Weathering grades can bolster steel in bridge builds

The local availability of weathering steel in larger plate thicknesses opens opportunities to further optimise the use of steel bridge designs as is more common in other developed nations.

Weathering steels have been used in construction since the 1960s, including buildings and bridges and have been used for bridges in countries including the US, UK, Japan, and Europe. In the early 2000s, around half of new steel bridges in the US were constructed from weathering steel.

While conventional steel girders are lightweight and provide flexibility in design and construction, ongoing painting and maintenance add to whole-of-life costs, particularly with inevitable increased labour costs. However, the introduction of weathering steel plate holds great potential to change this situation with the serviceable life of weathering steel bridges able to exceed 100 years and reduced maintenance regimes.

Weathering steels are high strength steels that develop a stable oxide layer on the surface of the steel known as the 'patina'. When used in the appropriate environment, the patina enhances the corrosion resistance of the steel compared to conventional structural steels, effectively 'weathering' the steel in a natural way. The protective rust patina layer develops under conditions of alternate wetting and drying cycles (usually over two to five years).

BlueScope started manufacturing weathering steels in the 1970's and over the past five years expanded its range to include up to 80mm in thickness. The REDCOR® steel WR350 range is are designated structural grades with similar mechanical property requirements as the standard high-strength structural AS/NZS 3678 Grade 350. The carbon level of the WR350 range is restricted to assist weldability. REDCOR® weathering steel grades have a corrosion index that exceeds the requirement in the ASTM A709 Standard, 'Structural Steel for Bridges'.

In addition, the weathering steel WR350 range has similar welding characteristics to conventional hot rolled AS/NZS 3678 Grade 350 and can be readily welded with all commonly used welding processes; SAW, FCAW, gas metal arc and manual metal arc. The welding Standard AS/NZS 1554 covers the welding requirements for AS/NZS 3678 WR350 weathering steels.

When designing weathering steels in bridge applications, careful consideration is required, as weathering steels cannot be in constant contact with water or soil and are not suitable for use in marine environments due to the salt spray producing high levels of chlorine ions that can induce a continuous wet environment. Industrial locations with very high SO2 levels may also not be suitable.

During the detail design phase, careful consideration must be given to ensure that the design details do not induce continuous wetness. These issues can be addressed through careful consideration of where drainage detail, crevices, expansion joints and bolting arrays are placed. Detailing of the steelwork must also account for controlling run-off to avoid staining, particularly for slope abutment headstocks, bearing plinths and drip pans.

By facilitating steel-intensive bridgework, weathering steels open up a raft of structural benefits, including the base material's innate qualities, such as high strength-to-weight ratio, lower and variable structural depths, longer spans, splice connections for continuous spans, less demand on substructure design, rapid construction, fabrication off-site in controlled, automated workshops, and all steelwork being visible for inspection in the finished structure.

Not only that, the enhanced corrosion resistance of weathering steels means that they can be used without the need for expensive paint systems, reducing the need for painting that can significantly lower both initial fabrication and ongoing maintenance costs. The likely reduction in ongoing maintenance costs may lead to weathering steel bridges having a lower life cycle cost.

There are a wealth of opportunities for innovation and optimisation of the material, such as developing standard weathering steel welded beam profiles for small bridge replacements, developing designs for multi span continuous I-girder bridges including bolted splices to stretch the spans, varying the depth and eliminate heavy girders and complicated splices for river crossings and brownfields projects, as well as for replacing hundreds of ageing regional timber bridges.

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*This article is based on a presentation on Innovation in Weathering Steel Bridge Design and Construction by BlueScope National Technical Manager – Uncoated **John Dryden**, Jacobs Technical Director for Bridges for Asia Pacific **John Steele** and bridge engineer with Jacobs **Peter Ticaric**, co-convened by the ASI and Engineers Australia during July.*