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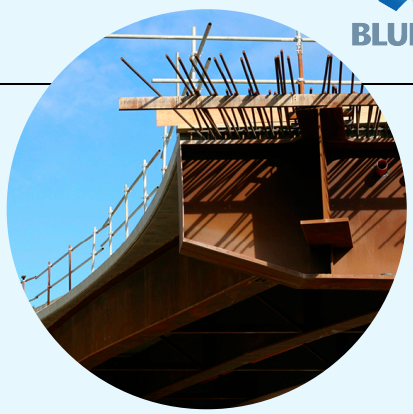

REDCOR™ weathering steel

Introduction

BlueScope REDCOR™ weathering steel is a high strength low alloy structural steel with enhanced atmospheric corrosion resistance compared to conventional structural steels in certain environments. REDCOR™ weathering steel forms a tightly adherent oxide layer, known as the "patina", that confers the enhanced corrosion resistance. BlueScope produces a range of REDCOR™ weathering steel in plate, hot rolled coil and cold rolled coil for facades, bridges, and other architectural and structural applications.

In Australia, weathering steel has typically been used for architectural applications and other non-structural applications such as truck bodies, rolling stock and shipping containers. While overseas, weathering steel has been widely used in structural applications such as bridges.

Formation of the "Patina"

REDCOR™ weathering steel develops a stable oxide layer, known as the "patina" that is tightly adherent to the base steel and consequently helps to resist continued corrosion over extended timeframes. The stable oxide layer of weathering steels is a result of three factors:

- The alloy composition of these types of steels
- Exposure to wet and dry cycles
- A suitable atmospheric environment.

REDCOR™ weathering steel develops the protective patina layer when exposed to alternating periods of wet and dry and hence require bold exposure for the patina to develop. The colour of the patina changes over time. When first formed the patina will be bright orange, but over time it will change to a dark brown, almost purple colour as shown below. The rate of development of the patina depends on the degree of exposure to the weather and the presence of contaminants such as chlorides and sulphides in the atmosphere.

In situations where one surface of a REDCOR™ weathering steel structure receives more exposure than the other there is likely to be a difference in appearance between the two surfaces. The more boldly exposed surface will form the patina more rapidly, whereas the protected surface will form the patina more slowly and have a rougher surface texture than the exposed side.

In comparison conventional structural steels form a rust layer that periodically detaches from the base steel leading to cycles of higher corrosion and an overall higher corrosion loss than weathering steel.

Limitations of BlueScope REDCOR™ weathering steel

REDCOR™ weathering steel is not suitable for all applications and in all environments. In particular weathering steels are not recommended in marine environments with high salt deposition rates. The proximity to the sea for which REDCOR™ weathering steels can be used depends on a variety of factors – wind direction and strength, presence of breaking surf and topography. In general weathering steel should not be used within 2 km of the coast, except where exposure testing confirms that the first year corrosion loss rate is less than 50 µm/year. Guidance as to the suitability for the use of BlueScope REDCOR™ weathering steels in marine environments is available in AS 2312 (Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings). The Weathering Steel Design Guide for Bridges in Australia developed by HERA (Heavy Engineering Research Association) and BlueScope offers more detailed information on this topic.

BlueScope REDCOR™ weathering steel is also not recommended for heavy industrial locations where high concentrations of sulphides likely to be present in the atmosphere, for example adjacent to smelters in locations such as Port Pirie or Mt Isa.

In addition, REDCOR™ weathering steel is not recommended for applications where the structure is constantly wet, such as submerged in water, being buried in soil or in areas of very high rainfall and humidity. The recommendation is that REDCOR™ weathering steel should not be used where the relative humidity exceeds 80% for more than 60% of the time. Where weathering resistant steels are used to span water a minimum distance of 2.5m is required above the water surface.

Use of REDCOR™ weathering steels

Handling and Preparation of REDCOR™ weathering steel

Care should be exercised in the handling of REDCOR™ weathering steel. The steel must be kept free from oil, chalk marks, paint, gouges, concrete splatter and similar staining by other construction materials. Any foreign matter adhering to the steel needs to be removed as soon as practicable. Care should also be exercised in design as run off staining may occur to the surrounding area depending on the nature of the surrounding surfaces, e.g. bare concrete. Further information on detailing is presented below.

Consideration to the correct location for the use of REDCOR™ weathering steel also needs to be considered. Contact with clothing may result in staining to clothing. A polyurethane coating may be used to prevent issues with contact to weathering steel. However, it is recommended that users seeking to coat REDCOR™ weathering steel consult a commercial paint supplier. Note that a coating will prevent the oxidation of the surface and will consequently prevent the development of the patina (oxide layer) that gives BlueScope REDCOR™ weathering steel its distinctive appearance.

For a uniform appearance of the REDCOR™ weathering steel following construction, it is recommended to grit blast the weathering steel. However, note the removal of the mill scale is not essential to the long term development of the patina, as the mill scale will weather off over time.

In applications where weathering steel structures are required to be buried in soil or gravel, a protective coating must be applied similar to that used for carbon structural steels. The coating should extend above the ground surface level. It is not necessary to paint weathering steel members encased in concrete.

Removal of graffiti from REDCOR™ weathering steel can be an issue, as with any material. Where this occurs high pressure water blasting or grit blasting can be used. However, note the patina will be removed and an uneven appearance will result. The patina will reform over a period of time, depending on the exposure and weather conditions.

Design Considerations

Detailing

Correct detailing is essential when using REDCOR™ weathering steel in order to ensure

a. there are no corrosion issues with the structure being built from weathering steel and
b. that staining of the surrounding areas does not occur.

In all detailing work it is important that the structure has good ventilation to enable the proper development of the patina.

A comprehensive guide to good detailing is presented in the HERA report – “Weathering Steel Design Guide for Bridges in Australia”. However, some important principles that need to be considered are:

– Eliminate entrapment points where moisture or debris accumulates
– Avoid expansion joints wherever possible
– Where joints are unavoidable seal the joint using an appropriate material such as neoprene or silicone.
– Seal box girders.

In terms of controlling run-off to surrounding structures the following methods should be considered:

– Diversion of run off by drip plates, sloping surfaces, downpipes and drains to carry the run off away from the structure.
– Use of coverings or coatings on sub-structure.
– Correct use of landscaping to collect the run off.

Welding

The REDCOR™ weathering steel can be readily welded both to other plates of weathering steel and to plain carbon structural steels. When welding these steels low hydrogen electrodes should be used.

Care should also be taken in the preparation of the welding procedure, in particular the need for preheat. Consult Australian/ New Zealand Standard AS/NZS 1554.1Structural Steel Welding – Welding of Steel Structures for more information. Note that weathering steel material is in Group 5 as are AS/NZS 3678-350 grade structural steels. However, for thicknesses >50 mm the WR350(B) material should be considered as a Group 6 material. Further information is available in BlueScope’s Technical Note: Guidance of welding in weathering steel.

The need to colour match weld areas is dependent on the end result required. Over a shorter period (e.g. 1-2 years) there may be little difference between standard electrodes and specialised electrodes designed for this type of steel (E70xx). However, over extended time periods the standard weld metal discolours and corrodes at a different rate to weathering steel. Where close colour matching is required, such as for architectural applications special, electrodes must be used (refer to BlueScope’s Technical Note: Guidance of welding in weathering steel or contact a welding consumable manufacturer). However, when welding thin plate (<12mm) there is sufficient dilution of the parent plate into the weld metal to typically result in a close colour match.

Bolted Connections

Weather resistant high strength bolts and washers are available for use in fabrication. It is important to ensure that moisture does not enter the joint and lead to corrosion issues. Joints should be sealed to prevent moisture intrusion.

Fixing

Fixing is generally done using acid-resistant stainless steel screws (steel grade 304), provided a rubber gasket is used to keep the two different steel types isolated. For any joints in weathering steel, gaps should be avoided between the bolt/screw and the material being joined. A recommended gasket material is neoprene. Joints that require end float should use a Teflon band (polytetrafluoride, PTFE), and for smaller screws/self-drilling screws etc, EPDM rubber gaskets should be used –again to isolate the screw from the weathering steel. Spacer plates should be used with other materials, as all metals are susceptible to crevice corrosion. The recommended gasket thickness is at least 1.0mm. Galvanised or cadium coated bolts are not generally recommended as the coating will wear off relatively quickly as a result of the galvanic action between the coating and the weathering steel. Smaller fixings, screws etc can be made of a more precious metal-such as brass or bronze-no galvanic corrosion will appear as the area of precious metal is small relative to the weathering steel.

Fixing - Facades

The fastening of weathering steel facades should follow the general principles outlined above. Weathering steel panel must be fastened in such a manner as to allow for adequate wet and dry cycles. Crevices must be avoided to ensure that the structure does not corrode and the run off must be controlled to prevent staining of the façade and surrounding structure.

Compatibility with Other Materials

As with all metals care must be exercised in terms of joining dissimilar metals to weathering steel. As mentioned above when joining stainless steel to weathering steel a spacer or gasket should be used. The direct bolting of galvanized fasteners onto a weathering steel structure may lead to a depletion in the galvanized coating of the fastener and staining of the weathering steel structure. However, the joining of weathering steel to carbon structural steels will not cause any corrosion issues.

As detailed above runoff from a weathering steel structure onto porous materials such as concrete, stone and brickwork should be avoided. Where this is not possible the porous materials should be sealed to enable cleaning.

Availability

RECOR™ weathering steels are available from BlueScope in a range of products as shown below:

Product	Australian Standards	Grade	Thickness Range (mm)	Impacted Testing Option Availability	Phosphorus Level
REDCOR™ weathering steel	AS/NZS 1595	CW300-G	0.7-2	N/A	High
	AS/NZS 1594	HW350	3-10	N/A	High
	AS/NZS 1594	HW350	3-10	N/A	High
	AS/NZS 3678	WR350(A)	8-12	L0, L20	High
	AS/NZS 3678	WR350(B)	10-80	L0, L20	Low

International standards for weathering resistant steels are typically based on two different chemical analysis types – high Phosphorous and low Phosphorous steel grades. The high Phosphorous weathering grades are restricted to lower thicknesses for weldability reasons. However, the high Phosphorous type of weathering steel offers high levels of corrosion resistance. The lower Phosphorous type of weathering resistant steels is favoured for structural applications such as bridges.

The availability table above shows that the CW300-G, HW350 and WR350(A) products are all made using the high Phosphorous chemistry, while the WR350(B) weathering resistant grade is manufactured to the low Phosphorous chemistry.

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