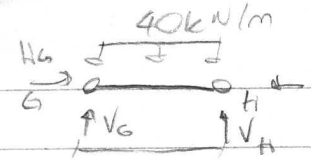
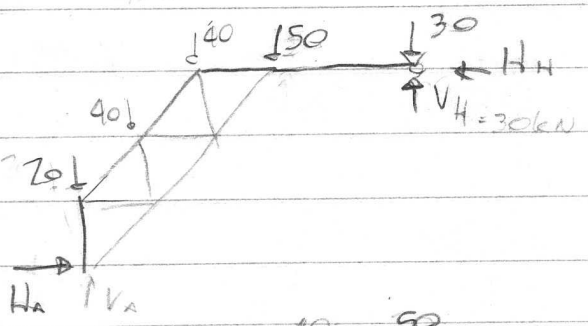


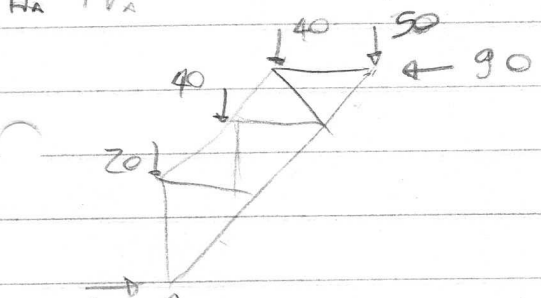
$V_G = V_H = 30kN$



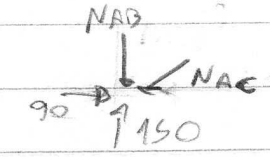
$\Sigma M_A = 0 = -150kN\,3m + H_H\,3m - 40kN\,1m - 40kN\,2m$

$H_H = 90kN = H_A$

$V_A + V_H = 180kN \rightarrow V_A = 150kN$



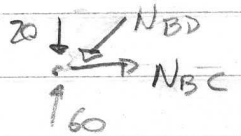
Nudo A



$\frac{N_{AC}\sqrt{2}}{2} = 90kN$ compr.

$N_{AC} = 90\sqrt{2}\ kN$ $\quad N_{AB} = 150 - \frac{N_{AC}\sqrt{2}}{2} = 60kN$ compr.

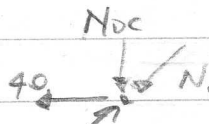
Nudo B



$\frac{N_{BD}\sqrt{2}}{2} = 40kN \rightarrow N_{BD} = 40\sqrt{2}$ compr.

$N_{BC} = 40kN$ trac

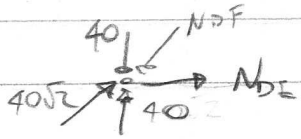
Nudo C



$N_{CE}\sqrt{2} + 40 = 90$ $\quad N_{CE} = 50\sqrt{2}$ compr

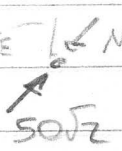
$\frac{N_{DC}\sqrt{2}}{2} = \frac{40\sqrt{2}}{2}$ $\quad N_{DC} = 40$ compr.

Nudo D



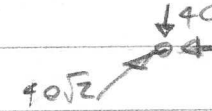
$N_{DF} = 40\sqrt{2}$ $\quad N_{DE} = 0$

Nudo E



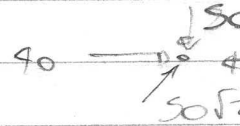
$N_{FE} = 0$ $\quad N_{EG} = 50\sqrt{2}$ compr.

Nudo F

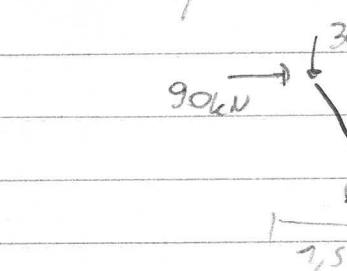


$N_{FG} = 40\,kN$ compr.

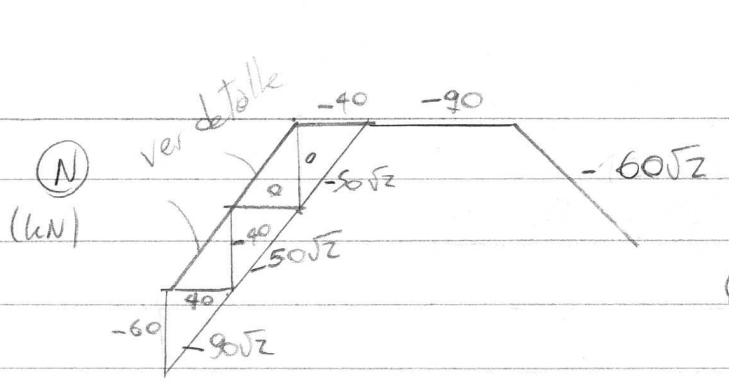
Nudo G

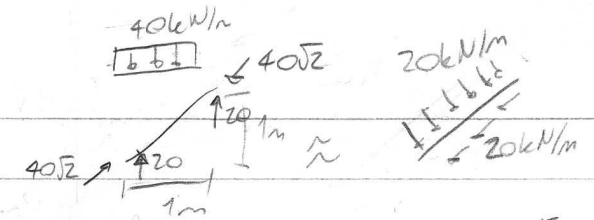


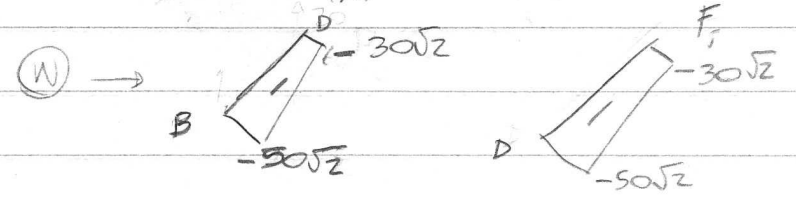
✓

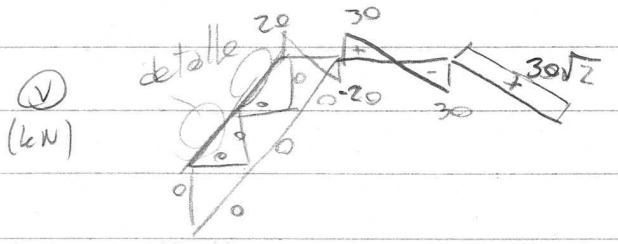


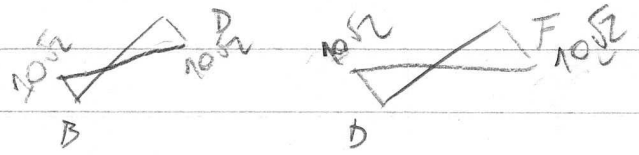
$M_I = 90kNm$

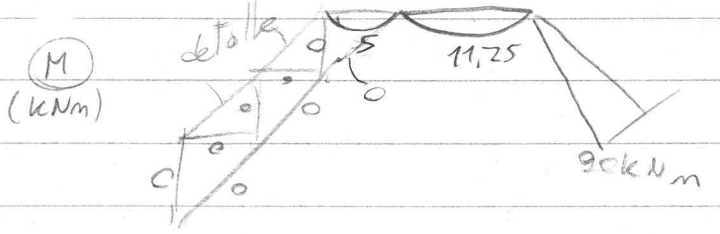












Barra GH $N = -90\,kN$ $M = 11{,}25\,kNm$

$$\sigma_{max} = \frac{1125\,kNcm}{W} + \frac{90\,kN}{A} \leq 14\,kN/cm^2$$ PNI 16

PNI 14 $W = 81{,}9\,cm^3$ $A = 18{,}3\,cm^2$ $\rightarrow \sigma_{max} = 13{,}7\,\frac{kN}{cm^2} + 4{,}9\,\frac{kN}{cm^2}$ ✗

PNI 16 $W = 117\,cm^3$ $A = 22{,}8\,cm^2$ $\sigma_{max} = 13{,}56\,kN/cm^2$ ✓

Barra HI $\sigma = \frac{30\sqrt{2}}{A} + \frac{9000\,kNcm}{W}$ PNI 32

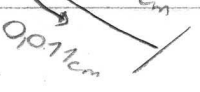
PNI 30 $W = 693\,cm^3$ $A = 69{,}1$ $\sigma = 14{,}39\,kN/cm^2$ ✗

PNI 32 $W = 782\,cm^3$ $A = 77{,}8$ $\sigma = 12{,}05$ ✓ $\rightarrow I = 12518\,cm^4$

Reticulado 1) $\sigma = \frac{-90\sqrt{2}}{A} \rightarrow A \geq 9{,}1\,cm^2$ PNI 10 2) $\sigma = \left|\frac{-40\sqrt{2}}{A}\right| + \frac{5000\,kNcm}{W}$

2) (cont.) PNI 14 $\sigma = \frac{40\sqrt{2}}{14{,}2} + \frac{5000\,kNcm}{81{,}9} = 10{,}16\,kN/cm^2$ PNI 12 $\sigma = 13{,}12\,kN/cm^2$ ✓ PNI 12

$$\delta_H = \frac{30\sqrt{2}\,(1{,}9m\sqrt{2})^3}{3EI} = 9{,}51cm \qquad \delta_H = \frac{-60\sqrt{2}\cdot 190\sqrt{2}}{EA} = 0{,}011cm$$



$\Delta l_{GH} = \frac{50\sqrt{2} \cdot 150_{cm}}{EA} = -0,022\,cm$

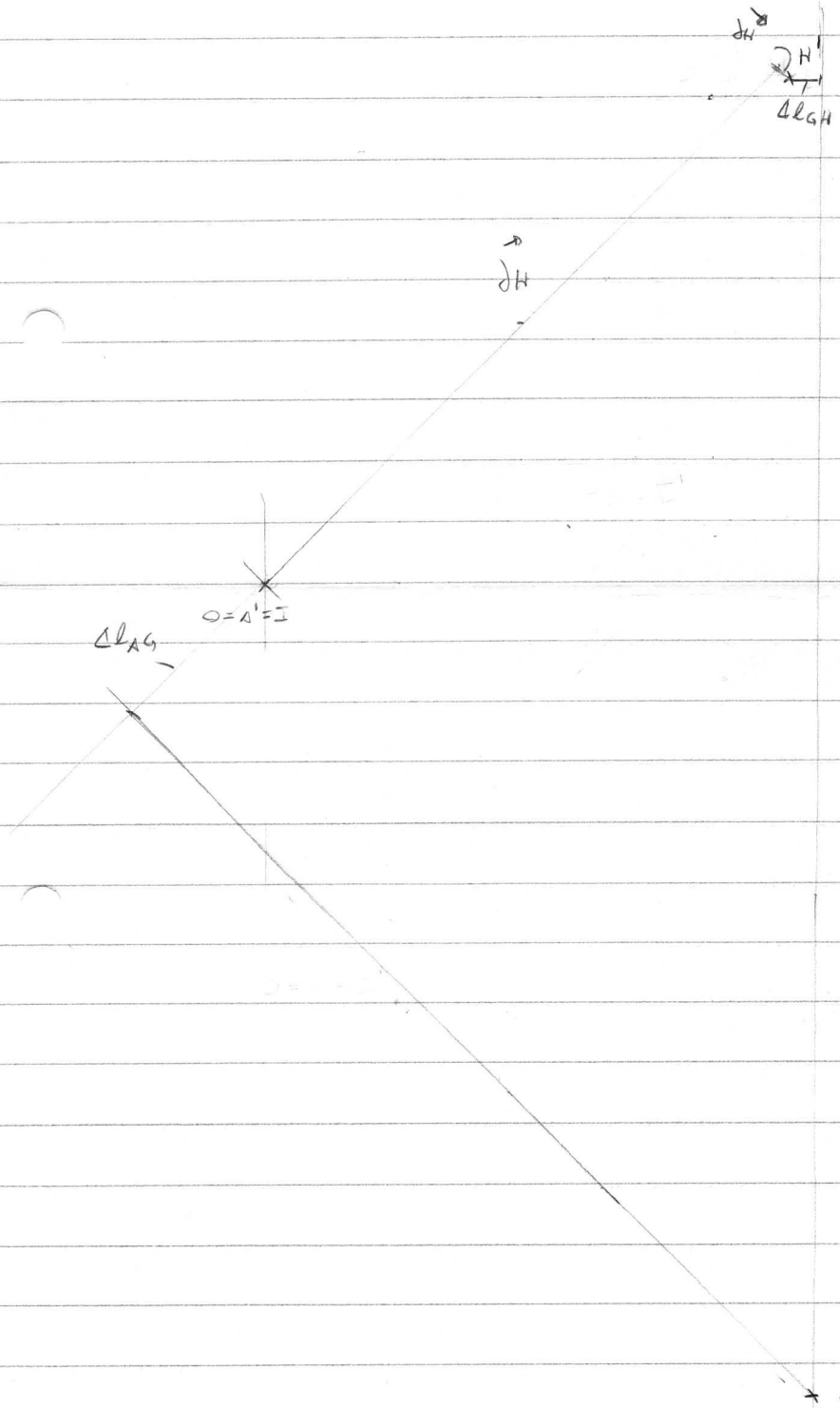
$\Delta l_{AG} = \frac{(90\sqrt{2} \cdot \sqrt{2}\,m + 2\sqrt{2} \times 50\sqrt{2}\,m)}{EA} = -0,13\,cm$

$\delta_H = 0,011\,cm$

$\delta_H = 0,51\,cm$

$\Delta l_{GH} = -0,022\,cm$

$\Delta l_{AG} = -0,13\,cm$



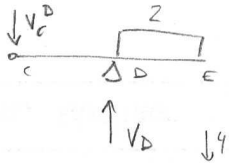
δ_H { $0,51\,cm$ ↗ ; $0,011\,cm$ → }

équivaut à $0,5\sqrt{2}\,cm$ ↑ ; $0,52\sqrt{2}\,cm$ →

δ_G { $\delta_G = 0,38\,cm$; $\delta_G^{\perp} = 0,38\,cm$ }

Ej. 2

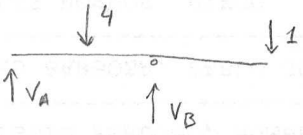
a)



$\Sigma M_C = 0 : \quad 2 \cdot 3 \cdot 4{,}5 - V_D \cdot 3 = 0 \Rightarrow V_D = 9\ kN$

$\Sigma V = 0 : \quad V_C = 9kN - 2m \cdot 3\ kN/m \Rightarrow V_C^D = 3\ kN$

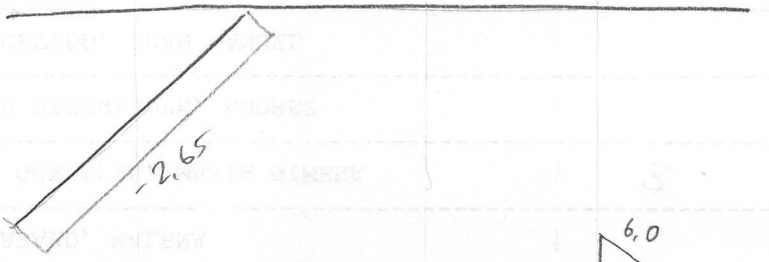
$\Rightarrow \Sigma V = 0 \Rightarrow V_C^I = 4kN - 3kN \Rightarrow V_C^I = 1\ kN$



$\Sigma M_A = 0 : \quad 4 \cdot 2 + 1 \cdot 7 - V_B \cdot 4 = 0 \Rightarrow V_B = 3{,}75\ kN$

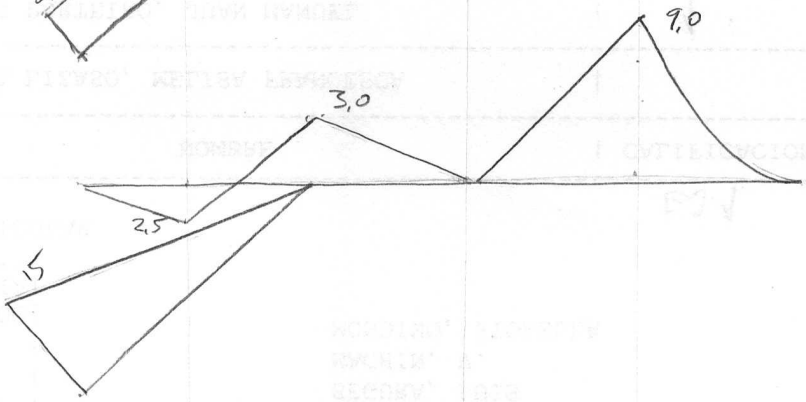
$\Sigma V = 0 : \quad V_A = 4 + 1 - 3{,}75 \Rightarrow V_A = 5{,}25\ kN$

$M_F = 3{,}75 \cdot 4 = 15\ kN.m$



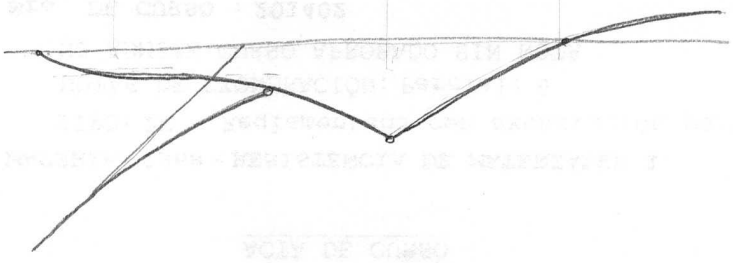
N [kN]

V [kN]



M [kN.m]

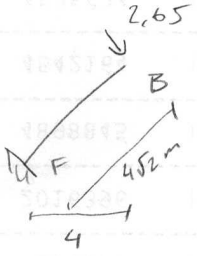
b) (u)



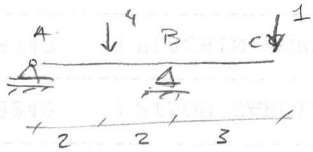
c) descenso de C

$E = 210\ GPa \quad I = 4788\ cm^4$

$\Rightarrow EI = 210 \cdot 10^9\ N/m^2 \cdot 4788 \cdot 10^{-8}\ m^4 = 10054\ kN m^2$



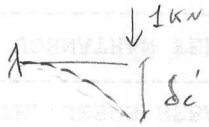
$$\delta_{B\downarrow} = \frac{2{,}65\ kN\ (4\sqrt{2}\ m)^3}{3\ EI} \Rightarrow \delta_{B\downarrow} = \frac{2{,}65\ kN\ (4\sqrt{2}\ m)^3}{3\sqrt{2}\ EI} = 113\ \frac{kN m^3}{EI}$$



$$\theta_B^{M\downarrow} = \frac{3kN\,m \cdot 4m}{3\ EI} = 4\ \frac{kN m^2}{EI}$$

$$\theta_B^{P\uparrow} = \frac{4kN \cdot (4m)^2}{16\ EI} = 4\ \frac{kN m^2}{EI}$$

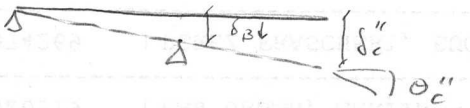
$$\Rightarrow \theta_{13} = 0$$



$$\delta_c' = \frac{1kN \cdot (3m)^3}{3\ EI} = 9\ \frac{kN m^3}{EI}\ (\downarrow)$$

$$\theta_c' = \frac{1kN\ (3m)^2}{2\ EI} = \frac{9}{2}\ \frac{kN m^2}{EI}\ (\circlearrowleft)$$

+



$$\delta_c'' = \frac{\delta_B}{4} \cdot 7 = 113\ \frac{kN m^3}{EI} \cdot \frac{7}{4} = 198\ \frac{kN m^3}{EI}\ (\downarrow)$$

$$\theta_c'' = \frac{\delta_B}{4m} = \frac{113\ kN m^3}{4\ m\ EI} = 28{,}3\ \frac{kN m^2}{EI}\ (\circlearrowright)$$

$$\Rightarrow \delta_c = \delta_c' + \delta_c'' = (9 + 198)\ \frac{kN m^3}{EI} = 207\ \frac{kN m^3}{EI} = 0{,}0206\ m = 20{,}6\ mm$$

$$\theta_c^{izq} = (4{,}5 + 28{,}3)\ \frac{kN m^2}{EI} = 32{,}8\ \frac{kN m^2}{EI} = 0{,}00326 = 3{,}26 \times 10^{-3}\ (\circlearrowright)$$

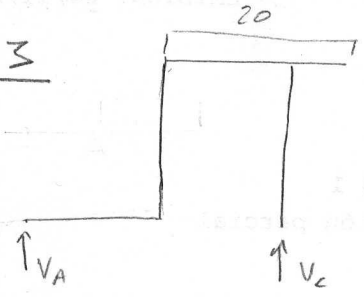
$$\theta_c^{d'} = \frac{9kN m \cdot 3m}{6\ EI} = \frac{9}{2}\ \frac{kN m^2}{EI}\ (\circlearrowleft) = 0{,}000448$$

$$\theta_c^{d''} = \frac{\delta_c}{3m} = \frac{0{,}0206\ m}{3m} = 0{,}00687\ (\circlearrowleft)$$

$$\theta_c^{der} = 0{,}00732\ (\circlearrowleft)$$

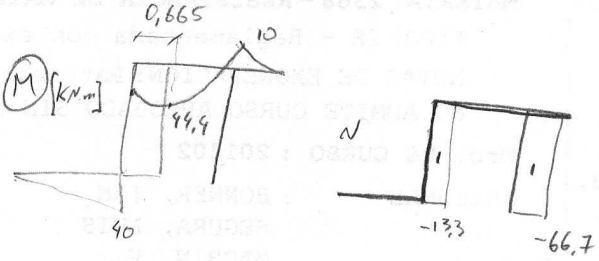
$$\theta_c^{der} = 7{,}32 \times 10^{-3}\ (\circlearrowleft)$$

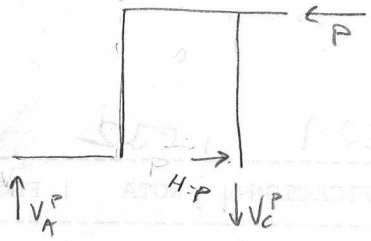
Ej. 3



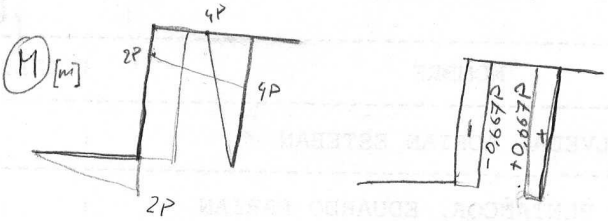
$20 \cdot 4 \cdot 5 = V_C \cdot 6 \Rightarrow \underline{V_C = 66,7\ kN}$

$V_A = 20 \cdot 4 - 66,7 \Rightarrow \underline{V_A = 13,3\ kN}$





$V_A^P = V_C^P = P \cdot 4/6 = 0,667\ P$



M_{DE} $\quad (V_A + V_A^P) - q \cdot x_m = 0$

$13,3 + 0,667\,P - 20 \cdot x_m = 0$

$\Rightarrow x_m = \underline{\dfrac{13,3\,kN + 0,667\,P}{20\,kN/m}}$

$M_{max} = M_D + \Delta M$

$M_D = 40\ kN.m + 2P_m$

$\Delta M = \dfrac{V_D \cdot x_m}{2} = \dfrac{(13,3\,kN + 0,667P)^2}{2 \cdot 20\,kN/m}$

$M_{max} = 40\ kN.m + 2P_m + \dfrac{(13,3\,kN + 0,667P)^2}{2 \cdot 20\,kN/m}$

$4,42\ kNm + 0,444\,P_m + 0,0111\ \dfrac{P^2 m}{kN}$

$M_{adm} = \sigma_{adm} \cdot W = 140\ 10^6\ N/m^2 \cdot 442\ 10^{-6}\ m^3$

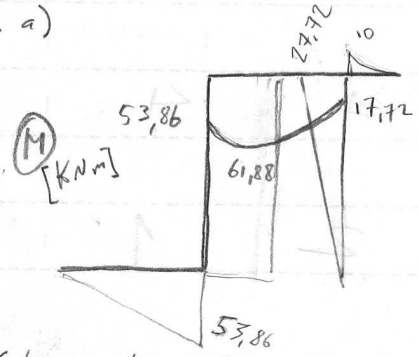
$M_{adm} = 61880\ N.m = 61,88\ KN.m$

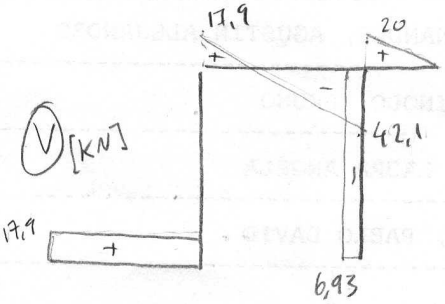
$M_{max} = M_{adm} \Rightarrow 0,0111\ \dfrac{P^2 m}{kN} + 2,444\,P_m - 17,46\ kN_m = 0$

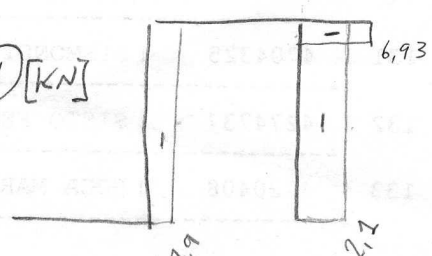
$\Rightarrow M_{max} = 44,42\ KN_m + 2,444\,P.m + 0,0111\ \dfrac{P^2 m}{kN}$

$\dfrac{-2,444 \pm \sqrt{(2,444)^2 + 4 \cdot 0,0111 \cdot 17,46}}{2 \cdot 0,0111} = \begin{cases} P_1 = 6,93\ kN \\ P_2 = -227\ kN \end{cases} \Rightarrow x_m = 0,90\ m$ ✓

2. a)





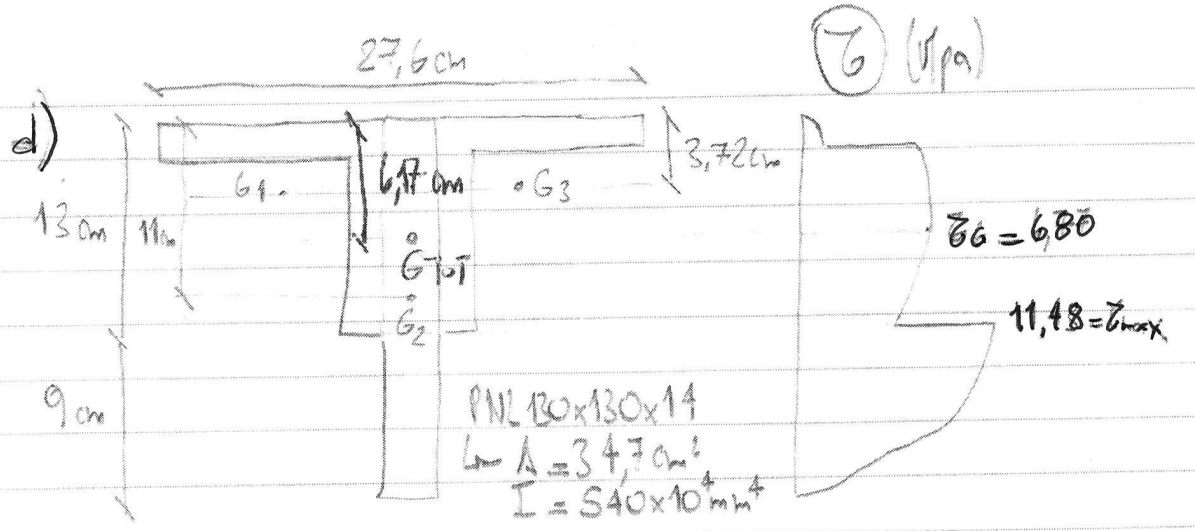


b) Colocar el perfil para que la flecha disminuya la tensión max. ⇒

BD: el ala a la izquierda.
CE: el ala a la derecha
EF: el ala hacia abajo

DE y AB es indiferente

d)



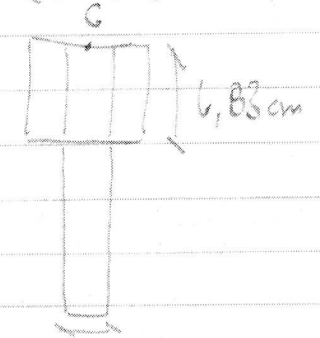
$A_{TOT} = 22 \times 1,6 + 2 \times 34,7 \rightarrow A_{TOT} = 104,6\ cm^2$

$y_G = \frac{1}{A_{TOT}} (2 \times 3,72 \times 34,7 + 22 \times 1,6 \times 11) \rightarrow y_G = 6,17\ cm$

$I_{x\,TOT} = 2\left(540 \times 10^{4} \times 10^{-12}\ m^4 + 34,7 \times 10^{2} \times 10^{-4}\ m^2 \times (6,17 - 3,72)^2 \times 10^{-4}\ m^2\right) + \frac{1,6 \times (22)^3}{12}\ cm^4 + 22 \times 1,6\ cm^2 (11 - 6,17)^2\ cm^2$

$I_{x\,TOT} = 3,73748 \times 10^{-5}\ m^4$

y_G:



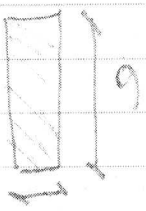
$y_G = 4,4 \times \frac{6,83^2}{2} + 1,6 \times 9 \times (6,83 + 4,5)$

$y_G = 265,78\ cm^3$

$\sigma_G = 42,1 \times 10^{3}\ N \times 265,78 \times 10^{-6}\ m^3 \,/\, 3,73748 \times 10^{-5}\ m^4 \times 4,4 \times 10^{-2}\ m$

$\sigma_G = 6,80 \times 10^{6}\ N/m^2 = 6,80\ MPa$

M:



$M = 9 \times 1,6 \times (6,83 + 4,5) \rightarrow M = 163,15\ cm^3$

$b = 1,6\ cm \rightarrow \sigma_{máx} = 11,48\ MPa$

Esta tensión se encuentra en la sección E del lado del vano D E.