DC53 Tool Steel Properties, Chemical Composition, and Applications

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What Is DC53 Tool Steel?

DC53 is a high-performance cold work die steel developed based on SKD11. It combines high hardness of 62–63 HRC with 2–3 times the toughness of SKD11. It features low heat treatment deformation and low risk of cracking during wire EDM processing. DC53 is primarily used in precision stamping, cold extrusion, and other cold work molds that require extremely high service life and dimensional accuracy.

Main Characteristics of DC53 Steel

- **High Hardness and High Toughness:** At 60 HRC, impact toughness exceeds 25 J/cm², which is 2–3 times higher than SKD11, solving the “high hardness but brittle” problem.
- **Low Deformation and High Precision:** Heat treatment deformation is 40% lower than SKD11, and wire cutting cracking rate is close to zero.
- **High Softening Resistance:** After quenching at 1040°C and tempering at 520°C, hardness reaches 62–63 HRC.
- **Long Service Life and High Wear Resistance:** Uniform fine carbide structure improves wear resistance by 15–20% compared to SKD11.
- **Good Machinability:** Annealed hardness ≤255 HB, excellent cutting and grinding performance.
- **Fatigue Resistance:** Bending fatigue strength reaches 1200–1400 MPa, 20% higher than SKD11.

DC53 Performance Data

1. Chemical Composition of DC53

Element	Typical Content (wt%)	Standard Range (wt%)	Main Function
C	0.95	0.90–1.00	Ensures hardness and wear resistance
Cr	8.00	7.50–8.50	Improves hardenability and forms carbides
Mo	2.00	1.80–2.20	Prevents temper brittleness
V	0.30	0.20–0.40	Refines grains and improves toughness
Si	1.00	0.80–1.20	Strengthens matrix and oxidation resistance
Mn	0.40	0.30–0.50	Improves hardenability
P	≤0.030	≤0.030	Impurity control
S	≤0.030	≤0.030	Prevents toughness reduction

2. Physical Properties

Property	Value	Unit	Description
Density	7.76	g/cm³	Room temperature density
Elastic Modulus	21700	MPa	Young’s modulus

Shear Modulus	8480	MPa	Shear stiffness
Poisson’s Ratio	0.28	-	Transverse/longitudinal strain ratio
Annealed Hardness	210–225	BHN	Machinable condition
Quenched Hardness	62–64	HRC	After heat treatment
Thermal Conductivity	25–30	W/m·K	Heat transfer ability
Expansion Coefficient	11.0×10^{-6}	/°C	20–200°C range

3. Mechanical Properties

Property	Value	Unit	Description
Tensile Strength	≥2000	MPa	After tempering
Yield Strength	≥1900	MPa	Plastic deformation threshold
Elongation	≥3	%	Ductility
Impact Toughness	45–60	J/cm²	No notch
Bending Strength	≥4500	MPa	Flexural resistance
Fracture Toughness	≥28	MPa·m¹/²	Crack resistance
Compressive Strength	≥4000	MPa	Compression resistance
High-Temperature Hardness	≥58	HRC	At 500°C

Typical Applications of DC53 Tool Steel

Application	Main Feature	Typical Products	Performance Advantage
Precision Stamping	High toughness	Electronic terminals	40–100% longer life than SKD11
Cold Extrusion	High compression resistance	Bolts	2–3× Cr12MoV
Cold Heading	Fatigue resistance	Nuts	2–3× Cr12MoV
Powder Metallurgy	High strength	Press molds	30–60% higher than SKD11
Drawing	Anti-sticking	Aluminum parts	50–100% higher than SKD11

Not Recommended Applications

Application Type	Main Limitation	Prohibited Products	Recommended Alternatives
Hot Work Dies	Poor heat resistance	Die casting molds	h23, SKD61
Large Dies	Insufficient hardenability	Auto body dies	5CrNiMo
Plastic Molds	Poor corrosion resistance	Mirror molds	S136, NAK80
Heavy Impact Dies	Low impact toughness	Thick plate cutting	S7, HSS

Typical Problems and Solutions

1. Rapid Tool Wear

- Use CBN or ultra-fine carbide tools
- Low cutting depth and feed

- High-pressure cooling
- Leave finishing allowance

2. Cracks After Heat Treatment

- Quenching at 1020–1040°C
- Multiple tempering cycles
- Avoid 300–400°C brittle zone
- Add fillet radius

3. Excessive Deformation

- Use fully forged materials
- Step heating
- Stress relief treatment
- Flexible clamping

4. Wire Cutting Cracks

- Stress relief before cutting
- Low current parameters
- Multiple passes
- Low-temperature tempering

5. Welding Cracks

- Use laser cladding or EDM welding
- Preheat 200–300°C
- Post-weld stress relief
- Local heat treatment

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