Remarks: See §4.4, pages 168 till 170
See §4.5, pages 171 till 184

Answers:

c. $F_\text{p} = 400\text{ kN}$

e. $\sigma_t = 0\text{ N/mm}^2$
$\sigma_b = +3,09\text{ N/mm}^2$

f. $\sigma_t = -12,35\text{ N/mm}^2$
$\sigma_b = +3,09\text{ N/mm}^2$

Explanation:

Cross-sectional properties:
$A = 86,4\times10^3\text{ mm}^2$ and $I_{zz} = 933,12\times10^6\text{ mm}^4$

a. $A_\text{v} = 16\text{ kN }(\downarrow)$; $B_\text{v} = 32\text{ kN }(\uparrow)$; $M_\text{A} = 0$; $M_{z;\text{B}} = -64\text{ kNm}$

b. Due to the prestressing element there is an eccentric normal compressive force applied at the beam ends: $N = -F_\text{p}$ and $M_z = +F_\text{p}\times(0,1\text{ m})$.

c. In B: $N = -F_\text{p}$ and $M_z = (-64\text{ kNm}) + F_\text{p}\times(0,1\text{ m})$

In B the greatest tensional stress will occur at the top fibers:

$$\sigma_t = -\frac{F_\text{p}}{A} + \frac{F_\text{p}\times(0,1\text{ m})(-0,18\text{ m})}{I_{zz}} + \frac{(-64\text{ kNm})(-0,18\text{ m})}{I_{zz}}$$

$$\sigma_t = -\frac{F_\text{p}}{86,4\times10^{-3}\text{ m}^2} - \frac{F_\text{p}\times(0,18\times10^{-3}\text{ m}^2)}{933,12\times10^{-6}\text{ m}^4} + \frac{11,52\text{ kNm}^2}{933,12\times10^{-6}\text{ m}^4} \le 0$$

After some working out:

$$-F_\text{p} - 1,667F_\text{p} + (1066,67\text{ kN}) \le 0 \;\Rightarrow\; F_p \ge 400\text{ kN}$$

e. At cross-section B: $N = -400\text{ kN}$ and $M_z = -24\text{ kNm}$

$$\sigma^{(N)} = \frac{-400\times10^3\text{ kN}}{933,12\times10^3\text{ mm}^2} = -4,63\text{ N/mm}^2$$

$$\sigma_t^{(M)} = \frac{(-24\times10^6\text{ Nmm})(-180\text{ mm})}{933,12\times10^6\text{ mm}^3} = +4,63\text{ N/mm}^2$$

$$\sigma_b^{(M)} = \frac{(-24\times10^6\text{ Nmm})(180\text{ mm})}{933,12\times10^6\text{ mm}^3} = -4,63\text{ N/mm}^2$$

f. At cross-section A: $N = -400\text{ kN}$ and $M_z = +40\text{ kNm}$

$$\sigma^{(N)} = \frac{-400\times10^3\text{ kN}}{933,12\times10^3\text{ mm}^2} = -4,63\text{ N/mm}^2$$

$$\sigma_\text{t}^{(M)} = \frac{(+40\times10^6\text{ Nmm})(-180\text{ mm})}{933,12\times10^6\text{ mm}^3} = -7,72\text{ N/mm}^2$$

$$\sigma_b^{(M)} = \frac{(+40\times10^6\text{ Nmm})(180\text{ mm})}{933,12\times10^6\text{ mm}^3} = +7,72\text{ N/mm}^2$$