P.1 $T_i = \dfrac{3M b_i}{\sum a_i b_i^3} = 3M b_i \dfrac{Ga}{3M} = Ga b_i$ for open legs.
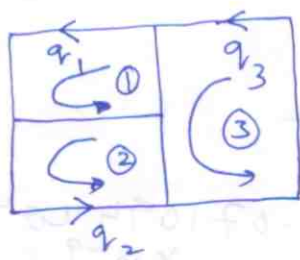
Case-I Max stress in open legs. Then it must occur in leg CA for which $b = 5mm$ as compared to leg EF for which $b = 3mm$. In that case.

$$\alpha = \frac{\tau_{max}}{G * 5} \longrightarrow \boxed{A}$$

Case-II Max stress in closed loops. There are 3 loops, ie $i = 1, 2, 3$.

We have $2G A_i \alpha = \oint \dfrac{q}{t} ds$.

$i^{th} loop$

$i=1: \Rightarrow 2G (100*75) \alpha = \dfrac{1}{5}\left[350 q_1 - 100 q_2 - 75 q_3\right] \rightarrow ①$

$i=2: 2G (100*75) \alpha = \dfrac{1}{5}\left[350 q_2 - 100 q_1 - 75 q_3\right] \rightarrow ②$

$i=3: 2G (100*150) \alpha = \dfrac{1}{5}\left[500 q_3 - 75 q_1 - 75 q_3\right] \rightarrow ③$

Soln of ①, ②, ③ is $q_1 = q_2 = q_3 = q$.

Put $q = \tau_{max} * 5$ in say ①, get,

$75000 \, G\alpha = 175 q = 175 \tau_{max} * 5$

$$\Rightarrow \alpha = \frac{\tau_{max}}{G}\left(\frac{875}{75000}\right) \longrightarrow \boxed{B}$$

Compare $\boxed{A}$ & $\boxed{B}$ $\Rightarrow$ critical case is $\boxed{B}$ ie Case II.

$$\Rightarrow M = \underbrace{\sum_{i=1}^{3} 2 q_i A_i}_{M_{loops}} + \underbrace{\frac{\alpha G}{3} \sum_{i=1}^{3} a_i b_i^3}_{M_{legs}}$$

$(\alpha G)_{critical} = (70)\left(\dfrac{875}{75000}\right)$; $\displaystyle\sum_{i=1}^{3} 2 q_i A_i = 2*70*5\begin{pmatrix}100*75+\\100*75+\\100*150\end{pmatrix}$

$\displaystyle\sum_{i=1}^{2} a_i b_i^3 = 100*5^3 + 75*3^3$

$M = 21011 \; N \text{-} m \blacktriangleleft$

$\therefore q_1 = q_2 = q_3 , \quad \tau_{BC} = \tau_{CD} = \tau_{cF} = 0 \blacktriangleleft$

P.2   BC's are:

$u_r = 0$ at $r = 100$ mm.

$\sigma_{rr} = 0$ at $r = 400$ mm.

$$0 = (\cdot 100)C_1 + \frac{C_2}{(\cdot 100)} + \frac{1 - 0.32^2}{8 * 12 * 10^9} * 2000\, \omega^2 (0.100)^3$$

$$0 = \frac{12 * 10^9}{1 - 0.32^2}\left[(1 + 0.32)C_1 - (1 - 0.32)\frac{C_2}{(0.400)^2} - (3 + 0.32)\frac{(1 - 0.32^2)}{8 * 12 * 10^9} * 2000\, \omega^2 (0.400)^2\right]$$

Solve C_1, C_2 in terms of ω^2.

$$0.1 C_1 + 10 C_2 = 1.87 * 10^{-11} \omega^2$$

$$1.32 C_1 - 4.25 C_2 = 9.93344 * 10^{-9} \omega^2$$

$$\Rightarrow C_2 = \frac{-9.6866 * 10^{-9}}{136.25} \omega^2 = -0.071094\, \omega^2 * 10^{-9}$$

$$C_1 = 7.2964 * 10^{-9} \omega^2$$

$$\sigma_{rr}^* = \frac{\sigma_{rr}}{E/1-\nu^2} = 9.631248 * 10^{-9} \omega^2 + \frac{4.834392 * 10^{-11}}{r^2}\omega^2 - \frac{62.084 * 10^{-9}}{r^2}\omega^2$$

$$\sigma_{\theta\theta}^* = \frac{\sigma_{\theta\theta}}{E/1-\nu^2} = 9.631248 * 10^{-9} \omega^2 - \frac{4.834392 * 10^{-11}}{r^2}\omega^2 - \frac{36.652 * 10^{-9}}{r^2}\omega^2$$

$$\frac{d\sigma_{rr}^*}{dr} = 0 = \left(-\frac{9.668784 * 10^{-11}}{r^3} - 124.168 * 10^{-9}\, r\right)\omega^2$$

↓
gives complex r or $r = 0$ which is out of domain.

So σ_{rr}^* is max at either $r = 100$ mm or 400 mm

$$\Rightarrow \left.\sigma_{rr}^*\right|_{r=100} = 1.38448 * 10^{-8}\, \omega^2, \quad \left.\sigma_{rr}^*\right|_{400} = 0 \;(\text{comes} -4.25 * 10^{-14} \text{ from computation})$$

$$\frac{d\sigma_{\theta\theta}}{dr} = 0 = \left[\frac{4.834392 * 10^{-11} * 2}{r^3} - \frac{36.652 * 10^{-9} * 2}{*r}\right] = 0$$

$\Rightarrow r = 0$ or $(1 - 318998 \times 10^{-3})^{1/4}$

$$= 0.190573 \, m = 190.573 \, mm$$

So, $(\sigma_{rr})_{max} = \dfrac{E}{1-\nu^2} \left. \sigma_{rr}^* \right|_{r=100mm} = 185.0909 \, \omega^2 \, N/m^2$

$(\sigma_{\theta\theta})_{max} = \dfrac{E}{1-\nu^2} \left. \sigma_{\theta\theta}^* \right|_{r=190.573mm} = 93.1683 \, \omega^2 \, N/m^2$

$\Rightarrow (\sigma_{rr})_{max}$ is the critical one.

$(\sigma_{rr})_{max} = \dfrac{\sigma_u}{SF} = \dfrac{20 \times 10^6}{2} \Rightarrow \omega_{max} = 232.438 \; rad/sec$