

Performance of the Mercer Off-Ramp Weathering Steel

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Introduction

This article provides an update on the corrosion performance of the State Highway 1 Mercer weathering steel off-ramp, following an inspection by Japanese expert Dr. Makoto Ohya, two and half years after construction.

State Highway 1 Mercer Off-ramp

The Mercer to Longswamp off-ramp has three spans of around 28 metres each, with 130 tonnes of weathering steel. Actual construction of the bridge was multi-phased, over a 6 month period, to allow for the realignment of the railway line. By mid-March 2006, all the steel had been erected and the concrete deck poured in-situ. Weathering steel was chosen for the off-ramp, even with a higher initial material cost in comparison to normal constructional steel, as it did not need a corrosion protection coating and promised reduced maintenance costs.

A hard protective patina typically forms on weathering steel over a period of around two years that inhibits further corrosion. The copper and nickel alloying elements in weathering steel and a low local relative humidity is what makes the stable patina layer adhere tightly to the base metal. The protective patina darkens with time, to a deep purple-brown colour. In locations of high relative humidity, particularly near the sea, or where the steel is wet for long periods of time, the protective patina won't develop and the steel will corrode in much the same way as unprotected mild steel. Weathering steel should be grit blasted to Sa 2 prior to erection to remove all mill scale, to ensure even patina development.

Weathering Steel Condition After 30 Months

The Mercer off-ramp is in a suitable location for reliable weathering steel performance, as recommended in the New Zealand Weathering Steel Guide for Bridges (Clifton, El Sarraf, 2005). Patina formation is progressing well as expected, as can be seen in the changes in appearance of the pier, from a rusty orange colour to a fairly consistent dark brown (Figure 1).



Figure 1: Mercer Off-ramp Pier, July 2006 (left) and August 2008 (right)

In September 2008, Japanese weathering steel expert Dr Makoto Ohya, visited New Zealand and measured the patina development of the weathering steel using equipment and techniques developed in Japan (Kihira et al, 2005). He found that the maximum patina thickness measured was 125 microns and the average thickness was 90 microns, and so was developing as expected. The design corrosion loss of the weathering steel for a 100

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year design life is calculated to be in the order of 200 microns over the whole structure, using the New Zealand Weathering Steel Guide for Bridges. The independent measurements taken by Dr Makoto Ohya are consistent with this, as once the patina is formed the corrosion rate of the steel will reduce greatly in comparison with mild steel (Figure 3). His method could be used in future to relatively quickly and inexpensively confirm the suitability of a site for weathering steel bridge, over a two year period during planning stages.

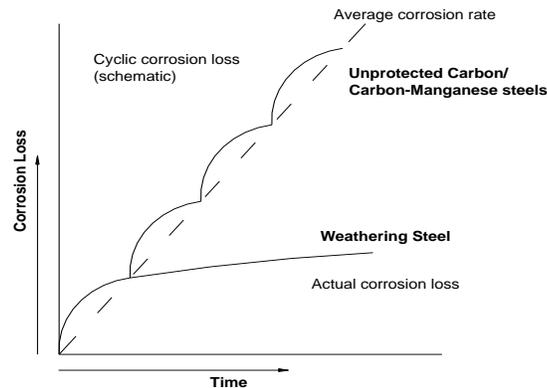


Figure 3 Comparison of Weathering and Carbon Steel Corrosion Loss.

Effect of Graffiti

Another advantage of weathering steel is how graffiti may be dealt with. Graffiti will locally slow the patina formation while the graffiti paint breaks down, however the effect is not ultimately detrimental to the performance of the steel. In Japan a light paint coating is often applied to weathering steel located near the sea to deliberately slow the patina development in more aggressive environments. After two years, graffiti put on the off-ramp is slowly fading as it breaks down and the patina forms through it (Figure 2). Another approach to graffiti is simply to high pressure water blast it off. The localised area will over a period of time redevelop its patina to match the colour of the surrounding steel.



Figure 2: Graffiti, July 2006 (left) and August 2008 (right)

Conclusion

The Mercer Off-ramp weathering steel is performing as predicted by the New Zealand Weathering Steel Guide for Bridges. This shows that weathering steel used in the correct environmental conditions of low relative humidity and recommended distance from the sea, provides a very cost effective, low maintenance solution for steel bridges in New Zealand. Patina development can now be easily measured using equipment and methods developed in Japan. This will be very useful in future to confirm a bridge site's suitability for a weathering steel option, over a two year period, during project planning and design stages.

References

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