TSR ROLLS

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Tangshan Iron & Steel Group Heavy Machinery Equipment Co., Ltd.

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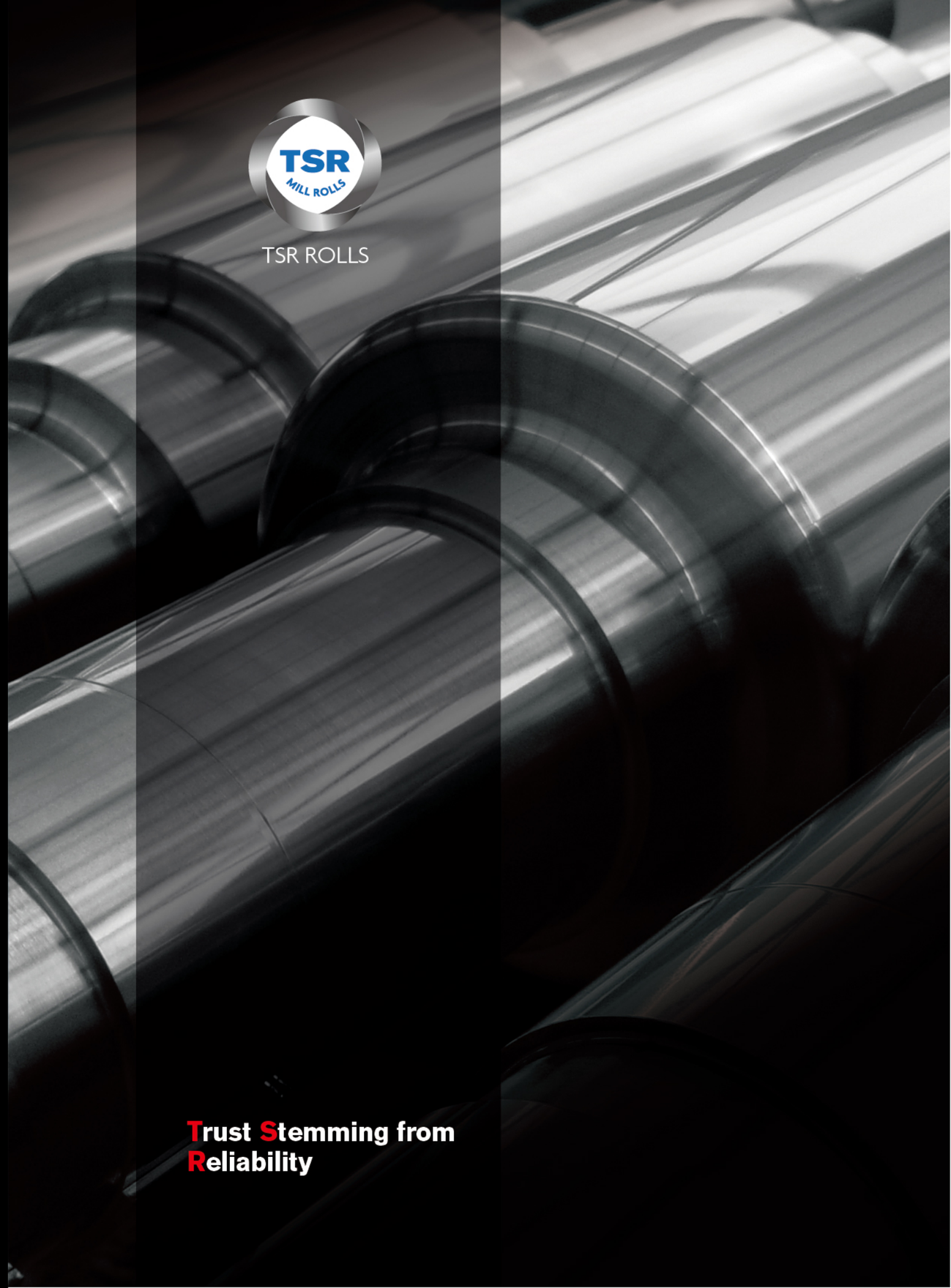


TSR ROLLS

Trust Stemming from Reliability

HICR STEEL

Symbol
HiCr Steel
Cast Steel

HiCr Steel is characterized by excellent fire crack resistance and very good oxidation behaviour at rolling temperature. Very good wear resistance and constant material properties throughout the shell layer.
HiCr Steel is manufactured by horizontal spin casting. No retained Austenite and the right structure and properties are obtained through the chemical composition, high temperature quenching and tempering cycles.

Core material: Nodular Iron

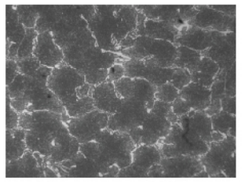
Application:

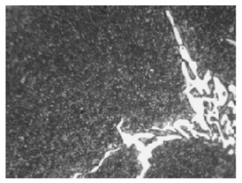
Work Rolls for Roughing Stands of conventional HSM
Early Stands of CSP Mill

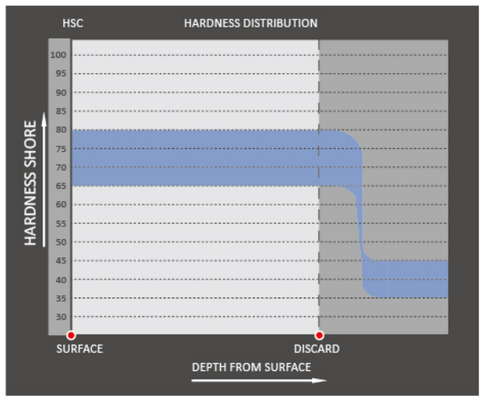
MATERIAL	CHEMISTRY							BARREL HARDNESS (HSC)
	C	Si	Mn	Cr	Ni	Mo	V	
HiCr Steel	0.90-2.00	0.40-1.40	0.40-1.40	9.0-15.0	0.60-1.60	1.00-2.00	≤1.00	65-80

	TYPICAL PHYSICAL PROPERTIES		
Neck Hardness (HSC)	Tensile Strength (N/mm²)	Unevenness of Barrel Surface Hardness (HSC)	Difference of Shell Thickness
35-45	shell ≥750 core & necks ≥400	<3	<10

HARDNESS DISTRIBUTION


Microstructure (100X)


Microstructure (500X)



EN-HICR IRON

Symbol
EN-HiCr-Iron
Cast Steel

Enhanced High Chromium Iron is widely used in early finishing stands of hot strip mills.The microstructure consists of a tempered bainitic / martensitic matrix with Cr_7C_3 carbides and MC type carbides homogeneously distributed in the matrix.

Core material: Nodular Iron

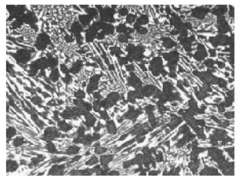
Application:

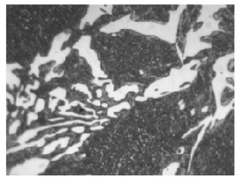
Work Rolls for early finishing stands (F1-F4) of HSM and early stands of CSP Mill.
Work Rolls for Heavy Plate mills and Temper mills

MATERIAL	CHEMISTRY							BARREL HARDNESS (HSC)
	C	Si	Mn	Cr	Ni	Mo	V	
HiCr Iron	2.60-3.20	0.40-1.20	0.30-1.20	16.0-22.0	1.00-2.00	1.00-3.00	≤1.5	70-85

	TYPICAL PHYSICAL PROPERTIES		
Neck Hardness (HSC)	Tensile Strength (N/mm²)	Unevenness of Barrel Surface Hardness (HSC)	Difference of Shell Thickness
35-45	shell ≥650 core & necks ≥400	<3	<10

HARDNESS DISTRIBUTION


Microstructure (100X)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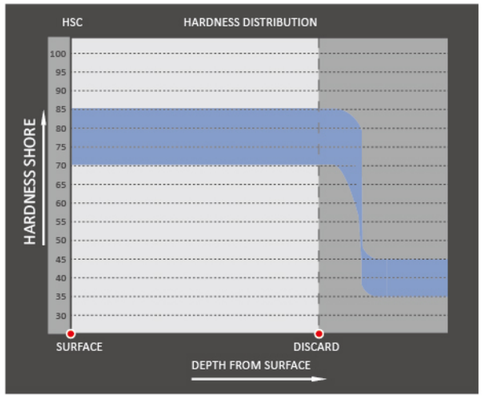


ROLL FOR HOT STRIP AND PLATE MILL

ENHANCED -ICDP

Symbol
EN-ICDP
Cast Iron

The enhanced ICDP is developed based on the classic Indefinite Chill Double Poured Cast Iron.The microstructure consists of a bainitic / martensistic matrix with Fe_3C and MC carbides homogeneously distributed and a certain amount of free graphite fine and also well distributed in the matrix.The rolls are double tempered to avoid retained Austenite and to obtain the right hardness level and the optimum residual stress level.

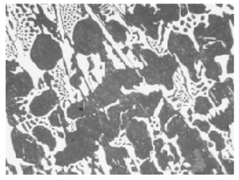
Core material: Nodular Iron or Grey Iron depending on the mill or customer's requirements

Application:

Late finishing stands (F4 – F7) of hot strip mills
Steckel mills, Heavy Plate mills and finishing stand of section mills

MATERIAL	CHEMISTRY							BARREL HARDNESS (HSC)
	C	Si	Mn	Cr	Ni	Mo	V+W+Ti+Nb	
EN-ICDP	2.90-3.40	0.60-1.60	0.50-1.50	1.20-2.00	3.50-5.00	0.20-1.00	≤2.5	70-82

	TYPICAL PHYSICAL PROPERTIES		
Neck Hardness (HSC)	Tensile Strength (N/mm²)	Unevenness of Barrel Surface Hardness (HSC)	Difference of Shell Thickness
35-45	≥400	<3	<10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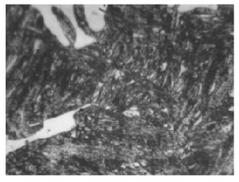
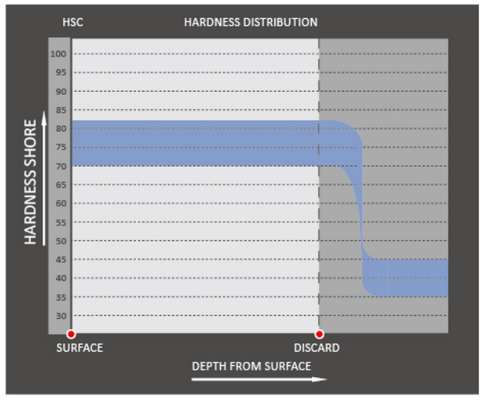

Microstructure (500X)

HARDNESS DISTRIBUTION



HIGH SPEED STEEL

Symbol
HSS
Cast Steel

The microstructure consists of tempered bainitic / martensitic matrix with primary and secondary carbides. Primary carbides MC, M_7C_3, M_6C and M_2C are originated during the eutectic solidification. Secondary carbides are precipitated during the High Temperature quench and tempering. The rolls are cast with the right structure to undergo the High Temperature quenching to promote the right precipitation of secondary carbides and optimum material properties. Excellent wear resistance and fire crack resistance and very good oxidation behaviour at rolling temperatures under the adequate rolling conditions are the main features of this grade.
Core material: Nodular Iron

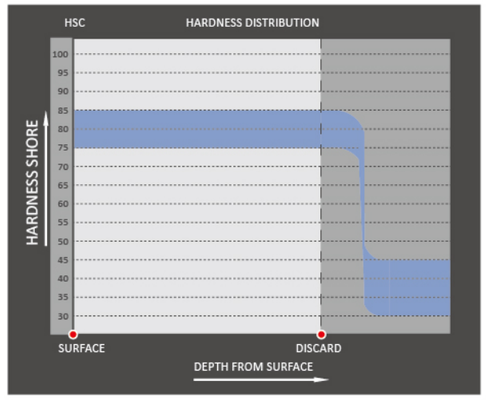
Application:

Work Rolls for early finishing stands (F1-F4) of HSM and early stands of CSP Mill.
Work Rolls for finishing stands of bar mills

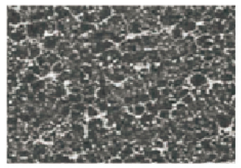
MATERIAL	CHEMISTRY								BARREL HARDNESS (HSC)
	C	Si	Mn	Cr	Ni	Mo	V	W	
HSS	1.50-2.20	0.30-1.00	0.40-1.20	3.00-8.00	0.50-1.50	2.00-8.00	2.00-9.00	0.00-8.00	75-85

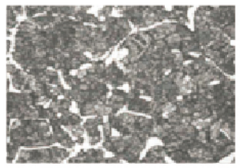
	TYPICAL PHYSICAL PROPERTIES		
Neck Hardness (HSC)	Tensile Strength (N/mm²)	Unevenness of Barrel Surface Hardness (HSC)	Difference of Shell Thickness
30-45	shell ≥800 core & necks ≥400	<3	<10

HARDNESS DISTRIBUTION



Material		Characteristics	Disadvantages
Shell	core		
High Carbon & High Vanadium HSS	Nodular Cast Iron	• With high alloy element, good quenching degree and hardenability, small hardness drop. Carbide is MC type granular and M6C strip, high micro hardness, low crack propagation • In high temperature rolling, barrel surface is easy to form compact oxidization film with strong adhesion.	• High coefficient of linear expansion. Easy to cause roll shape change in rolling, thus to affect precision of rolled material. • Wear resistance is depending on the time, thickness and completeness of the oxidization film. • For some thin material and low rolling temperature, it is hard to form good oxidization film. Thus, the wear resistance can't be sufficiently realized.


Microstructure (100X)


Microstructure (500X)

ROLL FOR HOT STRIP AND PLATE MILL

CAST BACK-UP ROLLS

TSR Rolls Cast Back Up Rolls are produced to a high hardness level of up to 75 HSC through a Differential Hardening process. The superior wear and mechanical hardening resistance are related to the bainitic / martensitic matrix and complex carbides finely distributed. In the Differential Hardening process the monoblock rolls are first heat treated to produce a fine pearlite necks and core structure followed by the differential hardening of the working layer (Austenitize, water quench and double tempering) to develop the optimum microstructure in the working layer.

The rolls are monoblock cast so no shell / core interface problems

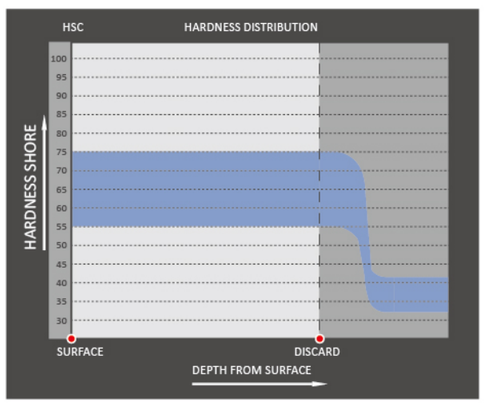
Application:

Back Up Rolls for 4-Hi Stands of Hot and Cold Strip mills and CSP Mills.
Work Rolls for 2-Hi roughing Stands of Hot Strip Mills (3 % Cr)

MATERIAL	GRADE	CHEMISTRY						BARREL HARDNESS (HSC)
		C	Si	Mn	Cr	Ni	Mo	
Cast Back-up Roll	3%Cr	0.30-0.50	0.30-0.60	0.40-1.0	2.50-3.50	0.60-1.50	0.30-0.60	55-62
	4%Cr	0.30-0.50	0.30-0.60	0.40-1.0	3.50-4.50	0.60-1.50	0.30-0.60	60-65
	5%Cr	0.30-0.50	0.30-0.60	0.40-1.0	4.50-5.50	0.60-1.50	0.50-0.80	65-75

	TYPICAL PHYSICAL PROPERTIES		
Neck Hardness (HSC)	Tensile Strength (N/mm²)	Unevenness of Barrel Surface Hardness (HSC)	Difference of Shell Thickness
⩽42	shell ≥1500 core & necks ≥750	<3	<10

HARDNESS DISTRIBUTION



ALLOY CAST STEEL

Symbol
AS
Cast Steel

Carbon contents of Alloyed Cast Steel range between 0.4 to 1.4 % depending of the hardness level. Additions of Cr, Ni, Mo and other alloying elements and the right heat treatment will develop a pearlitic or sorbitic structure.

In case of deep channels and grooves, we recommend a pre-machining of the grooves before the final heat treatment allowing the hardness to penetrate down to the bottom of the grooves and developing a uniform hardness along the barrel

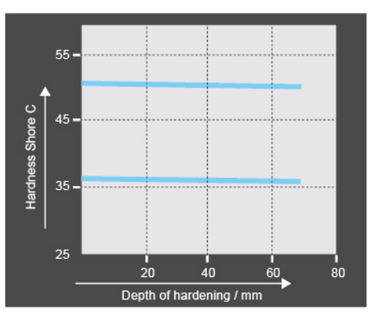
Application:

Roughing and BD stands of heavy section and medium section mills.

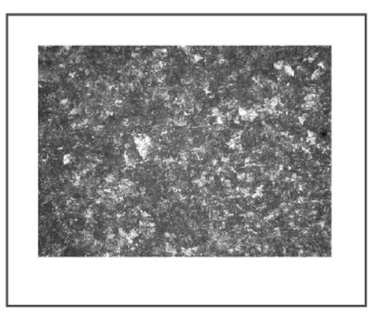
MATERIAL	GRADE	CHEMISTRY						BARREL HARDNESS (HSC)
		C	Si	Mn	Cr	Ni	Mo	
Alloy Steel	AS60	0.55-0.65	0.20-0.45	0.90-1.20	0.80-1.20		0.20-0.45	35-50
	AS65 I	0.55-0.65	0.20-0.60	0.50-1.00	0.80-1.20	0.20-1.50	0.20-0.60	35-45
	AS70	0.65-0.75	0.20-0.45	0.90-1.20				32-42
	AS70 I	0.65-0.75	0.20-0.45	1.40-1.80				35-45
	AS70 II	0.65-0.75	0.20-0.45	1.40-1.80			0.20-0.45	35-45
	AS75	0.70-0.80	0.20-0.45	0.60-0.90	0.75-1.00		0.20-0.45	35-50
	AS75 I	0.70-0.80	0.20-0.70	0.70-1.10	0.80-1.50	≥0.20	0.20-0.60	35-50

		TYPICAL PHYSICAL PROPERTIES	
GRADE	Neck Hardness (HSC)	Tensile Strength (N/mm²)	Unevenness of Barrel Surface Hardness (HSC)
AS60	≤45	≥650	<5
AS65 I	≤45	≥650	<5
AS70	≤45	≥600	<5
AS70 I	≤45	≥600	<5
AS70 II	≤45	≥680	<5
AS75	≤45	≥680	<5
AS75 I	≤45	≥700	<5

HARDNESS CURVE



MICROSTRUCTURE 100X



ADAMITE

Symbol
AD
Cast Steel

Adamite or Steel Base is a material with Carbon content and mechanical properties between Steel and Iron.The addition of Cr, Ni, Mo and other elements and a special heat treatment process will develop a high wear and fire cracking resistance together with a constant hardness along the working layer.

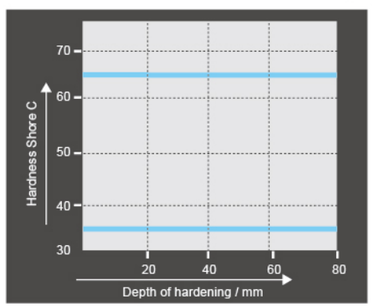
Application:

Intermediate and finishing stands of section mills.
Intermediate stands of bar mills.
Sleeves for Universal stands of heavy section mills.
Vertical Edgers of hot strip mills
Work Rolls for roughing stands of heavy plate mills.

MATERIAL	GRADE	CHEMISTRY						BARREL HARDNESS (HSD)
		C	Si	Mn	Cr	Ni	Mo	
Adamite	AD140	1.30-1.50	0.30-0.60	0.70-1.40	0.80-1.60		0.20-0.60	38-55
	AD140 I	1.30-1.50	0.30-0.60	0.70-1.10	0.80-1.20	0.50-1.20	0.20-0.60	35-50
	AD160	1.50-1.70	0.30-0.60	0.70-1.10	0.80-1.20		0.20-0.60	40-50
	AD160 I	1.50-1.70	0.30-0.60	0.80-1.30	0.80-2.00	≥0.20	0.20-0.60	40-60
	AD180	1.70-1.90	0.30-0.80	0.60-1.10	0.80-1.50	0.50-2.00	0.20-0.60	45-60
	AD190	1.80-2.00	0.30-0.80	0.60-1.20	1.50-3.50	1.00-2.00	0.20-0.60	55-65
	AD200	1.90-2.10	0.30-0.80	0.80-1.20	0.60-2.00	0.60-2.50	0.20-0.80	50-65

		TYPICAL PHYSICAL PROPERTIES	
Material	Neck Hardness (HSC)	Tensile Strength (N/mm²)	Unevenness of Barrel Surface Hardness (HSC)
AD140	≤45	≥590	<5
AD140 I	≤45	≥590	<5
AD160	≤50	≥490	<5
AD160 I	≤50	≥490	<5
AD180	≤50	≥490	<5
AD190	≤50	≥490	<5
AD200	≤50	≥490	<5

HARDNESS CURVE



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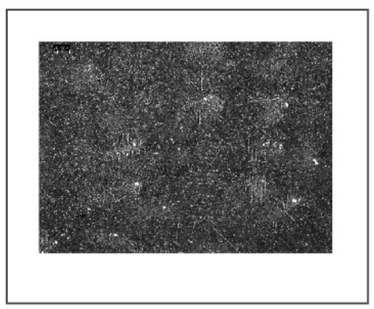


GRAPHITIC STEEL

Symbol
GS
Cast Steel

The carbon content and matrix of graphite steel rolls are similar to those of adamite rolls. Its main character is that it contains a small amount of fine graphite in its microstructure, which will increase its resistance to fire crack and prevent oxidized scales from adhering.

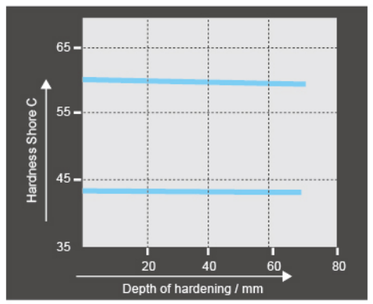
Application:

Intermediate and finishing stands of heavy section mills.
Finishing stands of rails
Pilger mills.
Vertical Edgers of hot strip mills

MATERIAL	GRADE	CHEMISTRY						BARREL HARDNESS (HSC)
		C	Si	Mn	Cr	Ni	Mo	
Graphite Steel	GS 140	1.30-1.50	1.30-1.60	0.50-1.00	0.40-1.00		0.20-0.50	36-46
	GS 160	1.50-1.70	0.80-1.50	0.60-1.00	0.50-1.50	0.20-1.00	0.20-0.60	40-60
	GS190	1.80-2.00	0.80-1.50	0.60-1.00	0.50-2.00	0.60-2.20	0.20-0.80	55-65

	TYPICAL PHYSICAL PROPERTIES		
Material	Tensile Strength (N/mm²)	Bending Strength(N/mm²)	Elongation (%)
Graphite Steel	≥450	650-1000	0.2-0.6

HARDNESS CURVE



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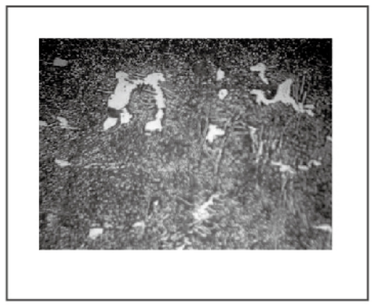


ROLLS FOR LONG PRODUCTS

PEARLITIC NODULAR CAST IRON

Symbol
SGP
Cast Iron

Pearlitic and Pearlitic / Sorbitic Nodular Iron are nodular grades alloyed with Cr, Ni, and Mo with Ni ranging between 1.50 % in the softer grades and 4 % in the harder grades. The right balance of Si and Cr will help to develop the adequate hardness level.
The rolls can be cast static or spun cast depending of the size of the working layer and the mill conditions.

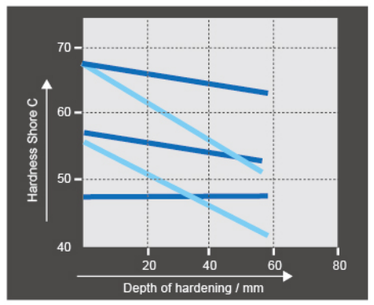
Application:

Roughing stands of bar, wire rod and medium section mills.
Intermediate stands of bar mills.
Sleeves of Universal stands

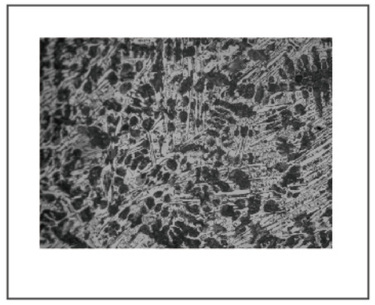
MATERIAL	GRADE	CHEMISTRY						BARREL HARDNESS (HSC)
		C	Si	Mn	Cr	Ni	Mo	
Pearlite (SGP)	Pearlite I	2.90-3.60	1.40-2.20	0.40-1.00	0.10-0.60	1.50-2.00	0.20-0.80	45-55
	Pearlite II	2.90-3.60	1.20-2.00	0.40-1.00	0.20-1.00	2.01-2.50	0.20-0.80	50-60
	Pearlite III	2.90-3.60	1.00-2.00	0.40-1.00	0.20-1.00	2.51-3.00	0.20-0.80	60-70

TYPICAL PHYSICAL PROPERTIES		
Neck Hardness (HSC)	Tensile Strength (N/mm²)	Unevenness of Barrel Surface Hardness (HSC)
35-55	≥350	<5

HARDNESS CURVE



MICROSTRUCTURE 100 X



BAINITIC NODULAR CAST IRON

Symbol
SGA
Cast Iron

Bainitic and bainitic / martensitic nodular iron are nodular grades alloyed with Cr, Ni, and Mo with higher Cr and Ni contents.
Compared to pearlitic irons, acicular irons show higher strength, toughness and wear resistance.
The rolls can be cast static or spun cast depending of the size of the working layer and the mill conditions.

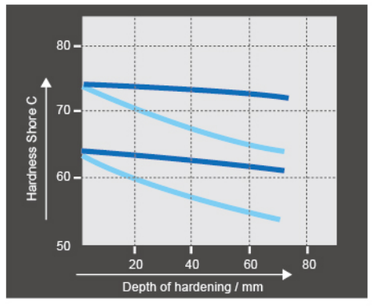
Application:

Intermediate and finishing stands of bar, wire rod and medium section mills.
Forming, sizing, reducing and straightening rolls for pipe and tube mills
Sleeves for Universal finishing stands (Horizontal & Vertical)

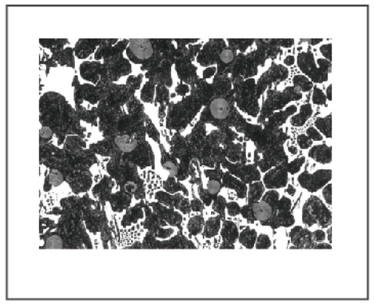
MATERIAL	GRADE	CHEMISTRY					BARREL HARDNESS (HSC)
		C	Si	Mn	Ni	Cr	
Bainite(SGA)	Bainite I	2.90-3.60	1.20-2.20	0.20-0.80	3.01-3.50	0.50-1.00	55-65
	Bainite II	2.90-3.60	1.00-2.00	0.20-0.80	3.51-4.50	0.50-1.00	65-75

TYPICAL PHYSICAL PROPERTIES		
Neck Hardness (HSC)	Tensile Strength (N/mm²)	Unevenness of Barrel Surface Hardness (HSC)
32-45	≥350	<5

HARDNESS CURVE



MICROSTRUCTURE 100 X

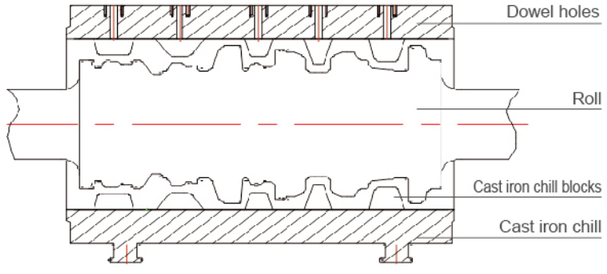


CAST ROLL WITH GROOVES

When rolls are deeply grooved as in Heavy Section mill rolls, it is necessary to produce a roll with a similar hardness at the top of the collar and at the bottom of the groove. A significant hardness fall off along the groove will lead to an uneven wearing behaviour and a rapid deterioration of the dimensional stability and tolerances of the rolled section. This will require frequent roll changes, redressings and a significant increase of the operational cost.
In the case of steel rolls, since the hardness and the microstructure are adjusted by the heat treatment, it is relatively easy to premachine the grooves before the heat treatment in order to have the same hardness at the top of the collars than at the bottom of the grooves.
In the case of cast iron rolls, where the microstructure and the hardness are basically obtained in as-cast condition, it is a distinct advantage to shape the mould of the roll with a contour as close as possible to the shape of the finished roll.
At TSR Rolls we have developed a moulding technique using a solid chill for the outer contour of the roll barrel and shaped cast iron chills bolted to the outer chill to produce the grooves promoting rapid solidification in the working area of the roll. This minimizes the appearance of solidification defects and produces a fine grained wear resistant structure which results in enhanced mill performance.

• Material: SGP • Maximum weight: 32T • Patent has been authorized

The grooved cast roll in as-cast condition



A basic sketch of the grooved mould.

ROLLS FOR LONG PRODUCTS

ALLOY INDEFINITE CHILLED CAST IRON

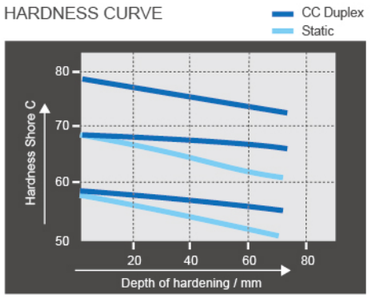
Symbol
IC
Cast Iron

Alloy Indefinite Chilled Cast Iron is a material between chill cast iron and grey cast iron. The sizes, shapes and distributions of graphite and carbide are controlled by the chilling effect and the contents of alloy elements. The addition of alloy elements such as Manganese, Nickel, Chromium, and Molybdenum changes the matrix microstructure from pearlite, bainite to martensite. The presence of small amount of fine graphite enhances the roll's resistance to spallling, thermal crack and wearability. This roll has small hardness gradient in the working layer of roll barrel and is suitable to medium and finishing stands for bar, wire and section mills.

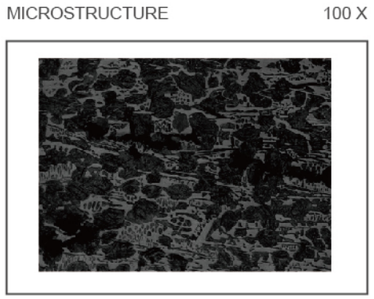
MATERIAL	GRADE	CHEMISTRY									BARREL HARDNESS (HSC)
		C	Si	Mn	Cr	Ni	Mo	V	W	Nb	
Indefinite Chilled (IC)	IC III	2.90-3.60	0.60-1.20	0.40-1.20	0.70-1.20	2.01-3.00	0.20-1.00				38-55
	IC IV	2.90-3.60	0.60-1.50	0.40-1.20	1.00-2.00	3.01-4.00	0.20-1.00				35-50
	IC V	2.90-3.60	0.60-1.50	0.40-1.20	1.00-2.00	3.01-4.80	0.20-2.00	0.20-2.00	0.00-2.00	0.00-2.00	40-50

	TYPICAL PHYSICAL PROPERTIES		
Material	Tensile Strength (N/mm²)	Bending Strength(N/mm²)	Elongation (%)
IC	400-500	700-1000	0.2-0.5

HARDNESS CURVE



MICROSTRUCTURE 100 X



HIGH SPEED STEEL

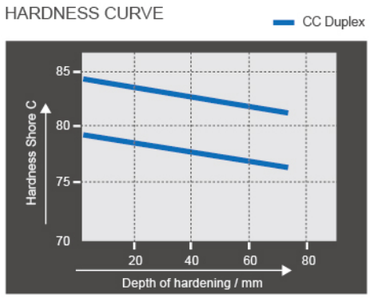
Symbol
HSS
Cast Steel

High-speed steel rolls are manufactured by centrifugal casting, the core material as spheroidal graphite cast iron. By adding vanadium, tungsten, niobium and other alloying elements and special heat treatment, the distribution of this material becomes martensite with good uniformity to ensure high hardness and hardness uniformity of Shell. High-speed steel materials deliver high hardness and wear resistance at high temperature. It can be used for finishing stand to increase the operating time and improve the quality of the surface of rolling material.

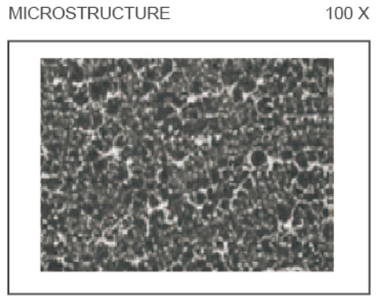
MATEAIAL	CHEMISTRY										BARREL HARDNESS (HSC)
	C	Si	Mn	p	s	Cr	Ni	Mo	V	W	
High Speed Steel	1.50-2.20	0.30-1.00	0.40-1.20	≤0.030	≤0.025	3.00-8.00	0.00-1.50	2.00-8.00	2.00-9.00	0.00-8.00	75-95

	TYPICAL PHYSICAL PROPERTIES		
Material	Neck Hardness (HSC)	Tensile Strength (N/mm²)	Unevenness of Barrel Surface Hardness (HSC)
High Speed Steel	30-45	≥350	<5

HARDNESS CURVE



MICROSTRUCTURE 100 X



ROLLS FOR LONG PRODUCTS

SLEEVE AND ROLL SHAFT

We produce various grades of sleeves and shafts or arbors for universal mills (Horizontal and Vertical Stands) in SGP, SGA, Adamite, Hi Cr Iron… The standard manufacturing method for the universal sleeves is double poured centrifugal casting with the outer shell made of high hardness and high alloy material and the core (central bore) made out of softer materials.

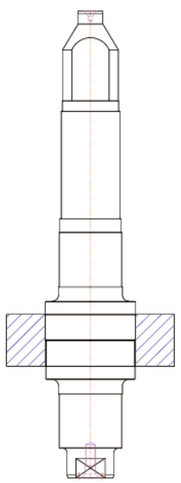
The shafts or arbors are made of low carbon alloy steel either cast or forged, Upon customer request we can assemble the sleeves and arbors by shrink fitting to form the whole roll.

SLEEVES

MATERIAL	CHEMISTRY						Hardness HSC	Tensile Strength
	C	Si	Mn	Cr	Ni	Mo		
SGP	2.90-3.60	1.00-2.20	0.40-1.00	0.20-1.20	1.50-3.00	0.20-0.80	55-70	≥450
SGA	2.90-3.60	1.00-2.20	0.20-0.80	0.20-1.50	3.0-4.50	0.50-1.00	60-75	≥450
Adamite	1.50-2.10	0.30-0.80	0.60-1.30	0.80-3.50	0.50-2.50	0.20-0.80	60-65	≥600
GS	1.60-2.20	1.20-2.00	0.50-1.50	1.00-3.00	1.00-3.00	0.40-0.80	60-65	≥700

SHAFTS

MATERIAL	CHEMISTRY					Tensile Strength (N/mm²)
	C	Si	Mn	Cr	Mo	
42CrMo	0.38-0.45	0.17-0.37	0.50-0.80	0.90-1.20	0.15-0.30	≥800



TSR ROLLS

Trust Stemming from Reliability