Remarks: See §5.4.3, pages 345 till 355
See §6.3.2 and §6.3.3, pages 438 till 445
See §6.4, example 7, pages 463 till 465

Answers:

a. $\tau_{max} = 3,5 \text{ N/mm}^2$

b. $\tau_{max} = 31,5 \text{ N/mm}^2$

Explanation:

$V_z = 31 \text{ kN}$; $M_t = 5,58 \text{ kNm}$

$I_{zz} = 622,08 \times 10^6 \text{ mm}^4$

$I_t = 3,84 \times 10^6 \text{ mm}^4$ (for cross-section II)

a. The maximum shear stress due to the shear force occurs in the flanges at the height of the NC:

$$\tau_{max} = \frac{(31 \times 10^3 \text{ N})(1944 \times 10^3 \text{ mm}^3)}{(40 \text{ mm})(622,08 \times 10^6 \text{ mm})} = 2,4 \text{ N/mm}^2$$

The shear stress due to the torsional moment is constant (Bredt):

$$\tau = \frac{5,58 \times 10^6 \text{ Nmm}}{2 \times (360 \times 360 \text{ mm}^2)(20 \text{ mm})} = 1,1 \text{ N/mm}^2$$

Total: $\tau_{max} = 3,5 \text{ N/mm}^2$; occurs in the left web at the height of the NC.

b. The shear stress distribution due to the shear force is the same for cross sections I and II: $\tau_{max} = 2,4 \text{ N/mm}^2$

The maximum shear stress due to torsional moment at the edges of the profile:

$$\tau_{max} = \frac{(5,58 \times 10^6 \text{ Nmm})(10 \text{ mm})}{\frac{1}{2}(3,84 \times 10^6 \text{ mm}^4)} = 29,1 \text{ N/mm}^2$$

Total: $\tau_{max} = 31,5 \text{ N/mm}^2$; which occurs at the height of the NC, in the left side of both webs