HARDNESS TESTS

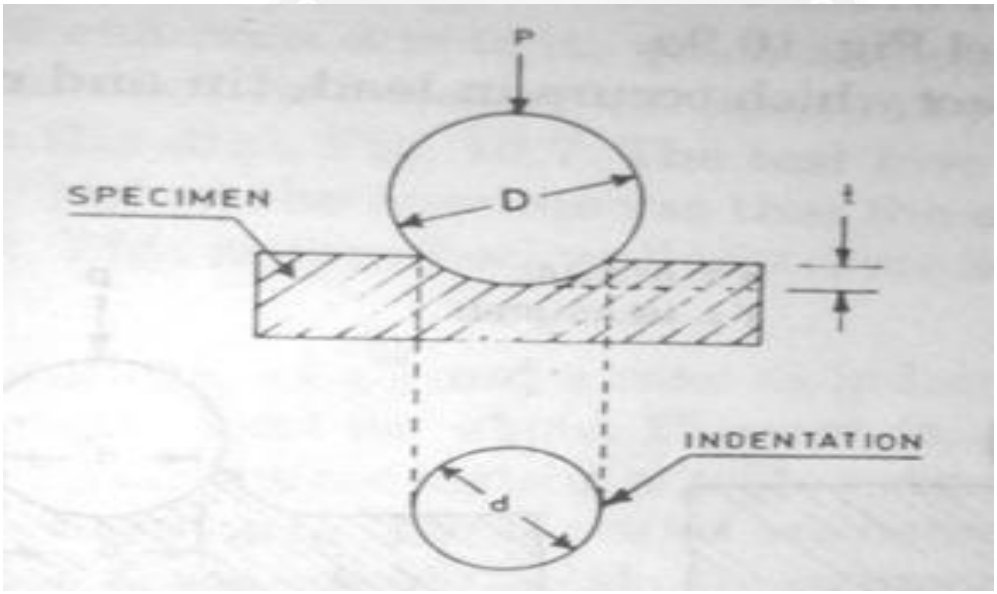
Hardness is a surface property and is defined as the resistance of a material against permanent deformation of scratch, cutting, indentation or mechanical wear.

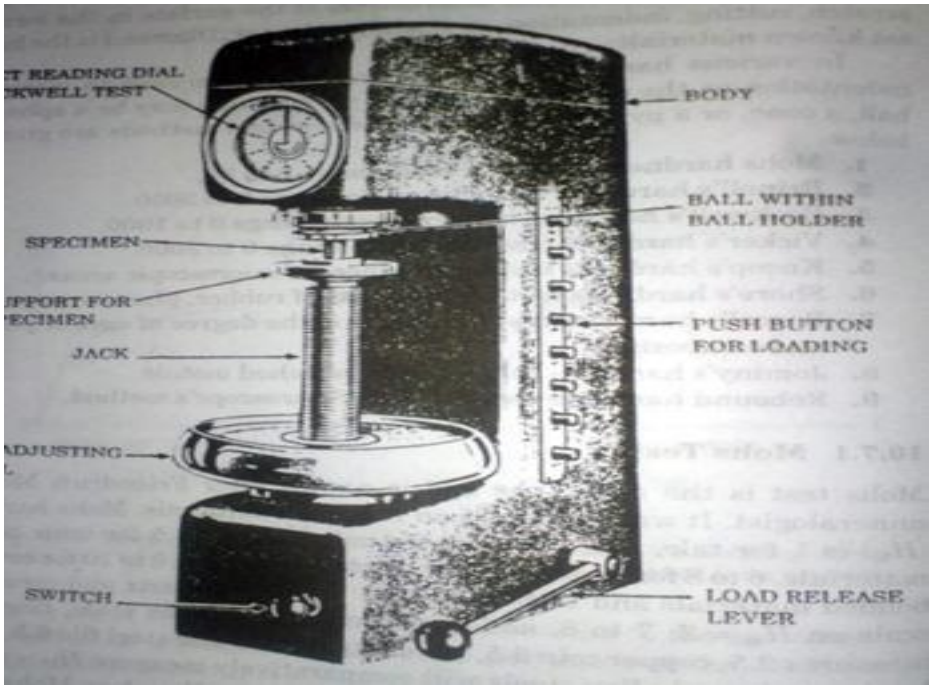
In various hardness tests, the indenters are used to introduce indentation on the surface. The shape of indenters may be a spherical ball, a cone, or a pyramid. Various hardness test methods are given as below:

1. Brinell's hardness test
2. Rockwell's hardness test.
3. Vicker's hardness test
4. Knoop's hardness test .

Brinell Hardness Test

This test employs a diamond or hardened steel ball as indenter. The ball is placed suitably in the upper housing of Brinell Hardness testing machine shown in the figure below. This machine is called a push-pull button type machine because the indenting load is applied by pushing a button. There are several push buttons, each of them specifies a known load. Before conducting the test, the surface of the specimen is made free from oil, grease, dust and dirt. The indenting load P is





applied on the specimen gradually for a minimum of 30 seconds.

Brinell hardness test machine

The effect of this load is to make an indentation of depth t and diameter d as shown in the figure

Indentation due to load

Brinell hardness test showing load, ball diameter, indented diameter and its thickness.

The Brinell Hardness Number (BHN) is then calculated as below after measuring d by an optical microscope.

Applied load

$$BHN = \frac{P}{\text{Area of impression of steel}}$$

$$\frac{D}{2}\left[D\sqrt{D^2 - d^2}\right]$$

Where P-load applied

D- Diameter of steel ball (mm) d- Diameter of indentation

Scale Information: Test requirements, observations, and limitations of Brinell hardness test can be enumerated as below:

1. The steel ball indenter may be used to test the specimen of cast iron, unhardened steel and light alloys.
2. Standard diameters of the ball are 2.5 mm, 5 mm and 10 mm.
3. Deformation of the ball during application of indenting load is neglected in calculating Brinell hardness number.
4. Usually, the diameter of indentation d = 0.2D to 0.7D.
5. Thickness of the specimen should not be less than 10 times of the impression.
6. If the impression of indentation is non-circular, the mean value should be taken from two diameters that are normal to each other.
7. Value of BHN is expressed in kg/mm2 or N/mm2.
8. For most of the metals, BHN is proportional to their tensile strengths.
9. For steel, the tensile strength = 35 BHN

Drawbacks of Brinell Hardness test:

i).Sinking effect which occurs in manganese steel and austenite stainless steel. ii)Piling-up effect which occurs in lead, tin and magnesium.

iii)Brinell hardness test is not accurate for BHN > 500, as the ball itself deforms.