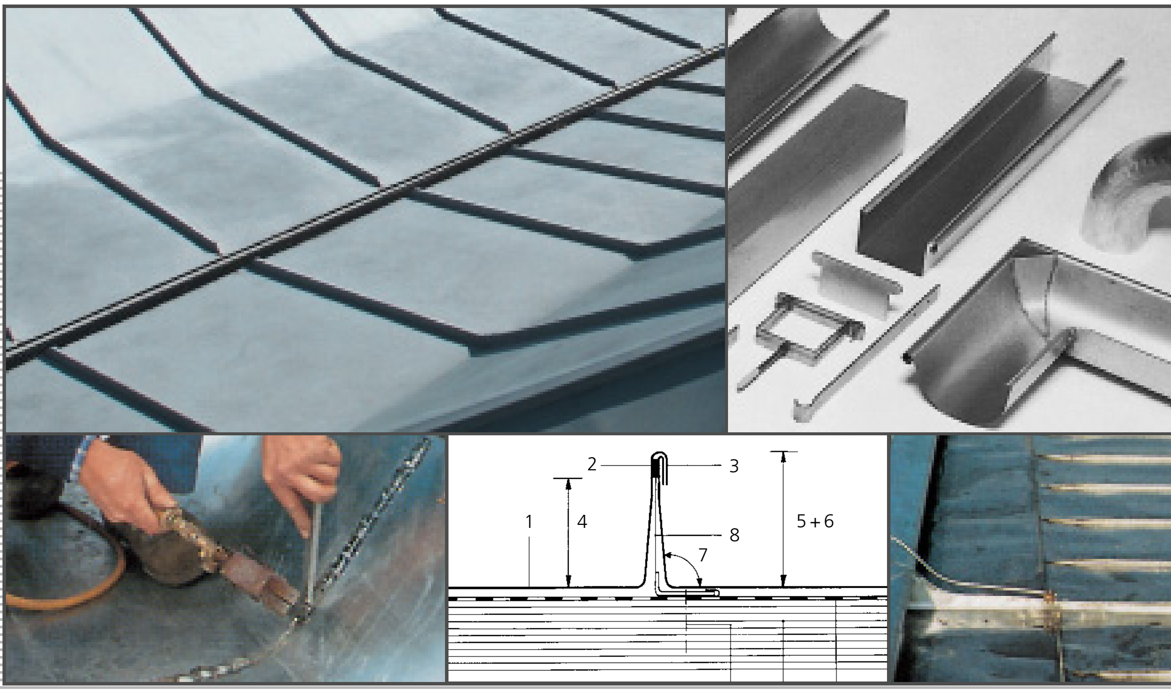
euro inox
The European
Stainless Steel
Development Association

# Technical Guide to Stainless Steel Roofing




Building Series, Volume 5

## Euro Inox

Euro Inox is the European market development association for stainless steel.
The members of Euro Inox include:

- European stainless steel producers
- National stainless steel development associations
- Development associations of the alloying element industries.

A prime objective of Euro Inox is to create awareness of the unique properties of stainless steels and to further their use in existing applications and in new markets. To assist this purpose, Euro Inox organises conferences and seminars, and issues guidance in printed form and electronic format, to enable architects, designers, specifiers, fabricators, and end users, to become more familiar with the material. Euro Inox also supports technical and market research.

## Editorial

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## Content





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# 1 Reasons for Stainless Steel in Roofing

In architectural applications, stainless steel is often used because of its attractive appearance. Facades, interior cladding, lifts and escalators, handrails and parapets are some of the most typical areas of stainless steel use. The family of stainless steels, however, has more to offer than just good looks. Its technical properties make it an ideal choice for many other building applications, in which additional durability requirements are essential.

For the owner of a building, the advantages of stainless steel roofs are mainly related to three aspects:

**Maximum life expectation**

The presence of air pollution highlights the need for corrosion resistant materials on buildings. The Chrysler Building in New York is clear proof that stainless steel is the ideal answer to this requirement. Built in 1929-1932, this building remains an outstanding testimonial for stainless steel in roofing and facade cladding. The stainless steel used was similar to today's 1.4301.

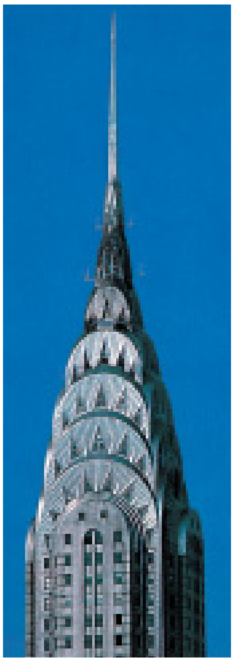
**Minimum Maintenance**

As maintenance costs continue to increase, it is important to bear these in mind right from the planning stage of a building. Due to its long-term corrosion resistance and its smooth surface finish, most stainless steel roofs, when designed and erected correctly, require very little maintenance.

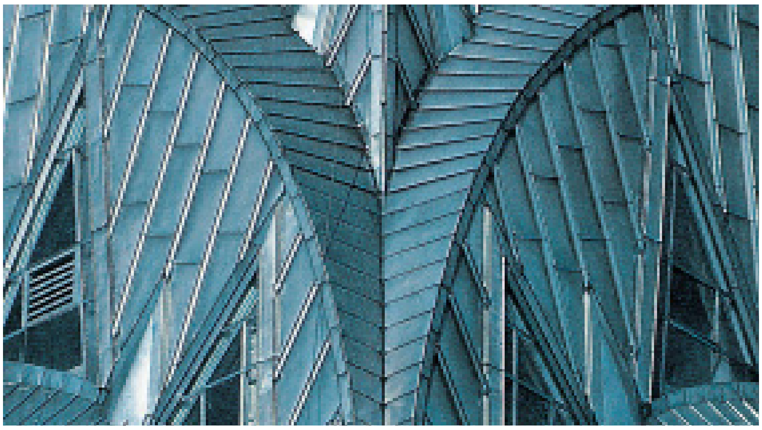
**Low weight**

Due to the high mechanical performance of stainless steel, the typical thickness of the material is lower than for most other metallic roofing materials. This can result in a lower overall weight after erection and therefore a lighter, more cost-effective supporting structure.

Stainless steel roofs can be made using a variety of techniques – from the traditional standing seam method to special welded techniques. In any case, more than thirty years experience demonstrates the high profile of the stainless steel solution in terms of durability.



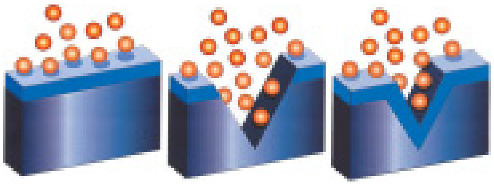
*Although it has only been cleaned once, the stainless steel roof of the Chrysler Building is still in excellent condition after more than 70 years.*



Photos: Informationsstelle Edelstahl Rostfrei, from the brochure "Höchste Zeit für Edelstahl"

## 1.1 The Self-Repair Capability of Stainless Steel

Stainless steel is an alloy containing at least 10.5 % chromium [1]. This gives the steel an inherent ability to protect itself from corrosion. Chromium in the steel reacts with oxygen in the air and/or water to which the steel surface is exposed, and forms an invisible protective film of a chromium-rich oxide. If this layer is damaged, mechanically or chemically, it is spontaneously rebuilt if oxygen is present. Corrosion resistance is increased with higher chromium levels and, additionally, by adding molybdenum to the alloy.



*Stainless steel builds up an invisible protective layer. If damaged, it re-forms spontaneously under the influence of oxygen from air or water.*

The presence of nickel improves formability and weldability. Nickel-containing stainless steels work-harden on cold forming and can thus give the fabricated part an additional structural function.

The most commonly used stainless steels have a chromium content of around 17 - 18% and a nickel content of 8 – 10.5%. This is why they are known as "18/8" or "18/10". These chromium-nickel grades are called “austenitic stainless steels”

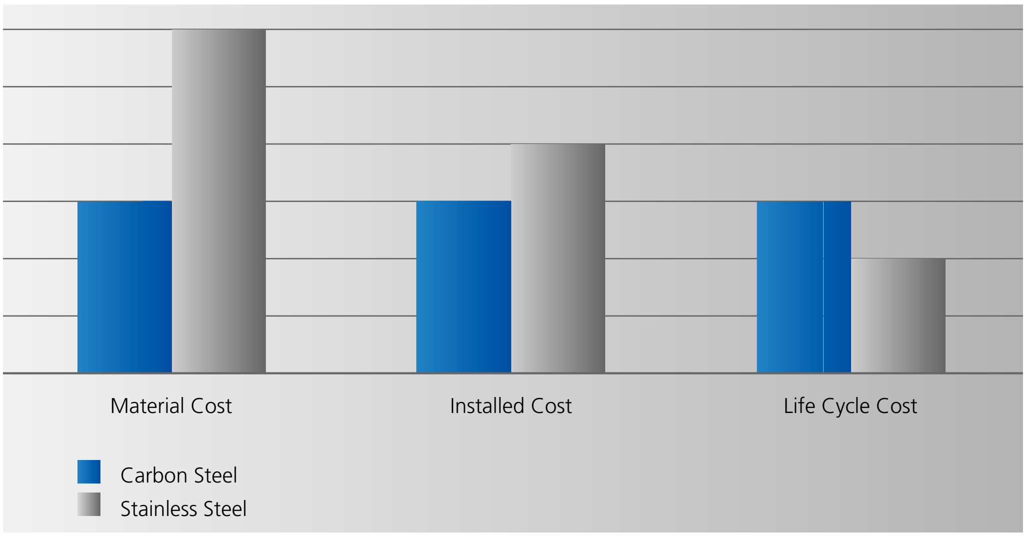
Another family of stainless steels are mainly alloyed with chromium and possibly other elements like Titanium. These are called “ferritic” grades. For roofing purposes, 12 - 17% chromium grades with organic or metallic coatings can be used.

## 1.2 Economics of Stainless Steel Roofing

A calculation of the **life cycle cost** of a roof for a given material takes into account the initial costs and the projected costs for the expected life of the roof. This whole life costing should include materials, fabrication, installation, operation, maintenance, down time, replacement due to wear and residual value. A detailed calculation programme for PC use is available from Euro Inox.

Although the initial cost of the stainless steel material may be higher than for other metallic materials, the installed cost (material + installation) is only slightly different. However the life cost for the stainless option can be significantly lower than for galvanised, organically coated carbon steel.

[1] See EN 10088: stainless steels are defined by a minimum chromium content of 10.5% and a maximum carbon content of 1.2%

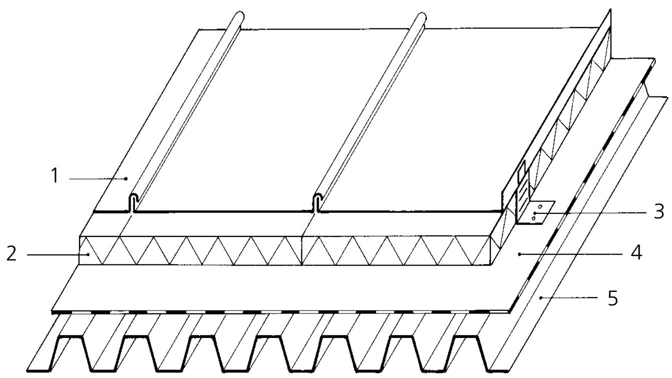



*Cost comparison of 0.6 mm coated galvanised carbon steel and 0.4 mm stainless steel grade 1.4401: Due to the mechanical properties of stainless steels, the material thickness can be reduced to 0.5 or 0.4 mm, providing a lighter weight (3.2 kg/m² for 0.4 mm stainless steel as against 4.7 kg/m² for 0.7 mm coated carbon steel). While coated carbon steel has a life expectation of 15 to 20 years, the service life of a stainless steel roof is generally that of the building.*

**Lower cost of the supporting structure**

As stainless steel is normally resistant to the corrosive influence of moisture underneath the cladding, it may not be necessary to provide a ventilated supporting construction. This allows the choice of a warm compact roof, which is often less costly and – when properly fitted – offers better building physics. However, in this case, a perfectly mounted vapour-barrier is a must.

*In the case of stainless steel, a ventilated supporting structure can be dispensable.*




Cross section of a warm compact roof
1 Stainless steel
2 Insulation
3 Sliding cleat
4 Vapour-barrier
5 Supporting structure

## 1.3 Physical Properties

Besides the aesthetic benefits and the durability of stainless steel, architects, owners and developers may choose stainless steel for its physical properties.

**Heat reflection**

Its smooth reflective surface provides stainless with excellent heat reflecting properties.

**Electric Conductivity**

The continuous membrane of a seam welded stainless roof can eliminate the need for extra lightning conductors. Often it is enough to connect the whole roof to a good earth. Stainless steel roofs can also contribute to electromagnetic shielding, which may be required for buildings that house sensitive electronic equipment.

**Fire resistance**

The melting point of stainless steel is around 1500°C, which is much higher than for most other roofing materials, e.g. Al 660° C, Zn 419° C, Cu 1083° C.

Photo: Outokumpu Stainless, Espoo

*Stainless steel can reflect heat, act as lightning conductors, shield against electromagnetic waves and add to the fire safety of the building.*

## 1.4 Mechanical Properties

The mechanical properties of stainless steel are particularly relevant to the roofing contractor who has to fabricate the roof. Ease of fabrication is closely related to the time spent and therefore the cost of erection.

Photo: Willem De Roover, Ghent

*Stainless steels are easy to fabricate – even at low temperatures.*

**Workability at Low Temperature**
The stainless steels commonly used for roofing are easy to form and join. They are not sensitive even to very low outdoor temperatures, so successful construction or erection is less dependant on the weather.

**Mechanical properties**
Stainless steel has excellent strength, ductility and toughness over a very wide temperature range. It is difficult to destroy. Its strength is so high that it is often possible to reduce the thickness of the cladding or construction elements. In addition, by cold forming the stiffness of the material is increased.

| Technical data | | | Qualities | | |
|---|---|---|---|---|---|
| | EN 1.4510 | EN 1.4301 | EN 1.4404 | EN 1.4436 | EN 1.4432 |
| Yield point 0,2 ($N/mm^2$) | Min. 230 | Min. 230 | Min. 240 | Min. 240 | Min. 240 |
| Tensile strength $N/mm^2$ | 420 to 600 | 540 to 750 | 530 to 680 | 550 to 700 | 550 to 700 |
| Elongation (%) | Min. 23 | Min. 45 | Min. 40 | Min. 40 | Min. 40 |
| Hardness (Vickers) | Max. 220 | Max. 220 | Max. 220 | Max. 220 | Max. 220 |
| Coefficient of linear expansion (m/m/°C) | $10 \times 10^{-6}$ | $16 \times 10^{-6}$ | $16 \times 10^{-6}$ | $16 \times 10^{-6}$ | $16 \times 10^{-6}$ |
| Density ($kg/dm^3$) | 7,7 | 7,9 | 7,9 | 7,9 | 7,9 |

## 1.5 Environmental Properties

Material selection today is greatly influenced by the aspect of sustainability:

- Building materials must be safe to use for the workers
- During the entire product life, the building material shall be neutral to the environment and not give off noxious substances into the air or through run-off water.
- At the end of its useful life, the building product shall not create a waste problem and shall be completely recyclable.

**Recycled Content and Recyclability**
Stainless steel is produced from up to 60% recycled material and can itself be 100% recycled, again and again. Whilst some other roofing materials have to be disposed of as hazardous waste, stainless steel can even have a positive scrap value at the end of the useful life of the building.

**Neutrality to Rain Water**
Stainless steel has a special homogenous passive layer, which ensures that the material does not affect the rainwater that finds its way back into the ground water.

## 1.6 Architectural Qualities

Few other elements of a building dominate its appearance as much as the shape of the roof. Stainless steel is suitable for any flat, pitched or curved roof geometry.

*There are few design limits in terms of shape and pitch.*

Photo: Akibadai Cultural Gymnasium, Fujisawa

**Design possibilities**

Stainless steel products are available in many different finishes. The range of surfaces varies from subdued greys, to bright mirror-type finishes. And they will all change their appearance as they reflect even subtle changes in the lighting conditions around them.

**Green Roofs**

Being resistant to roots and algae, stainless steel flat roofs are an excellent underlay for "green" roofs. The right choice of stainless grade and an appropriate drainage layer between the stainless and the organic material or other substratum will provide a garden for all seasons.

Photo: Binder und Sohn GmbH, Ingolstadt

*Durable green roofs are a part of a sustainable building philosophy.*

# 2 General Options

The architect and the roofing contractor can make a number of design decisions, which are related to the required visual effect, the roofing technique and the environment.

## 2.1 Stainless Steel Grade

Different alloys are used in different environments:

| | Grade according to EN 10088 | Cr | Ni | Mo | Environment Classification |
|---|---|---|---|---|---|
| Ferritic (typically tin coated) | 1.4510 | 18 | – | – | low |
| Austenitic | 1.4301 | 17,0-19,5 | 8,0-10,5 | – | low |
| Austenitic | 1.4401 | 16,5-18,5 | 10,0-13,0 | 2,0-2,5 | medium |
| Austenitic | 1.4404 | 16,5-18,5 | 10,0-13,0 | 2,0-2,5 | medium |
| Austenitic | 1.4436 | 16,5-18,5 | 10,5-13,0 | 2,5-3,0 | medium |
| Austenitic | 1.4432 | 16,5-18,5 | 10,5-13,0 | 2,5-3,0 | medium |
| Austenitic | 1.4439 | 16,5-18,5 | 12,5-14,5 | 4,0-5,0 | high |

In general, flat roofs should be designed with Molybdenum-bearing grades as a minimum.

| Class | Description of environment | Typical grade |
|---|---|---|
| low | Rural areas with frequent rainfall, and/or high temperature. Urban areas with low industrial activity and without significant pollution. | 1.4510 (Typically tin coated), 1.4301 |
| medium | Urban areas with higher pollution, industrial and coastal areas with higher rainfall. | 1.4401, 1.4404, 1.4435, 1.4436, 1.4432 |
| high | Areas of higher risk where chlorides, sulphur dioxide, fluorides also occur. Industrial or coastal areas with high temperature. Particular care should be taken to avoid crevices that might allow corrosive material, chlorides, etc… to accumulate. | 1.4439, 1.4539, 1.4547<br>1.4462 (Duplex) |

## 2.2 Surface Finish

| Finish | Standing seam Roof | Seam Welded Roof |
|---|---|---|
| 2B | X | X |
| Matt (blasted, rolled) | X | X |
| Patterned | X | – |
| Terne-coated | X | – |
| PVDF coated | X | X<br>part painted product only |
| Electrolytically coloured | X | X<br>colour destroyed in weld |

Of course when the roof just has to be functional, the choice is easy: the most common finish is 2B, which has a rather reflective, smooth, flat surface.
As a general rule it can be said that the brighter and smoother the finish, the better the corrosion resistance and the easier

maintenance. As a complete contrast, there are many dull and coloured finishes available. This choice is related to environment, neighbourhood and building design.
The Euro Inox brochure “Guide to Stainless Steel Finishes” provides further details.

For traditional roofing, dull-rolled or low reflective materials are often preferred. Mill finishes like 2B or 2R (Bright Annealed) can also be used if a higher degree of reflectivity is acceptable, or wanted.

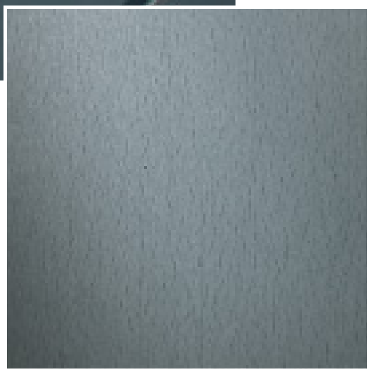
*Roofs in reflective 2B finish*

Photos: Willem De Roover, Ghent (top)
EDILTECOS, Mottalciata VC (centre)

*Mill finishes 2B (left) and 2R (right)*

Photo: UGINE & ALZ/RCC GmbH, Sersheim

Electrolytic coating on both sides with a very thin layer of 100% tin. The advantage of this tin layer is not only the matt grey appearance, but it simplifies the soldering of finishing pieces, such as gutters, roof penetrations and flashings. Accessories are readily available in this finish material.



*Tin-coated surface*

A range of low-reflective materials is produced in a number of different ways:

*Matt finishes produced by cold rolling*

A dull, matt finish can be obtained by a cold rolling process. Several producers offer a wide range of different finishes.

Photo: Rudolf Maierhofer, Neuötting

Special patterned designs for roofing purposes are also available.

*Patterned surface*

Photo: Martina Helzel, München

Another method of matt finishing is by blasting the material with a non-ferritic, benign granulate. This is often called bead blasting or shot peening. This process can be modified to produce a variety of plain reflective or dull textures, which are attractive and durable. However, the process can result in distortion of shape, especially if only one side is blasted.

*Bead-blasted surface*

Photo:
Rudolf Maierhofer, Neuötting

The use of coloured stainless steel is very popular in some countries. Some producers offer a PVDF coating with a typical thickness of 35 µm. There are also acrylic coatings on the market in a colourful range that can match with those available in painted carbon steel.

Other manufacturers produce colour by an electrolytic chemical process, which thickens the oxide layer to reflect a metallic-look in gold, blue, bronze, green, black and red.

## 2.3 Corrosion Resistance and Surface Protection

Normally, the general corrosion resistance of the stainless steel is not altered by finishing processes, but it should be remembered that the smoother the surface microstructure, the better the corrosion resistance for that grade.
Particularly, in severely polluted areas, rougher surfaces can harbour deposits of dirt and moisture that can stain or damage the stainless. It is important to design in such a way that rain water will easily wash and drain from the surface.

Many of the above products can be delivered with a protective strippable film to help prevent scratches, stains and general surface damage during fabrication and erection.

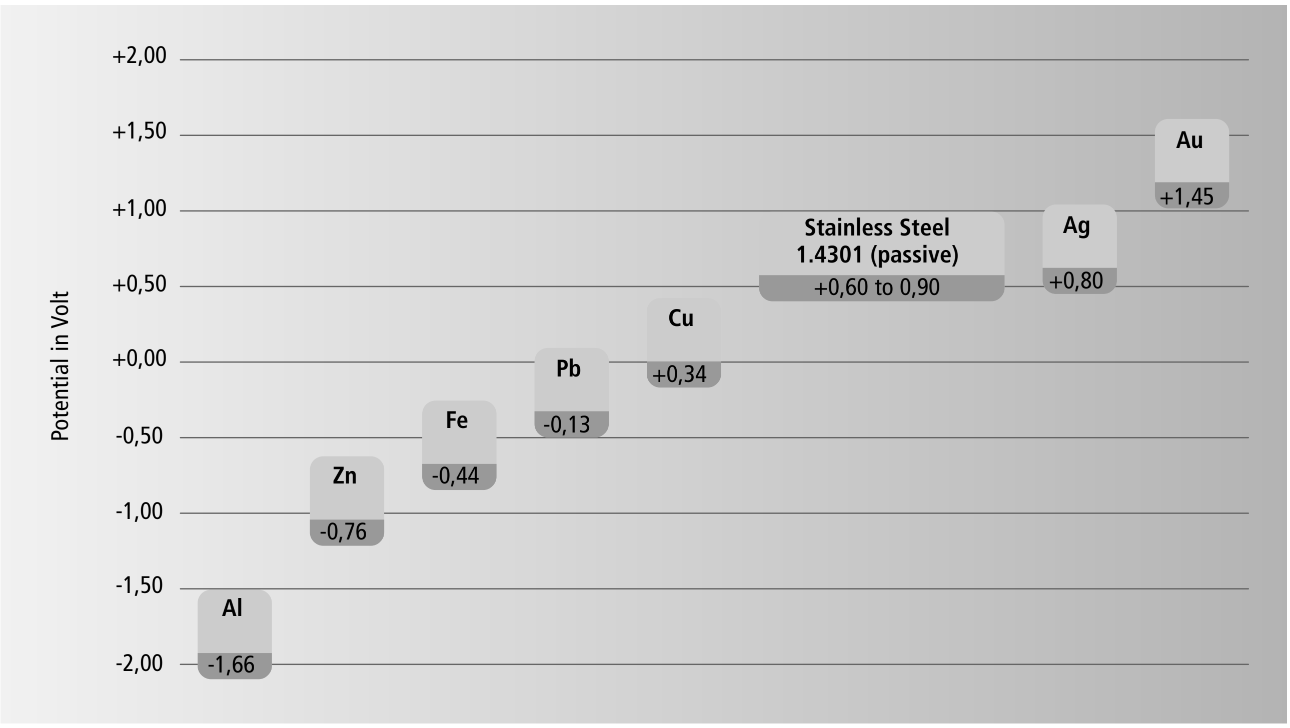
## 2.4 Compatibility with Other Materials

Stainless steel often comes into contact with other materials. In a roofing environment, bituminous felt is one of the classic contact materials. Whilst some other building metals or materials may suffer severe corrosion from bituminous felt and run-off water from such surfaces, stainless steel is highly resistant. This is one reason why stainless steel is often the more economical solution for renovation projects: damaged bituminous felt layers, which would otherwise have to be removed and disposed of as hazardous waste, can be left on the roof and covered by a stainless steel layer.
Occasionally, wood and concrete have been reported to release moisture that contains resins and preservatives, which induce corrosion in building metals. Experience indicates that stainless steel is resistant to these materials.

Care has to be taken in the case of combinations of metallic materials. These may be susceptible to galvanic corrosion, a process that reflects the principle of a battery: two metals – one relatively “noble” and the other much less “noble” – get into electrically conductive contact with each other through an electrolyte. In these circumstances, when a current flows from the less noble to the more noble material, the former is consumed. Stainless steel has a potential similar to that of silver and is generally the more noble partner. Rainwater and even the humidity in the air may suffice to form an electrolyte. If unprotected, the contact material may corrode, while the stainless steel will remain intact.
The larger the proportion of the more noble metallic material and the more the metals are different in terms of their normal potential (see graph next page), the higher the risk.

A widespread error is the use of non-stainless fasteners (e.g. galvanised screws, aluminium rivets...) on stainless steel components. As the surface of the stainless steel on a roof is large and that of the fastener small, galvanic corrosion may quickly deteriorate less noble fasteners. The use of stainless steel fasteners is therefore strongly advised.
Quite often, contact of stainless steel with other metallic materials is inevitable or even desired by the architect to create special visual effects. In these cases, the galvanic effect can be minimised if the stainless steel component is much smaller than the other metallic part (e.g. painted or galvanised carbon steel). For this reason, stainless steel fasteners in steel, aluminium, zinc or copper roofing should do not create problems.

However, if the stainless steel component is fairly large (a rule of thumb says more than 10% of the surface of the partner metal), it is important to electrically isolate the metals from one another. This can be done by means of coatings, insulating layers, and/or washers etc. to prevent a galvanic element from being created.

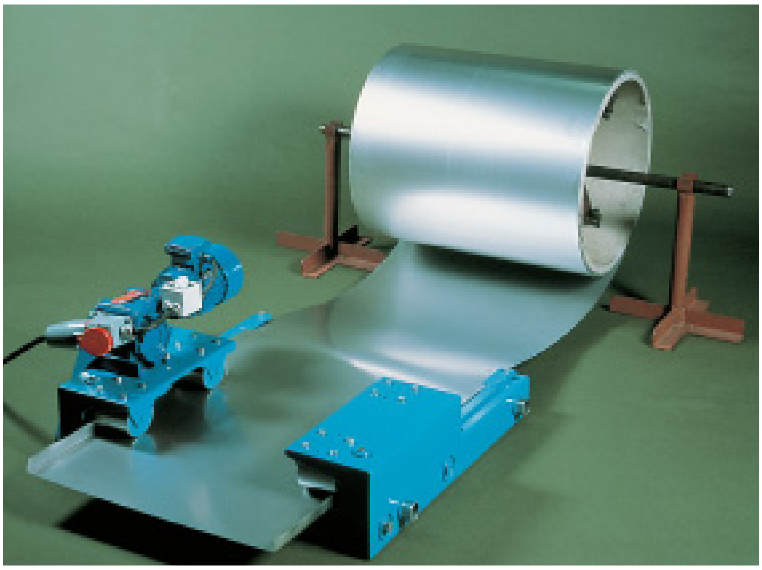



Normal potentials of building metals and some noble metals compared to a hydrogen electrode

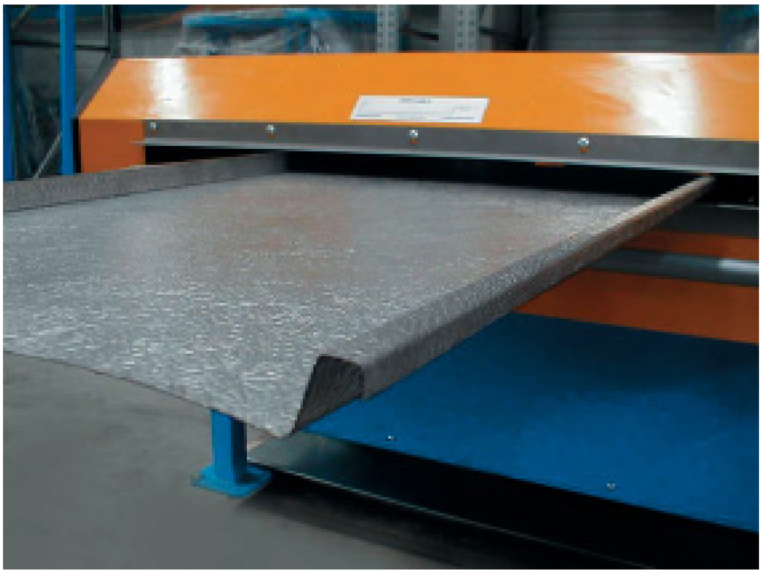
## 2.5 Tools

In general, most normal profiling, folding and bending machinery or hand tools for roofing can be used, but to avoid rust stains or scratches, the use of stainless, chromium plated or plastic tools and machine parts is recommended. The cleaning of the machines before use is required to prevent cross-contamination.

*Stainless steel roofs can be fabricated with the usual tools, provided contamination with carbon steel particles is prevented.*



*Simple profiling machine, mainly used for welding system.*

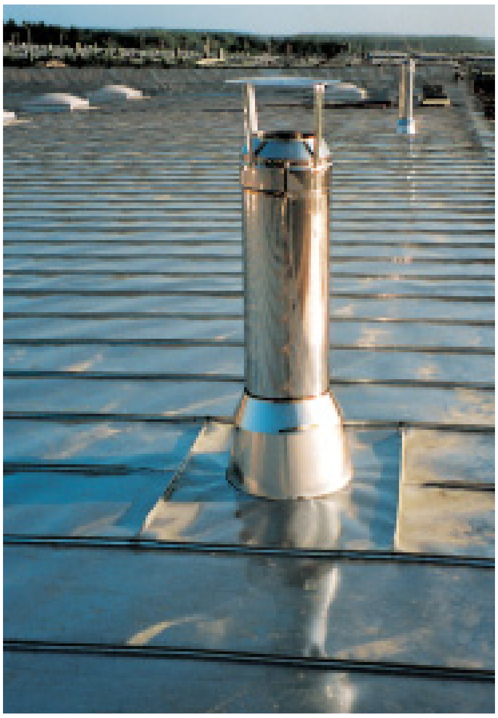


*Profiling machine for single and double folded roofs.*

Photos:
Rostfria Tak AB, Fagersta (top left),
Willem De Roover, Ghent (top right),
Battisti GmbH, Sulz (bottom)

## 2.6 Accessories

As a rule, cleats, sliding cleats, fasteners, evacuation pipes, gullies, ventilation tubes, etc. should also be made of stainless steel. If there are other roofing metals involved in the cladding, it is important to check their position on the galvanic scale. Insulation of materials, where appropriate, will help to avoid galvanic corrosion.



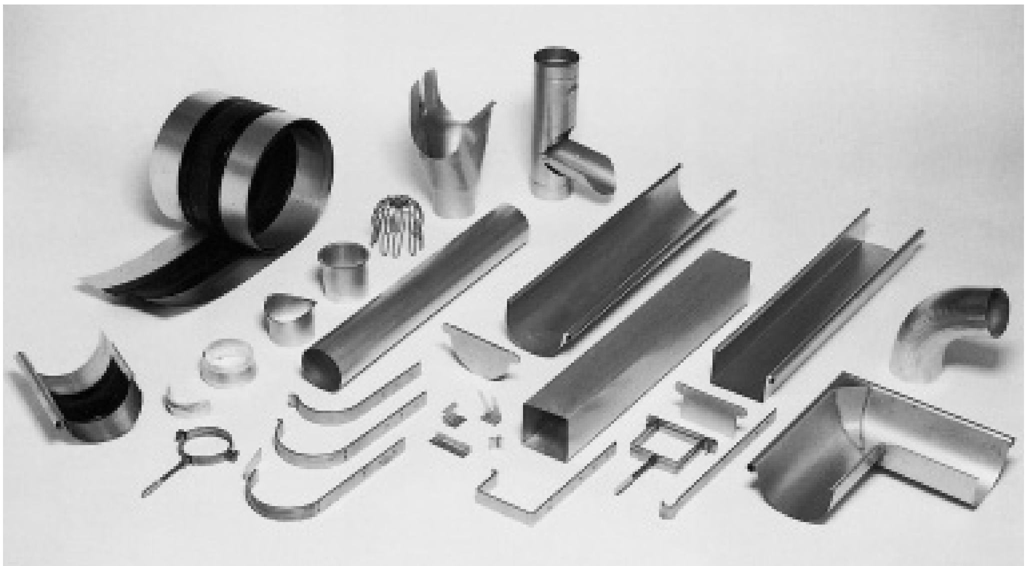
*Chimney*

*Sliding cleat*

*Stainless steel screws*

*Gutter and downpipe*

Photos:
Willem De Roover, Ghent,
Brandt Edelstahldach GmbH,
Cologne (below)



*A complete range of accessories is available.*

*Stainless steel is easy to solder if suitable flux and solder are used.*

Photo:
Brandt Edelstahldach GmbH, Cologne

## 2.7 Soldering Stainless Steel

Roof workers, who are used to working with other metallic materials, sometimes hesitate to use stainless steel because they are not sure about its soldering properties. Although soldering stainless steel requires a little more know-how, it is not difficult to learn and to become experienced.

The key to good results is in the use of suitable flux. Orthophosphoric acid based fluxes give excellent results and avoid any risks associated with chlorides.

In all cases, the stainless steel surfaces must be thoroughly cleaned and rinsed after soldering to remove all traces of flux. Flux used for other materials, e.g. copper and cinc, are not suitable for stainless steel. Soldering tools can be cleaned with stainless steel flux, but whetstone is to be avoided.

Different types of soft solder can be used

- high-purity tin, with a melting point of about 230°C
- tin-silver alloys and tin-lead alloys with a melting range of 215-250°C.

When parts to be joined by soldering are likely to be subjected to higher mechanical stress, the parts should be fastened beforehand with stainless steel pop rivets or spotwelds and then soldered in the usual way.

Photos:
Informationsstelle Edelstahl Rostfrei, Düsseldorf (centre, bottom)

# 3 Traditional Standing Seam Method

Stainless steel strip, generally 0.4 or 0.5 mm thick, can be delivered in coil widths between 350 mm and 670 mm. These thicknesses can be profiled on site but more often they are processed in the workshop, using specialist machinery.

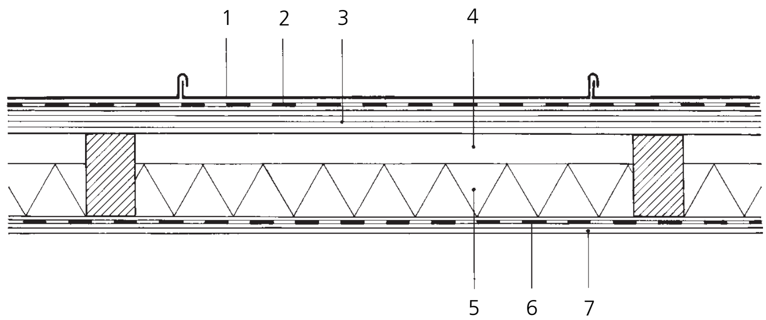

*Typical section shape of a standing seam tray*

## 3.1 Roof Design

A prefabricated tray needs a continuous underlayer on the roof.
In the case of the traditional cold and ventilated roof structure, the support is usually made of wooden planks, fixed with approximately 3 mm air gap between them. Boarding panels can also be used if suitably ventilated.
Wooden boarding should have a minimum thickness of 22 mm[1)] to ensure a secure fix for the stainless screws or nails. Generally, a membrane is supplied between the steel and the wood; this can be for acoustic or protective reasons. This traditional roof structure is often more expensive than the warm and compact structure, because of the double construction. On the other hand simple, lower cost cleats can be used.

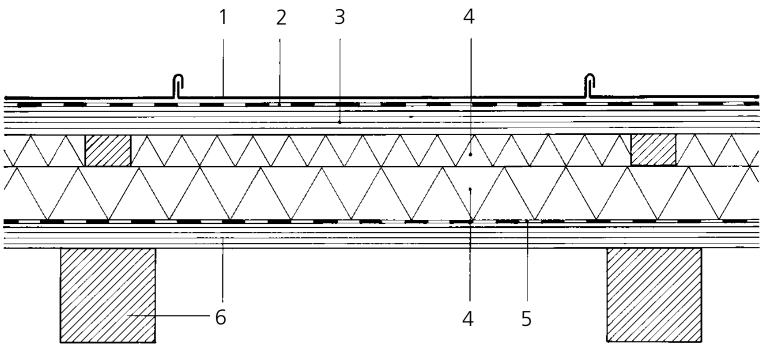
A warm compact roof structure is recommended because of its better building physics. In this case the continuous underlay can be formed by a wooden structure laid immediately on top of the insulation. However, it is more common today to use a layer of hard insulation, e.g. compacted mineral wool or foamed glass.
Correct installation of a good vapour barrier between the supporting structure and the thermal insulation is very important.

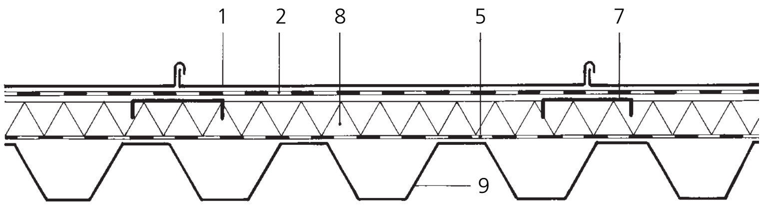
Typical structure of a cold ventilated roof
1 Stainless steel skin
2 Acoustic/protective membrane
3 Wooden support
4 Ventilated zone of 4 to 6 cm
5 Insulation
6 Vapour barrier
7 Interior liner

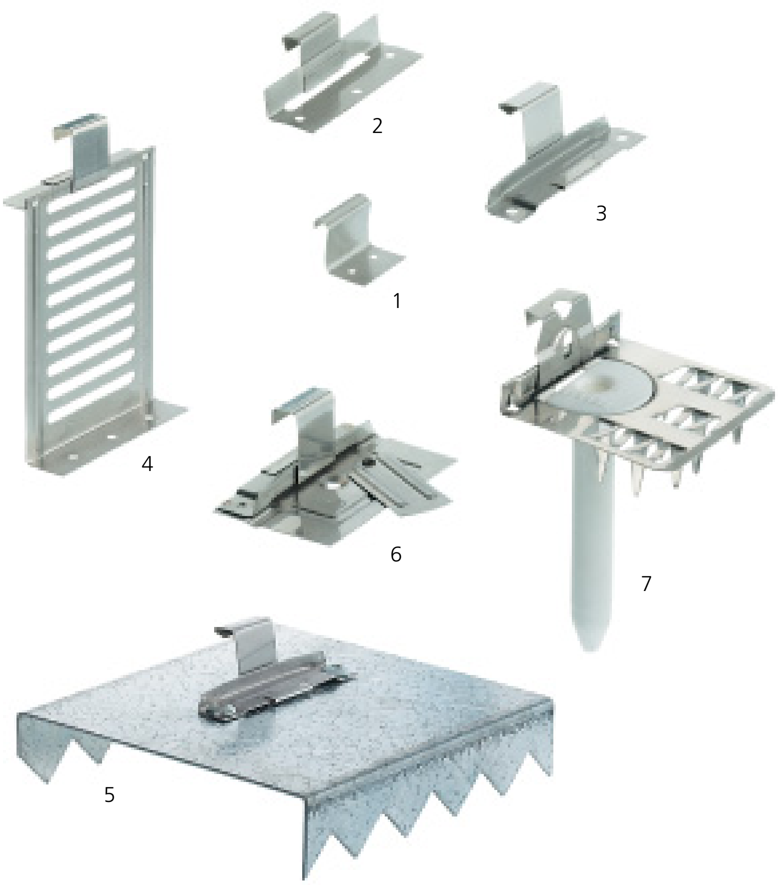



1) May vary from country to country

Typical structures of warm compact roofs
1 Stainless steel skin
2 Acoustic/protective membrane
3 Wooden support
4 Insulation
5 Vapour barrier
6 Wooden supporting structure
7 Stainless or galvanised steel fixing plate or profile
8 Hard insulation
9 Supporting steel deck



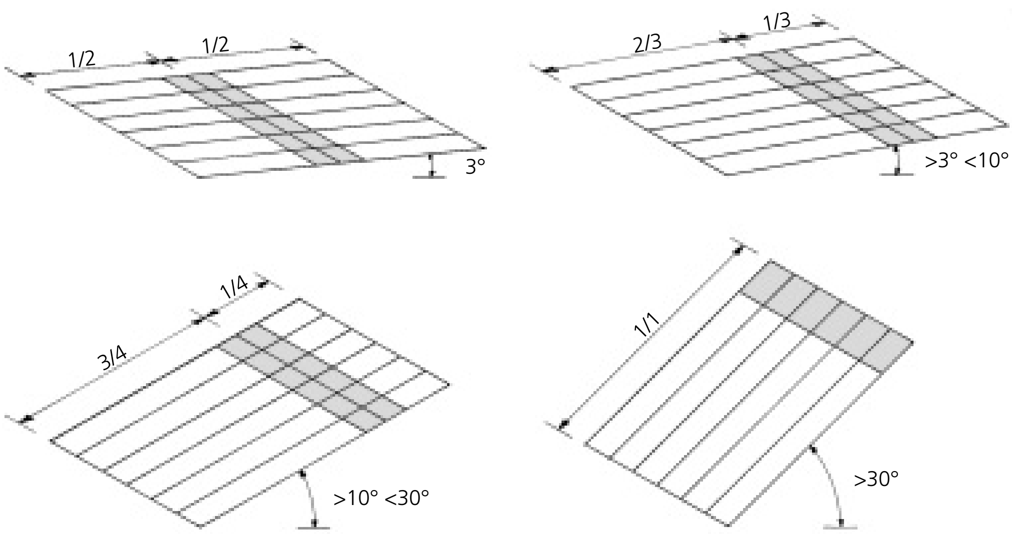

## 3.2 Fasteners

The stainless steel roof tray is fixed to the underlay using cleats, of which there are several types:

- Sliding or fixed cleats
- Cleats for direct fastening into wood for cold roofs or for fixing into metal plates or profiles
- For fixing between insulation panels or, directly through hard insulation blocks, there are specially designed cleats, e.g. Z-profiles or, GP or Krabban cleats.

Different types of cleats:
1 Fixed cleat
2, 3, 5 Sliding cleats
4 Z-profile
6 GP cleat
7 Krabban cleat

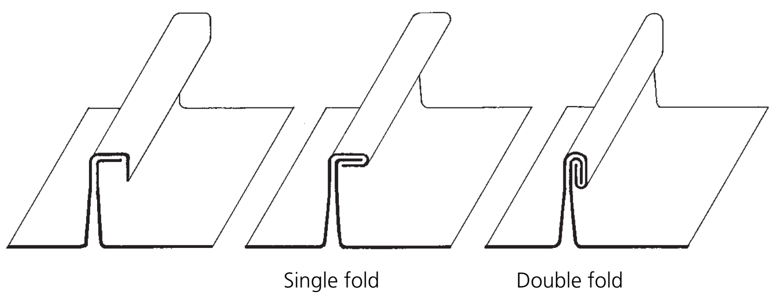
To calculate the number of cleats per square metre of roof, reference should be made to national standards before a specific assessment is made of each individual building. This should take account of height, slope, border zone, exposure, wind and snow loadings and geographical region.
Also the number of fixed or sliding cleats and their position will depend on the length of trays and the slope of the roof.




*The number and position of cleats depends on the pitch of the roof. Fixed cleats are positioned in the grey area.*

## 3.3 Folding Operation

After mounting the first roof tray, the second tray is hooked into the first and the joint is locked by single or double folding of the seam. In this way a weatherproof standing seam can be obtained. **Single folds** are only acceptable for slopes steeper than 75°. **Double folds** are recommended for pitched roofs with a minimum slope defined by national standards.



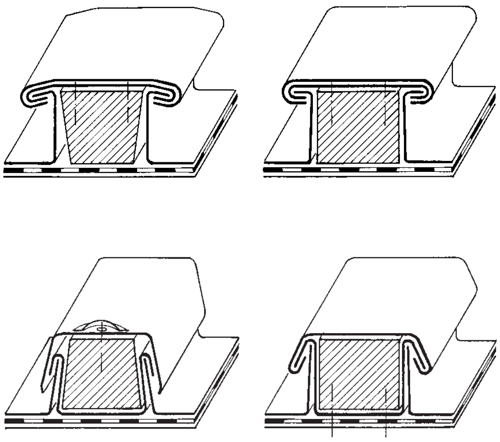

*Folding pattern in traditional standing seam roofing*

Folding can be done with hand tools, but it is more common to use special folding machines. The machine parts that come into contact with the stainless steel should be made of stainless or of special hardenable steel or alloy that leaves no residue on the stainless strip.

*Folding machines and hand tools used for folding.*

Photos:
Willem De Roover,
Ghent

Photo: Martina Helzel, Munich



*Variety of batten roll systems*

Another traditional roofing method is the batten seam or batten roll method. There are many variations, some of which are shown here. Batten roll or batten seam systems that use timber battens are less commonly used today.

*Stainless steel is also suitable for the batten roll method, which, however, is becoming less common.*

## 3.4 Suitable Roof Shapes

Traditional standing seam roofing methods can be used for a variety of shapes:

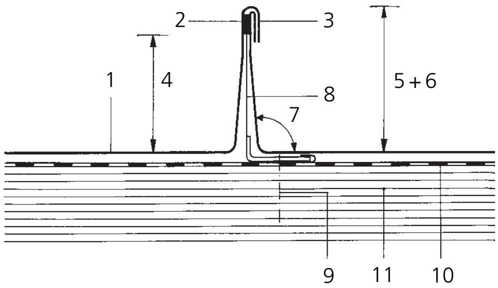
- Normal pitched roofs with minimum slope (as defined by national standards)
- Curved roofs, cylindrical roofs, spherical roofs.

*Standing seam roofing is suitable for pitched and curved roofs.*

Photos:
UGINE & ALZ, La Défense

# 4 Continuously Welded Standing Seam

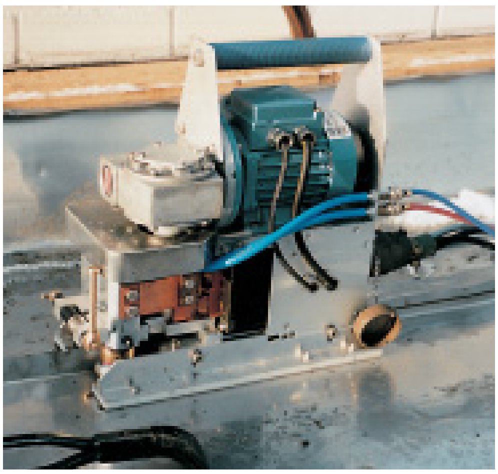
This system was developed almost 40 years ago in Sweden and has been adapted for use all over the world. Millions of square meters of roofs have been covered in this way.
The stainless steel strip used for this system is always an austenitic, weldable grade, e.g. EN 1.4404. Normally, 0.4 or 0.5 mm thick material is used either in coil or sheet and in narrow or full width forms (up to 1250 mm for loaded roofs).




1 Stainless steel strip
2 Continuous seam weld
3 Folded top of standing joint
4 Height to seamweld about 16 mm
5 Height of joint before folding about 30 mm
6 Height of joint after folding about 20 mm
7 Angle of about 92°
8 Sliding cleat
9 Stainless fastener
10 Acoustic/protective membrane
11 Supporting structure

## 4.1 Welding Technology

Roof strips with simple standing joints (~30 mm) are continuously welded together with a special welding machine. The process is resistance seam welding without filler material. In this continuous process, the weld is produced by electrodes in the form of wheels, which rotate either side of the upstanding joint as the machine travels along the seam at a speed of ~ 3.5 m/minute.



Photos:
Willem De Roover, Ghent (left),
Rostfria Tak AB, Fagersta (top)

*Resistance seam welding machine for the roofing industry. The welding electrodes and the transformer are cooled by a water flow.*

The modification of the microstructure in the heat-affected zone created by the weld is minimal as there is very little surface oxidation. The weld cools quickly, because of the high welding speed, the thin gauge of the material, (twice 0.4 or 0.5 mm) and the water-cooled welding wheels.
For mechanically fixed roofs, the very thin (0.15 mm) moving part of the sliding cleat is welded between with the two standing seams.
On seams that cannot be reached by the normal welding machine, a detail welder or a portable spotwelding machine is used.

*Portable spot welding equipment*

*Detail welding machine*

*Although not needed to ensure water tighness, the seam is folded to strengthen the section and to remove sharp edges.*

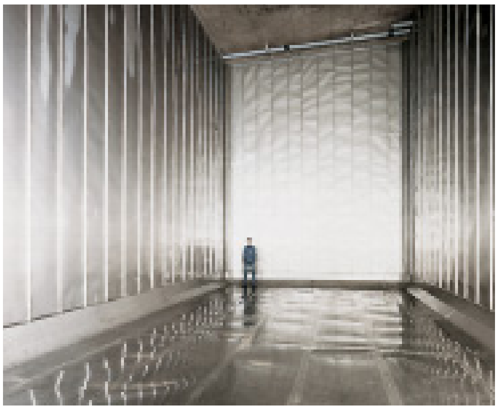
## 4.2 Folding Technique

After welding, a second machine folds the standing joint in a simple fold just above the weld line. This strengthens the joint and helps to straighten the seam.

Photos: Willem De Roover, Ghent

## 4.3 Watertightness

Standing seams produced by this method are watertight, even if submerged.



*The welding technique for roofing is similar to that for lining water reservoirs.*

Photos:
Outokumpu Stainless, Espoo (top),
Willem De Roover, Ghent (left)

*Welded seams provide watertightness even on zero-degree roofs that may be submerged.*

The most common application of this method is on completely flat or gently sloping roofs where ponding may occur. Often these are made of felt or other similar materials that can deteriorate over time. The welded method is as appropriate for small roofs and domestic buildings as it is for larger projects, such as schools, clinics, museums, where security for the life of the building is most important.

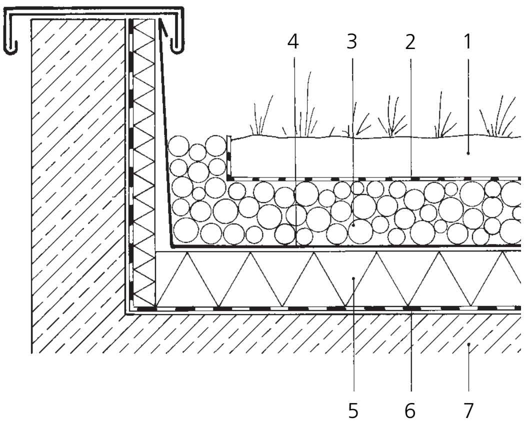
The system is particularly suited for new buildings, as the life expectancy of the roof can easily match that of the building itself.
Refurbishment of existing roofs, where other materials have failed, is an increasingly popular application. As stainless steel is resistant to bituminous materials, old roofing felt need not be removed.
Welded stainless steel roofing is also a good system for balcony floors and canopies.

*Welded stainless steel is typically used on flat roofs with little or no slope for which no other metallic solution is appropriate.*

Photos: Willem De Roover, Ghent

## 4.4 Green Roofs

Welded stainless steel is ideal for “green” roofs, because of its resistance to corrosion, to mechanical stress as well as to roots and algae. Only molybdenum alloyed grades should be used for this purpose.




1 Flowers and plants on substratum, 5 to 8 cm thick
2 Filter membrane
3 Drainage layer, 5 to 8 cm
4 Welded stainless roof, 0.4 mm
5 Thermal insulation
6 Vapour barrier
7 Supporting construction, concrete, wood, steel deck

*Stainless steel resists roots and algae on green roofs.*

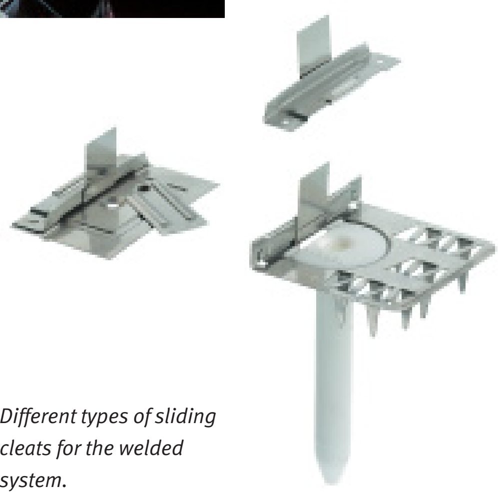
Photo: Binder und Sohn GmbH, Ingolstadt

## 4.5 Securing of Seam-Welded Roofs

The flat roof can be fixed mechanically using specially designed sliding cleats that allow thermal expansion. Or it can be secured by load – a layer of gravel, special loadstones, tiles, wooden decking or special green roof compounds.

*Securing can be achieved alternatively by cleats or loads.*

*A layer of gravel is pumped onto the roof.*



*Different types of sliding cleats for the welded system.*

Photos:
Rudolf Schmid GmbH, Großkarolinenfeld (top, centre)
Willem De Roover, Ghent (right)

## 4.6 Suitable Grades and Finishes

For flat roofs the recommended grade is always a Molybdenum-alloyed stainless steel like type 1.4404 or 1.4436. The coil width is typically 625 or 650 mm for mechanically fixed roofs and 800 to 1250 mm for loaded roofs. For higher wind-load areas or to match existing designs, coil widths of 400 to 600 mm may be specified.

The finish most commonly used is 2B for flat and loaded roofs, but it can also be a non-reflective, matt finish, obtained by blasting or cold rolling where aesthetics are more important.

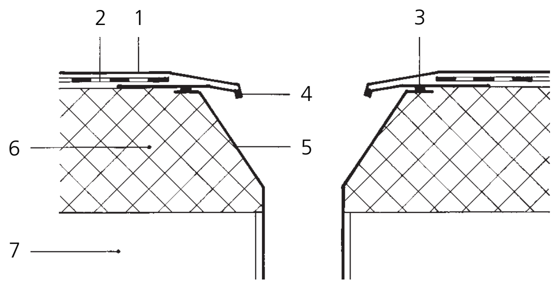
*A standard 2B mill finish offers a particularly cost-effective solution for flat roofs.*

*Matt (bead-blasted or rolled) finishes are also available.*

Photos:
Willem De Roover, Ghent (top), Lotharmaria Keiner, Fürstenfeldbruck/Florian Staufer, Munich (bottom)

## 4.7 Special Accessories

The welded system requires a specific set of stainless steel accessories. Besides the range of cleats, there are custom-made parts, such as gullies, with or without strainers for flat roofs and, ventilation pipes.




Cross section of an installed gully
1 Continuous welded stainless steel flat roof
2 Possible separating layer
3 Continuous spotwelding (workshop)
4 Continuous spotwelding (during installation on the roof)
5 Gully
6 Rigid thermal insulation
7 Supporting structure

*Custom-made gully (top), installed gully complete with strainer (bottom).*

Photos: Willem De Roover, Ghent

*Ventilation*

## 4.8 Reasons to Choose the Welded System

- There are hardly any limits in slope or flatness; curves, steep and flat sections can be combined
- The risk with near flat zones on cylindrical or spherical roof tops is reduced
- Welded roofs are watertight
- Tray sections can be erected perpendicular to the general shape of the roof
- The whole roof is one continuous skin, which offers a better protection against lightning, electromagnetic radiation (cage of Faraday-effect)
- Welded roofs are difficult to penetrate without special equipment, providing maximum safety against entry and escape.

Photos: Willem De Roover, Ghent

*Welded roofs can be used on most roof geometries.*

# 5 Other Systems

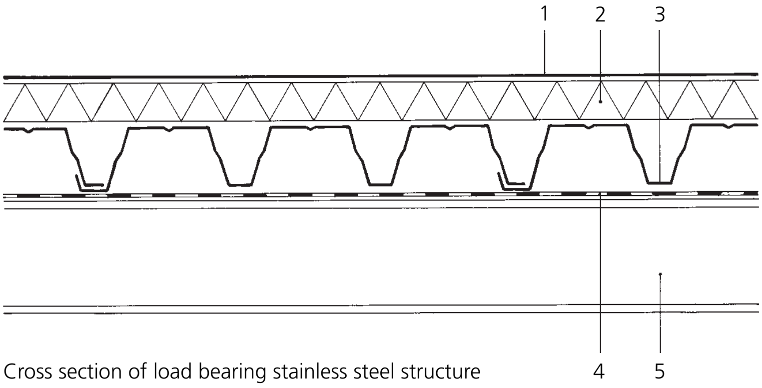
**Profiled roofing sheets**
These trapezoidal or sinusoidal profiled sheets can be used to ensure watertightness of sloped roofs and are normally fixed with visible stainless steel fasteners.
They do not need any continuous supporting structure. Wooden or steel beams with regular distances between them are used to fix and support the roofing sheets. This method is frequently used for industrial buildings, for both roofing and cladding.

*Profiled stainless steel is suitable for the entire building envelope.*

*Different types of corrugated stainless steel sheets*

Photos:
Outokumpu Stainless, Espoo (top left)
©2003, Samyn and Partner, Bastin & Evrard, Sofam, Brussels, Belgium (right).

Stainless steel profiled sheets with greater section depths are used for structural roof decking. These support different kinds of flat or pitched roofs where the environment within the building is corrosive e.g. paper mills, water purification plants, breweries or composting plants.

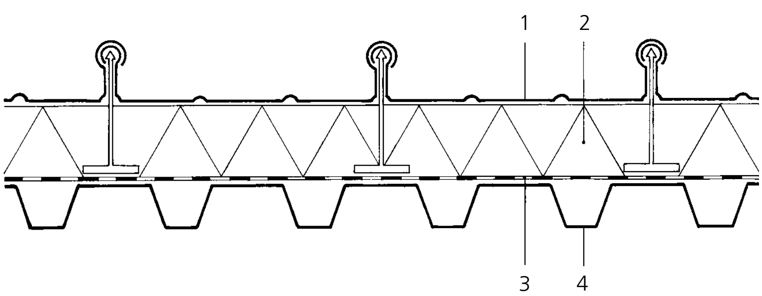



Cross section of load bearing stainless steel structure
1 Watertight roofing membrane, stainless or other systems
2 Thermal insulation
3 Supporting stainless steel deck
4 Protecting layer
5 Supporting beam

**Folded seam systems**

These preformed roofing sheets are normally between 300 and 600 mm wide with a standing seam up to 65 mm high.
The sheets are suspended from special cleats, fixed to every beam, then clamped together over the head of the cleat, with a special folding machine.

Photo:
Corus Bausysteme GmbH, Koblenz




Cross section of a folded seam system
1 Cleats and folded seams roof system
2 Thermal insulation
3 Vapour barrier
4 Steel deck

# *6 European Standards*

| | |
|---|---|
| EN 502 | Roofing products from metal sheet - Specification for fully supported roofing products of stainless steel sheet |
| EN 508-3 | Roofing products from metal sheet - Specification for self-supporting products of steel, aluminium or stainless steel sheet - Part 3: Stainless steel |
| EN 10088 | Stainless steels. List of stainless steels |
| EN 10088-2 | Stainless steels. Technical delivery conditions for sheet/plate and strip for general purposes |
| EN 10088-3 | Stainless steels. Technical delivery conditions for semi-finished products, bars, rods and sections for general purposes |
| EN 612 | Eaves gutters and rainwater downpipes of metal sheet. Definitions, classifications and requirements |

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