

Case Study 10 New York Pier Railings

Low Pollution Exposure
High Coastal Salt Exposure

New York City is spread over several islands. Long Island's new Queens West mixed-use development takes advantage of exceptional views of Manhattan Island. Gantry Plaza State Park is being developed on the East River waterfront in front of Queens West. Four rehabilitated industrial piers are part of the section of this park that was completed in 1998. **(Figure A)** The East River, which separates the islands, is a heavily traveled, narrow, brackish tidal strait.

Type 316 stainless steel (UNS S31600, EN 1.4401, SUS 316) is generally the most cost-effective choice for low maintenance, boldly exposed, long-term applications near the coast. It contains 2% molybdenum, which helps to prevent corrosion caused by salt. For maximum corrosion resistance, a smooth, micro-crevice free surface finish is needed. In this case, the railings and seating are Type 316 stainless steel with a rougher glass bead blasted finish. Despite this finish, most of the Type 316 stainless steel has remained attractive and corrosion free. **(Figure B)**



Figures A and B The Gantry Plaza State Park piers jut into the East River and make extensive use of Type 316 stainless steel seating and railings. The United Nations building is visible across the river. (Figure A: Photo Courtesy of Abel Bainnson Butz, LLP)



Figure C The Type 316 stainless steel has performed well on the piers. The exception is the splash zone, where there is discoloration caused by corrosion staining (right side of image).

Direct exposure to salt water spray or splashing is much more corrosive than typical coastal exposure. During high tide, brackish water hits the rocks and the old loading towers (gantries) concrete supports. Water splashes onto the stainless steel railings along the shore causing localized corrosion of the Type 316 stainless steel railings. **(Figure C)** Although it is unattractive, the corrosion rate is low and structural failure is not a concern. This staining is easily removed by cleaning.

After the Type 316 stainless steel corrosion problem was observed in the splash zone, a fifteen-month study was conducted using nine different stainless steel and finish combinations. All of the samples had rough finishes and were placed in the splash zone. Duplex 2205 stainless steel (UNS32205, EN 1.4462, SUS 329J3L) with a dull pickled finish provided the best performance. In localized splash zones, upgrading to a more corrosion resistant stainless steel can prevent staining. Higher strength duplex stainless steels can be used to reduce section sizes and material cost. A report on this corrosion study is available at <http://www.imoa.info>.

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

This park is in Queens County New York, which has a mixture of residential housing and light industry. It has low urban air pollution levels with annual mean sulfur dioxide levels of 18 µg/m³ and PM2.5 particulate levels of 12.9 µg/m³.

Section 2: Coastal Salt Exposure Not Splashed Score = 3 Splashed Score = 7

The railings and other applications that are not splashed were given a score of 3 because, although they are less than 30 m (100 ft) from salt water, the documented level of surface salt deposits is relatively low for a coastal location. Where the piers meet the shore, the railings are exposed to regular but not continuous splashing or spray during high tides and storms. Their level of salt exposure falls between the occasional and continuous splashing numbers in the scoring system. (+7)

Section 3: Local Weather Pattern Score = -1

New York has a temperate climate. Average daily temperatures range from 0°C (32°F) to 25°C (77°F). The average humidity level is 63%. New York averages one thunderstorm per week during the summer, 121 rainy days/year and annual precipitation levels of 1180 mm (46.7 inches). Regular heavy rain helps to remove corrosive surface deposits. (-1)

Section 4: Design Considerations Score = 1

Rough finishes retain more corrosive deposits and increase the probability of corrosion. The finish used is rougher than R_a 1 µm (40 µin), but properly applied glass bead blasting produces a smoothly rounded surface topography of peaks and valleys that is more readily rain-washed than other rough abrasive blasted finishes. (+1)

Section 5: Maintenance Schedule Score = 0

There were no plans for maintenance cleaning when the park was designed and most of the stainless steel has not been cleaned. The railings in the splash zone were cleaned approximately one year after installation and again about two years later. Because they are cleaned less than annually, the score is not reduced.

Stainless Steel Selection Total: Not Splashed Score = 3 Splashed Score = 7

Type 316 stainless steel with a smooth, crevice-free finish is appropriate for many coastal applications that are not exposed to salt spray, splashing or immersion. A score of 3 indicates that Type 316 stainless steel is appropriate for the applications that are not splashed. Over the years, occasional cleaning may be necessary to remove light staining.

The splash zone had a score of 7. This indicates that Type 316 stainless steel would be expected to corrode and even duplex 2205 stainless steel would have some light corrosion staining over time. A smoother finish and/or annual cleaning would lower the score to 5 or 6 and there would be little or no corrosion of 2205 stainless steel. A smooth finish and regular manual cleaning would be necessary to keep Type 316 stainless steel attractive. Of the samples tested, 2205 duplex stainless steel had the best corrosion performance. Any stainless steel with similar or greater corrosion resistance and a smooth finish would also be expected to do well.

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