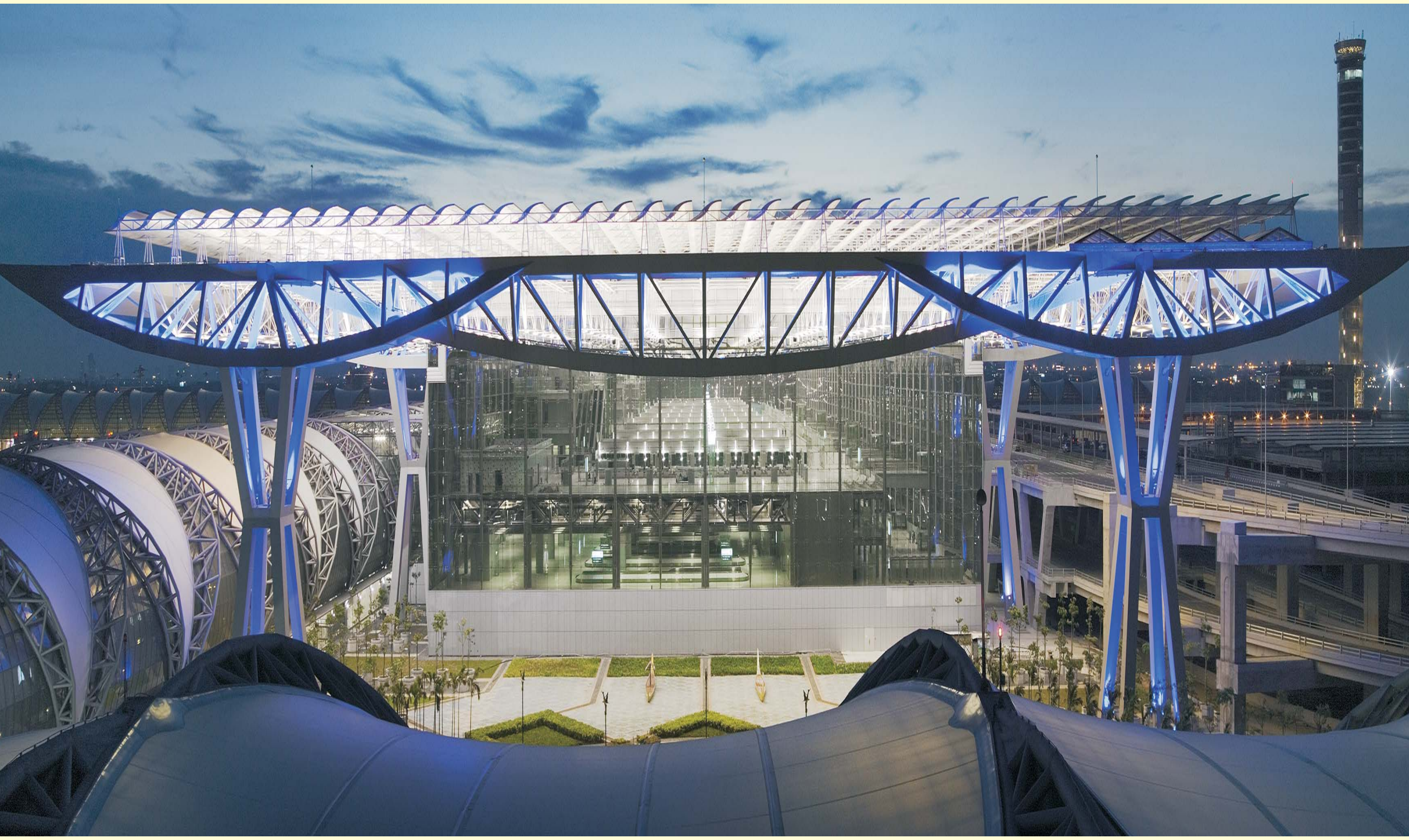
Sustainable Stainless Steel Transit Station Design

By Catherine Houska

Abstract:
Attractive, sustainable transit buildings are an important part of an efficient modern infrastructure. In addition to being attractive, properly specified stainless steels are durable, require minimal maintenance and provide long-term safety, security and traffic control. These factors and its inherent sustainability have made stainless steel an important design material for new transit buildings around the world. This review of stainless steel applications, benefits and specification will provide designers with the confidence to use it into designs capable of providing 50 or more years of service.

Keywords:
Stainless steel, train station, airport, subway station, sustainability, finish selection, glass curtain wall, roofing, structural design, fire resistance, corrosion resistance, recycled content, heat absorption reduction, roof runoff.



Suvarnabhumi Airport in Bangkok Type 316 supports for the glass curtain wall and Type 304 interior details
Photos courtesy of Rainer Viertböck

1. Introduction

Transit facilities such as train stations, airports and subway stations are a vital part of a modern infrastructure. Their efficient, uninterrupted service provides substantial economic and environmental benefits. While there are numerous attractive historic transit facilities around the world, most of the older structures were intended to simply be functional, low-maintenance and low-cost. Expanding cities and the desire to reduce highway congestion and fossil fuel use have encouraged governments around the world to replace, update and expand transit systems.

Several factors are influencing the design of new structures. First, the utilitarian, dim, often claustrophobic structures of the past are being replaced with attractive, spacious, often airy buildings. These modern facilities are intended to encourage mass transit use and serve as city gateways to welcome visitors while increasing system capacity and efficiency. Second, with the growing interest in sustainable design, governments are increasingly requiring 50 or even 100-year service life with minimal material replacement. Consequently, more thorough material comparisons are being made for exterior and interior applications which frequently include corrosion, scratch, impact and vandalism resistance; maintenance requirements; service life; recycled content; release of volatile organic compounds (VOCs) into the indoor environment; recapture or reuse of materials after service; and energy and water consumption.

The stainless steel parabolic roof on the JFK International Arrivals Building (former Terminal 4, 1956). (Figure 1)
Photo courtesy Overly Manufacturing Co.

In addition, public safety issues like floor slip resistance, security, fire and high wind resistance, seismic performance, long term railing and barrier integrity, and access for the elderly and disabled have become increasingly important. When these analyses are done, stainless steel consistently garners high marks, particularly in structures designed for thirty or more years of service.

2. The History

Although stainless steel is a relatively new construction material and only became available to designers in the mid-1920's, it has had a tremendous impact on international design. There are many high-profile structures where stainless steel has already provided up to 80 years of service without deterioration in appearance or metal replacement. When properly selected, fabricated, and maintained, stainless steel should last the life of the structure, even if that life extends over centuries. This makes stainless steel an attractive, cost-effective, environmentally friendly choice for sustainable transportation building designs.

2.1 Early Transit Applications

Designers began using stainless steel in train and subway stations and vehicles shortly after its introduction into the market. (The first all-stainless passenger train began operation in 1934.) By the 1960's and 1970's, stainless steel entrance doors, turnstiles, security gates, ticket booths and other components were common in rail and subway stations. In the 1950's, passenger air travel expanded significantly and stainless steel was selected for the new terminal applications. For example, in 1956, stainless steel was used for the parabolic roof on New York's JFK International Airport's new international arrivals building (the former Terminal 4). (Figure 1)

2.2 The Last 16 Years

Several internationally recognized transit buildings have helped to significantly increase stainless steel's use during the past 16 years. The completion of London's Waterloo International Railway Station in 1994 created a sparkling contemporary new entrance to the city for the international Eurostar trains. Nicholas Grimshaw Partnership made extensive use of stainless steel because of the desire for low maintenance and 125-year service life. Type 316 stainless steel was used for the highly visible station roof and its structural components, wear and corrosion resistant tread plate flooring, ticket and information booths, turnstiles, and security barriers. (Figure 2)

The designers of London's Waterloo Train Station used Type 316 stainless steel for roof structural supports and panels, slip resistant flooring and stair treads, ticket booths exteriors, railings and other items. (Figure 2)
Photo courtesy Nickel Institute

Roof of Ronald Reagan Airport (Figure 3)
Photo courtesy
Overly Manufacturing Co.,

In 1997, Ronald Reagan Washington National Airport B/C terminal was completed. Like Waterloo Station, it was designed to be a long lasting showplace entrance to a capital city. Type 304 stainless steel was used for roofing, entrance canopies and doors, ticket counters, column covers, curved stainless steel staircases, retail store entrances, planters, food service areas and tables, signage, information booths, elevators, security barriers and baggage carousels. (Figure 3, 3a) Like Waterloo Station, durable embossed stainless steel surface finishes were used extensively inside the building to limit scratching and impact damage.

The dull rolled-on stainless steel finish that was developed to meet this project's stringent low reflectivity roof requirements has subsequently been used on a variety of large airport and train station roofs around the world. Kowloon Train Station in Hong Kong (1998) was developed as part of a master plan to link the city to its new airport using a high-speed rail corridor and to encourage development of the West Kowloon reclamation. The station has 1.1 million m^2 (11.8 million ft^2) of mixed-use space and is many visitors first glimpse of Hong Kong. Attractive durable materials were selected including

Type 304 with a custom dull finish was used for the Bermuda style roof on Ronald Reagan Washington National Airport. It was also used for interior ticket counters, elevators, signage and other applications. (Figure 3a)
Photo courtesy Overly Manufacturing Co.,

a dull Type 316 roof that will withstand the corrosive coastal climate and the high winds associated with typhoons. Type 304 was selected for a range of interior applications such as escalators and column covers. (Figure 4)

Recent new sustainable airport, train station and subway designs have made extensive use of stainless steel. There has been a substantial increase in the use of stainless steel in traditional applications like ticket desks, turnstiles, column covers, and security barriers. In addition, several important trends have emerged. Small stainless steel tension rods or cable systems are increasingly being used to support large exterior and smaller interior glass curtain walls. These stainless steel supported curtain walls are particularly popular for larger airport terminals because their low visibility creates light airy structures where the structural components are attractive and do not obstruct the view. There has also been a significant increase in the use of stainless steel structural supports for glass canopies and for roofing.

The high profile Type 316 stainless steel roof on Hong Kong's Kowloon Station is many visitors first introduction to the city. (Figure 4)
Photo courtesy TFP Farrells

3. Recent Airport Projects

3.1 Aeropuerta de Barajas, Spain

When it was completed in 2004, Madrid's Aeropuerta de Barajas had the largest glass curtain walls of any airport terminal in the world. Richard Rogers Partnership and Estudio Lamela designed the terminal to be the gateway to Spain with bright open interior spaces. The high strength duplex stainless steel 2205 rods and connection system help to significantly minimize the size and visibility of the glass structural support system. Type 316 stainless fittings were also used in the design. Since the stainless steel structural supports do not have to be painted, long-term maintenance is minimized and the fine structural details are more visible and become a decorative design element (Figures 5, 5a). These spectacular glass walls fill the terminal with natural light creating a light airy appearance.

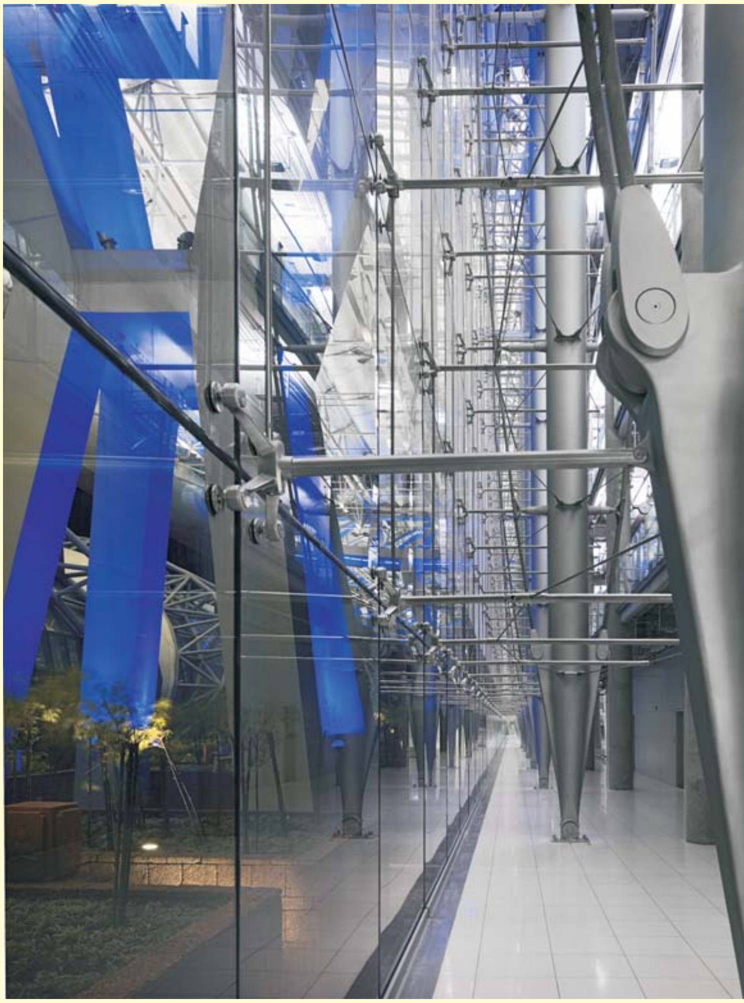
The glass curtain walls on Aeropuerta de Barajas are supported by high strength duplex 2205 and Type 316 stainless steel. (Figure 5). (Figure 5a below shows details) Photos courtesy: FOLCRÁ, Spain

3.2 Dallas/Ft. Worth International Airport, USA

The Dallas/Ft. Worth International Airport's new Terminal D (2005) used zero-VOC emitting stainless steel wall panels and other interior components to meet the US green building rating system (LEED) indoor air quality standards. And its striking dull rolled stainless steel roof meets current solar reflective index (SRI) requirements. New York's new Jamaica Station (2006), which provides a new train and bus hub for the city's suburbs, has a Type 316 roof with a dull rolled finish to meet 100-year service life requirements in a coastal location as well as many traditional durable stainless steel applications. (1)

3.3 Suvarnabhumi Airport, Thailand

Bangkok's new Suvarnabhumi Airport terminal was completed in 2006 and it is enclosed in glass curtain walls that rank among the largest in the world. It was designed to be a low-energy-need building using state-of-the-art technology. One of the most spectacular aspects of this Murphy/Jahn designed building are its glass curtain walls, which are supported by Type 316 cast spiders and tension rods that were cold worked to increase their strength (Figure 6) along with galvanized steel cables. Type 316 was selected because of its improved resistance to chloride stress corrosion cracking. The terminal is in a corrosive coastal environment and this structural application has sustained high loads.



Suvarnabhumi Airport in Bangkok Type 316 supports for the glass curtain wall and Type 304 interior details. (Figure 6) Photos courtesy of Rainer Viertböck

Suvarnabhumi Airport Ticketing Counter in Bangkok (Figure 6a). (Figure 6b below gives detail of stair case)
Photos courtesy Carl D'Silva

The result was a light airy, low maintenance structure. Richard Green, who consulted on the curtain wall, indicated that "cost analysis showed that the ability to use unpainted Type 316 made it less expensive than a coated carbon steel design". Like the other airports mentioned, the use of stainless steel for interior applications was also quite extensive. In addition to ticket and security desks, baggage handling and other common applications, Type 304 stainless steel was used for cable railings, stainless steel stairs and other attractive durable details. (Figures 6a & 6b)

3.4 Indianapolis International Airport, USA

The new Colonel H. Weir Cook Terminal at Indianapolis International Airport opened in November 2008. Like MIA, Type 304 stainless steel was used extensively within the new 111,000 m^2 (1.2 million ft^2) building. A variety of durable finishes were applied to the stainless steel to provide long-term scratch and impact resistance and durability. This included non-directional and patterned mechanical finishes.

Stainless steel provided tremendous design flexibility, because there is such a wide range of finishes that can resist scratching and impact damage. Applications included ticket counters, baggage handling, elevators, signage, planters, seating and other applications (Figures 7, 7a).

The new Colonel H. Weir Cook Terminal at Indianapolis International Airport used Type 304 stainless steel extensively in its interior. (Figure 7)
Photo courtesy of Forms + Surfaces

The new Colonel H. Weir Cook Terminal at Indianapolis International Airport used Type 304 stainless steel extensively in its interior. (Figure 7b) Photo courtesy of Forms + Surfaces

3.5 Ancona-Falconara Airport, Italy

The Ancona-Falconara Airport in the Marches region of Italy's Adriatic coast just added two new terminals in 2008. Like Madrid's new terminal, the large exterior glass walls have minimal visible support. In addition, the interior walls are also glass. The structural supports for the interior and exterior glass walls are made from Type 316 rods, cable and other components. Type 316 was also used for the signage, door and window frames, and the bar grating sunscreens for the windows.

3.6 Raleigh –Durham International Airport

Stainless steel's use in recent and current airport projects has not been limited to interior applications and the supports for glass curtain walls. Like the recent US airport terminals at the Dallas/Ft. Worth, Detroit, and Washington DC airports, the roofs for Phase 1 of Raleigh-Durham International Airport's new Terminal 2 (opened October 2008) are Type 304 with a special dull rolled finish, which has a very low level of reflectivity so that it will not blind pilots. Stainless steel roofing provides reliable longevity and remains attractive. Paint coatings will eventually fade, peel and have to be replaced. Furthermore, they may deteriorate more quickly if there is enough exposure to jet fuels.

Type 304 stainless steel was chosen because these airports are inland and not exposed to coastal or deicing salt. The same finish will be used on Phase 2 of the Raleigh-Durham terminal, which will open in 2011. It has also been selected for the new Sacramento California airport, which is under construction.

3.7 Southwest Oregon Regional Airport, USA

New airports of all sizes are using stainless steel for very visible applications. Several small US airports in resort communities have recently invested in new terminals. Since these airports primarily serve the private jets of wealthy individuals and corporations, stainless steel was selected for exterior walls panels, roofing, entrance canopies and other details because it gives them a high-end appearance. One example is the new Southwest Oregon Regional Airport. It is close to one of the most highly rated golf courses in the world. There are some commercial flights but it primarily serves private jets filled with golfers. It opened in July 2008. The exterior is covered natural 2B finish and blue-green electrochemically colored tiles. Type 316 was chosen due to its coastal location.

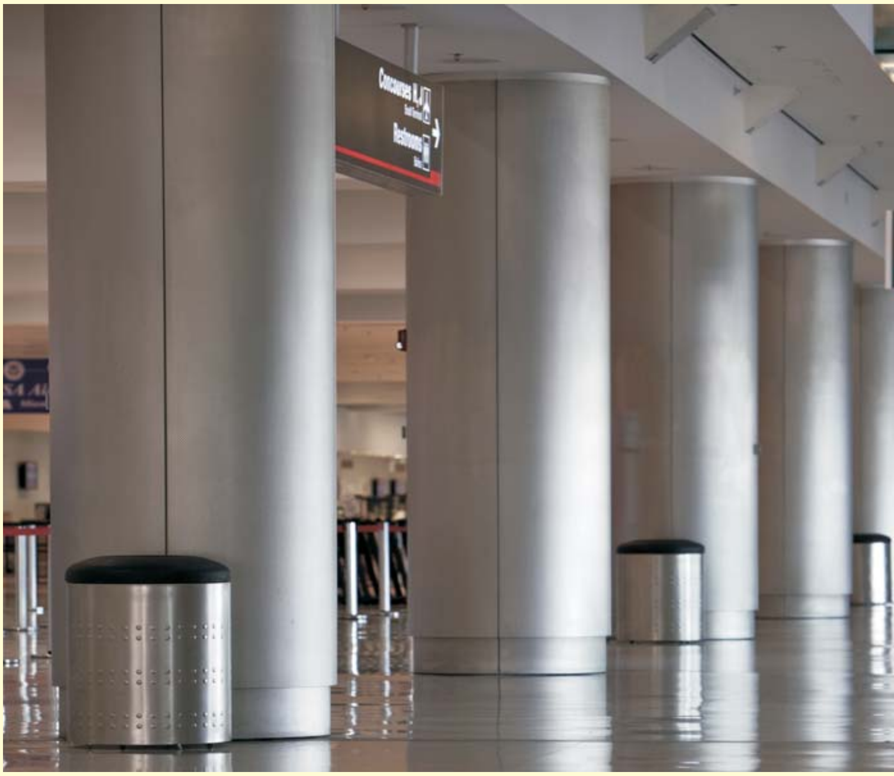
3.8 Miami International Airport, USA

Miami International Airport (MIA) is currently one of the world's largest airports and has the highest traffic flow of any airport in the world. It is a major gateway between North and South America. MIA is near completion of a major multi-phased expansion and renovation program that began in 1997 and will be completed in 2010. The expansion of the North and South Terminals and concourses will add 250,838 m^2 (2.7 million ft^2) to the facility. In addition, there have been significant renovations to the pre-existing terminal and concourse facilities, passenger parking garages additions, and a major expansion of cargo handling facilities.

Ticketing counter at Miami International's Airport (Figure 8) Photo courtesy of Forms + Surfaces

Stainless steel has been used extensively for interior and exterior applications throughout MIA because of its durability, impact and scratch resistance and the range of available finish options and patterns. Type 304 with embossed, bead blasted, non-directional scratch patterns, or No. 4 polished finishes was used extensively for interior applications such as signage, phone banks, display cabinets, column covers, elevator cabs, planters, recycling receptacles and wainscoting. Figures 8 & 8a. Some of these applications in the new South Terminal and renovated sections of the North and Central Terminals are given elsewhere in this article.

Type 316 was used for the exterior applications at MIA because of the airport's corrosive southern Florida location. Even inland locations in Florida have at least some coastal salt (chloride) exposure. Embossed and polished finishes have been used for parking garage wall panels and elevators, terminal entrance doors and column covers, and a sculpture. Despite the additional years of service, the stainless steel installed during the early and late project phases has a similar attractive appearance because appropriate grades and finishes were used for this demanding high traffic environment.



Columns clad in Type 304 stainless steel with bead blasted finish at Miami International (Figure 8a)
Photo courtesy of Forms + Surfaces

4.0 Train and Subway Stations

The Koperkhairane railway station at New Bombay used 10,000 square meters of painted Type 304 stainless for roofing
Photo courtesy Salem Steel Plant (SAIL)

4.1 Singapore Expo Center MRT Station

Singapore Expo Center's MRT Station (opened in 2001) was designed by noted architect Sir Norman Foster as part of the Changi Airport train line extension. It provides improved access to the Expo Center. It was designed to handle the high loads associated with events at the venue. Durable corrosion resistant materials were selected because of the coastal salt exposure and anticipated high traffic volumes. The spaceship inspired shapes of the domes have titanium roofs and the sheltered canopies, wall panels, and glass support system are Type 316 stainless steel. (Figure 9)

The spaceship inspired shapes of the domes on the Singapore Expo Center's MRT Station have titanium roofs and the sheltered areas and glass support system are Type 316 stainless steel. (Figure 9)
Photo courtesy: Nickel Institute

4.2 Britomart Train Station, Auckland

The Britomart Train Station in Auckland is the largest infrastructure project ever undertaken by a local authority in New Zealand. Completed in 2003, it used Type 316 for both the sheltered interior and exterior applications because of its close proximity to the coast. The ceiling, walls and column covers in the station's interior are covered with woven Type 316. (Figure 10) Custom embossed and polished covers were used on the forced ventilation pillars around the tracks and for decorative columns and other applications in the station. There was also selective use of electrochemically colored stainless steel. The exterior plaza has Type 316 ringed skylights, bus shelters and ventilation stacks.

The interior of the new Britomart Train Station in Auckland New Zealand used woven Type 316 of the ceiling and column covers. Custom embossed and polished covers were used on the forced ventilation pillars around the tracks. (Figure 10)
Photo courtesy: Nickel Institute, Catherine Houska photographer

4.3 European Stations

In Europe, new train and subway lines in Paris, London and Brussels have made extensive use of stainless steel because of its durability, corrosion and fire resistance and design flexibility. London's Vauxhall Cross Bus Station (completed in 2004), which is the second busiest in London, was designed to provide a link between the bus, rail, and subway lines; make public transit system access easier for cyclists; and help to revitalize the area. Type 316 with a coined linen finish was used for the sections of the curving roof and wall panels that are readily visible to pedestrians to provide a homogenous appearance. Photovoltaic solar cell panels placed on the roof reduce the station's energy requirements by 30%. (Figure 11)

Vauxhall Cross Station, London (Figure 11)
Photo credit: Thomas Pauly, Euro Inox

5. Stainless Steel Specification

The stainless steels most commonly used in architecture are Types 304/304L, 316/316L, and to a lesser extent 2205 but many other grades have been used. Stainless steels provide much higher corrosion resistance than other common architectural metals, particularly when there is pollution and chloride salt exposure (primarily deicing and coastal salt). In architectural applications, structural or perforation failure is generally only a concern in severe environments when an inappropriate stainless steel has been selected. Aesthetic deterioration from surface corrosion (rust colored staining) can be avoided with appropriate stainless steel grade and finish selection. There are numerous articles and industry association brochures to assist with stainless steel selection. (2)

5.1 Austenitic Stainless Steels

Types 304/304L and 316/316L are the most commonly used stainless steels for architectural applications. They provide identical strength levels and are easily formed and welded into virtually any architectural product. Both can be cold-worked to higher strength levels.

Type 304 is generally appropriate for climate controlled indoor and mild outdoor applications with low levels of urban pollution. If there will be some chloride salt exposure or higher pollution levels, Type 304 should be specified with a smooth finish and regular cleaning and the possibility of some staining between cleanings should be expected.

Because Type 316 contains molybdenum in addition to equivalent amounts of chromium and nickel to Type 304, it is more corrosion resistant. It is usually suggested for exposure to low to moderately corrosive coastal and deicing chloride salts and/or moderate industrial or higher urban pollution levels. It does not provide sufficient corrosion resistance for applications with high surface chloride salt accumulations or exposure the salt-water spray or splashing unless a smooth finish is specified and there will be regular cleaning.

Telephone Booth at Miami International
Photo courtesy of Forms + Surfaces

5.2 Duplex Stainless Steels

Duplex stainless steels like 2205 are significantly stronger than non-cold worked Types 304 and 316 and common structural carbon steels. Some, like 2205, can provide significant improvements in corrosion resistance compared with even Type 316. Their high strength and corrosion resistance allows designers to reduce structural section size, use the fine details of the bare metal supports as a sculptural design feature, and avoid the on-going maintenance of coating reapplication.

5.3 Identifying Coastal Locations

Coastal locations are typically defined as those within 8 to 16 km (5 to 10 miles) of a large salt water body (e.g. ocean, harbor, or salt lake). On islands, like Japan and Great Britain, and in areas with strong coastal storm patterns (US Gulf Coast), coastal salts have been documented much further inland. In addition, coastal salts can also be found much further inland on large peninsulas and in coastal areas with strong storm and weather patterns. For example, the entire US state of Florida is exposed to coastal salts. (3) More corrosion resistant stainless steels are typically used in saltwater spray and immersion applications and may be needed for sheltered locations that are not rain-washed.

5.4 Structural Applications

Cold worked Types 304 and 316, 2205 and other stainless steels are increasingly being used for low profile glass curtain walls, lightweight canopies, and other structures. For example, spectacular glass curtain walls supported by stainless steel were used to create striking exterior walls for Aeropuerta de Barajas (Madrid, 2004) and Suvarnabhumi Airport (Bangkok, 2006), which rank among the largest in the world. Smaller Type 316 and glass subway entrances were used for New York City's new Bowling Green Station and are shown in published plans for the city's new 2nd Avenue line (under construction).

6. Design Considerations

Generally transit buildings are expected to provide exceptional long-term performance with minimal maintenance. This is particularly true for rail and subway stations and their exterior wall, roof and elevated interior areas. Corrosive substances in the environment can accelerate the deterioration of construction materials and protective coatings. There is a direct correlation between a material's corrosion resistance and its longevity and the following factors should be considered during materials selection. The presence of pollution, particularly industrial, and de-icing and coastal salts can increase building exterior and sheltered component corrosion rates.

6.1 Sheltered Locations

Building areas that are open to the outside air, such as subway and train station entrances, are considered sheltered and are usually more corrosive than applications that are washed by rain. The guidelines for selecting stainless steel in the previous section can be applied to boldly exposed rain-washed components but sheltered locations can be more corrosive.

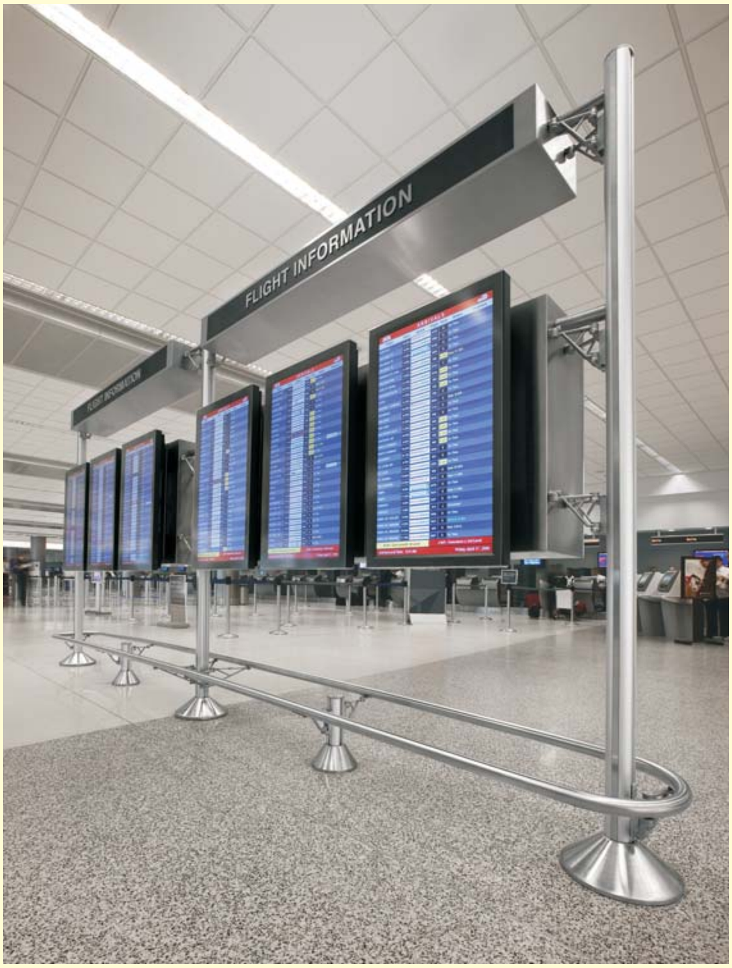
It is common for transit structures to have sheltered areas that are exposed to outside air. This should be considered during the selection of any sheltered material as it can lead to more corrosive conditions than would otherwise be expected. Higher levels of particulate deposits (e.g. dirt, salts, pollutants) accumulate on surfaces when there is no rain or manual washing and, if there is sufficient moisture from humid air, corrosion could occur if the material is not sufficiently corrosion resistant or if coatings deteriorate. A more corrosion resistant stainless steel or some maintenance washing is suggested for sheltered locations with chloride salt or corrosive pollution exposure.

6.2 Local Conditions

Designers also have to consider whether paint and coating deterioration on other types of architectural metals may be accelerated because of localized conditions. For example, this might occur on airport exteriors exposed to jet engine fuel fumes and in environments with high levels of wind blown abrasive particles (e.g. sand). Fuel exposure is not a concern with bare stainless steel, which is used for handling fuels because of its corrosion resistance. Sand storms and similar conditions can eventually change surface texture but stainless steel does not rely on coatings for corrosion protection and it is quite wear resistant.

6.3 Urine Exposure

Stainless steel is preferred for public bathroom partitions, dispensers, sinks and other items because, unlike painted and plastic surfaces, it can be quickly and thoroughly sanitized using chemical-free steam cleaning. It is also more ductile and impact resistant than porcelain or enameled steel. Many transit authorities specify Type 316 bathroom fixtures and partitions because it is more resistant to urine than Type 304. In fact the American Public transit Association (APTA) guidelines for transit buildings specifically recommend Type 316 where urine exposure is likely. Unfortunately, urine exposure in transit facilities is not always limited to bathrooms. Sometimes less visible areas in subway and train stations are also exposed. This can cause corrosion of some metals and odors can be difficult to remove from unsealed porous surfaces. For this reason, Type 316 is often used for wall panels, elevator cabs and other applications in these areas.



Flight Information at Miami International
Photo courtesy of Forms + Surfaces

6.4 Iron Particle Exposure

When subway and train systems use heavy rail (subway) or commuter trains that decelerate quickly, iron particles from track abrasion may be pushed into the station in the rushing air. These particles are most likely to be deposited on surfaces that are rough or porous and they can cause surface discoloration. Woven and rough stainless steel surface finishes should be avoided under these conditions, but smooth surfaces generally perform well because the wind forces generated by the trains blow particles from them before staining can occur.

6.5 Fire Resistance

Finally, stainless steel is preferred for acoustical panels in many parts of the world because of its superior resistance to fire and thermal radiation. Aluminum loses its strength quickly when exposed to relatively low fire temperatures and that can lead to acoustical panel collapse which can then block exits. While carbon steel can meet fire resistance requirements, it is a higher maintenance material and can become unattractive and deteriorate as coatings fail.

6.6 Cleaning

Stainless steel is easily cleaned with non-acidic, mild, chloride-free household cleaning products. The product choice depends on whether there is dirt, food, fingerprints or grease on the surface. Products like dishwashing detergents, degreasers, and even window cleaning products are regularly used to restore stainless steel surfaces. When surfaces are vandalized by the application of posters, paint or marker pens, they can be removed with paint and adhesive removers, soft non-metallic bristle brushes, and plastic scrapers. (4)

7. Finish Specification

Two factors must be considered when selecting stainless steel finishes for transit facilities. First, smoother surface finishes (*i.e.* Ra 20 micro-inches [Ra 12 microns] or less) accumulate fewer deposits (*i.e.* salt, dust or pollution), which can improve corrosion performance and appearance. Second, the ideal finishes for transit applications hide accidental scratching, impact damage or both.

7.1 Non-Directional & Textured Finishes

Non-directional light or heavy scratch patterns are ideal for applications like countertops, seating and baggage handling equipment because they hide surface damage. Deeper scratch patterns are rougher and will accumulate more dirt and corrosive deposits. For that reason, they are more suitable for interior surfaces or those that will be cleaned. When both impact and scratching damage is a concern (e.g. column covers and wall panels), textured (embossed or coined) or woven stainless steel should be considered.

Textured finishes are usually applied by pressing patterns into very smooth mill finishes, and, as long as the particular pattern selected is easily cleaned by rain and particulate levels in the air are not high, they can perform as well as much smoother finishes in exterior applications. Woven stainless can also be used for exterior applications like parking garages, airport fences, sunscreens and plant supports. But, woven products should not be used for applications with coastal or deicing salt exposure unless a more corrosion resistant grade than Type 316 is selected as crevice corrosion could occur.

8. Sustainable Design Benefits

In addition to providing long service life and the ability to avoid potentially toxic cleaning chemicals, stainless steel limits negative impacts on the environment in many ways. On average international stainless steel production contains about 60% recycled scrap content, and it is estimated that over 92% of the stainless steel used in buildings and infrastructure is recycled at the end of service. (5) In countries with a high historical use of stainless steel, the recycled content may be higher, particularly for common austenitic grades like Type 304 and 316. Stainless steel is not down-cycled and repeated recycling does not deteriorate properties. Unlike coated metals, carpeting, and other common construction products, stainless steel interior panels produce no emissions (VOCs). Stainless steel roofing and wall panels can also help reduce building cooling requirements and urban heat islands (UHIs).

8.1 Heat Retention

Testing of exterior wall and roof materials in the United States has shown that common stainless steel roofing and wall surface finishes retain and transmit less heat into the building than brick, concrete, wood and asphalt. This improvement can be even more substantial when roofs are well insulated and cavity wall construction is used. Stainless steel's low corrosion rate helps panels retain this high level of performance over time (with occasional cleaning to remove dirt buildup). As is true of other metals, special high reflectivity paints can be applied to further limit heat gain.

8.2 Roof Runoff

Numerous studies around the world have examined runoff from a wide variety of roof materials (*e.g.* asphalt, metal, clay tile, concrete). The primary purpose has been to determine whether the runoff is potentially toxic to humans, plants or wildlife. Stainless steel has lower metal or toxic substance run-off rates than any other common roof material. Furthermore, the runoff rates for nickel and chromium from stainless steel were often so low that they were below detectable limits and well under typical drinking water concentration limits. This makes stainless steel an ideal roofing material for environmentally sensitive locations and when water will be collected for irrigation and human consumption. Additional information on stainless steel sustainability can be found in previous Construction Specifier articles. (6)

9. Conclusions

Stainless steel is one of the most sustainable materials available for transit building construction because it provides long service life, can reduce energy requirements, does not require the use of hazardous cleaning chemicals and minimizes maintenance requirements. The use of stainless steel in transit buildings has increased substantially in the past 15 years with increased interest in sustainable construction but it also provides interesting aesthetic design alternatives such as low profile glass curtain wall. Performance is dependant on the selection of an appropriate stainless steel and finish for the application and literature and advice should be obtained from producers and the industry associations. (7)

Passport control area at Suvarnabhumi Airport in Bangkok
Photos courtesy Carl D'Silva

Acknowledgement

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Resources

Additional free information on stainless steel selection and its use in architectural applications is accessible through the Nickel Institute and International Molybdenum Association websites and offices.

Notes

1) "Wrapped in Stainless Steel, Sustainable curtain walls and roofing", Catherine Houska, <u>The Construction Specifier,</u> August 2008, pgs. 48-62.

2) Additional information on stainless steel selection and design can be found in "Designing on the Waterfront", Catherine Houska, <u>The Construction Specifier</u>, November 2007, pgs. 54-66; "Pushing the Design Envelope with Structural Stainless Steel", Catherine Houska and Kirk Wilson, <u>The Construction Specifier</u>, April 2007, pgs. 28-42; "Architectural Metal Corrosion; The de-icing salt threat" Catherine Houska, <u>The Construction Specifier,</u> December 2006, pgs. 104-112; "Metals for Corrosion Resistance: Part II", Catherine Houska, <u>The Construction Specifier,</u> November 2000; "Guidelines for Corrosion Prevention", Nickel Institute, Pub. 11 024; and "Which Stainless Steel Should Be Specified For Exterior Applications", International Molybdenum Association (IMOA).

3) Mapped historical data is available on the US National Atmospheric Deposition Program (NADP) website http://nadp.sws.uiuc.edu/isopleths/

4) Information on cleaning stainless steel can be found on the IMOA website (http://www.imoa.info) and in the Nickel Institute brochure (11 014) Guidelines For Maintenance and Cleaning

5) International Stainless Steel Forum (ISSF) website http://www.worldstainless.org/

6) "Comparing the Sustainability of Architectural Metals", Catherine Houska and Dr. Steven Young, <u>The Construction Specifier</u>, July 2006, pgs. 80 – 90. and "Wrapped in Stainless Steel, Sustainable curtain walls and roofing", Catherine Houska, <u>The Construction Specifier,</u> August 2008, pgs. 48-62.

7) There are stainless steel industry associations around the world. Some of the most useful sources for free technical literature and case studies are the Nickel Institute http://www.nickelinstitute.org, International Molybdenum Association http://www.imoa.info, Specialty Steel Industry of North America http://www.ssina.com, and Euro Inox http://www.euro-inox.org/.

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For guidelines on material selection, fabrication and surface finishing, contact :

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