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Hardness conversion reference

The hardness scales, an approximate steel conversion table between HV / HBW / HRC / HRB and tensile strength, and how to pick the right test.

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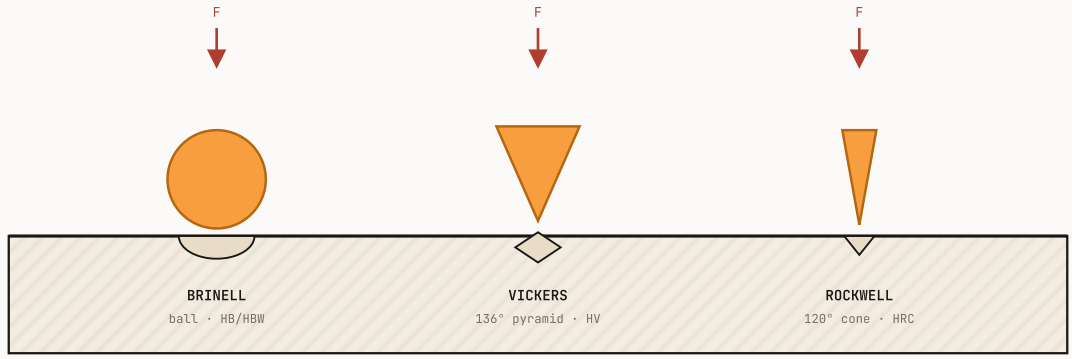
ABSTRACT

Hardness is a fast, near-non-destructive proxy for strength and wear resistance. Different scales suit different materials and ranges, and converting between them — or to tensile strength — is approximate and valid mainly for steels.

Section 1 explains the scales. Section 2 is the steel conversion table (HV / HBW / HRC / HRB ↔ tensile). Section 3 is the hardness-to-strength rule. Section 4 is how to choose and run the test. Section 5 is a durometer and typical-hardness quick reference.

HARDNESS INDENTERS — BRINELL · VICKERS · ROCKWELL



THE THREE METAL-HARDNESS TESTS PRESS A DIFFERENT INDENTER — A BALL (BRINELL), A SQUARE PYRAMID (VICKERS) OR A CONE (ROCKWELL) — AND MEASURE THE INDENT. CONVERSIONS BETWEEN THEM ARE APPROXIMATE AND MATERIAL-SPECIFIC.

CONTENTS

1. The hardness scales

Each test presses a defined indenter with a defined load and measures the indent — so a number only means something with its scale.

`Brinell (HBW)`	Tungsten-carbide ball; large indent averages over grain — castings, forgings, soft–medium metals
`Rockwell (HRC / HRB)`	Depth of a cone (C, hard steel) or ball (B, softer); fast, direct-reading — production
`Vickers (HV)`	136° diamond pyramid; one continuous scale, micro to macro — thin parts, coatings, research
`Knoop (HK)`	Elongated diamond; very thin layers and brittle materials
`Shore / durometer (A, D)`	Spring-loaded indenter for elastomers and plastics — A soft, D hard
`Mohs`	Scratch scale 1–10 for minerals/ceramics (qualitative)

2. Steel hardness conversion (approximate)

Per ASTM E140 / ISO 18265, **for steels**. Conversions are approximate and shift with alloy and condition — measure on the scale you need where it matters.

HV	HBW	HRC	HRB	TENSILE ≈ (MPA)
700	—	60	—	~2400
600	—	55	—	~2100
513	484	50	—	~1740
446	424	45	—	~1480
392	372	40	—	~1290
345	327	35	—	~1130
302	286	30	—	~980
266	252	24	100	~860
238	226	20	99	~770
209	199	—	95	~675
171	162	—	86	~545
143	136	—	78	~460
114	109	—	67	~370

Rockwell C is meaningful only above ~20 HRC; below that use Rockwell B or HV/HBW.

3. Hardness to tensile strength

For carbon and low-alloy **steels**, a useful rule:

`UTS (MPa) ≈ 3.4 × HBW` (equivalently ≈ 0.0034 × HV × 1000)

So a part at 200 HBW is roughly 680 MPa tensile. This is a **steel-only approximation** — it does not hold for aluminium, copper alloys, or hardened tool steels at the extremes. Use it to sanity-check, not to certify.

4. Choosing and running the test

- **Brinell**
  soft to medium metals, castings, forgings; the big ball averages over coarse grain. Needs a thick, flat sample.
- **Rockwell C**
  hardened steels (>20 HRC); fast and common on the shop floor. **Rockwell B** — softer steels, brass, aluminium.
- **Vickers**
  anything from foil to carbide on one scale; the go-to for thin parts, case depth, coatings and weld surveys (low loads = microhardness).
- **Shore durometer**
  elastomers and plastics only (Section 5).
- **Test caveats: prepare a clean, flat surface; the part must be thick enough that the indent doesn't "feel" the back face (≥10× indent depth); keep indents away from edges and from each other; and remember cross-scale conversions are approximate**
  report the scale actually measured.

5. Durometer and typical-hardness quick reference

Elastomers/plastics (Shore): rubber band ≈ A25 · pencil eraser ≈ A40 · car tyre tread ≈ A60–70 · typical O-ring ≈ A70 · shopping-cart wheel ≈ A95 · hard hat / PP ≈ D70–80 · acrylic ≈ D85–90. (Shore A and D overlap around A95 ≈ D45.)

Typical metal hardness: annealed mild steel ≈ 120 HB · 6061-T6 aluminium ≈ 95 HB · annealed 304 stainless ≈ 150 HV (≈80 HRB) · through-hardened tool steel ≈ 60–65 HRC · case-hardened steel surface ≈ 58–62 HRC.