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TECHNICAL GUIDES

Wear Liner Material Selection: Hardox, Manganese, or Ceramic for Your Application

Select the right wear liner material for crushers and chutes. Compare Hardox, manganese steel, and ceramic liners for different applications.

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Wear liner selection significantly impacts operating costs, maintenance frequency, and equipment availability in crushing and screening plants. Understanding the properties, applications, and economic trade-offs of different liner materials—Hardox steel, manganese steel, ceramic composites, and chromium carbide overlays—enables plant managers to optimize wear protection for their specific conditions.

Understanding Wear Mechanisms in Crushing Equipment

Before selecting liner materials, it's essential to understand the wear mechanisms present in different applications:

Primary Wear Mechanisms

WEAR TYPE	MECHANISM	TYPICAL LOCATIONS	MATERIAL RESPONSE
Abrasion	Hard particles scratching softer surface	Chutes, screens, hoppers	Hardness is primary defense
Impact	High-energy material collision	Primary crusher liners, impact bars	Toughness prevents cracking
Gouging	Large particles digging into surface	Jaw plates, cone mantles	Work hardening beneficial
Erosion	Fine particles at high velocity	Cyclones, slurry pipes	Ceramics excel
Adhesion	Material sticking and tearing surface	Wet material chutes	Low friction surfaces help

Application Severity Classification

Classify each application by severity to guide material selection:

SEVERITY	CHARACTERISTICS	EXAMPLES
Low	Fine material, low velocity, minimal impact	Sand chutes, fine screens
Medium	Mixed sizes, moderate velocity	Secondary crusher feed chutes
High	Large particles, high velocity or impact	Primary crusher discharge
Severe	Extreme impact or highly abrasive material	Jaw plates, HSI blow bars

Hardox Steel: High Hardness Wear Plate

Material Properties

Hardox is a family of quenched and tempered through-hardened wear steels manufactured by SSAB:

GRADE	HARDNESS (HBW)	IMPACT TOUGHNESS	PRIMARY APPLICATION
Hardox 400	370-430	Good (45J at -40°C)	General wear, good formability

GRADE	HARDNESS (HBW)	IMPACT TOUGHNESS	PRIMARY APPLICATION
Hardox 450	425-475	Good (40J at -40°C)	Dump bodies, buckets
Hardox 500	470-530	Moderate (35J at -40°C)	Chutes, hoppers, screens
Hardox 550	525-575	Lower (30J at -40°C)	Extreme abrasion
Hardox 600	570-640	Limited	Very extreme abrasion only

Advantages of Hardox Steel

- **Uniform hardness throughout thickness:** Maintains protection as liner wears
- **Good weldability:** Can be field repaired with proper procedures
- **Excellent impact resistance:** Won't crack under normal operating impacts
- **Formable:** Can be bent and shaped to complex geometries
- **Cost-effective:** Good balance of performance and price

Best Applications for Hardox

- Crusher feed hoppers and chutes
- Vibrating screen side plates and chutes
- Conveyor transfer points and skirt boards
- Dump truck bodies and buckets
- Any application requiring combined abrasion and impact resistance

Hardox Installation Best Practices

Welding procedures:

- Preheat to 100-150°C for thickness >25mm
- Use low-hydrogen electrodes (E7018 or equivalent)
- Maintain interpass temperature <200°C
- Allow slow cooling under insulating blanket

Cutting procedures:

- Plasma cutting preferred for clean edges

- Oxy-fuel cutting requires preheat for thick plates
- Allow for heat-affected zone softening at cut edges

Manganese Steel: Work-Hardening Wear Plate

Material Properties

Austenitic manganese steel (Hadfield steel, 11-14% Mn) work-hardens under impact, creating a hard surface while maintaining tough core:

PROPERTY	INITIAL VALUE	WORK-HARDENED VALUE
Surface hardness	200 HBW	500+ HBW
Core toughness	Excellent	Maintained
Yield strength	350 MPa	Variable
Elongation	40-50%	Reduced in work-hardened zone

Work Hardening Requirements

Manganese steel requires impact to develop its full wear resistance:

Conditions for effective work hardening:

- Impact energy sufficient to cause plastic deformation
- Repeated impacts to build up hardened layer
- Layer thickness 3-10mm depending on impact severity

Where manganese excels:

- Primary crusher jaw plates
- Cone crusher mantles and bowls
- Impact crusher blow bars (high-impact types)
- Hammer mill hammers
- Rail crossings and mining buckets

Where manganese is NOT suitable:

- Sliding abrasion without impact (it won't work harden)
- Fine material handling (insufficient impact)
- High-temperature applications (loses properties above 300°C)

Manganese Steel Grades for Crushing

GRADE	MANGANESE CONTENT	APPLICATION
Standard (12% Mn)	11-14%	General crushing
Modified (14% Mn)	14-18%	Higher impact applications
Chrome-modified	12-14% + 2% Cr	Combined impact and abrasion

Ceramic Composites: Extreme Abrasion Resistance

Types of Ceramic Wear Liners

Ceramic liners use alumina (Al_2O_3) or silicon carbide (SiC) ceramics bonded to steel backing plates:

CERAMIC TYPE	HARDNESS (HV)	IMPACT RESISTANCE	COST
Alumina (Al_2O_3) 92%	1,200-1,400	Moderate	Medium
Alumina (Al_2O_3) 95%	1,400-1,600	Lower	High
Silicon Carbide (SiC)	2,200-2,500	Low	Very high
Zirconia-toughened alumina	1,300-1,500	Better	High

Ceramic Tile Configurations

Bonding methods:

- **Epoxy bonded:** Tiles glued to steel backing, limited temperature
- **Mechanically retained:** Tiles held in steel framework
- **Rubber-backed:** Ceramics embedded in rubber for impact absorption

- **Welded ring system:** Steel rings welded to backing, ceramics drop in

Tile geometries:

- Square tiles (most common): 25×25mm to 50×50mm
- Hexagonal tiles: Better coverage at transfer points
- Cylindrical: For pipe linings

Best Applications for Ceramics

- Cyclone bodies and spigots (extreme fine particle erosion)
- Slurry pipe bends and elbows
- Fine material chutes with sliding abrasion
- Sand classifier internals
- Coal and ash handling where impact is minimal

Ceramic Limitations

- **Brittle:** Crack under direct impact from large particles
- **Temperature sensitive:** Epoxy bonds fail above 80-120°C
- **Installation critical:** Gaps allow undercutting wear
- **Repair difficult:** Usually requires complete replacement
- **High initial cost:** 3-5× cost of steel liners

Chromium Carbide Overlay (CCO)

Material Composition

CCO plates consist of chromium carbide hard facing deposited on mild steel backing:

PROPERTY	CCO OVERLAY	BACKING STEEL
Hardness	58-65 HRC (700-800 HV)	120-200 HBW
Thickness	3-10mm	6-25mm
Carbide content	30-40% volume	N/A

PROPERTY	CCO OVERLAY	BACKING STEEL
Carbide hardness	1,500-1,800 HV	N/A

CCO Manufacturing Methods

- **Submerged arc welding:** Most common, cost-effective for large areas
- **Open arc welding:** Faster deposition, more porosity
- **Plasma transfer arc:** Highest quality, smooth finish

Best Applications for CCO

- Screen deck panels and wear strips
- Bucket lips and cutting edges
- Crusher feed chutes with sliding material
- Pulverizer grinding rolls
- Any sliding abrasion application

CCO Advantages and Limitations

Advantages:

- Excellent resistance to sliding abrasion
- Can be applied to complex shapes
- Field weldable for repairs
- Good at elevated temperatures (to 600°C)

Limitations:

- Brittle surface layer cracks under severe impact
- Surface checking/cracking is normal but limits applications
- Higher cost than plain wear plate
- Limited bending/forming capability

Economic Comparison and Selection Guide

Cost-Per-Hour Analysis

The true cost of wear liners includes material cost, installation, and downtime:

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Cost per operating hour = (Material + Installation + Downtime) / Liner Life

Example: Screen deck panel comparison
                    Hardox 500    CCO 6/10      Ceramic-rubber
Material cost       Rs 15,000     Rs 35,000     Rs 85,000
Installation        Rs 2,000      Rs 2,500      Rs 5,000
Downtime (2 hrs)    Rs 10,000     Rs 10,000     Rs 10,000
Total cost          Rs 27,000     Rs 47,500     Rs 100,000
Life (hours)        2,000         4,500         12,000
Cost per hour       Rs 13.50      Rs 10.55      Rs 8.33
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Note: Despite highest material cost, ceramics may have lowest cost per operating hour in appropriate applications.

Selection Decision Matrix

APPLICATION CONDITION	RECOMMENDED MATERIAL	ALTERNATIVE
High impact, large particles	Manganese steel	Hardox 450
Moderate impact + abrasion	Hardox 500	Chrome manganese
Sliding abrasion, minimal impact	CCO	Hardox 550/600
Fine particle erosion	Ceramic	CCO
Wet sticky material	UHMW-PE liner	Ceramic (smooth)
High temperature (>300°C)	CCO	High-chrome cast iron

Material Selection by Equipment Type

EQUIPMENT	COMPONENT	PRIMARY CHOICE	ALTERNATIVE
Jaw crusher	Jaw plates	Manganese	-
Jaw crusher	Cheek plates	Manganese	Hardox 500

EQUIPMENT	COMPONENT	PRIMARY CHOICE	ALTERNATIVE
Cone crusher	Mantle/bowl	Manganese	-
HSI crusher	Blow bars	Chrome iron	Manganese (wet)
VSI crusher	Wear tips	Tungsten carbide	CCO
Vibrating screen	Side plates	Hardox 500	CCO
Feed hopper	Liner plates	Hardox 450	Manganese
Transfer chute	Wear plates	CCO	Ceramic tiles
Cyclone	Body liner	Ceramic	Rubber

Installation and Maintenance Considerations

Liner Monitoring Program

Implement systematic wear monitoring to optimize replacement timing:

- **Thickness measurement:** Ultrasonic or direct measurement at marked locations
- **Wear rate calculation:** mm/1000 tonnes processed
- **Replacement threshold:** Typically 70-80% worn
- **Pattern documentation:** Identify uneven wear for design improvement

Replacement Planning

Schedule liner changes to minimize production impact:

- Maintain inventory of high-wear items
- Combine multiple liner changes in single shutdown
- Pre-fit and prepare liners before shutdown
- Document actual vs predicted liner life for future planning

Proper wear liner material selection based on specific application conditions delivers significant cost savings over simply using the cheapest available option. The investment in understanding wear mechanisms and matching materials to applications consistently pays dividends through extended liner life and reduced downtime.

Topics: #Hardox #Manganese Steel #Wear Liners #Wear Parts

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