Données

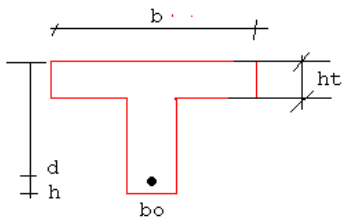
portée efficace lef := 5.26 **largeur des appuis** la := .10

largeur b := 5 bo := b ht := 0

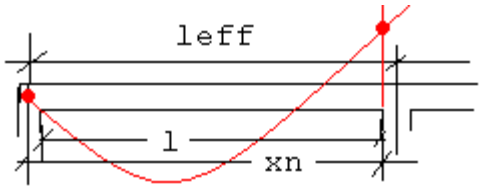
hauteur h := 0.16 portée entre nu l := lef – la

enrobage ci := 0.026 l = 5.160000000

cs := 0.026



$xn := lef - \frac{la}{2}$ xn = 5.210000000



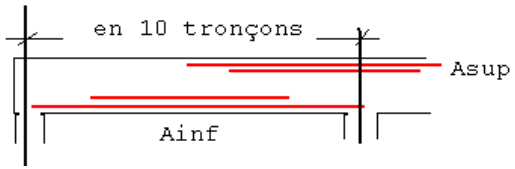
i := 0 .. 10 $x_i := i \cdot \frac{l}{10}$

h utile d := h – ci

d = 0.134

coefficient Ψ pour la part de wdi κ := 1

$s := \begin{cases} 0.2 & \text{if CHOIX = "N"} \\ 0.25 & \text{otherwise} \end{cases}$ s = 0.200000000



$fctm := 0.3 \cdot fck^{\frac{2}{3}}$

$x_i =$

	0
0	0
1	0.516
2	1.032
3	1.548
4	2.064
5	2.58
6	3.096
7	3.612
8	4.128
9	4.644
10	5.16

$As := \frac{Ainf}{10000}$ $Ac := \frac{Asup}{10000}$ b = 5.000000000

Résistance compression fck fck := 25 Mpa

humidité ambiante

Interieur 50% exterieur 80% RH := 70 en%

temps de fin de cure en jours ts := 2 jours

RAYON moyen =2xA/u en mm $ho := \frac{b \cdot h}{b + h} \cdot 1000$

date du chargement to := 30 jours

ho = 155.038759690

valeurs des aciers à donner sous forme de tableaux

Ainf :=

	0
0	13.07
1	15.52
2	26.14
3	26.14
4	26.14
5	26.14
6	26.14
7	16.34
8	13.07
9	13.07
10	13.07

Asup :=

	0
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	29.41
9	29.41
10	29.41

$Mapp := \frac{(g)\cdot lef^2}{10}$ $Mapp = 55.335200000$ $Mtppe := (g)\cdot xn\cdot\frac{(lef - xn)}{2} - Mapp\cdot\frac{xn}{lef}$

$Mpp_{i,0} := \begin{cases} Mappo & \text{if } i = 0 \\ \left[\left[(g)\cdot x_i\cdot\frac{(lef - x_i)}{2}\right] - Mapp\cdot\frac{x_i}{lef}\right] & \text{if } i < 10 \\ Mtppe & \text{if } i = 10 \end{cases}$

$Mcl := Mct$

moments en premiere travée et appuis dus aux charges permanentes g cl rev et q

g+cl+rev g+cl g q

$Mqp =$

	0
0	0.00
1	33.34
2	57.36
3	72.06
4	77.44
5	73.50
6	60.25
7	37.67
8	5.78
9	-35.43
10	-91.36

$Mcl =$

	0
0	0.00
1	23.81
2	40.97
3	51.47
4	55.32
5	52.50
6	43.03
7	26.91
8	4.13
9	-25.31
10	-65.26

$Mpp =$

	0
0	0.00
1	19.05
2	32.78
3	41.18
4	44.25
5	42.00
6	34.43
7	21.53
8	3.30
9	-20.25
10	-52.20

$Mq =$

	0
0	0.00
1	13.60
2	23.88
3	30.82
4	34.44
5	34.73
6	31.70
7	25.33
8	15.63
9	2.61
10	-15.50

calcul des modules béton

$Ecm := 1000\cdot\left[22\cdot\left(\frac{fcm}{10}\right)^{0.3}\right]$ $Ecm = 31475.806210019$ $EC := 1.05\cdot Ecm$ $EC = 33049.596520520$

$Eceff := \frac{Ecm}{1 + \phi(99999999999999999999, to, ho)}$ $Eceff = 9968.18$ $\phi(1000000000000000, to, ho) = 2.157627601$

coefficient d'équivalence du béton acier

$\alpha e := \frac{200000}{Ecm}$ $\alpha e = 6.354086649$ $\alpha := \frac{200000}{Eceff}$ $\alpha = 20.063839380$ hauteur utile $d = 0.134$ $Eceff = 9968.182$

CALCUL DES FLECHES à l'infini quasi permanentes EN INERTIE FISSUREE

$n := \alpha$

$n = 20.063839380$

axe neutre
section fissurée
sous longue durée

$$y_{(i,0)} := \begin{cases} 0 \text{ if } Mqp_{i,0} = 0 \\ \frac{\left[\left[n\cdot\left(As_{i,0}+Ac_{i,0}\right)\right]^2+2\cdot n\cdot b\cdot\left(As_{i,0}\cdot d+Ac_{i,0}\cdot cs\right)\right]^{0.5}-n\cdot\left(As_{i,0}+Ac_{i,0}\right)}{b} \text{ if } Mqp_{i,0}>0 \\ \frac{\left[\left[n\cdot\left(As_{i,0}+Ac_{i,0}\right)\right]^2+2\cdot n\cdot b\cdot\left(Ac_{i,0}\cdot d+As_{i,0}\cdot ci\right)\right]^{0.5}-n\cdot\left(As_{i,0}+Ac_{i,0}\right)}{b} \text{ if } Mqp_{i,0}<0 \end{cases}$$

calcul des contraintes

$$\sigma_{i,0} := \frac{\left|Mqp_{i,0}\right|}{1000}\cdot y_{i,0} \qquad \sigma c_{i,0} := \frac{\sigma_{i,0}}{I_{i,0}}$$

inertie fissurée
longue durée

$$I_{i,0} := \begin{cases} \left[bo\cdot\frac{\left(y_{i,0}\right)^3}{3}+n\cdot As_{i,0}\cdot\left(d-y_{i,0}\right)^2+n\cdot Ac_{(i,0)}\cdot\left(y_{i,0}-cs\right)^2\right] \text{ if } Mqp_{i,0}\geq 0 \\ \left[bo\cdot\frac{\left(y_{i,0}\right)^3}{3}+n\cdot Ac_{i,0}\cdot\left(d-y_{i,0}\right)^2+n\cdot As_{(i,0)}\cdot\left(y_{i,0}-ci\right)^2\right] \text{ otherwise} \end{cases}$$

$$\sigma a_{i,0} := n \cdot \frac{\left|Mqp_{i,0}\right|}{1000} \cdot \left(d - y_{i,0}\right) \qquad \sigma s_{i,0} := \frac{\sigma a_{i,0}}{I_{i,0}}$$

$$souplesse := \frac{1}{Ecm \cdot I} \qquad Ecm = 31475.81$$

$$fluage_{i,0} := \phi k\left(\sigma c_{i,0}\right)$$

$$cou_{i,0} := souplesse_{i,0} \cdot \frac{Mqp_{i,0}}{1000} \cdot \left(1 + fluage_{i,0}\right)$$

$$\phi k(t) := \begin{cases} \left[\phi(9999999999999, to, ho) \cdot \exp\left[1.5 \cdot \left(\frac{t}{fckt(to)} - 0.45\right)\right]\right] & \text{if } \frac{t}{fckt(to)} > 0.45 \\ \phi(99999999999999999999, to, ho) & \text{if } \frac{t}{fckt(to)} \le 0.45 \end{cases}$$

$fckt(to) = 25.000000000 \quad Eceff = 9968.181872704$

préparation courbe pour integration

$$vx := x^{\langle 0 \rangle} \quad vy := Mqp^{\langle 0 \rangle} \quad vs := lspline(vx, vy) \quad vy1 := cou^{\langle 0 \rangle}$$

$$vs1 := lspline(vx, vy1) \quad y2 := régress(vx, vy1, 2) \quad y3 := régress(vx, vy1, 3)$$

$$fc3(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3 \qquad fc(x) := y2_3 + y2_4 \cdot x + y2_5 \cdot x^2$$

rappel données | axe neutre | inertie | contraintes | coef fluage | courbures

$x =$

	0
0	0.00
1	0.52
2	1.03
3	1.55
4	2.06
5	2.58
6	3.10
7	3.61
8	4.13
9	4.64
10	5.16

$y =$

	0
0	0.000
1	0.035
2	0.044
3	0.044
4	0.044
5	0.044
6	0.044
7	0.036
8	0.031
9	0.044
10	0.044

$I =$

	0
0	0.000471
1	0.000377
2	0.000567
3	0.000567
4	0.000567
5	0.000567
6	0.000567
7	0.000393
8	0.000329
9	0.000628
10	0.000628

$\sigma c =$

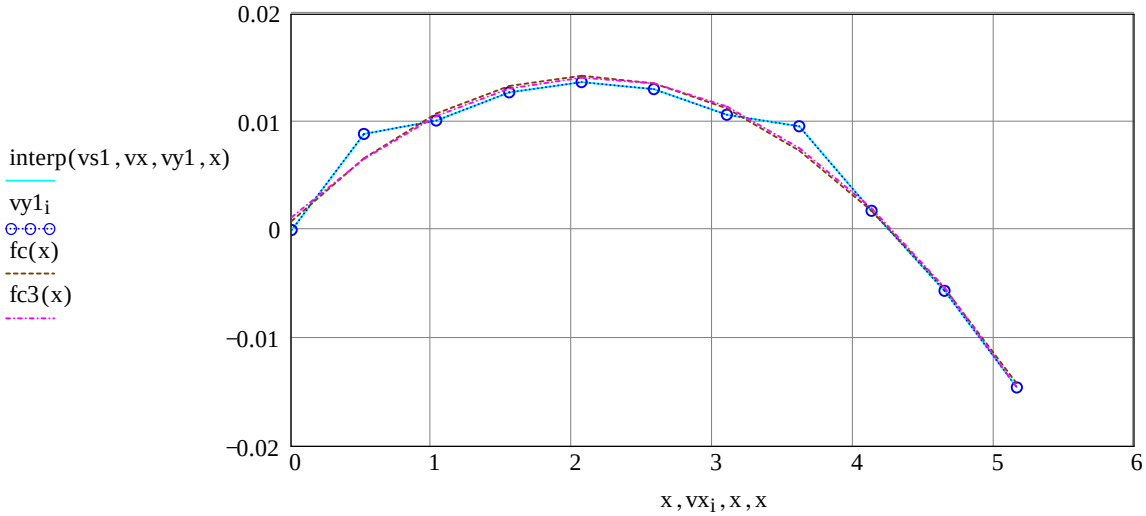
	0
0	0.0
1	3.1
2	4.4
3	5.5
4	6.0
5	5.6
6	4.6
7	3.4
8	0.5
9	2.5
10	6.4

$fluage_{i,0} =$

	0
0	2.158
1	2.158
2	2.158
3	2.158
4	2.158
5	2.158
6	2.158
7	2.158
8	2.158
9	2.158
10	2.158

$cou =$

	0
0	0.000000
1	0.008880
2	0.010153
3	0.012755
4	0.013708
5	0.013011
6	0.010665
7	0.009626
8	0.001760
9	-0.005656
10	-0.014584



portée

$l = 5.160000000$

les integrales sont calculées sur la base de la courbe fc3 qui passe par les points donnés

$i := 0 .. 10$

$\sigma s =$

	0
0	0.0
1	175.6
2	183.7
3	230.7
4	248.0
5	235.3
6	192.9
7	188.9
8	36.3
9	101.8
10	262.5

$\alpha = 20.063839380$ longue durée

$$v_i := \begin{cases} \dfrac{\frac{h^2 \cdot b}{2} + \alpha \cdot As_{i,0} \cdot d + \alpha \cdot Ac_{i,0} \cdot cs}{b \cdot h + \alpha \cdot As_{i,0} + \alpha \cdot Ac_{i,0}} & \text{if } Mqp_{i,0} \geq 0 \\ \dfrac{\frac{h^2 \cdot b}{2} + \alpha \cdot Ac_{i,0} \cdot d + \alpha \cdot As_{i,0} \cdot ci}{b \cdot h + \alpha \cdot As_{i,0} + \alpha \cdot Ac_{i,0}} & \text{if } Mqp_{i,0} < 0 \end{cases}$$

$$\sigma cb_i := \frac{Mqp_{i,0} \cdot (v_i)}{Ih_{i,0} \cdot 1000} \qquad fluage_{i,0} := \phi k(\sigma cb_{i,0})$$

INTEGRATION SIMPSON $i := 0 .. 10$

$$counf_{i,0} := \frac{Mqp_{i,0}}{1000 \cdot Ecm \cdot Ih_{i,0}} \cdot (1 + fluage_{i,0})$$

$$gf_{i,0} := 1 \cdot cou_{i,0} \cdot \left(1 - \frac{x_{i,0}}{l}\right) \qquad gnf_{i,0} := 1 \cdot counf_{i,0} \cdot \left(1 - \frac{x_{i,0}}{l}\right) \qquad g_{i,0} := \left[\zeta_i \cdot gf_{i,0} + (1 - \zeta_i) \cdot gnf_{i,0}\right]$$

$vy1 := g^{\langle 0 \rangle}$ $\quad y2 := régress(vx, vy1, 3)$ $\quad fc1(x) := y2_3 + y2_4 \cdot x + y2_5 \cdot x^2 + y2_6 \cdot x^3$ $\quad \omega r_i := \int_0^{x_i} fc1(t)\, dt$

$\omega o := (-\omega r)_{(10,0)}$ $\quad \omega o = -0.009647270$

Calcul en section non fissuree

$b = 5.000000000$ $\quad$ 5

axe neutre et inertie en section non fissurée $\quad h = 0.160000000$

$$Ih_{i,0} := \begin{cases} \left[\frac{b \cdot (v_i)^3}{3} + b \cdot \frac{(h - v_i)^3}{3} + \alpha \cdot As_{i,0} \cdot (d - v_i)^2\right] & \text{if } Mqp_{i,0} \geq 0 \\ \left[\frac{b \cdot (v_i)^3}{3} + b \cdot \frac{(h - v_i)^3}{3} + \alpha \cdot Ac_{i,0} \cdot (d - v_i)^2\right] & \text{if } Mqp_{i,0} < 0 \end{cases}$$

$$Mcr_{i,0} := \frac{fctm \cdot Ih_{i,0}}{h - v_i}$$

$$\zeta_i := \begin{cases} 0 & \text{if } Mqp_{i,0} = 0 \\ 1 - \left(\frac{1000 \cdot Mcr_{i,0}}{Mqp_{i,0}}\right)^2 & \text{if } \left|\frac{Mqp_{i,0}}{1000}\right| \geq |Mcr_{i,0}| \\ 0 & \text{otherwise} \end{cases}$$

$Ecm = 31475.806210019$ $\quad a = 0.516000000$

$gf_{i,0} := cou_{i,0}$ $gnf_{i,0} := counf_{i,0}$ $g_{i,0} := \left[\zeta_i \cdot gf_{i,0} + \left(1 - \zeta_i\right) \cdot gnf_{i,0} \right]$

$vy2 := g^{\langle 0 \rangle}$ $y4 := régress(vx, vy2, 3)$ $fc2(x) := y4_3 + y4_4 \cdot x + y4_5 \cdot x^2 + y4_6 \cdot x^3$ $\omega ro_i := \int_0^{x_i} fc2(t)\,dt + \omega o$

$g_{i,0} := \omega ro_{i,0}$

$vy2 := g^{\langle 0 \rangle}$ $y5 := régress(vx, vy2, 3)$ $fc3(x) := y5_3 + y5_4 \cdot x + y5_5 \cdot x^2 + y5_6 \cdot x^3$ $fl_i := \int_0^{x_i} fc3(t)\,dt$

flèche g+ cl+rev longue durée f en section fissurée et non fissurée fnf

$\omega o = -0.009647270$

courbure fissurée courbure non fissurée

fleche g+c+r à l'infini

$x =$

	0
0	0.00
1	0.52
2	1.03
3	1.55
4	2.06
5	2.58
6	3.10
7	3.61
8	4.13
9	4.64
10	5.16

$cou =$

	0
0	0.0000
1	0.0089
2	0.0102
3	0.0128
4	0.0137
5	0.0130
6	0.0107
7	0.0096
8	0.0018
9	-0.0057
10	-0.0146

$counf =$

	0
0	0.0000
1	0.0019
2	0.0031
3	0.0039
4	0.0042
5	0.0040
6	0.0033
7	0.0021
8	0.0003
9	-0.0019
10	-0.0049

$Mqp =$

	0
0	0.00
1	33.34
2	57.36
3	72.06
4	77.44
5	73.50
6	60.25
7	37.67
8	5.78
9	-35.43
10	-91.36

$Mcr =$

	0
0	0.058
1	0.059
2	0.062
3	0.062
4	0.062
5	0.062
6	0.062
7	0.059
8	0.056
9	0.061
10	0.061

$\zeta =$

	0
0	0.00
1	0.00
2	0.00
3	0.26
4	0.36
5	0.29
6	0.00
7	0.00
8	0.00
9	0.00
10	0.55

$1000fl =$

	0
0	0.0
1	-4.9
2	-9.3
3	-12.6
4	-14.3
5	-14.4
6	-12.9
7	-10.1
8	-6.5
9	-3.0
10	-0.5

$l = 5.160000000$

flèche totale g+q longue durée + q instantanée

$wt_i := fl_{(i,0)} + fi_{i,0}$

$1000wt =$

	0
0	0.00
1	-7.65
2	-14.45
3	-19.52
4	-22.30
5	-22.56
6	-20.36
7	-16.13
8	-10.60
9	-4.82
10	-0.18

détermination de wdi et wdv

$a := \frac{l}{10}$ $a = 0.516000000$ $i := 0..10$

fleche wdv en inertie fissurée

$\alpha = 20.063839380$ longue durée

$n := \alpha$

axe neutre
inertie fissurée
en longue durée

$$y_{(i,0)} := \begin{cases} 0 \text{ if } Mpp_{i,0} = 0 \\ \frac{\left[\left[n\cdot\left(As_{i,0}+Ac_{i,0}\right)\right]^2+2\cdot n\cdot b\cdot\left(As_{i,0}\cdot d+Ac_{i,0}\cdot cs\right)\right]^{0.5}-n\cdot\left(As_{i,0}+Ac_{i,0}\right)}{b} \text{ if } Mpp_{i,0}>0 \\ \frac{\left[\left[n\cdot\left(As_{i,0}+Ac_{i,0}\right)\right]^2+2\cdot n\cdot b\cdot\left(Ac_{i,0}\cdot d+As_{i,0}\cdot ci\right)\right]^{0.5}-n\cdot\left(As_{i,0}+Ac_{i,0}\right)}{b} \text{ if } Mpp_{i,0}<0 \end{cases}$$

sous le poids propre p seul

$Eceff = 9968.181872704$

$fckt(to) = 25.000000000$

$Ecm = 31475.806210019$

$$I_{i,0} := \begin{cases} \left[bo\cdot\frac{\left(y_{i,0}\right)^3}{3}+n\cdot As_{i,0}\cdot\left(d-y_{i,0}\right)^2+n\cdot Ac_{(i,0)}\cdot\left(y_{i,0}-cs\right)^2\right] \text{ if } Mpp_{i,0}\geq 0 \\ \left[bo\cdot\frac{\left(y_{i,0}\right)^3}{3}+n\cdot Ac_{i,0}\cdot\left(d-y_{i,0}\right)^2+n\cdot As_{(i,0)}\cdot\left(y_{i,0}-ci\right)^2\right] \text{ otherwise} \end{cases}$$

$$\sigma_{i,0} := \frac{\left|Mpp_{i,0}\right|}{1000}\cdot y_{i,0} \qquad \sigma c_{i,0} := \frac{\sigma_{i,0}}{I_{i,0}}$$

$$\sigma a_{i,0} := n\cdot\frac{\left|Mpp_{i,0}\right|}{1000}\cdot\left(d-y_{i,0}\right) \qquad \sigma s_{i,0} := \frac{\sigma a_{i,0}}{I_{i,0}}$$

$$souplesse := \frac{1}{Ecm\cdot I}$$

$$\phi k(t) := \begin{cases} \left[\phi(9999999999999,to,ho)\cdot\exp\left[1.5\cdot\left(\frac{t}{fckt(to)}-0.45\right)\right]\right] \text{ if } \frac{t}{fckt(to)}>0.45 \\ \phi(99999999999999999999,to,ho) \text{ if } \frac{t}{fckt(to)}\leq 0.45 \end{cases}$$

$$fluage_{i,0} := \phi k\left(\sigma c_{i,0}\right)$$

$$cou_{i,0} := souplesse_{i,0}\cdot\frac{Mpp_{i,0}}{1000}\cdot\left(1+fluage_{i,0}\right) \qquad g_{i,0} := 1\cdot cou_{i,0}\cdot\left(1-\frac{x_{i,0}}{l}\right)$$

INTEGRATION

Calcul en section non fissuree

$\alpha = 20.063839380$ $b = 5.000000000$ $h = 0.160000000$

axe neutre

$$v_i := \begin{cases} \dfrac{\frac{h^2 \cdot b}{2} + \alpha \cdot As_{i,0} \cdot d + \alpha \cdot Ac_{i,0} \cdot cs}{b \cdot h + \alpha \cdot As_{i,0} + \alpha \cdot Ac_{i,0}} & \text{if } Mpp_{i,0} \geq 0 \\ \dfrac{\frac{h^2 \cdot b}{2} + \alpha \cdot Ac_{i,0} \cdot d + \alpha \cdot As_{i,0} \cdot ci}{b \cdot h + \alpha \cdot As_{i,0} + \alpha \cdot Ac_{i,0}} & \text{if } Mpp_{i,0} < 0 \end{cases}$$

$$Ih_{i,0} := \begin{cases} \left[\frac{b \cdot (v_i)^3}{3} + b \cdot \frac{(h - v_i)^3}{3} + \alpha \cdot As_{i,0} \cdot (d - v_i)^2 \right] & \text{if } Mpp_{i,0} \geq 0 \\ \left[\frac{b \cdot (v_i)^3}{3} + b \cdot \frac{(h - v_i)^3}{3} + \alpha \cdot Ac_{i,0} \cdot (d - v_i)^2 \right] & \text{if } Mpp_{i,0} < 0 \end{cases}$$

$$\sigma cb_i := \frac{Mpp_{i,0} \cdot (v_i)}{Ih_{i,0} \cdot 1000} \qquad fluage_{i,0} := \phi k(\sigma cb_{i,0})$$

$$\zeta_i := \begin{cases} 0 & \text{if } Mpp_{i,0} = 0 \\ 1 - \left(\frac{1000 \cdot Mcr_{i,0}}{Mpp_{i,0}} \right)^2 & \text{if } \left| \frac{Mpp_{i,0}}{1000} \right| \geq |Mcr_{i,0}| \\ 0 & \text{otherwise} \end{cases}$$

$i := 0 .. 10$ $\qquad Mcr_{i,0} := \dfrac{fctm \cdot Ih_{i,0}}{h - v_i}$

$$counf_{i,0} := \frac{Mpp_{i,0}}{1000 \cdot Ecm \cdot Ih_{i,0}} \cdot (1 + fluage_{i,0})$$

INTEGRATION SIMPSON

$Ecm = 31475.806210019$ $a = 0.516000000$

$$gf_{i,0} := 1 \cdot cou_{i,0} \cdot \left(1 - \frac{x_{i,0}}{l}\right) \qquad gnf_{i,0} := 1 \cdot counf_{i,0} \cdot \left(1 - \frac{x_{i,0}}{l}\right) \qquad g_{i,0} := \left[\zeta_i \cdot gf_{i,0} + (1 - \zeta_i) \cdot gnf_{i,0} \right]$$

$vy1 := g^{\langle 0 \rangle}$ $\qquad y3 := régress(vx, vy1, 3)$ $\qquad fc1(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3$ $\qquad \omega r_i := \int_0^{x_i} fc1(t)\, dt$

$\omega o := (-\omega r)_{(10,0)}$ $\qquad \omega o = -0.003935384$

$gf_{i,0} := cou_{i,0}$ $gnf_{i,0} := counf_{i,0}$ $g_{i,0} := \left[\zeta_i \cdot gf_{i,0} + \left(1 - \zeta_i\right) \cdot gnf_{i,0} \right]$

$vy1 := g^{\langle 0 \rangle}$ $y3 := régress(vx, vy1, 3)$ $fc2(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3$ $\omega ro_i := \int_0^{x_i} fc2(t)\, dt + \omega o$

$g_{i,0} := \omega ro_{i,0}$

$vy1 := g^{\langle 0 \rangle}$ $y3 := régress(vx, vy1, 3)$ $fc3(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3$ $fdv_i := \int_0^{x_i} fc3(t)\, dt$

$wpv_i := fdv_i$

$\omega o = -0.003935384$

fleche à l'infini due au pp seul

sous le poids propre seul longue durée **fleche g à l'infini**

$x =$

	0
0	0.00
1	0.52
2	1.03
3	1.55
4	2.06
5	2.58
6	3.10
7	3.61
8	4.13
9	4.64
10	5.16

$1000Mcr =$

	0
0	58.3431
1	59.0139
2	61.8913
3	61.8913
4	61.8913
5	61.8913
6	61.8913
7	59.2378
8	56.0571
9	61.4743
10	61.4743

$\zeta =$

	0
0	0.0000
1	0.0000
2	0.0000
3	0.0000
4	0.0000
5	0.0000
6	0.0000
7	0.0000
8	0.0000
9	0.0000
10	0.0000

$Mpp =$

	0
0	0.00
1	19.05
2	32.78
3	41.18
4	44.25
5	42.00
6	34.43
7	21.53
8	3.30
9	-20.25
10	-52.20

$1000wpv =$

	0
0	0.0000
1	-1.9807
2	-3.6966
3	-4.9456
4	-5.6036
5	-5.6246
6	-5.0409
7	-3.9626
8	-2.5783
9	-1.1546
10	-0.0360

fleche instantanée à la mise en place des cloisons

$$Mapcl := \frac{cl \cdot lef^2}{10}$$ monent au nu d'appui $$Macle := \left[cl \cdot xn \cdot \frac{(lef - xn)}{2} \right] \cdot Mapcl \cdot \frac{xn}{lef}$$

$$Mt_{i,0} := \begin{cases} Maclo & \text{if } i = 0 \\ \left[(cl) \cdot x_i \cdot \frac{(lef - x_i)}{2} - Mapcl \cdot \frac{x_i}{lef} \right] & \text{if } i < 10 \\ Macle & \text{if } i = 10 \end{cases}$$

nouvelle définition pour Mcl

$$Mcl := Mt$$

calcul en instantanée et fissurée

$$\sigma_{i,0} := \frac{|Mcl_{i,0}|}{1000} \cdot yi_{i,0} \qquad \sigma c_{i,0} := \frac{\sigma_{i,0}}{Ii_{i,0}} \qquad souplesse := \frac{1}{Ecm \cdot Ii}$$

$$\sigma a_{i,0} := \alpha e \cdot \frac{|Mcl_{i,0}|}{1000} \cdot (d - yi_{i,0}) \qquad \sigma s_{i,0} := \frac{\sigma a_{i,0}}{Ii_{i,0}} \qquad coui_{i,0} := souplesse_{i,0} \cdot \frac{Mcl_{i,0}}{1000} \cdot (1)$$

calcul en instantanée

x =

	0
0	0.00000
1	0.51600
2	1.03200
3	1.54800
4	2.06400
5	2.58000
6	3.09600
7	3.61200
8	4.12800
9	4.64400
10	5.16000

y =

	0
0	0.0000
1	0.0351
2	0.0436
3	0.0436
4	0.0436
5	0.0436
6	0.0436
7	0.0359
8	0.0310
9	0.0440
10	0.0440

I =

	0
0	0.000471
1	0.000377
2	0.000567
3	0.000567
4	0.000567
5	0.000567
6	0.000567
7	0.000393
8	0.000329
9	0.000628
10	0.000628

σc =

	0
0	0.00000
1	0.71102
2	0.98128
3	1.23278
4	1.32485
5	1.25750
6	1.03072
7	0.78582
8	0.13856
9	1.16369
10	1.01418

σs =

	0
0	0.000
1	24.170
2	25.057
3	31.480
4	33.831
5	32.111
6	26.320
7	25.976
8	4.886
9	27.960
10	24.368

coui =

	0
0	0.000000
1	0.001070
2	0.001168
3	0.001467
4	0.001576
5	0.001496
6	0.001226
7	0.001156
8	0.000215
9	-0.001319
10	0.001150

$i := 0 .. 10$ $\quad a := \frac{l}{10}$ $\quad a = 0.52$

$g_{i,0} := 1 \cdot coui_{i,0} \cdot \left(1 - \frac{x_{i,0}}{l}\right)$

Calcul fleche instantanée en section non fissurée

$h = 0.160000000$ $\quad b = 5.000000000$ $\quad fctm = 2.564963920$ $\quad \alpha e = 6.354086649$

$$v1_i := \begin{cases} \frac{\frac{h^2 \cdot b}{2} + \alpha e \cdot As_{i,0} \cdot d + \alpha e \cdot Ac_{i,0} \cdot cs}{b \cdot h + \alpha e \cdot As_{i,0} + \alpha e \cdot Ac_{i,0}} & \text{if } Mcl_{i,0} \geq 0 \\ \frac{\frac{h^2 \cdot b}{2} + \alpha e \cdot Ac_{i,0} \cdot d + \alpha e \cdot As_{i,0} \cdot ci}{b \cdot h + \alpha e \cdot As_{i,0} + \alpha \cdot e\, Ac_{i,0}} & \text{if } Mcl_{i,0} < 0 \end{cases}$$

$$Iih_{i,0} := \begin{cases} \left[\frac{b \cdot (v1_i)^3}{3} + b \cdot \frac{(h - v1_i)^3}{3} + \alpha e \cdot As_{i,0} \cdot (d - v1_i)^2\right] & \text{if } Mcl_{i,0} \geq 0 \\ \left[\frac{b \cdot (v1_i)^3}{3} + b \cdot \frac{(h - v1_i)^3}{3} + \alpha e \cdot Ac_{i,0} \cdot (d - v1_i)^2\right] & \text{if } Mcl_{i,0} < 0 \end{cases}$$

$Micr_{i,0} := \frac{fctm \cdot Iih_{i,0}}{h - v1_i}$ $\quad \sigma icb_i := \frac{(Mcl_{i,0} + Mpp_{i,0}) \cdot (v1_i)}{Iih_{i,0} \cdot 1000}$

$$\zeta i_i := \begin{cases} 0 & \text{if } Mpp_{i,0} + Mcl_{i,0} = 0 \\ 1 - \left(\frac{1000 \cdot Mcr_{i,0}}{Mpp_{i,0} + Mcl_{i,0}}\right)^2 & \text{if } \left|\frac{Mpp_{i,0} + Mcl_{i,0}}{1000}\right| \geq |Mcr_{i,0}| \\ 0 & \text{otherwise} \end{cases}$$

$fluage_{i,0} := \phi k(\sigma icb_{i,0})$

$couinf_{i,0} := \frac{Mcl_{i,0}}{1000 \cdot Ecm \cdot Iih_{i,0}} \cdot 1$

$a = 0.516000000$

INTEGRATION

$gf_{i,0} := 1 \cdot coui_{i,0} \cdot \left(1 - \frac{x_{i,0}}{l}\right)$ $\quad gnf_{i,0} := 1 \cdot couinf_{i,0} \cdot \left(1 - \frac{x_{i,0}}{l}\right)$ $\quad g_{i,0} := \left[\zeta_i \cdot gf_{i,0} + (1 - \zeta i_i) \cdot gnf_{i,0}\right]$

$Ecm = 31475.806210019$

$vy1 := g^{\langle 0 \rangle}$ $\quad y3 := régress(vx, vy1, 3)$ $\quad fc1(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3$ $\quad \omega r_i := \int_0^{x_i} fc1(t)\, dt$

$\omega 1o := (-\omega r)_{(10,0)}$ $\quad \omega 1o = -0.000327904$

$gf_{i,0} := coui_{i,0}$ $gnf_{i,0} := couinf_{i,0}$ $g_{i,0} := \left[\zeta_i \cdot gf_{i,0} + \left(1 - \zeta_i\right) \cdot gnf_{i,0} \right]$ 13

$vy1 := g^{\langle 0 \rangle}$ $y3 := régress(vx, vy1, 3)$

$fc2(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3$

$\omega ro_i := \int_0^{x_i} fc2(t)\, dt + \omega 1o$

$g_{i,0} := \omega ro_{i,0}$ $vy1 := g^{\langle 0 \rangle}$ 14

$y3 := régress(vx, vy1, 3)$

$fc3(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3$

$fdvc_i := \int_0^{x_i} fc3(t)\, dt$

$wdv_i := fdvc_i + wpv_i$

$wd_i := wdi_i + \kappa \cdot \left(wdv_i - wdi_i\right)$

fleche nuisible $wl_i := wt_i - wd_i$

d'ou les fleches limites dans le cas ou lescloisons seraient mises en place tardivement

$Mpp =$

	0
0	0.00
1	19.05
2	32.78
3	41.18
4	44.25
5	42.00
6	34.43
7	21.53
8	3.30
9	-20.25
10	-52.20

$Mcl =$

	0
0	0.00
1	4.76
2	8.19
3	10.29
4	11.06
5	10.50
6	8.61
7	5.38
8	0.83
9	-5.06
10	8.92

$\frac{Mcr}{1000} =$

	0
0	0.00
1	0.00
2	0.00
3	0.00
4	0.00
5	0.00
6	0.00
7	0.00
8	0.00
9	0.00
10	0.00

$\zeta i =$

	0
0	0.000
1	0.000
2	0.000
3	0.000
4	0.000
5	0.000
6	0.000
7	0.000
8	0.000
9	0.000
10	0.000

$1000 \cdot wt =$

	0
0	0.000000000
1	-7.646253967
2	-14.449262761
3	-19.522925936
4	-22.304934143
5	-22.556769129
6	-20.363703731
7	-16.134801886
8	-10.602918622
9	-4.824700063
10	-0.180583427

les inerties

I =

	0
0	0.000470868
1	0.000376650
2	0.000566740
3	0.000566740
4	0.000566740
5	0.000566740
6	0.000566740
7	0.000392617
8	0.000329331
9	0.000628433
10	0.000628433

Ih =

	0
0	0.001780707
1	0.001794066
2	0.001850192
3	0.001850192
4	0.001850192
5	0.001850192
6	0.001850192
7	0.001798502
8	0.001792103
9	0.001869424
10	0.001869424

Ii =

	0
0	0.000149121
1	0.000141356
2	0.000222955
3	0.000222955
4	0.000222955
5	0.000222955
6	0.000222955
7	0.000147967
8	0.000121908
9	0.000121908
10	0.000246591

Iih =

	0
0	0.001730635
1	0.001735073
2	0.001754115
3	0.001754115
4	0.001754115
5	0.001754115
6	0.001754115
7	0.001736554
8	0.001731863
9	0.001884927
10	0.001731863

.

flèche wd

fleche wdi

pose différée

$\kappa = 1.000000000$

Si pose des cloisons instantanée

1000wt =

	0
0	0.0000
1	-7.6463
2	-14.4493
3	-19.5229
4	-22.3049
5	-22.5568
6	-20.3637
7	-16.1348
8	-10.6029
9	-4.8247

1000wd =

	0
0	0.000
1	-2.145
2	-3.988
3	-5.322
4	-6.020
5	-6.036
6	-5.405
7	-4.244
8	-2.749
9	-1.199
10	0.048

1000·wdi =

	0
0	0.0000
1	-0.7205
2	-1.4211
3	-1.9484
4	-2.2038
5	-2.1437
6	-1.7795
7	-1.1775
8	-0.4588
9	0.2005
10	0.5693

1000wl =

	0
0	0.00
1	-5.50
2	-10.46
3	-14.20
4	-16.29
5	-16.52
6	-14.96
7	-11.89
8	-7.85
9	-3.63
10	-0.23

1000·wnuisiblei =

	0
0	0.00
1	-6.93
2	-13.03
3	-17.57
4	-20.10
5	-20.41
6	-18.58
7	-14.96
8	-10.14
9	-5.03
10	-0.75

methode forfaitaire de calcul des fleches

$Mqp_4 = 77.441280000$

$Mq_4 = 34.443000000$

$n := 15$

$Mpp_4 = 44.252160000$

$Mcl_4 = 11.063040000$

$$y_{(i,0)} := \begin{cases} 0 & \text{if } Mqp_{i,0} = 0 \\ \dfrac{\left[\left[n\cdot\left(As_{i,0}+Ac_{i,0}\right)\right]^2+2\cdot n\cdot b\cdot\left(As_{i,0}\cdot d+Ac_{i,0}\cdot cs\right)\right]^{0.5}-n\cdot\left(As_{i,0}+Ac_{i,0}\right)}{b} & \text{if } Mqp_{i,0}>0 \\ \dfrac{\left[\left[n\cdot\left(As_{i,0}+Ac_{i,0}\right)\right]^2+2\cdot n\cdot b\cdot\left(Ac_{i,0}\cdot d+As_{i,0}\cdot ci\right)\right]^{0.5}-n\cdot\left(As_{i,0}+Ac_{i,0}\right)}{b} & \text{if } Mqp_{i,0}<0 \end{cases}$$

$$I_{i,0} := \begin{cases} \left[bo\cdot\dfrac{\left(y_{i,0}\right)^3}{3}+n\cdot As_{i,0}\cdot\left(d-y_{i,0}\right)^2+n\cdot Ac_{(i,0)}\cdot\left(y_{i,0}-cs\right)^2\right] & \text{if } Mqp_{i,0}\geq 0 \\ \left[bo\cdot\dfrac{\left(y_{i,0}\right)^3}{3}+n\cdot Ac_{i,0}\cdot\left(d-y_{i,0}\right)^2+n\cdot As_{(i,0)}\cdot\left(y_{i,0}-ci\right)^2\right] & \text{otherwise} \end{cases}$$

$$v_i := \begin{cases} \dfrac{\frac{h^2\cdot b}{2}+15\cdot As_{i,0}\cdot d+15\cdot Ac_{i,0}\cdot cs}{b\cdot h+15\cdot As_{i,0}+15\cdot Ac_{i,0}} & \text{if } Mqp_{i,0}\geq 0 \\ \dfrac{\frac{h^2\cdot b}{2}+15\cdot Ac_{i,0}\cdot d+15\cdot As_{i,0}\cdot ci}{b\cdot h+15\cdot As_{i,0}+15\cdot Ac_{i,0}} & \text{if } Mqp_{i,0}<0 \end{cases}$$

$$Ih_{i,0} := \begin{cases} \left[\dfrac{b\cdot\left(v_i\right)^3}{3}+b\cdot\dfrac{\left(h-v_i\right)^3}{3}+15\cdot As_{i,0}\cdot\left(d-v_i\right)^2\right] & \text{if } Mqp_{i,0}\geq 0 \\ \left[\dfrac{b\cdot\left(v_i\right)^3}{3}+b\cdot\dfrac{\left(h-v_i\right)^3}{3}+15\cdot Ac_{i,0}\cdot\left(d-v_i\right)^2\right] & \text{if } Mqp_{i,0}<0 \end{cases}$$

$I_{4,0} = 0.000458467$ $Ih_4 = 0.001815661$ $fluage_4 = 2.157627601$ $Mcr_4 := \frac{fctm \cdot Ih_4}{h - v_4}$ $v_4 = 0.082523016$ $h = 0.160000000$

$$wet := \frac{(Mqp_4)\cdot\frac{l^2}{10}}{1000Ecm\cdot I_4}\cdot(1 + fluage_4) + \frac{(Mq_4)\cdot\frac{l^2}{10}}{1000Ecm\cdot I_4} \qquad wht := \frac{(Mqp_4)\cdot\frac{l^2}{10}}{1000Ecm\cdot Ih_4}\cdot(1 + fluage_4) + \frac{(Mq_4)\cdot\frac{l^2}{10}}{1000Ecm\cdot Ih_4}$$

$Mqp_4 = 77.441280000$

$Mcr_4 = 0.060109526$

$l = 5.160000000$ $wet = 0.051472777$ $wht = 0.012997238$

$Ecm = 31475.806210019$

$$zt := \begin{cases} 0 & \text{if } Mqp_{4,0} = 0 \\ 1 - \left(\frac{1000\cdot Mcr_4}{Mqp_4 + Mq_4}\right)^{0.5} & \text{if } \left|\frac{Mqp_4 + Mq_4}{1000}\right| \geq |Mcr_4| \\ 0 & \text{otherwise} \end{cases}$$

$zt = 0.267028453$

$wst := wet\cdot zt + (1 - zt)\cdot wht$

$wst = 0.023271302$

à comparer à $(-wt)_4 = 0.022304934$

soit $\left(\frac{wt_4}{wst} + 1\right)\cdot 100 = 4$ %

$$wedi := \frac{(Mpp_4 + Mcl_4)\cdot\frac{l^2}{10}}{1000Ecm\cdot I_4} \qquad whdi := \frac{(Mcl_4 + Mpp_4)\cdot\frac{l^2}{10}}{1000Ecm\cdot Ih_4}$$

$Mcl_4 + Mpp_4 = 55.315200000$

$Ih_4 = 0.001815661$

$wedi = 0.010206076$ $whdi = 0.002577106$

$$zdi := \begin{cases} 0 & \text{if } Mpp_4 + Mcl_4 = 0 \\ 1 - \left(\frac{1000\cdot Mcr_{4,0}}{Mpp_{4,0} + Mcl_{4,0}}\right)^{0.5} & \text{if } \left|\frac{Mpp_{4,0} + Mcl_{4,0}}{1000}\right| \geq |Mcr_{4,0}| \\ 0 & \text{otherwise} \end{cases}$$

$zdi = 0.000000000$

$wdis := wedi\cdot zdi + (1 - zdi)\cdot whdi$

$wdis = 0.002577106$

à comparer à $(-wdi)_4 = 0.002203752$

soit $\left(\frac{wdi_4}{wdis} + 1\right)\cdot 100 = 14 \quad \%$

$$wedv := \frac{(Mpp_4)\cdot\frac{l^2}{10}}{1000Ecm\cdot I_4}\cdot(1 + fluage_4) + \frac{(Mcl_4)\cdot\frac{l^2}{10}}{1000Ecm\cdot I_4} \qquad whdv := \frac{(Mpp_4)\cdot\frac{l^2}{10}}{1000Ecm\cdot Ih_4}\cdot(1 + fluage_4) + \frac{(Mcl_4)\cdot\frac{l^2}{10}}{1000Ecm\cdot Ih_4}$$

$Mcl_4 + Mpp_4 = 55.315200000$

$wedv = 0.027822805$ $\qquad whdv = 0.007025454$

$Ih_4 = 0.001815661$

$$zdv := \begin{cases} 0 & \text{if } Mpp_4 + Mcl_4 = 0 \\ 1 - \left(\frac{1000\cdot Mcr_{4,0}}{Mpp_{4,0} + Mcl_{4,0}}\right)^{0.5} & \text{if } \left|\frac{Mpp_{4,0} + Mcl_{4,0}}{1000}\right| \geq |Mcr_4| \\ 0 & \text{otherwise} \end{cases}$$

$zdv = 0.000000000$

$wdvs := wedv\cdot zdv + (1 - zdv)\cdot whdv$ $\qquad wdvs = 0.007025454$

à comparer à $(-wdv)_4 = 0.006019548$

soit $\left(\frac{wdv_4}{wdvs} + 1\right)\cdot 100 = 14 \quad \%$

$wds := wdis + \kappa\cdot(wdvs - wdis)$

$\kappa = 1.000000000$

fleche nuisible $\qquad wls := wst - wds \qquad wls = 0.016245848$

$wl_4 = -0.016285386$ soit $\left(\frac{wl_4}{wls} + 1\right)\cdot 100 = -0 \quad \%$

choix du ciment s=0,2 si CEM 42,5R OU 52,5 N 52,5 R = classe R CHOIX =R
s=0,25 si CEM 42,5 N CLASSE N = classe N choix = N
autre choix=S

CHOIX := "N"

charges avant cloisons ou revetement g := 20 cl := 5 **Données charges**

charges au moment de la mise en place des éléments fragiles g + cl = 25.000000000

charges revêtement mise aprés éléments fragiles rv := 10

charges d'exploitation q := 12.5 Ψ2 := 0.3

charges permanentes totales p+c+r ps := g + cl + rv ps = 35.00

moment au nu d'appui de rive Mappo := 0 Mago := 0 Maclo := 0 Maco := 0 Maqo := 0

$$Map := \frac{(g + cl + rv)\cdot lef^2}{10} \qquad Map = 96.84$$

$$Maq := q\cdot\frac{lef^2}{20} \qquad Maq = 17.292$$

$$Mac := \frac{(g + cl)\cdot lef^2}{10} \qquad Mac = 69.17$$

monent au nu d'appui

$$Mage := \left[(g + cl + rv)\cdot xn\cdot\frac{(lef - xn)}{2} \right] - Map\cdot\frac{xn}{lef}$$

$$Maqe := \left[q\cdot xn\cdot\frac{(lef - xn)}{2} \right] - Maq\cdot\frac{xn}{lef}$$

$$Mtce := (g + cl)\cdot xn\cdot\frac{(lef - xn)}{2} - Mac\cdot\frac{xn}{lef}$$

$$Mt_{i,0} := \begin{cases} Mago & \text{if } i = 0 \\ \left[(g + cl + rv)\cdot x_i\cdot\frac{(lef - x_i)}{2} - Map\cdot\frac{x_i}{lef} \right] & \text{if } i < 10 \\ Mage & \text{if } i = 10 \end{cases}$$

$$Mqt_{i,0} := \begin{cases} Maqo & \text{if } i = 0 \\ \left[\left[q\cdot x_i\cdot\frac{(lef - x_i)}{2} \right] - Maq\cdot\frac{x_i}{lef} \right] & \text{if } i < 10 \\ Maqe & \text{if } i = 10 \end{cases}$$

$$Mct_{i,0} := \begin{cases} Maco & \text{if } i = 0 \\ \left[\left[(g + cl)\cdot x_i\cdot\frac{(lef - x_i)}{2} \right] - Mac\cdot\frac{x_i}{lef} \right] & \text{if } i < 10 \\ Mtce & \text{if } i = 10 \end{cases}$$

Mqp := Mt Mq := Mqt Mcl := Mct

$$fcm(t) := \begin{cases} \left[\exp\left[s\cdot\left[1-\left(\frac{28}{t}\right)^{0.5}\right]\right]\right]\cdot(fck+8) & \text{if } t < 28 \\ (fck+8) & \text{if } t \geq 28 \end{cases}$$

$$fckt(t) := \begin{cases} (fcm(t)-8) & \text{if } t < 28 \\ fck & \text{if } t \geq 28 \end{cases}$$

$fcm(28) = 33.000000000$

$fcm := fck + 8$ $\quad$ $fcm = 33.000000000$

$$\phi rh(ho) := \begin{cases} \left[\left[1+\frac{\left(1-\frac{RH}{100}\right)}{0.1\cdot ho^{\frac{1}{3}}}\right]\cdot\left(\frac{35}{fcm}\right)^{0.7}\right]\cdot\left(\frac{35}{fcm}\right)^{0.2} & \text{if } fcm > 35 \\ \left[\left[\left[1+\frac{\left(1-\frac{RH}{100}\right)}{0.1\cdot ho^{\frac{1}{3}}}\cdot 1\right]\cdot 1\right]\right] & \text{if } fcm \leq 35 \end{cases}$$

$$beta1(fcm) := \frac{16.8}{(fcm)^{0.5}}$$

$$beta2(to) := \frac{1}{\left(0.1+to^{0.2}\right)}$$

$$betahc := \begin{cases} \left[1.5\cdot\left[1+(0.012\cdot RH)^{18}\right]\cdot ho + 250\cdot\left(\frac{35}{fcm}\right)^{0.5}\right] & \text{if } fcm \geq 35 \\ \left[1.5\cdot\left[1+(0.012\cdot RH)^{18}\right]\cdot ho + 250\right] & \text{if } fcm < 35 \end{cases}$$

doit être inférieur à betahm

$$betahm := 1500\cdot\left(\frac{35}{fcm}\right)^{0.5}$$

$to = 30.000000000$ $\quad$ 0000000

$$betah := \begin{cases} betahc & \text{if } betahc \leq betahm \\ betahm & \text{otherwise} \end{cases}$$

$$\phi(t,to,ho) := \phi rh(ho)\cdot beta1(fcm)\cdot beta2(fcm)\cdot\left[\frac{(t-to)}{betah+t-to}\right]^{0.3}$$

CALCUL DES FLECHES instantanées sous charges d'exploitation EN INERTIE FISSUREE

$\alpha e = 6.354086649$

$Eceff = 9968.181872704$

$Eceff = 9968.181872704$

$Ecm = 31475.806210019$

$bo = 5.000000000$

$$yi_{(i,0)} := \begin{cases} 0 & \text{if } Mq_{i,0} = 0 \\ \dfrac{\left[\left[\alpha e\cdot\left(As_{i,0}+Ac_{i,0}\right)\right]^2+2\cdot\alpha e\cdot b\cdot\left(As_{i,0}\cdot d+Ac_{i,0}\cdot cs\right)\right]^{0.5}-\alpha e\cdot\left(As_{i,0}+Ac_{i,0}\right)}{b} & \text{if } Mq_{i,0}>0 \\ \dfrac{\left[\left[\alpha e\cdot\left(As_{i,0}+Ac_{i,0}\right)\right]^2+2\cdot\alpha e\cdot b\cdot\left(Ac_{i,0}\cdot d+As_{i,0}\cdot ci\right)\right]^{0.5}-\alpha e\cdot\left(As_{i,0}+Ac_{i,0}\right)}{b} & \text{if } Mq_{i,0}<0 \end{cases}$$

$$Ii_{i,0} := \begin{cases} \left[bo\cdot\dfrac{\left(yi_{i,0}\right)^3}{3}+\alpha e\cdot As_{i,0}\cdot\left(d-yi_{i,0}\right)^2+\alpha e\cdot Ac_{(i,0)}\cdot\left(yi_{i,0}-cs\right)^2\right] & \text{if } Mq_{i,0}\geq 0 \\ \left[bo\cdot\dfrac{\left(yi_{i,0}\right)^3}{3}+\alpha e\cdot Ac_{i,0}\cdot\left(d-yi_{i,0}\right)^2+\alpha e\cdot As_{(i,0)}\cdot\left(yi_{i,0}-ci\right)^2\right] & \text{otherwise} \end{cases}$$

$$\sigma i_{i,0} := \frac{\left|Mq_{i,0}\right|}{1000}\cdot yi_{i,0} \qquad \sigma ci_{i,0} := \frac{\sigma i_{i,0}}{Ii_{i,0}}$$

$$\sigma ai_{i,0} := \alpha e \cdot \frac{\left|Mq_{i,0}\right|}{1000} \cdot \left(d - yi_{i,0}\right) \qquad \sigma si_{i,0} := \frac{\sigma ai_{i,0}}{Ii_{i,0}}$$

$$souplessei := \frac{1}{Ecm \cdot Ii}$$

$$coui_{i,0} := souplessei_{i,0} \cdot \frac{Mq_{i,0}}{1000} \cdot (1)$$

$\sigma ci =$

	0
0	0.00
1	2.03
2	2.86
3	3.69
4	4.12
5	4.16
6	3.80
7	3.70
8	2.62
9	0.44
10	1.76

$\sigma si =$

	0
0	0.00
1	69.03
2	73.02
3	94.26
4	105.33
5	106.21
6	96.92
7	122.25
8	92.53
9	15.46
10	42.33

$x =$

	0
0	0.00
1	0.52
2	1.03
3	1.55
4	2.06
5	2.58
6	3.10
7	3.61
8	4.13
9	4.64
10	5.16

$Mq =$

	0
0	0.00
1	13.60
2	23.88
3	30.82
4	34.44
5	34.73
6	31.70
7	25.33
8	15.63
9	2.61
10	-15.50

$yi =$

	0
0	0.0000
1	0.0211
2	0.0267
3	0.0267
4	0.0267
5	0.0267
6	0.0267
7	0.0216
8	0.0205
9	0.0205
10	0.0280

$Ii =$

	0
0	0.000149
1	0.000141
2	0.000223
3	0.000223
4	0.000223
5	0.000223
6	0.000223
7	0.000148
8	0.000122
9	0.000122
10	0.000247

$coui =$

	0
0	0.000000
1	0.003057
2	0.003403
3	0.004392
4	0.004908
5	0.004949
6	0.004516
7	0.005438
8	0.004075
9	0.000681
10	-0.001997

$d = 0.134000000$

$\alpha e = 6.354086649$

FLECHE EN FISSUREE

INTEGRATION SIMPSON

$a := \frac{l}{10}$ $i := 0..10$ $a = 0.516000000$

Calcul fleche instantanée en section non fissurée

$h = 0.160000000$ $b = 5.000000000$ $fctm = 2.564963920$

$$v1_i := \begin{cases} \frac{\frac{h^2 \cdot b}{2} + \alpha e \cdot As_{i,0} \cdot d + \alpha e \cdot Ac_{i,0} \cdot cs}{b \cdot h + \alpha e \cdot As_{i,0} + \alpha e \cdot Ac_{i,0}} & \text{if } Mq_{i,0} \geq 0 \\ \frac{\frac{h^2 \cdot b}{2} + \alpha e \cdot Ac_{i,0} \cdot d + \alpha e \cdot As_{i,0} \cdot ci}{b \cdot h + \alpha e \cdot As_{i,0} + \alpha \cdot e\, Ac_{i,0}} & \text{if } Mq_{i,0} < 0 \end{cases}$$

$$Iih_{i,0} := \begin{cases} \left[\frac{b \cdot (v1_i)^3}{3} + b \cdot \frac{(h - v1_i)^3}{3} + \alpha e \cdot As_{i,0} \cdot (d - v1_i)^2 \right] & \text{if } Mq_{i,0} \geq 0 \\ \left[\frac{b \cdot (v1_i)^3}{3} + b \cdot \frac{(h - v1_i)^3}{3} + \alpha e \cdot Ac_{i,0} \cdot (d - v1_i)^2 \right] & \text{if } Mq_{i,0} < 0 \end{cases}$$

$$Micr_{i,0} := \frac{fctm \cdot Iih_{i,0}}{h - v1_i} \qquad \sigma icb_i := \frac{Mq_{i,0} \cdot (v1_i)}{Iih_{i,0} \cdot 1000}$$

$$\zeta i_i := \begin{cases} 0 & \text{if } Mq_{i,0} = 0 \\ 1 - \left(\frac{1000 \cdot Micr_{i,0}}{Mq_{i,0} + Mqp_{i,0}} \right)^2 & \text{if } \left| \frac{Mqp_{i,0} + Mq_{i,0}}{1000} \right| \geq \left| Micr_{i,0} \right| \\ 0 & \text{otherwise} \end{cases}$$

$fluage_{i,0} := \phi k(\sigma icb_{i,0})$

$$couinf_{i,0} := \frac{Mq_{i,0}}{1000 \cdot Ecm \cdot Iih_{i,0}} \cdot 1$$

INTEGRATION SIMPSON

$Ecm = 31475.806210019$ $a = 0.516000000$

$g1nf_{i,0} := 1 \cdot couinf_{i,0} \cdot \left(1 - \frac{x_{i,0}}{l}\right)$ $g1f_{i,0} := 1 \cdot coui_{i,0} \cdot \left(1 - \frac{x_{i,0}}{l}\right)$ $g1_{i,0} := \left[\zeta i_i \cdot g1f_{i,0} + (1 - \zeta i_i) \cdot g1nf_{i,0} \right]$

$vy1 := g1^{\langle 0 \rangle}$ $y3 := régress(vx, vy1, 3)$ $fc(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3$ $\omega 1r_i := \int_0^{x_i} fc(t)\, dt$

$\omega 1oi := (-\omega 1r)_{(10,0)}$ $\omega 1oi = -0.005303325$

$g1nf_{i,0} := couinf_{i,0}$ $g1f_{i,0} := coui_{i,0}$ $g1_{i,0} := \left[\zeta i_i \cdot g1f_{i,0} + \left(1 - \zeta i_i\right) \cdot g1nf_{i,0} \right]$

$vy1 := g1^{\langle 0 \rangle}$ $y3 := régress(vx, vy1, 3)$ $fc(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3$ $\omega iro_i := \int_0^{x_i} fc(t)\,dt + \omega 1oi$

$g1_{i,0} := \omega iro_{i,0}$ $vy1 := g1^{\langle 0 \rangle}$ $y3 := régress(vx, vy1, 3)$ $fc(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3$

$fi_i := \int_0^{x_i} fc(t)\,dt$

$Iih =$

	0
0	0.001731
1	0.001735
2	0.001754
3	0.001754
4	0.001754
5	0.001754
6	0.001754
7	0.001737
8	0.001732
9	0.001732
10	0.001885

flèche instantanée sous q

$couinf =$

	0
0	0.0000
1	0.0002
2	0.0004
3	0.0006
4	0.0006
5	0.0006
6	0.0006
7	0.0005
8	0.0003
9	0.0000
10	-0.0003

$\frac{Mq}{1000} =$

	0
0	0.000
1	0.014
2	0.024
3	0.031
4	0.034
5	0.035
6	0.032
7	0.025
8	0.016
9	0.003
10	-0.015

$Iicr =$

	0
0	0.06
1	0.06
2	0.06
3	0.06
4	0.06
5	0.06
6	0.06
7	0.06
8	0.06
9	0.06
10	0.05

$\zeta i =$

	0
0	0.000
1	0.000
2	0.507
3	0.693
4	0.740
5	0.722
6	0.615
7	0.205
8	0.000
9	0.000
10	0.753

$1000fi =$

	0
0	0.00
1	-2.73
2	-5.14
3	-6.95
4	-7.99
5	-8.16
6	-7.49
7	-6.06
8	-4.08
9	-1.83
10	0.30

$n := \alpha e$

$n = 6.35$

fleche instantanée
sous cloisons

axe neutre
en instantanée
section fissurée

$$yi_{(i,0)} := \begin{cases} 0 & \text{if } Mcl_{i,0} = 0 \\ \dfrac{\left[\left[n\cdot\left(As_{i,0}+Ac_{i,0}\right)\right]^2+2\cdot n\cdot b\cdot\left(As_{i,0}\cdot d+Ac_{i,0}\cdot cs\right)\right]^{0.5}-n\cdot\left(As_{i,0}+Ac_{i,0}\right)}{b} & \text{if } Mcl_{i,0}>0 \\ \dfrac{\left[\left[n\cdot\left(As_{i,0}+Ac_{i,0}\right)\right]^2+2\cdot n\cdot b\cdot\left(Ac_{i,0}\cdot d+As_{i,0}\cdot ci\right)\right]^{0.5}-n\cdot\left(As_{i,0}+Ac_{i,0}\right)}{b} & \text{if } Mcl_{i,0}<0 \end{cases}$$

$$\sigma_{i,0} := \frac{\left|Mcl_{i,0}\right|}{1000}\cdot yi_{i,0} \qquad \sigma c_{i,0} := \frac{\sigma_{i,0}}{Ii_{i,0}} \qquad souplesse := \frac{1}{Ecm\cdot Ii}$$

INTEGRATION

$\alpha e = 6.354086649$

$$\sigma a_{i,0} := \alpha e\cdot\frac{\left|Mcl_{i,0}\right|}{1000}\cdot\left(d-yi_{i,0}\right) \qquad \sigma s_{i,0} := \frac{\sigma a_{i,0}}{Ii_{i,0}}$$

$$coui_{i,0} := souplesse_{i,0}\cdot\frac{Mcl_{i,0}}{1000}\cdot(1)$$

$\alpha e = 6.354086649$

$x =$

	0
0	0.00000
1	0.51600
2	1.03200
3	1.54800
4	2.06400
5	2.58000
6	3.09600
7	3.61200
8	4.12800
9	4.64400
10	5.16000

$yi =$

	0
0	0.0000
1	0.0211
2	0.0267
3	0.0267
4	0.0267
5	0.0267
6	0.0267
7	0.0216
8	0.0205
9	0.0280
10	0.0280

$Ii =$

	0
0	0.000149
1	0.000141
2	0.000223
3	0.000223
4	0.000223
5	0.000223
6	0.000223
7	0.000148
8	0.000122
9	0.000122
10	0.000247

$\sigma c =$

	0
0	0.00000
1	3.55510
2	4.90640
3	6.16390
4	6.62426
5	6.28749
6	5.15358
7	3.92911
8	0.69279
9	5.81847
10	7.41636

$\sigma s =$

	0
0	0.000
1	120.849
2	125.287
3	157.398
4	169.154
5	160.554
6	131.599
7	129.879
8	24.429
9	139.801
10	178.194

$Mcl =$

	0
0	0.000
1	23.813
2	40.970
3	51.471
4	55.315
5	52.503
6	43.034
7	26.909
8	4.128
9	-25.310
10	-65.255

$coui =$

	0
0	0.000000
1	0.005352
2	0.005838
3	0.007334
4	0.007882
5	0.007482
6	0.006132
7	0.005778
8	0.001076
9	-0.006596
10	-0.008407

Calcul fleche instantanée en section non fissurée

$\alpha e = 6.354086649$

$h = 0.160000000 \quad b = 5.000000000 \quad fctm = 2.564963920$

$$v1_i := \begin{cases} \dfrac{\frac{h^2 \cdot b}{2} + \alpha e \cdot As_{i,0} \cdot d + \alpha e \cdot Ac_{i,0} \cdot cs}{b \cdot h + \alpha e \cdot As_{i,0} + \alpha e \cdot Ac_{i,0}} & \text{if } Mcl_{i,0} \geq 0 \\ \dfrac{\frac{h^2 \cdot b}{2} + \alpha e \cdot Ac_{i,0} \cdot d + \alpha e \cdot As_{i,0} \cdot ci}{b \cdot h + \alpha e \cdot As_{i,0} + \alpha \cdot e\, Ac_{i,0}} & \text{if } Mcl_{i,0} < 0 \end{cases}$$

$$Iih_{i,0} := \begin{cases} \left[\dfrac{b \cdot (v1_i)^3}{3} + b \cdot \dfrac{(h - v1_i)^3}{3} + \alpha e \cdot As_{i,0} \cdot (d - v1_i)^2 \right] & \text{if } Mcl_{i,0} \geq 0 \\ \left[\dfrac{b \cdot (v1_i)^3}{3} + b \cdot \dfrac{(h - v1_i)^3}{3} + \alpha e \cdot Ac_{i,0} \cdot (d - v1_i)^2 \right] & \text{if } Mcl_{i,0} < 0 \end{cases}$$

$$\sigma icb_i := \frac{Mcl_{i,0} \cdot (v1_i)}{Iih_{i,0} \cdot 1000} \qquad Micr_{i,0} := \frac{fctm \cdot Iih_{i,0}}{h - v1_i}$$

$Ecm = 31475.806210019$

$$\zeta i_i := \begin{cases} 0 & \text{if } Mcl_{i,0} = 0 \\ 1 - \left(\dfrac{1000 \cdot Micr_{i,0}}{Mcl_{i,0}} \right)^2 & \text{if } \left| \dfrac{Mcl_{i,0}}{1000} \right| \geq \left| Micr_{i,0} \right| \\ 0 & \text{otherwise} \end{cases}$$

$$fluage_{i,0} := \phi k(\sigma icb_{i,0}) \qquad couinf_{i,0} := \frac{Mcl_{i,0}}{1000 \cdot Ecm \cdot Iih_{i,0}} \cdot 1$$

$a = 0.516000000$

INTEGRATION

$$g1_{i,0} := 1 \cdot coui_{i,0} \cdot \left(1 - \frac{x_{i,0}}{l}\right) \qquad g1nf_{i,0} := 1 \cdot couinf_{i,0} \cdot \left(1 - \frac{x_{i,0}}{l}\right) \qquad g0_{i,0} := \left[\zeta i_i \cdot g1f_{i,0} + (1 - \zeta i_i) \cdot g1nf_{i,0} \right]$$

$vy1 := g0^{\langle 0 \rangle}$ $\qquad y3 := régress(vx, vy1, 3)$

$$fc1(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3 \qquad \omega 2r_i := \int_0^{x_i} fc1(t)\, dt$$

$$\omega 2io := (-\omega 2r)_{(10,0)} \qquad \omega 2io = -0.001423789$$

$g1f_{i,0} := coui_{i,0}$ $g1nf_{i,0} := couinf_{i,0}$ $g2_{i,0} := \left[\zeta i_i \cdot g1f_{i,0} + \left(1 - \zeta i_i\right) \cdot g1nf_{i,0} \right]$

$vy1 := g2^{\langle 0 \rangle}$ $y3 := régress(vx, vy1, 3)$ $fc2(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3$ $\omega ro_i := \int_0^{x_i} fc2(t)\, dt + \omega 2io$

$g3_{i,0} := \omega ro_{i,0}$ $vy1 := g3^{\langle 0 \rangle}$ $y3 := régress(vx, vy1, 3)$ $fc3(x) := y3_3 + y3_4 \cdot x + y3_5 \cdot x^2 + y3_6 \cdot x^3$ $fdi_i := \int_0^{x_i} fc3(t)\, dt$

$wdi_{i,0} := \left(fdi_i\right)$

fleches limites dans le cas ou lescloisons seraient mises en place rapidement

sous pp+cl

flèche wdi

$Iih =$

	0
0	0.00173
1	0.00174
2	0.00175
3	0.00175
4	0.00175
5	0.00175
6	0.00175
7	0.00174
8	0.00173
9	0.00188
10	0.00188

$couinf =$

	0
0	0.00000
1	0.00044
2	0.00074
3	0.00093
4	0.00100
5	0.00095
6	0.00078
7	0.00049
8	0.00008
9	-0.00043
10	-0.00110

$\frac{Mcl}{1000} =$

	0
0	0.00000
1	0.02381
2	0.04097
3	0.05147
4	0.05532
5	0.05250
6	0.04303
7	0.02691
8	0.00413
9	-0.02531
10	-0.06526

$Micr =$

	0
0	0.05588
1	0.05609
2	0.05702
3	0.05702
4	0.05702
5	0.05702
6	0.05702
7	0.05616
8	0.05506
9	0.05306
10	0.05306

$\zeta i =$

	0
0	0.000
1	0.000
2	0.000
3	0.000
4	0.000
5	0.000
6	0.000
7	0.000
8	0.000
9	0.000
10	0.339

$1000wdi =$

	0
0	0.000
1	-0.720
2	-1.421
3	-1.948
4	-2.204
5	-2.144
6	-1.780
7	-1.177
8	-0.459
9	0.200
10	0.569

si cloison mise en place rapidement

fleche totale

wnuisiblei := wt – wdi

1000wt =

	0
0	0.000000000
1	-7.646253967
2	-14.449262761
3	-19.522925936
4	-22.304934143
5	-22.556769129
6	-20.363703731
7	-16.134801886
8	-10.602918622
9	-4.824700063
10	-0.180583427

1000wnuisiblei =

	0
0	0.000000000
1	-6.925754964
2	-13.028164029
3	-17.574570295
4	-20.101182167
5	-20.413073357
6	-18.584182882
7	-14.957315067
8	-10.144139544
9	-5.025191248
10	-0.749870425