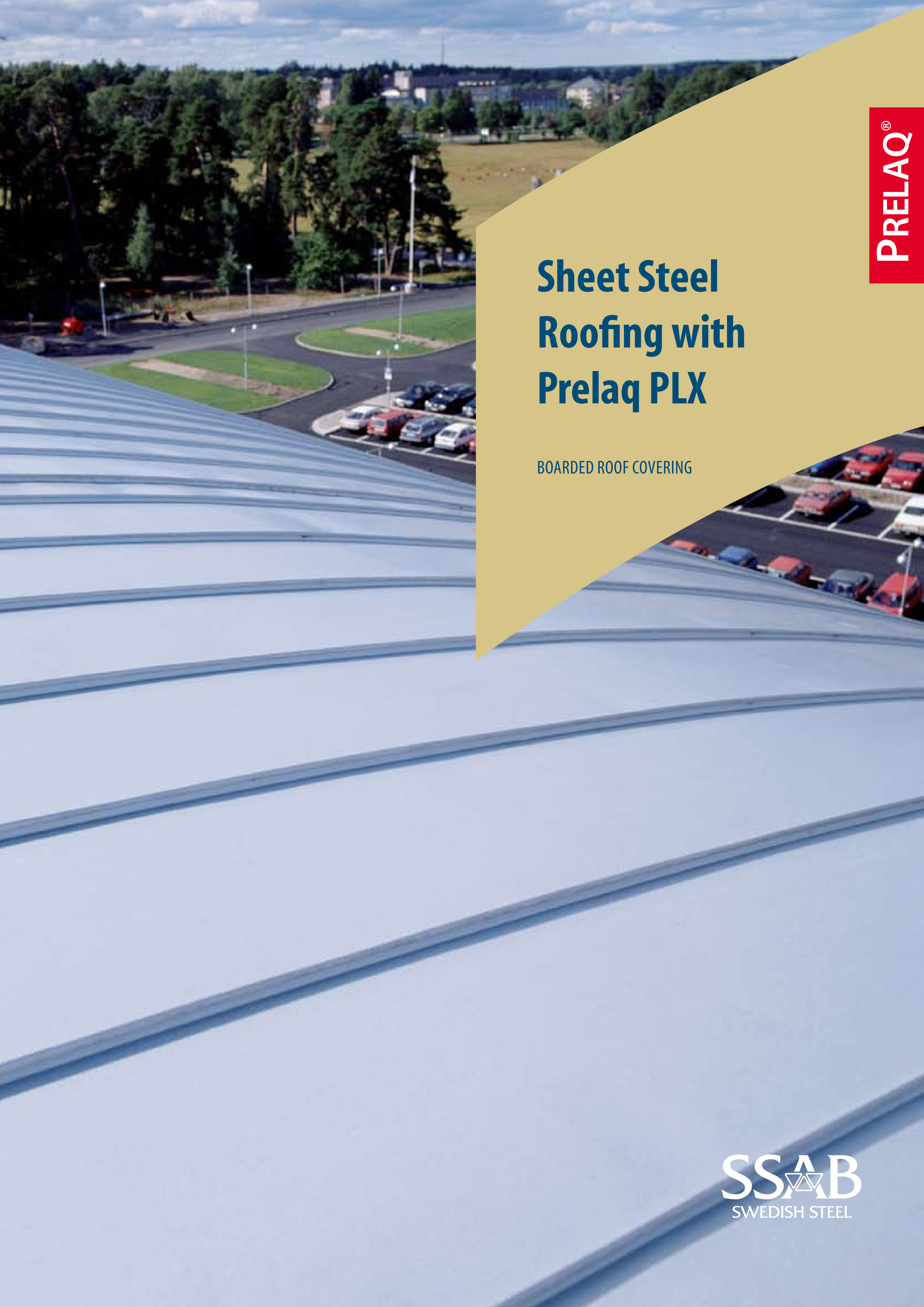


Sheet Steel Roofing with Prelaq PLX

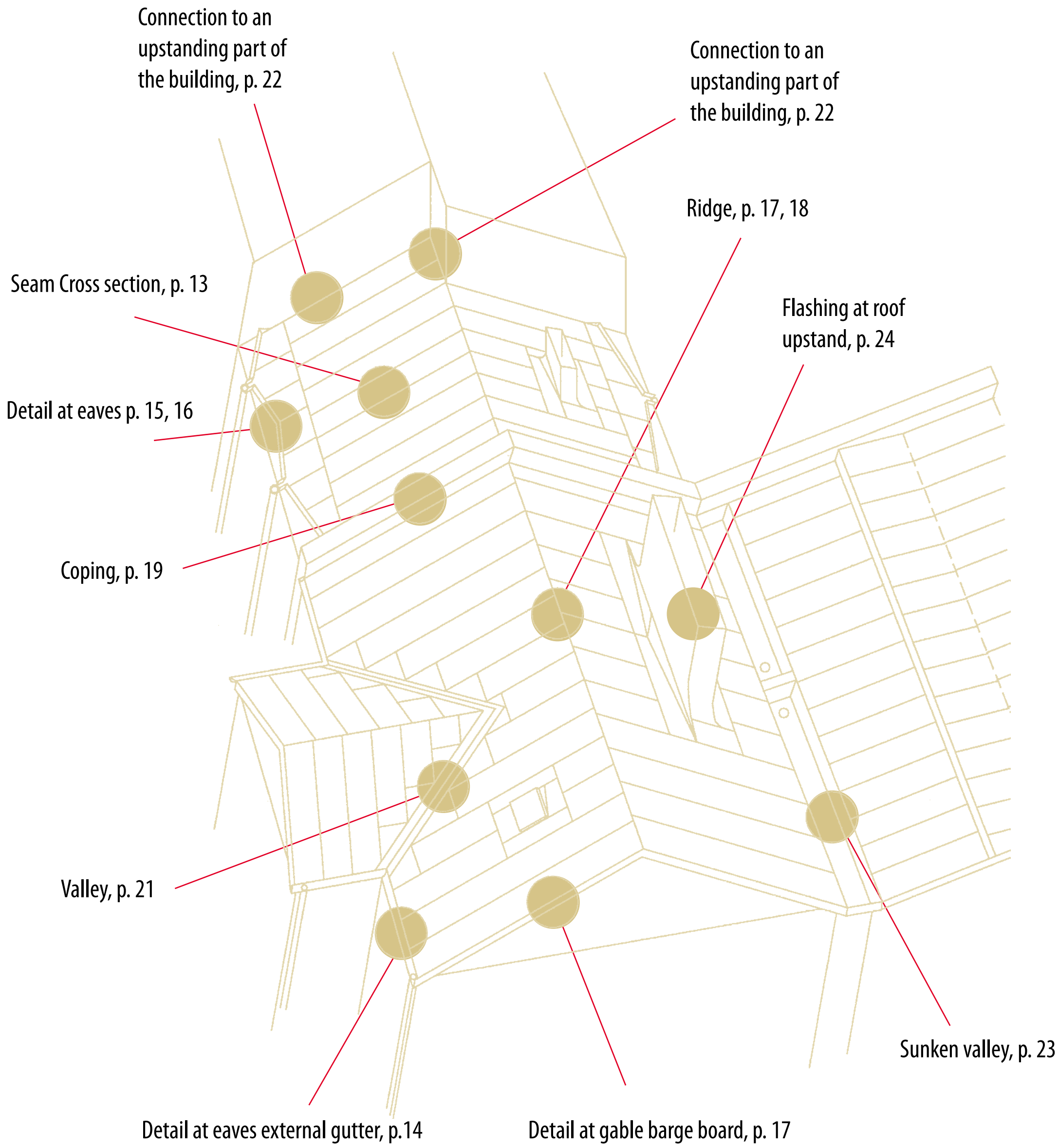
BOARDED ROOF COVERING

DETAIL REFERENCES

The numbering of the components on the typical drawings on pages 13-25 has been done in the order the components are normally fitted.

The notes on the general arrangement drawing below refer to the pages in this Handbook.

Roofing on timber roof covering – design details



PRELAQ®

This handbook deals with long strip roofing with Prelaq PLX on a boarded roof covering.

The instructions in this handbook are basically of a general nature. However, the detailed drawings are only intended to show typical designs, and they should be modified from case to case to suit the actual conditions.

CONTENTS

Sheet steel as roofing material

Sheet steel has long traditions as roofing material. However, sheet steel has undergone great changes over the years. The use of galvanized sheet steel that was then painted in situ began towards the end of the 19th century.

To an increasing extent, prepainted sheet steel of a special mild grade from SSAB Tunnplåt are being used today.

During the 19th century, the sheet roofing method was used for sheet steel roofing. Short sheets are used in this method, and standing seams and transverse seams are then made to join the sheets together. Sheet roofing is used today mainly for building on which the aim is to accentuate the appearance and quality, and also to put to use bygone roofing traditions.

However, long strip roofing dominates today as the sheet steel roofing method. Long strip roofing can be used for all types of buildings, provided that the pitch is sufficient, i.e. about 6°.

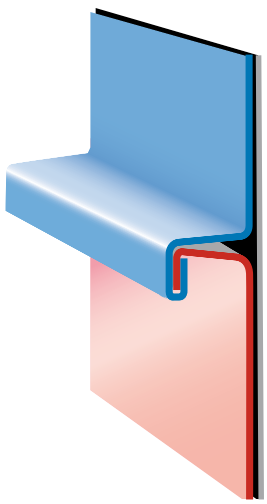
Many factors favour the use of sheet steel as roofing material. The reasons for using sheet steel as roofing material on industrial, commercial and residential buildings include appearance, resistance to fire, resistance to physical damage and a long useful life. In addition, prepainted sheet steel is 100% recyclable, which makes sheet steel a highly environmentally appropriate product.

Long strip roofing is often particularly appropriate if the roof pitch is shallow.

FOLDED SHEET ON WALLS

Strip or sheet cladding of walls offers wide opportunities for attractive and daring designs.

Full-length strips are usually employed for wall cladding, and these are folded together with ready-made standing folds into angle seams as shown in the figure below.



The strips can be arranged horizontally, sloping or vertically. The angle seam gives greater emphasis to the sheet joints. In addition, it is easier to achieve good flatness and avoid blow marks on the sheet surface.

In horizontal or sloping runs of strip, the fold should always face as shown in the figure in order to meet the tightness requirements.

In windy locations, it may be advisable to reduce the seam spacing to 300-500 mm in order to prevent fatigue damage and noise caused by movements of the sheet that could affect the areas below the roof. This may also be a problem when encasing ventilation enclosures.

Plywood with underlay felt is usually employed as the base for wall cladding.

Short sheet cladding joined together with various types of seams can be used for wall cladding in which the frontage of the building is to be accentuated for aesthetic reasons. Since damage due to blows, etc. must be avoided, sluice or overlap seams are used as the jointing method. In addition, the sheet can also be provided with welted joints. In this method, jointing is usually carried out as simple folded edges on a base of wood battens. Short sheet cladding of frontages should be done in consultation with an expert.

Choice between long strip roofing and sheet roofing

In principle, any building can be roofed with sheet steel. One of the limitations in northern countries is the pitch of the roof, which should be at least 1:10 or 5.7º. If full-length strips are used, if outside gutters are fitted for draining the roof, and if there are no obstacles in the form of skylights or the like, a roof pitch down to 3.6º (or about 1:16) may be acceptable.

The normal distance between folds is 600 mm, and the initial width of the strip is then 670 mm. Bulging of the sheet may sometimes occur, which is a natural trait of the material. If this is unacceptable, the distance between seams may be reduced to 500 mm.

Sheet roofing is used to draw attention to the sheet steel roof and put old roofing traditions to use. In addition to giving the roof a pattern, this method also has a stiffening effect that may be beneficial if the roof is exposed to high wind loads.

For a steep roof with a pitch of more than 14º, sheet roofing can be used for appearance reasons, but also to make the sheets easier to handle and enable them to be folded together in situ.

Prelaq PLX, Hornsgatan in Stockholm.

Material for sheet steel roofing

Prelaq PLX is a prepainted product adapted for sheet steel roofing.

The products have a special steel grade suitable for both mechanical and manual folding.

The steel is so mild that the spring-back is practically zero, and this is vitally important for ensuring that the seams will seal reliably. The yield strength of the material is around 180 N/mm^2. The thickness of the steel is as standard 0,6 mm.

PRELAQ PLX

The metallic coating Z 350 hot-dip galvanizing is used for the prepainted Prelaq Nova grade, i.e. a zinc coating of 350 g/m^2 on both sides. The thickness of metal coating is about 25 µm (0.025 mm) on each side.

PRELAQ PLX WITH DUAL FINISHES

The Prelaq Nova is produced with dual types of suface finishes,The normal type (Prelaq Nova) and a matt type (Prelaq Nova Matt). Aesthetical requirements indicate what is best suited for a specific building.

Prelaq Nova has a coating, with a total thickness of 50 µm. The thickness of the paint coat is optimized for wear resistance, wheathering resistance and consumption of resources.

Prelaq Nova Matt is extremely appropiate for long strip roofius. The product can be mechanical and manual folded without any problems. The coating has very good gloss- and colour retention properties. The specification of the coating is given in a separate product leaflet.

A thin coat of epoxy type paint is applied to the underside of the sheet. The colour of the paint is blue. The reverse side of the sheet is marked with the name Prelaq and the date of manufacture.

Thermal movements

For long strip roofing, it is important to take into account the movements of the strip occurring as a result of temperature changes. The sheet steel may sustain damage if insufficient expansion allowance is provided at verges or eaves, at roof upstands or at walls.

All materials expand or contract when the temperature changes. The change in length of aluminium sheet and zinc sheet is about twice that of steel sheet. The sheet length increases in the summer and decreases in the winter. The temperature of the roof material in the summer may be up to 75ºC, while in the winter, it could conceivably be as low as –35ºC. The length of the roof covering also changes, and the calculations below are therefore done to be on the safe side.

The temperature of the sheet steel at the time of the installation determines how the length will change from its original length in the summer and in the winter. The table below gives particulars of the change in length that can be expected for different installation temperatures.

In the table below, L is the distance in metres from the point where the movement is zero (fixed point) to the end of the sheet.

Table 1. Change in length for different installation temperatures.

Temperature at installing °C	Thermal movement in mm Summer (+75° C)	Winter (-35° C)
-10°	+ 1,0 · L	- 0,3 · L
0°	+ 0,9 · L	- 0,4 · L
+10°	+ 0,8 · L	- 0,5 · L
+20°	+ 0,7 · L	- 0,7 · L
+30°	+ 0,5 · L	- 0,8 · L

Change in length mm

Example:

Temperature during laying: +10ºC
Distance L from fixed point to eaves: 7 m

Change in length at eaves:
Expansion in the summer: +0.8 · 7 = approx. +6 mm
Contraction in the winter: -0.5 · 7 = approx. –4 mm

It is important to allow for thermal movements so that the sheet or its mountings will not be damaged. Longer strips should be secured by means of both fixed and sliding clips. Space for expansion and contraction must be allowed at joints and connections.

Strip lengths and fixed zones

The maximum permissible strip length is determined by the thermal movements and the facilities provided for taking up these movements. According to common practice, a sheet steel strip may have a continuous length of 15 metres from the centre of the fixed zone.

A fixed clip mounting or some other fixed point at which no movements can or should be taken up is regarded as a fixed zone. Fixed clips do not allow for any movements of the strip in its longitudinal direction, whereas sliding clips can take up a certain amount of movement of the strip. See also the section dealing with Securing by means of clips. The way in which temperature movements can be taken up at connections is decisive to the maximum permissible strip lengths.

The way in which fixed and movable zones are arranged is shown in principle below. Page 17 shows an example of how an expansion joint can be designed.

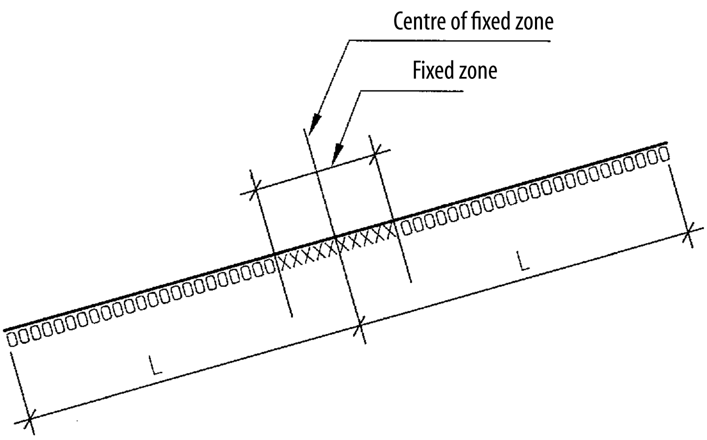


Figure 1.
Fixed and movable zones
The fixed zones should be in the same position at all strips from one gable end to the other, and their locations along the strip length for different roof pitches should be as shown below.

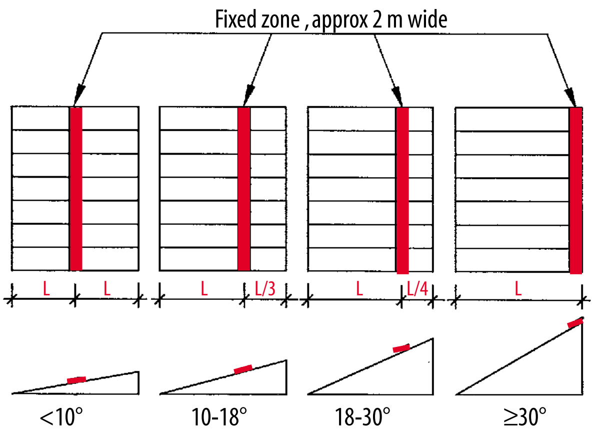


Figure 2.
Location of the fixed zone.
The location of the fixed zone should be specified in the documentation and the strip length should be specified in relation to the centre of the zone. The roofing should thus have a fixed zone that is about 2 metres long at which fixed clips are used, while other mountings are made by means of movable clips.

Roof covering for sheet steel roofing

Sheet steel roofing can be laid on various types of roof covering, the most common of which are boarded or plywood-covered roofs. A suitable thickness of tongue-and-groove boarding is 23 mm at a rafter spacing of 1.2 metres. If plywood is used, its thickness must be selected so that the stiffness of the roof covering will be the same as that of the boarding. The minimum thickness should be 19 mm at a rafter spacing of 1.2 m to ensure that the mounting of the clip will be secure. A layer of roofing felt must always be provided between the roof covering and the long strip roofing.

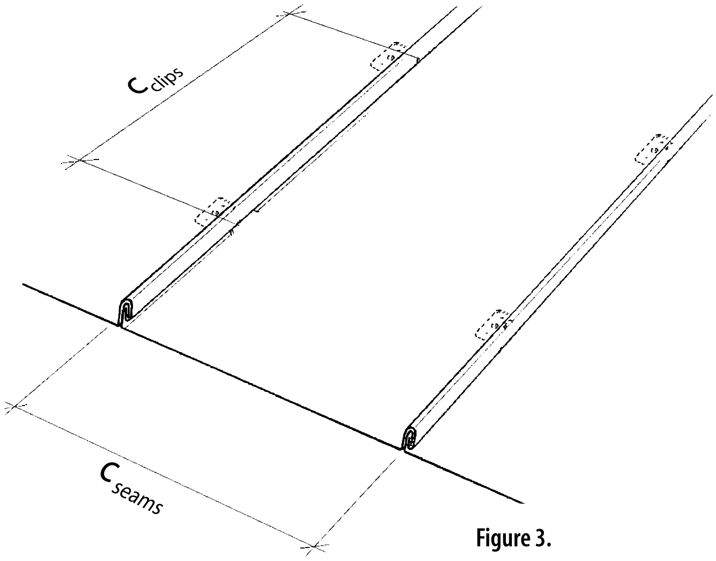


Figure 3.

Securing by means of clips

The function of clip is to secure the sheet steel strip to the roof covering. The clip is hooked onto the edge that then forms the inner sheet in the finished seam.

The clip should be made of metal-coated sheet steel or stainless steel, and should have an ultimate strength of at least 1 kN. The clip should have the correct height in relation to the design of the seam. Fixed clips should be used within the fixed zone (see under Temperature movements and strip lengths), and sliding clips in other areas. When fitting the clips, ensure that the sliding part is centred, so that it will be able to take up strip movements in both directions. The clips are normally secured to the roof covering by means of zinc-coated or stainless screws.

Several companies produce clips for timber roof covering for use in the seams formed by modern seam folding machines. Clips are also available with captive screws, which speeds up and simplifies fitting.

A special tool designed for fitting and screwing down the clip in one operation, with the operator standing while doing the work, is available on the market. This tool is particularly well suited for shallow pitch roofs.

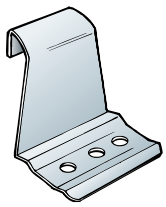


Figure 4.
Typical fixed clip

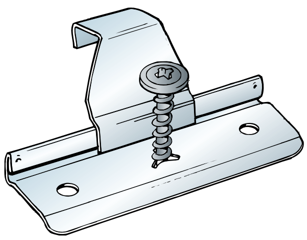


Figure 5.
Typical sliding clip with captive screw.

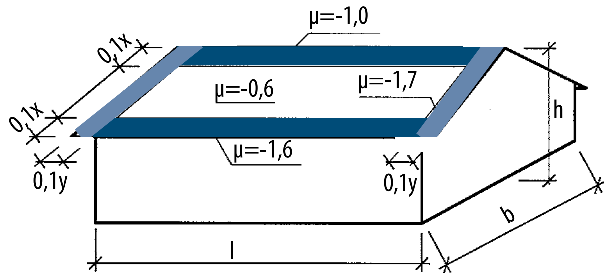
Wind loading

The roof of a building is subjected to suction forces caused by the wind. In the boundary zone along the outer edges of the roof, the wind suction may be 2–3 times higher than that on the inner surface.

The design wind load on a building is determined by the height, design and geographical location of the building. The conditions for determining the wind load are specified in national regulations.

The worst conceivable cases for gable roofs and pentroofs for Swedish conditions are shown in the figure below. The values are higher for arched roofs.

Gable roof with pitch >5°



x = lesser of (l and 2h)
y = lesser of (b and 2h)

Pentroof with pich >5°

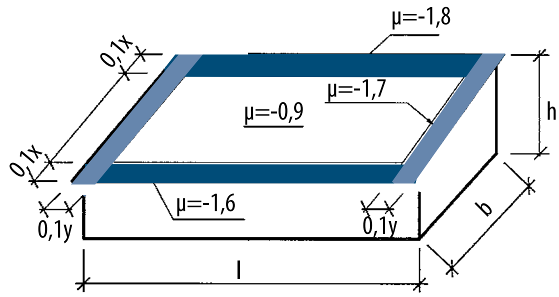


Figure 6.

y = lesser of (l and 2h)

In each roof zone, the design suction load can be calculated from the expression:

$$q_d = \mu\, 1{,}3^{*} q_k \quad (\mathrm{kN/m^2})$$

where q_d is the design value for the wind load.
μ is the form factor in accordance with Figure 6 or national regulations.
$1{,}3^{*}$ is the partial coefficient for variable load.
q_k is the characteristic velocity pressure in accordance with national regulations.

From the design suction load, the pull-out force F_t on the clip mounting can be calculated from the expression:

$$F_t = q_d \cdot c_{clips} \cdot c_{seam} \quad (\mathrm{kN})$$

where
c_{clips} is the distance between clip centres along the seam (see Figure 3).
c_{seam} is the distance between the seams (see Figure 3).

*Can be other value in accordance with national regulations

Clips should be secured by means of screws. Only one screw is normally needed for every clip. The conditions for calculating the pull-out forces in a timber roof covering are specified in national regulations. The pull-out values obtained from experience for 4.0 mm screws in a timber roof covering are given in Table 2 below.

Securing the clips to timber roof covering

Design conditions

The pull-out force Ft must be lower than or equal to the design pull-out force Rd for the clip mounting (Ft < Rd)

Clip spacing

Clips secured with screws can normally be spaced 600 mm apart, although a check calculation must be made for clips in boundary zones in locations exposed to wind forces. Particulars of the clip spacing on the various surfaces of the roof must be included in the drawing documentation.

It is always economically and technically justifiable to adjust the clip spacing to suit the wind loads, the fasteners and the roof covering material.

For the conditions specified above, Table 3 shows suitable spacing of clips, each of which of secured by one screw.

Timber thickness mm	R_d kN
16	0,55
19	0,69
23	0,87
25	0,96

Table 2.
Design pull-out forces for screws.
- Timber boarding or plywood
- One 4.0 mm diameter screw
- Design value R_d

Wind load q_k kN/m²	Gable roof and pent roof Clip spacing in mm.		
	Inner surface	Boundary zone	Corners[1] μ = -2,6
0,4	600	600	600
0,5	600	600	600
0,6	600	600	600
0,7	600	600	600
0,8	600	600	530
0,9	600	600	470
1,0	600	600	430
1,1	600	560	390
1,2	600	510	360

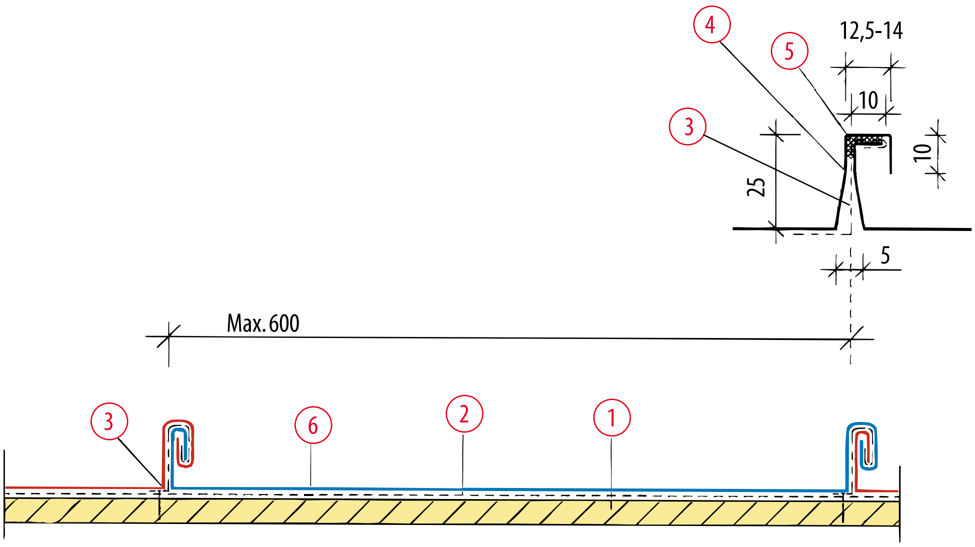
[1] Applies to the roof corners only for a roof pitch of <5° on a distance of 0.25x times 0.25y (0.25x for pentroof) in the corners as shown in Figure 6.

Table 3.
Spacing of clips for gable roofs and pentroofs.
- Roof covering of 23 mm timber boarding
- One screw per clip
- Form factors for wind as per national regulations. The values in the table below are based on Swedish regulations
- Seam spacing of 600 mm
- Other conditions in accordance with Table 2.

Roofing on timber roof covering

Apply seam sealant to all surfaces of the sheet that are in contact with one another. Remove excess seam sealant from the outside of the sheet surface. The seam sealant must make the seam watertight, must be durable, and must be formulated so that it will not attack the paint coat.

Seam cross-section



1. Tongue-and-groove boarding, at least 23 mm thick
2. Layer of roofing felt
3. Clips spaced a maximum of 600 mm apart. Design at the boundary zone to suit each individual case
4. Seam
5. Seam sealant
6. Prelaq PLX

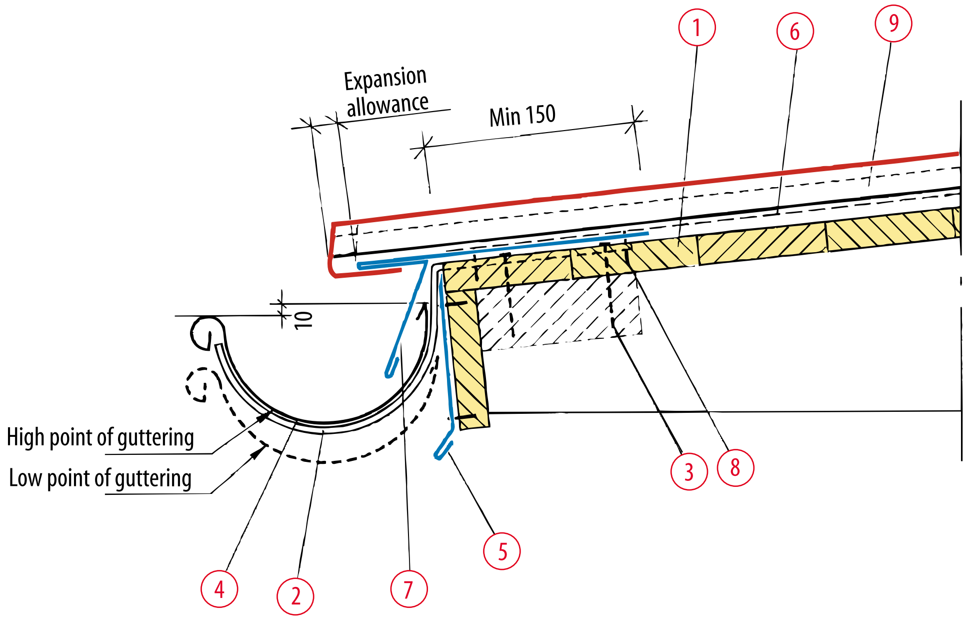
In long strip roofing, the strips should be connected to eaves by means of a single eaves fold. The expansion allowance should be sufficient to ensure that the roofing strip will overlap the eaves even at maximum expansion of the strip, and must not be so small that the strip may be damaged when it contracts.

See the section entitled Temperature movements and strip lengths.

The eaves should not be bent downwards so that the freedom of movement is restricted.

At the eaves, the roofing can be connected by a seam as shown in the figure above.

Detail at eaves – external gutter



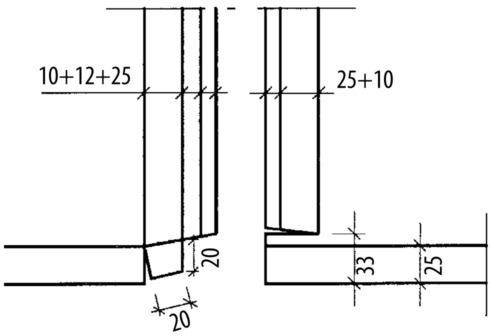
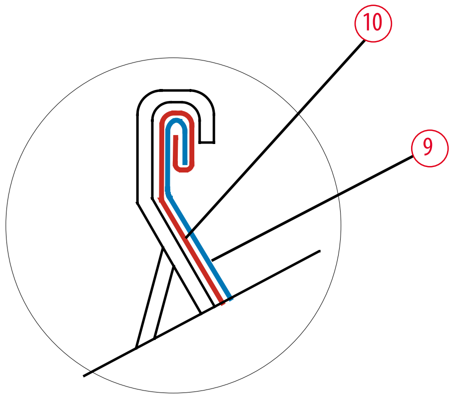


Figure 5. Developed view of sheet for seam termination.

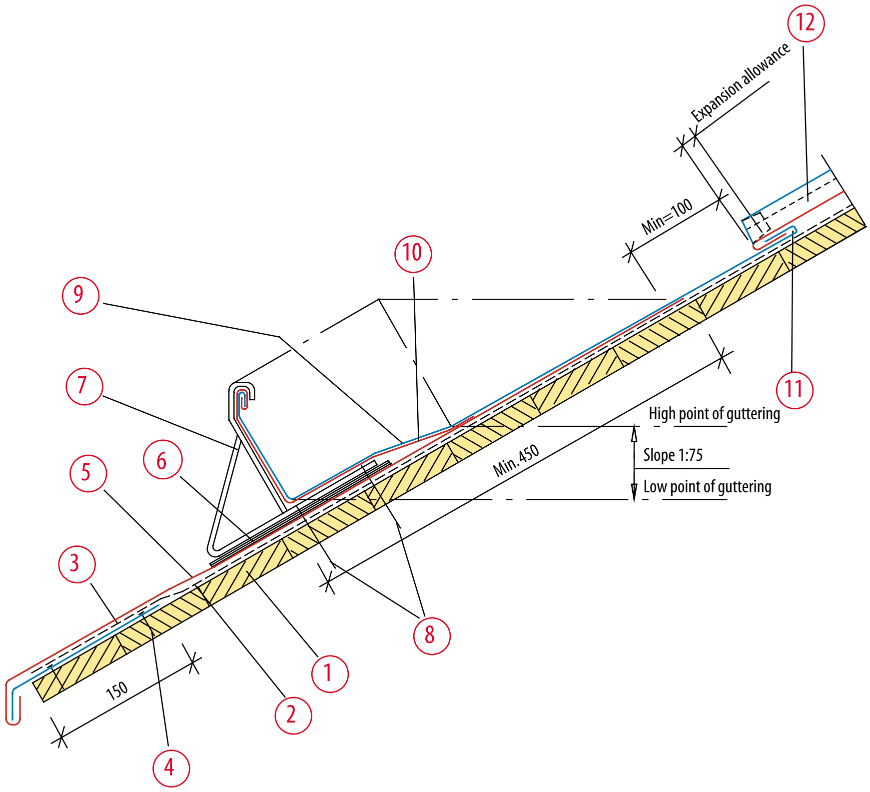
1. Tongue-and-groove boarding, at least 23 mm thick
2. Gutter brackets at 600 mm centres
3. Countersunk head screw
4. Gutter
5. Barge board facing 0.6 mm thick
6. Layer of roofing felt
7. Eaves sheet, 0.6 mm thick
8. Barbed nails at 150 mm centres in a zig-zag pattern
9. Prelaq PLX

In long strip roofing, the connection between the roofing and the eaves gutter must be designed in such a manner that movements of the strip will not be restricted. This can be done by providing an expansion joint with a single enlarged hook fold.



Detail at eaves with eaves gutter

For roof pitch of at least 30°

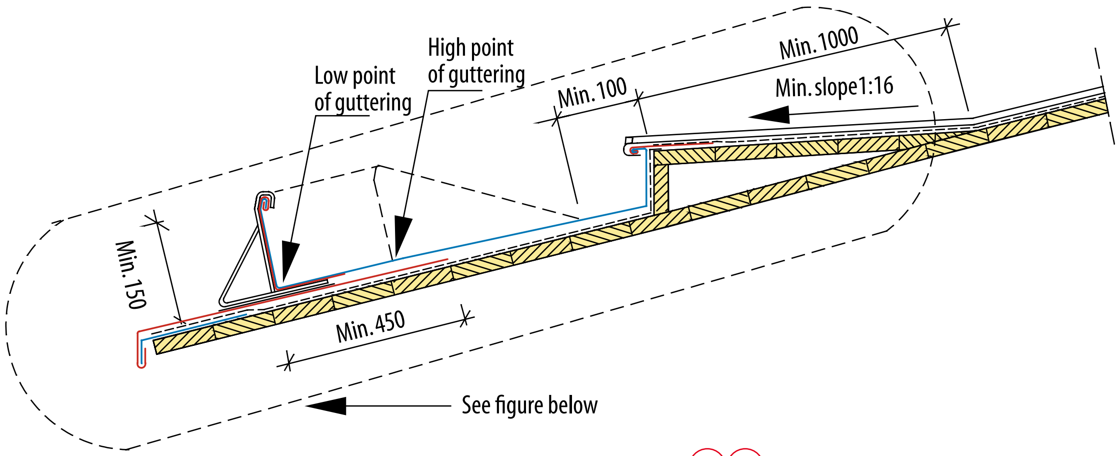


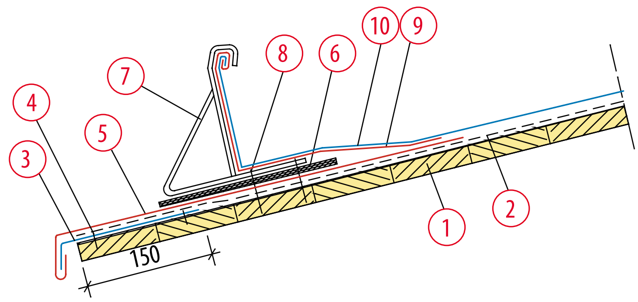
1. Tongue-and-groove boarding, at least 23 mm thick
2. Layer of roofing felt
3. Under-eaves strip, 0.6 mm thick
4. Barbed nails at 150 mm centres in a zig-zag pattern
5. Eaves sheet, 0.6 mm thick (extending 450 mm up under the gutter sheet)
6. 2 mm thick EPDM rubber seal between bracket hook and eaves sheet
7. Bracket hooks at up to 400 mm centres
8. Bracket hook fixing designed to suit each individual case
9. Gutter sheet of Prelaq PLX with max. seam spacing of 950 mm
10. Covering sheet Prelaq PLX
11. Single enlarged hook fold with expansion allowance
12. Prelaq PLX

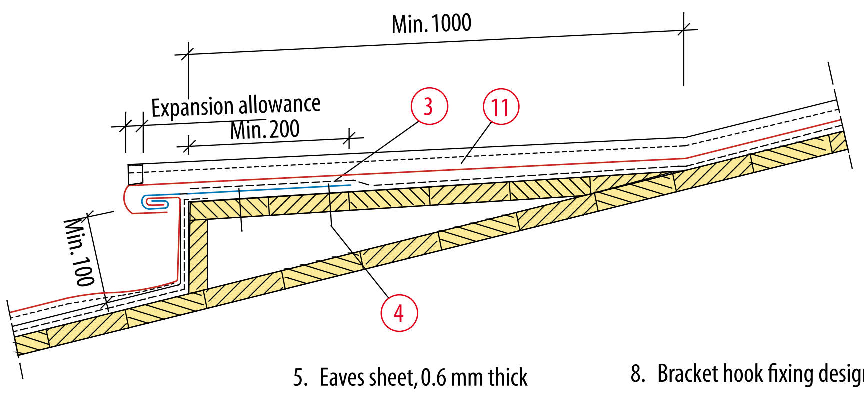
Detail at eaves with eaves gutter

For roof pitch of 14 - 30º

If an eaves gutter is to be used on a roof with a pitch of less than 30º, the connection must be made with an expansion joint to prevent water from seeping in. The design can be used for roof pitches down to 14º. An eaves gutter must not be used for shallower roof pitches. At roof pitches between 14º and 30º, careful consideration should be given to the requirement for a level difference between the gutter edge and the gutter seam/connection to the roofing. Instead of building up for an expansion joint, the gutter can be lowered by a corresponding amount.

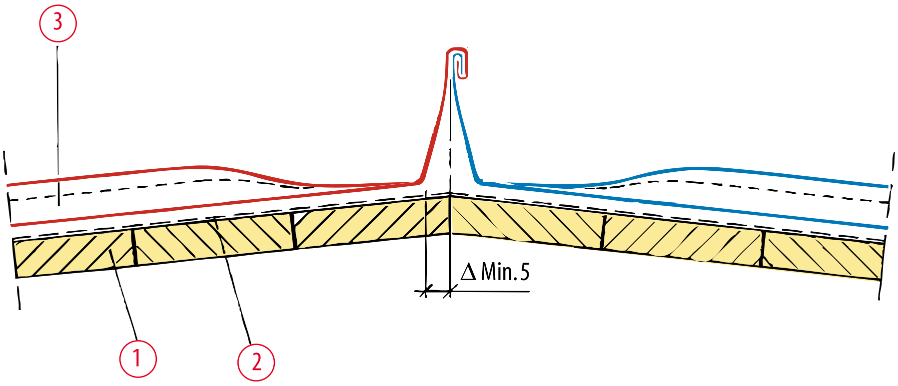






1. Tongue-and-groove boarding, at least 23 mm thick
2. Layer of roofing felt
3. Under-eaves strip, 0.6 mm thick
4. Barbed nails at 150 mm centres in a zig-zag pattern
5. Eaves sheet, 0.6 mm thick (extending 450 mm up under the gutter sheet)
6. 2 mm thick EPDM rubber seal between bracket hook and eaves sheet
7. Bracket hooks at up to 400 mm centres
8. Bracket hook fixing designed to suit each individual case
9. Coverings sheet Prelaq PLX
10. Gutter sheet of Prelaq PLX with max. seam spacing of 950 mm
11. Prelaq PLX

The height of the ridge seam should be adjusted to meet the requirement for expansion allowance for different strip lengths.



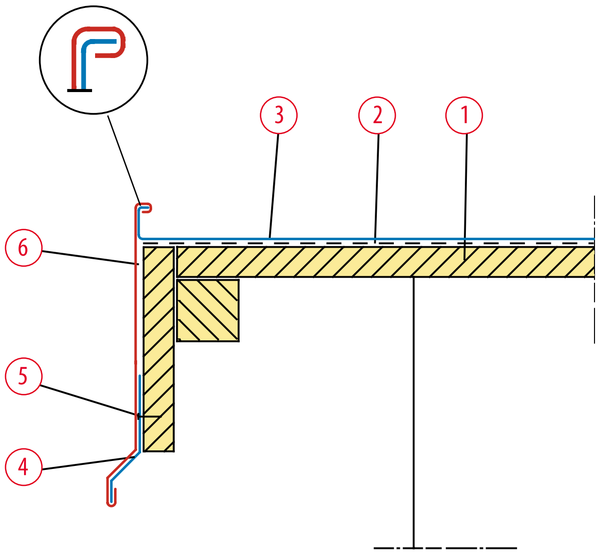
Detail at ridge

Folded ridge

1. Tongue-and-groove boarding, at least 23 mm thick.
2. Layer of roofing felt
3. Prelaq PLX.

The barge board facing shall be made of short sheets with a maximum length of 1950 mm and shall be joined with simple hook seams or sluice seams. However, if the frontage is rendered, only with simple hook seams.

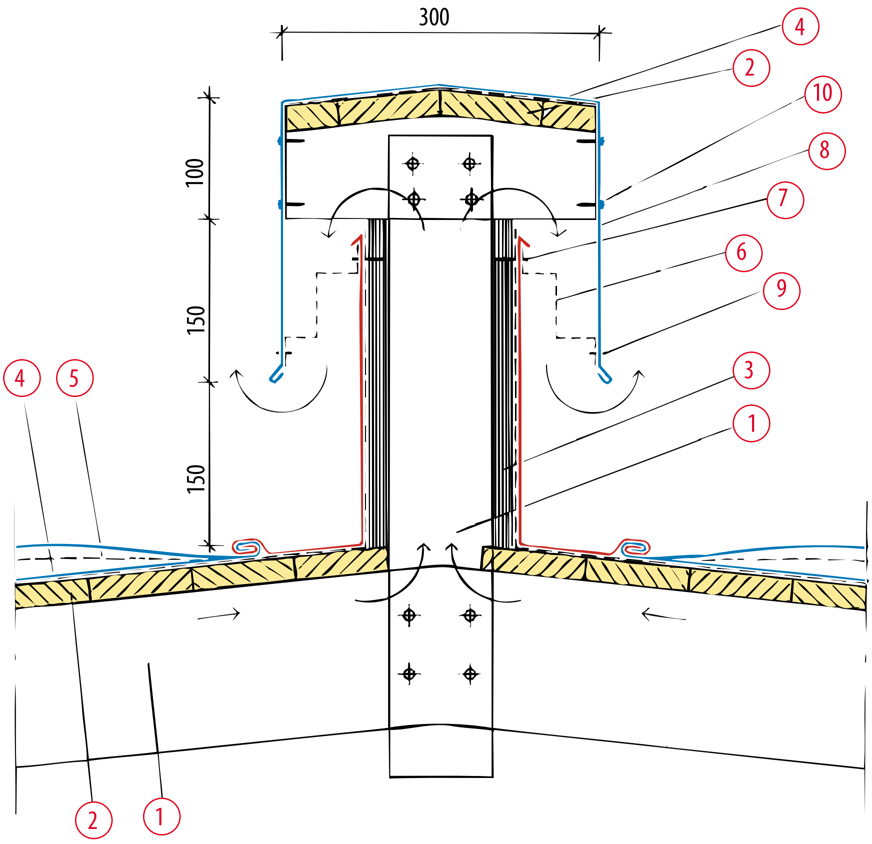
Detail at gable barge board



1. Tongue-and-groove boarding, at least 23 mm thick
2. Layer of roofing felt
3. Prelaq PLX
4. Continuous fixing strip
5. Barbed nails at 300 mm centres
6. Barge board cover strip, 0.6 mm thick

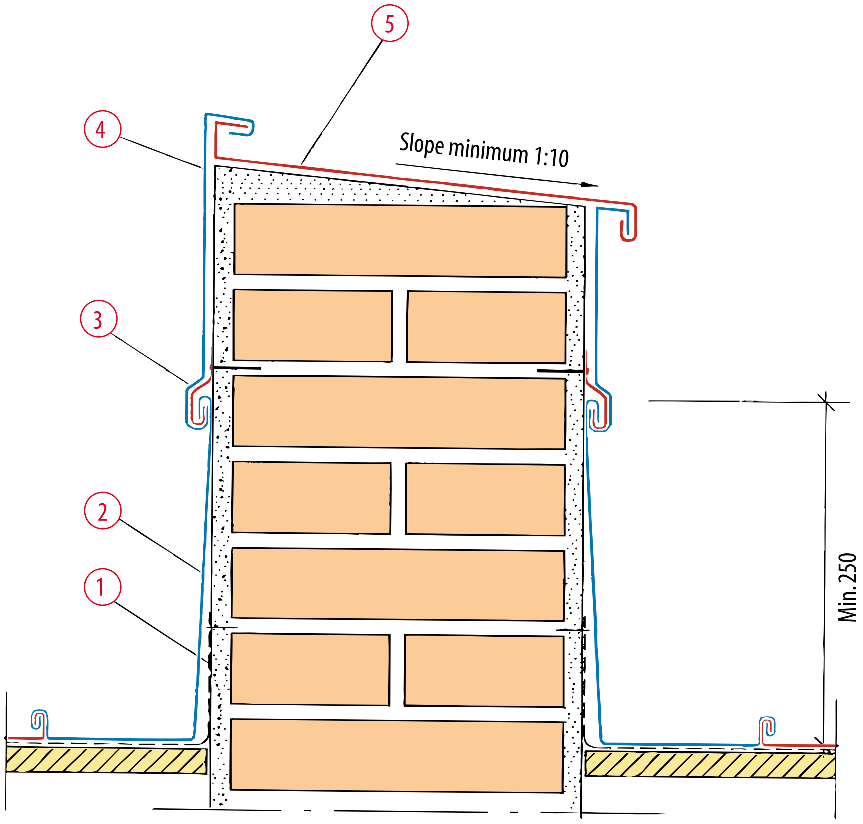
The above design provides a theoretical ventilation area of around 600 cm² per metre of ridge.

Ventilating ridge



1. Timber trusses, up to 1200 mm between centres.
2. Tongue-and-groove boarding, at least 23 mm thick
3. Plywood, at least 23 mm thick
4. Layer of roofing felt
5. Prelaq PLX
6. Perforated sheet, 3 mm dia. holes spaced 6 mm apart
7. Screws at 300 mm centres
8. Ridge hood, 0.6 mm thick
9. Pop rivets, 4.0 mm dia. at 300 mm centres
10. Stainless steel self-drilling screws at up to 1200 centres

Coping

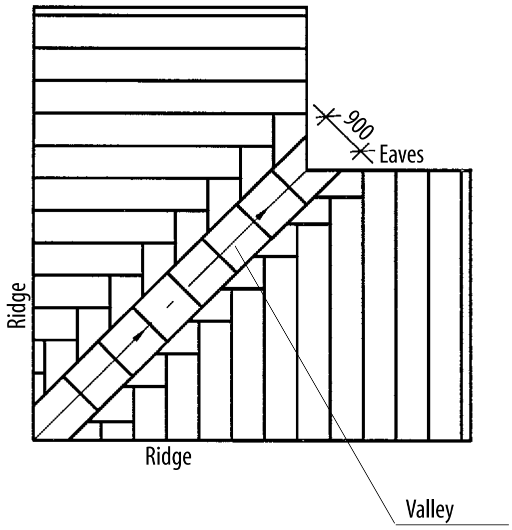


1. Layer of roofing felt
2. Prelaq PLX flashing with max. continuous lengths of 6 m
3. Hook clips at 600 mm centres
4. Side cladding, 0.6 mm thick
5. Coping sheet with double hook seams at transverse joints

Flat sheet roofing with Prelaq PLX

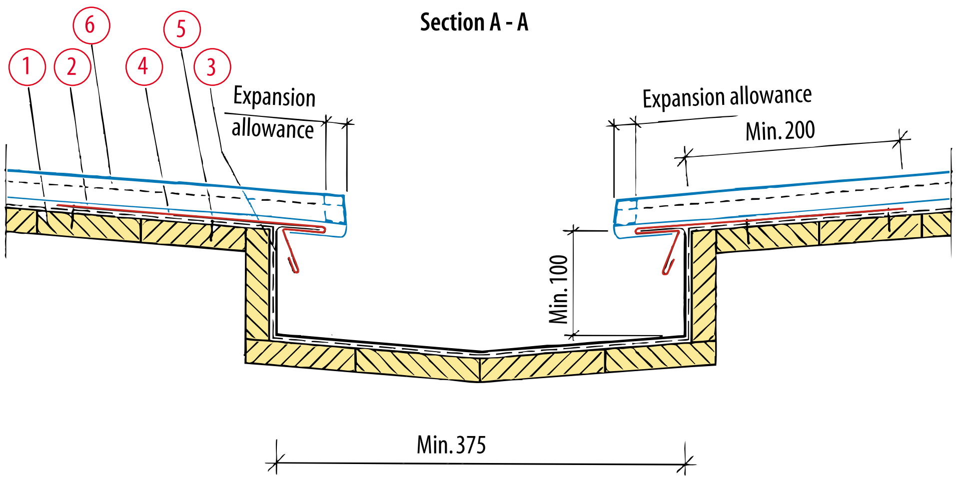
Valley

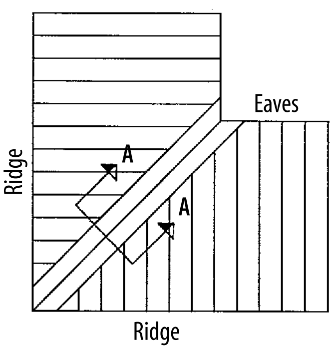
In normal cases, the valley should be made of steel sheet with a maximum seam spacing of 1200 mm and should be connected to the roofing sheet by means of standing valley seams. This is intended to allow freedom of movement of the material. Long strip roofing in accordance with the above figure should also be connected to the valley by means of closing pieces.



Sunken valley

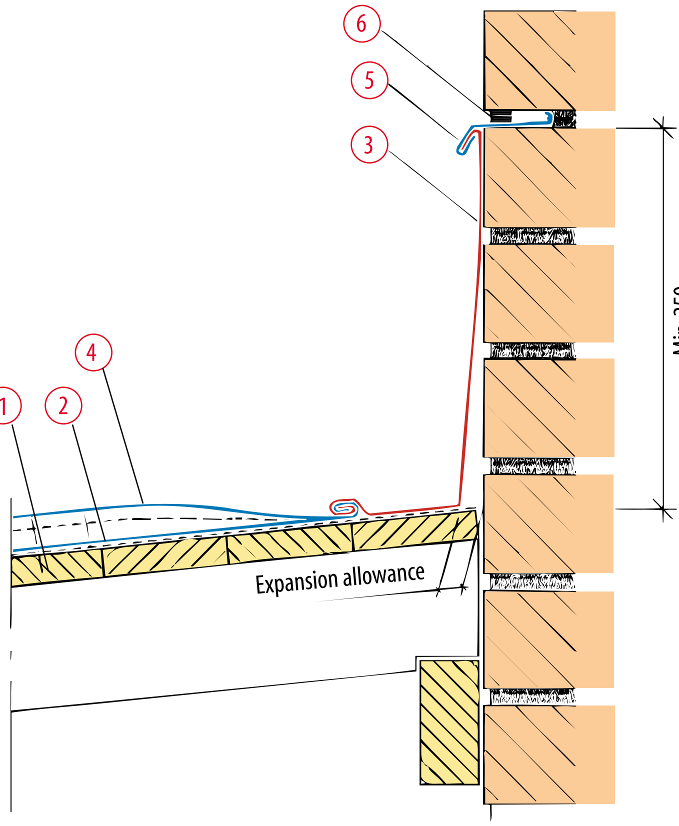
The valley design shown below will provide good expansion allowance for the strip. Closing pieces are not necessary in this design.





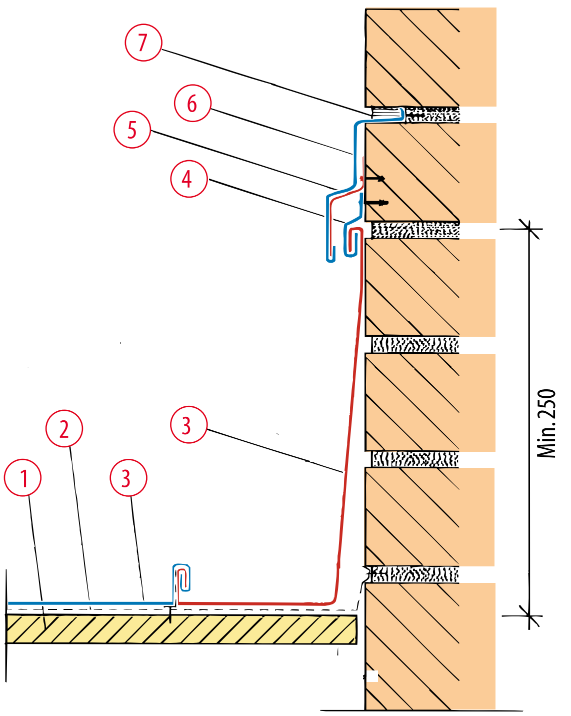
1. Tongue-and-groove boarding, at least 23 mm thick
2. Layer of roofing felt
3. Valley of Prelaq PLX. Max. continuous length of 6 m
4. Eaves sheet, 0.6 mm thick
5. Barbed nails at 150 mm centres in a zig-zag pattern
6. Prelaq PLX

Connection to an upstanding part of the building



High point

1. Tongue-and-groove boarding, at least 23 mm thick
2. Layer of roofing felt
3. Prelaq PLX, 0.6 mm thick. Max. continuous length of 6 m.
4. Prelaq PLX
5. Fixing strip, 0.6 mm thick
6. Jointing compound of durable quality

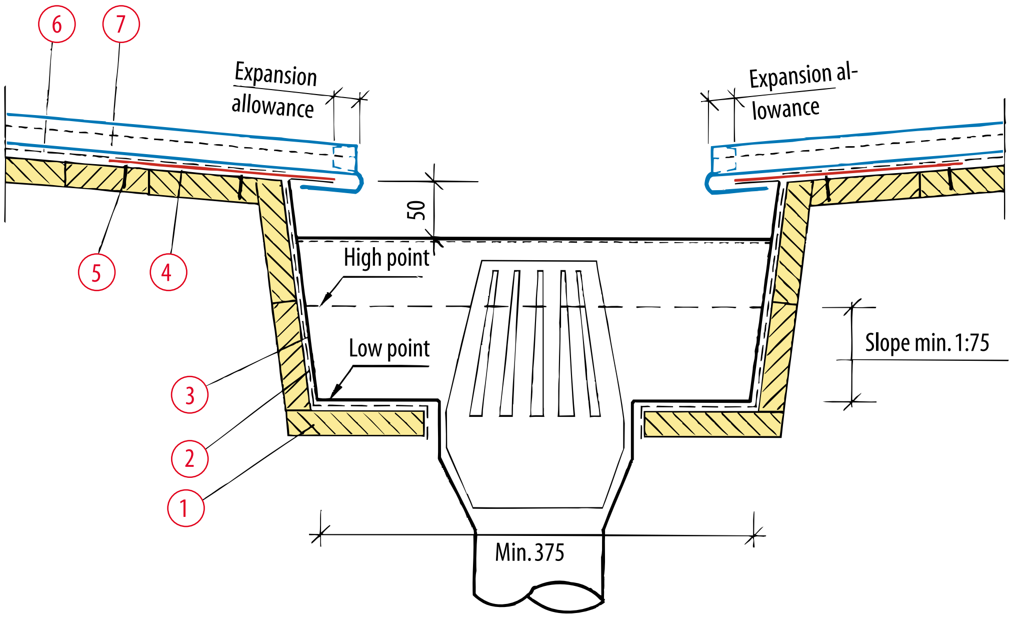


Side

1. Tongue-and-groove boarding, at least 23 mm thick
2. Layer of roofing felt
3. Prelaq PLX max continuous length of 6 m
4. Fixing strip, 0.6 mm thick
5. Continuous fixing strip, 0.6 mm thick. Secured to the vertical joints in the brickwork.
6. Flashing, 0.6 mm thick
7. Jointing compound of durable quality

In long strip roofing, a sunken valley can be produced in two ways, i.e. as double-folded sheet or as thick sheet with welded ends. In the latter alternative, the valley is made of 2 mm thick sheet with good anti-corrosion treatment, or of stainless steel sheet. The rain water outlet is welded to the valley. The valley is made in sections, each of which must be provided with an overflow. The overflow can also be designed as shown in the sketch, with connection to the nearest drain.

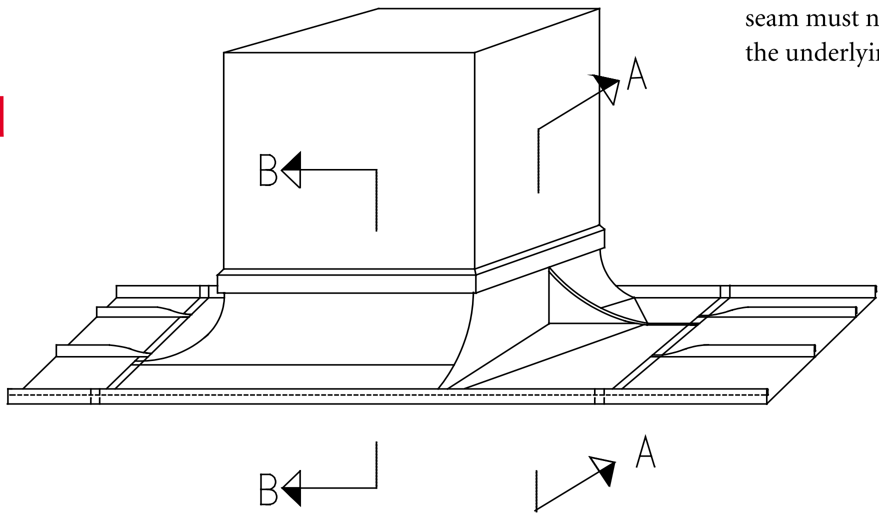
Sunken valley



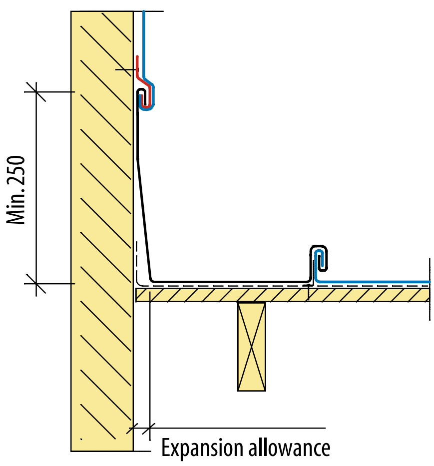
1. Tongue-and-groove boarding, at least 23 mm thick
2. Layer of roofing felt. All-welded rubber or equivalent sheet in the bottom and on the sides of the valley.
3. Seal-welded valley of 2 mm thick sheet steel or 1.0 – 1.25 mm thick stainless steel in sections of up to 12 m long.
4. Closing strip, 1.25 mm thick. Seam-welded to stainless steel sheet valley.
5. Barbed nails at 150 mm centres in a zig-zag pattern
6. Layer of roofing felt
7. Prelaq PLX

Flashing at roof upstand

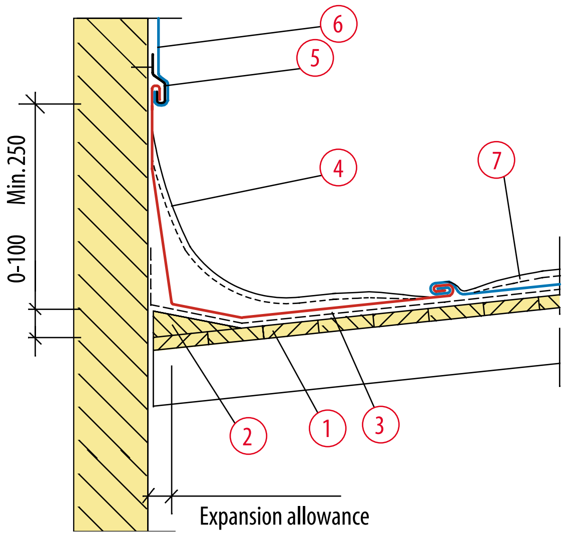
The flashing shall be made of the same material as the roofing. Fillets must extend at least 250 mm up on the roof upstand and be folded together with the side fixing strips. Curved seams shall be made in the corners. Expansion allowance must be provided. The connecting seam must not be clipped to the underlying surface.



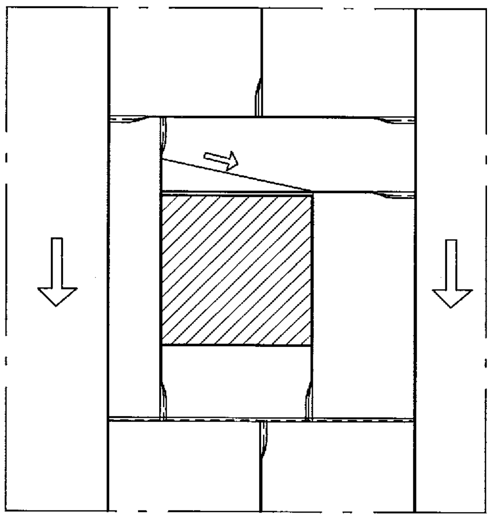
Section B - B



Section A - A

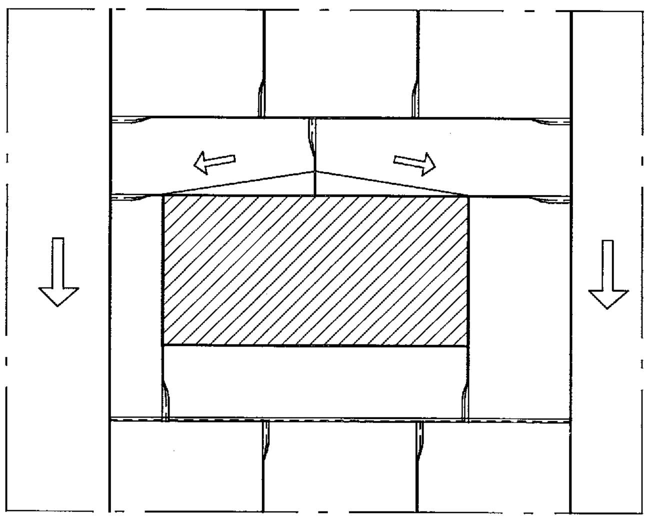


1. Tongue-and-groove boarding, at least 23 mm thick
2. Wedge-shaped wooden strip for supporting the upstand flashing
3. Layer of roofing felt
4. Fillet, 0.6 mm thick
5. Clips at 600 mm centres
6. Fixing strip, 0.6 mm thick
7. Prelaq PLX



Opening width
less than about 1000 mm

In the case of an upstand within two strip widths, the flashing should slope in one direction.



Opening
wider than about 1000 mm

In the case of bigger upstands, the flashing should slope in both directions.

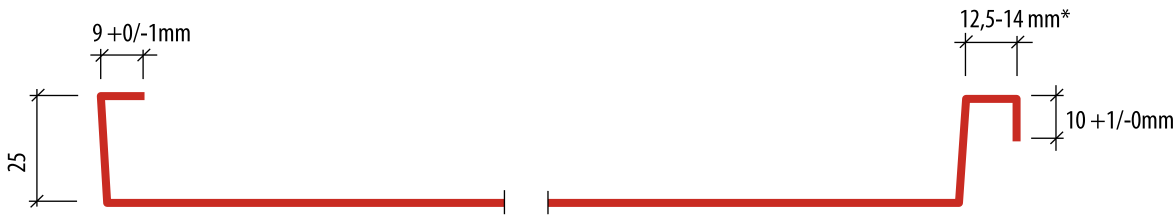
Work procedure for folding

PRE-FOLDING

In long strip roofing, the sheet steel strip is worked in two stages, i.e. pre-folding as shown in the adjacent figure, and seam folding carried out on the roof by means of a special machine (photo page 32).

In the past, both single-seam and double-seam folding were carried out in long strip roofing, but the modern machines used today carry out only double folding.

Regardless of the machines used, it is important to ensure that they are correctly preset, and that they are correctly serviced and maintained. As an example, the infeed tables and setting of the pre-folding machine must be checked, and the forming rollers must be kept clean to avoid damage to the paint coat on the seam. The dimensions of the seam must also be checked before seam folding is started on the roof. To achieve a good seam, it is important to check two dimensions in particular after pre-folding as shown in the figure below.



SHEET AFTER PRE-FOLDING

In the worst case, if any of these dimensions is incorrect, this may lead to the seam produced being a single seam instead of a double seam. The tolerance on the strips of Prelaq PLX for long strip roofing is –0/+2 mm. In the most cases, the deviation from 670 mm is very small. This eliminates the need for frequent adjust-ments to the prefolding machine to compensate for width variations.

*depending on folding machine type

SEAM FOLDING

When the strips are laid, they should be locked so that they do not move out of position when the seam folding machine is run. If the roofing is laid on a hard surface, such as a boarded roof, the strips can be locked at intervals of 1 metre, for instance. On softer surfaces, such as insulation, the locking arrangements should be more closely spaced. This locking is often carried out by means of folding tongs, although simple tools are available for this operation, so that the work can be done while operator is standing.

Before the seam folding machine is placed in position, the first fold should be made with folding tongs, for example, along a distance of about 300 mm. Then re-fold to a double seam along about 200 mm before the machine is placed in position. Make sure that the lever that moves the rollers onto the seam is easy to move down. This will ensure the longest possible useful life of the rollers. Follow the machine along the seam to make certain that re-folding is correctly done. This is particularly important if the long strip roofing is done on insulation.

It is preferable to run the seam folding machine from the top downwards. However, remember to turn the fold so that water will not be admitted into the fold, e.g. at valleys.

The procedure sometimes adopted is that a large number of strips are laid and they are locked in position for producing the seams with the seam folding machine at a later date. In such cases, the seams should not be made on successive strips from one side to the other since, by working on the entire seam, the seam folding machine may exert a transverse pull on the strips, which may result in sloping seams. Such stretching can be avoided by skipping a number of folds when making the seams and then going back to complete the seam folding.

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