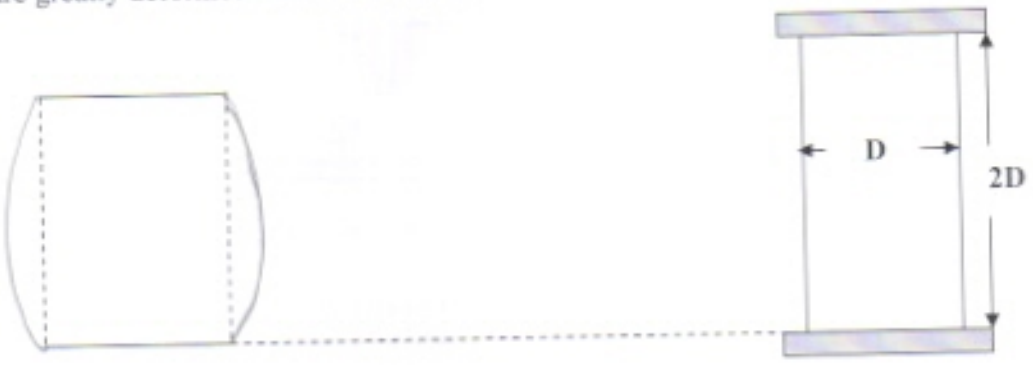
Lecture No. Nine: Test **Time: 2 Hours**

Compressive strength

Compressive strength should be determined on cylinders with a height equal to about two times the diameter. The ends of the cylinders should be carefully prepared to be parallel and plane surfaces.

For steels it is possible to determine the ultimate compressive strength only for brittle steels, since all ductile steel are greatly deformed under load and show no well defined fracture.



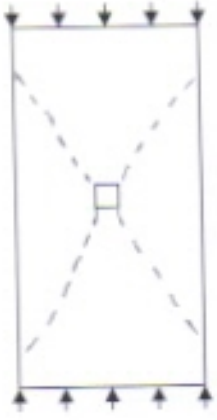
Ductile metal under the test

Compressive strength = P/A

Where P- Load at failure

A- Cross sectional area normal to load

Brittle material such as concrete is much weaker in tension and in shear than in compression, and failures of concrete specimens under compressive load are essentially shear failures on oblique planes. When the strength of concrete is high and lateral expansion at the end bearing surfaces is relatively unrestrained, the specimen may separate into columnar fragments what is known as a splitting fracture. Often failure occurs through a combination of shear and splitting.



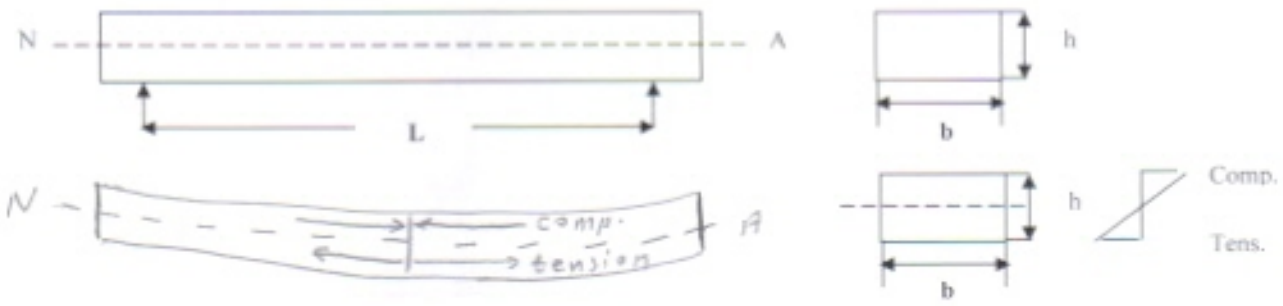
Shear Failure

Combination shear Failure and splitting failure

Splitting Failure

Flexural strength

In flexural test, the beam may be tested on simple supports. When a materials is subjected to being tensile and compressive stresses and in may cases direct shear stresses are developed.



Flexural strength is expressed in term of " modulus of rupture " which is the maximum tensile (or compressive) stress at rupture computed from the following formula :

$$S_b = MC/I$$

Where S_b – Stress in the fiber farthest from the neutral axis

M- Bending moment at the section

I- Moment of inertia of the cross section

C- Distance from neutral axis farthest fiber

The modulus of rupture is a good index for comparing different grades and glasses of materials. The beam test in flexural in a given series of tests should be of the same shape and size so that the modulus of rupture values can compared directly.

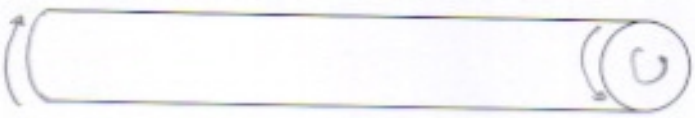
The flexural strength of a metal directly depends upon the tensile and compressive properties of that metal. If the section is symmetrical, the failure will occur on the tension side if the metal is not ductile and on the compression side if it is ductile.

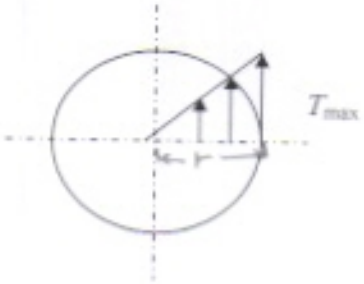
Torsion test

The torsion test is conducted by twisting a solid cylinder specimen. The torque and the angle of twist are measured. The intensity of the shearing stress due to torsion on any section of a cylinder shaft varies directly as the distance from the axis of the shaft and the maximum intensity of shearing stress is found at circumference. The mathematical expression for the maximum shearing stress in the extreme fiber of circular shaft is :

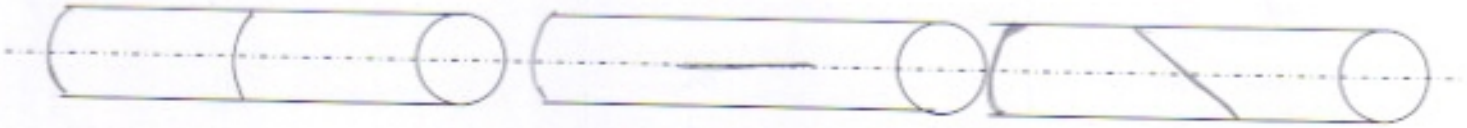
$$T_{max} = 2T/\pi r^3$$

Where T – is the torque
r- the radius of the section





The cracking was developed in the direction parallel to the shear plane. This plane may be parallel or perpendicular to the longitudinal axis of the specimen. It is probable that failure occurs in the plane making an angle with longitudinal axis as shown in Fig. below:



Shear plane perpendicular to the longitudinal axis

Shear plane parallel to the longitudinal axis

Shear plane making an angle with longitudinal axis

H.W. :

1. Differentiate between the behavior of ductile and brittle metal during compressive test?
2. Explain this sentences "The flexural strength of a metal directly depends upon the tensile and compressive properties"?
3. Determine the property of the metal that torsion test results depend upon?