BTS Construction Métallique

Session 2008

U42

Epreuve de note de calculs

CORRIGÉ

1 Actions climatiques :

1.1 Neige :

Montréjeau (31 : Haute Garonne)

Région IA2 | $s_{k,0} = 0,45\ kN/m^2$ à 200 m
| $s_{ad} = 1,00\ kN/m^2$ (charge exceptionnelle)

Influence de l'altitude

$A = 468$ m $\quad \Delta s_1 = (0,10\,A - 20)/100$

$= (0,10 \times 468 - 20)/100$

$= 0,268 \simeq 0,27\ kN/m^2$

$s_k = s_{k,0} + \Delta s_1$

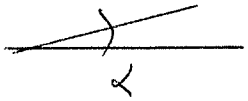
$= 0,45 + 0,27 = 0,72\ kN/m^2$

| $s_k = 0,72\ kN/m^2$
| $s_{ad} = 1,00\ kN/m^2$

Situations de projet durables $\quad s = \mu_i\, C_e\, C_t\, s_k = \mu_i \times 1 \times 1 \times s_k$

Situations de projet accidentelles $\quad s = \mu_i\, C_e\, C_t\, s_{Ad} = \mu_i \times 1 \times 1 \times s_{Ad}$

$\tan \alpha = \frac{2}{10} \quad \alpha = 11,31°$

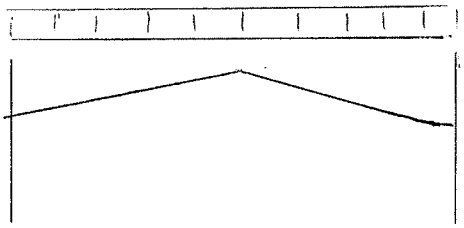


$\mu_1 = 0,8 \quad \mu_2 = 0,8 + 0,8\,\alpha/30 = 1,1$

Toiture à 2 versants :

Sans accumulation

S1

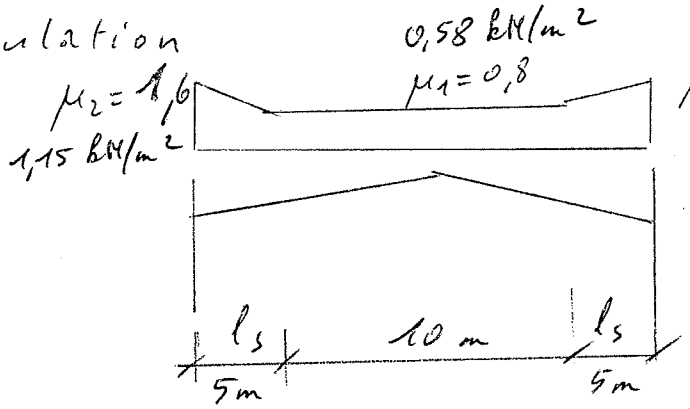


$\mu_1 = 0,8$

$s_1 = 0,8 \times 0,72$

$= 0,576 \text{ kN/m}^2$

Accumulation



$\mu_2 = \gamma h / s_k = 2 \times 2 / 0,72 = 5,5$ $\quad 0,8 \leq \mu_2 \leq 2$

$\Rightarrow \mu_2 = 2$ deux zones $\quad \mu_2 \leq 1,6 \Rightarrow \mu_2 = 1,6$

$l_s = 2h = 2 \times 2 = 4 \text{ m} \quad 5 \leq l_s \leq 15 \text{ m}$

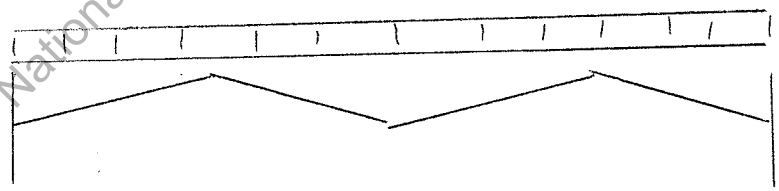
$\Rightarrow \underline{l_s = 5 \text{ m}}$

$\underline{s_1 = 0,576 \text{ kN/m}^2} \approx 0,58 \text{ kN/m}^2$

$s_2 = \mu_2 s_k = 1,6 \times 0,72 = \underline{1,15 \text{ kN/m}^2}$

Toiture à versants multiples

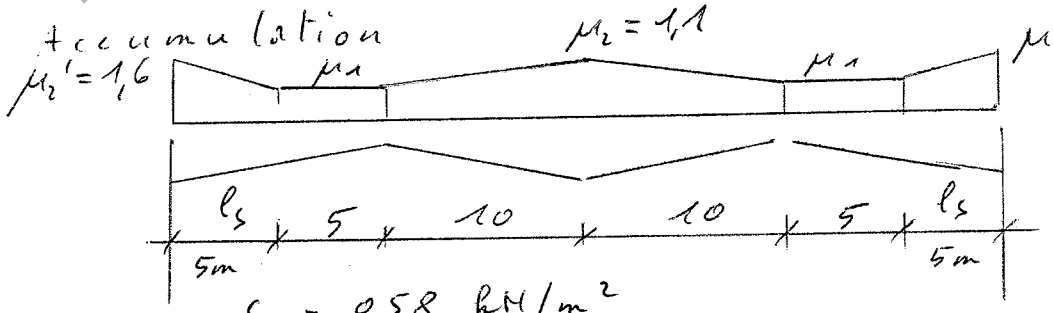
Sans accumulation



$\mu_1 = 0,8$

$s_1 = 0,58 \text{ kN/m}^2$

Accumulation



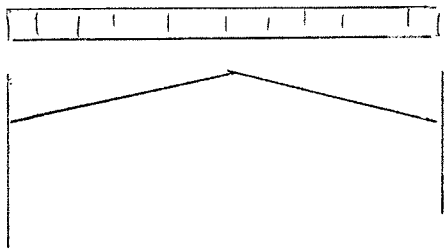
$s_1 = \underline{0,58 \text{ kN/m}^2}$

$s_2 = 1,1 \times 0,72 = \underline{0,79 \text{ kN/m}^2}$

$s_2' = \underline{1,15 \text{ kN/m}^2}$

Neige accidentelle (sans accumulation)

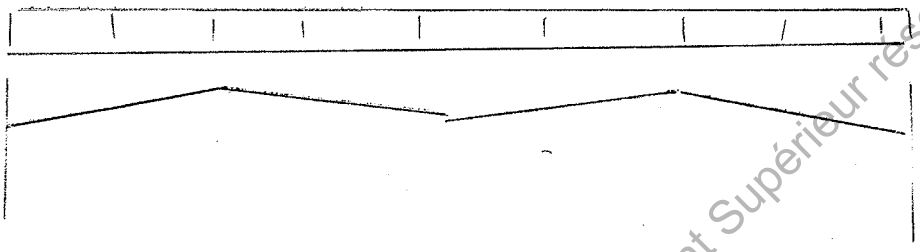
Toiture à 2 versants



$\mu_1 = 0,8$

$S_{ad} = 0,8 \times 1,00 = \underline{0,80\ kN/m^2}$

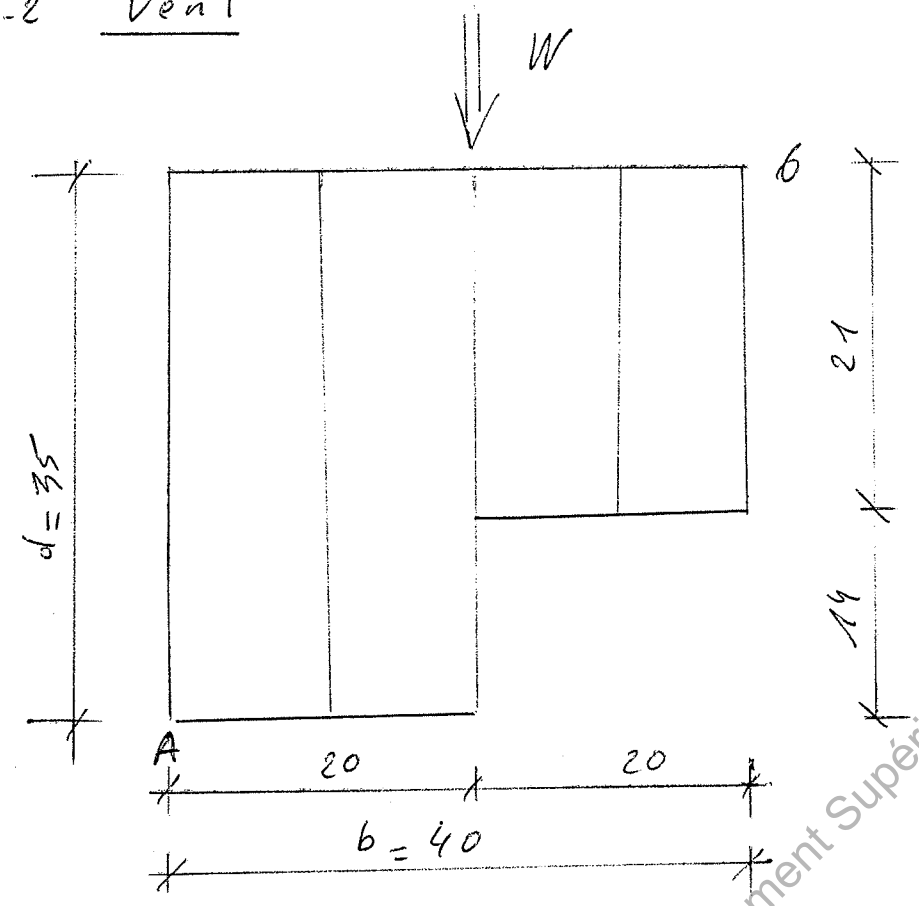
Toiture à versants multiples



$\mu_1 = 0,8$

$S_{ad} = \underline{0,80\ kN/m^2}$

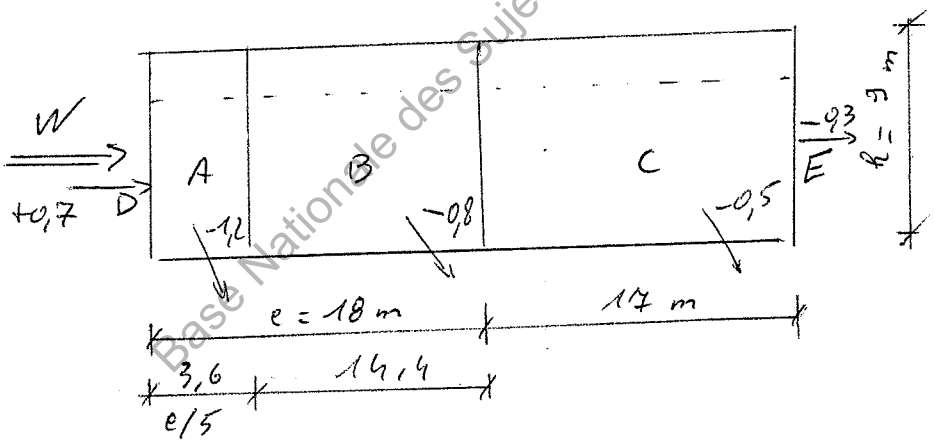
1-2 Vent



$h = 9\ m \leq b = 40\ m$ une seule zone en élévation

$e = \inf \begin{vmatrix} b = 40\ m \\ 2R = 18\ m \end{vmatrix}$ $e = 18\ m < d = 35\ m$

Paroi A



Surfaces $> 10\ m^2$

$\Rightarrow$ Cpe 10

$\frac{h}{d} = \frac{9}{35} = 0,257$

Zone A $C_{pe\,10} = -1,2$

Zone B $C_{pe\,10} = -0,8$

Zone C $C_{pe\,10} = -0,5$

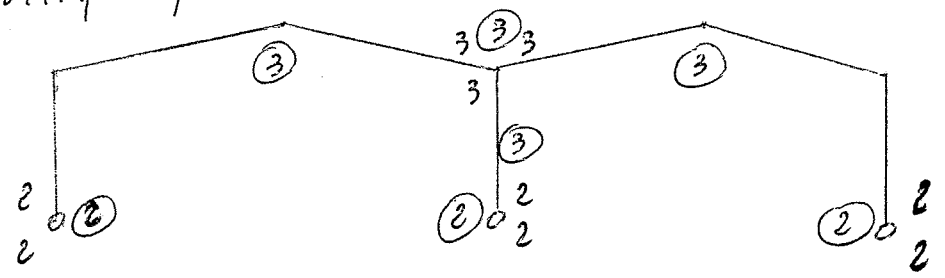
Zone D $C_{pe\,10} = +0,7$

Zone E $C_{pe\,10} = -0,3$

2 Analyse de la stabilité :

21 Stabilité transversale :

1 Portique file 4

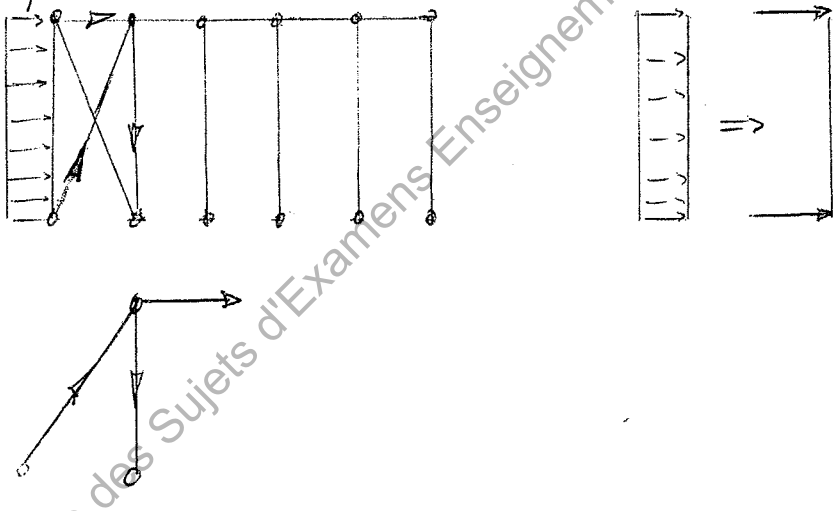


Eq $4 \times 3 + 3 \times 2 = 18$

Inc $3 \times 3 + 6 \times 2 = 21$

Hyper 3

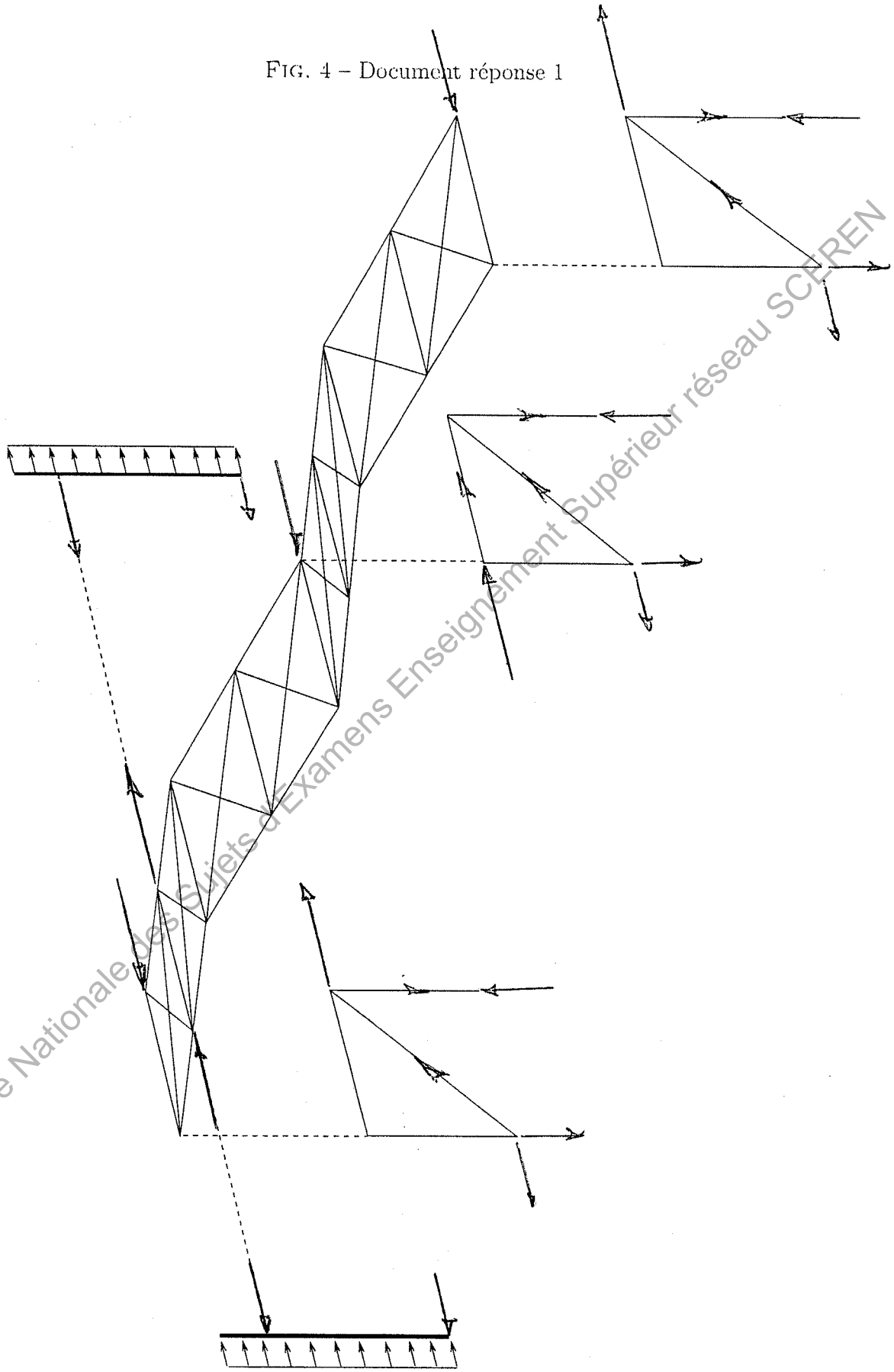
2 Pan de fer



22 Stabilité longitudinale

Voir bloc réponse p 6/9

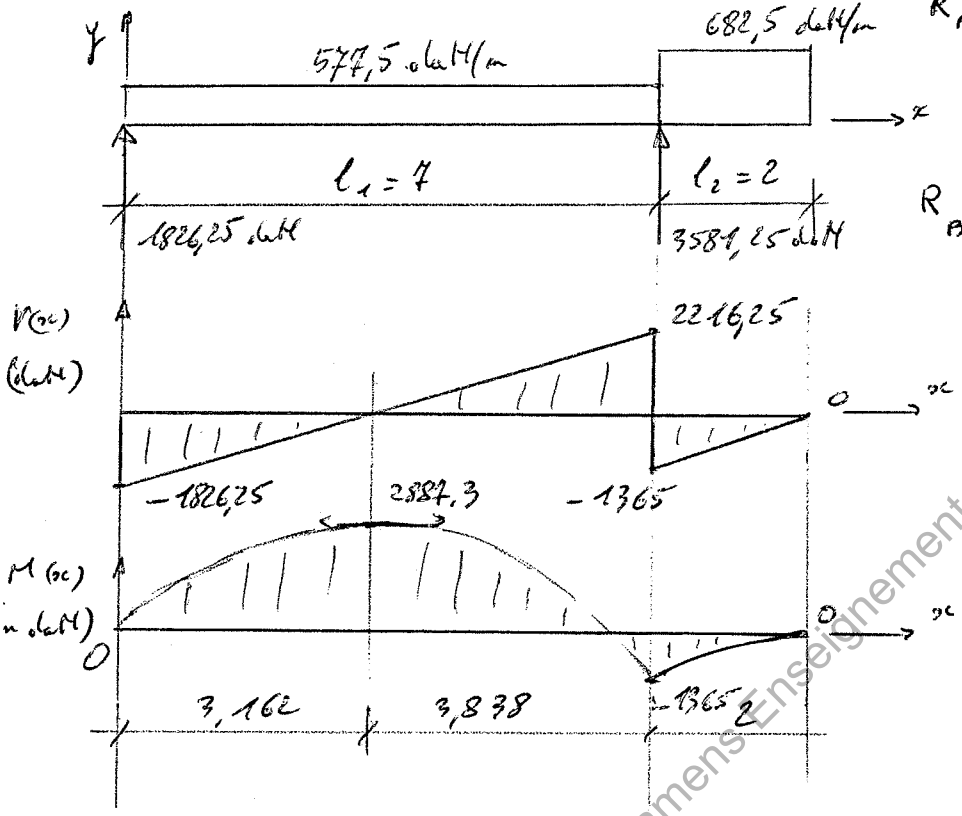
FIG. 4 – Document réponse 1



3 Etude d'un poteau de pignon

31

A1



$$R_A = \frac{577,5 \times 7}{2} - \frac{682,5 \times 2^2}{2 \times 7}$$

$$= \underline{1826,25 \text{ daN}}$$

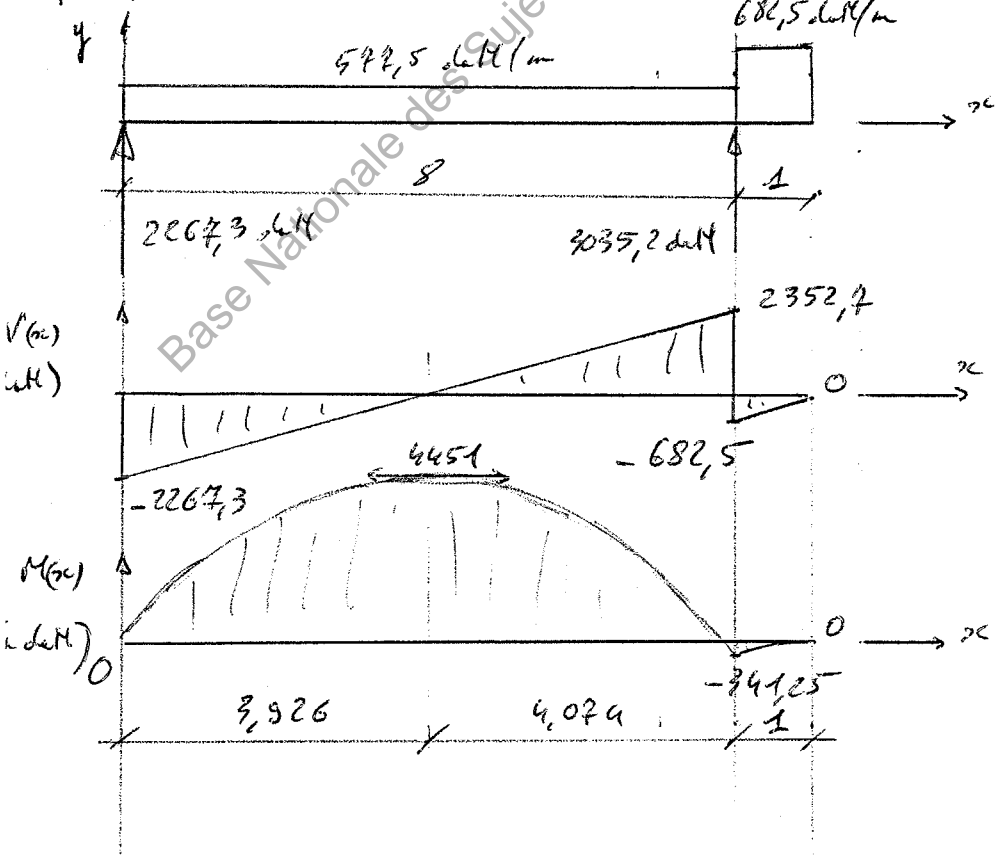
$$R_B = \frac{577,5 \times 7}{2} + 682,5 \times 2 \times \left(1 + \frac{2}{2 \times 7}\right)$$

$$= \underline{3581,25 \text{ daN}}$$

$$x = \frac{1826,25}{577,5} = \underline{3,162 \text{ m}}$$

$$M_{f\,max} = \underline{2888 \text{ m daN}}$$

B1



$$R_A = \frac{577,5 \times 8}{2} - \frac{682,5 \times 1^2}{2 \times 8}$$

$$= \underline{2267,3 \text{ daN}}$$

$$R_B = \frac{577,5 \times 8}{2} + 682,5 \times 1 \left(1 + \frac{1}{2 \times 8}\right)$$

$$= \underline{3035,2 \text{ daN}}$$

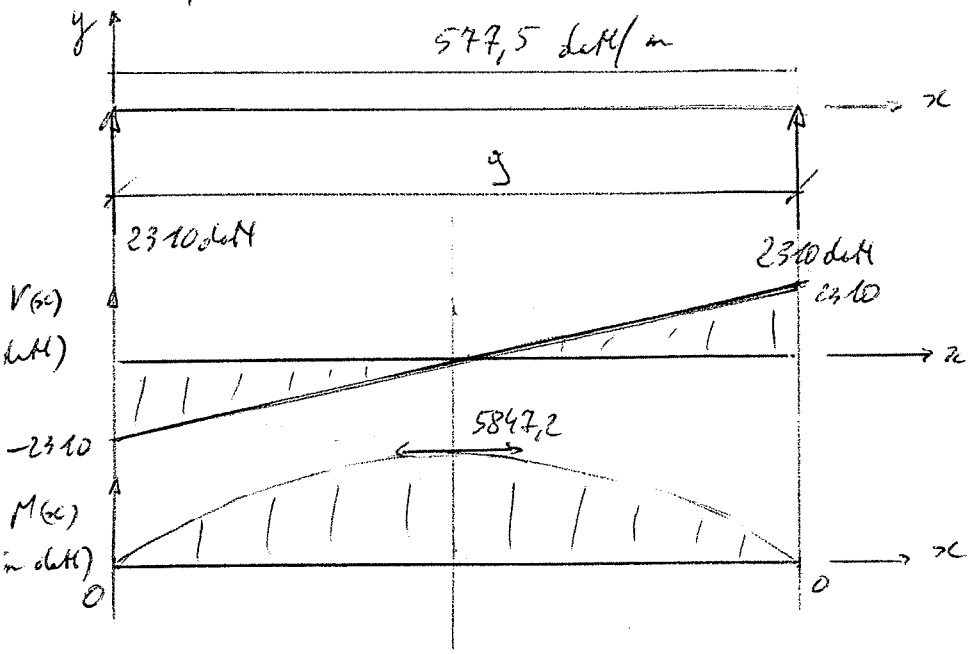
$$x = \frac{2267,3}{577,5} = \underline{3,926 \text{ m}}$$

$$M_{f\,max} = \underline{4451 \text{ m daN}}$$

TAB. 1 – Document réponse 2

Valeurs cherchées	Poteau $A1$	Poteau $B1$	Poteau $C1$
l_1 (mm)	7000	8000	9000
l_2 (mm)	2000	1000	0
R_A (daN)	1826,25	2267,3	2310
R_B (daN)	3581,25	3035,2	2310
x (mm)	3,162	3,926	4,500
Mf_{max} $(mdaN)$	2888	4451	5847,2

C1



$R_A = R_B = \frac{577{,}5 \times 8}{2}$

$= \underline{2310 \text{ daN}}$

$x = \frac{8}{2} = \underline{4{,}5 \text{ m}}$

$M_{f\,max} = \frac{p l^2}{8}$

$= \underline{5847{,}2 \text{ m daN}}$

3.2 Poteau fléchi S 275 IPE 160

Semelle en console comprimée

$\frac{c}{t} = \frac{(82 - 5 - 2\times 9)/2}{7{,}4} = \frac{23{,}5}{7{,}4} = 3{,}99$

$9\varepsilon = 9 \times 0{,}92 = 8{,}28$

$\frac{c}{t} = 3{,}99 \leqslant 9\varepsilon = 8{,}28$ semelle de classe 1

Âme fléchie

$\frac{c}{t} = \frac{d}{t_w} = \frac{127{,}2}{5} = 25{,}44$

$72\varepsilon = 72 \times 0{,}92 = 66{,}24$

$\frac{c}{t} = 25{,}44 \not\leqslant 72\varepsilon = 66{,}24$ âme de classe 1

IPE 160 classe 1

3-3 $p_1 = 252$ daN/m IPE 160

$f_{max} = \frac{H_1}{150} = \frac{9000}{150} = \underline{60 \text{ mm}}$

$f = -\frac{5 p l^4}{384 E I} = -\frac{5 \times 252 \times 10^{-2} \times 9000^4}{384 \times 210000 \times 869{,}3 \times 10^4} = \underline{-118 \text{ mm}}$

$f > f_{max}$ Section à revoir

3-4 $M_{f\,max} = \frac{p l^2}{8} = \frac{330 \times 9{,}000^2}{8} = 3341{,}25$ m daN

Section de classe 1

Vérifier $\frac{M_{Ed}}{M_{c,Rd}} \leqslant 1{,}0$

$$M_{c,Rd} = M_{pl,Rd} = \frac{W_{pl,y} f_y}{\gamma_{M0}} = \frac{123,9 \times 10^3 \times 275}{1}$$

$$= 34,1 \cdot 10^6 \text{ mm N}$$

$$= \underline{3407 \text{ mkN}}$$

$$\frac{M_{Ed}}{M_{c,Rd}} = \frac{3341,25}{3407} = 0,94 \leq 1 \quad \text{Vérifié}$$

Vérification au cisaillement

$$\frac{V_{Ed}}{V_{c,Rd}} \leq 1,0 \qquad V_{Ed} = \frac{pl}{2} = \frac{330 \times 9}{2} = 1485 \text{ daN}$$

$$V_{c,Rd} = V_{pl,Rd} = \frac{A_v (f_y/\sqrt{3})}{\gamma_{M0}}$$

$$A_v = A - 2b t_f + (t_w + 2r) t_f$$

$$= 2009 - 2 \times 82 \times 7,4 + (5 + 2 \times 9) \times 7,4$$

$$= \underline{965,6 \text{ mm}^2}$$

$$\eta h_w t_w = 1 \times 145,2 \times 5 = \underline{726 \text{ mm}^2} \quad \Big| \; A_v > \eta h_w t_w$$

$$V_{pl,Rd} = \frac{965,6 \times (275/\sqrt{3})}{1} = 153\,303,6 \text{ N}$$

$$= \underline{15\,331 \text{ daN}}$$

$$\frac{V_{Ed}}{V_{c,Rd}} = \frac{1485}{15\,331} = \underline{0,097} \leq 1 \quad \text{Vérifié}$$

4 Etude de la poutre au vent

4.1

$$p = 1781 \times 2 + 3186 \times 2 + 2850 \times 2 + 3186 \times 2 + 3581 + 964 \times 2 + 1366 \times 2 + 865 \times 2 + 1366 \times 2 + 1928 / 2 \times 20$$

$$= 915{,}925 \text{ daN/m}$$

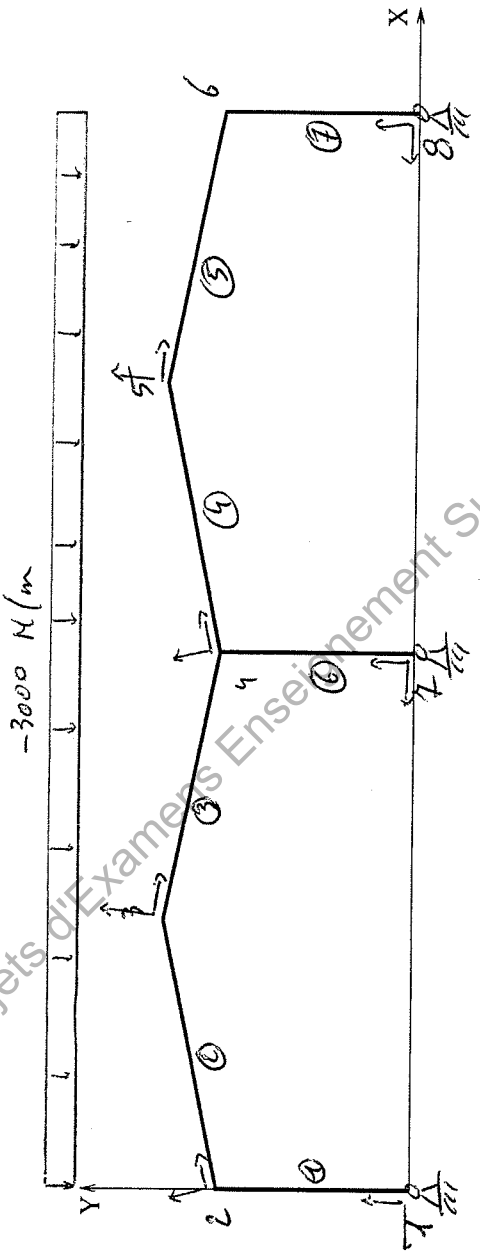
$$\simeq \underline{916 \text{ daN/m}}$$

4.2 Efforts sur les palées

$$\frac{3pl}{8} = \frac{3 \times 916 \times 20}{8} = \underline{6870 \text{ daN}}$$

$$\frac{5pl}{4} = \frac{5 \times 916 \times 20}{4} = \underline{22\,900 \text{ daN}}$$

FIG. 5 – Document réponse 3



5 Lecture de listing

5-1 Voir doc réponse

5-2 Actions de liaison

Noeud 1	$R_x = 11189,4$ N	$R_y = 29214,4$ N	$M_z = 0$
Noeud 7	$R_x = 0$	$R_y = 61571,2$ N	$M_z = 0$
Noeud 8	$R_x = -11189,4$ N	$R_y = 29214,4$ N	$M_z = 0$

Chargement

$p_y = -3000$ N/m

Sur x : $11189,4 - 11189,4 = 0$

Sur y : $29214,4 + 61571,2 + 29214,4 - 3000 \times 40 = 0$

$\Sigma M/_1$: $-3000 \times 40 \times 20 + 20 \times 61571,2 + 40 \times 29214,4 = 0$

=> la structure est en équilibre

5-3 Voir doc réponse

5.3.2 $p_y = -\frac{(26452,6 + 2964,8)}{10,128} = -2884,6$ N/m

$x = \frac{26452,6}{2884,6} = 9,170$ m

$M_{max} = -78326 + \frac{26452,6 \times 9,170}{2}$

$= 42959,2$ m.daN

$= 41438,3 + \frac{2964,8 \times 1,028}{2} = 42962,7$ m.daN

FIG. 6 – Document réponse 4