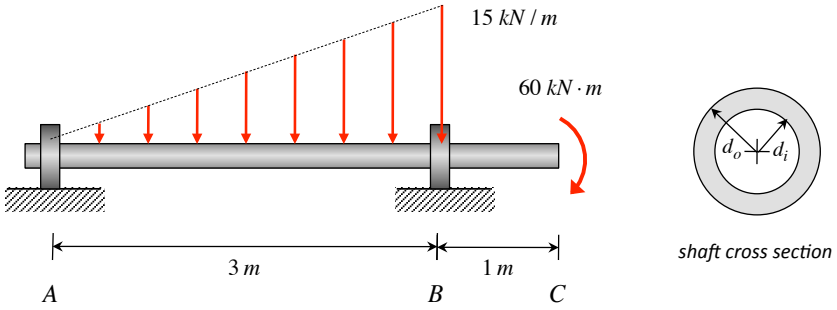
Example 10.12

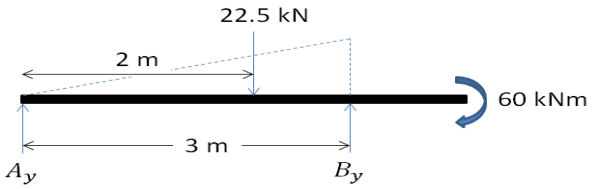
A tubular shaft has a cross section as shown in the figure. The inner and outer diameter are related by $d_i = 0.5d_o$. (Assume that A is a simply supported joint while B is a roller joint)

(a) Determine the absolute maximum flexural stress in the shaft if d_o =200 mm and its location.

(b) Determine the required dimensions of inner and outer diameter if the bending stress to cause failure is 300 MPa. Consider a F.S. of 3.



Solution



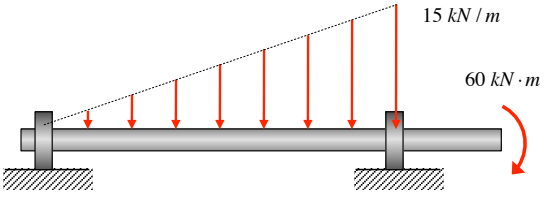
$d_i = 0.5d_o$

$d_o = 200mm$

$d_i = 100\ mm$

$I = \frac{\pi}{4}(100^4 - 50^4) = 73.631\ x\ 10^6 mm^4$

Free Body Diagram with equilibrium eqns:



$A_y + B_y = 22.5$

$22.5x2 - B_y(3) + 60 = 0$

$A_y = -12.5\ kN \quad ; \quad B_y = 35kN$

$M_{max} = 60kN$

$\sigma_{max} = \frac{M_{max}c}{I} = 81.487\ MPa$

$\sigma_f = 300\ MPa$

$\sigma_{allow} = \frac{300}{FS} = 100\ MPa$

$I = \frac{\pi}{4}\left[\left(\frac{d_o}{2}\right)^4 - \left(\frac{0.5d_o}{2}\right)^4\right] = 0.046d_o^4$

$\sigma_{allow} = 100 = \frac{60x10^6\left(\frac{d_o}{2}\right)}{0.046d_o^4}$

$d_o = 186.83\ mm$

$d_i = 93.416\ mm$