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Stainless Steel Finishes – Options and Application

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Summary

A wide range of surface finishes for stainless steel are available to the architect. These range from mill rolled surfaces to highly decorative coloured and textured finishes and the ultimate selection could be important, in external building applications or internal hygiene areas, for example, where it will have a major influence on the appearance, corrosion resistance, ease of cleaning, and resistance to damage. It is important, therefore, for the architect to have an appreciation of the options available for optimum realisation and performance.

The reference specification for process route and surface finish for sheet, plate, and strip, is the European Standard EN 10088 Part 2. This standard uses a combination of letter and number for designation purposes which are given here as appropriate.

Finishing Processes

The following descriptions and techniques illustrate the different forms of supply and the processes used to change the appearance of stainless steel. It is not the intention here to describe each individual category, for example there are several mill finishes which are appropriately described in manufacturers data and Standards, but to provide a general overview of the finishes and their application.

Mill finishes

These form the basic supply condition for all stainless steel flat products. They can be used in the supply condition but also form the basis for subsequent finishing operations. The 2D finish provides a suitable non-reflective surface that is widely used for roof sheeting.

Mechanically polished and brushed finishes

This further operation involves the use of abrasive materials such as belts, brushes and/or polishing mops and compounds. A wide range of finishes are available and both finish, and abrasive medium, should be carefully selected and agreed with the contractor in applications where consistent quality is important.
For external marine environments and architectural applications EN 10088 Part 2 stipulates a clean cut finish with a surface roughness of R_a 0.5 microns maximum.

Patterned finishes

Achieved by rolling or pressing, a variety of proprietary finishes are available with a surface roughness suitable for external architectural cladding, and for applications where cleanability and hygiene is important.

They are decorative and functional and particularly suitable for large flat areas, cladding for example, where visual optical distortions known as ‘oil canning’, are considerably reduced and undesirable. Care should be taken to ensure that in external applications the pattern runs from north to south to facilitate rainwater run off. Rainwater is beneficial to stainless steel.

Rolled material will have a directionality that is not obvious when viewed at ground level and for the cladding of large areas on tall structures, care should be taken to ensure that panels are fabricated and installed using material in the same direction. Under certain sunlight conditions, cladding panels which have been installed using the reverse rolling direction, can display a different shade to the other panels when viewed at an angle. The steel producer will mark the direction of rolling on the underside of the sheet if requested. This will help to ensure consistency of appearance in ensuing operations.

At ground level in areas of high public usage, for example, airport terminals, lift cages, and shopping malls, patterned finishes are popularly used as any damage effects tend to be less apparent.

Bead blasted finishes

Finishes with low reflectivity and no directionality are obtained by bead blasting and contrast well visually when adjacent to polished stainless steel. The texture of the surface varies with the bead material. Suitable materials include stainless steel particles, ceramic bead, shredded nutshell, aluminium oxide, and glass, which may be bead or shredded. Sand, which may contain ferrous particles, and carbon steel, should not be used as blasting material as they may contaminate the stainless surface and lead to corrosion staining.

Electro-polished surfaces

Generally used for sheet, plate, or intricate shaped components, this electro-chemical process improves the surface finish by removing the peaks of the irregular surface. In broad terms it will halve the degree of starting roughness, enhance reflectivity, and facilitate ease of cleaning. The process is used, for example, with teardrop patterned stainless steel floorplate to good effect.

Coloured finishes

The inert chromium oxide layer on the surface of stainless steel can be coloured by chemical process. The time dependent process is particularly suitable for the austenitic stainless steels. During immersion the surface film passes through a range of colour: bronze, gold, red, purple, blue and green, and consistency of colour is dependent upon the skill of the operator.

Stainless steel coloured by this process cannot be subsequently welded without destroying the colour, and repair of damaged surfaces is extremely difficult. The material can be formed and bent after colouring taking care that the surface is protected from damage during the process.

The final appearance is influenced by the substrate appearance, for example, a matt surface will result in a matt colour, and a highly polished substrate will result in a high gloss coloured appearance.

Organic coloured coatings

Stainless steel can be coated with organic PVF2 or Acrylic materials using specialist pre-treatment and coating processes. This material was developed for roofing and cladding and is available in a range of colour. It has been particularly successful in Japan.

Specialist finishes

An infinite range of exciting and dynamic designs are produced by specialist finishing companies. Almost any graphic design can be given to stainless steel using processes that include photoresist, acid etch, colour, pattern, polish and grind. These processes can be used individually or in combination, and end applications include building entrances and lift cages. Care should be exercised in cleaning these highly decorative finishes to ensure that the surface is not scratched or damaged.

Surface Roughness

The performance of stainless steel in terms of resistance to corrosion and cleanability, has been shown by research to be dependent upon the smoothness of the surface. Smooth surfaces will retain less dirt and contaminants than rough surfaces, and this is recognised by EN10088 Part 2 in stipulating a maximum surface roughness value of R_a = 0.5 microns for marine and architectural applications.
Stainless steel surface finishes are achieved by the use of abrasives and compounds and it should be borne in mind that these effectively ‘cut’ the surface of the steel to varying degree.

Surface roughness is likely to vary from finisher to finisher, according to the equipment and pressure applied, and the abrasive medium used.
Within each designated finish, therefore, there will be different values of surface roughness and this is normally expressed in R_a, or centre line average terms.
Typical roughness values for three commonly specified architectural surfaces are as shown in Table 1.

EN10088 Part 2 Designation	R_a in microns
2B	0,1 – 0,5
2J	0,2 – 1,0
2K	0,5 max.

Table 1. Typical surface roughness values

It is advisable, therefore, to agree with the producer, or specialist finisher, an acceptable level of R_a. In areas where a consistent finish is desirable, reference panels should be produced and held by each party, and an inspection procedure agreed.

Working with stainless steel

A protective plastic film is usually added to stainless steel by the producer or specialist finisher, and this should be retained wherever possible during fabrication, transit, and erection, to protect the surface from damage. The plastic film incorporates an adhesive backing, which will degrade when exposed to ultraviolet light, i.e. sunlight for extended periods. In the specific case of cladding on high rise structures, the film may not be stripped from the stainless steel for several months, which could result in adhesive particles remaining on the steel. To prevent airborne contaminants from adhering to these particles and subsequent staining, it will be necessary to remove the particles by cleaning. Early discussions with the steel producer and film manufacturer should result in the correct specification of film and adhesive alleviating the need for a cleaning process.

Retaining the film on the stainless steel until building work has been completed will protect the surface from mortar splashes and other undesirable stain creating compounds during erection of the building.

Stainless steel is readily fabricated by normal processes such as roll form, press brake, guillotine, punch, drill, and weld. The choice of fabrication process will depend upon the chosen surface finish, the design, method of connection, and end application. Importantly, equipment used to fabricate stainless steel should be clean and tools ideally should be dedicated stainless only to prevent particles of carbon steel contaminating the surface of the stainless steel. In exposed wet conditions the carbon steel particles will very quickly show as corrosion stains.

Welding processes particularly suitable for stainless steel include tungsten inert gas (TIG), plasma arc, metal inert gas (MIG), and resistance welding. Figure 1 shows an example of pressed panel with welded corners and fixing lugs.

Stud welding using capacitor discharge is a popular method deployed for the attachment of cladding panels as it eliminates weld clean-up and there is no visible surface marking.
Figure 2 shows an example of stud welding on a cladding panel.

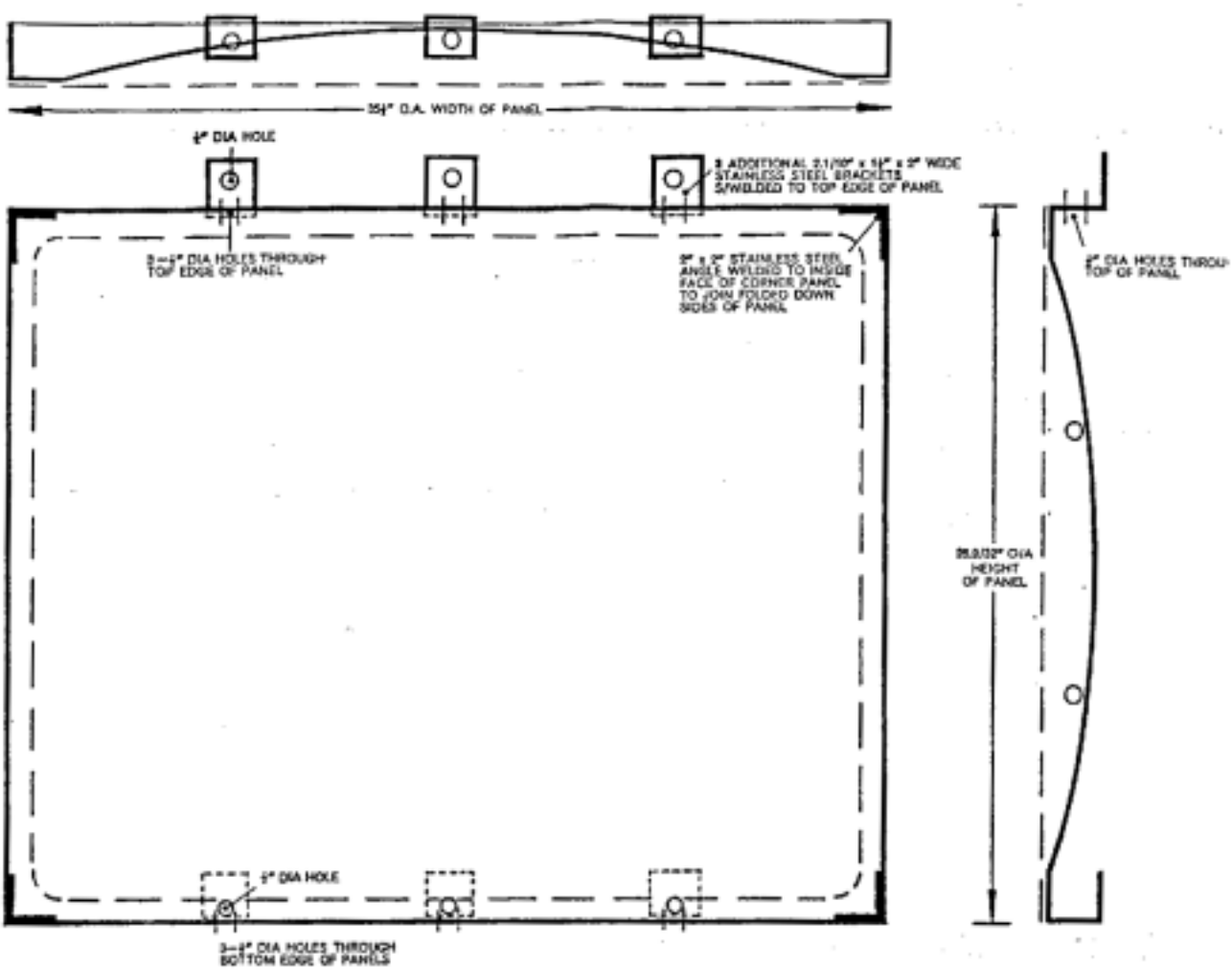

Figure 1: Example of fixing brackets welded to stainless steel pressed cladding panels

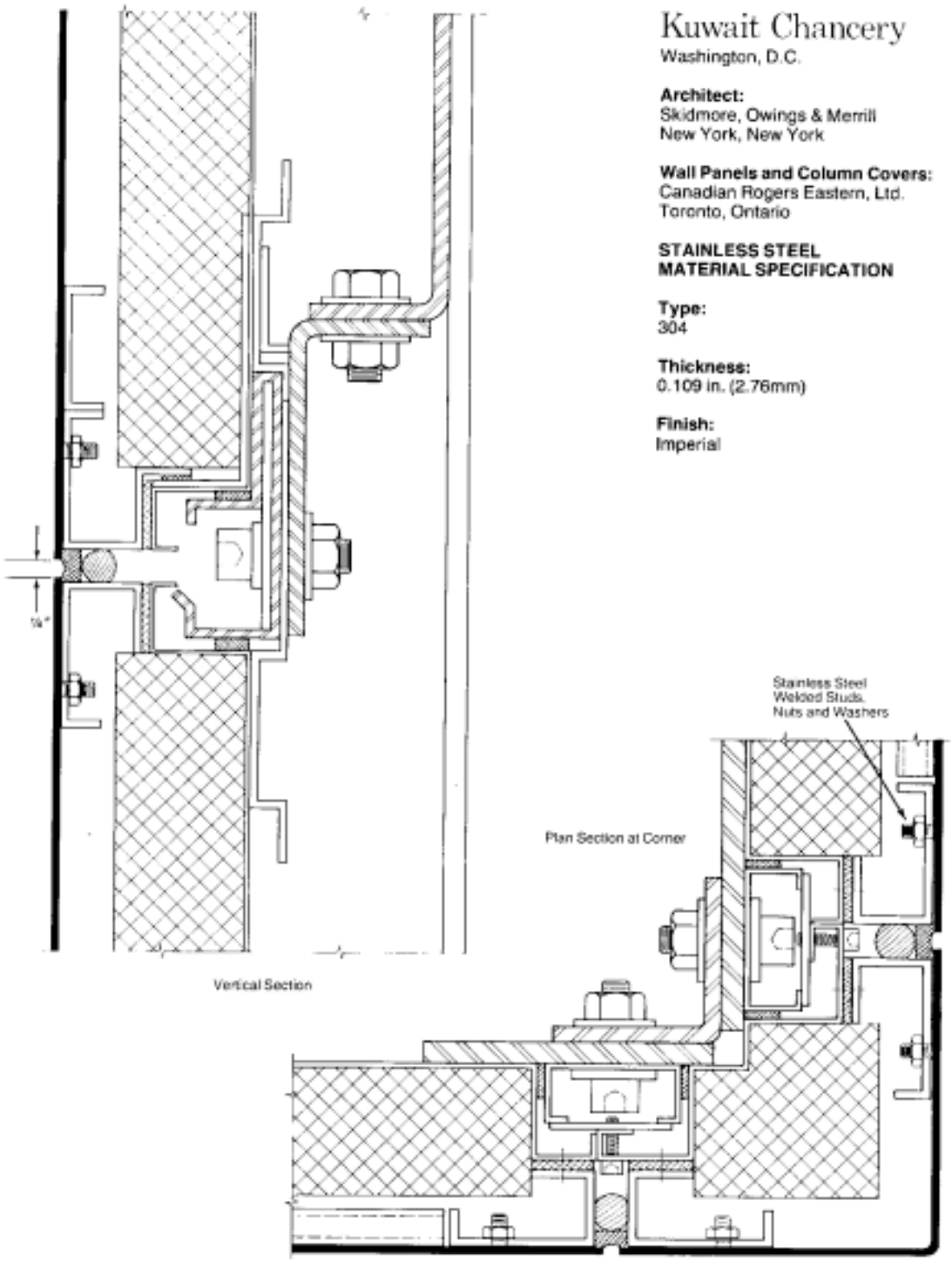

Figure 2: Detail of pressed panel fixed by stud welding

Care should be exercised with all welded components to ensure that the surface finish can be restored to the original finish after welding. Junctions and joints should be detailed to accomplish the restoration without undue difficulty.

Stainless steel is compatible with other building materials. Other materials, however, can effect stainless steel. For example, mortar droppings should be cleaned off as soon as is possible to prevent staining and subsequent cleaning. Abrasive and chloride bearing cleaning agents must not be used on stainless steel.

Stainless steel should be isolated from carbon steel products in areas where moisture will be present as stainless steel is more noble than carbon steel and corrosion of the carbon steel leading to corrosion staining of the stainless steel could result. Non metallic isolating materials such as nylon or teflon should be used as a separating barrier.

Advice on cleaning stainless steel is available from the producers.

Conclusions

The wide range of finishes available for stainless steel permits the architect to select a surface finish specifically for the purpose, alternatively, creative one off designs can be produced by the producer or specialist fabricator.

Stainless steel is an exciting material that has been used for many of the world's tallest buildings from Europe's tallest structure, the Canary Wharf Tower, to the Twin Towers in Kuala Lumpur. The Chrysler building in New York installed stainless steel at the top of the 319m tall structure in 1930. It has been cleaned twice, in 1961 and 1995, and remains in excellent condition.

Literaturhinweis

Euro Inox (ed.), Guide to Stainless Steel Finishes, Brussels, 2000 (Building Series, Volume 1)