

Question:

QUESTION 1

A gusset plate is attached to a column, as shown in Figure Q1, which supports a load of  $P$ . Design the rivets/bolts in region A where the load is applied eccentrically, having a group of bolts/rivets. The thickness of the plate is 16 mm. The parameters that should comply as follows:

Parameter	Description
Number of bolts/rivets	design assumption must be equal to or greater than three (3).
Safety factor and allowable shear stress	the design of safety factor values must be in the range of 2.4 - 2.6, and the allowable shear stress must be in 38 MPa - 42 MPa.
Diameter of bolts/rivets and bearing stress	the selection of the diameter of bolts/rivets in Table 15.2 must consider the bearing stress does not exceed 50 MPa.

- a) Determine the maximum force,  $P$  the rivet can withstand if the yield stress on the most heavily loaded rivet is 200 MPa.
- b) Calculate the possible mode of failures, i.e., bearing on the plate and shearing failure of the edge of the plate if the closest distance from rivet to the edge of the plate is 8 mm.

(20 marks)

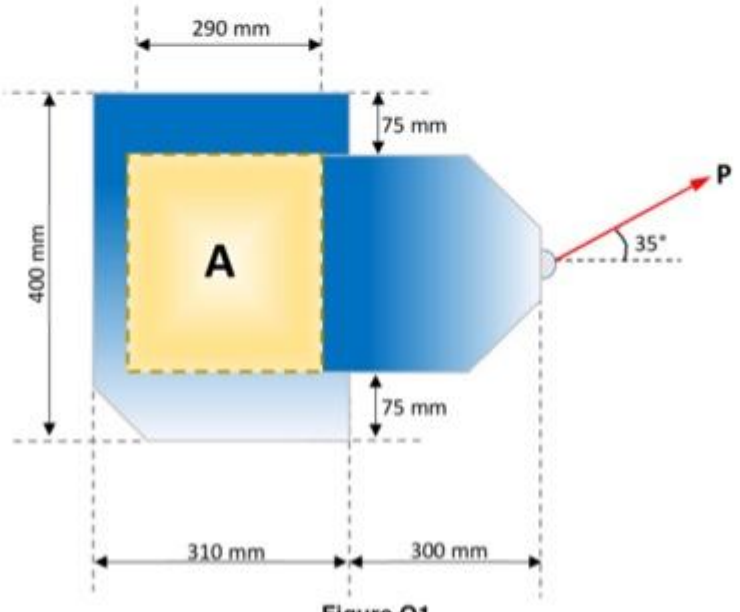


Figure Q1

Expert answer:

Answer 1:

Assume '4' rivets are attached

given thickness of plate is 16 mm

so diameter of rivet  $d = 6F = 94 \text{ mm}$

Margin  $> 1.5d$

$m \geq 36 \rightarrow$  Assumed  $m = 40$

① direct shear stress  $\tau = \frac{P}{4 \times \frac{\pi}{4} \times 16^2} = \frac{P}{1600\pi} = 0.000196 P$

② Secondary shear stress (Rivet 'A' is heavily loaded rivet)

$e = \text{eccentricity} = 610.6855 = 350$

By observe above dig, angle b/w  $P$  &  $F$  is small in rivet 'A' so it's heavily loaded rivet

Angle b/w  $F$  &  $P = 51.3 - 35 = 16.3^\circ$

$P \times e = \frac{F_1}{11} [l_1^2 + l_2^2 + l_3^2 + l_4^2]$

$P \times 350 = \frac{F_1}{163} [4 \times 16^2] = F_1 \times 0.53$

$F_1 = 0.53 P$

Now FBD of Rivet 'A'

$R = \sqrt{P_s^2 + F^2 + 2P_s F \cos 16.3} = P \sqrt{(0.25)^2 + (0.53)^2 + 2 \times 0.25 \times 0.53 \cos 16.3}$

$= 0.77 P$

① given yield stress in heavy loaded rivet = 200 MPa

$\rightarrow$  here rivet is s/t to pure shear

Max principle stress  $= 200 \text{ MPa} = \tau = \sigma_1$

$\sigma_1 = \tau = 200 \text{ MPa}$

$\frac{0.77 P}{\frac{\pi}{4} \times 16^2} = 200$

$P = 52.23 \text{ kN}$

② shear failure of rivet

$\tau = \frac{52.23 \times 0.77}{\frac{\pi}{4} \times 16^2} = 200 = \frac{200 \times 16^2}{\frac{\pi}{4} \times 16^2}$

$\rightarrow$  here rivet is safe in shear

but margin  $m_{\text{min}} = 1.5 \times d = 94$

$\rightarrow$  given margin is 8 mm

So  $\rightarrow$  it fail by tearing of the plate at edge