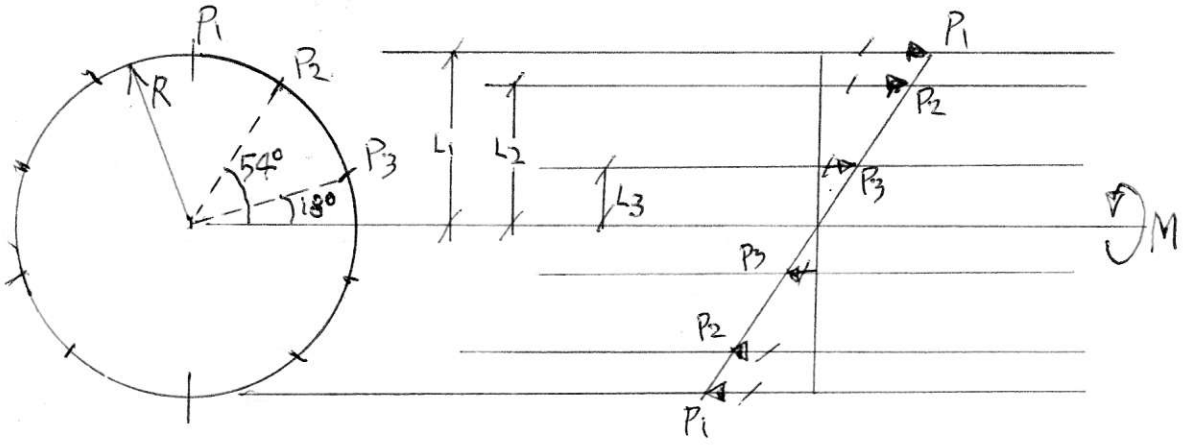
COUPLER JOINT – 10 FASTENERS

– CALCULATE MAXIMUM SHEAR FORCE



$$\Sigma M = 0 = 2P_1L_1 - 4P_2L_2 - 4P_3L_3 \quad \sim ①$$

ALSO $\frac{P_1}{L_1} = \frac{P_2}{L_2} = \frac{P_3}{L_3} \Rightarrow P_2 = P_1\frac{L_2}{L_1}$ ~② $\quad P_3 = P_1\frac{L_3}{L_1}$ ~③

FROM ①, ② & ③

$$M = 2P_1L_1 - 4L_2P_1\frac{L_2}{L_1} - 4L_3P_1\frac{L_3}{L_1}$$

$$= 2P_1\left(L_1 + 2\frac{L_2^2}{L_1} + 2\frac{L_3^2}{L_1}\right)$$

$$= 2P_1L_1\left[1 + 2\left(\frac{L_2}{L_1}\right)^2 + 2\left(\frac{L_3}{L_1}\right)^2\right]$$

$$= 4P_1L_1\left[\frac{1}{2} + \left(\frac{L_2}{L_1}\right)^2 + \left(\frac{L_3}{L_1}\right)^2\right.$$

$$\Rightarrow P_1 = \frac{M}{4L_1\left[\frac{1}{2} + \left(\frac{L_2}{L_1}\right)^2 + \left(\frac{L_3}{L_1}\right)^2\right]}$$

As $L_1 = R$, $L_2 = R\sin 54°$, $L_3 = R\sin 18°$

$$P_1 = \frac{M}{4R\left[\frac{1}{2} + \left(\frac{R\sin 54°}{R}\right)^2 + \left(\frac{R\sin 18°}{R}\right)^2\right.}$$

$$\sin^2 54^\circ + \sin^2 18^\circ = 3/4$$

$$\Rightarrow P_1 = \frac{M}{4R\left(\frac{1}{2} + 3/4\right)} = \frac{4M}{4R(5)} = \frac{1}{5}\frac{M}{R}$$