

D2 Tool Steel Compressive Strength and Microstructure

D2 hardens by air cooling and is normally put to work between about 58 and 60 HRC, where it carries pressure in punches, dies, coining tools and gauges. Two published measurements are collected here. The first follows what the austenitizing temperature does to the structure of D2, in terms of martensite, retained austenite and carbide. The second gives the ultimate compressive strength of D2 and D3 after hardening and tempering at 175 and 230 °C.

Reference only. This is a reference summary of published practice and not a specification of ours. The microstructure table comes from one heat of the D2 composition austenitized 30 minutes and oil quenched. The compressive table comes from a separate source, where both grades were hardened to their maximum hardness. Confirm the working values for a particular die against the material test certificate and the heat treatment specification before ordering.

Structure after austenitizing and quenching

Volume per cent of martensite, austenite and carbide in D2

Austenitizing temperature (°C)	Austenitizing temperature (°F)	Martensite (vol %)	Austenite (vol %)	Carbide (vol %)
1040	1900	79	7	14
1065	1950	65	22	13
1095	2000	33	55	12
1120	2050	5	85	10
1135	2075	2	88	10
1150	2100	2	88	10

Source, Table 12-3, Amounts of microconstituents in D2 tool steel as a function of austenitizing temperature, printed page 209 of Tool Steels (G. A. Roberts and G. Krauss), PDF page 203 of the copy consulted. Specimens were austenitized 30 minutes at temperature and quenched into oil. Composition of the heat, 1.60% C, 11.95% Cr, 0.33% Mn, 0.32% Si, 0.79% Mo, 0.25% V, 0.18% P and 0.010% S.

Compressive strength after hardening and tempering

Ultimate compressive strength of D2 and D3

Steel	Tempering temperature (°C)	Tempering temperature (°F)	Hardness (HRC)	Ultimate compressive strength (MPa)	Ultimate compressive strength (ksi)
D2	175	350	61.5	3841	557
D2	230	450	59.5	3641	528
D3	175	350	63.5	3634	527
D3	230	450	61.5	3290	477

Source, Table 12-4, Compressive strengths of high-carbon, high-chromium steels after hardening to maximum hardness and tempering at temperatures noted, printed page 211 of Tool Steels (G. A. Roberts and G. Krauss), PDF page 205 of the copy consulted.

The two tables answer two different questions. Raising the austenitizing temperature buys very little extra carbide, from 14 per cent down to 10 per cent, but it leaves a large amount of retained austenite behind, up to 88 per cent of the quenched structure. That retained austenite holds hardness down until tempering, which is why D2 is normally given two tempers and why hardness measured straight after the quench sits below the working hardness. On the compressive side, D2 carries 3841 MPa at 61.5 HRC after a 175 °C temper and 3641 MPa at 59.5 HRC after 230 °C, while D3 carries 3634 MPa and 3290 MPa at the same two tempering temperatures.

Aobo Steel, tool steel supplier

Aobo Steel supplies tool steel to distributors and mold, tool and die shops, including D2, D3, O1, O2, A2, S7, H13, H11, H10, H21, M2, M42, L6, P20 and 420 and 440C stainless. Forged or hot rolled, annealed or pre-hardened, cut to your sizes, with test certificates. Compiled from Tool Steels (G. A. Roberts and G. Krauss), Tables 12-3 and 12-4 on printed pages 209 and 211, the chapter on high-carbon, high-chromium cold-work tool steels.

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