Case Study 09 Australian Coastal Fence

Low Pollution Exposure
High Coastal Salt Exposure

Australia's Pacific Coast near Brisbane is a popular year round vacation destination that is developing rapidly. Vacationers are drawn by the area's warm climate, clean air, miles of beaches, and superb surfing conditions.

Called the Sunshine Coast to the north of Brisbane and the Gold Coast to the south, this area is a corrosive environment for construction materials. The rapid growth has made new facilities necessary including many handrails, balustrades, and swimming pool fences.

Both Type 304 (UNS S30400, EN 1.4301, SUS 304) stainless steel and Type 316 (UNS S31600, EN 1.4401, SUS 316) stainless steel were used for a fence around a seawater swimming pool adjoining the ocean. **(Figure A)** The posts are Type 304 stainless steel and the other railing and gate components are Type 316 stainless steel. As can be seen in **Figure B**, the posts are corroding.

Figure A Stainless steel is used regularly for coastal applications. If properly selected, it can remain attractive and structurally sound in this corrosive environment. (Photo Courtesy of Australian Stainless Steel Development Association)

Figure B The contrast in appearance between the gate and support post is due to stainless steel chemistry and surface roughness differences. The corrosion-free gate is Type 316 stainless steel and the post that is discolored by corrosion is Type 304 stainless steel.
(Photo Courtesy of Australian Stainless Steel Development Association)

Heavy surf and strong winds make salt (chloride) particulate levels in the air high, and salt is deposited on surfaces at an average daily rate of at least 3 grams/square meter.[1] The high average temperatures and high humidity levels accelerate corrosion. Fortunately, regular rain helps to reduce corrosion rates by limiting salt deposit build up.

Stainless steel is more resistant to corrosive coastal salts (chlorides) than other common architectural materials. Type 316 stainless steel is generally the most cost effective material choice for long-term, low-maintenance applications that are near the coast but not splashed or immersed in seawater. Type 316 stainless steel contains 2% molybdenum, which helps to prevent pitting and crevice corrosion caused by deposited salts. In low or no maintenance applications like this pool fence, it is also important to specify a smooth surface finish to minimize the potential for corrosion. As can be seen in **Figure B**, there is no corrosion on the Type 316 stainless steel gate and fence components.

When specifying stainless steel in a corrosive environment it is important to seal or eliminate crevices by welding and to use a design that is easily cleaned by rain. Most of the fence components were welded together which is preferred for a long-term structure. Unfortunately, not all of the welds were properly cleaned and dark discoloration (heat tint) and corrosion can be seen around some of the Type 316 stainless steel welds. Heat tint, the surface oxidation associated with the heat of welding, must be completely removed in order to restore the corrosion resistance of the stainless steel. If these welds are ground and/or pickled, they will perform as well as the rest of the Type 316 stainless steel in the fence. Heat tint does not reduce the structural properties, but it may be considered unsightly by the users of the material.

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Stainless Steel Selection Criteria

The IMOA publication, *Which Stainless Steel Should Be Specified for Exterior Applications?*, provides stainless steel selection assistance. The site and design scores below are based on the guidelines in that brochure. Copies can be downloaded from www.imoa.info or ordered by emailing info@imoa.info.

Section 1: Environment — **Score = 0**

Although Brisbane has moderate urban air pollution levels, the surrounding beach areas have low urban or rural pollution levels with automobiles being the primary source of pollution. In addition, the strong winds off the ocean prevent concentration of pollutants along the coast.

Section 2: Coastal Salt Exposure — **Score = 4 to 5**

The railing is less than 30 m (100 ft) from the ocean and each section's exposure to salt water varies. The section closest to the ocean is splashed when the surf is "up". (+5) The components shown in Figure B are farther from the water and are only exposed to salt spray during storms but their close proximity to the ocean and the rough surf mean that exposure to coastal salt (chlorides) is high. (+4)

Section 3: Local Weather Pattern — **Score = 0**

Brisbane and the surrounding coastal areas have a subtropical climate. The average daily temperatures range from 15.1°C (59.2°F) in the winter to 24.6°C (76.3°F) in the summer. The mean annual rainfall is 1575 mm (62 inches) and the rain is heavy enough to remove surface deposits. The warm temperatures and high average humidity levels (above 70% for half the year) make this environment corrosive, but the regular rain helps to remove surface deposits which reduces the probability of corrosion. This weather pattern is typical of a humid subtropical environment.

Section 4: Design Considerations — **Gate Score = -1** — **Post Score = 2**

The finishes on the Type 316 stainless steel gate and the Type 304 stainless steel post are very different. The coarse post has an average surface roughness of R_a 1.1 µm (43 µin) which increases the score (+2). The smoother gate has a surface roughness of about R_a 0.46 µm (18 µin), which reduces the score (-1). Corrosive substances have to remain on a surface for corrosion to occur. Rain more easily removes corrosive salt deposits from smooth finishes. In addition, a rougher finish retains rainwater longer, extending the time of wetness when corrosion can occur.

Section 5: Maintenance Schedule — **Score = 0**

It is not anticipated that the fence will ever be cleaned except by natural rainfall.

Stainless Steel Selection — **Total: Gate Score = 3 to 4** — **Post Score = 6 to 7**

Type 304 stainless steel is not appropriate for coastal applications unless: (1) a very smooth finish is specified; (2) there is regular cleaning; and (3) some staining between cleanings is acceptable. The Type 304 stainless steel fence post corrosion should have been anticipated. The problem was made worse by the very rough finish, which retained corrosive salt (chlorides) and accelerated the corrosion rate. A much more corrosion resistant stainless steel would have been necessary for corrosion-free performance with this rough finish. Although there is corrosion over the entire surface, it is superficial and structural failure is unlikely during the pool life, since it will corrode about 1,000 times more slowly than carbon steel.

A score of 3 means that Type 316 stainless steel is generally the most cost effective choice, so it is not surprising that the gate and most of the Type 316 fence components have remained attractive without maintenance. Type 316 stainless steel performs well in most coastal, low-to-moderate pollution environments as long as smooth surface finishes are specified and regular heavy rains remove surface deposits. Without maintenance, some light staining may occur over time, but it is easily removed. Unless there is regular cleaning, Type 316 stainless steel will corrode if it is regularly sprayed or splashed with salt water. This is why the fence section immediately adjoining the water has a score of 4.

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1 Corrosion Map of Australia, CSIRO Infrastructure Systems Engineering

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