BREVET DE TECHNICIEN SUPÉRIEUR
CONSTRUCTIONS MÉTALLIQUES
SESSION 2018

E4 : ANALYSE ET CALCUL DES STRUCTURES

U 42 Note de calculs

Durée : 4h – Coefficient : 3

ÉLÉMENTS DE CORRECTION

1°/ SURCHARGES CLIMATIQUES

1.1: NEIGE

$\alpha = 5,71°$ Nord, centre Cambrai $\rightarrow$ A1

$S_{k,0} = 0,45 \text{ kN/m}^2$ $S_{Ad} = 0$

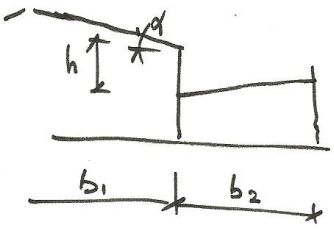
$A = 62 \text{ m} \Rightarrow \Delta S_1 = 0$

$\alpha < 30° \Rightarrow \mu_1 = 0,8$

$\mu_2 = 0,8 + \frac{0,8 \times 5,71}{30} = 0,952$

§5.36 $\Rightarrow$

$\mu_2 = \mu_s + \mu_w$



$b_1 = 23,3 \text{ m}$
$b_2 = 15,7 \text{ m}$
$h = 2,63$

$\mu_s = 0$

$\mu_w = \frac{b_1 + b_2}{2h}$

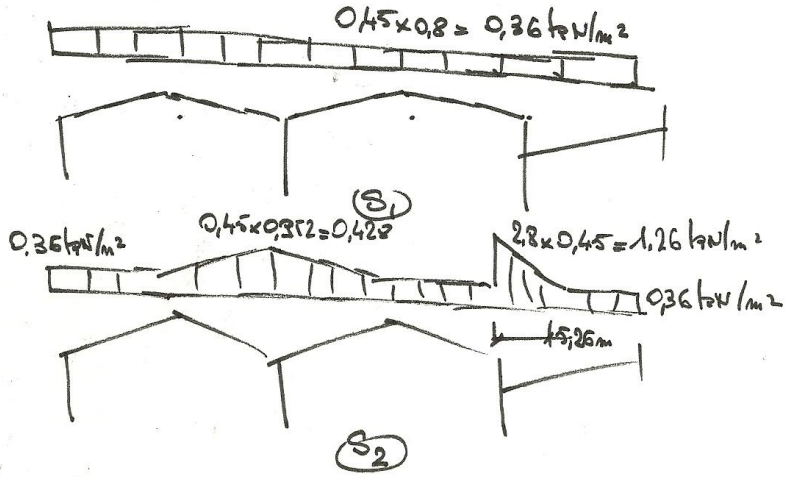
$= \frac{23,3 + 15,7}{2} = 19,5$

$\mu_w < \frac{8.h}{S_k} = \frac{2 \times 2,63}{0,45} = 11,69$ $\Rightarrow \mu_w = 2,8$

$0,8 < \mu_w < 2,8$

$l_s = 2h = 2 \times 2,63 = 5,26 \text{ m}$
$5 \text{ m} < l_s < 15 \text{ m}$ $\Rightarrow l_s = 5,26 \text{ m}.$

Neige sur toiture.



1.2: Vent

a): Cambrai → Region 2. $V_{b,0} = 24$ m/s

Categorie terrain III a $\Rightarrow z_0 = 0,2$ m $z_{min} = 5$ m.

$k_r = 0,19 \left(\frac{0,2}{0,05}\right)^{0,07} = 0,209$

$C_e(z) = 0,209^2 \ln\left(\frac{7,508}{0,2}\right)\left(7 + \ln\left(\frac{7,508}{0,2}\right)\right) = 1,688$

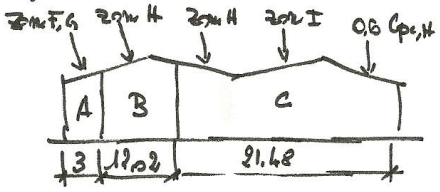
$q_b = 0,5 \times 1,225 \times 24^2 = 352,8$ Pa

$q_p(z) = 1,688 \times 352,8 = 595,7$ Pa.

b): Vent sur long pan.

$b = 36,5$ m $\quad e = \min(36,5 ; 2 \times 7,508) = 15,02$ m $< d \Rightarrow$ 3 zones sur pignon.

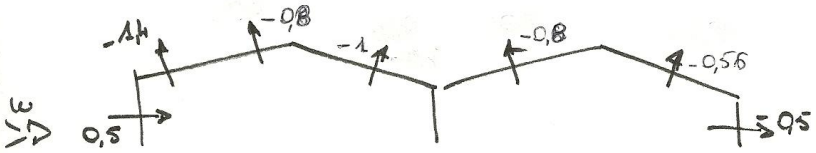
$d = 47,1$ m $\quad \frac{h}{d} = 0,16$



Zone	D	E
Cpe,10	+0,7	-0,3

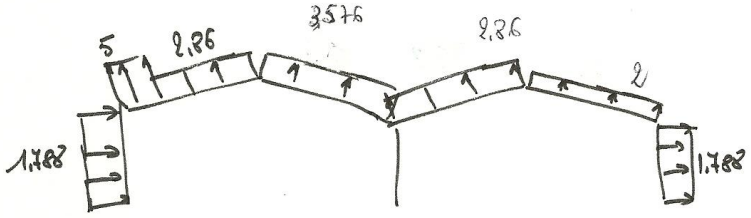
Versant 1		Versant 2	Vent 3	Vent 4
G	H	H	I	0,5. H
-1,2	-0,6	-0,8	-0,6	-0,36
0	0	-0,8		-0,36

c: Cpnet



d) Charges sur portiques files 2 à 5

$w = C_{pnet} \times 0,536 \times 5$



en kN/m

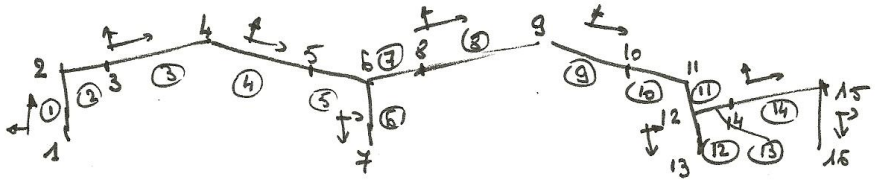
2° CHARGES SUR PORTIQUES 2 à 5

$g = 8,19 \times 9,81 \times 10^{-3}$ tôle
$+ 140 \times 0,08 \times 9,81 \times 10^{-3}$ isolant
$+ 9 \times 9,81 \times 10^{-3}$ étanchéité
$+ \frac{129}{2,34} \times 9,81 \times 10^{-3}$

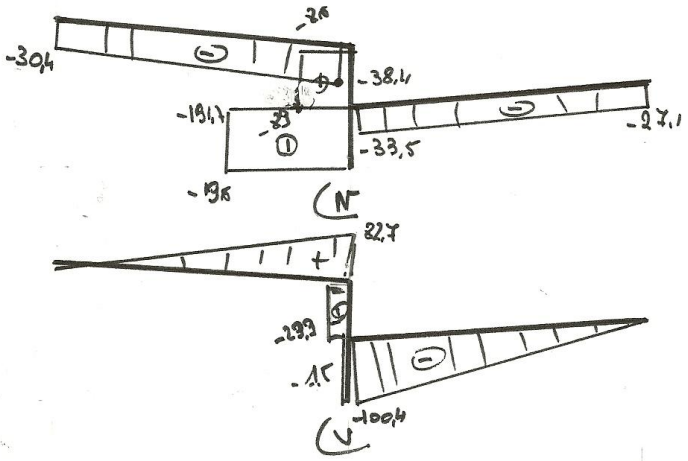
$= 0,333 \text{ kN/m}^2 \rightarrow g = 1,936 \text{ kN/m}$

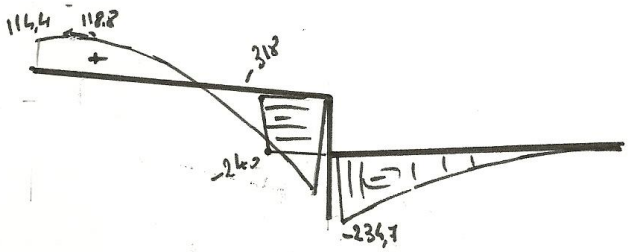
3° EXPLOITATION LISTING

3.1. Données.



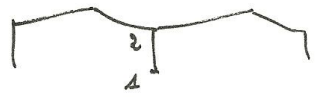
3.2 Diagrammes





4° VERIFICATION DES POTEAUX

4.1: Poteau file C



$\eta_1 = 1$

$\eta_2 = \dfrac{\frac{27690}{5,8}}{\frac{27690}{5,8} + \frac{23130}{11,708} + \frac{23130}{11,708}} = 0,543$

traverse $L = 3,015 + 8,693 = 11,708$ m

$L_{cry} = 5,9\left(0,5 + 0,14(1+0,543) + 0,055(1+0,543)^2\right)$

$= 4,997$ m

4.2. Poteau file F

$\bar{\lambda}_y = \left(\frac{590}{14,4}\right) \times \frac{1}{86,8} = 0,47$ $\qquad$ $\bar{\lambda}_z = \left(\frac{590}{7,46}\right) \times \frac{1}{86,8} = 0,91$

$\frac{h}{b} = \frac{330}{300} = 1,1 < 1,2$

file selon y → courbe b $\qquad \chi_y = 0,8973$

file selon z → courbe c $\qquad \chi_z = 0,5337$

a) Classe section = 1. (Tableau 3)

$N_{pl,Rd} = \frac{133,5 \times 275 \times 10^{-3} \times 10^2}{1} = 3671,25$ kN

$\frac{0,5 h_w . t_w . f_y}{\gamma_{M0}} = \frac{0,5 \times 297 \times 3,5 \times 275}{1} \times 10^{-3} = 387,56$ kN

$N_{Ed} < 0,25 N_{pl,Rd}$ $\qquad N_{Ed} < \frac{0,5 . h_w . t_w . f_y}{\gamma_{M0}}$ → N négligé

$V_{pl,z,Rd} = \frac{449 \times 275 \cdot 10^{-3}}{\sqrt{3} \times 1} = 713,7$ kN $\qquad V_{z,Ed} < 50\% V_{pl,z,Rd}$ → V négligé

$M_{pl,y,Rd} = \frac{1850 \times 275}{1} \times 10^{-3} = 508$ kN.m $> M_{y,Ed}$

b)

$C_1 = 1,77$

$C_2 = 0$

$M_{cr} = \left\{1,77 \frac{\pi^2 \times 21.10^6 \times 7436}{590^2} \sqrt{\frac{1824.6^3}{7436} + \frac{590^2 \times 8077 \times 127,2}{\pi^2 \times 210000 \times 7436}}\right\} . 10^{-5} = 1712$ kN.m

c) $\bar{\lambda}_{LT} = \sqrt{\frac{508}{1712}} = 0,545$

$\frac{h}{b} = 1,1 < 2$ → Courbe b => $\chi_{LT} = 0,9080$

6.61 => $\frac{N_{Ed}}{\chi_y N_{pl,Rd}} \ldots = \frac{91,21}{0,8973 \times 3671} + 0,968 \frac{268,6}{0,9080 \times 508} = 0,59 < 1$

6.62 => $\frac{N_{Ed}}{\chi_z N_{pl,Rd}} \ldots = \frac{91,21}{0,5337 \times 3671} + 0,684 \frac{268,6}{0,9080 \times 508} = 0,44 < 1$

5°/ VERIFICATION DES POTELETS

5.1 : E.L.S.

$$f_{max} = \frac{5 \times 2,31.10^{6} \times 6,83^{4}.10^{8}}{384 \times 21.10^{6} \times} = \quad cm = \frac{R}{}$$

5.2 E.L.U

a) Classe 1.

$$V_{pl,z,Rd} = \frac{153 \times 245.10^{-3}}{\sqrt{3} \times 1} = 212,4\ kN$$

$$V_{z,Ed} < 50\% V_{pl,z,Rd}$$

$$M_{pl,y,Rd} = \frac{185.245.10^{-3}}{1} = 48,375\ kN.m > M_{y,Ed}$$

b) Vent en dépression

c)

$C_1 = 1,13$

$C_2 = 0,45$

$z_g = -110\ mm$

$$M_{cr} = 1,13\left(\frac{\pi^2.21.10^6.265}{683^2}\left[\sqrt{\frac{227.10^3}{265} + \frac{683^2 \times 8,770 \times 3,07}{\pi^2 \times 21.10^4 \times 265}} + (-11 \times 0,45)\right] + 11 \times 0,45\right) \times 10^{-5}$$

$$= 36,14\ kN.m$$

d) $\frac{h}{b} = \frac{220}{110} = 2$ → Courbe a $\quad \bar{\lambda}_{LT} = \sqrt{\frac{48,375}{37}} = 1,15$

$\chi_{LT} = 0,3838$

$$M_{b,Rd} = 0,3838 \times 48,375 = 30,55\ kN.m > M_{y,Ed} \quad \text{OK !}$$