

## Out in the Open

BY KEITH A. GRUBB, P.E., S.E.

### Weathering steel in architectural applications.

**MENTION THE TOPIC OF WEATHERING STEEL** to a group of designers, and two things usually come to mind: COR-TEN and bridges. COR-TEN is a trade name developed by U.S. Steel to market weathering steel. And bridges—well—they're the most common application for weathering steel today.

So what is this stuff? Weathering steel is a steel alloy containing quantities of copper, chromium, nickel, and other alloying elements that enhance corrosion resistance. When the steel rusts under normal atmospheric conditions, it forms a protective patina that bonds with the surface of the steel. Over a relatively short period of time, the patina forms into an impervious layer that precludes further corrosion. Minor damage to the coating is self-healing. In its early stages, the

coating is a reddish-orange brown color. Over time, the coating thickens, the texture becomes a bit rougher, and the color deepens to a

rich purple-brown. With the patina protecting the steel from further rusting, there is no need for the expense of painting the steel to protect it from the weather. Its low maintenance requirements and rustic appearance make it a popular choice for highway bridges.

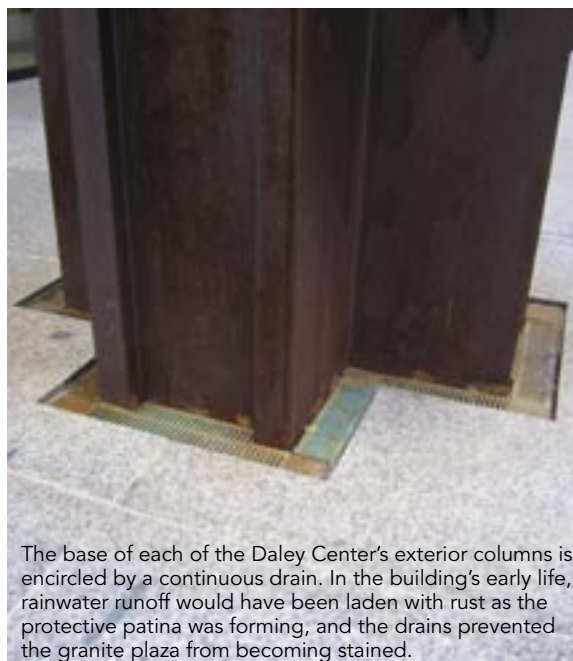
In the 1960s, the novelty of weathering steel (and its then-new 50 ksi yield stress) led to its application in buildings. Chicago's Richard J. Daley Center (1965) was the first building to be entirely built with exposed weathering steel. Interestingly, the plaza outside the Daley Center features a Pablo Picasso sculpture also made entirely of weathering steel.

#### Specification Specifics

ASTM A588 covers the majority of rolled structural shapes produced in weathering steel and can be considered the "base" specification for weathering steel for building applications. ASTM A709 is used primarily in bridge applications. Among its various grades, Grades 50W and HPS 50W are available in rolled shapes. Other grades such as HPS 70W, cover plates of various thick-



Photos by Keith Grubb



The base of each of the Daley Center's exterior columns is encircled by a continuous drain. In the building's early life, rainwater runoff would have been laden with rust as the protective patina was forming, and the drains prevented the granite plaza from becoming stained.



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Chicago's Richard J. Daley Center, as well as its iconic Pablo Picasso sculpture, was the first building to be entirely built with exposed weathering steel.

ness ranges. ASTM A242 is the original COR-TEN specification, which varies in yield strength from 42 ksi to 50 ksi depending on the shape or plate thickness. HSS with weathering steel characteristics are available as ASTM A847.

### Buying Basics

Because of the “exotic” nature of using weathering steel for building applications, AISC’s Steel Solutions Center often gets questions about the availability of weathering steel. Usually, relatively small quantities are required for specific architectural features, such as pedestrian bridges or canopies. An informal survey of AISC-member steel service centers found that many had at least some ASTM A588 material on hand for immediately delivery. Some

had extensive inventories (angles, channels, W-shapes, bar, sheet, and plate), and those that didn’t stock it would source it or could recommend another supplier. For a complete list of AISC-member service centers, visit [www.aisc.org/servicecenter](http://www.aisc.org/servicecenter).

HSS in weathering steel grades are somewhat more difficult to come across. According to Jim Collins, vice president of marketing for Metals USA, weathering steel HSS may only be available from one or two specialty service centers in the U.S. (See “Rare Shapes,” next page.)

Keep in mind that the weathering-steel-for-buildings market is extremely small: The most extensive inventory at any one service center was in the 200- to 300-ton range, and that total includes *all* shapes stocked. For projects

of any size, getting into a mill’s rolling schedule is definitely something to consider and discuss with a local fabricator or service center.

### Location, Location, Location

Frequent wet/dry cycles are key for the protective coating formation. Moisture from precipitation and dew, dried by the wind and sun, is essential for the formation of the patina. Because of this, weathering steel isn’t a good choice in environments that are constantly wet or humid—where the steel can’t dry. Also, weathering steel is not recommended for subsoil applications because the chemistry of some soils can corrode the steel.

Applications where the steel would be subject to salt spray, salt splashing,

### On the Road

Short-span bridges are ideally suited to weathering steel. Jim Collins of Metals USA notes that his company stocks W24, W27, W30, W36, W40, and W44 beams. They have supplied steel for bridges in the 150-ft to 200-ft-long range, with girder lengths of 60 ft to 80 ft. ASTM A588 is the most common specification he sees, and Metals USA supplies Charpy testing upon request. Collins has noticed a trend towards the use of W40 and W44 sections in the bridge market. For more information about using weathering steel for bridges, visit [www.aisc.org/weathering](http://www.aisc.org/weathering).

The Box Elder Creek Bridge in eastern Colorado (a 2007 National Steel Bridge Alliance Prize Bridge Award winner; see 11/07 MSC) employs W-shape weathering steel.



or salt-laden fogs from de-icing salts or coastal conditions are not good candidates for weathering steel. Salt precludes the development of the protective patina and dramatically accelerates corrosion.

### Devilish Details

The success of Chicago's Daley Center, from an aesthetic perspective, is largely due to the control of rainwater runoff and good maintenance. For example, the base of every exterior column is encircled by a continuous drain. In the building's early life, rainwater runoff would have been laden with rust as the protective patina was forming, and those drains prevented the granite plaza from becoming stained. Rust stains on the stone plaza from the façade of the building appear to be minimal, probably due to periodic stone maintenance. Also, the good condition of the columns is a sign that corrosive de-icing chemicals have either not been used on the plaza or have been kept away from the steel.

### Other Details to Watch for

**Design for drips:** Pay attention to drainage details by controlling rust-laden runoff. Drip pans and overhangs can keep water away from stainable surfaces below. Detail exposed slab expansion joints (such as in pedestrian walkway slabs) with troughs below to catch runoff if the joint fails. Masonry surfaces subject to runoff can be sealed or coated to minimize stain penetration. After the steel's initial weathering process, staining is much less intense, so often the stained coating can be sandblasted off (taking the majority of the rust stains with it) or left to weather away (with the rust stains slowly fading over time). The best way to avoid staining altogether is to positively control runoff.

**All wet:** Consider how rainwater or snow melt will drip, run, or pool on the structure. Uniform wetting and drying will create a more uniform patina and minimize streaks. Hollow or box members should either be sealed or designed

with drainage and vent holes—and screened, if necessary.

**Fastener facts:** To maintain the same appearance characteristics, Type 3 (weathering steel) versions of ASTM A325 and A490 bolts, nuts, and washers, are available. Galvanized fasteners are also used when appearance does not have to match. Besides the obvious difference in color, runoff from the zinc in galvanized fasteners can leave a light-colored stain on the weathering steel. DTIs (direct tension indicator washers) aren't available in weathering grades, so they should be galvanized and epoxy-coated if used.

**Weld wisdom:** AWS D1.1 includes provisions for welded joints with weathering steels. Although standard welding electrodes will produce welds with adequate strength, special welding electrodes have been developed that produce welds with the same weathering characteristics as weathering steel itself. Single-pass fillet welds made with standard electrodes generally include enough infused base metal to resist corrosion but will not have the same appearance as the weathering steel. The bottom passes of multi-pass welds can be made with standard electrodes (and finished with weathering electrodes), but special attention must be paid to the ends of welds to make sure the weathering electrode pass is on the surface. Because of this—and because of appearance issues—it's generally best to use weathering steel electrodes for all passes of multi-pass welds.

**Keep it clean:** The surface condition of the steel has a direct bearing on the weathered appearance of the steel. For exposed areas, it's a good idea to blast-clean the steel to remove mill scale if a uniform appearance is desired early in the life of the structure. Otherwise, the mill scale will weather away eventually, with no adverse affect on the strength of the member. Commercial blast-cleaning (SSPC-SP6) removes oil and grease and most of the mill scale and rust, producing a relatively uniform weathered appearance.

**Handle with care:** Any weathering steel that will be exposed should be handled carefully to avoid unsightly scratches and gouges. Keep weathering steel away from dirt and debris, and during construction protect the surface from concrete spills, mortar spatter, and other foreign substances. Wax crayon markings should only be used in inconspicuous locations but can be cleaned off with suitable solvent cleaning. Solvent cleaning will also remove oil and grease. None of these appearance issues have any affect on the performance of the steel.

MSC

### Resources

More detailed information on all of these tips is available online at [www.aisc.org/weathering](http://www.aisc.org/weathering). Posted resources include:

*Steel Bridge Design Handbook*, Chapter 23: <http://www.steelbridges.org/pages/designhandbook.html>

NSBA White Paper: *A Primer on Weathering Steel*: <http://www.steelbridges.org/pdfs/Weathering.pdf>

Arcelor-Mittal: "A Technical Overview of Weathering Steels for Bridges and General Construction"

### Rare Shapes

For hard-to-find weathering steel shapes, one source to try is the aptly named A588 and A572 Steel Company ([www.a588a572steel.com](http://www.a588a572steel.com)), which has locations in Birmingham, Ala. and Sewickley, Pa. According to Rhonda Heatherly, sales manager, A588 Co. stocks weathering steel varieties of just about all common connection materials: rolled angles from ¾-in. legs up through 8-in. legs; channels; and flat bars up to 8-in. wide. Sheet steel is available in thicknesses starting at 16 gauge up to 6-in.-thick steel plate.