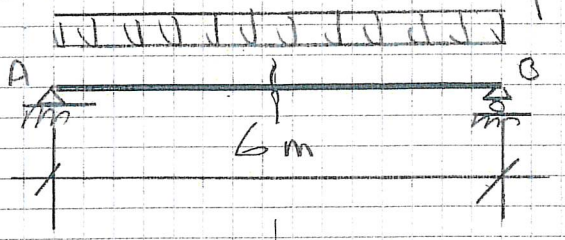
Dimensionnez la poutre ci-dessous

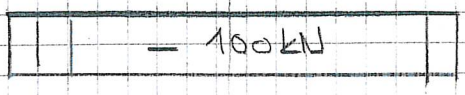
$q = 10\,kN/m$



$$M_{max} = \frac{ql^2}{8}$$

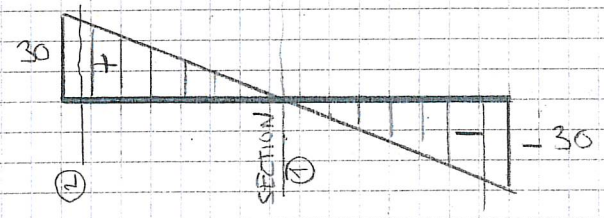
$\gamma_q = 1.5$

N



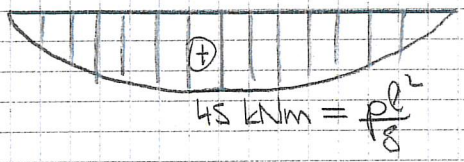
$\Rightarrow$ $N_d = -150\,kN$

V



$\Rightarrow$ $V_d = 45\,kN$

M

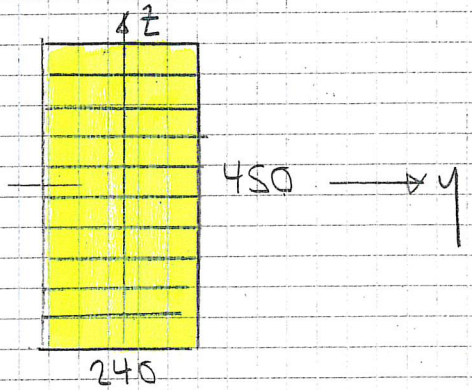


$\Rightarrow$ $M_d = 67,5\,kNm$

Sections choisies

Bois GL24H

1



$A = 108\,000\,mm^2$

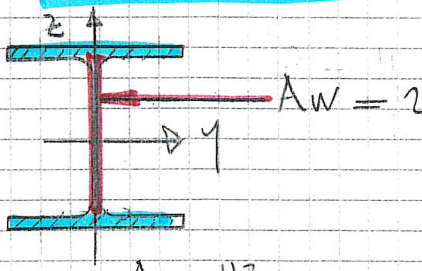
$I_y = \frac{BH^3}{12} = \frac{240 \cdot 450^3}{12} = 1,823E9\,mm^4$

$W_{yl} = \frac{BH^2}{6} = \frac{240 \cdot 450^2}{6} = 8,1E6\,mm^3$

$i_z = 0.289\,B = 0.289 \cdot 240 = 69\,mm$

$i_y = 0.289 \cdot H = 0.289 \cdot 450 = 130\,mm$

HEA 300 S235



$A = 11300\,mm$

$I_y = 182,6E6\,mm^4$

$W_{ely} = 1260E3\,mm^3$

$i_y = 127\,mm$

$i_z = 74,9\,mm$

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Contrôle 1er ordre

Bois :

$f_{md} = 16$ N/mm² (moment)

$f_{\parallel d} = f_{cd} = 14,5$ N/mm² (compression // aux fibres)

$f_{vd} = 1,8$ N/mm² (Jd)

$E_{bois} = 11\,000$ N/mm²

Acier :

$fd = 224$ N/mm² (moment + N)

$f_{vd} = 129$ N/mm²

Formule :

$$\frac{Nd\ (150\,kN)}{ft_d \text{ ou } f_{cd} \cdot A} + \frac{Myd\ (67.5\,kNm)}{fmd \cdot Wymin} + \frac{Mz_d\ (0 \text{ EGAL})}{fmd \cdot Wzmin} \leq 1$$

M/N

Bois :

$$\frac{150E3}{14.5 \cdot 108\,000} + \frac{67.5E6}{16 \cdot 8.1E6} = 0,096 + 0,521 \cong 0,62 \checkmark$$

Acier :

$$\frac{150E3}{224 \cdot 11300} + \frac{67.5E6}{224 \cdot 126E3} = 0,06 + 0,24 = 0,30 \checkmark$$

V

Bois :

$$f_{max} = \frac{3 \cdot Vd\,max}{2 \cdot Jvd \cdot Âme} = \frac{3 \cdot 45E3}{2 \cdot 1.8 \cdot 108000} = 0,35 \leq 1 \checkmark$$

Acier :

$$f_{max} = \frac{3 \cdot Vd\,max}{2 \cdot Jvd \cdot Âme = A_w} = \frac{3 \cdot 45E3}{2 \cdot 129 \cdot 2350} = 0,22 \leq 1 \checkmark$$

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Contrôle 2ème ordre

$l_{k_y} = l_{barre} = 6000$ mm

$l_{k_z} = l_{barre} = 6000$ mm

Bois

$\lambda_{k_z} = \frac{l_{k_z}}{i_z} = \frac{6000}{69} = 87 \leq 190$ (GL24h)

$\rightarrow f_{kd_z} = 6{,}05$ N/mm² (bois)

$N_{kd_z} = \frac{6.05 \cdot 108\,000}{1E3} = 653$ kN

$\lambda_{k_y} = \frac{l_{k_y}}{i_y} = \frac{6000}{130} \simeq 46 \leq 190$

$f_{kd_y} = 11.4$ N/mm²

$N_{kd_y} = \frac{11.4 \cdot 108\,000}{E3} = 1231$ kN (Critique 5513 kN)

Vérification : $\frac{N_d}{f_{kd_y} \cdot A} + \frac{M_{yd}}{f_{md} \cdot W_{y\,min}} = \frac{150}{1231} + 0.52 = 0{,}64$ ✓

$\frac{N_d}{f_{kd_z} \cdot A} + \frac{M_{zd}}{f_{md} \cdot W_{z\,min}} = \frac{150}{653} + 0 = 0{,}23$ ✓

acier

Idem pour acier

$\lambda_{k_z} = \frac{6000}{i_z = 74.9} = 80 \rightarrow f_{kd_z} = 140.9$ N/mm²

$N_{kd_z} = \frac{140.9 \cdot 11300}{E3} = 1592$ kN

$\lambda_{k_y} = \frac{6000}{i_y = 127} = 47 \rightarrow f_{kd_y} = 188.6$ N/mm²

$N_{kd_y} = \frac{188.6 \cdot 11300}{E3} = 2131$ kN

Vérification : $\frac{N_d}{f_{kd_y} \cdot A} + \frac{M_{yd}}{f_{md} \cdot W_{y\,min}} = \frac{150}{2131} + 0.24 = 0.31$ ✓

$\frac{N_d}{f_{kd_z} \cdot A} + \frac{M_{zd}}{f_{md} \cdot W_{z\,min}} = \frac{150}{1592} + 0 = 0.094$ ✓

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Aptitude au service

déformation $\leq \ell/350$ (g = surcharge négligé)

$w \leq \frac{6000}{350} = 17\ mm$

$$w = \frac{5}{384} \cdot \frac{q}{E} \cdot \frac{\ell^4}{I_y}$$

Bois : $w = \frac{5}{384} \cdot \frac{10\ N/mm}{11\,000\ (E_{bois})} \cdot \frac{6000^4}{I_y = 1.82E9} = 8,4\ mm \leq 17$

Conclusions: section GL24h 450/240 ok
la section pourrait être réduite
⇝ 400/200 à vérifier !

Acier : $w = \frac{5}{384} \cdot \frac{10\ N/mm}{210\,000} \cdot \frac{6000^4}{I_y = 182.6E6} = 4.4\ mm \leq 17$

Conclusions : section S235 HEA 300 ok
la section pourrait être reduite
⇝ ~ HEA 220 à vérifier !

AFRY
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