P1 C2 CI52K 2009

Datos

$b := 508mm$ $\quad fc := 35MPa$ $\quad Ec := 28GPa$

$L := 30m$ $\quad fcpi := 30MPa$ $\quad \gamma h := 25\frac{kN}{m^3}$

$R := 0.85$ $\quad \varepsilon u := 0.003$

Propiedades del cable

$fpy := 1470MPa$

$fpu := 1720MPa$

cargas

$\omega d := 8\frac{kN}{m}$ $\quad Md := 450kN\cdot m$ $\quad Md = 450\cdot kN\cdot m$

$\omega l := 20\frac{kN}{m}$ $\quad Ml := 1450kN\cdot m$ $\quad Ml = 1.45\times 10^3\cdot kN\cdot m$

Tensiones admisibles

$fci := -0.6fcpi$ $\quad fci = -18\cdot MPa$

$fti := 0.25\cdot\sqrt{fcpi\cdot MPa}$ $\quad fti = 1.369\cdot MPa$

$fcs := -0.6\cdot fc$ $\quad fcs = -21\cdot MPa$

$fts := 0.625\cdot\sqrt{fc\cdot MPa}$ $\quad fts = 3.698\cdot MPa$

Diseño Viga

Estimación de valores

$Ac := 509000mm^2$

$Ic := 108.5\cdot 10^9\cdot mm^4$ $\quad Ic = 1.085\times 10^{11}\cdot mm^4$

$\omega o := Ac\cdot\gamma h$ $\quad \omega o = 12.725\cdot\frac{kN}{m}$

$Mo := \frac{\omega o\cdot L^2}{8}$ $\quad Mo = 1.432\times 10^3\cdot kN\cdot m$

$c1 := 744mm$ $\quad c1 = 744\cdot mm$

$c2 := 628mm$

$S1 := \frac{(1-R)\cdot Mo + Md + Ml}{R\cdot fti - fcs}$ $\quad S1 = 9.541\times 10^7\cdot mm^3$

$S2 := \frac{(1-R)\cdot Mo + Md + Ml}{fts - R\cdot fci}$ $\quad S2 = 1.113\times 10^8\cdot mm^3$

$Sdis := \max(S1, S2)$ $Sdis = 1.113 \times 10^{8} \cdot mm^{3}$

$S1 := \frac{Ic}{c1}$ $S1 = 1.458 \times 10^{8} \cdot mm^{3}$

$S2 := \frac{Ic}{c2}$ $S2 = 1.728 \times 10^{8} \cdot mm^{3}$

$Mt := Mo + Md + Ml$ $Mt = 3.332 \times 10^{3} \cdot kN \cdot m$

excentricidad máxima

$dpr := 70mm$

$em := c2 - dpr$ $em = 558 \cdot mm$

Gráfico

$j := 0 .. 1000$ $e_j := j \cdot mm$ $r := \sqrt{\frac{Ic}{Ac}}$

$$fun1_j := \frac{\left(-1 + e_j \cdot \frac{c1}{r^2}\right)}{\left(fti + \frac{Mo}{S1}\right) \cdot Ac}$$

$$fun2_j := \frac{\left(1 + e_j \cdot \frac{c2}{r^2}\right)}{\left(-fci + \frac{Mo}{S2}\right) \cdot Ac}$$

$$fun3_j := \frac{R \cdot \left(1 + e_j \cdot \frac{c2}{r^2}\right)}{\left(-fts + \frac{Mt}{S2}\right) \cdot Ac}$$

$Mt = 3.332 \times 10^{3} \cdot kN \cdot m$

$$fun4_j := \frac{R \cdot \left(-1 + e_j \cdot \frac{c1}{r^2}\right)}{\left(fcs + \frac{Mt}{S1}\right) \cdot Ac}$$

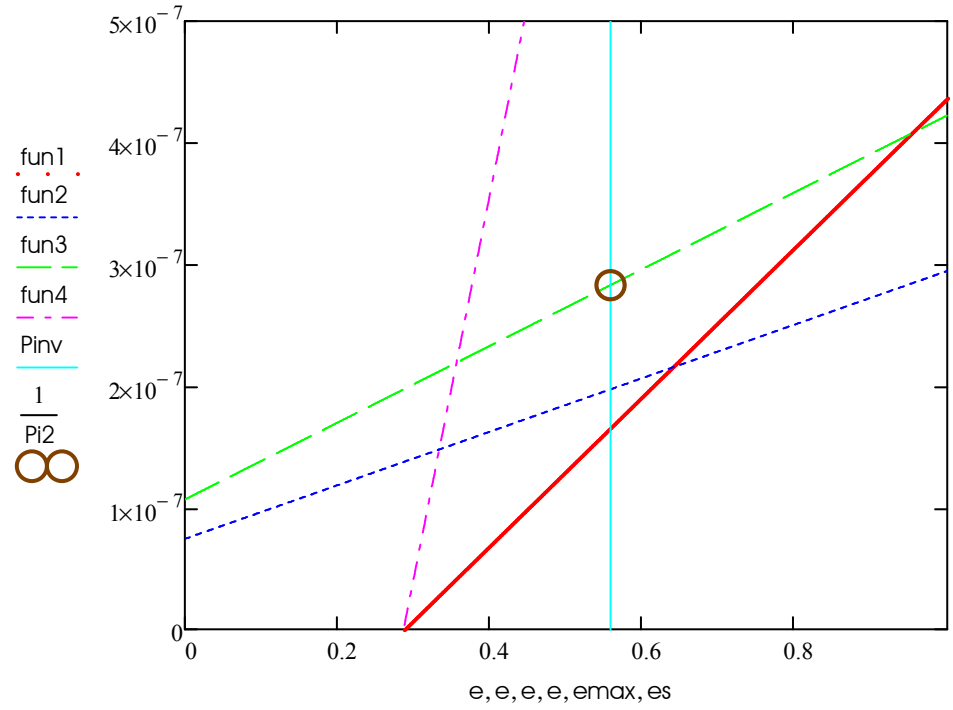
$emax := \begin{pmatrix} em \\ em \end{pmatrix}$ $Pinv := \begin{pmatrix} 0 \\ 1 \end{pmatrix}$

$es := 558 \cdot mm$

$$Pi2 := \frac{\left(-fts + \frac{Mt}{S2}\right)\cdot Ac}{R\cdot\left(1 + es\cdot\frac{c2}{r^2}\right)} \qquad Pi2 = 3.53\times 10^3\cdot kN$$

$$fpadm := -\min(0.82fpy, 0.74fpu) \qquad fpadm = -1.205\times 10^3\cdot MPa$$

$$Ap := \frac{-Pi2}{fpadm} \qquad Ap = 2.928\times 10^3\cdot mm^2$$



Resumen

$es = 558\cdot mm$

$Pi2 = 3.53\times 10^3\cdot kN$

$Ap = 2.928\times 10^3\cdot mm^2$

Determinación de Mn por Iteración

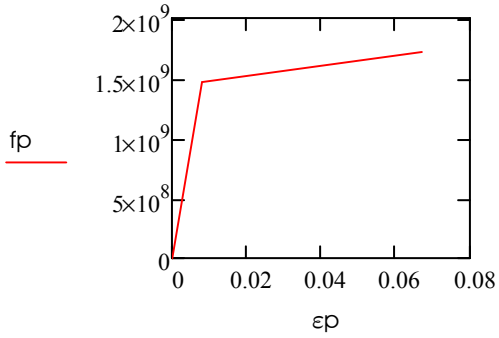
$$r := \sqrt{\frac{Ic}{Ac}} \qquad r = 461.696\cdot mm$$

$$\beta 1 := \begin{cases} 0.85 & \text{if } fc \le 30MPa \\ 0.85 - 0.008\cdot\left(\frac{fc}{MPa} - 30\right) & \text{if } 30MPa \le fc \le 55MPa \\ 0.65 & \text{if } fc \ge 55MPa \end{cases} \qquad \beta 1 = 0.81$$

$\varepsilon pu := 0.067$ $\varepsilon py := 0.008$

$Ep := \frac{fpy}{\varepsilon py}$ $Ep = 1.838 \times 10^{5}\cdot MPa$

$\varepsilon p := \begin{pmatrix} 0 \\ \varepsilon py \\ \varepsilon pu \end{pmatrix}$ $fp := \begin{pmatrix} 0 \\ fpy \\ fpu \end{pmatrix}$



$Pe := R\cdot Pi2$ $Pe = 3 \times 10^{3}\cdot kN$

$dp := c1 + es$ $dp = 1.302 \times 10^{3}\cdot mm$

Cargas últimas

$Mu := 1.2\cdot(Mo + Md) + 1.6Ml$ $Mu = 4.578 \times 10^{3}\cdot kN\cdot m$

Deformaciones

$c := 358mm$

$\varepsilon 1 := \frac{Pe}{Ap\cdot Ep}$ $\varepsilon 1 = 5.576 \times 10^{-3}$

$\varepsilon 2 := \frac{Pe}{Ac\cdot Ec}\cdot\left(1 + \frac{es^2}{r^2}\right)$ $\varepsilon 2 = 5.181 \times 10^{-4}$

$\varepsilon 3 := \varepsilon u\cdot\left(\frac{dp - c}{c}\right)$ $\varepsilon 3 = 7.911 \times 10^{-3}$

$\varepsilon ps := \varepsilon 1 + \varepsilon 2 + \varepsilon 3$

$mp := \frac{fpu - fpy}{\varepsilon pu - \varepsilon py}$ $np := fpy - mp\cdot\varepsilon py$

$$fps := \begin{cases} (\varepsilon ps \cdot Ep) & \text{if } \varepsilon ps \le \varepsilon py \\ (mp \cdot \varepsilon ps + np) & \text{if } \varepsilon ps > \varepsilon py \end{cases} \qquad fps = 1.495 \times 10^3 \cdot MPa$$

Ver1 := if(fps > fpu, "fps>fpu modificar diseño cable" , "diseño cable OK")

Ver1 = "diseño cable OK"

$$a := \frac{Ap \cdot fps}{0.85 \cdot fc \cdot b} \qquad a = 289.775 \cdot mm$$

$$Mn := Ap \cdot fps \cdot \left(dp - \frac{a}{2} \right) \qquad Mn = 5.067 \times 10^3 \cdot kN \cdot m$$

$$c := \frac{a}{\beta 1} \qquad c = 357.747 \cdot mm$$

Ver3 := if(0.9·Mn ≥ Mu, "diseño Ok" , "modificar diseño")

Ver3 = "modificar diseño"