STAINLESS STEEL DOORS CAN STAND UP TO FIRE AND CORROSIVE ENVIRONMENTS

CATHERINE M. HOUSKA

Nº 14043

Reprinted from
Doors and Hardware,
August1997

Distributed by
NICKEL
INSTITUTE

STAINLESS STEEL DOORS CAN STAND UP TO FIRE AND CORROSIVE ENVIRONMENTS

Nº 14043

By Catherine M. Houska, reprinted from *Doors and Hardware*, August 1997.

Clad entrance doors with a custom surface finish and matching architectural metal panels. *Courtesy of Forms & Surfaces*

Steeled Against The Elements

Stainless steel doors can stand up to fire and corrosive environments

NO MATTER WHAT THE BUILDING type or application, a door is expected to remain functional, secure and attractive for the life of the building. Fire, blast and sound resistance; ease of cleaning; and corrosion resistance are all practical reasons for selecting stainless steel doors, but they can also have decorative raised designs and elaborate surface finishes which provide limitless creative design possibilities.

Stainless steel may frame a glass door, clad a door, or be the entire door structural framing, hardware and exterior. Selection of the most appropriate door design is dependent on the application, service environment and customer requirements. Some of the most common applications are office building and store entrances, decorative interior doors, medical facilities, prisons, factories, storage facilities, swimming pools, private residences, public housing and transit facilities.

While many manufacturers have extensive door design experience, additional technical assistance specific to stainless steel is sometimes needed. The Nickel Development Institute (NiDI) is the international market development and applications research organization of the primary nickel industry. Free literature and technical assistance help decision-makers avoid common problems and make optimal use of the unique characteristics of stainless steel and other nickel-containing alloys.

Type 316, all-stainless steel doors on the New York City Housing Authority's Marble Hill Houses.
Courtesy of Next Door Company

Longevity

The first stainless steel doors were installed around 1930 on the Chrysler and other high profile buildings. These early doors are a testament to the longevity of stainless steel. One example is the entrance of the former Toronto Stock Exchange. These Type 302* doors were installed in 1936. Although these doors are near a busy street and regularly exposed to de-icing salts, they look like they could have been installed yesterday.

NiDI has inspected several buildings where stainless steel doors have given more than 60 years of service. Based on this experience, stainless steel doors can be expected to remain attractive and functional for more than 100 years if an appropriate grade and surface finish are selected, and if they are properly designed, fabricated, installed and maintained.

Cleaning and maintenance

Stainless steel door maintenance costs are low. Graffiti (paint, ink, etc.) can be removed easily with an appropriate solvent; refinishing is not required. Deliberate or accidental scratching can be hidden or minimized by appropriate surface finish selection. Because of the high strength of stainless steel, it is not easily scratched and scratches tend to be shallow.

Stainless steel can be cleaned using a variety of products but harsh abrasives and cleaning products that contain chlorides should be avoided. For exterior doors, occasional washing with a 5% ammonia solution or a mild detergent and water solution followed by a water rinse and squeegee dry is usually sufficient. Washing frequency is affected by the environment and application. Although regular cleaning can be difficult in the Winter, de-icing salts should not be left adhering to the door surface or threshold for prolonged periods of time.

Occasionally a very mild abrasive may be needed, particularly if cleaning is infrequent. The abrasive should be applied in the same direction as the surface finish grain. Many household cleaners, including some "stainless steel" polishes, contain harsh abrasives which could damage the finish and should be avoided. Abrasives should not be used on delicate finishes. All cleaners should be tested in an inconspicuous location before general application.

Smoother surface finishes and a vertical grain orientation retain less dirt and need less frequent cleaning. A soft, clean cloth or a soft synthetic fiber brush can be used in cleaning. Non-stainless metal brushes or scouring pads should never be used on stainless steel. Additional information on cleaning can be obtained from NiDI or the surface finish supplier.

Corrosion resistance

If an appropriate grade of stainless steel is selected and a regular maintenance schedule is followed, stainless steel doors will remain secure and attractive for the life of the building. The corrosion resistance of stainless steel makes it ideal for applications where it will be exposed to the atmosphere, humid locations, coastal environments, corrosive industrial applications, polluted urban areas and other challenging environments.

Although the term "stainless steel" is often used generically, there are more than 200 grades of stainless steel. It is important to select a specific grade. Types 304 and 316 are most commonly used for architecture. Type 304 provides good performance in rural, moderately polluted urban applications and coastal applications where the corrosion potential is low (low humidity and temperature). Type 316 is more corrosion resistant than Type 304 and is the most commonly used grade for marine, industrial and aggressive urban applications. Exposure to de-icing salts in northern cities can be more aggressive than a marine environment. In some very aggressive locations, even Type 316 may not provide adequate protection - a more corrosion resistant, highly alloyed stainless steel may be needed.

Table 1 (page 3) shows the expected performance of various grades of stainless steel in different service environments. The information is based on practical experience and evaluation of test samples that have been exposed to representative environments for as long as 26 years.

*Type refers to the make-up of the alloy of stainless steel-stainless steel alloys are comprised of various elemental metals, which are combined in different ratios to create the various types of stainless steel.

Data extracted from a publication by the South African Stainless Steel Development Association comparing the corrosion rates for Type 316 stainless steel, mild steel and aluminum are shown in Chart l. The samples were exposed for 20 years in urban and industrial coastal environments but were not exposed directly to salt spray. They were washed by rain but not cleaned. The mild steel and aluminum samples were not painted. The log scale of this chart shows the dramatic difference in corrosion resistance. The mild steel or aluminum corrosion rate would be much lower if a protective paint coating were applied and regularly maintained. This level of maintenance can be expensive and impractical in some applications. In all three locations, the pitting of the stainless steel was minor and would probably have been prevented by regular cleaning. While stainless steel can pit under severe conditions, it does not suffer general corrosion (rusting) leading to loss of structural integrity.

If not addressed in the design stage, galvanic corrosion may be a problem when aluminum or galvanized steel are used as structural members inside doors with stainless steel exteriors. Caution should be used when considering this combination for exterior doors or interior doors used in humid, damp environments like swimming pools. If the stainless steel exteriors are in direct contact with the framing and if the structural framing can be damp for extended periods of time, the corrosion of the aluminum and steel will be accelerated. The problem is more severe if the door is exposed to chloride-containing environ-

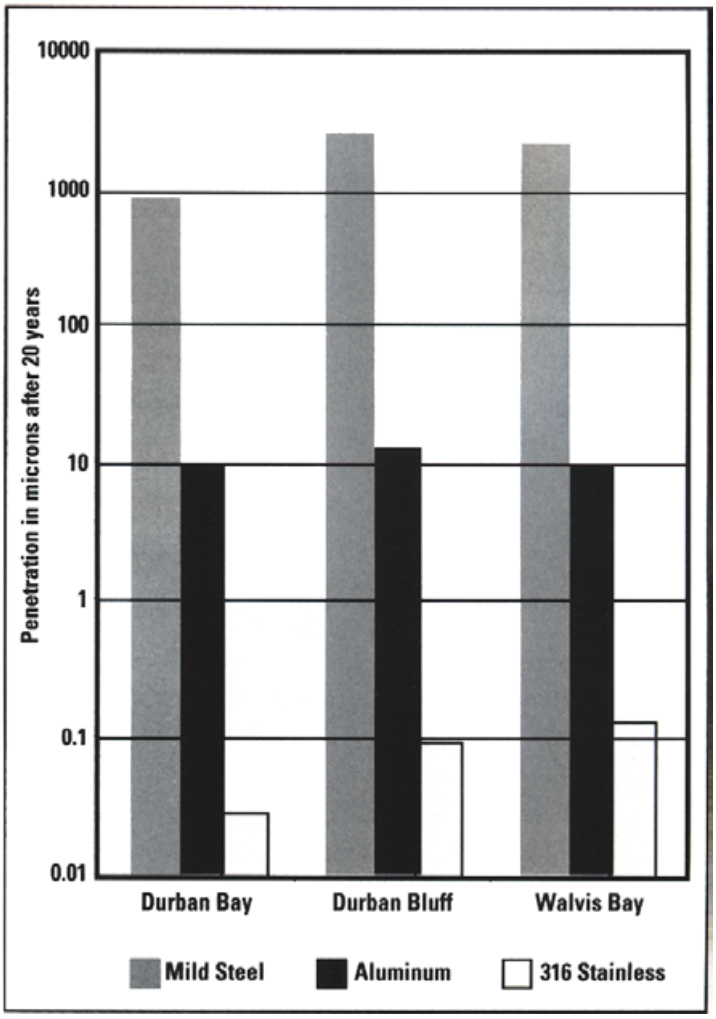

Chart 1: Comparison of the corrosion of Type 316 Stainless Steel, Galvanized Steel, and Aluminum after twenty years exposure at three urban or industrial coastal sites.
Courtesy of the South African Steel Development Association (SASSIDA)

Table 1: Suggested stainless teel grades for common service environments.

Location	Rural/Suburb			Urban			Industrial			Marine		
Grade (Type)	L	M	H	L	M	H	L	M	H	L	M	H
Higher Alloy Stainless Grades	●	●	●	●	●	●	●	●	✓	●	●	✓
316 (also 316L, 316Ti)	●	●	●	●	✓	✓	✓	✓	(✓)	✓	✓	(✓)
304 (also 302, 304L, 321, 347)	✓	✓	✓	✓	✓	(✓)	(✓)	(✓)	✗	✓	(✓)	✗
430	✓	(✓)	(✓)	✗	✗	✗	✗	✗	✗	✗	✗	✗

L = Least corrosive conditions within that category (i.e. low humidity, low temperatures).

M = Fairly typical of the category.

H = Corrosion likely to be higher than typical for the category (i.e. persistent high humidity, high ambient temperatures, particularly aggressive air pollutants).

● = Will generally give good service but may be a more expensive grade than necessary for the environment.

✓ = Probably the best choice for performance and cost.

(✓) = Grade could be suitable if precautions are taken (i.e., a relatively smooth surface is specified and it is washed regularly).

✗ = Likely to suffer excessive corrosion.

ments and the design fails to prevent penetration to the door interior. This will weaken the door structurally, and the corroding steel may stain the stainless steel exterior.

The accelerated corrosion caused by the galvanic couple can be prevented by a non-conducting physical barrier between the two metals. The aluminum or galvanized steel would then corrode at the rate normally expected for the service environment. If the environment is severe enough to cause corrosion of an aluminum or structural steel frame, a stainless steel frame should be considered. Like the exterior of the door, the stainless steel frame should have appropriate corrosion resistance for the environment.

Hygienic applications

Studies comparing the dirt and bacterial removal rate for stainless steel with that of other materials have found its cleanability to be similar to that of glass and china. This makes stainless steel ideal for medical facilities, laboratories, clean rooms, commercial kitchens and other food handling facilities, public bathrooms, and other applications where bacterial removal and cleanliness is critical.

Enameled surfaces, mineral resin and polycarbonate surfaces have rougher surfaces which trap bacteria and make it more difficult to remove. The clean cut of the polishing lines on a stainless steel surface consistently retained less bacteria, whether wiped with a mild detergent or cleaned with an abrasive cleaner. Although many hygienic applications require the use of an all-stainless door, this characteristic is also advantageous when stainless steel push plates and other hardware are used on other door types.

Security

Stainless steel doors are gaining popularity in security applications including prisons, courthouses, mental health facilities, service entrances, areas where expensive equipment is stored or maintained, and other applications where maintenance may be low and security needs are high. They are particularly popular in applications where the potential for corrosion of traditional steel security doors is high. The corrosion resistance of stainless steel ensures that the door will remain structurally sound. For a long service life, the door's exterior, structural components, frame and hardware should all be stainless steel so no part of the door deteriorates prematurely. Although different grades of stainless steel can be used in a single design, the various grades used should provide a similar level of corrosion resistance.

Fire protection

Metal doors are a popular choice for fire resistance. Like carbon steel, doors made entirely of stainless steel can be obtained with Underwriters Laboratory (UL) or Warnock Hersey fire ratings of up to three hours in compliance with NFPA 80 and ASTM E152.

NiDI was one of five sponsors of a fire and radiation resistance testing program for materials commonly used on off-shore platforms where aggressive hydrocarbon fires are a possibility. The test for fire resistance exposed the materials to direct flames. The galvanized mild steel passed the five minute exposure requirement reaching an average temperature of 642°C (1188°F) but large globules of molten zinc were observed falling. Type 316 stainless steel was tested for 45 minutes with a maximum average temperature of 705°C (1300°F). The deflection of the galvanized steel after five minutes was twice that of the stainless steel after 45 minutes.

The testing also evaluated heating by radiation rather than direct flames. The galvanized steel ladder needed two hours to reach a stable temperature of 552°C (1026°F). During that time, it lost its entire zinc coating. The stainless steel reached temperature stability at 556°C (1033°F) in three hours. The deflection of the stainless steel after three hours was about one-third that of the galvanized steel ladder after two hours.

Although both the galvanized steel and stainless steel maintained structural integrity during both tests, stainless steel would be preferred where dripping molten zinc or distortion of the door could make it inoperable.

Surface finishes

A wide range of surface finishes are available for stainless steel. They can be used independently or in conjunction with one another. The more readily available finishes are described in Table 2 (page 5) Polished finishes ranging from the rougher No. 3 and No. 4 to the mirror-like No. 7 and No. 8 finishes are commonly used. Scratches across the grain will be visible and can be repaired to a limited degree.

While these polished finishes are suitable for many applications, other finishes should be considered for high traffic or vandalism-prone areas where scratching is likely and a pristine appearance is desired.

The more highly polished mirror finishes are sometimes combined with etching, selective polishing, color and other techniques to create very decorative doors. These combinations are beautiful and dramatic in applications where the potential for deliberate or accidental scratching is low.

There is growing interest in colored finishes for a variety of architectural applications including doors. Both new and traditional coloring techniques give the designer a broad range of colors including gold, blue, black, red and purple. While paint removal and careful cleaning will not most of these finishes, they can be scratched and are more suitable for areas where the risk of damage is low. One colored finish which has been used successfully in aggressive applications is the embossed, colored and highlighted finish. The color is recessed in this finish and, therefore, protected.

Many of the more elaborate finishes, including color, limit the fabrication techniques that can be used without potentially damaging the surface. For that reason, they are usually clad onto a door. Depending on the fabrication method, clad doors may not be suitable for applications where they are exposed to significant temperature variation or other circumstances that could cause delamination. Companies that specialize in these decorative finishes and NiDI are excellent sources of information on fabrication techniques.

Coloured and embossed, coloured, and highlighted surface finish examples.

In high-traffic areas like public transit facilities, airports and public buildings, there is potential for deliberate or accidental scratching. The random uniform scratch patterns of the distressed and angel hair finishes, embossed finishes and decorative swirl patterns minimize or hide this damage. A wide variety of appearances are available within each of these surface finish categories. While these finishes are utilitarian, they can also be very decorative.

The embossed finishes should be considered when additional impact resistance is required. Stainless steel is work hardenable so, when stainless steel is cold worked by embossing, the strength is increased. The additional strength

Table 2: Surface Finishes

FINISH	DESCRIPTION
No. 3	Reflective finish with short, parallel, coarse grit lines produced with 80 to 150 grit abrasive
No. 4	Reflective finish with short, parallel finer grit lines produced with 180 to 240 grit abrasive wheels or belts
No. 5, Hairline	Reflective long, parallel lines, produced with a Scotch-Brite* pad
No. 6	Soft, fine satin appearance produced with Tampico brushes
No. 7	Hi hly reflective, very fine grit lines, mirror-like; polished with up to 320 grit
No. 8	Very close to a mirror but very fine grit lines still visible; polished to 320 grit followed by buffing
No. 9 (Super No. 8)	True mirror, no grit line
Selective Polishing	Selective polishing of unprotected areas to produce patterns
Swirl	Swirl patterns obtained with grinding wheels or stainless steel wire brushes
Engine Turn	Rings, circles or overlapping circles created with a CNC-operated machine
Distressed	Random scratch pattern covering entire surface
Angel Hair	Finer random scratch-pattern
Abrasive Blast	Matte, uniform, blast media choice determines appearance
Selective Etching	Etching of selected surface areas to obtain a pattern
Embossing	Raised patterns pressed into the stainless by rolling
Electrochemical	Applied to cut sheets, numerous colors (also called INCO or light interference coloring)
Epoxy Paint	Applied to coils, full range of colors
Sputtering	Thin layer of a colored material applied to surface
Plating	Electroplating with colored and/or precious metals
Perforated Designs	Simple or elaborate patterns

* **Scotch-Brite is an abrasive, non-metallic pad manufactured by 3M Corporation.**

reduces scratch depth and the pattern helps to break up visible scratch lines making them less noticeable. Embossing can be done over most finishes, and that can help hide damage from vandalism.

Perforated patterns have been used for decorative interior doors and clad over glass exterior doors for added security and a dramatic design effect. The designs range from basic to elaborate.

Stainless steel doors are a durable, beautiful, cost-effective and practical choice. The broad spectrum of surface finishes make stainless steel an attractive and increasingly popular choice for purely aesthetic reasons. Use of readily available stainless steel technical information can make the material choice easier, help avoid common problems, and ensure that the door will meet all functional and aesthetic needs. ♦

SUGGESTED NiDI LITERATURE

Publication 11 014: *Stainless Steel in architecture, building and construction:* Guidelines for maintenance and cleaning

Publication 14 008: *Sinks of stainless clean best, beat bacteria*

Publication 10 042: *Stainless steel for durability, fire-resistance and safety*

Publication 12 004: *Answers for Architects*

Publication 12009: *Advantages for Architects*

Publication: 9012: *Finishes for stainless steels*

Publication 11003: *Guidelines for selection of nickel stainless steels for marine environments, natural waters and brines*

Publication 11 016: *Directory of North American Suppliers of Stainless Steel Products for Building and Construction*

Life-cycle costing software for stainless steel (3.5-inch DOS diskettes)

Reprinted from *Doors and Hardware, August, 1997*