

Rockwell Hardness Test

The Rockwell hardness test method consists of indenting the test material with a diamond cone or hardened steel ball indenter. The indenter is forced into the test material under a preliminary minor load F_0 (Fig. 1A) usually 10 kgf. When equilibrium has been reached, an indicating device, which follows the movements of the indenter and so responds to changes in depth of penetration of the indenter is set to a datum position. While the preliminary minor load is still applied an additional major load is applied with resulting increase in penetration (Fig. 1B). When equilibrium has again been reached, the additional major load is removed but the preliminary minor load is still maintained. Removal of the additional major load allows a partial recovery, so reducing the depth of penetration (Fig. 1C). The permanent increase in depth of penetration, resulting from the application and removal of the additional major load is used to calculate the Rockwell hardness number.

$$HR = E - e$$

F_0 = preliminary minor load in kgf

F_1 = additional major load in kgf

F = total load in kgf

e = permanent increase in depth of penetration due to major load F_1 measured in units of 0.002 mm

E = a constant depending on form of indenter: 100 units for diamond indenter, 130 units for steel ball indenter

HR = Rockwell hardness number

D = diameter of steel ball

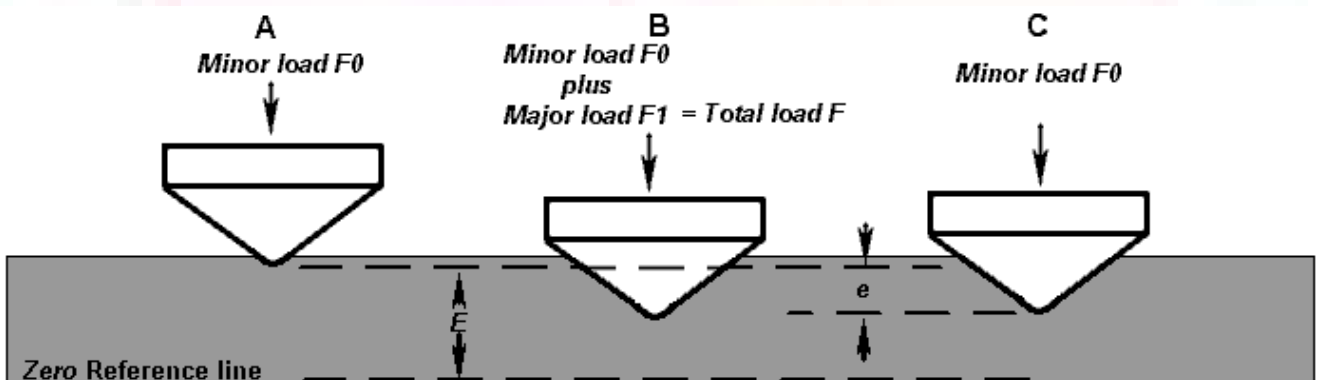


Fig. 1. Rockwell Principle

Rockwell Hardness Scales

Scale	Indenter	Minor Load <i>F</i> ₀ kgf	Major Load <i>F</i> ₁ kgf	Total Load <i>F</i> kgf	Value of <i>E</i>
A	Diamond cone	10	50	60	100
B	1/16" steel ball	10	90	100	130
C	Diamond cone	10	140	150	100
D	Diamond cone	10	90	100	100
E	1/8" steel ball	10	90	100	130
F	1/16" steel ball	10	50	60	130
G	1/16" steel ball	10	140	150	130
H	1/8" steel ball	10	50	60	130
K	1/8" steel ball	10	140	150	130
L	1/4" steel ball	10	50	60	130
M	1/4" steel ball	10	90	100	130
P	1/4" steel ball	10	140	150	130
R	1/2" steel ball	10	50	60	130
S	1/2" steel ball	10	90	100	130
V	1/2" steel ball	10	140	150	130

Typical Application of Rockwell Hardness Scales

- HRA Cemented carbides, thin steel and shallow case hardened steel
- HRB Copper alloys, soft steels, aluminium alloys, malleable irons, etc.
- HRC Steel, hard cast irons, case hardened steel and other materials harder than 100 HRB
- HRD Thin steel and medium case hardened steel and pearlitic malleable iron
- HRE Cast iron, aluminium and magnesium alloys, bearing metals
- HRF Annealed copper alloys, thin soft sheet metals
- HRG Phosphor bronze, beryllium copper, malleable irons
- HRH Aluminium, zinc, lead
- HRK }
- HRL }
- HRM } Soft bearing metals, plastics and other very soft materials
- HRP }
- HRR }
- HRS }
- HRV }

Advantages of the Rockwell hardness method include the direct Rockwell hardness number readout and rapid testing time. Disadvantages include many arbitrary non-related scales and possible effects from the specimen support anvil (try putting a cigarette paper under a test block and take note of the effect on the hardness reading! Vickers and Brinell methods don't suffer from this effect).