ROCKWELL HARDNESS TESTING

DESCRIPTION OF TECHNIQUE

Rockwell hardness testing is a general method for measuring the bulk hardness of metallic and polymer materials. Although hardness testing does not give a direct measurement of any performance properties, hardness of a material correlates directly with its strength, wear resistance, and other properties. Hardness testing is widely used for material evaluation because of its simplicity and low cost relative to direct measurement of many properties. Specifically, conversion charts from Rockwell hardness to tensile strength are available for some structural alloys, including steel and aluminum.

Rockwell hardness testing is an indentation testing method. The indenter is either a conical diamond (brale) or a hard steel ball. Different indenter ball diameters from 1/16 to 1/2 in. are used depending on the test scale.

To start the test, the indenter is "set" into the sample at a prescribed minor load. A major load is then applied and held for a set time period. The force on the indenter is then decreased back to the minor load. The Rockwell hardness number is calculated from the depth of permanent deformation of the indenter into the sample, i.e. the difference in indenter position before and after application of the major load. The minor and major loads can be applied using dead weights or springs. The indenter position is measured using an analog dial indicator or an electronic device with digital readout.

The various indenter types combined with a range of test loads form a matrix of Rockwell hardness scales that are applicable to a wide variety of materials. Each Rockwell hardness scale is identified by a letter designation indicative of the indenter type and the major and minor loads used for the test. The Rockwell hardness number is expressed as a combination of the measured numerical hardness value and the scale letter preceded by the letters, HR. For example, a hardness value of 80 on the Rockwell A scale is reported as 80 HRA.

TYPICAL APPLICATIONS OF ROCKWELL TEST SCALES

SCALE	APPLICATIONS
A	Cemented carbides, thin steels, shallow case-hardened steels. Only scale that is continuous over a wide range of material hardnesses.
B	Aluminum, copper, soft steels, and malleable iron.
C	Hardened steels, hard irons, deep case-hardened steels, titanium.
D	Thin steels, medium case-hardened steels, and pearlitic malleable iron.
E	Cast iron, aluminum, magnesium, and bearing metals.
F	Annealed coppers and thin, soft sheet metal.
G	Phosphor bronze, beryllium copper, and malleable irons.
H	Aluminum, zinc, and lead
K,L,M, P,R,S,V	Bearing metals and other very soft or thin materials.
N	Same materials as for HRA, HRC, and HRD, but thinner gauge or case depths.
T	Same materials as for HRB, HRF, and HRG, but for thinner gauge.
W,X,Y	Bearing materials, plasma spray coatings.

ANALYTICAL INFORMATION

Regular Rockwell Hardness Testing - Measures the bulk hardness of the material. There are separate scales for ferrous metals, nonferrous metals, and plastics. Common Rockwell hardness scales include A, B,C and F for metals and M and R for polymers.

Superficial Rockwell Hardness Testing - A more surface-sensitive measurement of hardness than regular Rockwell scales. This technique is useful for testing thin samples, samples with hardness gradients at the surface, and small areas. Superficial Rockwell hardness scales are N and T for metals and W, X and Y for nonmetallic materials and soft coatings.

Rockwell Hardness Test Scales		
Scale Symbol	**Penetrator**	**Load kg**
A	Brale	60
B	1/16-in. Ball	100
C	Brale	150
D	Brale	100
E	1/8-in. Ball	100
F	1/16-in. Ball	60
G	1/16-in. Ball	150
H	1/8-in. Ball	60
K	1/8-in. Ball	150
L	1/4-in. Ball	60
M	1/4-in. Ball	100
P	1/4-in. Ball	150
R	1/2-in. Ball	60
S	1/2-in. Ball	100
V	1/2-in. Ball	150
Superficial Tester Scales		
15N, 30N, 45N	N Brale	15, 30, 45
15T, 30T, 45T	1/16-in. Ball	15, 30, 45
15W, 30W, 45W	1/8-in. Ball	15, 30, 45
15X, 30X, 45X	1/4-in. Ball	15, 30, 45
15Y, 30Y, 45Y	1/2-in. Ball	15, 30, 45

TYPICAL APPLICATIONS

- Quality control for metal heat treatment
- Incoming material inspection
- Weld evaluations in steels and other alloys
- Grade verification for hard plastics
- Failure analysis

SAMPLE REQUIREMENTS

Testing is typically performed on flat or cylindrical samples. Cutting and/or machining are often required to obtain suitable test specimens from complex-shaped components. Smooth parallel surfaces, free of coatings, scale and gross contamination, are required for testing. The specific finish requirements depend on the material and test scale.

Rockwell Hardness Tester

Samples 6 in. (150 mm) thick or larger can be accommodated. The minimum sample size depends on the sample hardness and test scale. Cylindrical samples as small as 1/8 in. (3 mm) in diameter, and thin sheets 0.006 in. (150 µm) thick, are the minimum size for testing.