

$$D_e = 24 \text{ mm}$$

$$D_i = 20 \text{ mm}$$

$$M_t = 160 \text{ Nm} \Rightarrow = 160'000 \text{ Nmm}$$

acciaio ($E = 210'000 \text{ MPa}$; $G = 80'000 \text{ MPa}$)

$$\tau_{\max} = \frac{M_t}{W_p} = \frac{M_t}{\frac{\pi D_e^3}{16} \left[1 - \left(\frac{D_i}{D_e} \right)^4 \right]} = \frac{160'000 \text{ Nmm}}{\frac{\pi 24^3}{16} \left[1 - \left(\frac{20}{24} \right)^4 \right] \text{ mm}^3} = 113,85 \text{ MPa}$$

$$\varphi = \frac{M_t}{G \cdot J_p} = \frac{M_t}{G \cdot \frac{\pi (D_e^4 - D_i^4)}{32}} = \frac{160'000 \text{ Nmm}}{80'000 \text{ MPa} \cdot \frac{\pi (24^4 - 20^4)}{32} \text{ mm}^4} = 1,186 \cdot 10^{-4} \text{ rad}$$

B

$$D_e = 21 \text{ mm}; D_i = 18 \text{ mm}; M_t = 110 \text{ Nm} = 110'000 \text{ Nmm}$$

$$\tau_{\max} = 131,44 \text{ MPa}; \varphi = 1,5648 \cdot 10^{-4} \text{ rad.}$$

C

$$D_e = 22 \text{ mm}; D_i = 19 \text{ mm}; M_t = 150 \text{ Nm} = 150'000 \text{ Nmm}$$

$$\tau_{\max} = 161,70 \text{ MPa}; \varphi = 1,838 \cdot 10^{-4} \text{ rad}$$

D

$$D_e = 22 \text{ mm}; D_i = 18 \text{ mm}; M_t = 120 \text{ Nm} = 120'000 \text{ Nmm}$$