EXPERIMENT NO. 5(A)
DIRECT SHEAR TEST OF METAL SPECIMEN

OBJECTIVES

a. To determine the average shearing strength in single shear.

b. To determine the average shearing strength in double shear.

c. To observe the shape and texture of the fractured surface.

THEORY

If a member undergoes the action of a force such that a stress develops parallel to a plane, then this stress is known as shearing stress. The total force across and parallel to the plane is called shear. When the force is applied along the plane, it is called direct shear, often called transverse shear and the stress developed is called the direct shearing stress. Due to the application of load when the shearing stress develops along one shear area, it is called single shear while when shearing stress develops along two shear areas side by side, it is called double shear.

Average shearing stress for single shear, $\tau_{av} = \frac{P}{A}$

Average shearing stress for double shear, $\tau_{av} = \frac{P}{2A}$

Where, P is the load and A is the area.

APPARATUS

1. Universal testing machine
2. Shear tool for metal
3. Slide calipers

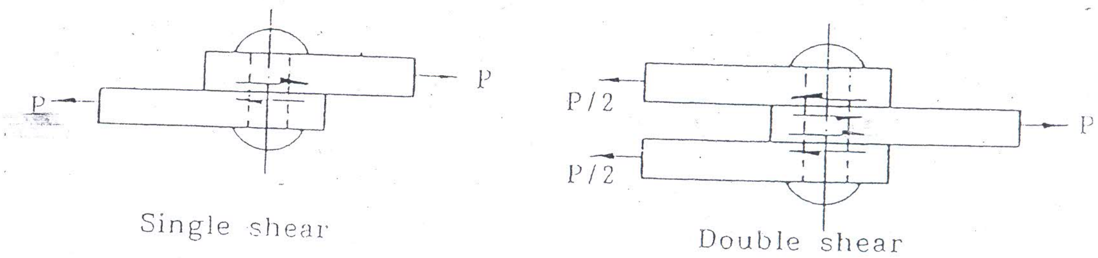

Fig: Single and double shear rivets.

SPECIMEN

Round rods of metal such as brass, steel, etc. of appropriate dimension suitable for the shear tool.

PROCEDURE

a. With the help of slide calipers, determine the mean diameter of each of the specimens.

b. Place the shear tool on the bed of the universal testing machine. Fix the specimen to be tested finally in the shear tool so that test for shear can be made.

c. Apply the load at slow speed until rupture takes place. Record the maximum load and observe the character of the rupture.

d. Repeat the test for the specimen of different materials. For a specimen of particular material several tests can be made in order to obtain the mean valve.

DATA AND RESULT

Material	Type of Shear	Specimen No.	Mean Diameter D (mm)	Area, A (mm^2)	Load, P (kg)	Shear Stress τ_{av} (N/mm^2)

DISCUSSION

Discuss the shape and texture of the fractured surface; the effect of size of the specimen on the result, if there is any; and the limitations of the direct shear test.

EXPERIMENT NO. 5(B)
TORSIONAL SHEAR TEST OF METAL

OBJECTIVES

a. To draw the stress-strain diagram.

b. To determine the modulus of rigidity.

c. To determine the shearing modulus of rupture.

d. To observe the nature of failure

THEORY

If a circular member is rigidity clamped at one end and is subjected to a moment at the other end in a plane perpendicular to the axis of the member, the member is said to be in torsion and the moment is called the twisting moment. As a result of twisting moment the member undergoes an angular displacement at one end with respect to the other end (Figure-1) and shearing stress on any cross-section of the member is perpendicular to its axis.

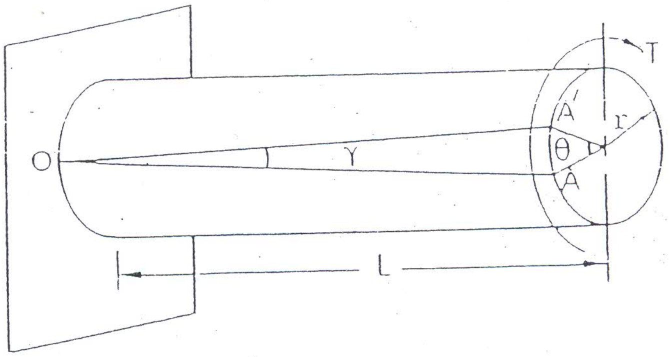

Figure-1: A circular member with a twisting moment.

Torsional Shearing Stress: The shearing stress developed due to the application of the twisting moment is called the torsional shearing stress. The torsional stress may be determined from the relationship,

$$\tau = \frac{T\rho}{J}$$

where, T is twisting moment or torque

ρ is any radial distance from the axis of circular member

J is polar moment of inertia of the cross-section.

For a solid circular section of diameter d, $J = \frac{\pi d^4}{32}$

Maximum shearing stress occurs at the surface at $\rho = r = d/2$. Therefore, the maximum shearing stress for solid circular shaft is

$$\tau_{max} = \frac{16T}{\pi d^3}$$

Shearing Strain: The angle γ (Figure-1) between the line OA in undeformed condition and the line OA' after deformation due to the twisting moment is defined as the shearing strain. This is measured in radians. Shearing strain can be expressed as

$$\gamma = \frac{r\theta}{L} = \frac{\theta d}{2L}$$

where, *r* is radius of the circular member

D is diameter of the circular member

Modulus of Rigidity: While the material behaves elastically, the ratio of the shearing stress to shearing strain is called the shearing modulus of elasticity or modulus of rigidity. It is expressed as,

$$G = \frac{\tau}{\gamma}$$

Angle of Twist: The angular displacement resulting from the torsional load is called angle of twist which may be obtained from the relationship,

$$\theta = \frac{TL}{GJ}$$

where, *L* is length over which θ is measured.

Shear Modulus of Rupture: It is the nominal surface stress corresponding to the maximum twisting moment and is computed from the normal elastic formula $\tau = \frac{16T}{\pi d^3}$. Although the shearing stress behaves nonlinearly after the elastic limit, it is sometimes used to calculate fictitious stress for the ultimate torque.

APPARATUS

1. Torsion testing machine
2. Torsiometer
3. Slide calipers

SPECIMEN

Standard mild steel specimen.

PROCEDURE

a. Measure the overall length and the mean diameter of the test section of the specimen with the help of slide caliper.

b. Adjust the torsion machine to set the protractor, torque meter and counter to zero reading.

c. Mount the specimen firmly in the torsion testing machine in the hexagonal sockets at the two ends.

d. Note the gauge length and least reading of the torsiometer and securely clamp the instrument with the specimen and torsiometer to zero reading.

e. Now apply the load with the help of input hand wheel and record the angle of twist and the corresponding torque for each increment of angle or twist. Increment of angle of twist shall be so made that there will be at least ten observations below the proportional limit; several close observations near the proportional limit and at least ten observations beyond the proportional limit. In the plastic region the increments of angle of twist has to be increased.

DISCUSSION

Discuss the results obtained from the test and nature of the graphs etc.

QUESTIONS

1. What is the difference between strength and stress?
2. What type of stress is developed in punching a metal piece?
3. Why do you need to use the standardized specimen?
4. What is the distinction between direct and torsional shearing stress?

DATA AND RESULT

Gauge length of the specimen, L = mm

Mean dia. of the specimen, d = mm

Overall length of the specimen, L_1 = mm

Torque meter constant, k = mm

Number of Observations	Torque, T (Nm)	Angle of twist, θ (Degree)	Strain, $\gamma = \frac{\theta d}{2L}$ (mm/mm)	Stress, $\tau = \frac{16T}{\pi d^3}$ (MPa)