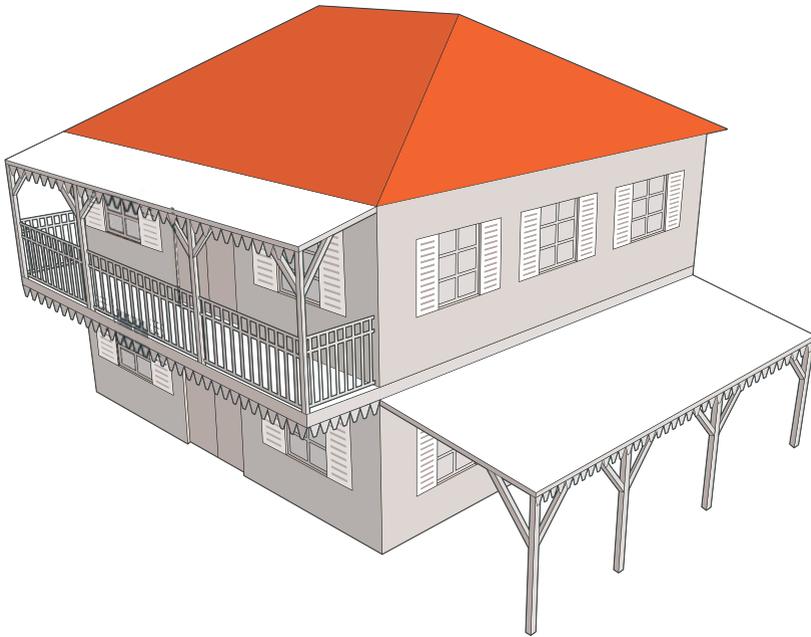




METAL ROOFS



Public Information Sheet



Contents

Foreword.....	4
Failure modes due to the effects of wind.....	6
Frame	9
Choice of materials	12
Installation.....	16
Fastening the sheeting	18
Positioning the bridges.....	20
Joints and appendages.....	21
Roof Ventilation.....	22
Tools and storage.....	23
Maintenance.....	24
Glossary.....	25
References.....	25

FOREWORD

This practical information sheet provides instructions for the installation of sheet metal roofing. It covers the individual features that directly influence the resistance of roofing against the effects of wind and seismic activity. Details for implementation of other roofing requirements are not included

■ Dimensions

The figures given are for simple structures:

- 2 levels maximum;
- surface area per level 100 m²;
- maximum height of each level 3 m;
- a square (10 x 10 m²) or rectangular shape connected to the two lower sides (e.g. 7 x 14 m²).

Other constructions can be completed using the same indications if a competent professional is consulted.



Figure 1: Roof that withstood

■ Warning



Figure 2: Do not pour concrete on roofing or high floors

Concrete must not be poured in place of lightweight roofing. This adds substantial mass to the top of the building, which is very risky in the event of an earthquake. Only qualified professionals (engineering firms and contractors) can consider this measure, subject to:

- an analysis of the existing structure;
- a design for the entire building including the reinforced structure and concrete, produced by a qualified engineering firm;
- reinforcement of the entire structure by a competent firm;
- concrete which is meticulously produced by a competent firm, with particular attention paid to the connection with the structure.

✓ *Note: contractors and engineering firms must be able to present their qualifications and references or, at least, an insurance certificate covering the planned work.*

FAILURE MODES DUE TO THE EFFECTS OF WIND



Figure 3: Batten with cross section that is too small and/or is fastened insufficiently

Figure 3 shows an example of a sheet that has been fastened correctly, however, its supporting batten has given way. There are three possible reasons for this failure:

- The cross section of the batten is too small;
- The batten is fastened insufficiently to the frame;
- The battens are spaced too far apart.



Figure 4: Undersized eave

Eave failures are also essentially related to the sheeting substrate. Figure 4 shows a large eave that, having failed, has dragged away some of the intermediate sheeting.

✓ *Note: the corners of buildings are where the forces are greatest.*



Figure 5: Incorrectly braced frame

Figure 5 shows first and foremost an example of a frame that was insufficiently braced or that is without bracing altogether (see the information sheet on timber frames). Note that, on this highly exposed building, almost all the roof appendages have been torn off.



Figure 6: Uplift of the roof edge – sheet too thin and insufficiently steep, insufficient fastening causing perforation

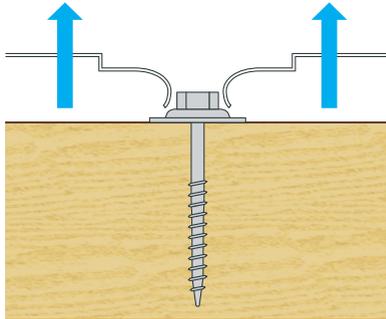
Figure 6 shows an example of sheets that are too thin and that are inadequately fixed, leading to some perforation. In addition, the cross section of the battens is too small and they are spaced too far apart at the roof edge.

If they are designed incorrectly, steel or aluminium sheet roofs have two possible failure modes under the effects of wind.

■ Shear failure of the sheeting (Diagram 7)

The sheeting is pulled off but the fastener remains in place. This may be due to:

- A sheet that is too thin => make sure to choose a sufficient thickness;
- A screw head that is too small => make sure to use saddle brackets that distribute the forces.



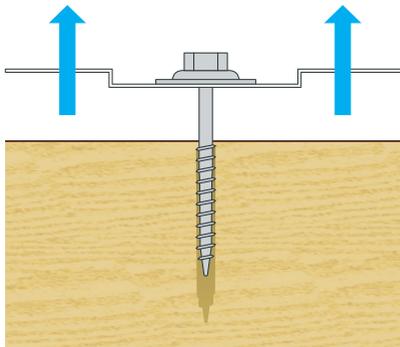
✓ Make sure to choose a sufficient thickness

✓ Make sure to use saddle brackets that distribute the forces

Figure 7: Punching the sheet metal

■ Ripping out or failure of the fasteners (Diagram 8)

If the fastener is not suited to the substrate, it may be pulled out along with the sheeting => make sure to choose a fastener that is suited to the substrate (timber, metal or concrete). The quality or thickness of the sheeting has no impact in terms of this failure mode.



✓ Choose fasteners suited to the material (wood, metal, concrete)

Figure 8: Ripping out or breaking the fasteners

FRAME

The frame must be designed according to the instructions in the information sheet on "timber frames". The instructions below relate to the installation of sheeting on the frame.

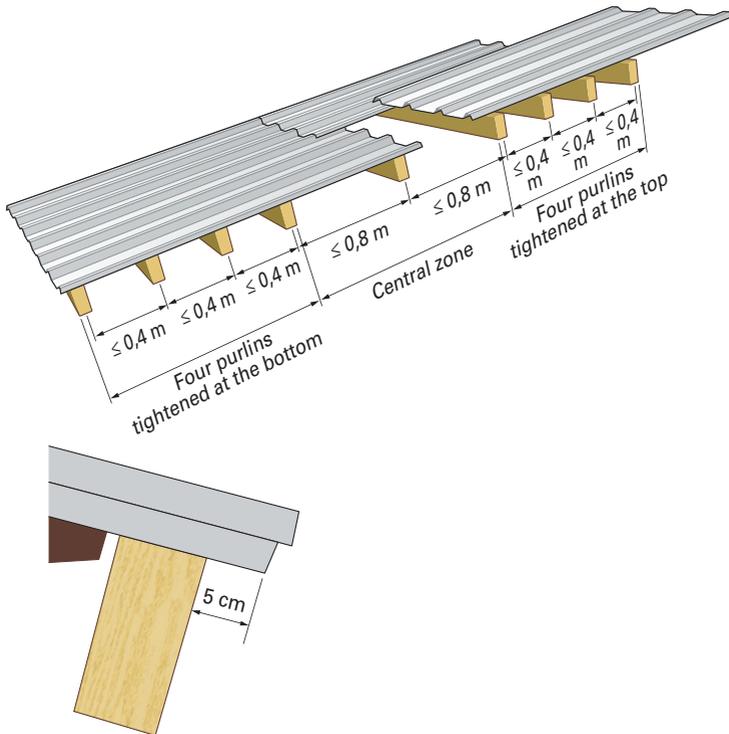


Figure 9: Arrangement on a frame built using purlins

The sheets are fastened to each purlin with a minimum of three bearings. The sheet overhang must be limited to approximately 5 cm over the lowest purlin.

- ✓ *Note: the optimal arrangement, ribbed sheeting on purlins, is shown in Figure 9. The sheets are steeper and the forces are transferred more directly onto the frame, resulting in increased robustness compared with other configurations.*

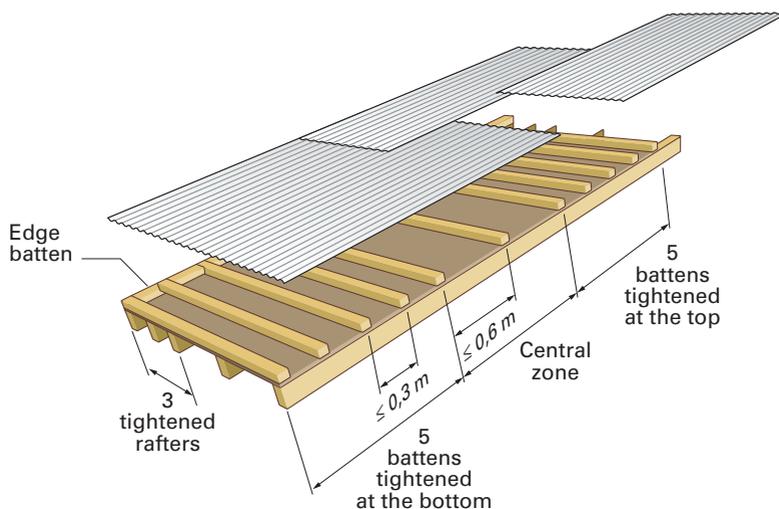


Figure 10: Arrangement on a frame built using rafters

Eaves are elements that are susceptible to the effects of wind as they are situated in the most exposed area of the building. They must be built in a manner that is continuous with the main frame. An overhang of more than 50 cm must be reinforced. A brace that matches the one specified in the information sheet on canopies can be used.

✓ *Note: The haunches of the frame must always be fastened to the wall ties.*

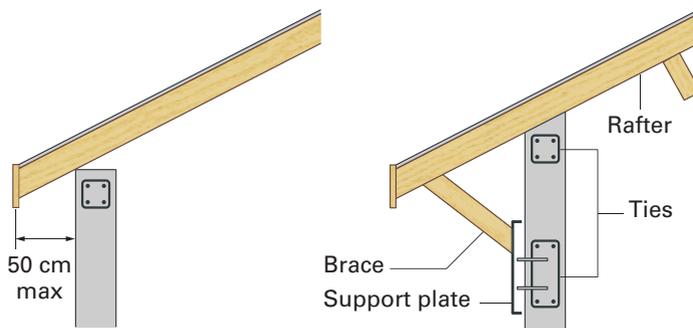


Figure 11: Eaves

On a frame built using rafters and battens, the sheets must be fastened to every batten. The rafters and battens are tightened at each edge of the roof. Additionally, the battens at the edges enable appendages to be fastened.

✓ *Note: traditionally, there are no roof overhangs in Saint-Martin.*

Figure 12 shows a common method of building frames in Saint-Martin. When structures are being repaired, it can be used subject to the following precautions:

- a plastic film must be placed between the wood and the concrete before pouring;
- the reinforcing steel mesh must be galvanized;
- there are 3 frames for the steel mesh on each side of the rafter, spaced 10 cm apart.

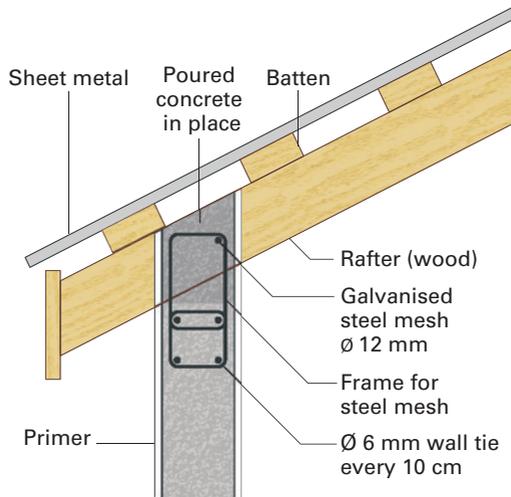


Figure 12: Common method of building frames in Saint Martin

✓ *Note: this configuration, although common in Saint-Martin, does not offer the same safety levels as new constructions. It is reserved for repairs to existing structures.*

CHOICE OF MATERIALS

The choice of building materials and products is essential to the safety and durability of buildings. This information sheet details the criteria for choosing the correct products. The performance levels relating to these criteria must be specified by the manufacturer and can be found on the product itself or on its label. In order for this information to be of use, it must be presented in a specific way – the CE marking format.



Figure 13: Logo appearing on a product with CE marking

■ Choice of roof sheeting

Given the marine environment of the island of Saint Martin, only the sheeting indicated in the table below shall be used. Note: the appendages must be made of the same type of material.

Type of Sheeting	Minimum Thickness	Protection
Aluminium	1.00 mm	Does not require coating Thermoplastic precoating
Galvanised steel (*) (away from seafront)	0.75 mm	AZ 185
Precoated steel (*) (away from seafront)	0.75 mm	Polyurethane 50 microns (µm) PVDF 60 microns (µm) PVC 200 microns (µm)
Stainless steel	1.00 mm	Does not require coating

(*) With the approval of the manufacturer.

A seafront construction is one that is exposed to sea spray. In general, this corresponds to a maximum distance of 800 m from the sea.

This choice has a significant impact on the durability and therefore the resistance of the roof.

Thinner sheets are less robust under extreme wind events.

■ Sheet dimensions

The following dimensions are recommended for the metal sheets.

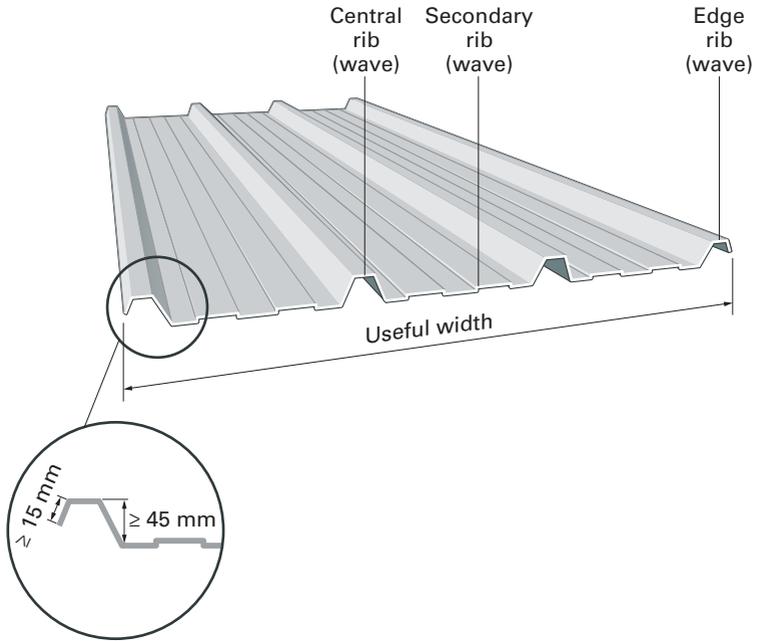


Figure 14: Ribbed sheet

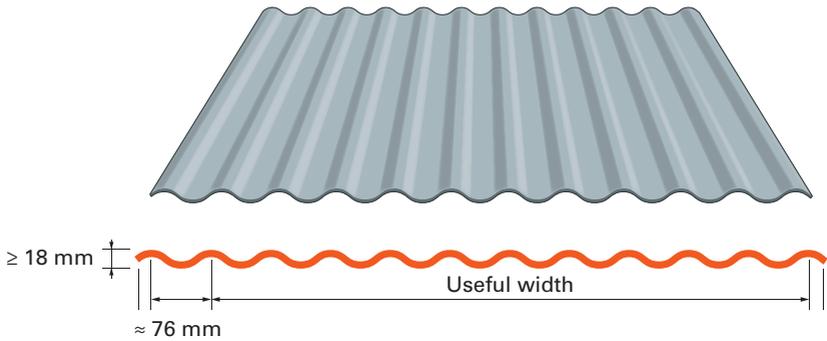


Figure 15: Corrugated sheet

■ Choice of fastenings and appendages

All fastenings must be made of stainless steel (A2). Sheets are fixed using the following components:

- Timber substrate: lag screw a minimum of 6 mm in diameter and 100 mm in length.
- Metal substrate: self-drilling or self-tapping screws a minimum of 5.5 mm in diameter and 60 mm in length.
- Saddle bracket: it must be suitable for the chosen sheeting and made of the same materials. If it is not sold together with the sheeting, it must be tested: once positioned on the rib, there must be no play.
- Bridge: it must be suitable for the chosen sheeting and made of the same materials or of plastic. If it is not sold together with the sheeting, it must be tested: once positioned under the wave, it must have the exact same height.

If galvanised steel fasteners are used, their durability will be less than that of the roofing. Roofing must be checked and renovated every 10 years or so.

Appendages at the periphery of the roof or that penetrate the roof may be used. They must be made of the same material as the chosen sheeting. The most common are:

Linear Appendages	Appendages for Specific Penetrations
Ridge cap	Vents
Fascia board	Flashings
Closure	Hopper

The role of closures is to close the volume under the sheets or their accessories. A comb filler is designed to let the air flow and prevent pests from getting in as well.

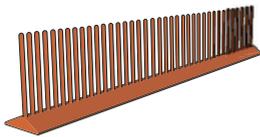


Figure 16: Comb filler

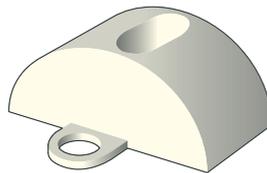


Figure 17: Bridge for corrugated sheeting



Figure 18: fastening assembly for corrugated sheeting

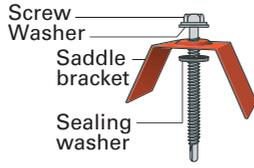


Figure 19: Screw – Washer – Saddle bracket

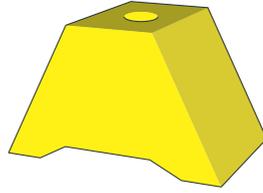


Figure 20: Bridge

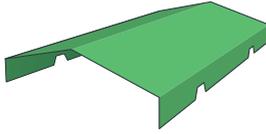


Figure 21: Ridge

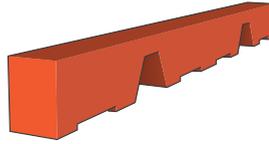


Figure 22: Closure



Figure 23: Do not nail the metal sheets

INSTALLATION

The roof must fulfil the following criteria:

- Sheets are laid on a minimum of 3 bearings.
- Minimum pitch of 15%.

The assembly is carried out from the bottom upwards and in the opposite direction to the prevailing winds.

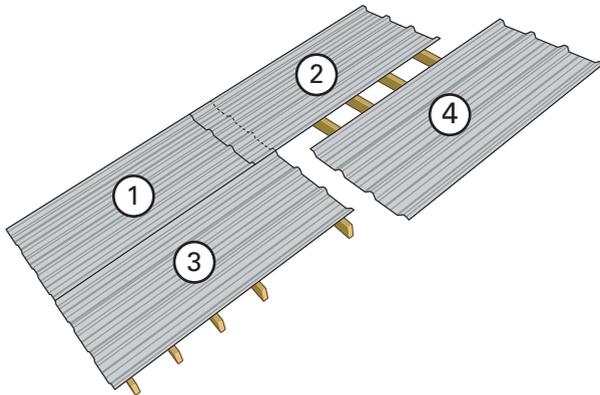


Figure 24: Order of assembly of the sheets

The supporting elements of the frame must have sufficient resistance (see the “frame” information sheet). In order to ensure sufficient stiffness of the sheeting, the centre-to-centre distances described below must be observed. The dimensions of the frame may result in shorter centre-to-centre distances.

■ Ribbed sheeting

- First four purlins from the bottom of the roof are spaced a maximum of 0.80 m apart.
- Maximum spacing of the purlins: 1.45 m

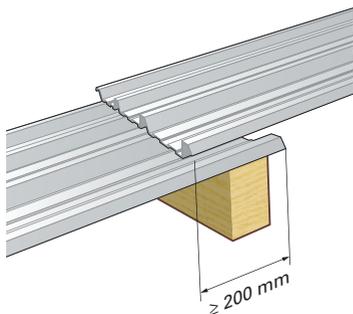


Figure 25: Overlap

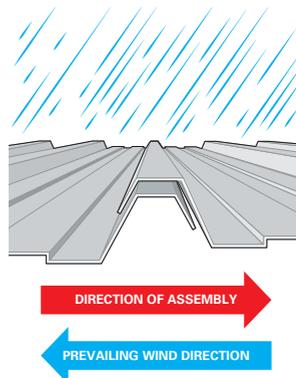


Figure 26: Direction of assembly

■ Corrugated sheeting

- First five battens from the bottom of the roof are spaced a maximum of 0.30 m apart;
- Maximum spacing of the battens: 0.6 m.

The sheets must overlap by 200 mm transversely over the purlins.

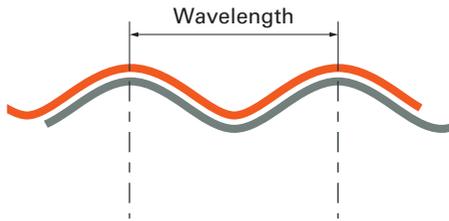


Figure 27: Minimum overlap of two waves for corrugated sheets

FASTENING THE SHEETING

The sheet fasteners are:

- lag screws for timber: diameter of 6 mm minimum, penetration into the purlin or batten of 50 mm minimum;
- self-drilling or self-tapping screws for metal purlins: diameter of 5.5 mm minimum, penetration into the purlin of at least 2 threads.

For ribbed sheeting, every rib must be fastened. A saddle bracket tailored to the profile of the sheet must be placed between the sealing washer and the screw head. This bracket prevents perforation of the sheeting. It is very important for the final strength of the roof. The bridges must be positioned according to the distribution specified in the next section. They prevent any potential movement of the sheeting under the dynamic effects of the wind.

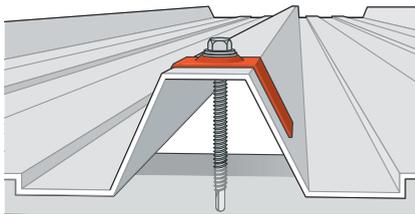


Figure 28: Screw in a metal purlin

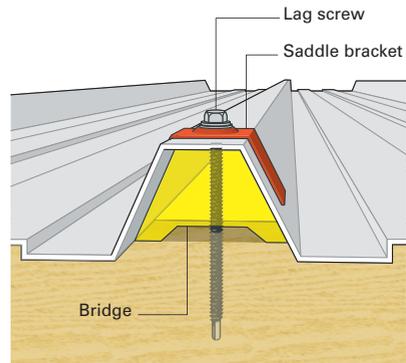


Figure 29: Lag screw in a timber purlin with a bridge

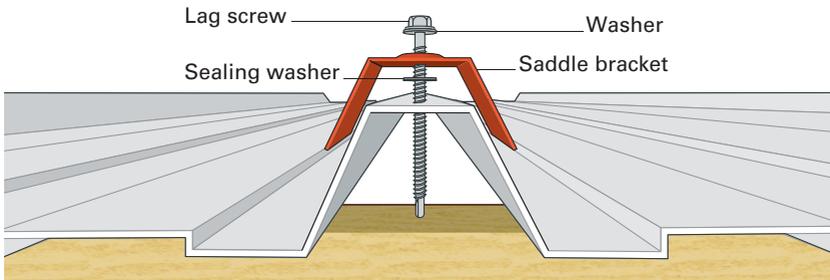


Figure 30: Exploded view

For corrugated sheeting, the fastenings are installed:

- on every overlap;
- every other wave;
- every third ridge, in a standard section;
- on all of the purlins and battens.

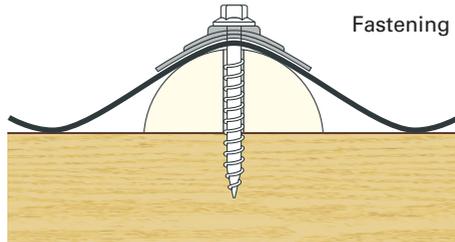


Figure 31: Fastening for corrugated sheeting

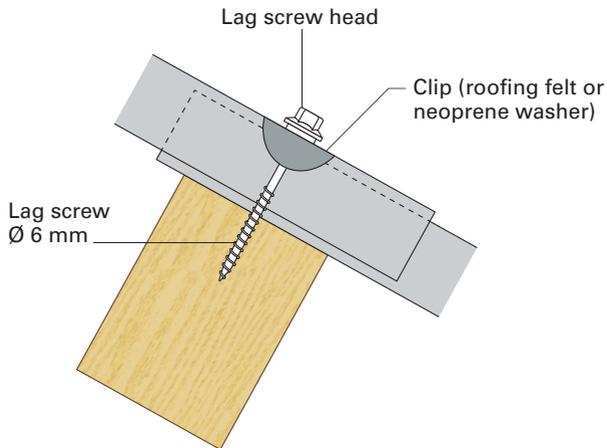


Figure 32: Fastening on longitudinal overlap (200 mm)

✓ Notes:

- the lag screws must be screwed in. They must never be inserted using a hammer.
- the tightening torque of the lag screws must not be too high. The sheet must not be deformed after tightening.

POSITIONING THE BRIDGES

A bridge must be positioned between the substrate and the sheet (cf. adjacent figure) at least at the edges and corners. When fastening the steel sheet to the substrate, the bridge – suited to the corresponding sheet profile – enables optimised tightening without deformation of the sheet. This in turn enables the assembly to be stiffened, thus avoiding ageing of the assembly accelerated by fatigue, due to the sheets beating against the substrate under the dynamic effects of the wind.

Therefore, a bridge must be installed for every fastening in the following locations:

- At 1.5 m from the bottom;
- At 1 m from the top;
- At 1 m from an edge.

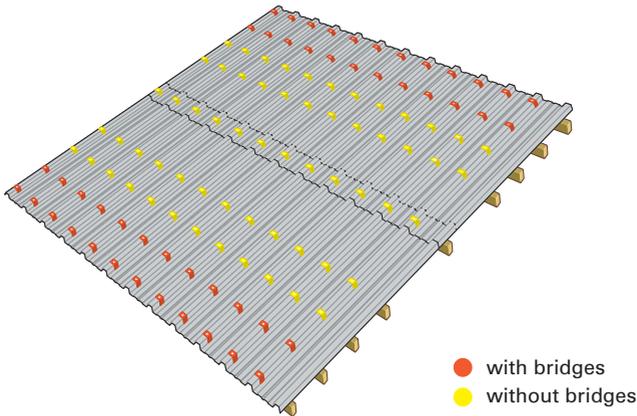


Figure 33: 3D view (yellow: without bridges / red: with bridges)

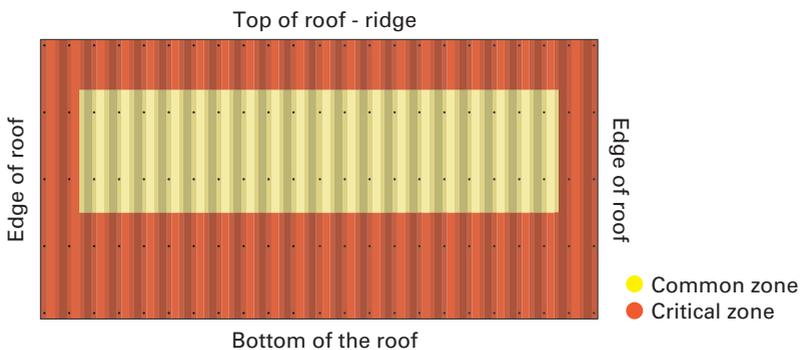


Figure 34: Top view

JOINTS AND APPENDAGES

Joints consist in securely connecting two elements together. The sheets must be connected together using stitching screws in order to ensure correct performance of the assembly. The maximum centre-to-centre distance is:

- Ribbed sheeting: 0.5 m including fastenings on the purlins.
- Corrugated sheeting: 0.3 m including fastenings on the battens.

Roof appendages must also be fastened correctly. This is especially important because they are situated in areas that are most exposed to the wind. The following should be applied:

- at least two fasteners per appendage;
- a maximum centre-to-centre distance between fasteners of 0.30 m or one screw per wave.

The fasteners must extend as far as the supporting element of the frame.

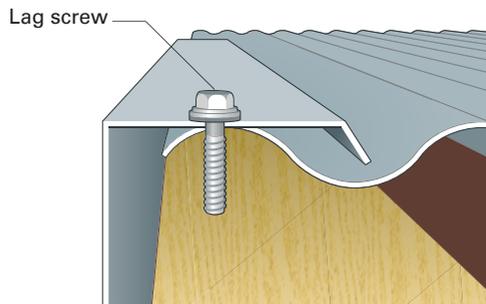


Figure 35: Fascia board fastener extending as far as the batten

Self-tapping screws with a minimum length of 19 mm should be used.

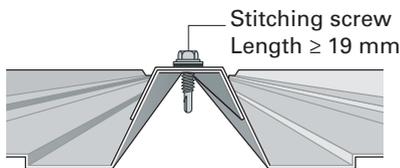


Figure 36: Joint between two sheets

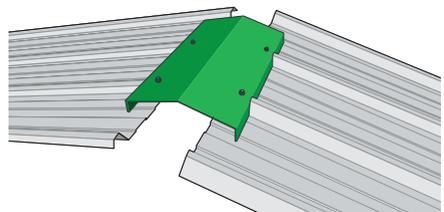


Figure 37: Unventilated ridge

ROOF VENTILATION

Ventilation of the roof is necessary to avoid condensation under the sheeting and to ensure thermal comfort during the hottest periods of the year.

It consists of ventilation at the bottom of the roof. In order to achieve this, the gap between the top of the wall and the sheeting must be a minimum of 40 mm.

✓ *Note: fill gaps with anti-pest comb fillers or grating.*

In addition, allow for upper ventilation for more efficient extraction of warm air. The material suppliers may offer solutions that allow roof ridge ventilation.

TOOLS AND STORAGE

On site, packs of materials must be stored away from any dampness (rain, condensation, etc.). Ideally, packs should be stored in a slanted position, under shelter and in a ventilated area.

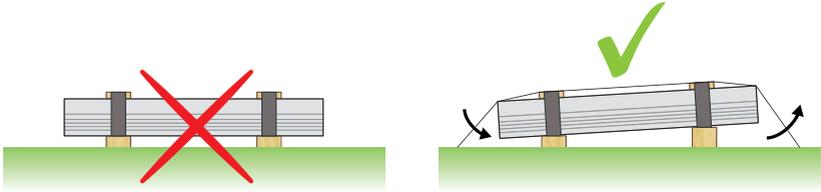


Figure 38: Storage – drawings to be continued

In order to avoid any scratches, sheets must be handled in a way that prevents the end of a sheet from rubbing against the sheet below. Gloves must be worn.

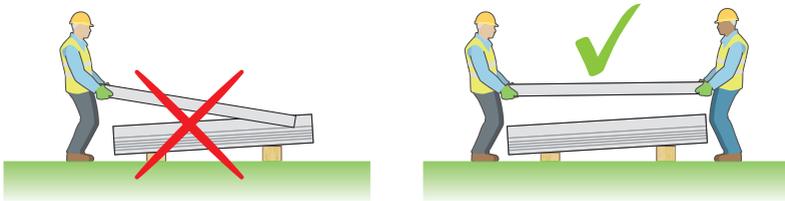


Figure 39: Manutention

In order to avoid any risk of premature corrosion or degradation of the coating, cut-outs must only be made using the nibbling machine.

The shavings resulting from cutting must be removed to avoid premature corrosion of the sheet metal.

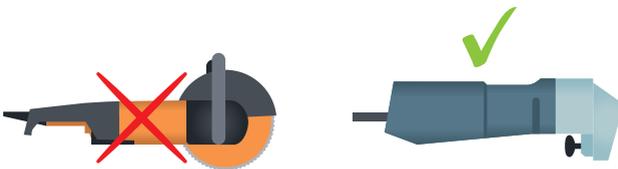


Figure 40: Tools

Use of a hammer when installing the sheeting is prohibited. Hammer prohibited

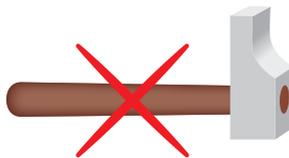


Figure 41: Do not use hammers

MAINTENANCE

Maintenance of sheet metal roofs must be carried out once per year, when the hurricane season is approaching. At that time, an inspection should be performed to ensure that there has been no premature degradation.

At the end of the first year, check that the sheets are securely tightened (retighten without deforming the sheeting). The temperature and drying of the timber may cause deformations that loosen the tightness of the lag screws.

✓ *Note: The tightening must be rechecked after a hurricane.*

From the exterior:

- Check that the water outlets are not blocked by vegetation, especially if the roof is below any trees.
- Check that the fastenings show no signs of corrosion.
- In particular, check that the appendages are securely fastened.
- Check that the sheet edges show no signs of corrosion.

If you discover a problem, do not hesitate to change the fastenings and sheet if necessary.

From the interior:

- Check that there are no signs of rust. If you discover signs of rust, identify the source and change the relevant fastening.
- Check that the sheets do not contain any rust spots. The presence of rust spots indicates that there is regular condensation, which means that the ventilation of the roof spaces must now be increased.

Glossary

Appendage: a component for completing the roof edges or for penetrations.

Batten: a linear component made of timber that is in direct contact with the sheets screwed onto the bracing plates and rafters.

Joint: the connection between two components of the roof. For example, between two sheets or between one sheet and one appendage.

Purlin: a linear component of the frame that is in direct contact with the sheets.

Rafter: a linear component made of timber that supports the bracing plates and battens.

Sheet: a metal plate that is profiled in such a way as to give it resistance.

References

DTU 40.35 (P34-205): Ribbed plate roof consisting of coated steel sheets.

DTU 40.36 (P34-206): Ribbed pre-coated or non-pre-coated aluminium plate roof.

Règles Antilles [Caribbean Regulations] – 1992 revision.

✓ *Note: all dimensions provided are the default. A roofing designer may deviate therefrom subject to calculations that comply with DTU 40.35.*

Photos

CAUE [*Conseil d'Architecture, d'Urbanisme et de l'Environnement* – Council for Architecture, Town Planning and the Environment] Guadeloupe.

DEAL [*Direction de l'Environnement, de l'Aménagement et du Logement* – Environment, Planning and Housing Directorate] Martinique and Guadeloupe.

Délégation interministérielle pour la reconstruction des îles de Saint-Barthélemy et Saint-Martin [Interministerial delegation for the reconstruction of the islands of Saint Barthélemy and Saint Martin].

Diagrams

Laurent Stefano



PRACTICAL GUIDE ON POST-HURRICANE REPAIRS

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