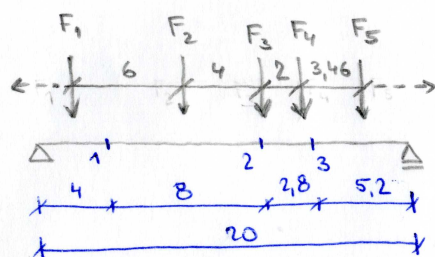


Určení extrémních účinků od pohyblivého zatížení

- Winklerovo, břemenové a Šolinovo kritérium

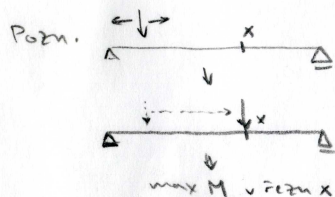
Př. Zjistěte polohu zatěžovací soustavy sil tak, aby

- vyvodila maximální moment v řezech 1, 2, 3
- vyvodila maximální moment pod silami F_1, F_2, F_3, F_4, F_5
- vyvodila maximální možný moment na daném nosníku (max max M)



$$\begin{aligned} F_1 &= 200 \text{ kN} & F_4 &= 100 \text{ kN} \\ F_2 &= 200 \text{ kN} & F_5 &= 100 \text{ kN} \\ F_3 &= 190 \text{ kN} \end{aligned}$$

a) max M v daném řezu ... Winklerovo kritérium



$$\sum_{i=1}^{k-1} F_i \leq \frac{x}{L} \cdot \sum_{i=1}^n F_i \leq \sum_{i=1}^k F_i$$

řez 1: $x=4\text{m}$, $L=20\text{m}$

$$k=1? \dots \sum_{i=1}^0 F_i = 0$$

$$\frac{x}{L} \sum_{i=1}^n F_i = \frac{4}{20} \cdot \sum_{i=1}^5 F_i = \frac{4}{20} \cdot (200 + 200 + 190 + 100 + 100) = 158 \text{ kN}$$

$$\sum_{i=1}^1 F_i = 200 \text{ kN}$$

$$\frac{x \cdot x'}{L} = \frac{4 \cdot 16}{20} = 3,2$$

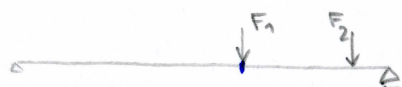
$$\Rightarrow 0 \text{ kN} \leq 158 \text{ kN} \leq 200 \text{ kN} \quad \checkmark$$

$\Rightarrow F_1$ je kritické břemeno ($F_k = F_1$)

$$\begin{aligned} \max M_{x1} &= \sum_{i=1}^5 F_i \cdot \eta_i = 200 \cdot 3,2 + 200 \cdot \frac{3,2 \cdot 10}{16} + 190 \cdot \frac{3,2 \cdot 6}{16} + 100 \cdot \frac{3,2 \cdot 4}{16} + 100 \cdot \frac{3,2 \cdot 0,54}{16} = \\ &= 1358,8 \text{ kNm} \\ \frac{\eta_2}{10} &= \frac{3,2}{16} \end{aligned}$$

řez 2: $x = 12\text{m}$, $L = 20\text{m}$

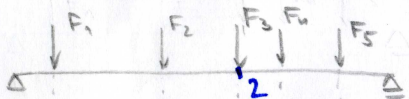
$k=1 ? \dots 0 \leq (\frac{12}{20} \cdot 400) = 240 \leq 200 \text{ kN} \quad \times$



$k=2 ? \dots 200 \leq (\frac{12}{20} \cdot 690) = 414 \leq 400 \text{ kN} \quad \times$

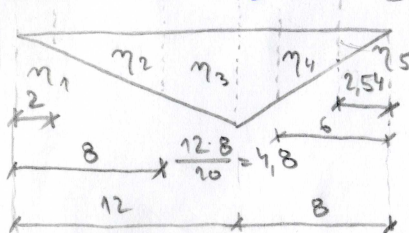


$k=3 ? \dots 400 \leq (\frac{12}{20} \cdot 790) = 474 \leq 590 \text{ kN} \quad \checkmark$



$\Rightarrow F_3$ je kritické břemeno ($F_1 = F_3$)

M_{x2}



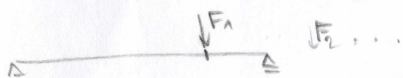
$$\max M_{x2} = \sum_{i=1}^5 F_i \eta_i = 200 \cdot \frac{4.8 \cdot 2}{12} + 200 \cdot \frac{4.8 \cdot 8}{12} + 190 \cdot 4.8 + 100 \cdot \frac{4.8 \cdot 6}{8} + 100 \cdot \frac{4.8 \cdot 2.54}{8} = \underline{\underline{2224.4 \text{ kNm}}}$$

$\frac{\eta_1}{2} = \frac{4.8}{12}$

$\frac{\eta_5}{2.54} = \frac{4.8}{8}$

řez 3: $x = 14.8\text{m}$, $L = 20\text{m}$

$k=1 ? \dots 0 \leq (\frac{14.8}{20} \cdot 200) = 148 \leq 200 \text{ kN} \quad \checkmark$

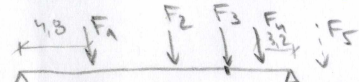


$\rightarrow$ nutno dále ověřit pro vyšší počet sil (až po $F_1 + F_5$)

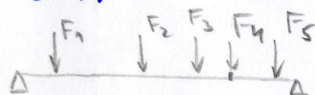
$k=2 ? \dots 200 \leq (\frac{14.8}{20} \cdot 590) = 436.6 \leq 400 \text{ kN} \quad \times$



$k=3 ? \dots 400 \leq (\frac{14.8}{20} \cdot 690) = 510.6 \leq 590 \text{ kN} \quad \checkmark$

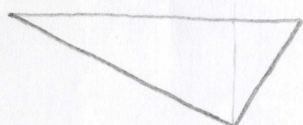


$k=4 ? \dots 590 \leq (\frac{14.8}{20} \cdot 790) = 584.6 \leq 690 \text{ kN} \quad \times$



$k=5 ? \dots 490 \leq (\frac{14.8}{20} \cdot 590) = 436.6 \leq 590 \text{ kN} \quad \times$

M_{x3}



$\frac{14.8 \cdot 5.2}{20} = 3.848$

$M_{x3}^{F_1} = 200 \cdot 3.848 = 769.6 \text{ kNm}$

$M_{x3}^{F_3} = 200 \cdot \frac{4.8 \cdot 3.848}{14.8} + 200 \cdot \frac{10.8 \cdot 3.848}{14.8} + 190 \cdot 3.848 + 100 \cdot \frac{3.2 \cdot 3.848}{5.2} = \underline{\underline{1779.12 \text{ kNm} = \max M_{x3}}}$