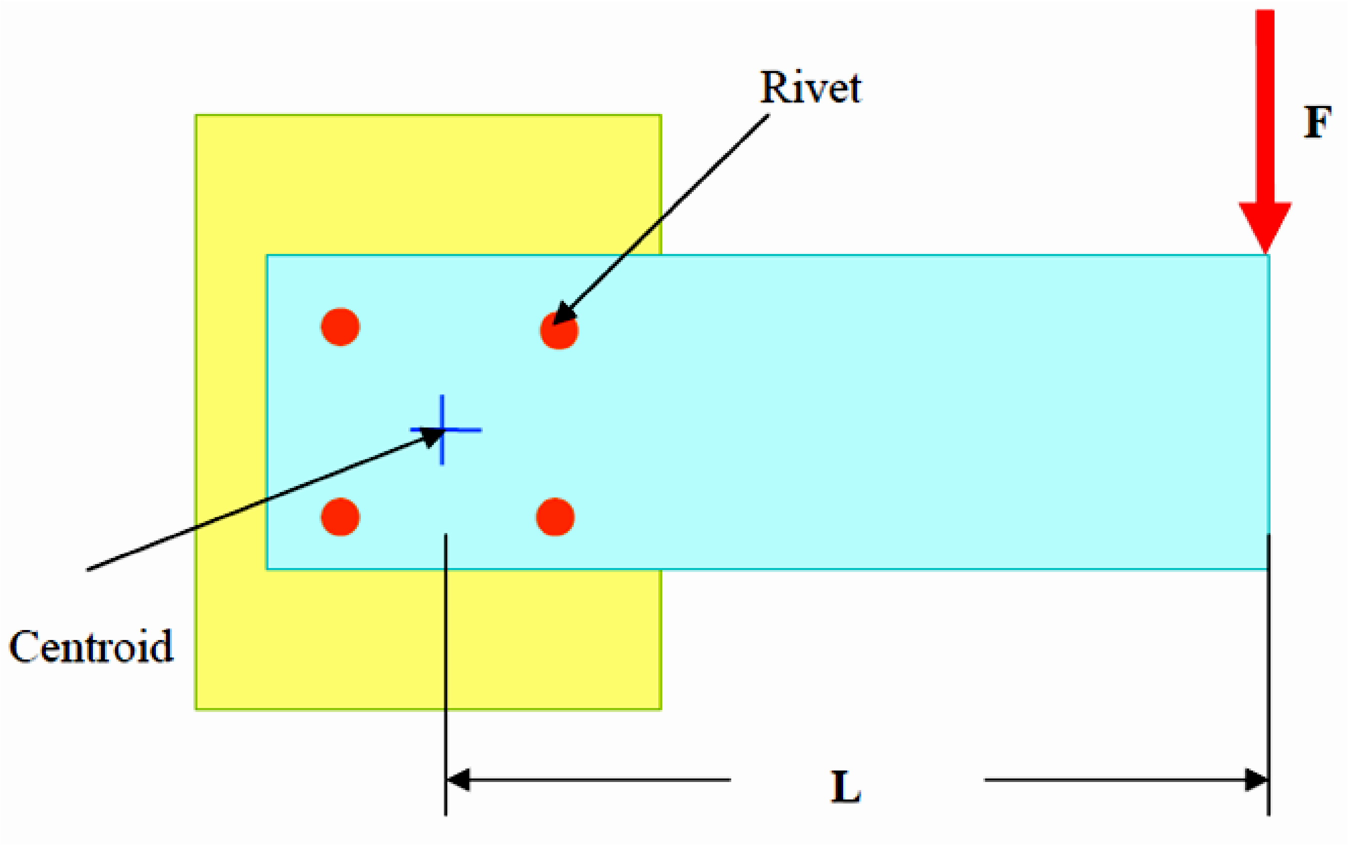
Lecture # 12

Riveted Joints - Eccentric Loading

Riveted Joints - Eccentric Loading

Consider, a bracket, which carries a vertical load. The bracket, in this case, is connected to the wall by four rivets as shown in figure.



Riveted Joints - Eccentric Loading

The force, in addition to inducing direct shear of magnitude *F/*4 in each rivet, causes the whole assembly to rotate.

Hence additional shear forces appear in the rivets.

Once again, the problem is a statically indeterminate one and additional assumptions are required.

These are as following:

(i) magnitude of additional shear force is proportional to the distance between the rivet center and the centroid of the rivet assembly, whose co-ordinates are defined as

$$\bar{x} = \frac{\sum A_i x_i}{\sum A_i}, \bar{y} = \frac{\sum A_i x_i}{\sum A_i}$$

(A_i=area of the cross-sectionof the i-th rivet)

Riveted Joints - Eccentric Loading

(ii) directions of the force is perpendicular to the line joining centroid of the rivet group and the rivet center and the sense is governed by the rotation of the bracket.

Noting that for identical rivets the centroid is the geometric center of the rectangle, the force in the i-th rivet is $f_i = \alpha l_i$ *or* $\alpha = (f_i / l_i)$

where α = proportional constant, l_i = distance of the i-th rivet from centroid. Taking moment about the centroid, we get $\sum_i f_i l_i = FL$

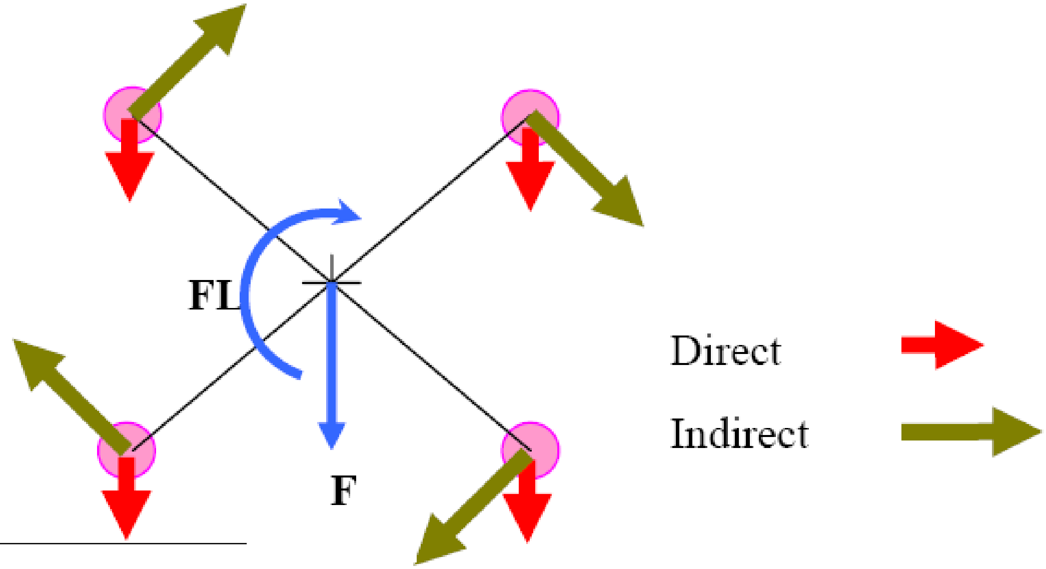
since f_i is proportional to l_i $\therefore f_i = \alpha l_i$

$$\therefore \sum_i \alpha (l_i{}^2) = FL \text{ or } \alpha = \frac{\text{FL}}{\sum_i l_i{}^2} = \frac{f_i}{l_i}$$

$$\text{Thus, the additional force is } f_i = \frac{\text{FL}}{\sum_i l_i{}^2} l_i$$

Riveted Joints - Eccentric Loading

The net force in the i-th rivet is obtained by parallelogram law of vector addition as



$$f_i' = \sqrt{f_i^2 + \left(\frac{F}{4}\right)^2 + 2\left(\frac{F}{4}\right) f_i \cos\theta_i}$$

where θ_i=angle between the lines of action of the forces shown in the figure.

For safe designing we must have $\tau = \max(f_1'/A) \leq \tau$

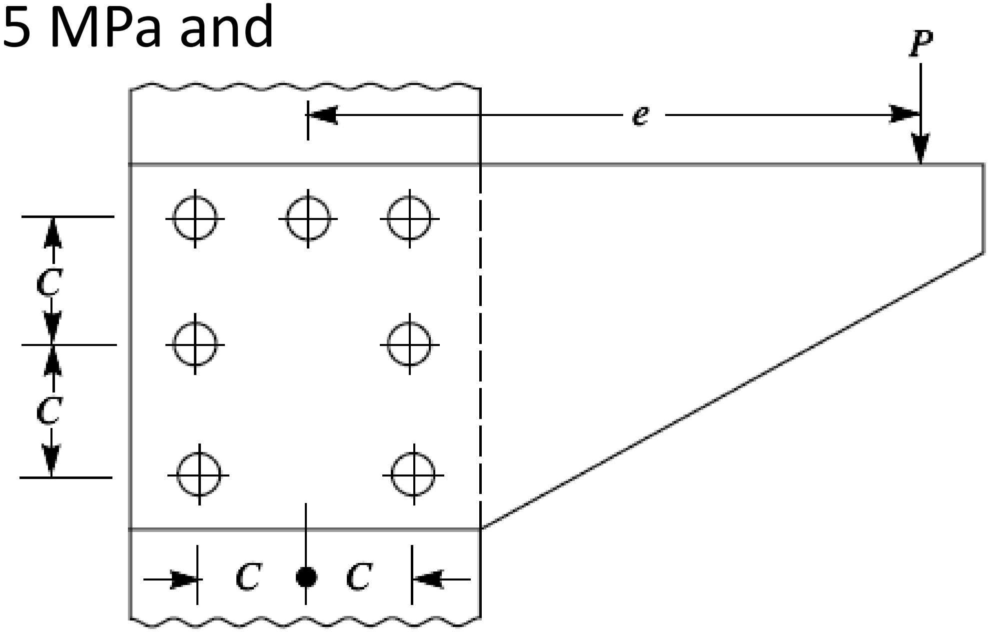
where τ =allowable shear stress of the rivet.

Riveted Joints - Eccentric Loading

Example.14

An eccentrically loaded lap riveted joint is to be designed for a steel bracket as shown in figure. The bracket plate is 25 mm thick. All rivets are to be of the same size. Load on the bracket, P = 50 kN; rivet spacing, C = 100 mm; load arm, e = 400 mm.

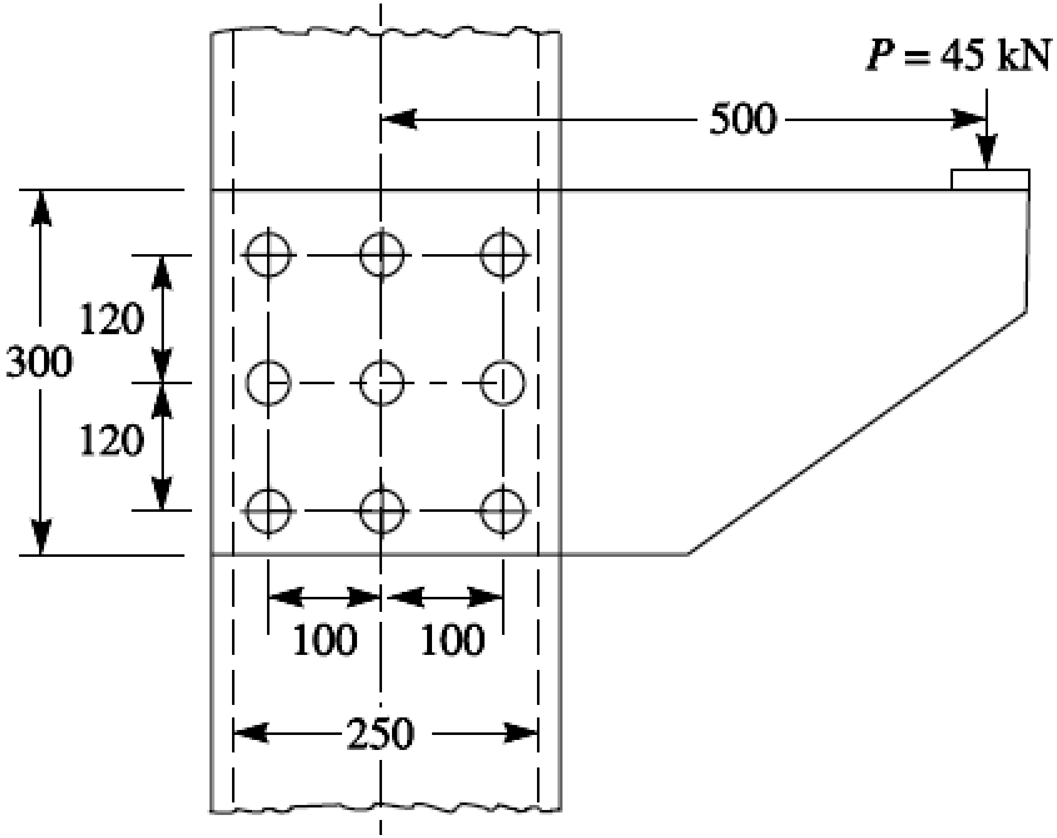
Permissible shear stress is 65 MPa and crushing stress is 120 MPa. Determine the size of the rivets to be used for the joint.



Riveted Joints - Eccentric Loading

Example.15

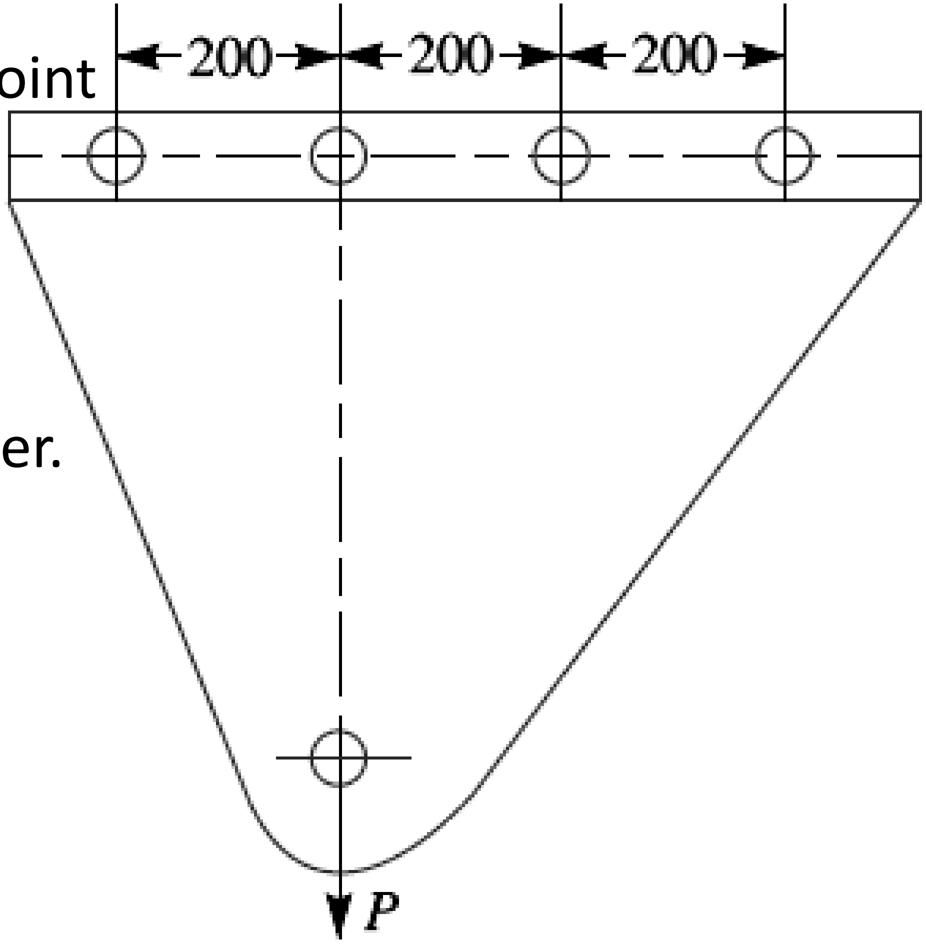
The bracket as shown in Fig., is to carry a load of 45 kN. Determine the size of the rivet if the shear stress is not to exceed 40 MPa. Assume all rivets of the same size.



Riveted Joints - Eccentric Loading

Example.16

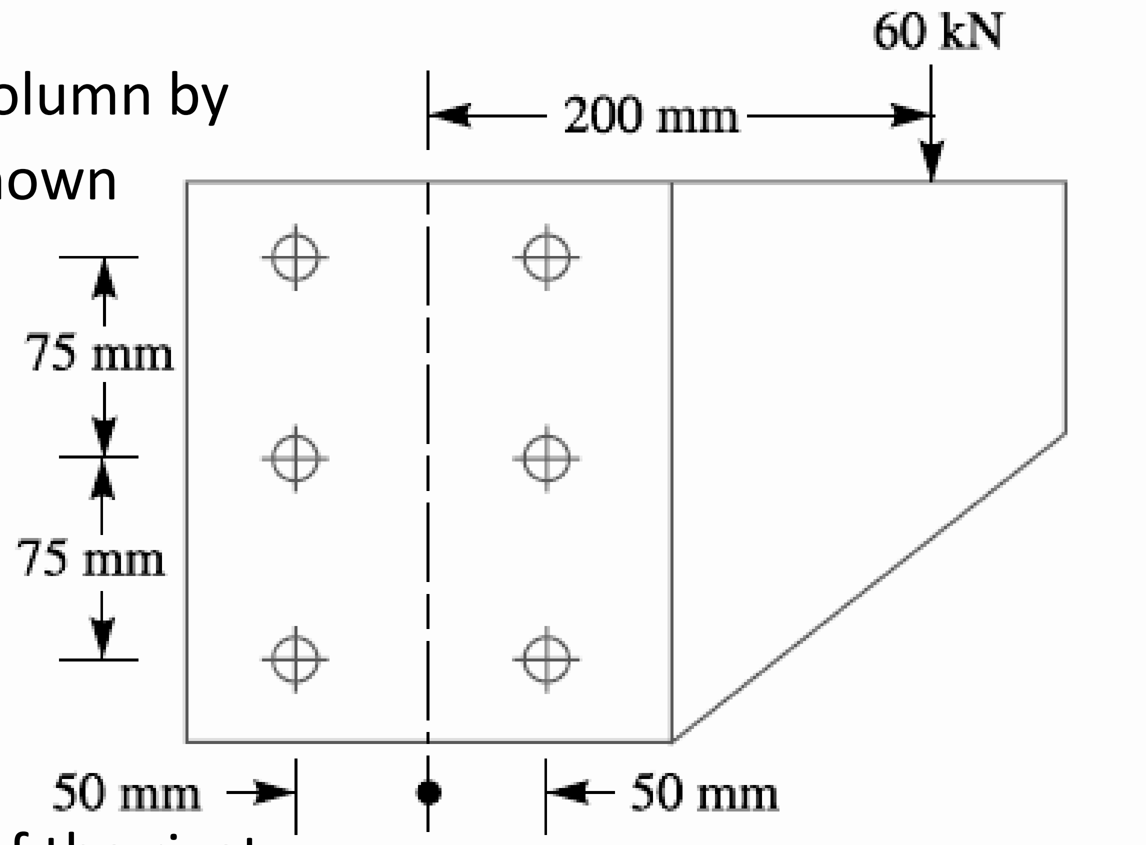
Find the value of P for the joint shown in Fig. based on a working shear stress of 100 MPa for the rivets. The four rivets are equal, each of 20 mm diameter.



Riveted Joints - Eccentric Loading

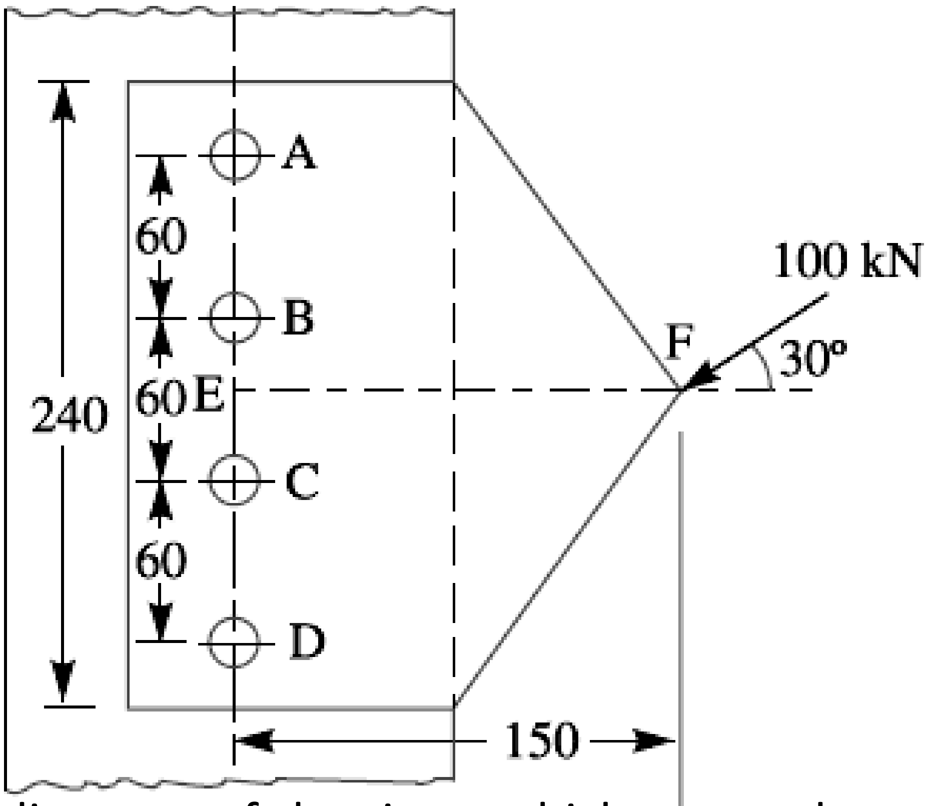
Example.17

A bracket is riveted to a column by 6 rivets of equal size as shown in Fig. It carries a load of 60 kN at a distance of 200 mm from the centre of the column. If the maximum shear stress in the rivet is limited to 150 MPa, determine the diameter of the rivet.



Riveted Joints - Eccentric Loading

Example.18



A bracket in the form of a plate is fittedto a column by means of four rivets A, B, C and D in the same vertical line, as shown in Fig. AB = BC = CD = 60 mm. E is the mid-point of BC. A load of 100 kN is applied to the bracket at a point F which is at a horizontal distance of 150 m from E. The load acts at an angle of 30° to the horizontal. Determine the diameter of the rivets which are made of steel having a yield stress in shear of 240 MPa. Take a factor of safety of 1.5. What would be the thickness of the plate taking an allowable bending stress of 125 MPa for the plate, assuming its total width at section ABCD as 240 mm?

References

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