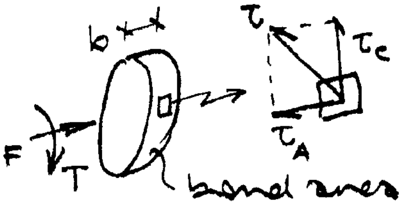
8

Approach: Find the actual shear stress, τ, in each bond (left L and right R as sketched. τ is made up of two components - an axial component τ_A due to F, and a circumferential component τ_C due to T - which may be combined vectorially.



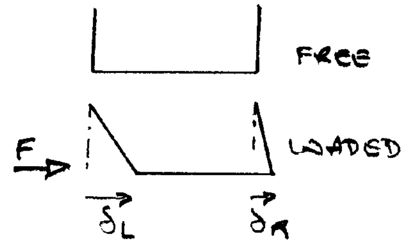
Assuming τ_A and τ_C are both uniform, their stress resultants may be found from F and T individually - though in each case the problem is indeterminate.

AXIAL

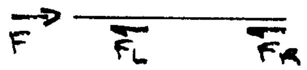
Compatibility

If δ_L and δ_R are the deflexions of the discs in an axial direction, the contraction of the tube, δ_t is

$$\delta_t = \delta_L - \delta_R.$$



Equilibrium



The stress resultants in the bonds are F_L and F_R, and

$$F_L + F_R = F = 500 \text{ N}.$$

Note that the tube experiences the compressive force F_R between the discs (consider RH free body)

Constitutive Laws note $G = E/2(1+\nu)$

Discs: $F_L = k_d \delta_L$ and $F_R = k_d \delta_R$

where k_d is the disc stiffness

$$k_d = \frac{2\pi b G}{\ln r_o/r_i} = \frac{2\pi \times 20 \times 2}{2(1+0.5)\ln\frac{100}{60}} = 164 \text{ N/mm}$$

$\text{mm} \ \frac{\text{N}}{\text{mm}^2}$

Tube: $F_t = F_R = k_t \delta_t$

where k_t is the axial stiffness of tube

$$k_d = AE/L = \frac{\pi}{4}(60^2 - 54^2) \times 2\times10^3/600 = 1791$$

$\text{mm}^2 \quad \frac{\text{N}}{\text{mm}^2} \quad \frac{1}{\text{mm}} \quad \text{N/mm}.$

Solution $F_L = 261$ N $F_R = 239$ N

i.e. load just about equally shared since tube is so much stiffer than discs.

Dividing these by the bond area

$$A = \pi D b = \pi \times 60 \times 20 \text{ mm}^2$$

gives the axial shear components:

$\tau_L = 69$ kPa $\tau_R = 63$ kPa.