Case Study 02 Minneapolis Exterior Wall Panels and Window Frames

Moderate Urban Pollution
Moderate Deicing Salt Exposure

The Frederick R. Weisman Art Museum in Minneapolis, Minnesota, USA adjoins a major road and bridge where deicing salts are used **(Figure A)**. Frank O. Gehry, the building's architect, recognized the corrosive nature of the environment and selected Type 316 (UNS S31600, EN 1.4401, SUS 316) stainless steel wall panels **(Figure B)**. Type 316 contains 2% molybdenum, which improves pitting and crevice corrosion resistance. This is particularly helpful in preventing salt damage.

The closest panels are about 4.6 meter (15 feet) from the road. A smooth No. 4 finish was specified with an average surface roughness of R_a 0.5 µm or 20 µin. During design, it was assumed that there would be little or no manual cleaning of the building. The building is cleaned about every five years to remove dirt accumulation. The design, smooth surface finish, and vertical finish grain orientation make it easy for natural rain-washing to remove salt.

Figure A (above) Type 316 stainless steel with a smooth surface finish and a design that encourages rain cleaning was the right choice for the Weisman Art Museum. Although it is beside a busy road where deicing salt is used, there is no corrosion. The color of the building changes constantly as it reflects the surrounding environment.

Figure B (right) This Type 316 wall panel on the Weisman Art museum is within 4.6 meter (15 feet) of the road and has not been cleaned in five years. There is no corrosion. (Photo Courtesy of the Nickel Institute)

Figure C This Type 304 stainless steel window frame has not been cleaned in five years. Type 304 that is exposed to deicing salt must be cleaned regularly to remove corrosive deposits. Even with that precaution, some staining may occur between cleanings. (Photo Courtesy of the Nickel Institute)

The Type 304 (UNS S30400, EN 1.4301, SUS 304) stainless steel window frame is a few blocks away from the museum on the same busy road **(Figure C)**. Both the window frame and the Weisman panel shown in Figure B have similar deicing salt exposure, are about the same distance from the road, and have smooth finishes.

When these photos were taken, it had been about five years since either the window frame or the panel was washed. The only significant differences between them are the type of stainless steel used and that the window frame is partially sheltered from rain by the surrounding closely spaced high-rise buildings.

Although the environment is identical, the appearance of these components is very different. The museum's Type 316 wall panels are in excellent condition with no corrosion and only a small amount of dirt accumulation. The Type 304 window frame is badly stained by corrosion.

INTERNATIONAL MOLYBDENUM ASSOCIATION

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 = 2

Both sites are in downtown Minneapolis. The average sulfur dioxide level is 8 µg/m^3, which is relatively low, but the average air borne particulate level (PM10) is 36 µg/m^3, which is moderate. The site was classified as having moderate levels of urban pollution.

Section 2: Deicing Salt Exposure — Score = 3

Minneapolis has long, cold winters with an average total snowfall of 1422 mm (56 inches). Deicing salt, either sodium chloride or calcium chloride, is used to melt snow and ice. Deicing salt carried by road mist has been found as high as the 59th floor of closely spaced buildings and as far as 1 km (0.6 miles) from busy roads.[1] If the temperature and humidity levels are high enough, salt deposits absorb moisture from the air and can corrode some stainless steels and other architectural metals.[2] The front and sides of both buildings have moderate deicing salt exposure (less than 30 meters (100 feet) from a busy road).

Section 3: Local Weather Pattern — Score = -1

The normal daily low and high temperatures in Minneapolis range between -13°C and 29°C (9°F and 84°F) and annual rainfall is about 711 mm (28 inches) and is concentrated in the warmest months. There is significant snowfall during the six winter months. For best performance, it is important to remove salt deposits soon after the last snowfall and to wash away dust, which may contain salt, during the warmer months. On average, there are 37 days with thunderstorms during the warmer months, so there is regular heavy rain to remove corrosive deposits on exposed surfaces. Minneapolis can be classified as a temperate climate with regular heavy rain, which has a score of -1.

Section 4: Design Considerations — Window Frame Score = 0 — Museum Score = -1

Both structures have finishes with surface roughness below R_a 0.5 µm or 20 µin. Smooth finishes retain less salt, which reduces the possibility of corrosion (score -1). The museum panels are boldly exposed and rain can remove salt deposits. The window frames are slightly recessed and the surrounding buildings shelter them, preventing effective rain washing (score +1). Unless sheltered areas are manually washed or a more corrosion resistant stainless steel is used, these frames are more likely to have corrosion problems.

Section 5: Maintenance Schedule — Score = 0

Neither building is washed on a regular basis.

Stainless Steel Selection — Total: — Window Frame Score = 4 — Museum Score = 3

Even with a smooth finish, Type 304 should not be specified in areas where deicing salts are used unless it will be cleaned frequently. In similar applications, adequate performance has been achieved by cleaning four times per year but there may be light staining between cleanings. This frequency of cleaning would lower the window score to 2 making Type 304 an acceptable choice. In applications with moderate deicing salt exposure, Type 316 stainless steel typically provides good performance if a smooth surface finish and vertical finish grain orientation are specified, surfaces are boldly exposed to rain, and there is heavy rain on a sufficiently frequent basis to remove surface deposits.

1 Allen L. Williams and Gary J. Stensland, Illinois Department of Transportation, “Atmospheric Dispersion Study of Deicing Salt Applied to Roads”, Physical Research Report No. 149, January 2006

2 Calcium chloride becomes corrosive at 0°C (32°F) and 45% humidity and sodium chloride becomes corrosive at 10°C (50°F) and 76% humidity.

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