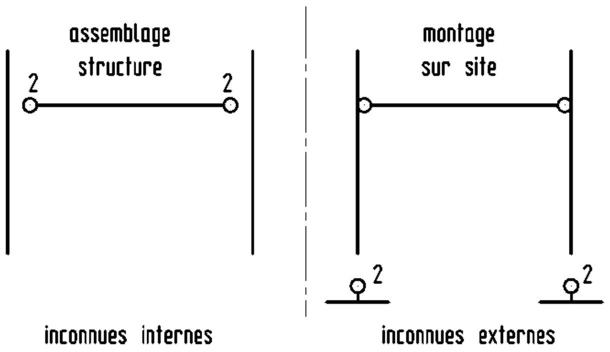
"Éléments" de correction:

Q1.... *la réponse est dans le texte qui précède la question* !

Q2.



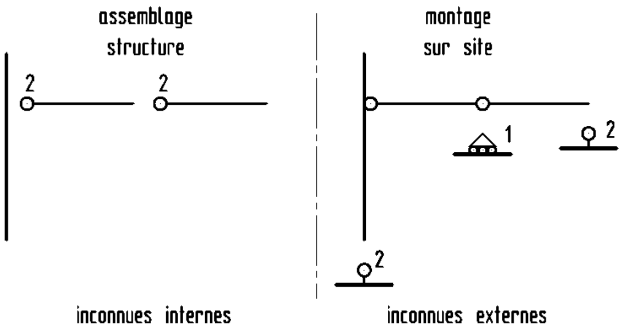
(2+2) + (2+2) = 8 Inc.

3 b ==> 3 PFS ==> 3x3Eq. = 9 Eq.

hypostatique de degré 1

La poutre au vent doit donc bloquer 1 degré de liberté.

Q3.

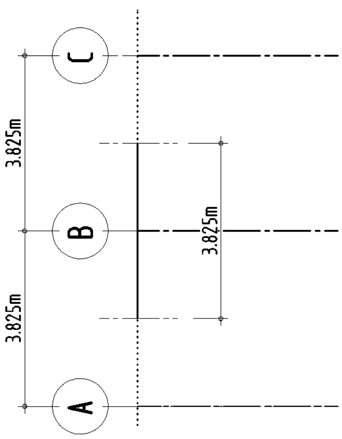


(2+2) + (2+1+2) = 9 Inc.

3 b ==> 3 PFS ==> 3x3Eq. = 9 Eq.

IsOstatique

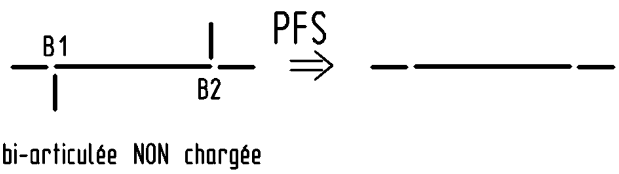
Q4.



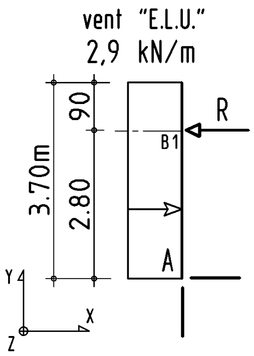
$$1.\underbrace{(3,825/2+3,825/2)}_{m^2/m}.\overbrace{50,5}^{Wk}.\underbrace{1,5}_{\text{pondération ELU}} = 289,74 \text{ daN/m} \cong 2,9 \text{ kN/m}$$

Q5.

Isolons la barre "B1-B2"

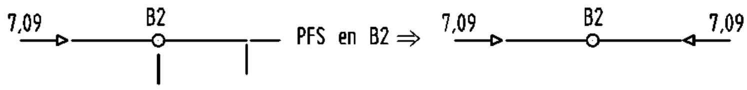


Isolons le panneau. PFS en A:



$M_{Az} = 0 \Longrightarrow R = 3{,}7^2/2.2{,}9/2{,}8 = 7{,}09$kN

Isolons "B_1-B_2" +"B_2-B_3".



Q6.

L'effort maxi est $N_{sis,Ed}$ = 23,5 kN ==> $\sigma_{c,o,d}$ = $23{,}5.10^{-3}/0{,}14^2$ = 1,2 MPa < 17 Mpa (vérifié!)

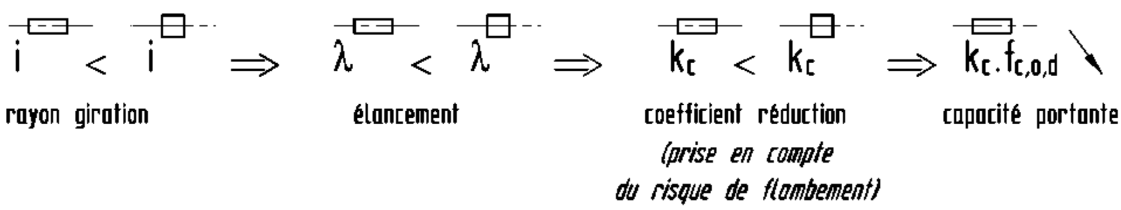
Q7.

La différence de capacité portante est liée à la différence de longueur de flambement.

Q8.

La sensibilité au flambement dépend de l'élancement de la barre $\lambda = L_{cr}/i$

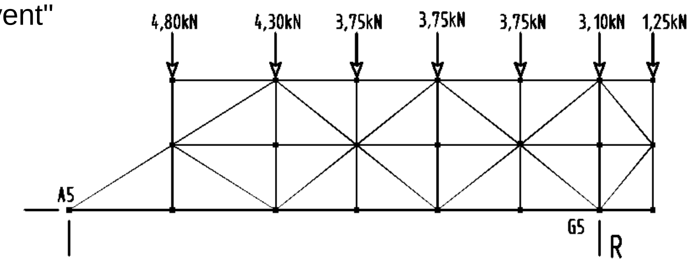
A longueur de flambement égale,



Ici, il faut donc reprendre le calcul.

Q9.

Isolons la "poutre au vent"



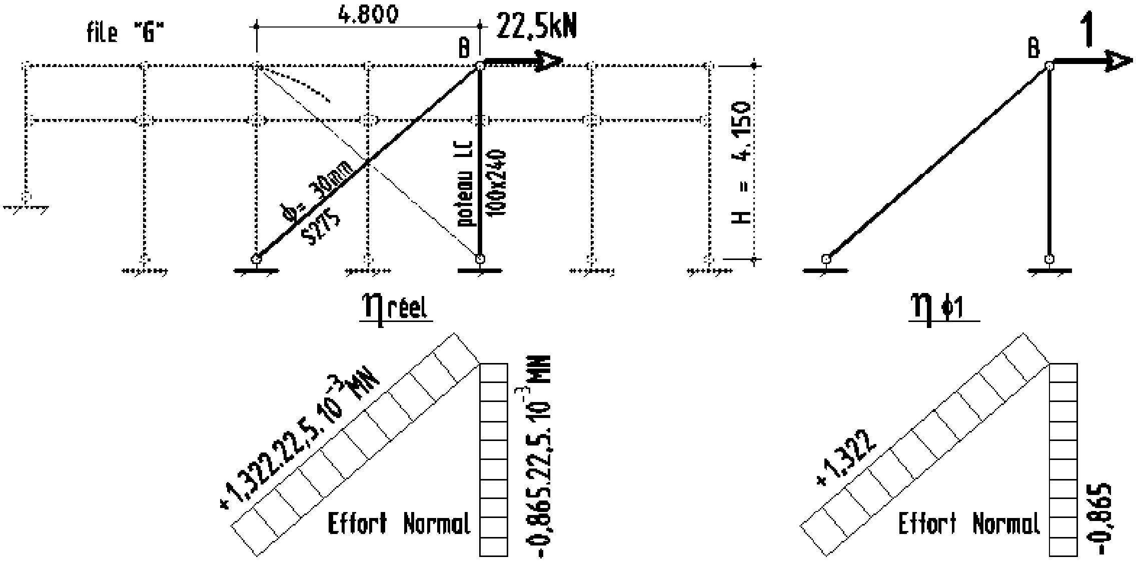
PFS en A5 ==> R =

R = (3,825.4,8+7,65.4,3+10,85.3,75+13,65.3,75+16,72.3,75+19,65.3,1+21,625.1,25)/19,69 = 14,92 kN

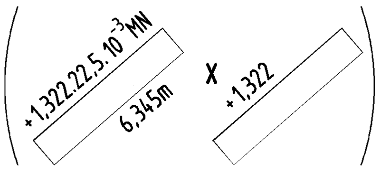
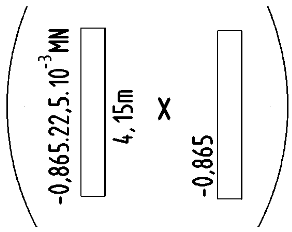
Q10.

L'élancement de la barre est tel (*faible rayon de giration compte tenu de la longueur de flambement*) qu'elle va "flamber" sous l'effort de compression (ne reprendra plus d'effort).

Q11.



$$1.\Delta_H^{G_5} = \int_{str} \frac{N(x)^{réel}.N(x)^{\phi 1}}{E.A}.dx$$

$\Delta_H^{G_5} = \dfrac{1}{2{,}1.10^5.\pi.\frac{0{,}03^2}{4}}$  $+ \dfrac{1}{1{,}16.10^4.0{,}1.0{,}24}$ 

$$\Delta_H^{G_5} = \frac{6{,}345.1{,}322.22{,}5.10^{-3}.1{,}322}{2{,}1.10^5.\pi.\frac{0{,}03^2}{4}} + \frac{4{,}15(-0{,}865.22{,}5.10^{-3})(-0{,}865)}{1{,}16.10^4.0{,}1.0{,}24} = 1{,}705.10^{-3} + 0{,}251.10^{-3}\ \text{m}$$

$\Delta_H^{G_5} = 1{,}9^{56}$ mm

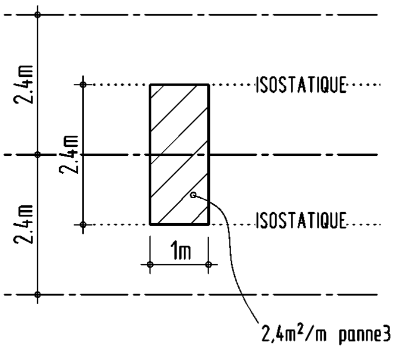
$\Delta_H^{G_5} \cong 2$ mm $<$ $\Delta_H^{lim} = 4150/500 = 8{,}3$ mm : *vérifié* !

Q12.

$$N_{t,Rd} = N_{pl,Rd} = A.\frac{f_y}{\gamma_{Mo}} = \pi.\frac{0{,}03^2}{4}.\frac{275}{1} = 0{,}194MN \qquad N_{Ed} = 1{,}322.72 = 95{,}2\ kN$$

Taux de travail = $\dfrac{N_{Ed}}{N_{t,Rd}} = \dfrac{95{,}2}{194} = 49\% < 100\%$ vérifié!

Q13.



Charges surfaciques:

Permanentes G = 0,6 kN/m²

Variables S = 1,71 kN/m²

Charges linéiques:

Permanentes g = 2,4.0,6 + 1.0,12.0,52.4,4 = 1,72 kN/m

Variables s = 2,4.1,71 = 4,1 kN/m

Q14.

$$v_{inst}(s) = \frac{5.5{,}15.10^{-3}.7{,}43^4}{384.1{,}16.10^4.\frac{0{,}12.0{,}52^3}{12}} = 12{,}5.10^{-3}m = 12{,}5mm < v_{inst,Q}^{lim} = \frac{L}{300} = \frac{7430}{300} = 24{,}7mm \text{ Vérifié!}$$

Q15.

$$v_{net,fin} = v_{inst}(g).\left(1+k_{def}\right) + v_{inst}(g) = 12{,}5.\frac{2{,}05}{5{,}15}.(1+0{,}8) + 12{,}5 = 21{,}5mm$$

$$< v_{net,fin}^{lim} = \frac{L}{200} = \frac{7430}{200} = 37{,}15mm \text{ vérifié!}$$

Q16.

Ici, neige à H < 1000m

==> $\psi_2 = 0$ ==> $v_{inst}(s).\left(1+\psi_2.k_{def}\right) = v_{inst}(s).\left(1+0.k_{def}\right) = v_{inst}(s)$

Q17.

$$\tau_d = 1{,}5\,.\frac{V_{Ed}}{A} = \frac{1{,}5.10{,}5.10^{-3}.7{,}43}{2.0{,}12.0{,}52} = 0{,}94 \text{ MPa}$$

$$f_{v,d} = k_{mod}.\frac{f_{v,k}}{\gamma_M} = 0{,}9.2{,}7/1{,}25 = 1{,}94 \text{ MPa}$$

Taux de travail = $\frac{\tau_d}{f_{v,d}} = \frac{0{,}94}{1{,}94} =$ 49,2% < 100% vérifié!

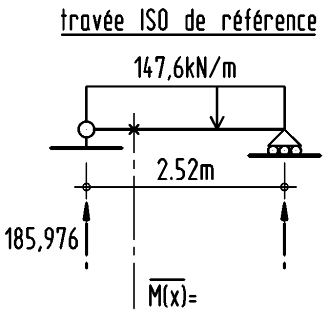
Q18.

$$\sigma_{md} = \frac{6.M_{Ed}}{bh^2} = \frac{6.10{,}5.10^{-3}.7{,}43^2}{8.0{,}12.0{,}52^2} = 13{,}4 \text{ MPa}$$

$$f_{md} = k_h.k_{mod}.\frac{f_{m,k}}{\gamma_M} = 1{,}014.0{,}9.24/1{,}25 = 17{,}52 \text{ MPa}$$

Taux de travail = $\frac{\sigma_{md}}{f_{md}} = \frac{13{,}4}{17{,}52} =$ 76,5% < 100% vérifié!

Q19.



$$\bar{M}(x)^{iso} = -\left(-185{,}976x + \frac{x^2}{2}.147{,}6\right) = -73{,}8x^2 + 185{,}976x$$

$$\bar{M}(x)^{hyper} = \bar{M}(x)^{iso} + \bar{M}_g + \frac{\bar{M}_d - \bar{M}_g}{L}.x$$

$$= -73{,}8x^2 + 185{,}976x - 125 + \frac{0-(-125)}{2{,}52}.x$$

$$\bar{M}(x)^{hyper} = -73{,}8x^2 + 235{,}579x - 125$$

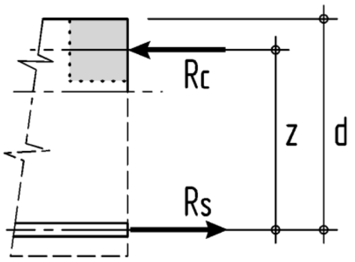
$\bar{V}(x)^{hyper} = 147{,}6x - 235{,}579$ s'annule pour $x_o = \frac{235{,}579}{147{,}6} = 1{,}596m$

$M_{max}^{S4} = -73{,}8(1{,}596)^2 + 235{,}579.1{,}596 - 125 \cong 63\ m.kN$ donc peu différent de 63,2 mkN

Les charges amenées par les pannes ont peu d'influence sur la valeur du moment maxi en "travée S4".

Q20.

$$d^{réel} = 343mm < 0{,}9h = 0{,}9.400 = 360mm$$



$$d \searrow \Rightarrow z \searrow \Rightarrow A_{s,cal} = \frac{M}{z.\sigma_{st}} \nearrow$$

Il faut donc recalculer que $A_{s,cal}$ reste inférieure à $A_{s,réelle}$!

Q21.

$$\mu_u = \frac{M_u}{b_w.d^2.f_{cd}} = \frac{113{,}9.10^{-3}}{0{,}2.0{,}343^2.\frac{25}{1{,}5}} = 0{,}2904 < 0{,}372 \quad \Rightarrow \quad \sigma_{st} = f_{yd}$$

$$\alpha_u = 1{,}25\left(1 - \sqrt{1 - 2\mu_u}\right) = 1{,}25\left(1 - \sqrt{1 - 2.0{,}2904}\right) = 0{,}4407$$

(Hauteur de béton comprimé : $\chi_u = \alpha_u.d = 0{,}4407.343 \cong 151\ mm$*)*

$z_u = d(1 - 0{,}4.\alpha_u) = 343(1 - 0{,}4.0{,}4407) = 282{,}5\ mm$ (< *303,75 du tableau obtenu avec d= 0,9h*)

$$A_{s,cal} = \frac{M_u}{z.f_{yd}} = \frac{113{,}9.10^{-3}}{0{,}2825.\frac{500}{1{,}15}} = 9{,}27.10^{-4}\ m^2 = 9{,}27\ cm^2$$

$9{,}27\ cm^2$ > $8{,}62\ cm^2$ (*7,5% supérieur à la valeur obtenue avec d=0,9h. Confirme la nécessité de recalculer...*)

$9{,}27\ cm^2 \cong 6HA14 = 9{,}24\ cm^2$ (0,3% *supérieur, mais écart acceptable*)