

Spm 1

$$R_A = \frac{F \cdot L/8 + q \cdot L \cdot L/2 + pL/4 \cdot \frac{3}{4}L}{L}$$

$$= \frac{1}{8}F + \frac{1}{2}qL + \frac{3}{8} \cdot \frac{1}{4} \cdot 20 \cdot 6$$

$$= \frac{1}{8} \cdot 30 + \frac{1}{2} \cdot 20 \cdot 6 + \frac{3}{8} \cdot \frac{1}{4} \cdot 20 \cdot 6 = \underline{90,04 \text{ kN}}$$

$$R_B = \frac{7}{8}F + \frac{1}{2}qL + \frac{1}{8} \cdot \frac{1}{4} \cdot 20 \cdot 6 = \underline{90,04 \text{ kN}}$$

$M_{\max}$  er p' midten af bjælken, hvor

$$M = R_A \cdot L/2 + F \cdot \frac{3}{8}L + q \cdot \frac{1}{2} \cdot \frac{L}{2}$$

$$= 90 \cdot 6/2 + 30 \cdot \frac{3}{8} \cdot 6 + 20 \cdot \frac{6}{2} \cdot \frac{6}{4} = \underline{\underline{112,5 \text{ kNm}}}$$

$$V_{\max} = \underline{\underline{90 \text{ kN}}}$$

Spm 2

- Vi antager 1) trykzone i bøjelængde og  
2) normalkomment trækstift. og

$$f_{cd} = 15 / 1,45 = 10,3 \text{ MPa}$$

$$E_{cu3} = 3,5 \cdot 10^{-3}$$

$$f_{yd} = 500 / 1,2 = 416,7 \text{ MPa}$$

$$E_{cu1} = 5 \cdot 10^{-2}$$

$$\epsilon_{yd} = 416,7 / 2 \cdot 10^5 = 2,08 \cdot 10^{-3}$$

$$\eta = \frac{A_s f_{yd}}{b f_{cd}} = \frac{8 \pi (20/2)^2 \cdot 416,7}{1500 \cdot 10,3} = \underline{67,8 \text{ mm}}$$

$$< \xi_f = 150 \text{ mm} \checkmark$$

$$x = \eta / \alpha = 67,8 / 0,8$$

$$= 84,7 \text{ mm}$$

$$\bar{d} = 600 - 15 - 8 - 20/2 = \underline{\underline{567 \text{ mm}}}$$

$\Rightarrow$

$$\epsilon_s = \frac{E_{cu3}}{x} (d - x) = \frac{3,5 \cdot 10^{-3}}{84,7} (567 - 84,7) = \underline{\underline{2,0 \cdot 10^{-2}}}$$

$$\underline{\underline{\epsilon_{yd} = 2,08 \cdot 10^{-3} < \epsilon_s = 2,0 \cdot 10^{-2} < E_{cu1} = 5 \cdot 10^{-2}}}$$

Trærsnittet er her med normalt forment  
og trykzonen blev i toflangen.

$$\begin{aligned} \Rightarrow M_{ed} &= A_s f_{yd} (d - \frac{a}{2}) \\ &= 8\pi (20/2)^2 \cdot 416,7 (367 - 184,7/2) \\ &= 549,5 \cdot 10^6 \text{ Nmm} = 549,5 \text{ MNm} \end{aligned}$$

$$> M_{ed} = 150 \text{ MNm}$$

Bjælken kan bære

### spm. 3

$$\begin{aligned} V_{rd,l} &= 2 A_s f_{yd} \frac{1}{\cot \theta} \\ &= 2 \cdot 8\pi (20/2)^2 \cdot 416,7 / 2,5 \\ &= 837,8 \cdot 10^3 \text{ N} = \underline{837,8 \text{ kN}} \end{aligned}$$

$$\begin{aligned} V_{rd,w} &= A_{sw} f_{yd} z \cot \theta / 5 \\ z &= d - a/2 = 367 - 67,8/2 = \underline{333,1 \text{ mm}} \end{aligned}$$

$$\begin{aligned} V_{rd,w} &= 2 \cdot 2 \cdot \pi (8/2)^2 \cdot 416,7 \cdot 333,1 \cdot 2,5 / 250 \\ &= 446,6 \cdot 10^3 \text{ N} = \underline{446,6 \text{ kN}} \end{aligned}$$

$$\begin{aligned} V_{rd,g} &= 5w V f_{cd} z \cot \theta / (1 + \cot^2 \theta) \\ v &= 0,7 - 15/200 = \underline{0,625} \end{aligned}$$

$$\begin{aligned} V_{rd,c} &= 2 \cdot 250 \cdot 0,625 \cdot 193 \cdot \frac{333,1 \cdot 2,5}{1 + 2,5^2} \\ &= 591,7 \cdot 10^3 \text{ N} = \underline{591,7 \text{ kN}} \end{aligned}$$

$$\Rightarrow V_{ed} = \underline{446,6 \text{ kN}} > V_{ed} = 150 \text{ kN}$$

Bjælken kan bære