

# K110 Mold Steel Guide: Properties, Applications, and Machining



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Service: Moldsteells provides one-stop mold steel supply, cut-to-size, and CNC finishing services.

## What is K110 Mold Steel?

K110 is a high-carbon, high-chromium cold work mold steel with a carbon content of 1.50%-1.70% and a chromium content of 11%-13%. After quenching, its hardness can reach HRC 60-64. It boasts excellent wear resistance and good dimensional stability, with a compressive strength of approximately 2800 MPa. It is ideal for manufacturing high-load, high-wear cold work molds such as cold punching dies, cold heading dies, and drawing dies, making it the preferred material for applications requiring extreme wear resistance.

## Main Characteristics of K110 Steel

- **Ultra-High Hardness:** Quenched hardness of HRC 60-64, superior to D2 steel, suitable for high-wear applications like high-load cold punching and heading.
- **Excellent Wear Resistance:** High carbon and chromium content form a large number of carbides. Wear resistance is better than Cr12 steel and second only to high-speed steel, significantly extending mold life.
- **Great Dimensional Stability:** Minimal deformation during heat treatment ensures mold precision, suitable for precision blanking dies and drawing dies.
- **High Compressive Strength:** Compressive strength is approx. 2800 MPa, with bending strength at approx. 2200 MPa, capable of withstanding heavy-duty conditions.
- **Moderate Toughness:** Impact toughness  $\alpha_k$  is about 12-15 J/cm<sup>2</sup>, maintaining high hardness while reducing the risk of brittle fracture.
- **Good Polishing Performance:** High surface finish can be achieved after proper treatment, suitable for precision molds requiring high surface quality.
- **Basic Corrosion Resistance:** Chromium content of 11%-13% provides fundamental anti-corrosion capabilities for humid environments.

- Good Grindability: Easy to grind to achieve high surface quality, facilitating finishing and repairs.

## 1. Chemical Composition Table

Element Symbol	Typical Content (%)	Standard Range (%)	Core Role
Cr	11.5	11.00-13.00	Forms chromium carbides to increase hardness, improves hardenability, and provides corrosion resistance.
C	1.55	1.40-1.60	Provides hardness and wear resistance; forms carbides to enhance edge retention.
Mo	0.7	0.70-1.20	Improves hardenability and toughness; enhances wear resistance and high-temperature strength.
V	1.0	0.50-1.10	Refines grains; forms hard vanadium carbides to improve wear resistance and toughness.
Mn	0.4	≤0.60	Increases hardenability and improves processing performance and strength.
Si	0.3	≤0.60	Improves strength and heat resistance; acts as a deoxidizer.
P	≤0.001	≤0.030	Impurity element; requires strict control.
S	-	≤0.030	Impurity element; requires strict control.

## 2. K110 Physical Properties Table (Inherent Material Attributes)

Performance Index	Value Range	Unit	Remarks
Density	7.7	g/cm <sup>3</sup>	At room temperature, approx. 0.278 lb/in <sup>3</sup>

Melting Point	1420	°C	Approx. 2590°F
Elastic Modulus	200	GPa	Young's Modulus at room temperature
Poisson's Ratio	0.28-0.30	-	Elastic deformation parameter
Specific Heat Capacity	460	J/(kg·K)	At room temperature (20°C)
Thermal Conductivity	20-25	W/(m·K)	Increases slightly with temperature at room temp
Thermal Expansion Coeff.	10.4-11.7	$\times 10^{-6} / ^\circ\text{C}$	Temperature range 20-100°C
Electrical Resistivity	Approx. 0.57	$\mu\Omega\cdot\text{m}$	At room temperature
Hardness (As-delivered)	$\leq 250$	HB	Soft annealed state
Hardness (Heat-treated)	60-62	HRC	After quenching + low-temperature tempering
Tensile Strength (Annealed)	$\geq 480$	MPa	Minimum value in annealed state
Tensile Strength (Quenched)	$\geq 2000$	MPa	High hardness state after quenching and tempering
Yield Strength (Annealed)	$\geq 275$	MPa	Minimum value in annealed state
Yield Strength (Quenched)	$\geq 1800$	MPa	High hardness state after quenching and tempering
Elongation	Approx. 16	%	Under annealed state

### 3. K110 Mechanical Properties Table (Stress Response Characteristics)

Performance Index	Value Range	Unit	Remarks
Hardness (Quenched)	63-65	HRC	As-quenched state before tempering
Hardness (200°C Temper)	61-62	HRC	Recommended for cold work molds
Hardness (250°C Temper)	59-60	HRC	Improved toughness, slightly lower hardness
Tensile Strength	2200-2500	MPa	After quenching + low-temp tempering
Yield Strength	1800-2000	MPa	After quenching + low-temp tempering
Compressive Strength	2800-3200	MPa	Key indicator for cold extrusion dies
Bending Strength	2500-2800	MPa	Ability to withstand bending loads
Elongation	1.5-2.5	%	Low elongation for high-hardness materials
Impact Toughness (Unnotched)	12-15	J/cm <sup>2</sup>	Typical value at 200°C tempering
Impact Toughness (200°C Temper)	10-12	J/cm <sup>2</sup>	Low-temp tempering, priority on hardness
Impact Toughness (250°C Temper)	13-15	J/cm <sup>2</sup>	Mid-temp tempering, priority on toughness
Fatigue Strength (10 <sup>7</sup> cycles)	650-750	MPa	Cyclic fatigue limit
Elastic Modulus	200-210	GPa	Young's Modulus at room temperature
Poisson's Ratio	0.28-0.30	-	Elastic deformation parameter
Wear Resistance (Pin-on-Disk)	0.08-0.12	mm <sup>3</sup> /(N·m)	Pin-on-disk wear test data
Wear Resistance	0.5-0.8	mm <sup>3</sup> /1000 times	Dry sand/rubber wheel wear test data

(Dry Wheel)			
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## Typical Applications of K110 Mold Steel

Application Field	Core Characteristics	Typical Products	Performance Advantage
Precision Stamping	High Wear Resistance + Dimensional Stability	Connectors, Motor Cores, Precision Springs	Life increased by 3x+ vs Cr12; 67%-100% vs D2
Cold Extrusion	High Compressive Strength + Wear Resistance	Aluminum Profiles, Non-ferrous Parts	Life increased by 2-3x vs ordinary mold steel
Powder Metallurgy	Ultra-high Wear Resistance + Precision	Gears, Precision Structural Parts	Life increased by 4x (20k to 80k cycles)
Thread Processing	High Hardness + Wear Resistance	Bolt/Screw Thread Rolling Dies	Life significantly superior to D2 steel
Cold Heading	High Wear Resistance + Compressive Strength	Bolt/Nut Cold Heading Dies	Good performance for mass production
Shearing/Cutting	High Wear Resistance	Thin Sheet Shearing Dies ( $\leq 1\text{mm}$ )	Longer life for thin material shearing
Stretching/Drawin g	High Wear Resistance + Dimensional Stability	Wire/Tube Drawing Dies	Excellent wear resistance and size retention

## Scenarios Where K110 is NOT Recommended

Not Recommended Scenario	Core Limitations	Typical Failure Mode	Alternative Material Suggestion

Cold Heading/Extrusion	Low Impact Toughness (10-15J/cm <sup>2</sup> )	Chipping, Fracture (<500 pieces)	DC53, LD, S7
Thick Plate Blanking (≥3-6mm)	Insufficient Toughness	Edge Chipping, Cracking	A2, D2, Cr12MoV
Large Molds (Length >500mm)	Limited Hardenability	Cracking, Deformation during heat treatment	Cr12MoV
Hot Work Molds (>250°C)	Insufficient Thermal Stability	Softening, Failure	H13
Plastic Molds	Hard to Machine, No Corrosion Resistance	Difficulty in processing, Rusting	718H, S136, NAK80
Precision Progressive Dies	Insufficient Fatigue Strength	Fatigue Cracking (at 30k cycles)	SKH-9, SKH-51
Deep Drawing Dies	Poor Ductility (1.5-2.5% Elongation)	Cracking	Cr12MoV
Shearing Thick Plates (≥6mm)	Insufficient Impact Resistance	Edge Chipping, short life (50% of D2)	LD, Cr12MoV
Auto Body Panel Drawing	Poor Ductility, Insufficient Toughness	Orange-peel Cracking	Specialized Drawing Steel
Thin-walled/Sharp Corner Molds	Stress Concentration, Low Toughness	Fracture at Sharp Corners	Higher Toughness Mold Steels
Mirror Polishing Required	High Chromium, Poor Polishing	Cannot reach mirror finish	S136, NAK80
Powder Metallurgy Dies	Insufficient Compressive Strength	Rapid Wear due to impact	Specialized Powder Metallurgy Steels

## What Tools to Use for K110 Machining?

Stage / Material Hardness	Tool Type	Coating Priority	Recommended Brands
Roughing (Annealed HRC25-30)	Standard Carbide (WC-Co)	TiAlN Coating	Zhuzhou Diamond YC30S, Sandvik GC4225, Zigong Great Wall 798
Semi-finishing (Pre-hardened HRC35-45)	Ultra-fine Grain Carbide (0.5-1 $\mu$ m)	AlTiN (Priority) > TiSiN	Sandvik GC1030, Kennametal KC5010, Zhuzhou Diamond YBG205, Iscar
Finishing (HRC50-55)	High-performance Carbide or CBN	AlTiN (for Carbide) / No coating (CBN)	Sandvik GC1030, Kennametal KC5010, Halnn Superhard BN-H10
Finishing (HRC55-65)	CBN Tools (Solid or Brazed)	No Coating	Imported: Sumitomo BN-S200/BNC200, Element Six CBN300, Sandvik CB7015, Kennametal KBN10, Seco, Walter, Kyocera; China: Funik FBN-S30, Halnn Superhard, Zhengzhou Xinya

## K110 Machining Parameter Selection Logic

Core Dimension	Selection Logic	Practical Parameters
Cutting Speed ( $V_c$ )	Harder material requires lower speed; CBN allows high speed.	Annealed: 80-150 m/min; Quenched (HRC55-65): 150-250 m/min (CBN)
Feed Rate (F)	$F = S \times Z \times f_z$ ; Higher hardness requires lower feed.	Roughing: 0.1-0.25 mm/r; Finishing: 0.05-0.15 mm/r
Depth of Cut ( $a_p$ )	Max 1/10 to 1/5 of tool diameter.	Roughing (Annealed): 0.5-2 mm; Finishing: 0.05-0.3 mm
Spindle Speed (S)	$S = (1000 \cdot V_c) / (\pi \cdot D)$ ; Larger diameter requires lower RPM.	Annealed: 1200-2000 rpm; HRC55-65: 600-1000 rpm (CBN)

Cooling Method	High hardness requires higher pressure cooling (5-8 bar).	Annealed: Emulsion (5-10%); Quenched: High-pressure cooling or Oil-based
Path Strategy	Helical/Ramp entry; Climb milling to reduce wear.	Helical entry; Climb milling; Stepover: Roughing 50-70%, Finishing 10-30%

## Typical Problems and Solutions for K110 Steel Molds

### 1. What to do if K110 cold extrusion dies break easily?

Cause: Low toughness (10-15 J/cm<sup>2</sup>) cannot withstand the impact load of cold extrusion.

Solutions:

- ① Reduce hardness to HRC 58-60 to improve toughness.
- ② Switch to tougher materials (DC53, SKD11).
- ③ Perform cryogenic treatment.
- ④ K110 is generally not recommended for cold extrusion.

### 2. How to solve edge chipping in K110 stamping dies?

Cause: Excessive hardness (HRC 61) reduces toughness; stress concentration at the edge.

Solutions:

- ① Reduce hardness to HRC 58-60.
- ② Apply a radius to the edge (R0.3).
- ③ Check if the stamping material thickness exceeds limits.
- ④ Switch to Cr12MoV or DC53.

### 3. What to do about serious deformation after heat treatment?

Cause: Austenite temperature too high, improper cooling, or uneven original structure.

Solutions:

- ① Use stepped heating.
- ② Use isothermal quenching processes.
- ③ Perform spheroidizing annealing beforehand.
- ④ Leave 0.5-1mm machining allowance.
- ⑤ Find a professional heat treatment facility.

#### **4. Difficult milling and fast tool wear?**

Cause: K110's high hardness and wear resistance are too much for standard tools.

Solutions:

- ① Complete most machining before heat treatment.
- ② Use CBN tools after heat treatment.
- ③ Use extreme pressure (EP) cutting fluids.
- ④ Consider DC53 for better machinability.

#### **5. Cracks appearing during grinding?**

Cause: Excessive grinding stress or insufficient cooling.

Solutions:

- ① Use resin-bonded wheels (80-120 mesh).
- ② Maintain grinding speed at 20-25 m/s.
- ③ Use ample water-soluble grinding fluid.
- ④ Intermittent grinding.
- ⑤ Low-temperature tempering (180-200°C for 2 hours) after grinding.

#### **6. Which tools are best for K110?**

Before Heat Treatment: High-speed steel (HSS) tools (W6Mo5Cr4V2) or carbide tools (YG8, YG6).

After Heat Treatment: Must use CBN tools (Sumitomo BN-S200, Kyocera CB50) or diamond tools.

Parameters: Speed 15-30 m/min, Feed 0.05-0.1 mm/r.



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