Destructive Test

Introduction

As the name suggests, destructive testing (DT) includes methods where the material is broken down in order to determine mechanical properties, such as strength, toughness and hardness.

Advantages of Destructive Testing (DT)

- Verifies properties of a material
- Determines quality of welds
- Helps to reduce failures, accidents and costs
- Ensures compliance with regulations

TENSILE TEST

A tensile test, also known as tension test, is probably the most fundamental type of mechanical test is performed on a material. Tensile tests are simple, relatively inexpensive, and fully standardized. By pulling on something, you will very quickly determine how the material will react to forces being applied in tension. As the material is being pulled, you will find its strength along with how much it will elongate.

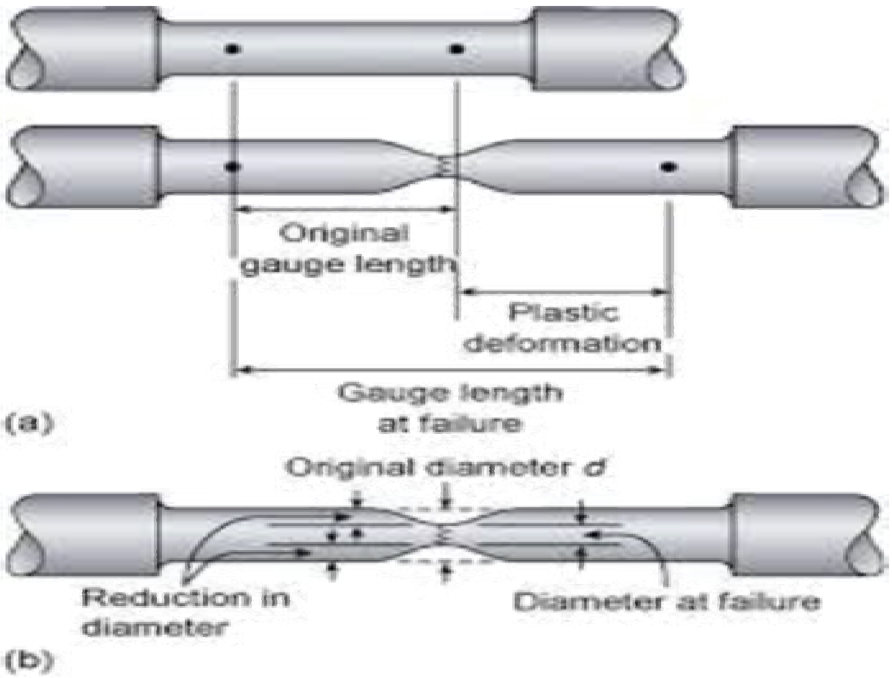


Fig: 1

COMPRESSION TEST

Method for determining behavior of materials under crushing loads. Specimen is compressed, and deformation at various loads is recorded. Compressive stress and strain are calculated and plotted as a stress-strain diagram which is used to determine elastic limit, proportional limit, yield point, yield strength and (for some materials) compressive strength.

"Axial compression testing is a useful procedure for measuring the plastic flow behavior and ductile fracture limits of a material. Measuring the plastic flow behavior requires frictionless (homogenous compression) test conditions, while measuring ductile fracture limits takes advantage of the barrel formation and controlled stress and strain conditions at the equator of the barreled surface when compression is carried out with friction.

Axial compression testing is also useful for measurement of elastic and compressive fracture properties of brittle

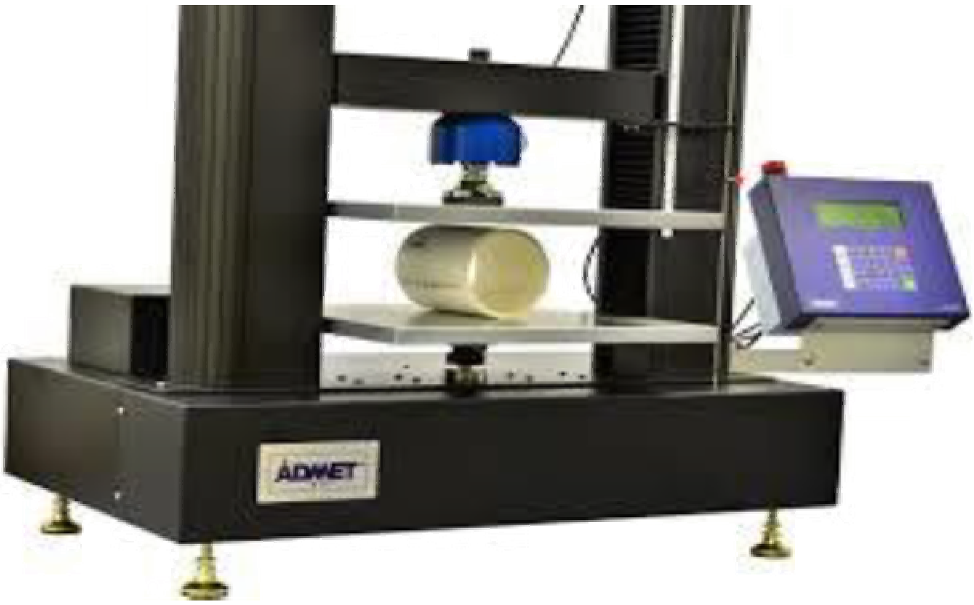


Fig: 2

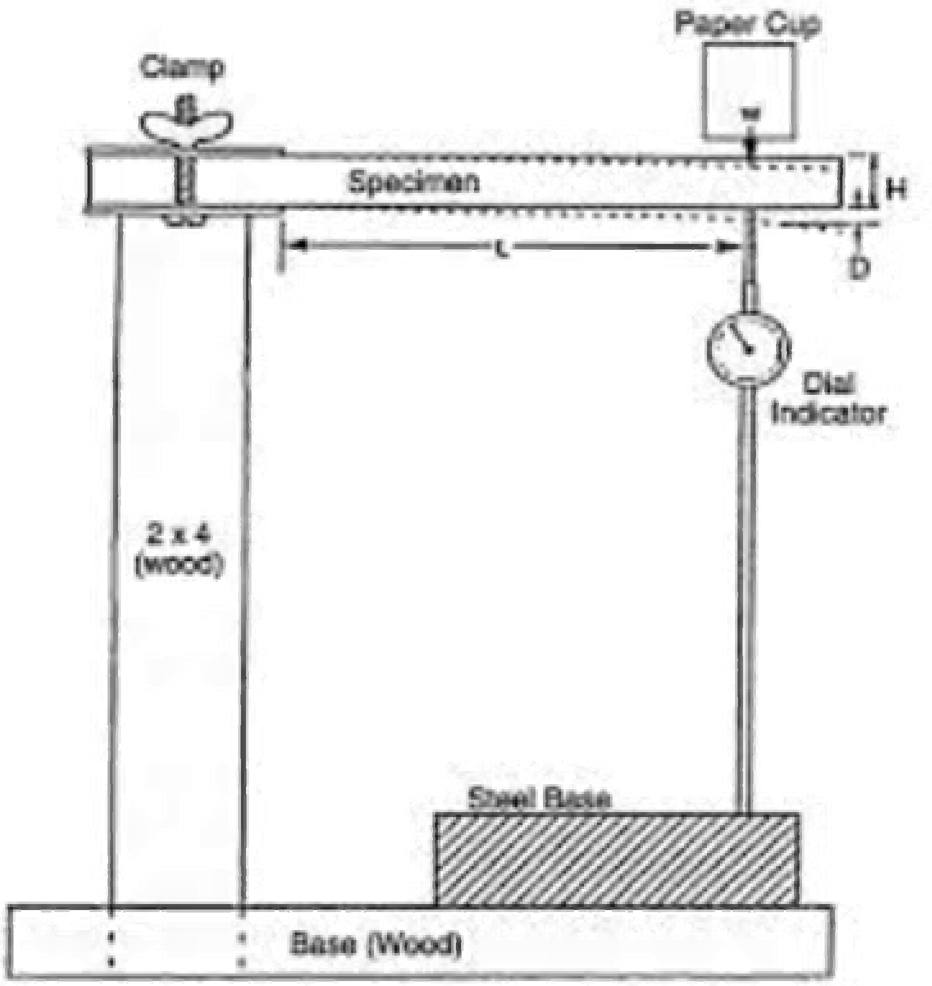
materials or low-ductility materials. In any case, the use of specimens having large L/D ratios should be avoided to prevent buckling and shearing modes of deformation1."

The image at right shows variation of the strains during a compression test without friction (homogenous compression) and with progressively higher levels of friction and decreasing aspect ratio L/D (shown as H/D)1.

BENDING TEST

The flexure test method measures behavior of materials subjected to simple beam loading. It is also called a transverse beam test with some materials. Maximum fiber stress and maximum strain are calculated for increments of load. Results are plotted in a stress-strain diagram. Flexural strength is defined as the maximum stress in the outermost fiber. This is calculated at the surface of the specimen on the convex or tension side. Flexural modulus is calculated from the slope of the stress vs. deflection curve. If the curve has no linear region, a secant line is fitted to the curve to determine slope.

A flexure test produces tensile stress in the convex side of the specimen and compression stress in the concave side. This creates an area of shear stress along the midline. To ensure the primary failure comes from tensile or compression stress the shear stress must be minimized. This is done by controlling the span to depth ratio; the length of the outer span divided by the height (depth) of the specimen. For most materials S/d=16 is acceptable. Some materials require S/d=32 to 64 to keep the shear stress low enough.



TORSION TEST

A torsion test measures the strength of any material against maximum twisting forces. It is an extremely common test used in material mechanics to measure how much of a twist a certain material can withstand before cracking or breaking. This applied pressure is referred to as torque. Materials typically used in the manufacturing industry, such as metal fasteners and beams, are often subject to torsion testing to determine their strength under duress.

There are three broad categories under which a torsion test can take place:

- **Failure testing:** it involves twisting the material until it breaks.
- **Proof testing:** it is used to observe whether a material can bear a certain amount of torque load over a given period of time.
- **Operational testing:** it is used to test specific products to confirm their elastic limit before going on the market.

It is critical for the results of each torsion test to be recorded. Recording is done through creating a stress-strain diagram with the angle of twist values on the X-axis and the torque values on the Y-axis. Using a torsion testing apparatus, twisting is performed at quarter-degree increments with the torque that it can withstand recorded. The strain corresponds to the twist angle, and the stress corresponds to the torque measured. After testing, metal materials are categorized as being either ductile or brittle. Ductile metals such as steel or aluminium have high elastic limits and can withstand a great deal of strain before breaking. Brittle materials such as cast iron and concrete have low elastic limits and do not require much strain before rupturing.

Without performing a torsion test, materials would not be properly vetted before being released for industrial use. It is of paramount importance that the ability for a material to bear a certain amount of twisting is accurately measured. Otherwise, structures and machines that depend on such materials could break down causing instability, work flow interruption or even significant damage and injury.

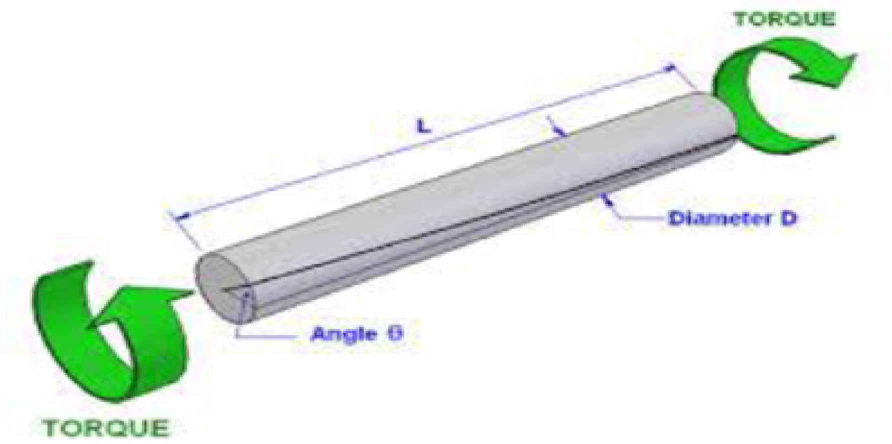


Fig: 4

- Torsion test is not widely accepted as much as tensile test.
- Torsion tests are made on materials to determine such properties as the modulus of elasticity in shear, the torsion yield strength and the modulus of rupture.
- Often used for testing brittle materials and can be tested in full-sized parts, i.e., shafts, axles and twist drills which are subjected to torsional loading in service.

HARDNESS TEST:

Hardness is the resistance of a material to permanent indentation. It is important to recognize that **hardness test is an empirical test** and therefore hardness is **not a material property**. This is because there are several different hardness tests that will each determine a different hardness value for the same piece of material. Therefore, hardness depends on the test method and every test result has a label identifying the test method used.

Hardness is, however, used extensively to characterize materials and to determine if they are suitable for their intended use or not. All of the hardness tests described below involves the use of a specifically shaped indenter, significantly harder than the test sample that is pressed into the surface of the sample using a specific force. Either the depth or size of the indent is measured to determine a hardness value.

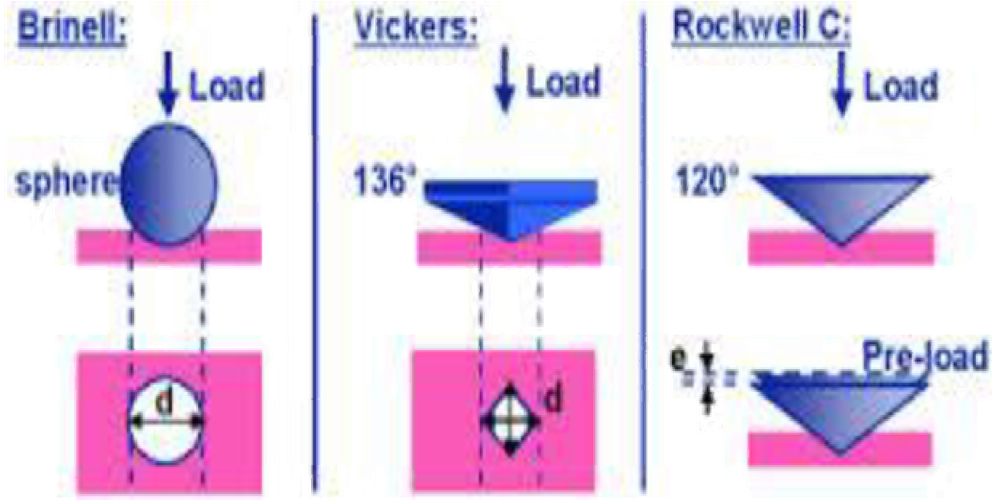
Advantages of Hardness Test:

- Easy to perform
- Quick - 1 to 30 seconds
- Relatively inexpensive
- Finished parts can be tested - but not ruined
- Virtually any size and shape can be tested

The most common uses for hardness tests is to verify the heat treatment of a part and to determine if a material has the properties necessary for its intended use. Establishing a correlation between the hardness result and the desired material property allows this, making hardness tests very useful in industrial and R&D applications. **Hardness Scales:**

There are five major hardness scales:

- Brinell - HB
- Knoop - HK
- Rockwell - HR
- Shore - HS
- Vickers – HV



Brinell:
Load
sphere
d
Vickers:
Load
136°
d
Rockwell C:
Load
120°
Pre-load