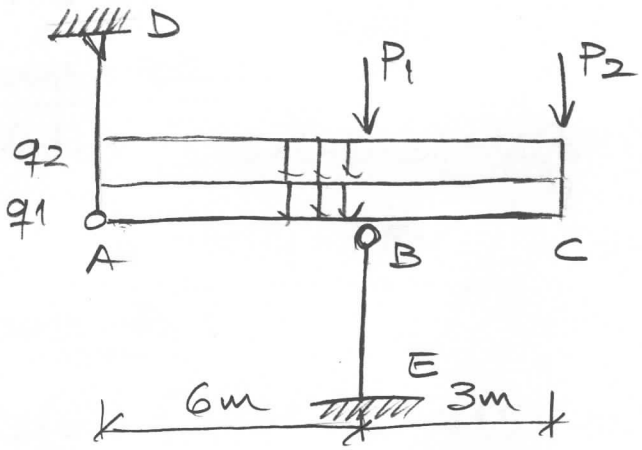
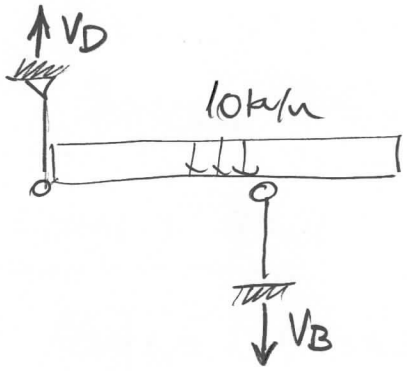
AM17 - Bl - 1000

EDIFICAÇÃO COMERCIAL
AÇO MR250



q1: PP VIGA MET. 10 kN/m 1,25 –
q2: OCUPAÇÃO 35 kN/m 1,50 0,7
P1: PP EQUIP. FIXO: 50kN 1,50 –
P2: SOBREC. MANUT.: 40kN 1,50 0,7

⇒ DETERMINAR OS INTERVALOS DE SOLICITAÇÃO NAS BARRAS AD E BE;



q1 $\Sigma M_A = 0 \circlearrowright +$

$V_B \times 6m + 10kN/m \times 9m \times 4,5m =$

$V_B = \frac{1}{6} \times (-405) = \underline{-67,5\ kN}$

$\Sigma F_V = 0 \quad \uparrow +$

$V_D + 67,5kN - 10\frac{kN}{m} \times 9m = 0$

$V_D = -67,5 + 9 \times 10 = \underline{+22,5\ kN}$

P/q2 IDEM PORÉM:

$V_B = \frac{1}{6}(-35 \times 9 \times 4,5) = \underline{-236,25\ kN}$ $(3 \times V_{B\,q1})$

$V_D = -236,25 + 35 \times 9 = \underline{+78,75\ kN}$ $(3 \times V_{D\,q1})$

P/P1: $V_B = \underline{-50\ kN}$

$V_D = \underline{0\ kN}$

P/P2:

$\Sigma M_A = 0 \circlearrowright + \quad V_B \times 6m + 40kN \times 9m = 0$

$V_B = \frac{1}{6}(-40 \times 9) = \underline{-60\ kN}$

$\Sigma F_V = 0 \quad \uparrow + \quad 60kN - 40kN + V_D = 0$

$V_D = 40 - 60 = \underline{-20kN}$

P/ Barra AD:

COMB1 Q2:

$N_{sd1} = [1,25 \times (-67,5) + 1,5(-50)] + 1,5(-236,25) + [1,5(-60) \times 0,7]$

$= -576,75\ kN$ //

COMB P2:

$N_{sd2} = [1,25(-67,5) + 1,5 \times (-50)] + 1,5(-60) + [1,5(-236,25) \times 0,7]$

$= -497,44\ kN$ //

P/ Barra BE:

COMB1 Q2:

$N_{sd1} = [1,25 \times 22,5] + 1,5(78,75)$

$= +146,25\ kN$

COMB2 P2:

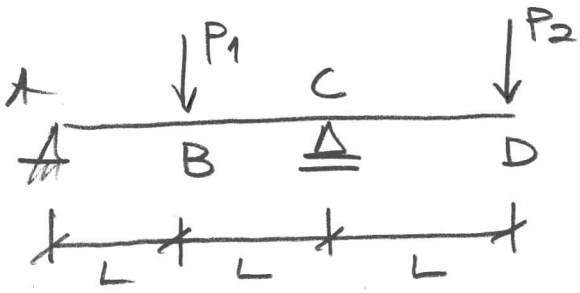
$N_{sd2} = [1,0 \times 22,5] + 1,5(-20)$

$= -7,5\ kN$

AD: $[-497,44 ; -576,75]\ kN$

BE: $[-7,5 ; 146,25]\ kN$

AM17-B1-1001



DADOS:

P_1: P.P. EST. MET. 100kN

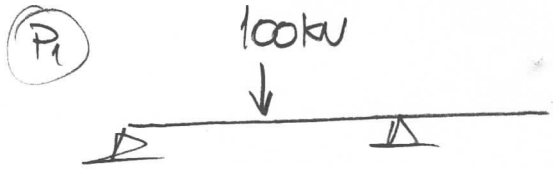
P_2: ACID. OCUPAÇÃO 250kN

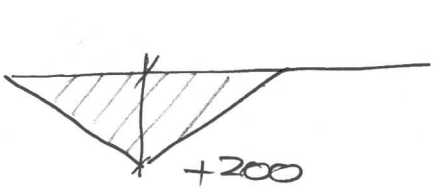
L = 4m EDIFICAÇÃO COMERCIAL

COMB. NORMAL (ELU)

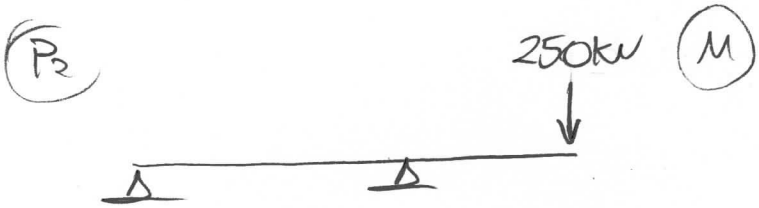
=> PEDE-SE:

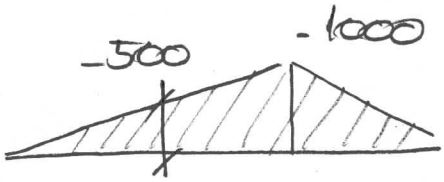
MÁXIMO E MÍNIMO MOMENTO FLETOR NO PONTO B;





$$\frac{Pab}{L} = \frac{100kN \times 4m \times 4m}{8m} = 200kNm$$





$M_C = -250 \times 4m = -1000kNm$

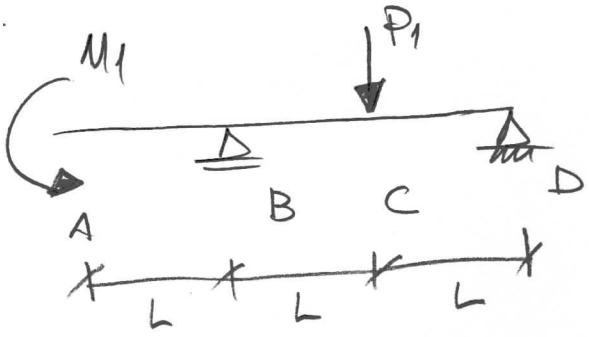
$M_B = -1000kNm/2 = -500kNm$

$M_{sd\,B}^{máx} = 1,25 \times 200kNm = \underline{+250kNm}$

$M_{sd\,B}^{mín} = 1,00 \times 200kNm + 1,5 \times (-500kNm) = \underline{-550kNm}$

RESPOSTA: $M_{sd\,B} = [-550kNm;\ +250kNm]$

AM17 - B1 - 1002



- EDIFICAÇÃO COMERCIAL
- L = 4,0 m

CARGAS:

M1 : P.P. EST. METÁLICA : 600 kNm

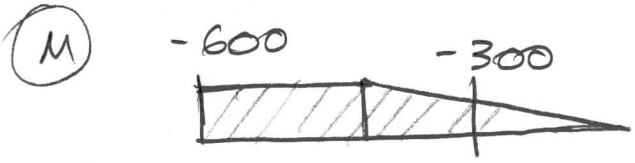
P1 : ACIDENTAL OCUPAÇÃO : 120 kN

PEDE-SE

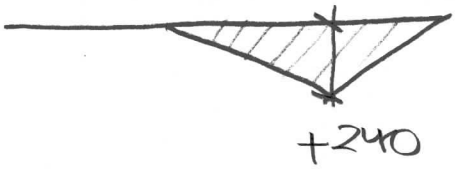
MÁXIMO E MÍNIMO MOMENTO NO PONTO C;

→ COMB. NORMAL ELU;









$$\frac{Pab}{L} = \frac{120kN \times 4m \times 4m}{8m} = 240 kNm$$

COMB 1 (+)

$$M_{sd_C^1} = 1{,}00 \times (-300) + 1{,}5 \times 240 = +60\ kNm$$

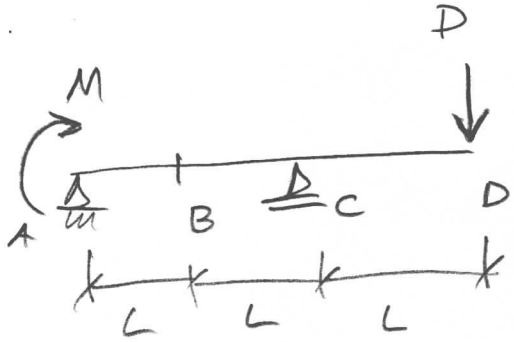
COMB 2 (−)

$$M_{sd_C^2} = 1{,}25 \times -300 = -375\ kNm$$

RESPOSTA: $M_{sd_C} = [-375\ kNm;\ +60\ kNm]$

AM17-B1-1003

- EDIFICAÇÃO COMERCIAL
- COMBINAÇÃO NORMAL ELU
- L = 4m



CARGAS:

M: P.P. DE EST. METÁLICA: 120kNm

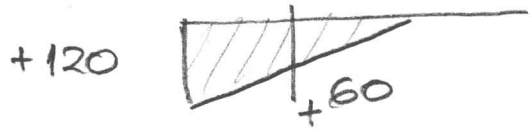
P: ACID. DE OCUPAÇÃO: 80kN

PEDE-SE:

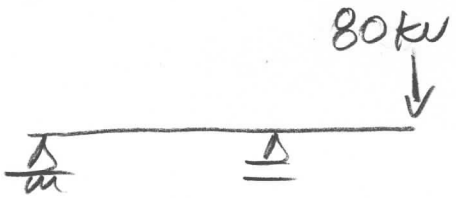
MÁXIMO E MÍNIMO MOMENTO FLETOR NO PONTO B;

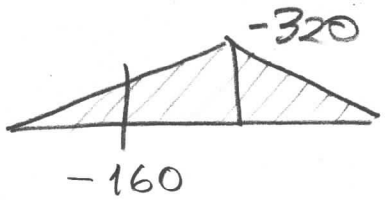
M:





P:





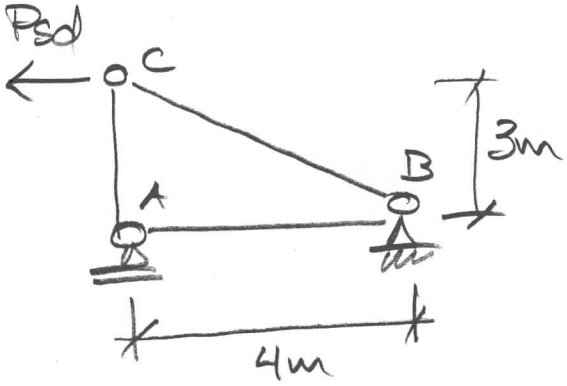
COMB1 ⊕ $M_{sd_B} = 1{,}25 \times 60\,kNm = +75\,kNm$

COMB2 ⊖ $M_{sd_B} = 1{,}00 \times 60\,kNm + 1{,}50(-160)\,kNm$

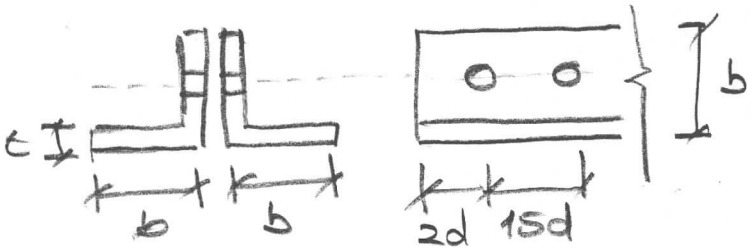
$= -180\,kNm$

RESPOSTA: $M_{sd_B} = [-180\,kNm;\ +75\,kNm]$

AM17-B1-2000



=> DETALHE DAS FOLHAS DAS BARRAS;



- AÇO MR250;
- ADOTAR $C_t = 0,90$;
- $d_{NOMINAL} = 16mm$;
- $b = 120mm$ / $t = 8mm$

CALCULAR QUAL A MÁXIMA CARGA Psd POSSÍVEL DE SER APLICADA P/ QUE A BARRA $\overline{CB}$ RESISTA EM TERMOS DAS VERIFICAÇÕES ESB E RSL?

$$A_g = \left(b - \frac{t}{2}\right) \times 2 \times t \times 2 = \left(12 - \frac{0,8}{2}\right) \times 2 \times 0,8 \times 2 = 37,12 cm^2$$

$$d_{pad} = 16mm + 3,5mm = 19,5mm = 1,95cm$$

$$A_n = 37,12 cm^2 - 1,95cm \times 0,8cm \times 2 = 34 cm^2$$

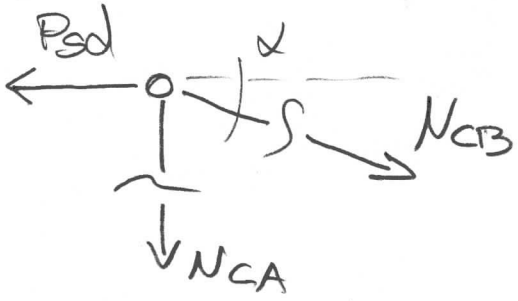
$$A_e = 0,90 \times 34 cm^2 = 30,6 cm^2$$

$$Rdt_{ESB} = 37,12 cm^2 \times 25 kN/cm^2 / 1,1 = 843,64 kN$$

$$Rdt_{RSL} = 34 cm^2 \times 40 kN/cm^2 / 1,35 = 1007,4 kN$$

Máximo $N_{sd\,CB} = 843,64 kN$

-> RELAÇÃO Psd x $N_{sd\,\overline{CB}}$



$\cos \alpha = 4/5$

$\operatorname{sen} \alpha = 3/5$

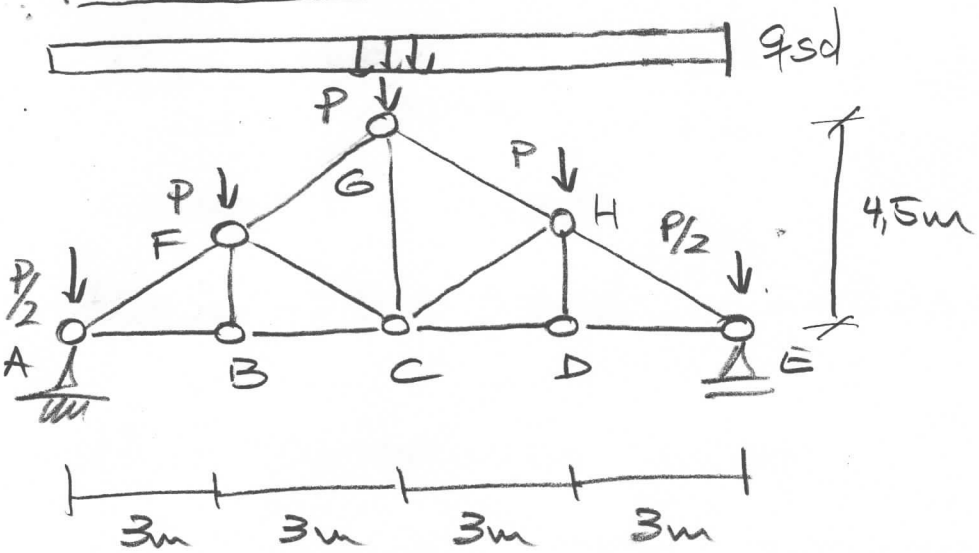
$\Sigma F_H = 0 \rightarrow \oplus$

$- P_{sd} + N_{CB} \times \cos \alpha = 0$

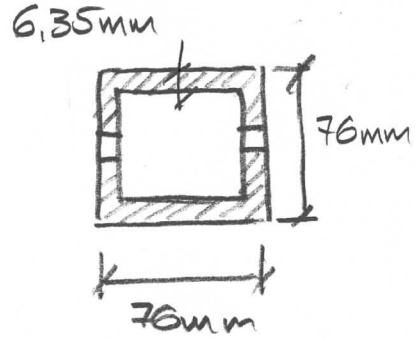
$P_{sd} = N_{CB} \times \cos \alpha = N_{CB} \times 4/5$

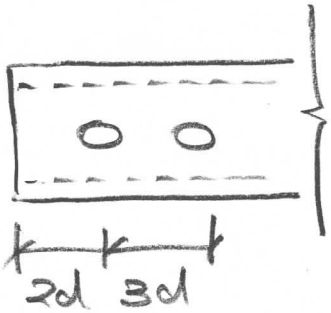
$P_{sd} = 843{,}64\,kN \times 4/5 = \boxed{674{,}91\,kN}$ //

AM17-B1-3000



SEÇÃO TRANSV. DE TODAS AS BARRAS





AÇO AR 350; PERFIL SOLDADO

d = 16mm; qsd É SEMPRE GRAVITACIONAL;

→ PEDE-SE:

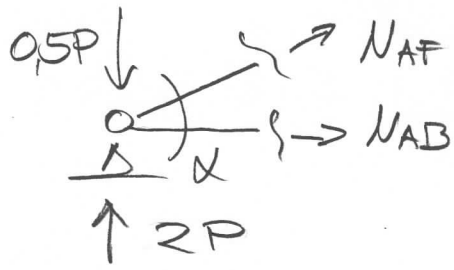
CALCULAR QUAL A MÁXIMA CARGA DISTRIBUÍDA qsd [em kN/m] EM VALOR DE CÁLCULO, POSSÍVEL DE SER APLICADA DE MODO QUE A BARRA $\bar{AF}$ ATENDA A SOLICITAÇÃO AO QUAL ESTÁ SUBMETIDA EM FUNÇÃO DE qsd;

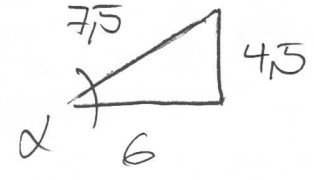
↳ RESOLUÇÃO:

REAÇÕES DE APOIO: $V_A = V_E = 2P$

RELAÇÃO P × qsd: $P = 3q_{sd}$

SOLICITAÇÃO EM $\bar{AF}$:





$\cos\alpha = 6/7{,}5 = 0{,}8$

$\operatorname{sen}\alpha = 4{,}5/7{,}5 = 0{,}6$

$\Sigma F_V = 0 \uparrow \quad 2P - 0{,}5P + N_{AF}\,sen\alpha = 0$

$N_{AF} = -1{,}5P / sen\alpha = -\frac{1{,}5P}{0{,}6} = -2{,}5P$

como $P = 3qsd$

$N_{AF} = -2{,}5 \times 3qsd = -7{,}5qsd$

AF É COMPRIMIDA LOGO:

$L_{ADO\ INTERNO} = 7{,}6cm - 2 \times 0{,}635cm = 6{,}33cm$

$Ag = (7{,}6cm)^2 - (6{,}33cm)^2 = 17{,}691\,cm^2$

$I = \frac{(7{,}6cm)^4}{12} - \frac{(6{,}33cm)^2}{12} = 144{,}2\,cm^4$

$r = \sqrt{\frac{144{,}2cm^4}{17{,}691cm^2}} = 2{,}855\,cm$

$\lambda = KL/r = \frac{1{,}0\sqrt{300^2+225^2}}{2{,}855cm} = \frac{1{,}0 \times 375cm}{2{,}855cm} = 131{,}3 < 200$ ok!

→ FLAMBAGEM LOCAL: (SOMENTE AA)

$b/t = \frac{6{,}33cm}{0{,}635cm} = 9{,}969$

$b/t_{lim} = 1{,}40\sqrt{\frac{20000\,kN/cm^2}{35\,kN/cm^2}} = 33{,}466$

$Qa = 1$
$Qs = 1$
$Q = 1$

→ FLAMBAGEM POR FLEXÃO:

$\lambda_{0y} = 131{,}3\sqrt{\frac{1 \times 35}{\pi^2 \times 20000}} = 1{,}748$

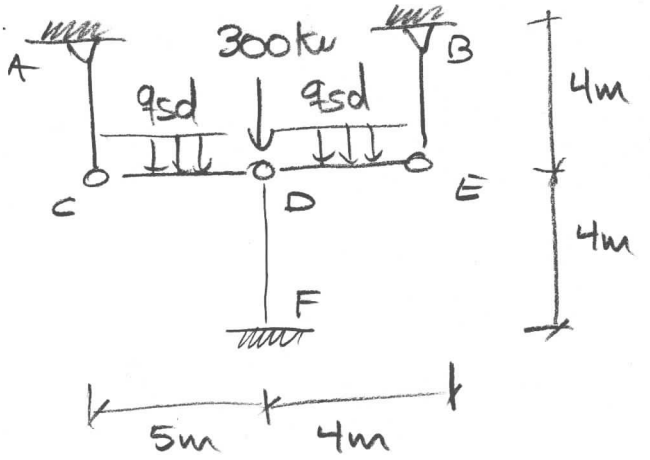
$$\chi_y = 0{,}877 / 1{,}748^2 = 0{,}2870$$

$$N_{cRd} = 0{,}2870 \times 1 \times 17{,}69\ cm^2 \times 35\ kN/cm^2 / 1{,}1$$

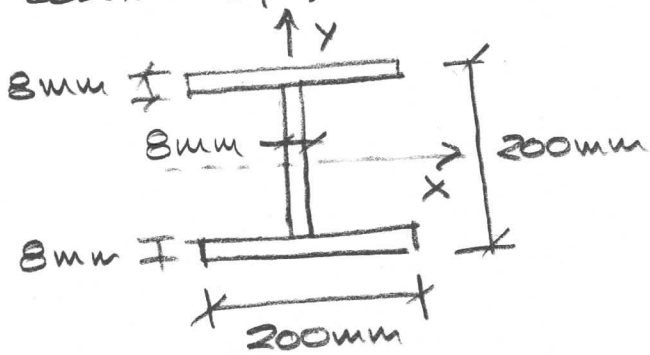
$$N_{cRd} = 161{,}5\ kN$$

$$q_{sd} = N_{AF} / 7{,}5 = \frac{161{,}5\ kN}{7{,}5\ m} = \boxed{21{,}53\ kN/m}$$

AM17-B1-3001



SEÇÃO TRANSVERSAL DA COLUNA DF:



AÇO MR250 / PERFIL SOLDADO

→ CONSIDERAR QUE AS VINCULAÇÕES SÃO IGUAIS PARA AMBOS EIXOS (X e Y);

↳ PEDE-SE: O MÁXIMO VALOR POSSÍVEL PARA A CARGA qsd [EM kN/m] DE MODO QUE A COLUNA DE ATENDA A VERIFICAÇÃO DE COMPRESSÃO CENTRADA;

$$Nsd = 300kN + qsd \times \left(\frac{4m}{2} + \frac{5m}{2}\right)$$

$$Nsd = 300kN + qsd \times 4{,}5m$$

$$qsd = (Nsd - 300kN)/4{,}5m$$

PROPRIEDADES GEOMÉTRICAS:

$$Ag = 0{,}8 \times (20 - 1{,}6) + 2 \times 0{,}8 \times 20 = 46{,}72cm^2$$

$$Iy = 2 \times 98 \times \frac{20^3}{12} + (20 - 1{,}6) \times \frac{0{,}8^3}{12} = 1067{,}5cm^4$$

$$ry = \sqrt{\frac{1067{,}5}{46{,}72}} = 4{,}7801cm \qquad ky = 0{,}8$$

$$\lambda y = 0{,}8 \times 400cm / 4{,}7801cm = 66{,}944 < 200 \text{ ok!!!}$$

FLAMBAGEM LOCAL:

→ ELEMENTO AA:

$$b/t_{AUM} = \frac{(20-1,6)\,cm}{0,8\,cm} = 23$$

$$b/t_{lim} = 1,49\sqrt{\frac{20000}{25}} = 42,143$$

$\Big\}$ $Qa = 1$

→ ELEMENTOS AL:

$$b/t_{MESA} = \frac{0,5 \times 20,0\,cm}{0,8\,cm} = 12,5 \quad (\text{GRUPO 5})$$

$$kc = \frac{4}{\sqrt{23}} = 0,83406$$

$$b/t_{lim} = 0,64\sqrt{\frac{20000}{(25/0,83406)}} = 16,532$$

$\Big\}$ $Qs = 1$

FLAMBAGEM POR FLEXÃO:

$$\lambda_{oy} = 66,944\sqrt{\frac{1 \times 25}{\pi^2 \times 20000}} = 0,75338$$

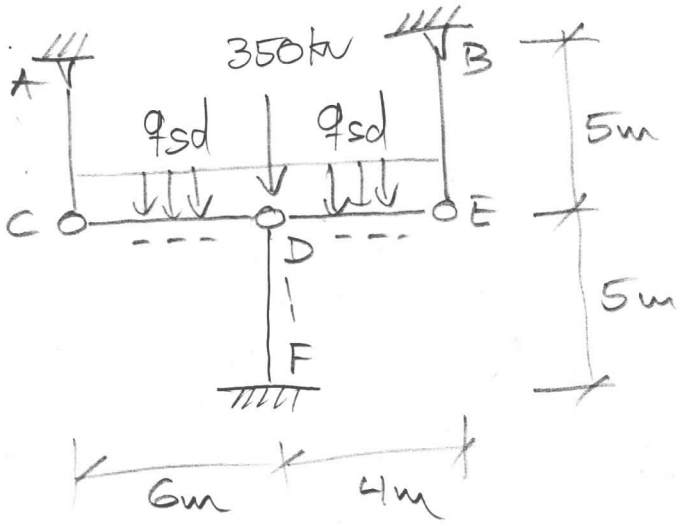
$$\chi_y = 0,658^{0,75338^2} = 0,78855$$

$$N_{CRd\,y} = 0,78855 \times 1 \times 46,72\,cm^2 \times 25\,kN/cm^2 \,/\, 1,1$$

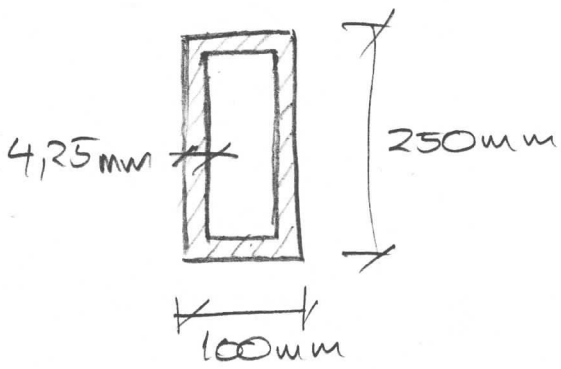
$$N_{CRd\,y} = 836,71\,kN$$

$$q_{sd} = (836,71\,kN - 300\,kN)/4,5\,m = \boxed{119,27\,kN/m}$$

AM17 - B1 - 3003



SEÇÃO TRANSVERSAL (GRUPO 1) DA COLUNA DF



AÇO MR250

PEDE-SE: Qual a máxima carga qsd (em valor de cálculo) possível de ser aplicada de modo que a coluna DF atenda as verificações pertinentes?

→ SOLICITAÇÃO NA COLUNA:

$$N_{sd} = 350kN + q_{sd} \times 6m/2 + q_{sd} \times 4m/2$$

$$N_{sd} = 350kN + q_{sd} \times 5m$$

$$q_{sd} = (N_{sd} - 350kN)/5m$$

→ PROPRIEDADES GEOMÉTRICAS (SOMENTE DO EIXO DE MENOR INÉRCIA)

$$A_g = 25 \times 10\,cm^2 - (25-0,85)(10-0,85)\,cm^2$$

$$A_g = 29,028\,cm^2$$

$$I_v = \frac{25 \times 10^3}{12} - \frac{(25-0,85)(10-0,85)^3}{12}$$

$$I_v = 541,64\,cm^4$$

$$r_V = \sqrt{\frac{541{,}64\,cm^4}{29{,}028\,cm^2}} = 4{,}3196\,cm$$

$$\lambda = \frac{0{,}8 \times 500\,cm}{4{,}3196\,cm} = 92{,}601 < 200 \text{ ok!}$$

→ FLAMBAGEM LOCAL: (SOMENTE AA)

$$b/t_{ALMA_V} = \frac{(250mm - 8{,}5mm)}{4{,}25mm} = \frac{241{,}5}{4{,}25} = 56{,}824$$

$$b/t_{lim} = 1{,}40\sqrt{\frac{20000\,kN/cm^2}{25\,kN/cm^2}} = 39{,}597$$

OCORRE FLAMBAGEM AA NAS CHAPAS VERTICAIS;

$$bef = 1{,}92 \times 0{,}425\sqrt{\frac{20000}{25}}\left[1 - \frac{0{,}38}{56{,}824}\sqrt{\frac{20000}{25}}\right] = 18{,}714\,cm$$

$$b/t_{ALMA_H} = \frac{(100mm - 8{,}5mm)}{4{,}25mm} = 21{,}529$$

NÃO OCORRE FLAMBAGEM AA NAS CHAPAS HORIZONTAIS;

$$Aef = 29{,}028\,cm^2 - 2[24{,}15\,cm - 18{,}714\,cm] \times 0{,}425\,cm$$

$$Aef = 24{,}407\,cm^2$$

$$Qa = \frac{24{,}407\,cm^2}{29{,}028\,cm^2} = 0{,}84081$$

→ FLAMBAGEM POR FLEXÃO;

$$\chi_0 = 92{,}601\sqrt{\frac{0{,}84081 \times 25}{\pi^2 \times 20000}} = 0{,}95559$$

$$\chi = 0{,}658^{0{,}95559^2} = 0{,}68236$$

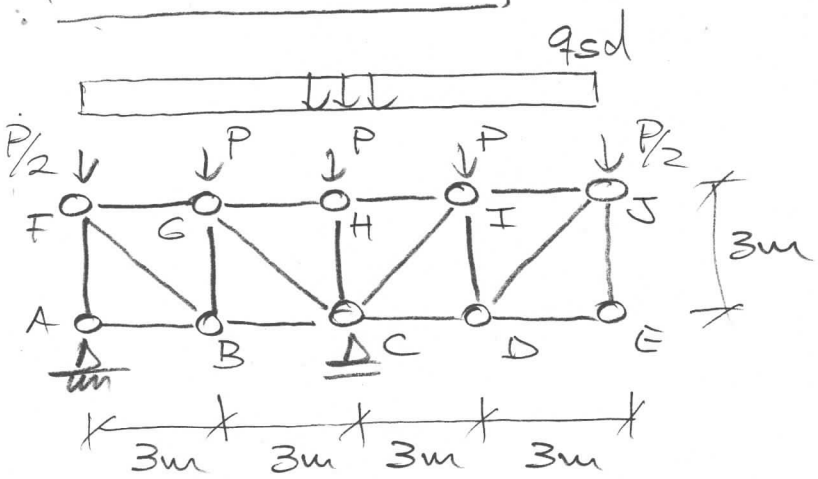
$$N_{crd} = 0{,}68236 \times 0{,}84081 \times 29{,}028\,cm^2 \times 25\,kN/cm^2 / 1{,}1$$

$$N_{crd} = 378{,}51\,kN$$

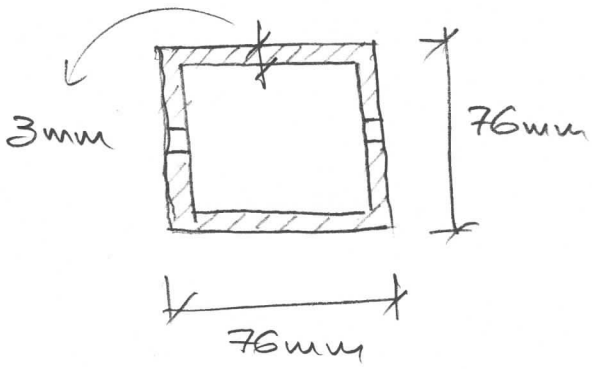
$$q_{sd} = (378{,}51 - 350)\,kN / 5\,m$$

$$\boxed{q_{sd} = 5{,}702\,kN/m}$$

AM17 - B1 - 3002

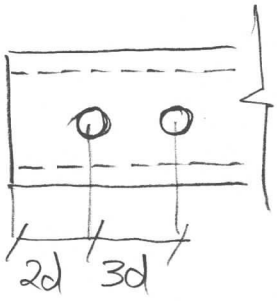


SEÇÃO TRANSVERSAL DAS BARRAS



NR250 / d = 16mm

DETALHE DAS POLIAS DAS BARRAS

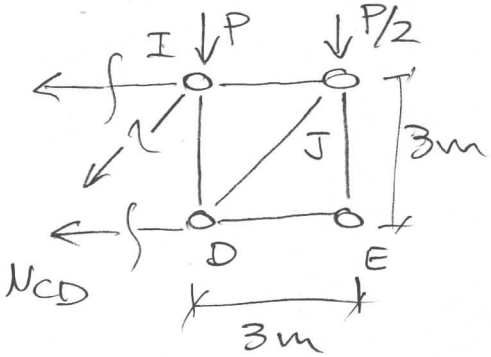


PEDE-SE: Qual a máxima carga distribuída qsd (em valor de cálculo) possível de ser aplicada, de modo que a barra CD atenda as verificações pertinentes?

OBS: qsd é sempre gravitacional

(1) RELAÇÃO $N_{CD} \times q_{sd}$:

$P = 3m \times q_{sd}$



$\Sigma M_I = 0$ (+)

$N_{CD} \times 3m + P/2 \times 3m = 0$

$N_{CD} = -P/2$

$N_{CD} = -3m\, q_{sd}/2$

$$q_{sd} = \frac{2}{3m} N_{cd}$$

BARRA CD PORTANTO É COMPRIMIDA;

→ FLAMBAGEM LOCAL:

- Não há elemento AL ∴ $Q_s = 1$

$$b/t_{ALMA} = \frac{76\,mm - 2 \times 3\,mm}{3\,mm} = \frac{70\,mm}{3\,mm} = 23{,}33$$

$$b/t_{lim} = 1{,}40 \sqrt{\frac{20000\,kN/cm^2}{25\,kN/cm^2}} = 39{,}60$$

$Q_a = 1$ (NÃO OCORRE FLAMBAGEM AA)

→ FLAMBAGEM POR FLEXÃO:

$$A_g = (7{,}6\,cm)^2 - (7{,}0\,cm^2) = 8{,}76\,cm^2$$

$$I = (7{,}6\,cm)^4/12 - \frac{(7{,}0\,cm)^4}{12} = 77{,}93\,cm^4$$

$$r = \sqrt{\frac{77{,}93\,cm^4}{8{,}76\,cm^2}} = 2{,}983\,cm$$

$$\lambda = 1{,}0 \times 300\,cm / 2{,}983\,cm = 100{,}6 < 200 \text{ ok}$$

$$\lambda_0 = 100{,}6 \sqrt{\frac{1 \times 25\,kN/cm^2}{\pi^2 \times 20000\,kN/cm^2}} = 1{,}132$$

$$\chi = 0{,}658^{1{,}132^2} = 0{,}5849$$

$$N_{crd} = 0{,}5849 \times 1 \times 8{,}76\,cm^2 \times 25\,kN/cm^2 / 1{,}1 = 116{,}4\,kN$$

$$q_{sd} = \frac{2 \times 116{,}4\,kN}{3\,m} = \boxed{77{,}6\,kN/m}$$