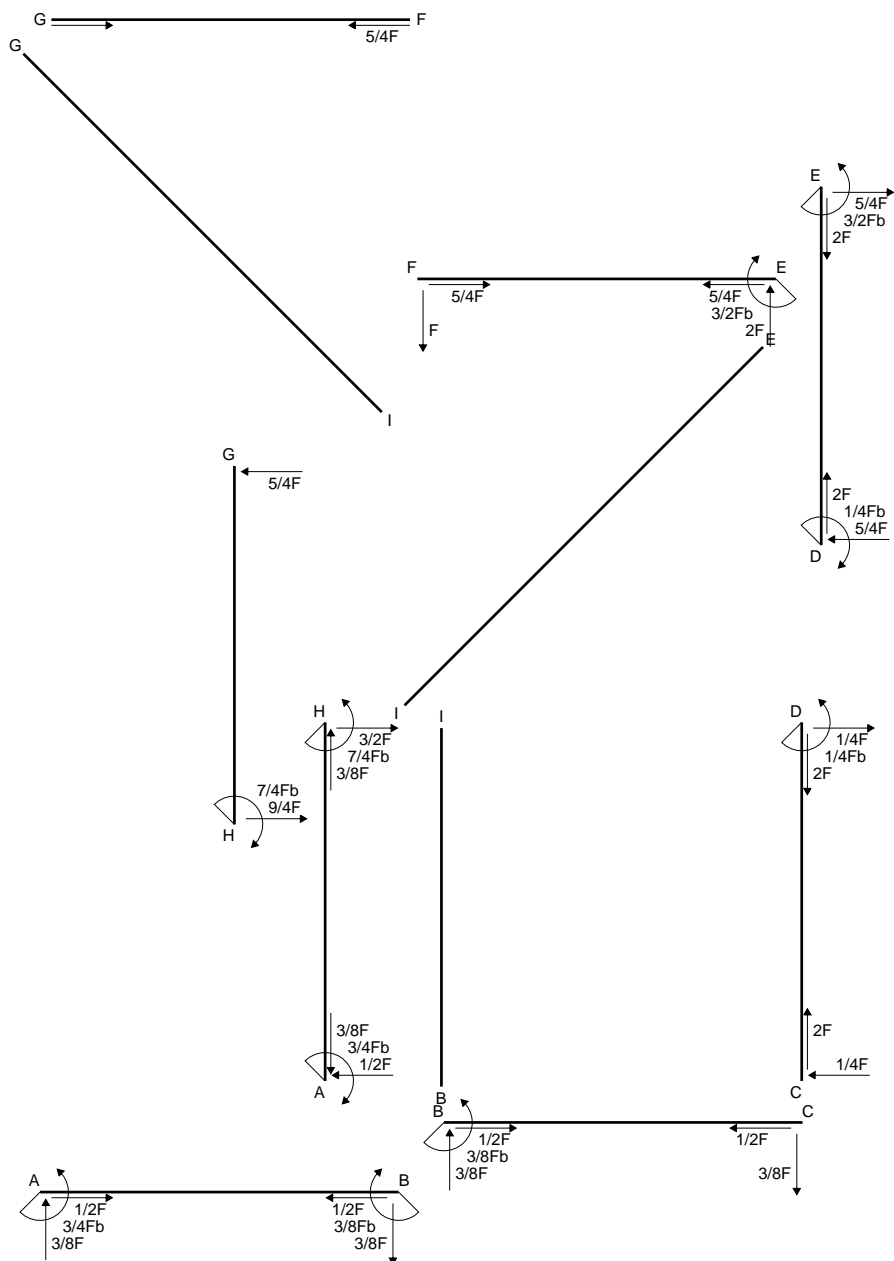
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

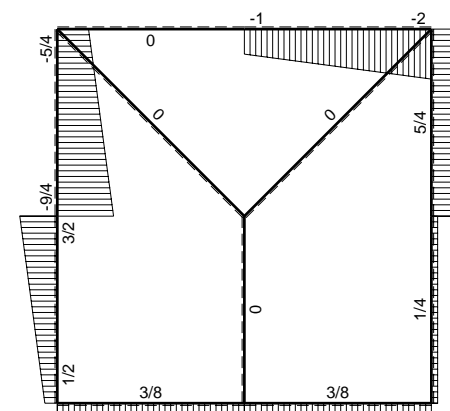


- A = 906. mm<sup>2</sup>
- J<sub>u</sub> = 253401. mm<sup>4</sup>
- J<sub>v</sub> = 44028. mm<sup>4</sup>
- y<sub>g</sub> = 28.68 mm
- T<sub>y</sub> = -3105. N
- M<sub>x</sub> = -1762950. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.68 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -199.5 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -19.68 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -136.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.555 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 137.2 N/mm<sup>2</sup>
- S = 4461. mm<sup>3</sup>

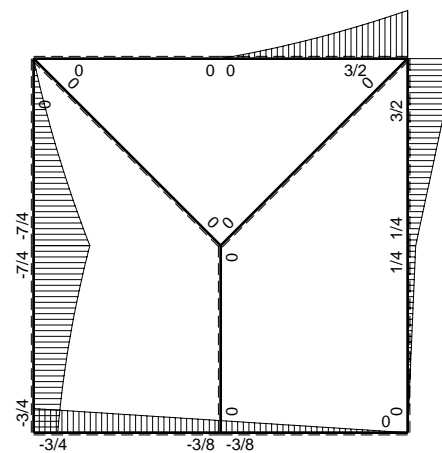




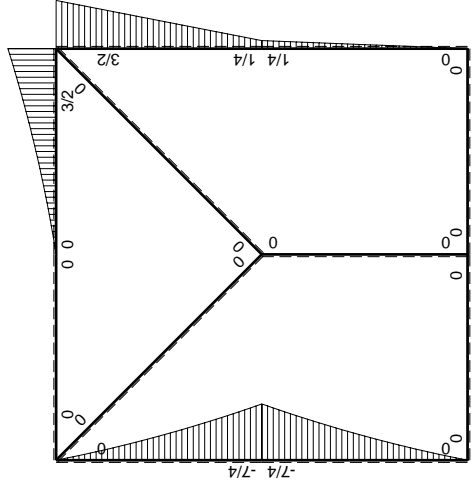
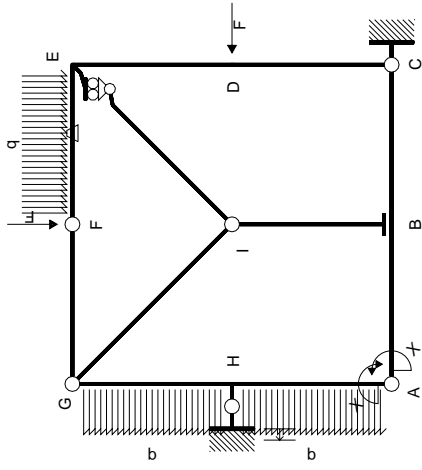
← ⊕ → F



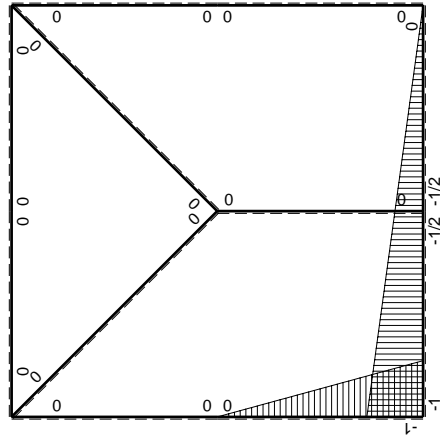
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	$Fb/EJ$	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

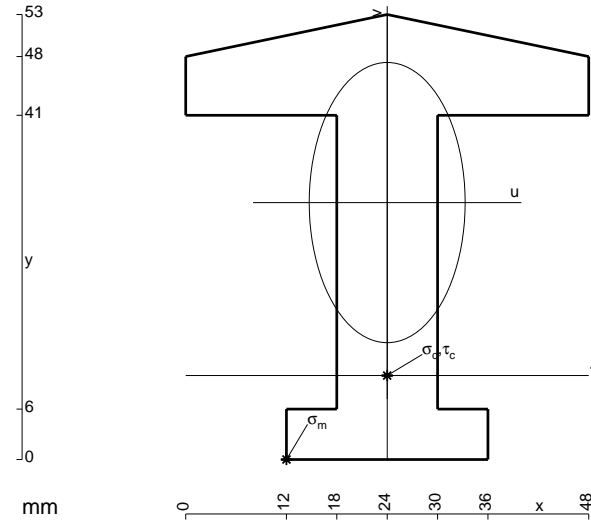
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

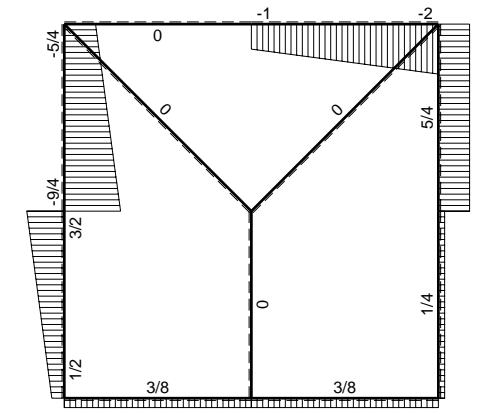
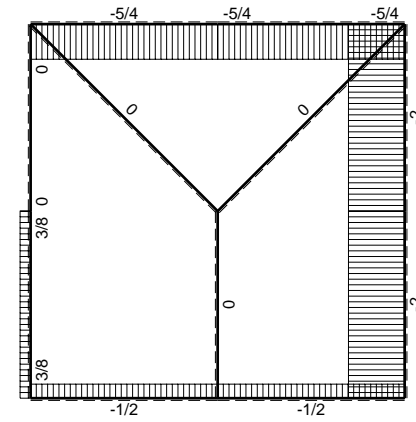
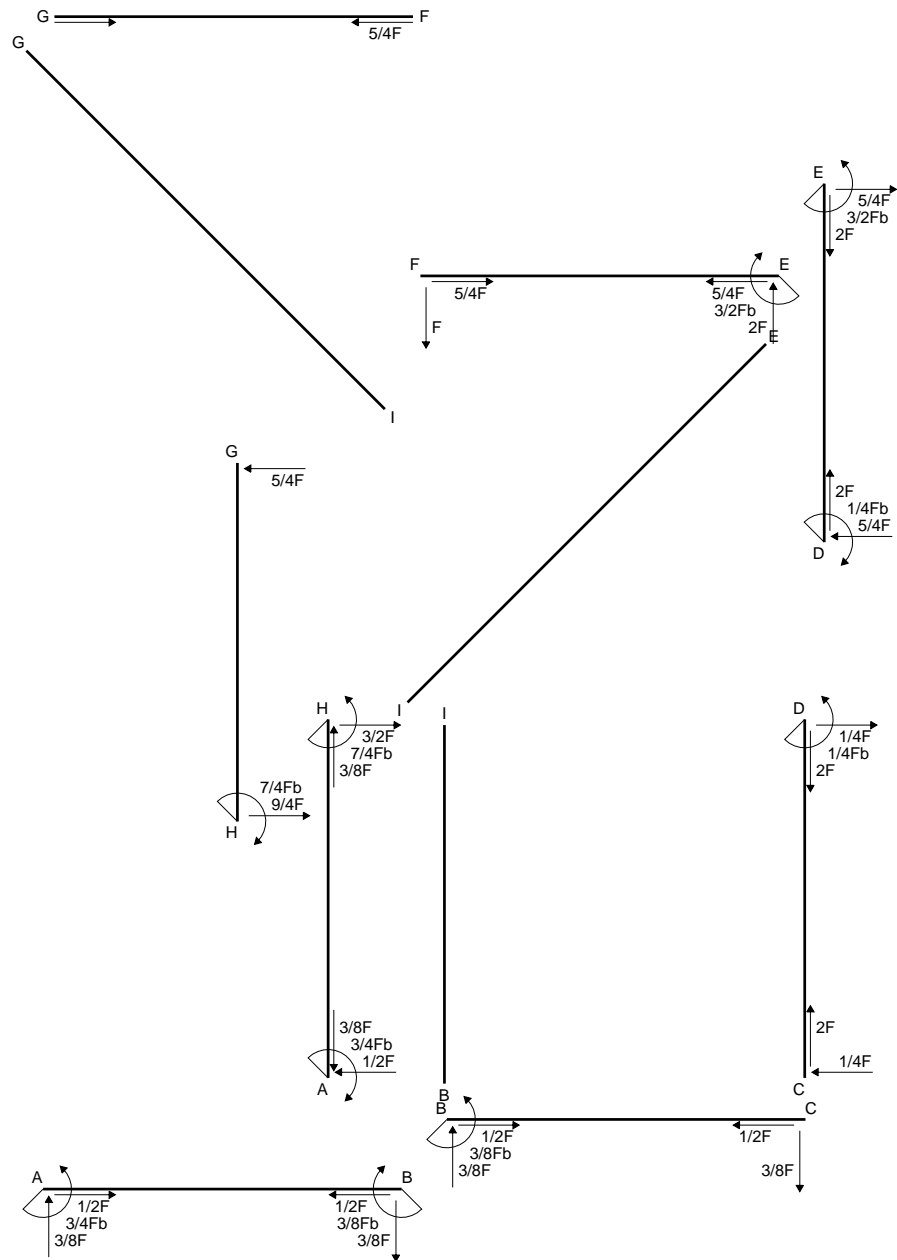
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

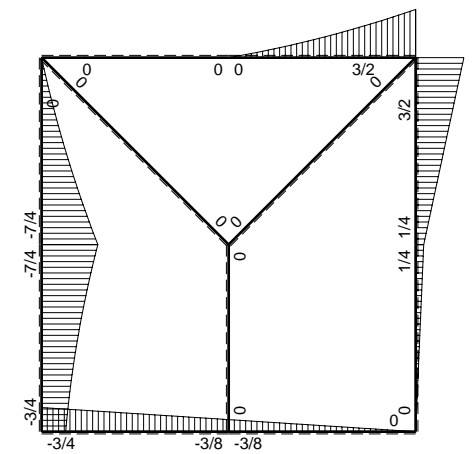


- A = 1020. mm<sup>2</sup>
- J<sub>u</sub> = 284254. mm<sup>4</sup>
- J<sub>v</sub> = 87984. mm<sup>4</sup>
- y<sub>g</sub> = 30.6 mm
- T<sub>y</sub> = -3195. N
- M<sub>x</sub> = -1938300. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.6 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -208.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -20.6 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -140.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.739 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 140.7 N/mm<sup>2</sup>
- S = 5060. mm<sup>3</sup>

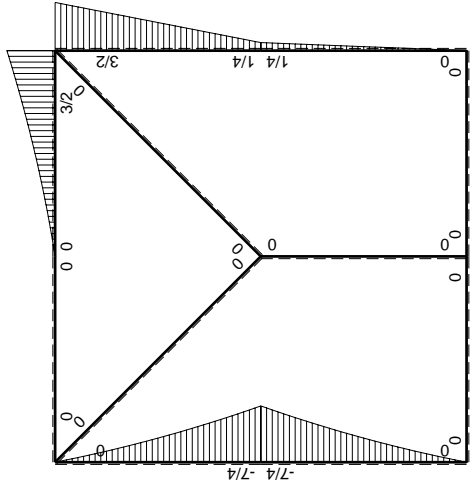
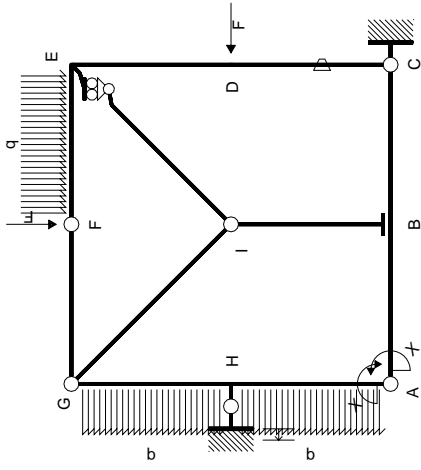


← ⊕ → F

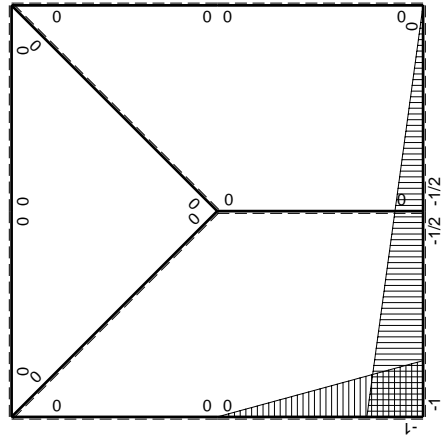
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	$Fb/EJ$	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

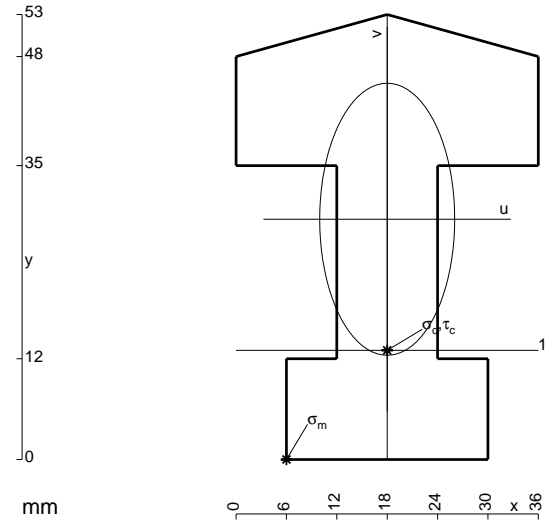
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

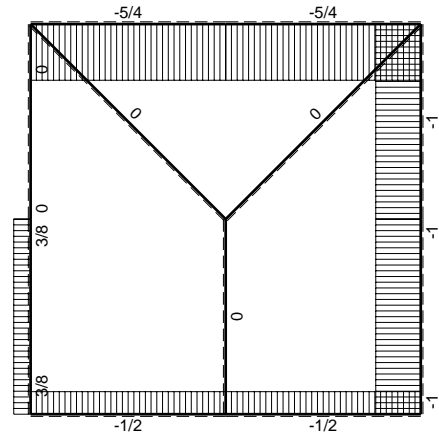
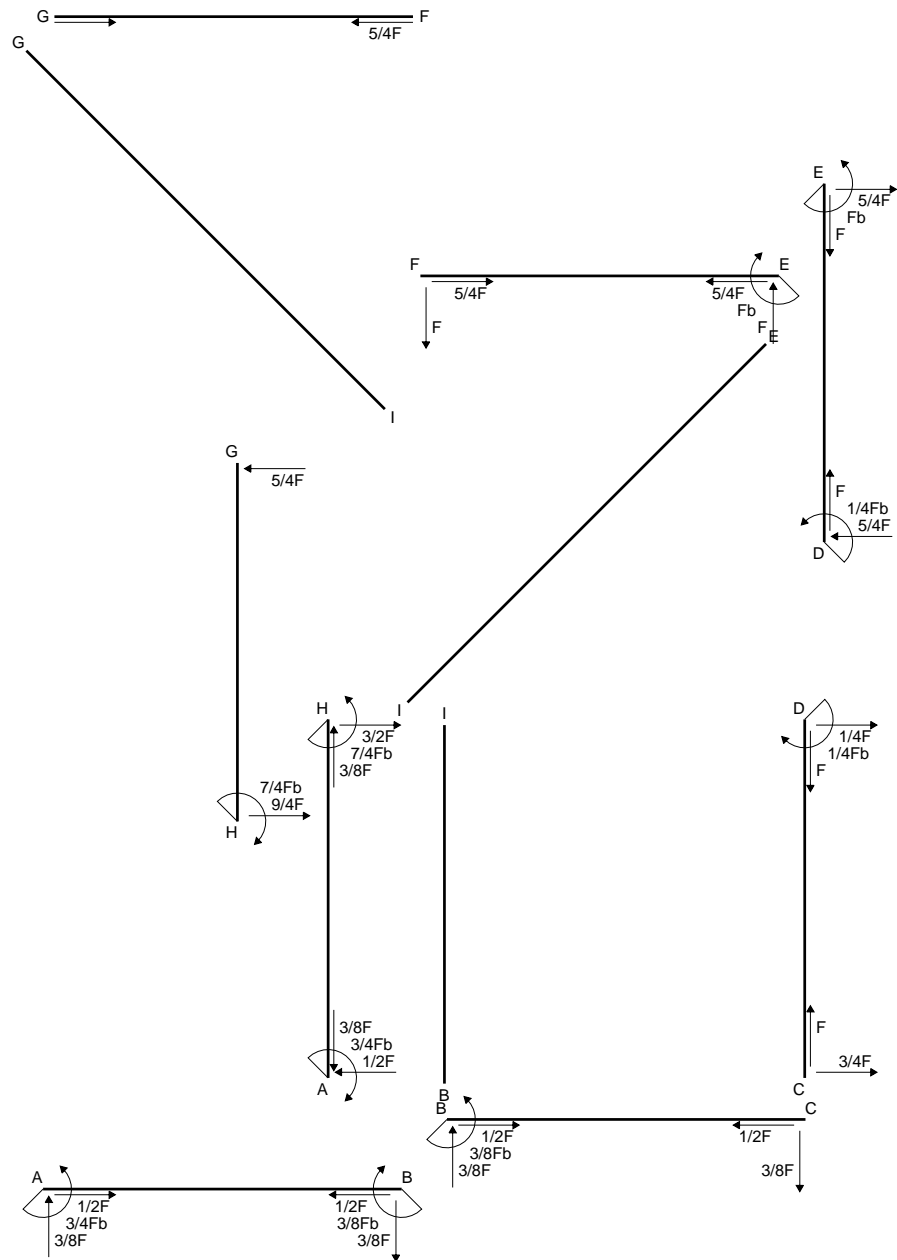
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

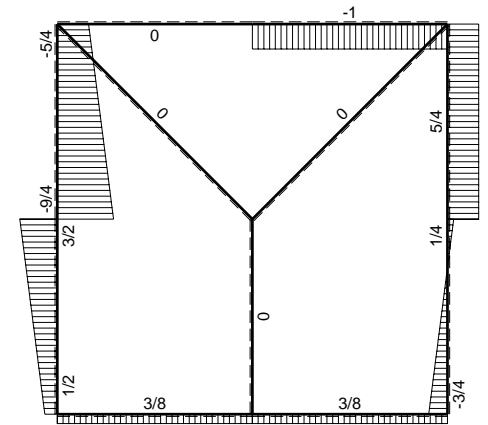


- A = 1122. mm<sup>2</sup>
- J<sub>u</sub> = 294439. mm<sup>4</sup>
- J<sub>v</sub> = 72540. mm<sup>4</sup>
- y<sub>g</sub> = 28.61 mm
- T<sub>y</sub> = -3488. N
- M<sub>x</sub> = -2251380. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.61 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -218.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.61 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -119.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.62 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 119.9 N/mm<sup>2</sup>
- S = 6706. mm<sup>3</sup>

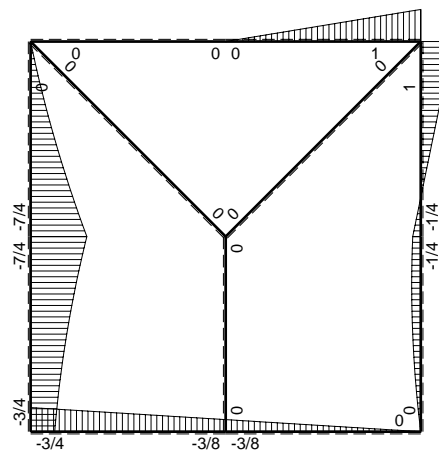




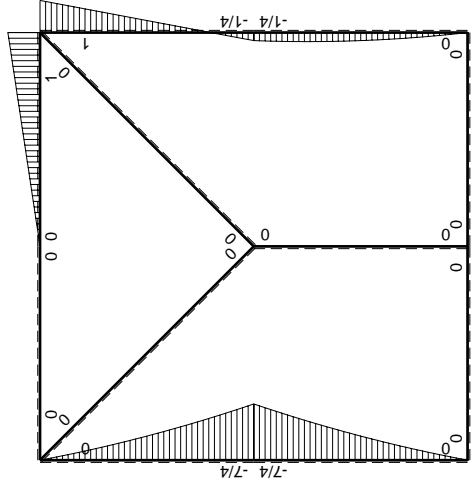
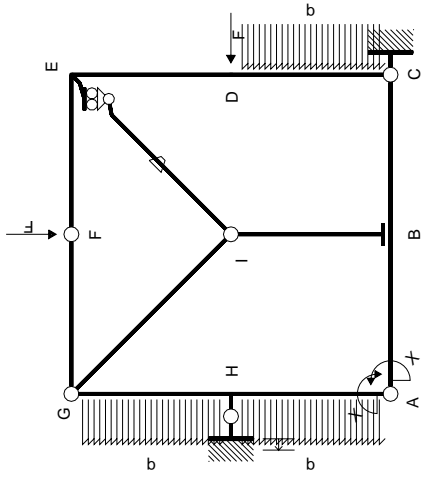
$\leftarrow \boxed{+} \rightarrow F$



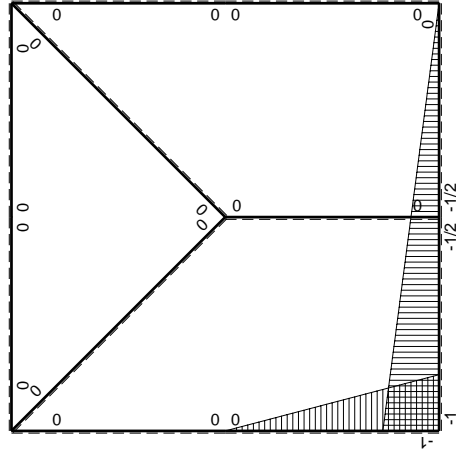
$\uparrow \boxed{+} \downarrow F$



$\curvearrowright \boxed{+} \curvearrowleft Fb$



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

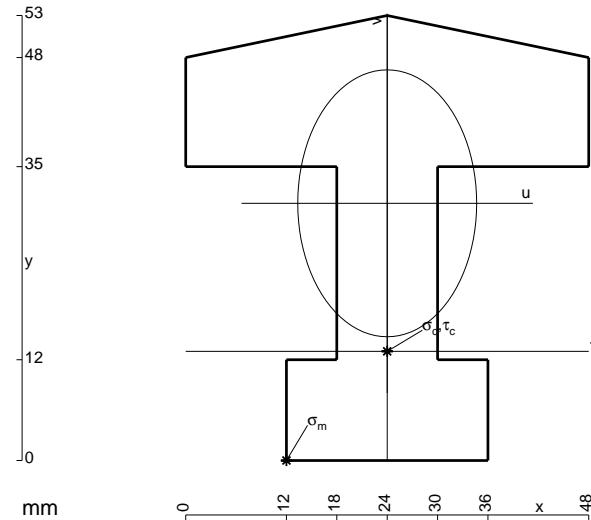
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

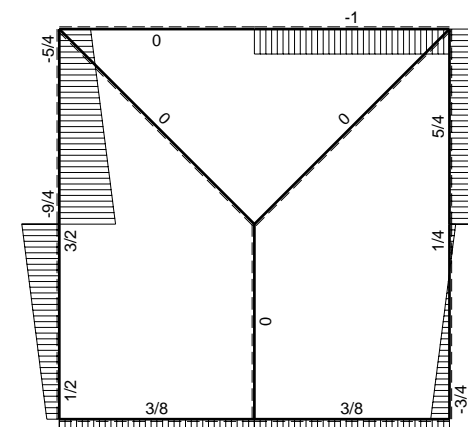
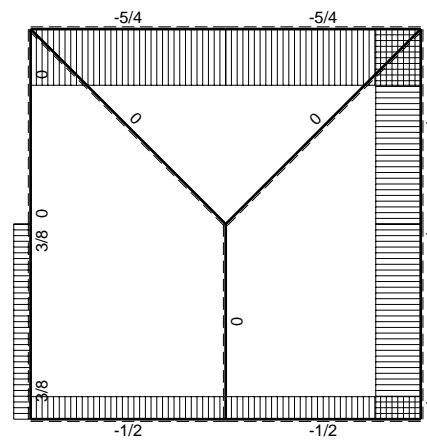
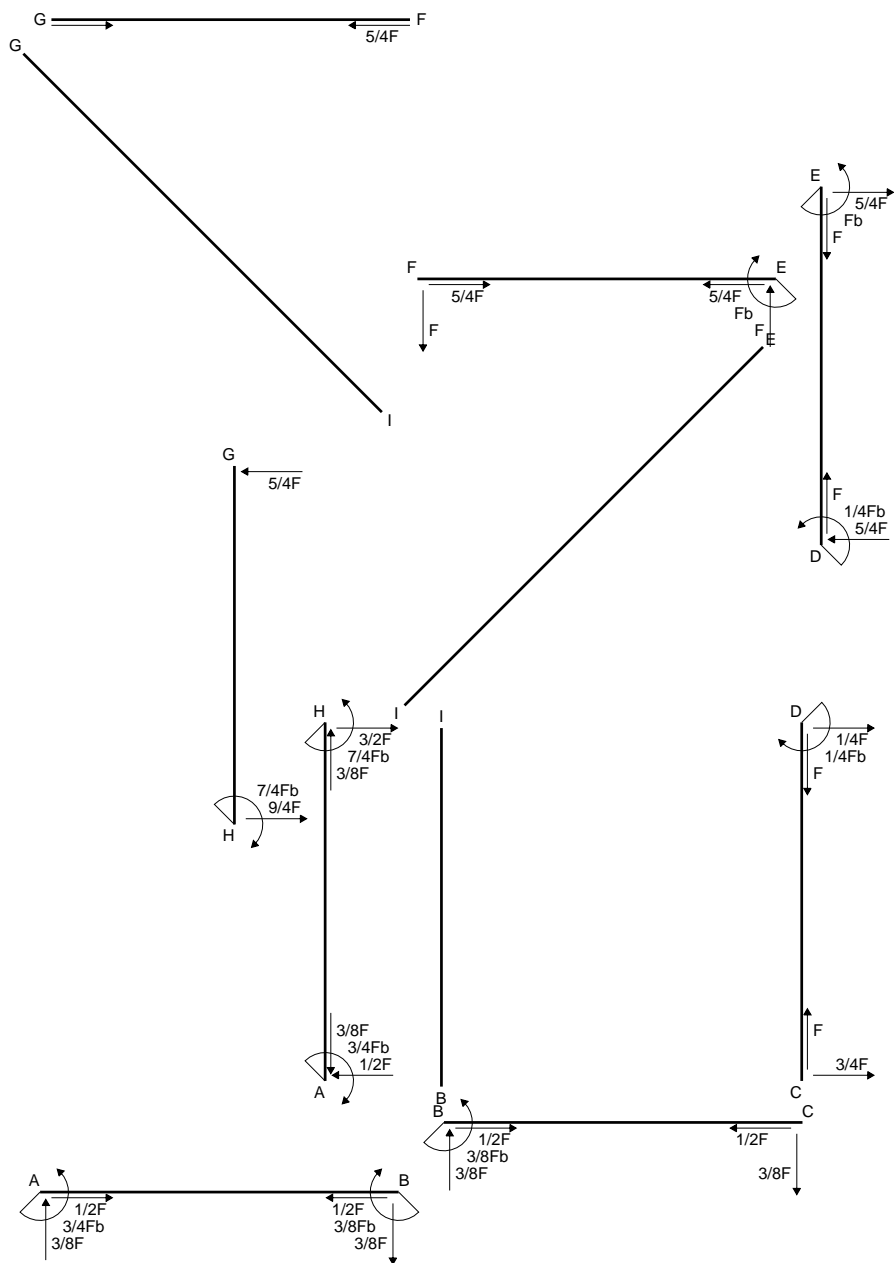
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

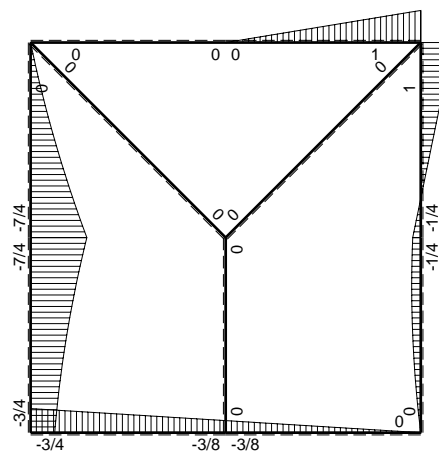


- A = 1308. mm<sup>2</sup>
- J<sub>u</sub> = 330537. mm<sup>4</sup>
- J<sub>v</sub> = 148464. mm<sup>4</sup>
- y<sub>g</sub> = 30.63 mm
- T<sub>y</sub> = -3623. N
- M<sub>x</sub> = -2479400. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.63 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -229.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -17.63 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -132.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.678 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sub>c</sub><sup>2</sup> + 3τ<sub>c</sub><sup>2</sup> = 132.8 N/mm<sup>2</sup>
- S = 7312. mm<sup>3</sup>

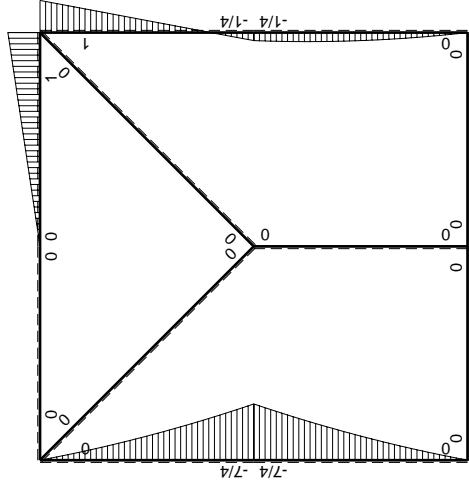
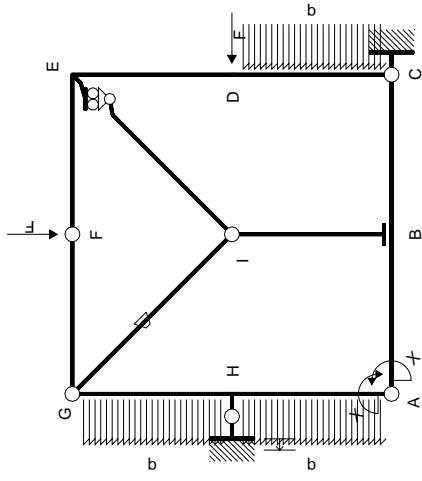


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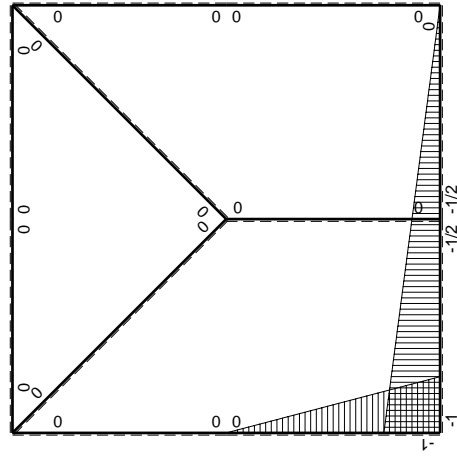
↑ ⊕ ↓ F



⊕ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

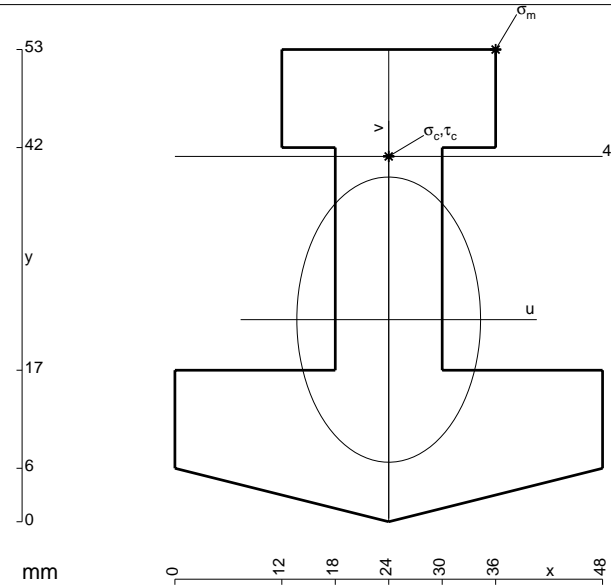
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

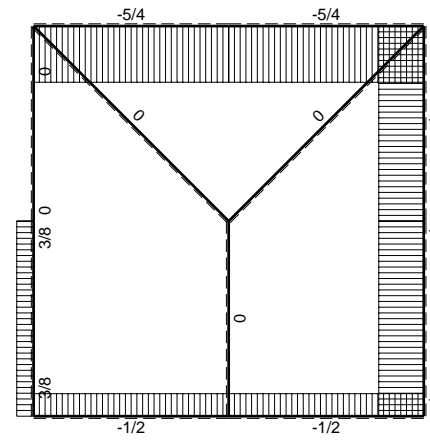
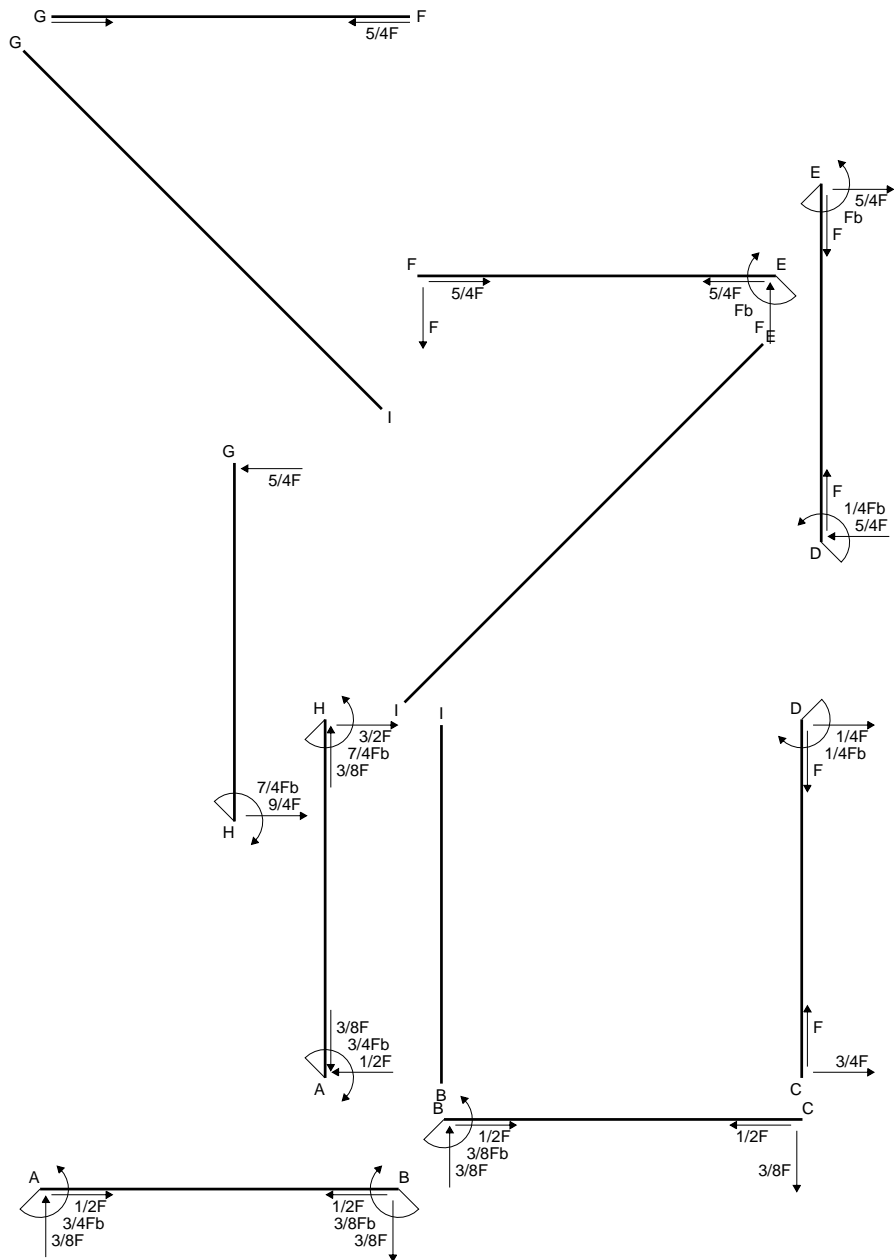
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

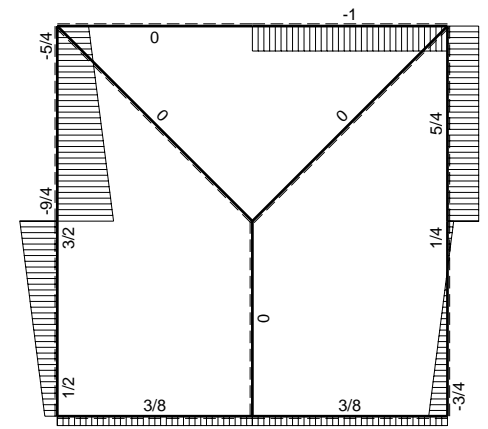


- A = 1236. mm<sup>2</sup>
- J<sub>u</sub> = 316729. mm<sup>4</sup>
- J<sub>v</sub> = 131472. mm<sup>4</sup>
- y<sub>g</sub> = 22.68 mm
- T<sub>y</sub> = -3465. N
- M<sub>x</sub> = -2506350. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.32 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = 239.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 18.32 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = 144.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.178 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 145.3 N/mm<sup>2</sup>
- S = 6777. mm<sup>3</sup>

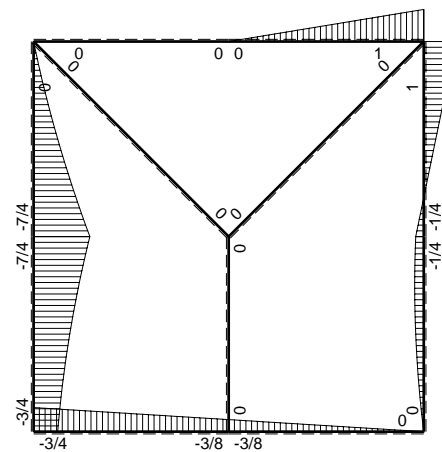




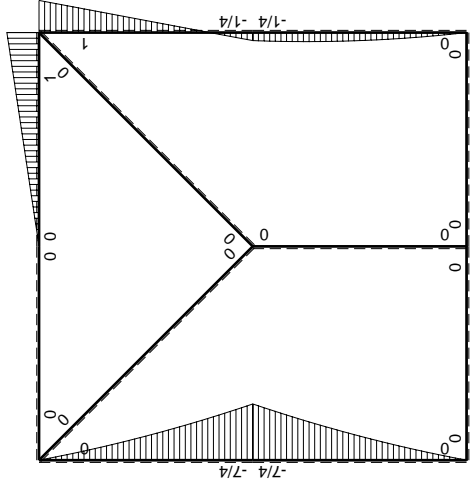
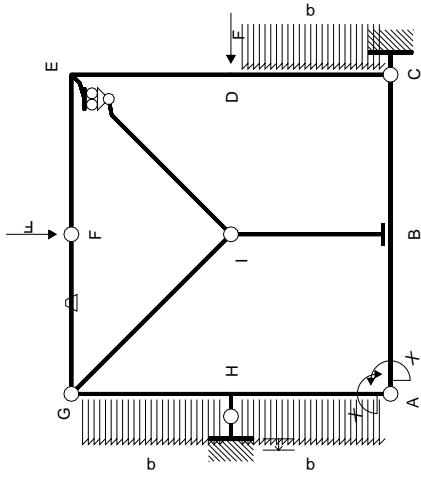
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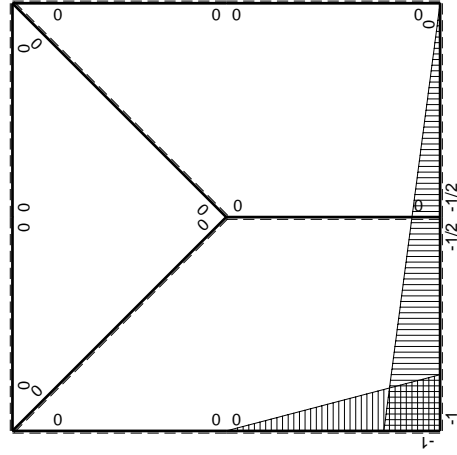
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica X=1

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	0	0	0	0			
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
GF b	0	0	$Fb/EJ$	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

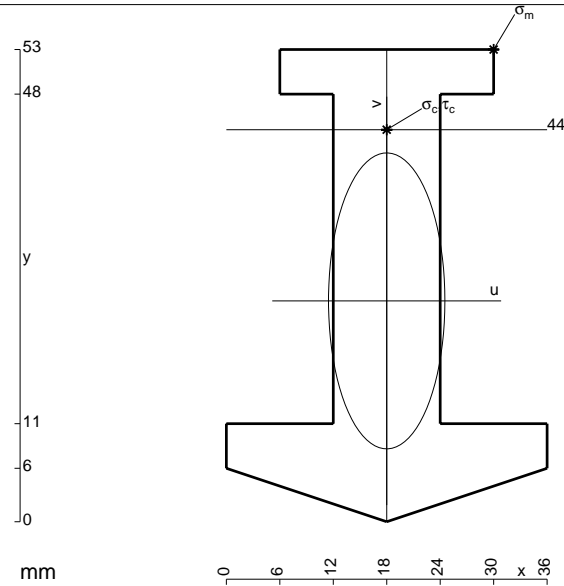
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

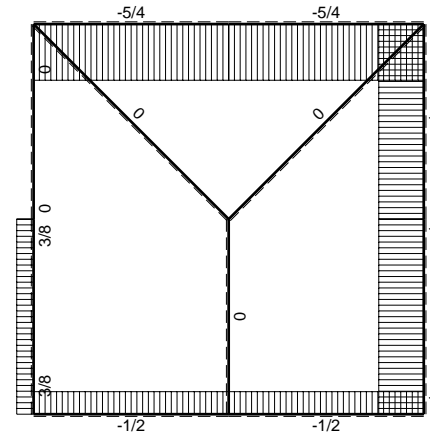
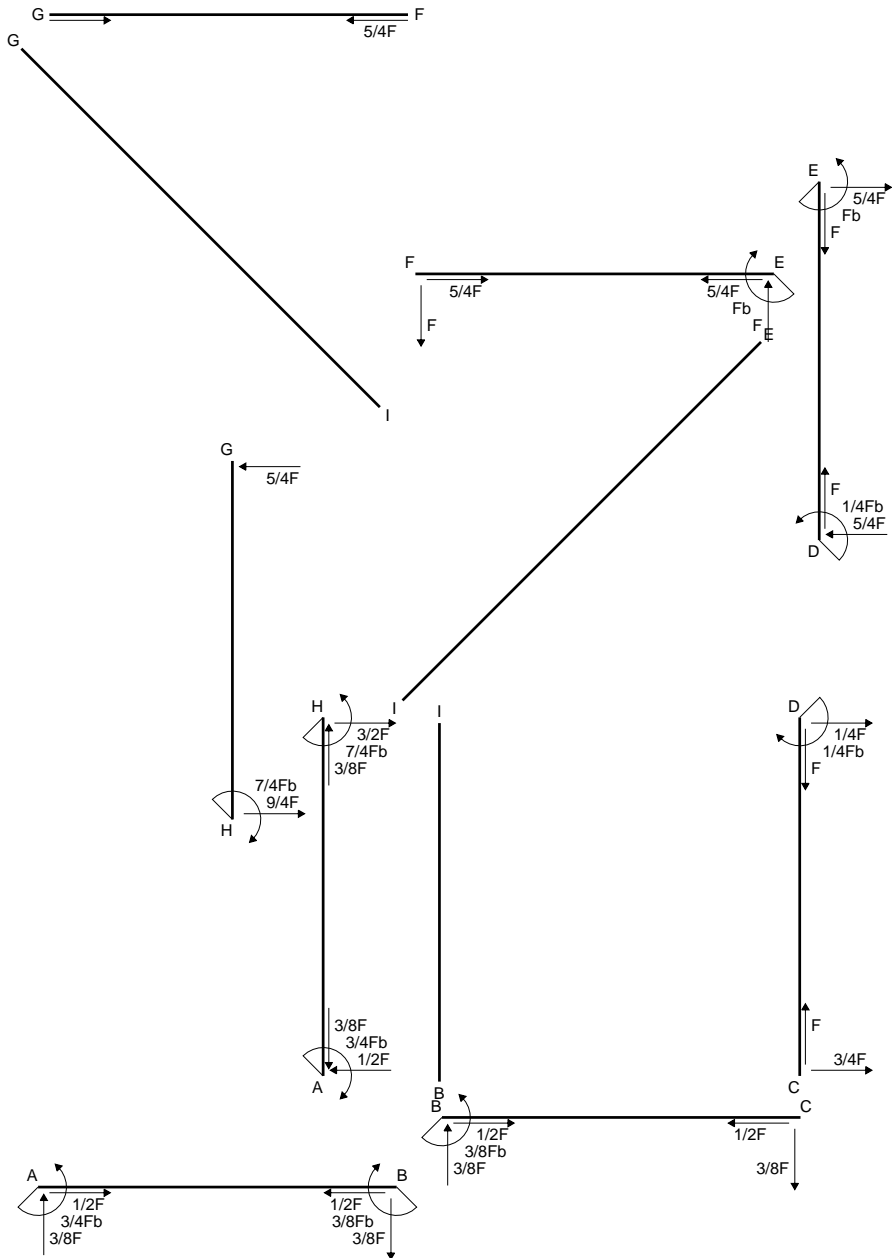
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

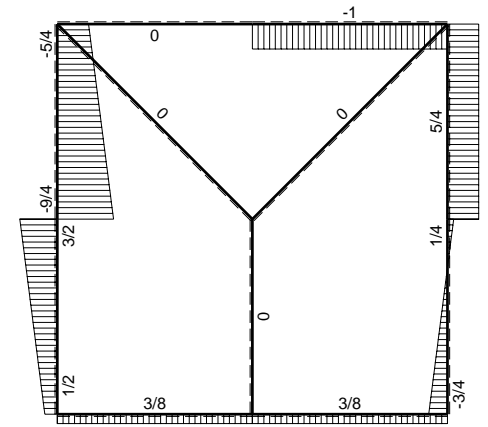
$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



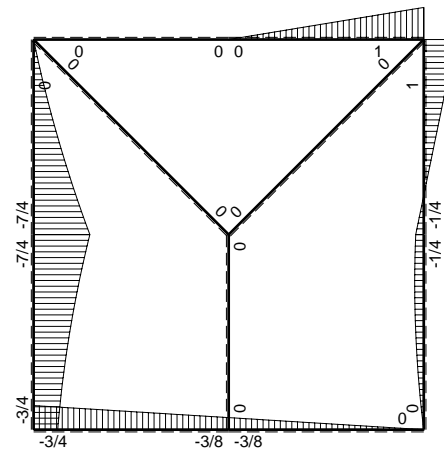
- A = 852. mm<sup>2</sup>
- J<sub>u</sub> = 235110. mm<sup>4</sup>
- J<sub>v</sub> = 36360. mm<sup>4</sup>
- y<sub>g</sub> = 24.79 mm
- T<sub>y</sub> = -4365. N
- M<sub>x</sub> = -1663550. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.21 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = 199.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 44. mm
- v<sub>c</sub> = 19.21 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = 135.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.349 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 136.4 N/mm<sup>2</sup>
- S = 4103. mm<sup>3</sup>



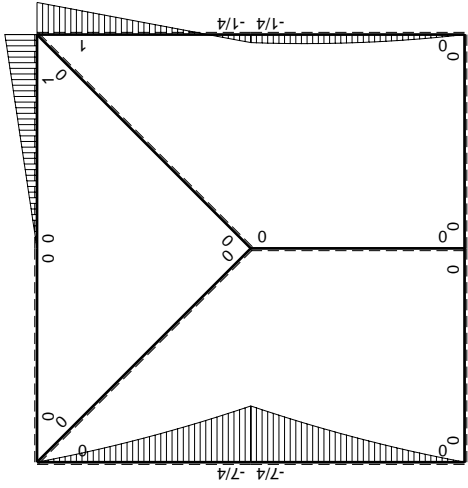
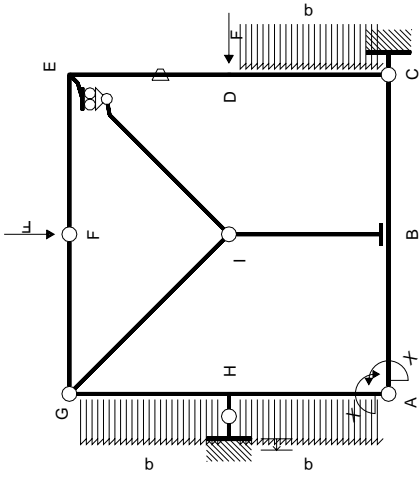
← ⊕ → F



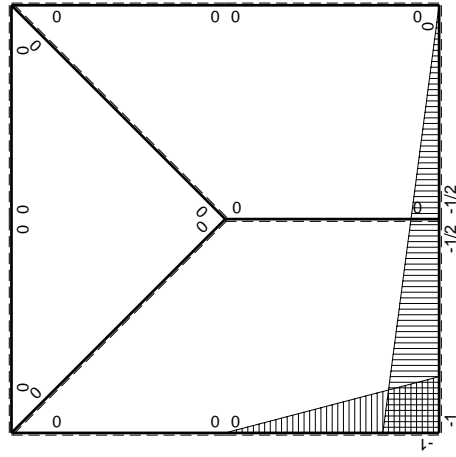
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	$Fb/EJ$	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

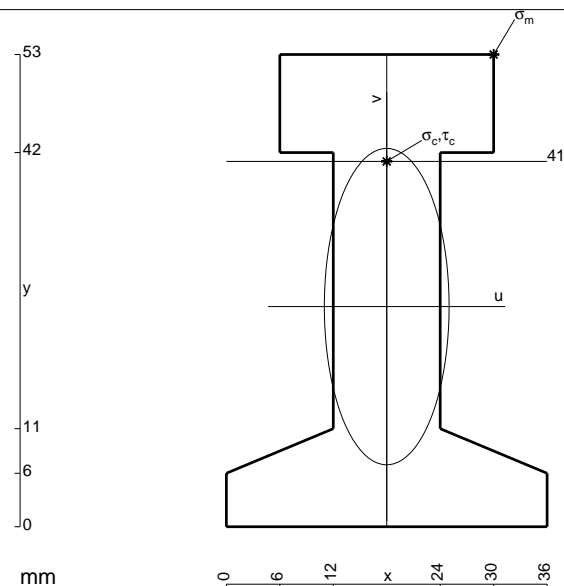
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

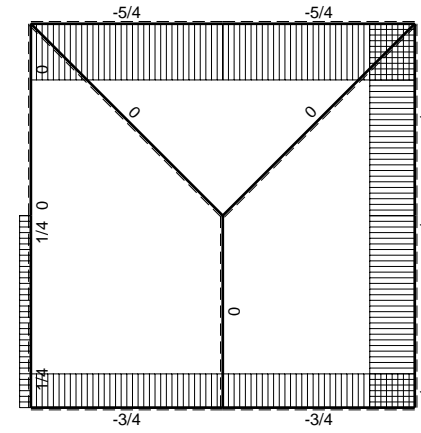
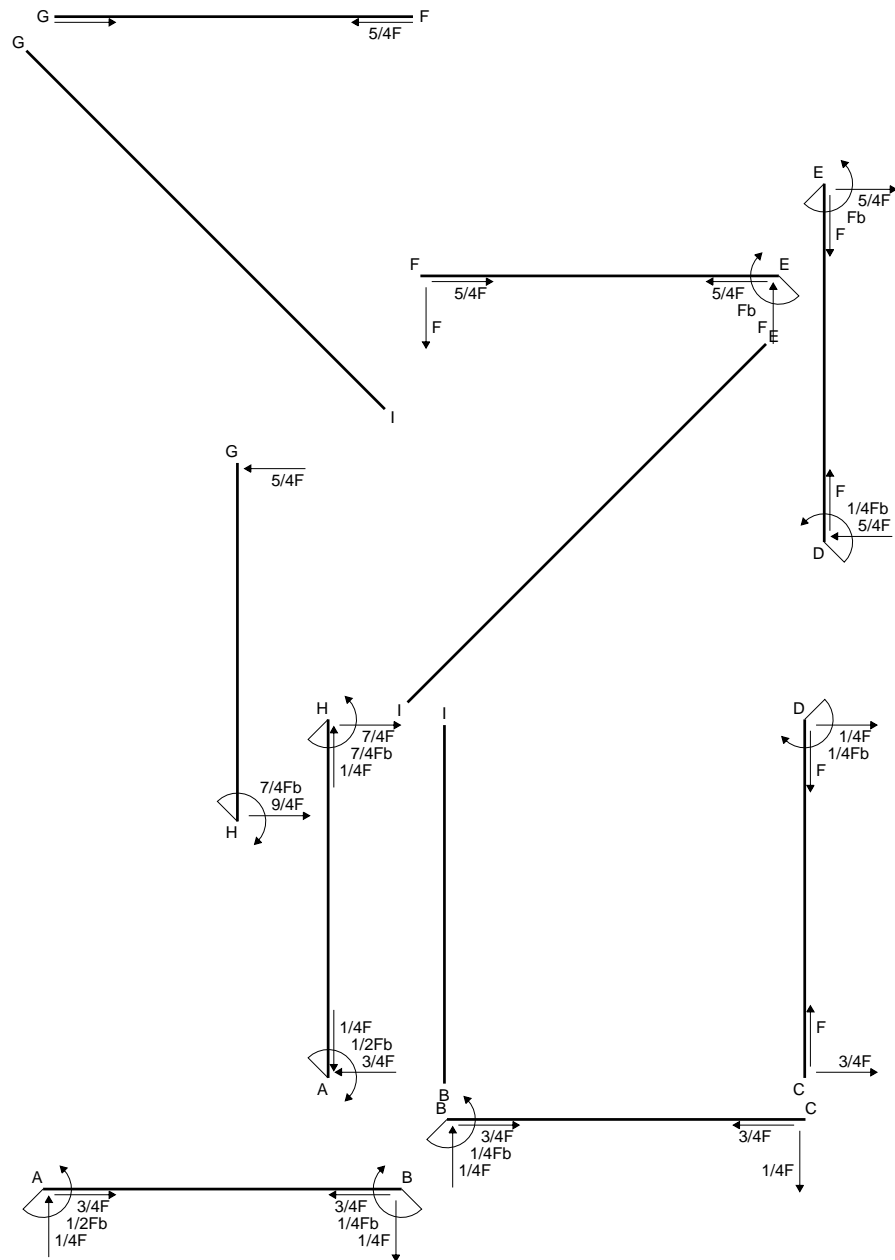
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

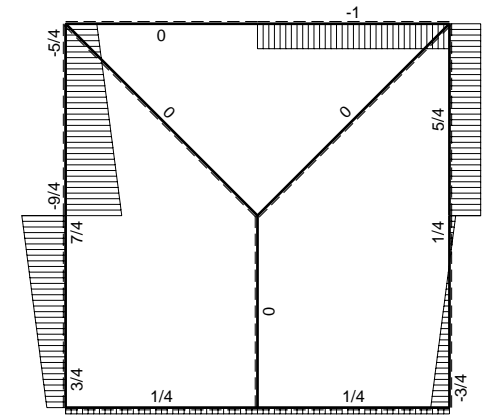


- A = 972. mm<sup>2</sup>
- J<sub>u</sub> = 306619. mm<sup>4</sup>
- J<sub>v</sub> = 47664. mm<sup>4</sup>
- y<sub>g</sub> = 24.71 mm
- T<sub>y</sub> = -5513. N
- M<sub>x</sub> = -2272380. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.29 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = 209.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 16.29 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = 120.7 N/mm<sup>2</sup>
- τ<sub>c</sub> = 9.317 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 121.8 N/mm<sup>2</sup>
- S = 6219. mm<sup>3</sup>

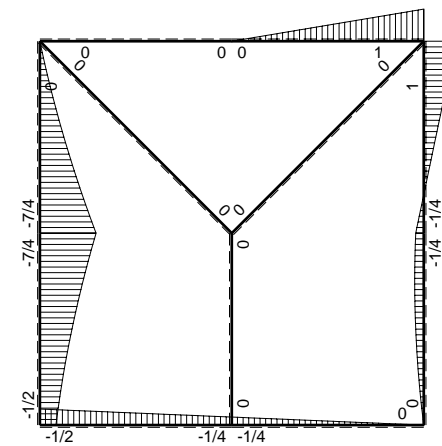




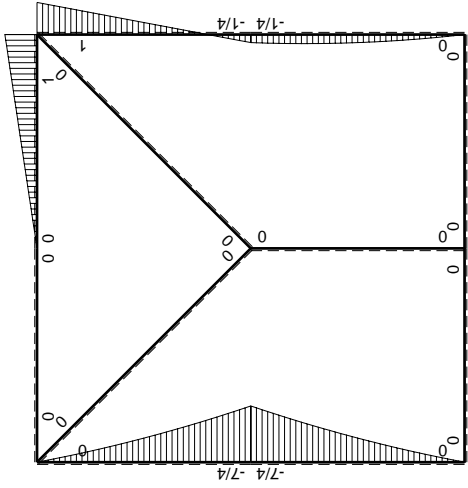
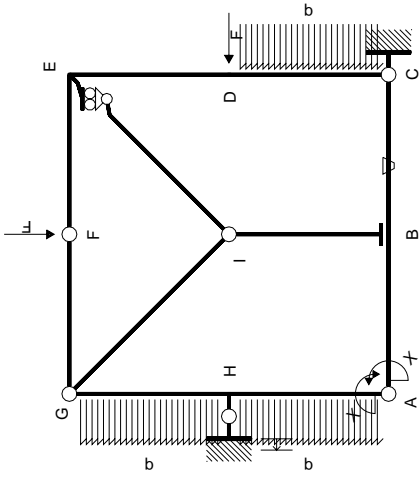
← ⊕ →  $F$



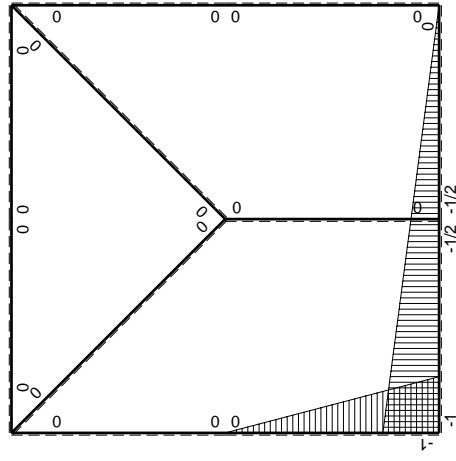
↑ ⊕ ↓  $F$



⊕ ⊖  $Fb$



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	$-Fb/EJ$	0	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(0+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	$Fb/EJ$	0	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/2Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 - 1/2 x/b) \theta dx = [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/4 b) \theta = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/2 x/b) \theta dx = [-1/4 x^2/b]_0^b \theta$$

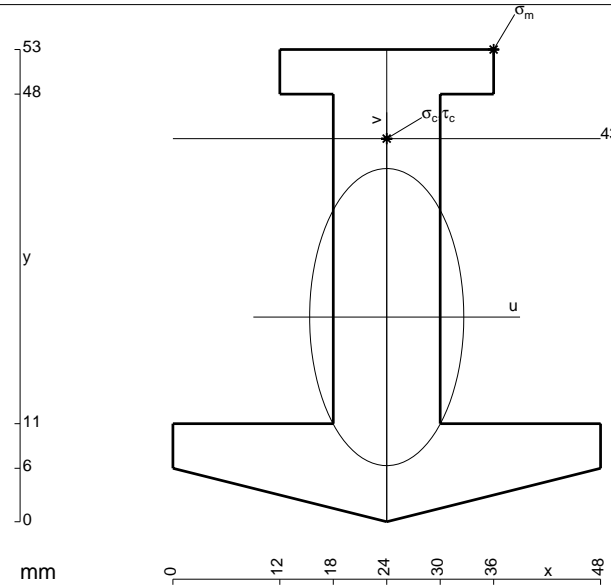
$$= (-1/4 b) \theta = 1/4 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

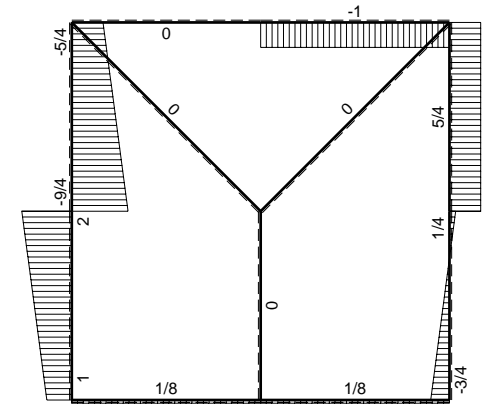
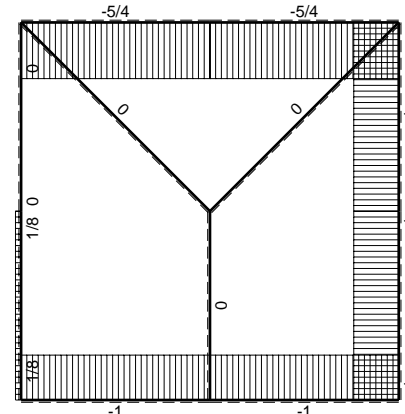
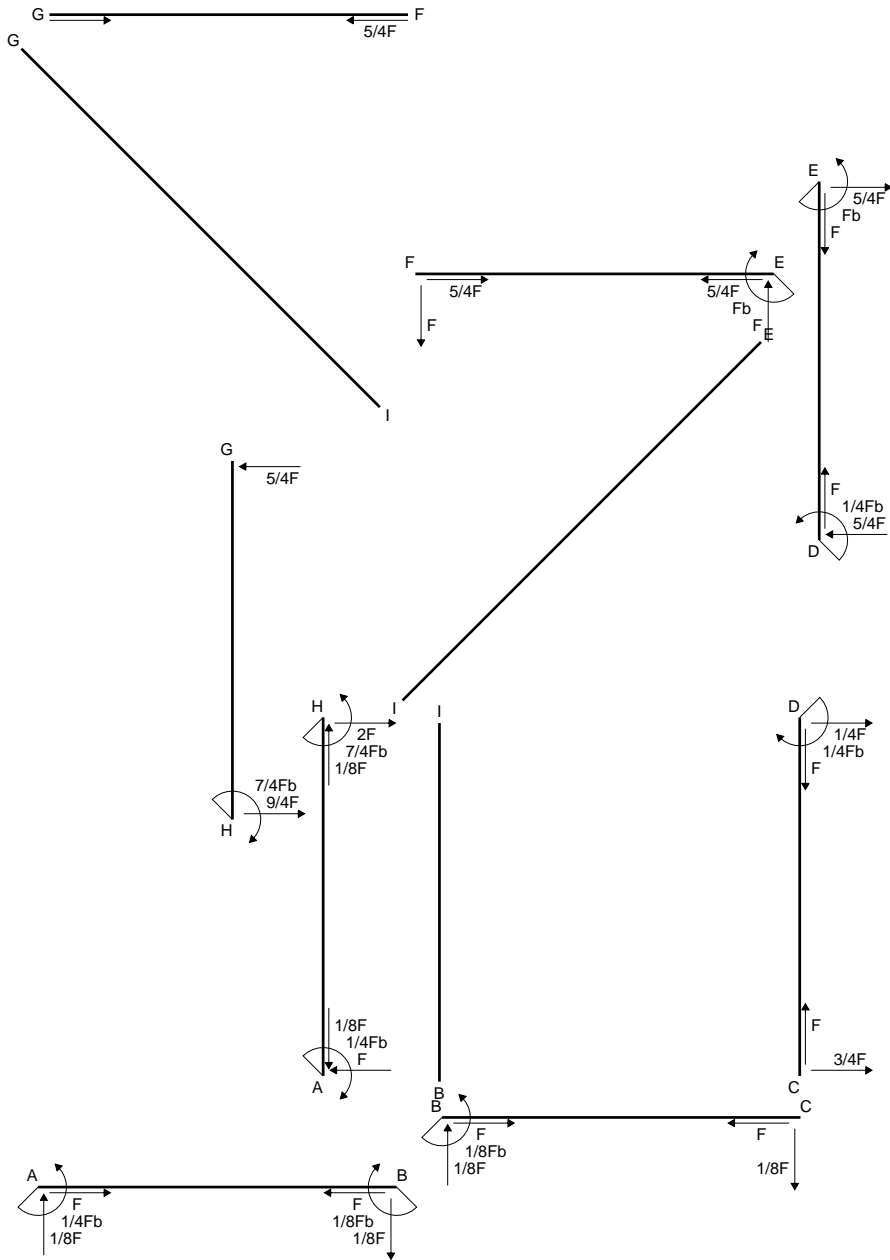
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

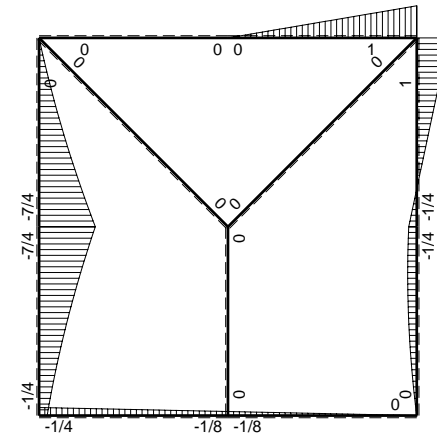


- A = 948. mm<sup>2</sup>
- J<sub>u</sub> = 263643. mm<sup>4</sup>
- J<sub>v</sub> = 70992. mm<sup>4</sup>
- y<sub>g</sub> = 22.97 mm
- T<sub>y</sub> = -4275. N
- M<sub>x</sub> = -1928500. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.03 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = 219.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 43. mm
- v<sub>c</sub> = 20.03 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = 146.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.291 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 146.9 N/mm<sup>2</sup>
- S = 4656. mm<sup>3</sup>

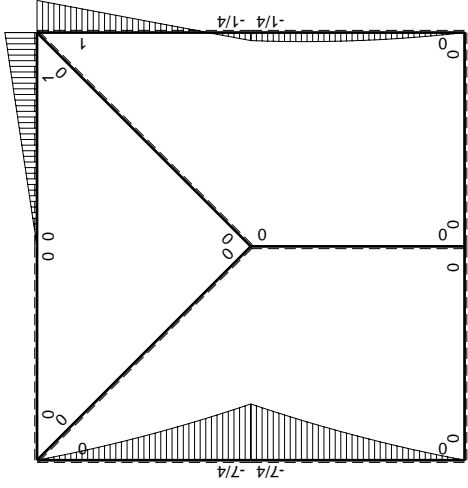
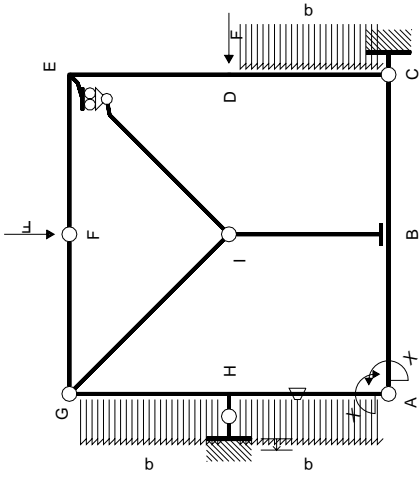


← ⊕ → F

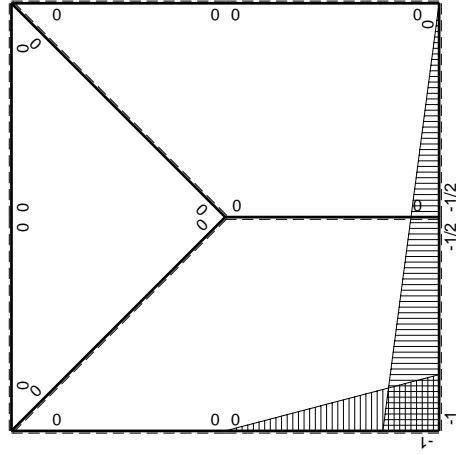
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	$-Fb/EJ$	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	$Fx/EJ$	$x^2/b^2$	$(1/4+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	$Fb/EJ$	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

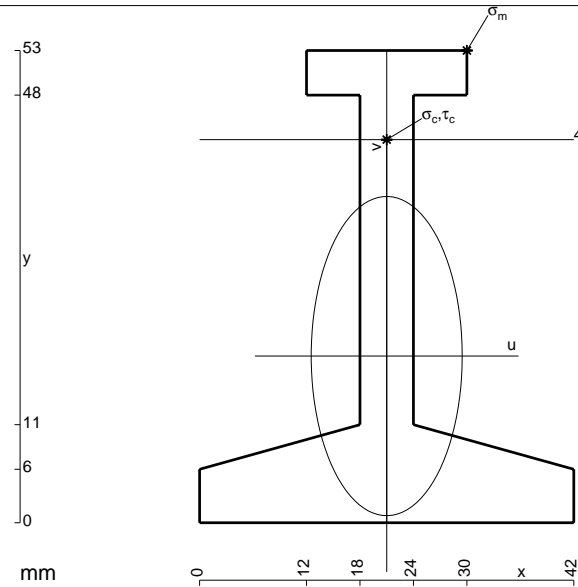
$$= [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 3/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

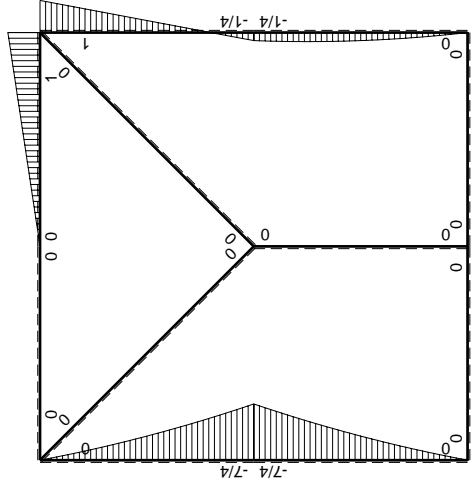
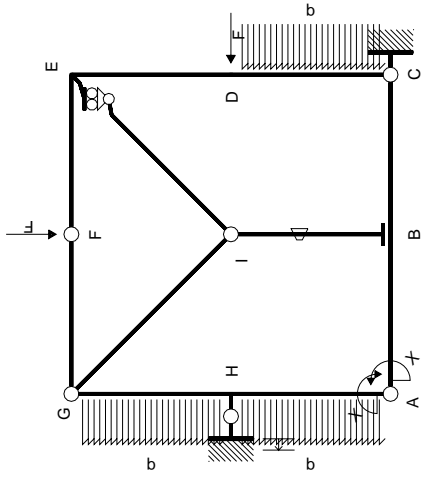
$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 3/4 Fb^2/EJ$$



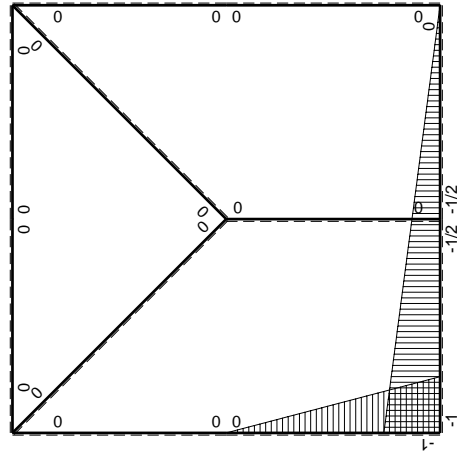
- A = 684. mm<sup>2</sup>
- J<sub>u</sub> = 219556. mm<sup>4</sup>
- J<sub>v</sub> = 49140. mm<sup>4</sup>
- y<sub>g</sub> = 18.71 mm
- T<sub>y</sub> = -2993. N
- M<sub>x</sub> = -1466330. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 34.29 mm
- σ<sub>m</sub> = -M<sub>v</sub>/J<sub>u</sub> = 229. N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 43. mm
- v<sub>c</sub> = 24.29 mm
- σ<sub>c</sub> = -M<sub>v</sub>/J<sub>u</sub> = 162.2 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.326 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 162.9 N/mm<sup>2</sup>
- S = 3665. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
BI b	0	0	$Fb/EJ$	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ x - 1/2 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x + 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x - 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = \left[ 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = \left[ 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = \left[ x - x^2/b + 1/3 x^3/b^2 \right]_0^b 1/EJ$$

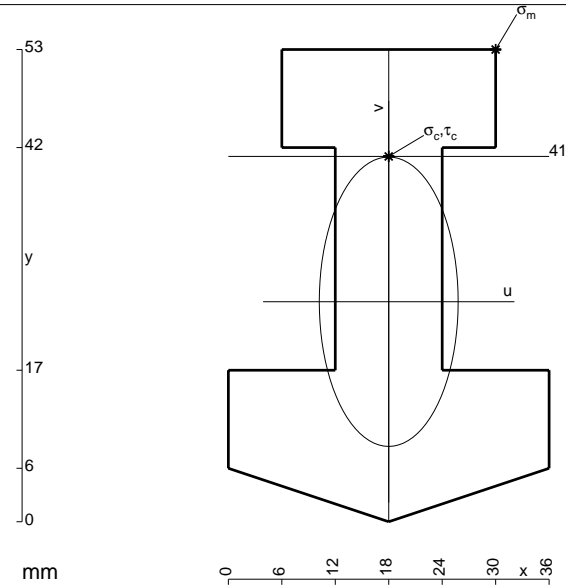
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



$$A = 1068. \text{ mm}^2$$

$$J_u = 281922. \text{ mm}^4$$

$$J_v = 64872. \text{ mm}^4$$

$$y_g = 24.7 \text{ mm}$$

$$T_y = -4500. \text{ N}$$

$$M_x = -2380000. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 28.3 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 238.9 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 41. \text{ mm}$$

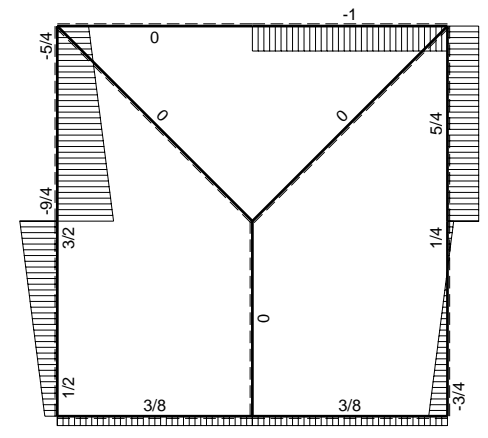
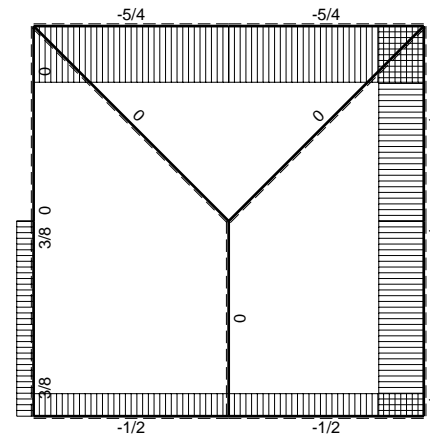
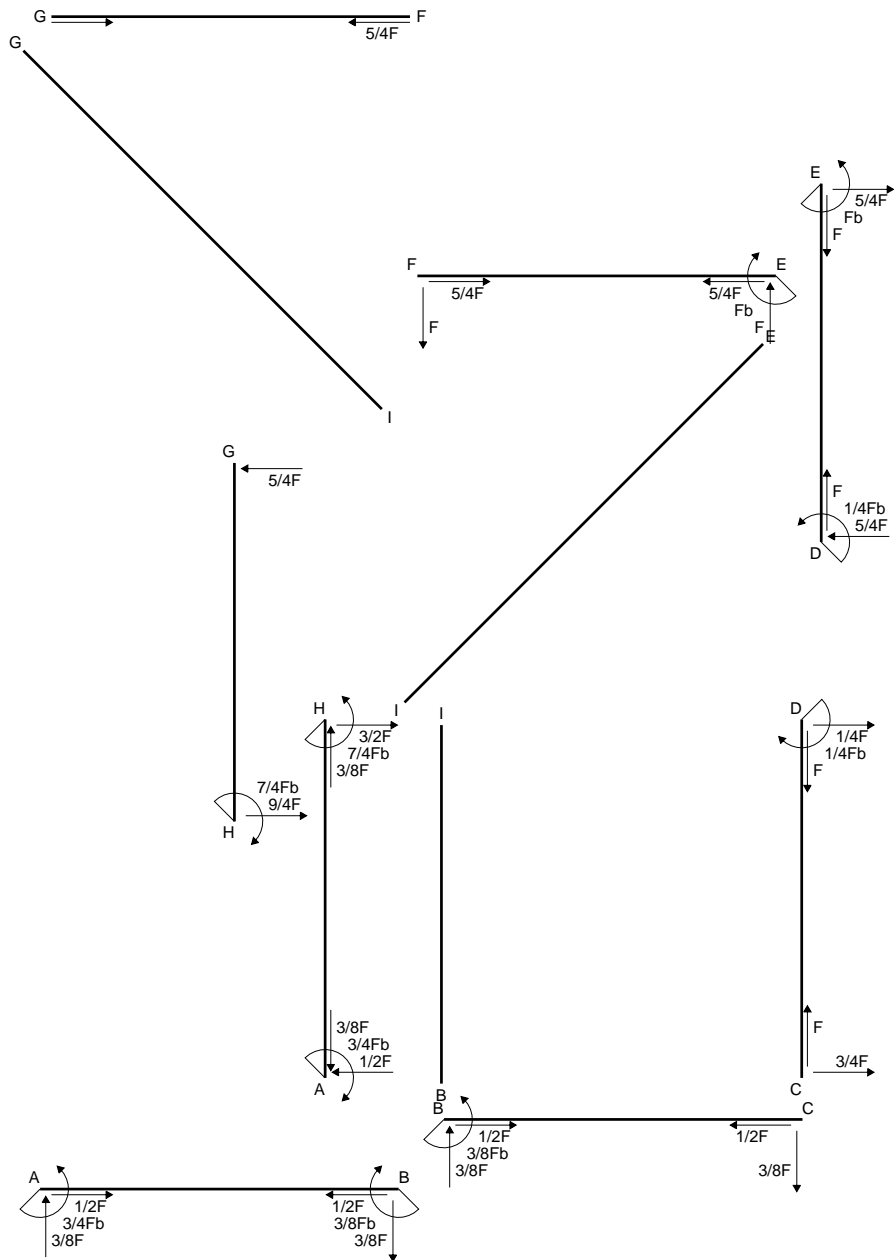
$$v_c = 16.3 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 137.6 \text{ N/mm}^2$$

$$\tau_c = 8.276 \text{ N/mm}^2$$

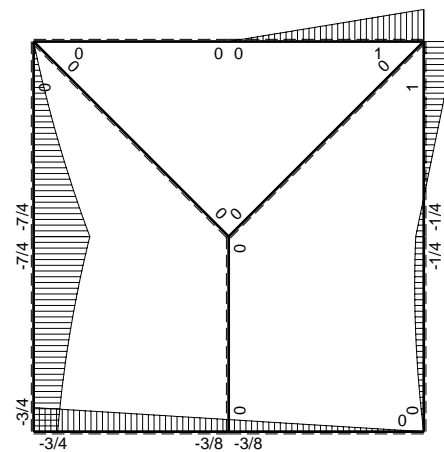
$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 138.4 \text{ N/mm}^2$$

$$S = 6222. \text{ mm}^3$$



← ⊕ → F

↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-5/4Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	$Fb/EJ$	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

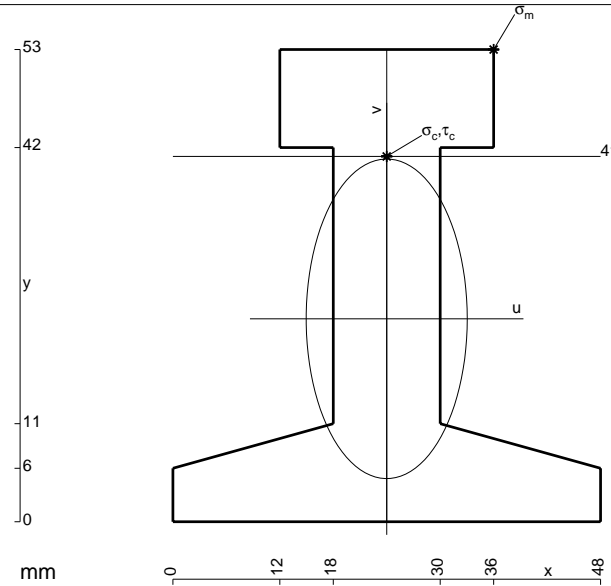
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

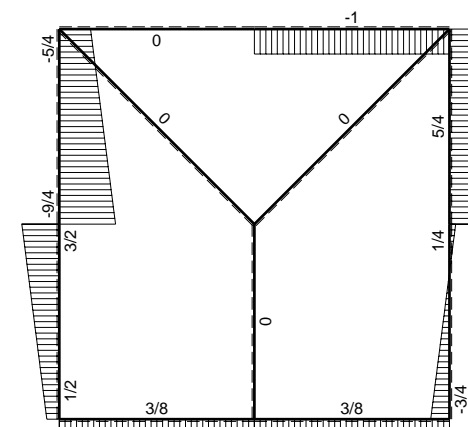
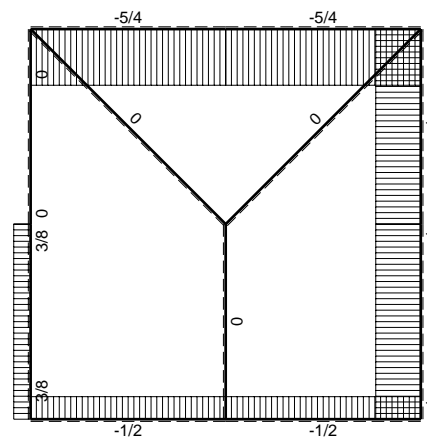
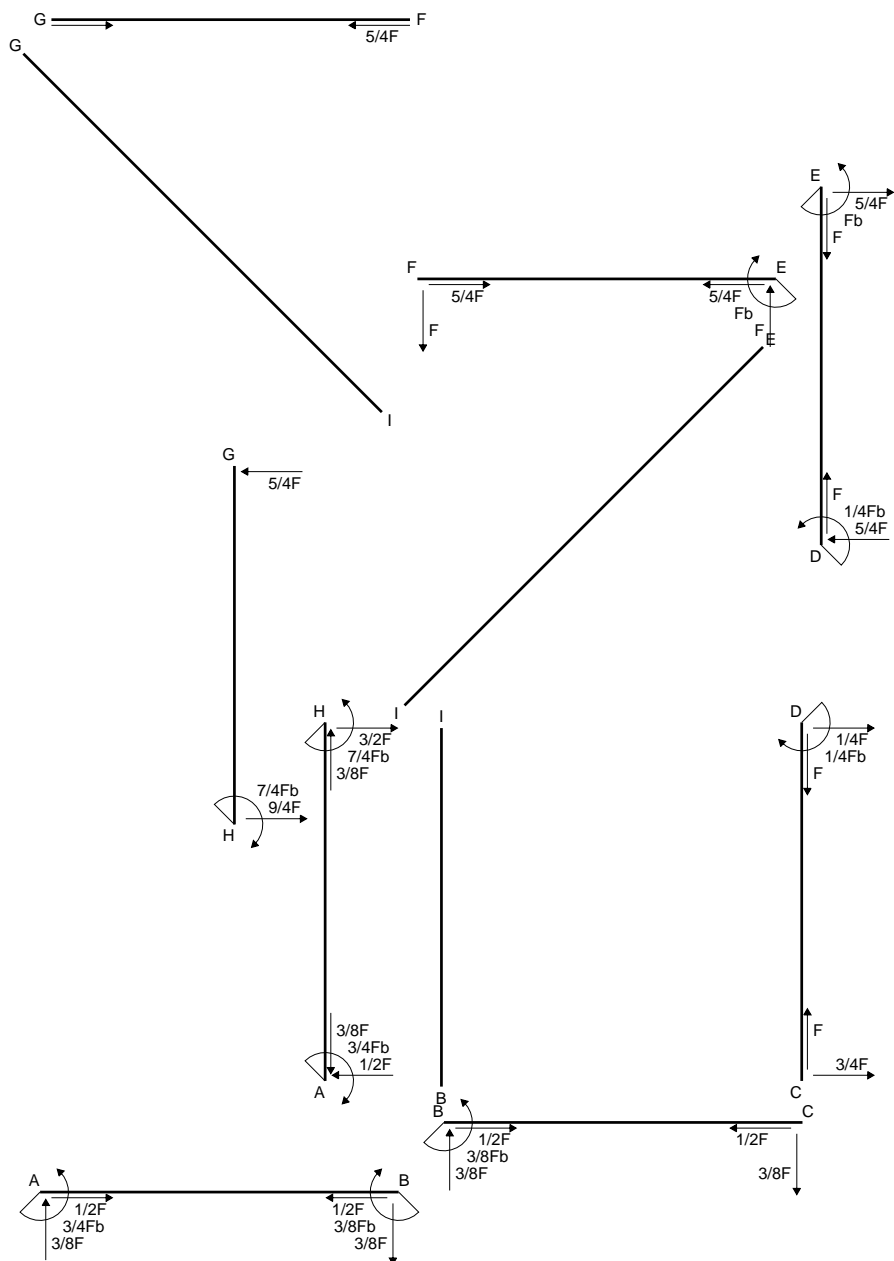
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



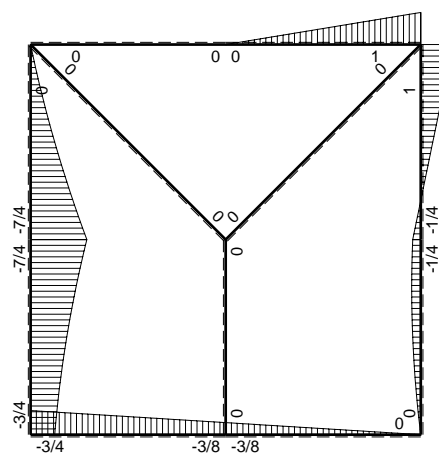
- A = 1074. mm<sup>2</sup>
- J<sub>u</sub> = 345511. mm<sup>4</sup>
- J<sub>v</sub> = 87732. mm<sup>4</sup>
- y<sub>g</sub> = 22.78 mm
- T<sub>y</sub> = -4005. N
- M<sub>x</sub> = -2273950. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.22 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = 198.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 18.22 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = 119.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.522 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 120.5 N/mm<sup>2</sup>
- S = 6752. mm<sup>3</sup>



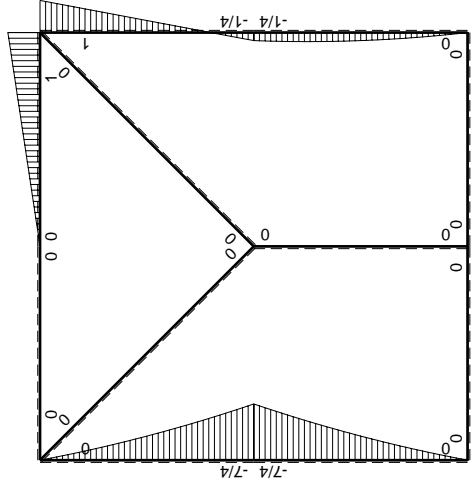
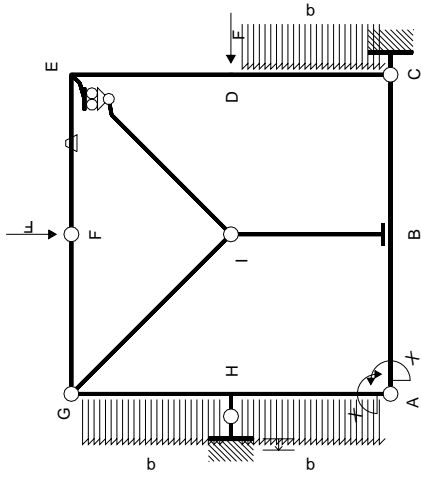


← ⊕ → F

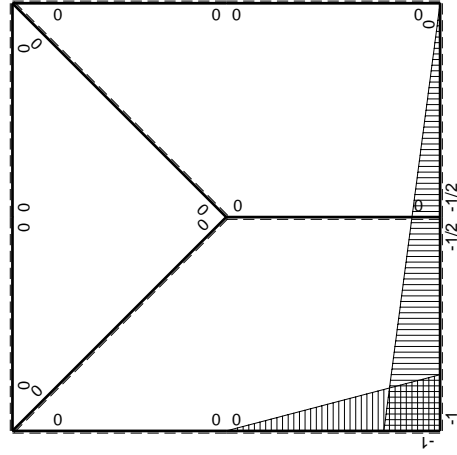
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	0	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	$-Fb/EJ$	0	0	0	0+0	0	
FE b	0	$-Fx$	$Fb/EJ$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2 x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

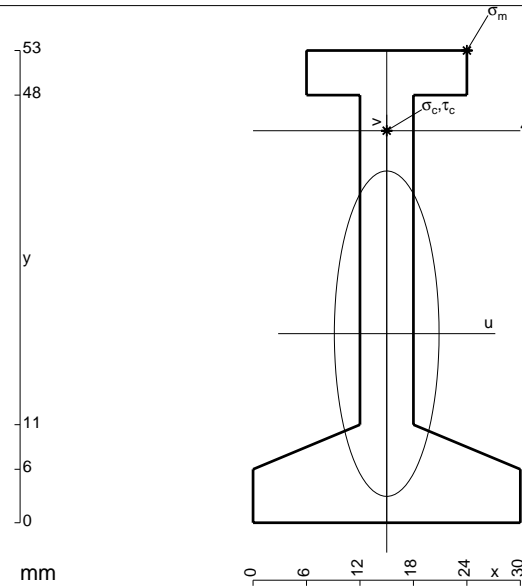
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

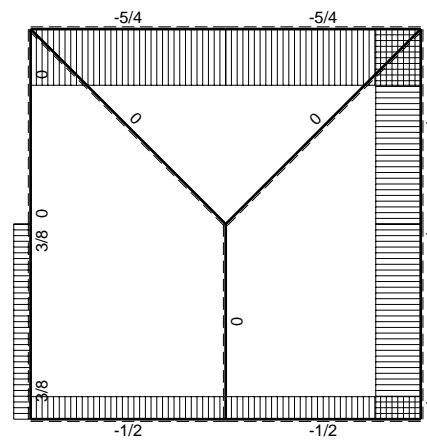
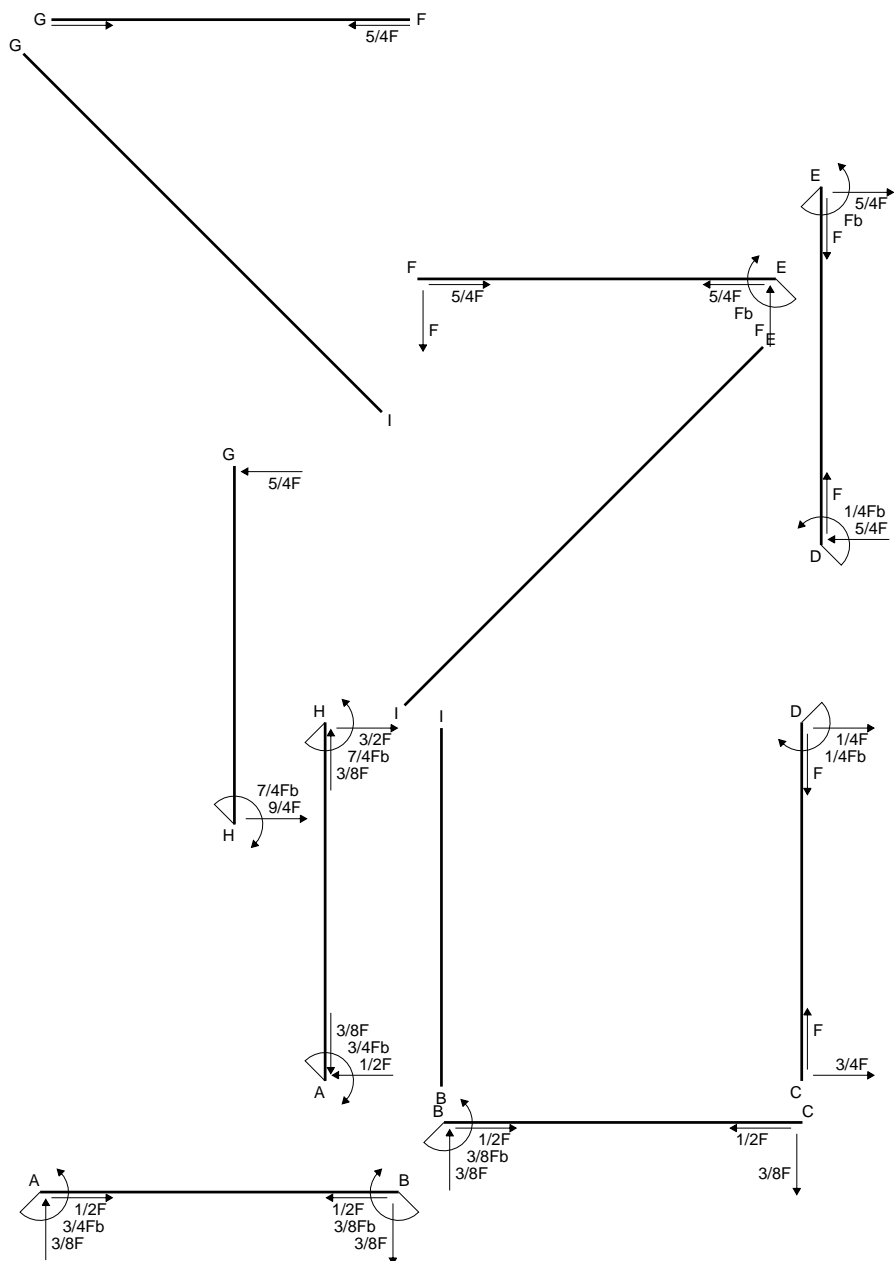
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

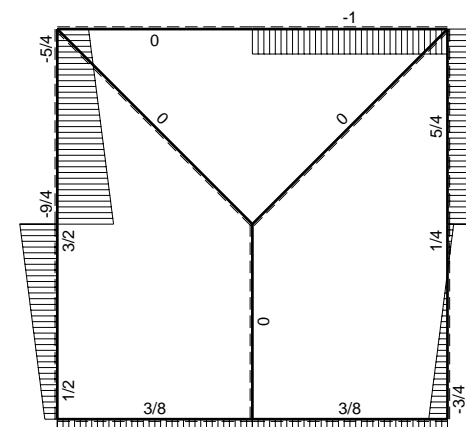
$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



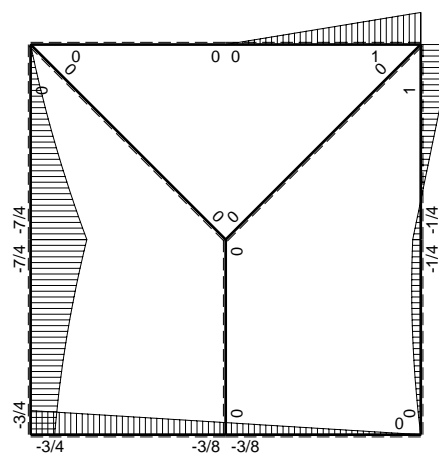
- A = 582. mm<sup>2</sup>
- J<sub>u</sub> = 194208. mm<sup>4</sup>
- J<sub>v</sub> = 20106. mm<sup>4</sup>
- y<sub>g</sub> = 21.22 mm
- T<sub>y</sub> = -2115. N
- M<sub>x</sub> = -1283100. Nmm
- x<sub>m</sub> = 24. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 31.78 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = 210. N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 44. mm
- v<sub>c</sub> = 22.78 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = 150.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.863 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 150.9 N/mm<sup>2</sup>
- S = 3230. mm<sup>3</sup>



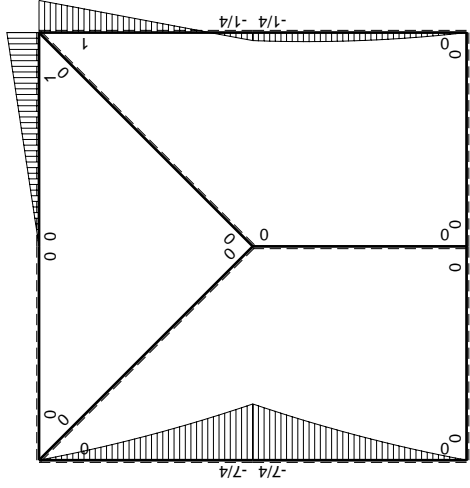
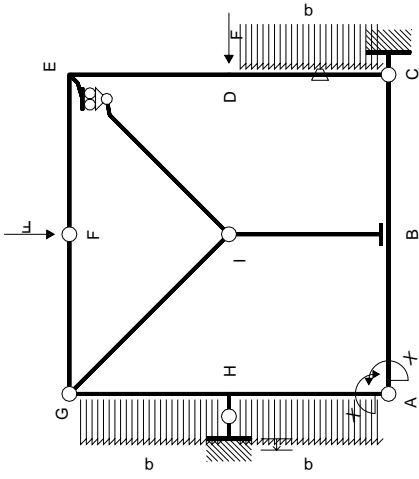
← ⊕ → F



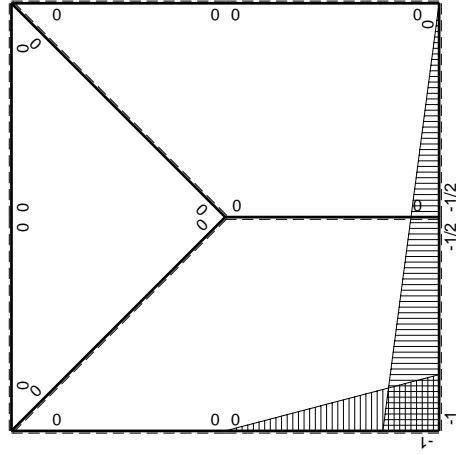
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-3/4Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	$1/4Fb+1/4Fx-1/2qx^2$	$Fb/EJ$	0	0	0			
DE b	0	$-1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-Fb+5/4Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

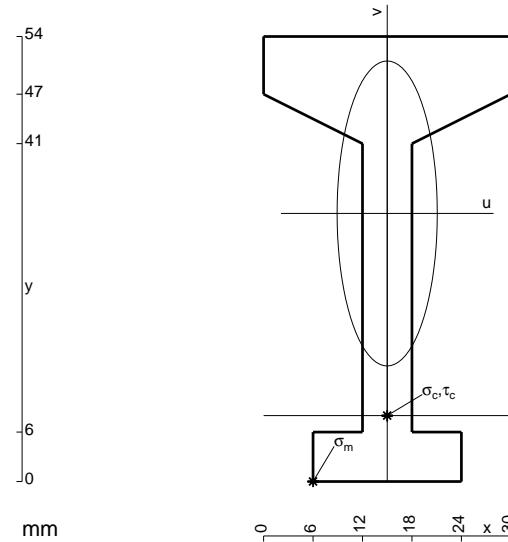
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

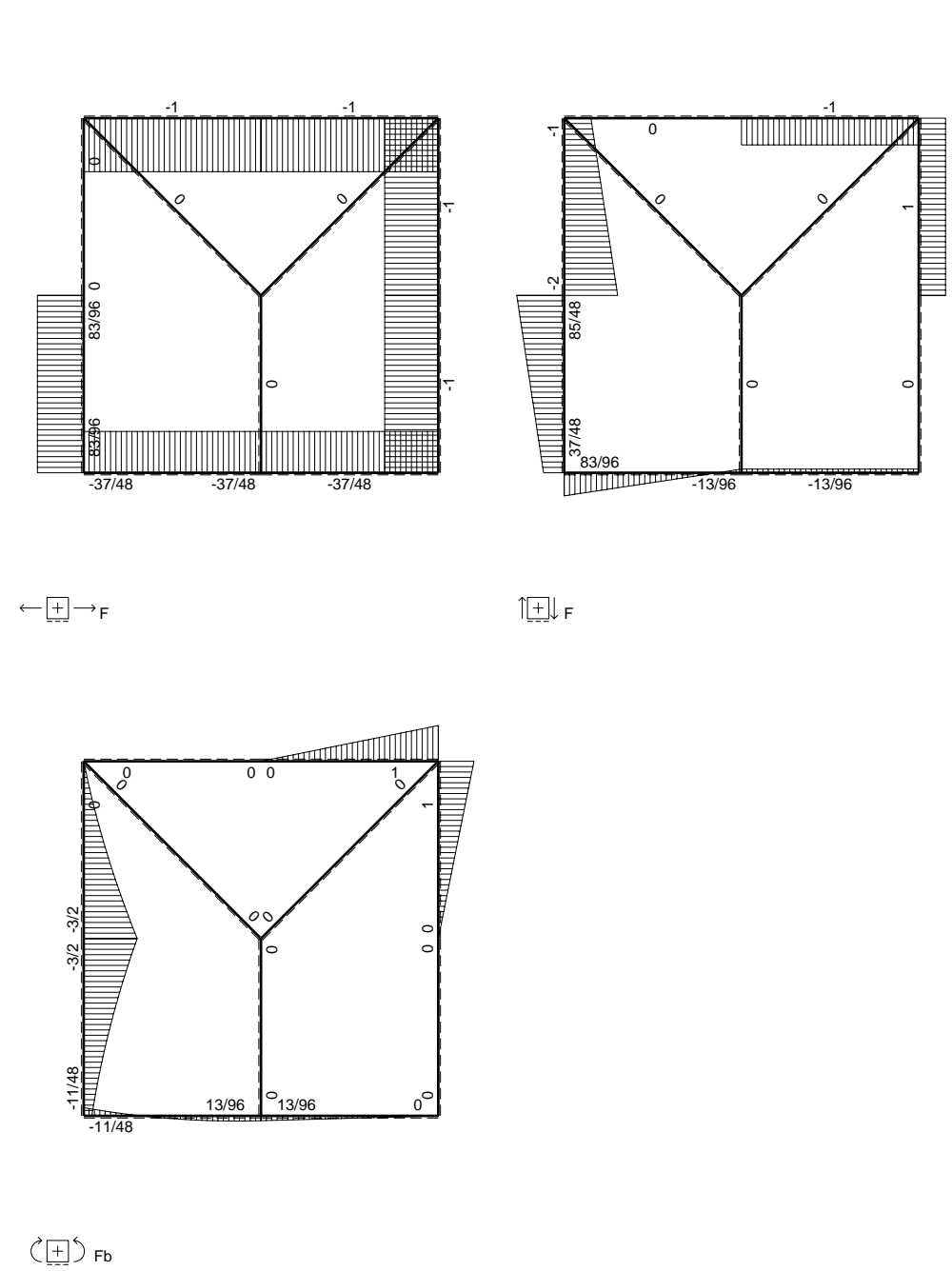
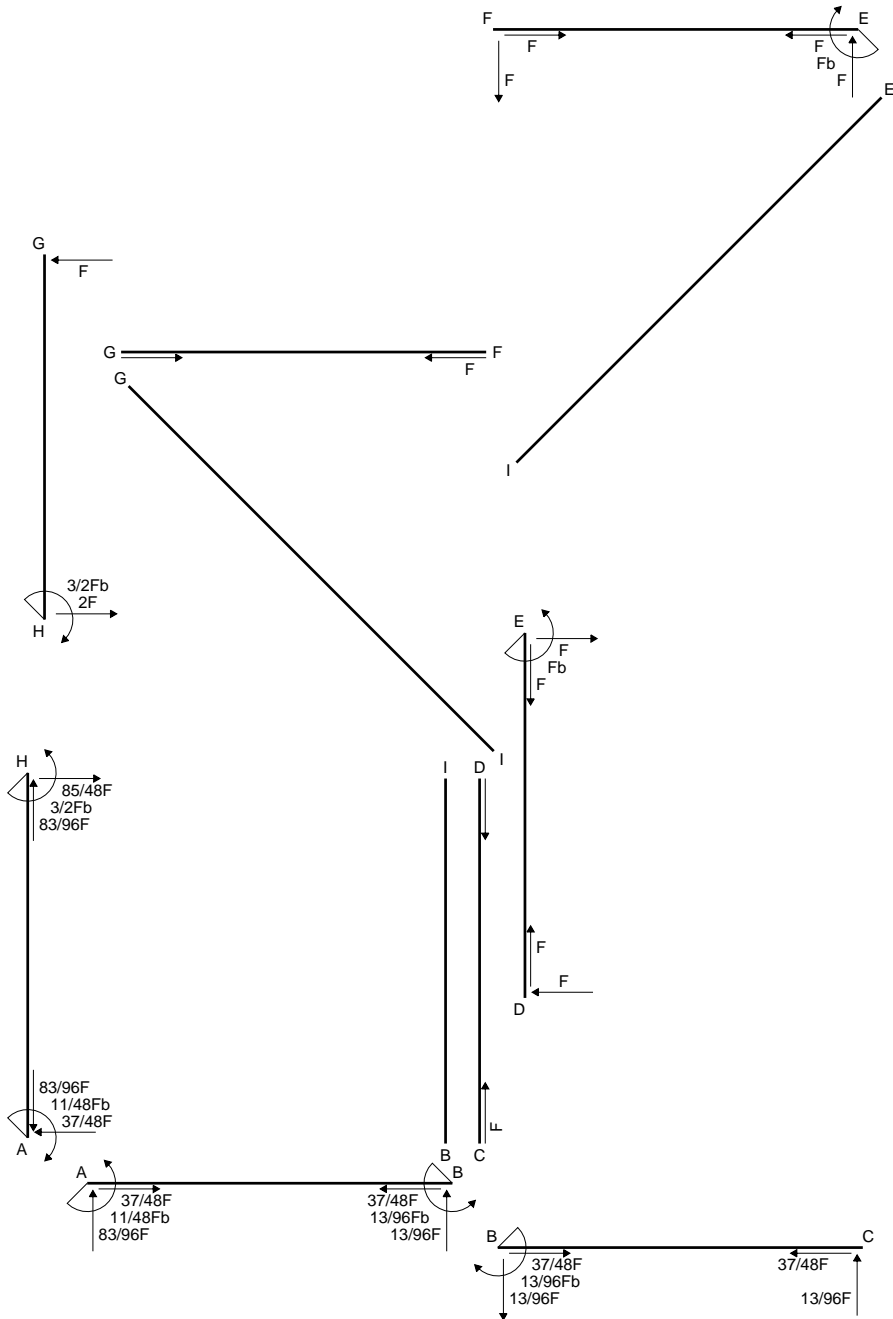
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

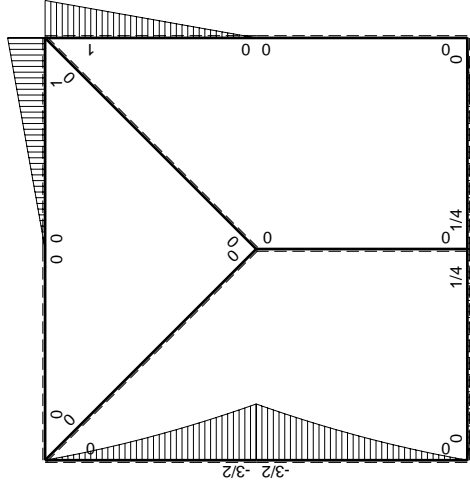
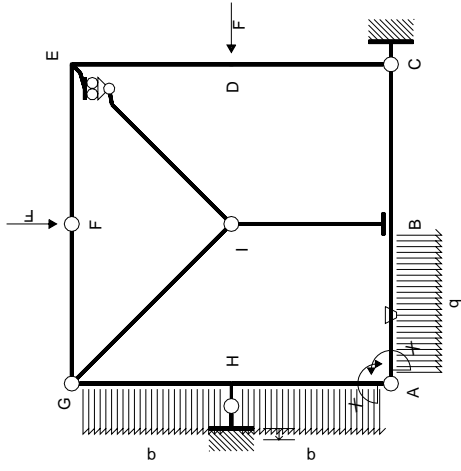
$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



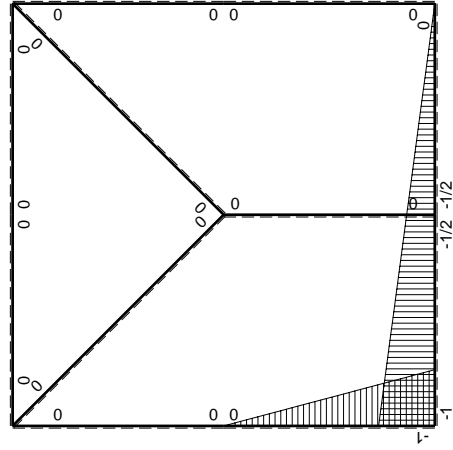
- A = 636. mm<sup>2</sup>
- J<sub>u</sub> = 217919. mm<sup>4</sup>
- J<sub>v</sub> = 23508. mm<sup>4</sup>
- y<sub>g</sub> = 32.53 mm
- T<sub>y</sub> = -2228. N
- M<sub>x</sub> = -1472630. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -32.53 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -219.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 8. mm
- v<sub>c</sub> = -24.53 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -165.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.955 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup> + 3τ<sup>2</sup> = 166.1 N/mm<sup>2</sup>
- S = 3495. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	$-1+1/2x/b$	$3/4Fx-1/2qx^2$	$-Fb/EJ$	$-3/4Fx+7/8Fx^2/b-1/4qx^3/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-7/48+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb-1/4Fx+1/2qx^2$	$Fb/EJ$	$-1/8Fb-1/4Fx+1/8Fx^2/b+1/4qx^3/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/4Fb-1/4Fx$	0	$-1/8Fb+1/4Fx-1/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/4Fx$	0	$-1/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	0	$3/2Fx-2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	0	$Fx-1/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-11/48Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$11/48Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-3/4 x/b + 7/8 x^2/b^2 - 1/4 x^3/b^3) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [-3/8 x^2/b + 7/24 x^3/b^2 - 1/16 x^4/b^3]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (-3/8 b + 7/24 b - 1/16 b) Fb 1/EJ + (b - 1/4 b) \theta = 29/48 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 - 1/4 x/b + 1/8 x^2/b^2 + 1/4 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [-1/8 x - 1/8 x^2/b + 1/24 x^3/b^2 + 1/16 x^4/b^3]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-1/8 b - 1/8 b + 1/24 b + 1/16 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 29/48 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/8 + 1/4 x/b - 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/8 x^2/b - 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/8 b - 1/24 b) Fb 1/EJ = -1/24 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/8 x^2/b^2) Fb 1/EJ dx = [-1/24 x^3/b^2]_0^b Fb 1/EJ$$

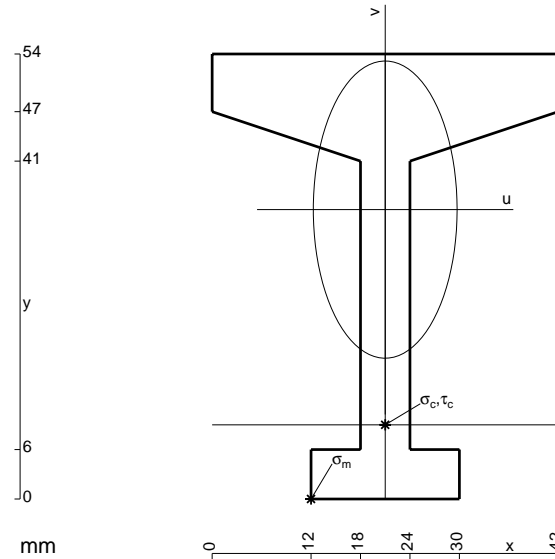
$$= (-1/24 b) Fb 1/EJ = -1/24 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3/2 x/b - 2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

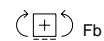
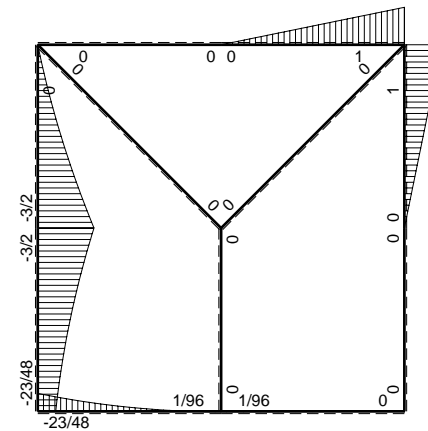
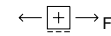
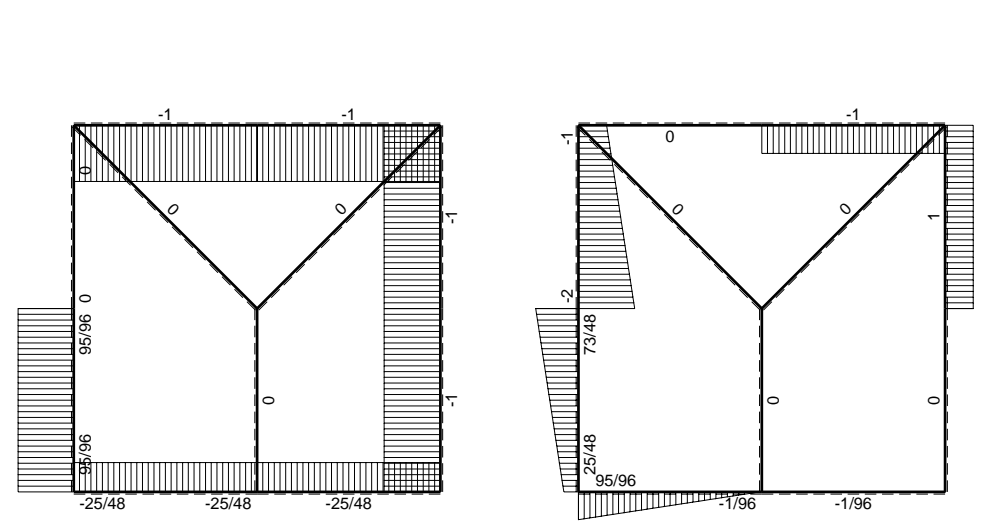
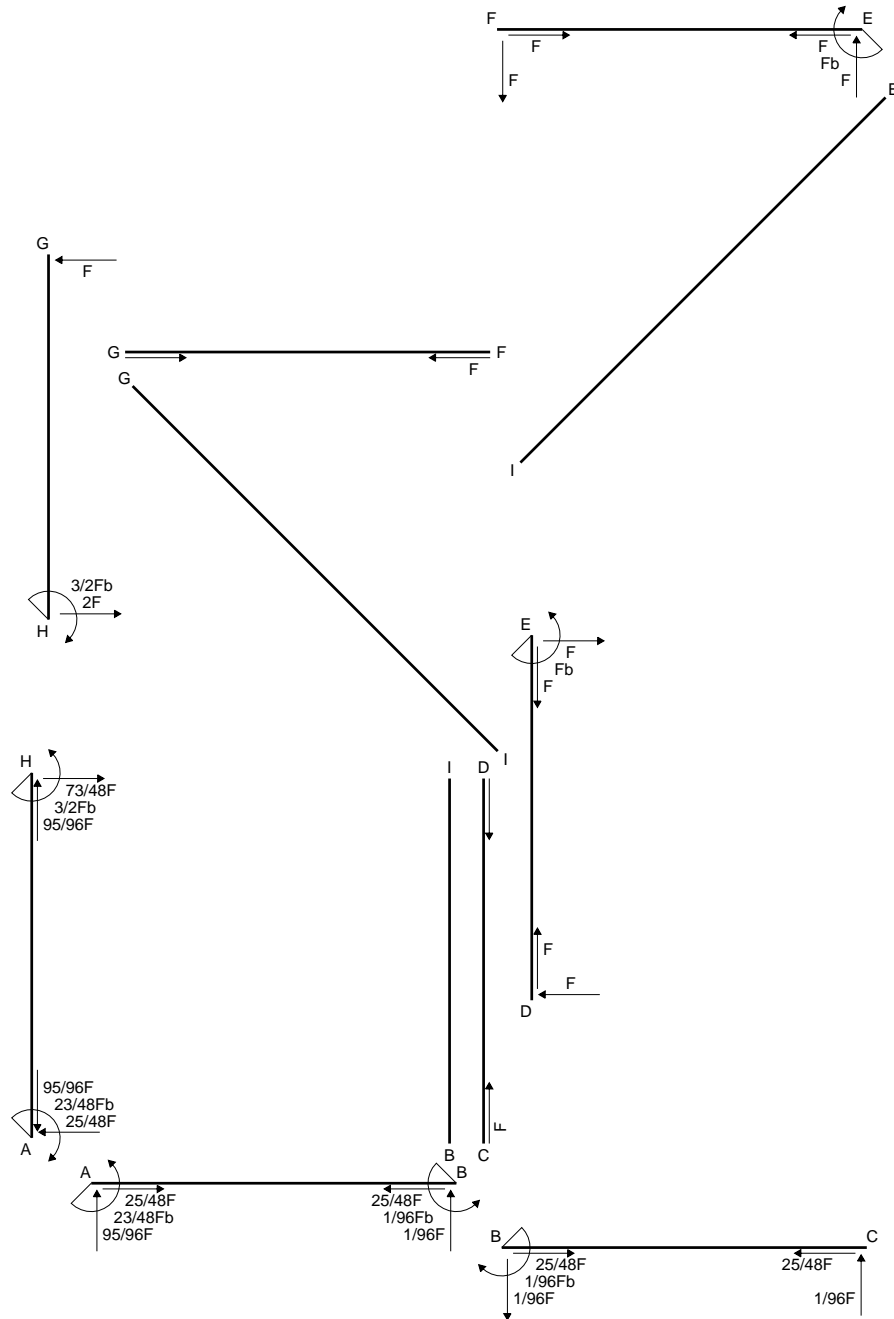
$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

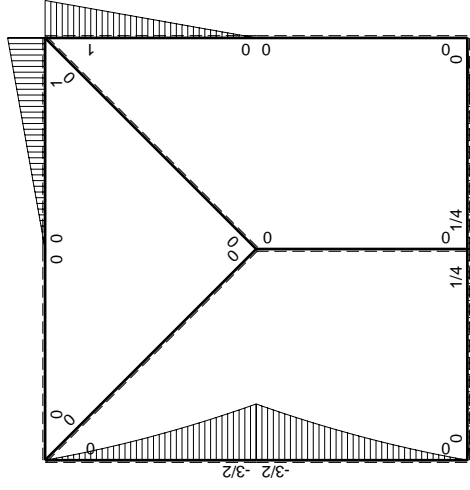
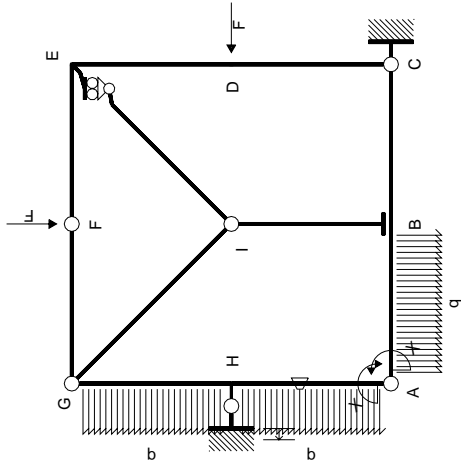
$$L_{AH}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

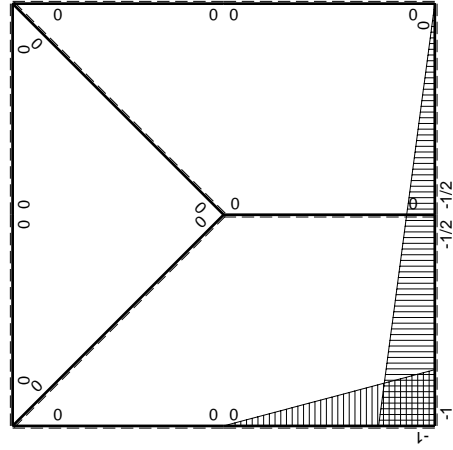


- A = 756. mm<sup>2</sup>
- J<sub>u</sub> = 245989. mm<sup>4</sup>
- J<sub>v</sub> = 57564. mm<sup>4</sup>
- y<sub>g</sub> = 35.12 mm
- T<sub>y</sub> = -2380. N
- M<sub>x</sub> = -1606500. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -35.12 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -229.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -26.12 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -170.6 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.395 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup> + 3τ<sup>2</sup> = 170.9 N/mm<sup>2</sup>
- S = 3966. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	$-1+1/2x/b$	$3/4Fx-1/2qx^2$	0	$-3/4Fx+7/8Fx^2/b-1/4qx^3/b$	0	$1-x/b+1/4x^2/b^2$	$(-7/48+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb-1/4Fx+1/2qx^2$	0	$-1/8Fb-1/4Fx+1/8Fx^2/b+1/4qx^3/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/4Fb-1/4Fx$	0	$-1/8Fb+1/4Fx-1/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/4Fx$	0	$-1/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	$-Fb/EJ$	$3/2Fx-2Fx^2/b+1/2qx^3/b$	$Fx/EJ$	$x^2/b^2$	$(5/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	$Fb/EJ$	$Fx-1/2Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-23/48Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$23/48Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{x_0} = \int_0^b (-3/4 x/b + 7/8 x^2/b^2 - 1/4 x^3/b^3) Fb 1/EJ dx = [-3/8 x^2/b + 7/24 x^3/b^2 - 1/16 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-3/8 b + 7/24 b - 1/16 b) Fb 1/EJ = -7/48 Fb^2/EJ$$

$$L_{BA}^{x_0} = \int_0^b (-1/8 - 1/4 x/b + 1/8 x^2/b^2 + 1/4 x^3/b^3) Fb 1/EJ dx$$

$$= [-1/8 x - 1/8 x^2/b + 1/24 x^3/b^2 + 1/16 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-1/8 b - 1/8 b + 1/24 b + 1/16 b) Fb 1/EJ = -7/48 Fb^2/EJ$$

$$L_{BC}^{x_0} = \int_0^b (-1/8 + 1/4 x/b - 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/8 x^2/b - 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/8 b - 1/24 b) Fb 1/EJ = -1/24 Fb^2/EJ$$

$$L_{CB}^{x_0} = \int_0^b (-1/8 x^2/b^2) Fb 1/EJ dx = [-1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/24 b) Fb 1/EJ = -1/24 Fb^2/EJ$$

$$L_{HA}^{x_0} = \int_0^b (3/2 x/b - 2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

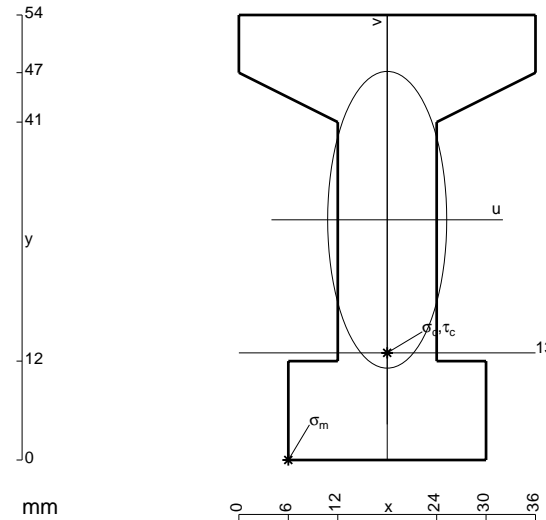
$$= [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 17/24 Fb^2/EJ$$

$$L_{AH}^{x_0} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 17/24 Fb^2/EJ$$



$$A = 1032. \text{ mm}^2$$

$$J_u = 334856. \text{ mm}^4$$

$$J_v = 53856. \text{ mm}^4$$

$$y_g = 29.15 \text{ mm}$$

$$T_y = -3860. \text{ N}$$

$$M_x = -2750250. \text{ Nmm}$$

$$x_m = 6. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -29.15 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -239.4 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

$$v_c = -16.15 \text{ mm}$$

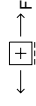
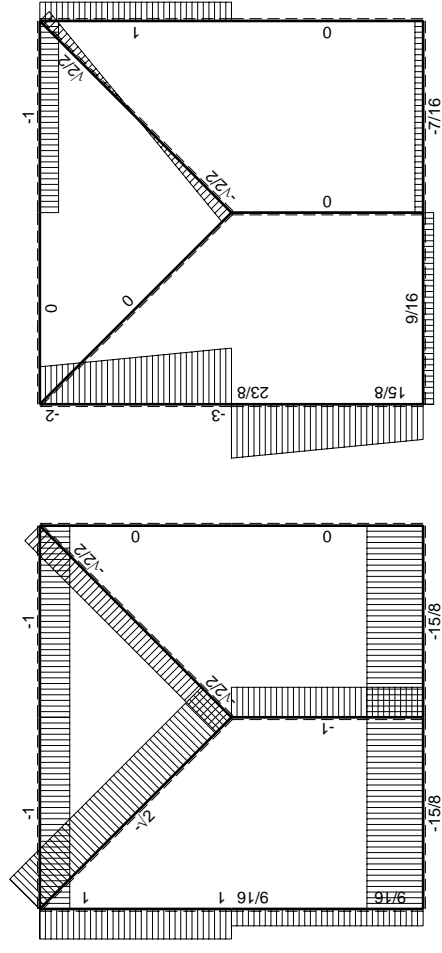
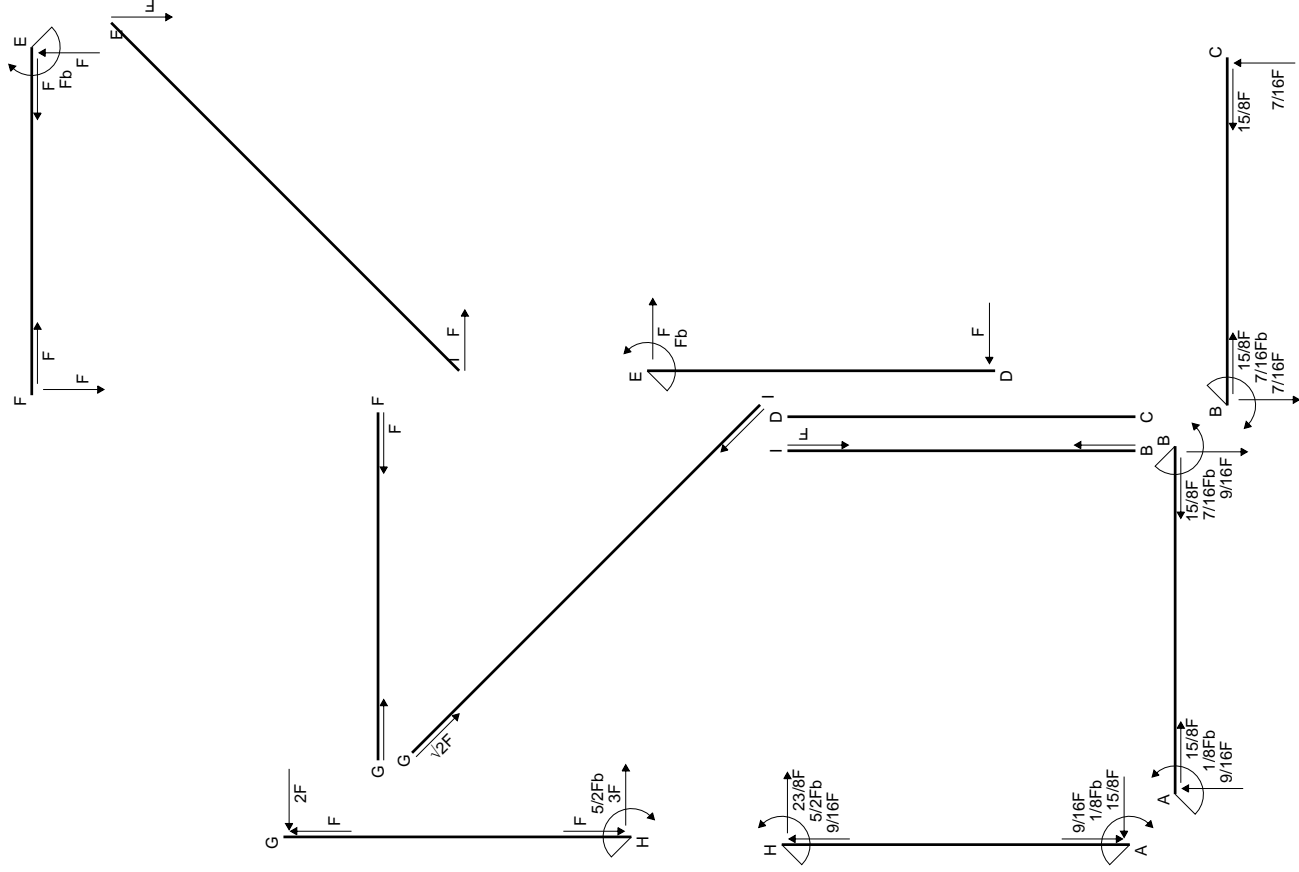
$$\sigma_c = -Mv/J_u = -132.7 \text{ N/mm}^2$$

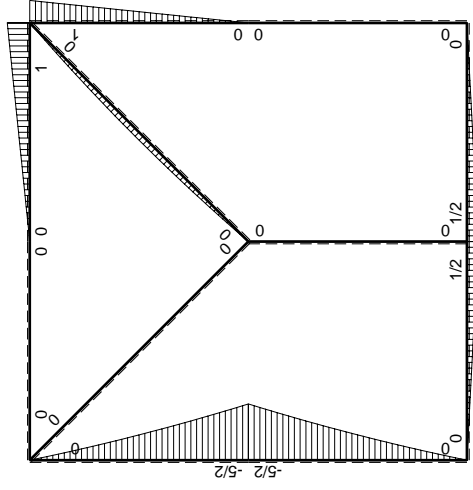
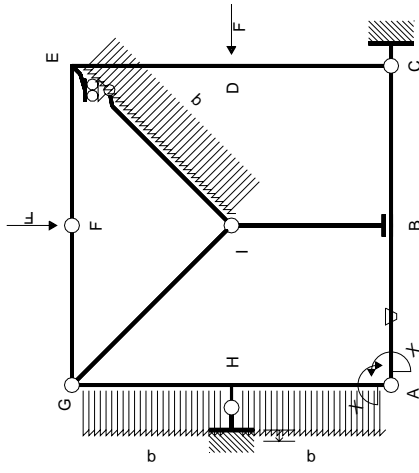
$$\tau_c = 6.597 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 133.1 \text{ N/mm}^2$$

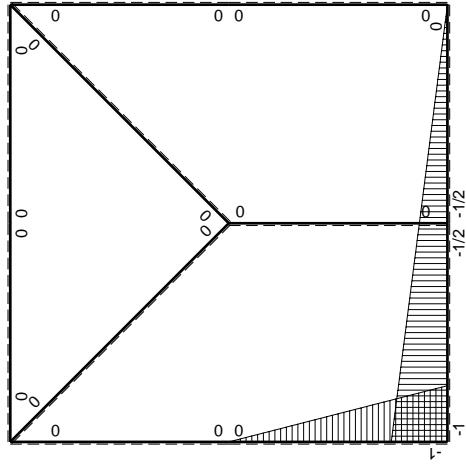
$$S = 6867. \text{ mm}^3$$







$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	$-Fb/EJ$	$-1/2Fx+1/4Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-1/6+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	$Fb/EJ$	$-1/4Fb+1/4Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ + (b - 1/4 b) \theta = 7/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

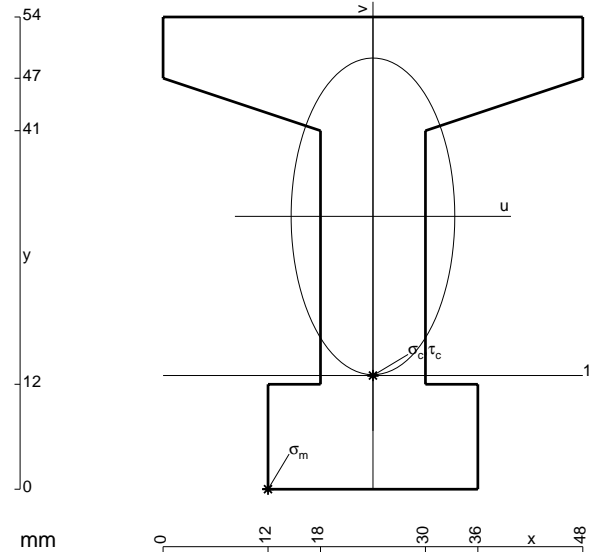
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

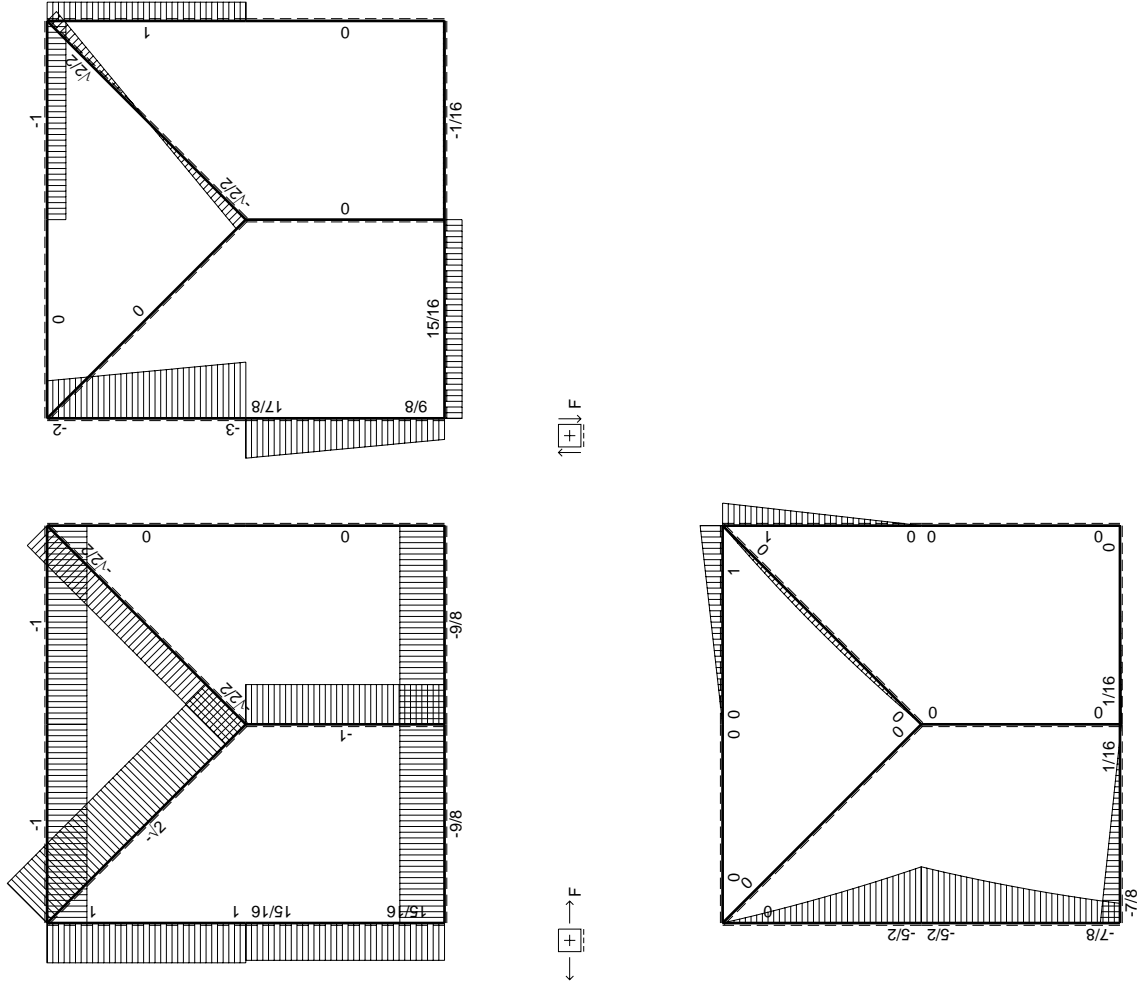
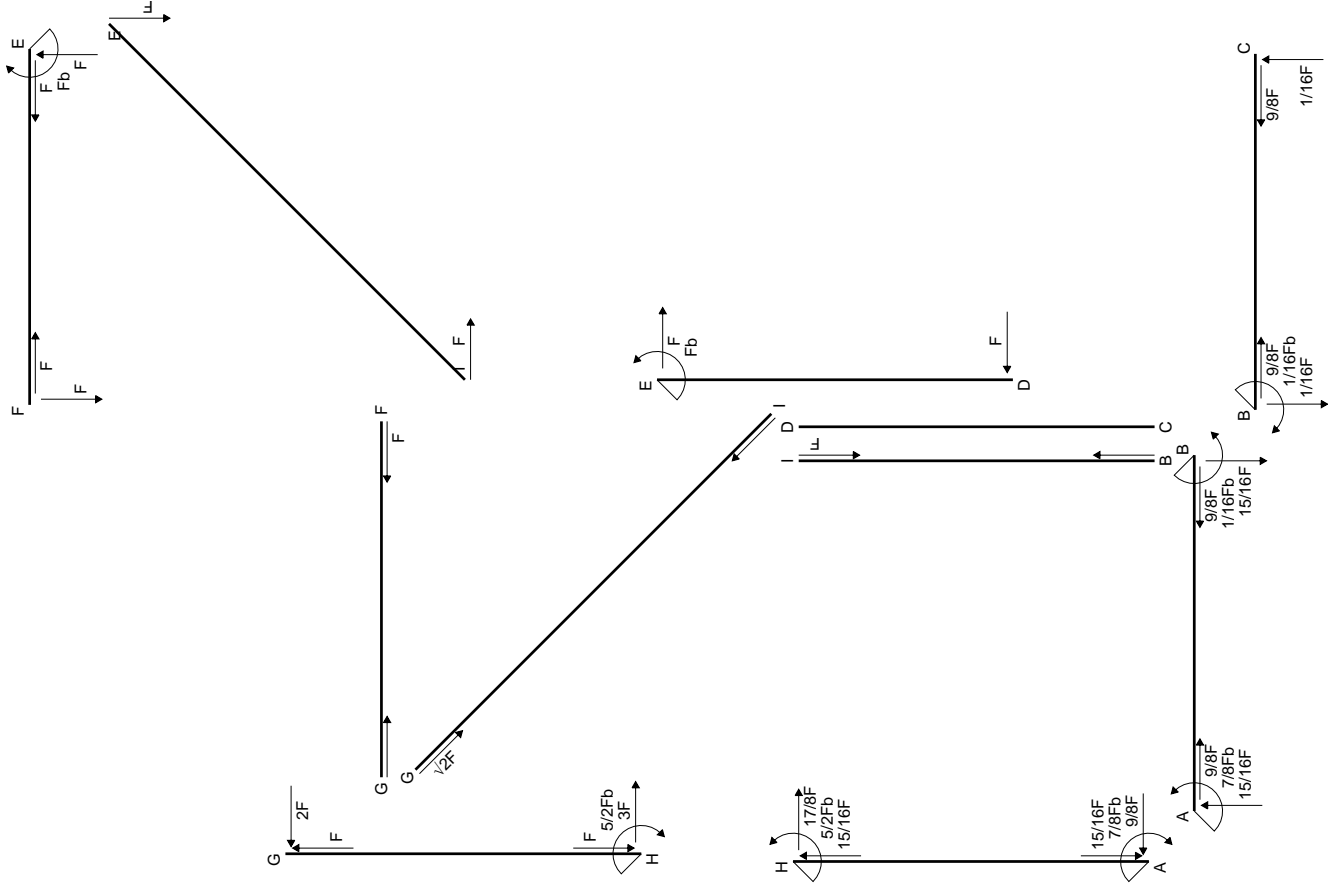
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

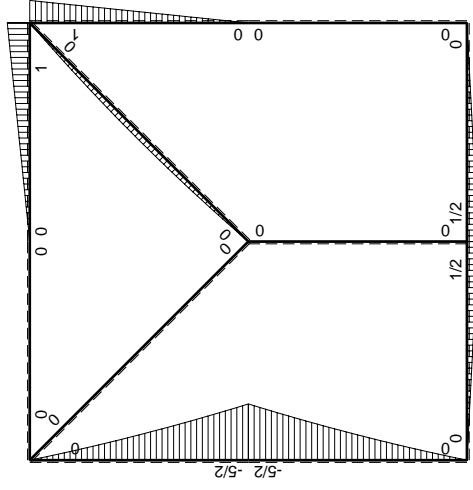
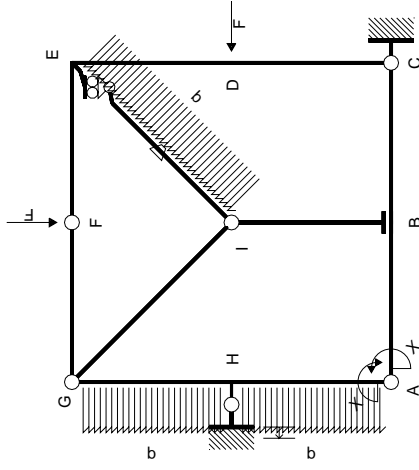
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

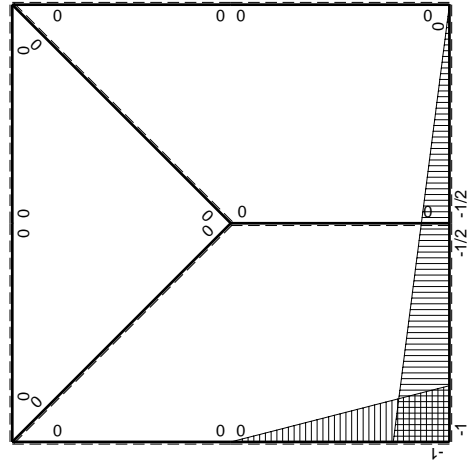


- A = 1152. mm<sup>2</sup>
- J<sub>u</sub> = 377748. mm<sup>4</sup>
- J<sub>v</sub> = 100872. mm<sup>4</sup>
- y<sub>g</sub> = 31.2 mm
- N = 1950. N
- T<sub>y</sub> = -5850. N
- M<sub>x</sub> = -2437500. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -31.2 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -199.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -18.2 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -115.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 9.657 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 117. N/mm<sup>2</sup>
- S = 7483. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	-Fb/EJ	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

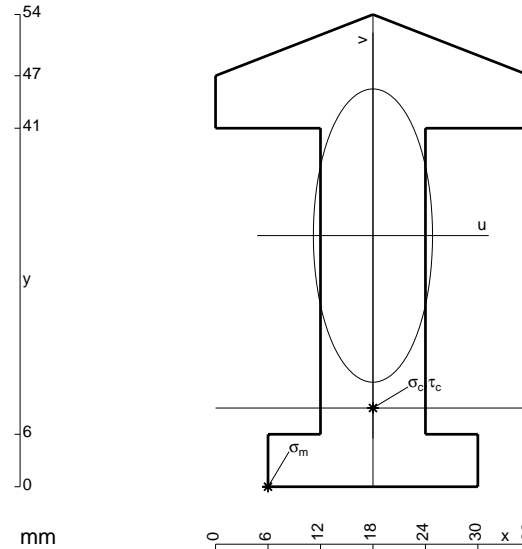
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

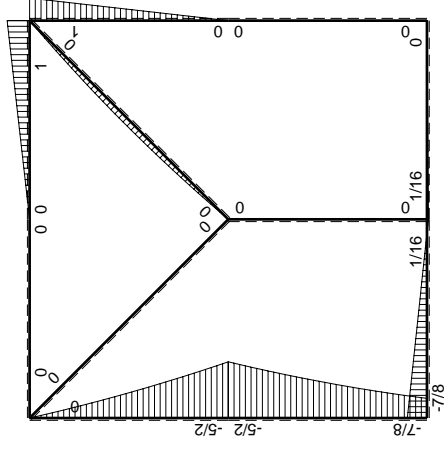
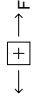
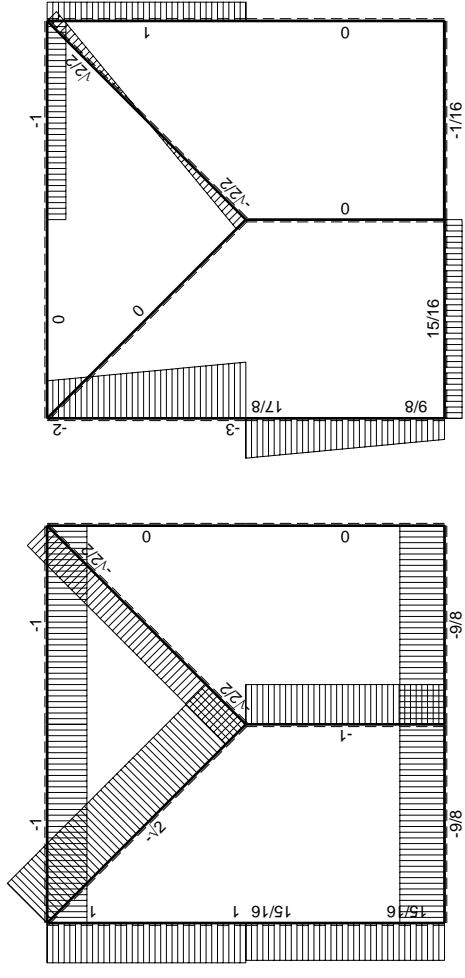
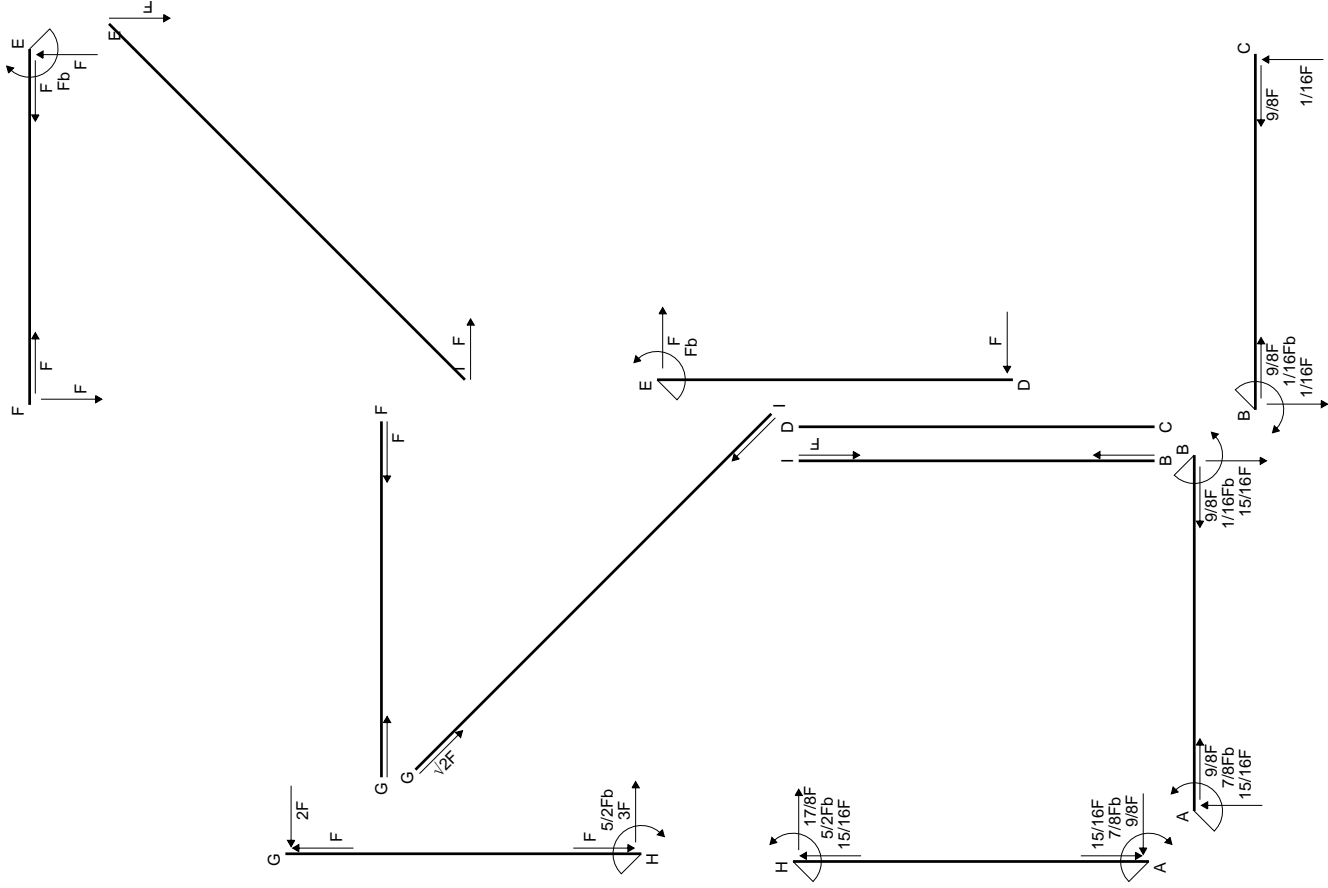
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

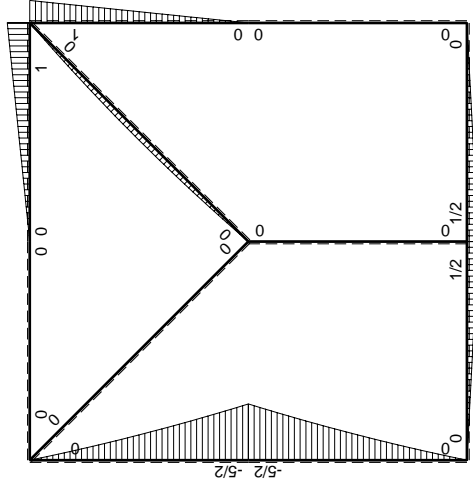
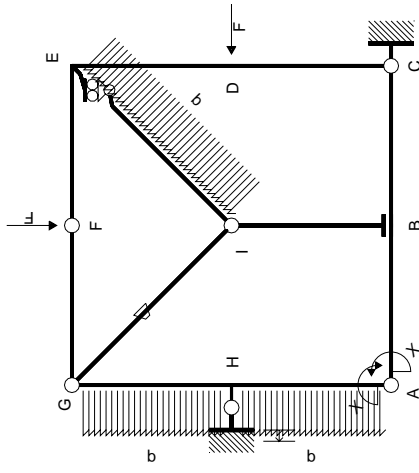
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



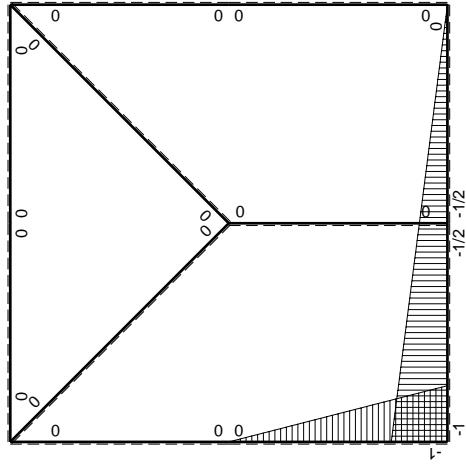
- A = 906. mm<sup>2</sup>
- J<sub>u</sub> = 254971. mm<sup>4</sup>
- J<sub>v</sub> = 42084. mm<sup>4</sup>
- y<sub>g</sub> = 28.72 mm
- N = 1360. N
- T<sub>y</sub> = -4080. N
- M<sub>x</sub> = -1870000. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.72 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -209.1 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -19.72 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -143.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.958 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 143.5 N/mm<sup>2</sup>
- S = 4468. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

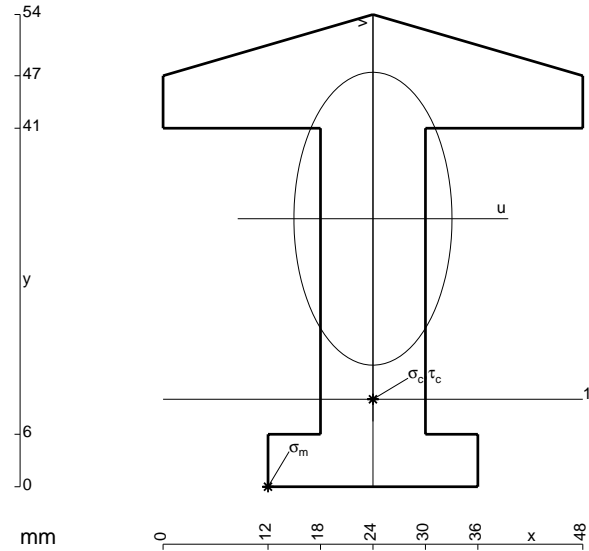
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

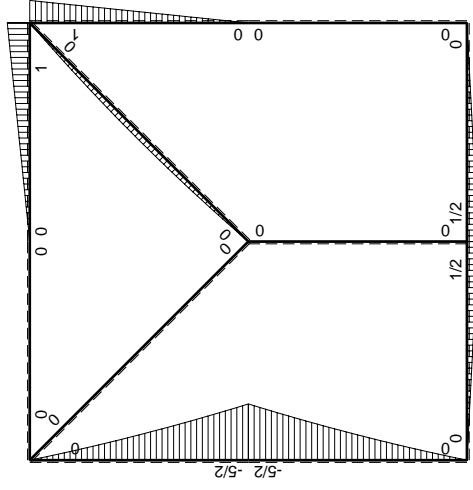
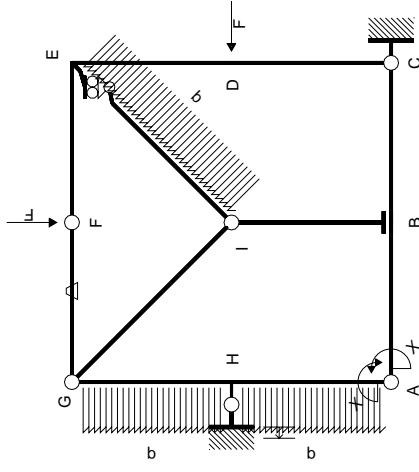
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

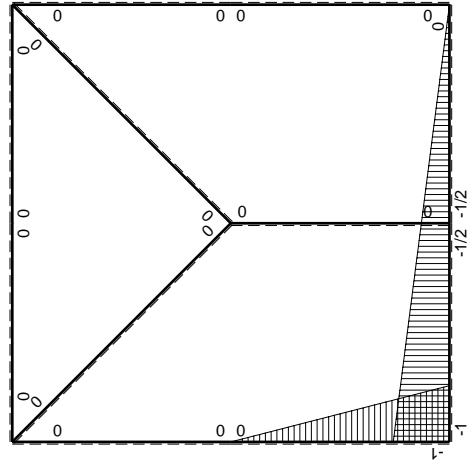


- A = 1020. mm<sup>2</sup>
- J<sub>u</sub> = 286162. mm<sup>4</sup>
- J<sub>v</sub> = 83376. mm<sup>4</sup>
- y<sub>g</sub> = 30.65 mm
- N = 1370. N
- T<sub>y</sub> = -4110. N
- M<sub>x</sub> = -2055000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.65 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -218.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -20.65 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -146.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.066 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 147.3 N/mm<sup>2</sup>
- S = 5069. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	0	0	0	0			
FG b	0	0	-Fb/EJ	0	0	0	0+0	0	
GF b	0	0	Fb/EJ	0	0	0			
GH b	0	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

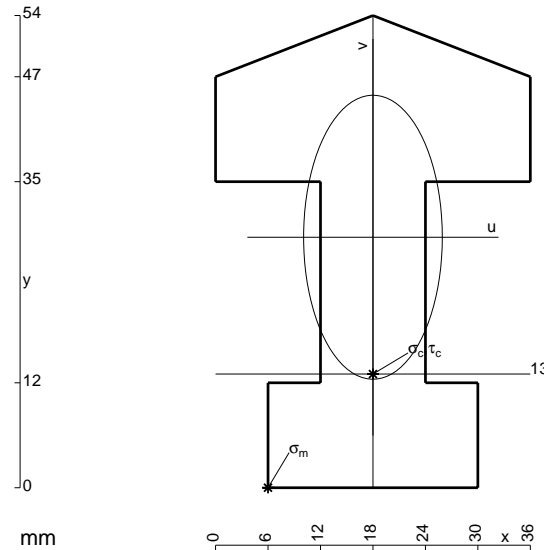
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

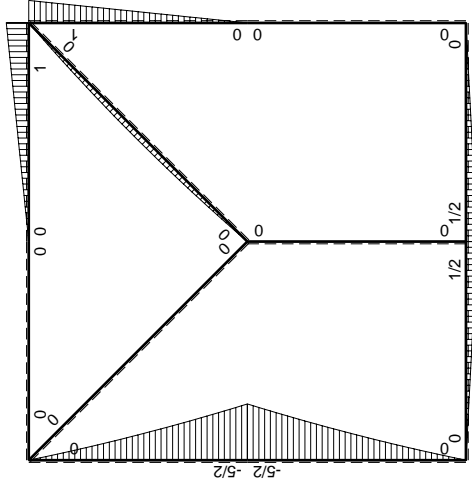
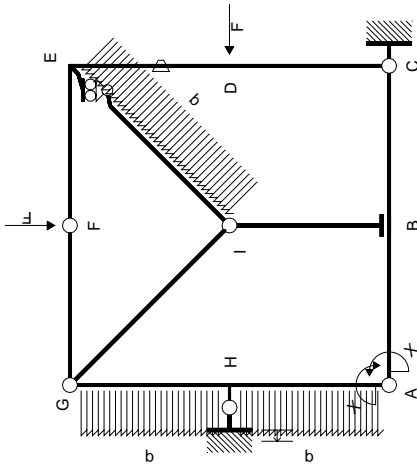
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



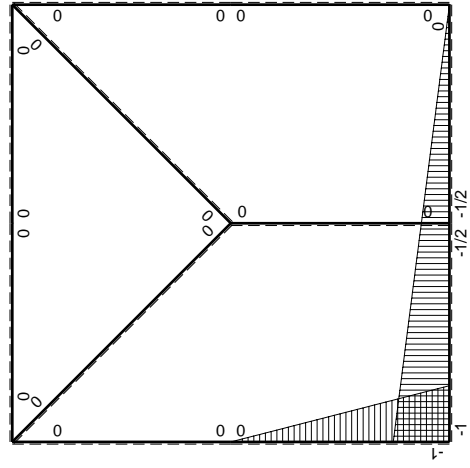
- A = 1122. mm<sup>2</sup>
- J<sub>u</sub> = 296013. mm<sup>4</sup>
- J<sub>v</sub> = 70596. mm<sup>4</sup>
- y<sub>g</sub> = 28.65 mm
- N = 1470. N
- T<sub>y</sub> = -4410. N
- M<sub>x</sub> = -2388750. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.65 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -229.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.65 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -125. N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.338 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 125.8 N/mm<sup>2</sup>
- S = 6716. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	$Fb/EJ$	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

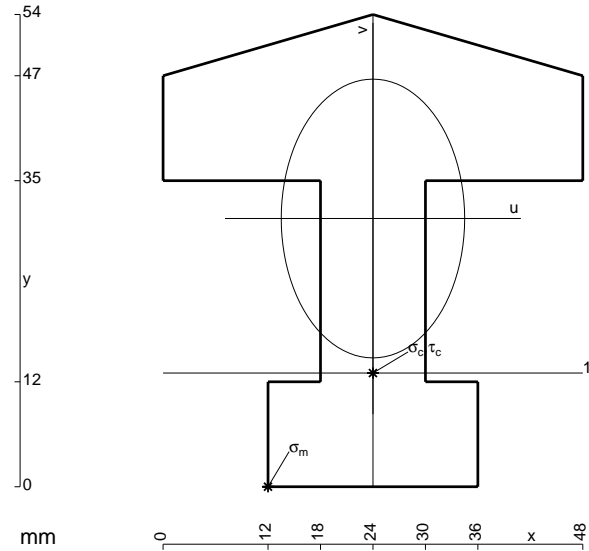
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

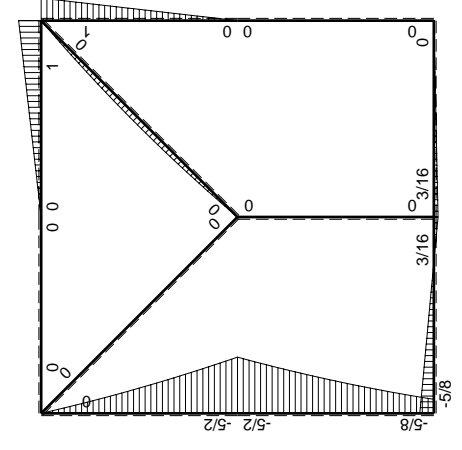
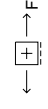
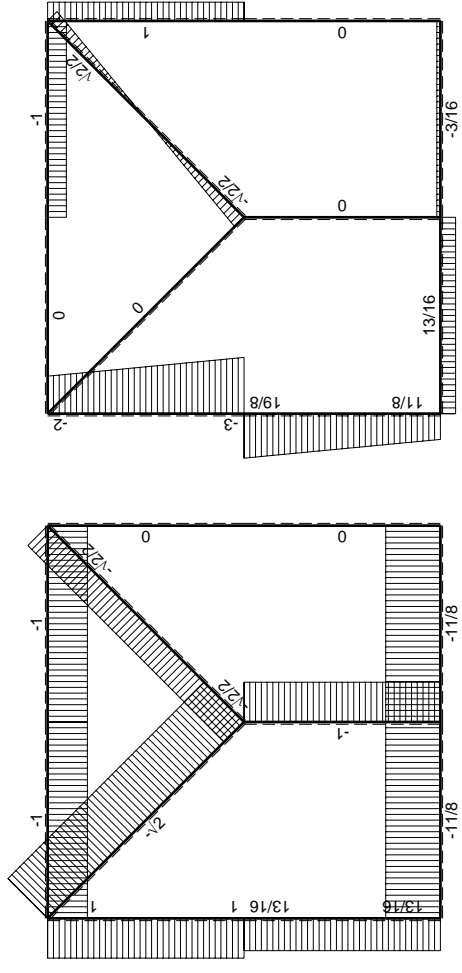
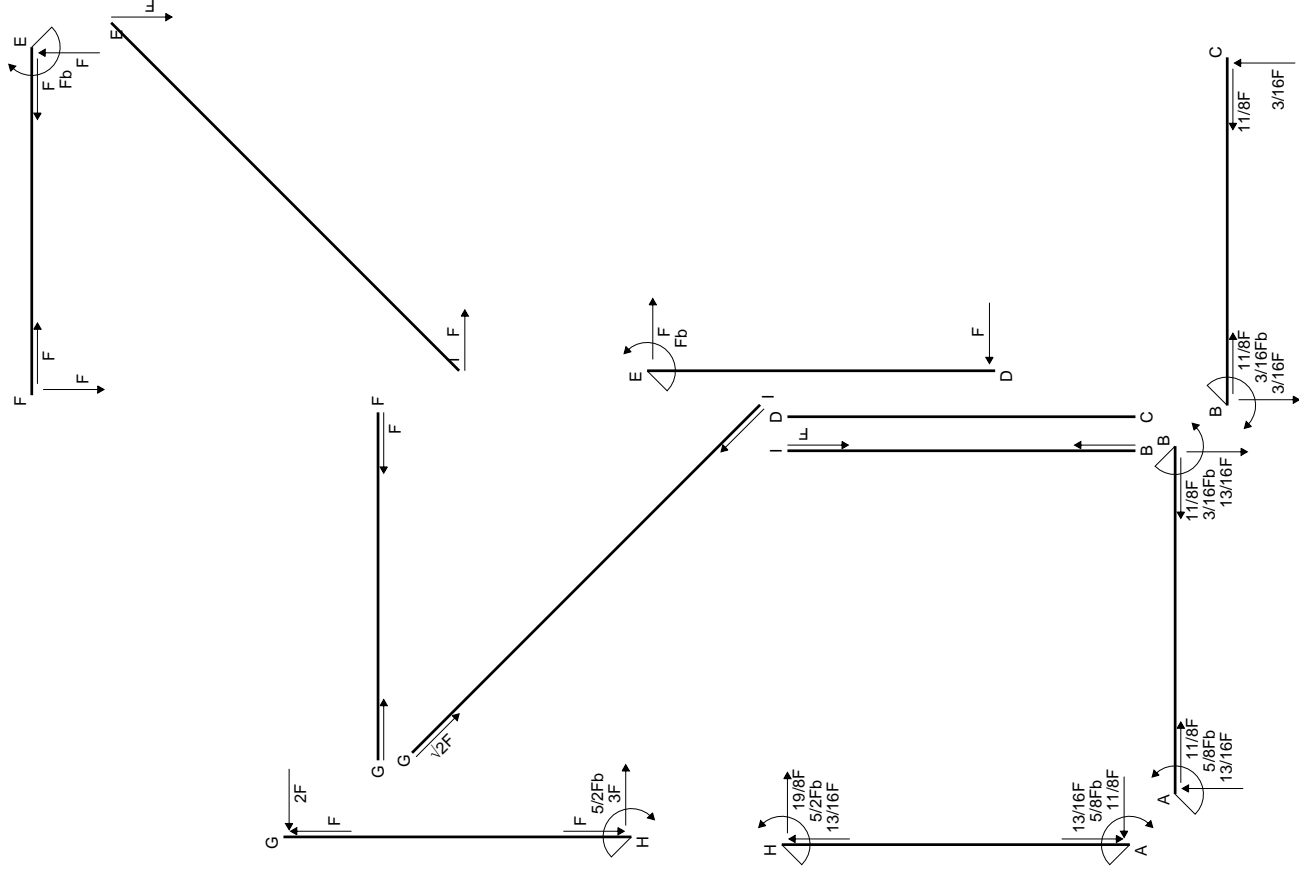
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

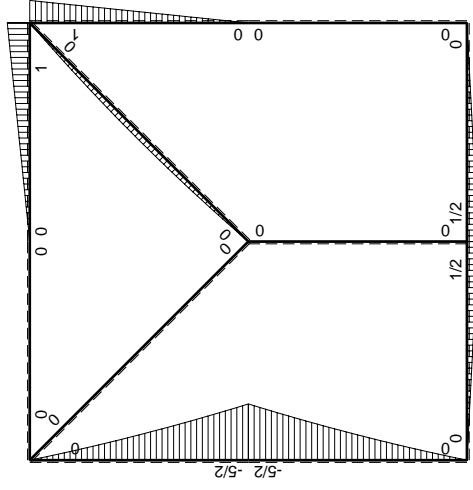
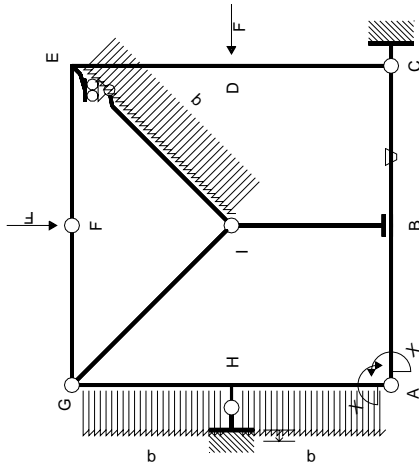
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

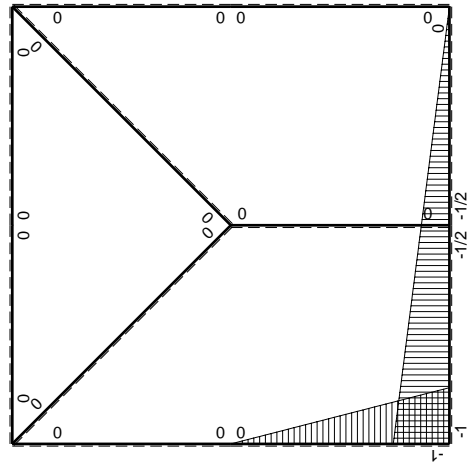


- A = 1308. mm<sup>2</sup>
- J<sub>u</sub> = 332443. mm<sup>4</sup>
- J<sub>v</sub> = 143856. mm<sup>4</sup>
- y<sub>g</sub> = 30.67 mm
- N = 1490. N
- T<sub>y</sub> = -4470. N
- M<sub>x</sub> = -2607500. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.67 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -239.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -17.67 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -137.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.206 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 138.2 N/mm<sup>2</sup>
- S = 7323. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	$-Fb/EJ$	$-1/4Fb+1/2Fx-1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	$Fb/EJ$	$-1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/6 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

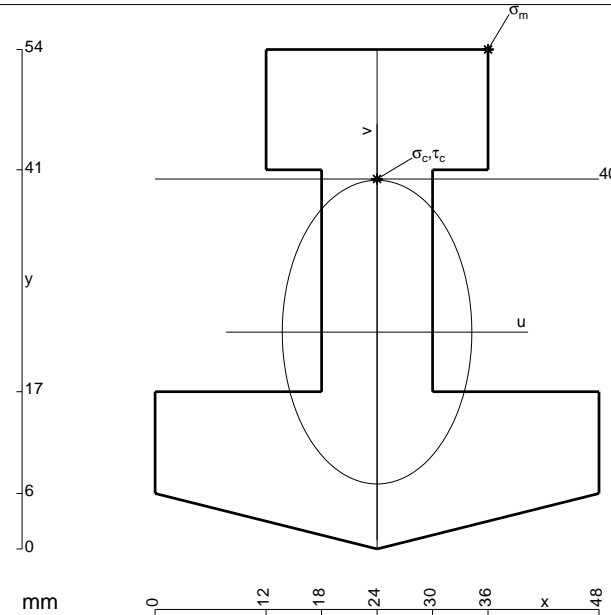
$$= (-1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/6 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

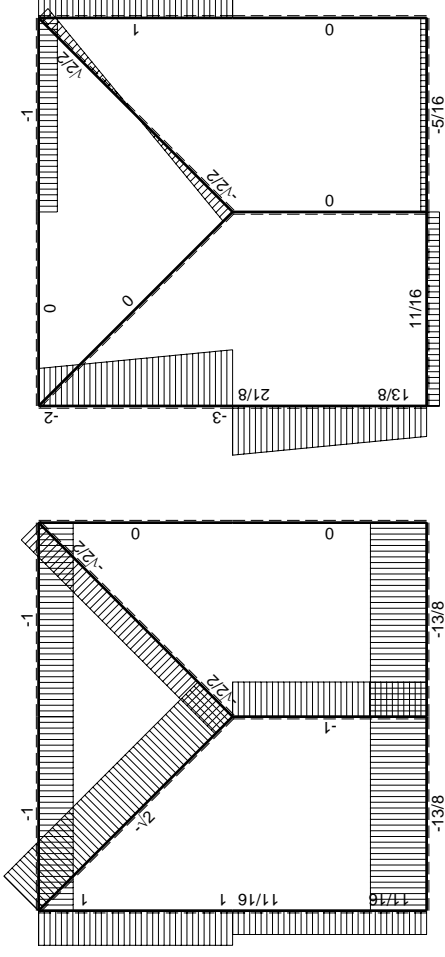
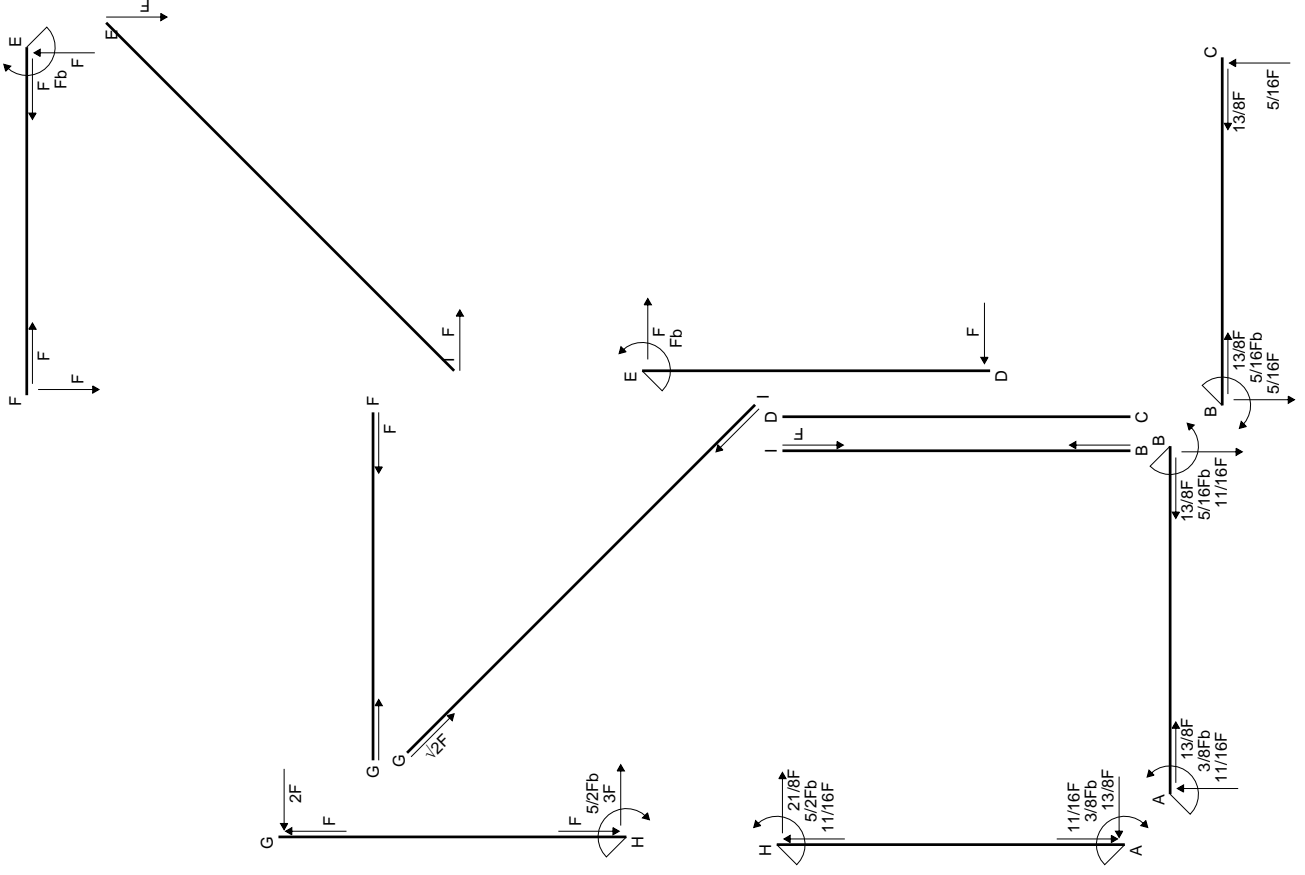
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



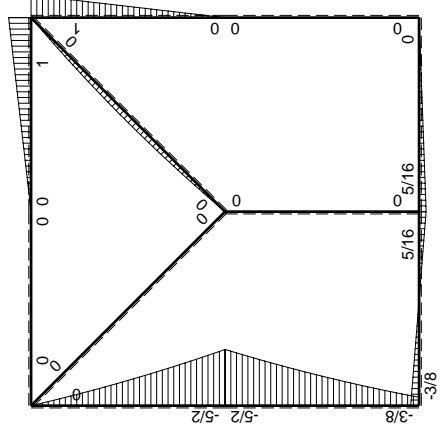
- A = 1272. mm<sup>2</sup>
- J<sub>u</sub> = 343038. mm<sup>4</sup>
- J<sub>v</sub> = 133632. mm<sup>4</sup>
- y<sub>g</sub> = 23.44 mm
- N = 1190. N
- T<sub>y</sub> = -3570. N
- M<sub>x</sub> = -2231250. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.56 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 199.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 16.56 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 108.6 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.687 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 109.2 N/mm<sup>2</sup>
- S = 7710. mm<sup>3</sup>



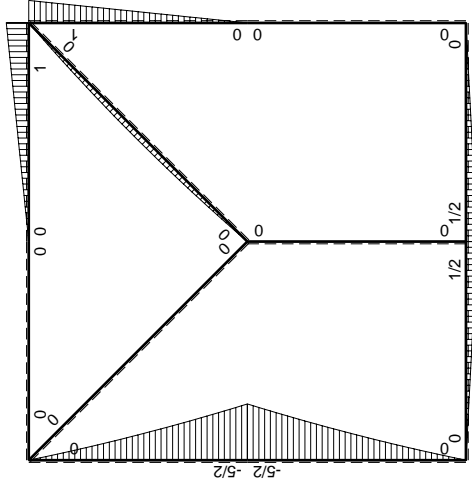
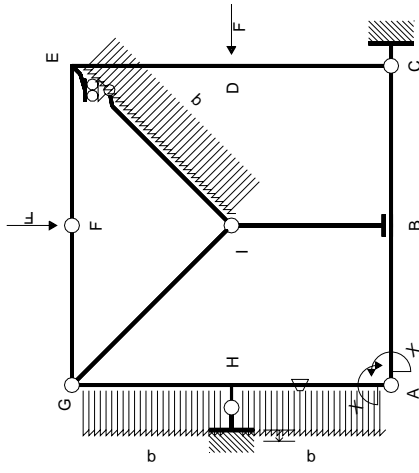


← (+) → F

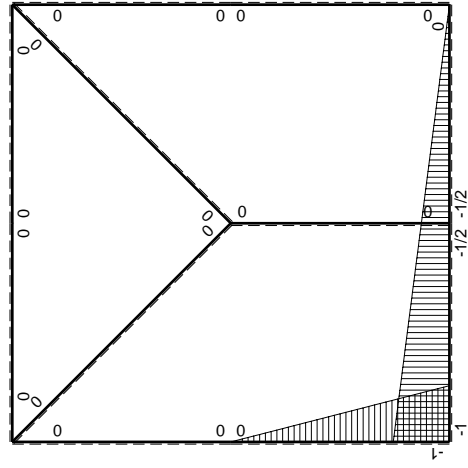
↑ (+) ↓ F



← (+) → F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	-Fb/EJ	$5/2Fx-3Fx^2/b+1/2qx^3/b$	Fx/EJ	$x^2/b^2$	$(3/8+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	Fb/EJ	$2Fx-3/2Fx^2/b-1/2qx^3/b$	Fb/EJ-Fx/EJ	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							-Fb <sup>2</sup> /EJ	
	totali							-3/8Fb <sup>2</sup> /EJ	Xb/EJ
	iperstatica $X=W_{AB}$							3/8Fb	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

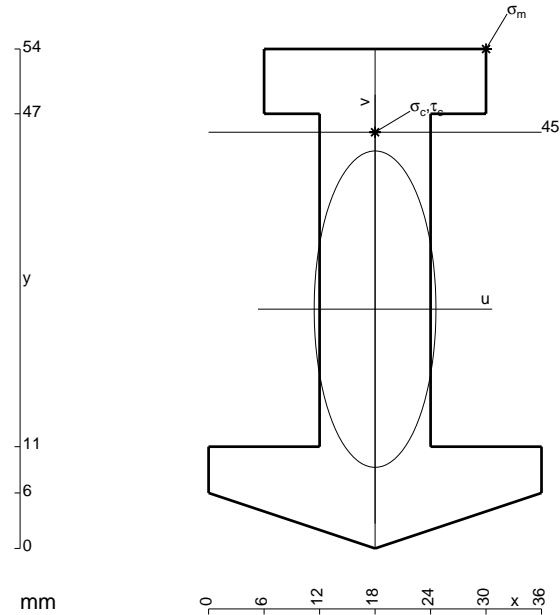
$$= [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 7/8 Fb^2/EJ$$

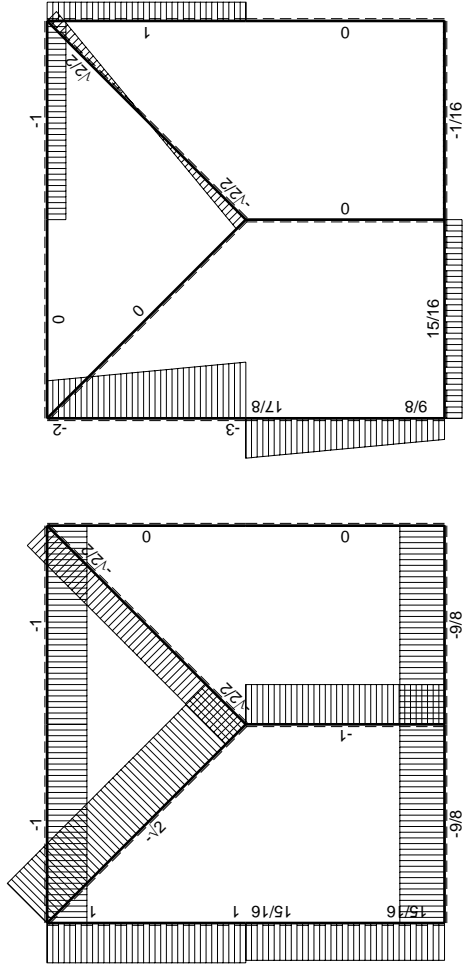
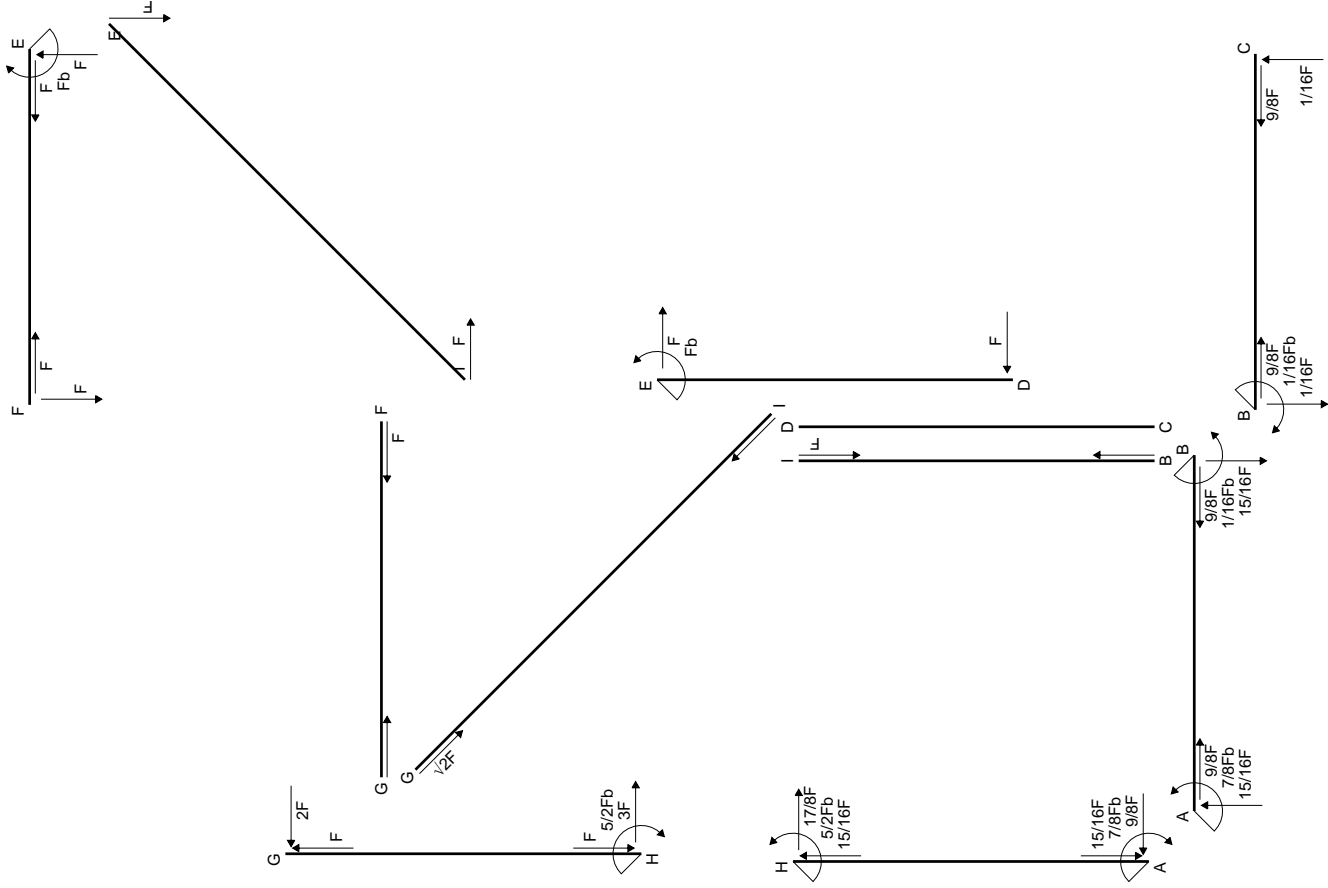
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 7/8 Fb^2/EJ$$

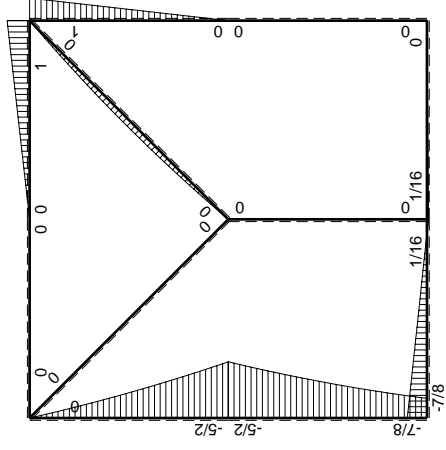


- A = 888. mm<sup>2</sup>
- J<sub>u</sub> = 260045. mm<sup>4</sup>
- J<sub>v</sub> = 38520. mm<sup>4</sup>
- y<sub>g</sub> = 25.87 mm
- N = 960. N
- T<sub>y</sub> = -2880. N
- M<sub>x</sub> = -1920000. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.13 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 208.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 45. mm
- v<sub>c</sub> = 19.13 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 142.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.264 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 142.5 N/mm<sup>2</sup>
- S = 4621. mm<sup>3</sup>

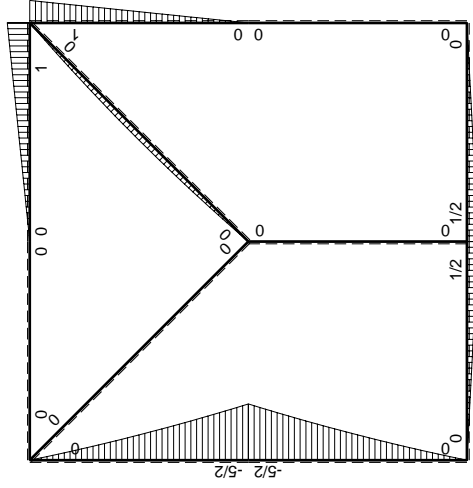
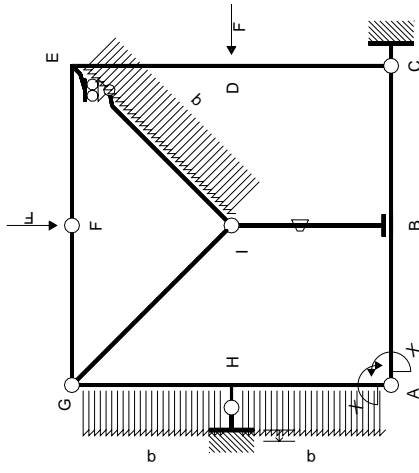


← ⊕ → F

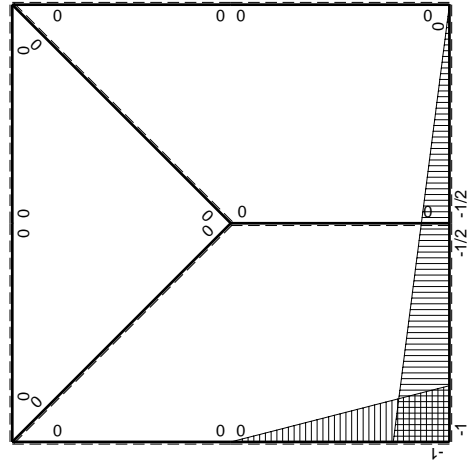
↑ ⊕ ↓ F



← ⊕ → Fb



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	-Fb/EJ	0	0	0	0+0	0	
BI b	0	0	Fb/EJ	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

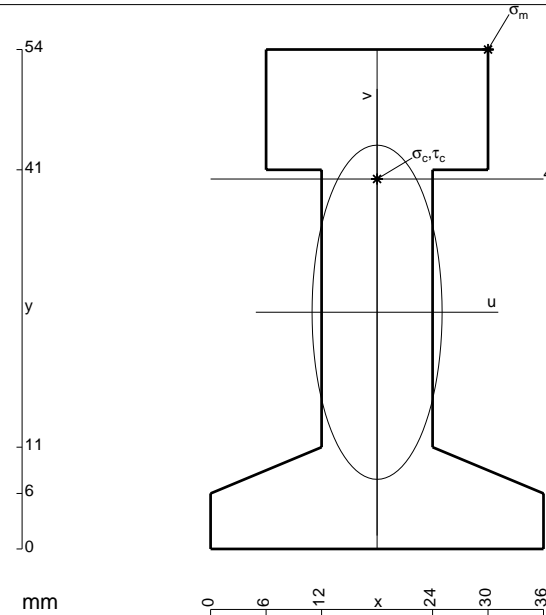
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

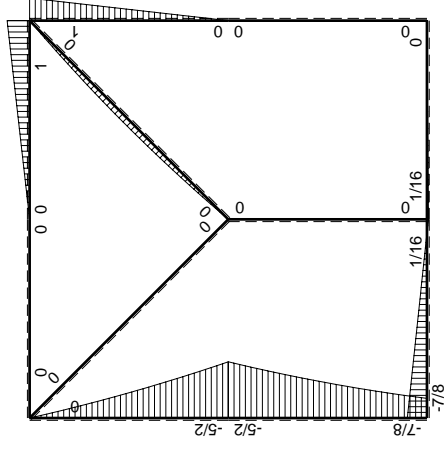
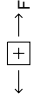
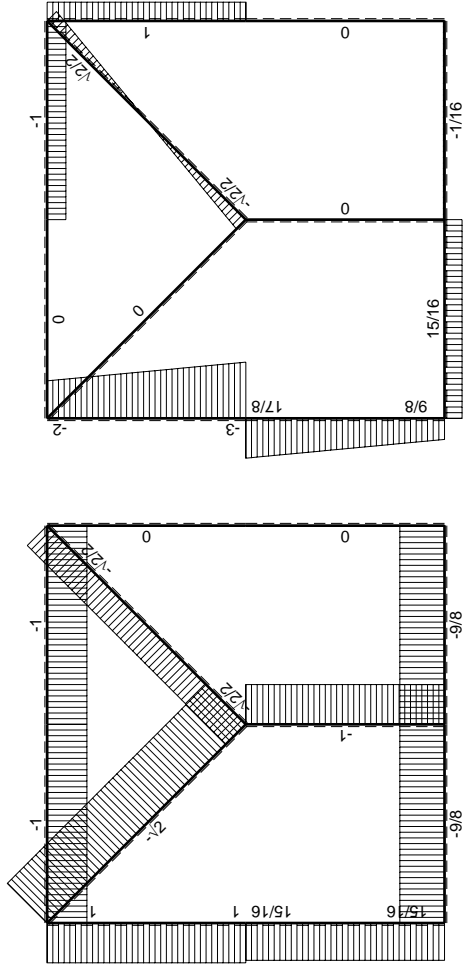
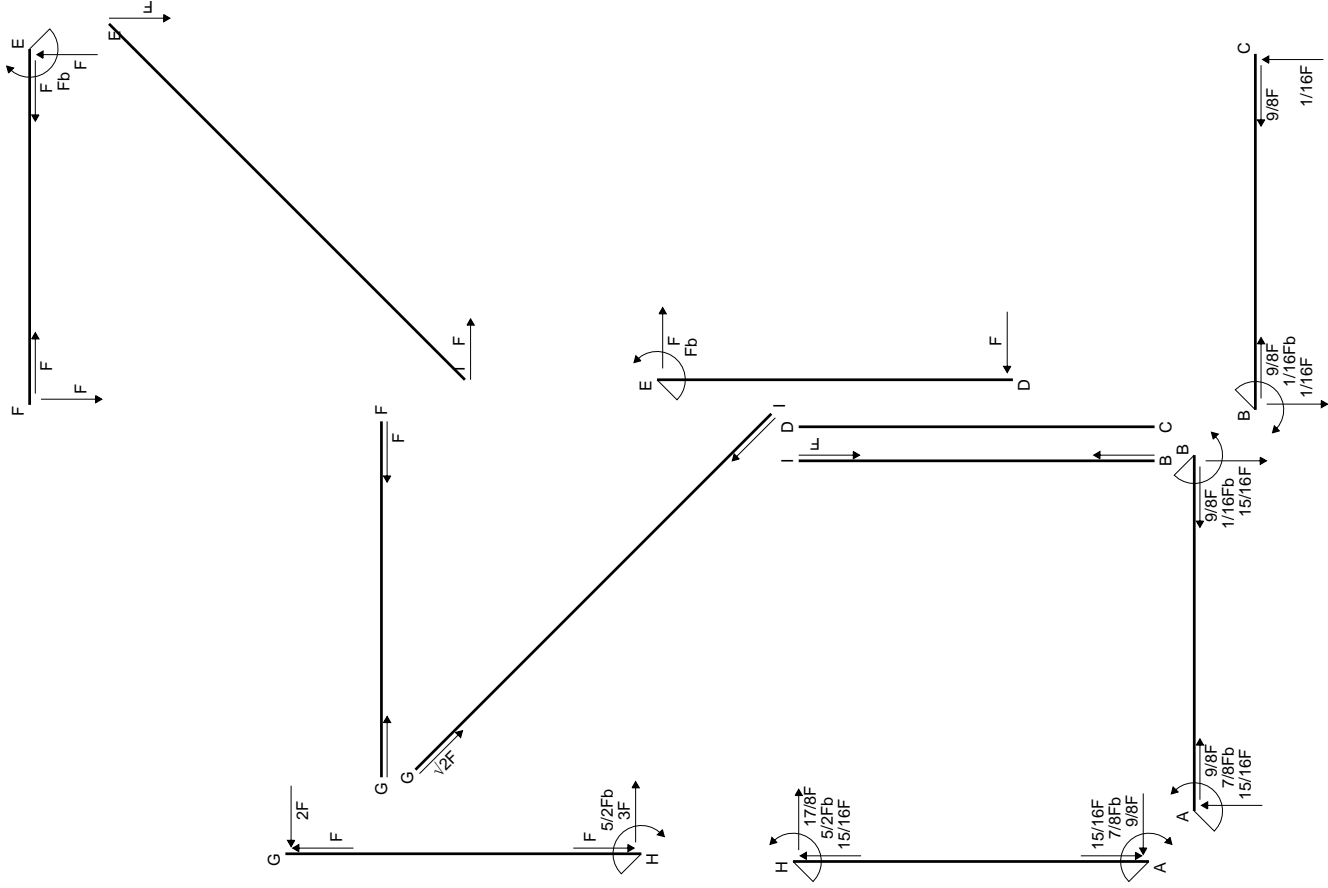
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

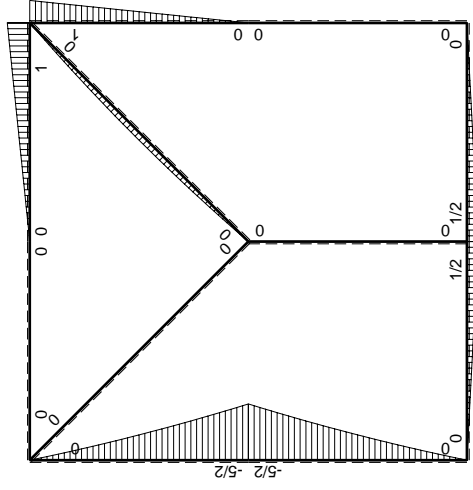
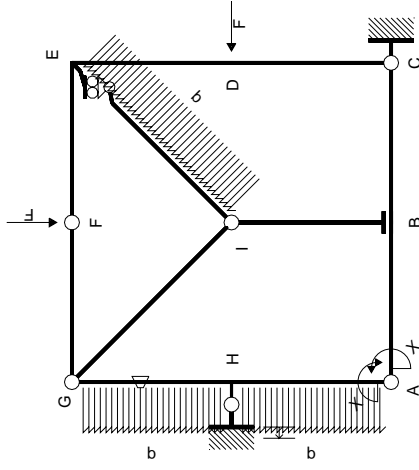
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



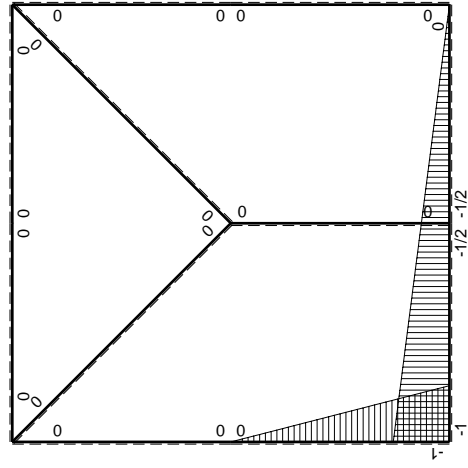
- A = 1008. mm<sup>2</sup>
- J<sub>u</sub> = 329111. mm<sup>4</sup>
- J<sub>v</sub> = 49824. mm<sup>4</sup>
- y<sub>g</sub> = 25.59 mm
- N = 1190. N
- T<sub>y</sub> = -3570. N
- M<sub>x</sub> = -2528750. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.41 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 219.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 14.41 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 111.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.34 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 112.4 N/mm<sup>2</sup>
- S = 7014. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	-Fb/EJ	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	Fb/EJ	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

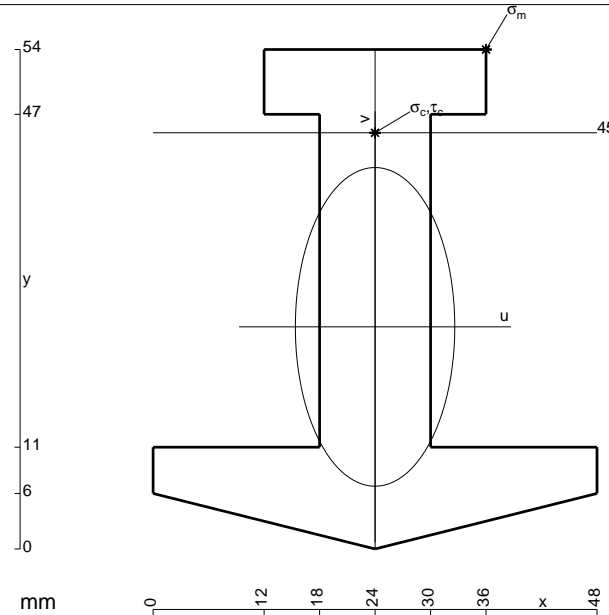
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

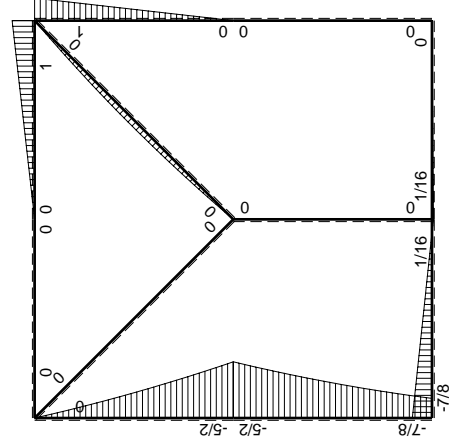
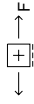
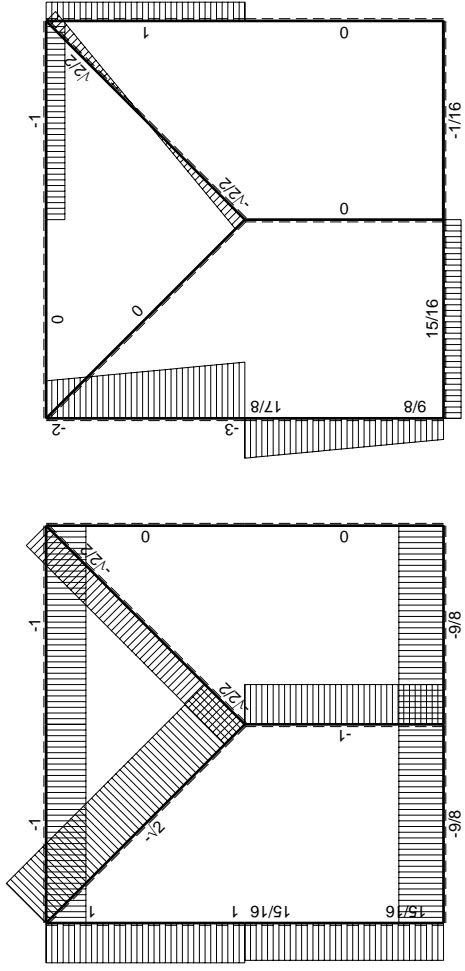
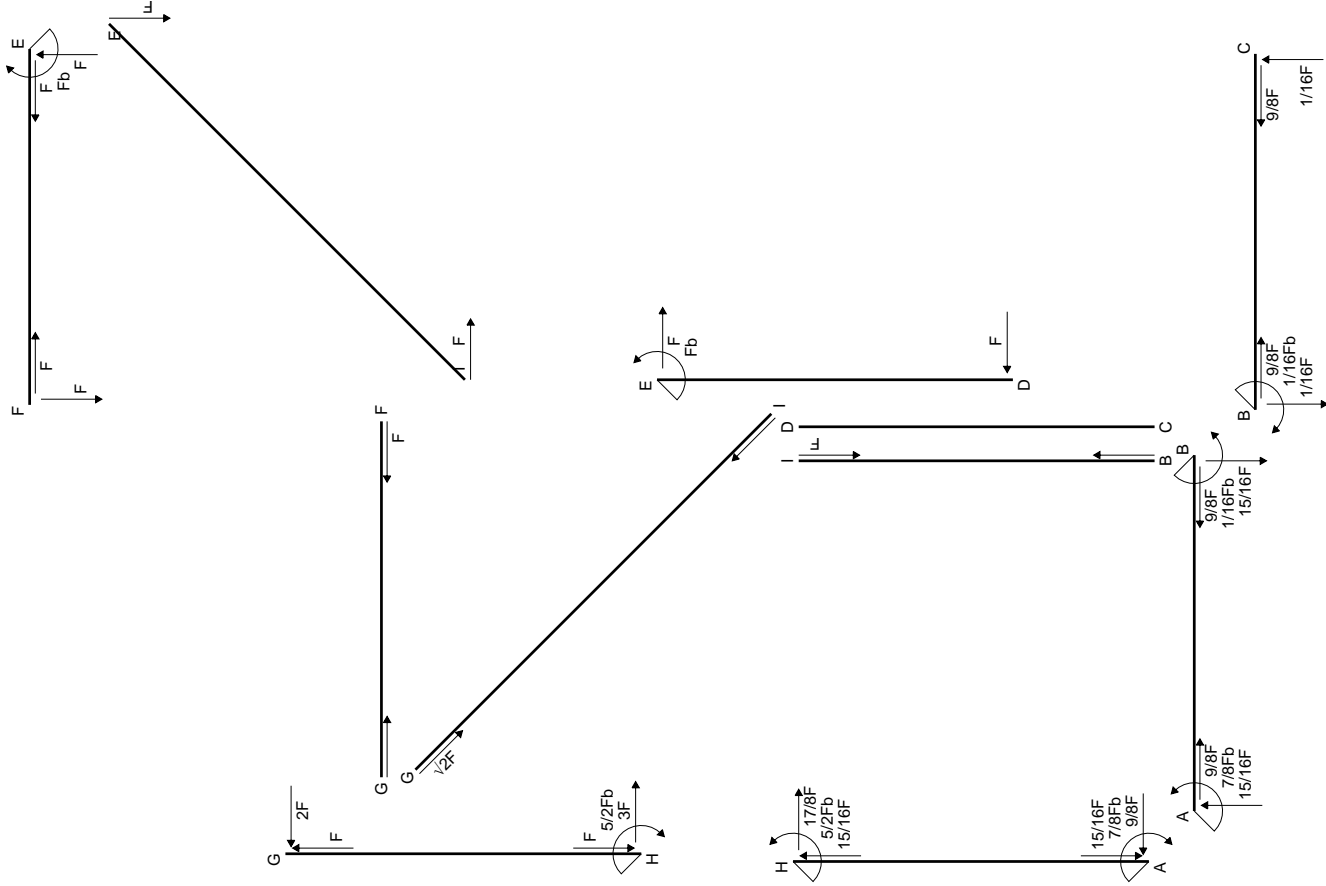
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

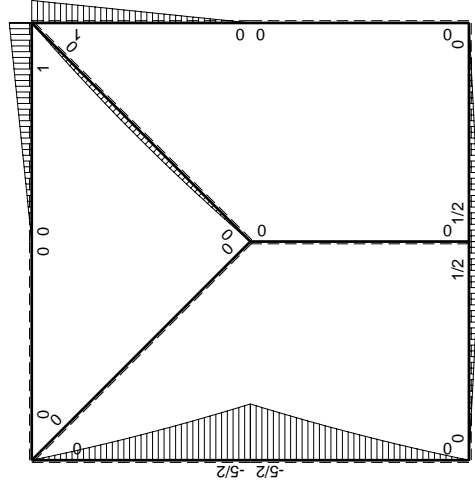
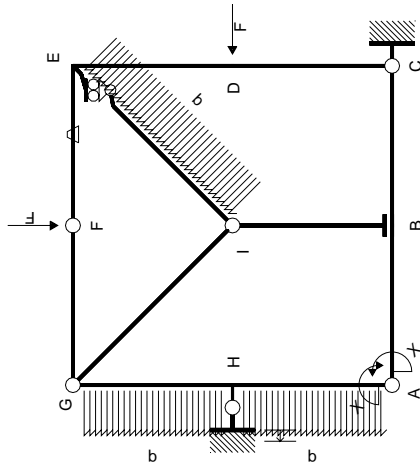
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

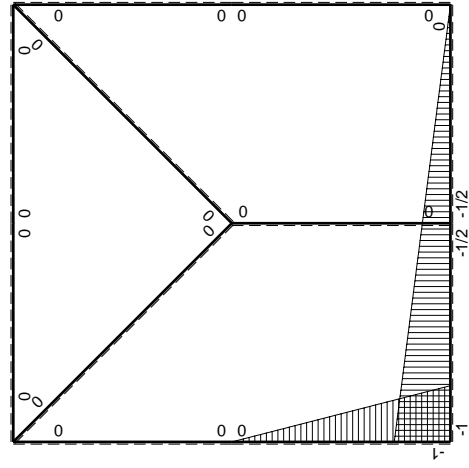


- A = 984. mm<sup>2</sup>
- J<sub>u</sub> = 292168. mm<sup>4</sup>
- J<sub>v</sub> = 73152. mm<sup>4</sup>
- y<sub>g</sub> = 24.01 mm
- N = 990. N
- T<sub>y</sub> = -2970. N
- M<sub>x</sub> = -2227500. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 29.99 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 229.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 45. mm
- v<sub>c</sub> = 20.99 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 161. N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.217 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 161.2 N/mm<sup>2</sup>
- S = 4978. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	-Fb/EJ	0	0	0	0+0	0	
FE b	0	-Fx	Fb/EJ	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

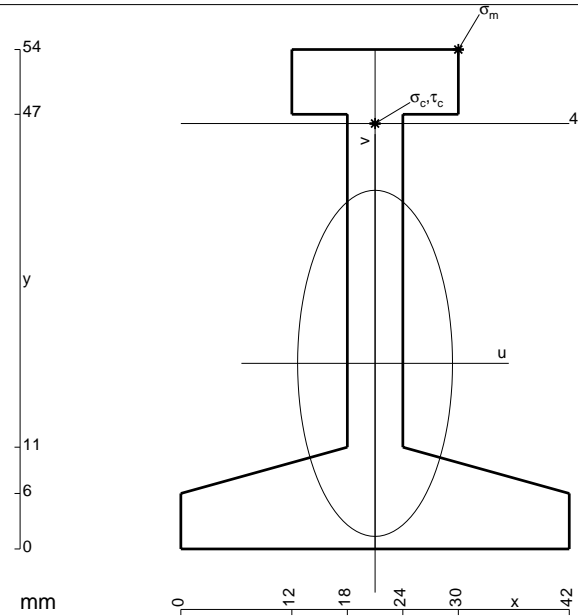
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

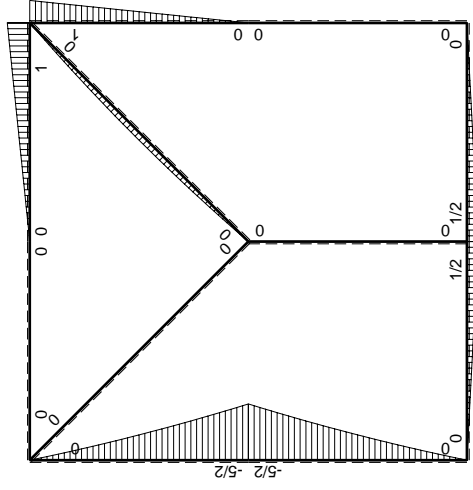
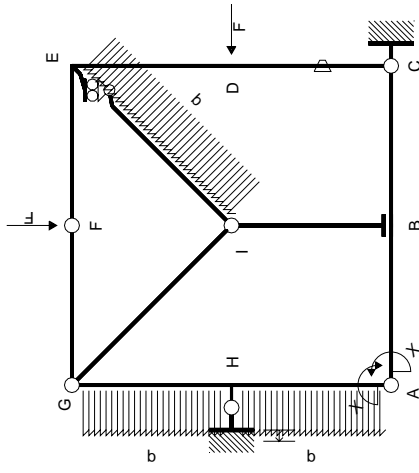
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



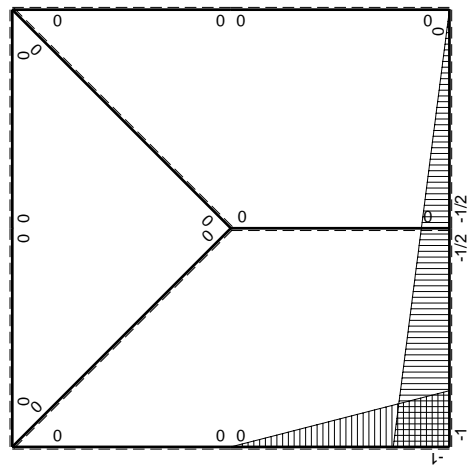
- A = 714. mm<sup>2</sup>
- J<sub>u</sub> = 249976. mm<sup>4</sup>
- J<sub>v</sub> = 50094. mm<sup>4</sup>
- y<sub>g</sub> = 20.07 mm
- N = 740. N
- T<sub>y</sub> = -2220. N
- M<sub>x</sub> = -1757500. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 33.93 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 239.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 46. mm
- v<sub>c</sub> = 25.93 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 183.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.91 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 183.6 N/mm<sup>2</sup>
- S = 3993. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	0	$Fb/EJ$	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	$-Fb+Fx$	0	0	0	0			
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0	
FE b	0	$-Fx$	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

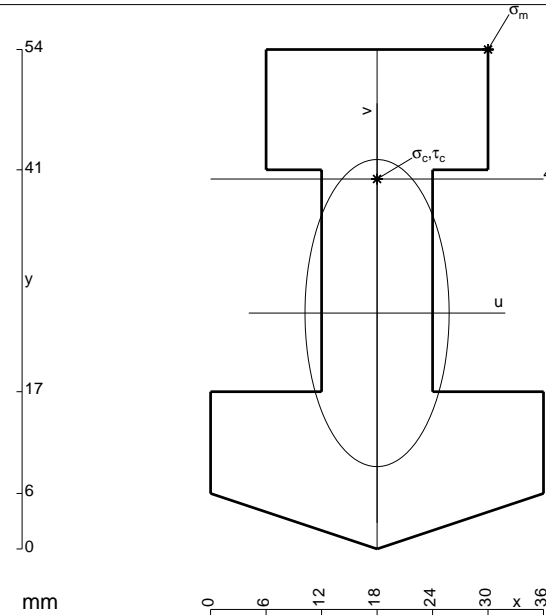
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

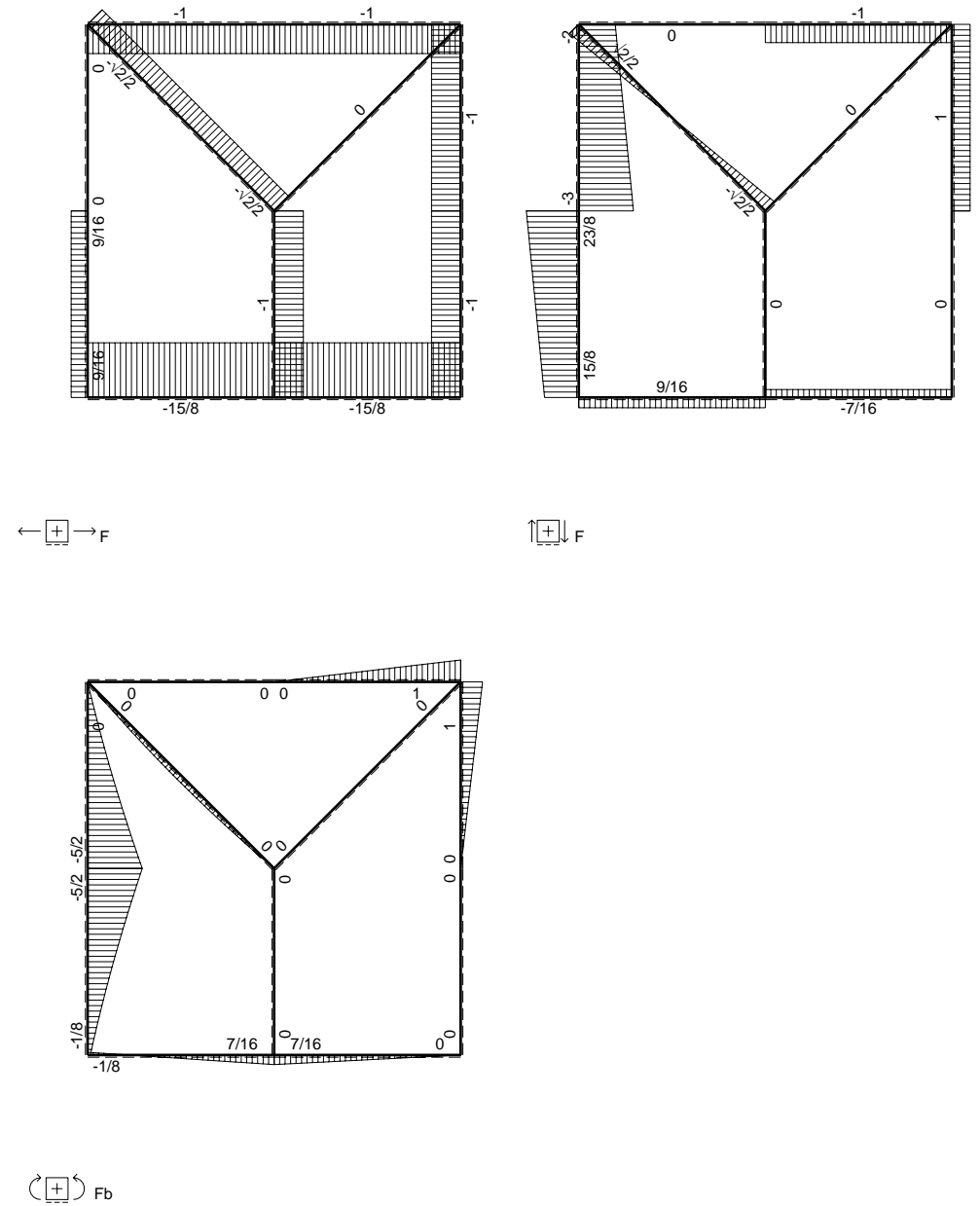
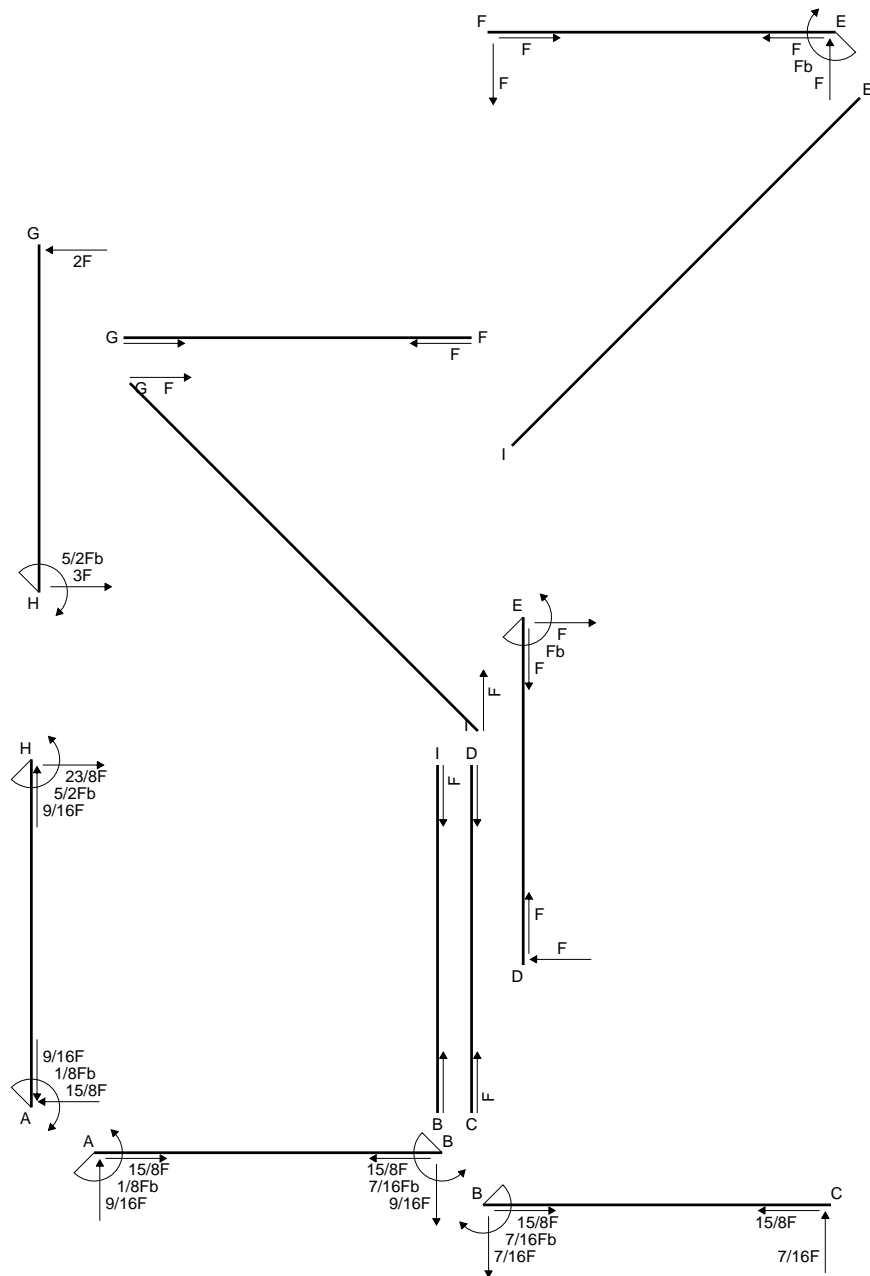
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

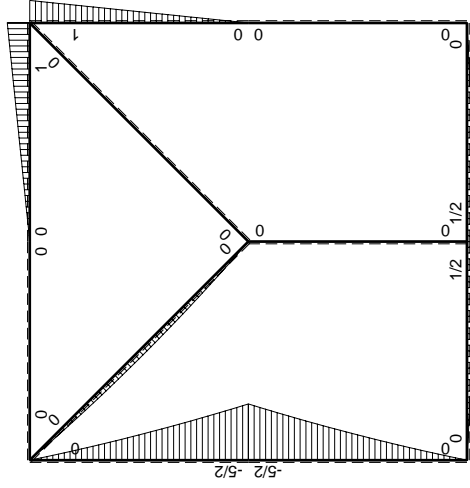
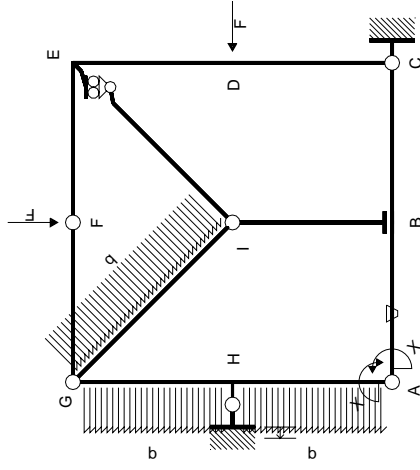
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

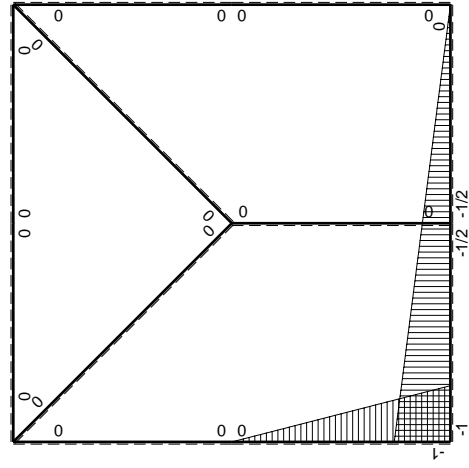


- A = 1104. mm<sup>2</sup>
- J<sub>u</sub> = 304502. mm<sup>4</sup>
- J<sub>v</sub> = 67032. mm<sup>4</sup>
- y<sub>g</sub> = 25.51 mm
- N = 1690. N
- T<sub>y</sub> = -5070. N
- M<sub>x</sub> = -2112500. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.49 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 199.2 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 14.49 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 102.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 9.771 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 103.5 N/mm<sup>2</sup>
- S = 7042. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	$-Fb/EJ$	$-1/2Fx+1/4Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-1/6+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	$Fb/EJ$	$-1/4Fb+1/4Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{x\theta} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [x - 1/2 x^2/b]_0^b \theta$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ + (b - 1/2 b) \theta = 7/12 Fb^2/EJ$$

$$L_{BA}^{x\theta} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/12 Fb^2/EJ$$

$$L_{BC}^{x\theta} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{x\theta} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

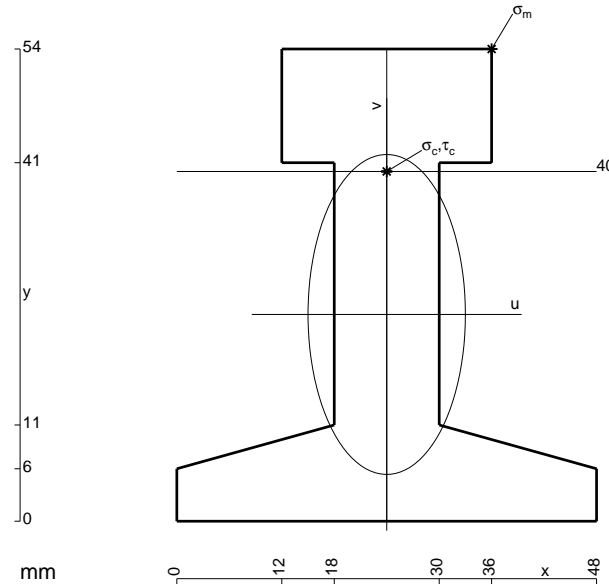
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{x\theta} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

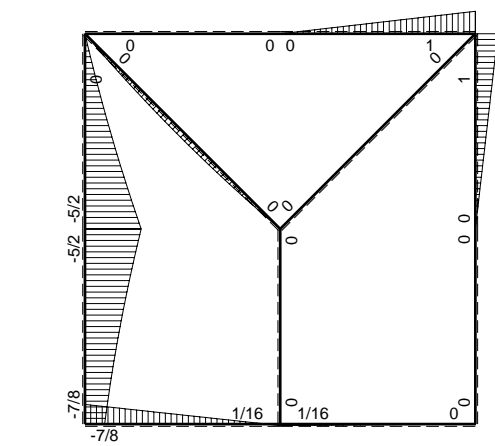
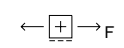
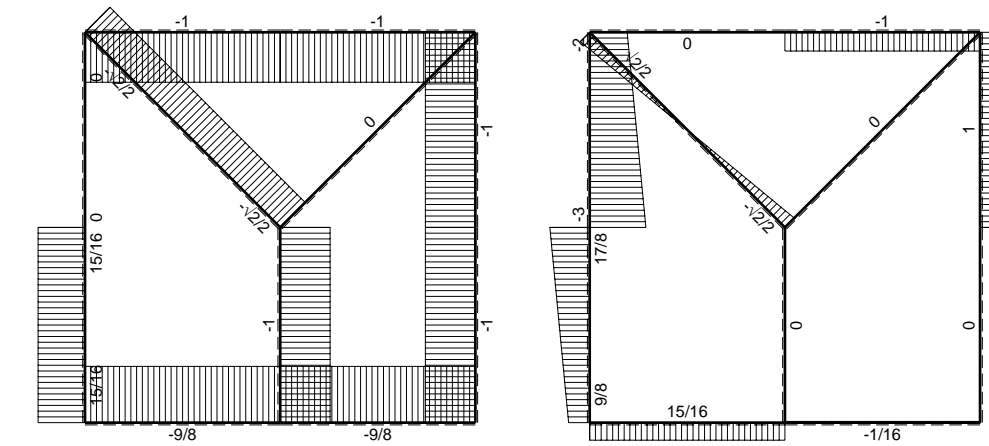
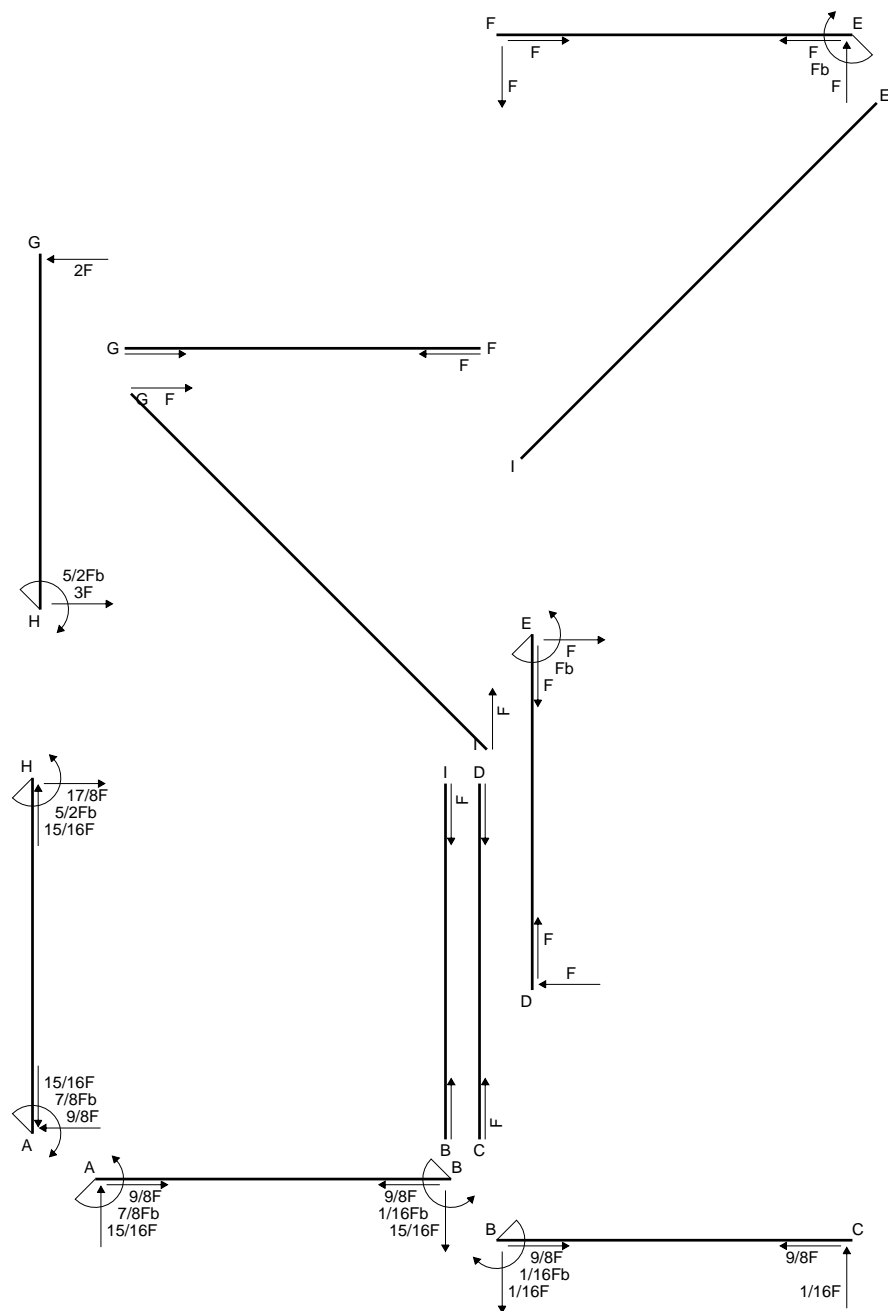
$$L_{AH}^{x\theta} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

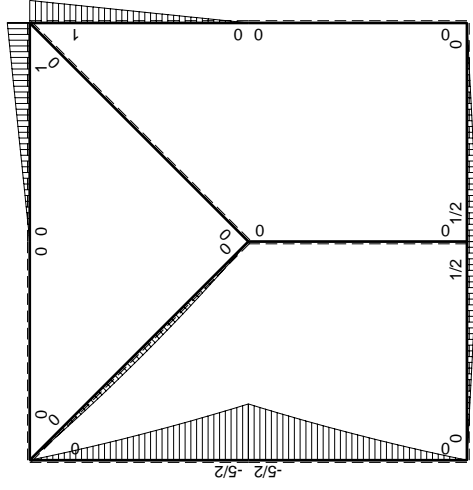
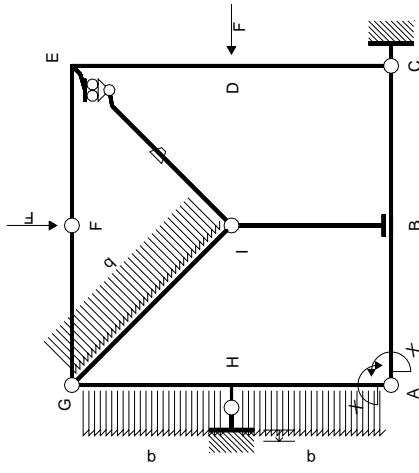
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



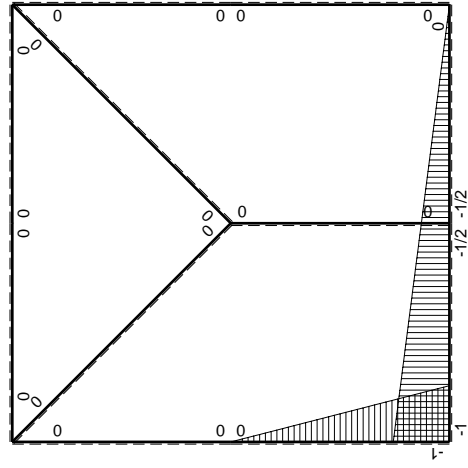
- A = 1110. mm<sup>2</sup>
- J<sub>u</sub> = 371542. mm<sup>4</sup>
- J<sub>v</sub> = 89892. mm<sup>4</sup>
- y<sub>g</sub> = 23.64 mm
- T<sub>y</sub> = -5580. N
- M<sub>x</sub> = -2557500. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.36 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = 209. N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 16.36 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = 112.6 N/mm<sup>2</sup>
- τ<sub>c</sub> = 9.569 N/mm<sup>2</sup>
- σ<sub>σ</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 113.8 N/mm<sup>2</sup>
- S = 7646. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

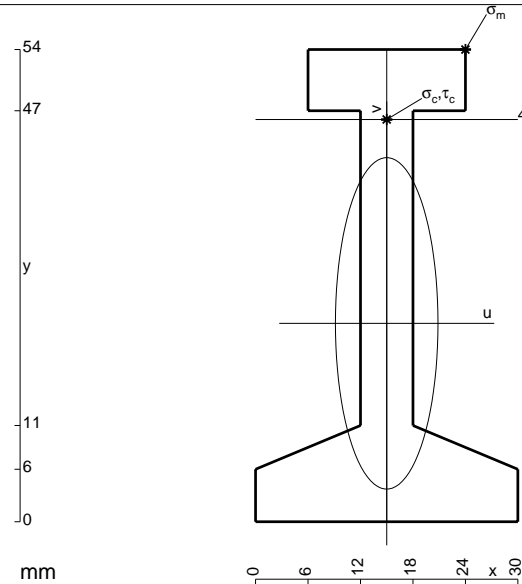
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

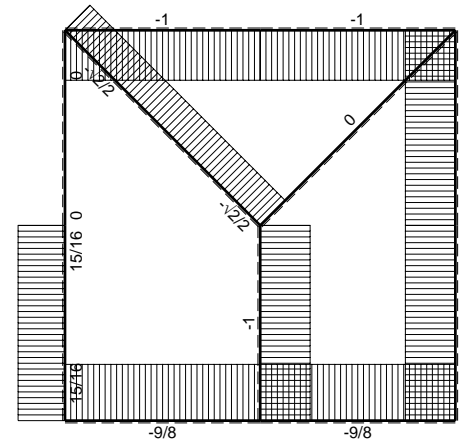
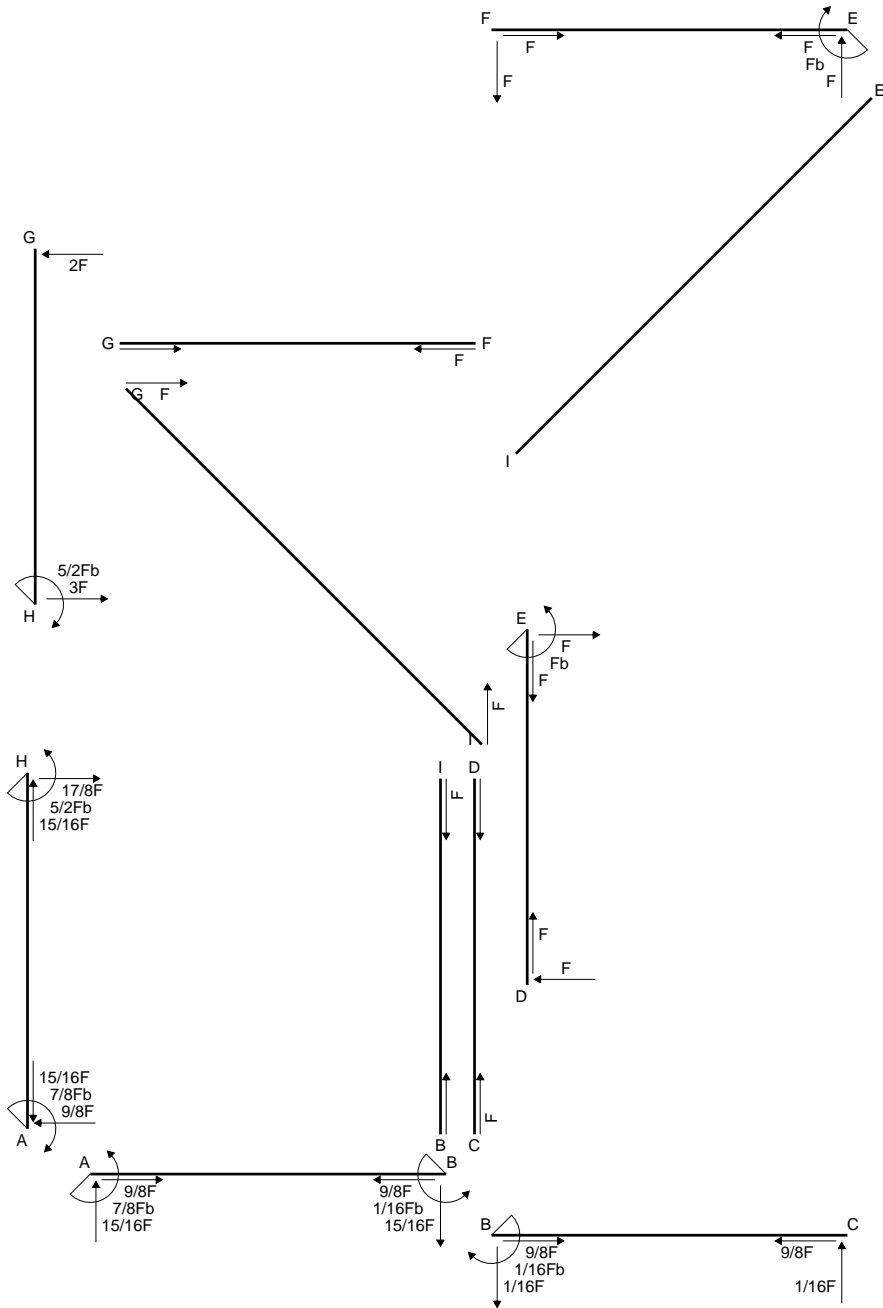
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

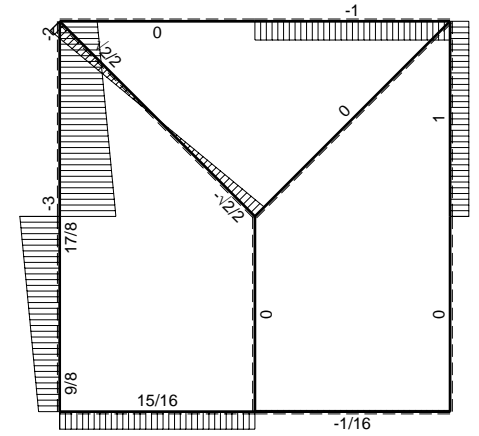
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



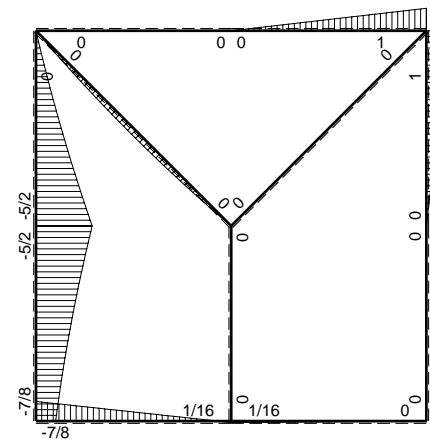
- A = 612. mm<sup>2</sup>
- J<sub>u</sub> = 219945. mm<sup>4</sup>
- J<sub>v</sub> = 21060. mm<sup>4</sup>
- y<sub>g</sub> = 22.68 mm
- T<sub>y</sub> = -3090. N
- M<sub>x</sub> = -1545000. Nmm
- x<sub>m</sub> = 24. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 31.32 mm
- σ<sub>m</sub> = -M<sub>v</sub>/J<sub>u</sub> = 220. N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 46. mm
- v<sub>c</sub> = 23.32 mm
- σ<sub>c</sub> = -M<sub>v</sub>/J<sub>u</sub> = 163.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.541 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 164.5 N/mm<sup>2</sup>
- S = 3648. mm<sup>3</sup>



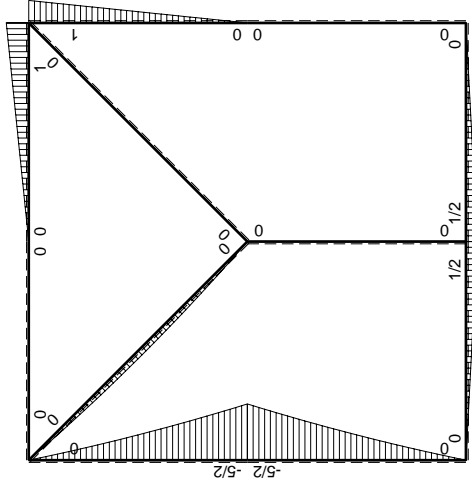
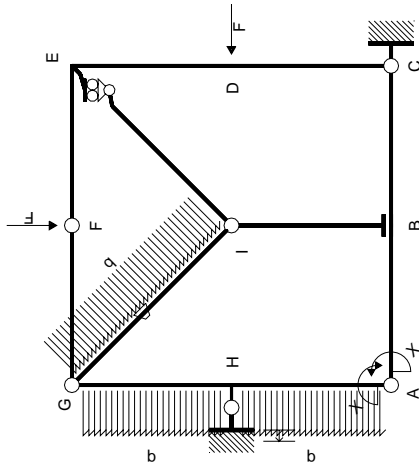
← ⊕ → F



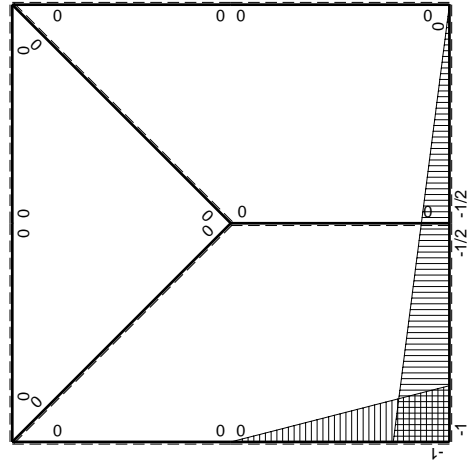
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	-Fb/EJ	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

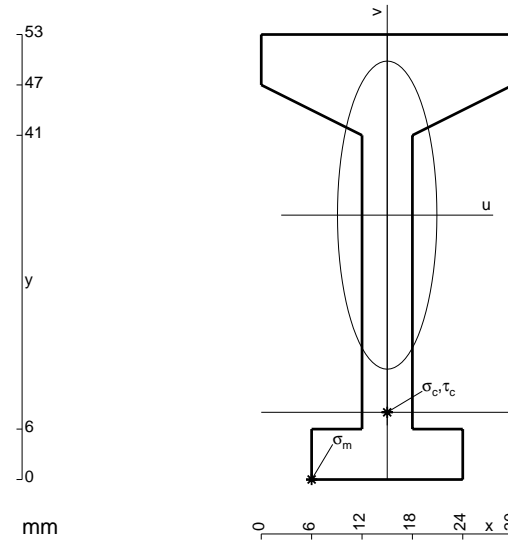
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

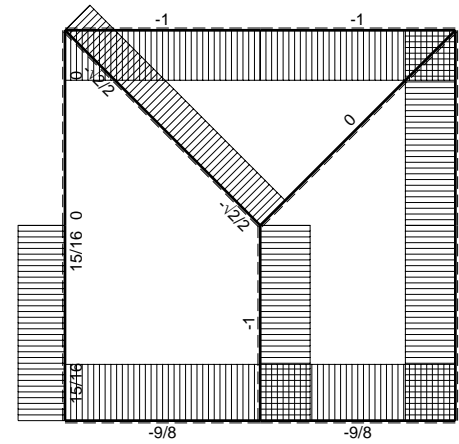
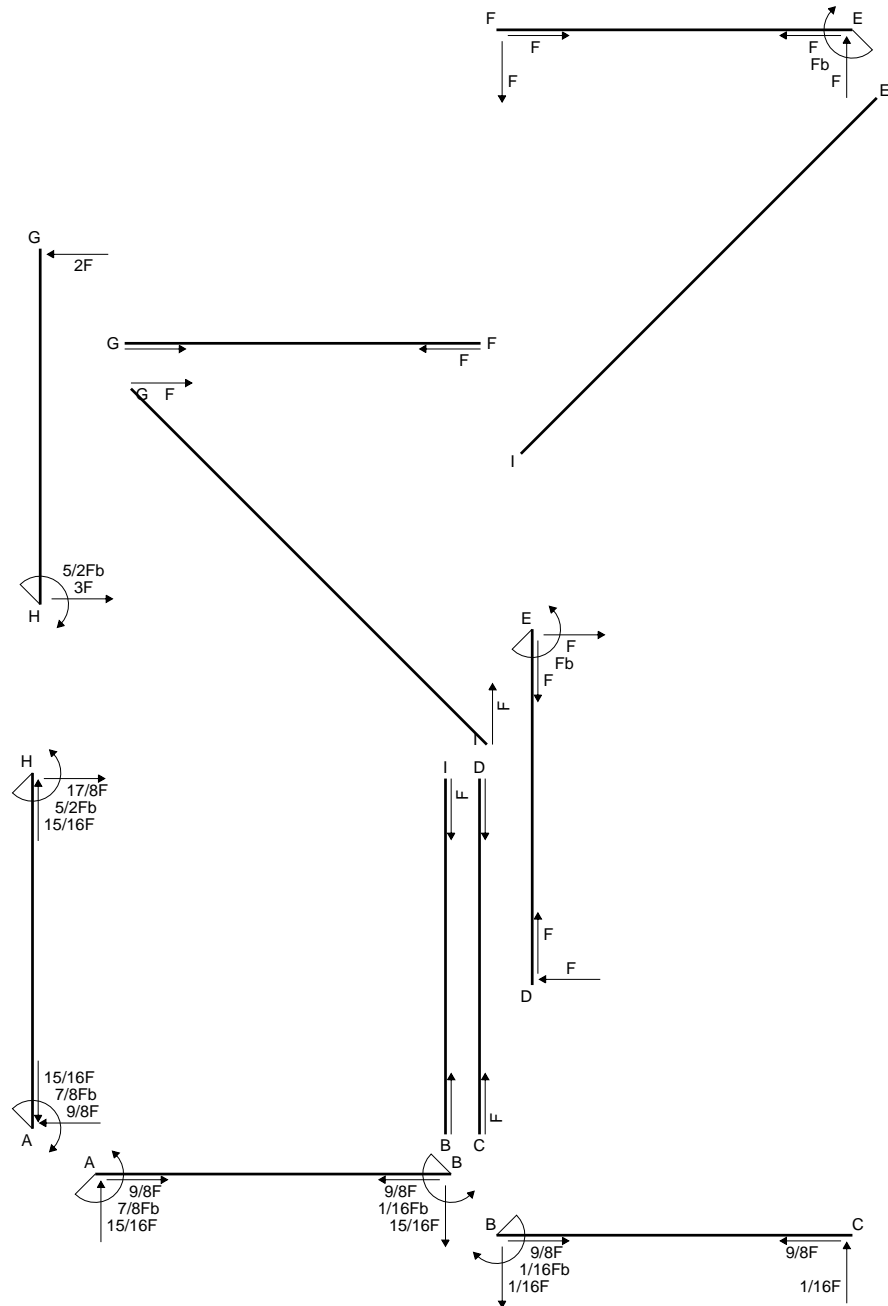
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

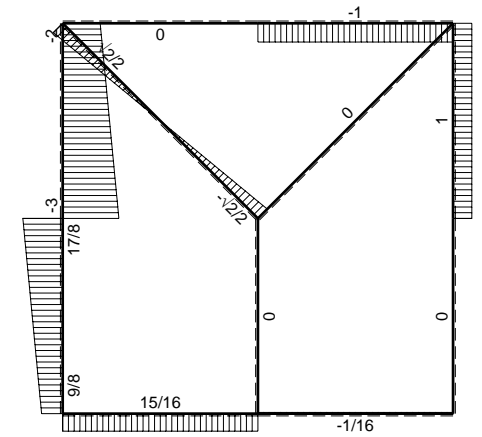


- A = 606. mm<sup>2</sup>
- J<sub>u</sub> = 204068. mm<sup>4</sup>
- J<sub>v</sub> = 21258. mm<sup>4</sup>
- y<sub>g</sub> = 31.49 mm
- T<sub>y</sub> = -2820. N
- M<sub>x</sub> = -1480500. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -31.49 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -228.5 N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 8. mm
- v<sub>c</sub> = -23.49 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -170.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.763 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 170.9 N/mm<sup>2</sup>
- S = 3371. mm<sup>3</sup>

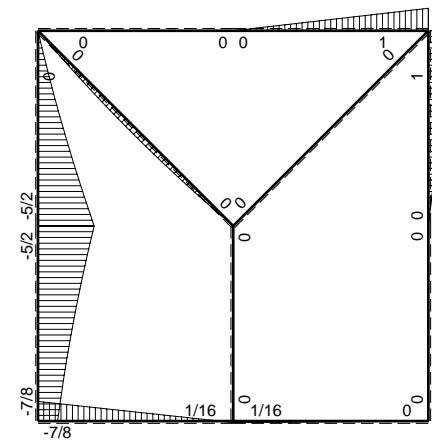




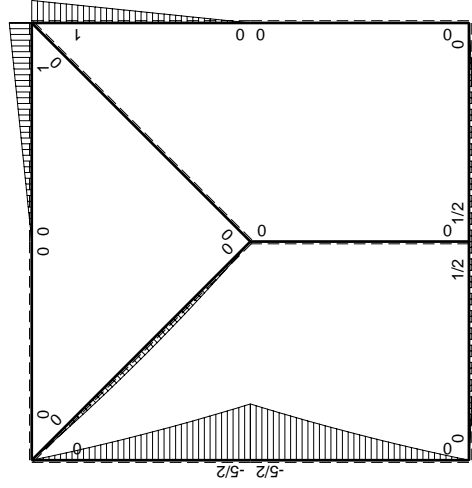
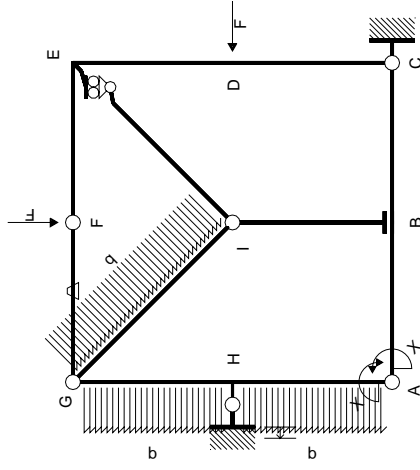
← ⊕ → F



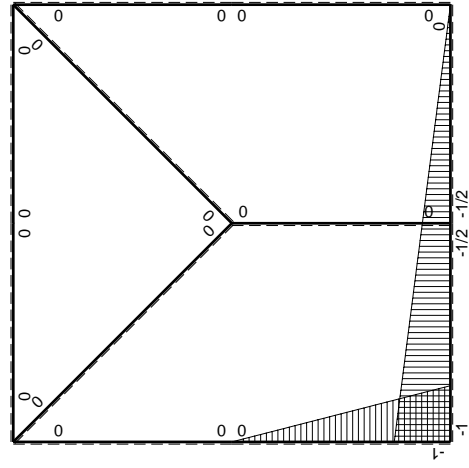
↑ ⊕ ↓ F



⊕ ⊖ Fb



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica X=1

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	0	0	0	0			
FG b	0	0	-Fb/EJ	0	0	0	0+0	0	
GF b	0	0	Fb/EJ	0	0	0			
GH b	0	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

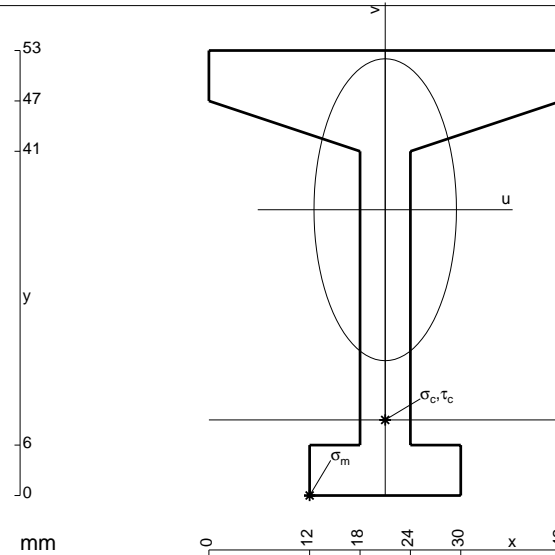
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

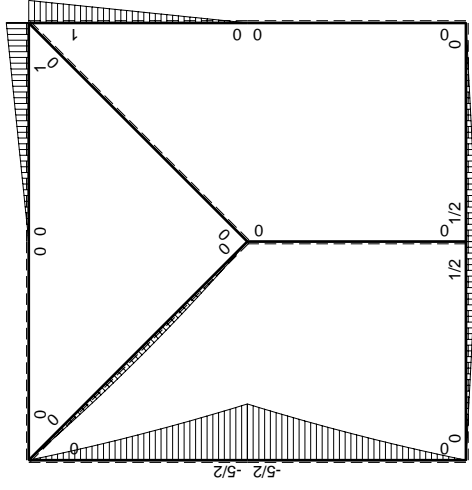
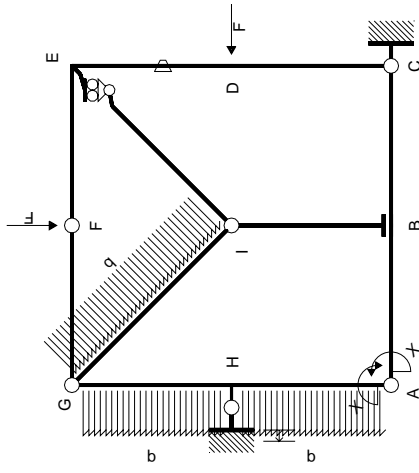
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

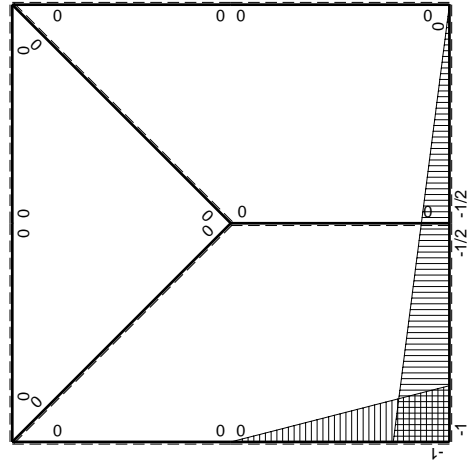


- A = 714. mm<sup>2</sup>
- J<sub>u</sub> = 230961. mm<sup>4</sup>
- J<sub>v</sub> = 51390. mm<sup>4</sup>
- y<sub>g</sub> = 34.04 mm
- T<sub>y</sub> = -2850. N
- M<sub>x</sub> = -1615000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -34.04 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -238. N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -25.04 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -175.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.876 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 175.6 N/mm<sup>2</sup>
- S = 3830. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
CD b	0	0	0	0	0	0	0+0	0
DC b	0	0	0	0	0	0	0+0	0
DE b	0	Fx	$-Fb/EJ$	0	0	0	0+0	0
ED b	0	$-Fb+Fx$	$Fb/EJ$	0	0	0	0+0	0
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0
FE b	0	$-Fx$	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0
IB b	0	0	0	0	0	0	0+0	0
BI b	0	0	0	0	0	0	0+0	0
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
H	cedimento nodo $-H_{1H}u_H$						$-Fb^2/EJ$	
	totali						$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$						$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

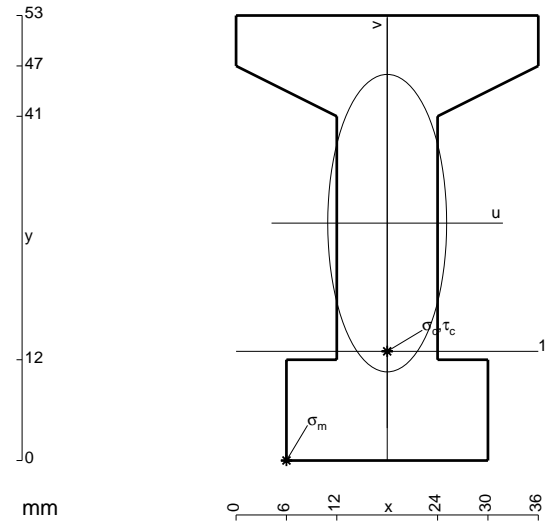
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

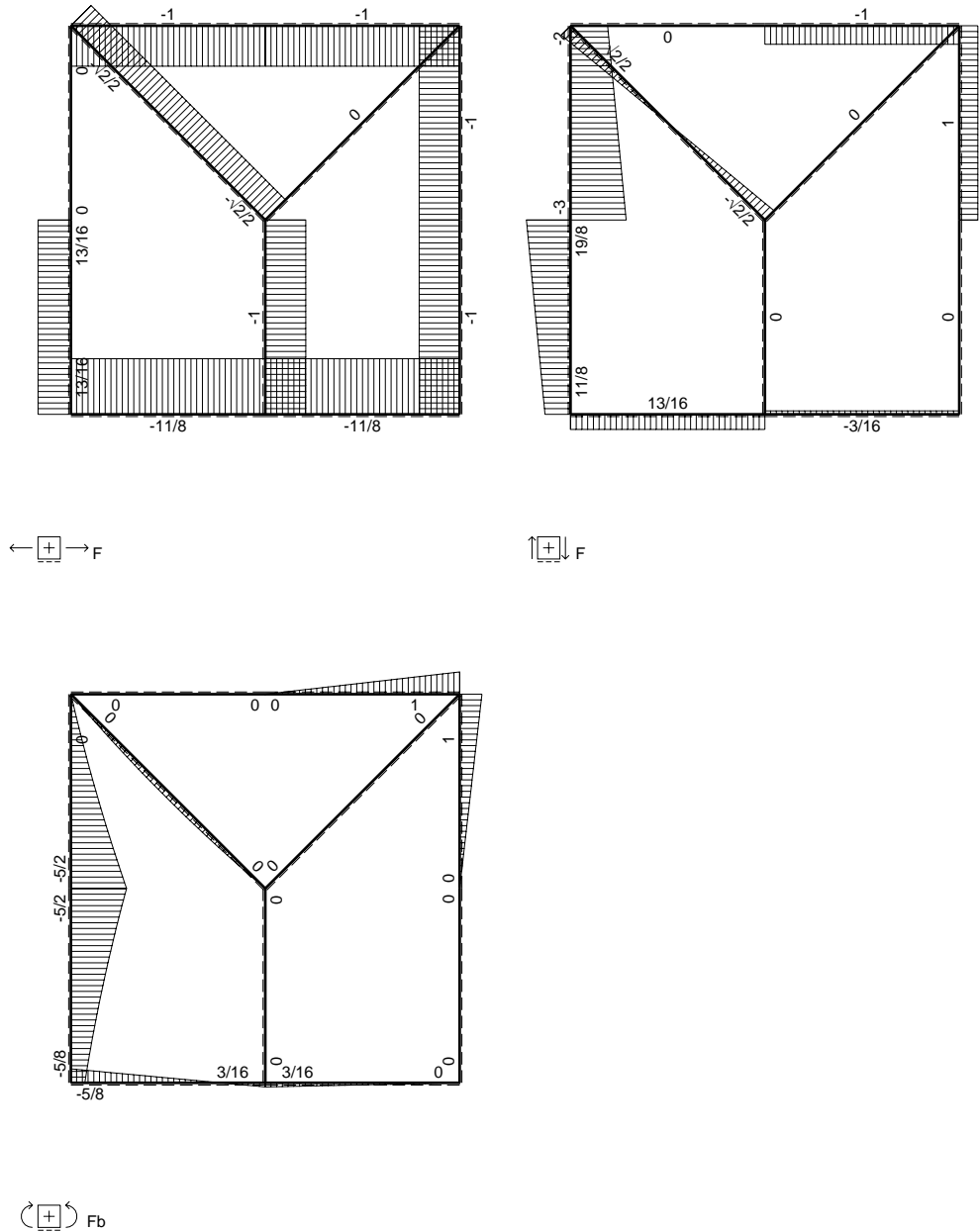
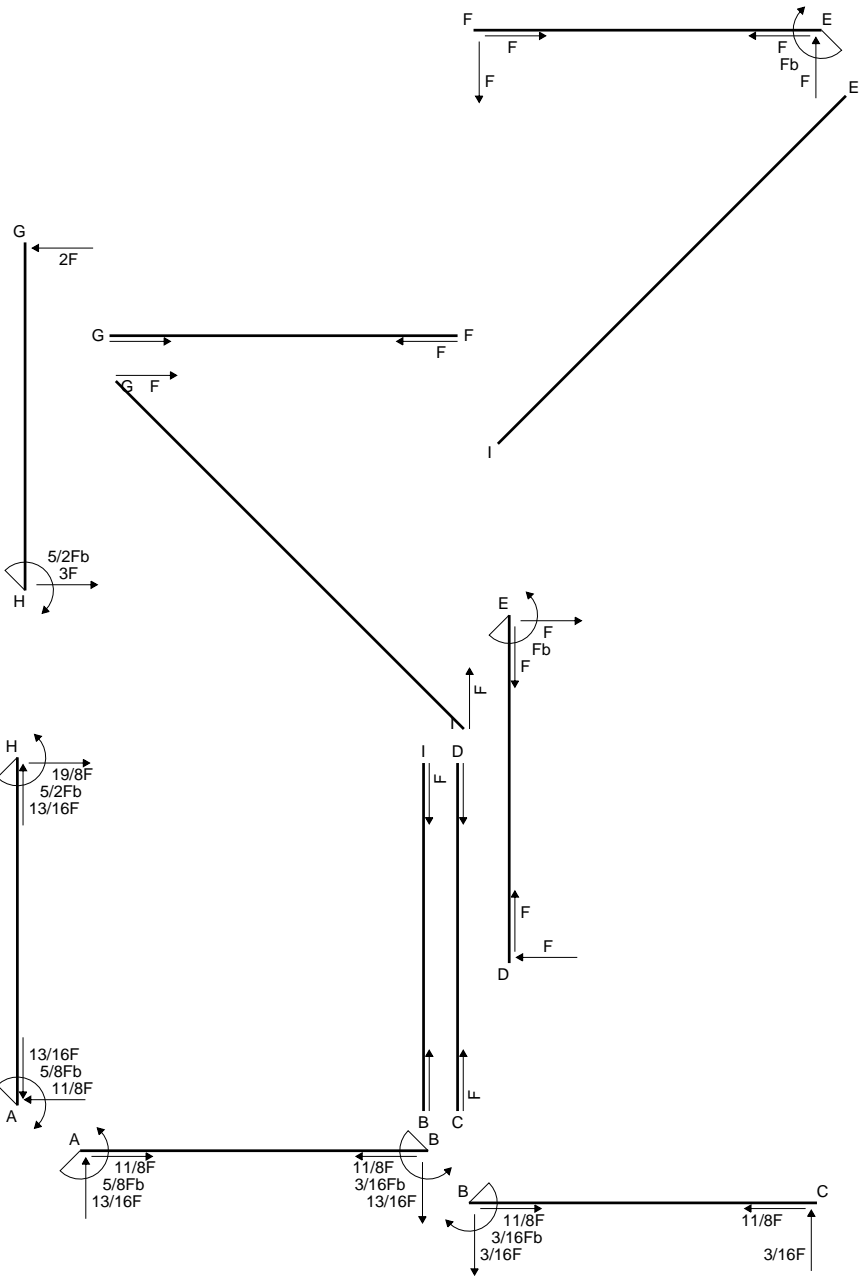
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

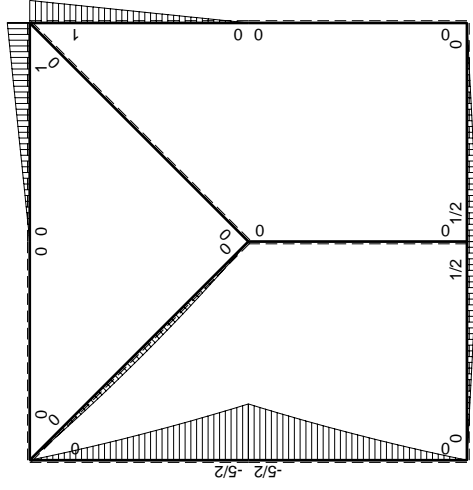
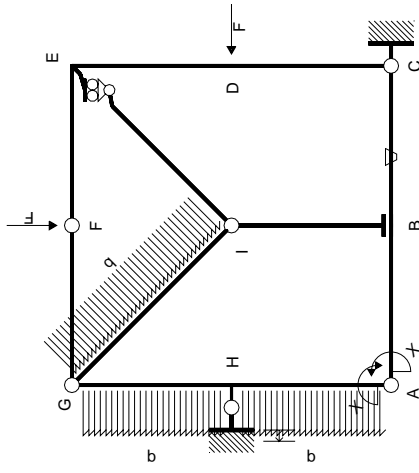
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



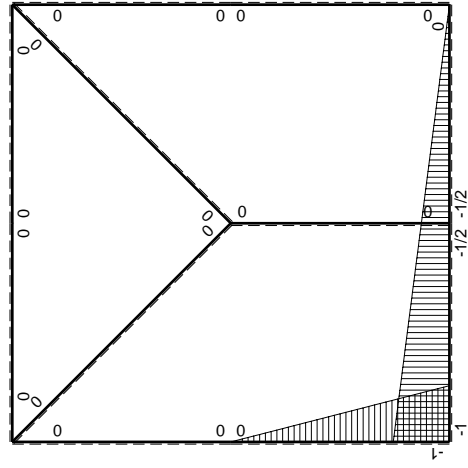
- A = 996. mm<sup>2</sup>
- J<sub>u</sub> = 312739. mm<sup>4</sup>
- J<sub>v</sub> = 49968. mm<sup>4</sup>
- y<sub>g</sub> = 28.27 mm
- T<sub>y</sub> = -3630. N
- M<sub>x</sub> = -2208250. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.27 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -199.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.27 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -107.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.387 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 108.4 N/mm<sup>2</sup>
- S = 6603. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	$-Fb/EJ$	$-1/4Fb+1/2Fx-1/4Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	$Fb/EJ$	$-1/4Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/6 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

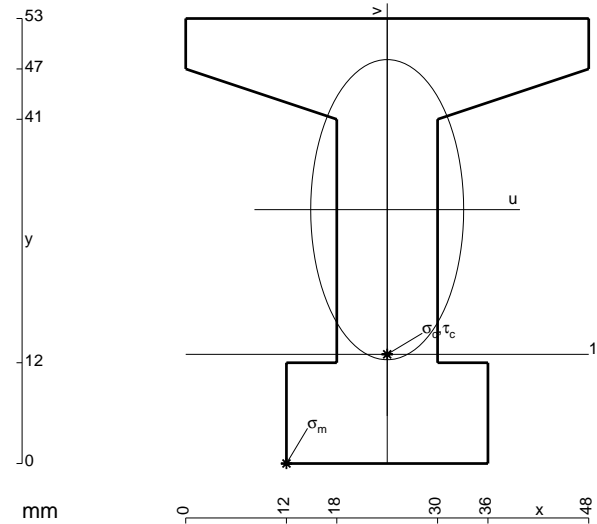
$$= (-1/12 b) Fb 1/EJ + (-1/4 b) \theta = 1/6 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

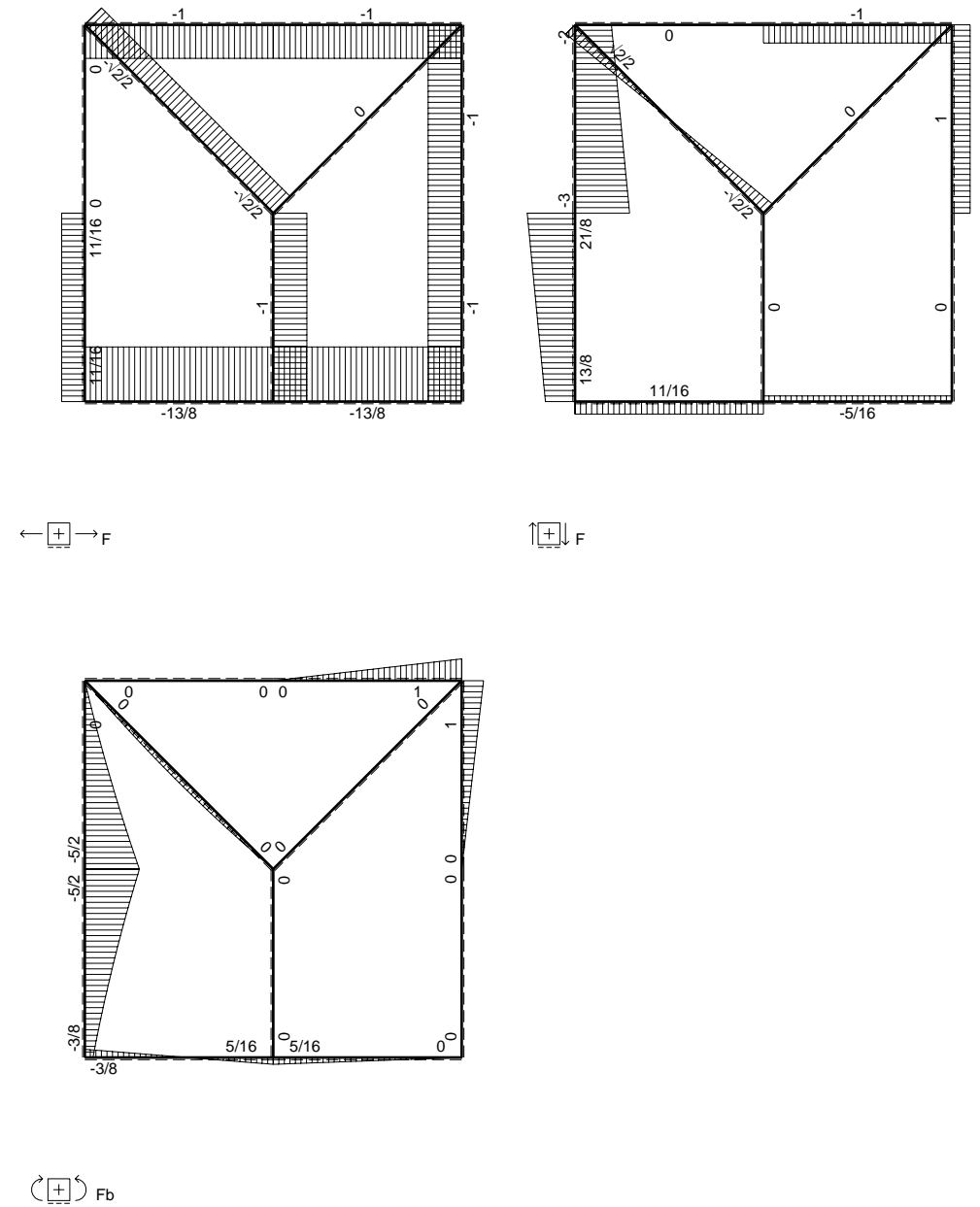
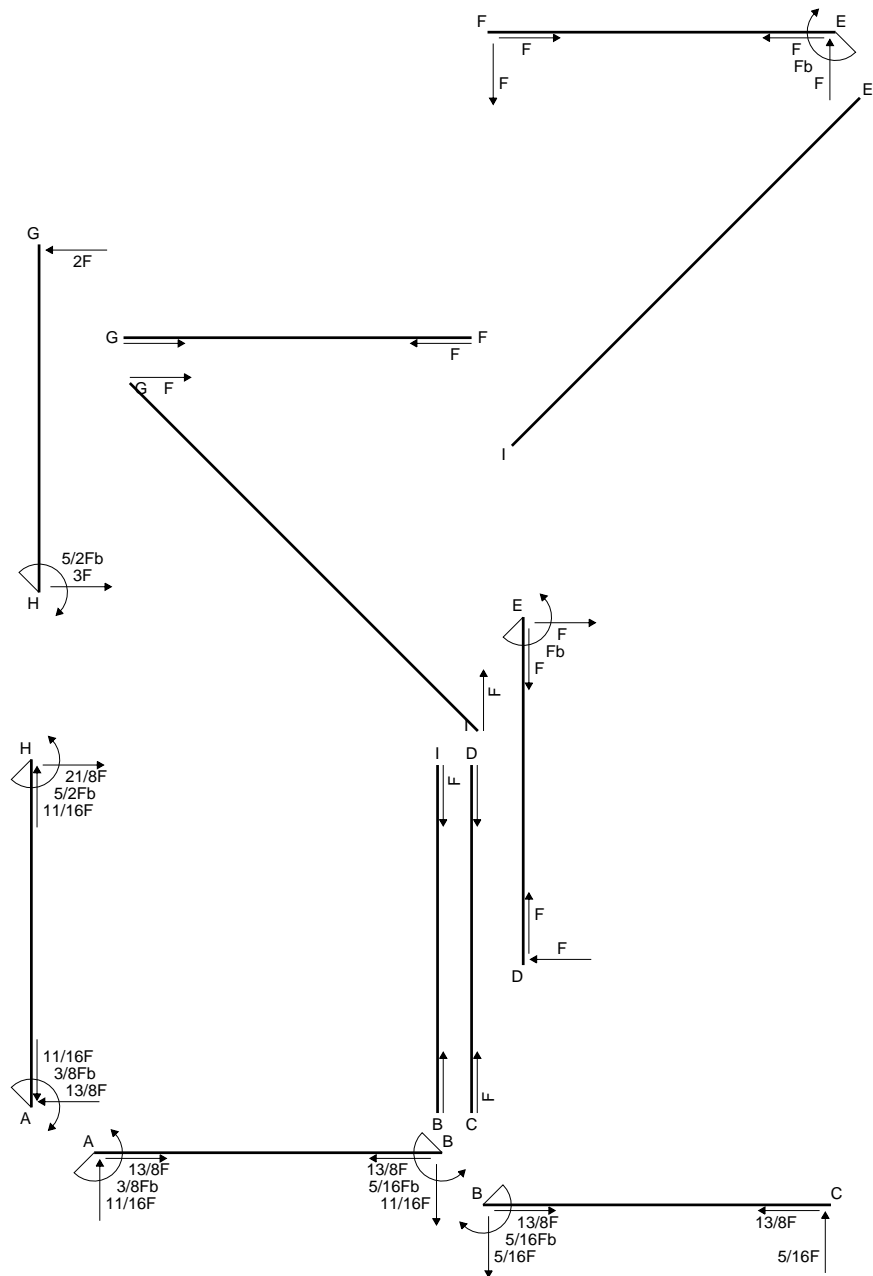
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

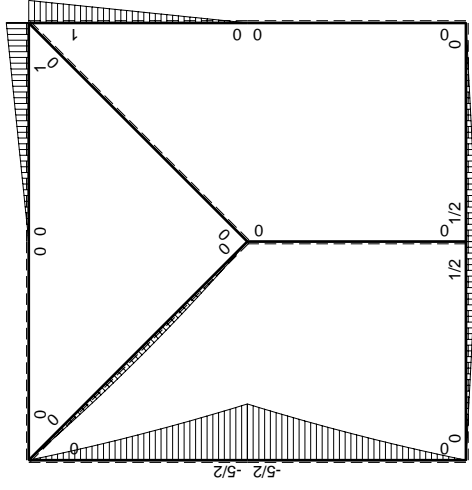
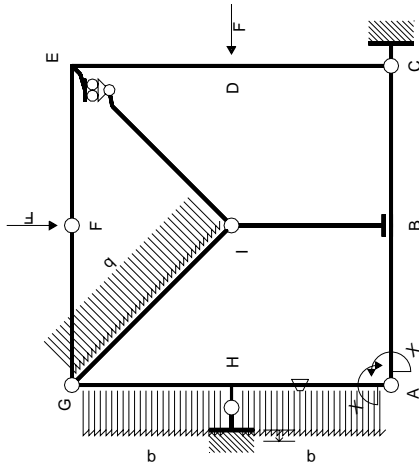
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

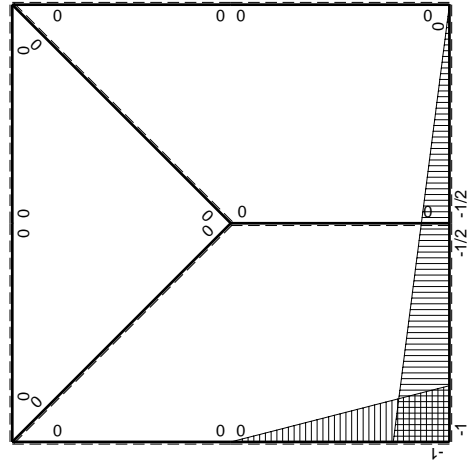


- A = 1104. mm<sup>2</sup>
- J<sub>u</sub> = 352844. mm<sup>4</sup>
- J<sub>v</sub> = 91656. mm<sup>4</sup>
- y<sub>g</sub> = 30.23 mm
- T<sub>y</sub> = -3750. N
- M<sub>x</sub> = -2437500. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.23 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -208.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -17.23 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -119.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.37 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 119.6 N/mm<sup>2</sup>
- S = 7192. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_X$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	-Fb/EJ	$5/2Fx-3Fx^2/b+1/2qx^3/b$	Fx/EJ	$x^2/b^2$	$(3/8+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	Fb/EJ	$2Fx-3/2Fx^2/b-1/2qx^3/b$	Fb/EJ-Fx/EJ	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

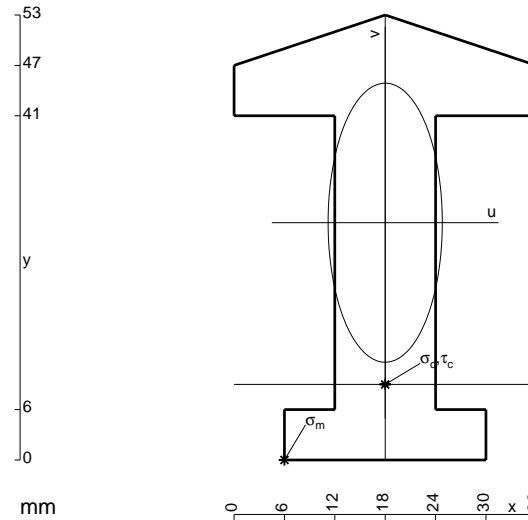
$$= [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 7/8 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

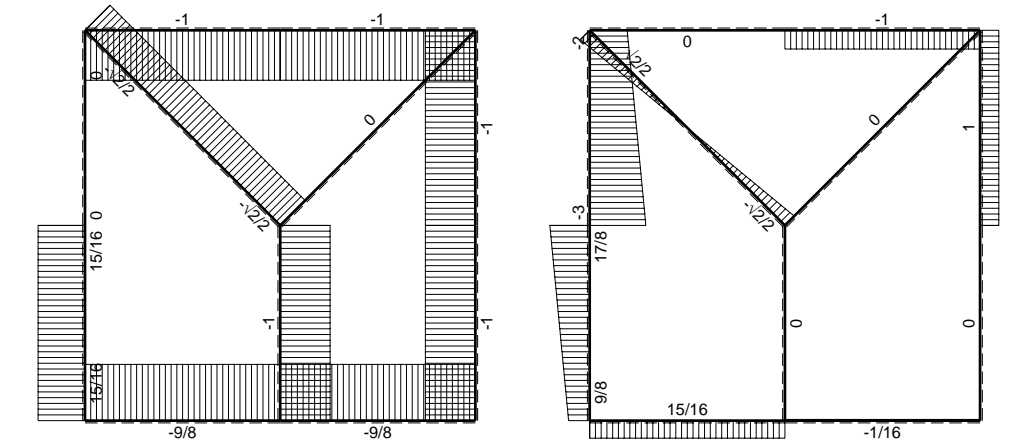
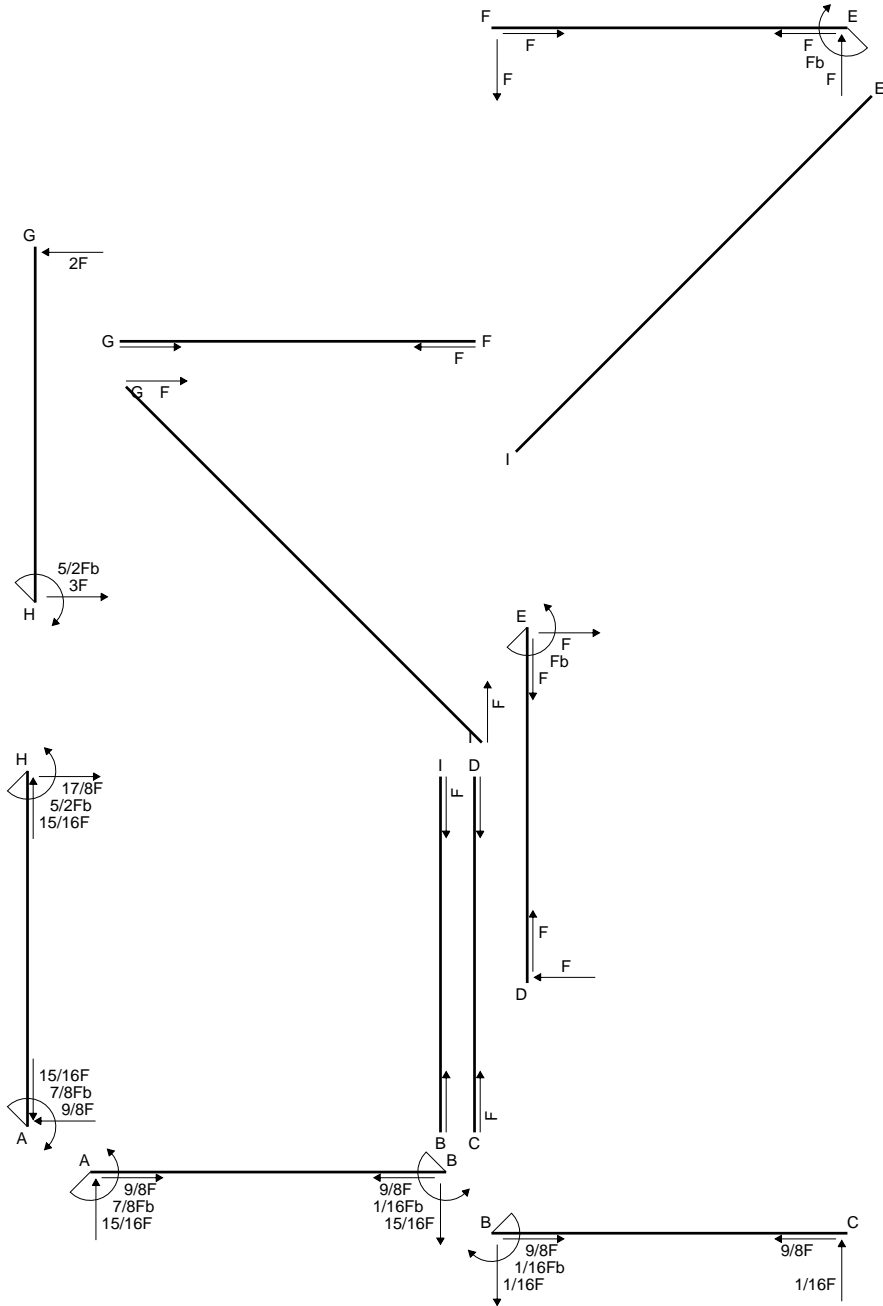
$$= [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 7/8 Fb^2/EJ$$



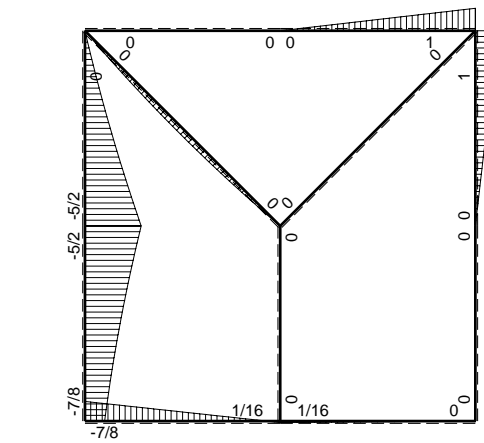
- A = 888. mm<sup>2</sup>
- J<sub>u</sub> = 245538. mm<sup>4</sup>
- J<sub>v</sub> = 41112. mm<sup>4</sup>
- y<sub>g</sub> = 28.26 mm
- T<sub>y</sub> = -2760. N
- M<sub>x</sub> = -1909000. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.26 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -219.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -19.26 mm
- σ<sub>c</sub> = -Mv/J<sub>v</sub> = -149.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.108 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup> + 3τ<sup>2</sup> = 149.9 N/mm<sup>2</sup>
- S = 4385. mm<sup>3</sup>



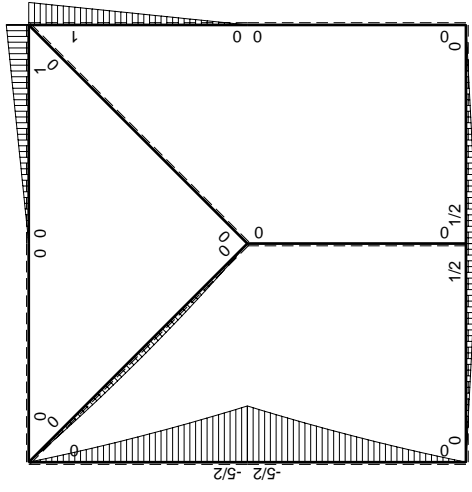
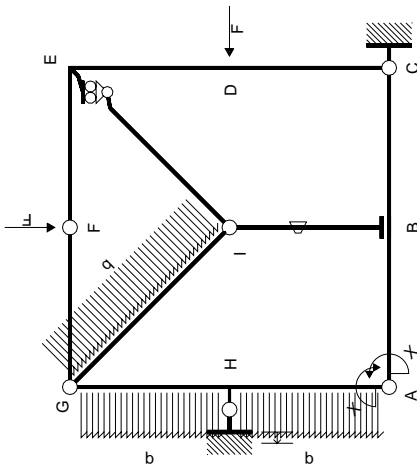


← ⊕ → F

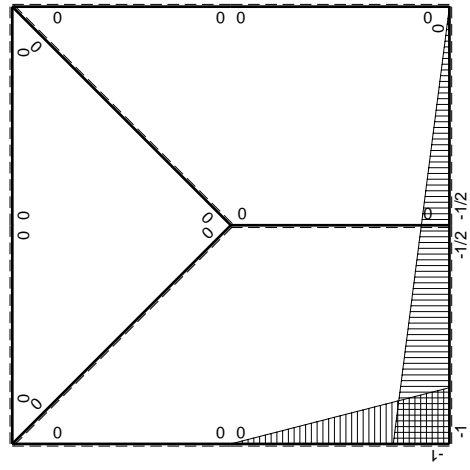
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	0	-Fb/EJ	0	0	0	0+0	0	
BI b	0	0	Fb/EJ	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

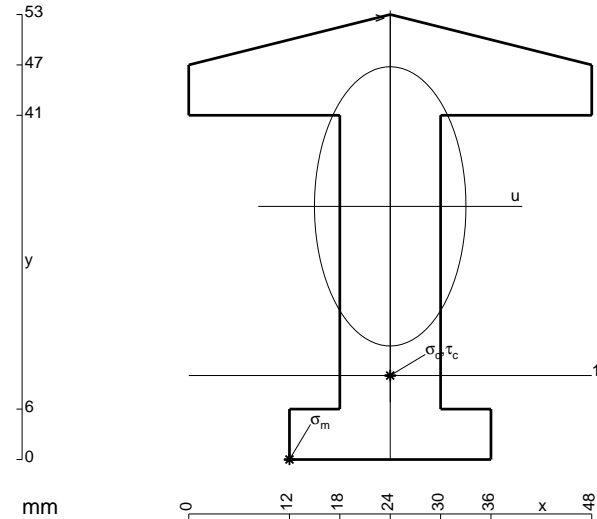
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

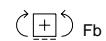
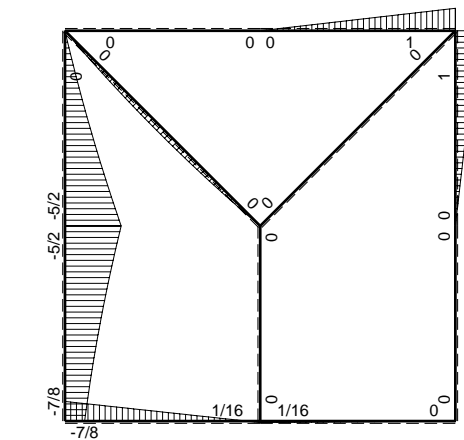
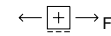
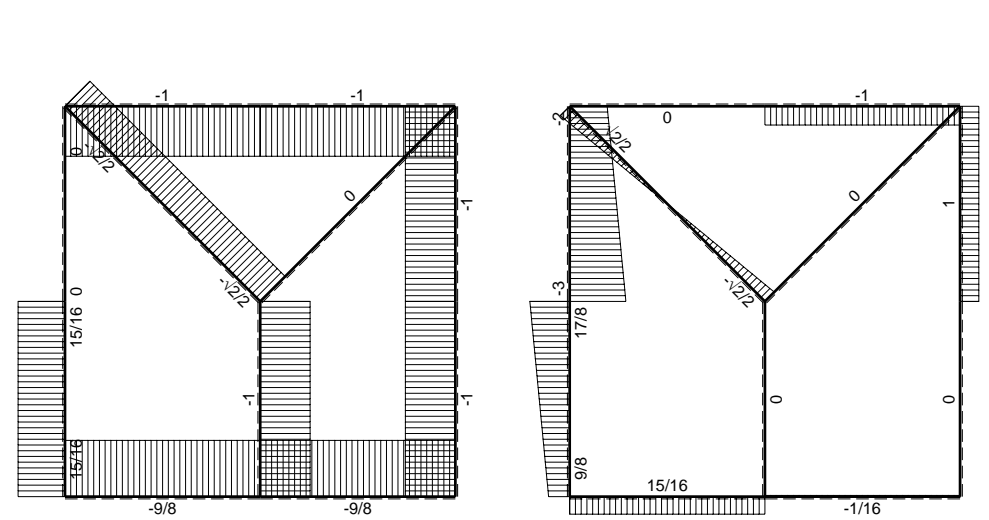
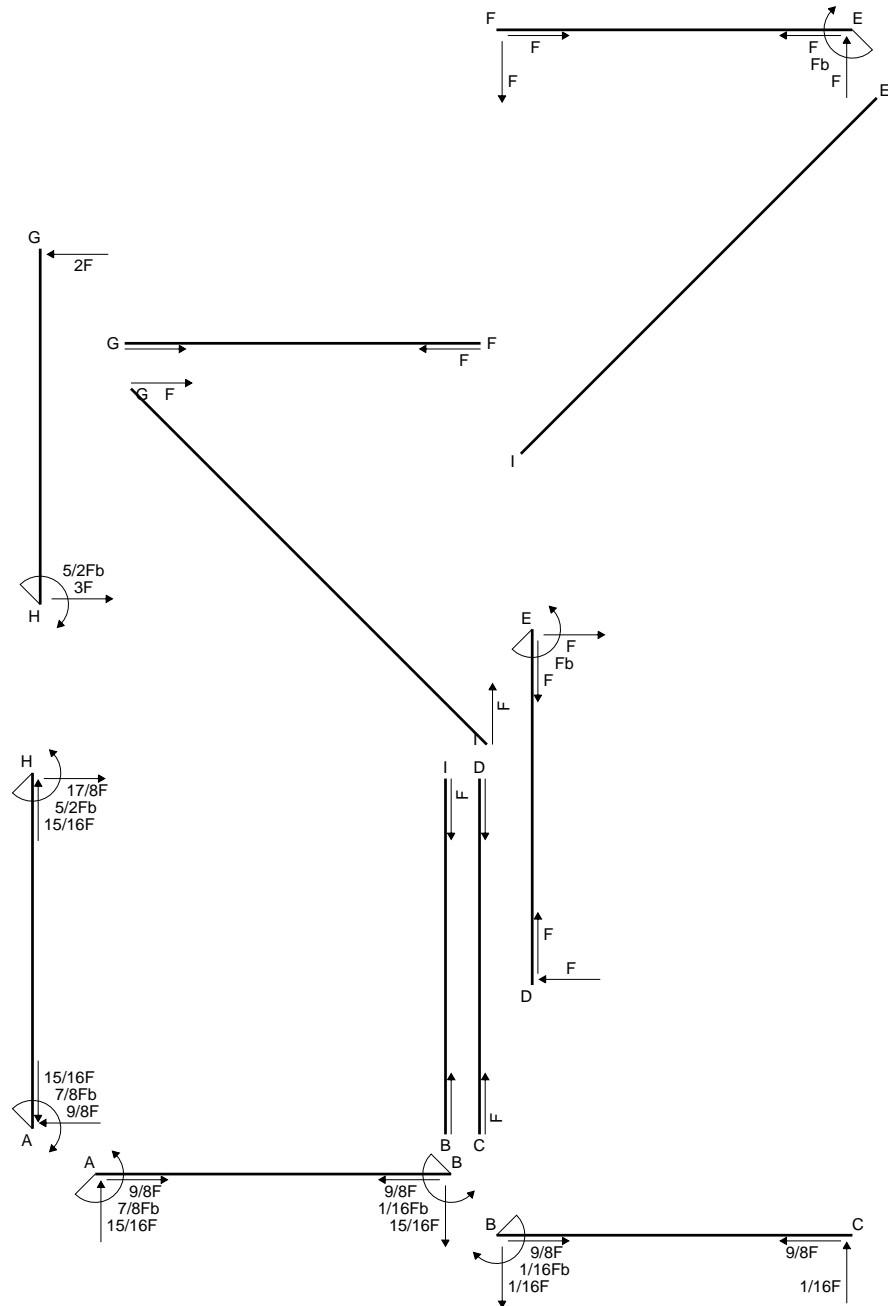
$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

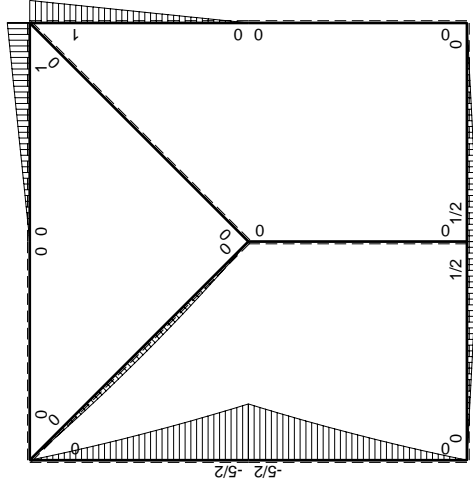
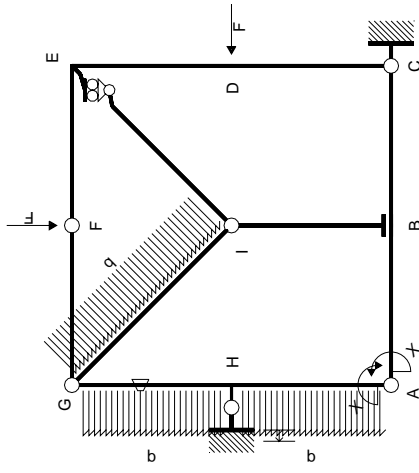
$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

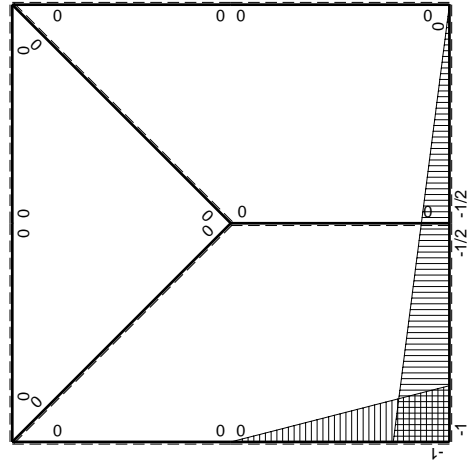


- A = 996. mm<sup>2</sup>
- J<sub>u</sub> = 275589. mm<sup>4</sup>
- J<sub>v</sub> = 81072. mm<sup>4</sup>
- y<sub>g</sub> = 30.15 mm
- T<sub>y</sub> = -2850. N
- M<sub>x</sub> = -2090000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.15 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -228.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 10. mm
- V<sub>c</sub> = -20.15 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -152.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.286 N/mm<sup>2</sup>
- σ<sub>0</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 153. N/mm<sup>2</sup>
- S = 4973. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	0	0	0	0	0+0	0	
FE b	0	-Fx	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	$-2Fx-1/2qx^2$	-Fb/EJ	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	Fb/EJ	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

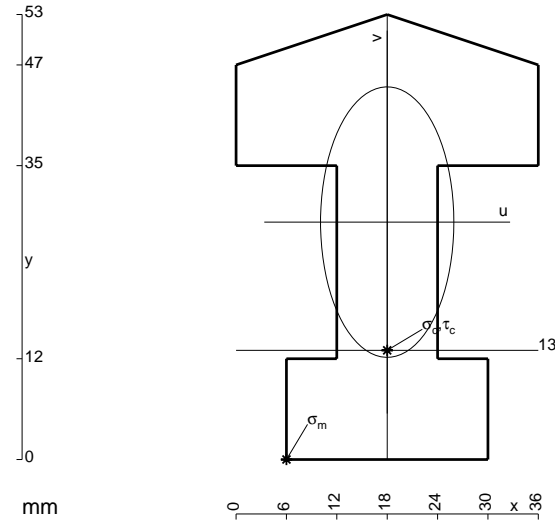
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

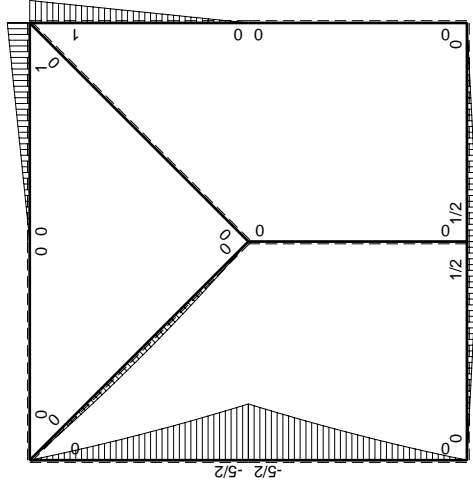
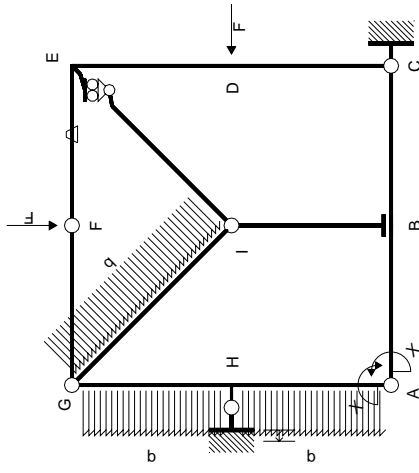
$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



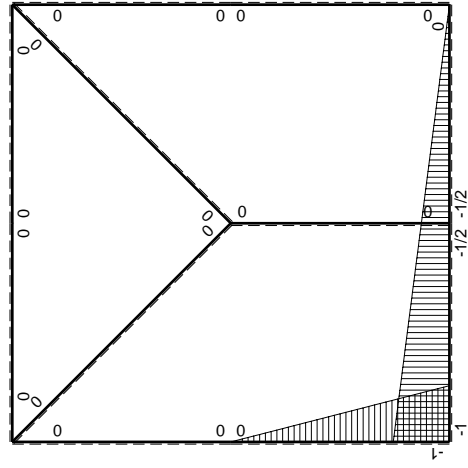
- A = 1104. mm<sup>2</sup>
- J<sub>u</sub> = 286555. mm<sup>4</sup>
- J<sub>v</sub> = 69624. mm<sup>4</sup>
- y<sub>g</sub> = 28.28 mm
- T<sub>y</sub> = -3120. N
- M<sub>x</sub> = -2418000. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.28 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -238.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 13. mm
- v<sub>c</sub> = -15.28 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -128.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.993 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 129.3 N/mm<sup>2</sup>
- S = 6605. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	0	0	0	0	0	0+0	0	
DC b	0	0	0	0	0	0			
DE b	0	Fx	0	0	0	0	0+0	0	
ED b	0	-Fb+Fx	0	0	0	0			
EF b	0	Fb-Fx	-Fb/EJ	0	0	0	0+0	0	
FE b	0	-Fx	Fb/EJ	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

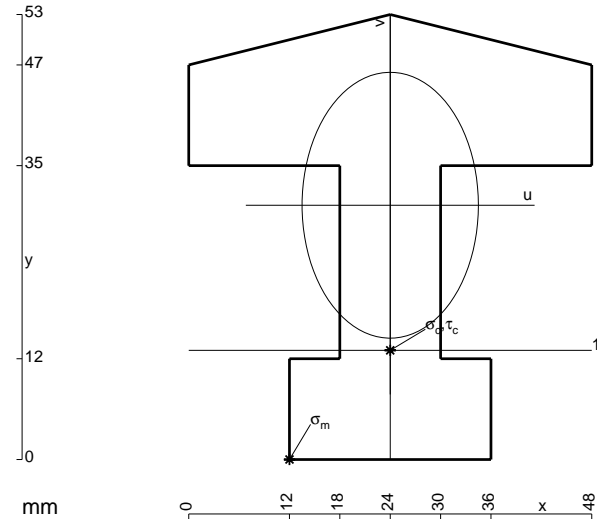
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



$$A = 1284. \text{ mm}^2$$

$$J_u = 321948. \text{ mm}^4$$

$$J_v = 141552. \text{ mm}^4$$

$$y_g = 30.28 \text{ mm}$$

$$T_y = -5190. \text{ N}$$

$$M_x = -2119250. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -30.28 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -199.4 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 13. \text{ mm}$$

$$v_c = -17.28 \text{ mm}$$

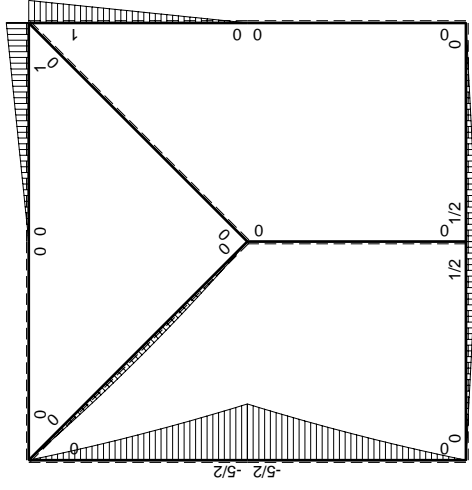
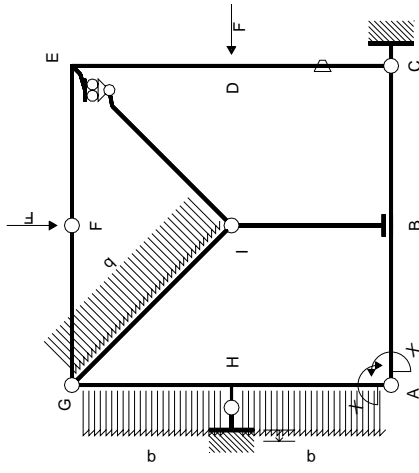
$$\sigma_c = -Mv/J_u = -113.8 \text{ N/mm}^2$$

$$\tau_c = 9.682 \text{ N/mm}^2$$

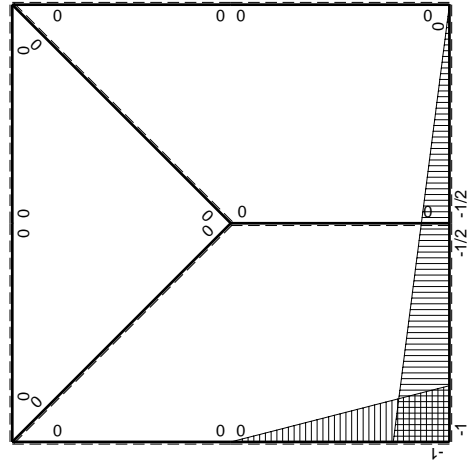
$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 115. \text{ N/mm}^2$$

$$S = 7208. \text{ mm}^3$$





$M_0$ , flessione da carichi assegnati



$M_1$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$
CD b	0	0	$-Fb/EJ$	0	0	0	0+0	0
DC b	0	0	$Fb/EJ$	0	0	0	0+0	0
DE b	0	$Fx$	0	0	0	0	0+0	0
ED b	0	$-Fb+Fx$	0	0	0	0	0+0	0
EF b	0	$Fb-Fx$	0	0	0	0	0+0	0
FE b	0	$-Fx$	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	$-2Fx-1/2qx^2$	0	0	0	0	0+0	0
HG b	0	$5/2Fb-3Fx+1/2qx^2$	0	0	0	0	0+0	0
GI $\sqrt{2}b$	0	$\sqrt{2}/2Fx-1/2qx^2$	0	0	0	0	0	0
IB b	0	0	0	0	0	0	0+0	0
BI b	0	0	0	0	0	0	0+0	0
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0
HA b	$-x/b$	$-5/2Fb+3Fx-1/2qx^2$	0	$5/2Fx-3Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
AH b	$1-x/b$	$2Fx+1/2qx^2$	0	$2Fx-3/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$	$(3/8+0)Fb^2/EJ$	$1/3Xb/EJ$
H	cedimento nodo $-H_{1H}u_H$						$-Fb^2/EJ$	
	totali						$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$						$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ x - 1/2 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x + 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x - 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = \left[ 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = \left[ 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = \left[ x - x^2/b + 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = \left[ -1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = \left[ -1/4 x + 1/12 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = \left[ -1/4 x + 1/4 x^2/b - 1/12 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = \left[ -1/12 x^3/b^2 \right]_0^b Fb 1/EJ$$

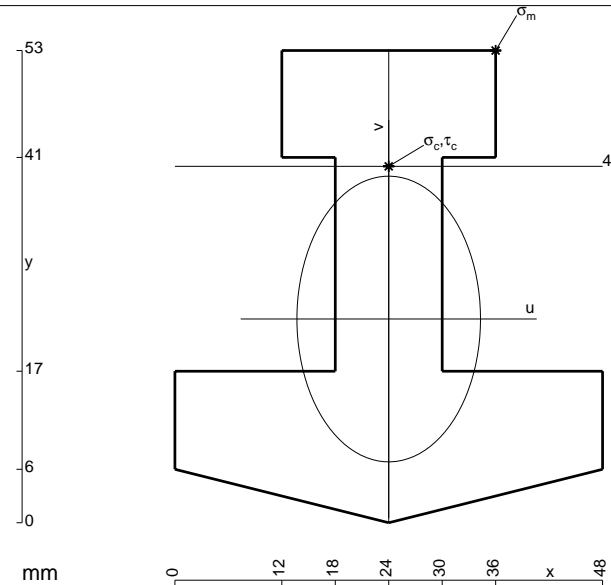
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (5/2 x/b - 3 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 5/4 x^2/b - x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (5/4 b - b + 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = \left[ x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (b - 1/2 b - 1/8 b) Fb 1/EJ = 3/8 Fb^2/EJ$$



$$A = 1248. \text{ mm}^2$$

$$J_u = 320937. \text{ mm}^4$$

$$J_v = 132480. \text{ mm}^4$$

$$y_g = 22.87 \text{ mm}$$

$$T_y = -5040. \text{ N}$$

$$M_x = -2226000. \text{ Nmm}$$

$$x_m = 36. \text{ mm}$$

$$y_m = 53. \text{ mm}$$

$$u_m = 12. \text{ mm}$$

$$v_m = 30.13 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 209. \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 40. \text{ mm}$$

$$v_c = 17.13 \text{ mm}$$

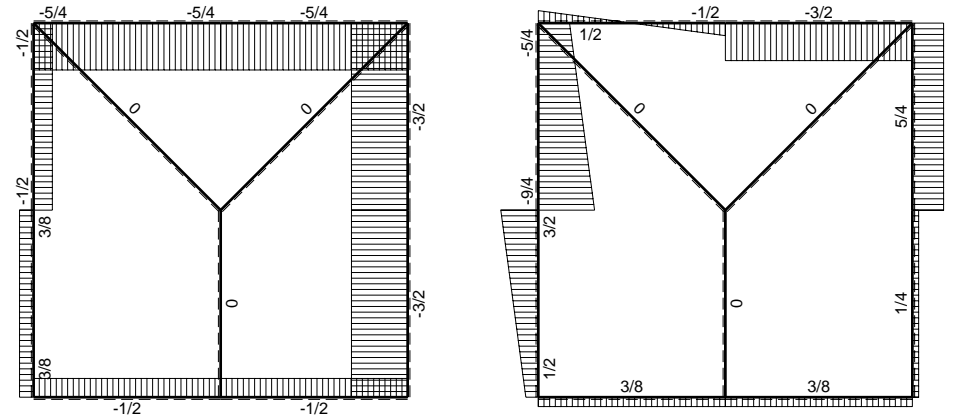
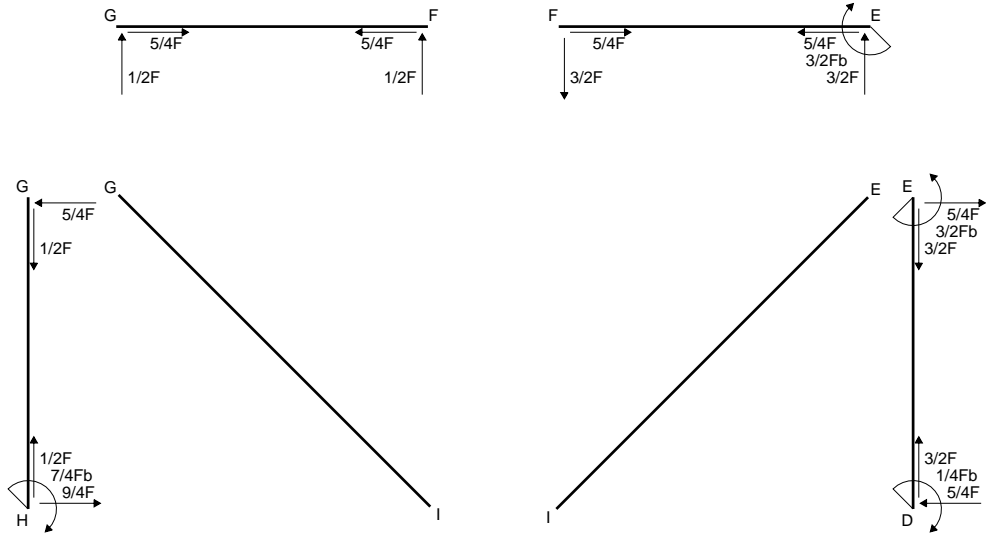
$$\sigma_c = -Mv/J_u = 118.8 \text{ N/mm}^2$$

$$\tau_c = 9.373 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 119.9 \text{ N/mm}^2$$

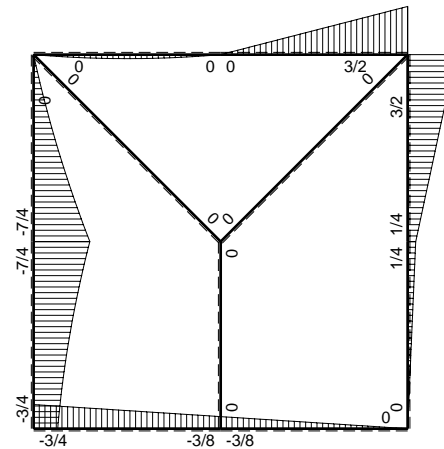
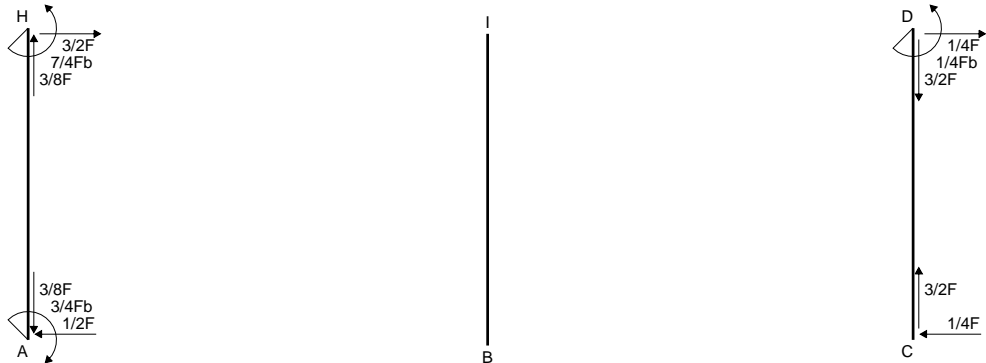
$$S = 7162. \text{ mm}^3$$



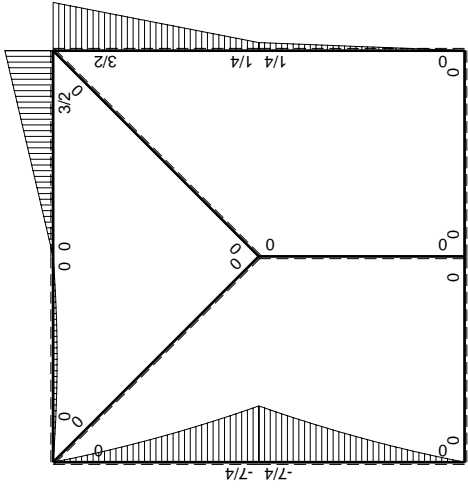
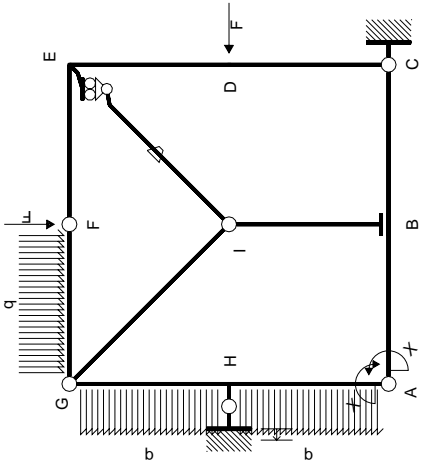


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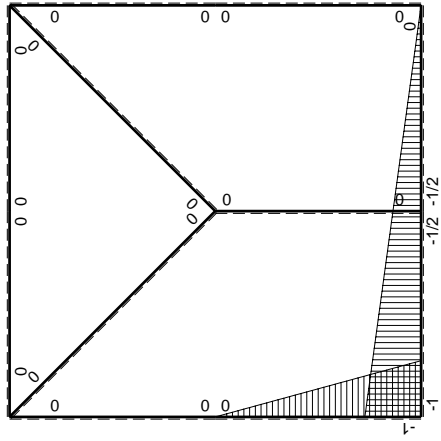
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

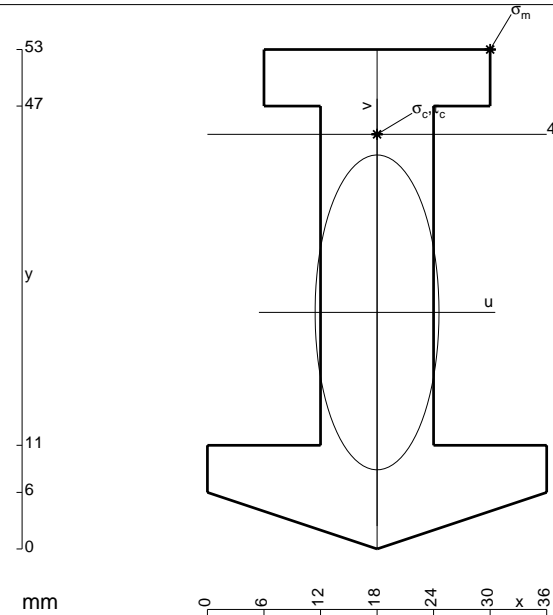
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

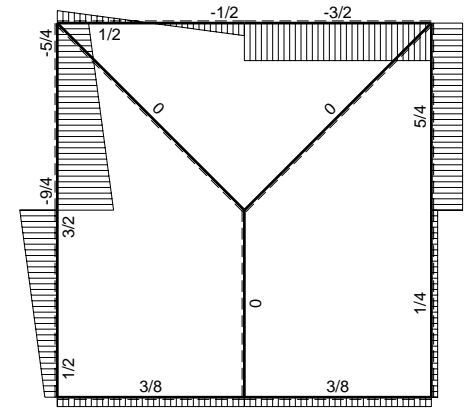
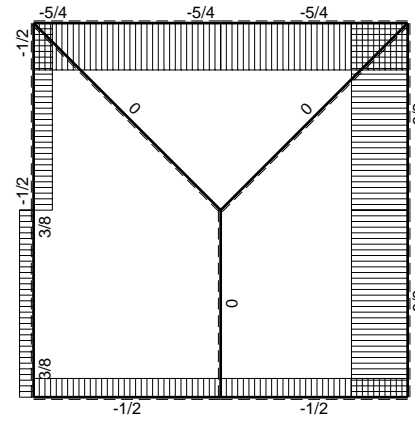
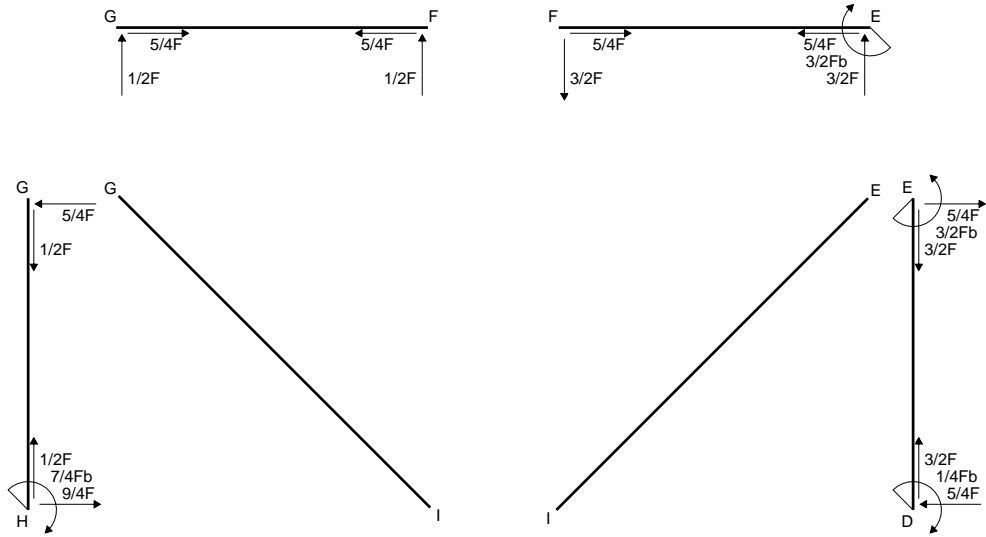
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

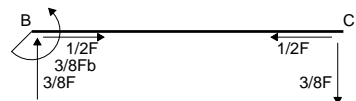
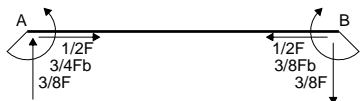
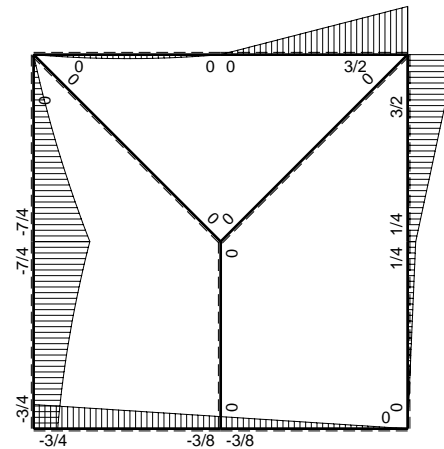
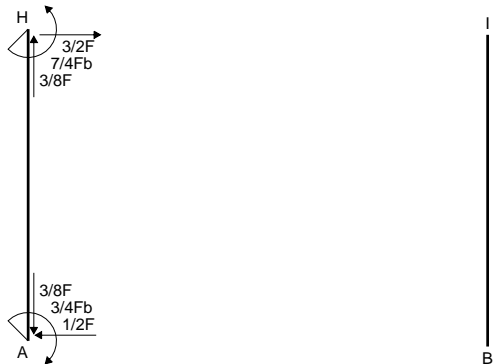


$A = 864. \text{ mm}^2$   
 $J_u = 241215. \text{ mm}^4$   
 $J_v = 37368. \text{ mm}^4$   
 $y_g = 25.1 \text{ mm}$   
 $N = -940. \text{ N}$   
 $T_y = -4230. \text{ N}$   
 $M_x = -1908200. \text{ Nmm}$   
 $x_m = 30. \text{ mm}$   
 $y_m = 53. \text{ mm}$   
 $u_m = 12. \text{ mm}$   
 $v_m = 27.9 \text{ mm}$   
 $\sigma_m = N/A - Mv/J_u = 219.6 \text{ N/mm}^2$   
 $x_c = 18. \text{ mm}$   
 $y_c = 44. \text{ mm}$   
 $v_c = 18.9 \text{ mm}$   
 $\sigma_c = N/A - Mv/J_u = 148.4 \text{ N/mm}^2$   
 $\tau_c = 6.312 \text{ N/mm}^2$   
 $\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 148.8 \text{ N/mm}^2$   
 $S = 4319. \text{ mm}^3$

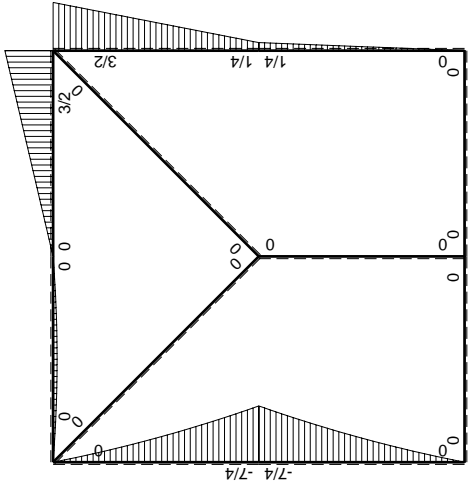
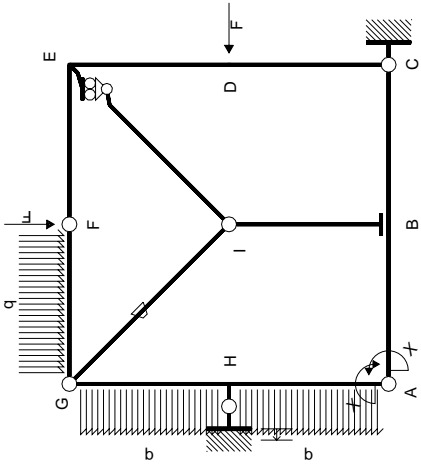


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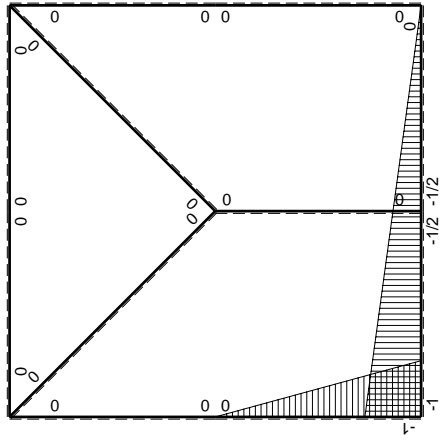
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2 x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

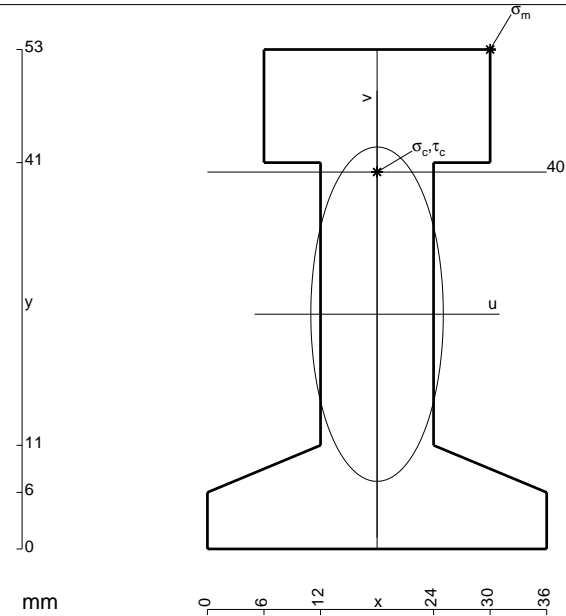
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

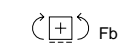
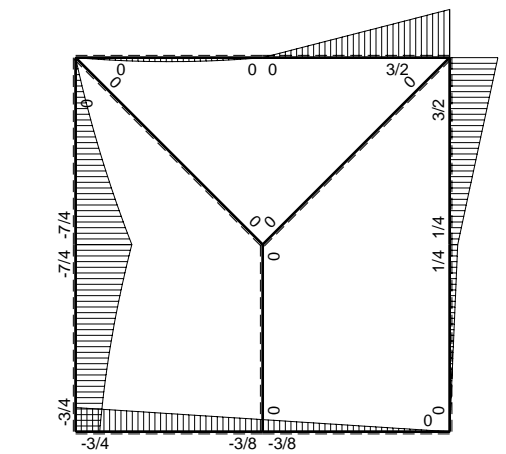
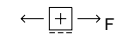
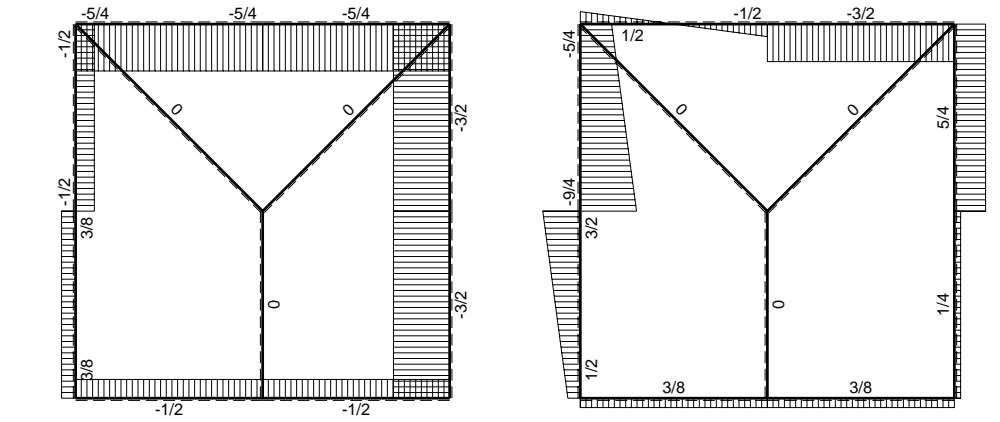
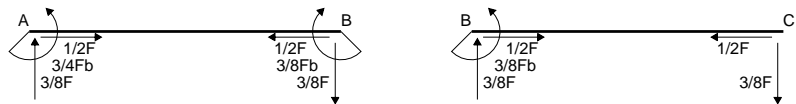
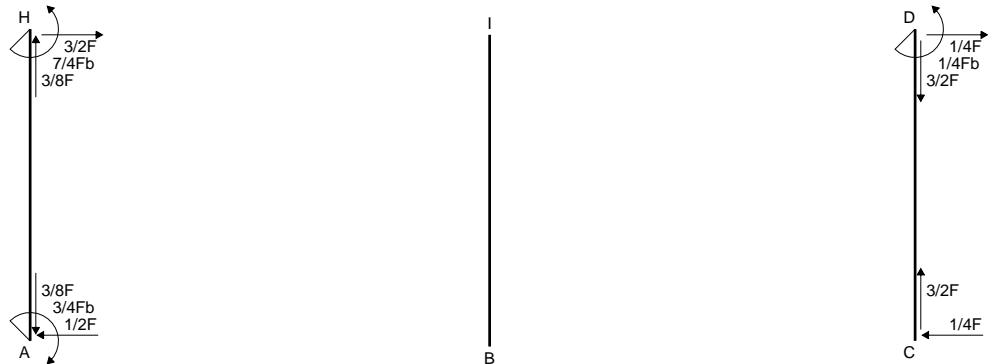
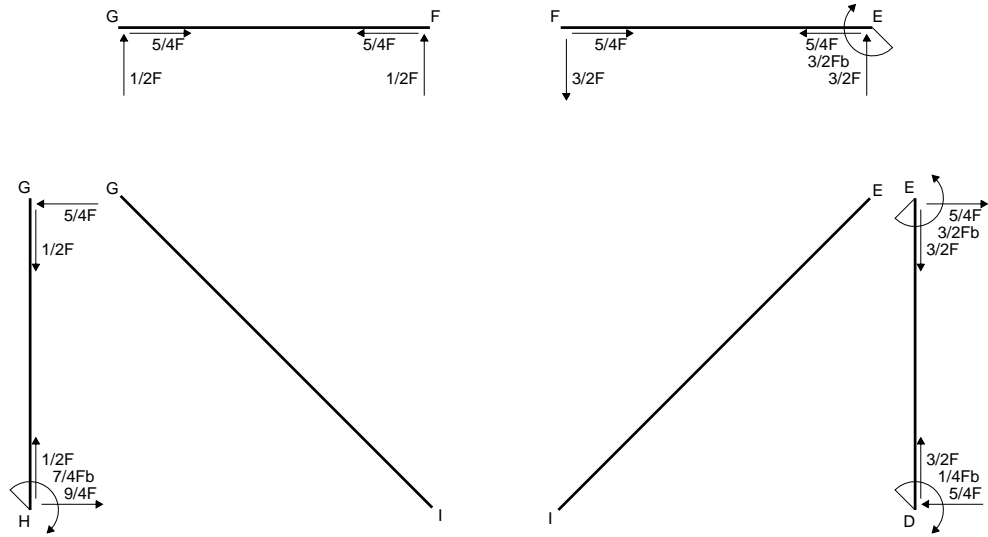
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

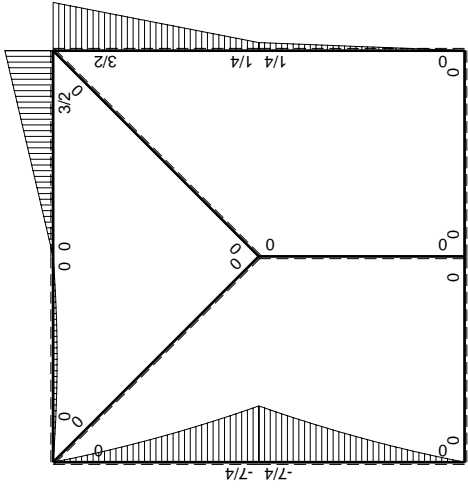
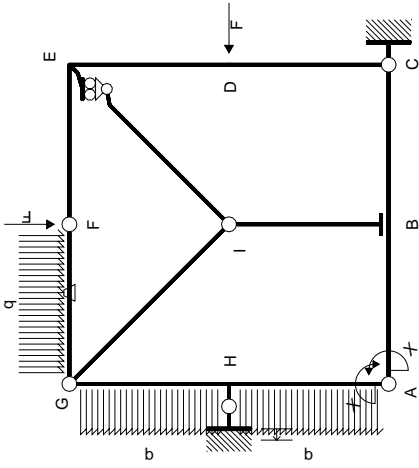
$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



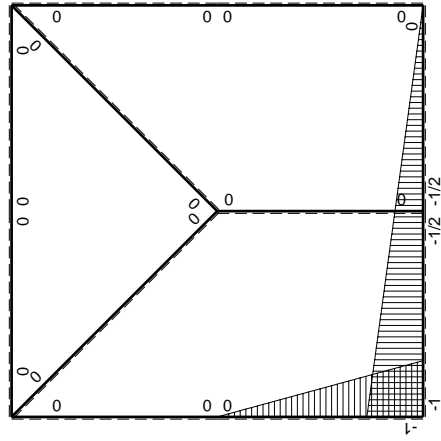
- A = 984. mm<sup>2</sup>
- J<sub>u</sub> = 309963. mm<sup>4</sup>
- J<sub>v</sub> = 48672. mm<sup>4</sup>
- y<sub>g</sub> = 24.91 mm
- N = -1155. N
- T<sub>y</sub> = -5198. N
- M<sub>x</sub> = -2546780. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.09 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 229.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 15.09 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 122.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 9.15 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup> + 3τ<sup>2</sup> = 123.8 N/mm<sup>2</sup>
- S = 6548. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	$Fb/EJ$	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

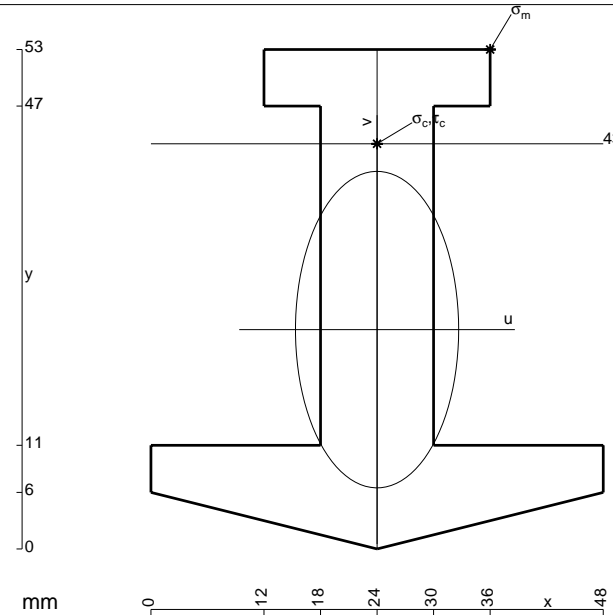
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

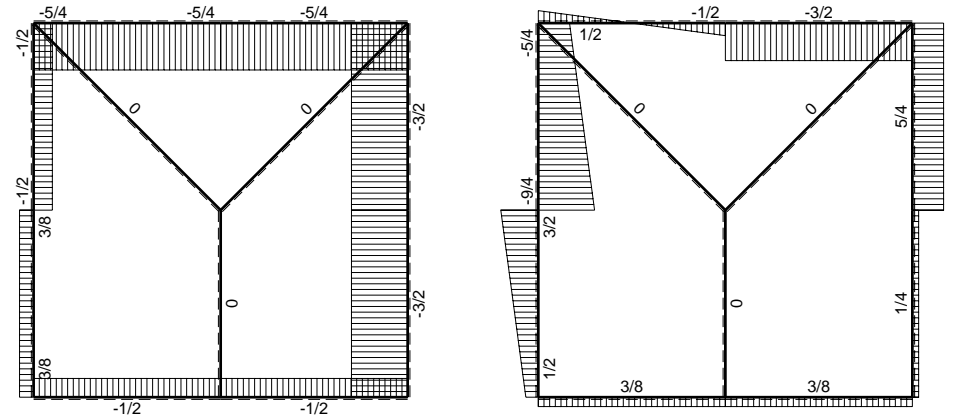
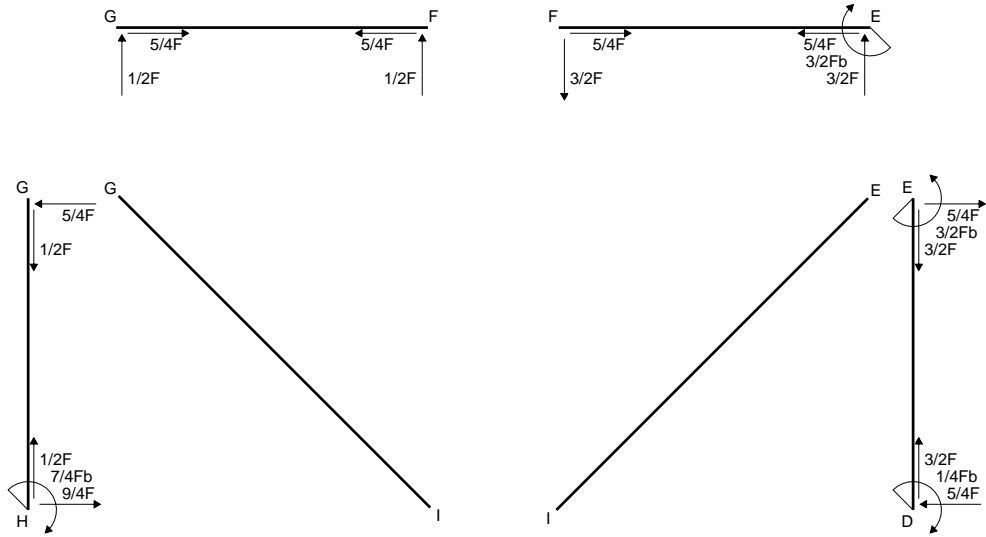
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

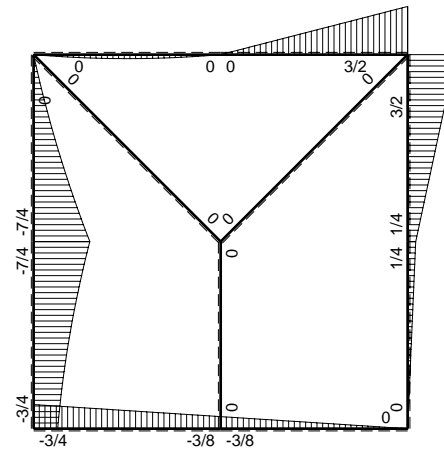
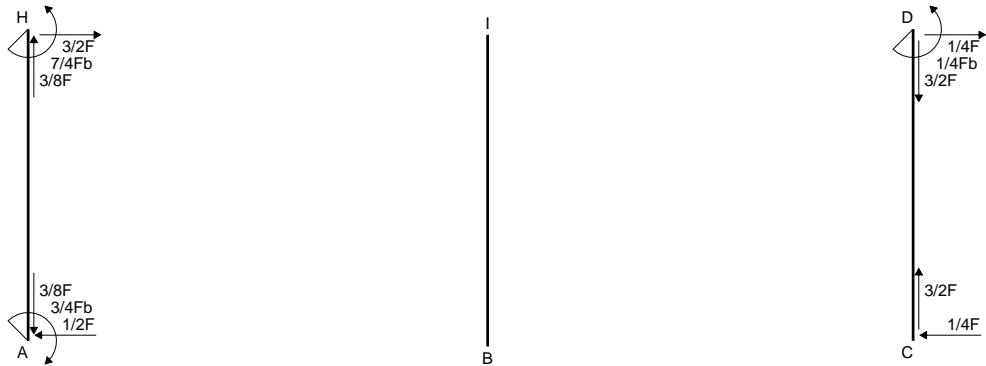


- A = 960. mm<sup>2</sup>
- J<sub>u</sub> = 270775. mm<sup>4</sup>
- J<sub>v</sub> = 72000. mm<sup>4</sup>
- y<sub>g</sub> = 23.27 mm
- N = -920. N
- T<sub>y</sub> = -4140. N
- M<sub>x</sub> = -2189600. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 29.73 mm
- σ<sub>m</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = 239.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 43. mm
- v<sub>c</sub> = 19.73 mm
- σ<sub>c</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = 158.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.232 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 158.9 N/mm<sup>2</sup>
- S = 4891. mm<sup>3</sup>

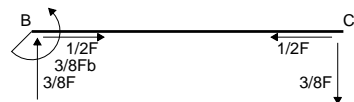
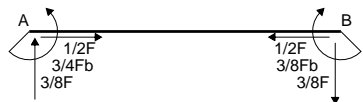


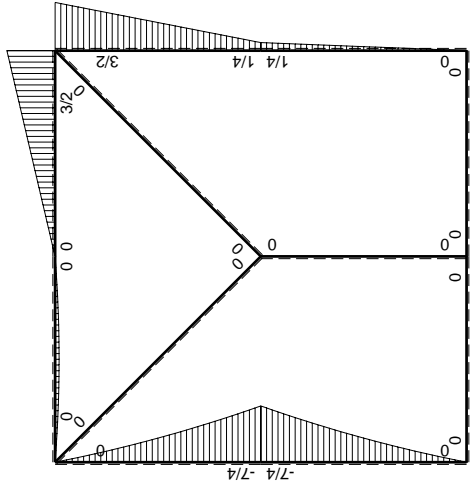
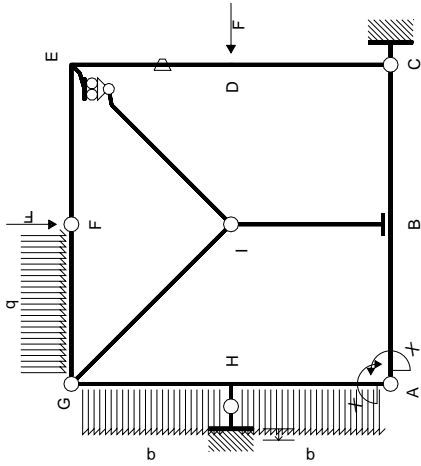
← ⊕ → F

↑ ⊕ ↓ F

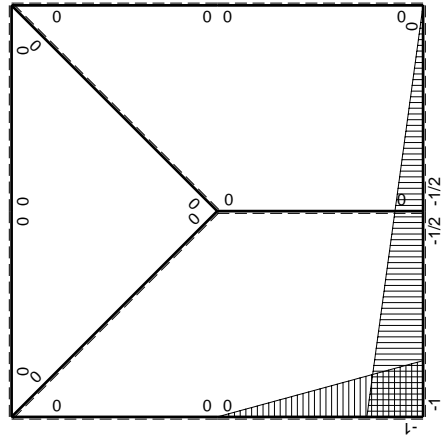


⊕ ⊖ F<sub>b</sub>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	$Fb/EJ$	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

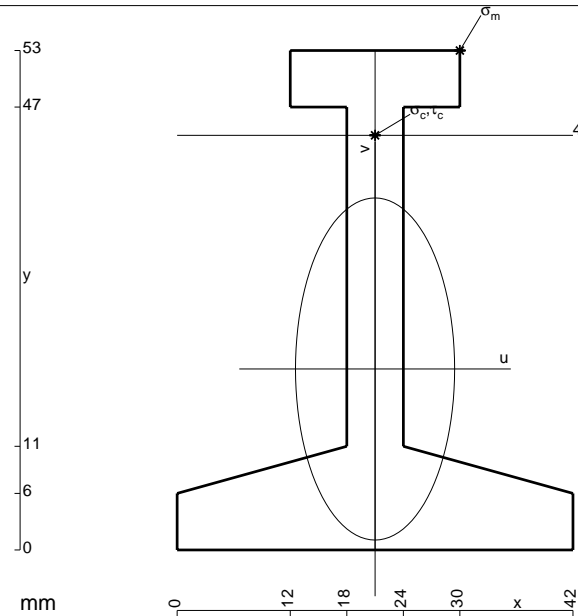
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

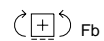
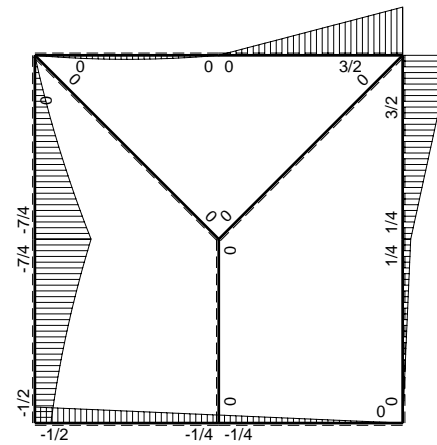
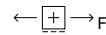
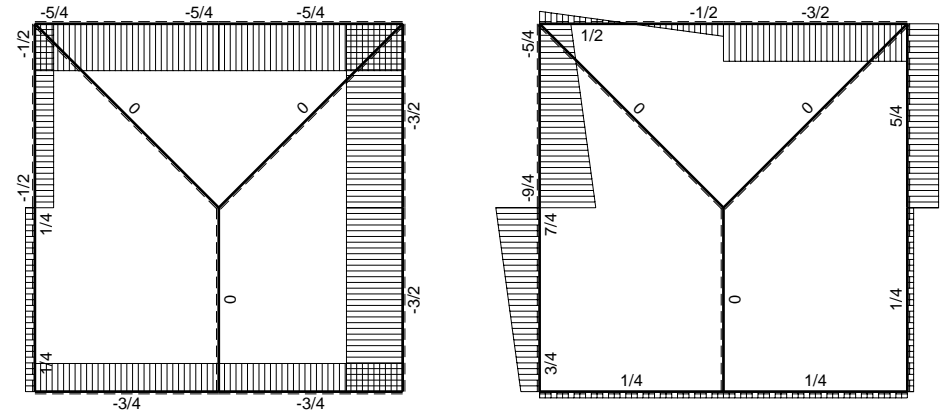
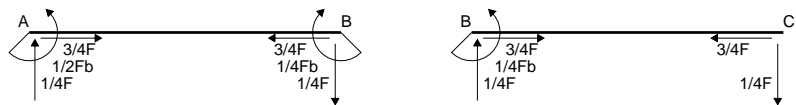
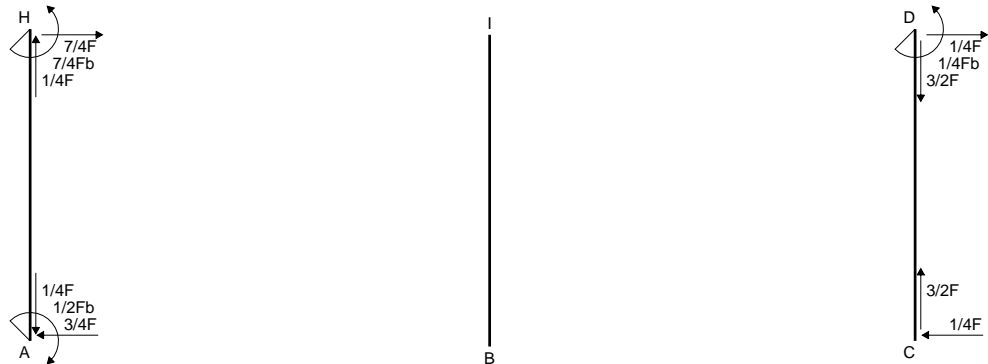
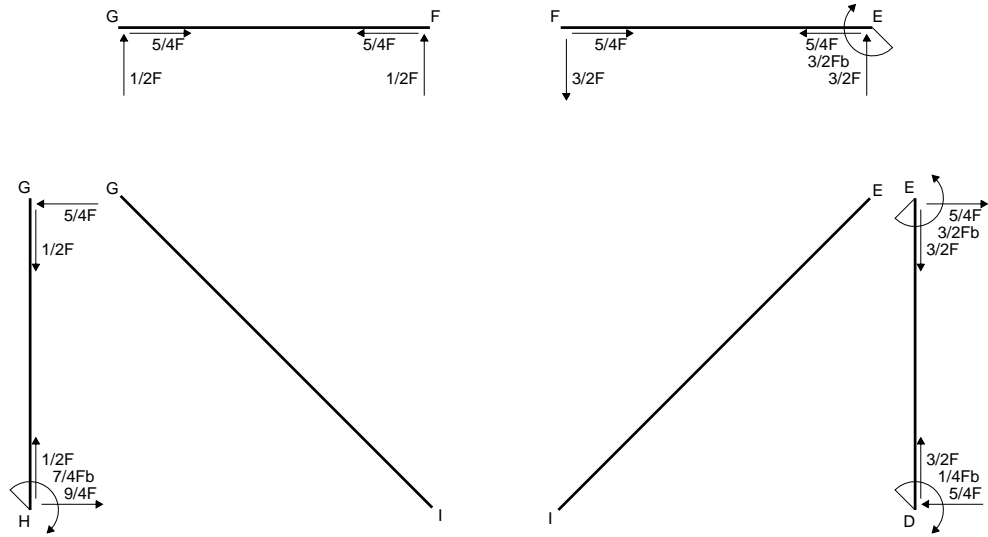
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

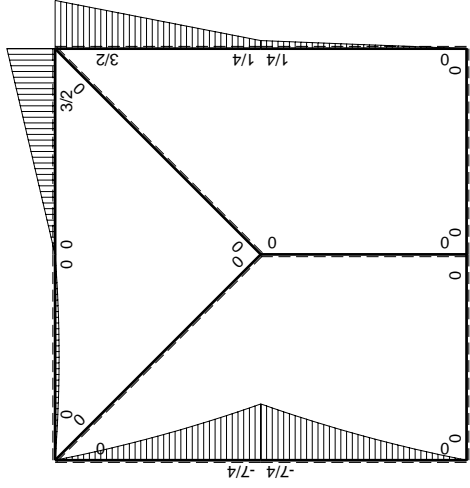
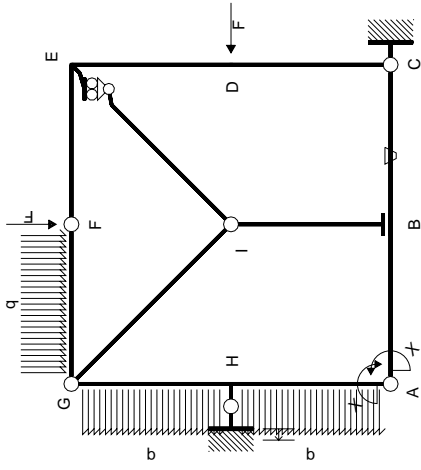
$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



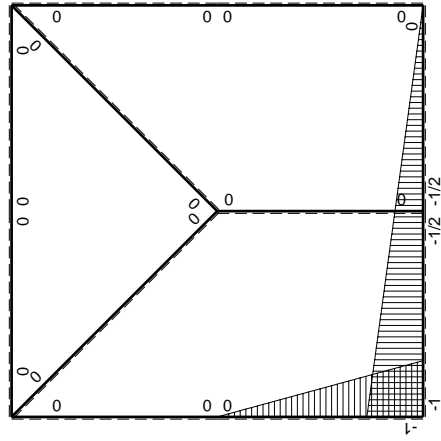
$A = 696. \text{ mm}^2$   
 $J_u = 229334. \text{ mm}^4$   
 $J_v = 49608. \text{ mm}^4$   
 $y_g = 19.2 \text{ mm}$   
 $N = -530. \text{ N}$   
 $T_y = -2385. \text{ N}$   
 $M_x = -1354150. \text{ Nmm}$   
 $x_m = 30. \text{ mm}$   
 $y_m = 53. \text{ mm}$   
 $u_m = 9. \text{ mm}$   
 $v_m = 33.8 \text{ mm}$   
 $\sigma_m = N/A - Mv/J_u = 198.8 \text{ N/mm}^2$   
 $x_c = 21. \text{ mm}$   
 $y_c = 44. \text{ mm}$   
 $v_c = 24.8 \text{ mm}$   
 $\sigma_c = N/A - Mv/J_u = 145.7 \text{ N/mm}^2$   
 $\tau_c = 6.586 \text{ N/mm}^2$   
 $\sigma_\varrho = \sqrt{\sigma^2 + 3\tau^2} = 146.1 \text{ N/mm}^2$   
 $S = 3799. \text{ mm}^3$







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	$-Fb/EJ$	0	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(0+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	$Fb/EJ$	0	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/2Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 - 1/2 x/b) \theta dx = [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/4 b) \theta = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/2 x/b) \theta dx = [-1/4 x^2/b]_0^b \theta$$

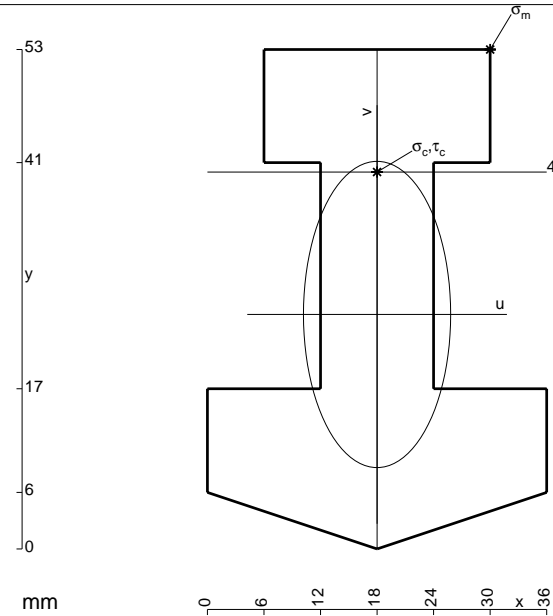
$$= (-1/4 b) \theta = 1/4 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

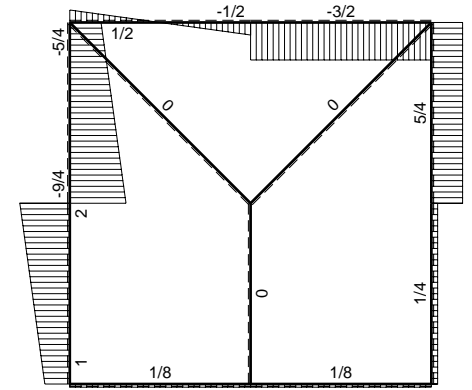
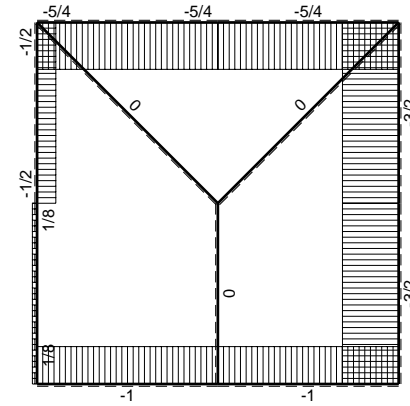
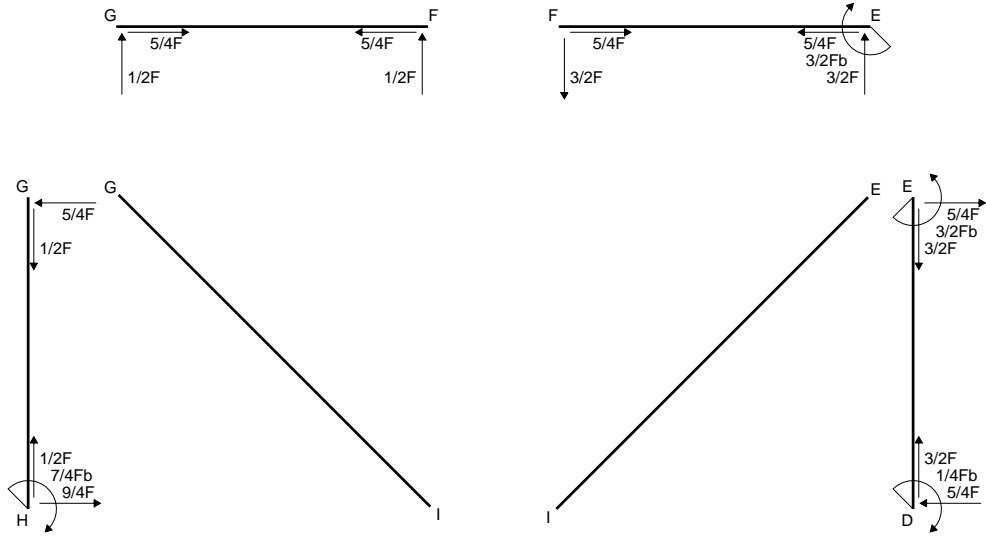
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

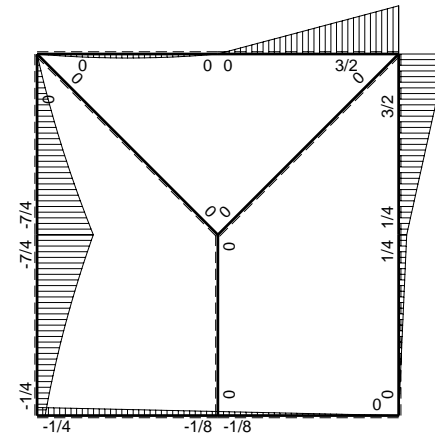
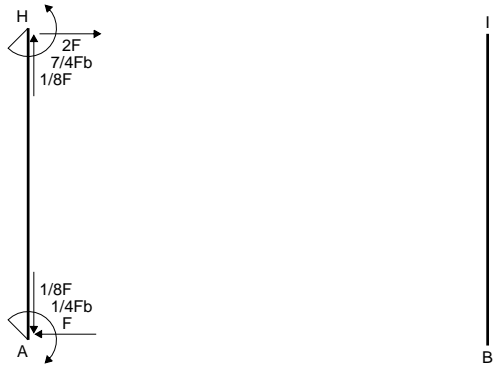


- A = 1080. mm<sup>2</sup>
- J<sub>u</sub> = 285273. mm<sup>4</sup>
- J<sub>v</sub> = 65880. mm<sup>4</sup>
- y<sub>g</sub> = 24.88 mm
- N = -780. N
- T<sub>y</sub> = -3510. N
- M<sub>x</sub> = -2129400. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.12 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 209.2 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 15.12 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 112.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.723 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 112.7 N/mm<sup>2</sup>
- S = 6557. mm<sup>3</sup>

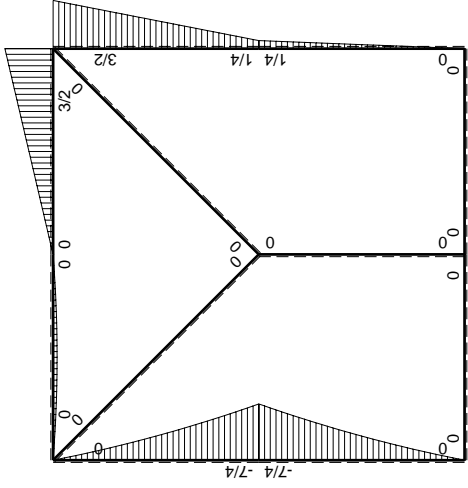
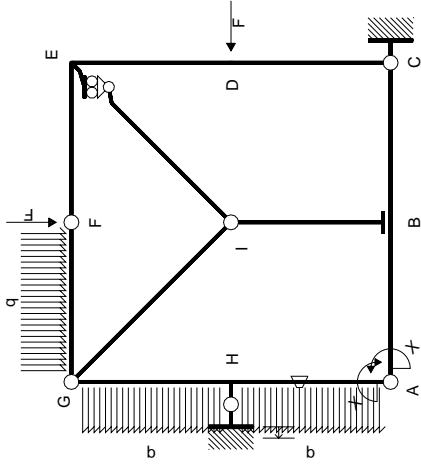


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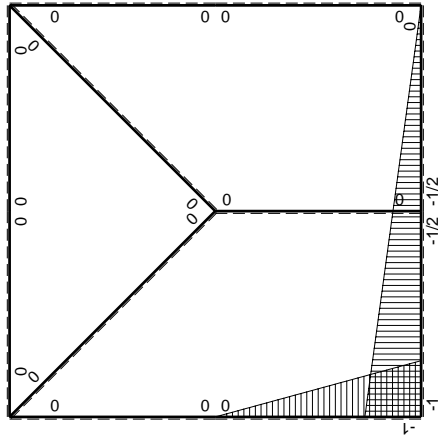
↑ ⊕ ↓ F



⊕ ⊖ Fb



$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	$-Fb/EJ$	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	$Fx/EJ$	$x^2/b^2$	$(1/4+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	$Fb/EJ$	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

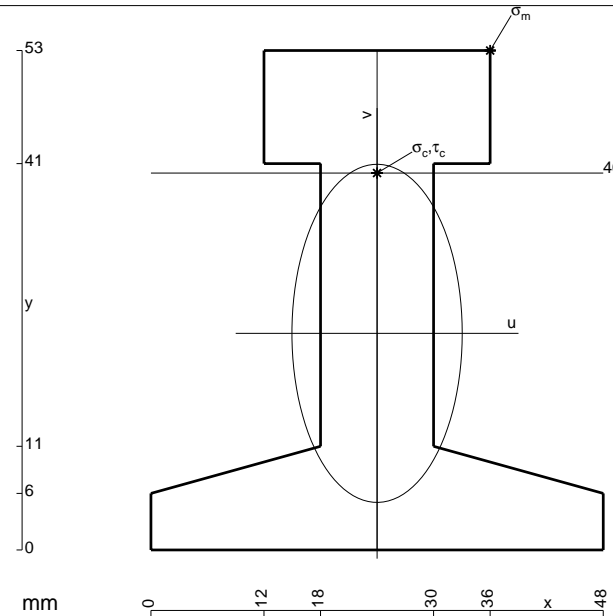
$$= [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 3/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

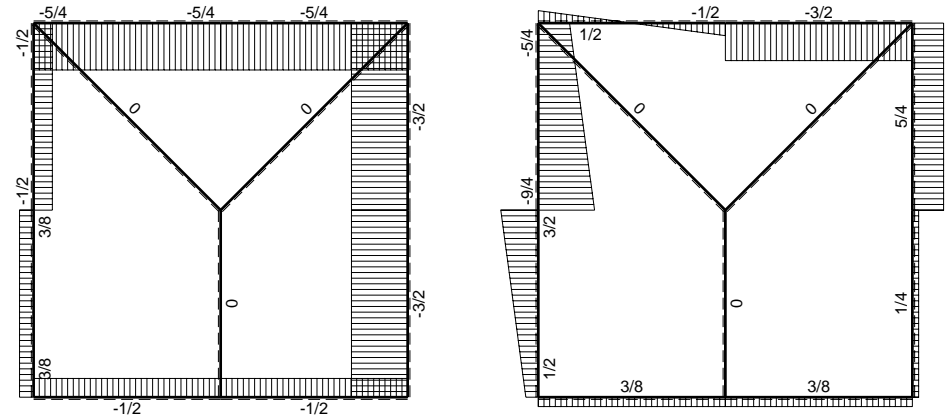
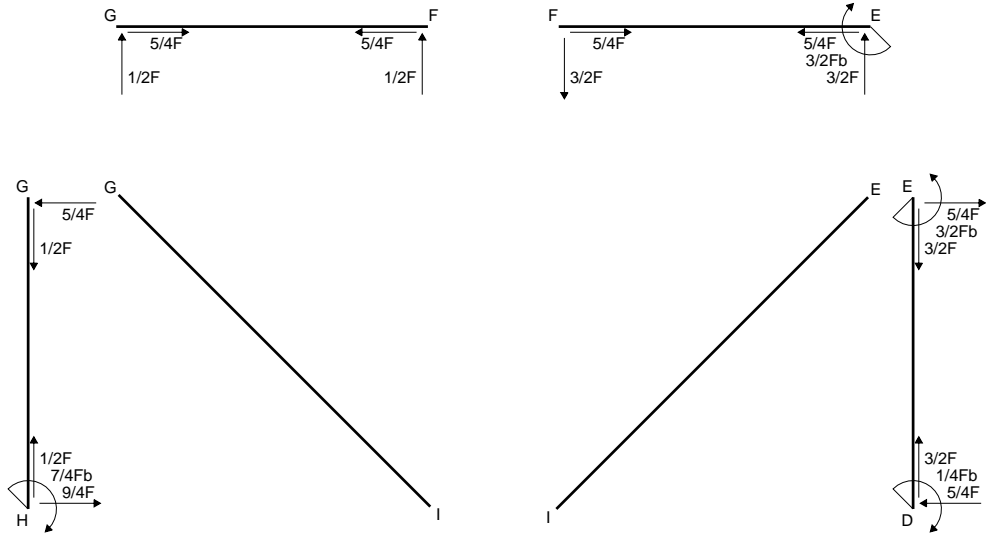
$$= [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 3/4 Fb^2/EJ$$



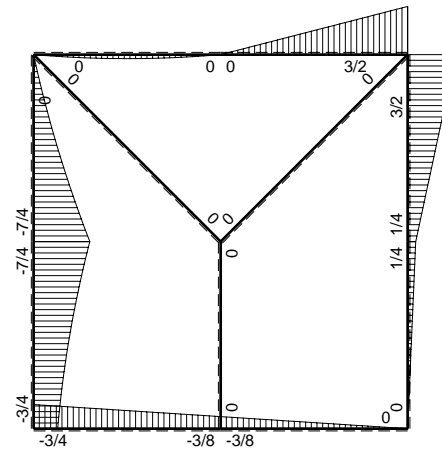
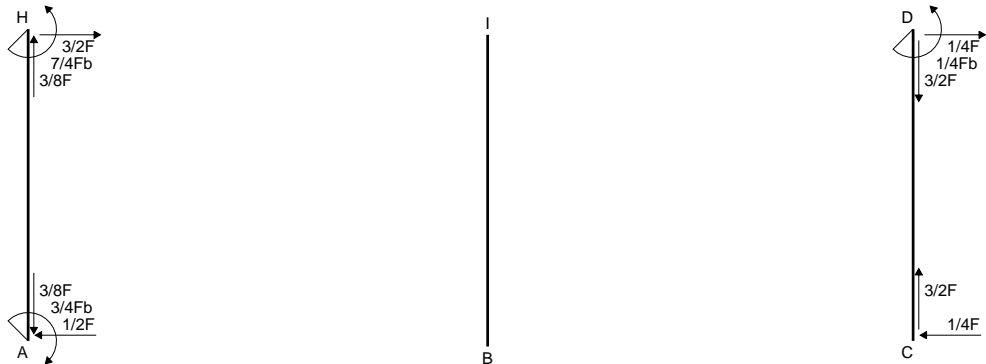
- A = 1086. mm<sup>2</sup>
- J<sub>u</sub> = 349673. mm<sup>4</sup>
- J<sub>v</sub> = 88740. mm<sup>4</sup>
- y<sub>g</sub> = 22.98 mm
- N = -885. N
- T<sub>y</sub> = -3983. N
- M<sub>x</sub> = -2570930. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.02 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 219.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 40. mm
- v<sub>c</sub> = 17.02 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 124.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.764 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 124.8 N/mm<sup>2</sup>
- S = 7127. mm<sup>3</sup>



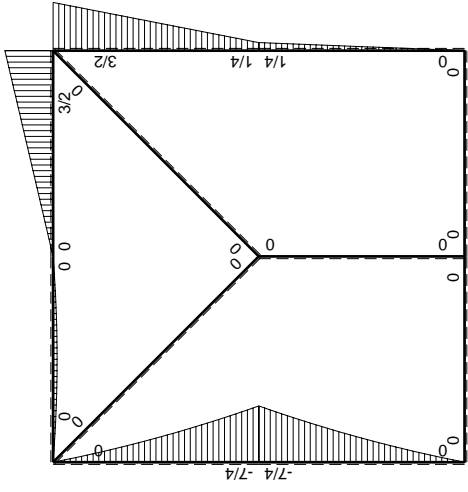
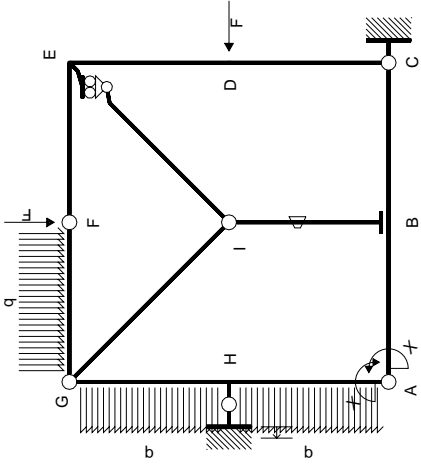


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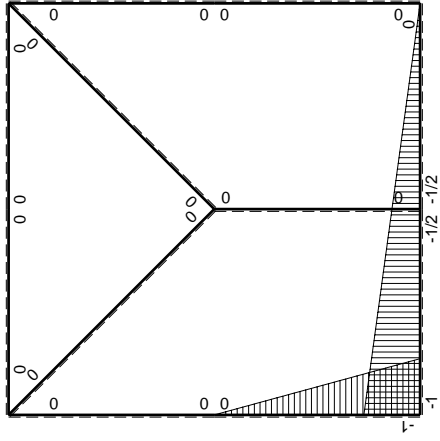
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



M<sub>0</sub> flessione da carichi assegnati



M<sub>x</sub> flessione da iperstatica X=1

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
BI b	0	0	$Fb/EJ$	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

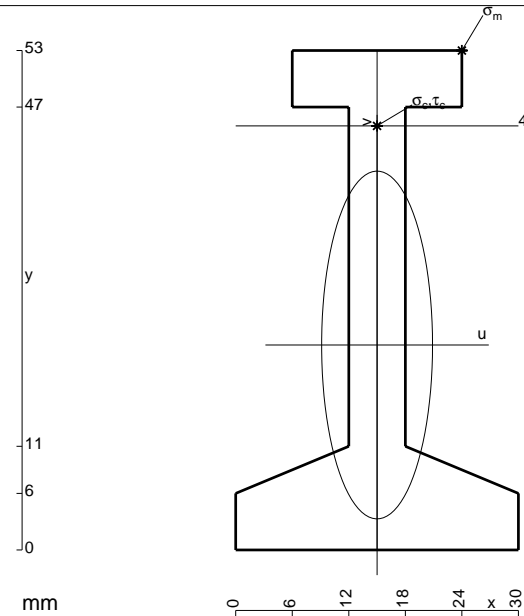
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

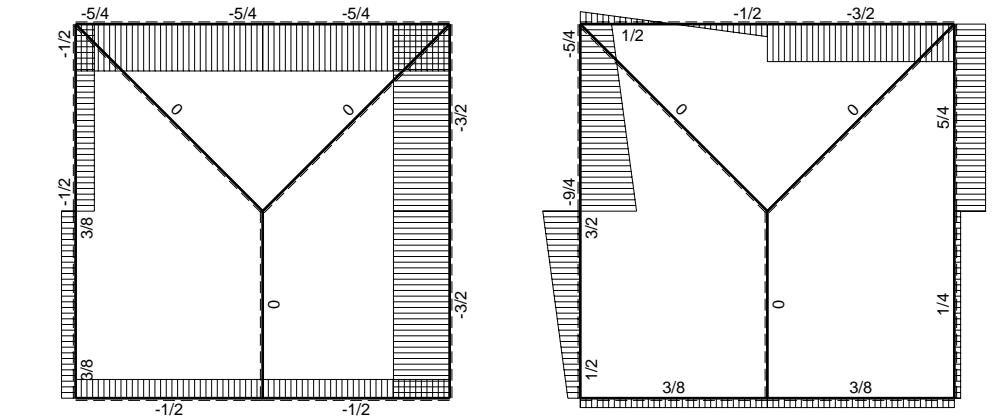
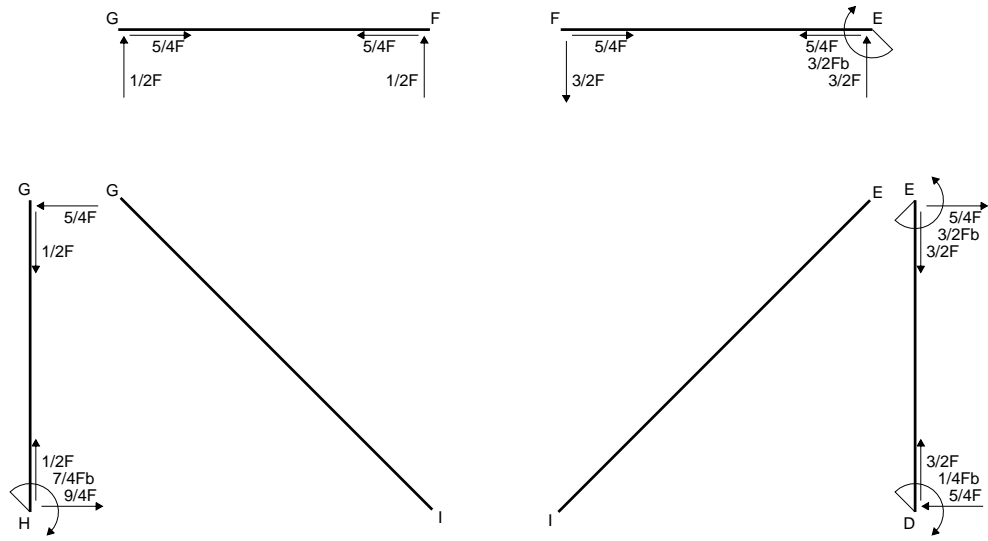
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

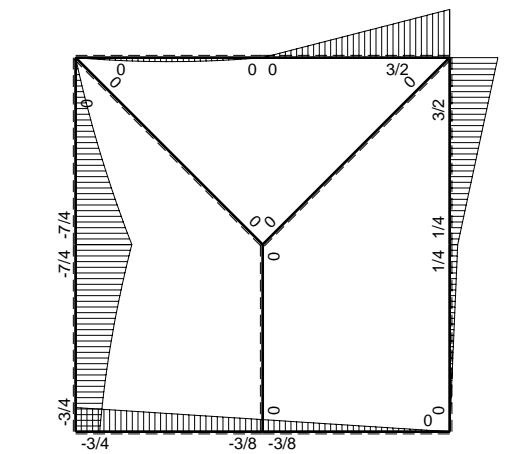
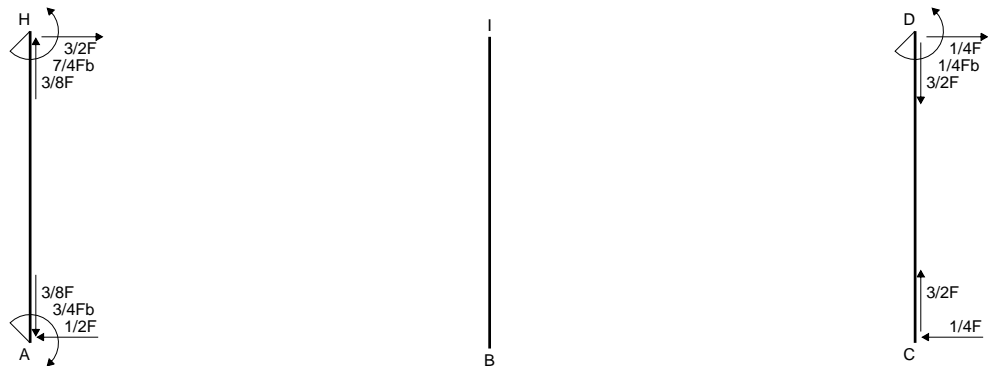


$A = 594. \text{ mm}^2$   
 $J_u = 202331. \text{ mm}^4$   
 $J_v = 20574. \text{ mm}^4$   
 $y_g = 21.75 \text{ mm}$   
 $N = -485. \text{ N}$   
 $T_y = -2183. \text{ N}$   
 $M_x = -1493800. \text{ Nmm}$   
 $x_m = 24. \text{ mm}$   
 $y_m = 53. \text{ mm}$   
 $u_m = 9. \text{ mm}$   
 $v_m = 31.25 \text{ mm}$   
 $\sigma_m = N/A - Mv/J_u = 229.9 \text{ N/mm}^2$   
 $x_c = 15. \text{ mm}$   
 $y_c = 45. \text{ mm}$   
 $v_c = 23.25 \text{ mm}$   
 $\sigma_c = N/A - Mv/J_u = 170.8 \text{ N/mm}^2$   
 $\tau_c = 6.008 \text{ N/mm}^2$   
 $\sigma_\rho = \sqrt{\sigma^2 + 3\tau^2} = 171.2 \text{ N/mm}^2$   
 $S = 3342. \text{ mm}^3$

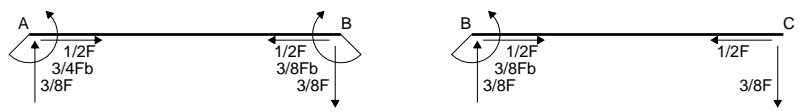


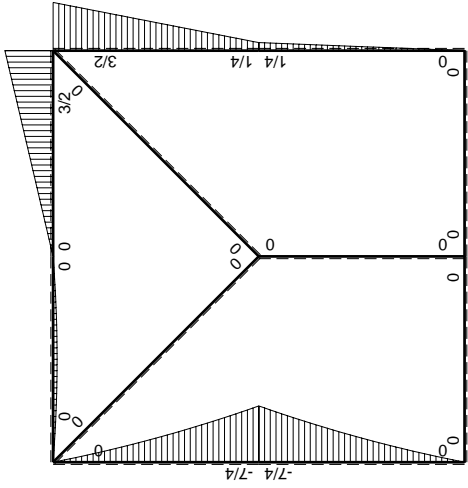
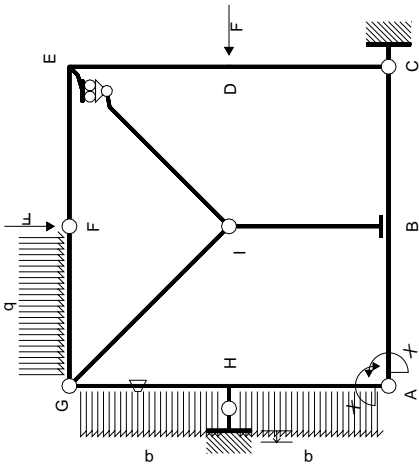
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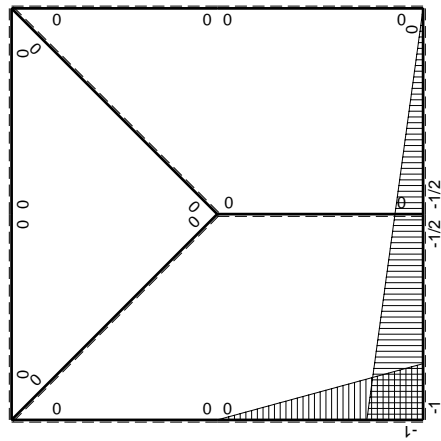


⊕ ⊖ F<sub>b</sub>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	$Fb/EJ$	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ x - 1/2 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x + 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x - 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = \left[ 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = \left[ 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = \left[ x - x^2/b + 1/3 x^3/b^2 \right]_0^b 1/EJ$$

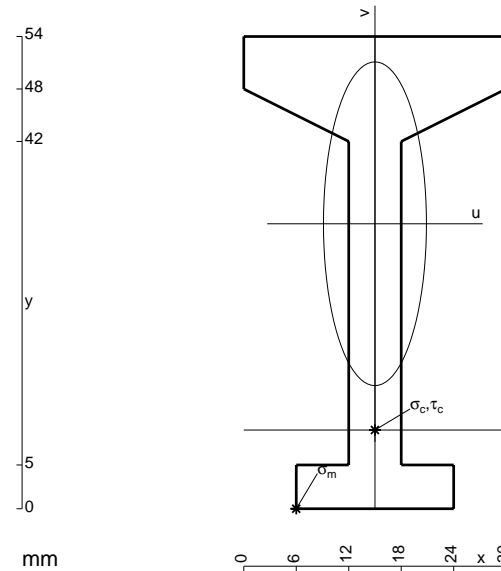
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



$$A = 600. \text{ mm}^2$$

$$J_u = 205635. \text{ mm}^4$$

$$J_v = 20808. \text{ mm}^4$$

$$y_g = 32.59 \text{ mm}$$

$$N = -450. \text{ N}$$

$$T_y = -2025. \text{ N}$$

$$M_x = -1496250. \text{ Nmm}$$

$$x_m = 6. \text{ mm}$$

$$u_m = -9. \text{ mm}$$

$$v_m = -32.59 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = -237.9 \text{ N/mm}^2$$

$$x_c = 15. \text{ mm}$$

$$y_c = 9. \text{ mm}$$

$$v_c = -23.59 \text{ mm}$$

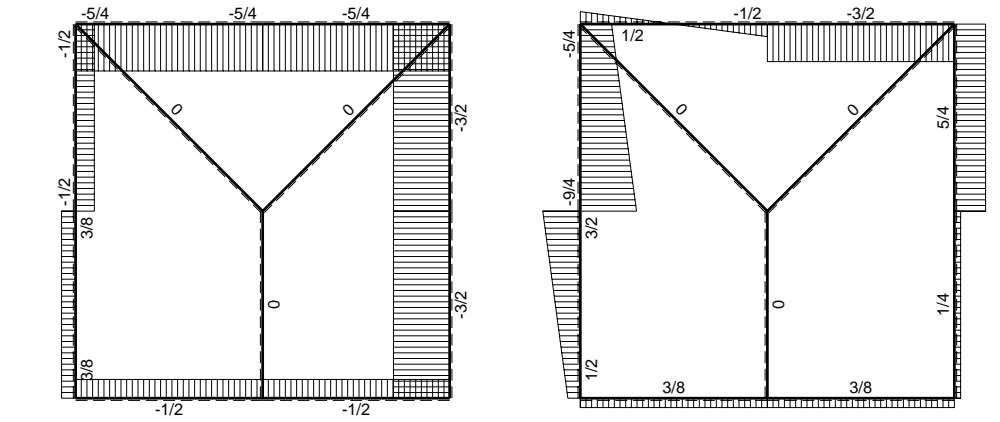
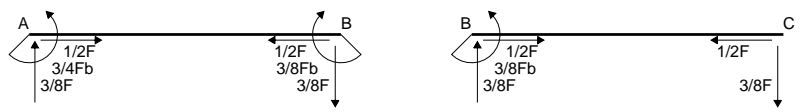
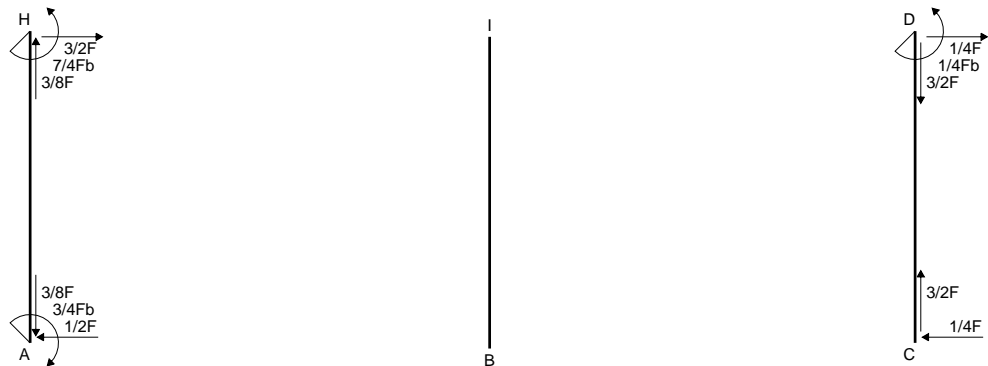
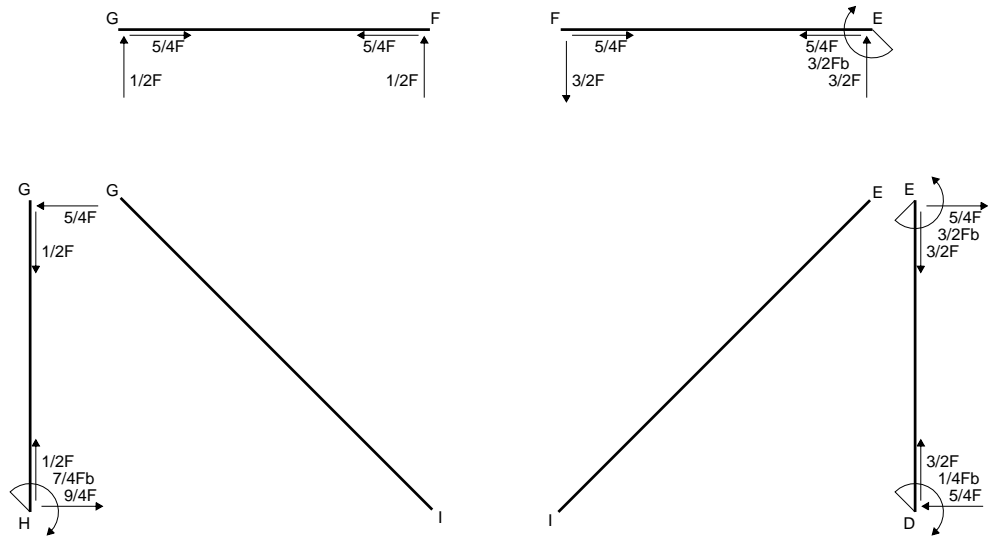
$$\sigma_c = N/A - Mv/J_u = -172.4 \text{ N/mm}^2$$

$$\tau_c = 5.453 \text{ N/mm}^2$$

$$\sigma_x = \sqrt{\sigma^2 + 3\tau^2} = 172.7 \text{ N/mm}^2$$

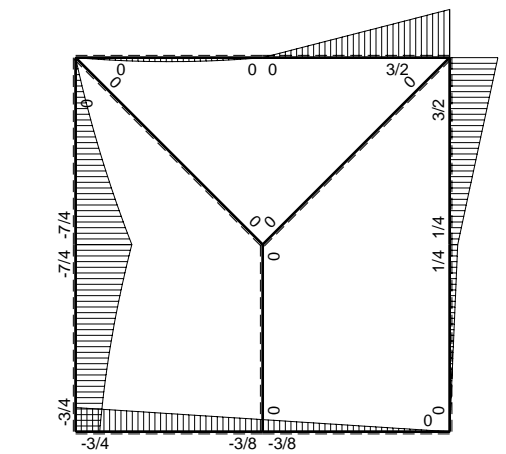
$$S = 3322. \text{ mm}^3$$



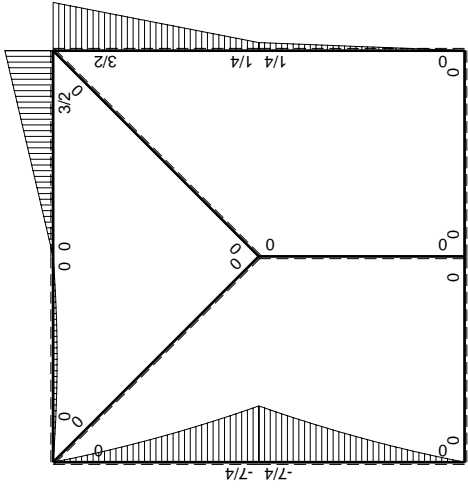
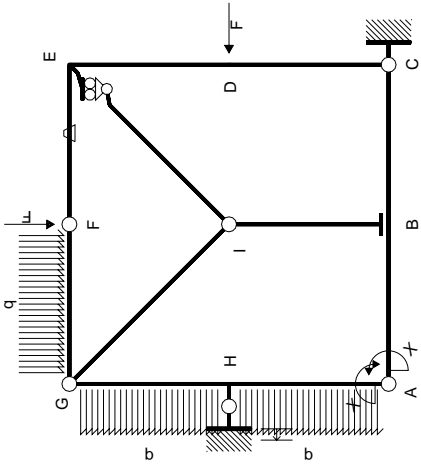


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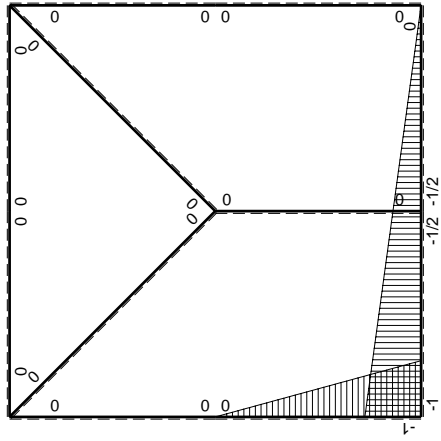
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	$-Fb/EJ$	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	$Fb/EJ$	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

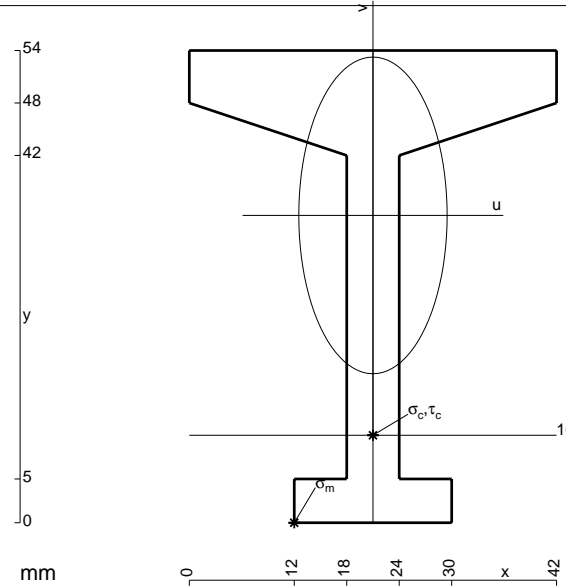
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{x_0} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

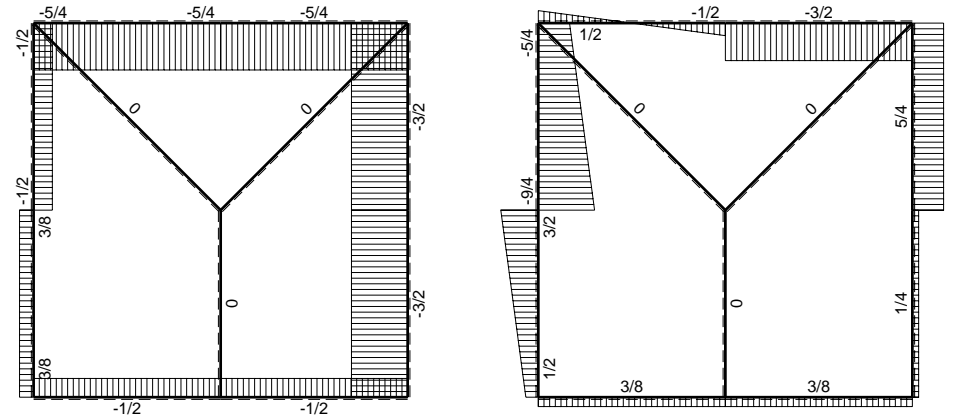
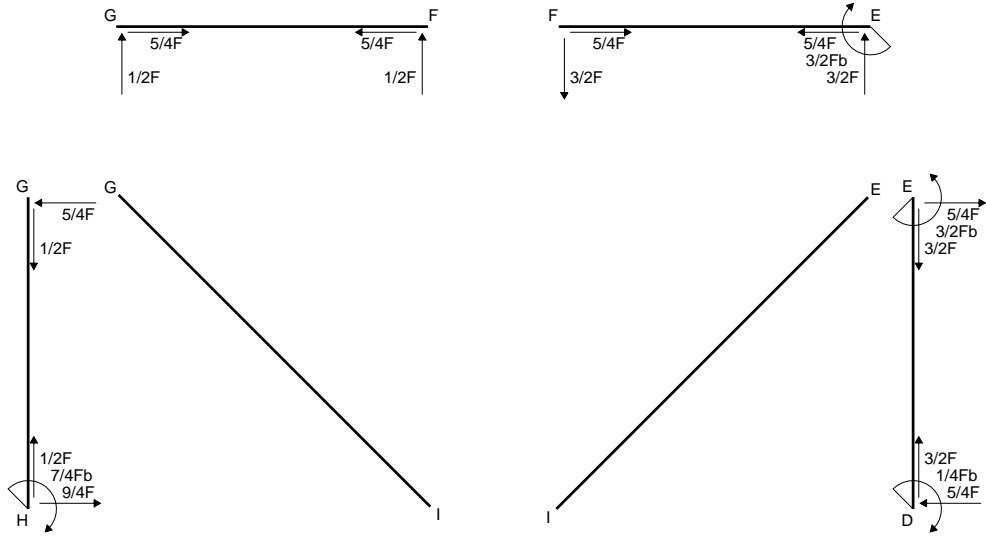
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{x_0} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

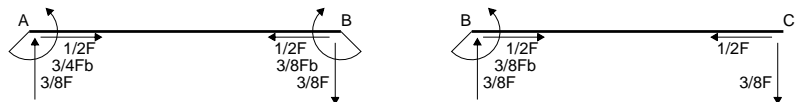
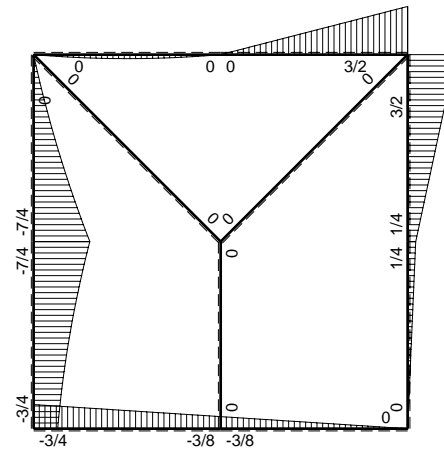
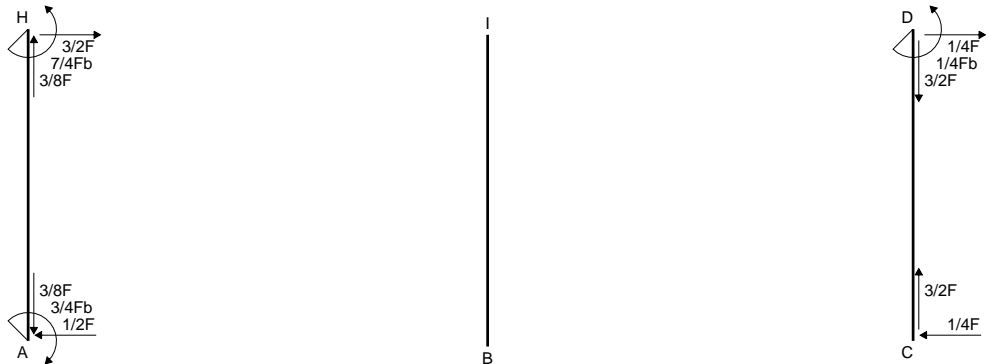


- A = 708. mm<sup>2</sup>
- J<sub>u</sub> = 232181. mm<sup>4</sup>
- J<sub>v</sub> = 50940. mm<sup>4</sup>
- y<sub>g</sub> = 35.14 mm
- N = -750. N
- T<sub>y</sub> = -3375. N
- M<sub>x</sub> = -1312500. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -35.14 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -199.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -25.14 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -143.2 N/mm<sup>2</sup>
- τ<sub>c</sub> = 9.127 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 144.1 N/mm<sup>2</sup>
- S = 3767. mm<sup>3</sup>

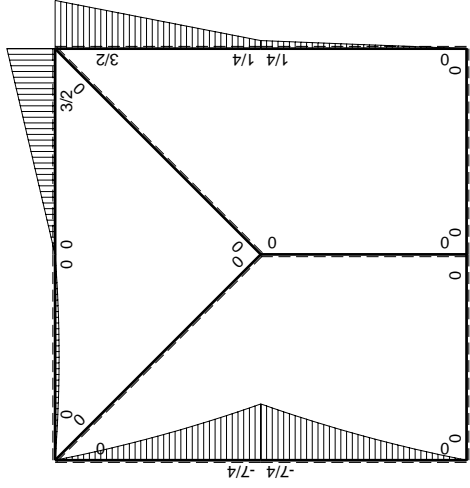
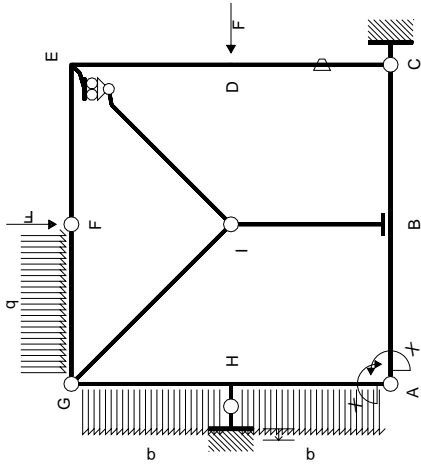


← ⊕ → F

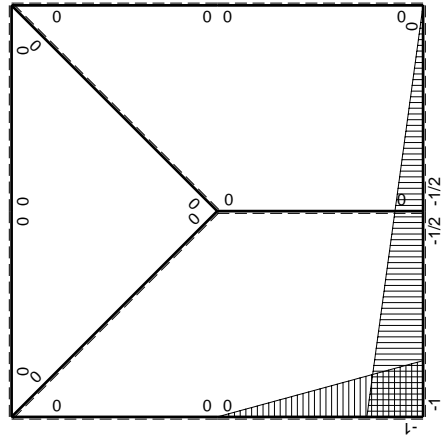
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	$Fb/EJ$	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
FE b	0	$-3/2Fx$	0	0	0	0			
FG b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
GF b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

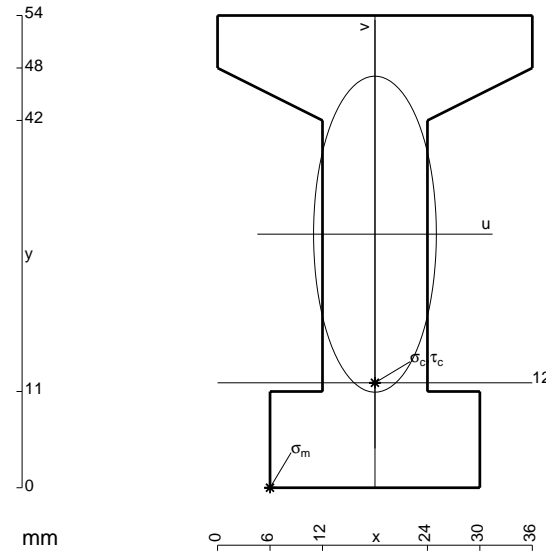
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

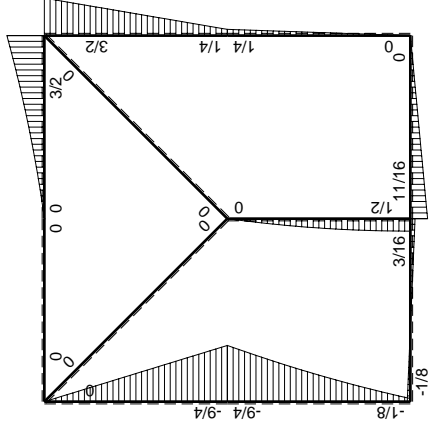
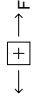
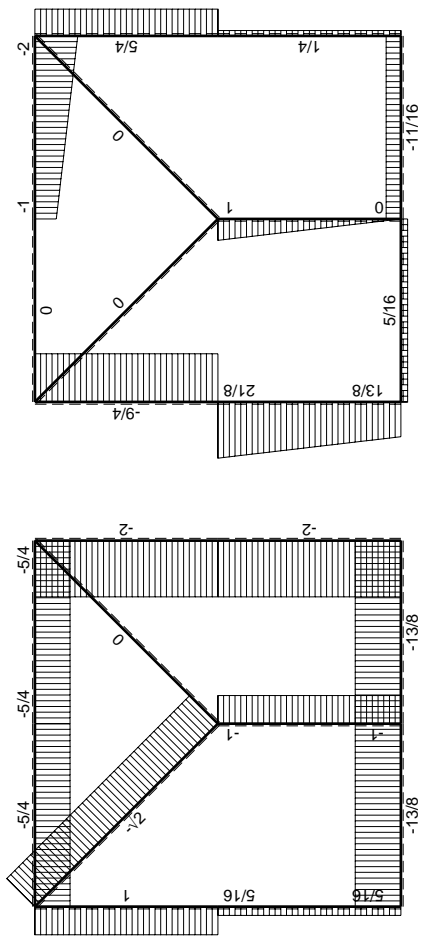
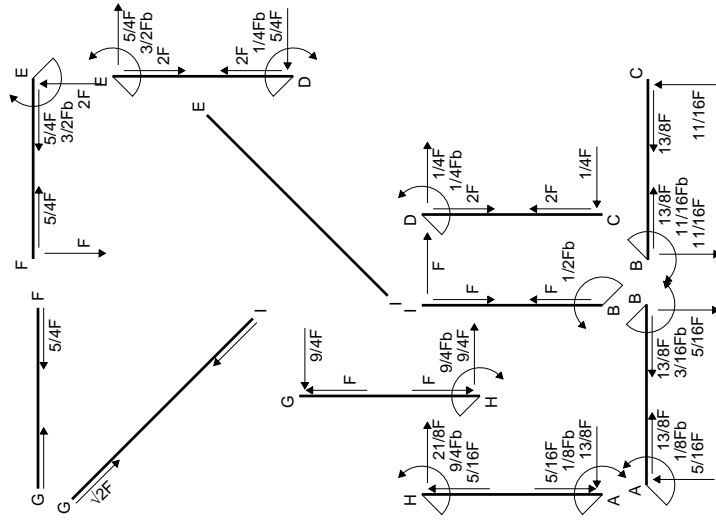
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



- A = 996. mm<sup>2</sup>
- J<sub>u</sub> = 325364. mm<sup>4</sup>
- J<sub>v</sub> = 49104. mm<sup>4</sup>
- y<sub>g</sub> = 28.99 mm
- N = -1215. N
- T<sub>y</sub> = -5468. N
- M<sub>x</sub> = -2338880. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.99 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -209.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 12. mm
- v<sub>c</sub> = -16.99 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -123.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.98 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 124.4 N/mm<sup>2</sup>
- S = 6412. mm<sup>3</sup>







Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	$-Fb/EJ$	$-1/4Fx+1/8Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-1/12+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	$Fb/EJ$	$-1/8Fb+1/8Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ + (b - 1/4 b) \theta = 2/3 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 2/3 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

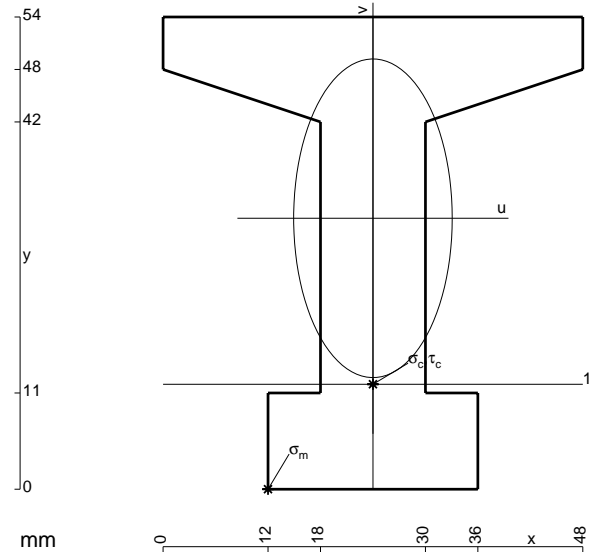
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

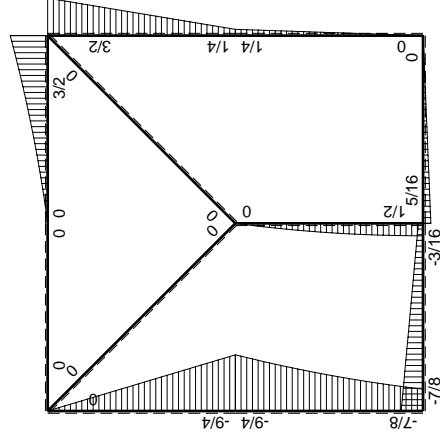
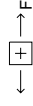
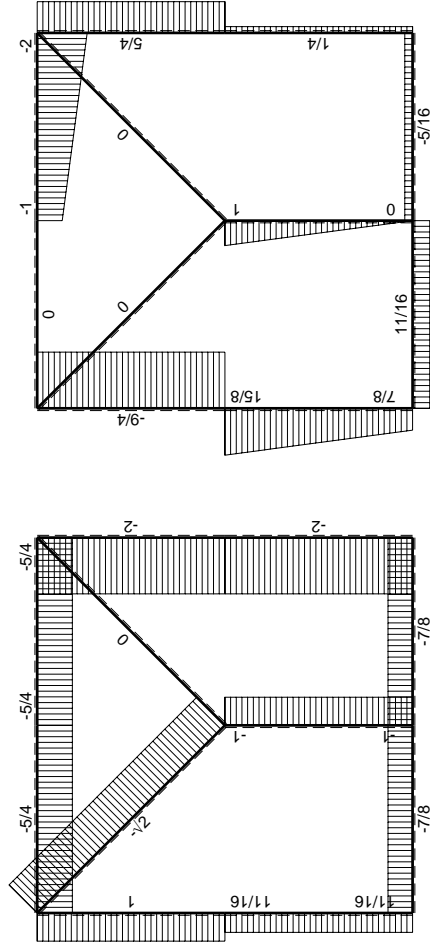
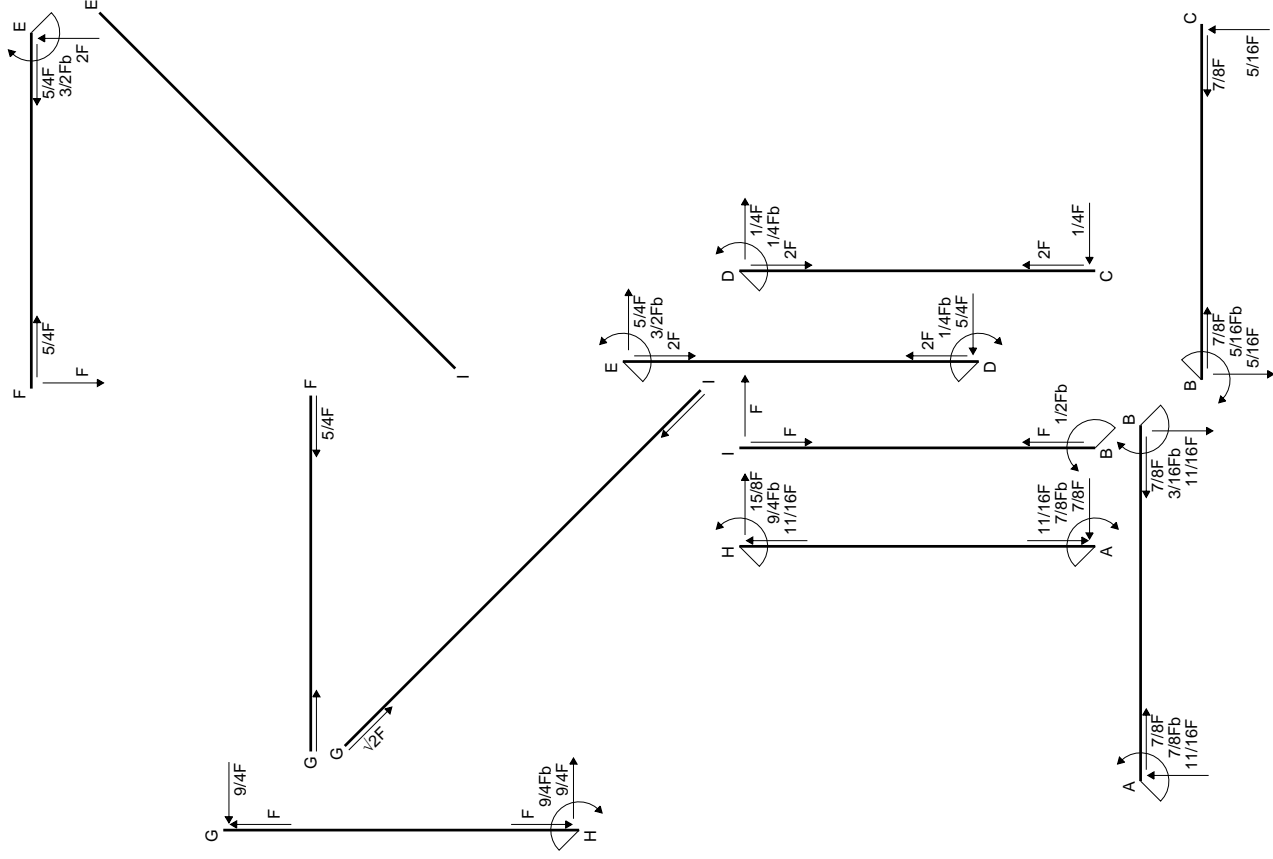
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

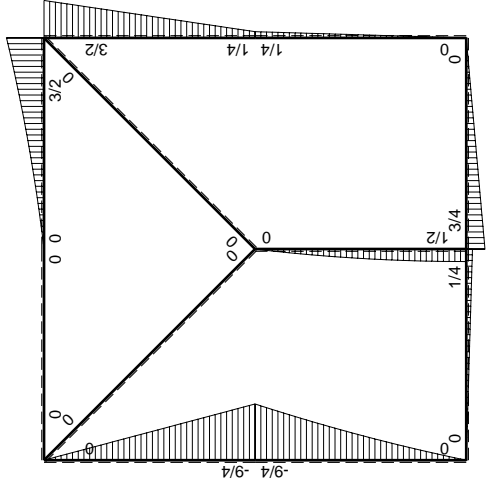
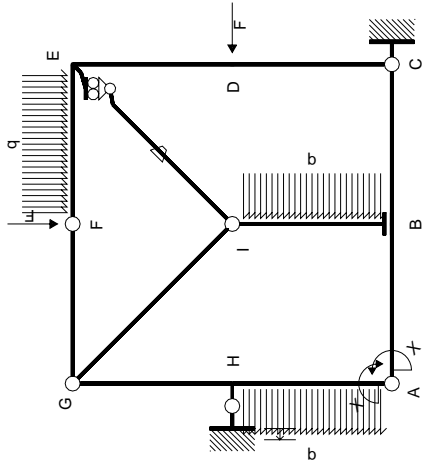
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

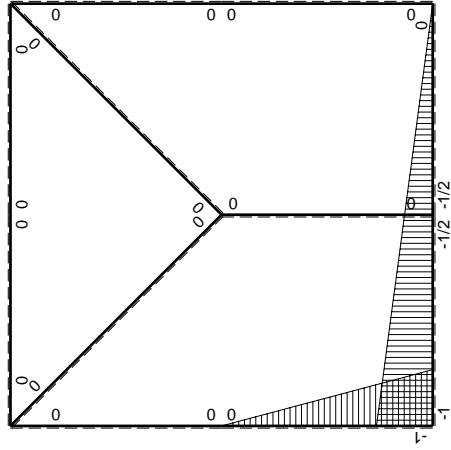


- A = 1104. mm<sup>2</sup>
- J<sub>u</sub> = 366560. mm<sup>4</sup>
- J<sub>v</sub> = 90792. mm<sup>4</sup>
- y<sub>g</sub> = 30.98 mm
- N = 1940. N
- T<sub>y</sub> = -4365. N
- M<sub>x</sub> = -2619000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.98 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -219.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 12. mm
- v<sub>c</sub> = -18.98 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -133.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.908 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 134.4 N/mm<sup>2</sup>
- S = 6962. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

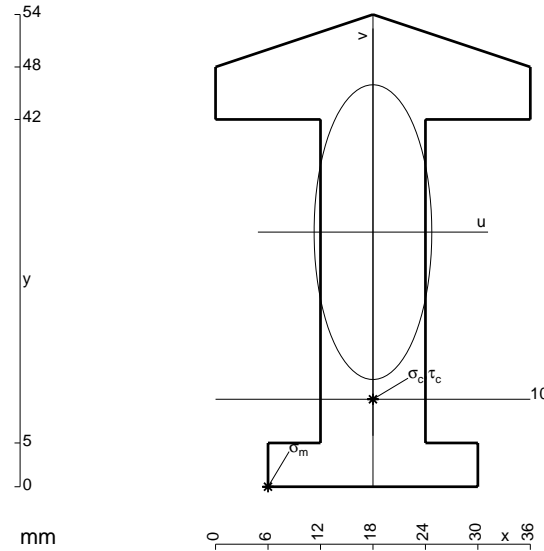
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

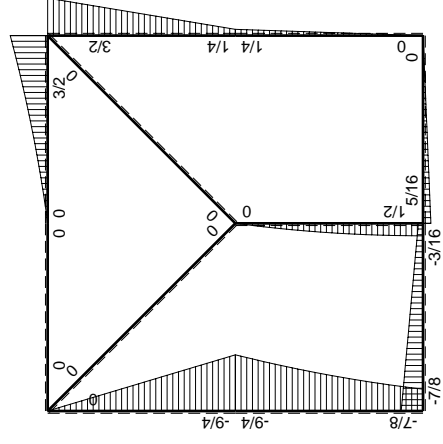
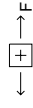
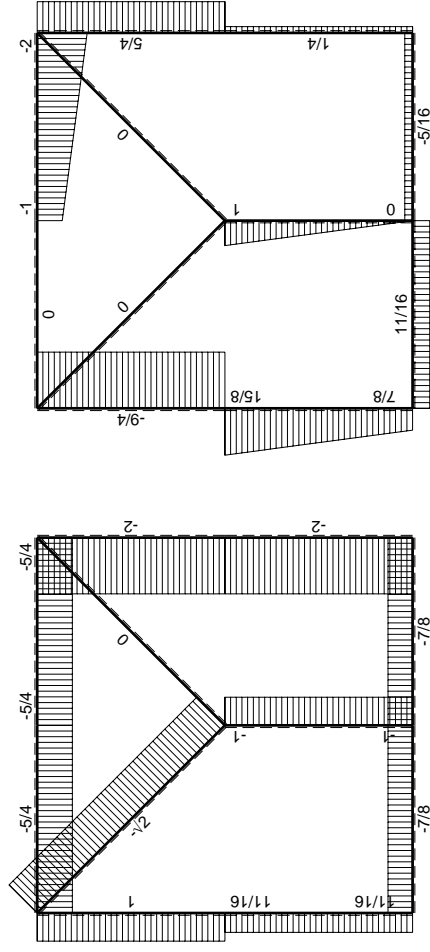
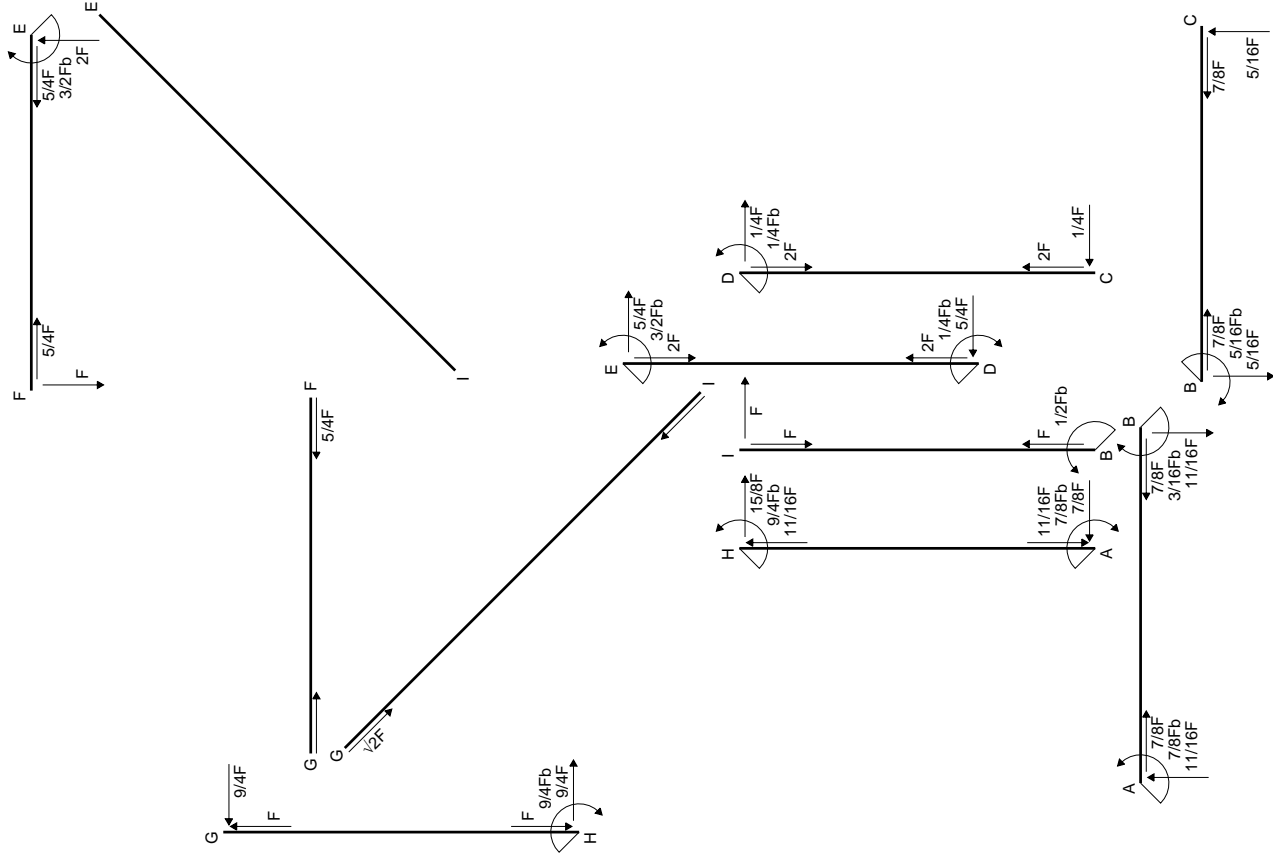
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

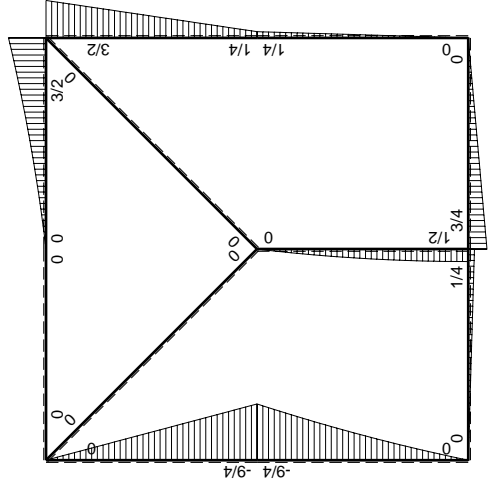
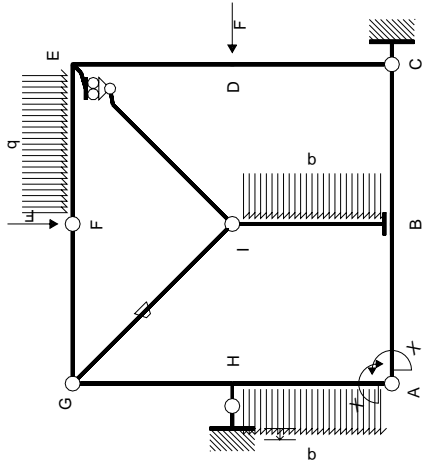
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



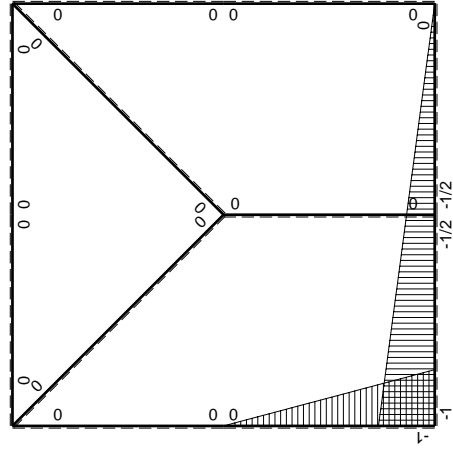
- A = 888. mm<sup>2</sup>
- J<sub>u</sub> = 252380. mm<sup>4</sup>
- J<sub>v</sub> = 40248. mm<sup>4</sup>
- y<sub>g</sub> = 29.11 mm
- N = 1370. N
- T<sub>y</sub> = -3083. N
- M<sub>x</sub> = -2003630. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -29.11 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -229.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -19.11 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -150.2 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.571 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 150.4 N/mm<sup>2</sup>
- S = 4491. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica X=1

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

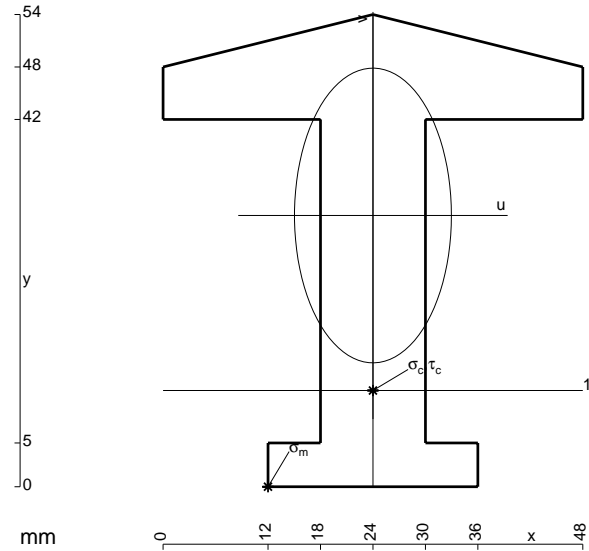
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

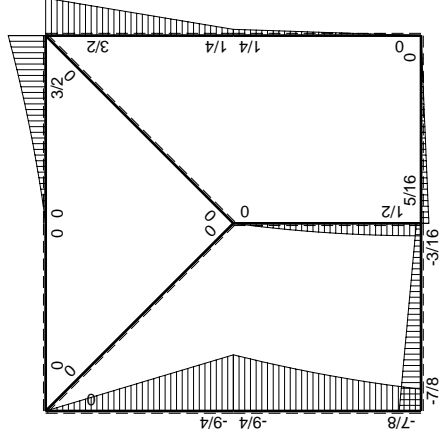
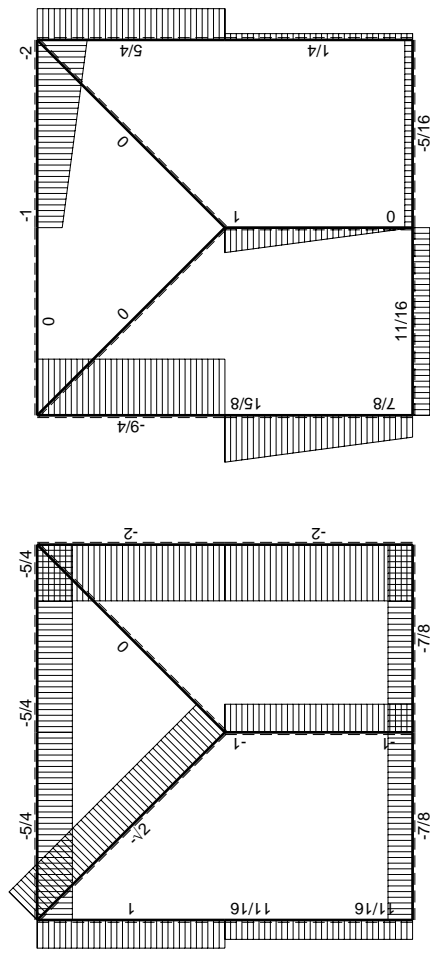
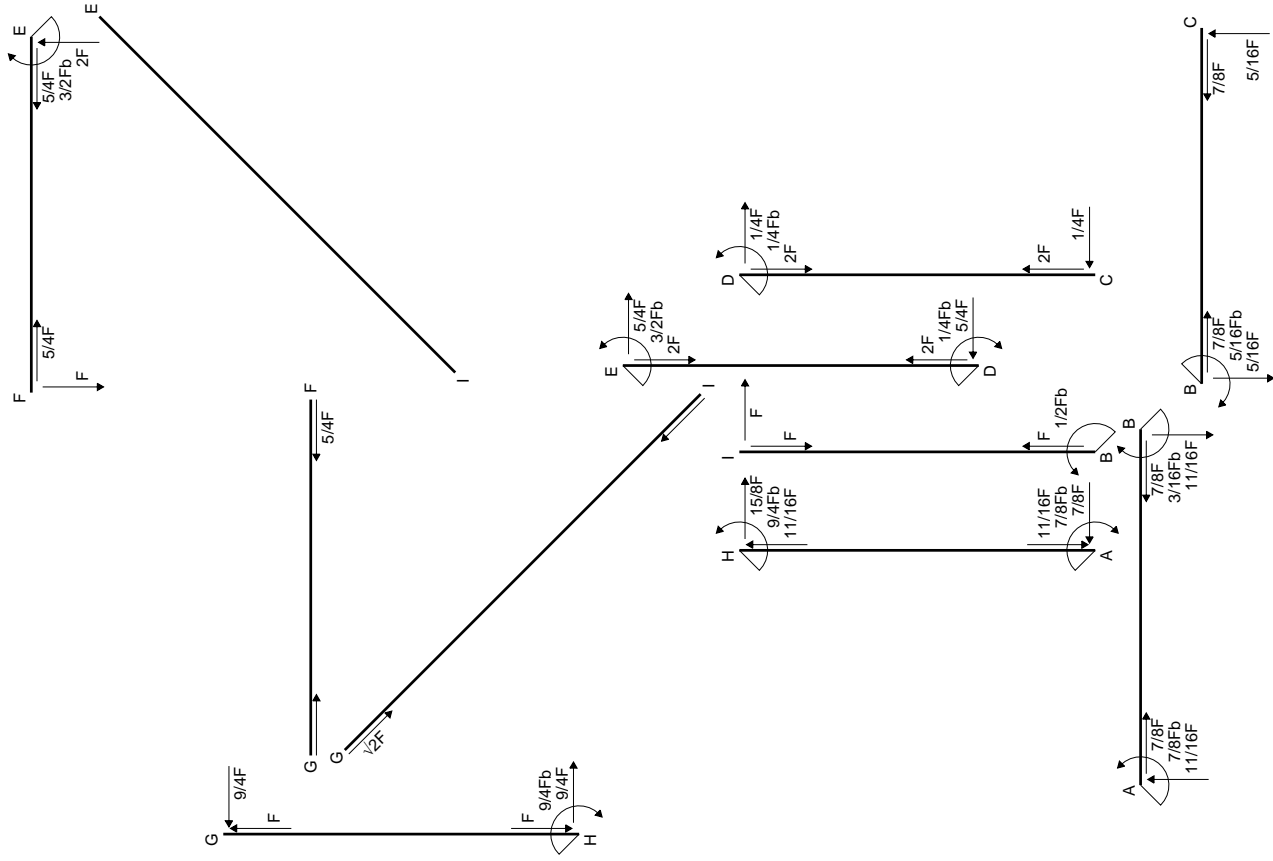
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

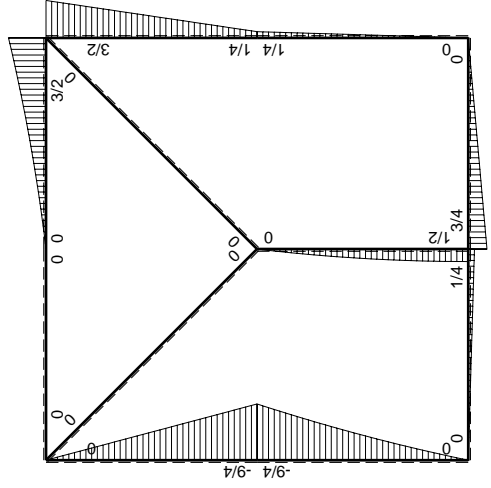
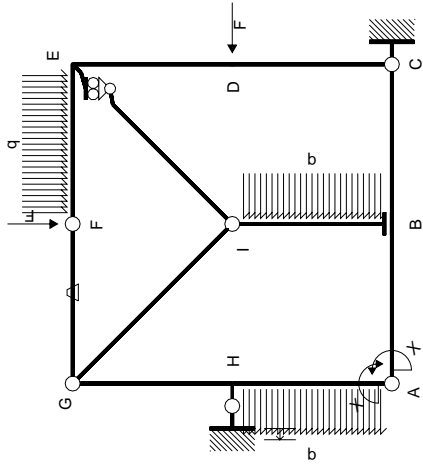
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

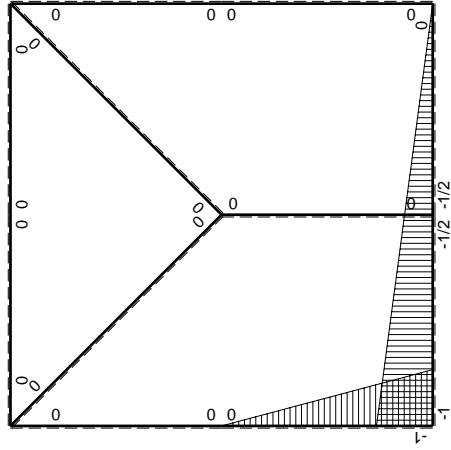


- A = 996. mm<sup>2</sup>
- J<sub>u</sub> = 282932. mm<sup>4</sup>
- J<sub>v</sub> = 80208. mm<sup>4</sup>
- y<sub>g</sub> = 31.02 mm
- N = 1390. N
- T<sub>y</sub> = -3128. N
- M<sub>x</sub> = -2189250. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -31.02 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -238.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 11. mm
- v<sub>c</sub> = -20.02 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -153.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.679 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 153.7 N/mm<sup>2</sup>
- S = 5079. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	0	0	0	0			
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
GF b	0	0	$Fb/EJ$	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

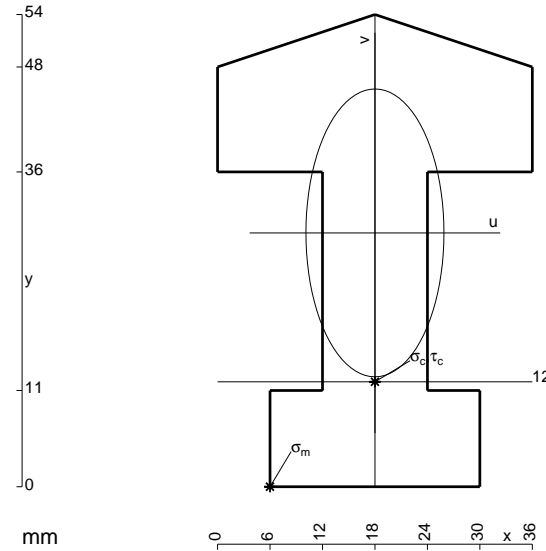
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

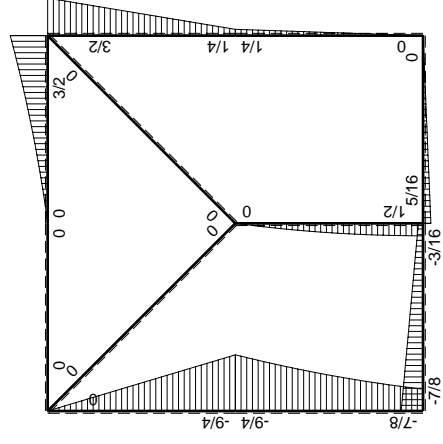
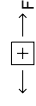
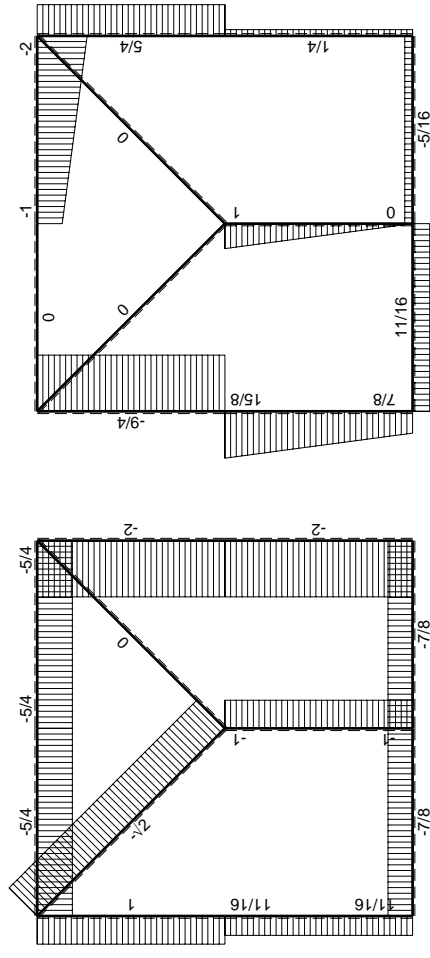
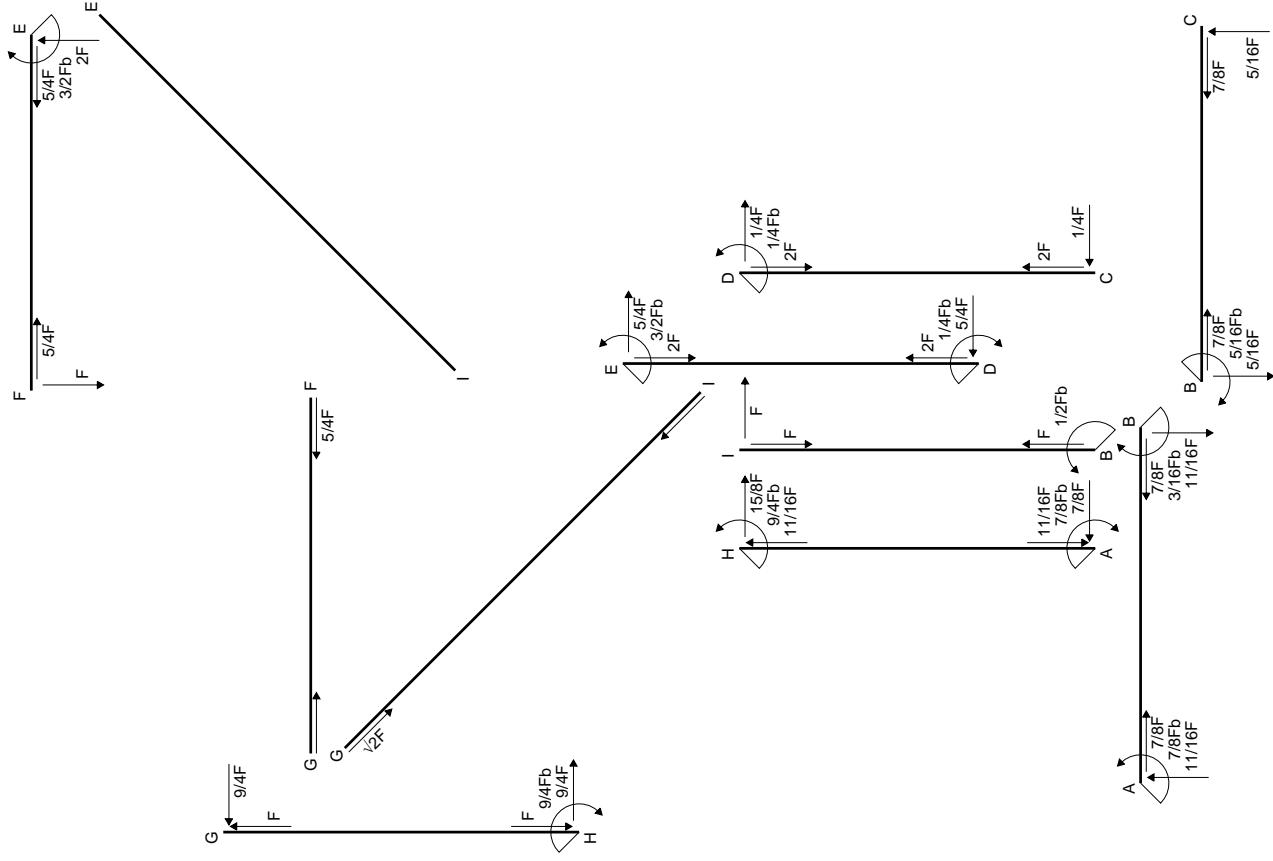
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

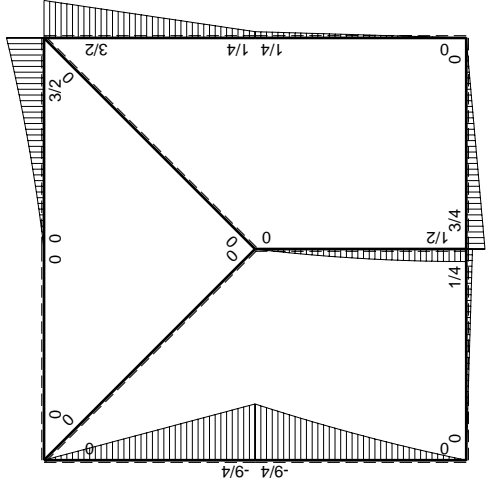
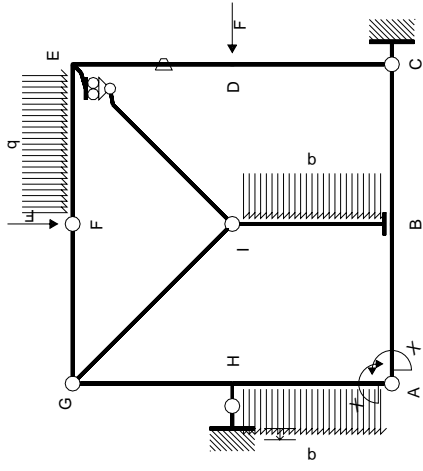
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



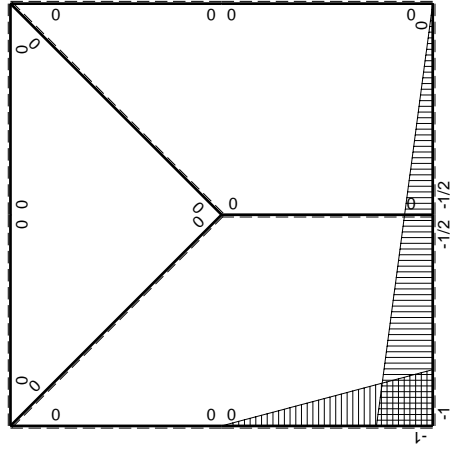
- A = 1104. mm<sup>2</sup>
- J<sub>u</sub> = 299191. mm<sup>4</sup>
- J<sub>v</sub> = 68760. mm<sup>4</sup>
- y<sub>g</sub> = 29.03 mm
- N = 1220. N
- T<sub>y</sub> = -2745. N
- M<sub>x</sub> = -2058750. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -29.03 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -198.6 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 12. mm
- v<sub>c</sub> = -17.03 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -116.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.91 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 116.4 N/mm<sup>2</sup>
- S = 6422. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	$Fb/EJ$	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0			
FE b	0	$-Fx-1/2qx^2$	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			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

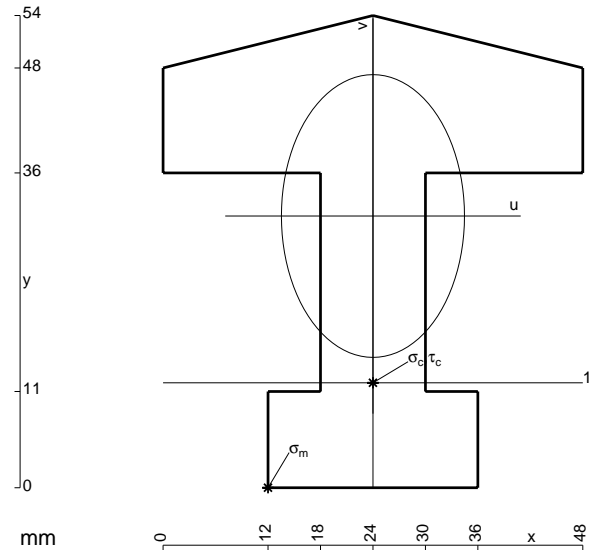
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

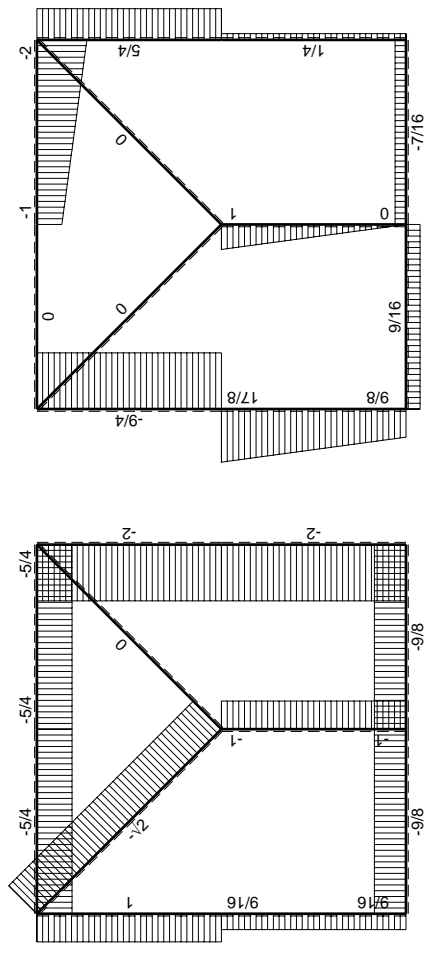
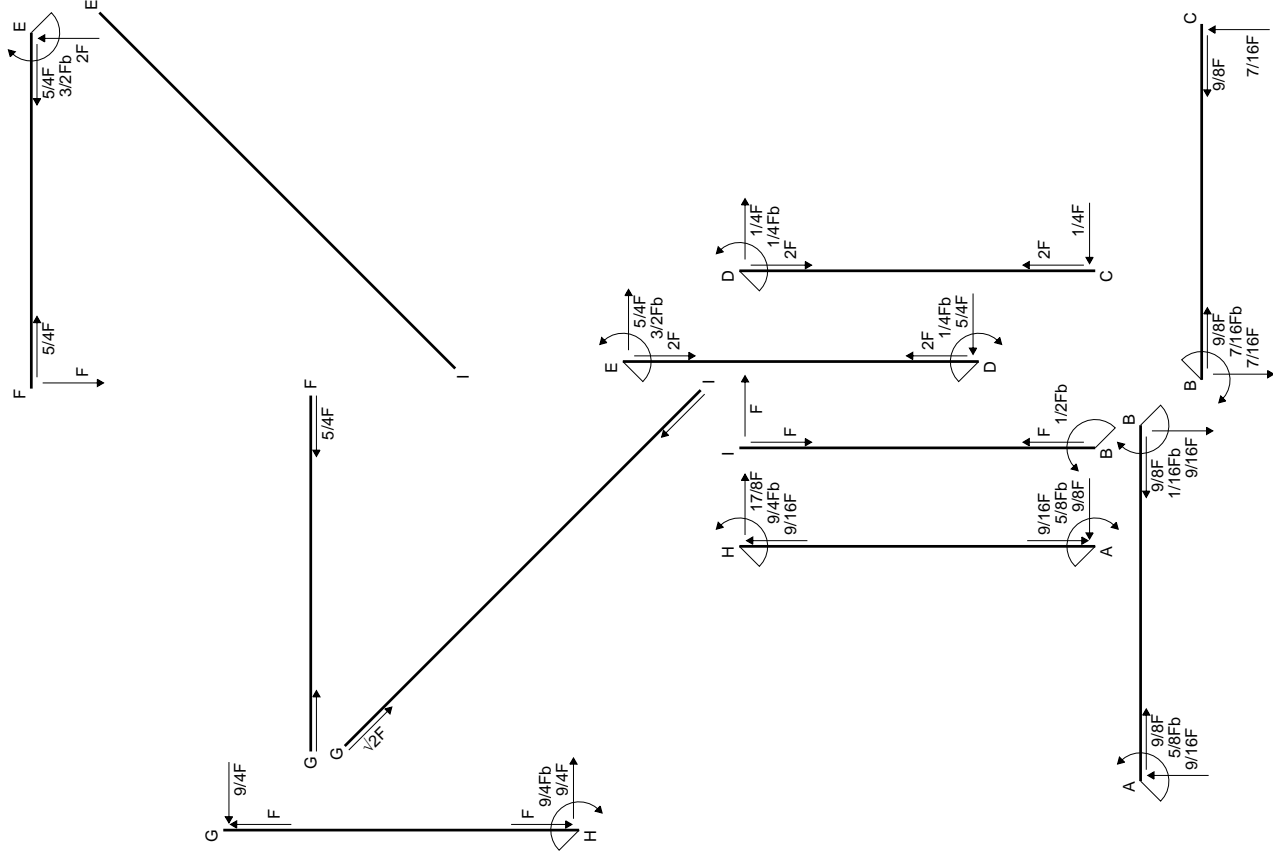
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

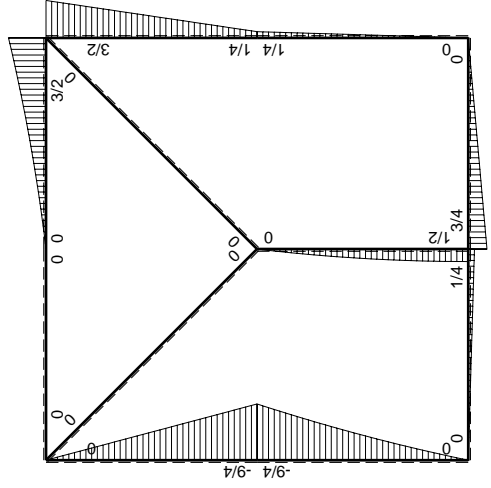
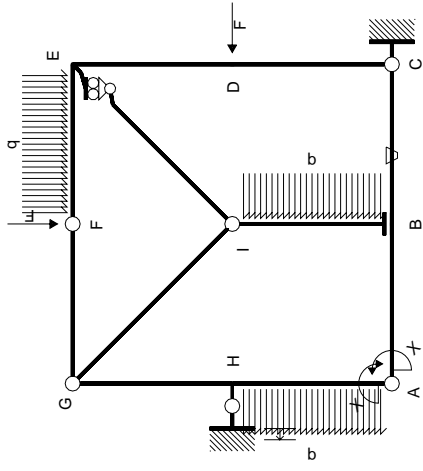
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

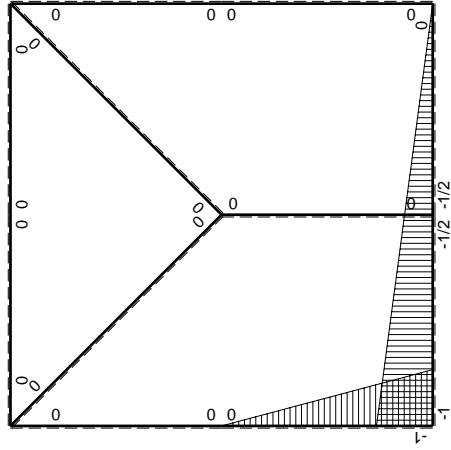


- A = 1284. mm<sup>2</sup>
- J<sub>u</sub> = 335702. mm<sup>4</sup>
- J<sub>v</sub> = 140688. mm<sup>4</sup>
- y<sub>g</sub> = 31.07 mm
- N = 1260. N
- T<sub>y</sub> = -2835. N
- M<sub>x</sub> = -2268000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -31.07 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -208.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 12. mm
- v<sub>c</sub> = -19.07 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -127.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.916 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 128.1 N/mm<sup>2</sup>
- S = 6985. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	$-Fb/EJ$	$-3/8Fb+3/4Fx-3/8Fx^2/b$	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	$Fb/EJ$	$-3/8Fx^2/b$	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-5/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$5/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (1/2 - 1/2 x/b) \theta dx$$

$$= [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ + [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ + (1/2 b - 1/4 b) \theta = 1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 x/b) \theta dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ + [-1/4 x^2/b]_0^b \theta$$

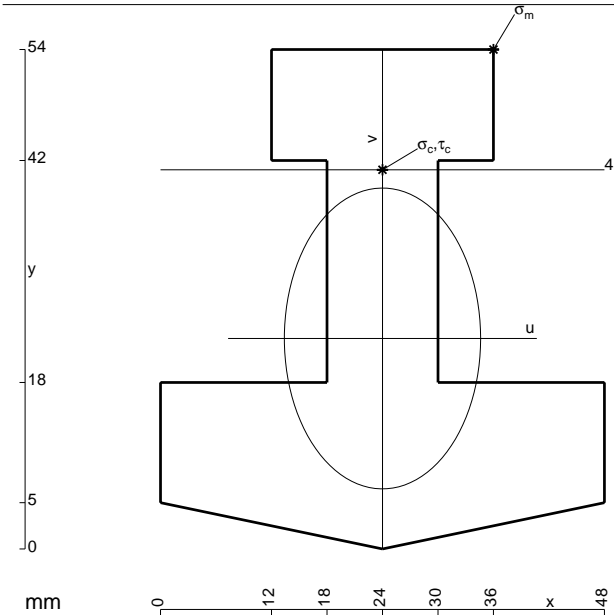
$$= (-1/8 b) Fb 1/EJ + (-1/4 b) \theta = 1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

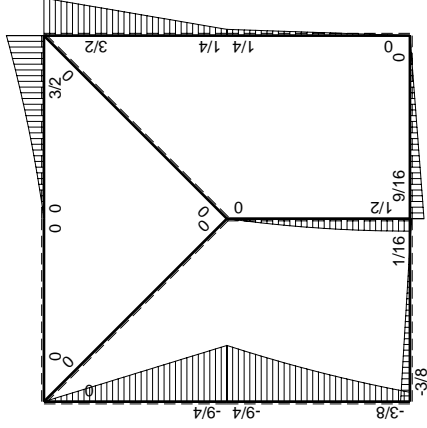
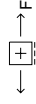
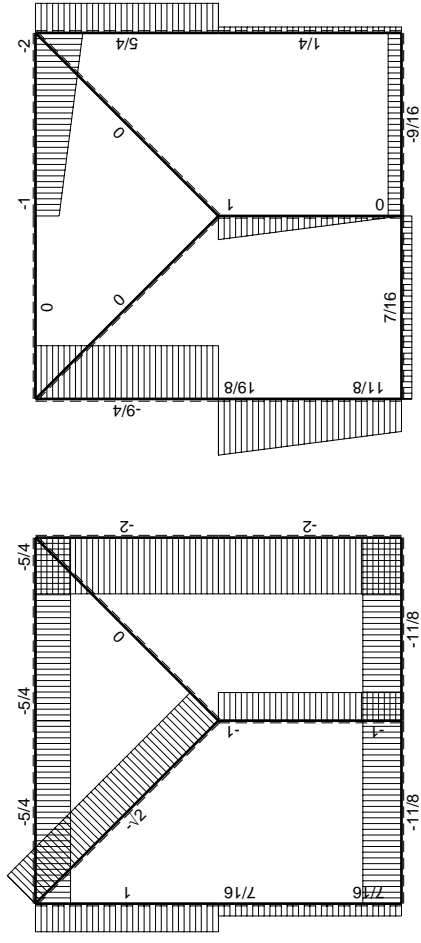
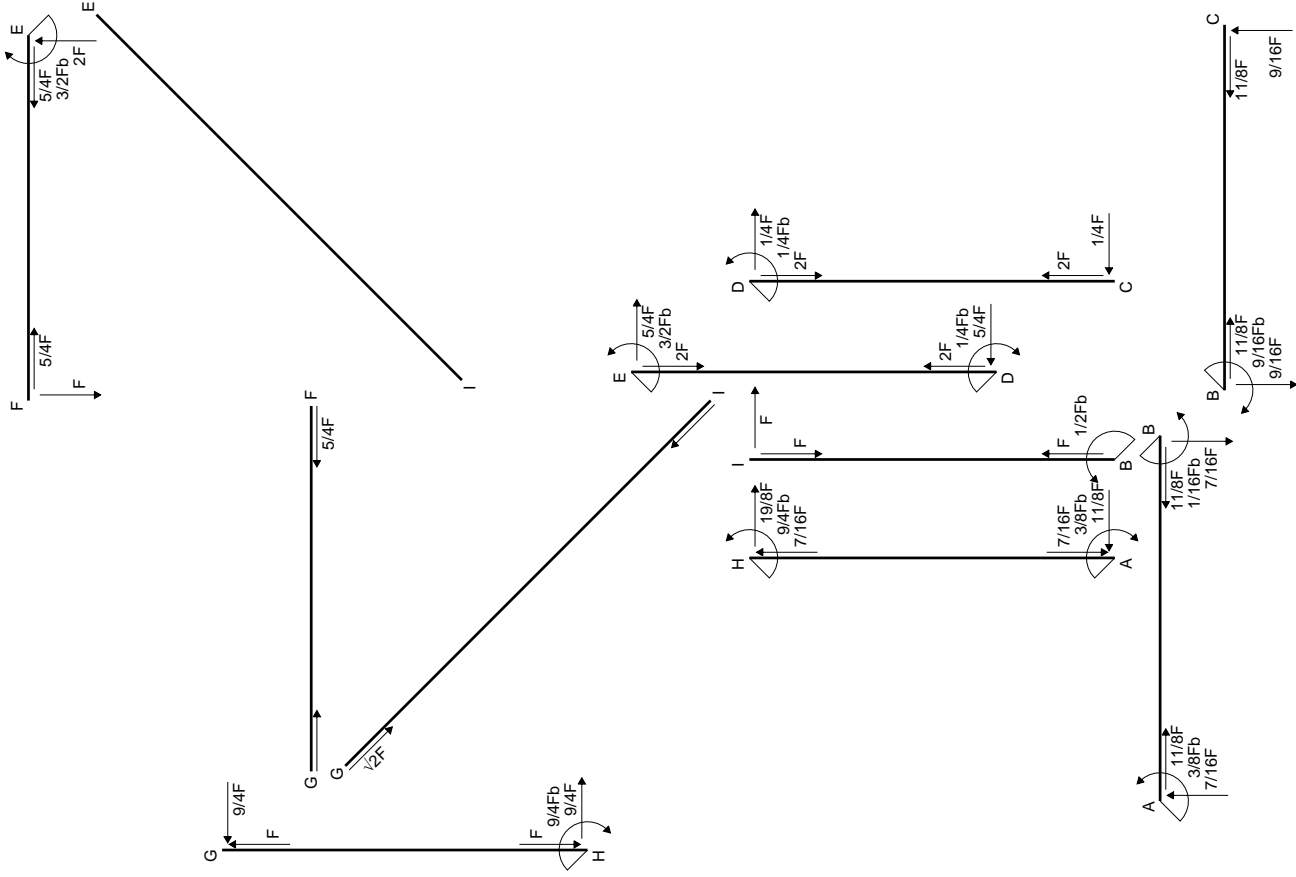
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

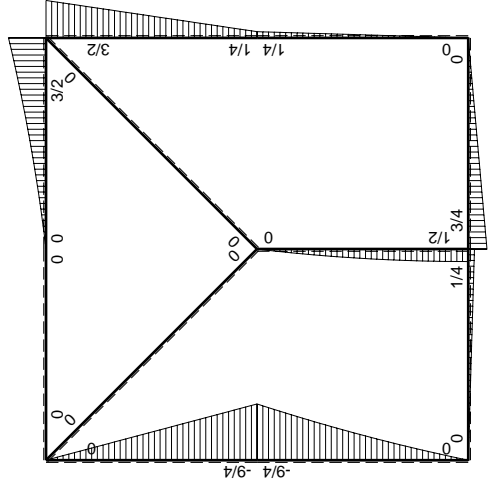
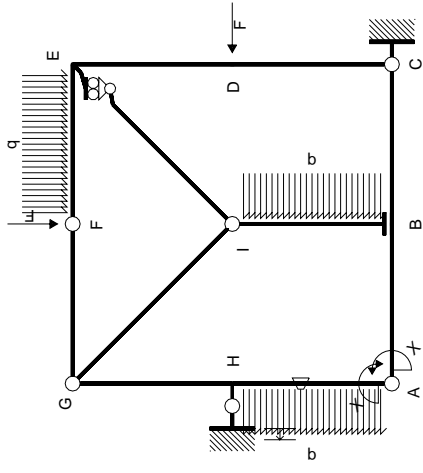
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



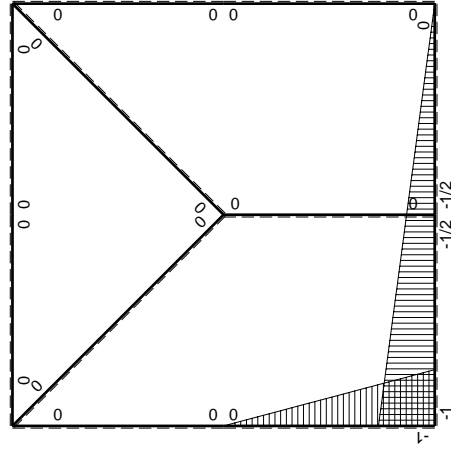
- A = 1320. mm<sup>2</sup>
- J<sub>u</sub> = 349206. mm<sup>4</sup>
- J<sub>v</sub> = 148608. mm<sup>4</sup>
- y<sub>g</sub> = 22.76 mm
- N = 1280. N
- T<sub>y</sub> = -2880. N
- M<sub>x</sub> = -2448000. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 31.24 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 220. N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 18.24 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>v</sub> = 128.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.151 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 129.2 N/mm<sup>2</sup>
- S = 7495. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	$-Fb/EJ$	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	$Fx/EJ$	$x^2/b^2$	$(1/3+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	$Fb/EJ$	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

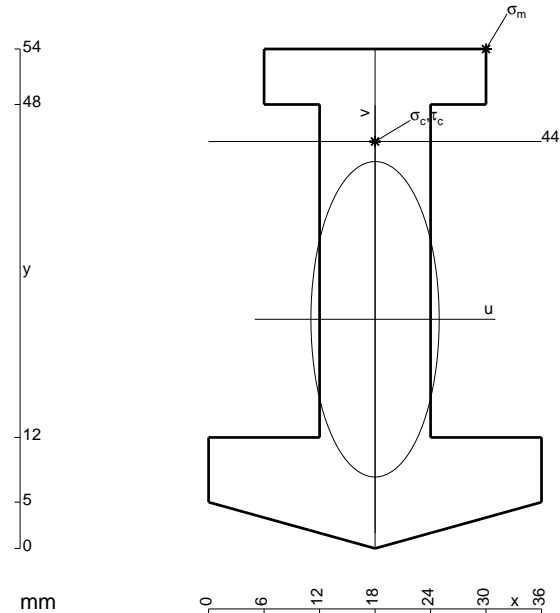
$$= [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 5/6 Fb^2/EJ$$

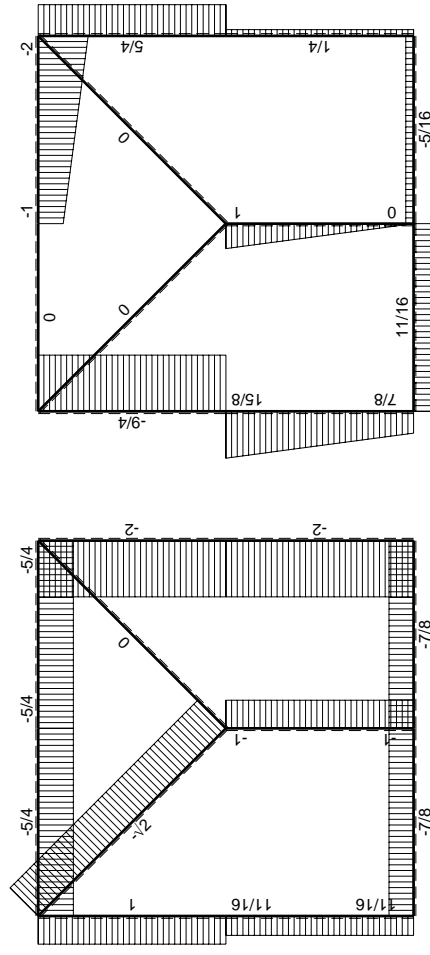
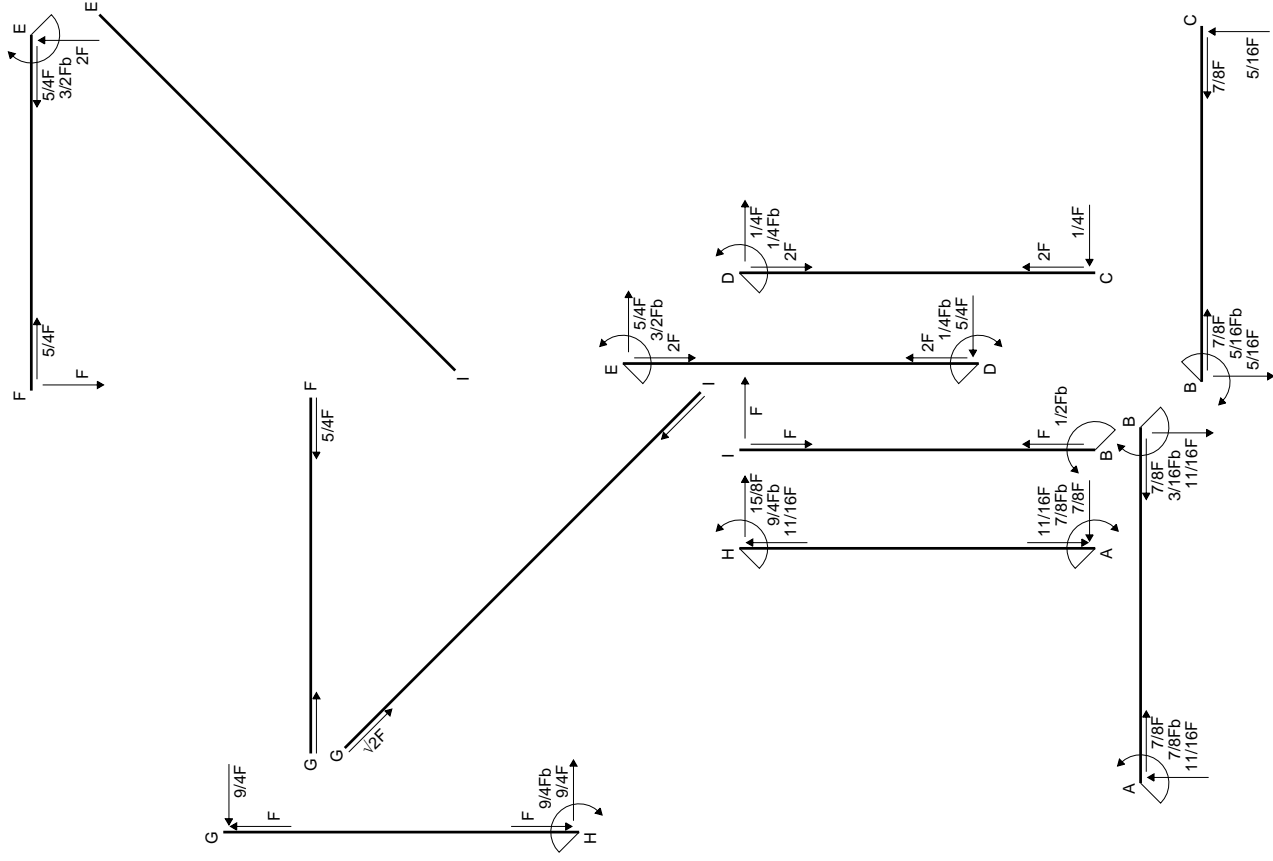
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 5/6 Fb^2/EJ$$



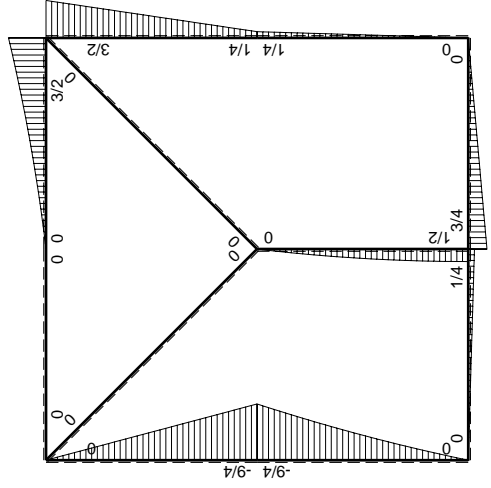
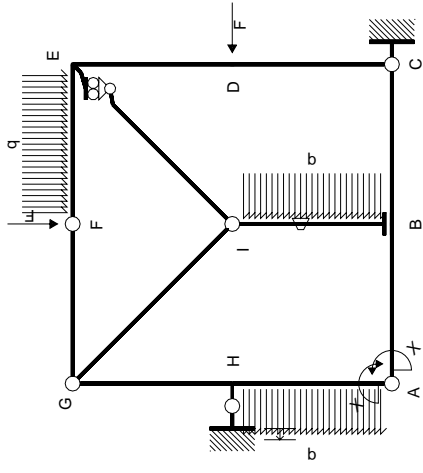
- A = 918. mm<sup>2</sup>
- J<sub>u</sub> = 267198. mm<sup>4</sup>
- J<sub>v</sub> = 44172. mm<sup>4</sup>
- y<sub>g</sub> = 24.78 mm
- N = 1030. N
- T<sub>y</sub> = -2318. N
- M<sub>x</sub> = -2085750. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 29.22 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 229.2 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 44. mm
- v<sub>c</sub> = 19.22 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 151.2 N/mm<sup>2</sup>
- τ<sub>c</sub> = 3.465 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 151.3 N/mm<sup>2</sup>
- S = 4795. mm<sup>3</sup>



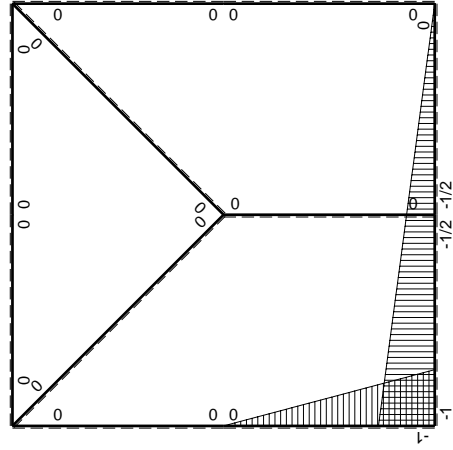
← + → F

↑ + ↓ F

← + → F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	$Fb/EJ$	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

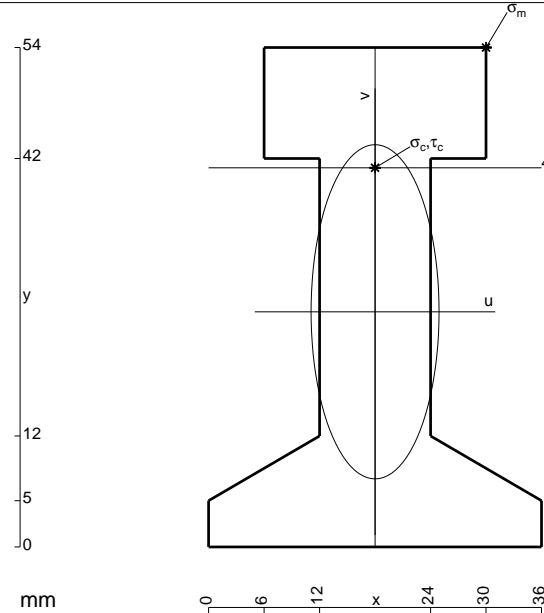
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

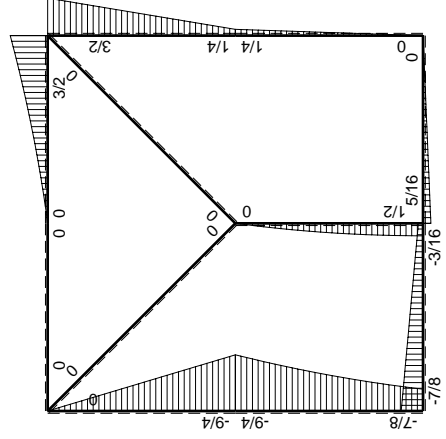
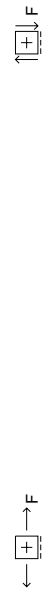
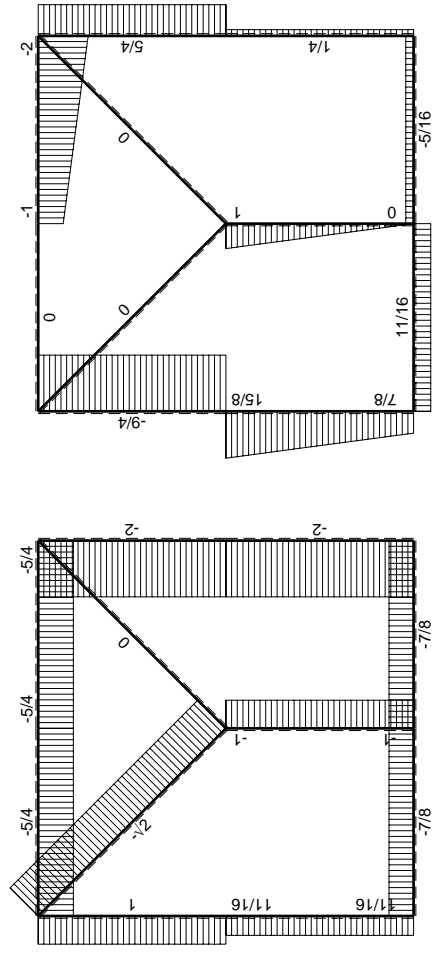
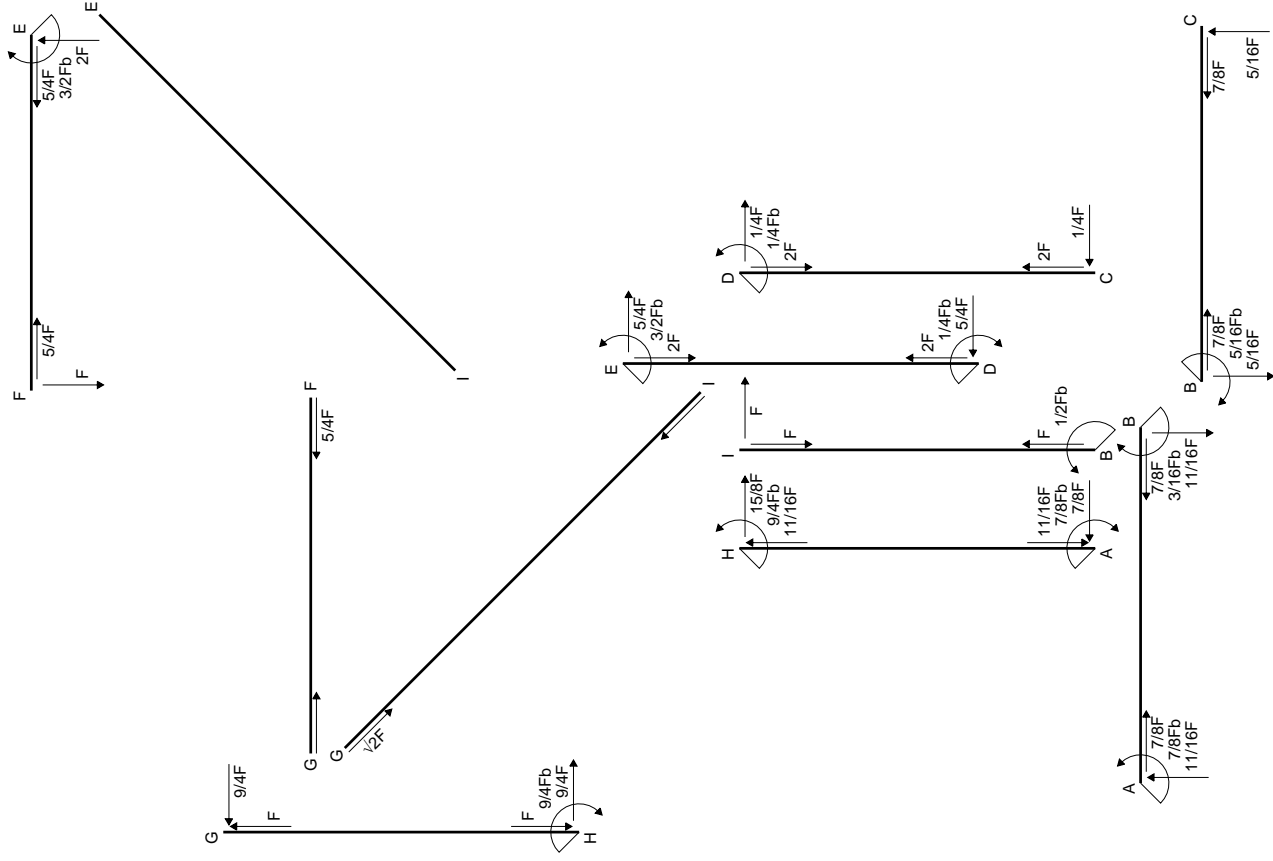
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

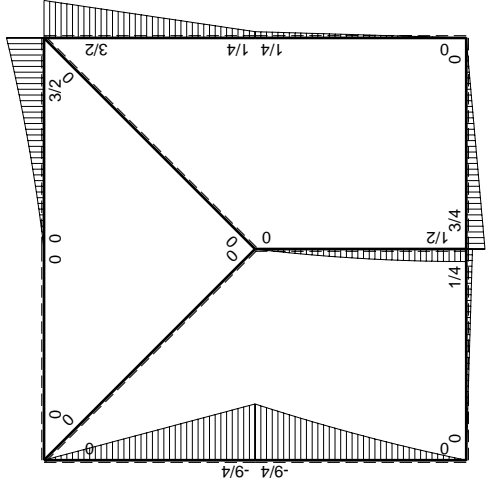
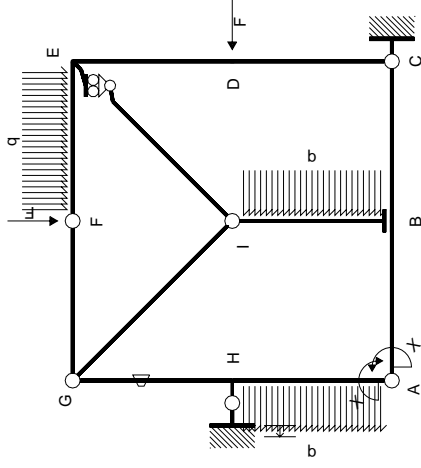
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



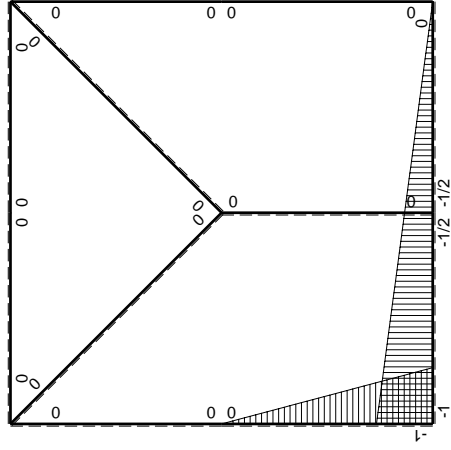
- A = 996. mm<sup>2</sup>
- J<sub>u</sub> = 325226. mm<sup>4</sup>
- J<sub>v</sub> = 47664. mm<sup>4</sup>
- y<sub>g</sub> = 25.43 mm
- N = 1270. N
- T<sub>y</sub> = -2858. N
- M<sub>x</sub> = -2714630. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.57 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 239.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 15.57 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 131.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.901 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 131.5 N/mm<sup>2</sup>
- S = 6694. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	$Fb/EJ$	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

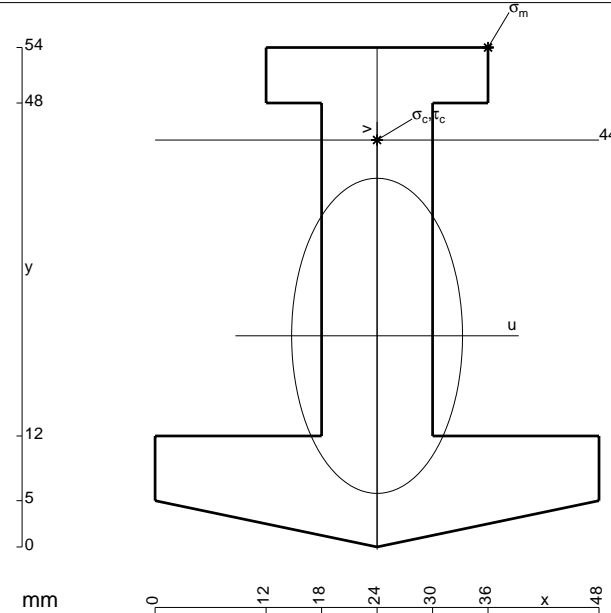
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

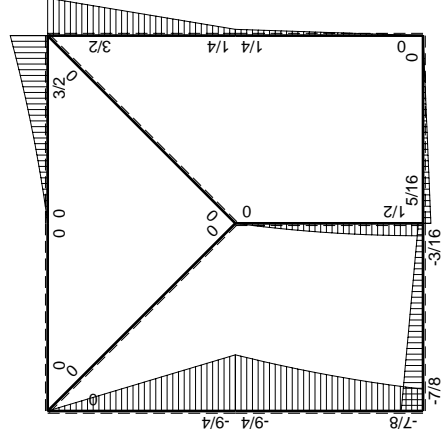
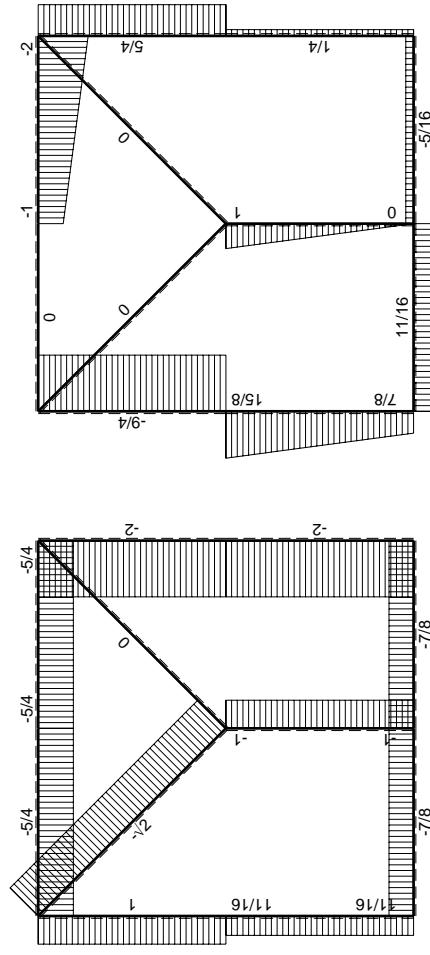
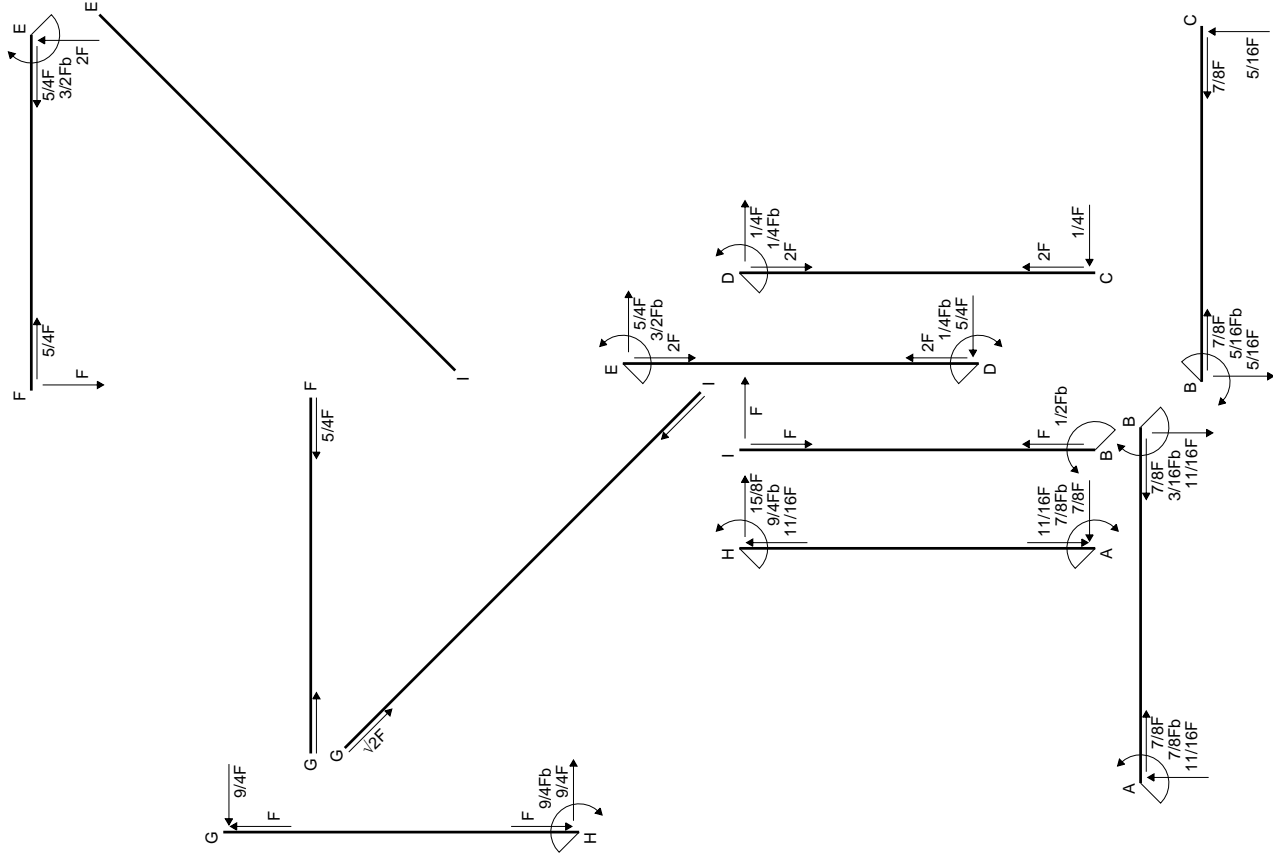
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

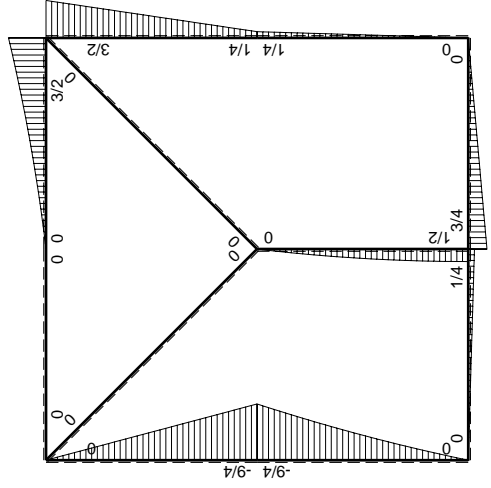
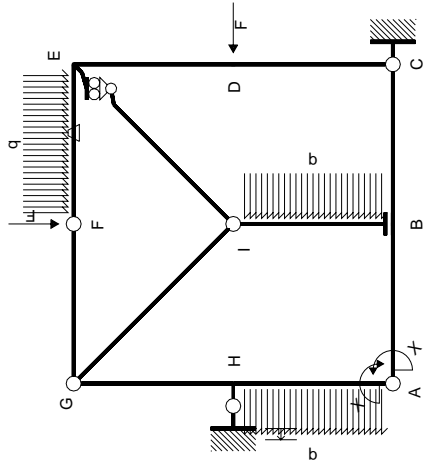
$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

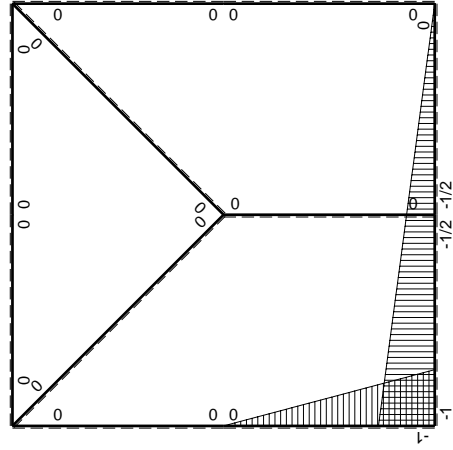


- A = 1032. mm<sup>2</sup>
- J<sub>u</sub> = 299718. mm<sup>4</sup>
- J<sub>v</sub> = 88128. mm<sup>4</sup>
- y<sub>g</sub> = 22.83 mm
- N = 1690. N
- T<sub>y</sub> = -3803. N
- M<sub>x</sub> = -1901250. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 31.17 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 199.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 44. mm
- v<sub>c</sub> = 21.17 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 135.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.465 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 136.3 N/mm<sup>2</sup>
- S = 5169. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	$Fb/EJ$	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ x - 1/2 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x + 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x - 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = \left[ 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = \left[ 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = \left[ x - x^2/b + 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = \left[ -1/8 x^2/b + 1/24 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = \left[ -1/8 x + 1/24 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = \left[ -3/8 x + 3/8 x^2/b - 1/8 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = \left[ -1/8 x^3/b^2 \right]_0^b Fb 1/EJ$$

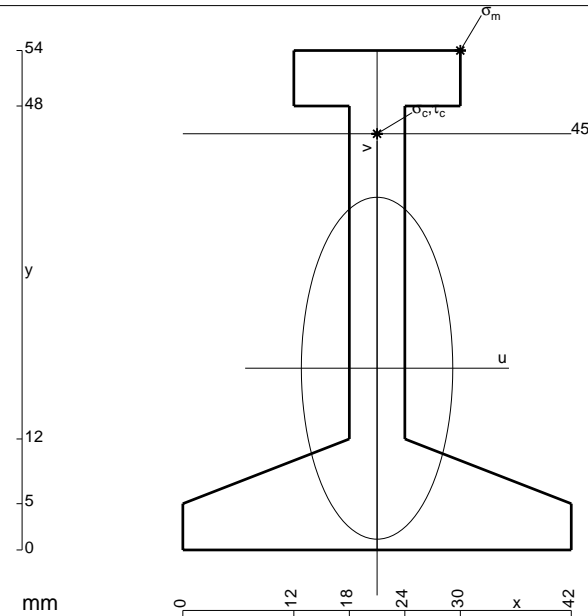
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



$$A = 702. \text{ mm}^2$$

$$J_u = 239989. \text{ mm}^4$$

$$J_v = 47034. \text{ mm}^4$$

$$y_g = 19.65 \text{ mm}$$

$$N = 1170. \text{ N}$$

$$T_y = -2633. \text{ N}$$

$$M_x = -1447880. \text{ Nmm}$$

$$x_m = 30. \text{ mm}$$

$$y_m = 54. \text{ mm}$$

$$u_m = 9. \text{ mm}$$

$$v_m = 34.35 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = 208.9 \text{ N/mm}^2$$

$$x_c = 21. \text{ mm}$$

$$y_c = 45. \text{ mm}$$

$$v_c = 25.35 \text{ mm}$$

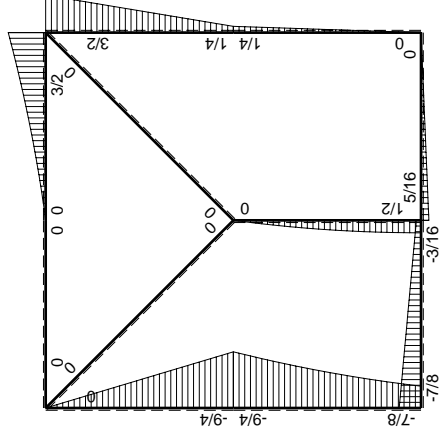
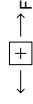
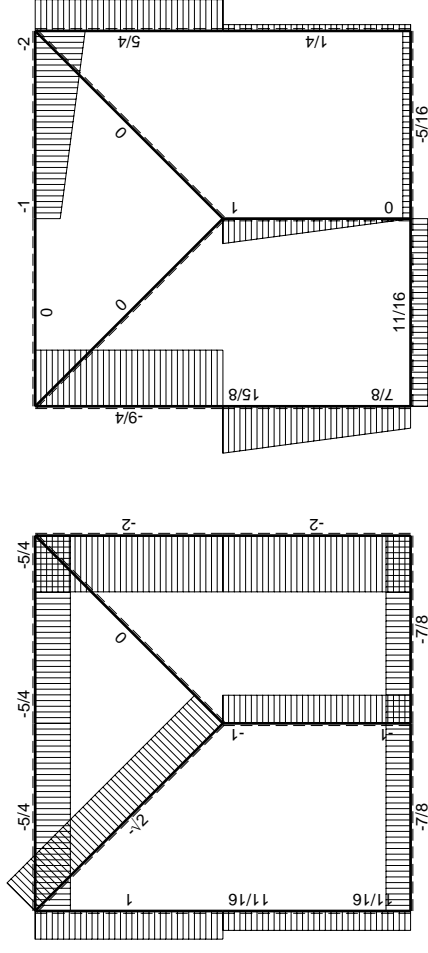
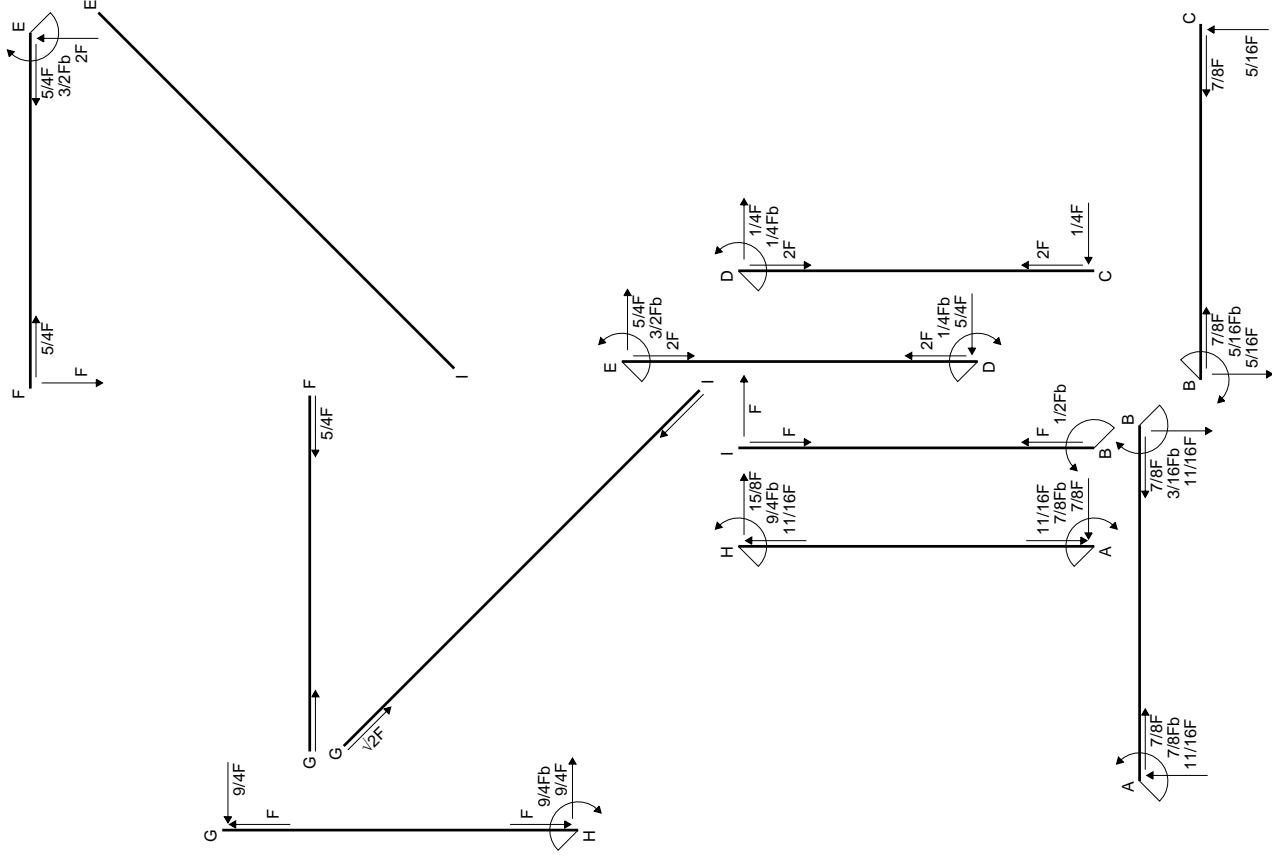
$$\sigma_c = N/A - Mv/J_u = 154.6 \text{ N/mm}^2$$

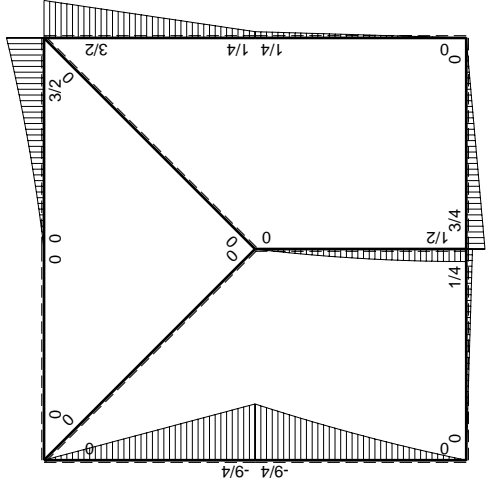
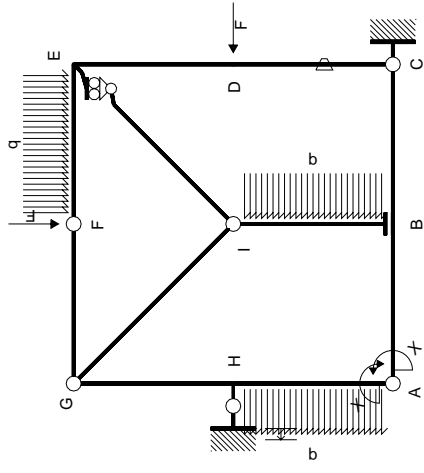
$$\tau_c = 7.074 \text{ N/mm}^2$$

$$\sigma_\rho = \sqrt{\sigma^2 + 3\tau^2} = 155.1 \text{ N/mm}^2$$

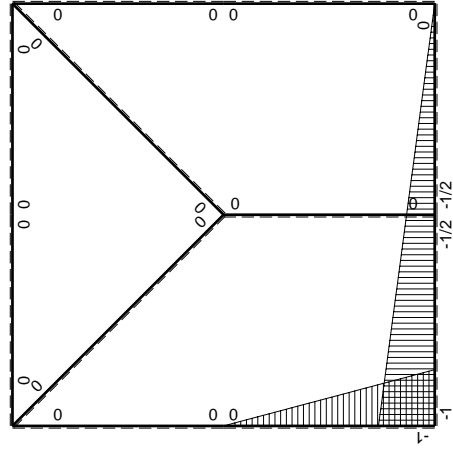
$$S = 3869. \text{ mm}^3$$







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/4Fx$	0	$-1/4Fx+1/8Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb+1/4Fx$	0	$-1/8Fb+1/8Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	$3/4Fb-3/4Fx$	0	$-3/8Fb+3/4Fx-3/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/8+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-3/4Fx$	0	$-3/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	$Fb/EJ$	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	$Fx-1/2qx^2$	0	0	0	0	0+0	0	
BI b	0	$-1/2Fb+1/2qx^2$	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/8Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/8Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/4 x/b + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^2/b + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/8 + 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/24 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-3/8 + 3/4 x/b - 3/8 x^2/b^2) Fb 1/EJ dx = [-3/8 x + 3/8 x^2/b - 1/8 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-3/8 b + 3/8 b - 1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-3/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x^3/b^2]_0^b Fb 1/EJ$$

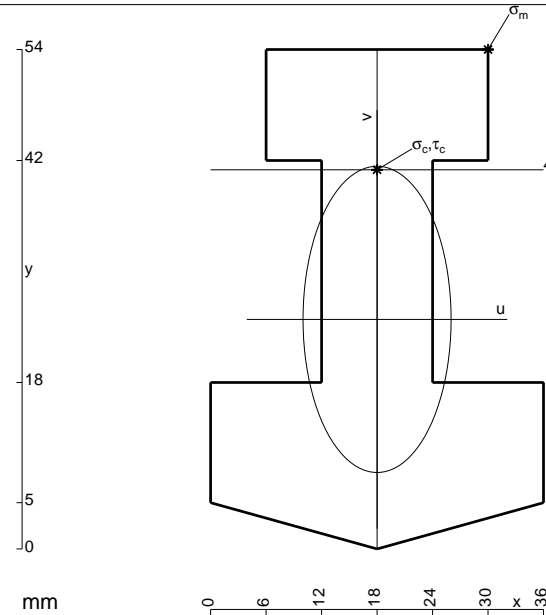
$$= (-1/8 b) Fb 1/EJ = -1/8 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

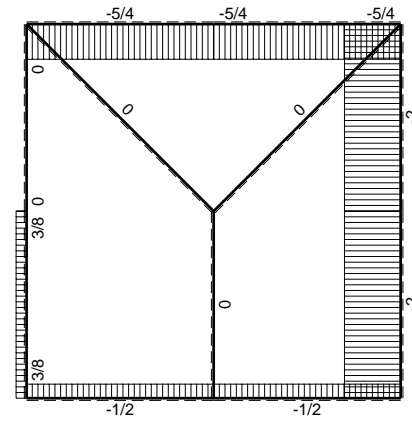
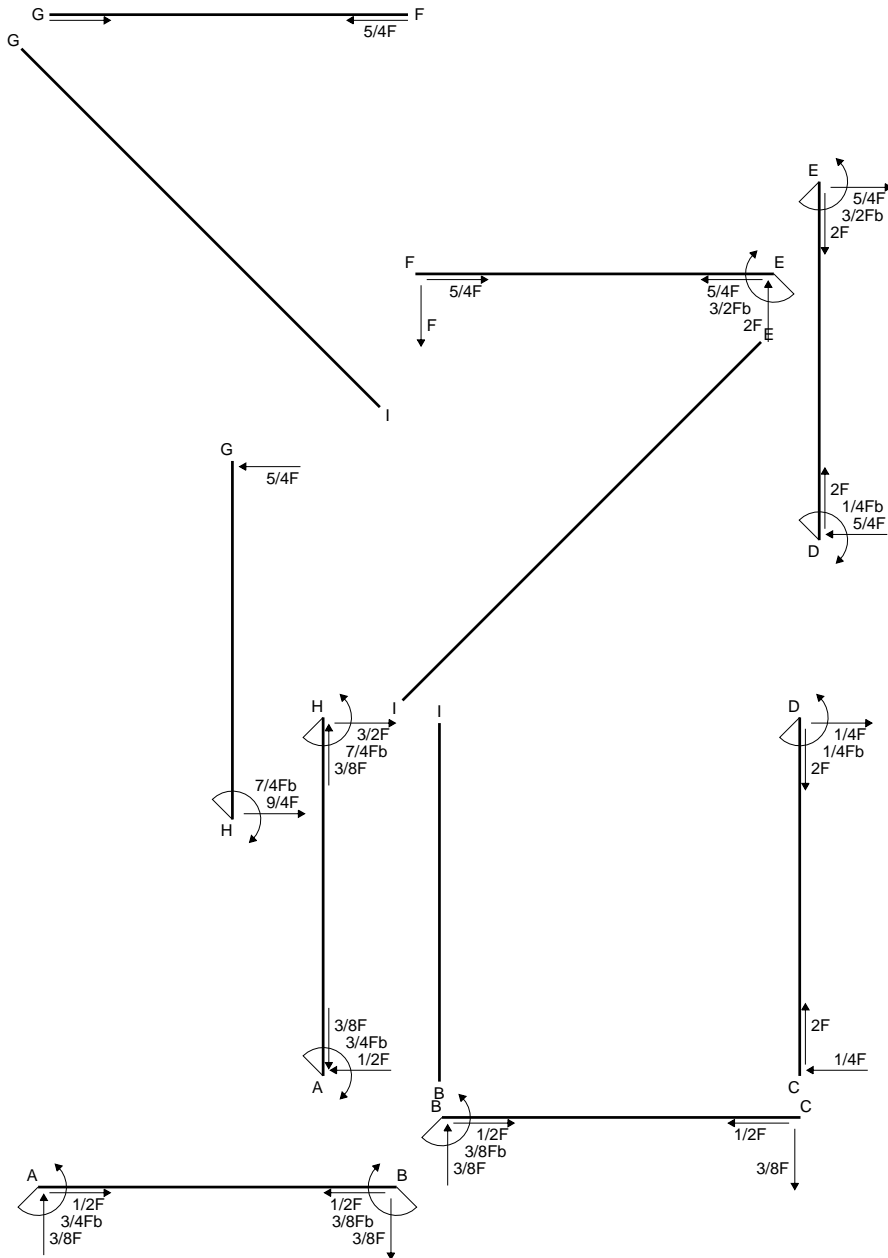
$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

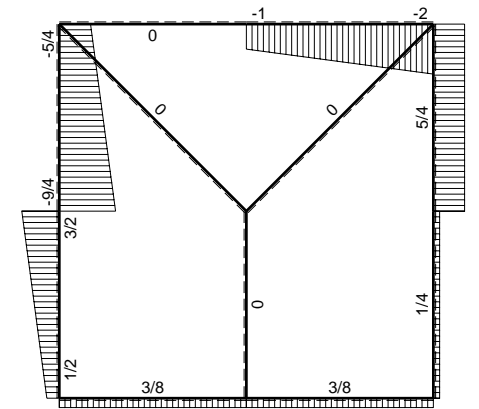
$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



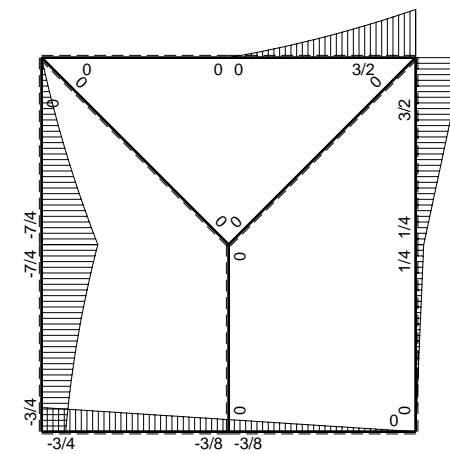
- A = 1134. mm<sup>2</sup>
- J<sub>u</sub> = 311054. mm<sup>4</sup>
- J<sub>v</sub> = 72684. mm<sup>4</sup>
- y<sub>g</sub> = 24.82 mm
- N = 1720. N
- T<sub>y</sub> = -3870. N
- M<sub>x</sub> = -2322000. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 29.18 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = 219.3 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 16.18 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = 122.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.129 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 122.9 N/mm<sup>2</sup>
- S = 6876. mm<sup>3</sup>



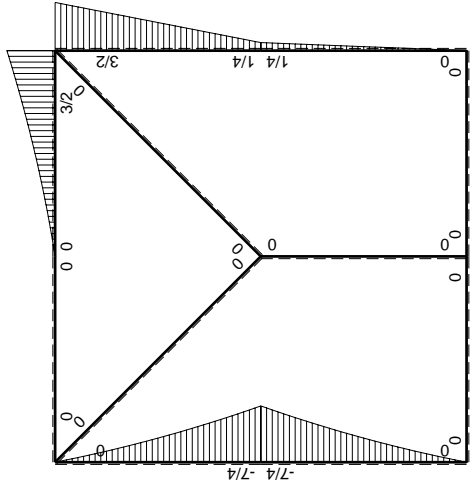
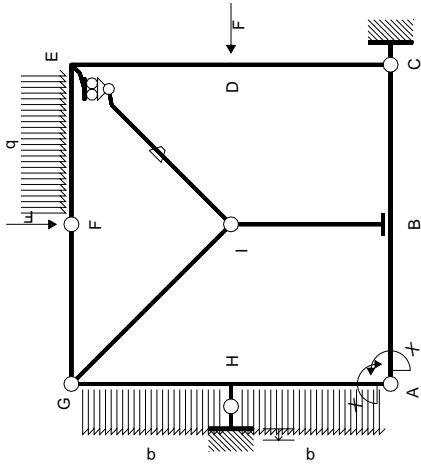
← ⊕ → F



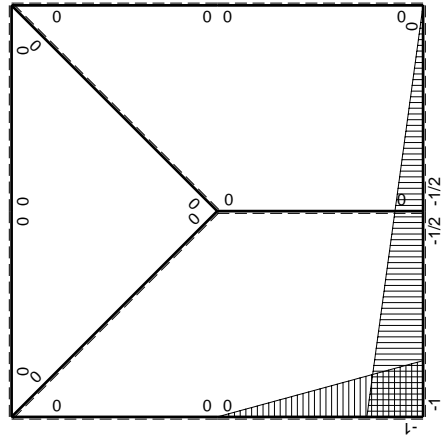
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

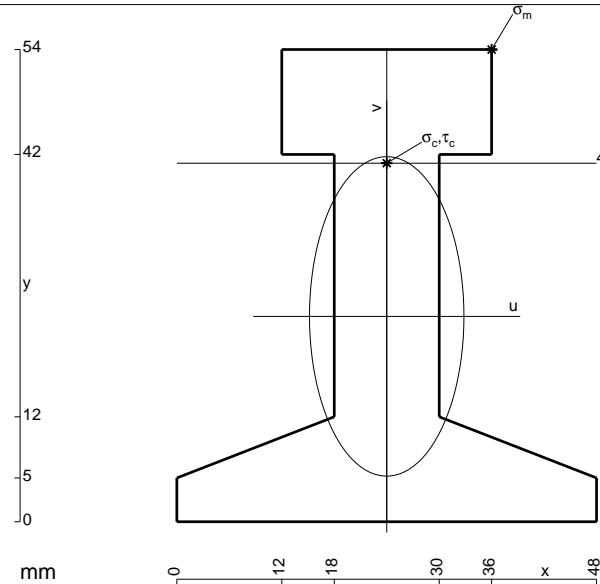
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

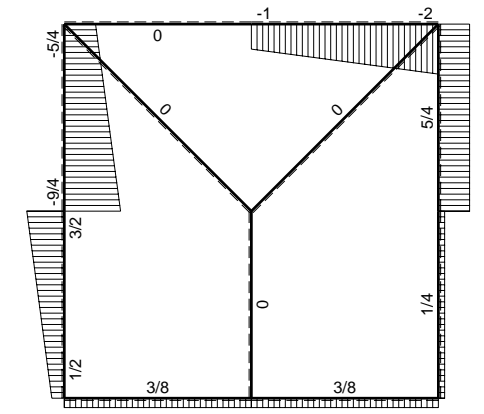
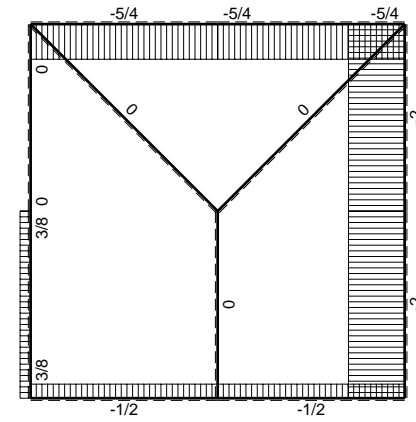
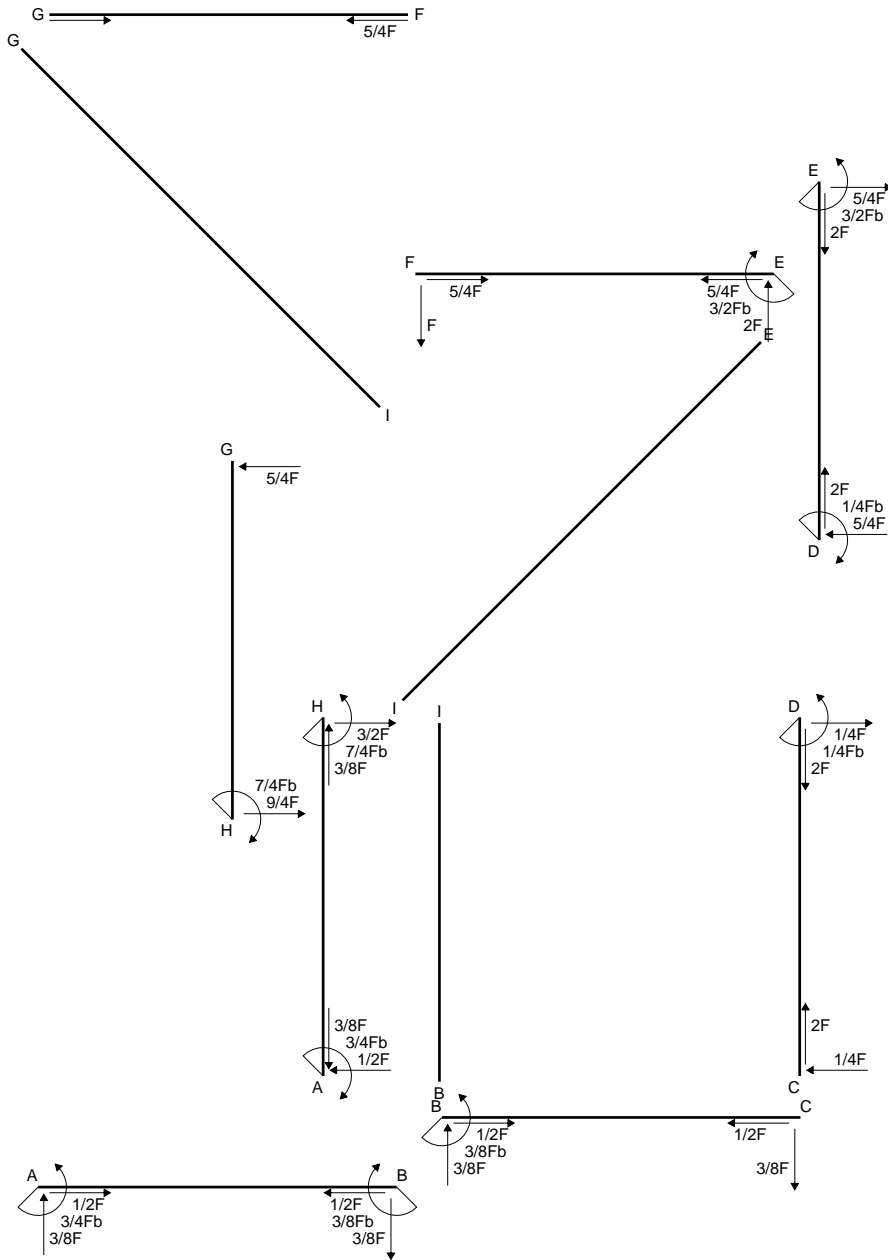
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



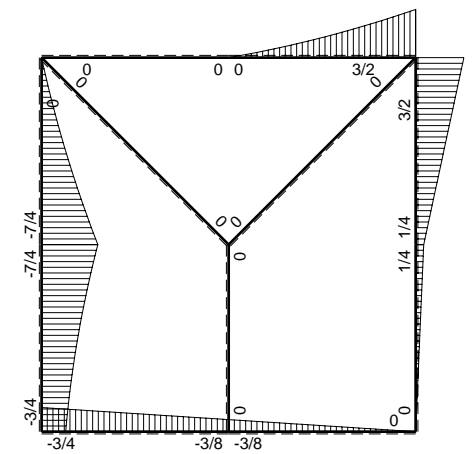
- A = 1098. mm<sup>2</sup>
- J<sub>u</sub> = 366595. mm<sup>4</sup>
- J<sub>v</sub> = 85644. mm<sup>4</sup>
- y<sub>g</sub> = 23.48 mm
- T<sub>y</sub> = -5445. N
- M<sub>x</sub> = -2752750. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.52 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = 229.2 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 17.52 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = 131.6 N/mm<sup>2</sup>
- τ<sub>c</sub> = 9.008 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 132.5 N/mm<sup>2</sup>
- S = 7278. mm<sup>3</sup>



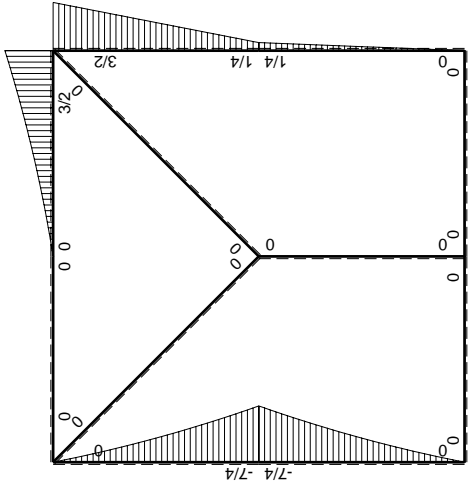
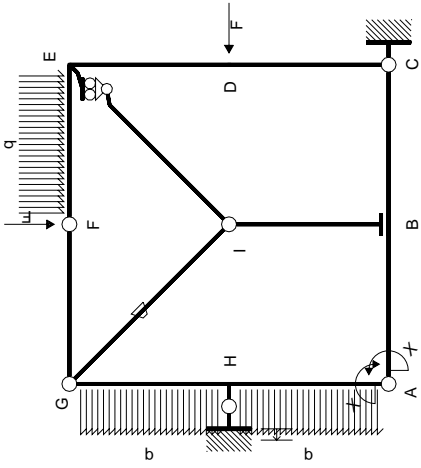


← ⊕ → F

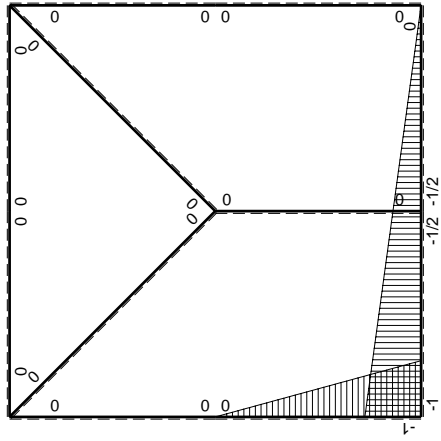
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

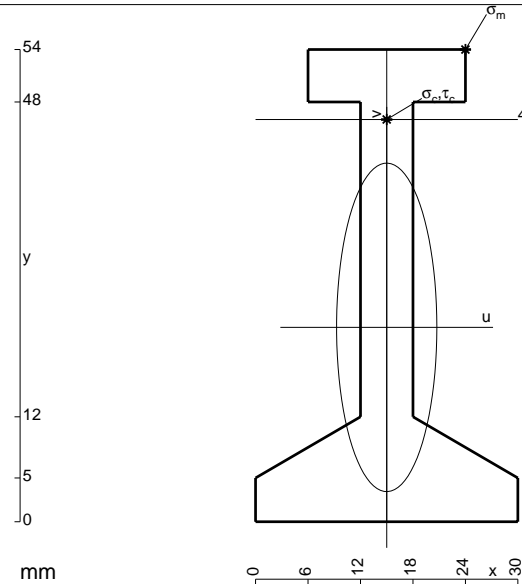
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

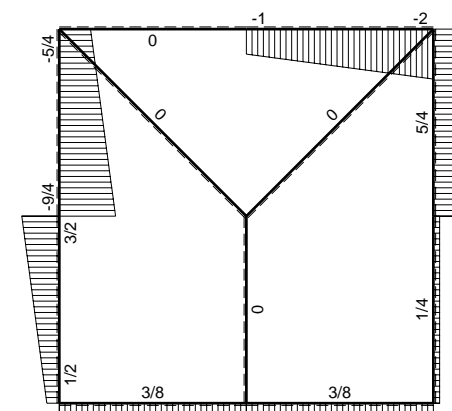
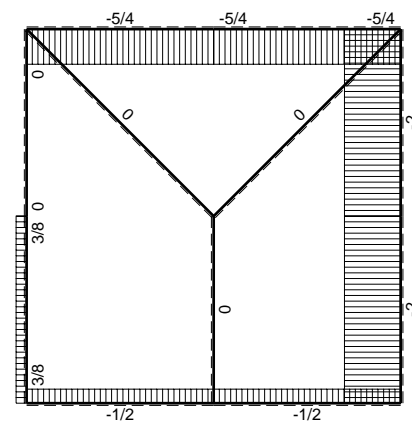
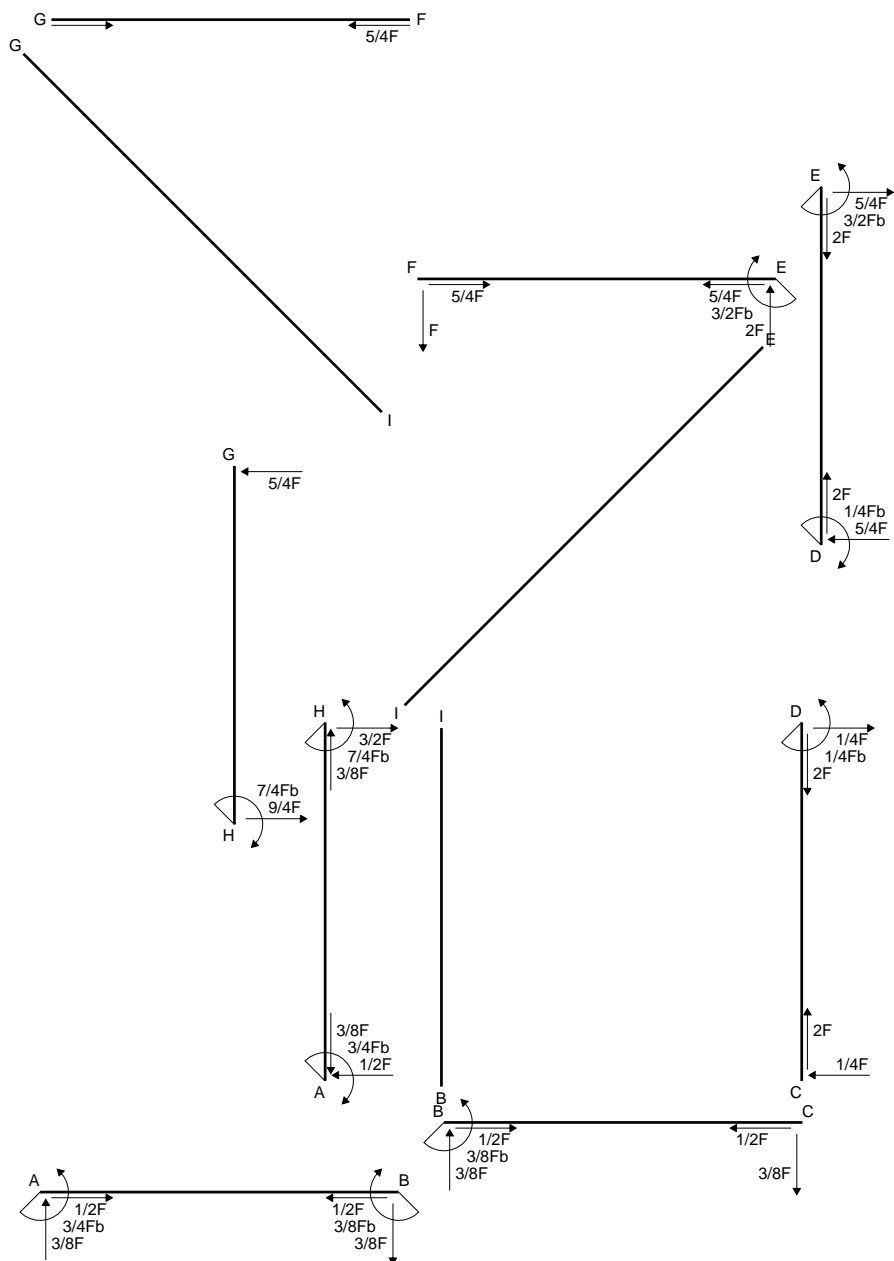
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

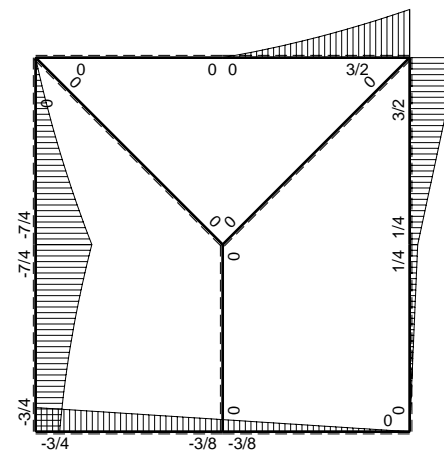


- A = 600. mm<sup>2</sup>
- J<sub>u</sub> = 211747. mm<sup>4</sup>
- J<sub>v</sub> = 19728. mm<sup>4</sup>
- y<sub>g</sub> = 22.23 mm
- T<sub>y</sub> = -2925. N
- M<sub>x</sub> = -1592500. Nmm
- x<sub>m</sub> = 24. mm
- y<sub>m</sub> = 54. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 31.77 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = 239. N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 46. mm
- v<sub>c</sub> = 23.77 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = 178.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 7.839 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 179.3 N/mm<sup>2</sup>
- S = 3405. mm<sup>3</sup>

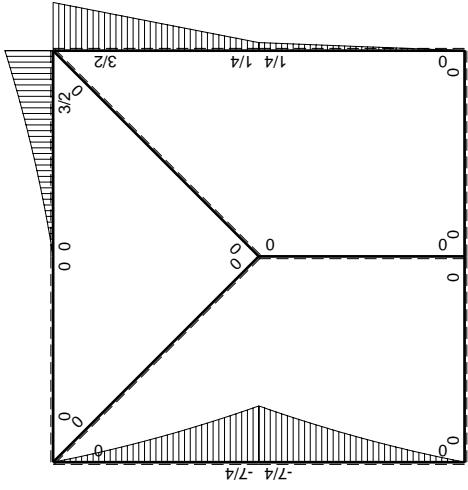
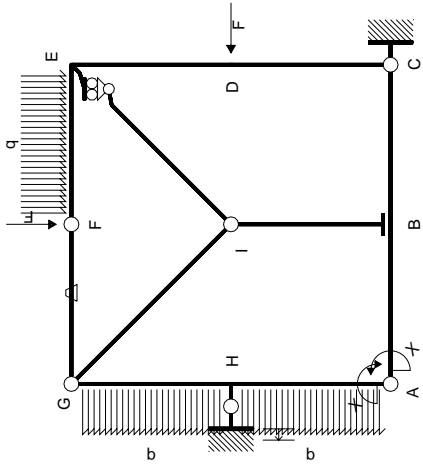


← ⊕ → F

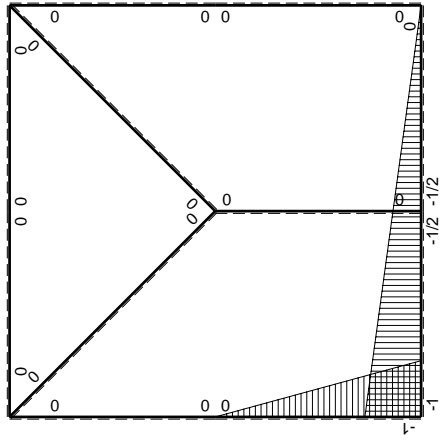
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	0	0	0	0			
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
GF b	0	0	$Fb/EJ$	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

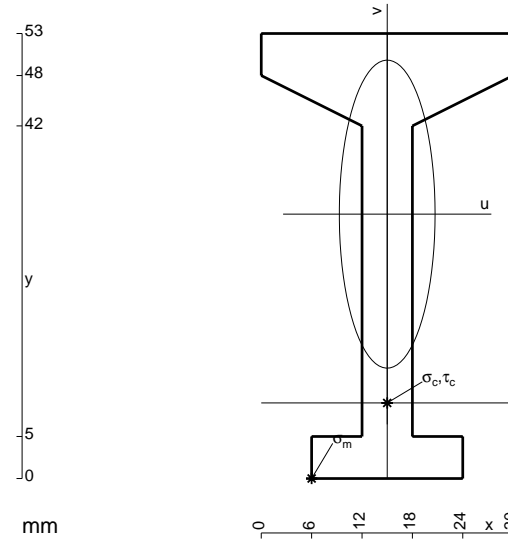
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

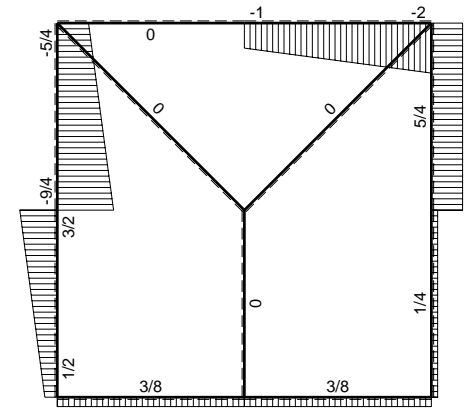
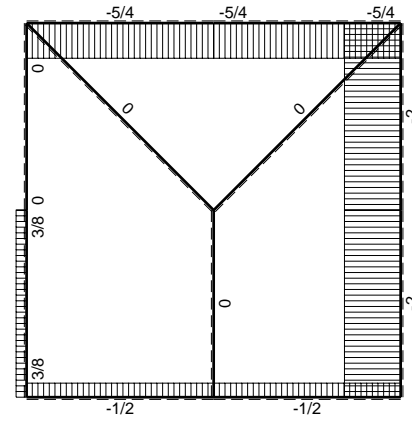
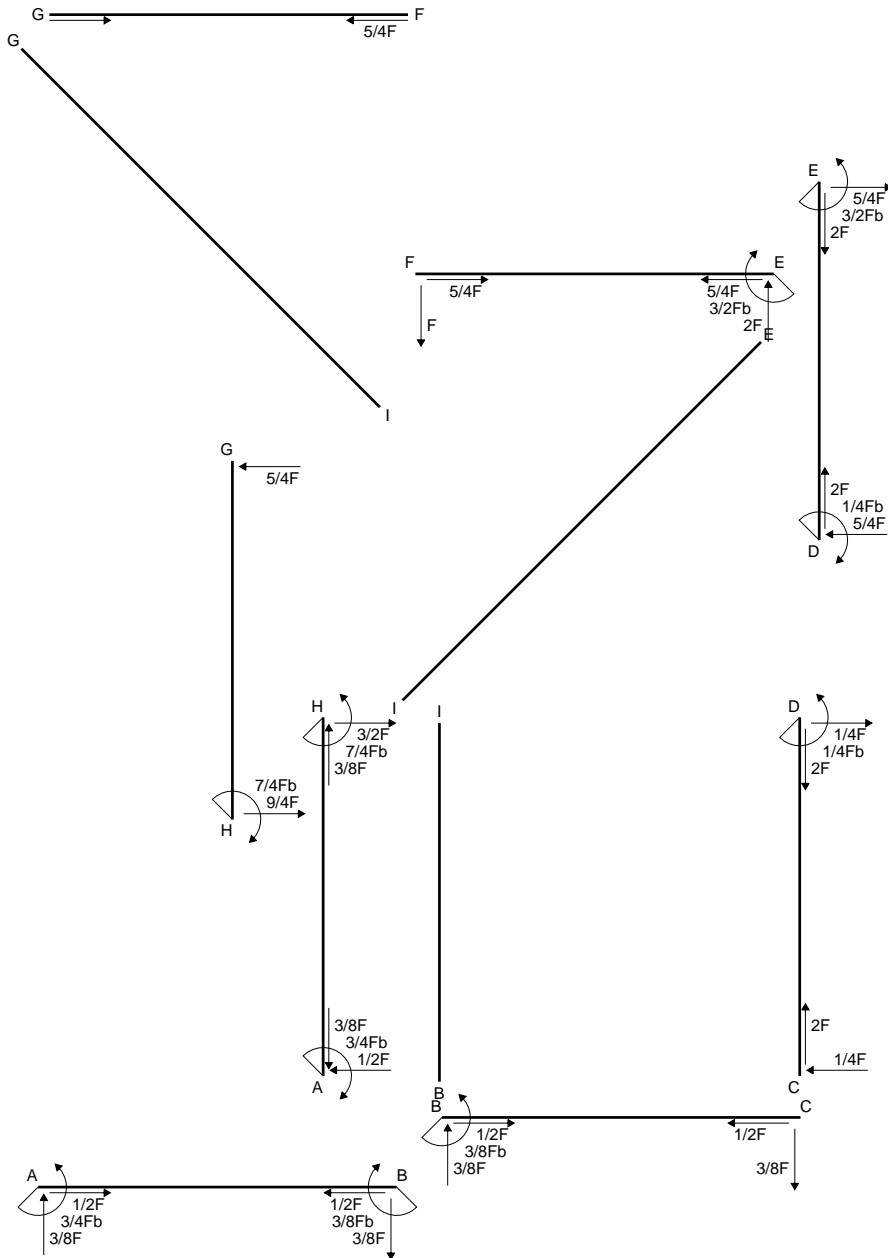
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



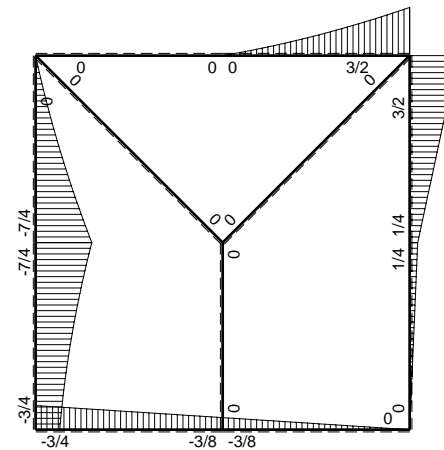
- A = 570. mm<sup>2</sup>
- J<sub>u</sub> = 191825. mm<sup>4</sup>
- J<sub>v</sub> = 18558. mm<sup>4</sup>
- y<sub>g</sub> = 31.49 mm
- T<sub>y</sub> = -2138. N
- M<sub>x</sub> = -1213630. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -31.49 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -199.2 N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -22.49 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -142.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.937 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 142.7 N/mm<sup>2</sup>
- S = 3197. mm<sup>3</sup>



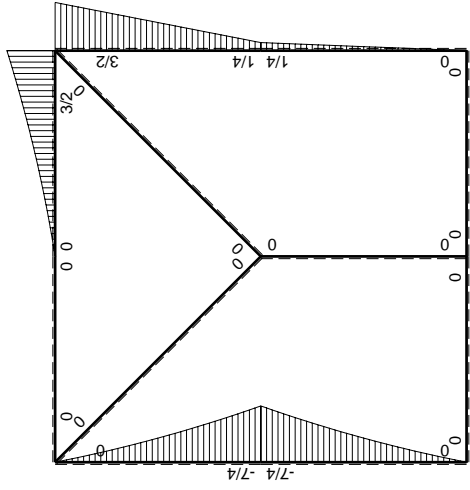
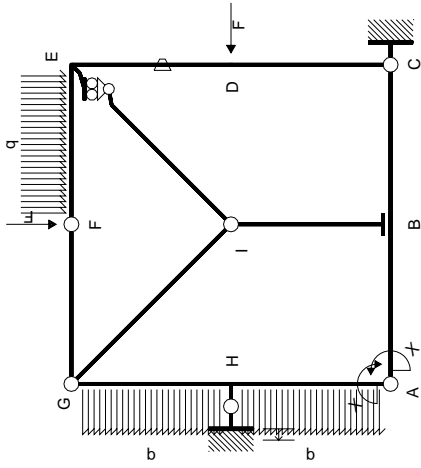


← ⊕ → F

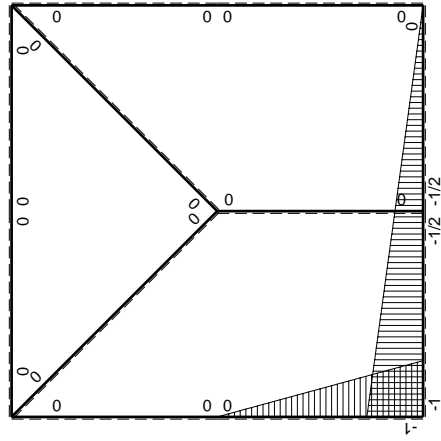
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	$Fb/EJ$	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

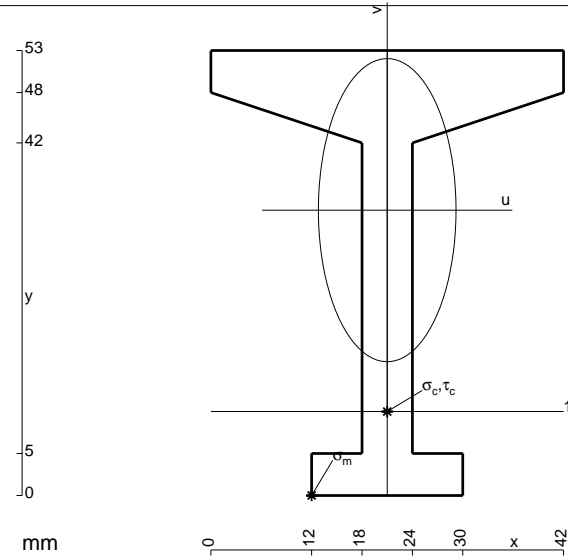
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

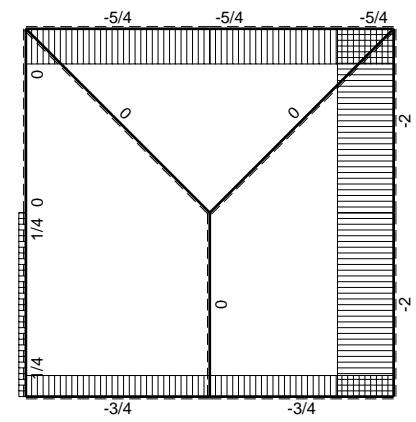
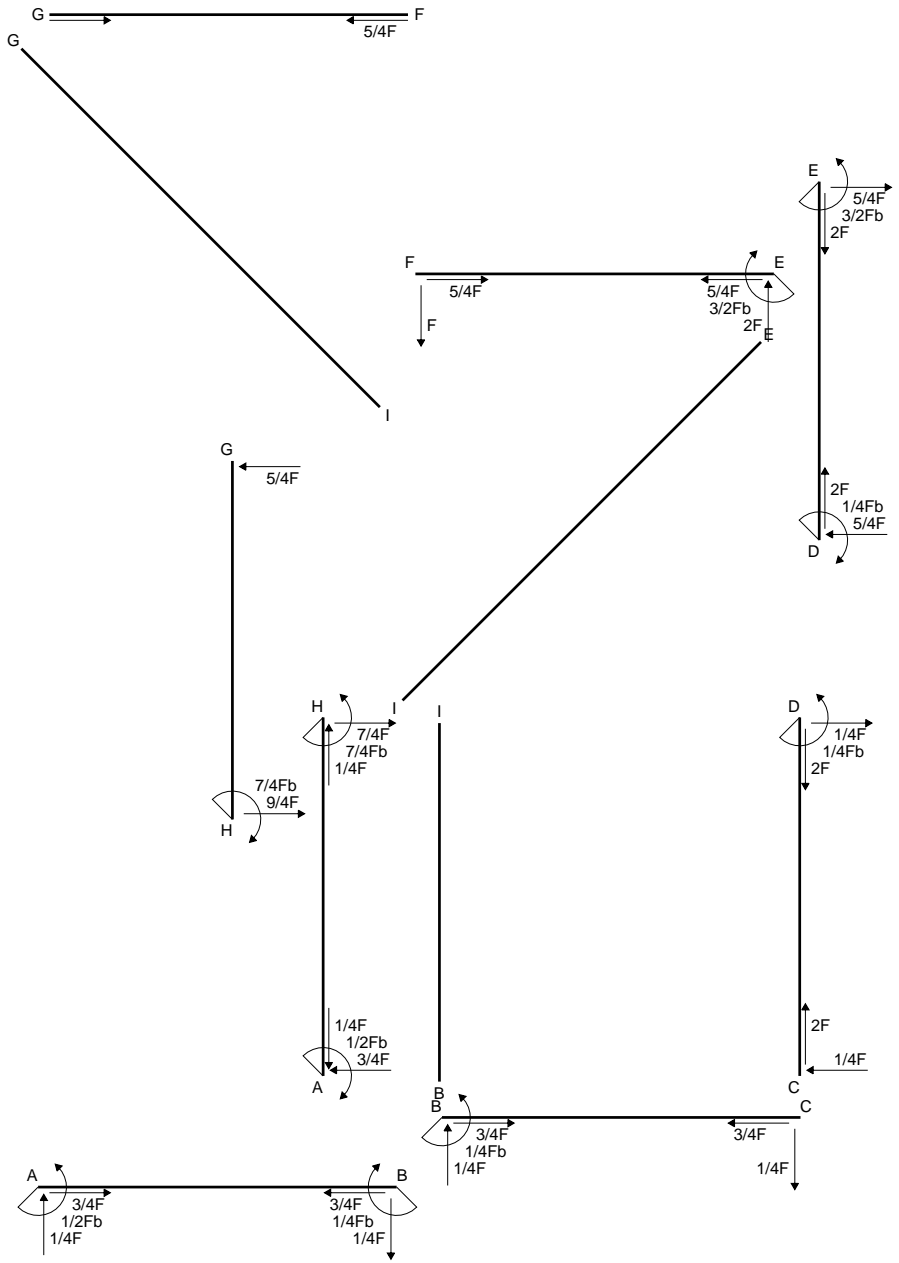
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

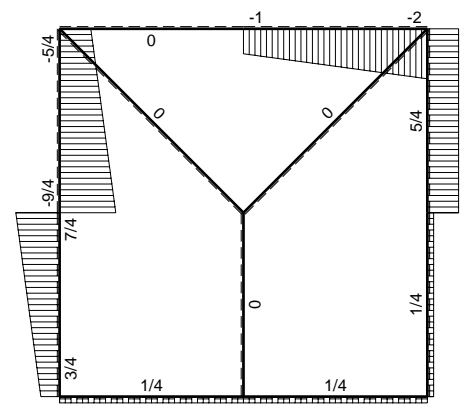
$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



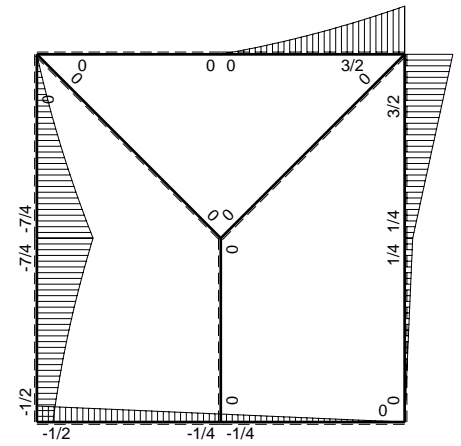
- A = 666. mm<sup>2</sup>
- J<sub>u</sub> = 217134. mm<sup>4</sup>
- J<sub>v</sub> = 44766. mm<sup>4</sup>
- y<sub>g</sub> = 33.99 mm
- T<sub>y</sub> = -2205. N
- M<sub>x</sub> = -1337700. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -33.99 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -209.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -23.99 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -147.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.141 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 148.2 N/mm<sup>2</sup>
- S = 3628. mm<sup>3</sup>



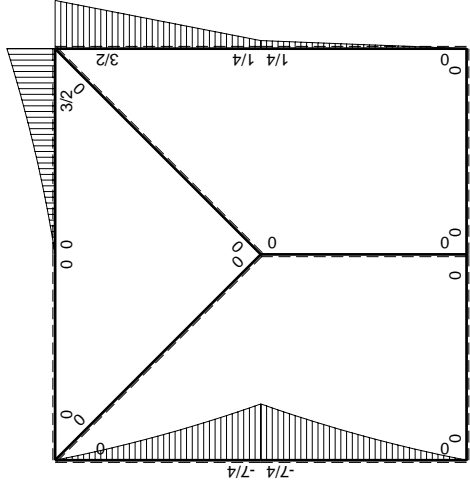
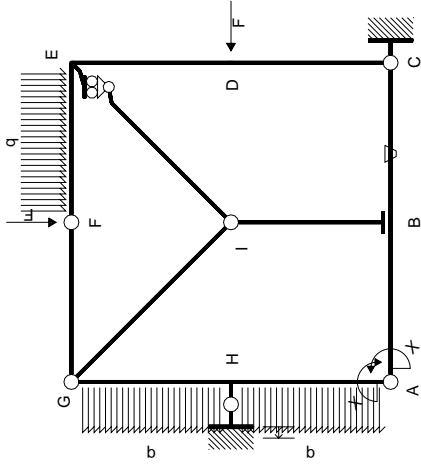
← ⊕ → F



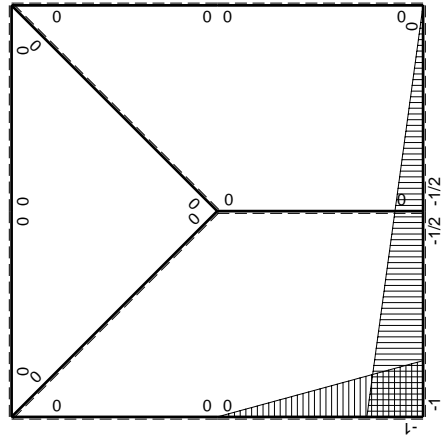
↑ ⊕ ↓ F



⊕ ⊖ Fb



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	$-Fb/EJ$	0	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(0+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	$Fb/EJ$	0	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/2Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/2Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ x - 1/2 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x + 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x - 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = \left[ 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = \left[ 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = \left[ x - x^2/b + 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 - 1/2 x/b) \theta dx = \left[ 1/2 x - 1/4 x^2/b \right]_0^b \theta$$

$$= (1/2 b - 1/4 b) \theta = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/2 x/b) \theta dx = \left[ -1/4 x^2/b \right]_0^b \theta$$

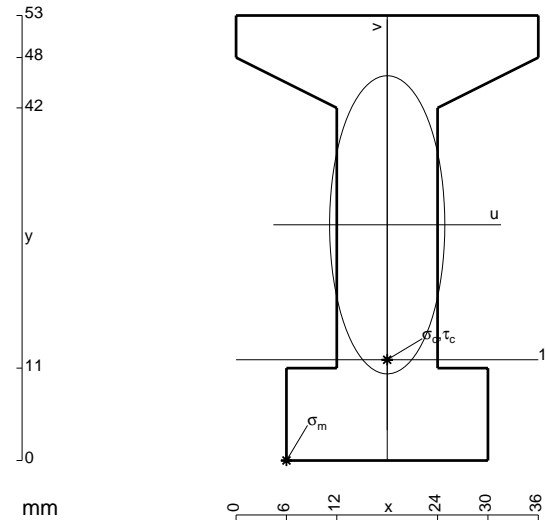
$$= (-1/4 b) \theta = 1/4 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



$$A = 960. \text{ mm}^2$$

$$J_u = 302931. \text{ mm}^4$$

$$J_v = 45216. \text{ mm}^4$$

$$y_g = 28.08 \text{ mm}$$

$$T_y = -3668. \text{ N}$$

$$M_x = -2367580. \text{ Nmm}$$

$$x_m = 6. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -28.08 \text{ mm}$$

$$\sigma_m = -Mv/J_u = -219.4 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 12. \text{ mm}$$

$$v_c = -16.08 \text{ mm}$$

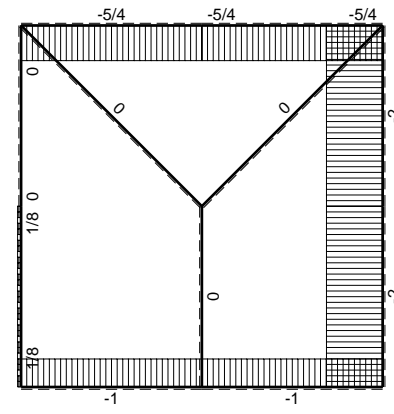
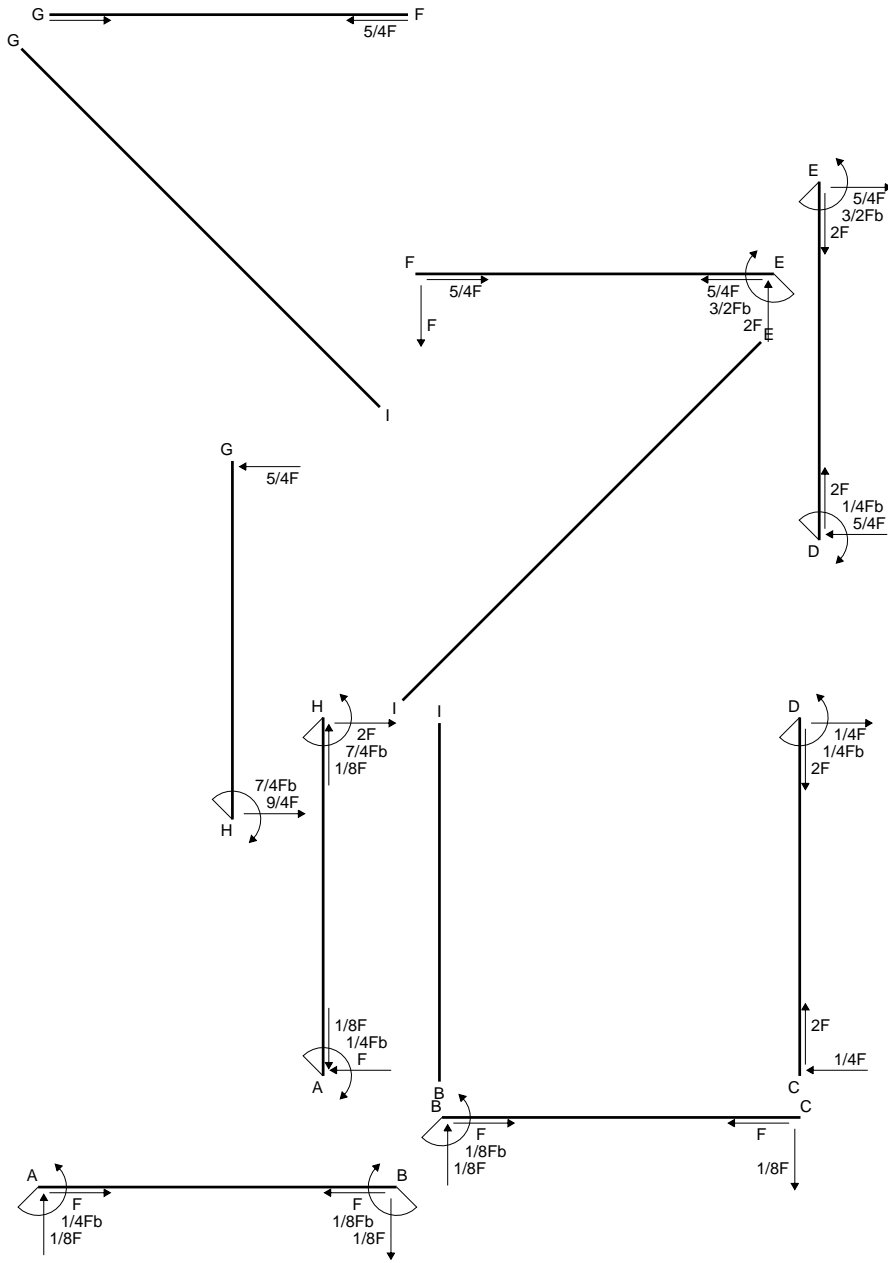
$$\sigma_c = -Mv/J_u = -125.6 \text{ N/mm}^2$$

$$\tau_c = 6.213 \text{ N/mm}^2$$

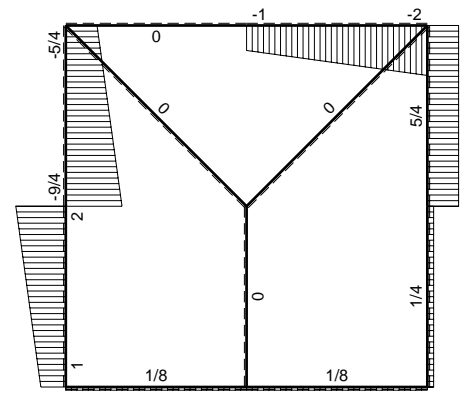
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 126.1 \text{ N/mm}^2$$

$$S = 6159. \text{ mm}^3$$

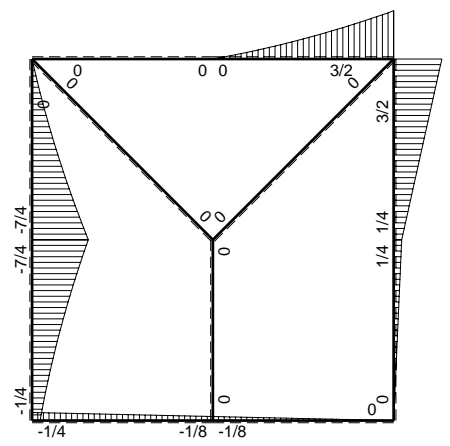




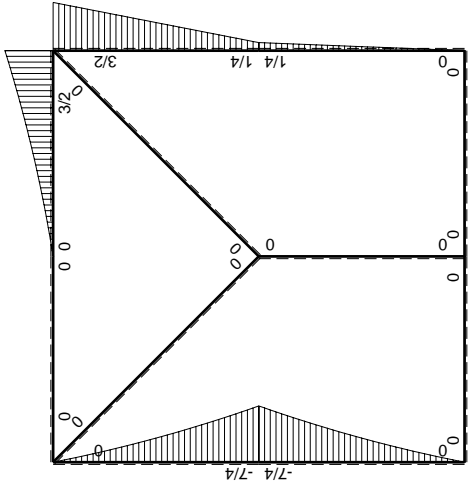
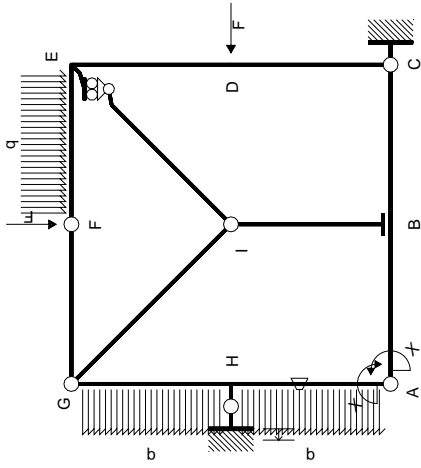
← ⊕ → F



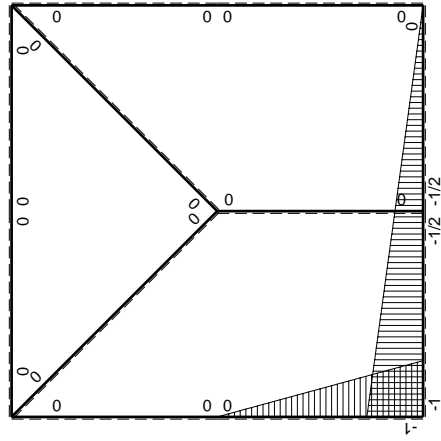
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	$-Fb/EJ$	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	$Fx/EJ$	$x^2/b^2$	$(1/4+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	$Fb/EJ$	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2 x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

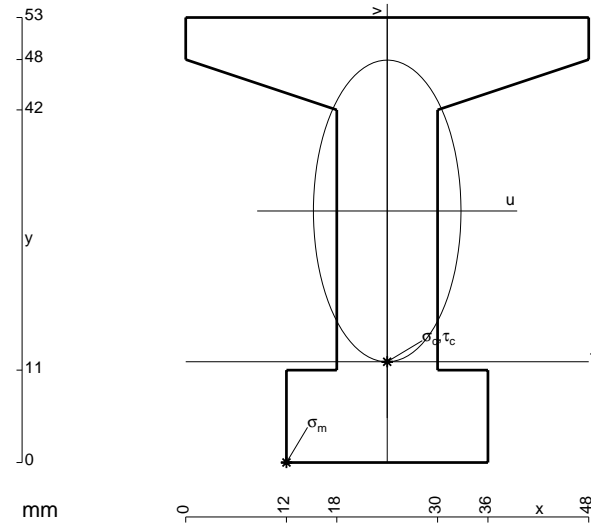
$$= [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 3/4 Fb^2/EJ$$

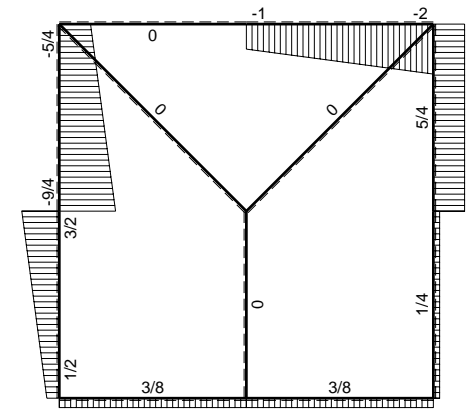
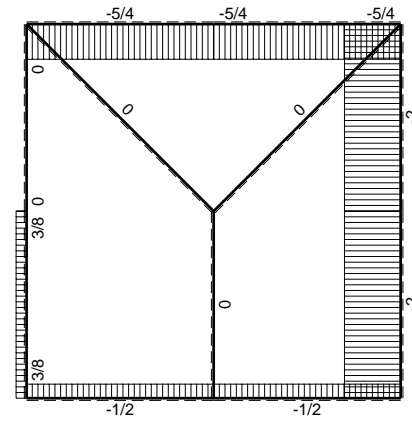
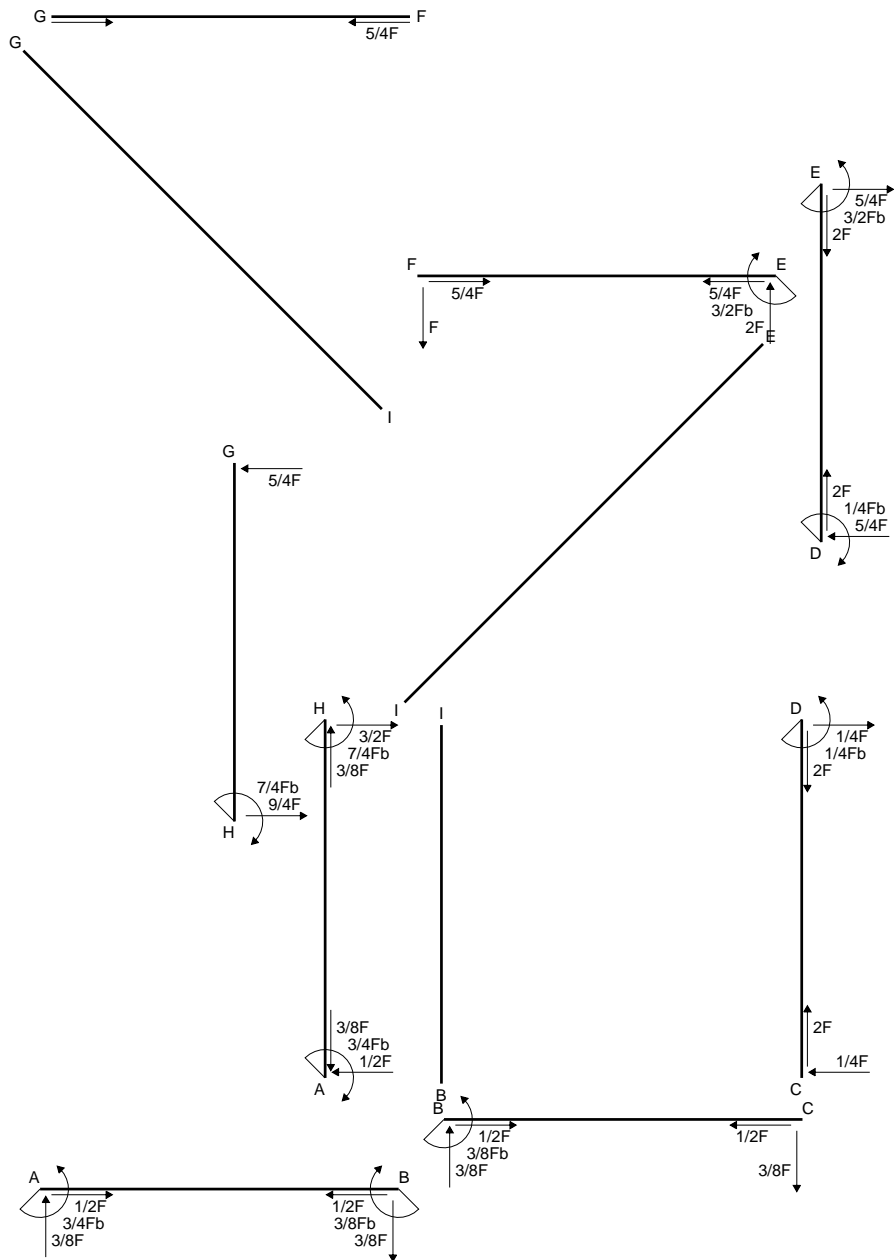
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

$$= [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 3/4 Fb^2/EJ$$

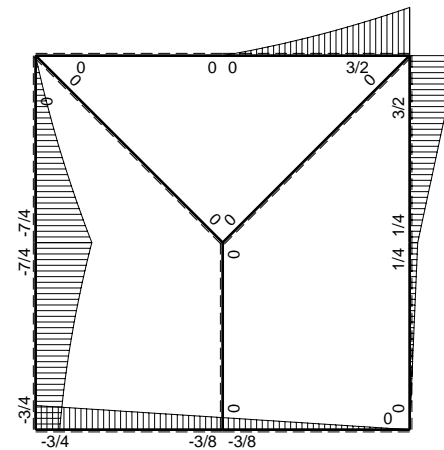


$A = 1056. \text{ mm}^2$   
 $J_u = 341114. \text{ mm}^4$   
 $J_v = 81576. \text{ mm}^4$   
 $y_g = 29.96 \text{ mm}$   
 $T_y = -3825. \text{ N}$   
 $M_x = -2618000. \text{ Nmm}$   
 $x_m = 12. \text{ mm}$   
 $u_m = -12. \text{ mm}$   
 $v_m = -29.96 \text{ mm}$   
 $\sigma_m = -Mv/J_u = -229.9 \text{ N/mm}^2$   
 $x_c = 24. \text{ mm}$   
 $y_c = 12. \text{ mm}$   
 $v_c = -17.96 \text{ mm}$   
 $\sigma_c = -Mv/J_u = -137.8 \text{ N/mm}^2$   
 $\tau_c = 6.241 \text{ N/mm}^2$   
 $\sigma_\rho = \sqrt{\sigma^2 + 3\tau^2} = 138.3 \text{ N/mm}^2$   
 $S = 6679. \text{ mm}^3$

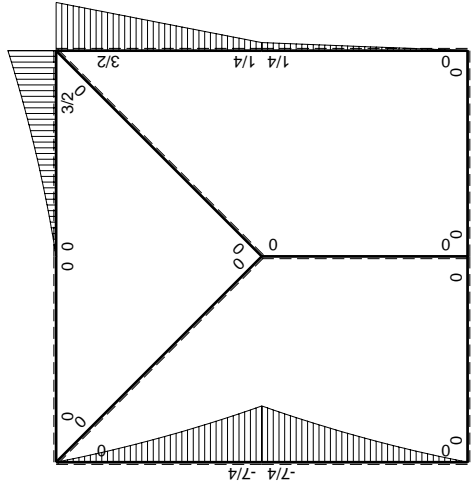
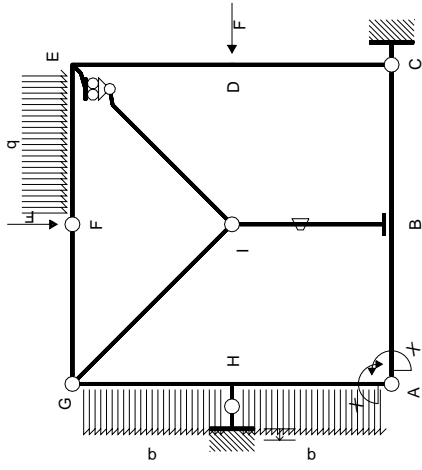


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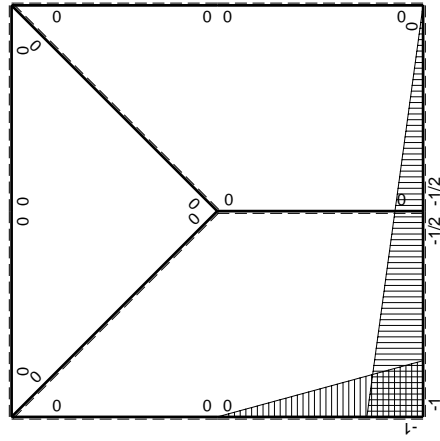
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
BI b	0	0	$Fb/EJ$	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

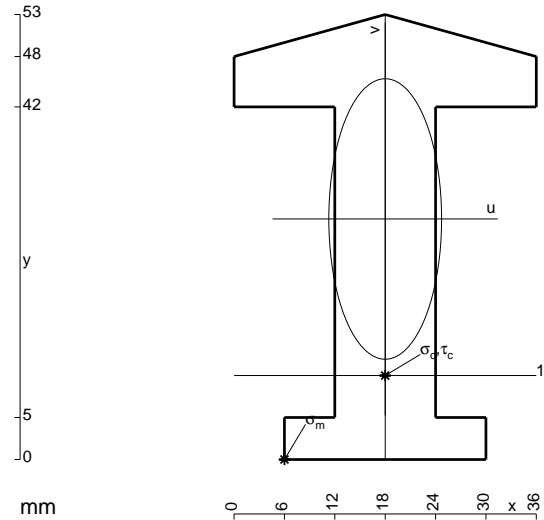
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

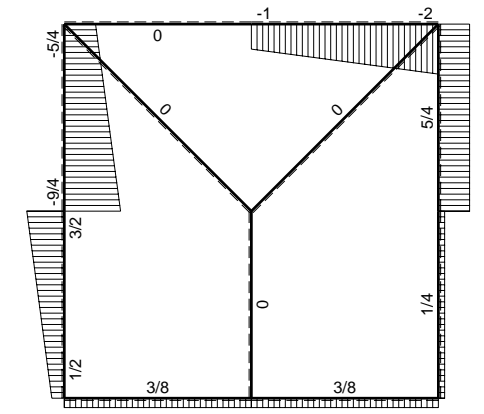
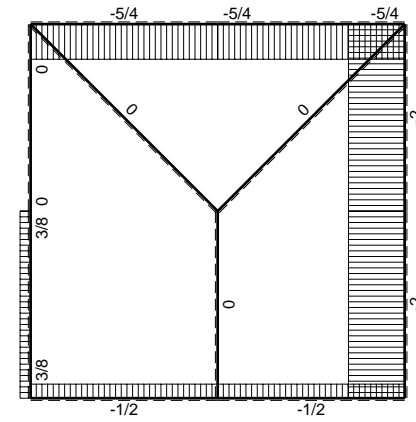
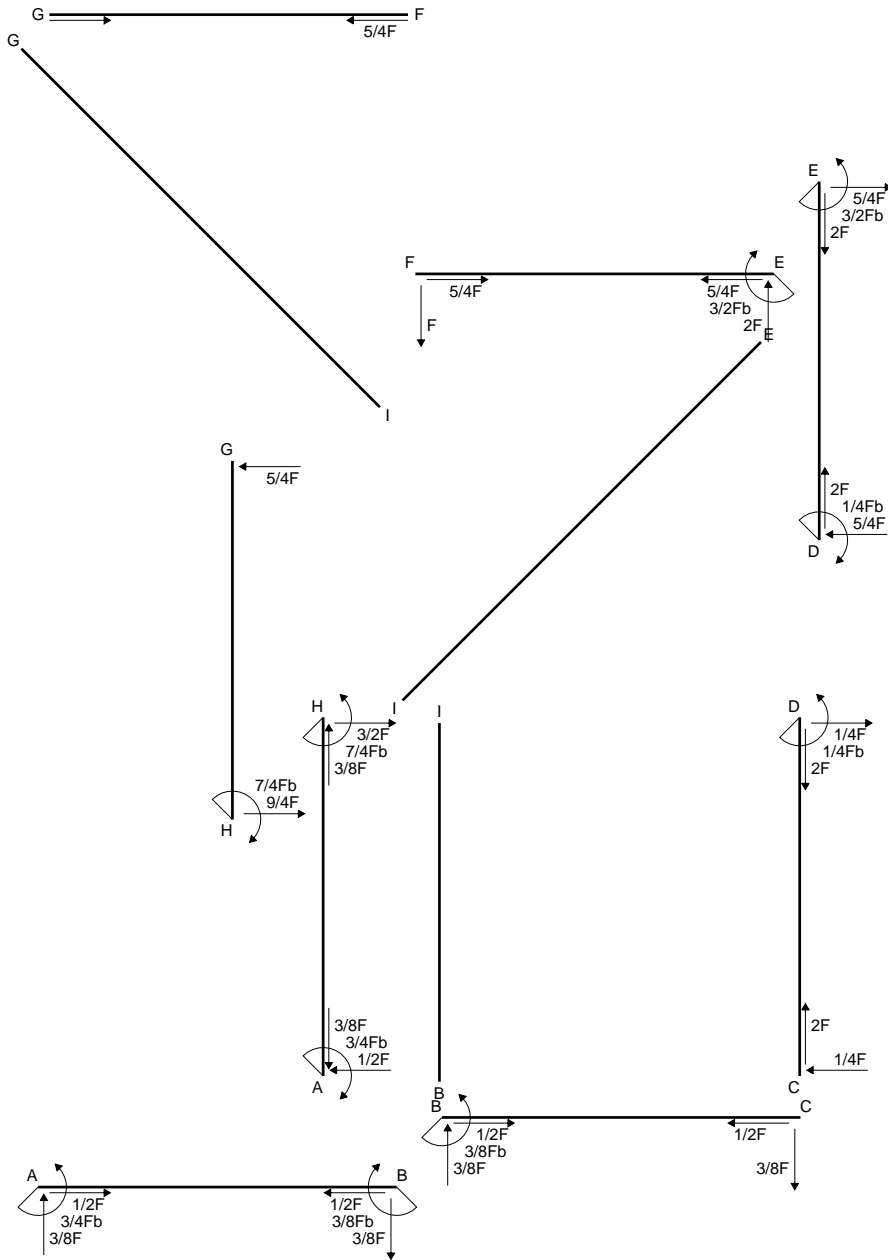
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



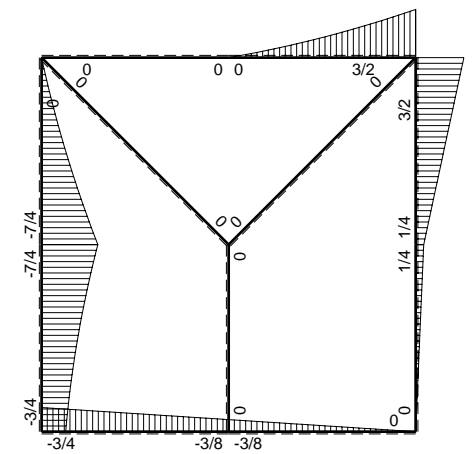
- A = 870. mm<sup>2</sup>
- J<sub>u</sub> = 243005. mm<sup>4</sup>
- J<sub>v</sub> = 39276. mm<sup>4</sup>
- y<sub>g</sub> = 28.65 mm
- T<sub>y</sub> = -2813. N
- M<sub>x</sub> = -2034380. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.65 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -239.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -18.65 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -156.1 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.25 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 156.3 N/mm<sup>2</sup>
- S = 4407. mm<sup>3</sup>



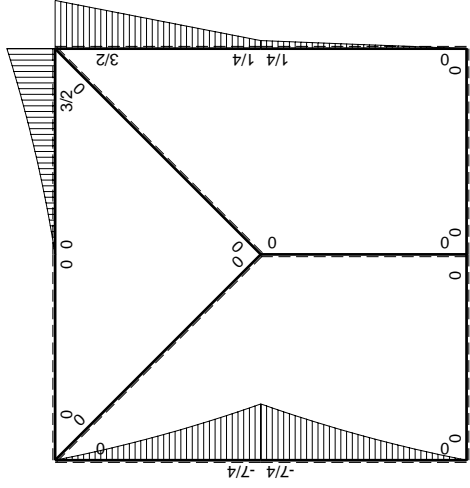
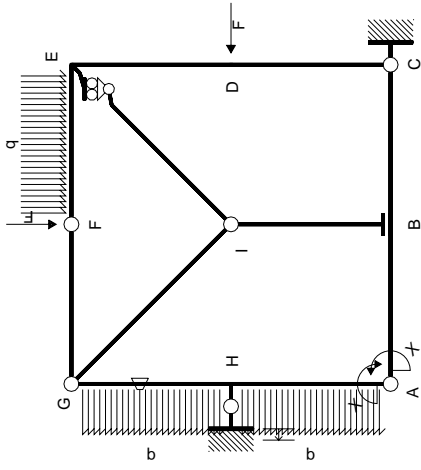


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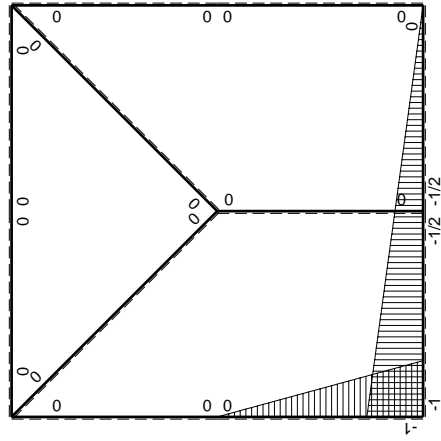
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	$Fb/EJ$	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

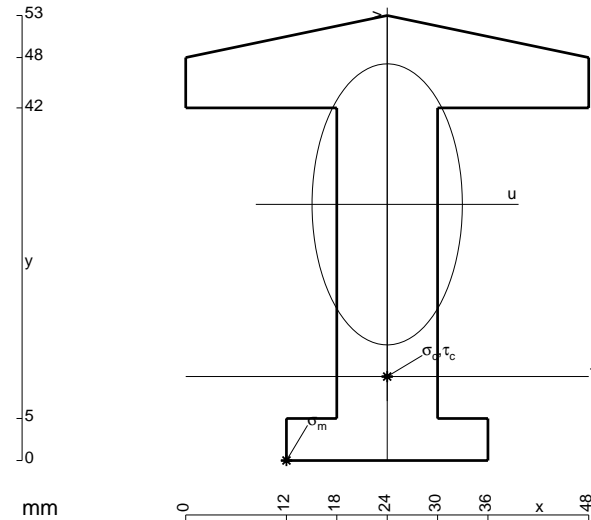
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

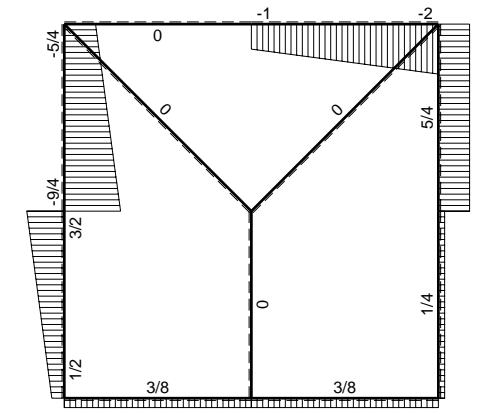
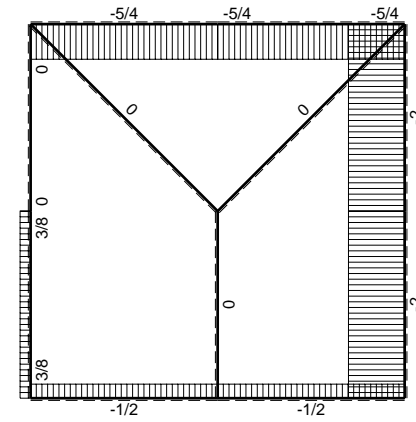
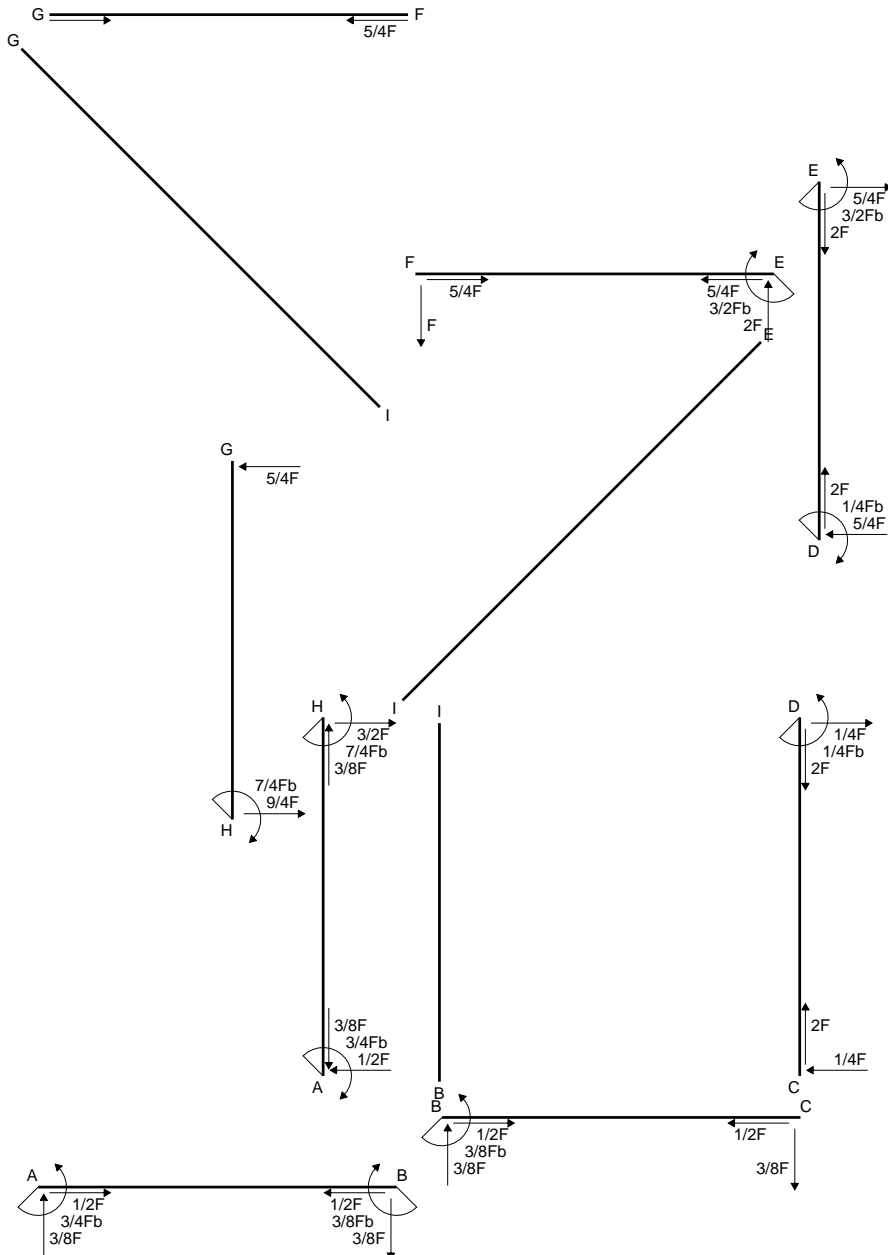
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

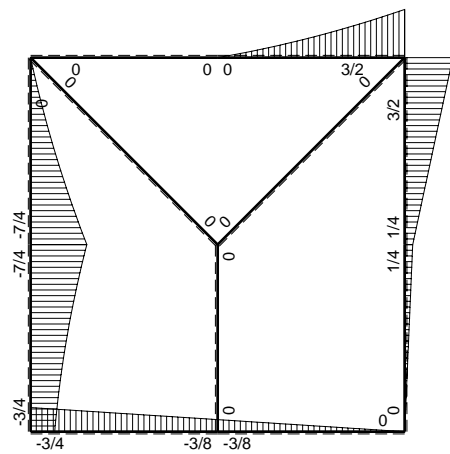


- A = 972. mm<sup>2</sup>
- J<sub>u</sub> = 272405. mm<sup>4</sup>
- J<sub>v</sub> = 77904. mm<sup>4</sup>
- y<sub>g</sub> = 30.51 mm
- T<sub>y</sub> = -4680. N
- M<sub>x</sub> = -1783600. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.51 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -199.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -20.51 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -134.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.788 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 134.8 N/mm<sup>2</sup>
- S = 4741. mm<sup>3</sup>

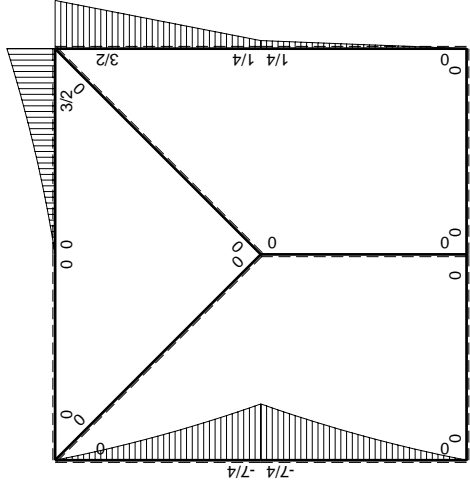
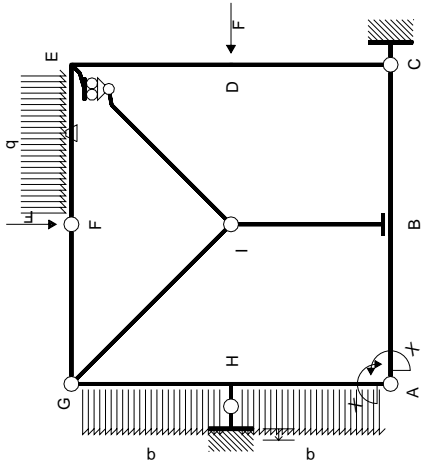


← ⊕ → F

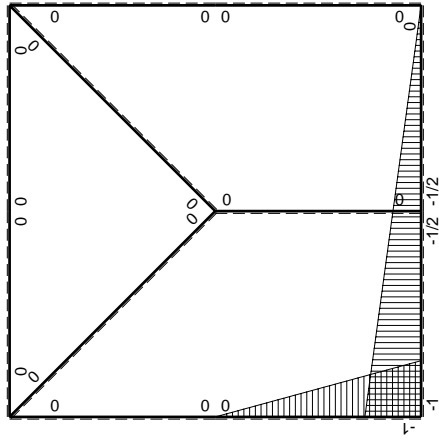
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	$Fb/EJ$	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

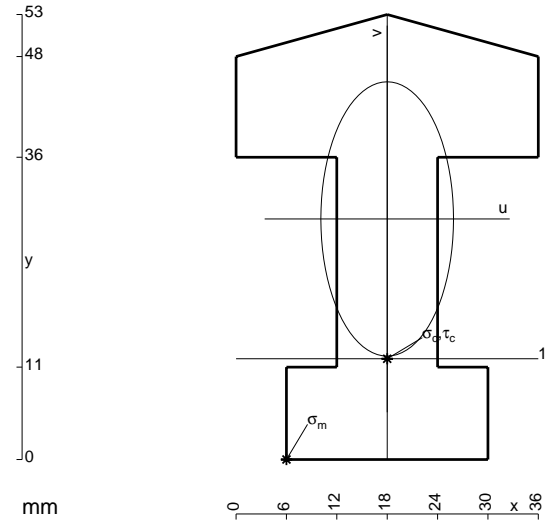
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

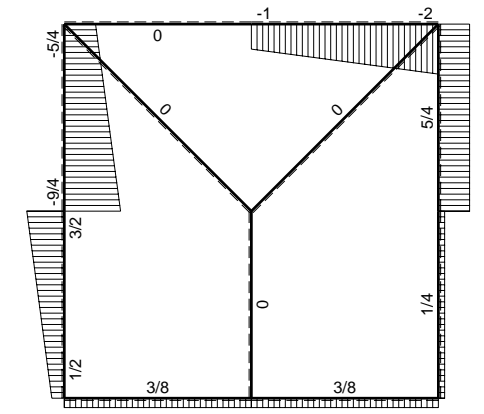
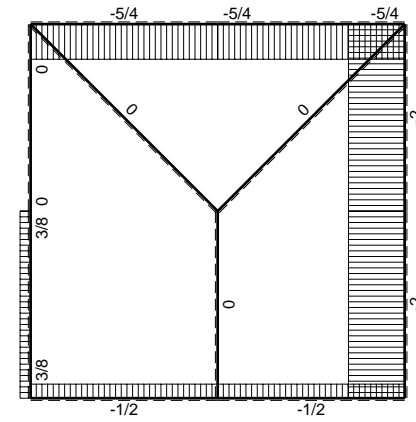
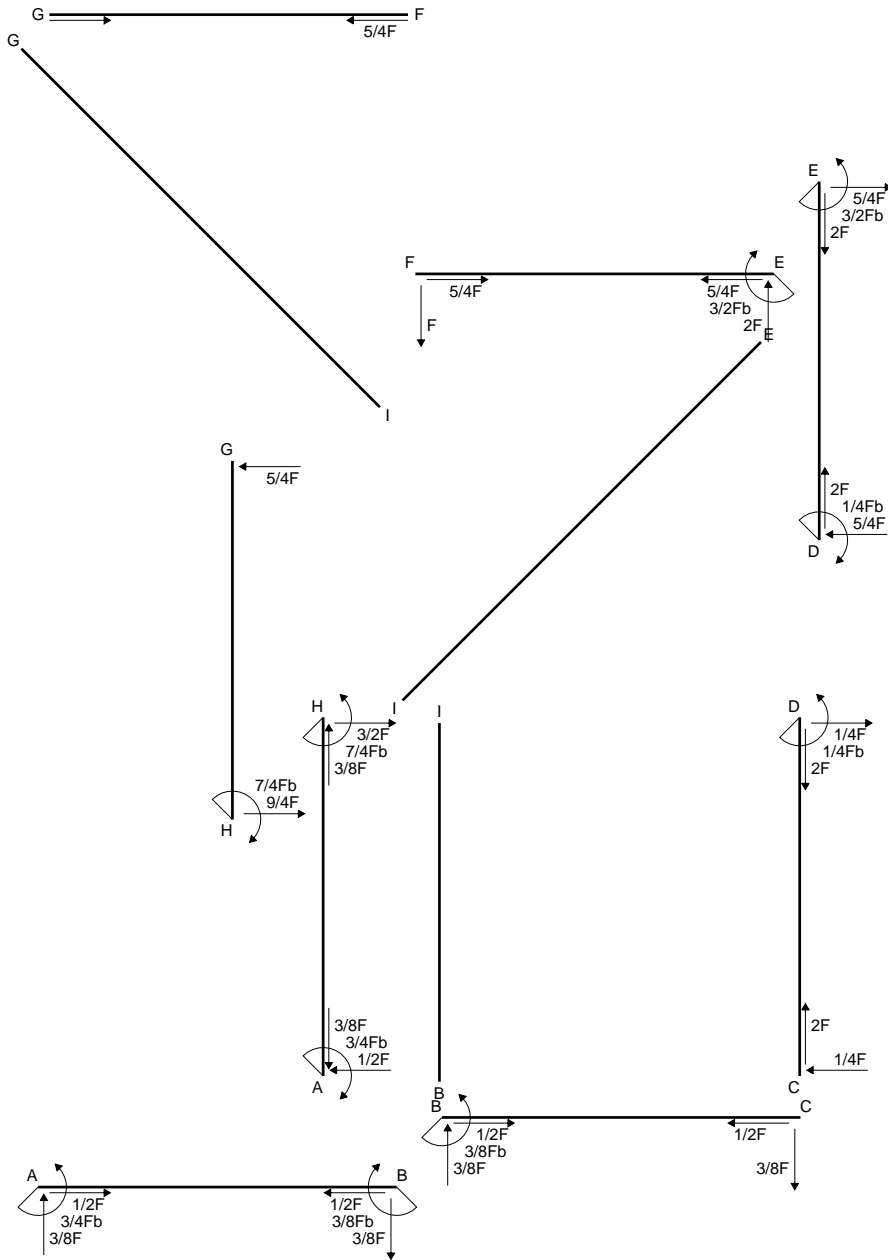
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$



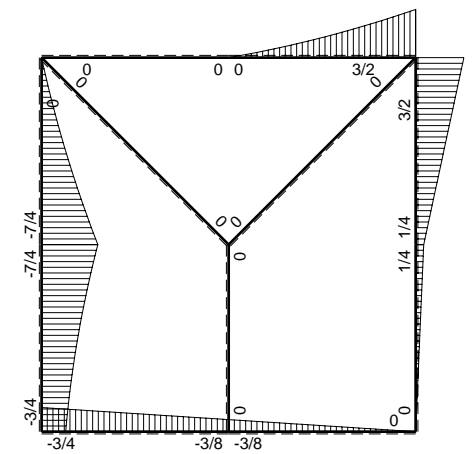
- A = 1086. mm<sup>2</sup>
- J<sub>u</sub> = 289781. mm<sup>4</sup>
- J<sub>v</sub> = 67788. mm<sup>4</sup>
- y<sub>g</sub> = 28.65 mm
- T<sub>y</sub> = -5130. N
- M<sub>x</sub> = -2114700. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.65 mm
- σ<sub>m</sub> = -Mv/J<sub>u</sub> = -209.1 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 12. mm
- v<sub>c</sub> = -16.65 mm
- σ<sub>c</sub> = -Mv/J<sub>u</sub> = -121.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 9.321 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 122.6 N/mm<sup>2</sup>
- S = 6318. mm<sup>3</sup>



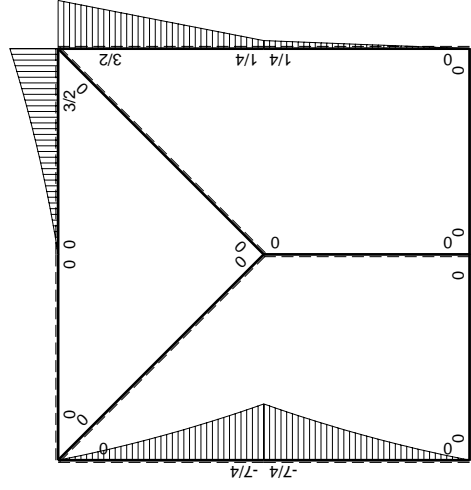
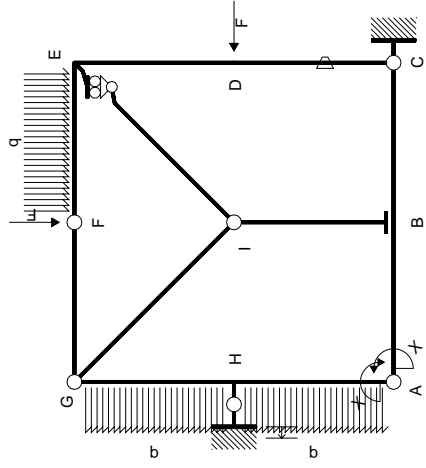


← ⊕ → F

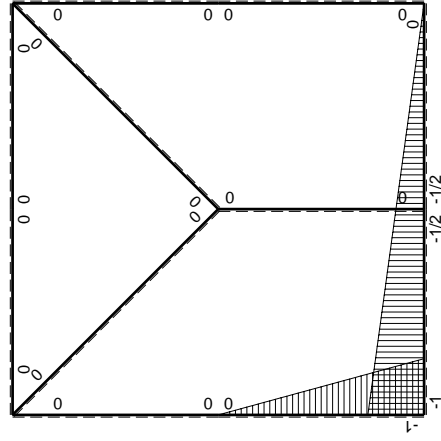
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$ , flessione da carichi assegnati



$M_x$ , flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	$Fb/EJ$	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx-1/2qx^2$	0	0	0	0	0+0	0	
HG b	0	$7/4Fb-9/4Fx+1/2qx^2$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-7/4Fb+9/4Fx-1/2qx^2$	0	$7/4Fx-9/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/4+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$5/4Fx+1/2qx^2$	0	$5/4Fx-3/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-3/4Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$3/4Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

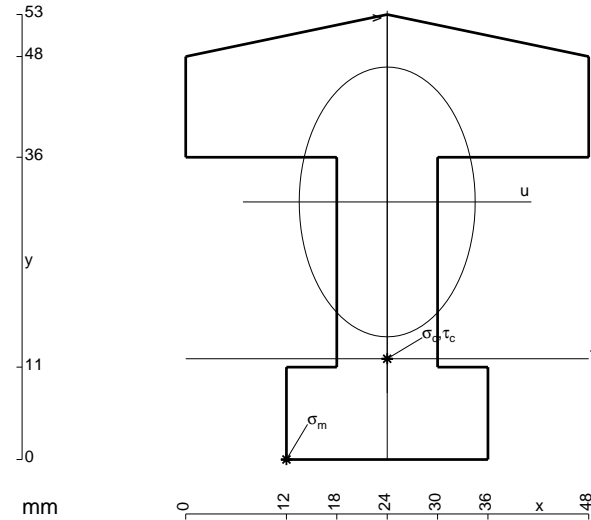
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (7/4 x/b - 9/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 3/4 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

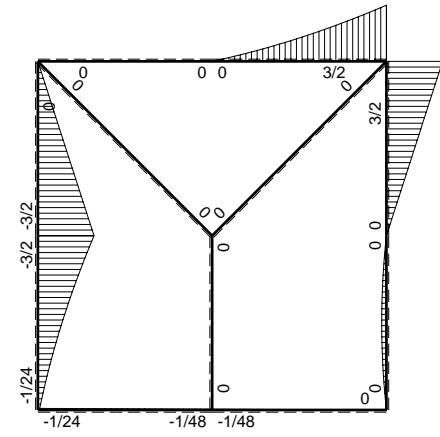
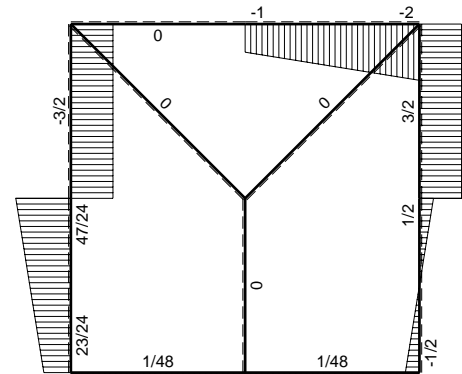
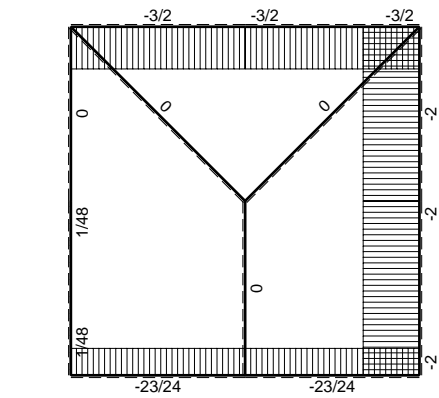
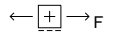
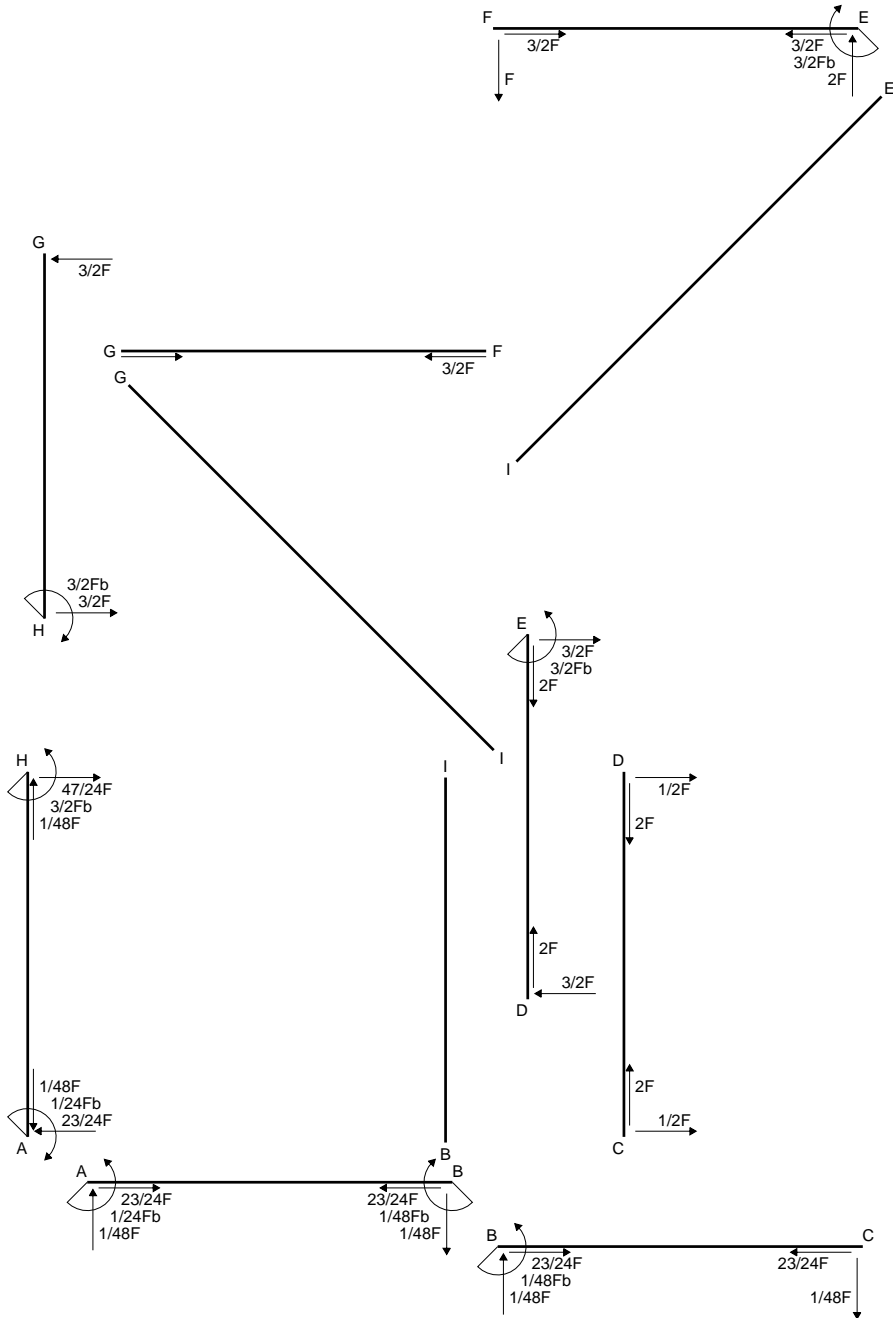
$$= (7/8 b - 3/4 b + 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

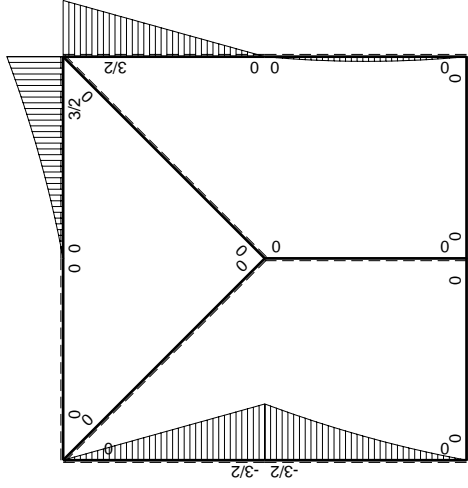
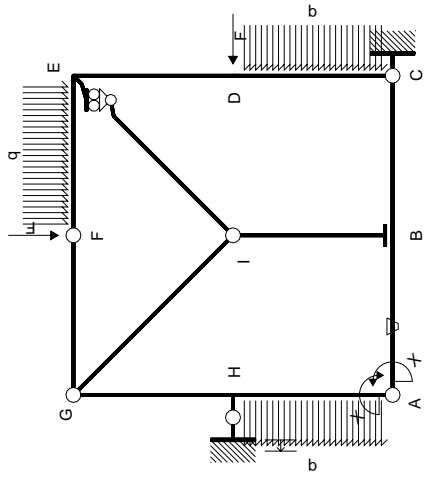
$$L_{AH}^{xo} = \int_0^b (5/4 x/b - 3/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 1/4 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (5/8 b - 1/4 b - 1/8 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

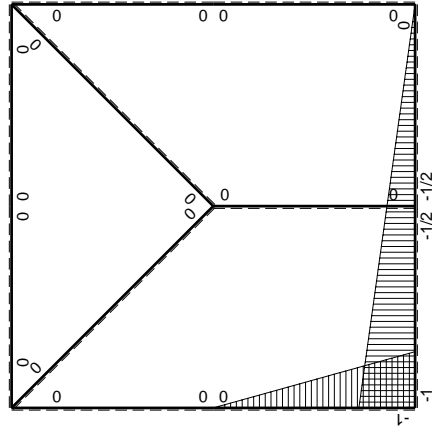


$A = 1260. \text{ mm}^2$   
 $J_u = 325285. \text{ mm}^4$   
 $J_v = 138384. \text{ mm}^4$   
 $y_g = 30.68 \text{ mm}$   
 $T_y = -5153. \text{ N}$   
 $M_x = -2324350. \text{ Nmm}$   
 $x_m = 12. \text{ mm}$   
 $u_m = -12. \text{ mm}$   
 $v_m = -30.68 \text{ mm}$   
 $\sigma_m = -Mv/J_u = -219.2 \text{ N/mm}^2$   
 $x_c = 24. \text{ mm}$   
 $y_c = 12. \text{ mm}$   
 $v_c = -18.68 \text{ mm}$   
 $\sigma_c = -Mv/J_u = -133.5 \text{ N/mm}^2$   
 $\tau_c = 9.078 \text{ N/mm}^2$   
 $\sigma_\rho = \sqrt{\sigma^2 + 3\tau^2} = 134.4 \text{ N/mm}^2$   
 $S = 6877. \text{ mm}^3$





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	$-1+1/2x/b$	0	$-Fb/EJ$	0	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(0+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	$Fb/EJ$	0	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
DE b	0	$3/2Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+3/2Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$3/2Fb-3/2Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	0	$3/2Fx-2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	0	$Fx-1/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/24Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/24Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (1 - 1/2 x/b) \theta dx = [x - 1/4 x^2/b]_0^b \theta$$

$$= (b - 1/4 b) \theta = 3/4 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/2 - 1/2 x/b) \theta dx = [-1/2 x - 1/4 x^2/b]_0^b \theta$$

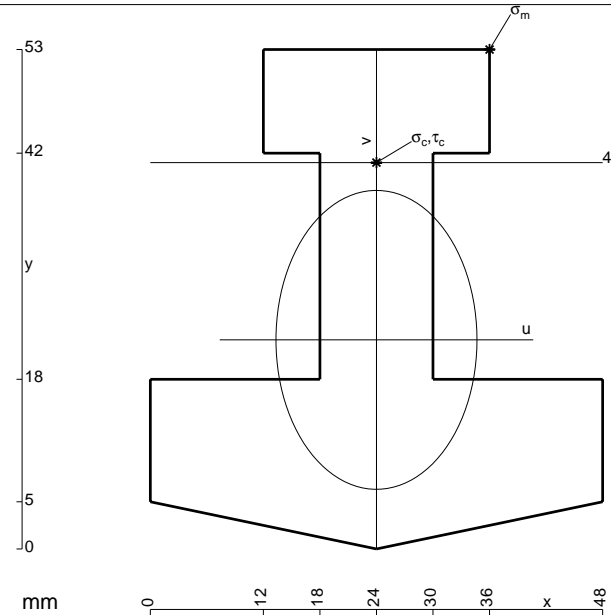
$$= (-1/2 b - 1/4 b) \theta = 3/4 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3/2 x/b - 2x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

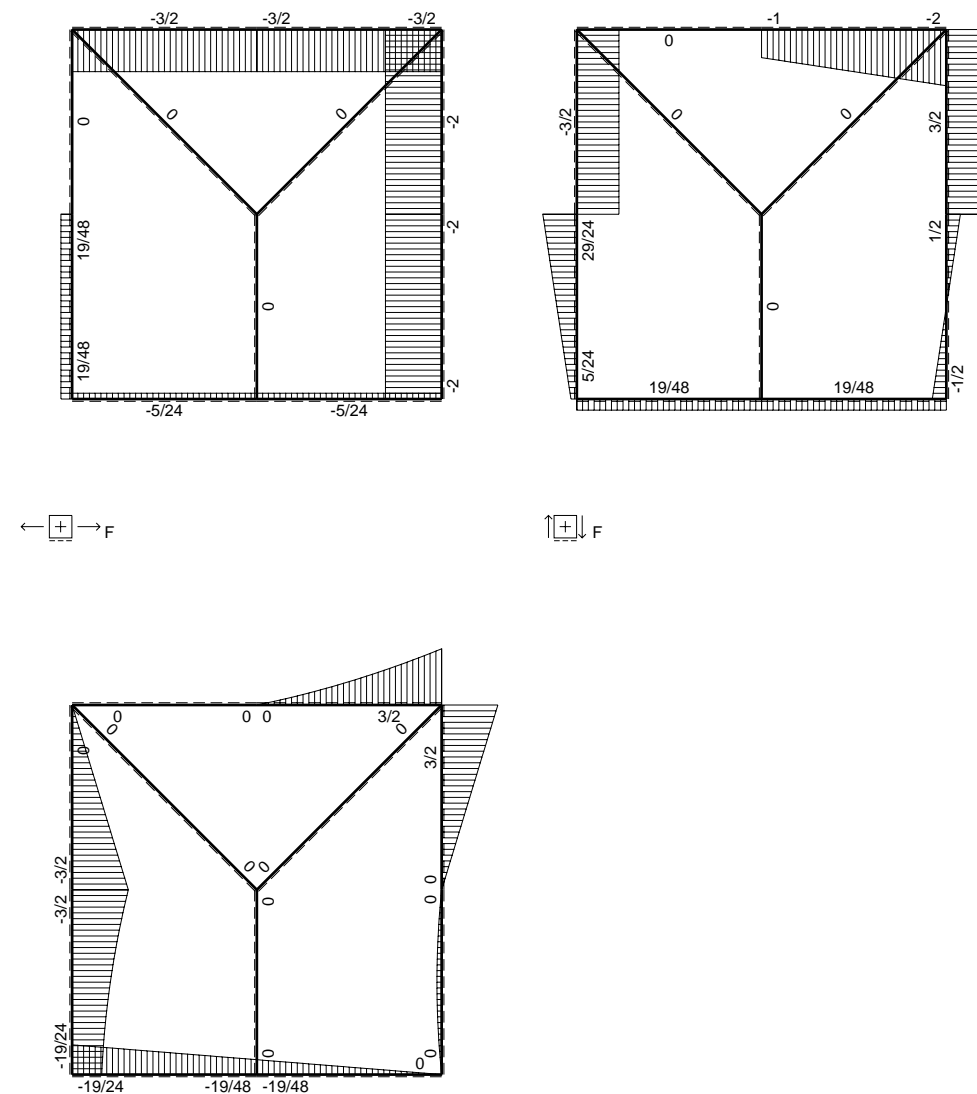
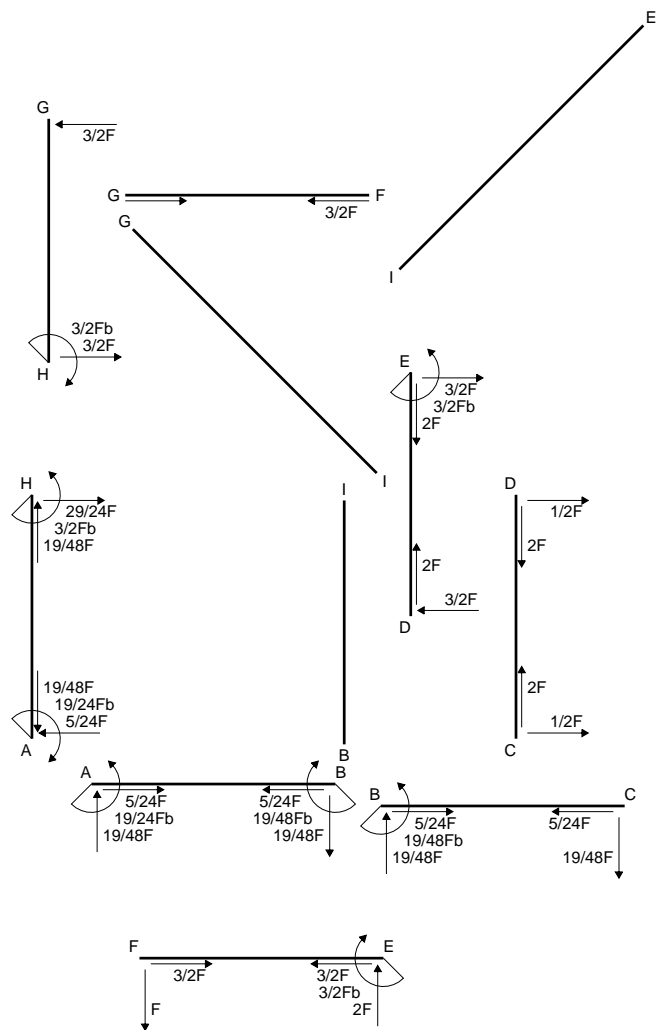
$$L_{AH}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

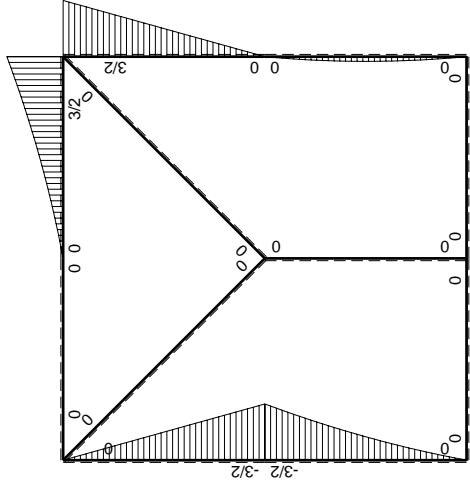
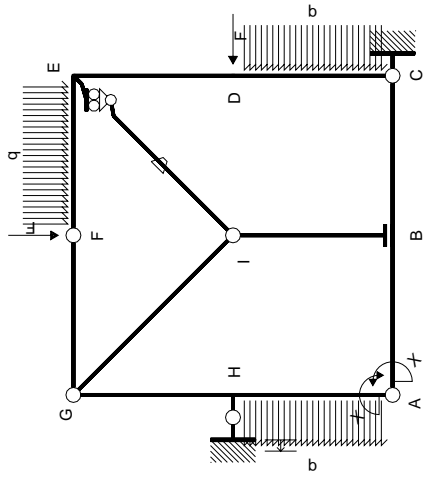
$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



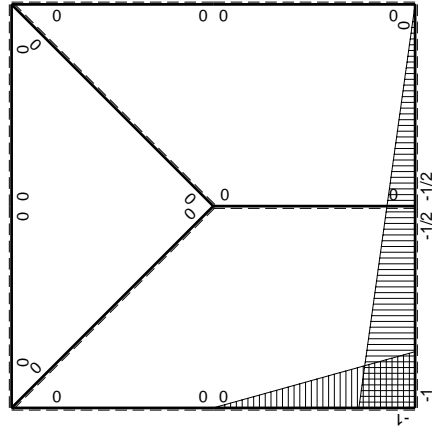
- A = 1296. mm<sup>2</sup>
- J<sub>u</sub> = 326102. mm<sup>4</sup>
- J<sub>v</sub> = 147456. mm<sup>4</sup>
- y<sub>g</sub> = 22.19 mm
- N = -3810. N
- T<sub>y</sub> = -5080. N
- M<sub>x</sub> = 2400300. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.81 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -229.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 18.81 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -141.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.976 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 142.3 N/mm<sup>2</sup>
- S = 6914. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
DE b	0	$3/2Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+3/2Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$3/2Fb-3/2Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	0	$3/2Fx-2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	0	$Fx-1/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-19/24Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$19/24Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

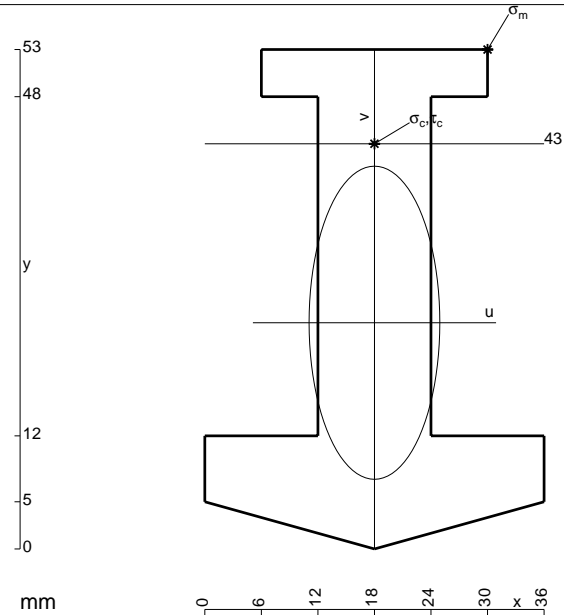
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (3/2 x/b - 2x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

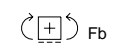
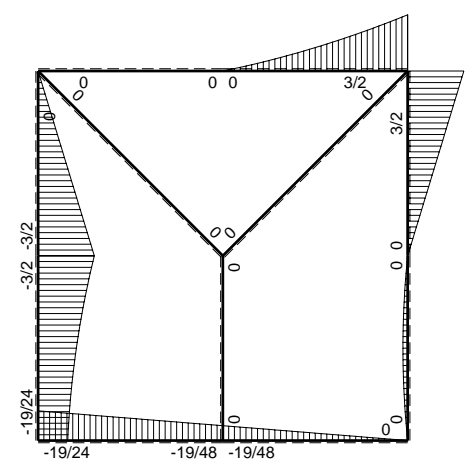
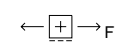
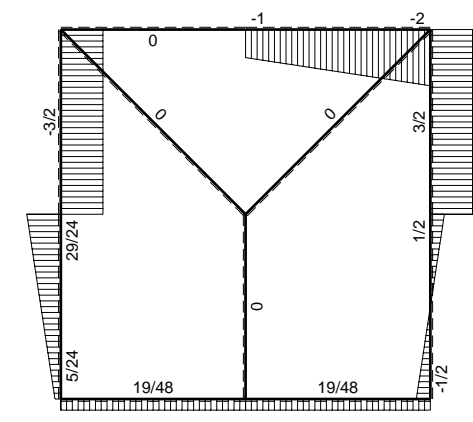
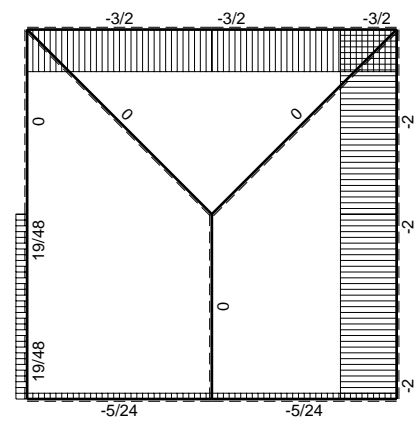
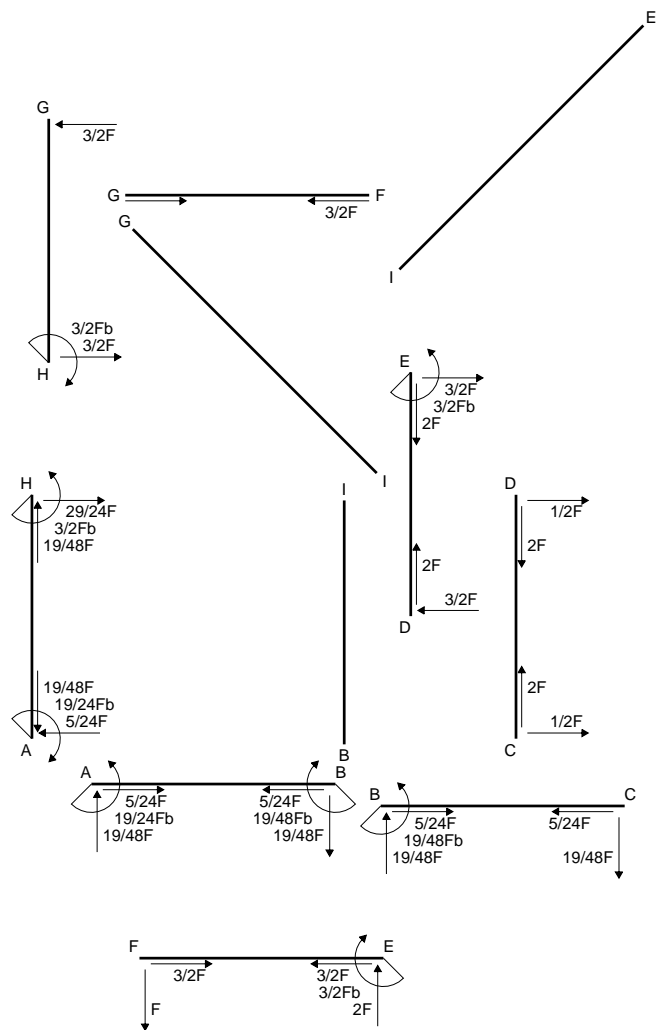
$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

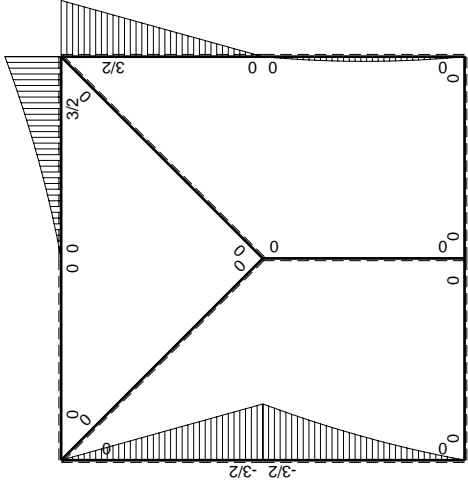
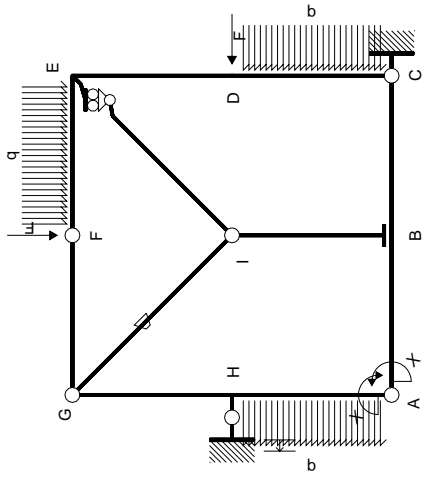
$$L_{AH}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

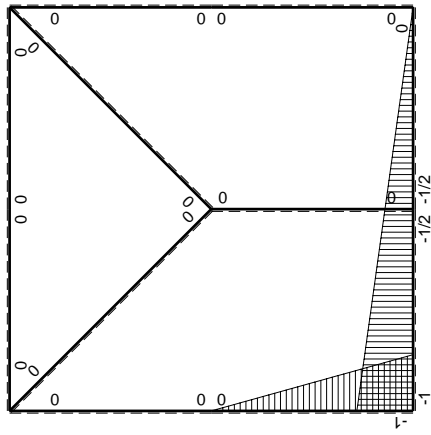


- A = 894. mm<sup>2</sup>
- J<sub>u</sub> = 246865. mm<sup>4</sup>
- J<sub>v</sub> = 43020. mm<sup>4</sup>
- y<sub>g</sub> = 24.01 mm
- N = -2955. N
- T<sub>y</sub> = -3940. N
- M<sub>x</sub> = 2009400. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.99 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -239.3 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 43. mm
- v<sub>c</sub> = 18.99 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -157.9 N/mm<sup>2</sup>
- τ<sub>c</sub> = 5.944 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 158.2 N/mm<sup>2</sup>
- S = 4469. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
DE b	0	$3/2Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+3/2Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$3/2Fb-3/2Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	0	$3/2Fx-2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	0	$Fx-1/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-19/24Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$19/24Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2 x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

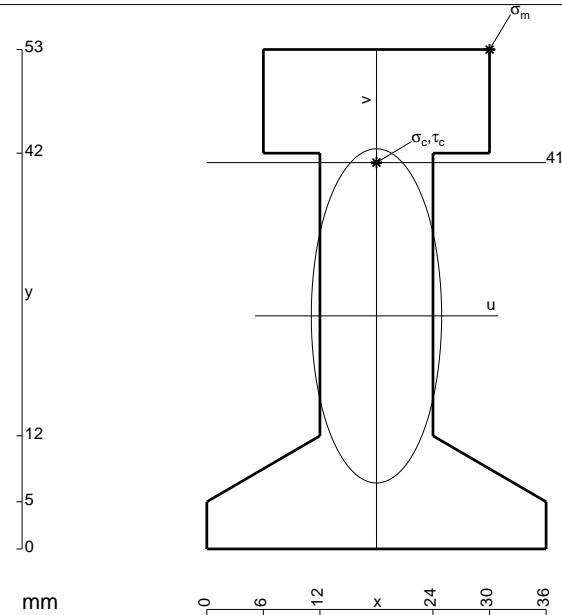
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (3/2 x/b - 2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

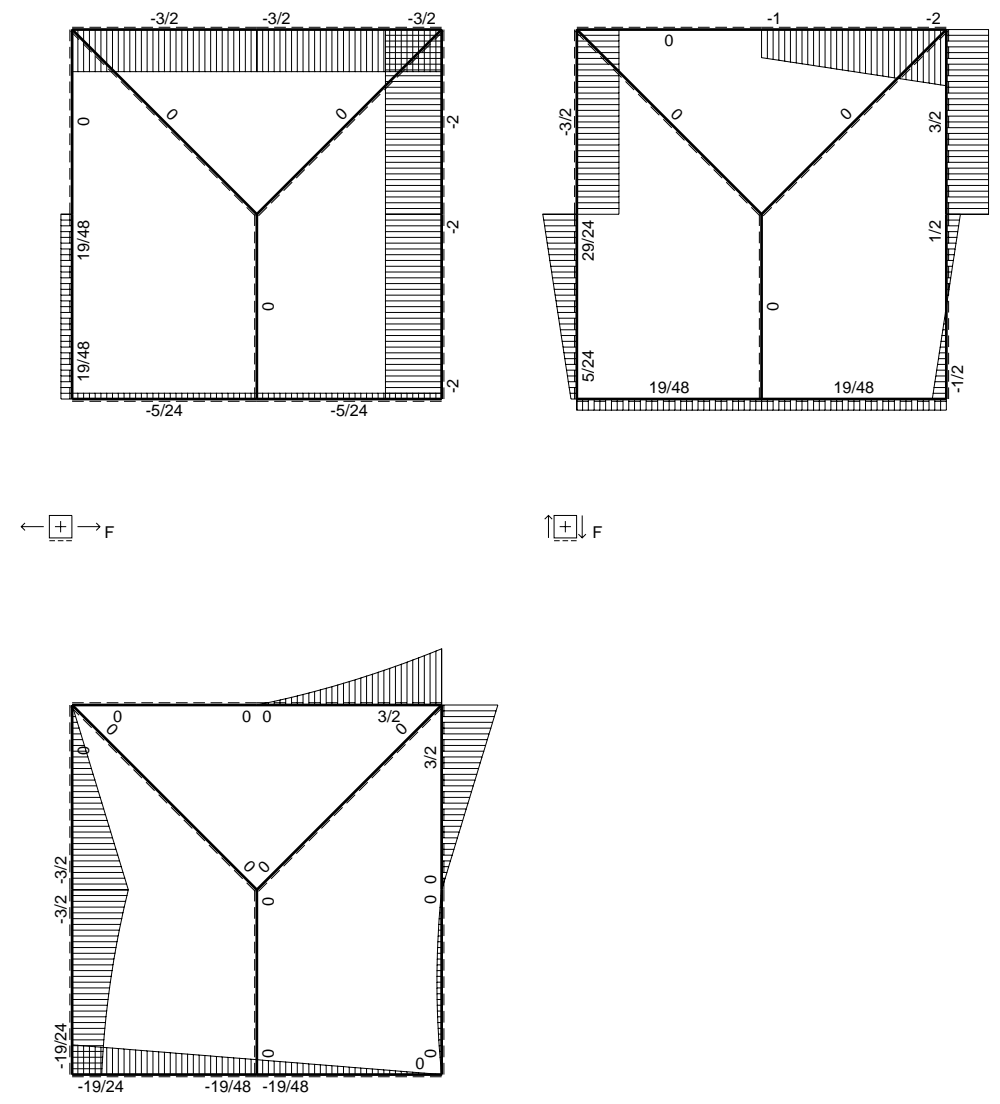
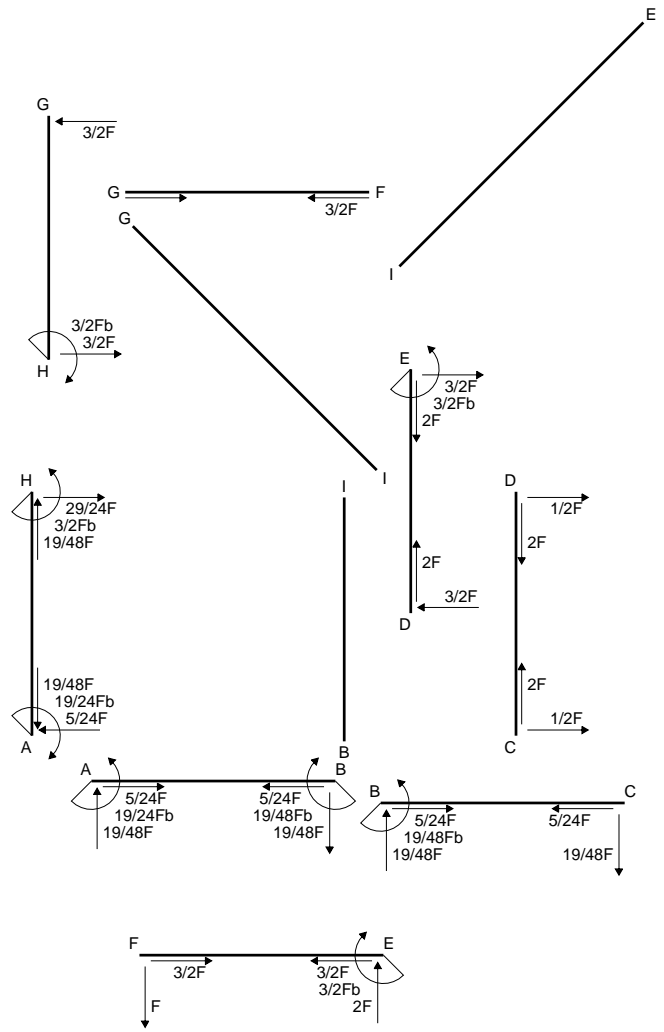
$$L_{AH}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

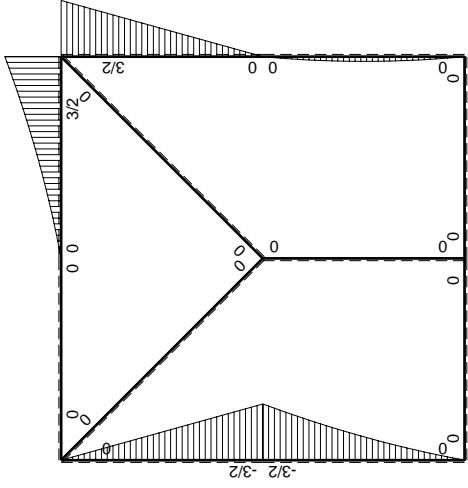
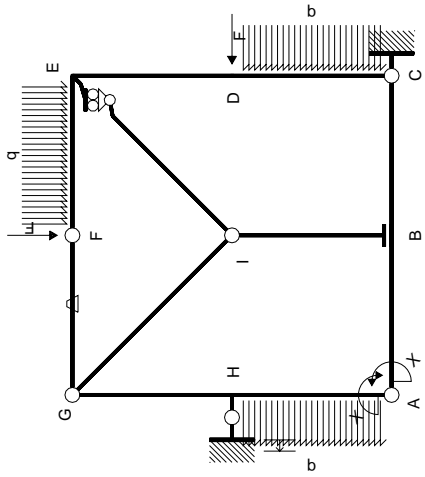
$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



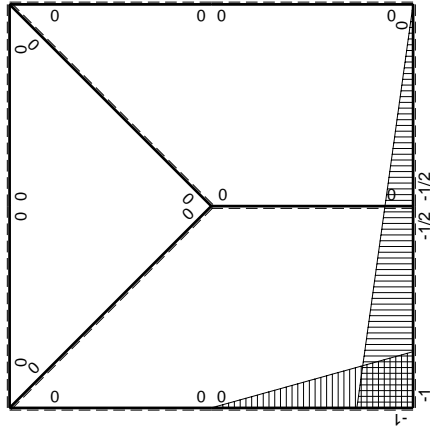
- A = 972. mm<sup>2</sup>
- J<sub>u</sub> = 305841. mm<sup>4</sup>
- J<sub>v</sub> = 46512. mm<sup>4</sup>
- y<sub>g</sub> = 24.73 mm
- N = -2910. N
- T<sub>y</sub> = -3880. N
- M<sub>x</sub> = 2124300. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.27 mm
- v<sub>m</sub> = 28.27 mm
- σ<sub>m</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = -199.3 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 16.27 mm
- σ<sub>c</sub> = N/A - M<sub>v</sub>/J<sub>u</sub> = -116. N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.567 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 116.5 N/mm<sup>2</sup>
- S = 6212. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
DE b	0	$3/2Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+3/2Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	0	0	0	0			
FG b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
GF b	0	0	$Fb/EJ$	0	0	0			
GH b	0	$-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$3/2Fb-3/2Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	0	$3/2Fx-2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	0	$Fx-1/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-19/24Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$19/24Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2 x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

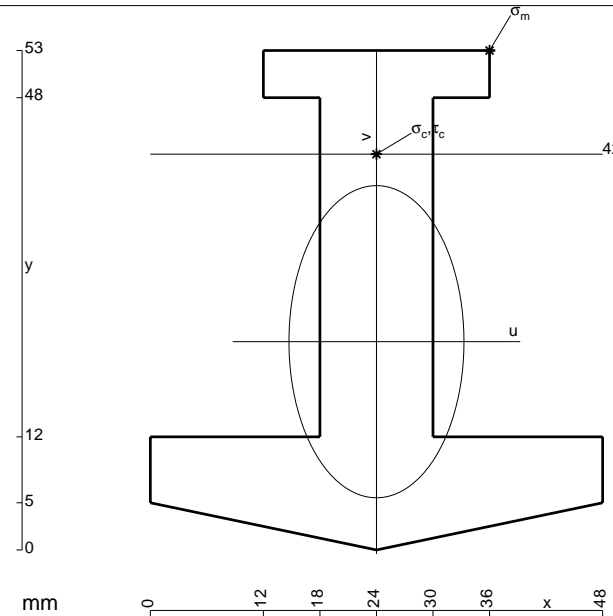
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (3/2 x/b - 2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

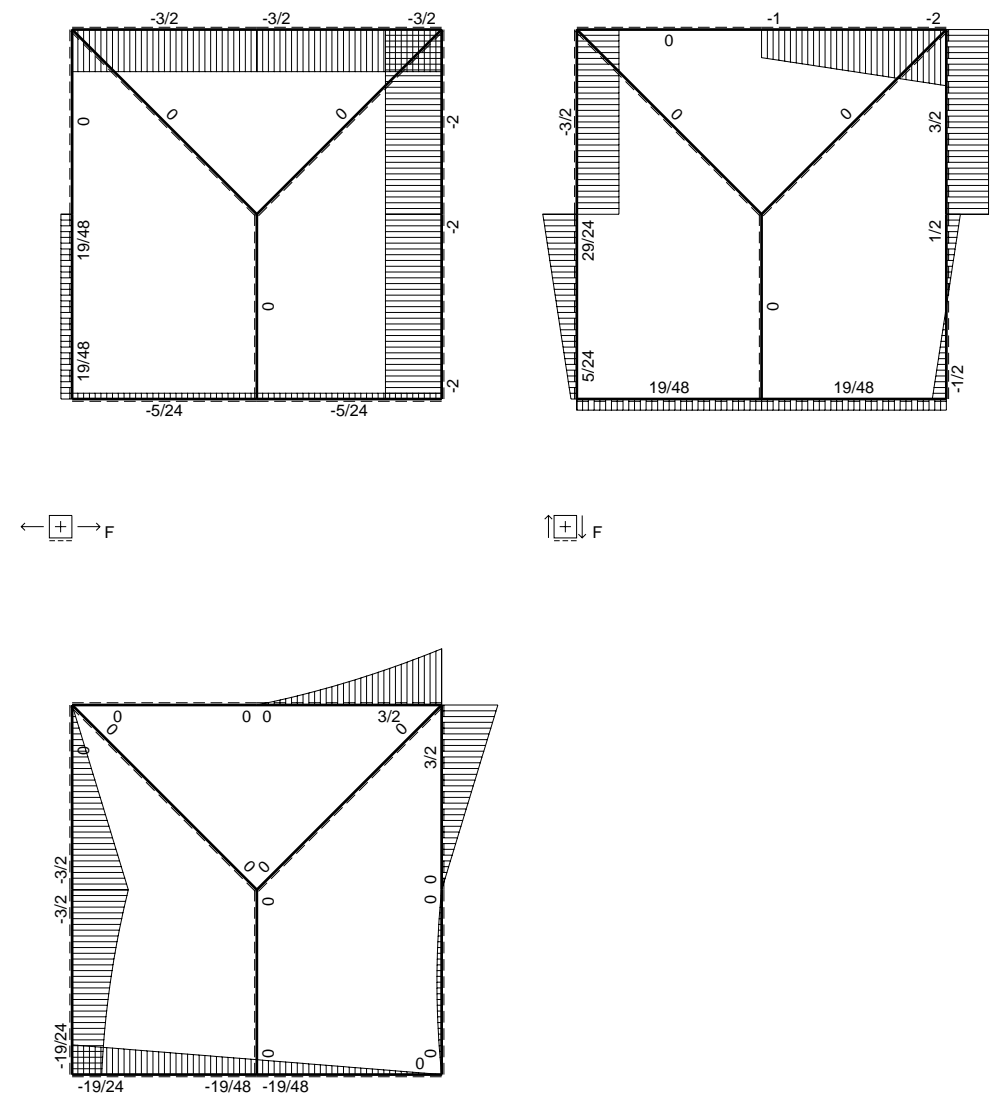
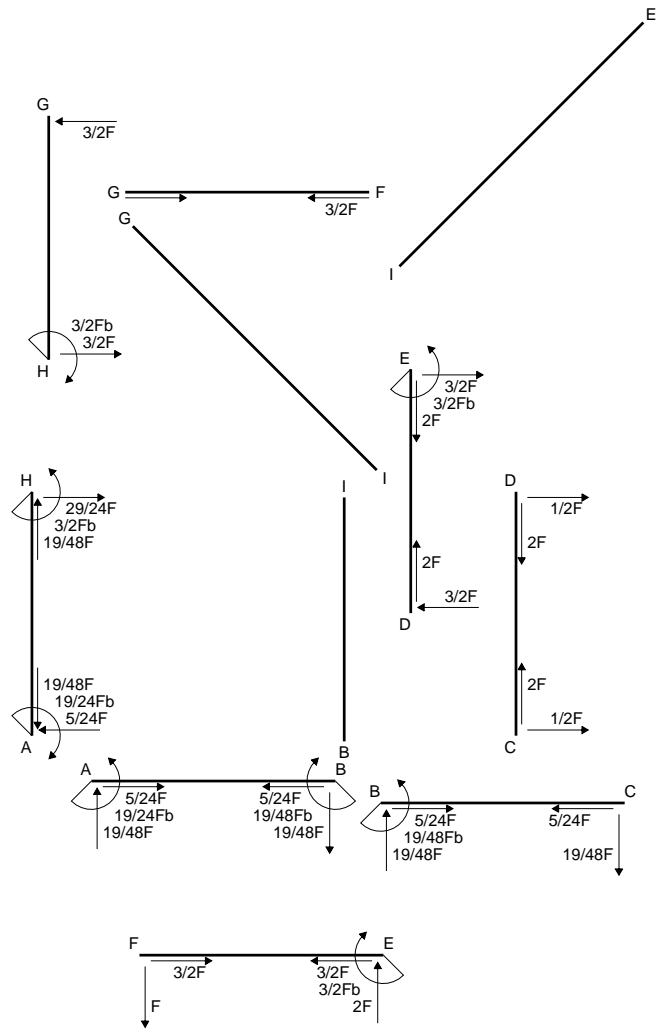
$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

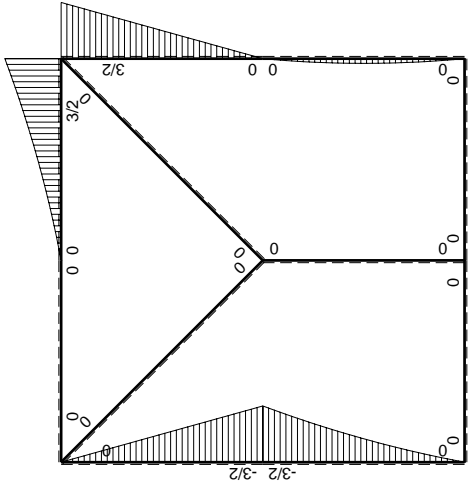
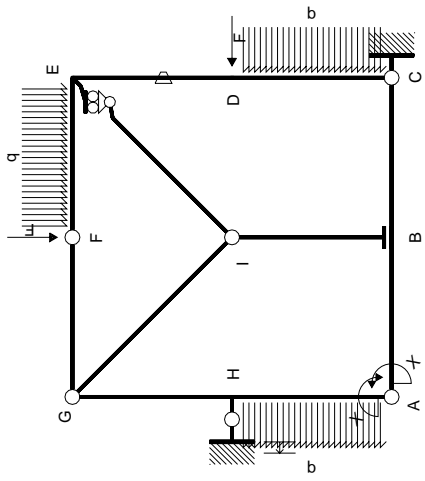
$$L_{AH}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

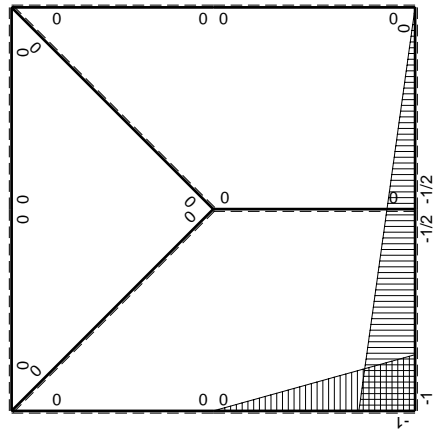


- A = 1008. mm<sup>2</sup>
- J<sub>u</sub> = 276602. mm<sup>4</sup>
- J<sub>v</sub> = 86976. mm<sup>4</sup>
- y<sub>g</sub> = 22.1 mm
- N = -2370. N
- T<sub>y</sub> = -3160. N
- M<sub>x</sub> = 1848600. Nmm
- x<sub>m</sub> = 36. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.9 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = -208.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 42. mm
- v<sub>c</sub> = 19.9 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = -135.4 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.814 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 135.6 N/mm<sup>2</sup>
- S = 5057. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
DE b	0	$3/2Fx$	$-Fb/EJ$	0	0	0	0+0	0	
ED b	0	$-3/2Fb+3/2Fx$	$Fb/EJ$	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$3/2Fb-3/2Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	0	$3/2Fx-2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	0	$Fx-1/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-19/24Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$19/24Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

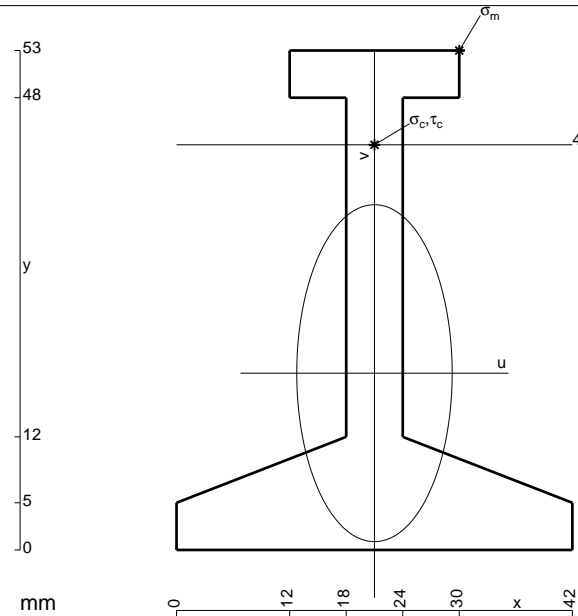
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (3/2 x/b - 2x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

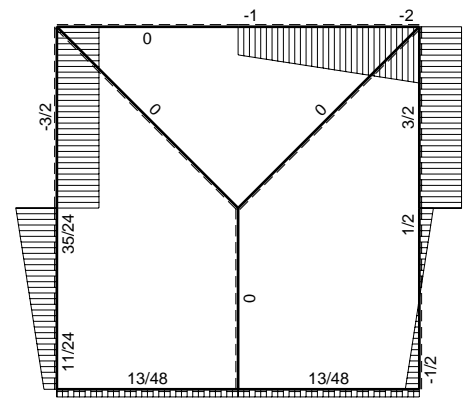
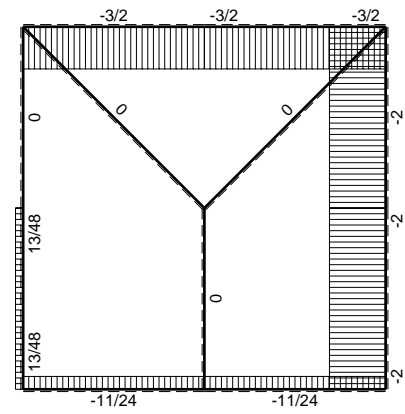
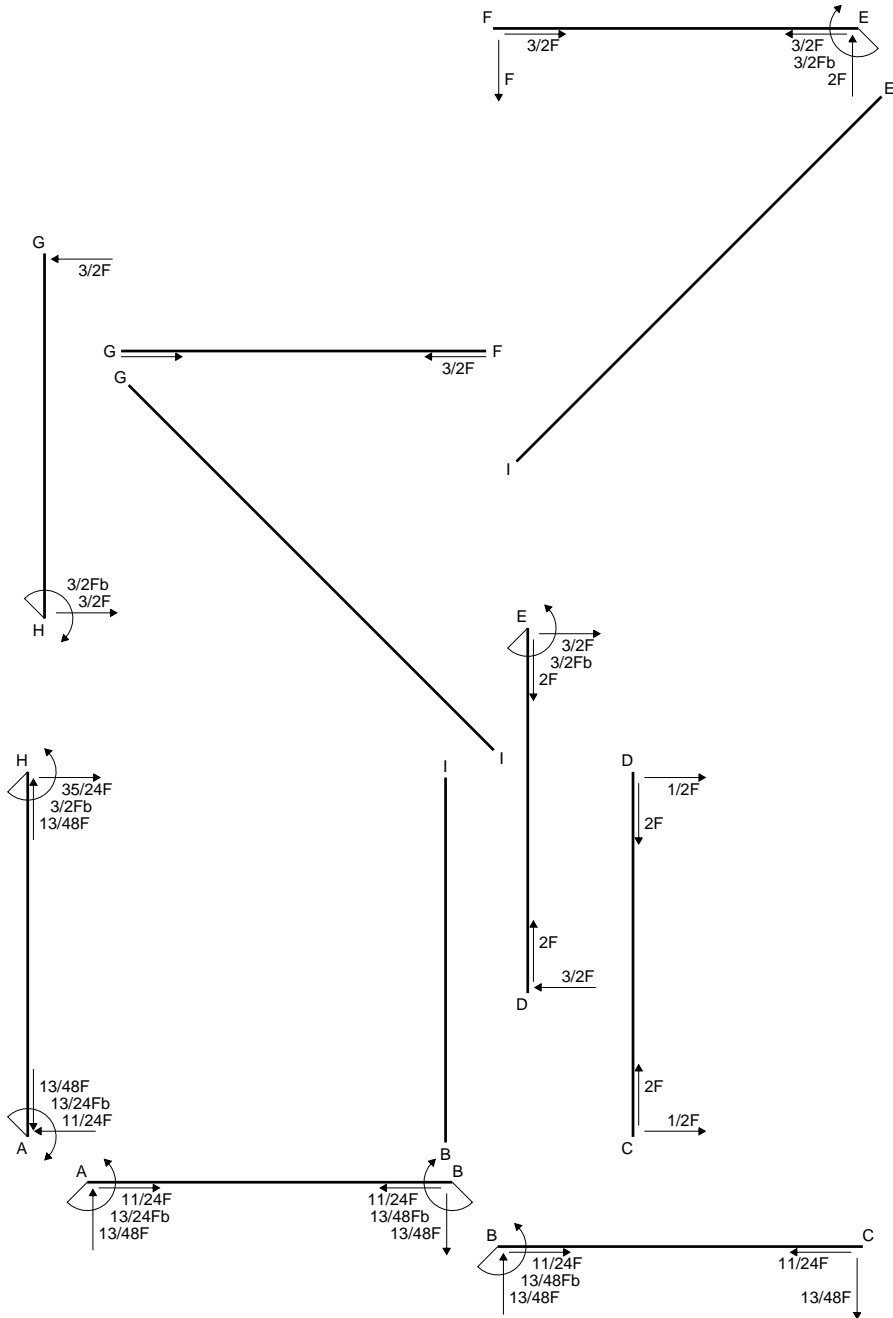
$$L_{AH}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



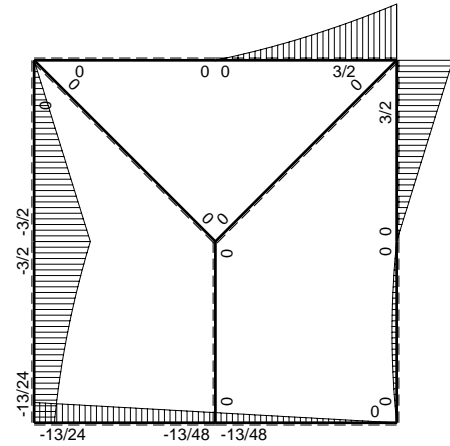
- A = 684. mm<sup>2</sup>
- J<sub>u</sub> = 218819. mm<sup>4</sup>
- J<sub>v</sub> = 46548. mm<sup>4</sup>
- y<sub>g</sub> = 18.76 mm
- N = -1665. N
- T<sub>y</sub> = -2220. N
- M<sub>x</sub> = 1381950. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 34.24 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -218.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 43. mm
- v<sub>c</sub> = 24.24 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -155.5 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.187 N/mm<sup>2</sup>
- σ<sub>q</sub> = √σ<sup>2</sup>+3τ<sup>2</sup> = 155.9 N/mm<sup>2</sup>
- S = 3659. mm<sup>3</sup>



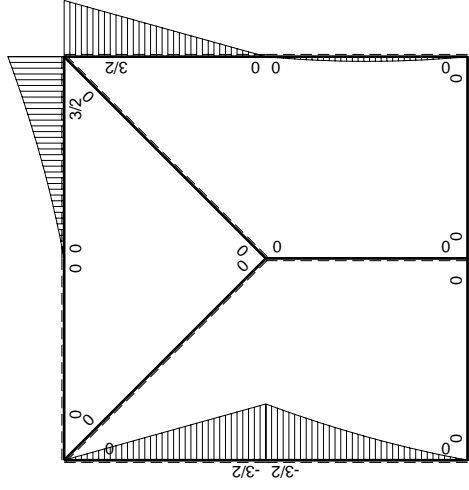
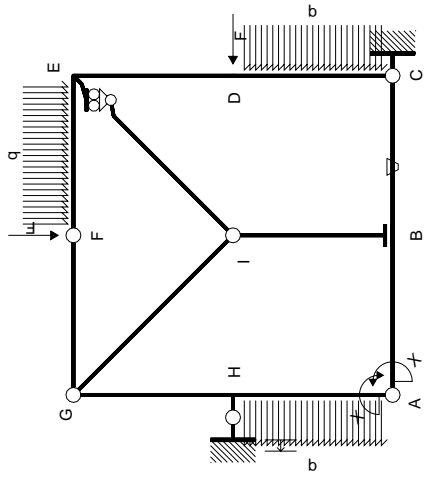


← ⊕ → F

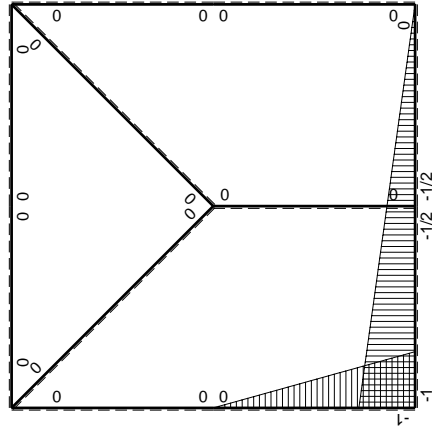
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	$-Fb/EJ$	0	$1/2Fb/EJ-1/2Fx/EJ$	$1/4-1/2x/b+1/4x^2/b^2$	$(0+1/4)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	$Fb/EJ$	0	$1/2Fx/EJ$	$1/4x^2/b^2$			
CD b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
DE b	0	$3/2Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+3/2Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$3/2Fb-3/2Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	0	$3/2Fx-2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	0	$Fx-1/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-13/24Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$13/24Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{BC}^{xo} = \int_0^b (1/2 - 1/2 x/b) \theta dx = [1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (1/2 b - 1/4 b) \theta = 1/4 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/2 x/b) \theta dx = [-1/4 x^2/b]_0^b \theta$$

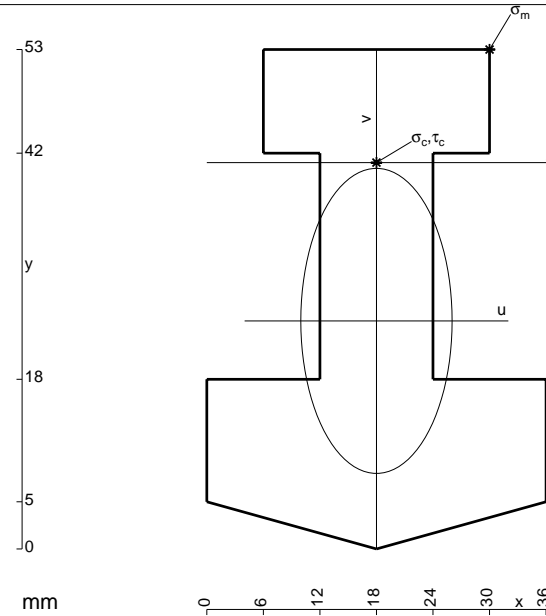
$$= (-1/4 b) \theta = 1/4 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (3/2 x/b - 2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

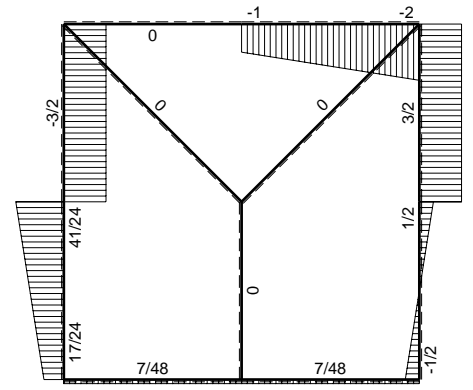
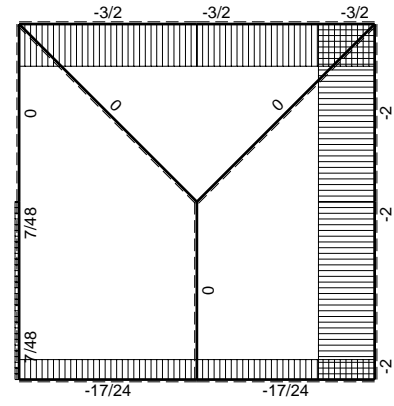
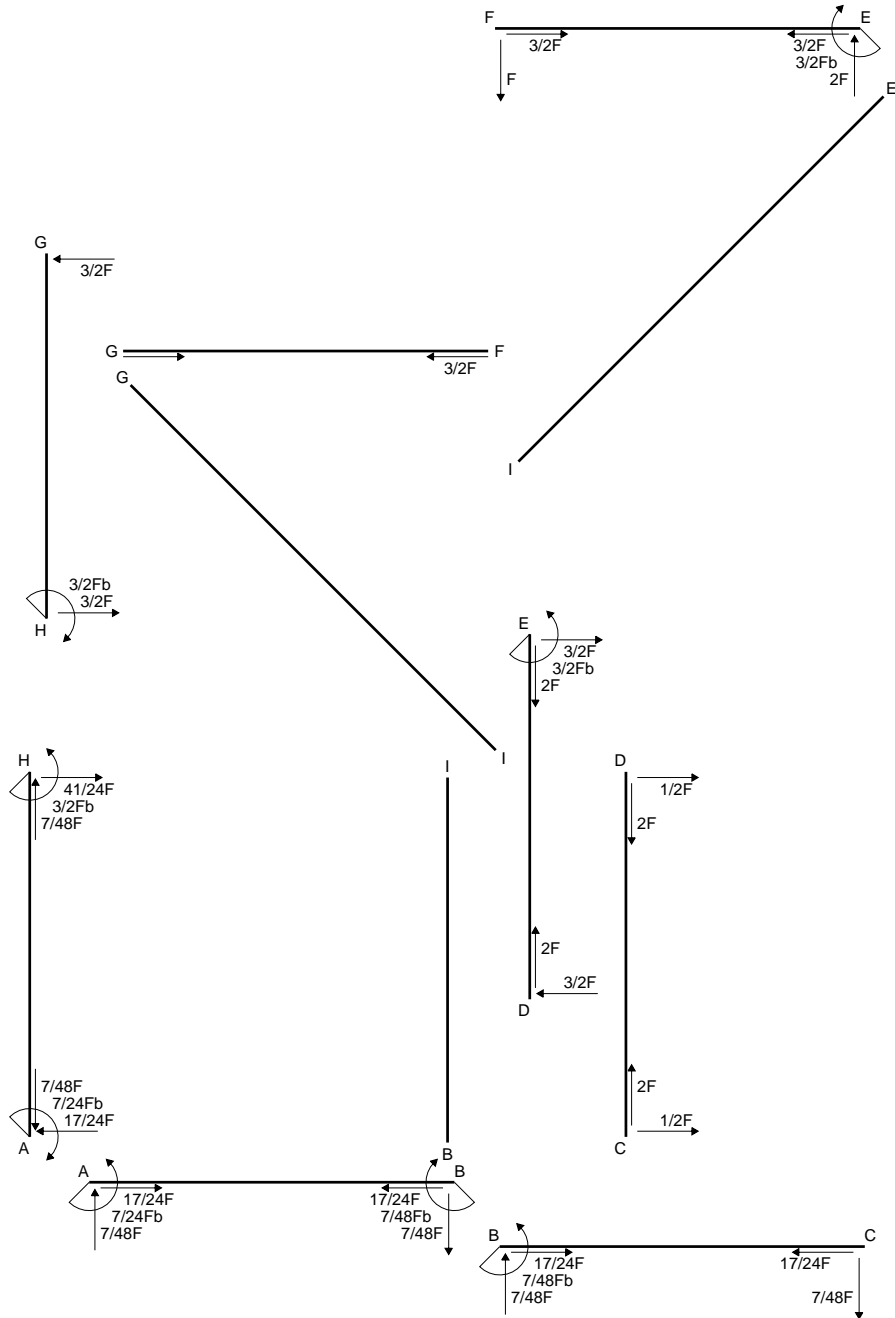
$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

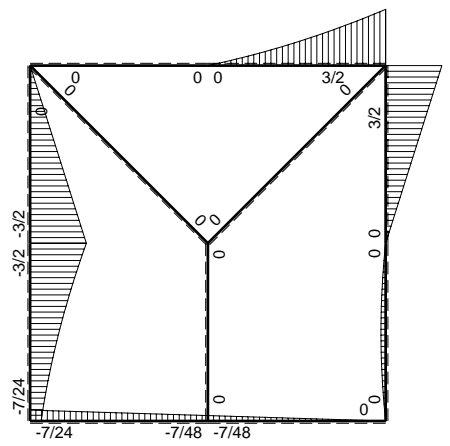


- A = 1110. mm<sup>2</sup>
- J<sub>u</sub> = 290885. mm<sup>4</sup>
- J<sub>v</sub> = 71532. mm<sup>4</sup>
- y<sub>g</sub> = 24.2 mm
- N = -2610. N
- T<sub>y</sub> = -3480. N
- M<sub>x</sub> = 2296800. Nmm
- x<sub>m</sub> = 30. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 28.8 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -229.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 16.8 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -135. N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.339 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 135.4 N/mm<sup>2</sup>
- S = 6359. mm<sup>3</sup>

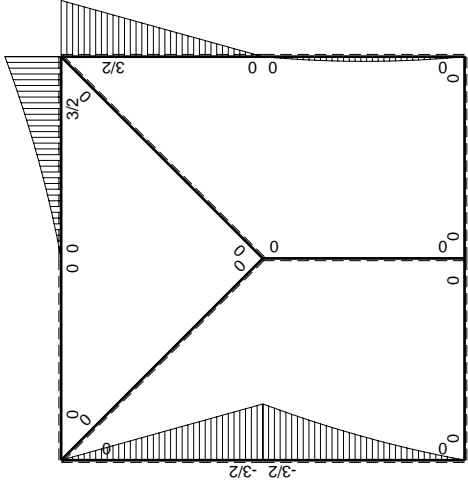
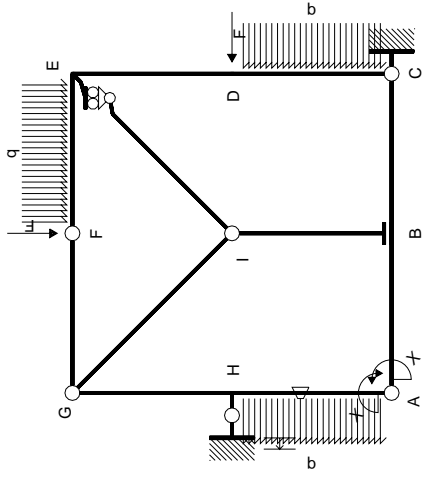


← ⊕ → F

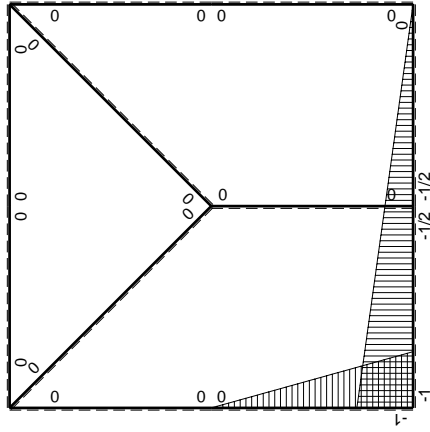
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x / EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CD b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/2Fx-1/2qx^2$	0	0	0	0	0+0	0	
DE b	0	$3/2Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+3/2Fx$	0	0	0	0	0+0	0	
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$3/2Fb-3/2Fx$	0	0	0	0	0+0	0	
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0	0+0	0	
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	$-Fb/EJ$	$3/2Fx-2Fx^2/b+1/2qx^3/b$	$Fx/EJ$	$x^2/b^2$	$(5/24+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	$Fb/EJ$	$Fx-1/2Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-7/24Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$7/24Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (3/2 x/b - 2x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

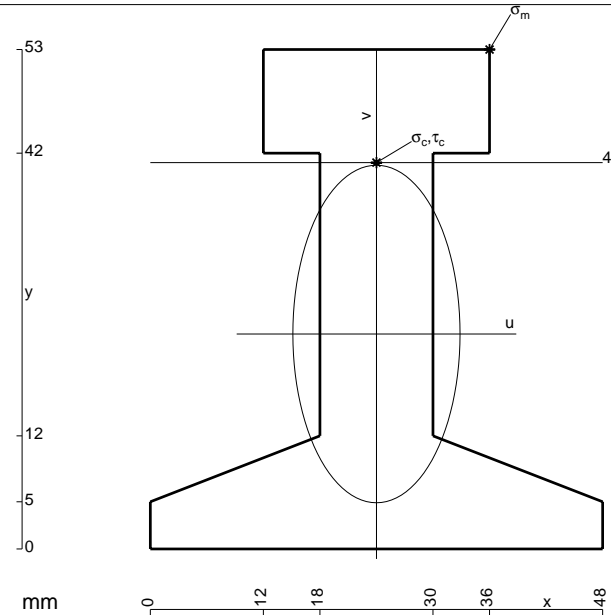
$$= [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 17/24 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

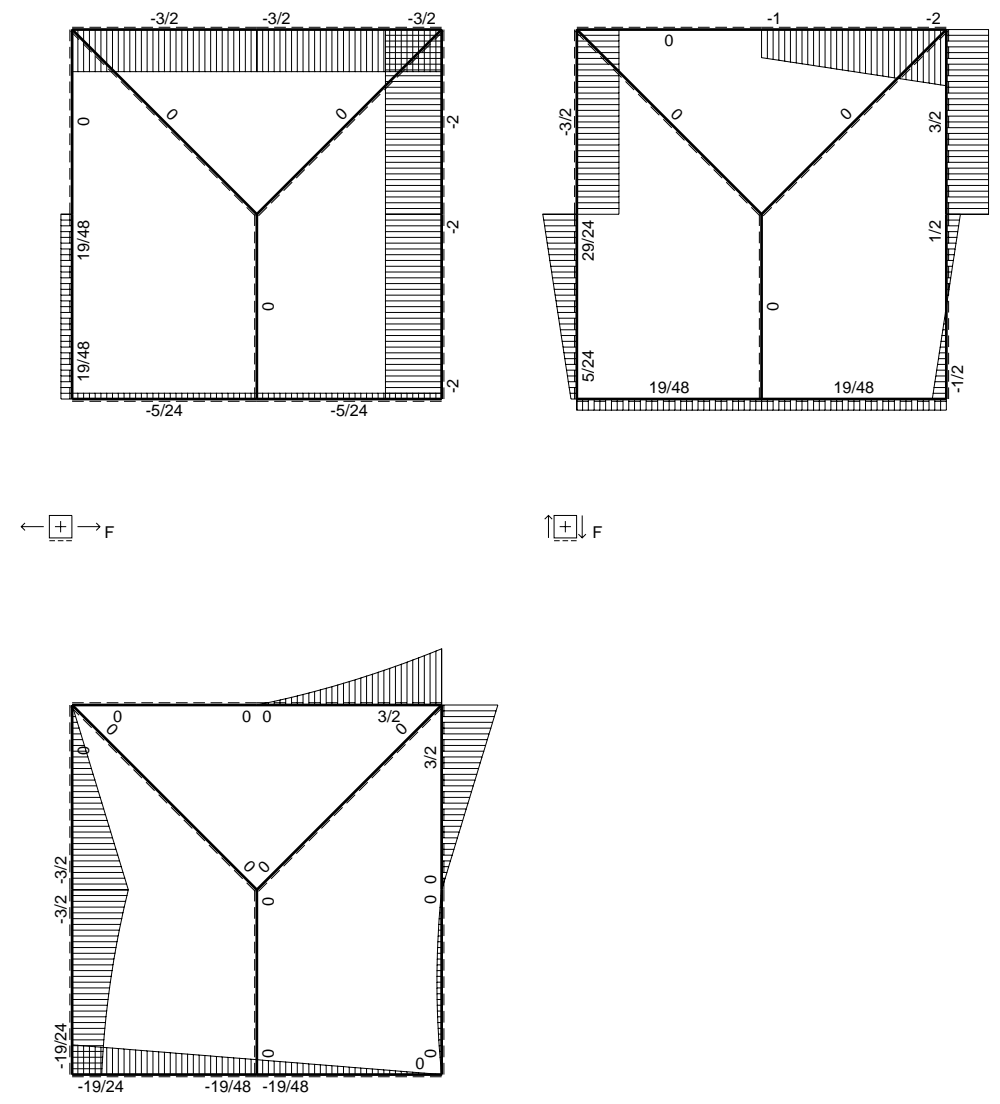
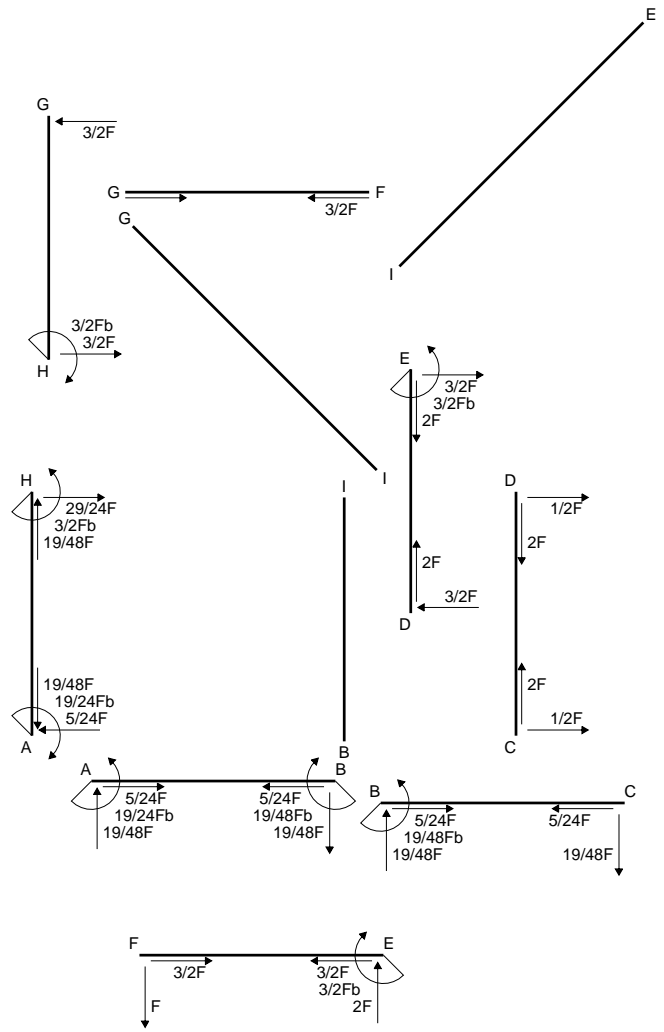
$$= [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

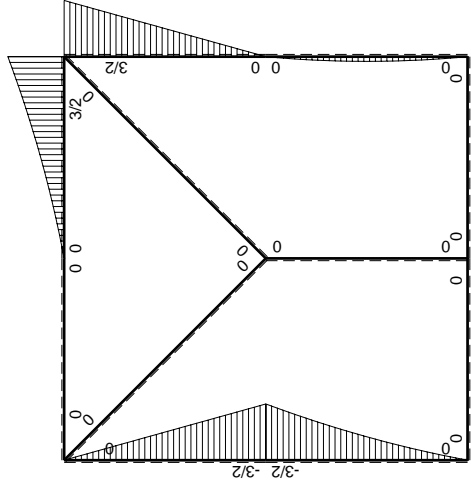
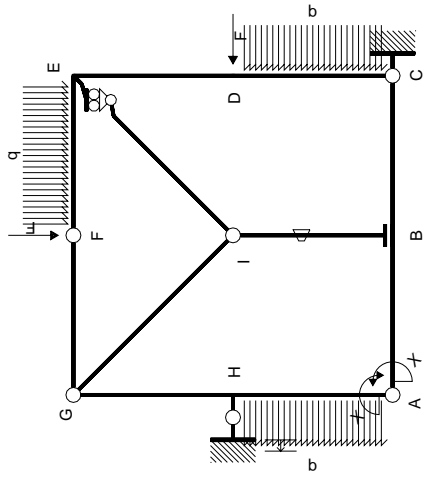
$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 17/24 Fb^2/EJ$$



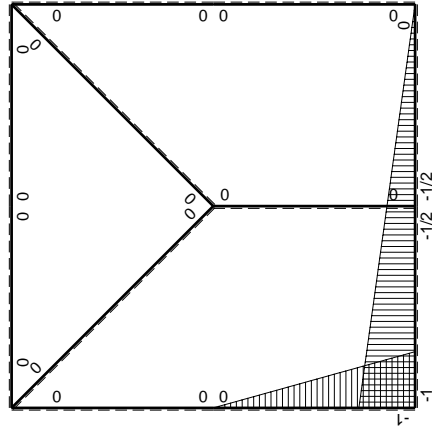
- A = 1074. mm<sup>2</sup>
- J<sub>u</sub> = 344482. mm<sup>4</sup>
- J<sub>v</sub> = 84492. mm<sup>4</sup>
- y<sub>g</sub> = 22.81 mm
- N = -2910. N
- T<sub>y</sub> = -3880. N
- M<sub>x</sub> = 2706300. Nmm
- x<sub>m</sub> = 36. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 12. mm
- v<sub>m</sub> = 30.19 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -239.9 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 41. mm
- v<sub>c</sub> = 18.19 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -145.6 N/mm<sup>2</sup>
- τ<sub>c</sub> = 6.328 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 146. N/mm<sup>2</sup>
- S = 6742. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_1$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
DE b	0	$3/2Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+3/2Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$3/2Fb-3/2Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	$-Fb/EJ$	0	0	0	0+0	0	
BI b	0	0	$Fb/EJ$	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	0	$3/2Fx-2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	0	$Fx-1/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-19/24Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$19/24Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2 x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

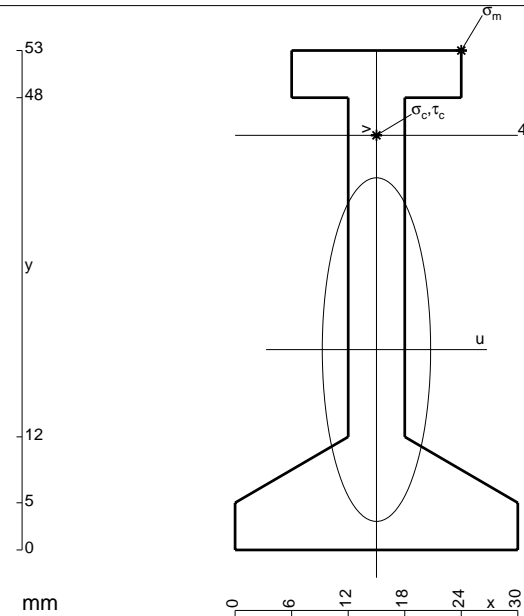
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (3/2 x/b - 2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

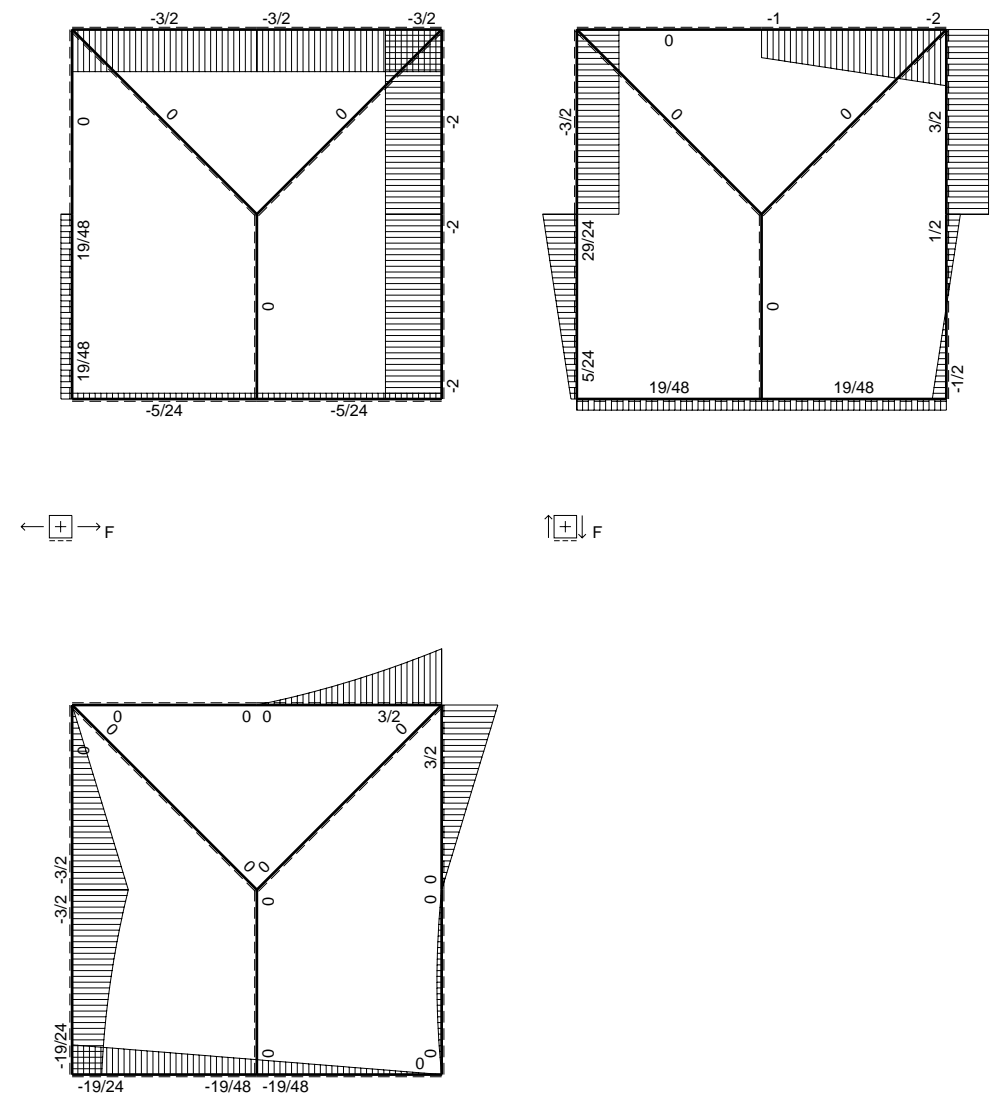
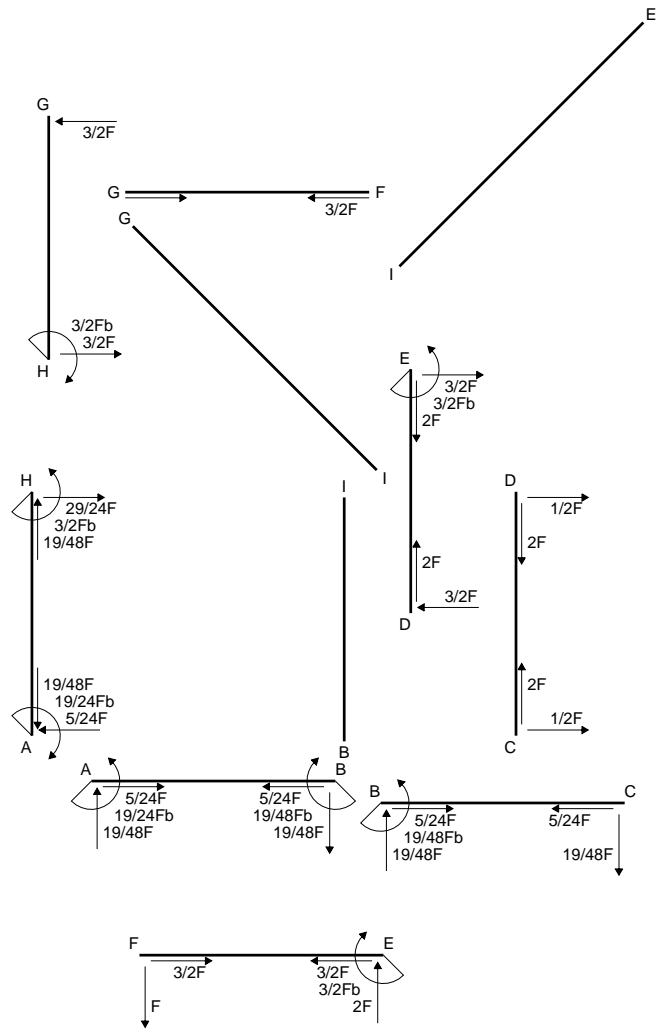
$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

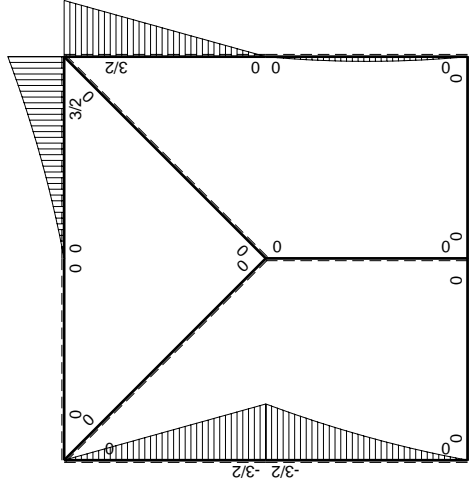
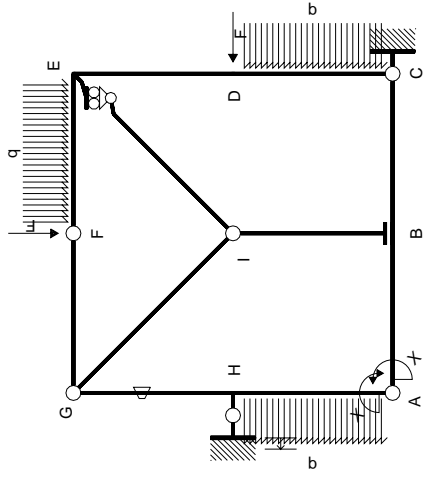
$$L_{AH}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

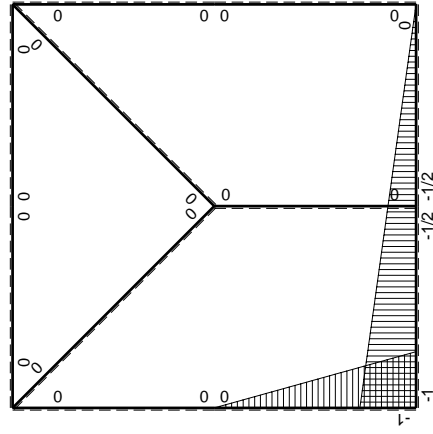


- A = 582. mm<sup>2</sup>
- J<sub>u</sub> = 193597. mm<sup>4</sup>
- J<sub>v</sub> = 19242. mm<sup>4</sup>
- y<sub>g</sub> = 21.26 mm
- N = -2430. N
- T<sub>y</sub> = -3240. N
- M<sub>x</sub> = 1190700. Nmm
- x<sub>m</sub> = 24. mm
- y<sub>m</sub> = 53. mm
- u<sub>m</sub> = 9. mm
- v<sub>m</sub> = 31.74 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -199.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 44. mm
- v<sub>c</sub> = 22.74 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -144. N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.997 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 144.9 N/mm<sup>2</sup>
- S = 3225. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
DE b	0	$3/2Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+3/2Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-3/2Fx$	$-Fb/EJ$	0	0	0	0+0	0	
HG b	0	$3/2Fb-3/2Fx$	$Fb/EJ$	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	0	$3/2Fx-2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	0	$Fx-1/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-19/24Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$19/24Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

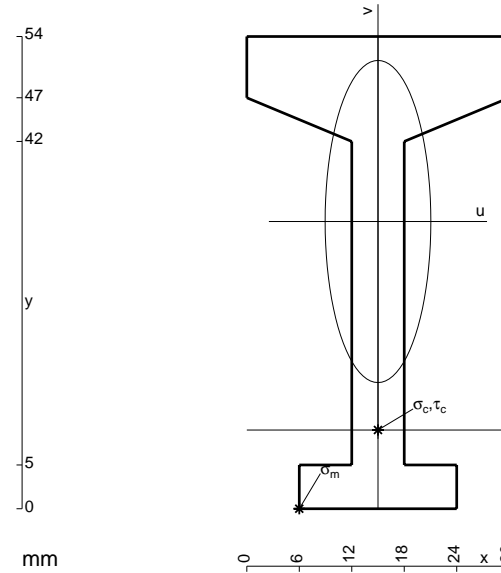
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (3/2 x/b - 2x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

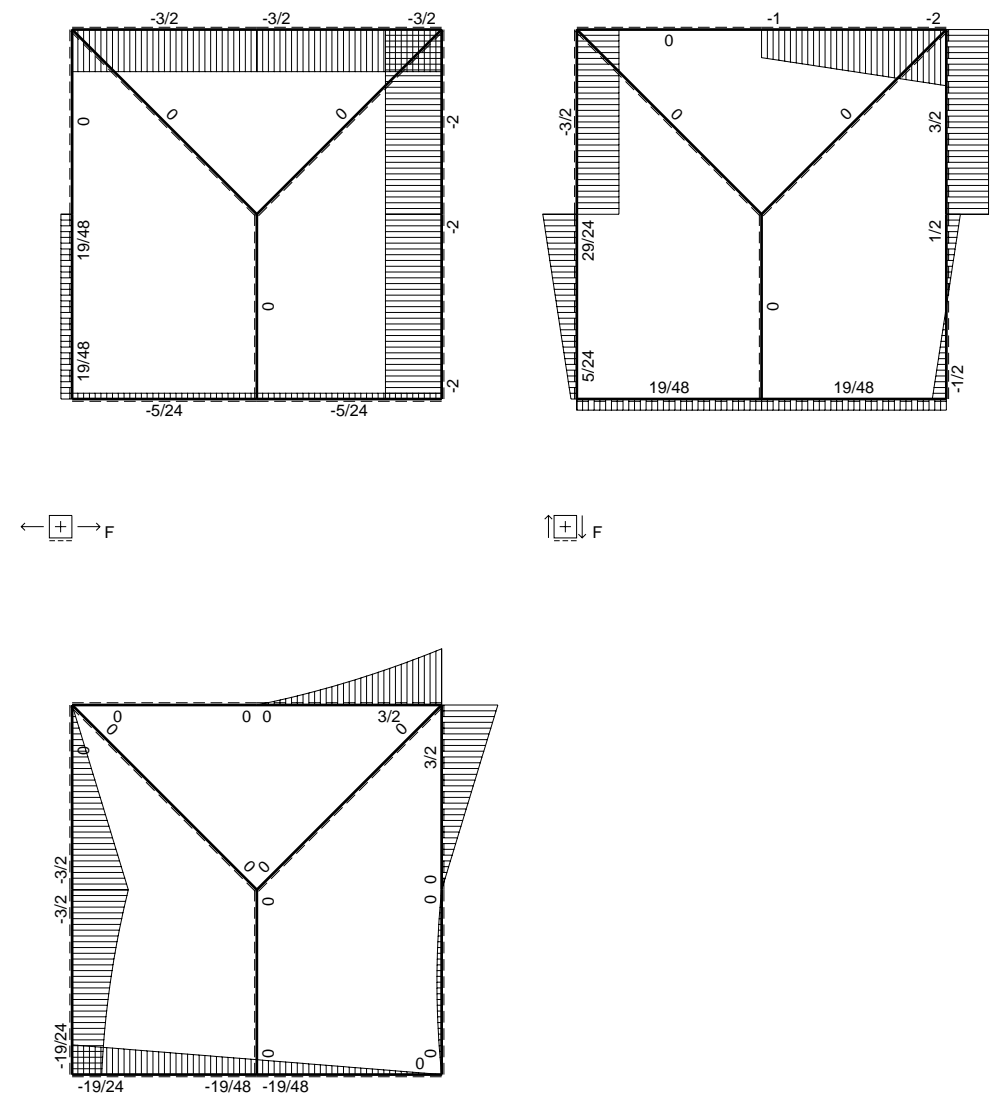
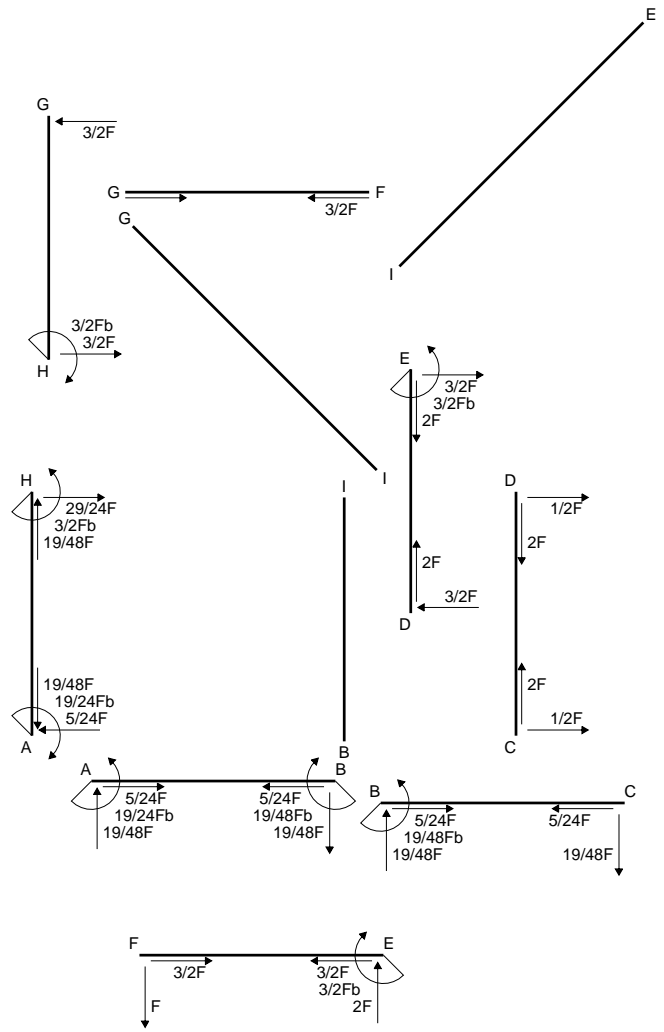
$$L_{AH}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

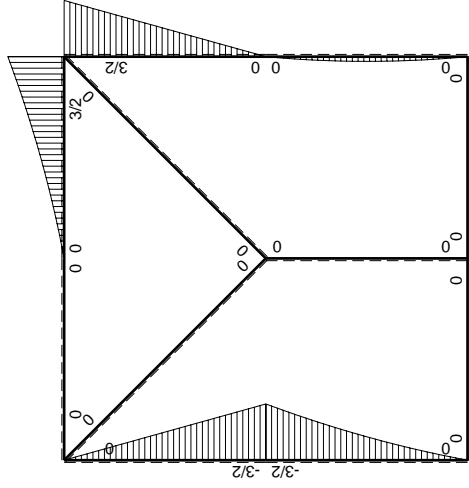
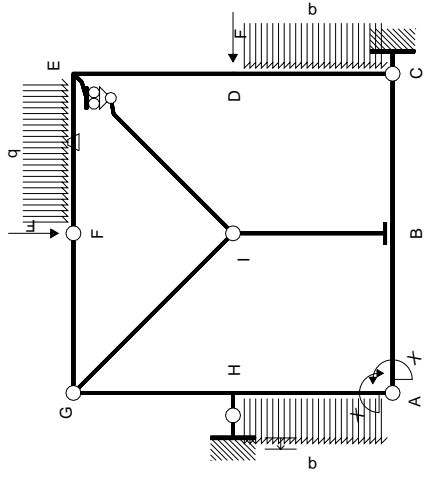
$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



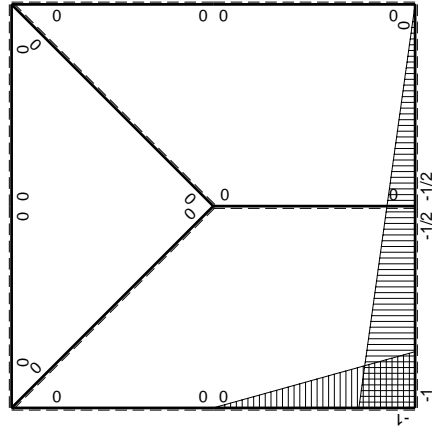
- A = 612. mm<sup>2</sup>
- J<sub>u</sub> = 207668. mm<sup>4</sup>
- J<sub>v</sub> = 22356. mm<sup>4</sup>
- y<sub>g</sub> = 32.85 mm
- N = -2460. N
- T<sub>y</sub> = -3280. N
- M<sub>x</sub> = 1353000. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -32.85 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 210. N/mm<sup>2</sup>
- x<sub>c</sub> = 15. mm
- y<sub>c</sub> = 9. mm
- v<sub>c</sub> = -23.85 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 151.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.823 N/mm<sup>2</sup>
- σ<sub>g</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 152.1 N/mm<sup>2</sup>
- S = 3351. mm<sup>3</sup>







$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica X=1

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-1/2Fx+1/2qx^2$	0	0	0	0	0+0	0	
DC b	0	$1/2Fx-1/2qx^2$	0	0	0	0			
DE b	0	$3/2Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+3/2Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	$Fb/EJ$	0	0	0			
FG b	0	0	0	0	0	0	0+0	0	
GF b	0	0	0	0	0	0			
GH b	0	$-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$3/2Fb-3/2Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	0	$3/2Fx-2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	0	$Fx-1/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-19/24Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$19/24Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

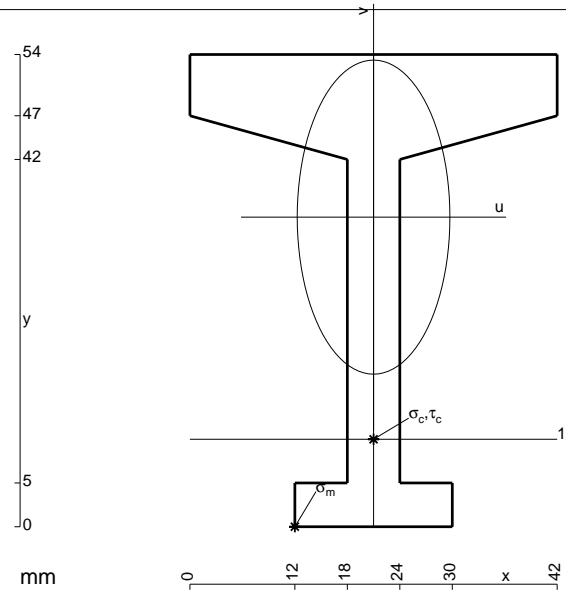
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (3/2 x/b - 2x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

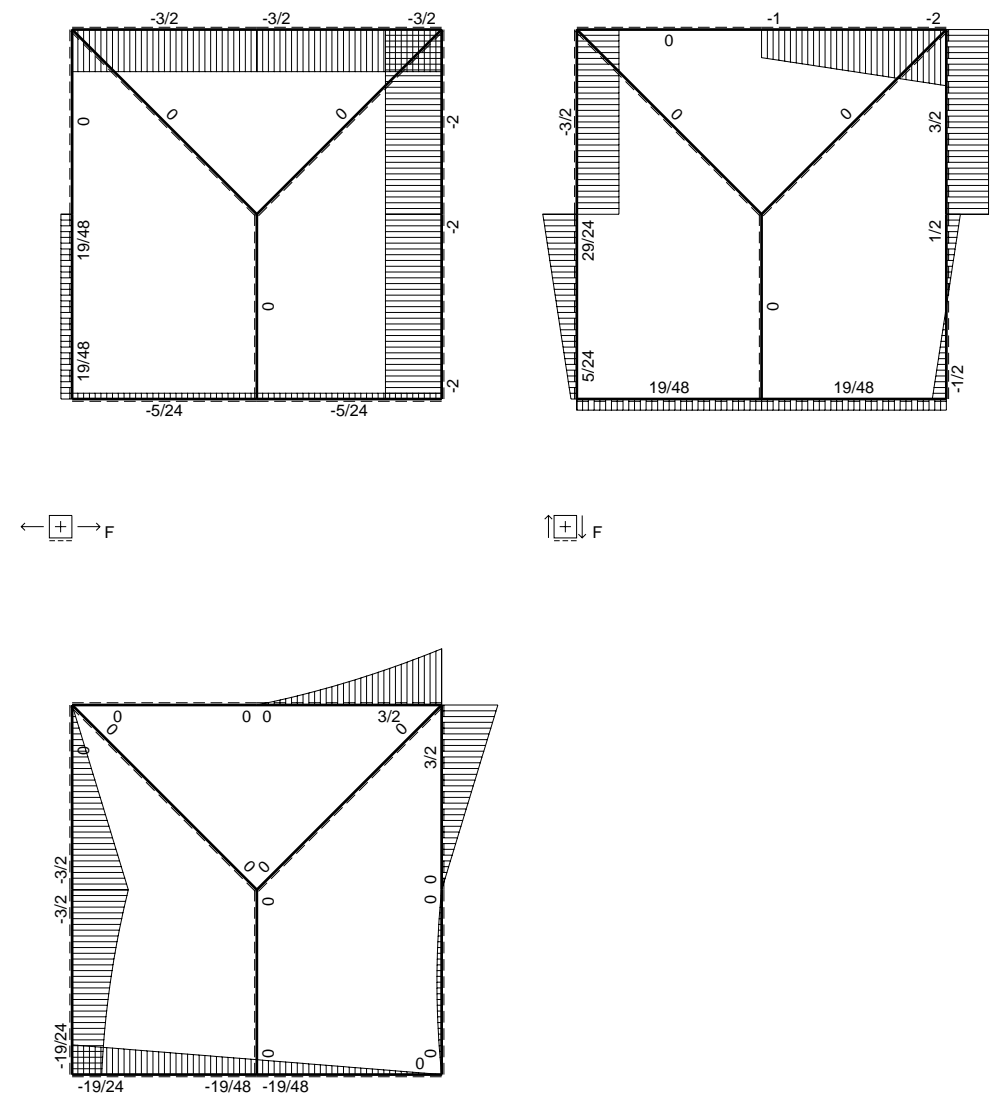
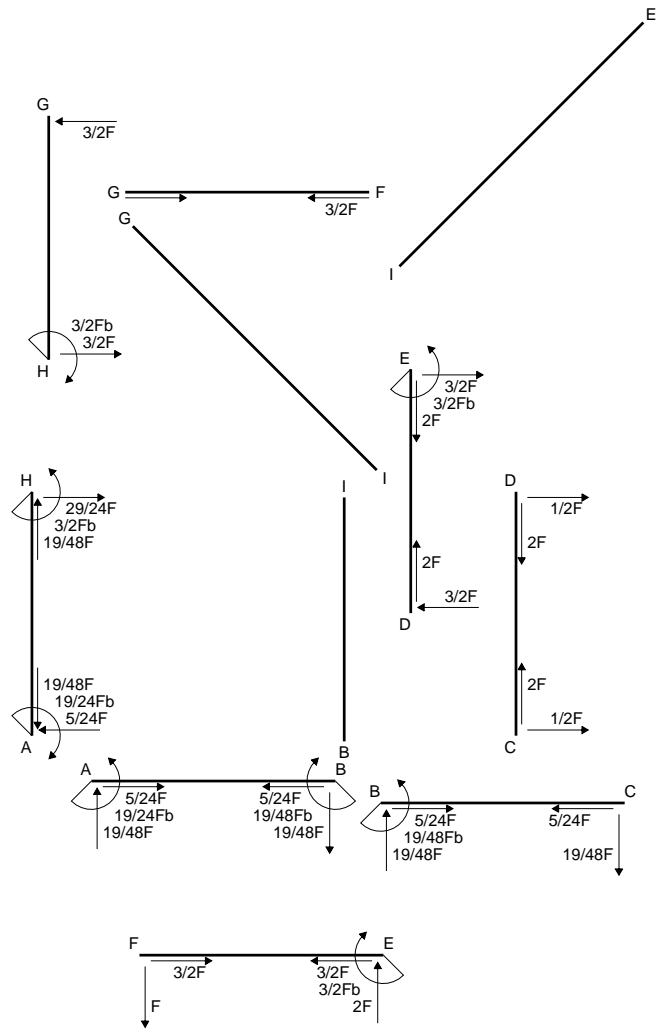
$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

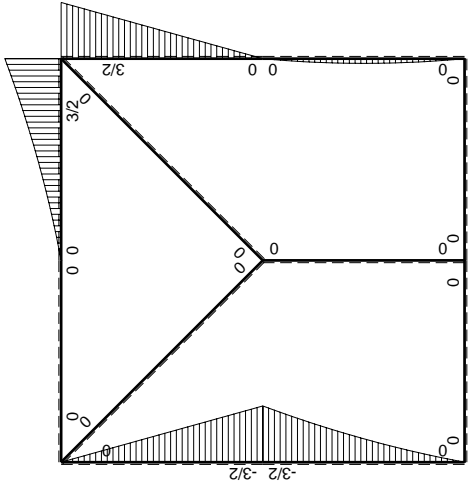
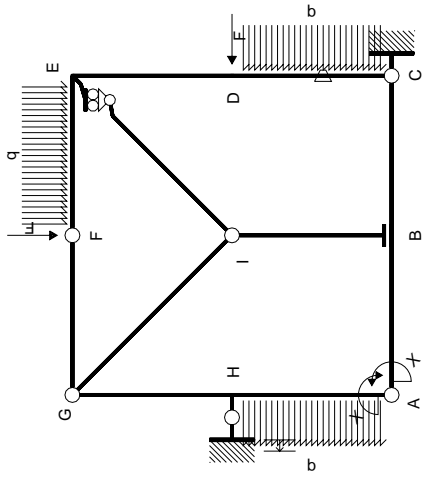
$$L_{AH}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

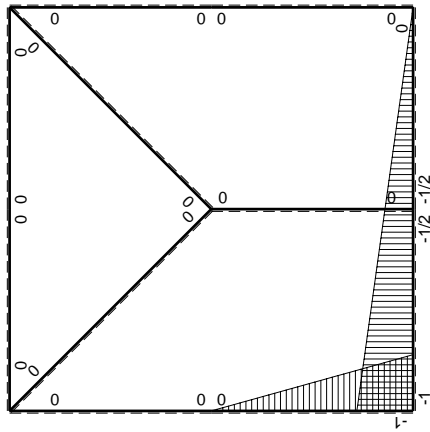


- A = 726. mm<sup>2</sup>
- J<sub>u</sub> = 234156. mm<sup>4</sup>
- J<sub>v</sub> = 55314. mm<sup>4</sup>
- y<sub>g</sub> = 35.4 mm
- N = -2460. N
- T<sub>y</sub> = -3280. N
- M<sub>x</sub> = 1476000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -9. mm
- v<sub>m</sub> = -35.4 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 219.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 21. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -25.41 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 156.8 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.868 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 157.5 N/mm<sup>2</sup>
- S = 3799. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	0	0	0	0	$1-x/b+1/4x^2/b^2$	0+0	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	0	0	0	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	0	0	0	0	$1/4-1/2x/b+1/4x^2/b^2$	0+0	$1/12Xb/EJ$	
CB b	$1/2x/b$	0	0	0	0	$1/4x^2/b^2$			
CD b	0	$-1/2Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0+0	0	
DC b	0	$1/2Fx-1/2qx^2$	$Fb/EJ$	0	0	0			
DE b	0	$3/2Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+3/2Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-3/2Fx$	0	0	0	0	0+0	0	
HG b	0	$3/2Fb-3/2Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-3/2Fb+2Fx-1/2qx^2$	0	$3/2Fx-2Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(5/24+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$Fx+1/2qx^2$	0	$Fx-1/2Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-19/24Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$19/24Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2 x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

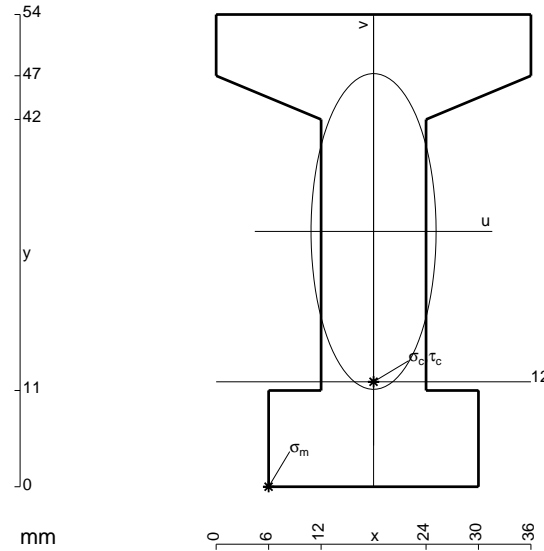
$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{HA}^{xo} = \int_0^b (3/2 x/b - 2 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [3/4 x^2/b - 2/3 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/4 b - 2/3 b + 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$

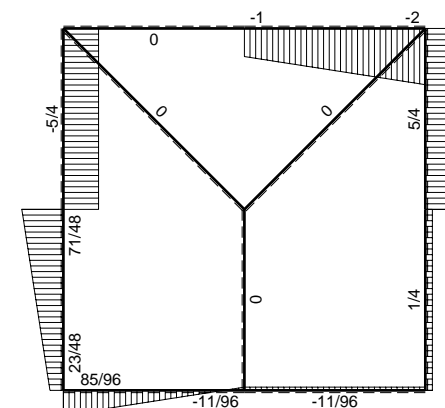
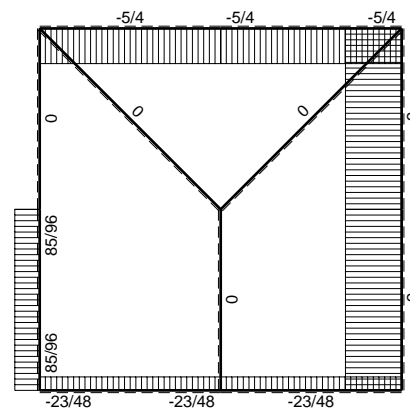
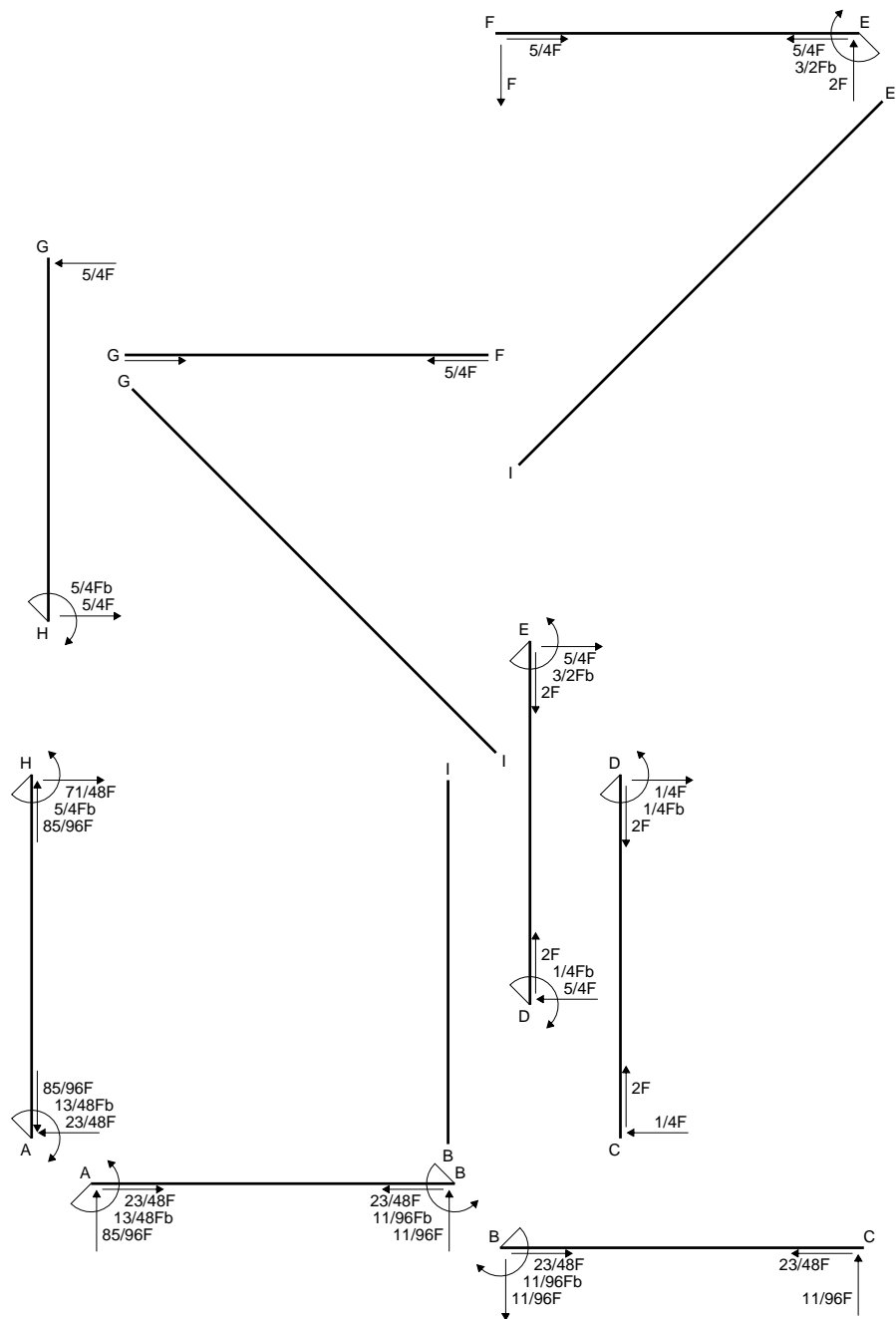
$$L_{AH}^{xo} = \int_0^b (x/b - 1/2 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [1/2 x^2/b - 1/6 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (1/2 b - 1/6 b - 1/8 b) Fb 1/EJ = 5/24 Fb^2/EJ$$



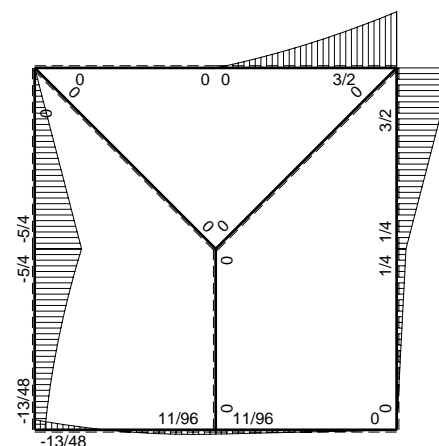
- A = 1008. mm<sup>2</sup>
- J<sub>u</sub> = 328681. mm<sup>4</sup>
- J<sub>v</sub> = 51552. mm<sup>4</sup>
- y<sub>g</sub> = 29.19 mm
- N = -4050. N
- T<sub>y</sub> = -5400. N
- M<sub>x</sub> = 2632500. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -29.19 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 229.8 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 12. mm
- v<sub>c</sub> = -17.19 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 133.7 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.854 N/mm<sup>2</sup>
- σ<sub>q</sub> = √(σ<sup>2</sup> + 3τ<sup>2</sup>) = 134.6 N/mm<sup>2</sup>
- S = 6467. mm<sup>3</sup>



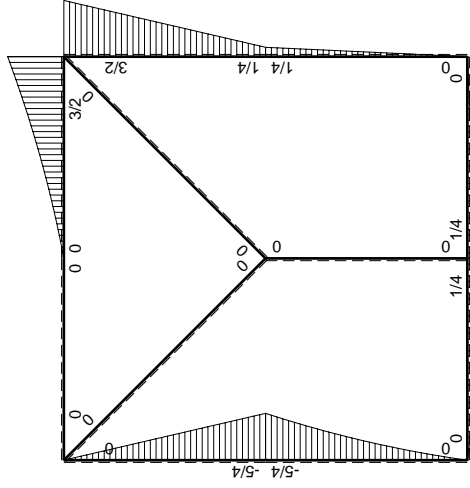
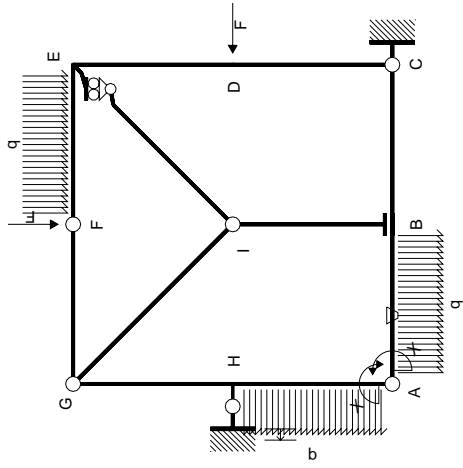


← ⊕ → F

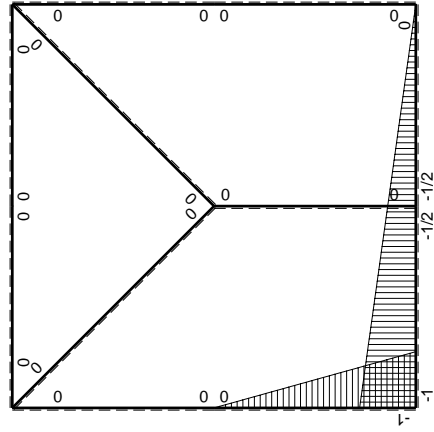
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	$-1+1/2x/b$	$3/4Fx-1/2qx^2$	$-Fb/EJ$	$-3/4Fx+7/8Fx^2/b-1/4qx^3/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-7/48+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb-1/4Fx+1/2qx^2$	$Fb/EJ$	$-1/8Fb-1/4Fx+1/8Fx^2/b+1/4qx^3/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/4Fb-1/4Fx$	0	$-1/8Fb+1/4Fx-1/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/4Fx$	0	$-1/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx$	0	0	0	0	0+0	0	
HG b	0	$5/4Fb-5/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/4Fb+7/4Fx-1/2qx^2$	0	$5/4Fx-7/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/6+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$3/4Fx+1/2qx^2$	0	$3/4Fx-1/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-13/48Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$13/48Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{x_0} = \int_0^b (-3/4 x/b + 7/8 x^2/b^2 - 1/4 x^3/b^3) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [-3/8 x^2/b + 7/24 x^3/b^2 - 1/16 x^4/b^3]_0^b Fb 1/EJ + [x - 1/4 x^2/b]_0^b \theta$$

$$= (-3/8 b + 7/24 b - 1/16 b) Fb 1/EJ + (b - 1/4 b) \theta = 29/48 Fb^2/EJ$$

$$L_{BA}^{x_0} = \int_0^b (-1/8 - 1/4 x/b + 1/8 x^2/b^2 + 1/4 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [-1/8 x - 1/8 x^2/b + 1/24 x^3/b^2 + 1/16 x^4/b^3]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-1/8 b - 1/8 b + 1/24 b + 1/16 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 29/48 Fb^2/EJ$$

$$L_{BC}^{x_0} = \int_0^b (-1/8 + 1/4 x/b - 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/8 x^2/b - 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/8 b - 1/24 b) Fb 1/EJ = -1/24 Fb^2/EJ$$

$$L_{CB}^{x_0} = \int_0^b (-1/8 x^2/b^2) Fb 1/EJ dx = [-1/24 x^3/b^2]_0^b Fb 1/EJ$$

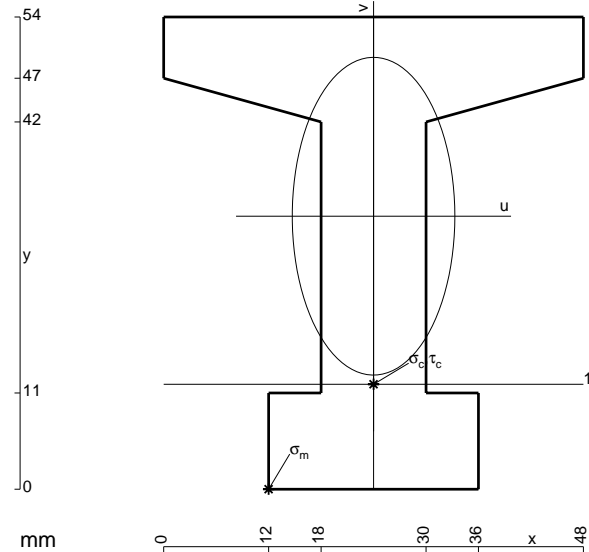
$$= (-1/24 b) Fb 1/EJ = -1/24 Fb^2/EJ$$

$$L_{HA}^{x_0} = \int_0^b (5/4 x/b - 7/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [5/8 x^2/b - 7/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

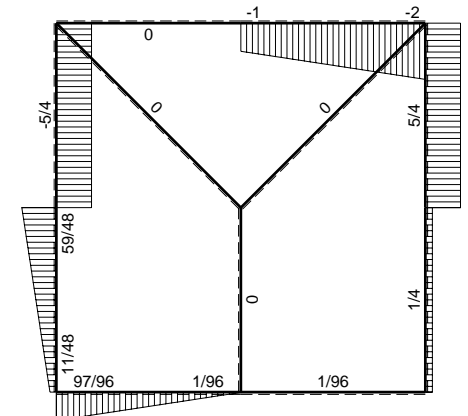
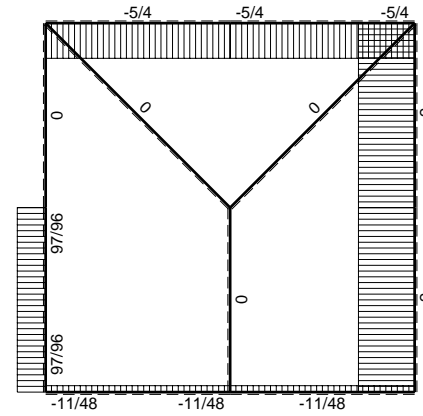
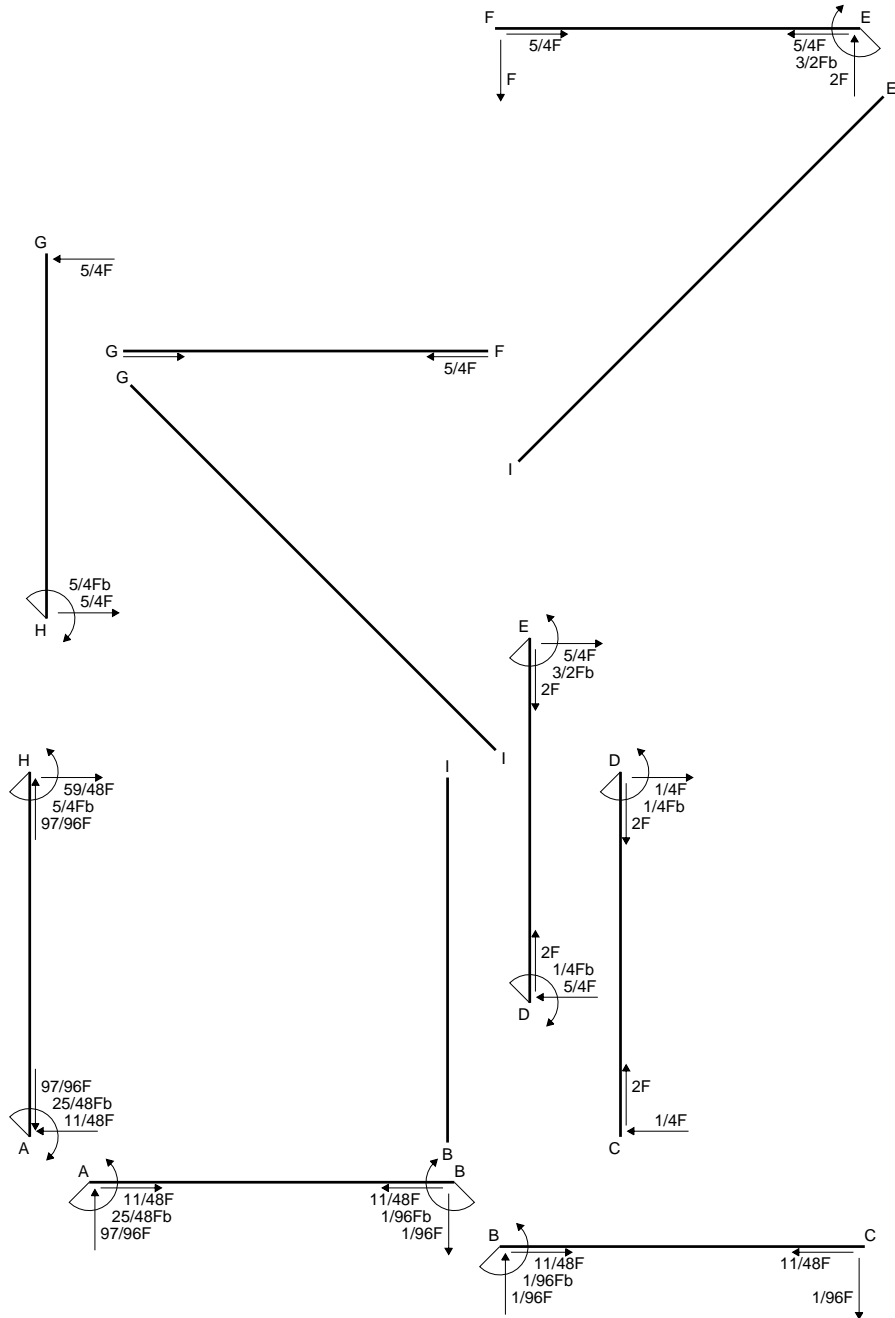
$$= (5/8 b - 7/12 b + 1/8 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

$$L_{AH}^{x_0} = \int_0^b (3/4 x/b - 1/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [3/8 x^2/b - 1/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (3/8 b - 1/12 b - 1/8 b) Fb 1/EJ = 1/6 Fb^2/EJ$$

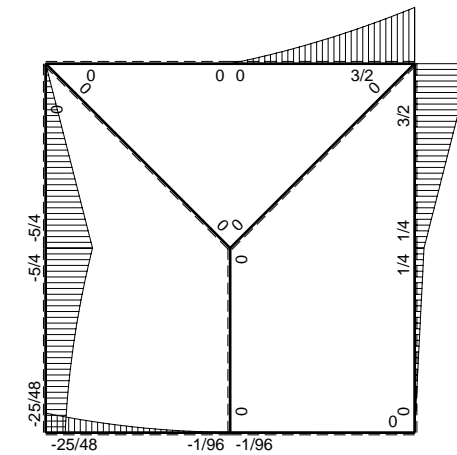


- A = 1122. mm<sup>2</sup>
- J<sub>u</sub> = 370409. mm<sup>4</sup>
- J<sub>v</sub> = 96948. mm<sup>4</sup>
- y<sub>g</sub> = 31.22 mm
- N = -3425. N
- T<sub>y</sub> = -5480. N
- M<sub>x</sub> = 2877000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -31.22 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 239.4 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 12. mm
- v<sub>c</sub> = -19.22 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 146.2 N/mm<sup>2</sup>
- τ<sub>c</sub> = 8.663 N/mm<sup>2</sup>
- σ<sub>o</sub> = √σ<sup>2</sup> + 3τ<sup>2</sup> = 147. N/mm<sup>2</sup>
- S = 7027. mm<sup>3</sup>

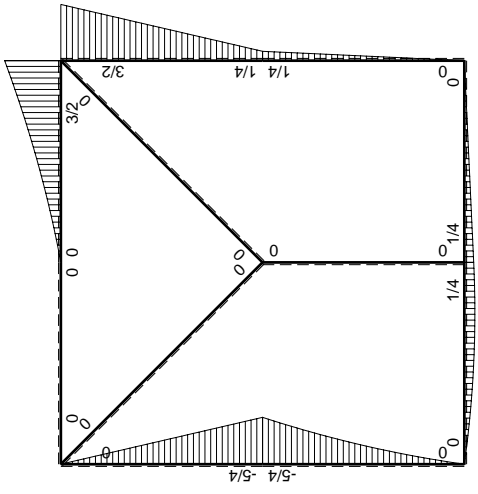
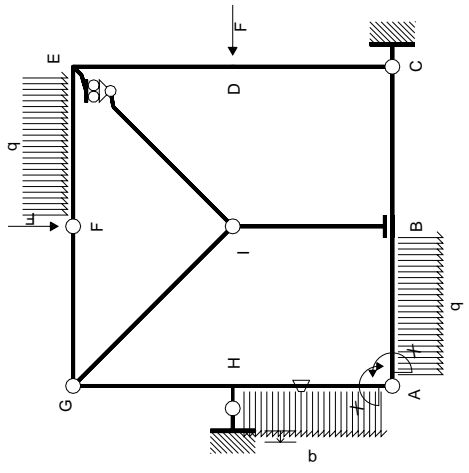


← ⊕ → F

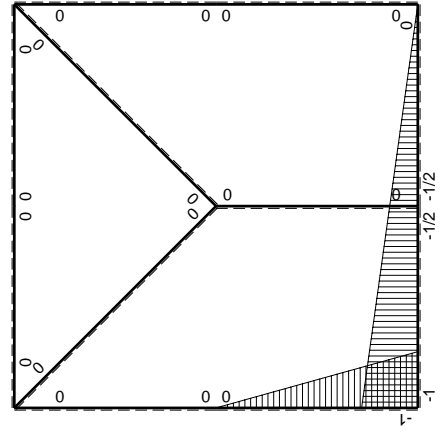
↑ ⊕ ↓ F



⊕ ⊖ F<sub>b</sub>



$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$3/4Fx-1/2qx^2$	0	$-3/4Fx+7/8Fx^2/b-1/4qx^3/b$	0	$1-x/b+1/4x^2/b^2$	$(-7/48+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/4Fb-1/4Fx+1/2qx^2$	0	$-1/8Fb-1/4Fx+1/8Fx^2/b+1/4qx^3/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/4Fb-1/4Fx$	0	$-1/8Fb+1/4Fx-1/8Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/24+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/4Fx$	0	$-1/8Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-5/4Fx$	0	0	0	0	0+0	0	
HG b	0	$5/4Fb-5/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	0	0	0	0	0	0	0	
HA b	$-x/b$	$-5/4Fb+7/4Fx-1/2qx^2$	$-Fb/EJ$	$5/4Fx-7/4Fx^2/b+1/2qx^3/b$	$Fx/EJ$	$x^2/b^2$	$(1/6+1/2)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$3/4Fx+1/2qx^2$	$Fb/EJ$	$3/4Fx-1/4Fx^2/b-1/2qx^3/b$	$Fb/EJ-Fx/EJ$	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-25/48Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$25/48Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{x_0} = \int_0^b (-3/4 x/b + 7/8 x^2/b^2 - 1/4 x^3/b^3) Fb 1/EJ dx = [-3/8 x^2/b + 7/24 x^3/b^2 - 1/16 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-3/8 b + 7/24 b - 1/16 b) Fb 1/EJ = -7/48 Fb^2/EJ$$

$$L_{BA}^{x_0} = \int_0^b (-1/8 - 1/4 x/b + 1/8 x^2/b^2 + 1/4 x^3/b^3) Fb 1/EJ dx$$

$$= [-1/8 x - 1/8 x^2/b + 1/24 x^3/b^2 + 1/16 x^4/b^3]_0^b Fb 1/EJ$$

$$= (-1/8 b - 1/8 b + 1/24 b + 1/16 b) Fb 1/EJ = -7/48 Fb^2/EJ$$

$$L_{BC}^{x_0} = \int_0^b (-1/8 + 1/4 x/b - 1/8 x^2/b^2) Fb 1/EJ dx = [-1/8 x + 1/8 x^2/b - 1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/8 b + 1/8 b - 1/24 b) Fb 1/EJ = -1/24 Fb^2/EJ$$

$$L_{CB}^{x_0} = \int_0^b (-1/8 x^2/b^2) Fb 1/EJ dx = [-1/24 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/24 b) Fb 1/EJ = -1/24 Fb^2/EJ$$

$$L_{HA}^{x_0} = \int_0^b (5/4 x/b - 7/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (x/b) \theta dx$$

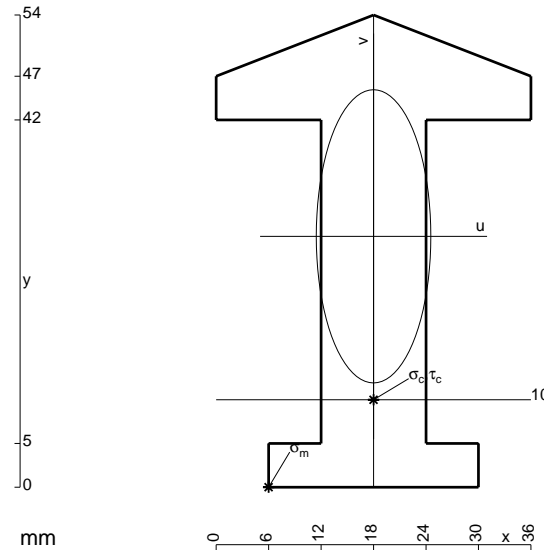
$$= [5/8 x^2/b - 7/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ + [1/2 x^2/b]_0^b \theta$$

$$= (5/8 b - 7/12 b + 1/8 b) Fb 1/EJ + (1/2 b) \theta = 2/3 Fb^2/EJ$$

$$L_{AH}^{x_0} = \int_0^b (3/4 x/b - 1/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx + \int_0^b (-1 + x/b) \theta dx$$

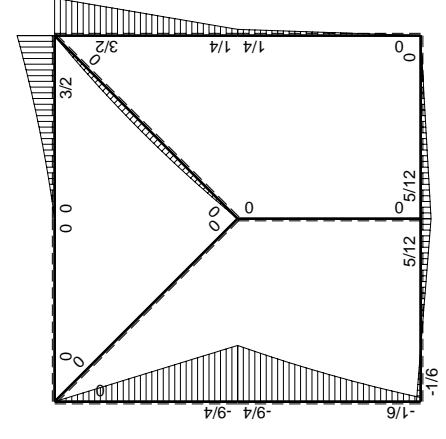
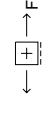
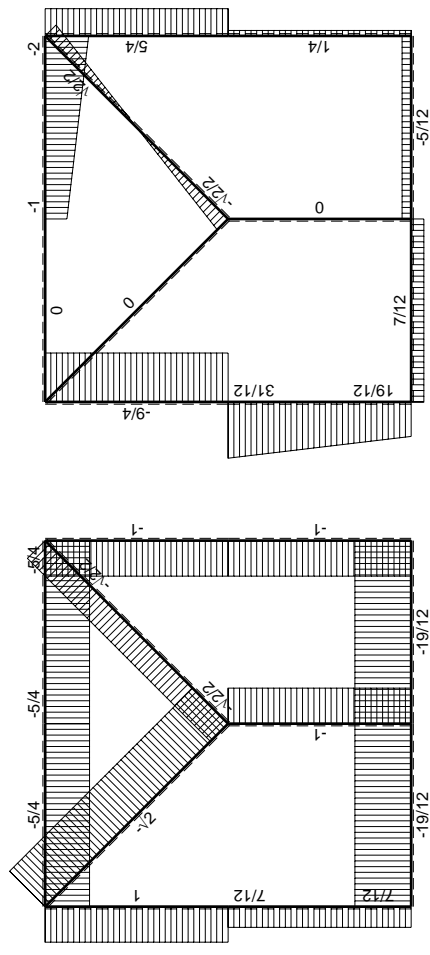
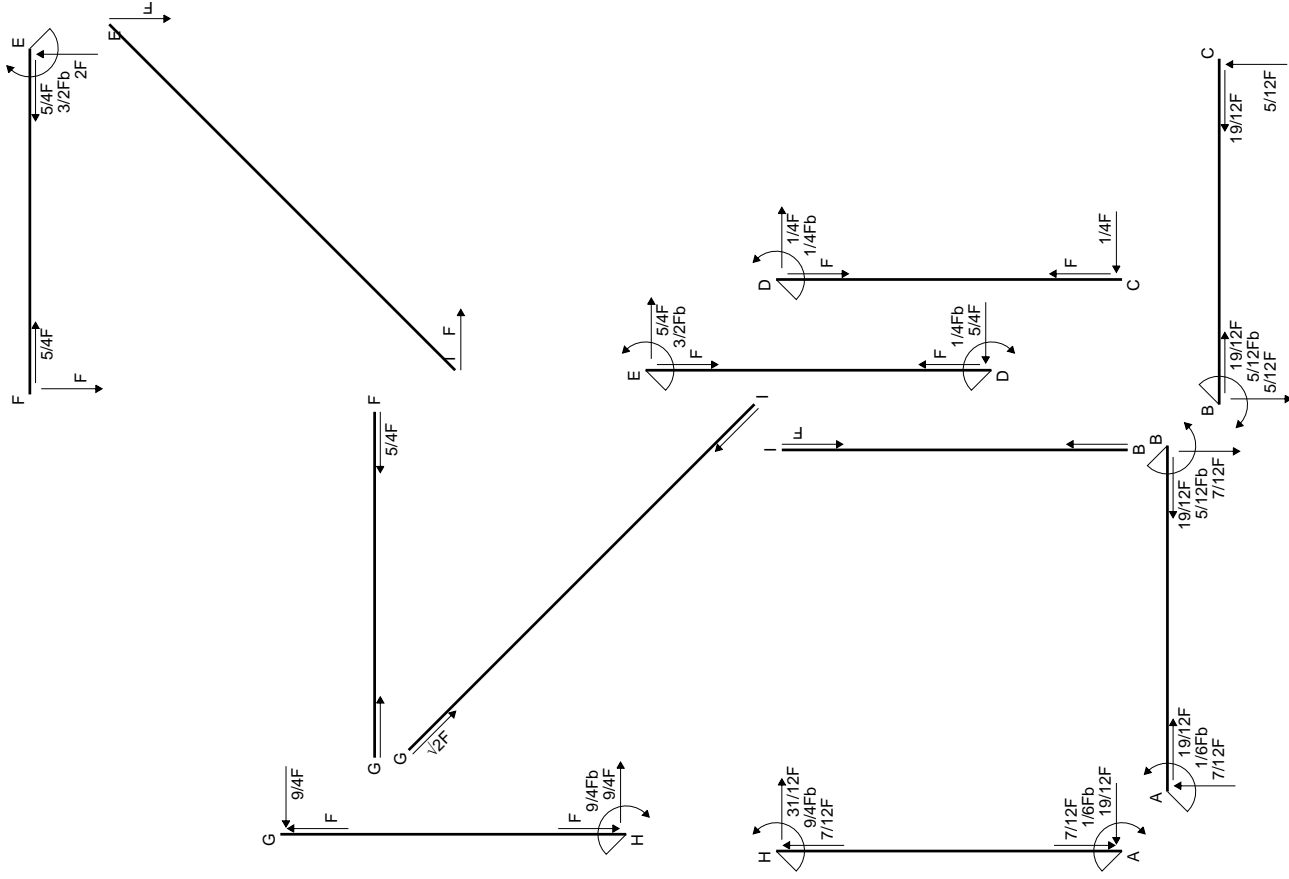
$$= [3/8 x^2/b - 1/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ + [-x + 1/2 x^2/b]_0^b \theta$$

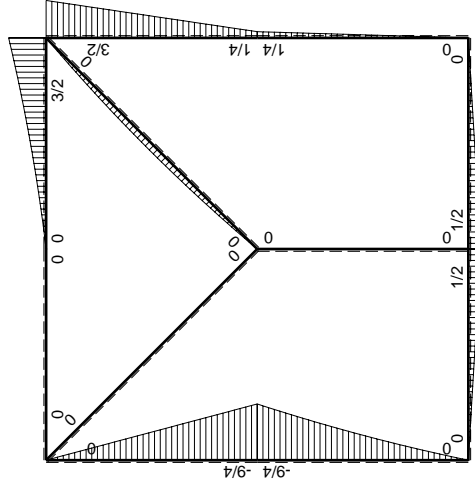
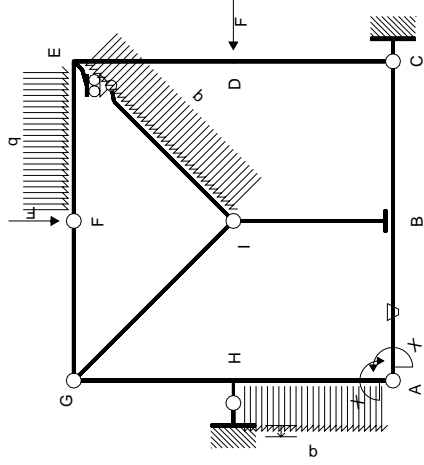
$$= (3/8 b - 1/12 b - 1/8 b) Fb 1/EJ + (-b + 1/2 b) \theta = 2/3 Fb^2/EJ$$



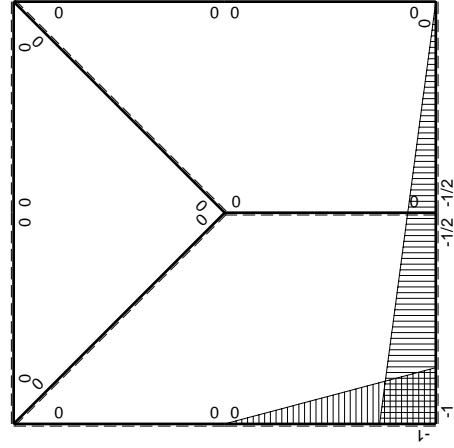
- A = 870. mm<sup>2</sup>
- J<sub>u</sub> = 244577. mm<sup>4</sup>
- J<sub>v</sub> = 37332. mm<sup>4</sup>
- y<sub>g</sub> = 28.69 mm
- N = -1913. N
- T<sub>y</sub> = -3060. N
- M<sub>x</sub> = 1721250. Nmm
- x<sub>m</sub> = 6. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -28.69 mm
- σ<sub>m</sub> = N/A - Mv/J<sub>u</sub> = 199.7 N/mm<sup>2</sup>
- x<sub>c</sub> = 18. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -18.69 mm
- σ<sub>c</sub> = N/A - Mv/J<sub>u</sub> = 129.3 N/mm<sup>2</sup>
- τ<sub>c</sub> = 4.602 N/mm<sup>2</sup>
- σ<sub>0</sub> = √σ<sup>2</sup> + 3τ<sup>2</sup> = 129.6 N/mm<sup>2</sup>
- S = 4414. mm<sup>3</sup>







  $M_0$  flessione da carichi assegnati



  $M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJdx$	
AB b	$-1+1/2x/b$	$1/2Fx$	$-Fb/EJ$	$-1/2Fx+1/4Fx^2/b$	$Fb/EJ-1/2Fx/EJ$	$1-x/b+1/4x^2/b^2$	$(-1/6+3/4)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	$Fb/EJ$	$-1/4Fb+1/4Fx^2/b$	$1/2Fb/EJ+1/2Fx/EJ$	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-1/6Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$1/6Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{x\theta} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (1 - 1/2 x/b) \theta dx$$

$$= [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ + [x - 1/2 x^2/b]_0^b \theta$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ + (b - 1/2 b) \theta = 7/12 Fb^2/EJ$$

$$L_{BA}^{x\theta} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx + \int_0^b (-1/2 - 1/2 x/b) \theta dx$$

$$= [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ + [-1/2 x - 1/4 x^2/b]_0^b \theta$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ + (-1/2 b - 1/4 b) \theta = 7/12 Fb^2/EJ$$

$$L_{BC}^{x\theta} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{x\theta} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

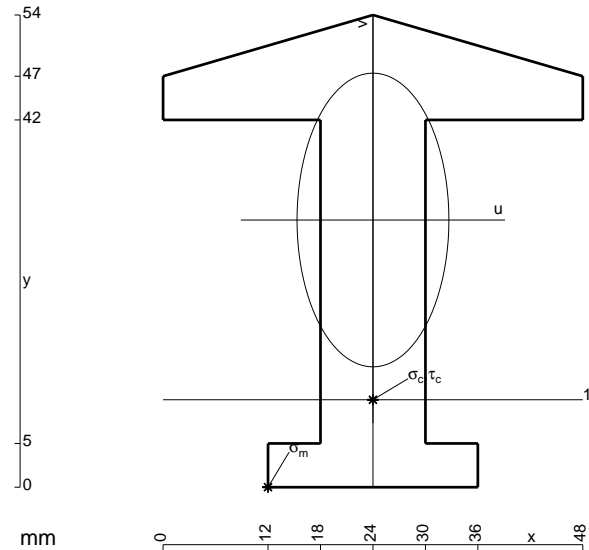
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{x\theta} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

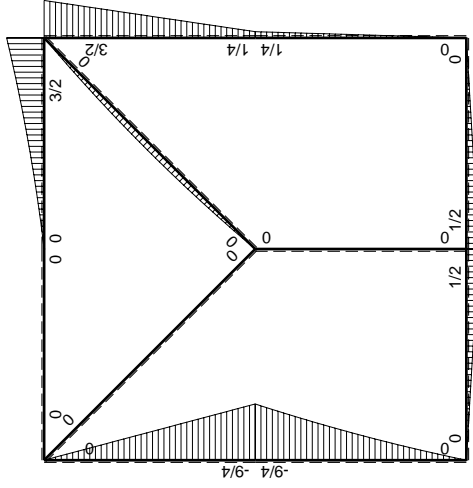
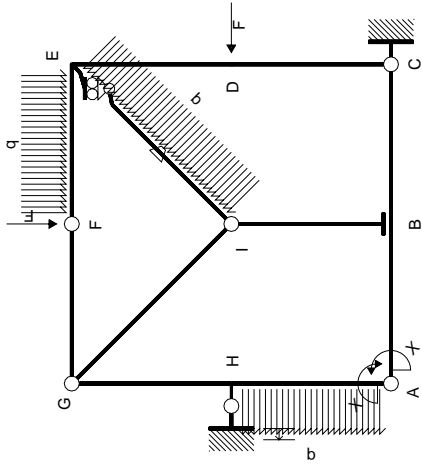
$$L_{AH}^{x\theta} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

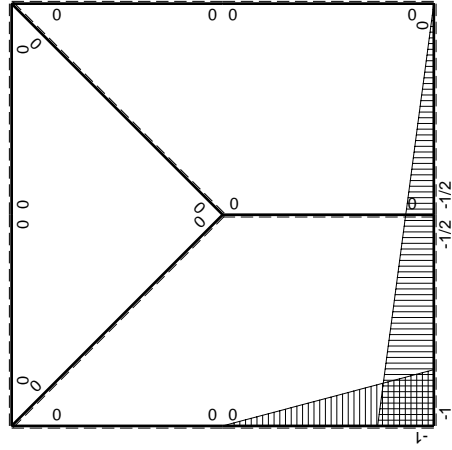


- A = 972. mm<sup>2</sup>
- J<sub>u</sub> = 274322. mm<sup>4</sup>
- J<sub>v</sub> = 73296. mm<sup>4</sup>
- y<sub>g</sub> = 30.56 mm
- N = 1050. N
- T<sub>y</sub> = -2363. N
- M<sub>x</sub> = -1890000. Nmm
- x<sub>m</sub> = 12. mm
- u<sub>m</sub> = -12. mm
- v<sub>m</sub> = -30.56 mm
- σ<sub>m</sub> = N/A-Mv/J<sub>u</sub> = -209.5 N/mm<sup>2</sup>
- x<sub>c</sub> = 24. mm
- y<sub>c</sub> = 10. mm
- v<sub>c</sub> = -20.56 mm
- σ<sub>c</sub> = N/A-Mv/J<sub>u</sub> = -140.6 N/mm<sup>2</sup>
- τ<sub>c</sub> = 3.409 N/mm<sup>2</sup>
- σ<sub>o</sub> = √(σ<sup>2</sup>+3τ<sup>2</sup>) = 140.7 N/mm<sup>2</sup>
- S = 4750. mm<sup>3</sup>





$M_0$  flessione da carichi assegnati



$M_x$  flessione da iperstatica  $X=1$

Quadro contributi PLV per iperstatica  $X=W_{AB}$ 

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	0	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	$-Fb/EJ$	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-11/12Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$11/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = [x - 1/2 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x + 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = [1/4 x - 1/4 x^2/b + 1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = [1/12 x^3/b^2]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = [1/3 x^3/b^2]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = [x - x^2/b + 1/3 x^3/b^2]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x^2/b + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = [-1/4 x + 1/4 x^2/b - 1/12 x^3/b^2]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = [-1/12 x^3/b^2]_0^b Fb 1/EJ$$

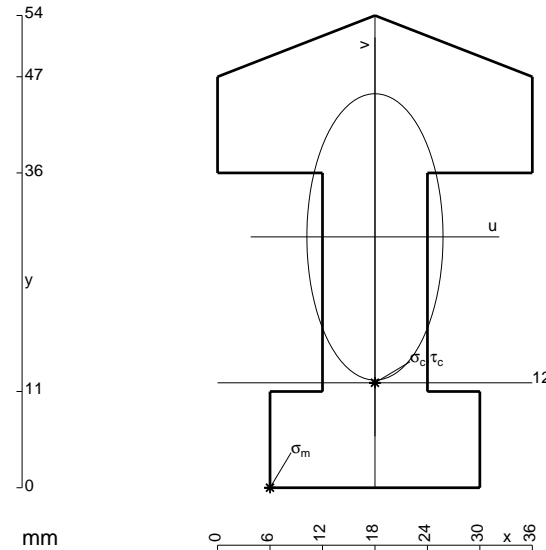
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = [9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = [7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



$$A = 1086. \text{ mm}^2$$

$$J_u = 291353. \text{ mm}^4$$

$$J_v = 65844. \text{ mm}^4$$

$$y_g = 28.69 \text{ mm}$$

$$N = 1170. \text{ N}$$

$$T_y = -2633. \text{ N}$$

$$M_x = -2237630. \text{ Nmm}$$

$$x_m = 6. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -28.69 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = -219.2 \text{ N/mm}^2$$

$$x_c = 18. \text{ mm}$$

$$y_c = 12. \text{ mm}$$

$$v_c = -16.69 \text{ mm}$$

$$\sigma_c = N/A - Mv/J_u = -127.1 \text{ N/mm}^2$$

$$\tau_c = 4.764 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 127.3 \text{ N/mm}^2$$

$$S = 6327. \text{ mm}^3$$







Quadro contributi PLV per iperstatica  $X=W_{AB}$

→	$M_x(x)$	$M_o(x)$	$\theta$	$M_x M_o$	$M_x \theta$	$M_x M_x$	$\int M_x(M_o/EJ+\theta)dx$	$\int X M_x M_x/EJ dx$	
AB b	$-1+1/2x/b$	$1/2Fx$	0	$-1/2Fx+1/4Fx^2/b$	0	$1-x/b+1/4x^2/b^2$	$(-1/6+0)Fb^2/EJ$	$7/12Xb/EJ$	
BA b	$1/2+1/2x/b$	$-1/2Fb+1/2Fx$	0	$-1/4Fb+1/4Fx^2/b$	0	$1/4+1/2x/b+1/4x^2/b^2$			
BC b	$-1/2+1/2x/b$	$1/2Fb-1/2Fx$	0	$-1/4Fb+1/2Fx-1/4Fx^2/b$	0	$1/4-1/2x/b+1/4x^2/b^2$	$(-1/12+0)Fb^2/EJ$	$1/12Xb/EJ$	
CB b	$1/2x/b$	$-1/2Fx$	0	$-1/4Fx^2/b$	0	$1/4x^2/b^2$			
CD b	0	$1/4Fx$	0	0	0	0	0+0	0	
DC b	0	$-1/4Fb+1/4Fx$	0	0	0	0			
DE b	0	$1/4Fb+5/4Fx$	0	0	0	0	0+0	0	
ED b	0	$-3/2Fb+5/4Fx$	0	0	0	0			
EF b	0	$3/2Fb-2Fx+1/2qx^2$	0	0	0	0	0+0	0	
FE b	0	$-Fx-1/2qx^2$	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	$-9/4Fx$	0	0	0	0	0+0	0	
HG b	0	$9/4Fb-9/4Fx$	0	0	0	0			
GI $\sqrt{2}b$	0	0	$-Fb/EJ$	0	0	0	0	0	
IB b	0	0	0	0	0	0	0+0	0	
BI b	0	0	0	0	0	0			
IE $\sqrt{2}b$	0	$-\sqrt{2}/2Fx+1/2qx^2$	0	0	0	0	0	0	
HA b	$-x/b$	$-9/4Fb+11/4Fx-1/2qx^2$	0	$9/4Fx-11/4Fx^2/b+1/2qx^3/b$	0	$x^2/b^2$	$(1/3+0)Fb^2/EJ$	$1/3Xb/EJ$	
AH b	$1-x/b$	$7/4Fx+1/2qx^2$	0	$7/4Fx-5/4Fx^2/b-1/2qx^3/b$	0	$1-2x/b+x^2/b^2$			
H	cedimento nodo $-H_{1H}u_H$							$-Fb^2/EJ$	
	totali							$-11/12Fb^2/EJ$	$Xb/EJ$
	iperstatica $X=W_{AB}$							$11/12Fb$	

Sviluppi di calcolo iperstatica

$$L_{AB}^{xx} = \int_0^b (1 - x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ x - 1/2 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - 1/2 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BA}^{xx} = \int_0^b (1/4 + 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x + 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b + 1/4 b + 1/12 b) 1/EJ = 7/12 b/EJ$$

$$L_{BC}^{xx} = \int_0^b (1/4 - 1/2 x/b + 1/4 x^2/b^2) 1/EJ dx = \left[ 1/4 x - 1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/4 b - 1/4 b + 1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{CB}^{xx} = \int_0^b (1/4 x^2/b^2) 1/EJ dx = \left[ 1/12 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/12 b) 1/EJ = 1/12 b/EJ$$

$$L_{HA}^{xx} = \int_0^b (x^2/b^2) 1/EJ dx = \left[ 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AH}^{xx} = \int_0^b (1 - 2x/b + x^2/b^2) 1/EJ dx = \left[ x - x^2/b + 1/3 x^3/b^2 \right]_0^b 1/EJ$$

$$= (b - b + 1/3 b) 1/EJ = 1/3 b/EJ$$

$$L_{AB}^{xo} = \int_0^b (-1/2 x/b + 1/4 x^2/b^2) Fb 1/EJ dx = \left[ -1/4 x^2/b + 1/12 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BA}^{xo} = \int_0^b (-1/4 + 1/4 x^2/b^2) Fb 1/EJ dx = \left[ -1/4 x + 1/12 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/12 b) Fb 1/EJ = -1/6 Fb^2/EJ$$

$$L_{BC}^{xo} = \int_0^b (-1/4 + 1/2 x/b - 1/4 x^2/b^2) Fb 1/EJ dx = \left[ -1/4 x + 1/4 x^2/b - 1/12 x^3/b^2 \right]_0^b Fb 1/EJ$$

$$= (-1/4 b + 1/4 b - 1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{CB}^{xo} = \int_0^b (-1/4 x^2/b^2) Fb 1/EJ dx = \left[ -1/12 x^3/b^2 \right]_0^b Fb 1/EJ$$

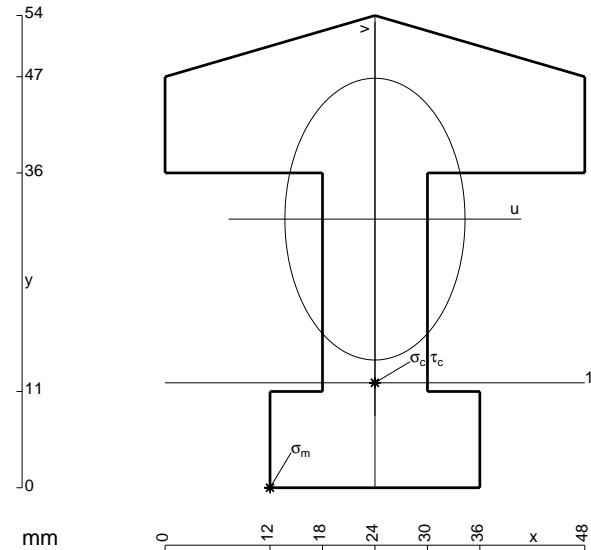
$$= (-1/12 b) Fb 1/EJ = -1/12 Fb^2/EJ$$

$$L_{HA}^{xo} = \int_0^b (9/4 x/b - 11/4 x^2/b^2 + 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 9/8 x^2/b - 11/12 x^3/b^2 + 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (9/8 b - 11/12 b + 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

$$L_{AH}^{xo} = \int_0^b (7/4 x/b - 5/4 x^2/b^2 - 1/2 x^3/b^3) Fb 1/EJ dx = \left[ 7/8 x^2/b - 5/12 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb 1/EJ$$

$$= (7/8 b - 5/12 b - 1/8 b) Fb 1/EJ = 1/3 Fb^2/EJ$$



$$A = 1260. \text{ mm}^2$$

$$J_u = 327186. \text{ mm}^4$$

$$J_v = 133776. \text{ mm}^4$$

$$y_g = 30.72 \text{ mm}$$

$$N = 1210. \text{ N}$$

$$T_y = -2723. \text{ N}$$

$$M_x = -2450250. \text{ Nmm}$$

$$x_m = 12. \text{ mm}$$

$$u_m = -12. \text{ mm}$$

$$v_m = -30.72 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = -229.1 \text{ N/mm}^2$$

$$x_c = 24. \text{ mm}$$

$$y_c = 12. \text{ mm}$$

$$v_c = -18.72 \text{ mm}$$

$$\sigma_c = N/A - Mv/J_u = -139.2 \text{ N/mm}^2$$

$$\tau_c = 4.776 \text{ N/mm}^2$$

$$\sigma_q = \sqrt{\sigma^2 + 3\tau^2} = 139.4 \text{ N/mm}^2$$

$$S = 6888. \text{ mm}^3$$