2.8. U zadanom presjeku čeličnog nosača prikazanog poprečnog presjeka djeluju rezne sile prema slici:

a) Odrediti normalna i posmična naprezanja u točkama "A", "B", "C" i "D"
b) Izračunaj koeficijente sigurnosti u točkama "B", "C" i "D" po teoriji najvećih posmičnih naprezanja
c) Izračunaj koeficijent sigurnosti u točki "A" po teoriji potencijalne energije promjene oblika

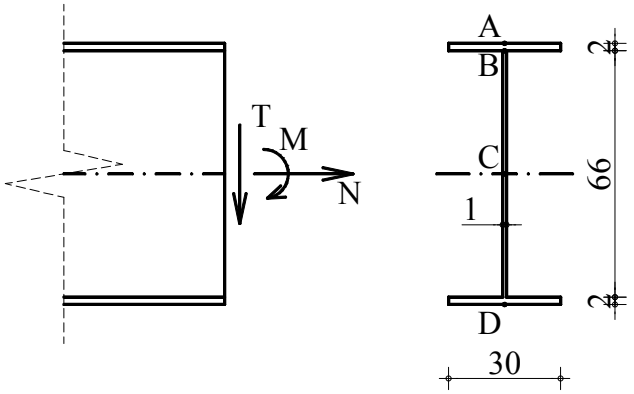
ako je poznato:

$$M = 400\text{kNm}$$

$$N = 150\text{kN}$$

$$T = 300\text{kN}$$

$$\sigma_R = 22.0\frac{\text{kN}}{\text{cm}^2}$$



a) Normalna i posmična naprezanja

$$I = \frac{1\cdot 66^3}{12} + 2\cdot\left(\frac{30\cdot 2^3}{12} + 30\cdot 2\cdot 34^2\right) = 162718\text{cm}^4$$

$$A = 66\cdot 1 + 2\cdot 30\cdot 2 = 186\text{cm}^2$$

$$S_A = 0$$

$$S_B = 30\cdot 2\cdot 34 = 2040\text{cm}^3$$

$$S_C = 30\cdot 2\cdot 34 + 33\cdot 1\cdot 16.5 = 2584.5\text{cm}^3$$

$$S_D = 0$$

Točka "A"

$$\sigma_A = \frac{M}{I}\cdot y_A + \frac{N}{A} = \frac{400\text{kNm}}{162718\text{cm}^4}\cdot 35\text{cm} + \frac{150\text{kN}}{186\text{cm}^2} =$$

$$= 8.6 + 0.8 = 9.4\frac{\text{kN}}{\text{cm}^2}$$

$$\tau_A = 0$$

Točka "B"

$$\sigma_B = \frac{M}{I}\cdot y_B + \frac{N}{A} = \frac{400\text{kNm}}{162718\text{cm}^4}\cdot 33\text{cm} + \frac{150\text{kN}}{186\text{cm}^2} =$$

$$= 8.1 + 0.8 = 8.9\frac{\text{kN}}{\text{cm}^2}$$

$$\tau_B = \frac{T\cdot S_B}{I\cdot b_B} = \frac{300\text{kN}\cdot 2040\text{cm}^3}{162718\text{cm}^4\cdot 1\text{cm}} = 3.80\frac{\text{kN}}{\text{cm}^2}$$

Točka "C"

$$\sigma_C = \frac{N}{A} = \frac{150\text{kN}}{186\text{cm}^2} = 0.8\frac{\text{kN}}{\text{cm}^2}$$

$$\tau_C = \frac{T \cdot S_C}{I \cdot b_C} = \frac{300\text{kN} \cdot 2584.5\text{cm}^3}{162718\text{cm}^4 \cdot 1\text{cm}} = 4.80\frac{\text{kN}}{\text{cm}^2}$$

Točka "D"

$$\sigma_D = -\frac{M}{I} \cdot y_D + \frac{N}{A} = -\frac{400\text{kNm}}{162718\text{cm}^4} \cdot 35\text{cm} + \frac{150\text{kN}}{186\text{cm}^2} =$$

$$= -8.6 + 0.8 = -7.8\frac{\text{kN}}{\text{cm}^2}$$

$$\tau_D = 0$$

Ekvivalentna jednoosna naprezanja prema teoriji maksimalnih posmičnih naprezanja

$$\sigma_{ekv} = \sqrt{\sigma^2 + 4\tau^2}$$

Točka "B"

$$\sigma_{ekv.B} = \sqrt{\sigma^2 + 4\tau^2} = \sqrt{8.9^2 + 4 \cdot 3.8^2} = 11.7\frac{\text{kN}}{\text{cm}^2}$$

$$k_B = \frac{\sigma_R}{\sigma_{ekv.B}} = \frac{22\frac{\text{kN}}{\text{cm}^2}}{11.7\frac{\text{kN}}{\text{cm}^2}} = 1.88$$

Točka "C"

$$\sigma_{ekv.C} = \sqrt{\sigma^2 + 4\tau^2} = \sqrt{0.8^2 + 4 \cdot 4.8^2} = 9.6\frac{\text{kN}}{\text{cm}^2}$$

$$k_C = \frac{\sigma_R}{\sigma_{ekv.C}} = \frac{22\frac{\text{kN}}{\text{cm}^2}}{9.6\frac{\text{kN}}{\text{cm}^2}} = 2.29$$

Točka "D"

$$\sigma_{ekv.D} = \sqrt{\sigma^2 + 4\tau^2} = \sqrt{7.8^2 + 4 \cdot 0^2} = 7.8\frac{\text{kN}}{\text{cm}^2}$$

$$k_D = \frac{\sigma_R}{\sigma_{ekv.D}} = \frac{22\frac{\text{kN}}{\text{cm}^2}}{7.8\frac{\text{kN}}{\text{cm}^2}} = 2.82$$

Ekvivalentna jednoosna naprezanja prema teoriji potencijalne energije promjene oblika

$$\sigma_{ekv}{}^2 = \sigma_1{}^2 + \sigma_2{}^2 + \sigma_3{}^2$$

$$\sigma_{ekv.A}{}^2 = \sigma_1{}^2$$

$$k_D = \frac{\sigma_R}{\sigma_{ekv.A}} = \frac{22\frac{\text{kN}}{\text{cm}^2}}{9.4\frac{\text{kN}}{\text{cm}^2}} = 2.34$$