1 3rd Year Design and Production

Joints – Lecture 2

2 Riveted Joints

2.1 Simplified Approach: "Uniform Shear Method" assumes

- Negligible friction and bending under load
- Applied shear loads are resisted equally by each rivet
- Load is distributed evenly (no misalignment)
- There is good fit between the rivets and the plate

3 Riveted Joints – Analysis

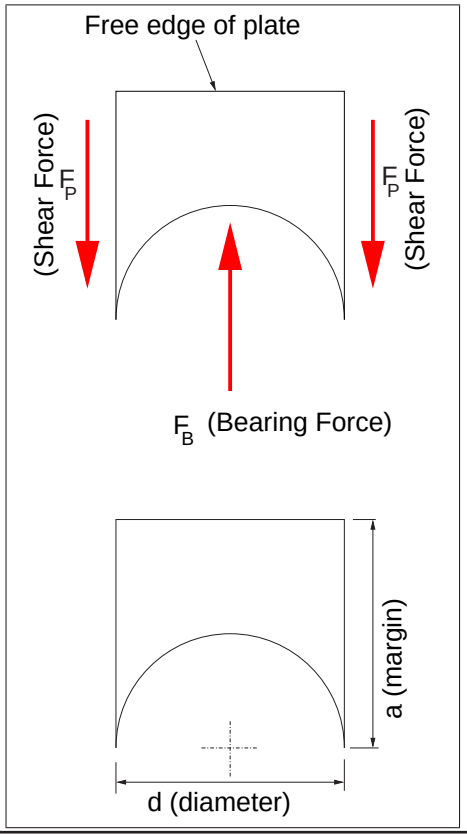
3.1 Behaviour of Riveted Joints – Force Transfer

- Rivets are best suited to transmitting shear force
- Generally a riveted joint constitutes a **redundant structure**
- Yielding of a rivet leads to a reduction in its stiffness. This reduces the load it is taking, and leads to some of the shed-load being transferred to other rivets
- Failure occurs due to sequential yielding until stress in all rivets reaches or exceeds their yield strength. Then ductile failure occurs in the joint.

3.2 Key Variables

- Rivet and plate cross-sectional area
- Position of centroid of rivet joint when it is subjected to torque or to eccentric loading
- Material properties of the rivet and the plate

4 Riveted Joints – Tear-Out



- **Marginal Failure** or **Tear-out**
- By equilibrium: $2F_p = F_b$
- If shear strength of plate is τ_p then tearout failure will occur when

$$F_b \geq 2(\tau_p)(t)(a)$$

- t is the thickness of the plate, a is the margin
- Rule of thumb: choose a margin 1.5 to 2 times the rivet or bolt diameter

5 Riveted Joints – Torsional Loading

5.1 Stress Distribution

- Shear stress in any rivet is proprortional to its distance from the torque origin
- Direction of the shear force is in the direction of the shear strain

5.2 Torque Origin

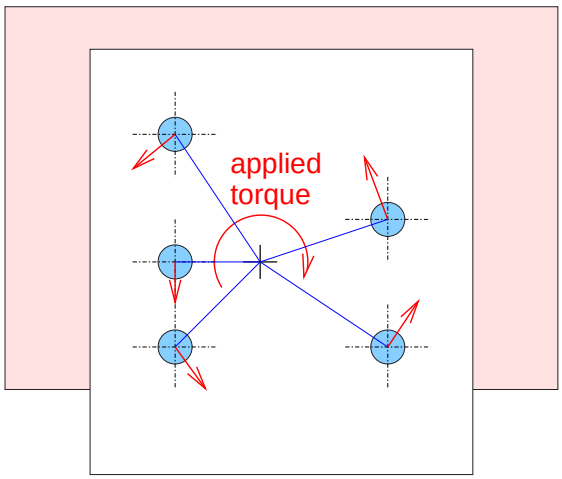
- The point at which the torque acts is given by the centroid of the rivet group
- Centroid, (X_c, Y_c) is given by:

$$X_c = \frac{\sum A_i X_i}{\sum A_i} \qquad \text{and} \qquad Y_c = \frac{\sum A_i Y_i}{\sum A_i}$$

6 Riveted Joints – Torsional Loading

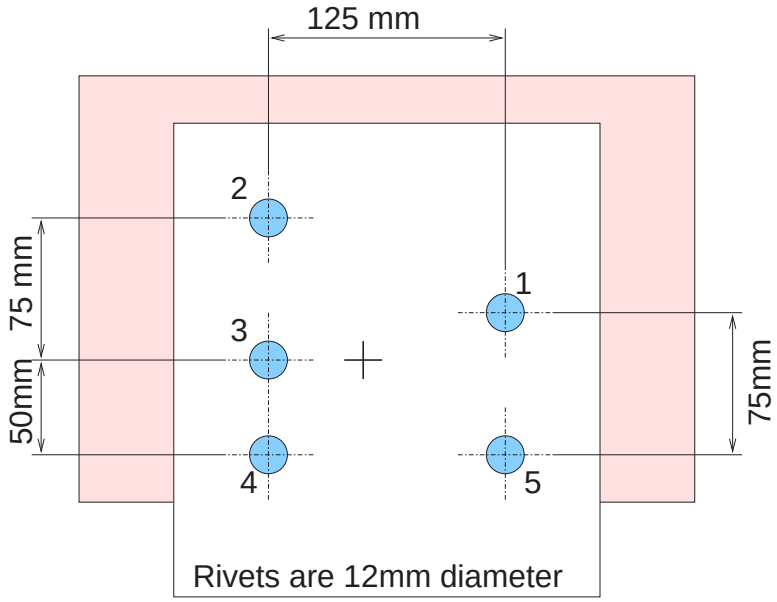
6.1 Assumptions

- Dimensions remain the same after the torsion is applied
- Shear strain in rivet is proportional to distance from centroid
- Shear stress in rivet is proportional to shear strain
- Rivet with greatest stress is the one farthest from centroid



7 Riveted Joints – Torsional Loading

7.1 Example

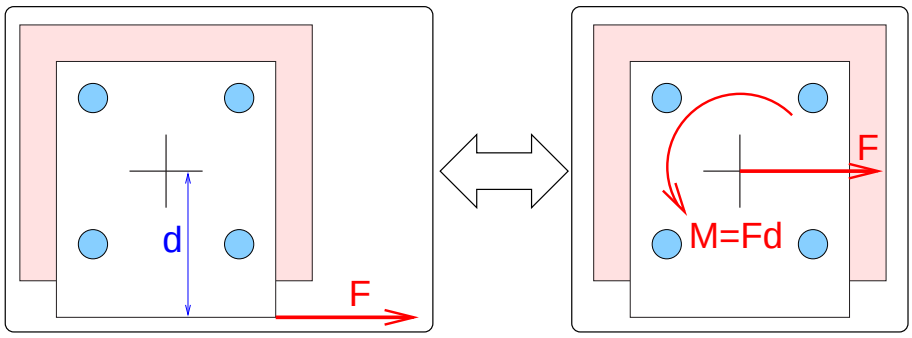


The illustrated joint is subject to a 2.7kN torque, find the resulting shear stress in the rivets.

8 Riveted Joints – Torsional Loading

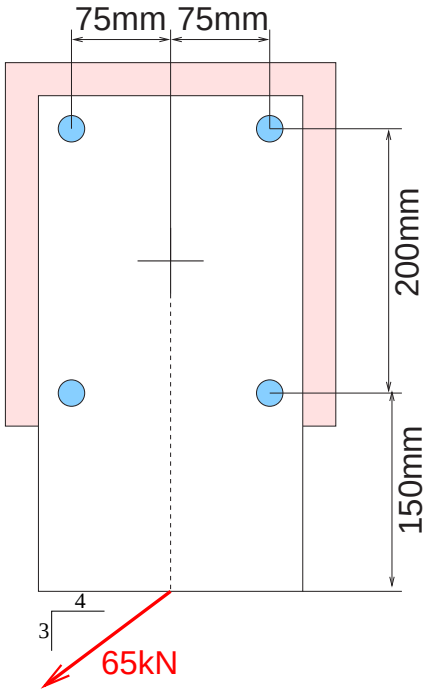
8.1 Eccentric Loads

- Load is not a pure torque
- Resultant force does not pass through the centroid of the joint
- Think of it like a force and a couple.
  - Force
  - Couple (moment of the force about the centroid)
- Look at effect of each separately and analyse joint.



9 Riveted Joints – Eccentric Loading

9.1 Example



Find the stresses in the rivets. Rivet diameter is 25 mm.