Remarks: See §6.2.3, pages 424 till 426

Answers:

a. $\tau_{max} = 22,5 \text{ N/mm}^2$

b. $\tau_{min} = 18,1 \text{ N/mm}^2$

c. $\Delta\varphi = 7,5\times10^{-3} \text{ rad} \quad (= 0,43^\circ)$

Explanation:

a. $\tau_{max} = \dfrac{(15\times10^6 \text{ Nmm})(90 \text{ mm})}{60\times10^6 \text{ mm}^4} = 22,5 \text{ N/mm}^2$

b. $\frac{1}{2}\pi\left\{(90 \text{ mm})^4 - R_i^4)\right\} = 60\times10^6 \text{ mm}^4 \rightarrow R_i = 72,36 \text{ mm}$

$\tau_{min} = \dfrac{(15\times10^6 \text{ Nmm})(72,36 \text{ mm})}{60\times10^6 \text{ mm}^4} = 18,1 \text{ N/mm}^2$

Or the shorter way:

$\tau_{min} = \dfrac{72,36}{90}\times 22,5 \text{ N/mm}^2$

c $\Delta\varphi = \dfrac{(15\times10^6 \text{ Nmm})(2400 \text{ mm})}{(80\times10^3 \text{ N/mm}^2)(60\times10^6 \text{ mm}^3)} = 7,5\times10^{-3} \text{ rad} \quad (= 0,43^\circ)$