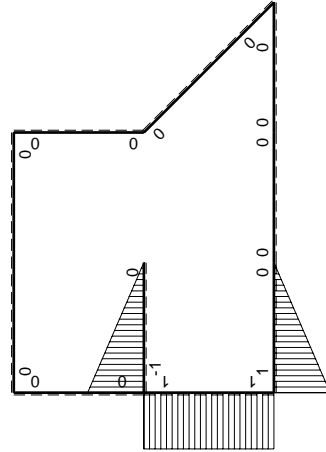


Schema di calcolo iperstatico

(\oplus) M_0 flessione da carichi assegnati



(\oplus) M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica X=V_A

→	$M_x(x)$	$M_0(x)$	$M_x M_0$	$M_x M_x$	$\int M_x M_0 / E J dx$	$\int M_x M_x / E J dx$
AB b	0	-1/2Fb+1/2Fx	0	0	0	0
BA b	0	1/2Fx	0	0	0	0
BC b	0	1/2Fx	0	0	0	0
CB b	0	-1/2Fb+1/2Fx	0	0	0	0
CD √2b	0	1/2Fb-√2/4Fx	0	0	0	0
DE b	0	0	0	0	0	0
ED b	0	0	0	0	0	0
EF 2b	0	Fb-1/2Fx	0	0	0	0
FE 2b	0	-1/2Fx	0	0	0	0
GA b	b-x	-Fb+1/2Fx	-Fb ² +3/2Fbx-1/2Fx ²	b ² -2bx+x ²	-5/12Fb ³ /EJ	1/3Xb ³ /EJ
AG b	-x	1/2Fb+1/2Fx	-1/2Fbx-1/2Fx ²	x ²		
FH b	0	-1/2qx ²	0	0	0	0
HF b	0	1/2Fb-Fx+1/2qx ²	0	0	0	0
HI b	-b+x	Fb-Fx	-Fb ² +2Fbx-Fx ²	b ² -2bx+x ²	-1/3Fb ³ /EJ	1/3Xb ³ /EJ
IH b	x	-Fx	-Fx ²	x ²		
HG b	b	-3/2Fb+Fx-1/2qx ²	-3/2Fb ² +Fbx-1/2Fx ²	b ²	-7/6Fb ³ /EJ	Xb ³ /EJ
GH b	-b	Fb+1/2qx ²	-Fb ² -1/2Fx ²	b ²		
HG	elongazione asta $N_{1HG} = N_{HG} - HG$				Fb ³ /EJ	
A	molla nodo $-V_{1A}(V_{0A} + XV_{1A})/k_A$					1/4Xb ³ /EJ
	totali				-11/12Fb ³ /EJ	23/12Xb ³ /EJ
	iperstatica X=V _A				11/23F	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

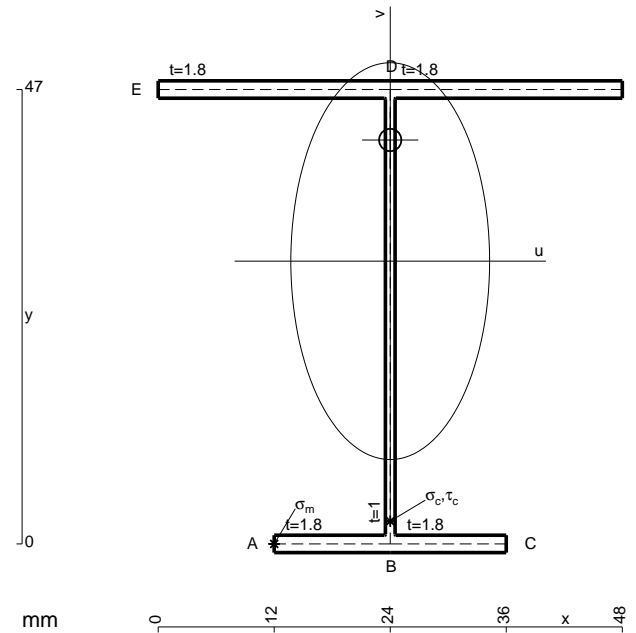
$$= [-3/2 x + 1/2 x^2/b - 1/6 x^3/b^2]_0^b Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ$$

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

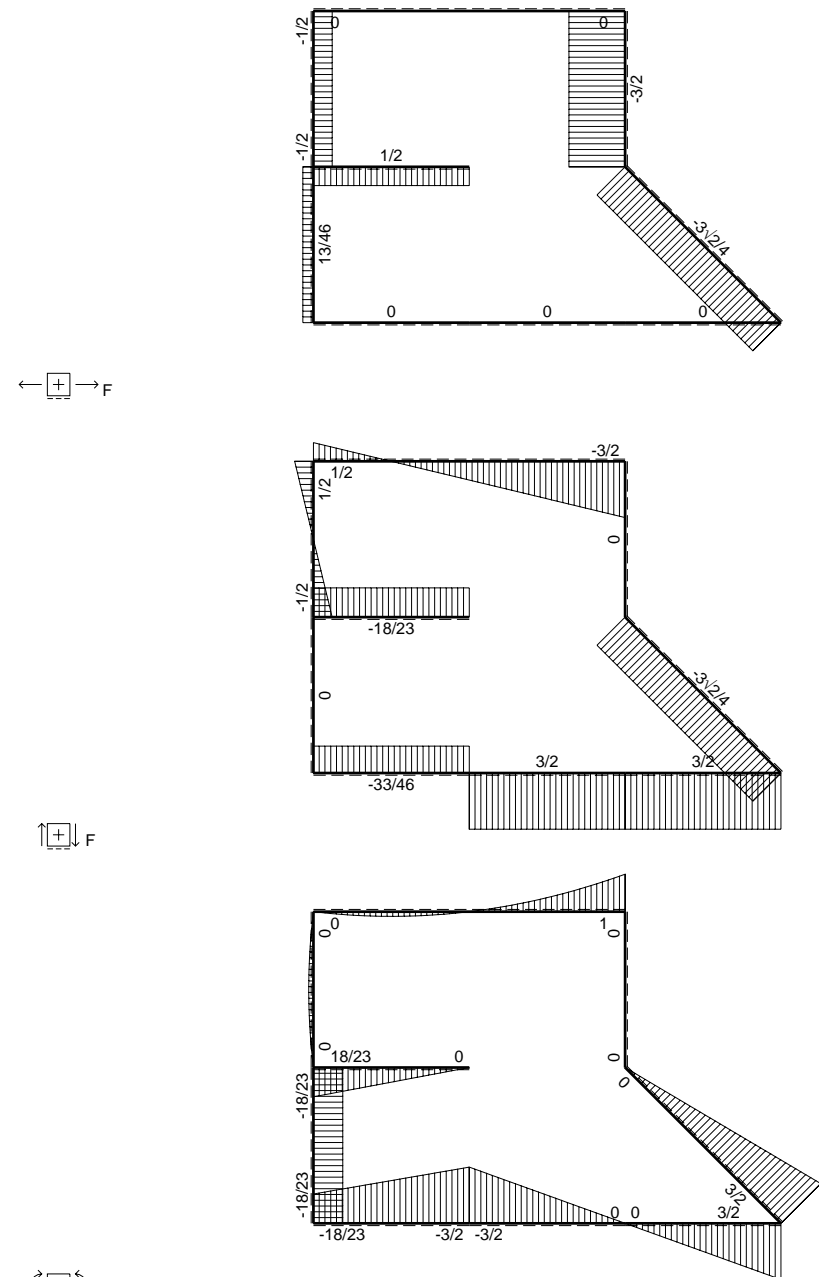
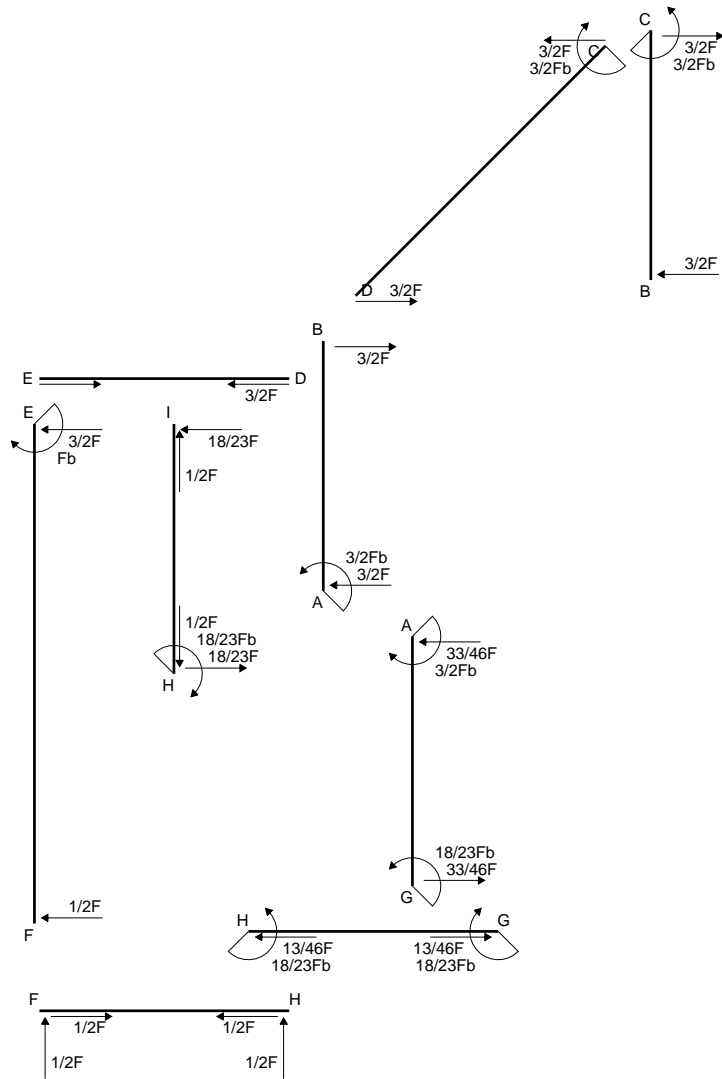
$$L_{GH}^{xo} = \int_0^b (-1 - 1/2 x^2/b^2) Fb^2 1/EJ dx + 1 (-1) (-1) Fb^3/EJ$$

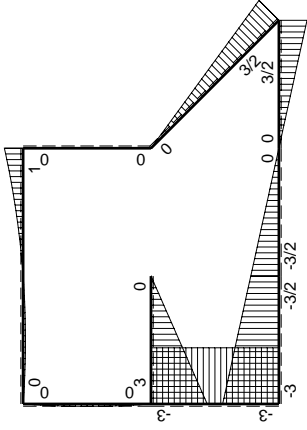
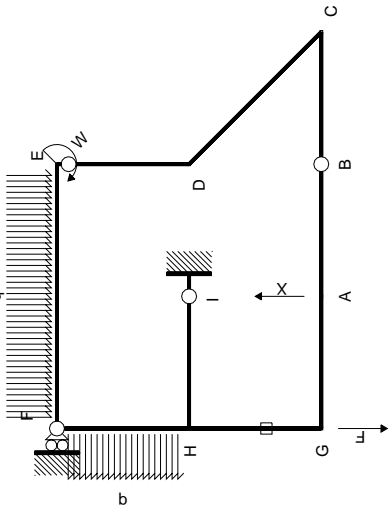
$$= [-x - 1/6 x^3/b^2]_0^b Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ$$

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



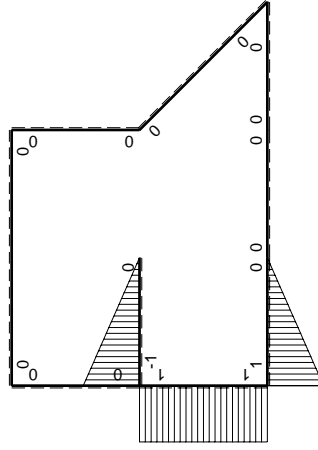
- A = 176.6 mm²
- J_u = 74388. mm⁴
- J_v = 18662. mm⁴
- J_t = 155.6 mm⁴
- y_o = 12.53 mm
- y_g = 29.25 mm
- T_y = -635. N
- M_x = 508000. Nmm
- x_m = 12. mm
- u_m = -12. mm
- v_m = -29.25 mm
- σ_m = -M_v/J_u = 199.7 N/mm²
- x_c = 24. mm
- v_c = -29.25 mm
- σ_c = -M_v/J_u = 199.7 N/mm²
- τ_c = T_S/t_{J_u} = 10.79 N/mm²
- τ_g = T_S/t_{J_u} = 10.79 N/mm²
- t_c = 1270. mm
- σ_o = √σ²+3τ² = 200.6 N/mm²





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=V_A$

\rightarrow	$M_x(x)$	$M_0(x)$	$M_x M_0$	$M_x M_x$	$\int M_x M_0 / EJ dx$	$\int M_x M_x / EJ dx$
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0
BA b	0	$3/2Fx$	0	0	0	0
BC b	0	$3/2Fx$	0	0	0	0
CB b	0	$-3/2Fb+3/2Fx$	0	0	0	0
CD $\sqrt{2}b$	0	$3/2Fb-3\sqrt{2}/4Fx$	0	0	0	0
DE b	0	0	0	0	0	0
ED b	0	0	0	0	0	0
EF 2b	0	$Fb-3/2Fx+1/2qx^2$	0	0	0	0
FE 2b	0	$1/2Fx-1/2qx^2$	0	0	0	0
GA b	b-x	$-3Fb+3/2Fx$	$-3Fb^2+9/2Fbx-3/2Fx^2$	$b^2-2bx+x^2$	$-5/4Fb^3/EJ$	$1/3Xb^3/EJ$
AG b	-x	$3/2Fb+3/2Fx$	$-3/2Fbx-3/2Fx^2$	x^2		
FH b	0	$1/2Fx-1/2qx^2$	0	0	0	0
HF b	0	$-1/2Fx+1/2qx^2$	0	0	0	0
HI b	-b+x	$3Fb-3Fx$	$-3Fb^2+6Fbx-3Fx^2$	$b^2-2bx+x^2$	$-Fb^3/EJ$	$1/3Xb^3/EJ$
IH b	x	$-3Fx$	$-3Fx^2$	x^2		
HG b	b	$-3Fb$	$-3Fb^2$	b^2	$-3Fb^3/EJ$	Xb^3/EJ
GH b	-b	$3Fb$	$-3Fb^2$	b^2		
HG	elongazione asta $N_{1HG} = N_{HG} - HG$				Fb^3/EJ	
A	molla nodo $-V_{1A}(V_{0A} + XV_{1A})/k_A$					$1/4Xb^3/EJ$
	totali				$-17/4Fb^3/EJ$	$23/12Xb^3/EJ$
	iperstatica $X=V_A$				51/23F	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (-3b + 9/4 b - 1/2 b) Fb^2 1/EJ = -5/4 Fb^3/EJ$$

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

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

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

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

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

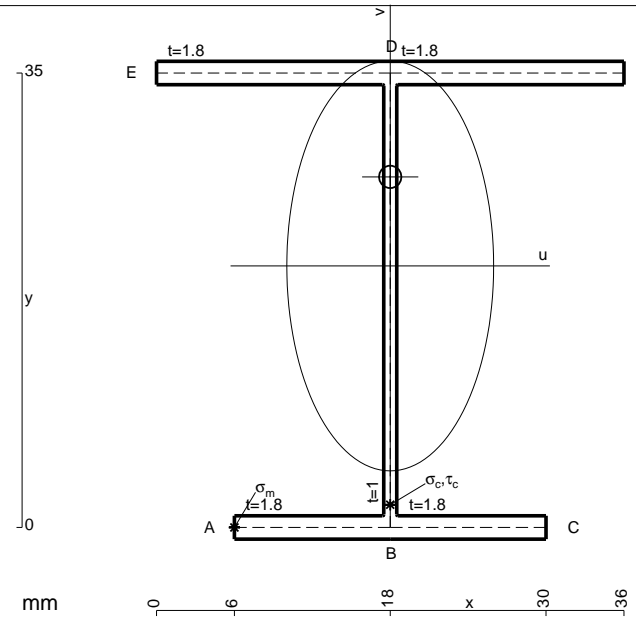
$$= (-b) Fb^2 1/EJ = - Fb^3/EJ$$

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

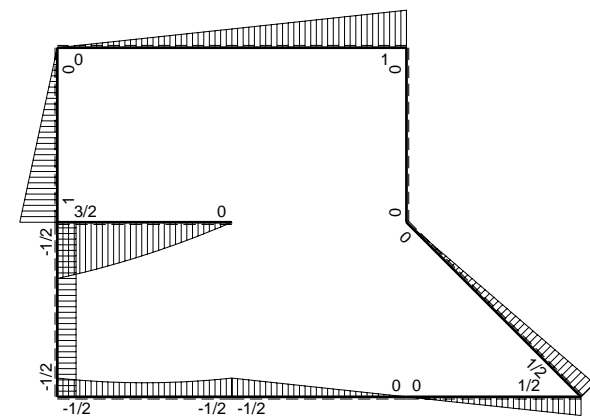
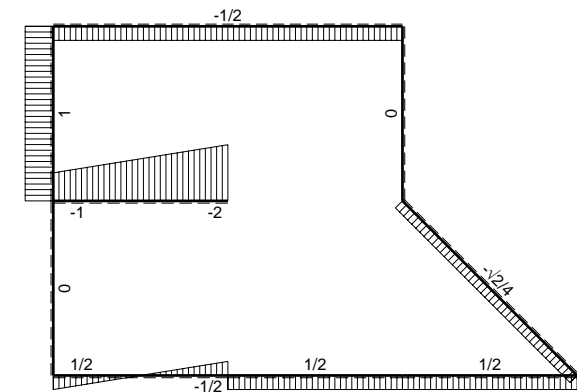
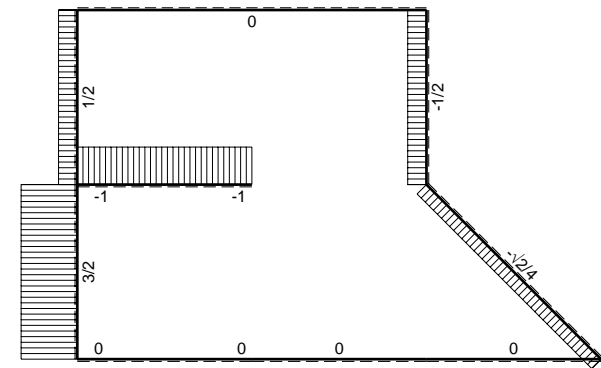
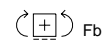
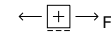
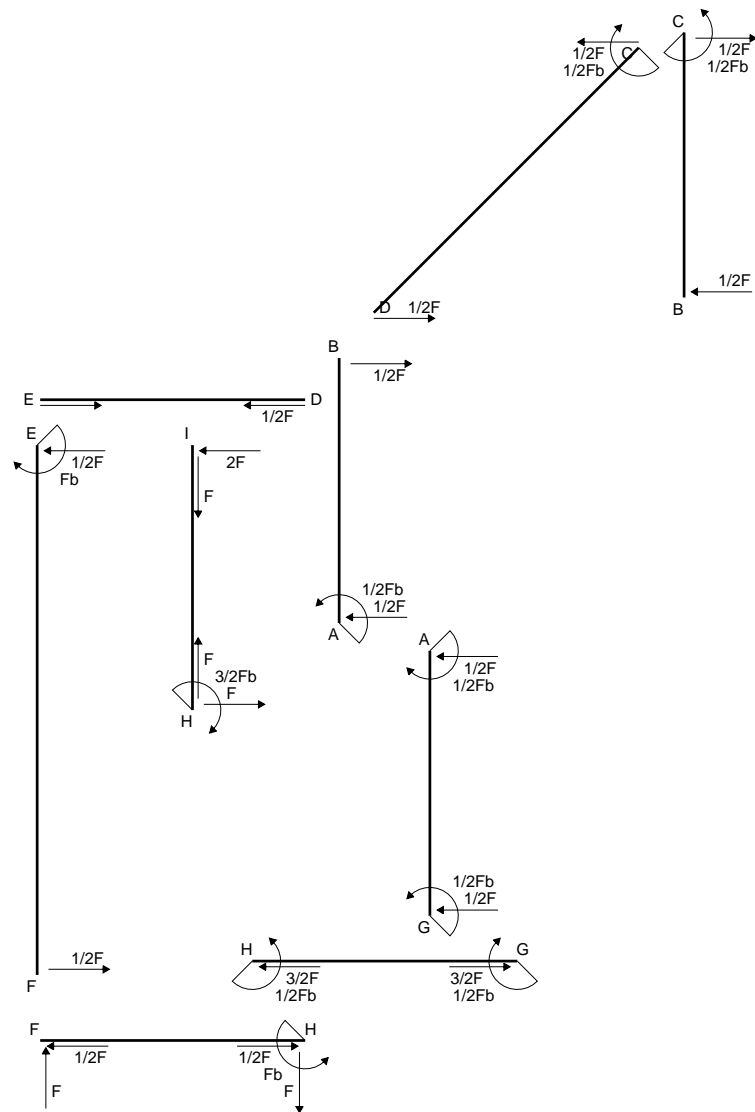
$$= (-3b) Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ = -2 Fb^3/EJ$$

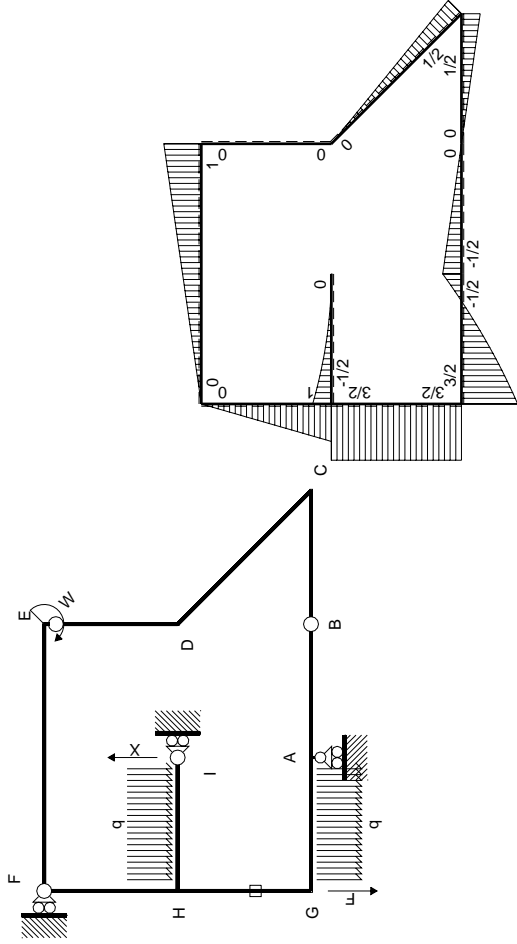
$$L_{GH}^{xo} = \int_0^b (-3) Fb^2 1/EJ dx + 1 (-1) (-1) Fb^3/EJ = [-3x]_0^b Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ$$

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



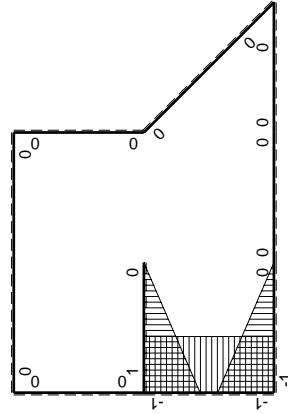
- A = 143. mm²
- J_u = 35649. mm⁴
- J_v = 9072. mm⁴
- J_i = 128.3 mm⁴
- y_o = 6.857 mm
- y_g = 20.14 mm
- T_y = 780. N
- M_x = -351000. Nmm
- x_m = 6. mm
- u_m = -12. mm
- v_m = -20.14 mm
- σ_m = -Mv/J_u = -198.3 N/mm²
- x_c = 18. mm
- v_c = -20.14 mm
- σ_c = -Mv/J_u = -198.3 N/mm²
- τ_c = TS'/tJ_u = 19.04 N/mm²
- τ_g = TS'/tJ_u = 19.04 N/mm²
- t_c = 520. mm
- σ_o = √σ²+3τ² = 201.1 N/mm²





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=V_1$

→	$M_x(x)$	$M_o(x)$	$M_x M_o$	$M_x M_x$	$\int M_x M_o / EJ dx$	$\int X M_x M_x / EJ dx$
AB b	0	$-1/2Fb+1/2Fx$	0	0	0	0
BA b	0	$1/2Fx$	0	0		
BC b	0	$1/2Fx$	0	0	0	0
CB b	0	$-1/2Fb+1/2Fx$	0	0		
CD $\sqrt{2}b$	0	$1/2Fb-\sqrt{2}/4Fx$	0	0	0	0
DE b	0	0	0	0	0	0
ED b	0	0	0	0		
EF 2b	0	$Fb-1/2Fx$	0	0	0	0
FE 2b	0	$-1/2Fx$	0	0		
GA b	$-b+x$	$3/2Fb-3/2Fx-1/2qx^2$	$-3/2Fb^2+3Fbx-Fx^2-1/2qx^3$	$b^2-2bx+x^2$	$-11/24Fb^3/EJ$	$1/3Xb^3/EJ$
AG b	x	$1/2Fb-5/2Fx+1/2qx^2$	$1/2Fbx-5/2Fx^2+1/2qx^3$	x^2		
FH b	0	Fx	0	0	0	0
HF b	0	$-Fb+Fx$	0	0		
HI b	$b-x$	$-1/2Fb+Fx-1/2qx^2$	$-1/2Fb^2+3/2Fbx-3/2Fx^2+1/2qx^3$	$b^2-2bx+x^2$	$-1/8Fb^3/EJ$	$1/3Xb^3/EJ$
IH b	$-x$	$1/2qx^2$	$-1/2qx^3$	x^2		
HG b	$-b$	$3/2Fb$	$-3/2Fb^2$	b^2	$-3/2Fb^3/EJ$	Xb^3/EJ
GH b	b	$-3/2Fb$	$-3/2Fb^2$	b^2		
HG	elongazione asta $N_{1HG} \epsilon_{HG} L_{HG}$				$-Fb^3/EJ$	
A	molla nodo $-V_{1A}(V_{oA}+XV_{1A})/k_A$				$-3/4Fb^3/EJ$	$1/4Xb^3/EJ$
	totali				$-23/6Fb^3/EJ$	$23/12Xb^3/EJ$
	iperstatica $X=V_1$				$2F$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (-3/2 b + 3/2 b - 1/3 b - 1/8 b) Fb^2 1/EJ = -11/24 Fb^3/EJ$$

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

$$= (1/4 b - 5/6 b + 1/8 b) Fb^2 1/EJ = -11/24 Fb^3/EJ$$

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

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

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

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

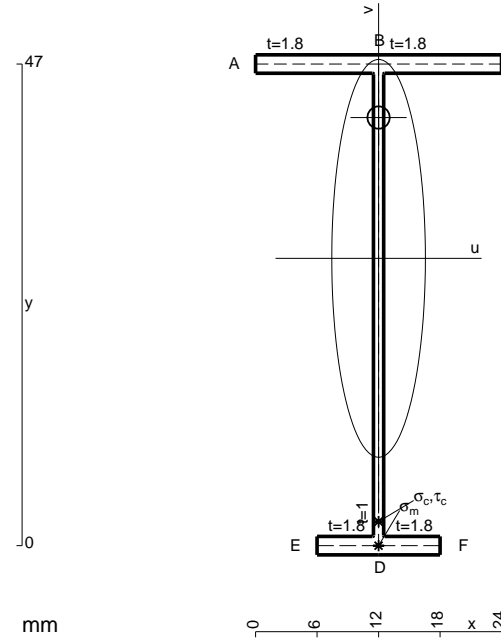
$$= (-1/8 b) Fb^2 1/EJ = -1/8 Fb^3/EJ$$

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

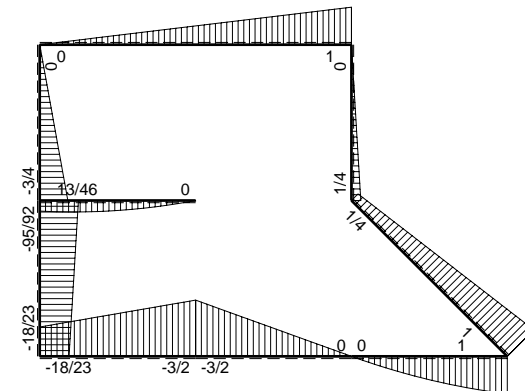
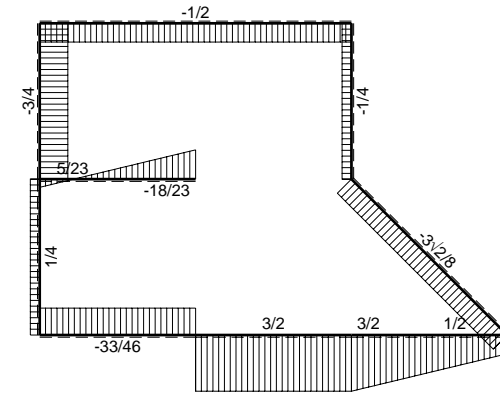
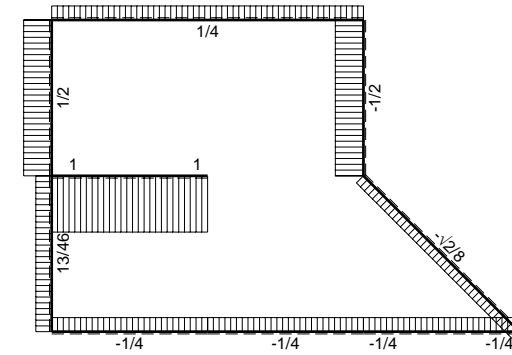
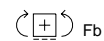
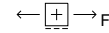
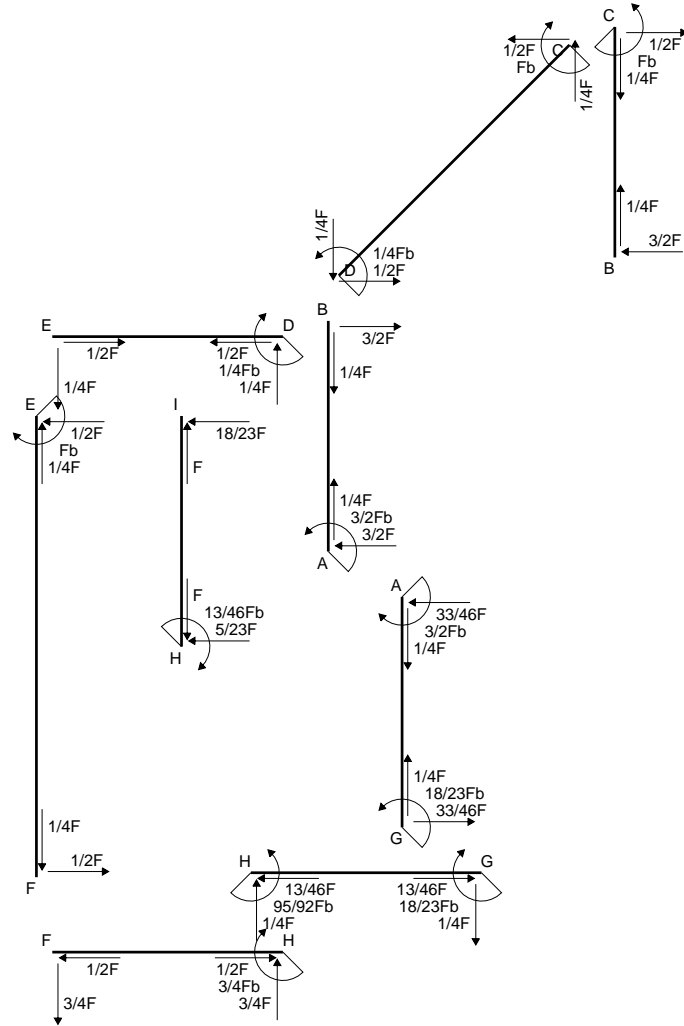
$$= (-3/2 b) Fb^2 1/EJ - 1 (-1) (-1) Fb^3/EJ = -5/2 Fb^3/EJ$$

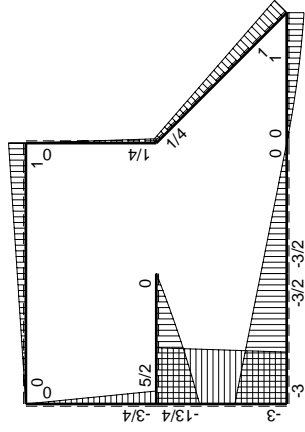
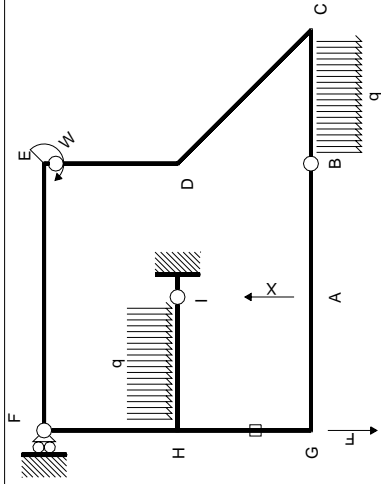
$$L_{GH}^{x_0} = \int_0^b (-3/2) Fb^2 1/EJ dx - 1 (-1) (-1) Fb^3/EJ = \left[-3/2 x \right]_0^b Fb^2 1/EJ - 1 (-1) (-1) Fb^3/EJ$$

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



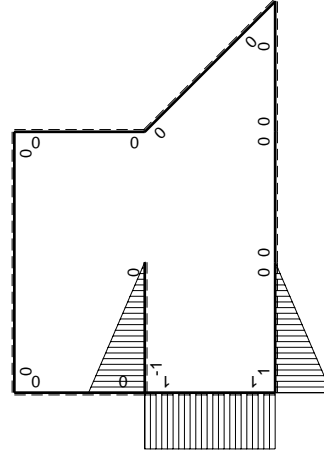
- A = 111.8 mm²
- J_u = 42133. mm⁴
- J_v = 2333. mm⁴
- J_t = 85.65 mm⁴
- y_o = 13.74 mm
- y_g = 28.04 mm
- N = 235. N
- T_y = 470. N
- M_x = 357200. Nmm
- x_m = 12. mm
- v_m = -28.04 mm
- σ_m = N/A-Mv/J_u = 239.8 N/mm²
- y_c = 3. mm
- u_c = -12. mm
- v_c = -25.04 mm
- σ_c = N/A-Mv/J_u = 239.8 N/mm²
- τ_c = TS_t/tJ_u = 6.756 N/mm²
- τ_g = TS_t/tJ_u = 6.756 N/mm²
- t_c = 470. mm
- σ_o = √σ²+3τ² = 240.1 N/mm²





Schema di calcolo iperstatico

M_0 , flessione da carichi assegnati



M_1 , flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=V_A$

→	$M_x(x)$	$M_o(x)$	$M_x M_o$	$M_x M_x$	$\int M_x M_o / EJ dx$	$\int X M_x M_x / EJ dx$
AB b	0	$-3/2Fb+3/2Fx$	0	0	0	0
BA b	0	$3/2Fx$	0	0	0	0
BC b	0	$3/2Fx-1/2qx^2$	0	0	0	0
CB b	0	$-Fb+1/2Fx+1/2qx^2$	0	0	0	0
CD $\sqrt{2}b$	0	$Fb-3\sqrt{2}/8Fx$	0	0	0	0
DE b	0	$1/4Fb-1/4Fx$	0	0	0	0
ED b	0	$-1/4Fx$	0	0	0	0
EF 2b	0	$Fb-1/2Fx$	0	0	0	0
FE 2b	0	$-1/2Fx$	0	0	0	0
GA b	b-x	$-3Fb+3/2Fx$	$-3Fb^2+9/2Fbx-3/2Fx^2$	$b^2-2bx+x^2$	$-5/4Fb^3/EJ$	$1/3Xb^3/EJ$
AG b	-x	$3/2Fb+3/2Fx$	$-3/2Fbx-3/2Fx^2$	x^2		
FH b	0	$-3/4Fx$	0	0	0	0
HF b	0	$3/4Fb-3/4Fx$	0	0		
HI b	-b+x	$5/2Fb-2Fx-1/2qx^2$	$-5/2Fb^2+9/2Fbx-3/2Fx^2-1/2qx^3$	$b^2-2bx+x^2$	$-7/8Fb^3/EJ$	$1/3Xb^3/EJ$
IH b	x	$-3Fx+1/2qx^2$	$-3Fx^2+1/2qx^3$	x^2		
HG b	b	$-13/4Fb+1/4Fx$	$-13/4Fb^2+1/4Fbx$	b^2	$-25/8Fb^3/EJ$	Xb^3/EJ
GH b	-b	$3Fb+1/4Fx$	$-3Fb^2-1/4Fbx$	b^2		
HG	elongazione asta $N_{1HG} \epsilon_{HG} L_{HG}$				Fb^3/EJ	
A	molla nodo $-V_{1A}(V_{oA}+XV_{1A})/k_A$					$1/4Xb^3/EJ$
	totali				$-17/4Fb^3/EJ$	$23/12Xb^3/EJ$
	iperstatica $X=V_A$				$51/23F$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (-3b + 9/4 b - 1/2 b) Fb^2 1/EJ = -5/4 Fb^3/EJ$$

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

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

$$L_{HI}^{xo} = \int_0^b (-5/2 + 9/2 x/b - 3/2 x^2/b^2 - 1/2 x^3/b^3) Fb^2 1/EJ dx$$

$$= \left[-5/2 x + 9/4 x^2/b - 1/2 x^3/b^2 - 1/8 x^4/b^3 \right]_0^b Fb^2 1/EJ$$

$$= (-5/2 b + 9/4 b - 1/2 b - 1/8 b) Fb^2 1/EJ = -7/8 Fb^3/EJ$$

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

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

$$L_{HG}^{xo} = \int_0^b (-13/4 + 1/4 x/b) Fb^2 1/EJ dx + 1 \quad (-1) \quad (-1) \quad Fb^3/EJ$$

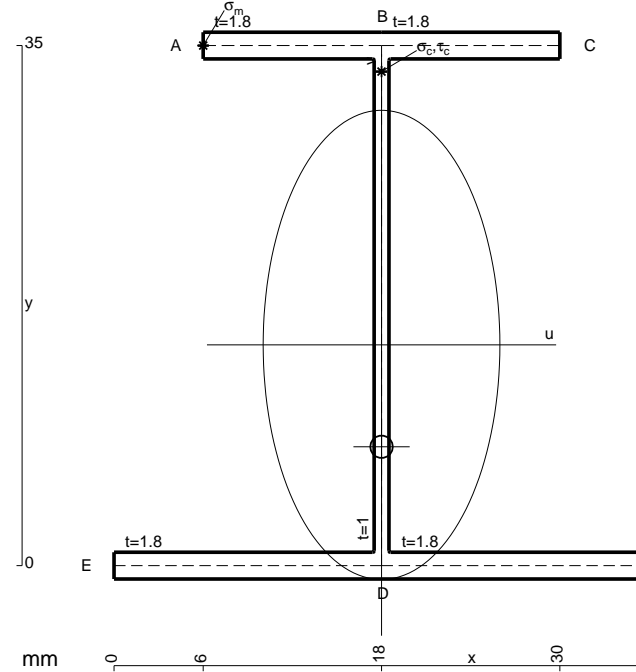
$$= \left[-13/4 x + 1/8 x^2/b \right]_0^b Fb^2 1/EJ + 1 \quad (-1) \quad (-1) \quad Fb^3/EJ$$

$$= (-13/4 b + 1/8 b) Fb^2 1/EJ + 1 \quad (-1) \quad (-1) \quad Fb^3/EJ = -17/8 Fb^3/EJ$$

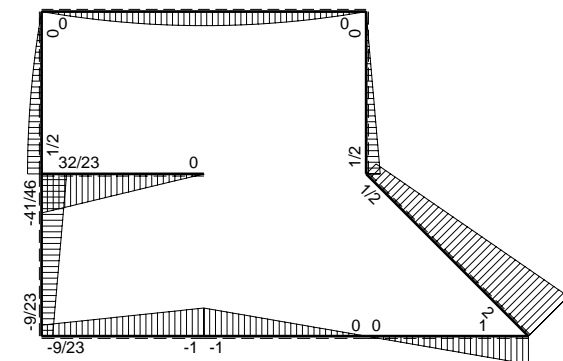
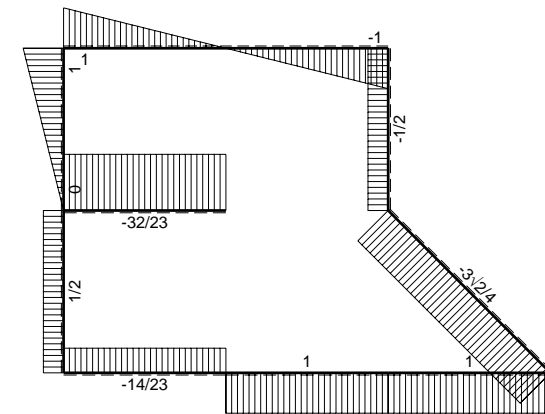
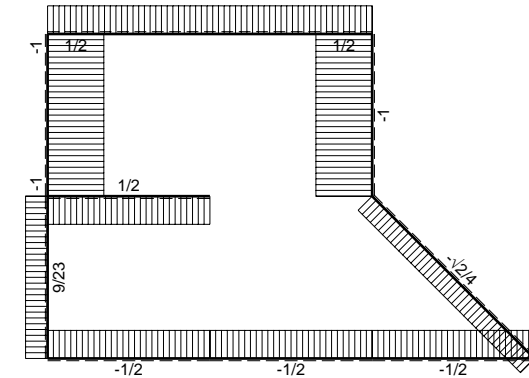
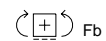
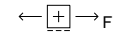
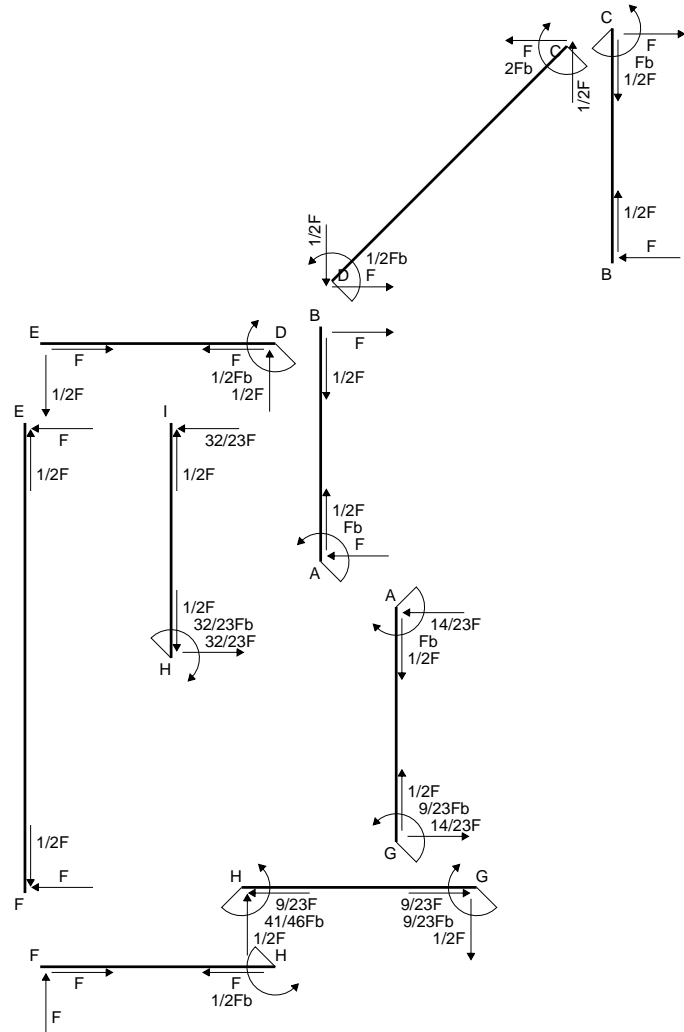
$$L_{GH}^{xo} = \int_0^b (-3 - 1/4 x/b) Fb^2 1/EJ dx + 1 \quad (-1) \quad (-1) \quad Fb^3/EJ$$

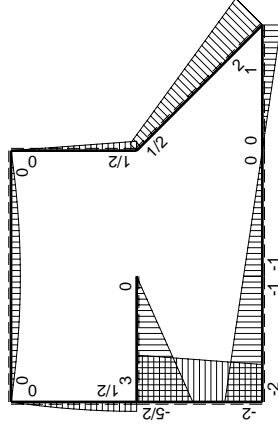
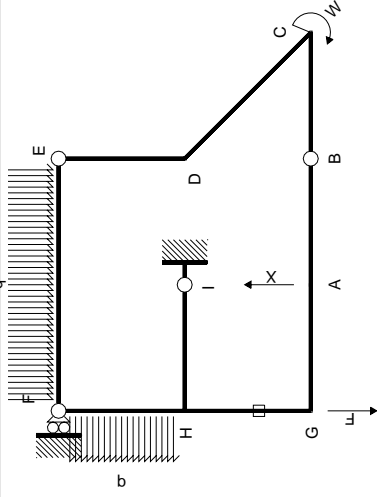
$$= \left[-3x - 1/8 x^2/b \right]_0^b Fb^2 1/EJ + 1 \quad (-1) \quad (-1) \quad Fb^3/EJ$$

$$= (-3b - 1/8 b) Fb^2 1/EJ + 1 \quad (-1) \quad (-1) \quad Fb^3/EJ = -17/8 Fb^3/EJ$$



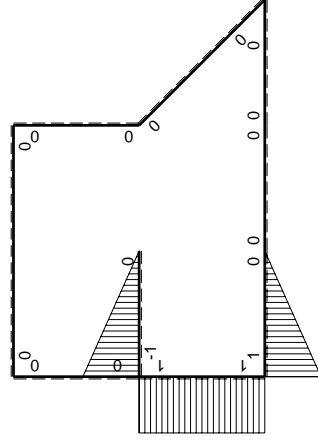
- A = 143. mm²
- J_u = 35649. mm⁴
- J_v = 9072. mm⁴
- J_t = 128.3 mm⁴
- y_o = -6.857 mm
- y_g = 14.86 mm
- N = -127.5 N
- T_y = 765. N
- M_x = -367200. Nmm
- x_m = 6. mm
- y_m = 35. mm
- u_m = -12. mm
- v_m = 20.14 mm
- σ_m = N/A-Mv/J_u = 206.6 N/mm²
- x_c = 18. mm
- y_c = 35. mm
- v_c = 20.14 mm
- σ_c = N/A-Mv/J_u = 206.6 N/mm²
- τ_c = TS'/tJ_u = 18.67 N/mm²
- τ_g = TS'/tJ_u = 18.67 N/mm²
- t_c = 510. mm
- σ_o = √σ²+3τ² = 209.1 N/mm²





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica $X=1$

Quadro contributi PLV per iperstatica $X=V_A$

\rightarrow	$M_x(x)$	$M_0(x)$	$M_x M_0$	$M_x M_x$	$\int M_x M_0 / EJ dx$	$\int X M_x M_x / EJ dx$
AB b	0	-Fb+Fx	0	0	0	0
BA b	0	Fx	0	0	0	0
BC b	0	Fx	0	0	0	0
CB b	0	-Fb+Fx	0	0	0	0
CD $\sqrt{2}b$	0	$2Fb-3\sqrt{2}/4Fx$	0	0	0	0
DE b	0	$1/2Fb-1/2Fx$	0	0	0	0
ED b	0	-1/2Fx	0	0	0	0
EF 2b	0	-Fx+1/2qx ²	0	0	0	0
FE 2b	0	Fx-1/2qx ²	0	0	0	0
GA b	b-x	-2Fb+Fx	$-2Fb^2+3Fbx-Fx^2$	$b^2-2bx+x^2$	$-5/6Fb^3/EJ$	$1/3Xb^3/EJ$
AG b	-x	Fb+Fx	$-Fbx-Fx^2$	x^2	$-Fb^3/EJ$	$1/3Xb^3/EJ$
FH b	0	Fx-1/2qx ²	0	0	0	0
HF b	0	-1/2Fb+1/2qx ²	0	0	0	0
HI b	-b+x	3Fb-3Fx	$-3Fb^2+6Fbx-3Fx^2$	$b^2-2bx+x^2$	$-Fb^3/EJ$	$1/3Xb^3/EJ$
IH b	x	-3Fx	$-3Fx^2$	x^2	$-9/4Fb^3/EJ$	Xb^3/EJ
HG b	b	-5/2Fb+1/2Fx	$-5/2Fb^2+1/2Fbx$	b^2	$-9/4Fb^3/EJ$	Xb^3/EJ
GH b	-b	2Fb+1/2Fx	$-2Fb^2-1/2Fbx$	b^2	$-9/4Fb^3/EJ$	Xb^3/EJ
HG	elongazione asta $N_{1,HG}^{\pm HG}$				Fb^3/EJ	
A	molla nodo $-V_{1A}(V_{0A}+XV_{1A})/k_A$					$1/4Xb^3/EJ$
	totali				$-37/12Fb^3/EJ$	$23/12Xb^3/EJ$
	iperstatica $X=V_A$				$37/23F$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

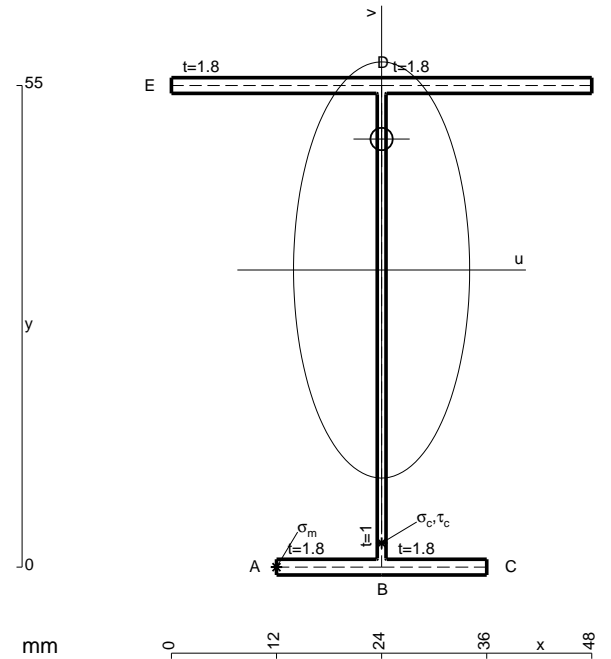
$$= [-5/2 x + 1/4 x^2/b]_0^b Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ$$

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

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

$$= [-2x - 1/4 x^2/b]_0^b Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ$$

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



$$A = 184.6 \text{ mm}^2$$

$$J_u = 104229. \text{ mm}^4$$

$$J_v = 18662. \text{ mm}^4$$

$$J_t = 158.3 \text{ mm}^4$$

$$y_o = 14.95 \text{ mm}$$

$$y_g = 33.94 \text{ mm}$$

$$N = -222.7 \text{ N}$$

$$T_y = -668.2 \text{ N}$$

$$M_x = 642600. \text{ Nmm}$$

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

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

$$v_m = -33.94 \text{ mm}$$

$$\sigma_m = N/A - Mv/J_u = 208. \text{ N/mm}^2$$

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

$$v_c = -33.94 \text{ mm}$$

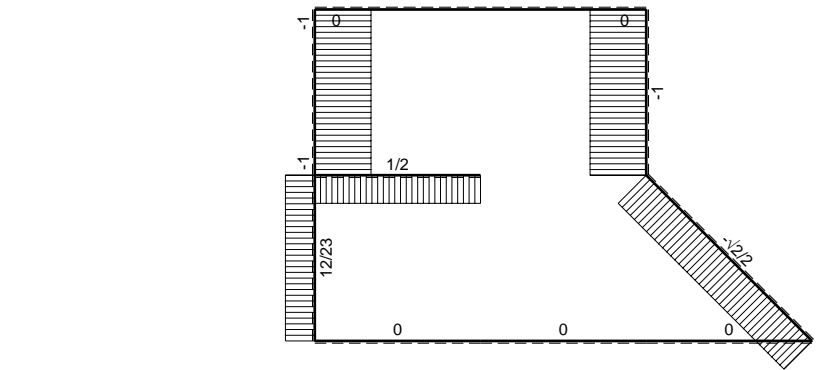
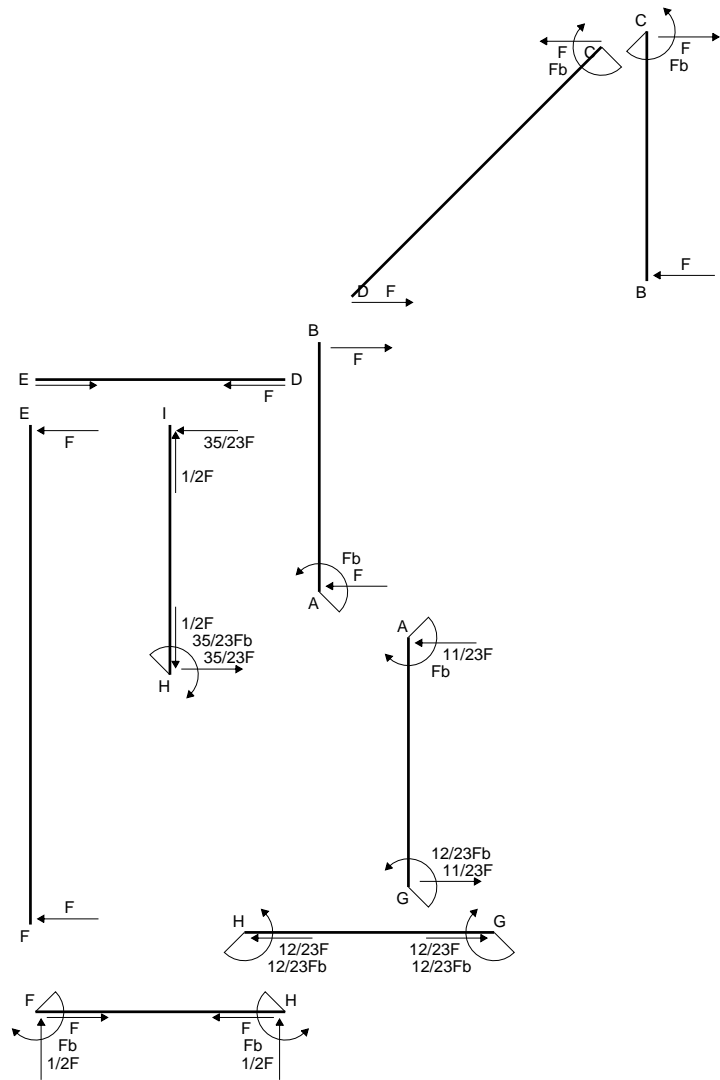
$$\sigma_c = N/A - Mv/J_u = 208. \text{ N/mm}^2$$

$$\tau_c = TS'/tJ_u = 9.399 \text{ N/mm}^2$$

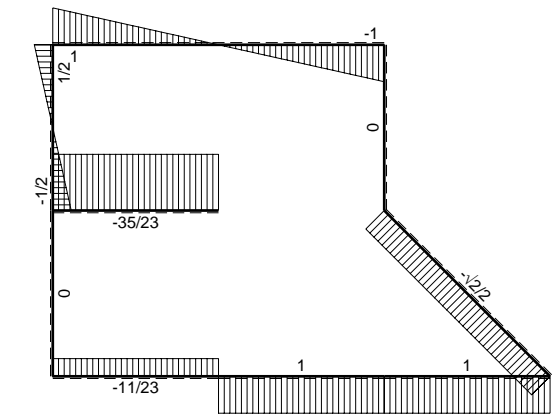
$$\tau_g = TS'/tJ_u = 9.399 \text{ N/mm}^2$$

$$t_c = 630. \text{ mm}$$

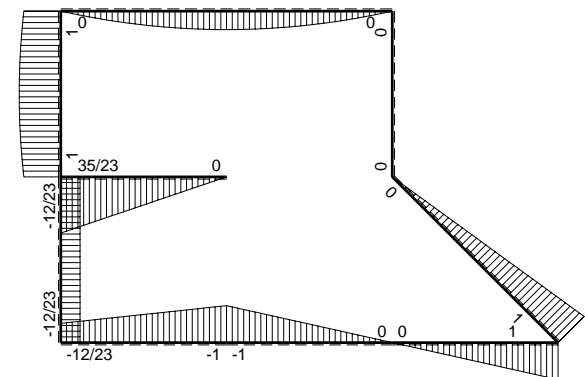
$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 208.7 \text{ N/mm}^2$$



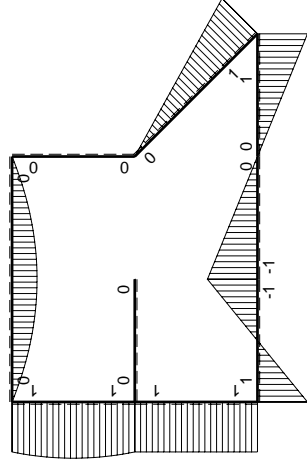
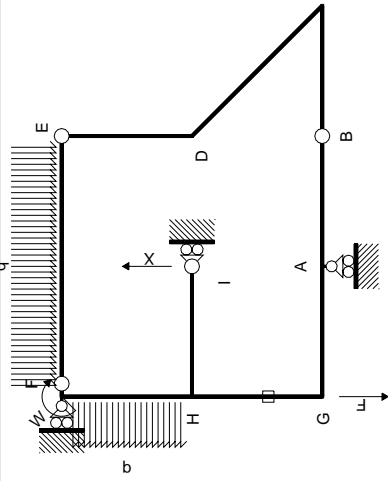
$\leftarrow \oplus \rightarrow F$



$\uparrow \oplus \downarrow F_b$

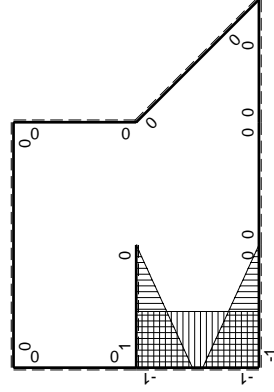


$\leftarrow \oplus \rightarrow F_b$



Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contribuiti PLV per iperstatica $X=V_1$

\rightarrow	$M_x(x)$	$M_0(x)$	$M_x M_0$	$M_x M_x$	$\int M_x M_0 / EJ dx$	$\int M_x M_x / EJ dx$
AB b	0	-Fb+Fx	0	0	0	0
BA b	0	Fx	0	0	0	0
BC b	0	Fx	0	0	0	0
CB b	0	-Fb+Fx	0	0	0	0
CD $\sqrt{2}b$	0	$Fb-\sqrt{2}/2Fx$	0	0	0	0
DE b	0	0	0	0	0	0
ED b	0	0	0	0	0	0
EF 2b	0	$-Fx+1/2qx^2$	0	0	0	0
FE 2b	0	$Fx-1/2qx^2$	0	0	0	0
GA b	-b+x	Fb-2Fx	$-Fb^2+3Fbx-2Fx^2$	$b^2-2bx+x^2$	$-1/6Fb^3/EJ$	$1/3Xb^3/EJ$
AG b	x	Fb-2Fx	$Fbx-2Fx^2$	x^2	0	0
FH b	0	$Fb+1/2Fx-1/2qx^2$	0	0	0	0
HF b	0	$-Fb-1/2Fx+1/2qx^2$	0	0	0	0
HI b	b-x	0	0	$b^2-2bx+x^2$	0	$1/3Xb^3/EJ$
IH b	-x	0	0	x^2	0	0
HG b	-b	Fb	$-Fb^2$	b^2	$-Fb^3/EJ$	Xb^3/EJ
GH b	b	-Fb	$-Fb^2$	b^2	$-Fb^3/EJ$	0
HG	elongazione asta $N_{1HG^{\pm HG}} \pm HG$				$-Fb^3/EJ$	
A	molla nodo $-V_{1A}(V_{0A} + XV_{1A})/k_A$				$-3/4Fb^3/EJ$	$1/4Xb^3/EJ$
	totali				$-35/12Fb^3/EJ$	$23/12Xb^3/EJ$
	iperstatica $X=V_1$				35/23F	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

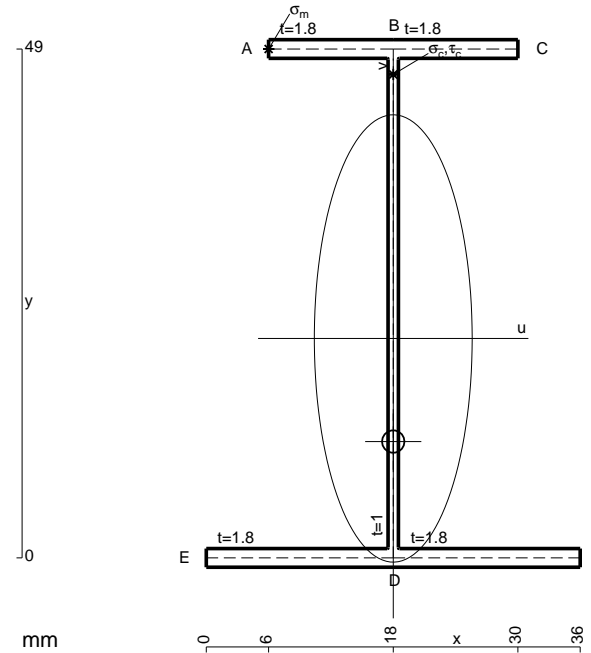
$$= (1/2 b - 2/3 b) Fb^2 1/EJ = -1/6 Fb^3/EJ$$

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

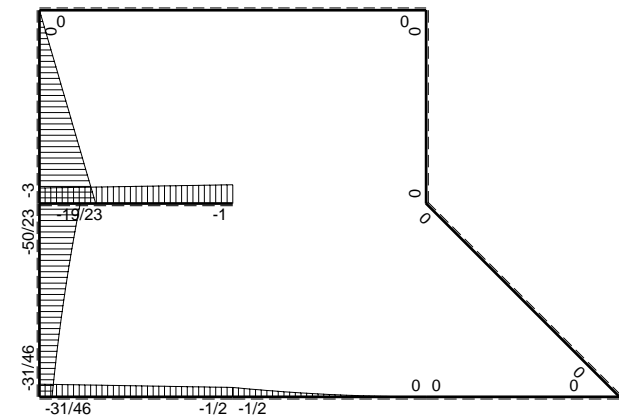
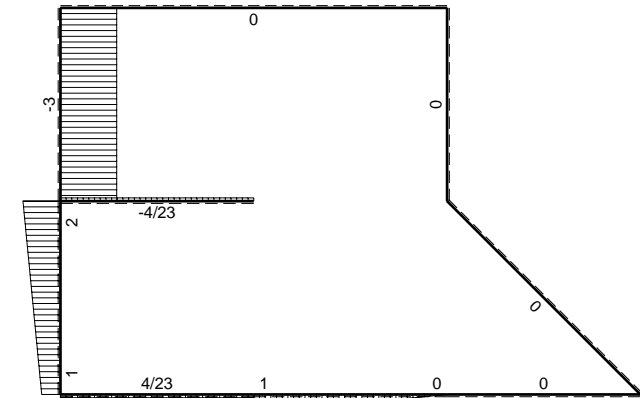
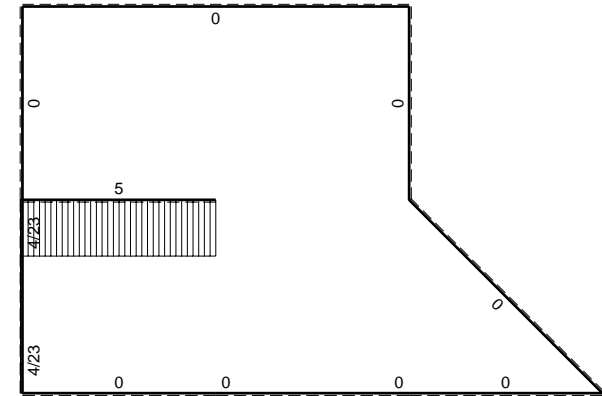
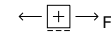
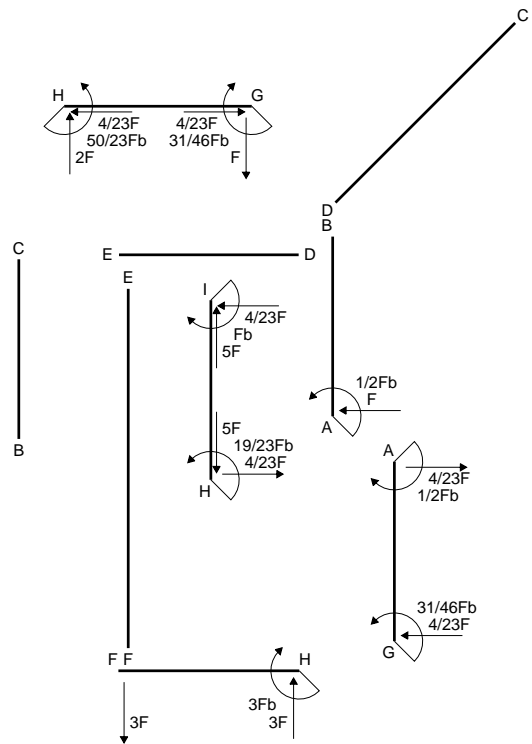
$$= (-b) Fb^2 1/EJ - 1 \cdot (-1) \cdot (-1) Fb^3/EJ = -2 Fb^3/EJ$$

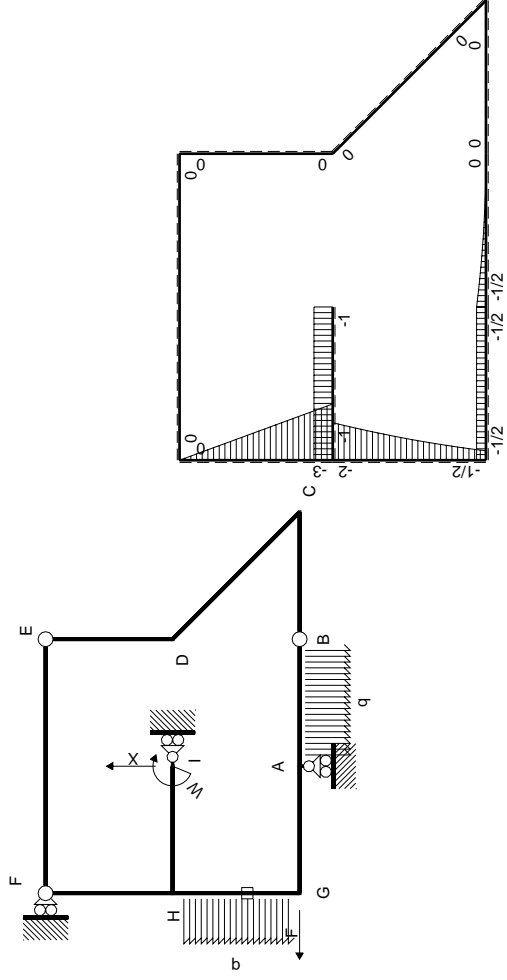
$$L_{GH}^{xo} = \int_0^b (-1) Fb^2 1/EJ dx - 1 \cdot (-1) \cdot (-1) Fb^3/EJ = \left[-x \right]_0^b Fb^2 1/EJ - 1 \cdot (-1) \cdot (-1) Fb^3/EJ$$

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



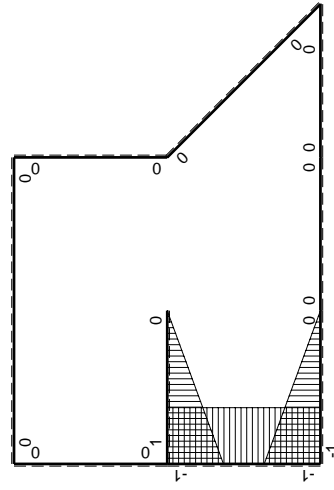
- A = 157. mm²
- J_u = 72847. mm⁴
- J_v = 9072. mm⁴
- J_i = 133. mm⁴
- y_o = -9.929 mm
- y_g = 21.13 mm
- T_y = 800. N
- M_x = -568000. Nmm
- x_m = 6. mm
- y_m = 49. mm
- u_m = -12. mm
- v_m = 27.87 mm
- σ_m = -M_v/J_u = 217.3 N/mm²
- x_c = 18. mm
- y_c = 49. mm
- v_c = 27.87 mm
- σ_c = -M_v/J_u = 217.3 N/mm²
- τ_c = T_S/t_{J_u} = 13.22 N/mm²
- τ_g = T_S/t_{J_u} = 13.22 N/mm²
- t_c = 800. mm
- σ_o = √(σ²+3τ²) = 218.5 N/mm²





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contribuiti PLV per iperstatica $X=V_1$

\rightarrow	$M_x(x)$	$M_0(x)$	$M_x M_0$	$M_x M_x$	$\int M_x M_0 / EJ dx$	$\int X M_x M_x / EJ dx$
AB b	0	$-1/2Fb+Fx-1/2qx^2$	0	0	0	0
BA b	0	$1/2qx^2$	0	0	0	0
BC b	0	0	0	0	0	0
CB b	0	0	0	0	0	0
CD $\sqrt{2}b$	0	0	0	0	0	0
DE b	0	0	0	0	0	0
ED b	0	0	0	0	0	0
EF 2b	0	0	0	0	0	0
FE 2b	0	0	0	0	0	0
GA b	$-b+x$	$-1/2Fb$	$1/2Fb^2-1/2Fbx$	$b^2-2bx+x^2$	$1/4Fb^3/EJ$	$1/3Xb^3/EJ$
AG b	x	$1/2Fb$	$1/2Fbx$	x^2	$1/4Fb^3/EJ$	$1/3Xb^3/EJ$
FH b	0	$-3Fx$	0	0	0	0
HF b	0	$3Fb-3Fx$	0	0	0	0
HI b	$b-x$	$-Fb$	$-Fb^2+Fbx$	$b^2-2bx+x^2$	$-1/2Fb^3/EJ$	$1/3Xb^3/EJ$
IH b	$-x$	Fb	$-Fbx$	x^2	$-1/2Fb^3/EJ$	$1/3Xb^3/EJ$
HG b	$-b$	$-2Fb+2Fx-1/2qx^2$	$2Fb^2-2Fbx+1/2Fx^2$	b^2	$7/6Fb^3/EJ$	Xb^3/EJ
GH b	b	$1/2Fb+Fx+1/2qx^2$	$1/2Fb^2+Fbx+1/2Fx^2$	b^2	$7/6Fb^3/EJ$	Xb^3/EJ
HG	elongazione asta $N_{1HG^{\pm HG}} \pm HG$					
A	molla nodo $-V_{1A}(V_{0A} + XV_{1A})/k_A$					
	totali					
	iperstatica $X=V_1$					
	4/23F					

Sviluppi di calcolo iperstatica

M_x flessione da iperstatica X=1

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

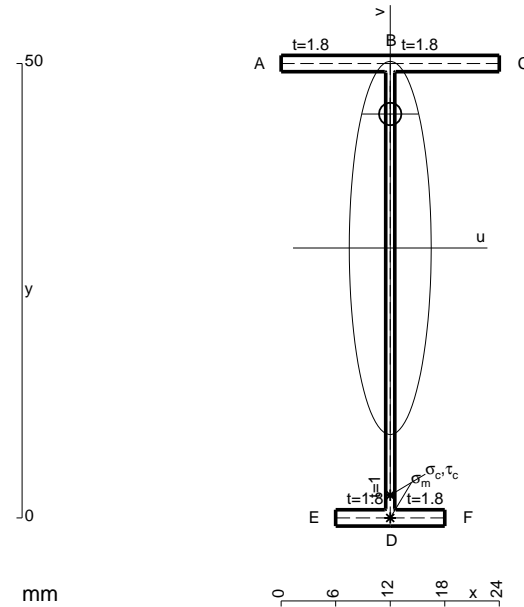
$$= \left[2x - x^2/b + 1/6 x^3/b^2 \right]_0^b Fb^2 1/EJ - 1 \cdot (-1) \cdot (-1) Fb^3/EJ$$

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

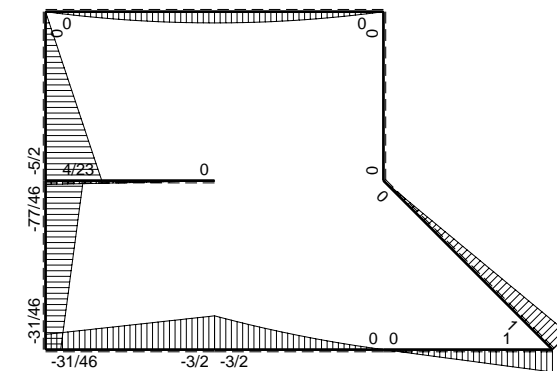
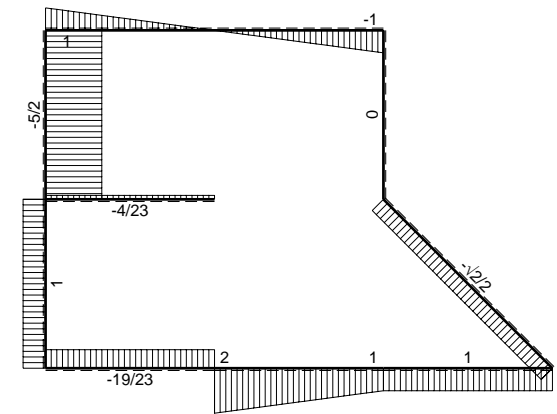
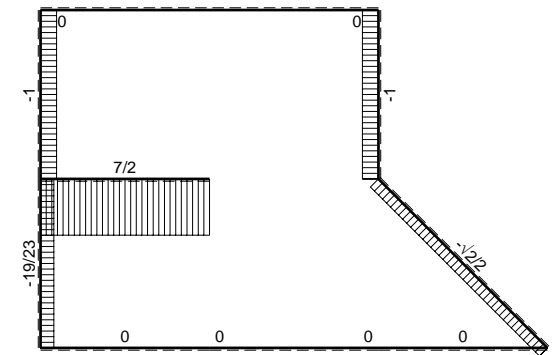
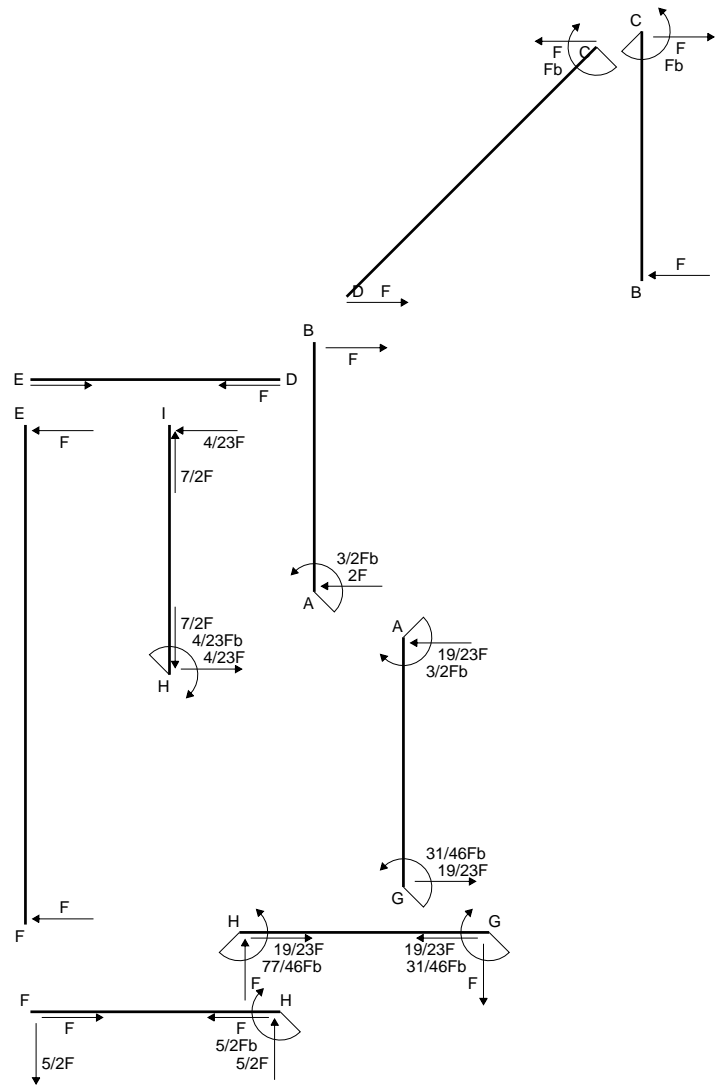
$$L_{GH}^{xo} = \int_0^b (1/2 + x/b + 1/2 x^2/b^2) Fb^2 1/EJ dx - 1 \cdot (-1) \cdot (-1) Fb^3/EJ$$

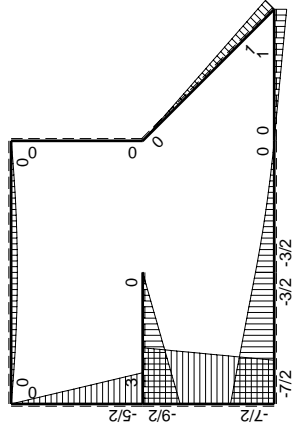
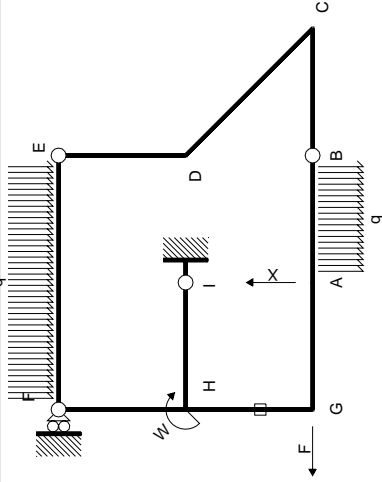
$$= \left[1/2 x + 1/2 x^2/b + 1/6 x^3/b^2 \right]_0^b Fb^2 1/EJ - 1 \cdot (-1) \cdot (-1) Fb^3/EJ$$

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



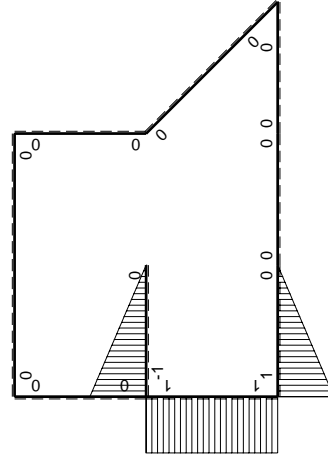
- A = 114.8 mm²
- J_u = 48377. mm⁴
- J_v = 2333. mm⁴
- J_t = 86.65 mm⁴
- y_o = 14.74 mm
- y_g = 29.7 mm
- T_y = -720. N
- M_x = -338400. Nmm
- x_m = 12. mm
- v_m = -29.7 mm
- σ_m = -M_v/J_u = -207.8 N/mm²
- y_c = 3. mm
- u_c = -12. mm
- v_c = -26.7 mm
- σ_c = -M_v/J_v = -207.8 N/mm²
- τ_c = T_S/tJ_u = 9.549 N/mm²
- τ_g = T_S/tJ_v = 9.549 N/mm²
- t_c = 240. mm
- σ_o = √σ²+3τ² = 208.4 N/mm²





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica X=V_A

→	$M_x(x)$	$M_0(x)$	$M_x M_0$	$M_x M_x$	$\int M_x M_0 / EJ dx$	$\int M_x M_x / EJ dx$
AB b	0	$-3/2Fb+2Fx-1/2qx^2$	0	0	0	0
BA b	0	$Fx+1/2qx^2$	0	0	0	0
BC b	0	Fx	0	0	0	0
CB b	0	$-Fb+Fx$	0	0	0	0
CD $\sqrt{2}b$	0	$Fb-\sqrt{2}/2Fx$	0	0	0	0
DE b	0	0	0	0	0	0
ED b	0	0	0	0	0	0
EF 2b	0	$-Fx+1/2qx^2$	0	0	0	0
FE 2b	0	$Fx-1/2qx^2$	0	0	0	0
GA b	b-x	$-7/2Fb+2Fx$	$-7/2Fb^2+11/2Fbx-2Fx^2$	$b^2-2bx+x^2$	$-17/12Fb^3/EJ$	$1/3Xb^3/EJ$
AG b	-x	$3/2Fb+2Fx$	$-3/2Fbx-2Fx^2$	x^2		
FH b	0	$-5/2Fx$	0	0	0	0
HF b	0	$5/2Fb-5/2Fx$	0	0	0	0
HI b	-b+x	$3Fb-3Fx$	$-3Fb^2+6Fbx-3Fx^2$	$b^2-2bx+x^2$	$-Fb^3/EJ$	$1/3Xb^3/EJ$
IH b	x	$-3Fx$	$-3Fx^2$	x^2		
HG b	b	$-9/2Fb+Fx$	$-9/2Fb^2+Fbx$	b^2	$-4Fb^3/EJ$	Xb^3/EJ
GH b	-b	$7/2Fb+Fx$	$-7/2Fb^2-Fbx$	b^2		
HG	elongazione asta $N_{1HG^5HG^1HG}$					
A	molla nodo $-V_{1A}(V_{0A}+XV_{1A})/k_A$					
	totali					
	iperstatica X=V _A					
					$65/23F$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{GA}^{xo} = \int_0^b (-7/2 + 11/2 x/b - 2x^2/b^2) Fb^2 1/EJ dx = [-7/2 x + 11/4 x^2/b - 2/3 x^3/b^2]_0^b Fb^2 1/EJ$$

$$= (-7/2 b + 11/4 b - 2/3 b) Fb^2 1/EJ = -17/12 Fb^3/EJ$$

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

$$= (-3/4 b - 2/3 b) Fb^2 1/EJ = -17/12 Fb^3/EJ$$

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

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

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

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

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

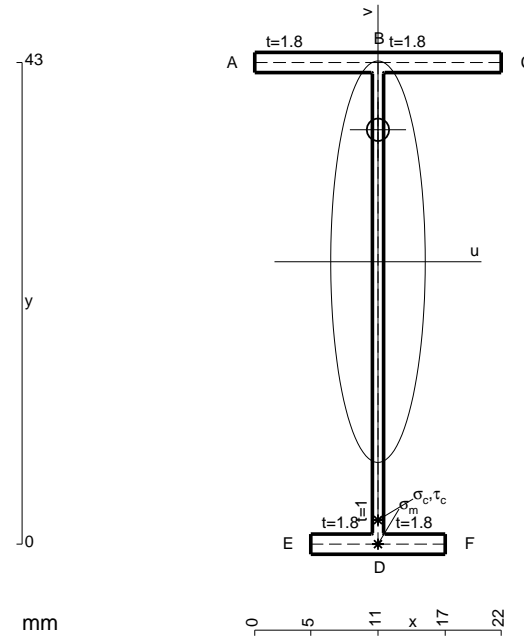
$$= [-9/2 x + 1/2 x^2/b]_0^b Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ$$

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

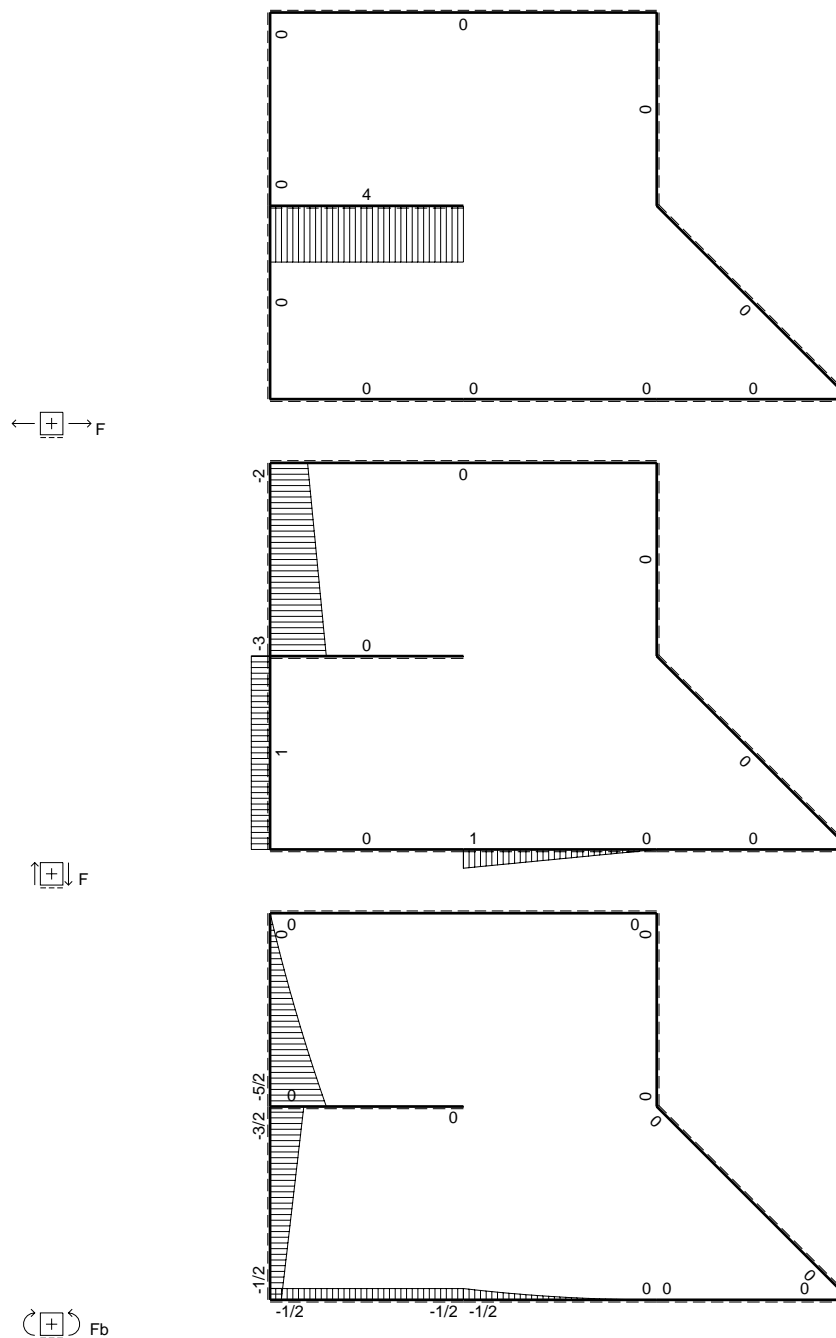
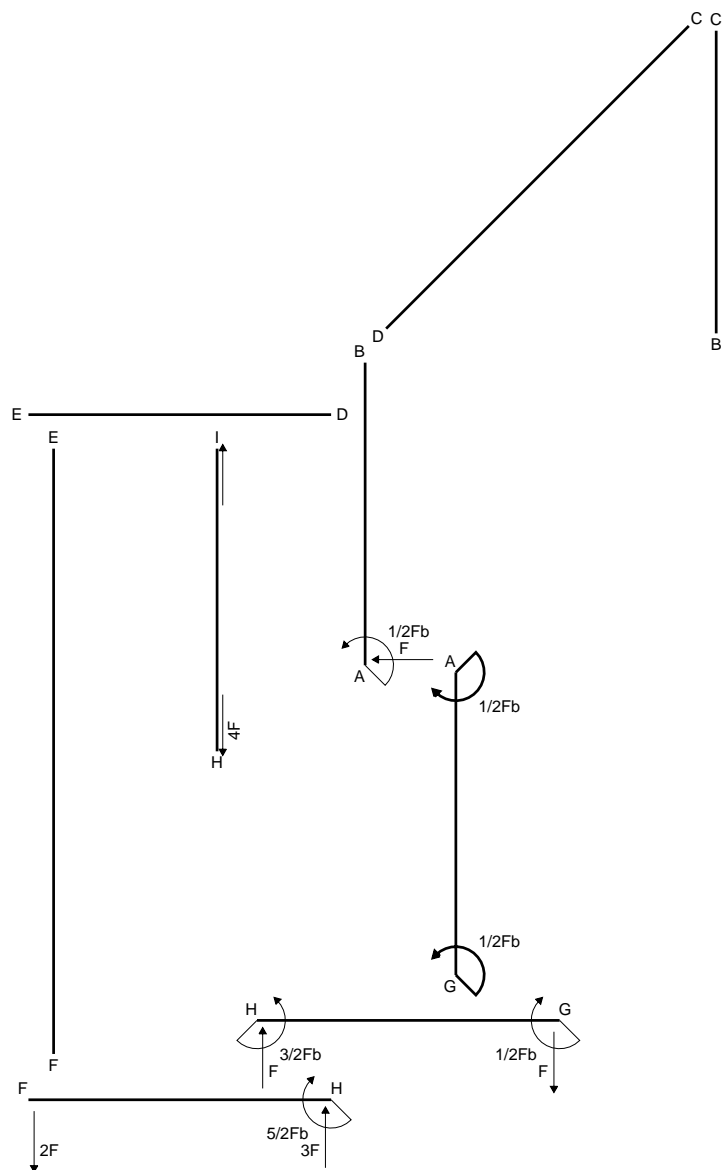
$$L_{GH}^{xo} = \int_0^b (-7/2 - x/b) Fb^2 1/EJ dx + 1 (-1) (-1) Fb^3/EJ$$

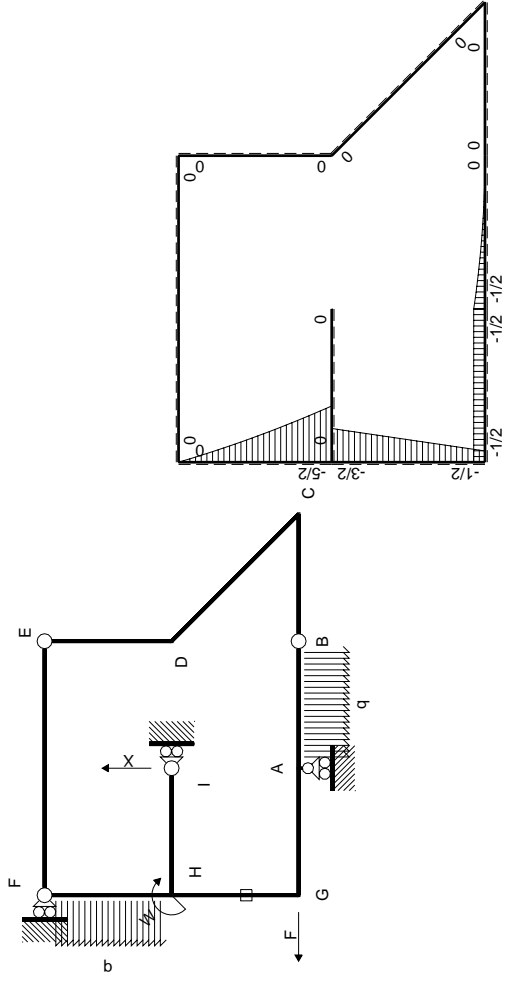
$$= [-7/2 x - 1/2 x^2/b]_0^b Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ$$

$$= (-7/2 b - 1/2 b) Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ = -3 Fb^3/EJ$$



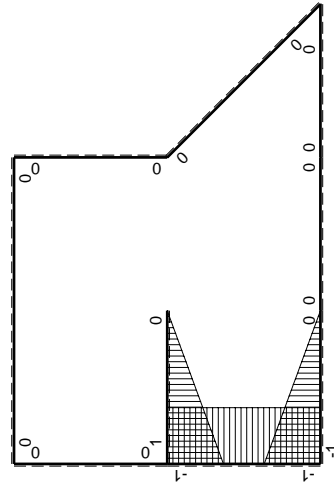
- A = 104.2 mm²
- J_u = 33478. mm⁴
- J_v = 1856. mm⁴
- J_t = 80.43 mm⁴
- y_o = 11.78 mm
- y_g = 25.21 mm
- N = -240. N
- T_y = -600. N
- M_x = -306000. Nmm
- x_m = 11. mm
- v_m = -25.21 mm
- σ_m = N/A-Mv/J_u = -232.8 N/mm²
- y_c = 3. mm
- u_c = -11. mm
- v_c = -22.21 mm
- σ_c = N/A-Mv/J_u = -232.8 N/mm²
- τ_c = TS/tJ_u = 9.761 N/mm²
- τ_g = TS/tJ_u = 9.761 N/mm²
- t_c = 240. mm
- σ_o = √σ²+3τ² = 233.4 N/mm²





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=V_1$

\rightarrow	$M_x(x)$	$M_0(x)$	$M_x M_0$	$M_x M_x$	$\int M_x M_0 / EJ dx$	$\int X M_x M_x / EJ dx$	
AB b	0	$-1/2Fb + Fx - 1/2qx^2$	0	0	0	0	
BA b	0	$1/2qx^2$	0	0	0	0	
BC b	0	0	0	0	0	0	
CB b	0	0	0	0	0	0	
CD $\sqrt{2}b$	0	0	0	0	0	0	
DE b	0	0	0	0	0	0	
ED b	0	0	0	0	0	0	
EF 2b	0	0	0	0	0	0	
FE 2b	0	0	0	0	0	0	
GA b	$-b+x$	$-1/2Fb$	$1/2Fb^2 - 1/2Fbx$	$b^2 - 2bx + x^2$	$1/4Fb^3/EJ$	$1/3Xb^3/EJ$	
AG b	x	$1/2Fb$	$1/2Fbx$	x^2			
FH b	0	$-2Fx - 1/2qx^2$	0	0	0	0	
HF b	0	$5/2Fb - 3Fx + 1/2qx^2$	0	0	0	0	
HI b	b-x	0	0	$b^2 - 2bx + x^2$	0	$1/3Xb^3/EJ$	
IH b	-x	0	0	x^2	0	Xb^3/EJ	
HG b	-b	$-3/2Fb + Fx$	$3/2Fb^2 - Fbx$	b^2	Fb^3/EJ	Xb^3/EJ	
GH b	b	$1/2Fb + Fx$	$1/2Fb^2 + Fbx$	b^2			
HG	elongazione asta $N_{1HG} = N_{HG} - HG$						
A	molla nodo $-V_{1A}(V_{0A} + XV_{1A})/k_A$						
	totali						
	iperstatica $X=V_1$						

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

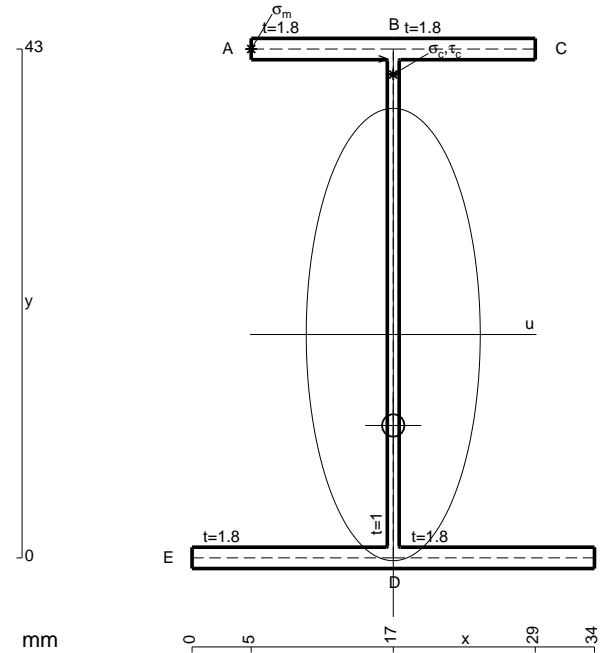
$$= \left[3/2 x - 1/2 x^2/b \right]_0^b Fb^2 1/EJ - 1 (-1) (-1) Fb^3/EJ$$

$$= (3/2 b - 1/2 b) Fb^2 1/EJ - 1 (-1) (-1) Fb^3/EJ = 0$$

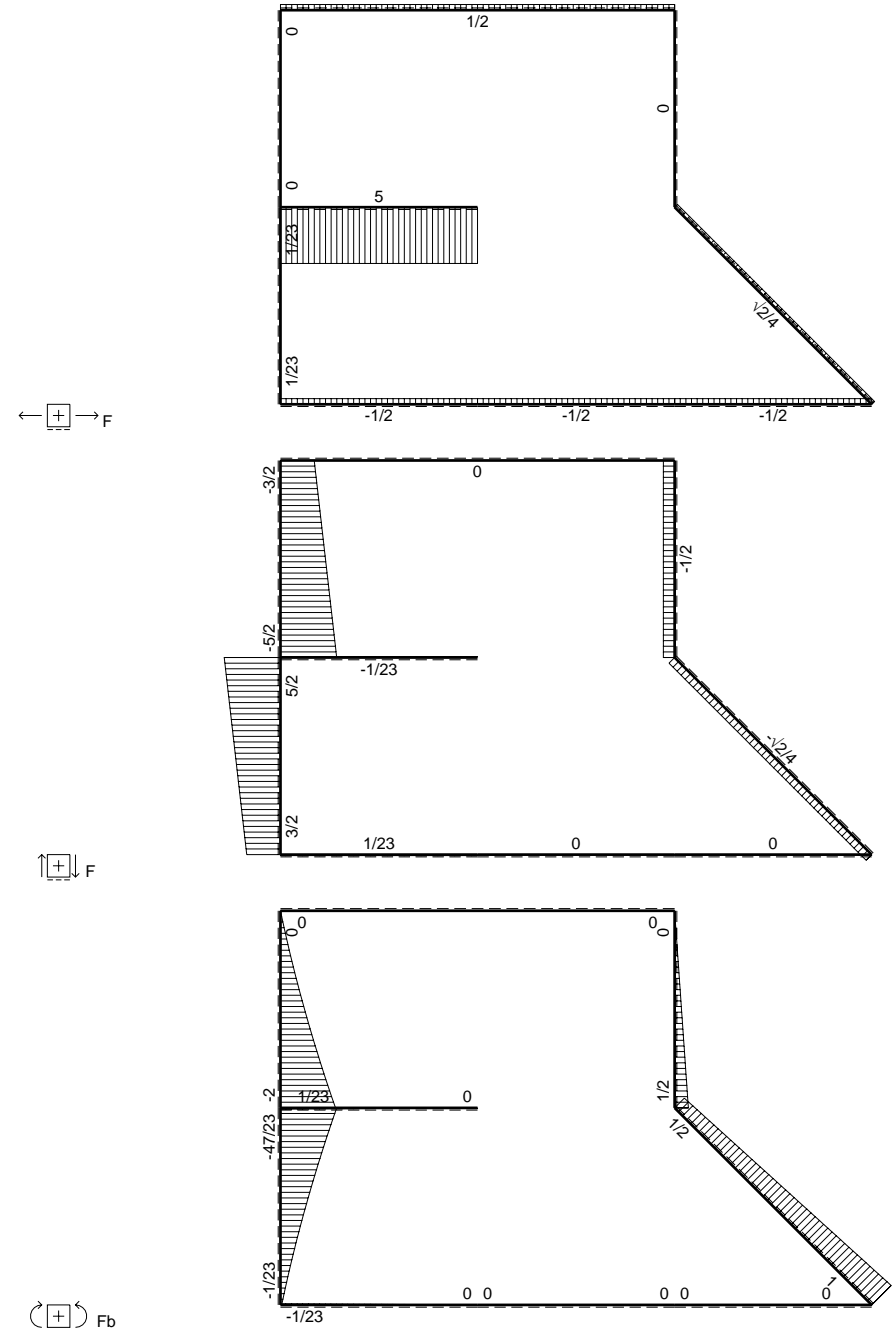
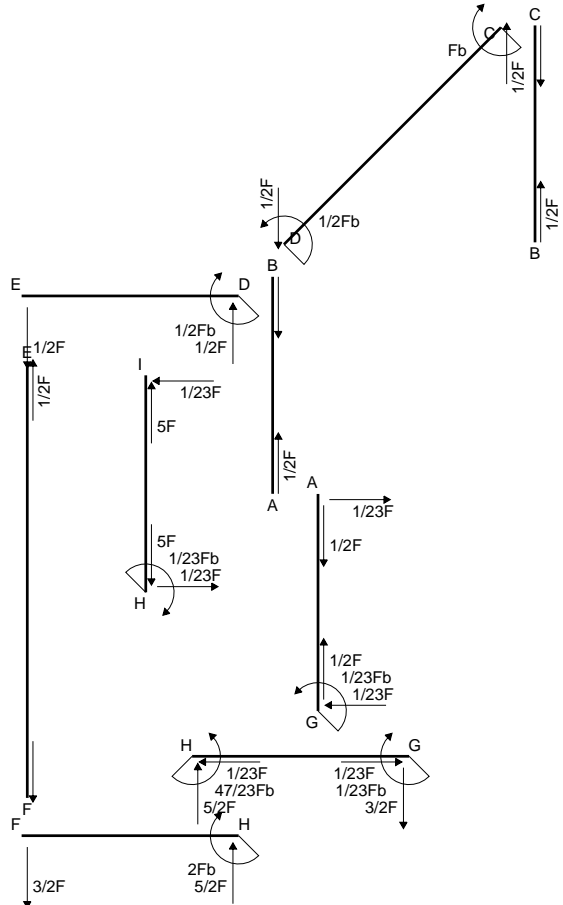
$$L_{GH}^{xo} = \int_0^b (1/2 + x/b) Fb^2 1/EJ dx - 1 (-1) (-1) Fb^3/EJ$$

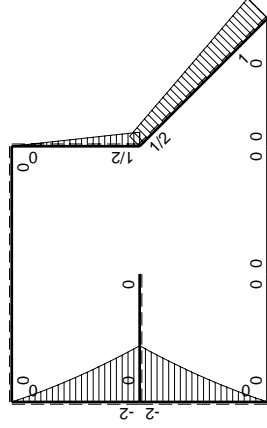
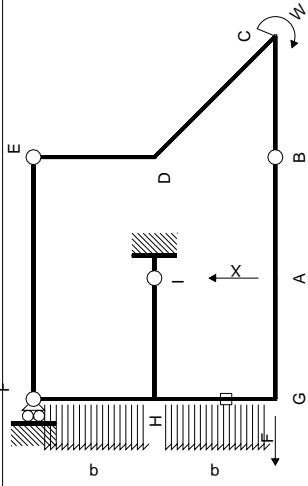
$$= \left[1/2 x + 1/2 x^2/b \right]_0^b Fb^2 1/EJ - 1 (-1) (-1) Fb^3/EJ$$

$$= (1/2 b + 1/2 b) Fb^2 1/EJ - 1 (-1) (-1) Fb^3/EJ = 0$$



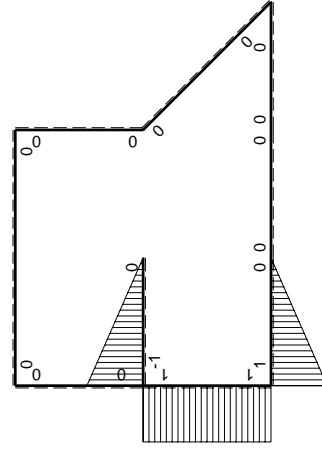
$A = 147.4 \text{ mm}^2$
 $J_u = 53868. \text{ mm}^4$
 $J_v = 7969. \text{ mm}^4$
 $J_t = 127.1 \text{ mm}^4$
 $y_o = -7.686 \text{ mm}$
 $y_g = 18.87 \text{ mm}$
 $T_y = -930. \text{ N}$
 $M_x = -457250. \text{ Nmm}$
 $x_m = 5. \text{ mm}$
 $y_m = 43. \text{ mm}$
 $u_m = -12. \text{ mm}$
 $v_m = 24.13 \text{ mm}$
 $\sigma_m = -Mv/J_u = 204.8 \text{ N/mm}^2$
 $x_c = 17. \text{ mm}$
 $y_c = 43. \text{ mm}$
 $v_c = 24.13 \text{ mm}$
 $\sigma_c = -Mv/J_u = 204.8 \text{ N/mm}^2$
 $\tau_c = TS/tJ_u = 17.99 \text{ N/mm}^2$
 $\tau_g = TS/tJ_u = 17.99 \text{ N/mm}^2$
 $t_c = 310. \text{ mm}$
 $\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 207.1 \text{ N/mm}^2$





Schema di calcolo iperstatico

M₀ flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica X=V_A

→	M _x (x)	M ₀ (x)	M _x M ₀	M _x M _x	∫M _x M ₀ /EJdx	∫XM _x M ₀ /EJdx
AB b	0	0	0	0	0	0
BA b	0	0	0	0	0	0
BC b	0	0	0	0	0	0
CB b	0	0	0	0	0	0
CD √2b	0	Fb-√2/4Fx	0	0	0	0
DE b	0	1/2Fb-1/2Fx	0	0	0	0
ED b	0	-1/2Fx	0	0	0	0
EF 2b	0	0	0	0	0	0
FE 2b	0	0	0	0	0	0
GA b	b-x	0	0	b ² -2bx+x ²	0	1/3Xb ³ /EJ
AG b	-x	0	0	x ²	0	0
FH b	0	-3/2Fx-1/2qx ²	0	0	0	0
HF b	0	2Fb-5/2Fx+1/2qx ²	0	0	0	0
HI b	-b+x	0	0	b ² -2bx+x ²	0	1/3Xb ³ /EJ
IH b	x	0	0	x ²	0	0
HG b	b	-2Fb+5/2Fx-1/2qx ²	-2Fb ² +5/2Fbx-1/2Fx ²	b ²	-1/12Fb ³ /EJ	Xb ³ /EJ
GH b	-b	3/2Fx+1/2qx ²	-3/2Fbx-1/2Fx ²	b ²	0	0
HG	elongazione asta N _{1HG} ^{±HG} ±HG				Fb ³ /EJ	
A	molla nodo -V _{1A} (V _{0A} +XV _{1A})/k _A					1/4Xb ³ /EJ
	totali				1/12Fb ³ /EJ	23/12Xb ³ /EJ
	iperstatica X=V _A					-1/23F

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

$$L_{HG}^{x_0} = \int_0^b (-2 + 5/2 x/b - 1/2 x^2/b^2) Fb^2 1/EJ dx + 1 \quad (-1) \quad (-1) \quad Fb^3/EJ$$

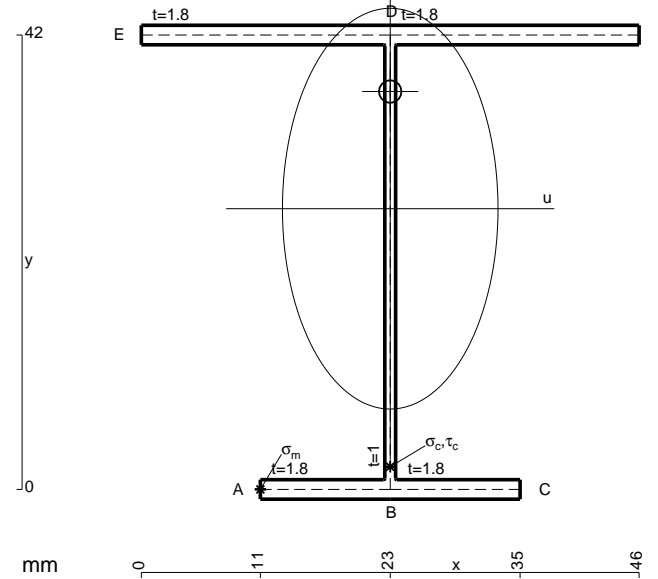
$$= [-2x + 5/4 x^2/b - 1/6 x^3/b^2]_0^b Fb^2 1/EJ + 1 \quad (-1) \quad (-1) \quad Fb^3/EJ$$

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

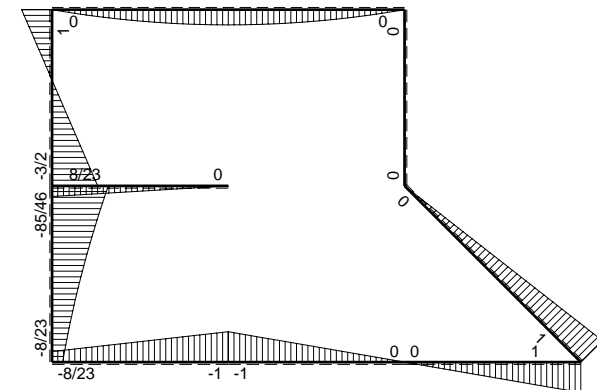
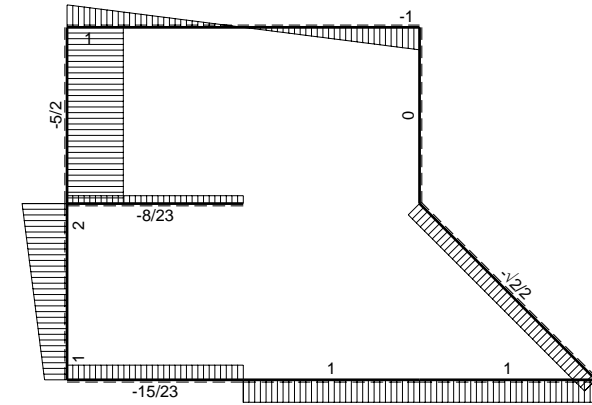
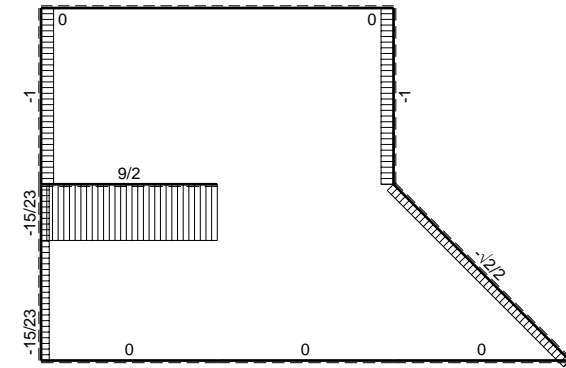
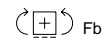
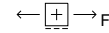
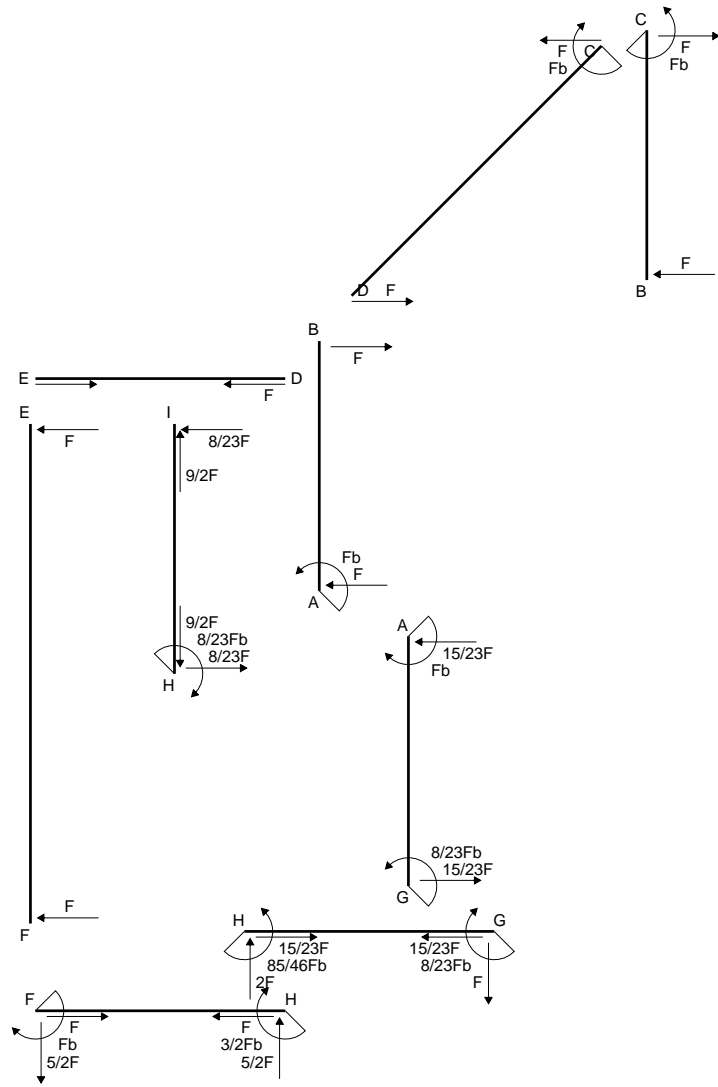
$$L_{GH}^{x_0} = \int_0^b (-3/2 x/b - 1/2 x^2/b^2) Fb^2 1/EJ dx + 1 \quad (-1) \quad (-1) \quad Fb^3/EJ$$

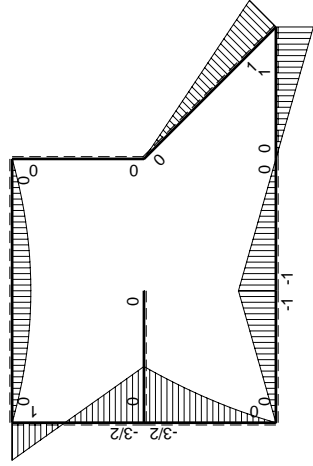
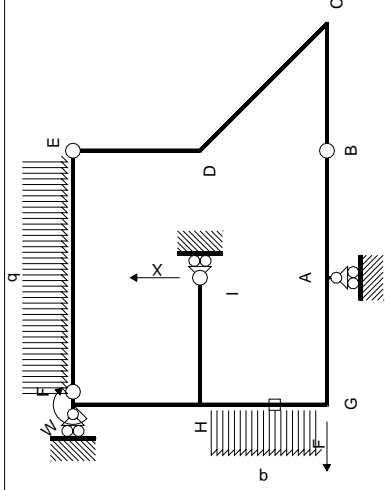
$$= [-3/4 x^2/b - 1/6 x^3/b^2]_0^b Fb^2 1/EJ + 1 \quad (-1) \quad (-1) \quad Fb^3/EJ$$

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



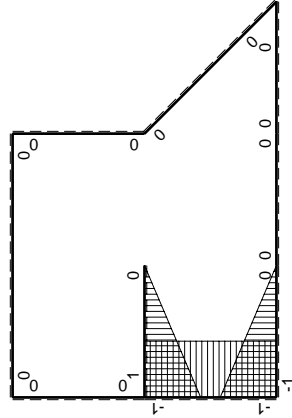
- A = 168. mm²
- J_u = 57624. mm⁴
- J_v = 16674. mm⁴
- J_i = 150.1 mm⁴
- y_o = 10.83 mm
- y_g = 25.95 mm
- T_y = -1375. N
- M_x = -506000. Nmm
- x_m = 11. mm
- u_m = -12. mm
- v_m = -25.95 mm
- σ_m = -Mv/J_u = -227.9 N/mm²
- x_c = 23. mm
- v_c = -25.95 mm
- σ_c = -Mv/J_u = -227.9 N/mm²
- τ_c = TS'/tJ_u = 26.75 N/mm²
- τ_g = TS'/tJ_u = 26.75 N/mm²
- t_c = 550. mm
- σ_o = √σ²+3τ² = 232.5 N/mm²





Schema di calcolo iperstatico

(+) M_0 flessione da carichi assegnati



Quadro contribuiti PLV per iperstatica $X=V_1$

→	$M_x(x)$	$M_0(x)$	$M_x M_0$	$M_x M_x$	$\int M_x M_0/EJ dx$	$\int X M_x M_x/EJ dx$
AB b	0	-Fb+Fx	0	0	0	0
BA b	0	Fx	0	0	0	0
BC b	0	Fx	0	0	0	0
CB b	0	-Fb+Fx	0	0	0	0
CD $\sqrt{2}b$	0	Fb- $\sqrt{2}/2Fx$	0	0	0	0
DE b	0	0	0	0	0	0
ED b	0	0	0	0	0	0
EF 2b	0	-Fx+ $1/2qx^2$	0	0	0	0
FE 2b	0	Fx- $1/2qx^2$	0	0	0	0
GA b	-b+x	-Fx	Fbx-Fx ²	b ² -2bx+x ²	$1/6Fb^3/EJ$	$1/3Xb^3/EJ$
AG b	x	Fb-Fx	Fbx-Fx ²	x ²	0	0
FH b	0	Fb-5/2Fx	0	0	0	0
HF b	0	3/2Fb-5/2Fx	0	0	0	0
HI b	b-x	0	0	b ² -2bx+x ²	0	$1/3Xb^3/EJ$
IH b	-x	0	0	x ²	0	0
HG b	-b	-3/2Fb+2Fx- $1/2qx^2$	$3/2Fb^2-2Fbx+1/2Fx^2$	b ²	$2/3Fb^3/EJ$	Xb^3/EJ
GH b	b	Fx+ $1/2qx^2$	Fbx+ $1/2Fx^2$	b ²	0	0
HG	elongazione asta $N_{1HG^{\pm}HG}$				-Fb ³ /EJ	
A	molla nodo - $V_{1A}(V_{0A}+XV_{1A})/k_A$				- $1/2Fb^3/EJ$	$1/4Xb^3/EJ$
totali					-2/3Fb ³ /EJ	23/12Xb ³ /EJ
iperstatica $X=V_1$					8/23F	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

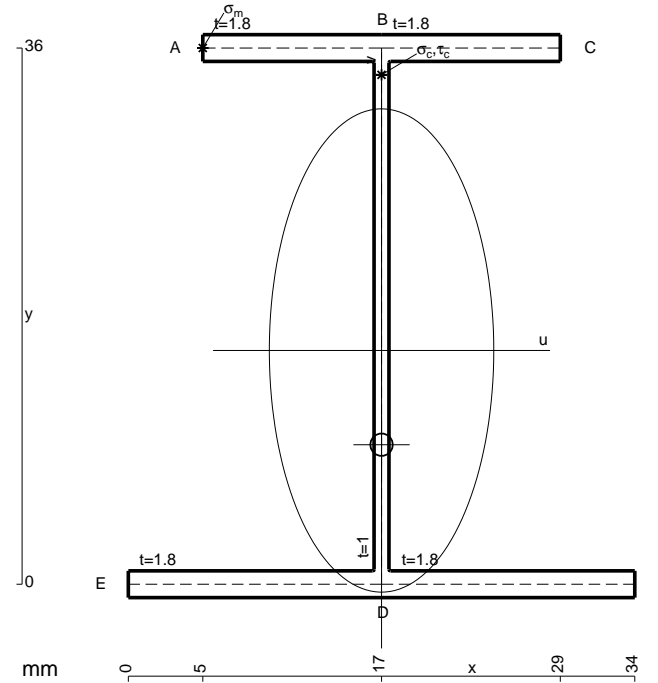
$$= [3/2 x - x^2/b + 1/6 x^3/b^2]_0^b Fb^2 1/EJ - 1 (-1) (-1) Fb^3/EJ$$

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

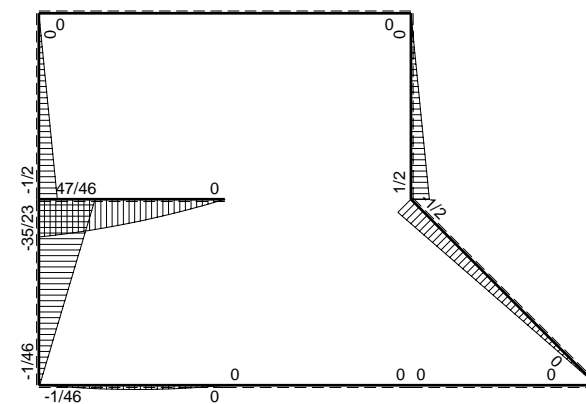
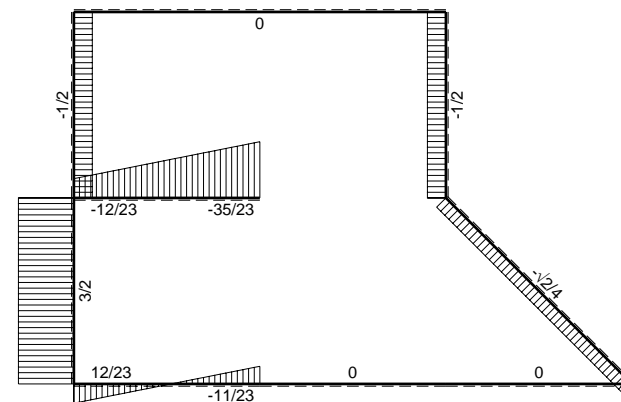
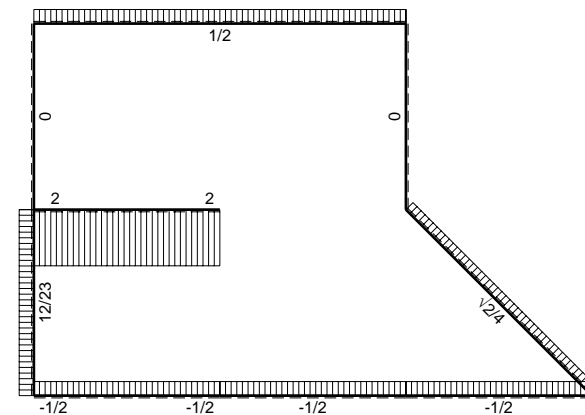
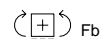
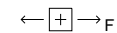
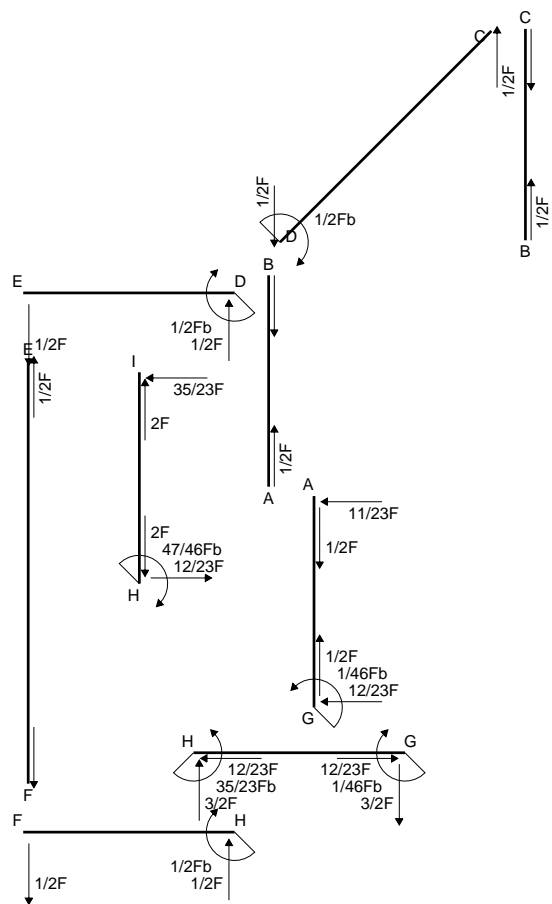
$$L_{GH}^{xo} = \int_0^b (x/b + 1/2 x^2/b^2) Fb^2 1/EJ dx - 1 (-1) (-1) Fb^3/EJ$$

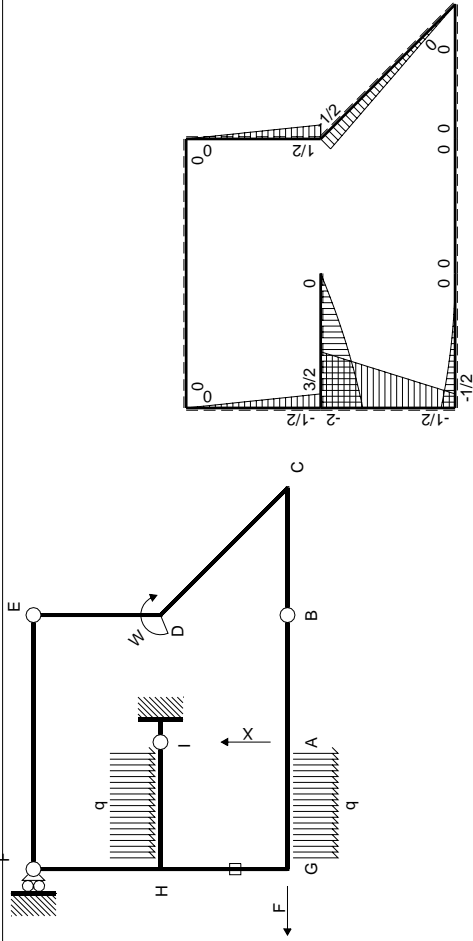
$$= [1/2 x^2/b + 1/6 x^3/b^2]_0^b Fb^2 1/EJ - 1 (-1) (-1) Fb^3/EJ$$

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



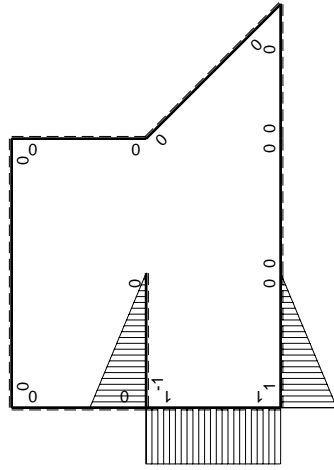
- A = 140.4 mm²
- J_u = 36966. mm⁴
- J_v = 7969. mm⁴
- J_t = 124.8 mm⁴
- y_o = -6.325 mm
- y_g = 15.69 mm
- N = -520. N
- T_y = -1300. N
- M_x = -382200. Nmm
- x_m = 5. mm
- y_m = 36. mm
- u_m = -12. mm
- v_m = 20.31 mm
- σ_m = N/A-Mv/J_u = 206.3 N/mm²
- x_c = 17. mm
- y_c = 36. mm
- v_c = 20.31 mm
- σ_c = N/A-Mv/J_u = 206.3 N/mm²
- τ_c = TS_y/tJ_u = 30.85 N/mm²
- τ_g = TS_y/tJ_u = 30.85 N/mm²
- t_c = 520. mm
- σ_o = √σ²+3τ² = 213.1 N/mm²





Schema di calcolo iperstatico

M_0 , flessione da carichi assegnati



M_x , flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=V_A$

→	$M_x(x)$	$M_o(x)$	$M_x M_o$	$M_x M_x$	$\int M_x M_o / EJ dx$	$\int X M_x M_x / EJ dx$
AB b	0	0	0	0	0	0
BA b	0	0	0	0	0	0
BC b	0	0	0	0	0	0
CB b	0	0	0	0	0	0
CD $\sqrt{2}b$	0	$-\sqrt{2}/4Fx$	0	0	0	0
DE b	0	$1/2Fb-1/2Fx$	0	0	0	0
ED b	0	$-1/2Fx$	0	0	0	0
EF 2b	0	0	0	0	0	0
FE 2b	0	0	0	0	0	0
GA b	b-x	$-1/2Fb+Fx-1/2qx^2$	$-1/2Fb^2+3/2Fbx-3/2Fx^2+1/2qx^3$	$b^2-2bx+x^2$	$-1/8Fb^3/EJ$	$1/3Xb^3/EJ$
AG b	-x	$1/2qx^2$	$-1/2qx^3$	x^2		
FH b	0	$-1/2Fx$	0	0	0	0
HF b	0	$1/2Fb-1/2Fx$	0	0	0	0
HI b	-b+x	$3/2Fb-Fx-1/2qx^2$	$-3/2Fb^2+5/2Fbx-1/2Fx^2-1/2qx^3$	$b^2-2bx+x^2$	$-13/24Fb^3/EJ$	$1/3Xb^3/EJ$
IH b	x	$-2Fx+1/2qx^2$	$-2Fx^2+1/2qx^3$	x^2		
HG b	b	$-2Fb+3/2Fx$	$-2Fb^2+3/2Fbx$	b^2	$-5/4Fb^3/EJ$	Xb^3/EJ
GH b	-b	$1/2Fb+3/2Fx$	$-1/2Fb^2-3/2Fbx$	b^2		
HG	elongazione asta $N_{1HG} \epsilon_{HG} L_{HG}$				Fb^3/EJ	
A	molla nodo $-V_{1A}(V_{oA}+XV_{1A})/k_A$					$1/4Xb^3/EJ$
	totali				$-11/12Fb^3/EJ$	$23/12Xb^3/EJ$
	iperstatica $X=V_A$				$11/23F$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (-3/2 b + 5/4 b - 1/6 b - 1/8 b) Fb^2 1/EJ = -13/24 Fb^3/EJ$$

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

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

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

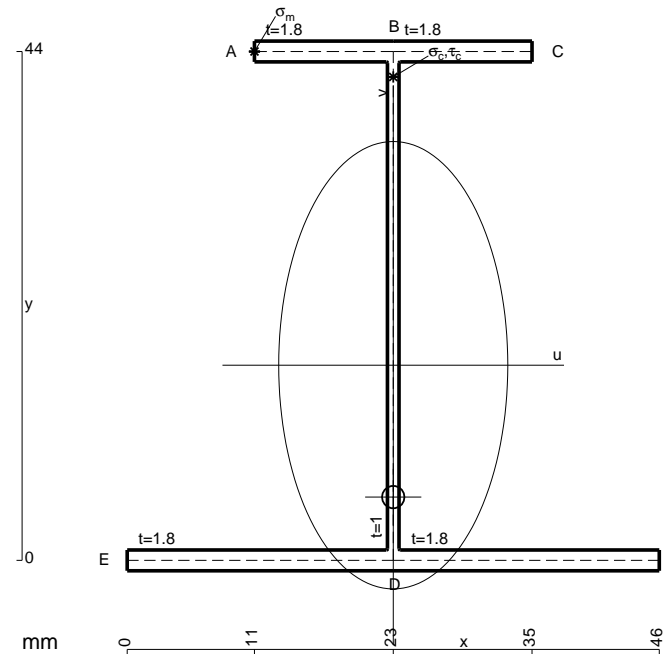
$$= \left[-2 x + 3/4 x^2/b \right]_0^b Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ$$

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

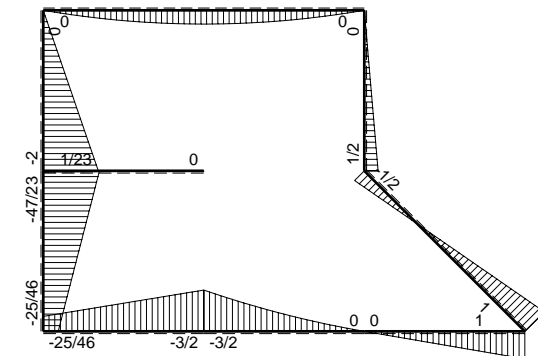
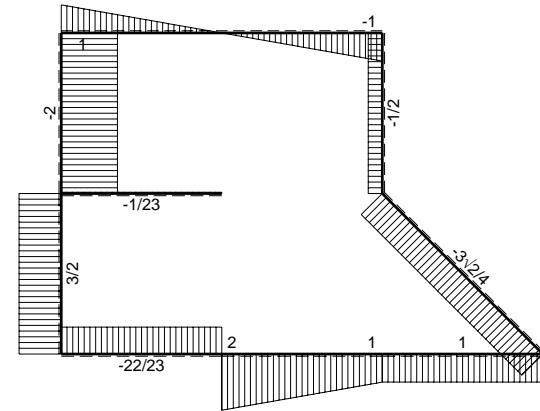
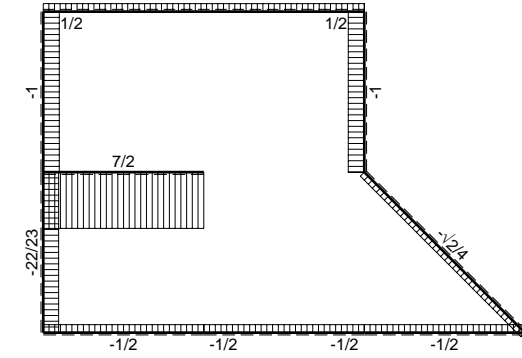
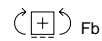
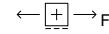
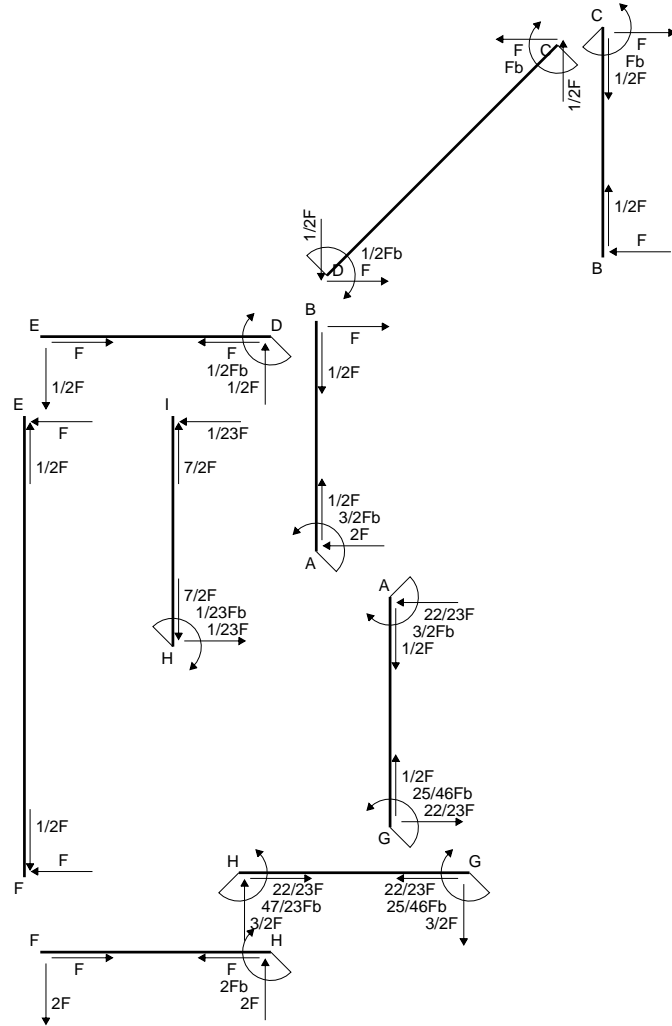
$$L_{GH}^{x_0} = \int_0^b (-1/2 - 3/2 x/b) Fb^2 1/EJ dx + 1 (-1) (-1) Fb^3/EJ$$

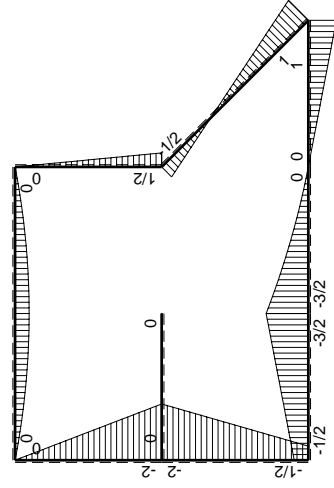
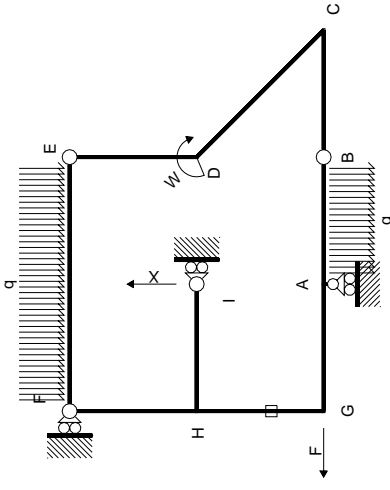
$$= \left[-1/2 x - 3/4 x^2/b \right]_0^b Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ$$

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

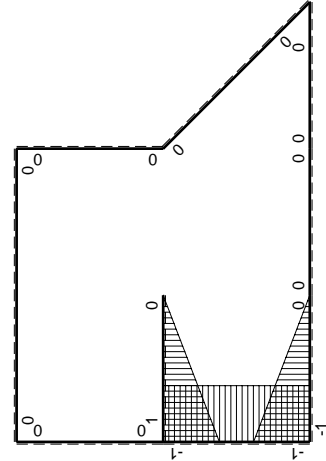


- A = 170. mm²
- J_u = 63618. mm⁴
- J_v = 16674. mm⁴
- J_t = 150.7 mm⁴
- y_o = -11.4 mm
- y_g = 16.88 mm
- T_y = -820. N
- M_x = 492000. Nmm
- x_m = 11. mm
- y_m = 44. mm
- u_m = -12. mm
- v_m = 27.12 mm
- σ_m = -Mv/J_u = -209.8 N/mm²
- x_c = 23. mm
- y_c = 44. mm
- v_c = 27.12 mm
- σ_c = -Mv/J_u = -209.8 N/mm²
- τ_c = TS_v/tJ_u = 15.1 N/mm²
- τ_g = TS_v/tJ_u = 15.1 N/mm²
- t_c = 1640. mm
- σ_o = √(σ² + 3τ²) = 211.4 N/mm²





M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=V_1$

\rightarrow	$M_x(x)$	$M_0(x)$	$M_x M_0$	$M_x M_x$	$\int M_x M_0 / E J dx$	$\int M_x M_x / E J dx$
AB b	0	$-3/2Fb+2Fx-1/2qx^2$	0	0	0	0
BA b	0	$Fx+1/2qx^2$	0	0	0	0
BC b	0	Fx	0	0	0	0
CB b	0	$-Fb+Fx$	0	0	0	0
CD $\sqrt{2}b$	0	$Fb-3\sqrt{2}/4Fx$	0	0	0	0
DE b	0	$1/2Fb-1/2Fx$	0	0	0	0
ED b	0	$-1/2Fx$	0	0	0	0
EF 2b	0	$-Fx+1/2qx^2$	0	0	0	0
FE 2b	0	$Fx-1/2qx^2$	0	0	0	0
GA b	$-b+x$	$-1/2Fb-Fx$	$1/2Fb^2+1/2Fbx-Fx^2$	$b^2-2bx+x^2$	$5/12Fb^3/EJ$	$1/3Xb^3/EJ$
AG b	x	$3/2Fb-Fx$	$3/2Fbx-Fx^2$	x^2	0	0
FH b	0	$-2Fx$	0	0	0	0
HF b	0	$2Fb-2Fx$	0	0	0	0
HI b	$b-x$	0	0	$b^2-2bx+x^2$	0	$1/3Xb^3/EJ$
IH b	$-x$	0	0	x^2	0	0
HG b	$-b$	$-2Fb+3/2Fx$	$2Fb^2-3/2Fbx$	b^2	$5/4Fb^3/EJ$	Xb^3/EJ
GH b	b	$1/2Fb+3/2Fx$	$1/2Fb^2+3/2Fbx$	b^2	0	0
HG	elongazione asta $N_{1HG^{\pm HG}} \pm HG$					
A	molla nodo $-V_{1A}(V_{0A} + XV_{1A})/k_A$					
	totali					
	iperstatica $X=V_1$					
	1/23F					

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

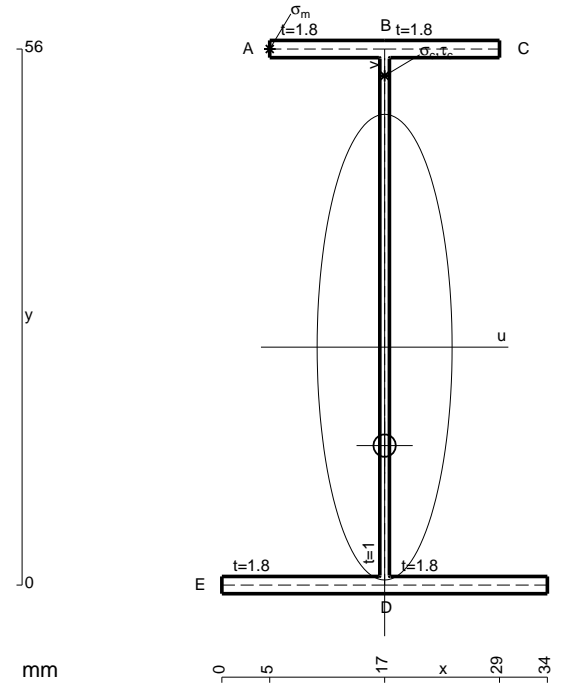
$$= [2x - 3/4 x^2/b]_0^b Fb^2 1/EJ - 1 \quad (-1) \quad (-1) \quad Fb^3/EJ$$

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

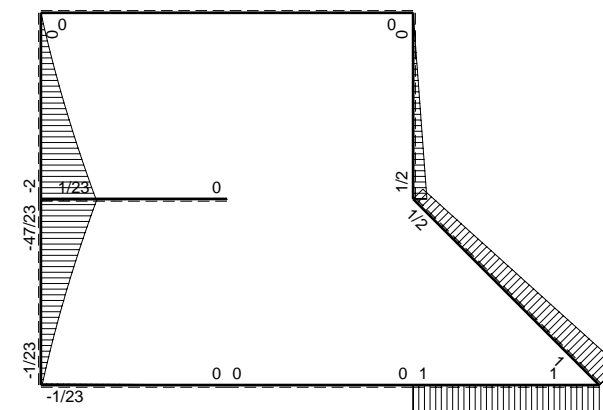
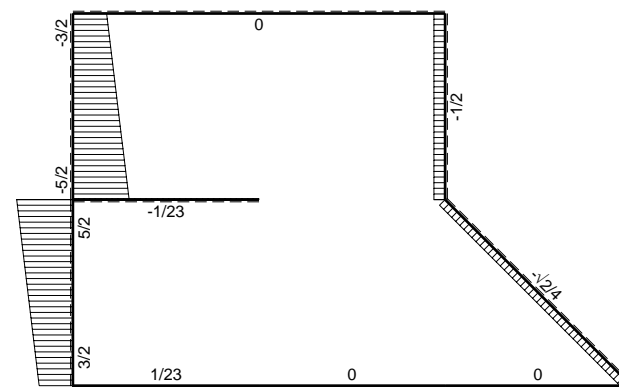
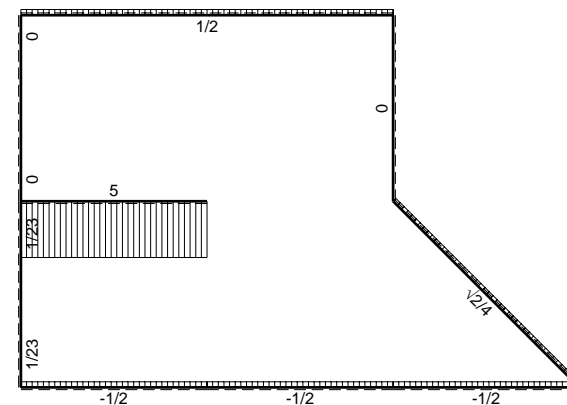
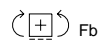
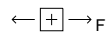
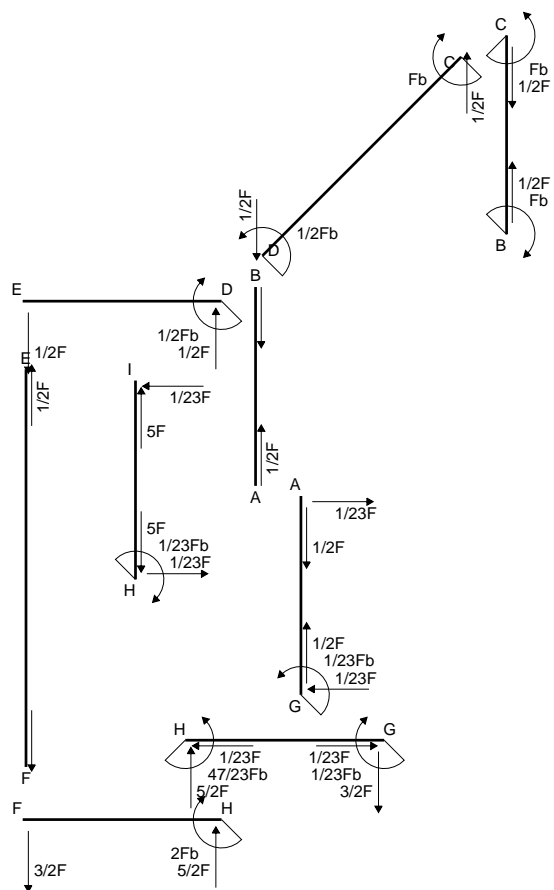
$$L_{GH}^{xo} = \int_0^b (1/2 + 3/2 x/b) Fb^2 1/EJ dx - 1 \quad (-1) \quad (-1) \quad Fb^3/EJ$$

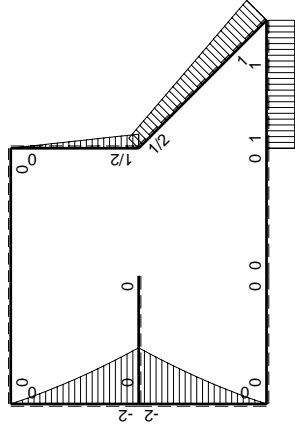
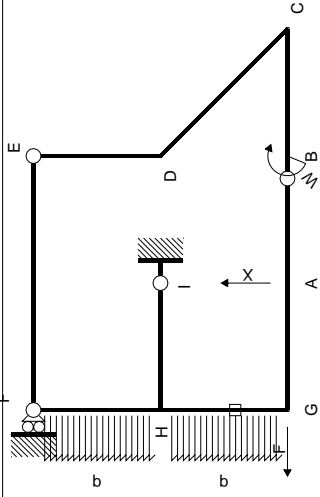
$$= [1/2 x + 3/4 x^2/b]_0^b Fb^2 1/EJ - 1 \quad (-1) \quad (-1) \quad Fb^3/EJ$$

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



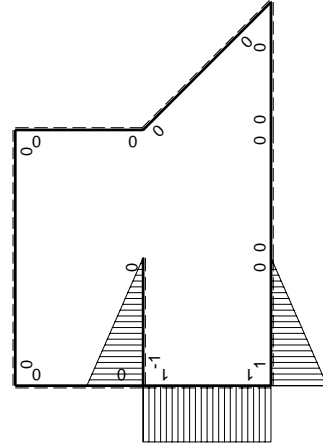
- A = 160.4 mm²
- J_u = 94901. mm⁴
- J_v = 7969. mm⁴
- J_x = 131.4 mm⁴
- y_o = -10.29 mm
- y_g = 24.86 mm
- N = -590. N
- T_y = -1180. N
- M_x = -672600. Nmm
- x_m = 5. mm
- y_m = 56. mm
- u_m = -12. mm
- v_m = 31.14 mm
- σ_m = N/A - Mv/J_u = 217. N/mm²
- x_c = 17. mm
- y_c = 56. mm
- v_c = 31.14 mm
- σ_c = N/A - Mv/J_u = 217. N/mm²
- τ_c = TS_v/tJ_u = 16.73 N/mm²
- τ_g = TS_v/tJ_u = 16.73 N/mm²
- t_c = 590. mm
- σ_o = √σ² + 3τ² = 219. N/mm²





Schema di calcolo iperstatico

M_0 flessione da carichi assegnati



M_x flessione da iperstatica X=1

Quadro contributi PLV per iperstatica $X=V_A$

\rightarrow	$M_x(x)$	$M_0(x)$	$M_x M_0$	$M_x^2 M_x$	$\int M_x M_0 / EJ dx$	$\int X M_x^2 M_x / EJ dx$	
AB b	0	0	0	0	0	0	
BA b	0	0	0	0	0	0	
BC b	0	Fb	0	0	0	0	
CB b	0	-Fb	0	0	0	0	
CD $\sqrt{2}b$	0	$Fb - \sqrt{2}/4Fx$	0	0	0	0	
DE b	0	$1/2Fb - 1/2Fx$	0	0	0	0	
ED b	0	$-1/2Fx$	0	0	0	0	
EF 2b	0	0	0	0	0	0	
FE 2b	0	0	0	0	0	0	
GA b	b-x	0	0	$b^2 - 2bx + x^2$	0	$1/3Xb^3/EJ$	
AG b	-x	0	0	x^2	0	0	
FH b	0	$-3/2Fx - 1/2qx^2$	0	0	0	0	
HF b	0	$2Fb - 5/2Fx + 1/2qx^2$	0	0	0	0	
HI b	-b+x	0	0	$b^2 - 2bx + x^2$	0	$1/3Xb^3/EJ$	
IH b	x	0	0	x^2	0	0	
HG b	b	$-2Fb + 5/2Fx - 1/2qx^2$	$-2Fb^2 + 5/2Fbx - 1/2Fx^2$	b^2	$-1/12Fb^3/EJ$	Xb^3/EJ	
GH b	-b	$3/2Fx + 1/2qx^2$	$-3/2Fbx - 1/2Fx^2$	b^2	0	0	
HG	elongazione asta $N_{1HG^5HG^4HG}$						Fb^3/EJ
A	molla nodo $-V_{1A}(V_{0A} + XV_{1A})/k_A$						$1/4Xb^3/EJ$
	totali						$1/12Fb^3/EJ$
	iperstatica $X=V_A$						$-1/23F$

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

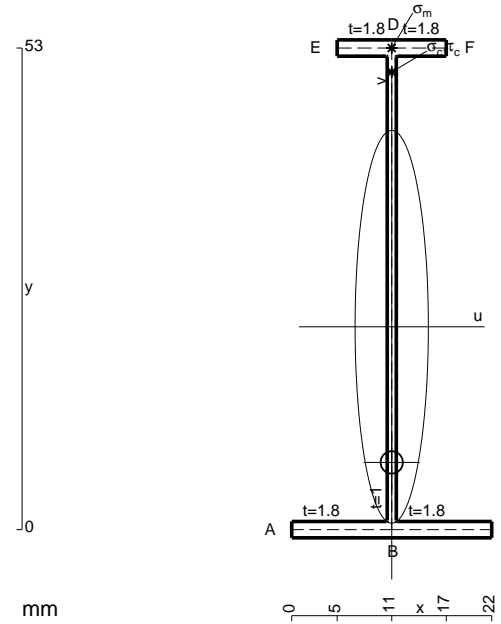
$$= \left[-2x + 5/4 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ$$

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

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

$$= \left[-3/4 x^2/b - 1/6 x^3/b^2 \right]_0^b Fb^2 1/EJ + 1 (-1) (-1) Fb^3/EJ$$

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



$$A = 114.2 \text{ mm}^2$$

$$J_u = 53392. \text{ mm}^4$$

$$J_v = 1856. \text{ mm}^4$$

$$J_t = 83.76 \text{ mm}^4$$

$$y_o = -14.92 \text{ mm}$$

$$y_g = 22.32 \text{ mm}$$

$$T_y = -850. \text{ N}$$

$$M_x = -394400. \text{ Nmm}$$

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

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

$$v_m = 30.68 \text{ mm}$$

$$\sigma_m = -Mv/J_u = 226.6 \text{ N/mm}^2$$

$$y_c = 2. \text{ mm}$$

$$u_c = -11. \text{ mm}$$

$$v_c = -20.32 \text{ mm}$$

$$\sigma_c = -Mv/J_u = 226.6 \text{ N/mm}^2$$

$$\tau_c = TS^*/tJ_u = 10.55 \text{ N/mm}^2$$

$$\tau_g = TS^*/tJ_u = 10.55 \text{ N/mm}^2$$

$$t_c = 340. \text{ mm}$$

$$\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 227.3 \text{ N/mm}^2$$

