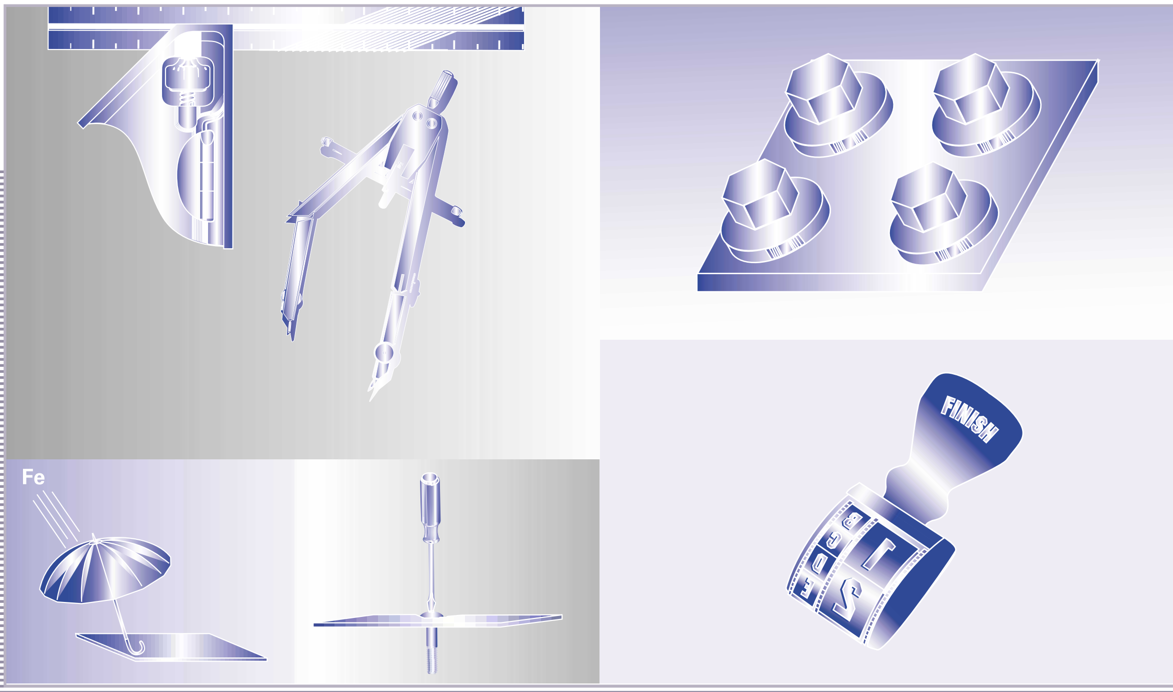
euro inox
The European Stainless Steel Development Association

Good Fabrication in Architectural Stainless Steel



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ISBN 2-87997-062-8

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1. Introduction

Architects specify stainless steel for its excellent corrosion resistance as well as for its visual qualities. Good fabrication is essential to maintain both these features. Stainless steel is not more difficult to cut, form and join than other metallic materials, but it may be different. Respecting those small differences is the key to success.

The **target audience** of this paper is architects, developers, owners and other persons involved in material selection who, without going into the detail of fabrication technique, wish to have a checklist of the major points to be observed.

It is the **objective** of this paper to make these specifiers aware of some of the evaluation criteria that may be useful in

- checking design parameters
- selecting the right fabricator
- supervising the work on site
- clearing the work before handover.

2. Material Selection

Stainless steel is a family of more than one hundred metallic alloys. Their common feature is that they have a maximum carbon content of 1.2% and a minimum chromium content of 10.5%. Within this family of grades, there are different degrees of corrosion resistance to various media – from the very mild conditions in the interior of office buildings to the more corrosive conditions prevailing in an external marine environment or the splash zones of building components exposed to de-icing salt or sea water.

However, more than 90 percent of all building applications can be covered with just a handful of grades:

1.4301

By far the most popular grade is the classical alloy called "18/8" or "18/10". This is an iron alloy with ~18% Chromium (Cr) and 8.5 to 10% Nickel (Ni). The European standard designation according to EN 10088/1 is 1.4301, the equivalent American designation is 304. This is the usual grade for pots and pans, kitchen utensils and professional catering equipment. It is also the standard grade for building interiors and exterior applications in a normal urban atmosphere.

The other asset of this grade is its excellent formability and weldability, which enable the architect to create complex shapes, sharp lines and invisible joints.

1.4307
Instead of grade 1.4301 fabricators often use 1.4307, which is lower in carbon, ensuring sound welds in material thicker than 6 mm. In thinner dimensions, grade 1.4307 can always replace the alloy 1.4301 without any disadvantage to the user.

For more corrosive conditions, a grade with an additional content of Molybdenum (Mo) should be used. Even in small quantities, Mo improves the corrosion resistance of stainless steel considerably. Mo-containing grades are also suited to coastal regions, where halides (mainly chlorides) are in the air. These are deposited on exposed surfaces. As the moisture dries up, the salt remains on the surface. This process is continuously repeated, leading to chloride concentrations on the surfaces that may be much higher than in the air.

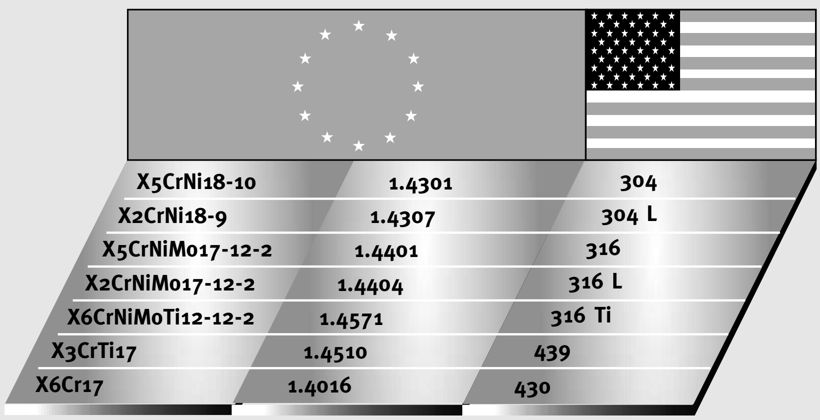
Another source of chlorides is de-icing salt, to which street furniture or the lower parts of facades may be exposed.

In industrial atmospheres, relevant sources of pollution may be industrial plants emitting sulphur dioxide.

In such circumstances, Mo-containing stainless steels are an imperative. They should also be considered for milder conditions when occasional cleaning is not guaranteed.

1.4401
The most typical representative of this family is grade 1.4401 (again with 18% of Cr, 8.5 to 10% Ni and 2.5% of Mo). The American equivalent denomination is 316.

1.4404
As with the "basic" grade mentioned above, there is a low carbon variant (1.4404 / 316 L) which is typically used in wall thicknesses greater than 6 mm, but can always replace grade 1.4401 (316) in thinner dimensions without any technical disadvantages.



1.4571
For fasteners and other non-decorative applications, grade 1.4571 (316 Ti) can be used as an alternative to the low carbon grade 1.4404. In addition to Cr, Ni and Mo, it also contains Titanium (Ti), a stabiliser ensuring full corrosion resistance in welds of thick stainless steel bar or plate. It is important to notice that this grade is not suitable for polishing and should therefore not be specified for decorative applications.

A second group of stainless steels are the so-called ferritic grades. They are Cr-alloyed steels with possible additions of Mo and / or Ti.

1.4510
One example of such an application is roofing, where a ferritic grade 1.4510 is sometimes used (instead of an austenitic grade such as 1.4401). It is a Ti stabilised Cr steel with a resistance to corrosion similar to 1.4301 (304).

1.4016
The non-stabilised counterpart, 1.4016 is used mainly for interior applications.

With this relatively small selection of grades, the majority of architectural components can be designed and fabricated successfully. Only in very specialised applications may other grades be necessary. Fasteners for ceilings in indoor swimming pools, for instance, are exposed to extreme corrosive attacks. The combination of mechanical stress and condensation of Cl-containing humid air makes the corrosive conditions extremely demanding. Due to new metallurgical developments, highly alloyed austenitic grades (like 1.4529 and 1.4539) and super-duplex grades are available for even such exceptional conditions.

At the lower end of the scale are the low-cost 10.5. to 12% Cr ferritic grades. They may be considered for reinforcement purposes, but are not suitable for general architectural applications.

When evaluating quotes, it is therefore important to ensure that reference is made to a specific grade, using designations according to EN 10088. The term "stainless steel" alone and even such popular names as "18/10" may refer to markedly different grades with widely differing material prices and make it impossible to compare proposal coming from different fabricators correctly.

3. Finishes

In architectural applications, the demands on the finishing quality are generally much higher than in other technical applications. Error-free communication between the architect and the fabricator is crucial.

The stainless steel finishes are defined by EN 10088/3. A summary of the relevant architectural finishes is given in the Euro Inox publication *Guide to Stainless Steel Finishes*.

Note, however, that these are indicative only and allow considerable variation. So, for instance, a 2B finish provided by one supplier may not be exactly identical to a 2B finish produced by another. Even within the same company, slight differences may occur between different batches of stainless steel. To avoid difficult discussions later on in the construction process, the following precautions should be taken:

- Use only specifications according to EN 10088/3.
- Specifications should include samples agreed between the architect and the supplier.
- In critical applications, stainless steel from the same batch should be used.

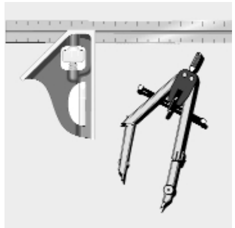
Fabricated components, such as panels or cassettes, should be mounted so that they are aligned consistently with the rolling direction of the stainless steel. Otherwise, differences in reflectivity may be detected under certain light conditions. Care should therefore be taken to ensure that the specification requires the mill to mark the rolling direction on the underside of the stainless steel sheet. The same rule applies to the polishing direction, if a polished finish is specified.

Ferritic (Cr containing) and austenitic (Cr and Ni containing) stainless steel panels, used for cladding, should not be mixed, although both grades may be technically suitable. The Cr alloyed ferritic grades have a slightly colder, the Cr and Ni alloyed austenitic grades a warmer hue. The difference in colour between austenitic and ferritic grades may become visible in critical applications.

The Euro Inox CD ROM *Guide to Stainless Steel Finishes* provides a realistic visual impression of the wide range of available surface finishes. The document is also available in printed form and will be sent free of charge upon request.

4. Design

The design should avoid the need for on-site welding and provide enough space to access joints with welding torches and polishing belts. Recess areas, where humidity and dirt can accumulate, must be avoided.



5. Fabrication

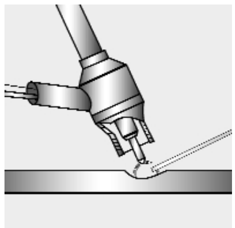
The best way of ensuring a good result is the **selection of a qualified and experienced stainless steel fabricator.** A look at the fabricator's workshop and examples of previous work carried out using stainless steel will give the architect or contractor a precise idea of the level of quality to which the fabricator can work.

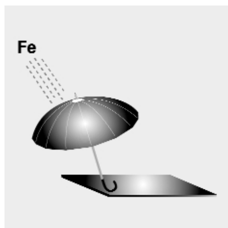
5.1 Avoiding Contamination

The corrosion resistance of stainless steel can be jeopardised by contamination with carbon steel, typically in the form of dust from cutting, grinding and welding. For this reason, it is strongly recommended to **separate carbon steel and stainless steel fabrication** in the workshop. **Separate sets of hand tools** must be used. Machinery like break presses requires **thorough cleaning** when going from carbon steel to stainless steel.

In **storing and handling** stainless steel, any direct contact between stainless steel and carbon steel, e.g. lift forks, chains etc. should be avoided.

5.2 Welded Joints





In the fist place, architects should endeavour to design their stainless steel components in such a way that **on-site welding is minimised**, as it is much easier to control the welding conditions in a workshop environment than on site.

Although most if the welding techniques used for carbon steel are also suitable for stainless steel, it is crucial to **use the right fillers**, which should generally be higher alloyed than the base material.

A very good yardstick of a fabricator's expertise is the **finishing of welded joints**.

After welding, good finishing of the joints is crucial. Welding will inevitably produce heat tint in and around the weld. In the tinted area, the natural self-repair mechanism of stainless steel is no longer guaranteed. It must therefore be **removed, either chemically through pickling, or mechanically through grinding and polishing**.

Welding will destroy the decorative surface of the stainless steel, which must be **reconstituted by grinding and polishing**. By using grinding belts of the same grain size as the original finish (typically grain 180 or 240), visually seamless welds can be reached.

5.3 Mechanical Joints

Screwing is another popular joining technique. A frequent error is the use of galvanised screws for fastening stainless steel. Joining the "noble" alloy stainless steel with a much less noble material like carbon steel screws or aluminium rivets produces galvanic cells, as soon an electrolyte comes into play. Even in indoor environments, the humidity from ambient air may form such an electrolyte. As in any galvanic cell, a current will flow from the less noble (carbon steel or aluminium) to the more noble (stainless steel) material, and the less noble one will corrode away. This is why galvanised screws, which would otherwise last for decade, rust away very quickly if used to fasten stainless steel fabrications. The rust stains resulting from this corrosion process can again contaminate the stainless steel and induce pitting corrosion. Therefore, it is imperative to **use stainless steel fasteners for stainless steel components**.

5.4 Influence of Fastening Techniques on Optical Flatness

Screwing stainless steel panels too tight my lead to distortions. **Stud welds** may be a suitable alternative. If done correctly, studs can be welded to stainless steel sheet (from a minimum sheet thickness of 1.5 mm) without the weld showing through on the front side.

Especially for smaller applications, **adhesive bonding** has grown in importance. This technique avoids problems of distortion; however the joints may be sensitive to shear stress.

Oil canning is a phenomenon encountered in the fabrication of metallic cassettes and panels. Stainless (especially austenitic stainless) steels have a lower heat conductivity than carbon steel and a larger thermal expansion. It is therefore advised not to make stainless steel panels too wide and to give the fabrication expansion space.

5.5 Cleaning and Maintenance

Even excellent stainless steel fabrications may be spoilt by unsuitable **initial cleaning procedures**. Please consider the Euro Inox document *The Cleaning and Maintenance of Architectural Stainless Steel Finishes* for reference.

With a few simple steps an architect, developer or owner can find out which points deserve particular attention, helping him to achieve results that reflect his expectations.

The *Architects' Guide to Stainless Steel* by the Steel Construction Insitute (SCI) contains further detailed information. A broader description of stainless steel fabrication processes is given in the book *Working with Stainless Steel* which is available from Euro Inox for € 50.

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ISBN 2-87997-062-8

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