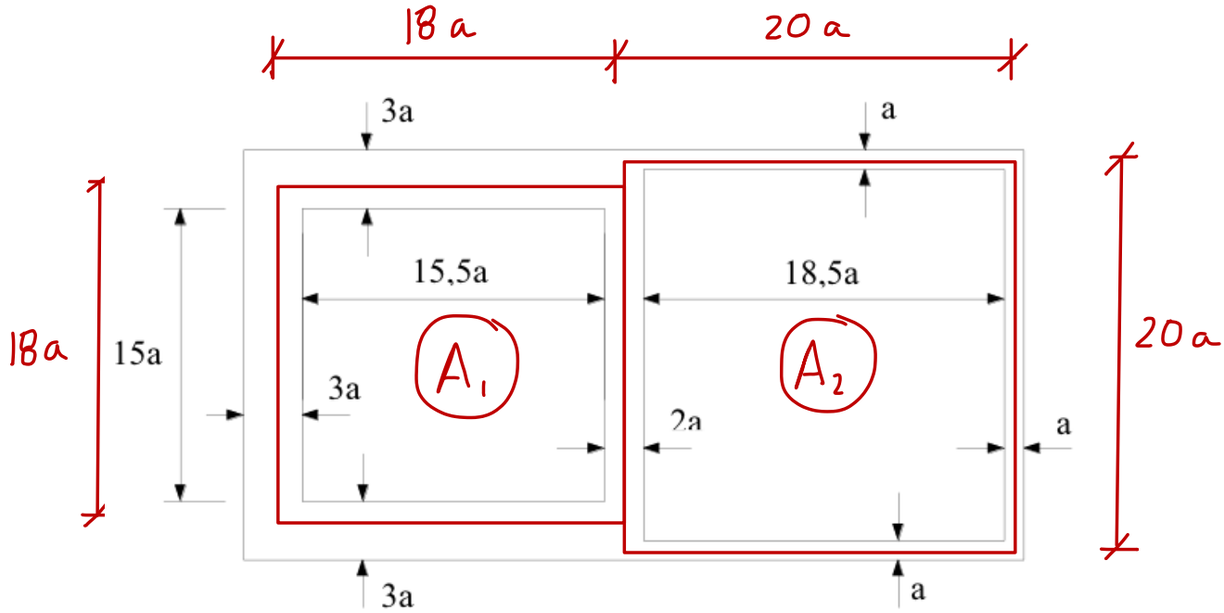
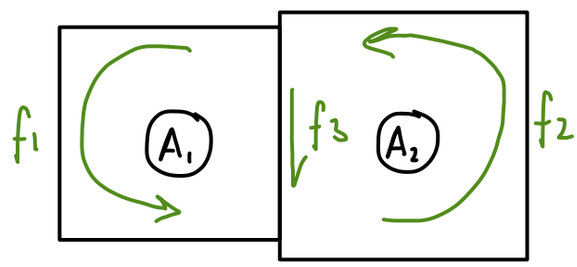
Calcule a distribuição de tensões tangenciais e a rotação por unidade de comprimento, provocadas por um momento torsor T actuante na secção representada na figura seguinte.



$$A_m^1 = (18a)^2 = 324\,a^2$$

$$A_m^2 = (20a)^2 = 400\,a^2$$



$$T = T_1 + T_2 = 2\,A_m^1 f_1 + 2\,A_m^2 f_2$$

$$f_1 + f_3 = f_2$$

$$\alpha = \frac{\oint \gamma \, ds}{2 A_m}$$

$$G\gamma = \tau \Rightarrow G\gamma = f/e \Rightarrow \gamma = \frac{f}{Ge}$$

$$\alpha_1 = \alpha_2 \Rightarrow \frac{\oint \frac{f}{Ge} ds}{2 A_m^1} = \frac{\oint \frac{f}{Ge} ds}{2 A_m^2}$$

$$\frac{1}{324}\left[f_1 \frac{1}{3a} 3 \times 18a - (f_2 - f_1)\left(\frac{1}{2a} 18a\right)\right] = \frac{1}{400}\left[f_2 \frac{1}{a}(3 \times 20a + 2a) + (f_2 - f_1) \times \left(\frac{1}{2a} 18a\right)\right]$$

$$\Rightarrow \boxed{f_1 = 1{,}94 f_2}$$

$$T = 2 \times 324 a^2 f_1 + 2 \times 400 a^2 \times \frac{1}{1{,}94} f_1 \Rightarrow f_1 = 9{,}43 \times 10^{-4} \frac{T}{a^2}$$

$$f_2 = 4{,}8617 \times 10^{-4} \frac{T}{a^2}$$

$$f_3 = 4{,}5682 \times 10^{-4} \frac{T}{a^2}$$

$$\tau_1 = 3{,}143 \times 10^{-4} \frac{T}{a^3} \; ; \quad \tau_2 = 4{,}8617 \times 10^{-4} \frac{T}{a^3} \; ; \quad \tau_3 = 2{,}2841 \times 10^{-4} \frac{T}{a^3}$$

$$\alpha = 3{,}2539 \times 10^{-5} \frac{T}{G a^4}$$