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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.

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.

When considering the use of REDCOR® weathering steel particular attention is required in key areas that have a strong influence on the corrosion performance and appearance of the product. Potential staining of surrounding areas from REDCOR® run-off also needs to be closely considered and managed appropriately. These key areas are discussed in further detail within this bulletin.

Formation of the 'patina'

REDCOR® weathering steel, when exposed in certain environments, develops a stable oxide layer, known as the 'patina' that is tightly adherent to the base steel and consequently achieves a lower corrosion rate 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 requires bold exposure for the patina to develop. The colour of the patina changes over time. When first formed the patina will be bright orange (see Figure 1), but over time it will change to a dark brown, almost purple colour. 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.

Figure 1: Example of bright orange early onset patina

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.

USE OF REDCOR® WEATHERING STEEL

Limitations

REDCOR® weathering steel is not suitable for all applications or in all environments. In particular weathering steels are not recommended in marine environments with high salt deposition rates. The proximity to marine influence for which REDCOR® weathering steels can be used depends on a variety of factors – wind direction and strength, proximity and type of marine influence and topography.

BlueScope REDCOR® weathering steel is also not recommended for heavy industrial locations where high concentrations of sulphides are 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 opposite is also true, weathering steel is not recommended in applications or at locations where wet and dry cycles do not regularly occur.

Handling and Preparation

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. 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.

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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 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 (see Figure 2).

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

Figure 2: Concrete staining due to incorrect management of runoff from weathering steel wall directly above

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

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 1554.1:2014 '*Structural Steel Welding – Welding of Steel Structures'* for more information. Note that weathering steel material is in Group 5 as are AS/NZS 3678:2016 -350 grade structural steels. However, for thicknesses >50 mm the WR350B materials should be considered as a Group 6 material. Further information is available in BlueScope's Technical Note: *'Guidance on the welding of weathering steels'*.

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 on the welding of weathering steels'* 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 ingress.

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 polytetrafluoride (PTFE) band, 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 cadmium 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.

Fixing - Facades

The fastening of weathering steel facades should follow the general principles outlined above. Weathering steel panels 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 facade 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.

The joining of weathering steel to carbon structural steels is unlikely to cause corrosion issues for the weathering steel (the metals have a similar level of reactivity), however, if the carbon steel is left unprotected it will corrode at a faster rate than weathering steel that has a well-formed patina in an appropriate environment, so protection of the carbon steel should be considered.

As detailed above, runoff from a weathering steel structure onto porous materials such as concrete, stone and brickwork should be avoided (see Figure 2). Where this is not possible the porous materials should be sealed to enable cleaning.

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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 1595:2002	CW300A	0.7-2	N/A	High
	AS/NZS 1594:2002	HW350A	3-10	N/A	High
	AS/NZS 3678:2016	WR350A	By Enquiry	N/A	High
	AS/NZS 3678:2016	WR350L0A	By Enquiry	L0	High
	AS/NZS 3678:2016	WR350B	10-80	N/A	Low
	AS/NZS 3678:2016	WR350L0B	10-80	L0	Low
	AS/NZS 3678:2016	WR350L20B	10-80	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 CW300A, HW350A, WR350A and WR350L0A products are all made using the high Phosphorous chemistry, while the WR350B, WR350L0B and WR350L20B weathering resistant grades are manufactured to the low Phosphorous chemistry.

REFERENCED AUSTRALIAN STANDARDS

- AS/NZS 3678:2016 Structural steel – Hot-rolled plates, floorplates and slabs.
- AS/NZS 1594:2002 Hot-rolled steel flat products.
- AS/NZS 1554.1:2014 Structural steel welding – Welding of steel structures.

RELATED TECHNICAL LITERATURE

'*Weathering Steel Design Guide for Bridges in Australia',* Heavy Engineering Research Association (HERA), 2017.
'*Guidance on the welding of weathering steels',* BlueScope Technical Note, 2017.

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