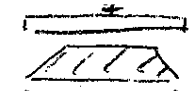
Ejercicio 1

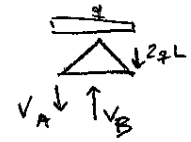
Tramo CG



$\Sigma M_C = 0 \quad V_G = \frac{4L \cdot q \cdot 2L}{4L} = 2qL$

$\Sigma V = 0 \quad V_C = 4qL - 2qL = 2qL$

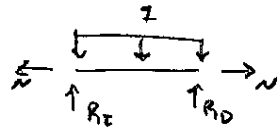
Tramo AC



$\Sigma M_A = 0 \quad V_B = \frac{2qL \cdot L + 2qL \cdot 2L}{1L}$

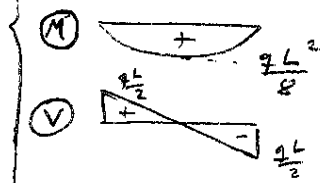
$\Sigma V = 0 \quad V_A = 6qL - 2qL - 2qL$

Barras con carga:



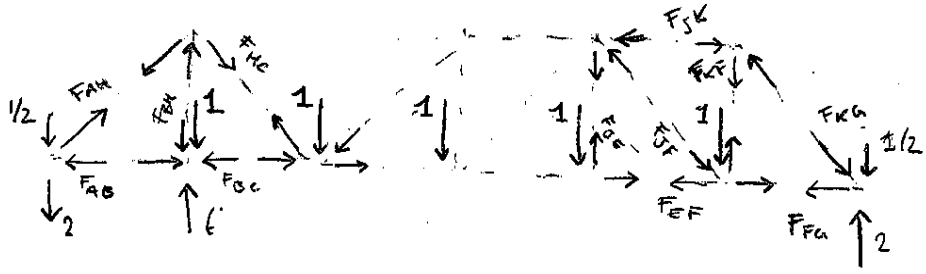
$R_D = R_I = \frac{qL}{2} \Rightarrow$

Diag. s.l.c.t.



para todas las barras con carga.

Eq. nodos: (todo × qL)



Nodo G:

$(\Sigma V) \quad F_{KGV} = 1,5$

$F_{KGH} = F_{KGV} = 1,5 \Rightarrow F_{KG} = \sqrt{2} \cdot 1,5 = 2,12$

$(\Sigma H) \quad F_{FG} = 1,5$

Nodo K

$(\Sigma H) \quad F_{JK} = 1,5$

$(\Sigma V) \quad F_{KF} = 1,5$

Nodo F

$(\Sigma V) \quad F_{JFV} = 1,5 - 1 = 0,5$

$F_{JFH} = F_{JFV} = 0,5$

$\hookrightarrow F_{JF} = \sqrt{2} \cdot 0,5 = 1,0$

$(\Sigma H) \quad F_{EF} = 1,5 + 0,5 = 2$

Nudo E

$(\Sigma V) \quad F_{JE} = 1$

Verifico Nudo J

$(\Sigma V) \quad 1 = 0,5 \times 2 \checkmark$

Por simetría tramo CG

$F_{IJ} = F_{JK} = 1,5$

$F_{DJ} = F_{JF} = 1,06$

$F_{DE} = F_{EF} = 2$

$F_{CI} = F_{KG} = 2,12$

$F_{CD} = F_{FG} = 1,5$

Nodo A

$(\Sigma V) \quad F_{AHV} = 2 + 1/2 = 2,5$

$F_{AHH} = F_{AHV} = 2,5$

$F_{AH} = \sqrt{2} \cdot 2,5 = 3,54$

$F_{AB} = F_{AHH} = 2,5$

Nodo H

$(\Sigma H) \quad F_{HCH} = F_{AHH} = 2,5 \Rightarrow F_{HC} = 3,54$

$(\Sigma V) \quad F_{BH} = F_{HCV} + F_{AHV} = 2,5 + 2,5 = 5$

Nodo B

$(\Sigma V) \quad 5 + 1 = 6 \checkmark$

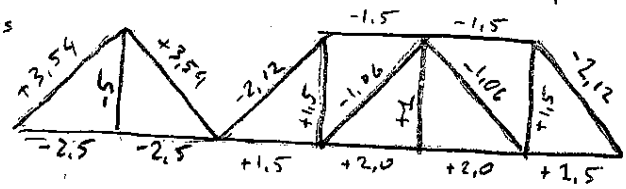
$(\Sigma H) \quad F_{BC} = F_{AB} = 2,5$

Nodo C (verif)

$(\Sigma H) \quad 1,5 + 2,5 = 2,5 + 1,5 \checkmark$

$(\Sigma V) \quad 1 + 1,5 = 2,5 \checkmark$

Directos



Ej. 1. parte b) cordon inferior

$$M = \frac{qL^2}{8} = \frac{50\ KN/m\ (1m)^2}{8} = 6.25\ KNm$$

$$N_{max} = 2,5\ qL = 2,5 \cdot 50 KN/m \cdot 1m = 125\ KN$$

$$\frac{6,25\ KNm}{W} + \frac{125\ KN}{A} \leq 140\ MPa = 140\ \frac{KN}{cm^2}$$

$$\frac{625\ cm}{14\ KN/cm^2\ W} + \frac{125}{14\ KN/cm\ A} \leq 1$$

$$\boxed{\frac{44,6\ cm^3}{W} + \frac{8,93\ cm^2}{A} \leq 1}$$

tanteo PNI 14 $0,54 + 0,49 = 1,03$ ×

PNI 16 $0,38 + 0,39 = 0,77 \leq 1$ ✓ $\Rightarrow$ **PNI 16**

barras sup

$$N_{max} = 5\ qL = 250\ KN$$

$$\sigma_{max} = \frac{N_{max}}{A} \leq \sigma_{adm} \Rightarrow A \geq \frac{N_{max}}{\sigma_{adm}} = \frac{250\ KN}{14\ KN/cm^2}$$

$$A \geq 17,89\ cm^2 \Rightarrow a \geq \sqrt{17,89} = 4,23$$

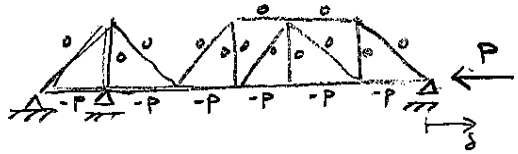
$$\boxed{a \geq 4,23\ cm}$$

parte c)

Barra	$F(qL)$	$\Delta\ell\left(\frac{qL}{AE}\right)$	$F(P)$	$\Delta\ell_P\left(\frac{P}{AE}\right)$
AB	-2,5	-2,5	-1	-1
BC	-2.5	-2.5	-1	-1
CD	+1,5	+1,5	-1	-1
DE	+2	+2	-1	-1
EF	+2	+2	-1	-1
FG	+1,5	+1,5	-1	-1

Barra alineadas $\delta_G^q = \Sigma\ \Delta\ell = 2\ \frac{qL}{AE}$

Fuerza en G: (horiz, la vert. no produce desp)



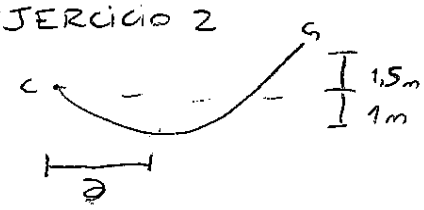
$$\delta_{G(P)} = \Sigma\ \Delta\ell(P) = -6\ \frac{P}{AE}$$

$$\delta_{Tot} = \delta_G^q + \delta_{G(P)} = 2\ \frac{qL}{AE} - 6\ \frac{P}{AE} = 0$$

$$\Rightarrow \underline{\underline{P = \frac{2}{6}\ qL = \frac{1}{3}\ qL = \frac{50\ KN/m \cdot 1m}{3} = 16,7\ KN}}$$

EJERCICIO 2

a)



$q = 1,5\,kN/m$

$y(x) = \frac{q}{2H}x^2 + bx + c$

$y(0) = 0 \rightarrow c = 0$

- $y(6m) = 1,5m \rightarrow \frac{q}{2H}(6m)^2 + b(6m) = 1,5m$ (1)
- $y'(a) = 0 \rightarrow \frac{q}{H}(a) + b = 0$ (2)
- $y(a) = -1m \rightarrow \frac{q}{2H}a^2 + ba = -1m$ (3)

Por (2) $b = -\frac{1,5\,kN/m \cdot a}{H}$

(2) y (3) $\frac{1,5\,kN/m}{2H}a^2 - \frac{1,5\,kN/m \cdot a}{H} \cdot a = -1m \rightarrow 1m = \frac{1,5\,kN/m}{2H}a^2 \rightarrow \boxed{2H = 1,5\frac{kN}{m}a^2}$

(1) y (2) $\frac{1,5\,kN/m}{2H}(6m)^2 - \frac{1,5\,kN/m \cdot a \cdot 6m}{H} = 1,5m \rightarrow \boxed{\frac{27\,kN\,m}{H} - \frac{9\,kN/m\,a}{H} - 1,5m = 0}$

[B] $27\,kN\,m - 9\,kN/m \cdot a - 1,5m \cdot H = 0$ y por [A] $H = 0,75\frac{kN}{m^2}a^2$

$\rightarrow -1,125\frac{kN}{m}a^2 - 9\frac{kN}{m}a + 27\,kN\,m = 0 \rightarrow a = \frac{9 \pm \sqrt{9^2 + 4 \cdot 27 \cdot 1,125}}{2,25}$

$a = 2,32m$ y [A] $\boxed{H = 4,05\,kN}$

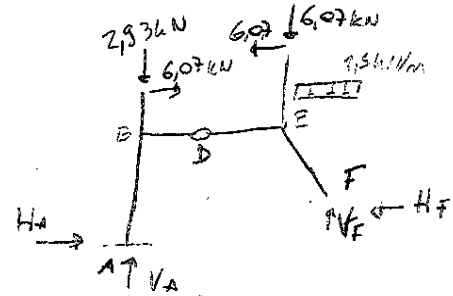
b) H aumenta 50% $\rightarrow H = 6,07\,kN \rightarrow y(x) = \frac{1,5\,kN/m}{2 \times 6,07\,kN}x^2 + bx$

$y(6m) = 1,5m \rightarrow y(6m) = \frac{1,5\,kN/m \cdot 36m^2}{2 \times 6,07\,kN} + b \cdot 6m \rightarrow b = -0,49$

$\rightarrow y(x) = 0,123x^2 - 0,49x \rightarrow y'(0) = 0,49$ y $\boxed{y'(6m) = 0,99}$ ← EN PUNTO DE Tmáx ES G.

$\rightarrow y'(x) = 0,99 \quad \alpha \simeq 44°42' \rightarrow V_G = H_G = 6,07\,kN \rightarrow T_{max} = 6,07\,kN \cdot \sqrt{2} = 8,5$

$\boxed{T_{max} = 8,59\,kN}$



$V_C + V_{C_1} = 1,5\,kN/m \cdot 6m \rightarrow V_C = 2,93\,kN$

$V_A + V_F = 12\,kN$

$H_A = H_F$

$\sum M_D^{izq} = 0 = V_A \cdot 3m - H_A \cdot 4m - 2,93kN \cdot 3m + 6,07kN \cdot 1m$

$\sum M_F = 0 = V_A \cdot 8m - H_A \cdot 2m - 2,93kN \cdot 8m - 6,07kN \cdot 2m - 1,5kN/m \cdot 1m \cdot 2m$

$V_A \cdot 3 - 4H_A = 2,72$

$V_A \cdot 8 - 2H_A = 47,68$

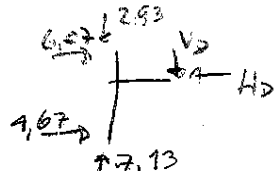
$V_A \cdot 3 - 4H_A = 2,72$

$V_A \cdot 16 - 4H_A = 95,37$

$13V_A = 7,13\,kN$

$\boxed{V_A = 7,13kN} \rightarrow \boxed{V_F = 4,87kN}$

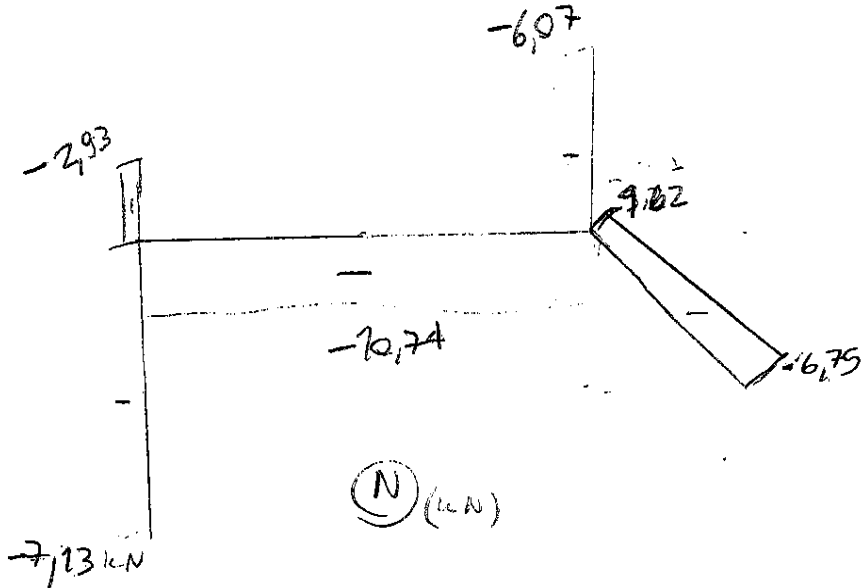
$H_A = H_F = 4,67\,kN$



$H_D = 10,74kN$

$V_D = 9,20kN$

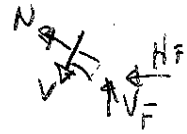
EJERCICIO 2 (CONT.)

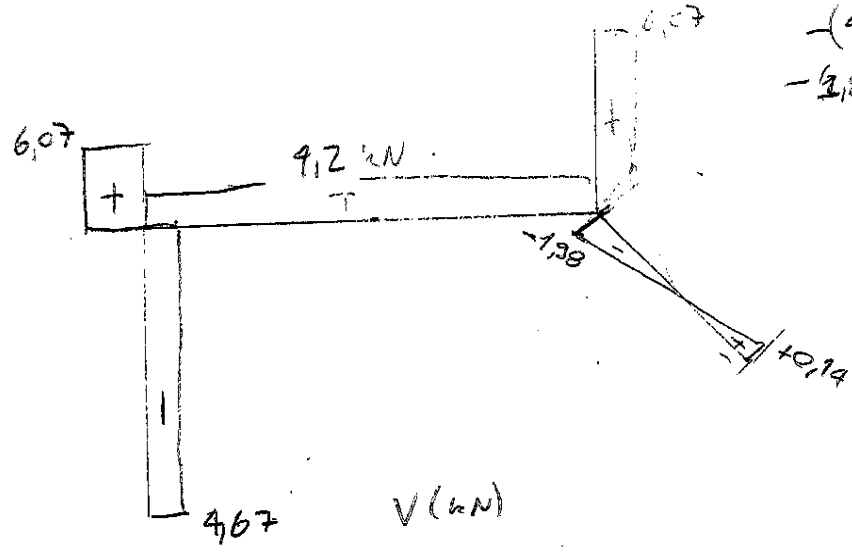


N (kN)

$(4,87+4,67)\frac{\sqrt{2}}{2} = 6,75$

$(1,87+4,67)\frac{\sqrt{2}}{2} = 4,62$

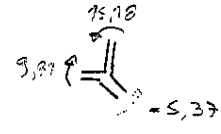


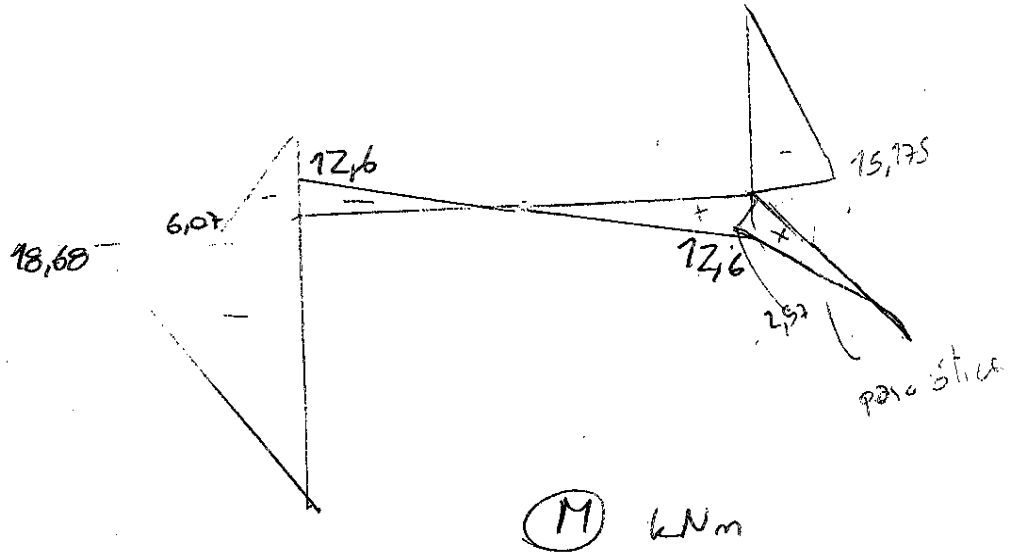


V (kN)

$-(4,87-4,67)\frac{\sqrt{2}}{2} = -0,14$

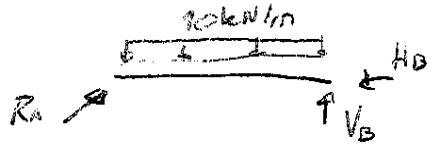
$-(1,87-4,67)\frac{\sqrt{2}}{2} = +1,98$





M kNm

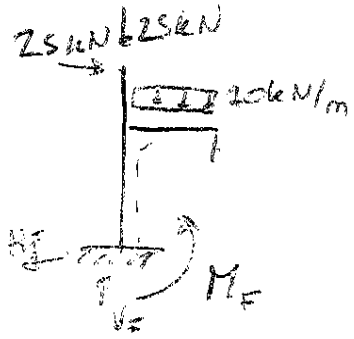
EJERCICIO 3



$R_A \cdot \frac{\sqrt{2}}{2} + V_B = 50kN$

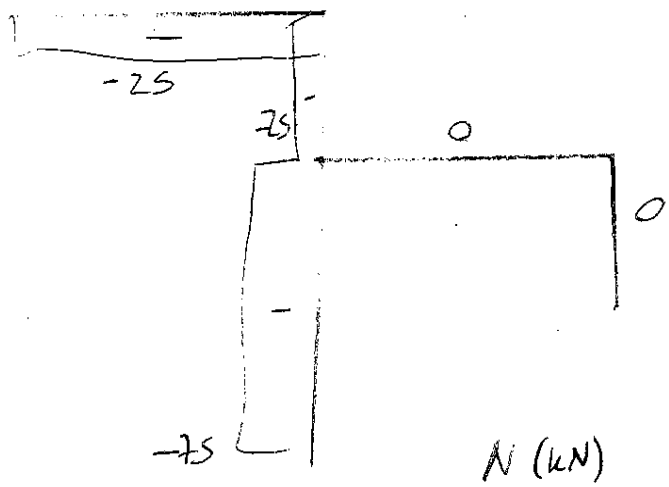
$\sum M_A = 0 = 5 V_B - 10kN/m \cdot 5m \cdot 2{,}5m$

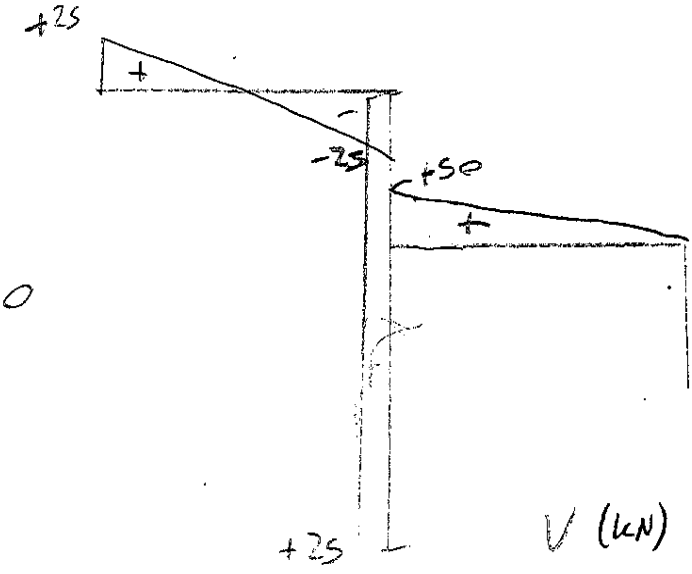
$\rightarrow V_B = 25\,kN \quad R_A = \sqrt{2} \cdot 25kN \quad H_B = 25kN$

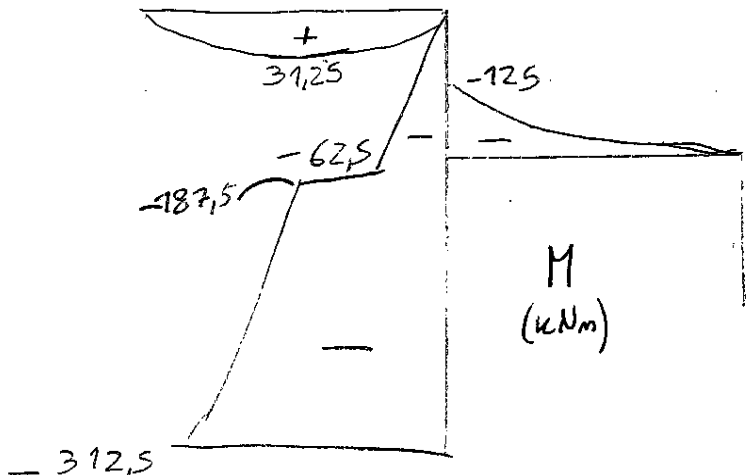


$V_F = 25kN \quad H_F = 25kN$

$M_F = 50kN \cdot 2{,}5m + 25kN \cdot 2{,}5m = +312{,}5kNm$







Peor combinación de solicitaciones

$M = -312{,}5kNm \quad N = -75kN$

$I = I_{perfil} + 2 \times 13cm \times 2cm \times \left(\frac{h}{2} + 1\right)^2$

$A = A_{perfil} + 2 \times 13cm \times 2cm$

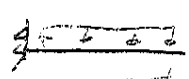
$\frac{14kN}{cm^2} \geq \frac{31250kNcm}{I + 52\left(\frac{h}{2} + 1\right)^2}\left(\frac{h}{2} + 2\right) + \frac{75kN}{A + 52cm^2}$

PNI 38 $I = 24010cm^4$ $A = 107cm^2$ $I_{TOT} = 44810$ $A_{TOT} = 159cm^2$ $\sigma_{max} = 15{,}12kN/cm^2$ NO.

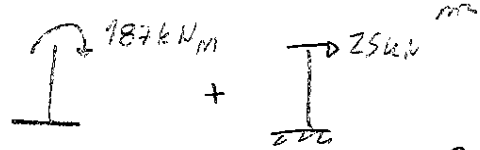
PNI 40 $I = 29210cm^4$ $A = 118cm^2$ $I_{TOT} = 52142cm^4$ $A_{TOT} = 170cm^2$ $\sigma_{max} = 13{,}63kN/cm^2$ OK.

PNI 40.

$\vec{\delta_E} = -\theta_D \cdot 2{,}5m + \vec{\delta_C}$ $\quad I = 5214{,}2\,cm^4 \quad E = 210\,GPa = 21$

$\theta_D \rightarrow$ si $\theta_C = 0$ 

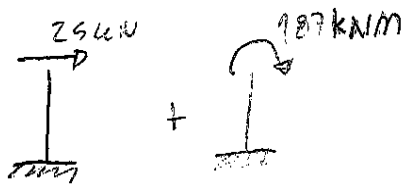
$\theta_{D_1} = \frac{q L^3}{6EI} = \frac{10\,kN/m\,(5m)^3}{6 \cdot 5{,}2142\times10^{-4}\,m^4 \times 21\times10^7\,kN/m^2} = 1,9$

$\theta_C \neq 0 \rightarrow \theta_{D_2} = \theta_C \rightarrow$ 

$\theta_C = \frac{P L^2}{2EI} = \frac{25kN\,(5m)^2}{2 \cdot 21\times10^7\,\frac{kN}{cm^2} \times 5{,}2142\times10^{-4}\,m^4} = 2{,}85\times10^{-3}$

$\theta_C = \frac{M_0 L}{EI} = \frac{187\,kNm \cdot 5m}{5{,}2142\times10^{-4}\,m^4 \times 21\times10^7\,kN/m^2} = 8,5$

$\theta_D = (2{,}85 + 1{,}9 + 8{,}5)\times10^{-3} = 13{,}25\times10^{-3}$

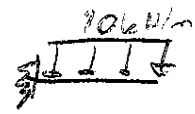
$\vec{\delta_C}$ 

$\delta_C = \frac{25kN\,(5m)^3}{3 \cdot 21\times10^7\,kN/m^2 \cdot 5{,}2142\times10^{-4}\,m^4} = 9{,}51\times10^{-3}$

$\delta_C^2 = \frac{187\,kNm \cdot (5)^2}{2 \cdot 21\times10^7\,\frac{kN}{m^2} \times 5{,}2142\times10^{-4}\,m^4} = 0{,}021$

$\vec{\delta_C} = 0{,}0305m$ hacia la derecha

$\vec{\delta_E} = 0{,}0305m - 2{,}5m \times 1{,}325\times10^{-2} = \underline{2{,}6mm}$ hacia la

$\delta_E^{\downarrow} = \delta_D^{\downarrow}$ $\quad \delta_D^1$ 

$\delta_D^1 = \frac{5qL^4}{384EI} = \frac{10\,kN/m\,(5m)^4}{384 \cdot 21\times10^7\,kN/m^2 \times 5{,}2142\times10^{-4}\,m^4} = 7{,}1\times1$

$\theta_C \neq 0 \rightarrow \delta_D^2 = \theta_C \cdot L = (8{,}5 + 2{,}85)\times10^{-3} \cdot 5m = 5{,}67cm$

$\boxed{\delta_E^{\downarrow} = 6{,}4cm}$