

Table 16-3 → $f = 0.06$

$$P_{max} = 300 \text{ psi} \approx 2.1 \text{ MPa}$$

$$V_{max} = 3600 \text{ ft/min}$$

کشش راست $F = \frac{M_N + M_f}{c}$

کشش چپ $F = \frac{M_N - M_f}{c}$

$$M_N = \frac{P_a b r a}{\sin \theta_a} \int_{\theta_1}^{\theta_2} \sin^2 \theta d\theta = \frac{P_a b r a}{\sin \theta_a} \left[\frac{\theta}{2} - \frac{1}{4} \sin 2\theta \right]_{\theta_1}^{\theta_2}$$

$$M_f = \frac{f P_a b r}{\sin \theta_a} \int_{\theta_1}^{\theta_2} \sin \theta (r - a \cos \theta) d\theta = \frac{f P_a b r}{\sin \theta_a} \left[-r \cos \theta - \frac{a}{2} \sin^2 \theta \right]_{\theta_1}^{\theta_2}$$

$$a = 120 \text{ mm}$$

$$r = \frac{500}{2} = 250 \text{ mm}$$

$$b = 30 \text{ mm}$$

$$\left. \begin{array}{l} \theta_1 = 20^\circ \\ \theta_2 = 120^\circ \end{array} \right\} \theta_a = 90^\circ$$

$$M_N = \frac{2.1 \times 10^6 \times 30 \times 10^{-3} \times 250 \times 10^{-3} \times 120 \times 10^{-3}}{\sin 90} \left[\frac{\theta}{2} - \frac{1}{4} \sin 2\theta \right]_{20}^{120}$$

$$\rightarrow M_N = 1890 \left[\left(120 \times \frac{1}{2} \times \frac{2\pi}{360} - \frac{1}{4} \sin 240 \right) - \left(20 \times \frac{1}{2} \times \frac{2\pi}{360} - \frac{1}{4} \sin 40 \right) \right]$$

$$\rightarrow M_N = 1890 [1.05 + 0.22 - 0.17 + 0.16] = 2381.4 \text{ Nm}$$

$$M_f = \frac{0.06 \times 2.1 \times 10^6 \times 30 \times 10^{-3} \times 250 \times 10^{-3}}{\sin 90} \left[-250 \times 10^{-3} \cos \theta - \frac{120 \times 10^{-3}}{2} \sin^2 \theta \right]_{20}^{120}$$

$$\rightarrow M_f = 945 \left[\left(-250 \times 10^{-3} \cos 120 - \frac{120 \times 10^{-3}}{2} \sin^2 120 \right) - \left(-250 \times 10^{-3} \cos 20 - \frac{120 \times 10^{-3}}{2} \sin^2 20 \right) \right]$$

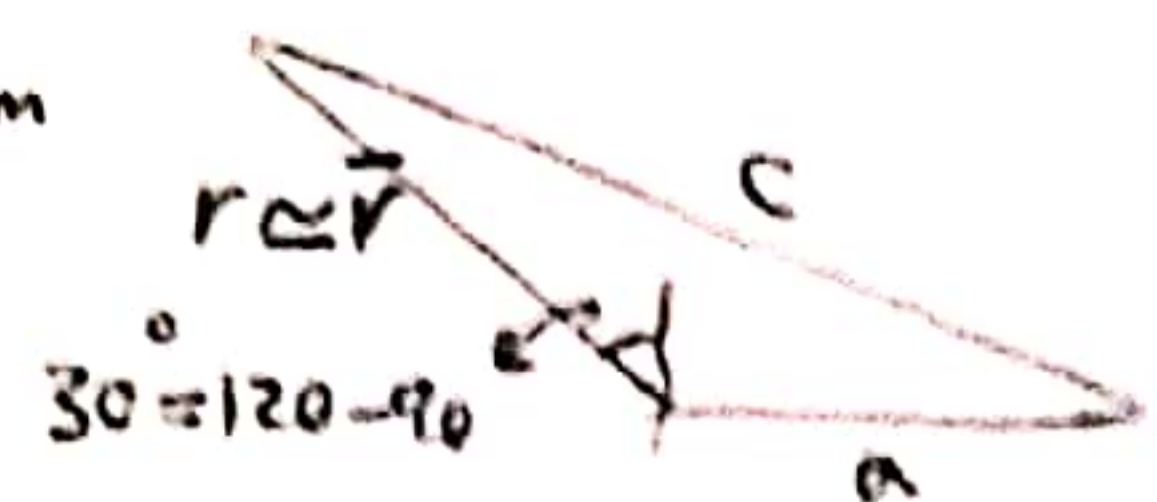
$$\rightarrow M_f = 945 [-0.13 - 0.05 + 0.23 + 0.01] = 56.7 \text{ N.m}$$

$$c^2 = a^2 + r^2 - 2ar \cos 120$$

$$c^2 = 120^2 + 250^2 - 2 \times 120 \times 250 \cos 120 = 106,900$$

$$14,400 \quad 62,500 \quad -30,000$$

$$c = 327 \text{ mm}$$



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کشش داخل $F = \frac{M_N + M_F}{c} = \frac{2381.4 + 56.7}{327 \times 10^{-3}} = 7.5 \text{ kN}$

کشش خارج $F = \frac{M_N - M_F}{c} = \frac{2381.4 - 56.7}{327 \times 10^{-3}} = 7.1 \text{ kN}$

$$T = \frac{f T_a b r^2}{\sin \theta a} \int_{\theta_1}^{\theta_2} \sin \theta d\theta = \frac{f T_a b r^2}{\sin \theta a} [\cos \theta]_{\theta_1}^{\theta_2}$$

$$\rightarrow T = \frac{0.06 \times 2.1 \times 10^6 \times 30 \times 10^{-3} \times (250 \times 10^{-3})^2}{\sin 90} [-\cos \theta]_{20}^{120}$$

$$\rightarrow T = 236.3 [-\cos 120 + \cos 20] = +340.2 \text{ Nm}$$

کشش در میان است!
 نیروی کشش داخل بیشتر از نیروی کشش خارج است! پس مصالح در امتداد کشش خارج مستعمل می‌شوند!

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سوال 12

Table 16-3 → $f = 0.38$

$P_{max} = 100 \text{ psi}$

$T_{max} = 300 - 660^\circ \text{ F}$ → کاربرد خودرزی
 کاربرد مستطع کاربرد قائم
 $V_{max} = 3600 \text{ ft/min}$

توزیدی

~~$T = \frac{Ff}{4} (D+d)$ Uniform wear
 $T = \frac{Ff}{3} \frac{D^3-d^3}{D^2-d^2}$ Uniform pressure~~

مستطع
 $T = \frac{1}{2} (\theta_2 - \theta_1) f P_a r_i (r_o^2 - r_i^2)$ Uniform wear
 $T = \frac{1}{3} (\theta_2 - \theta_1) f P_a (r_o^3 - r_i^3)$ Uniform pressure

مستطع
 $F = (\theta_2 - \theta_1) P_a r_i (r_o - r_i)$ Uniform wear
 $F = \frac{1}{2} (\theta_2 - \theta_1) P_a (r_o^2 - r_i^2)$ Uniform pressure

توزیدی

$T = \frac{Ff}{4 \sin \alpha} (D+d)$ Uniform wear
 $T = \frac{Ff}{3 \sin \alpha} \frac{D^3-d^3}{D^2-d^2}$ Uniform pressure

توزیدی

$15000 = \frac{1}{2} (60-0) \times \frac{2\pi}{360} \times 0.38 P_a \times 8 (12^2 - 8^2) \rightarrow P_a = 117.86 \text{ psi}$ NOK
 $15000 = \frac{1}{3} (60-0) \times \frac{2\pi}{360} \times 0.38 P_a (12^3 - 8^3) \rightarrow P_a = 93.04 \text{ psi}$ OK
 $F = (60-0) \times \frac{2\pi}{360} \times 117.86 \times 8 (12-8) = 3.95 \text{ klb}$
 $F = \frac{1}{2} (60-0) \times \frac{2\pi}{360} \times 93.04 \times (12^2 - 8^2) = 3.90 \text{ klb}$

توزیدی

$15000 = \frac{F \times 0.38}{4 \sin(1)} (12+11) \Rightarrow F = 119.75 \text{ lb}$
 $15000 = \frac{F \times 0.38}{3 \sin(1)} \times \frac{12^3 - 11^3}{12^2 - 11^2} \Rightarrow F = 119.67 \text{ lb}$

$F = \frac{\pi P_a d}{2} (D-d) \Rightarrow P_a = \frac{2 \times 119.75}{\pi \times 11 \times (12-11)} = 6.9 \text{ psi}$ OK $< P_{max}$
 $F = \frac{\pi P_a}{4} (D^2 - d^2) \Rightarrow P_a = \frac{4 \times 119.67}{\pi \times (12^2 - 11^2)} = 6.6 \text{ psi}$ OK $< P_{max}$