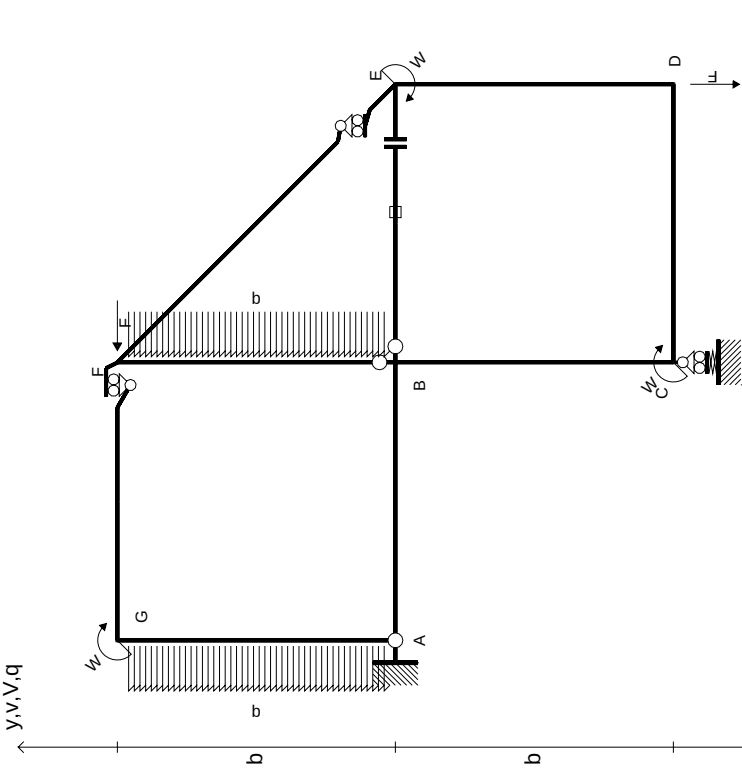
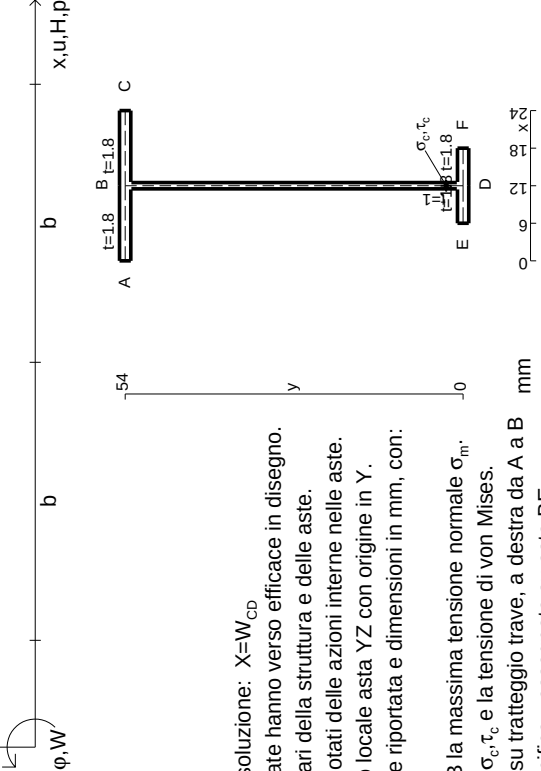
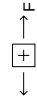
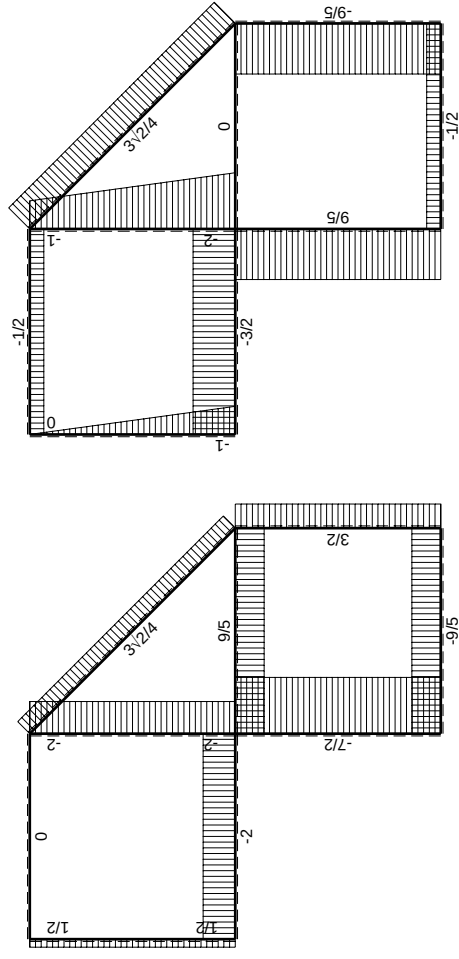
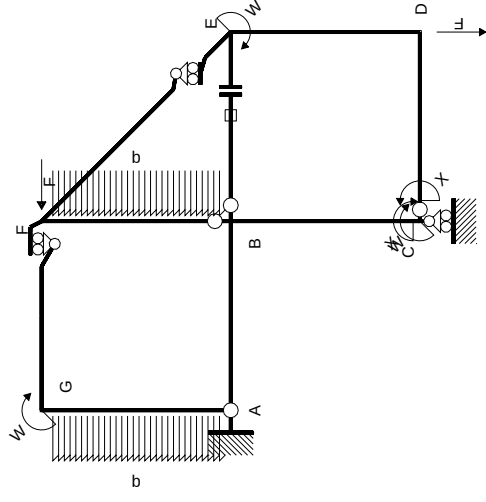


$H_{FB} = -F$
 $V_D = -F$
 $W_C = -W = -Fb$
 $W_G = -W = -Fb$
 $W_E = -W = -Fb$
 $p_{GA} = -q = -F/b$
 $p_{FB} = -q = -F/b$
 $\varepsilon_{BE} = -\alpha T = -b^2 F/EJ$
 $k_C = 4EJ/b^3$
 $EJ_{AB} = EJ$
 $EJ_{BC} = EJ$
 $EJ_{CD} = EJ$
 $EJ_{DE} = EJ$
 $EJ_{EF} = EJ$
 $EJ_{FG} = EJ$
 $EJ_{GA} = EJ$
 $EJ_{FB} = EJ$
 $EJ_{BE} = EJ$



Reazioni iperstatiche in soluzione: $X=W_{CD}$
Carichi e deformazioni date hanno verso efficace in disegno.
Calcolare reazioni vincolari della struttura e delle aste.
Tracciare i diagrammi quotati delle azioni interne nelle aste.
 $J_{YZ} - X_{YZ} - \theta_{YZ}$ riferimento locale asta YZ con origine in Y.
La trave AB ha la sezione riportata e dimensioni in mm, con:
 $b = 860 \text{ mm}$, $F = 300 \text{ N}$
Calcolare sulla sezione B la massima tensione normale σ_m .
Calcolare in * le tensioni σ_c, τ_c e la tensione di von Mises.
Lembo inferiore sezione su tratteggio trave, a destra da A a B
Elongazione termica specifica ε assegnata su asta BE.





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

→	$M_x(x)$	$M_o(x)$	$M_x M_o$	$M_x M_x$	$\int M_x M_o / EJ dx$	$\int X M_x M_x / EJ dx$
AB b	0	-3/2Fx	0	0	0	0
BA b	0	3/2Fb-3/2Fx	0	0		
BC b	-x/b	-3/2Fb+1/2Fx	3/2Fx-1/2Fx ² /b	x ² /b ²	7/12Fb ² /EJ	1/3Xb/EJ
CB b	1-x/b	Fb+1/2Fx	Fb-1/2Fx-1/2Fx ² /b	1-2x/b+x ² /b ²		
CD b	-1	-1/2Fx	1/2Fx	1	1/4Fb ² /EJ	Xb/EJ
DC b	1	1/2Fb-1/2Fx	1/2Fb-1/2Fx	1		
DE b	-1+x/b	-1/2Fb-1/2Fx	1/2Fb-1/2Fx ² /b	1-2x/b+x ² /b ²	1/3Fb ² /EJ	1/3Xb/EJ
ED b	x/b	Fb-1/2Fx	Fx-1/2Fx ² /b	x ² /b ²		
EF $\sqrt{2}b$	0	3 $\sqrt{2}$ /4Fx	0	0	0	0
FG b	0	-1/2Fx	0	0	0	0
GF b	0	1/2Fb-1/2Fx	0	0		
GA b	0	1/2Fb-1/2qx ²	0	0	0	0
AG b	0	-Fx+1/2qx ²	0	0		
FB b	0	3/2Fb-Fx-1/2qx ²	0	0	0	0
BF b	0	-2Fx+1/2qx ²	0	0		
BE b	0	0	0	0	0	0
EB b	0	0	0	0		
BE	elongazione asta $N_{1BE} \epsilon_{BE} L_{BE}$				Fb ² /EJ	
	totali				13/6Fb ² /EJ	5/3Xb/EJ
	iperstatica $X=W_{CD}$				-13/10Fb	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (3/4 b - 1/6 b) Fb 1/EJ = 7/12 Fb^2/EJ$$

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

$$= (b - 1/4 b - 1/6 b) Fb 1/EJ = 7/12 Fb^2/EJ$$

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

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

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

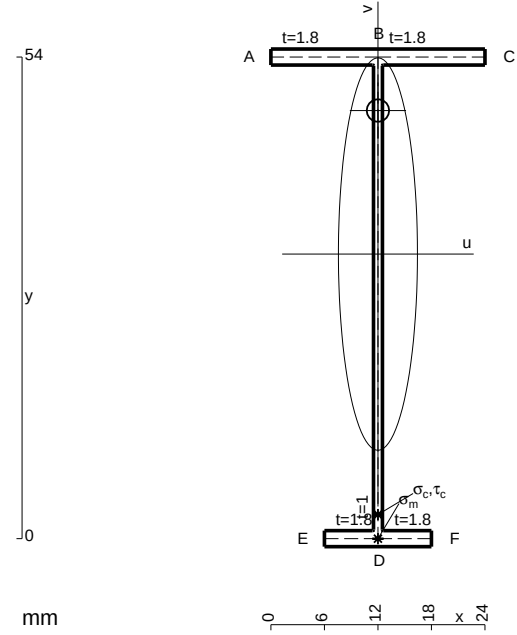
$$= (1/2 b - 1/4 b) Fb 1/EJ = 1/4 Fb^2/EJ$$

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

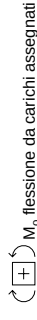
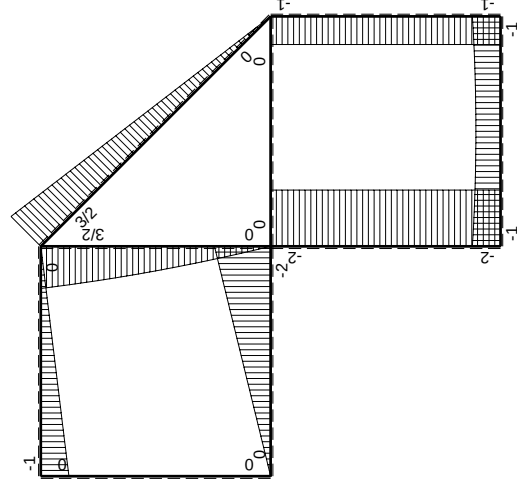
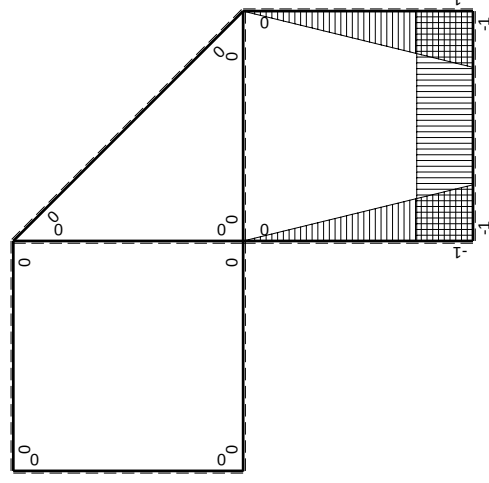
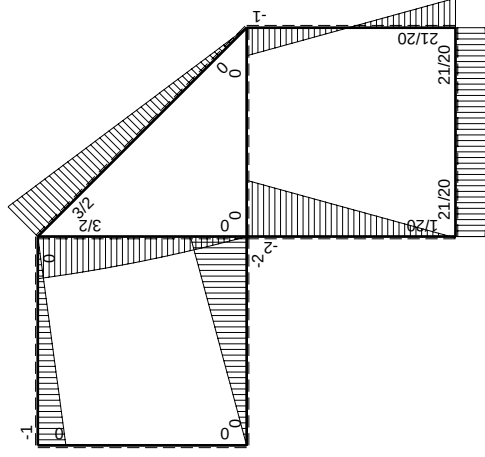
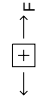
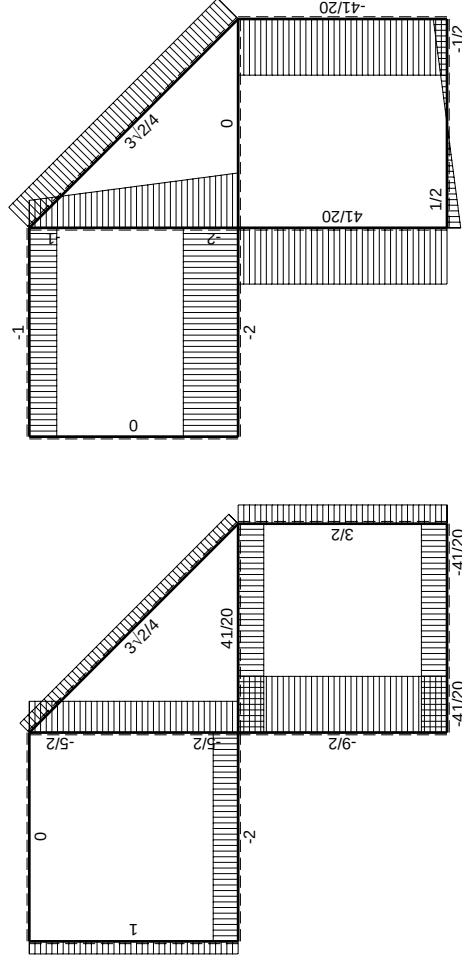
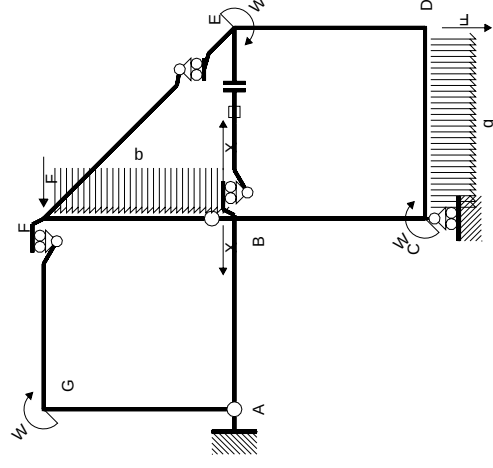
$$= (1/2 b - 1/6 b) Fb 1/EJ = 1/3 Fb^2/EJ$$

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

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



$A = 118.8 \text{ mm}^2$
 $J_u = 57498. \text{ mm}^4$
 $J_v = 2333. \text{ mm}^4$
 $J_t = 87.98 \text{ mm}^4$
 $y_o = 16.09 \text{ mm}$
 $y_g = 31.91 \text{ mm}$
 $N = -600. \text{ N}$
 $T_y = -450. \text{ N}$
 $M_x = -387000. \text{ Nmm}$
 $x_m = 12. \text{ mm}$
 $v_m = -31.91 \text{ mm}$
 $\sigma_m = N/A - Mv/J_u = -219.8 \text{ N/mm}^2$
 $y_c = 3. \text{ mm}$
 $u_c = -12. \text{ mm}$
 $v_c = -28.91 \text{ mm}$
 $\sigma_c = N/A - Mv/J_u = -219.8 \text{ N/mm}^2$
 $\tau_c = TS^*/tJ_u = 5.394 \text{ N/mm}^2$
 $\tau_g = TS^*/tJ_u = 5.394 \text{ N/mm}^2$
 $t_c = 300. \text{ mm}$
 $\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 220. \text{ N/mm}^2$



Quadro contributi PLV per iperstatica $X=H_{BE}$

→	$M_x(x)$	$M_0(x)$	$M_x M_0$	$M_x M_x$	$\int M_x M_0 / EJ dx$	$\int X M_x M_x / EJ dx$
AB b	0	-2Fx	0	0	0	0
BA b	0	2Fb-2Fx	0	0		
BC b	-x	-2Fb	2Fbx	x^2	Fb^3/EJ	$1/3 Xb^3/EJ$
CB b	b-x	2Fb	$2Fb^2-2Fbx$	$b^2-2bx+x^2$		
CD b	-b	$-Fb+1/2Fx-1/2qx^2$	$Fb^2-1/2Fbx+1/2Fx^2$	b^2	$11/12 Fb^3/EJ$	Xb^3/EJ
DC b	b	$Fb-1/2Fx+1/2qx^2$	$Fb^2-1/2Fbx+1/2Fx^2$	b^2		
DE b	-b+x	-Fb	Fb^2-Fbx	$b^2-2bx+x^2$	$1/2 Fb^3/EJ$	$1/3 Xb^3/EJ$
ED b	x	Fb	Fbx	x^2		
EF $\sqrt{2}b$	0	$3\sqrt{2}/4 Fx$	0	0	0	0
FG b	0	-Fx	0	0	0	0
GF b	0	Fb-Fx	0	0		
GA b	0	0	0	0	0	0
AG b	0	0	0	0		
FB b	0	$3/2 Fb-Fx-1/2 qx^2$	0	0	0	0
BF b	0	$-2Fx+1/2 qx^2$	0	0		
BE b	0	0	0	0	0	0
EB b	0	0	0	0		
BE	elongazione asta $N_{1BE} \varepsilon_{BE} L_{BE}$				Fb^3/EJ	
	totali				$41/12 Fb^3/EJ$	$5/3 Xb^3/EJ$
	iperstatica $X=H_{BE}$				$-41/20 F$	

Sviluppi di calcolo iperstatica

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= (b - 1/4 b + 1/6 b) Fb^2 1/EJ = 11/12 Fb^3/EJ$$

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

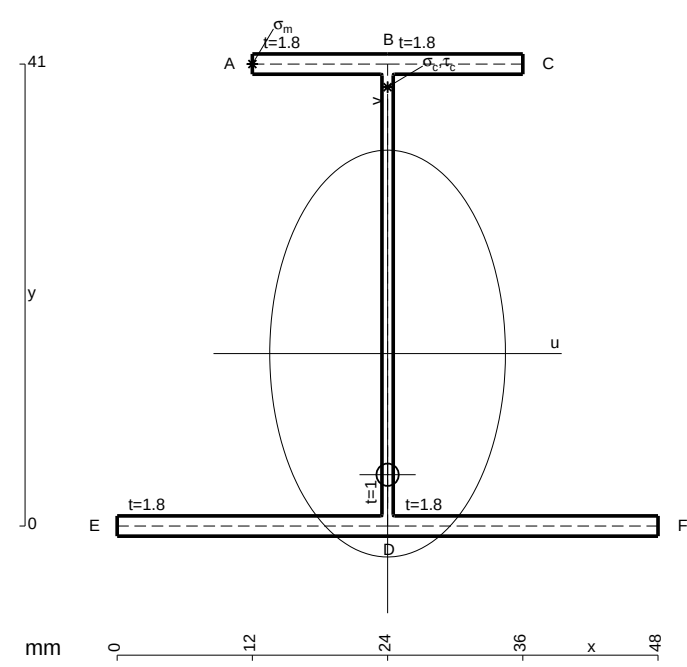
$$= (b - 1/4 b + 1/6 b) Fb^2 1/EJ = 11/12 Fb^3/EJ$$

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

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

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

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



$A = 170.6 \text{ mm}^2$
 $J_u = 55611. \text{ mm}^4$
 $J_v = 18662. \text{ mm}^4$
 $J_t = 153.6 \text{ mm}^4$
 $y_o = -10.75 \text{ mm}$
 $y_g = 15.31 \text{ mm}$
 $N = -1060. \text{ N}$
 $T_y = -1060. \text{ N}$
 $M_x = -487600. \text{ Nmm}$
 $x_m = 12. \text{ mm}$
 $y_m = 41. \text{ mm}$
 $u_m = -12. \text{ mm}$
 $v_m = 25.69 \text{ mm}$
 $\sigma_m = N/A - Mv/J_u = 219. \text{ N/mm}^2$
 $x_c = 24. \text{ mm}$
 $y_c = 41. \text{ mm}$
 $v_c = 25.69 \text{ mm}$
 $\sigma_c = N/A - Mv/J_u = 219. \text{ N/mm}^2$
 $\tau_c = TS'/tJ_u = 21.16 \text{ N/mm}^2$
 $\tau_g = TS'/tJ_u = 21.16 \text{ N/mm}^2$
 $t_c = 530. \text{ mm}$
 $\sigma_o = \sqrt{\sigma^2 + 3\tau^2} = 222.1 \text{ N/mm}^2$