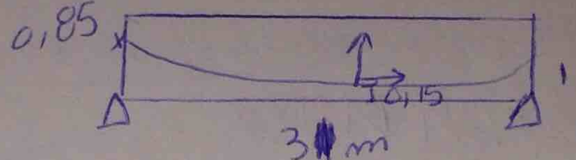
2-a- Pertes de frottement : 2012

$\sigma = \sigma_0 \times e^{-\mu\alpha - Kx}$ $\sigma_0 = 0{,}75 f_{prg} = 1395$ Mpa

$y = ax^2 + bx + c$

$x = 0 \Rightarrow y = 0 \Rightarrow \boxed{c = 0}$



$\left.\frac{dy}{dx}\right|_{x=0} = 0 \Rightarrow \boxed{b = 0}$

$y = ax^2 \Rightarrow x = 15{,}5$ m ; $y = 0{,}85$ m $\Rightarrow a = \frac{0{,}85}{(15{,}5)^2} \Rightarrow \boxed{a = 3{,}54 \times 10^{-3}}$

$\boxed{y = 3{,}54 \times 10^{-3} x^2} \Rightarrow \boxed{\frac{dy}{dx} = 7{,}08 \times 10^{-3} x}$

$\alpha_1 = \left.\frac{dy}{dx}\right|_{x=15{,}5} = 0{,}10974$ rd

$\sigma(15{,}5) = 1395 \times e^{-(0{,}2 \times 0{,}10974 + 0{,}0015 \times 15{,}5)}$

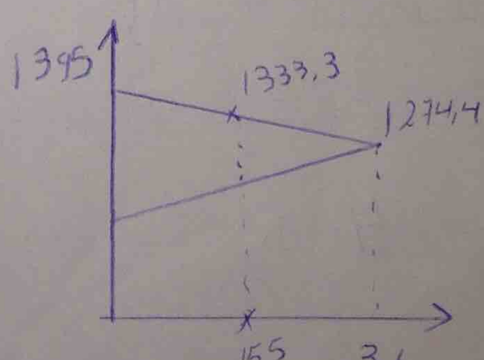
$\boxed{\sigma(15{,}5) = 1333{,}3 \text{ Mpa}}$

$\sigma(31) = 1395 \times e^{-(0{,}2 \times 0{,}21948 + 0{,}0015 \times 31)}$

$\boxed{\sigma(31) = 1274{,}4 \text{ Mpa}}$

Pertes par rentrée d'ancrage :

$\alpha = \left.\frac{dy}{dx}\right|_{x=1{,}46} = 0{,}01034$



$P = \frac{\mu\alpha + Kx}{x} = \frac{0{,}2 \times 0{,}10974 + 0{,}0015 \times 15{,}5}{15{,}5}$

$P(15{,}5) = 2{,}916 \times 10^{-3}$

$\lambda = \sqrt{\frac{g E_p}{\sigma_0 P}} = \sqrt{\frac{6 \times 10^{-3} \times 195000}{1395 \times 2{,}916 \times 10^{-3}}} = 16{,}96$ m

$\sigma(\lambda) = e^{-[0{,}2 \times (0{,}10974 + 2 \times 0{,}01034) + 0{,}0015 \times (16{,}96 + 1{,}46)]} \times 1395$

$\boxed{\sigma(\lambda) = 1322 \text{ Mpa}}$

2-b- $15,5 < \lambda < 31$

2-c- $F = \sigma S = 0,75 \times 1860 \times 4 \times 19 \times 150 \times 10^{-6}$

$F = 15,9\,MN$ (sans perte)

Perte par non simultanéité:

$\sigma_b \begin{pmatrix} \lambda = 15,5 \\ y = 2 - 0,15 - 0,796 = 1,054 \end{pmatrix} = \dfrac{4 \times 19 \times 1322 \times 150 \times 10^{-6}}{5,31} + \dfrac{4 \times 19 \times 1322 \times 150 \times 10^{-6} (1,054)(-1,054)}{2,432} + \dfrac{14,935 \times (-1,054)}{2,432}$

$\sigma_b = 2,84 + 6,88 - 6,47$

$\boxed{\sigma_b = 3,25\,Mpa}$

$\Delta\sigma_p = \dfrac{E_p \sigma_b}{2E_b} = \dfrac{195000 \times 3,25}{2 \times 11000\sqrt[3]{25}} = 9,85\,Mpa$

$\boxed{\sigma_p} = 1322 - 9,85 = \boxed{1312,2\,Mpa}$

Perte en retrait $\Delta\sigma_r = \varepsilon_r E_p = 2 \times 10^{-4} \times 195000 = 39\,Mpa$

Perte due au fluage: $\Delta\sigma_p = \dfrac{2\sigma_{bc} E_p}{E_i}$

$\sigma_{bc} = \dfrac{4 \times 19 \times 1312,2 \times 150 \times 10^{-6}}{5,31} + \dfrac{4 \times 19 \times 1312,2 \times 150 \times 10^{-6} (-1,054)(-1,054)}{2,432}$

$- 6,47 - \dfrac{3,15 \times (1,054)}{2,432} - \dfrac{9,9 \times (1,054)}{2,432}$

$\sigma_{bc} = 2,82 + 6,83 - 6,47 - 1,37 - 4,29 \Rightarrow$ $\sigma_{bc} = -2,48\,Mpa$

7,45 → 7
7:50 800
700 → 72