





# COLD-ROLLED STEELS



- Automotive**
- Appliances**
- Construction**
- Lighting**
- Office Furniture**

**COLD-ROLLED STEELS** provide excellent thickness and flatness tolerances, surface finish, and press formability. Cleveland-Cliffs manufactures the following low and ultra-low-carbon grades to meet a variety of customer formability requirements: Commercial Steel (CS Type B), Drawing Steel (DS Type B), Extra Deep Drawing Steel (EDDS), and Extra Deep Drawing Steel Plus (EDDS+). Cleveland-Cliffs also produces High Strength Low Alloy Steel (HSLAS) and Structural Steel (SS) grades for those applications that require specified strength levels. Cold-rolled steels can also be specified as Dent Resistant (DR) or Bake Hardenable (BH) for applications that require dent resistance after forming and painting. At Cleveland-Cliffs, cold-rolled product can either be batch anneal or continuously annealed. The optimal routing is selected based on the ordered requirements. Each grade can be processed with several surface finishes depending on customer requirements.

## COLD-ROLLED STEELS

### Product Features

#### **EXCELLENT SURFACE APPEARANCE**

Cold-rolled steels have manufacturing controls in place assuring consistent surface quality to satisfy customer requirements.

#### **FORMABILITY**

Cold-rolled steels can be used to produce parts with forming, ranging from simple bends to extreme deep drawing requirements.

#### **PAINTABILITY**

Cold-rolled steels, due to stringent surface roughness controls, are readily paintable using an appropriate paint system.

#### **WELDABILITY**

Cold-rolled steels can be joined using accepted welding practices.

### Surface Finish

Cold-rolled steels are manufactured with a matte finish obtained by rolling with specially roughened rolls on the cold mill and the temper mill. This finish helps to maintain effective lubrication during metal forming and improves the appearance of painted surfaces. Additionally, non-standard finishes are available.

### Surface Protection and Lubrication

To prevent rusting in transit and storage, Cold-rolled steels are supplied with a rust-protective oil film or press forming lubricants. Cleveland-Cliffs will apply a rust-preventative oil unless otherwise specified.



## COLD-ROLLED STEELS

### Formability and Mechanical Properties

The formability of all steel products is a result of the interaction of many variables. The variables include: the mechanical properties of the steel, the forming system (tooling) used to manufacture parts and the lubrication used during forming. Cleveland-Cliffs can directly affect the mechanical properties of the steel. Tight control over chemical composition, hot-rolling parameters, amount of cold reduction, annealing time and temperature, and the amount of temper rolling allow the production of high-quality cold-rolled steel products to meet customer requirements.

#### **COMMERCIAL STEEL (CS)**

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

To minimize the occurrence of fluting or stretcher strains during forming, CS products are temper rolled as a normal step in the mill processing.

#### **DRAWING STEEL (DS)**

For more severe forming applications, Drawing Steel Type B (DS Type B) should be ordered. DS Type B has a controlled carbon content of less than 0.08%C and is produced in such a manner that parts formed from DS Type B Steel should not exhibit stretcher strain.

#### **DEEP DRAWING STEEL (DDS)**

Deep Drawing Steel is typically produced as low carbon steel with a max carbon of 0.06%C, Interstitial-Free (I-F) steel is also allowed at producer's discretion but is not required. This type of steel should be ordered for applications that require the most consistent type of low-carbon steel.

#### **EXTRA DEEP DRAWING STEEL (EDDS)**

Extra Deep Drawing Steel or Extra Deep Drawing Steel Plus (EDDS+) should be ordered for the most demanding forming applications. These steels, also known as Interstitial Free (I-F) steels are produced from a vacuum-degassed, stabilized grade.

#### **HIGH STRENGTH (HSLA) OR STRUCTURAL STEEL (SS)**

For high strength or structural applications, cold-rolled steels are also available in yield strengths up to 60 ksi. (420 MPa) and up to grade 50, as shown in Table 2, page 5.

#### **DENT RESISTANT (DR) OR BAKE HARD STEEL (BH)**

Cold-rolled steels can also be specified as Dent Resistant (DR) or Bake Hardenable (BH) for applications that require dent resistance after forming and painting. See Table 3, page 3.

Typical mechanical properties are shown in Table 1, page 3. The n-Value, i.e. strain hardening exponent, has been shown to correlate with stretch forming behavior, while the  $r_m$  is a measure of deep-drawing capability.

#### **PRESS HARDENABLE STEELS (PHS)**

Press Hardenable Steel (PHS), commonly referred to as Mn22B5 or 15B22, is available as cold-rolled full hard or annealed and tempered. This material is used in hot stamping applications to achieve final ultimate tensile strength approaching 1500 MPa.

#### **SPECIFIED HARDNESS**

This is available in a variety of hardness ranges, with a minimum of 15 point range. When ordering this quality, chemistry cannot be specified. All ranges may not be available.

# COLD-ROLLED STEELS

## PAINTABILITY

Cold-rolled steels can be readily painted using a variety of paint systems 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 (Zn) or iron phosphates give good results on cold-rolled steels. Mild abrasion prior to pretreating may also be used to enhance mechanical bonding of the paint.

Cold-rolled Steels can be supplied as pre-painted or pre-primed through Cleveland-Cliffs' arrangements with outside coil coaters.

## ENGINEERING PROPERTIES

Young's Modulus of Elasticity	200 x 10 <sup>3</sup> MPa at 20 °C
Density	7.87 g/cm <sup>3</sup> at 20 °C
Coefficient of Thermal Expansion	Low-Carbon/HSLAS: 12.4 μm/m/°C in 20 – 100 °C range I-F Steel: 12.9 μm/m/°C in 20 – 100 °C range
Thermal Conductivity	Low-Carbon/HSLAS: 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 – 100 °C range
Electrical Resistivity	0.142 μΩ·m at 20 °C

## OUTSIDE PROCESSING

Tailored blanks, tension leveling, re-squaring, slitting, cut-to-length and coil coating are just some of the services Cleveland-Cliffs can provide through arrangements with outside processors.

## SPECIFICATIONS

Cold-rolled steels are produced in conformance to the following specifications.

ASTM A1008	CS/DS/DDS/EDDS/SS/HSLAS/DR/BH
ASTM A568	General
ASTM A794	CS Carbon (0.16 – 0.25%)
SAE J1392	HSLAS/SS
SAE J2340	HSLAS/DR/BH/RA
SAE J2329	CS/DS/DDS/EDDS
SAE J403	General
Press Hardenable	Full Hard and Annealed/Tempered Rolled

*For any specifications not listed here, contact your Cleveland-Cliffs sales representative.*

## TECHNICAL ASSISTANCE

Cleveland-Cliffs' Technical Representatives can provide you with more detailed information concerning this product. They also are available to assist you in reviewing any welding, forming, painting or other material selection issue.

## MILL LIMITS

Cold-rolled steels are available in thicknesses from 0.015 – 0.135 in. (0.381 – 3.429 mm), and widths to 80 in. (2032 mm), depending on dimensions and product quality.

The standard coil inner diameter is 24 in. (609 mm).

Thickness, width, and flatness tolerances are covered in ASTM A568.

# COLD-ROLLED STEELS

## Tables

**TABLE 1 – TYPICAL MECHANICAL PROPERTIES – STANDARD GRADES**

Quality Designation	Description	YS		UTS		% Elong. in 2"	Rockwell Hardness	n-Value	r <sub>m</sub>
		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.	29	200	46	317	39	B42	—	—
Drawing Steel DS (DS Type B)	Type B is made by adding aluminum to the molten steel and may be used in drawing applications.	25	172	44	303	43	B37	0.22	16
Extra Deep Drawing Steel (EDDS)	Interstitial Free (I-F) steels are made by adding titanium and/or niobium to the molten steel after vacuum degassing and offer excellent drawability.	21	145	42	303	45	B30	0.23	17
Extra Deep Drawing Steel Plus (EDDS+)	Interstitial Free (I-F) steels are made by adding titanium and/or niobium to the molten steel after vacuum degassing and offer excellent drawability.	20	138	42	296	46	B30	0.25	1.8

Typical properties produced by Cleveland-Cliffs for these grades.

These are ordered by the appropriate ASTM Specification. A1008, which contain typical mechanical properties and required chemical compositions.

**TABLE 2 – ASTM SPECIFIED PROPERTIES**

Quality Designation	Description	Min. YS		Min. UTS		Min. Elong. %
		ksi.	MPa	ksi.	MPa	
Structural Steel	Grade 25	25	170	42	290	26
	Grade 30	30	205	45	310	24
	Grade 33 Type 1 & 2	33	230	48	330	22
	Grade 40 Type 1 & 2	40	275	52	358	20
	Grade 50	50	340	65	450	18
	Grade 80 (Full Hard Only)	80	550	82	565	—
High-Strength Low-Alloy Steel (HSLAS)	Grade 40/SAE J1392 040 YLK	40	280	55	380	25
	Grade 40/SAE J1392 040 XLK	40	280	50	340	25
	Grade 45 CL 1/SAE J1392 045 YLK	45	310	60	415	22
	Grade 45 CL 2/SAE J1392 045 XLK	45	310	55	380	22
	Grade 50 CL 1/SAE J1392 050 YLK	50	340	65	450	20
	Grade 50 CL 2/SAE J1392 050 XLK	50	340	60	410	20
High-Strength Low-Alloy Steel (HSLAS-F)	Grade 50	50	340	60	410	22
	Grade 60	60	410	70	480	18

# COLD-ROLLED STEELS

## Tables

**TABLE 3 – SAE SPECIFIED PROPERTIES**

Quality Designation	Description	Min. YS	Min. UTS	n-Value
		MPa	MPa	
Bake Hardenable 180	SAE J2340 Type 180B	180	300	0.19
Dent Resistant 210	SAE J2340 Type 201A	210	330	0.19
Bake Hardenable 210	SAE J2340 Type 210B	210	320	0.17
Recovery Annealed 830	SAE J2340 Type 830R	830	860	—

### About Cleveland-Cliffs Inc.

Cleveland-Cliffs is the largest flat-rolled steel producer in North America. Founded in 1847 as a mine operator, Cliffs also is the largest manufacturer of iron ore pellets in North America. The Company is vertically integrated from mined raw materials and direct reduced iron to primary steelmaking and downstream finishing, stamping, tooling, and tubing. The Company serves a diverse range of markets due to its comprehensive offering of flat-rolled steel products and is the largest steel supplier to the automotive industry in North America. Headquartered in Cleveland, Ohio, Cleveland-Cliffs employs approximately 25,000 people across its mining, steel and downstream manufacturing operations in the United States and Canada.



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