

Hot Rolled STEELS



AK Steel produces Hot Rolled Steels to meet the strictest chemistry and dimensional requirements, in a wide variety of grades.

Consistency from coil to coil is maintained by applying ladle metallurgy and continuous casting to molten steel, plus rolling on a modernized 80" wide hot strip mill — the only one in the domestic industry equipped for pair-cross rolling — that features on-line roll grinding, work-roll bending and automatic gauge control.

These technologies enable AK Steel to meet the most demanding customer specifications for hot bands, hot rolled sheet coils, cut- and mill-edge coils, plus cut lengths and custom blanks. Hydrochloric acid pickling helps produce excellent strip surfaces.

PRODUCT FEATURES

■ Formability

Hot Rolled Steels can be used to produce parts containing simple bends as well as drawn parts.

■ Thickness Control

Pair-cross rolling, work roll bending, and computerized automatic gauge control system assure that AK Steel's Hot Rolled Steels have excellent thickness control from coil edge-to-center and end-to-end.

■ Weldability

Hot Rolled Steels can be joined using virtually any accepted welding practice.

■ Wide Variety of Grades and Sizes Available

A wide variety of Hot Rolled Steels are available in thicknesses of 0.071" (1.80 mm) to 0.350" (8.89 mm) and widths of 40" (1016 mm) to 80" (2032 mm), depending on thickness.

PROCESS

AK Steel is committed to producing top quality products by fully utilizing modern, well-maintained equipment. This begins by producing slabs at the basic oxygen furnaces and continuous casters both at Ashland, KY and Middletown, OH. Vacuum degassing and ladle refining are available to produce a uniform chemistry for Hot Rolled Steel. The Hot Strip Mill is designed to produce excellent surface, uniform mechanical properties, and consistent thickness and crown. Walking beam furnaces minimize surface damage during slab

reheating. Scale breakers remove heavy furnace scale and provide a uniform surface for rolling. Strip temperatures are controlled at critical points during rolling to produce the desired mechanical properties. The finishing mill, with pair-cross rolling, work roll bending, on-line roll grinding, and automatic thickness control produces excellent thickness and crown control on all AK Steel Hot Rolled Steels. Finally, hydrochloric acid pickling can be used to remove the oxide produced during rolling.

FORMABILITY AND MECHANICAL PROPERTIES

The formability of all steel products is a result of the interaction of many variables, the main ones being the mechanical properties of the steel, the forming system (tooling) used to manufacture parts and the lubrication used during forming. Of these three, AK Steel can only directly affect the mechanical properties of the steel. Tight control over chemical composition and hot rolling parameters allows the production of high quality Hot Rolled Steels to meet customers' requirements.

Commercial Steel (CS Type B) should be used for moderate forming or bending applications. CS products are produced from aluminum-killed continuously cast slabs and unless otherwise specified, have a carbon content of less than 0.15%.

For more severe forming applications, Drawing Steel (DS Type

B) should be ordered. DS has a controlled carbon content (<0.06%). For more formability and to help minimize coil breaks, DS with Boron should be ordered. Typical mechanical properties are shown in Table 1.

For high strength (HSLAS) or structural applications (SS), Hot Rolled Steels are also available in yield strengths up to 60 ksi as shown in Table 2. HSLAS is intended for applications where greater strength or weight savings are important.

Strength of HSLAS is achieved from columbium or vanadium additions. Two classes are available which are similar in strength, but Class 2 offers improved weldability and more formability than Class 1. SS is available for structural purposes where specific mechanical properties are required. Strength is achieved by carbon and manganese additions.

TABLE 1 – TYPICAL MECHANICAL PROPERTIES – STANDARD GRADES

Quality Designation	Description	YS		UTS		Elong. %	Hardness HRb
		ksi	MPa	ksi	MPa		
Commercial Steel (CS Type B)	May be moderately formed. A specimen cut in any direction can be bent flat on itself without cracking.	39	270	52	360	39	61
Drawing Steel (DS Type B)	DS is made by adding aluminum to the molten steel and may be used in drawing applications.	35	240	48	330	41	56
Drawing Steel with Boron (DS Type B)	DS is made by adding aluminum and boron to the molten steel and may be used in severe drawing applications.	32	220	48	330	43	50

Typical properties produced by AK Steel for these grades. These are ordered by the appropriate ASTM Specification A 568, A 569, A 622, and A 635 which do not specify mechanical properties.

Commercial Steel and Drawing Steel are designations of the various steels described in ASTM A 569 and ASTM A 622. Each of these steel sheet designations is associated with unique requirements for chemical composition and with nonmandatory, typical mechanical properties.

TABLE 2 – ASTM SPECIFIED PROPERTIES – HIGHER STRENGTH GRADES

Quality Designation	Description	Min. YS		Min. UTS		Min. Elong. %	
		ksi	MPa	ksi	MPa		
Structural Quality (SQ)	A 570	Grade 30 ^{2,3}	30	205	49	340	25
		Grade 33 ^{2,3}	33	230	52	360	23
		Grade 36 ^{2,3}	36	250	53	365	22
		Grade 40 ^{2,3}	40	275	55	380	21
		Grade 45 ^{2,3}	45	310	60	410	19
		Grade 50 ^{2,3}	50	340	65	450	17
	A 907	Grade 55 ^{2,3}	55	380	70	480	15
		Grade 30 ^{2,3}	30	205	49	340	22
		Grade 33 ^{2,3}	33	230	52	360	22
		Grade 36 ^{2,3}	36	250	53	365	21
A 635	For conversion to A36 plate	36	250	58-80	400-550	23	
Medium/High Strength Low Alloy (HSLA)	A 607	Class 1					
		Grade 45 Formable 45K ^{4,5}	45	310	60	410	25
		Grade 50 Formable 50K ^{4,5}	50	340	65	450	22
		Grade 55 Formable 55K ^{4,5}	55	380	70	480	20
	Class 2	Grade 60 Formable 60K ^{4,5}	60	410	75	520	18
		Grade 45 Formable 45K ^{4,5}	45	310	55	380	25
		Grade 50 Formable 50K ^{4,5}	50	340	60	410	22
		Grade 55 Formable 55K ^{4,5}	55	380	65	450	20
		Grade 60 Formable 60K ^{4,5}	60	410	70	480	18
		A 715	Grade 50 Formable 50F ^{4,5}	50	340	60	410
	Grade 60 Formable 60F ^{4,5}		60	410	70	480	22

OTHER GRADES

Medium/High Strength Low Alloy (HSLA)	Formable 40K ⁵	40	275	55	380	26
	Formable 50F ^{5,6}	50	340	65	450	22
	Formable 55F ^{5,6}	55	380	70	480	20
	Formable 60F ^{5,6}	60	410	75	520	18

1. Gauge dependent

2. For gauges up to 0.229", ASTM A 570 must be specified, gauges >0.230", ASTM A 907 must be used.

3. Items 0.180 to 0.230" gauge which are >48" wide may be ordered to either A 570 or A 907.

4. ASTM A 607 is for Hot Rolled and Cold Rolled grades. AK Steel produces Type 1 (columbium bearing only), but as either Class 1 or Class 2. Class 1 has limits placed on C, Mn, P and S with a 15 ksi difference between the minimum specified YS and UTS. Class 2 limits only C and has a 10 ksi difference between the minimum specified YS and UTS.

5. AK Steel Formable Grade – K indicates killed, F indicates inclusion controlled low alloy.

6. SAE J1392 (under development at time of publication).

JOINING SYSTEMS

Most Hot Rolled Steels can be readily fabricated using a variety of welding and joining processes. This is largely due to the low carbon and alloy content, strength levels, and low impurity characteristics of these materials. Depending on gauge, surface conditions (pickled or unpickled) and joint design, suitable processes include arc welding, resistance welding, brazing, and soldering.

Resistance spot/seam/projection welding, soldering, and

brazing normally are incompatible with unpickled hot rolled steel. However, many arc welding processes which utilize consumable filler materials can be used successfully on unpickled (referred to as "black") Hot Rolled Steels.

Additional factors must be considered when welding higher carbon and high strength hot rolled grades. Technical assistance is available to select appropriate welding techniques for these steels.

PAINTABILITY

Plain, unpickled Hot Rolled Steels normally are unsuitable for painting. However, Hot Rolled Pickled Steel provides a suitable surface for painting provided proper care is taken in preparing the material. Prior to painting, the surface should be carefully cleaned with either a solvent

or alkaline cleaner. Cleaning should be followed by a pre-treatment prior to painting. Zinc or iron phosphates give good results on Hot Rolled Steels. Mild abrasion prior to pre-treating may also be used to enhance mechanical bonding of the paint.

APPLICATIONS

Hot Rolled Steels are used where heavy thickness, strength levels, and formability are required. Many unexposed structural applications exist in automotive and appliance markets. These include frame components, brackets, brake components, wheels,

clutch plates, tubing, and compressor shells. Construction, industrial machinery, agricultural equipment, railroad, and ship building are all areas where Hot Rolled Steels are used for panels, frames, and component parts.

SPECIFICATIONS

Hot Rolled Steels are produced in conformance with the following specifications:

ASTM A 568	General requirements
ASTM A 569	CS
ASTM A 570	SS
ASTM A 607	HSLAS
ASTM A 622	DS
ASTM A 635	Heavy gauge HR for conversion to plate
ASTM A 659	CS Carbon (0.16% - 0.25%)
ASTM A 715	HSLAS with improved formability
ASTM A 749	General requirements for HSLA HR
ASTM A 907	SS heavy gauge
SAE J1392	HSLA

For any specification not listed here, please consult your AK Sales or Technical Representative.

ENGINEERING PROPERTIES

TABLE 3

Young's Modulus of Elasticity	200 x 10 ⁶ MPa at 20°C
Density	7.87 g/cm ³ at 20°C
Coefficient of Thermal Expansion	Low-Carbon/HSLA: 12.4 μm/m/°C in 20°C to 100°C range I-F Steel: 12.9 μm/m/°C in 20°C to 100°C range
Thermal Conductivity	Low-Carbon/HSLA: 89 W/m°C at 20°C I-F Steel: 93 W/m°C at 20°C
Specific Heat	481 J/kg/°C in 50°C to 100°C range
Electrical Resistivity	0.142 μΩm at 20°C

OUTSIDE PROCESSING

Pickling, temper rolling, re-squaring, slitting, and cutting-to-length are just some of the services AK Steel can

provide through arrangements with outside processors.

MORE INFORMATION/TECHNICAL ASSISTANCE

AK Steel's Technical Representatives can provide you with more detailed information concerning this product. They also are available to assist you in

solving any welding, forming, painting, or other material selection issue.

MILL LIMITS

Hot Rolled Steels are available in thicknesses of 0.071" (1.80 mm) to 0.350" (8.89 mm) and widths of 40" (1016 mm) to 80" (2032 mm), depending on thickness. For sizes outside these limits, please inquire.

The standard inner diameter of Hot Rolled Pickled coils is 24" (610 mm) while Hot Bands have inside diameters of 30" (762 mm).

Thickness, width, and flatness tolerances are covered in ASTM Specification A 568.



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Data referring to mechanical properties and chemical analyses are the result of tests performed on specimens obtained from specific locations of the products in accordance with prescribed sampling procedures; any warranty thereof is limited to the values obtained at such locations and by such procedures. There is no warranty with respect to values of the materials at other locations.

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