Langtids nedbøyning pga. permanente laster

Antar følgende lasthistorie:

- Egenlast påført ved $t_0 = 7$ døgn etter støping
- Nyttelast påført ved $t_0 = 90$ døgn — " —

30% av nyttelasten regnes som permanent.

- Kryptallberegning EC2 Tillegg B:

$\boxed{\text{Antar } RH = 50\%}$

$$\varphi(\infty, 7) = \varphi_0 \cdot \beta_c(\infty, 7)$$

$$\varphi_0 = \varphi_{RH} \cdot \beta(f_{cm}) \cdot \beta(t_0)$$

$$\varphi_{RH} = \left[1 + \frac{1 - RH/100}{0.1 \cdot \sqrt[3]{h_0}} \cdot \alpha_1\right] \cdot \alpha_2$$

$$\alpha_1 = \left[\frac{35}{f_{cm}}\right]^{0.7} = (35/43)^{0.7} = 0.866$$

$$\alpha_2 = \left(\frac{35}{f_{cm}}\right)^{0.2} = (35/43)^{0.2} = 0.960$$

$$\alpha_3 = \left(\frac{35}{f_{cm}}\right)^{0.5} = (35/43)^{0.5} = 0.902$$

$$h_0 = \frac{2A_c}{u} = \frac{2 \cdot 1000 \cdot 280}{2 \cdot 1000} = 280 \text{ mm}$$

$$\varphi_{RH} = \left[1 + \frac{1 - 50/100}{0.1 \cdot \sqrt[3]{280}} \cdot 0.866\right] \cdot 0.960 = 1.595$$

$$\beta(f_{cm}) = \frac{16.8}{\sqrt{f_{cm}}} \Rightarrow \beta(43) = \frac{16.8}{\sqrt{43}} = 2.56$$

$$\beta(t_0) = \frac{1}{0.1 + t_0^{0.20}} \Rightarrow \beta(7) = \frac{1}{0.1 + 7^{0.20}} = 0.635$$

$$\varphi_0 = 1.595 \cdot 2.56 \cdot 0.635 = 2.59$$

$$\beta_c(t = \infty, t_0) = 1$$

$$\Rightarrow \underline{\varphi(\infty, 7) = 2.59}$$

For $t_0 = 90$ døgn har vi samme φ_{RH} og $\beta(f_{cm})$.

$$\beta(t_0 = 90) = \frac{1}{0.1 + 90^{0.20}} = 0.391$$

$$\Rightarrow \underline{\varphi(\infty, 90)} = 1.595 \cdot 2.56 \cdot 0.391 = \underline{1.60}$$

• Effektiv E-modul   EC2   7.4.3 (5)

$$E_{c,eff} = \frac{E_{cm}}{1 + \varphi(\infty, t_0)}$$

$$\Rightarrow E_{c1,eff} = \frac{E_{cm}}{1 + \varphi(\infty, 7)} = \frac{34000}{1 + 2{,}59} = 9471 \text{ MPa}$$

$$E_{c2,eff} = \frac{E_{cm}}{1 + \varphi(\infty, 90)} = \frac{34000}{1 + 1{,}60} = 13077 \text{ MPa}$$

$$E_{c,middel} = \frac{1 + 1}{\frac{1}{9471} + \frac{1}{13077}} = 11{,}0 \cdot 10^3 \text{ MPa}$$

• Bøyningsstivhet for stadium II opprisset tverrsnitt.

$$\eta = \frac{E_s}{E_{c,middel}} = \frac{2{,}0 \cdot 10^5}{11{,}0 \cdot 10^3} = 18{,}2$$

minste verdi!

$$\rho = \frac{A_s}{b \cdot d} = \frac{404 \text{ mm}^2/\text{m}}{1000 \cdot 237} = 1{,}70 \cdot 10^{-3}$$

$$\alpha = \sqrt{(\eta\rho)^2 + 2\eta\rho} - \eta\rho = 0{,}220$$

$$I_c = \frac{1}{2}\alpha^2\left(1 - \frac{\alpha}{3}\right) \cdot b \cdot d^3 = \frac{1}{2} \cdot 0{,}220^2 \left(1 - \frac{0{,}220}{3}\right) \cdot 10^3 \cdot 237^3 \text{ mm}^4/\text{m}$$

$$= 2{,}99 \cdot 10^8 \text{ mm}^4/\text{m}$$

$$\Rightarrow \underline{(EI)_{II}} = E_{c,middel} \cdot I_c = 11{,}0 \cdot 10^3 \cdot 2{,}99 \cdot 10^8$$

$$\underline{= 3{,}29 \cdot 10^{12} \text{ Nmm}^2/\text{m}}$$

Verdier fra Robot: $\delta_{Robot} = 2{,}51$ mm, $E_{Robot} = E_{cm}$

$$I_{Robot} = \frac{1}{12} \cdot b \cdot h^3 = \frac{1}{12} \cdot 10^3 \cdot 280^3 = 18{,}3 \cdot 10^8 \text{ mm}^4/\text{m}$$

Skalerer nedbøyning med formelen

$$\underline{\delta} = \delta_{Robot} \cdot \frac{(EI)_{Robot}}{(EI)_{II}} = 2{,}51 \text{ mm} \cdot \frac{34000 \cdot 18{,}3 \cdot 10^8}{3{,}29 \cdot 10^{12}}$$

$$\underline{= 47{,}5 \text{ mm}}$$

Med maks nedbøyning etter EC2 som $L/250 = 7200/250 = 28{,}8$ mm

er <u>nedbøyningen for stor!</u>