ArcelorMittal USA

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Plate

Duracorr®/A1010: Bridge Applications and Fabrication Guidelines

Introduction

Duracorr®/ASTM A1010 should be considered for bridge applications where severe chloride corrosive environments or excessive time of wetness exist. This includes exposure to excessive road salts or marine environments where long-term maintenance is difficult to guarantee. Short-term accelerated marine and Kure Beach marine atmosphere tests have demonstrated superiority of Duracorr to traditional weathering steels and to galvanized protective coatings (see Figures 1 and 2). Examples of sites worthy of consideration are: overpasses in northern climates with minimal vertical clearance, bridges over depressed roadways subject to concentrated salt spray, or those along the seacoast. However, Duracorr is not intended for long-term immersion in salt-water environments.

Availability

Duracorr is available in maximum thicknesses of 2 in. (51mm), widths to 126 in. (3200 mm) and lengths to 540 in. (13.7 m), all depending on overall weight of the plate.

Mechanical Properties

Duracorr can be produced to meet the requirements of ASTM A709 Grade 50W through 2 in. (51 mm) thick. This includes Charpy-V-Notch testing in Zone 3 fracture-critical requirements, when specified (see Fig. 3). Duracorr can also be specified as ASTM A1010 Grade 50.

Fabrication Guidelines

Thermal Cutting

Due to the high chromium content of Duracorr, it cannot be efficiently cut using traditional oxy-fuel cutting (gas cutting). Plasma cutting, powder cutting or laser cutting is recommended. Cutting techniques should follow equipment supplier guidelines with particular care not to use excessive cutting speeds. Due to the low carbon content of Duracorr, the thermal cut edges are not excessively hard.

Life Cycle Cost Analysis

It has been demonstrated (Ref. 4) that if A1010 replaces painted steel girders in a bridge, the initial cost difference is overcome after one re-painting cycle (see Fig. 4).

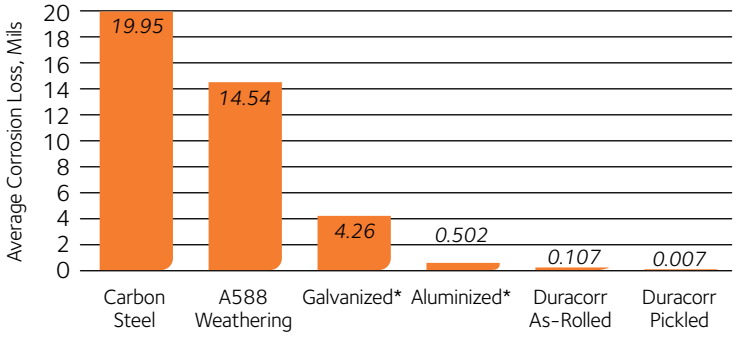
Weathering

Duracorr will develop a light tan patina after long-term atmospheric exposure. This patina is lighter in color and takes much longer to develop than in A588 or A709-50W traditional weathering steels. If the mill scale is left on the plate, the weathering pattern is non-uniform. Plate and/or members can be blasted to provide a more uniform appearance. Sand, ceramic or other non-iron blasting media is recommended because of use of steel shot or grit for blasting will leave residual iron on the product; which will rust giving a speckled appearance. An SSPC#6 blast is recommended for initial applications – the same as what is done with traditional weathering steel girders.

Fasteners

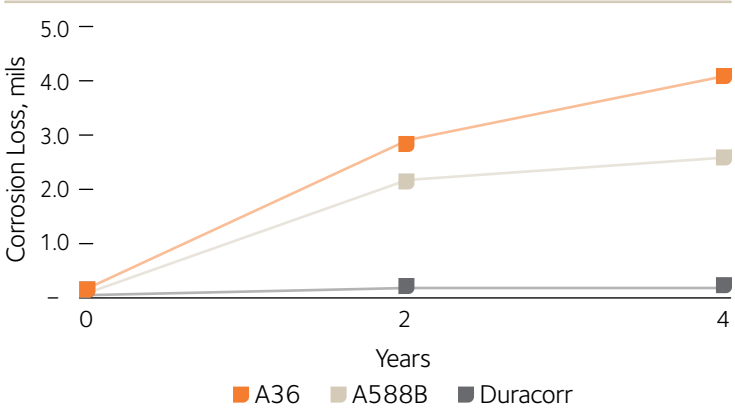
Bolts, nuts and washers for fastening Duracorr members should be made of 410 stainless steel or be hot dip galvanized. When galvanized fasteners are used, uneven surface stains can be expected on Duracorr in the vicinity of the fastener.

Figure 1
Corrosion Performance in SAE J2334 Test (1)



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

Figure 2
Duracorr Exposure Trials
Kure Beach 25m Location



Formability and Machinability

Duracorr exhibits forming and machining characteristics meeting or exceeding the performance of other 50 ksi (345 MPa) minimum yield strength steels, e.g., ASTM A709 Grade 50W.

Heat Forming, Curving and Straightening

Duracorr can be effectively modified by heat curving if a maximum temperature of 1200ºF is observed.

Shear Connectors

Traditional carbon steel shear studs can be used with Duracorr with no additional restrictions.

Recommended consumables by welding process

Welding Process	Filler Wire Designation	Filler Wire Specification	Flux or Shielding Gas**
FCAW	E309LTx-x, E308LTx-x, E316LTx-x	ANSI/AWS A5.22	CO_2, Ar-O_2 (1-5%), Ar-CO_2 (5-25%)
GMAW	ER309L, ER308L, ER316L, ER309LSi*, ER308LSi*, ER316LSi*	ANSI/AWS A5.9	Ar-O_2 (1-5%), Ar-CO_2 (5-25%)
SMAW	E309L-xx, E308L-xx, E316L-xx	ANSI/AWS A5.4	Not Used
GTAW	ER309L, ER308L, ER316L, ER309LSi*, ER308LSi*, ER316LSi*	ANSI/AWS A5.9	Argon
SAW	ER309L, ER308L, ER316L, ER309LSi*, ER308LSi*, ER316LSi*	ANSI/AWS A5.9	Neutral Flux

* Higher silicon wires yield improved wetting and bead appearance. Some increased risk of weld metal cracking.

** Match to electrode per manufacturer's recommendation.

Welding

Duracorr is readily weldable via commonly used welding processes, both to itself as well as to carbon and stainless steels, provided that appropriate consumables and fabrication procedures are utilized. 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 D1.5, "Bridge Welding Code" 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. More specific Duracorr-related practices are described below:

- For thicknesses less than 0.5", weld heat input should be limited to a maximum of 25 kJ/in to avoid diminished heat-affected zone (HAZ) toughness. For thicker plates, higher heat inputs to 70 kJ/in. have been successfully used. Voltage and current should be set at the low to middle portion of the electrode manufacturer's range. Weld beads should be of the stringer type and of a size sufficient for the application without overwelding.
- The flux-cored arc (FCAW), gas metal arc (GMAW), shielded metal arc (SMAW), and gas tungsten arc (GTAW) welding processes are generally suitable for joining Duracorr. Higher heat input processes like submerged arc (SAW) and the spray transfer modes of the other wire-fed processes should only be used after verification that the weld properties obtained are appropriate for the given application.
- Duracorr need only be preheated sufficiently to eliminate any surface moisture. A maximum interpass temperature of 212ºF is recommended.
- Postweld stress relief heat treatment is allowable with a maximum PWHT temperature of 1300ºF.
- Austenitic filler metals, including 309L, 308L, and 316L stainless are recommended for arc welding Duracorr. Higher silicon versions of these fillers (309LSi, 308LSi, 316LSi) can be used, where necessary, to improve wetting and/or weld appearance, albeit at some risk of increased weld metal crack sensitivity. Welding Duracorr to carbon steel should always be done employing 309L. The use of "matching" filler metals is not recommended. See table to the left for the consumables guide.

Figure 3
A1010 CVN at +10°F for Oregon Dodge Creek Bridge

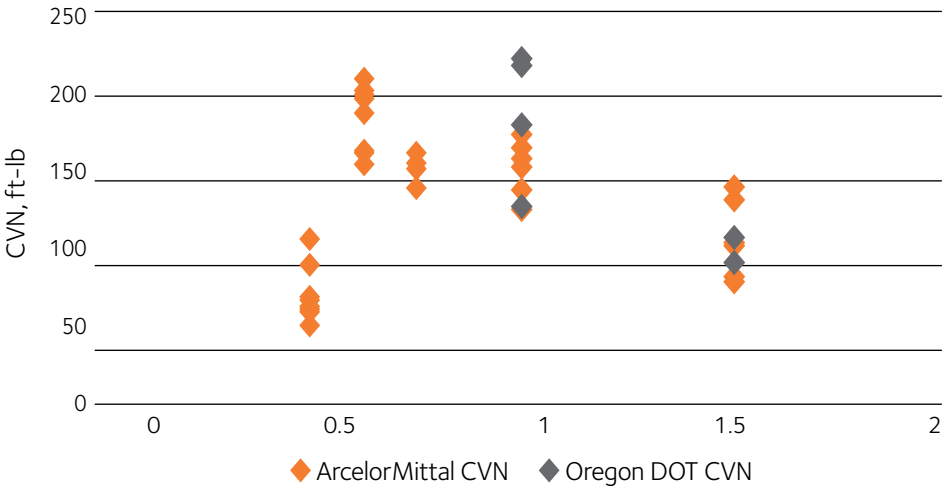
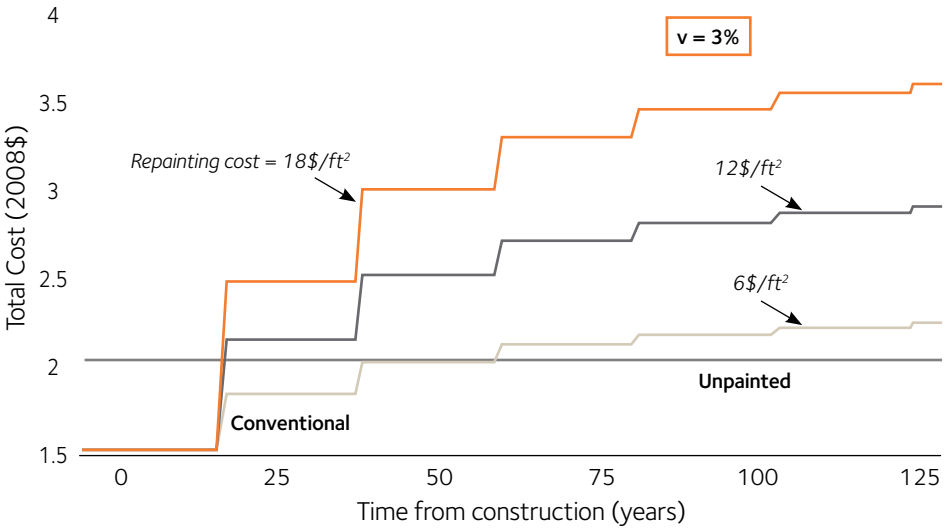


Figure 4
Girder repainting at 20 year intervals



Deterministic Life Cycle Cost Analysis

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.
4. N. M. Okasha, D. M. Frangopol, F. B. Fletcher, A. D. Wilson, "Life-Cycle Cost Analyses of a New Steel for Bridges", Journal of Bridge Engineering, Jan./Feb. 2012 pp.168-172.

Further Information

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Bridge applications of A1010

Location	Open	Why A1010	Span	Plate Thickness
Colusa County, Ca., over local canal	2004	One foot clearance over canal, thin section	2x38'	0.16 – 1"
Coatesville, Pa. steel plant, over local creek	2012	Salt use, excessive time of wetness	2x49'	3/8- 1.50"
Astoria, Oregon, Hwy. 138 and Dodge Creek	2012	Excessive time of wetness	130'	0.5 -1.75"
Oregon, U.S. Rte. 30 and Mill Creek	2013	Excessive time of wetness	120'	0.5 - 1.5"

Coatesville steel mill Duracorr®/A1010 bridge.

Colusa County, CA, A1010 Bridge, 2004 -2012.

Oregon DOT Dodge Creek A1010 Bridge.

Mill Creek Bridge, U.S. Route 30, Astoria, Oregon.

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