ArcelorMittal USA

ArcelorMittal

Plate

Duracorr®: Life-Cycle Cost-Effective 12% Chromium Stainless Steel

Introduction

Duracorr® is a low-cost, 12% chromium, dual-phase stainless steel product produced by ArcelorMittal USA. When compared to weathering, painted or galvanized steels, it has life cycle cost advantages that permit its effective use in a wide variety of applications. Duracorr Grades 40 and 50 are formable, weldable and exhibit good toughness. Also, Duracorr 300, with a 300 HB nominal hardness, is available for applications where both abrasion and corrosion resistance are required.

Duracorr is substantially more corrosion-resistant than weathering, painted or galvanized steels.

Duracorr is described by ASTM A1010. It is also listed in ASTM A240 as UNS designation S41003. ASME code approval is pending. Inquire with ArcelorMittal USA Plate offices for the latest available information concerning pressure vessel applications. The steel may be used in a number of applications requiring strength and corrosion resistance.

Bridge fabricated from A1010/Duracorr, Coatesville, PA

Current and Potential Applications

- Coal Cars
- Ore Cars
- Quarry Equipment
- Truck Salt Spreaders
- Street Sweepers
- Oil Sands Piping
- Grain Hopper Cars
- Sugar Beet Processing Equipment
- Storage Bins
- Drain Covers
- Electrical Transmission Towers
- Coal Handling Equipment
- Cement Plant Equipment
- Floor Plate
- Bus Frames
- Tubing
- Fertilizer Handling and Storage
- Manure Hoppers and Spreaders
- Dry Docks
- Sewage Plant Equipment
- Bridges

Chemistry

Duracorr is produced to the chemical composition shown in Table 1 and is melted and refined by the Vacuum Oxygen Decarburization (VOD) Process. It exhibits a fine-grain, dual-phase microstructure of ferrite and tempered martensite.

Table 1
Specified Composition

	C	Mn	P	S	Si	Cr	Ni	N	Mo
ASTM 1010 UNS S41003	0.03	1.50	0.040	0.010	1.00	10.5-12.5	1.50	0.030	-
Duracorr	0.025	1.50	0.040	0.010	0.70	11.0-12.5	1.00	0.030	0.20-0.35

(Maximum wt. %, except as noted)

Wet rock, phosphate hopper rail car.

Availability

Table 2
Sizes

Product Form [4]	Standard Available Sizes for Duracorr[1] Thickness (min.-max.)		Width (max.)	
	In.	mm	In.	mm
Plate [3]	0.1875-2.0	4.8-50.8	126	3200
Floor Plate [2]	0.250-1.0	6.35-25	96	2438

(1) ASTM A480 Hot-Rolled Mill Plate tolerances apply to all product forms.

(2) Plate length depends on plate thickness and width (UL-approved tread). Inquire for thicknesses between 0.250 in. (6.35 mm) to 1.0 in. (25 mm).

(3) Lengths to 540 in. (13.7 m). Ask for other sizes.

(4) Duracorr cold rolled sheet and plate in coil are no longer available from ArcelorMittal USA.

Finishes

Duracorr is available in plate and sheet with the following finish:

- Hot Rolled Annealed "Black"

Pipe and Structural Tubing

Pipe and structural tubing are available in a variety of sizes from fabricators.

Figure 1
Duracorr floor plate with Sure-foot® UL-approved pattern.

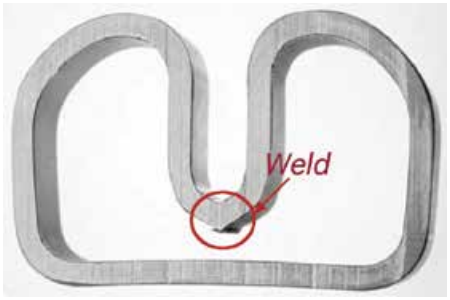


Figure 2
1/4" x 4" x 4" Duracorr ERW structural tubing longitudinal crush test.

Mechanical Properties

Tensile Strength and Toughness

The specified mechanical properties for the two ASTM specifications that cover Duracorr are shown in Table 3. The tensile property distributions shown in Figure 3 are for Duracorr Grade 50. Examples of Charpy V-Notch (CVN) impact curves and distributions are provided in Figures 4 and 5.

Table 3
Specified Mechanical Properties

	ASTM A240 UNS S41003		ASTM 1010 Grade 40 (Optional)		ASTM 1010 Grade 50 (Standard)	
Ultimate Tensile Strength, Min. ksi (MPa)	66 ksi	445 MPa	66 ksi	445 MPa	70 ksi	485 MPa
Yield Strength, min. ksi (MPa)	40 ksi	275 MPa	40 ksi	275 MPa	50 ksi	345 MPa
Elongation in 2 in. (50 mm), min.	18%	–	18%	–	18%	
Brinell Hardness, max.	223 HB [1]	–	–	–	–	

(1) Converts to 20 HRC

Duracorr 300

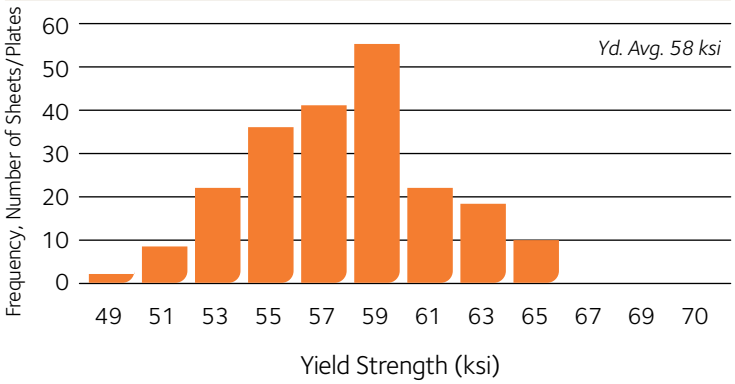
An abrasion resistant form of Duracorr heat treated is available as Duracorr 300, with hardness levels of 260-360 HB. See www.arcelormittal.com for more details on this product.

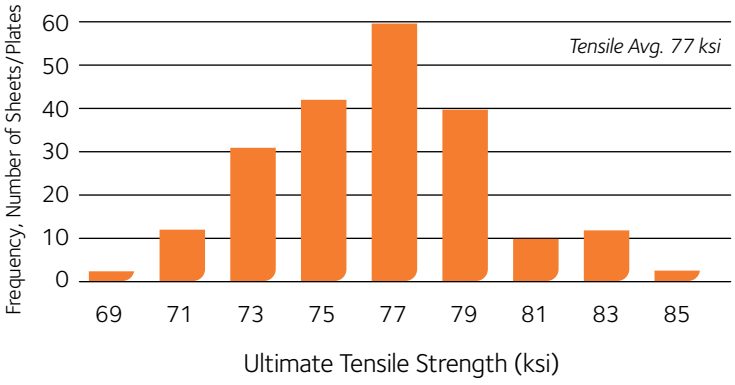
High-Temperature Tensile Properties

Duracorr may be considered for high-temperature applications. To assist in evaluating its applicability, Figure 6 presents a comparison of yield strength properties versus other steels. Note that up to 1000ºF Duracorr demonstrates similar strength properties to Type 304 stainless steel. It is not recommended Duracorr be used at temperatures above 800ºF without considering creep design procedures. High-temperature stress-rupture and creep data were developed for Duracorr. Check with ArcelorMittal USA Plate offices for the latest available information.

Grade 50 Typical Mechanical Properties

Figure 3
Tensile Property Distributions
0.157 – 0.375" Thick Product





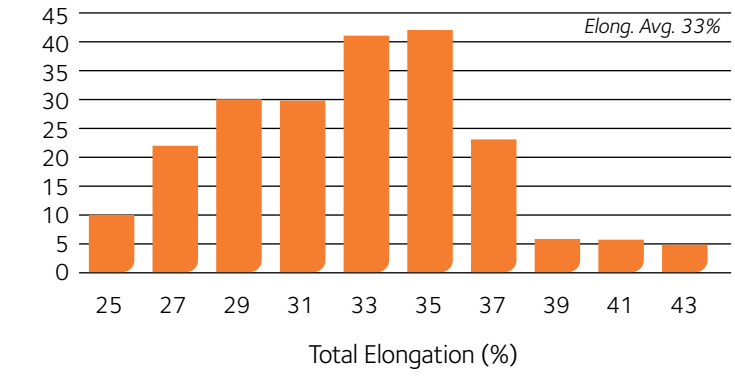
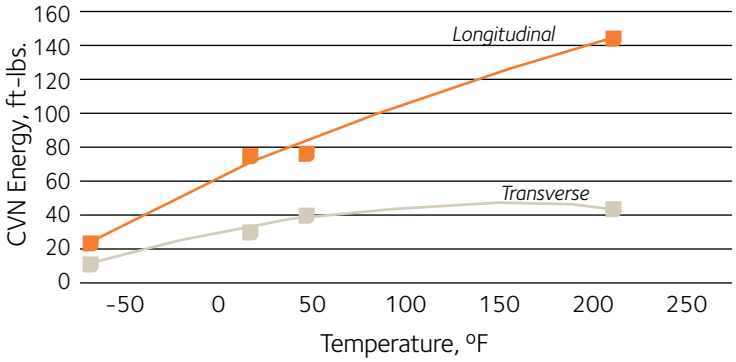
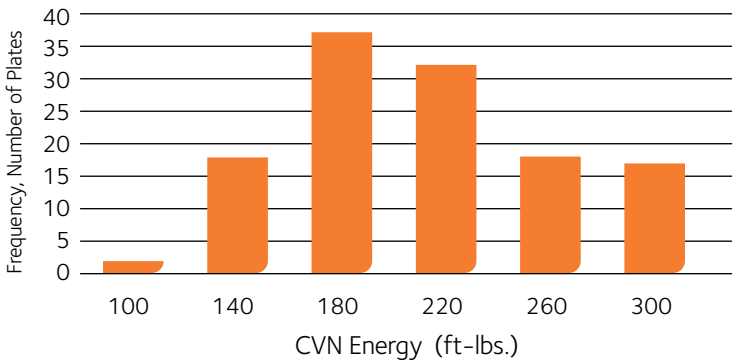


Figure 4
Charpy V-Notch Impact Curves
0.25 in. Thick Plate



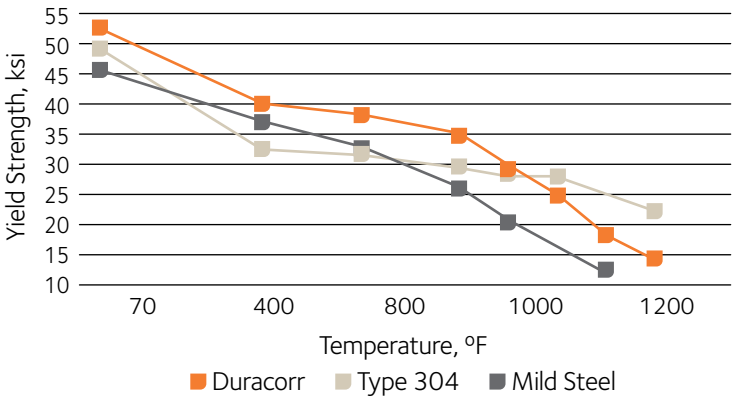
1/2 Size CVN Specimens Converted to Full Size

Figure 5
Longitudinal Charpy-V-Notch Impact Distributions
at Room Temperature*
.25 - .375" Thick Plate



* 3/4 and 1/2 CVN specimens converted to full size

Figure 6
Elevated Temperature Data
Yield Strength Compared to Other Steels



Fatigue Properties

The fatigue behavior of Duracorr Grade 50 is comparable to other steels with 50 ksi minimum yield strength. When welded, Duracorr weldments perform similarly to other 50 ksi structural steels.

Corrosion Behavior

Corrosion of stainless steel can occur by a number of mechanisms including general, galvanic, pitting, crevice, intergranular and stress. The excellent behavior of Duracorr in general corrosion is shown in Table 4, where it is compared to other metals in water with different chloride concentrations.

Corrosion Rates of Various Metals in Water [1] Mils (0.001 inches) per year

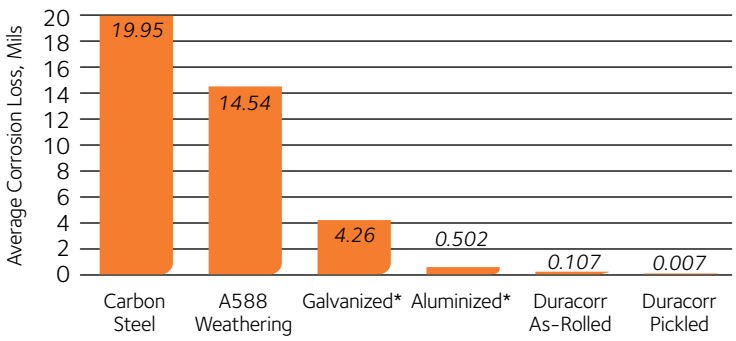
Table 4
Test Temperature = 77°F (25°C) and pH = 7.0
Chloride Concentration (ppm)

Alloy	50 [2]	150	250	1000	5000	20000 [3]
Type 304	0.1	0.1	0.1	0.2	0.2	0.2
Duracorr	0.3	0.5	0.4	2.1	1.2	2.6
Weathering Steel	3.7	3.5	4.1	4.3	3.5	3.1
Galvanized Steel	7.4	16	11	7.6	6.3	5.9
Aluminum 5083	0.6	3.9	0.9	4.8	4.8	2.3

(1) No pitting attack observed in any of the test specimens.
(2) Tap water.
(3) Sea water.

Further support for Duracorr's behavior in chloride environments is provided by the SAE J2334 salt, wet/dry, 80-cycle corrosion test. These results are shown in Figure 7 versus other metals. Duracorr also exhibited good crevice corrosion resistance after 120-cycle exposure in the SAE J2334 corrosion test.

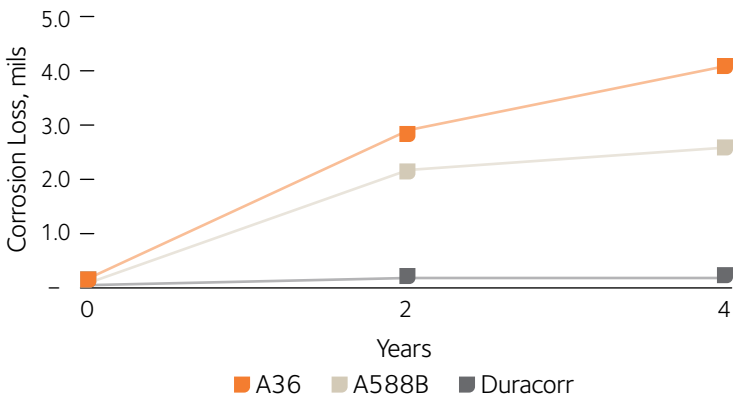
Figure 7
Corrosion Performance in SAE J2334 Test [1]



* Coated carbon steels
(1) salt, wet/dry, 8-week test

Kure Beach, NC marine atmospheric exposure tests 25 meters from mean tide level revealed hot rolled Duracorr panels exhibited better corrosion resistance than A36 or A588 after four years of exposure as shown in Figure 8.

Figure 8
Duracorr Exposure Trials
Kure Beach 25m Location



Often, Duracorr may be in contact with carbon steel in the fabrication of different products. Such a design feature may promote galvanic corrosion. When two different metals touch in a corrosive solution, a galvanic couple is created and accelerated corrosion of the less corrosion-resistant metal occurs. This effect can be reduced if the surface area of the carbon steel is large compared to the area of Duracorr. If the reverse is present – for example, carbon steel rivets in Duracorr – carbon steel will corrode at a significantly higher rate. Therefore, it is important to use stainless rivets, bolts or interior structural elements if Duracorr is in contact with a corrosive environment.

The environment in which Duracorr is used dictates its applicability. Duracorr has been used in challenging corrosive applications including rail cars and equipment for processing high-sulfur coal, water tanks in street sweepers and processing equipment for sugar beets. Contact ArcelorMittal USA Plate offices to review other applications.

Processing Guidelines

Duracorr exhibits a fine-grained microstructure of ferrite and tempered martensite that imparts attractive fabrication characteristics. Duracorr is formable and weldable when the guidelines below are followed.

Cold Forming

Duracorr forming behavior is similar to 50 ksi minimum yield strength HSLA steel products.

- When bending Duracorr with sawed, plasma-cut or ground edges, a 1/2t (t = thickness) minimum bend radius can be used.
- If the edges are sheared, the 1/2t radius only applies to bends perpendicular to the major rolling direction. Bends parallel to the major rolling direction should use a 2t minimum bend radius. The 1/2t guideline may be used for all orientations if the complete cold-worked sheared edge (face and burr) in the location of the bend is ground, removing approximately 0.05 in. of metal.

Welding

Duracorr is readily weldable to itself, employing commonly used welding processes to itself, as well as to carbon and stainless steels, providing appropriate consumables and fabrication procedures are used. The parts to be welded should be free of loose/thick scale, moisture, grease and/or other foreign materials that could potentially influence weld quality. Qualification of the welding procedures per an appropriate code; e.g., ANSI/AWS D1.1, "Structural Welding Code – Steel" is recommended. As for welding any material, welder fume exposure should be minimized through the use of ventilation, fume extractors and/or respirators, as necessary for the given conditions. See our welding guidelines for Duracorr at: www.arcelormittal.com.

Bridge Fabrication

More specific details on fabricating bridge members of Duracorr are available on our website at: www.arcelormittal.com.

References

1. Fletcher, F. B., Ferry, B. N. and Beblo, D. G., "High Performance Corrosion-Resistant Structural Steel", High Performance Structural Steels, ASM International, 1995.
2. Fletcher, F. B., Townsend, H. E. and Wilson, A. D., "Corrosion Performance of Improved Weathering Steels for Bridges", World Steel Bridge Symposium, National Steel Bridge Alliance, Orlando, FL, November 19-20, 2003.
3. Fletcher, F. B., Wilson, A. D., Strasky, J., Kilpatrick, J. N., Mlcoch, L. T., and Wrysinski, J. S., "Stainless Steel for Accelerated Bridge Construction", FHWA Accelerated Bridge Construction Conference, San Diego, CA, 2005.

Further Information

Contact Martin Francis at ArcelorMittal USA at T +1 610 383 2069 or email martin.francis@arcelormittal.com.

Continuing updates of this information can be found on our website at: www.arcelormittal.com.

Truck for salt spreading.

ArcelorMittal USA
Corporate Office
1 South Dearborn Street
18th Floor
Chicago, IL 60603-9888
USA

T +1 800 422 9422
www.arcelormittal.com

ArcelorMittal USA
Plate
ARC Building
139 Modena Road
Coatesville, PA 19320-0911
USA

T +1 800 966 5352
www.arcelormittal.com

ArcelorMittal USA
Plate
250 West U.S. Highway 12
Burns Harbor, IN 46304-9745
USA

T +1 800 422 9422
www.arcelormittal.com

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