EXPERIMENT No. 9

(To be performed by group of 4-5 students)

1.0 Title :

Design of fasteners.

2.0 Prior concepts:

Types of thread profiles used in screwed joint.

Types of Welded joints.

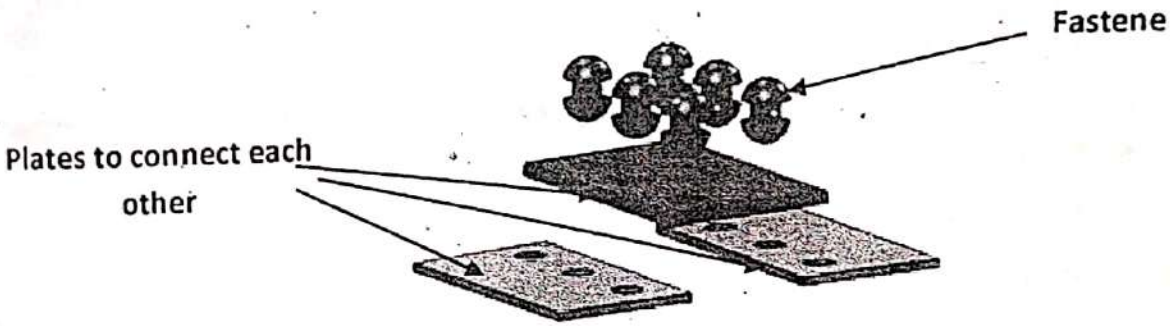
Application of screwed and welded joint.

3.0 New concepts :

Proposition 1: Fasteners

A fastener is a hardware device that mechanically joins or affixes two or more objects together.

Concepts Structure:

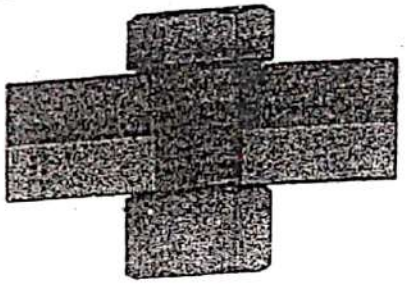
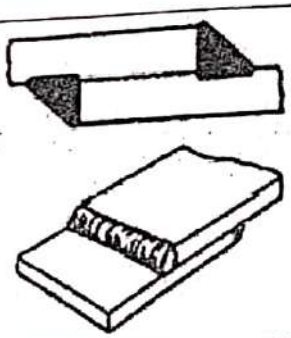


Proposition 2: Types of Fasteners

Fasteners are basically classified in two categories.

1. Screwed joint
2. Welded joint

Concepts Structure:

Screwed joint	
Welded joint	

4.0 Learning Objectives:

Intellectuai Skills:

- Analyze and evaluate the loads, forces, stresses involved in fasteners and decide the dimensions.
- Apply the basic knowledge of the earlier subject like Strength of Materials, Engineering Mechanics, Mechanical engineering drawing.
- Understand modes of failure in fasteners and decide the design criteria.

Motor Skills:

- Ability to draw and determine the area subjected to failure for given stress condition.
- Ability to calculate various dimensions of machine component under given load condition using appropriate criterion for failure.

5.0 Learning Aids:

- Working Model of fasteners.

6.0 Stepwise Procedure :

Teacher Activity:

1. Introduce the students about various types of fasteners with practical examples.
2. Provide the value of load and Material strength to each group of students.

Student Activity:

1. Observe in groups the given type of fastener and Select the value of Load / Force to which the fastener is subjected to, under the guidance of Teacher.

2. Observe in groups the given Fastener and identify the different stresses and draw two-dimensional diagram showing the area of failure under the observation.
3. Observe in groups the given fastener and determine the various dimensions of fastener by writing the strength equations for particular stress conditions, under the observation.
4. Check the safety and reliability of component for the determined dimensions for other stresses considering other failure criterion, and note down the observations.

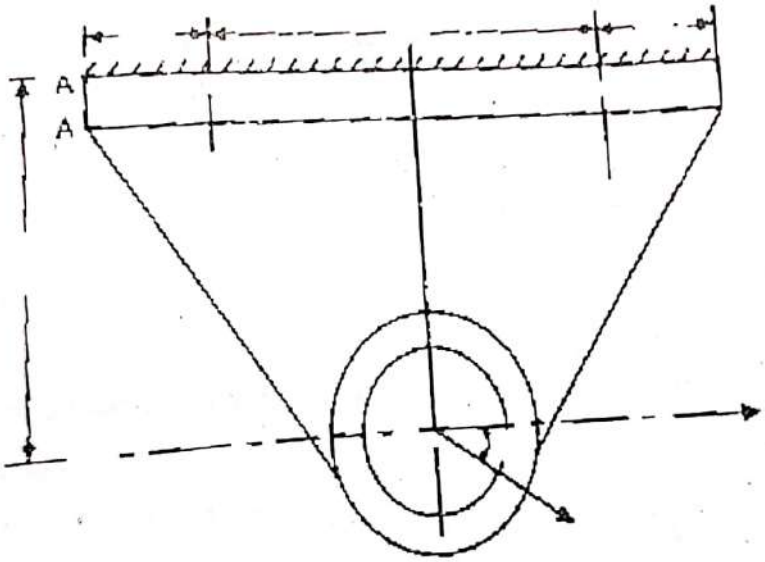
7.0 Observations :

1. **Design of Screwed joint:**

Figure shows a bracket of jib crane. It is connected to the crane by using 4 bolts. The bracket carries a maximum load of .....kN inclined at ..... To horizontal. Calculate the size of bolts required to fix bracket Assume Tensile stress .....MPa.

(Teacher shall provide the value of Force, Stress, angle of inclination of force with horizontal and dimensions required in below figure)

Solution:



Given data:

P = Force applied on the bracket in N.

P_h = Horizontal component of force applied on bracket

= P Cosθ = ...Cos..... = ...N

P_v = Vertical component of force applied on bracket

= P Sinθ = ...Sin..... = ...N

n = Number of bolts used to connect bracket to crane = ...

σ_t = Tensile stress for bolt material = ...N/mm^2

l_1 = Length of bolts at 1 from end A = ...mm

l_2 = Length of bolts at 2 from end A = ...mm

l = Length of force from end A = ...mm

Step 1 Consider vertical component of force (P_v) and calculate tensile force (P_{t1}).

In this case due to vertical component of force (P_v), the bolt will be subjected to direct tensile force (P_{t1})

$P_{t1} = P_{t1} = \frac{P_V}{n}$ = ... = ...N

Step 2 Consider Horizontal component of force (P_h) and calculate direct Shear force (P_s)

In this case due to Horizontal component of force (P_h), the bolt will be subjected to direct tensile force (P_s)

$P_s = P_s = \frac{P_h}{n}$ = ... = ...N

Step 3 Consider Horizontal component of force (P_h) and calculate direct tensiie force (P_{t2})

Horizontal component of force (P_h) will try to tilt the bracket in the clockwise direction about edge A-A and then the bolts will be subjected to tensile stress due to turning moment.

The maximum tensile force on a heavily loaded bolts P_{t2} may be obtained as follow

$$P_{t2} = \frac{P \times l \times l_2}{2\left[(l_1)^2 + (l_2)^2\right]}$$

= .....

= .....

Step 4 Calculate total tensile force (P_t)

Total tensile force (P_t) = $P_{t1} + P_{t2}$ = ...+.....=.....N

Step 5 Calculate equivalent tensile force (P_{te})

When the bolts are subjected to shear as weil as tensile load, then equivalent force may be determine as follows

$$P_{te} = \frac{1}{2}\left[P_t + \sqrt{(P_t)^2 + 4(P_s)^2}\right]$$

P_{te} = ...

= .....

= .....N

Step 6 Calculate Core diameter of screw (d_c)

If d_c is core diameter of bolt and σ_t is tensile stress of bolt material then

$$\sigma_t = \frac{P_{te}}{\frac{\pi}{4} dc^2} \qquad \therefore dc^2 = \frac{P_{te}}{\frac{\pi}{4}\sigma_t}$$

d_c^2 = ...

d_c =.....

Step 6 Calculate Major diameter of screw (d_o) and select the bolt from standard

Major diameter of bolt d_o can be calculated by using empirical equation

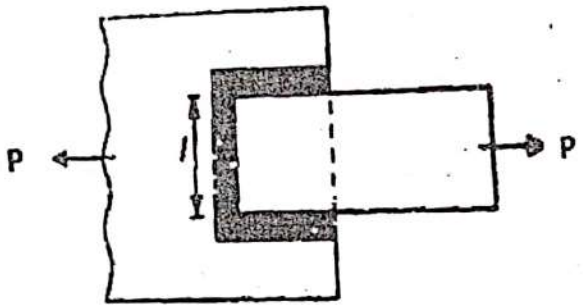
$d_o = 1.19\ d_c = 1.19$ ..... = ...mm

Select the type of bolt M.....

2. **Design of Welded joint:**

A steel plate .....mm wide and .....mm thick, is joined with another steel plate by means of a single transverse and double fillet welds, as shown in figure. The strength of the welded joint should be equal to the strength of plates to be joined. The permissible tensile and shear stresses for the weld material and plates are .....MPa and .....MPa respectively. Find the length of weld. Assume tensile force acting on the plates as static

(Teacher shall provide the value of Force, Stresses and dimensions of plate)



Given data:

P = Force applied on plates in N

b = width of plate = ...mm.

t = thickness of plate = ...mm

σ_t = Tensile stress for weld material = ...N/mm^2

ζ = shear stress for weld material = ...N/mm^2.

Step 1 Calculate effective length of transverse weld (l_1)

The effective length of weld (l_1) for transverse weld may be obtained by subtracting 12.5 mm from the width of the plate

l_1 = width of plate – 12.5 = ... – 12.5 = ...mm

Step 2 Calculate Force (P) applied on plates.

Maximum force which the plate can carry is

Force (P) = Tensile Stress × Area of plate = $\sigma_t * b * t$

= ..... × .....×.....=.....N

Step 3 Calculate Force (P_1) on single transverse weld.

Force carried by single transverse weld is given by

$P_1 = 0.707 * b * l_1 * \sigma_t = 0.707$ ×.....×.....×..... = ...N

Step 4 Calculate Force (P_2) on double parallel weld.

Force carried by double parallel weld is given by (this force in terms of l_2)

$P_2 = 0.707 * b * l_2 * \zeta = 0.707 \times \ldots\ldots \times l_2 \times \ldots\ldots = \ldots\ldots l_2.N$

Step 5 Calculate length of each parallel fillet.

Total force (P) = $P_1 + P_2$

$\ldots\ldots = \ldots\ldots + \ldots\ldots l_2$

$l_2 = \ldots\ldots mm$

For starting and stopping of weld run, 12.5 mm is added to length of weld

$l = l_2 + 12.5 = \ldots\ldots + 12.5 = \ldots\ldots mm$

8.0 Questions for confirmation of learning:

(Student shall write answers to the questions at the time of practical independently before completing the experiment to have self-feedback. He/ She may refer to the notes, etc. Teacher shall supervise.)

1. Give two examples where screwed joints are preferred over welded joints.

   i. .....

   ii. .....

2. Write down the two advantages and two disadvantages of screwed joints.

   Advantages of screwed joint

   .....

   Disadvantages of screwed joint

   .....

3. Write down the two advantages and two disadvantages of Welded joints.

   Advantages of welded joint

   .....

   Disadvantages of welded joint

   .....

9.0 Conclusion:

1. In case of screwed joint major diameter of bolt (d_0) is.....(0.84 or 1.19 or 1.25) times core diameter of bolt (d_c).
2. The distance from a point on one thread to the corresponding point on the next is known as.....(Pitch/lead/crest)

3. In order to allow for starting and stopping of the bead .....(12.5/1./11.5) mm should be added to the length of each weld obtained.

4. For reinforced fillet welds the dimension may be taken as .....(0.85/0.4/1.5) times thickness of plate (t).

10.0 Student Activity (Field Visit)

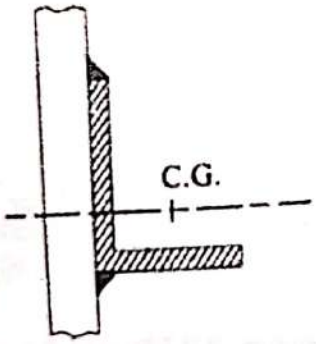
(Teacher shall form a group of 4-5 students each. Each group shall perform only one allotted activity from the following. Teacher shall supervise these activities).

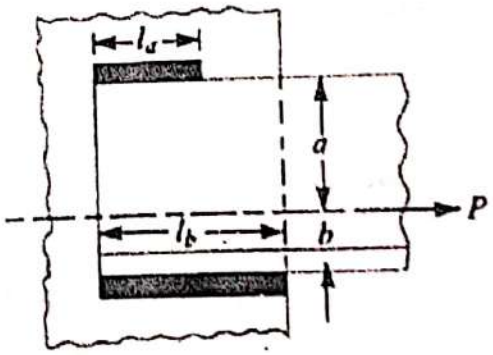
1. A Mild Steel cover plate is to be designed in shell of pressure vessel. The hole is .....mm in diameter. The pressure inside vessel is .....N/mm². Design the bolt. Assume tensile stress .....MPa. take thickness of cover plate t = ...mm

(Teacher shall provide the value of pressure, Stresses and dimensions of cover plate)

2. A .....×.....×..... mm angle is to be welded to a steel plate by fillet welds as shown in figure. If the angle is subjected to static load of .....kN, find the length of weld at the top and bottom. The allowable shear stress for static loading may be taken as .....MPa

(Teacher shall provide the value of dimensions of angle, force and Stresses)





(Space for answer)

.....

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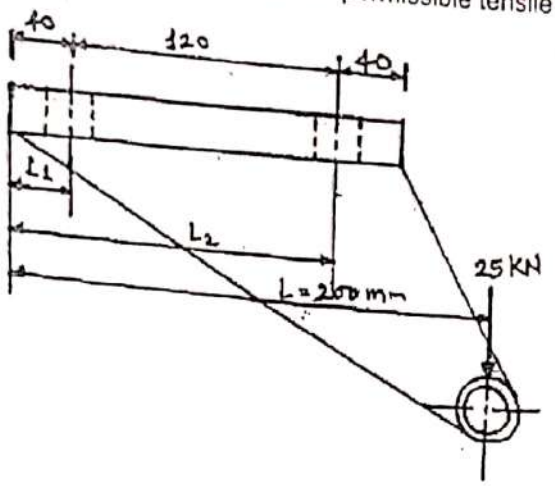
.....

11.0 Questions:

Write answers to Q....Q....Q....Q.... (Teacher shall allot the question)

1. Explain with neat sketch bolt of uniform strength.
2. The cylinder head of steam engine is subjected to a steam pressure of 0.7 N/mm^2. It is held in position by means of 12 bolts. The bolts are tighten with the initial preload of 1.5 times the steam load. A soft copper gasket is used to make the joint leak proof. The effective diameter of cylinder is 300 mm. find the size of bolts so that the stress in the bolt not to exceed 100 MPa
3. Determine the safe tensile load for bolts M20 and M36. Assume the bolts are not initially stresses and take the safe tensile stress as 200 MPa
4. A wall bracket is attached to a wall by mean of four bolts, two at a distance of 50 mm from the lower edge and remaining two at a distance of 450 mm from the lower bolts. It supports a load of 50 kN at a distance of 500 mm from the wall. Sketch the arrangements and estimate the diameter of bolts. Assume working in stress in tension as 80 N/mm^2.
5. A plate 75 mm wide and 12.5 mm thick is joined with another plate by a single transverse, double parallel fillet weld. The maximum tensile and shear stress are 70 N/mm2 and 56 N/mm^2 respectively. Find the length of each parallel fillet weld if joint subjected to 90 kN.

6. A bracket carrying a vertical load of 25kN as shown in figure the load is taken up by 4 bolts for fixing the bracket. Determine the size of bolt for permissible tensile stress of 80 N/mm².



7. Determine the length of the weld run for a plate of size 120 mm wide and 15 mm thick to be welded to another plate by mean of

   i. A single transverse weld

   ii. Double parallel fillet welds when the joint is subjected to variable load.

(Space for Answers)