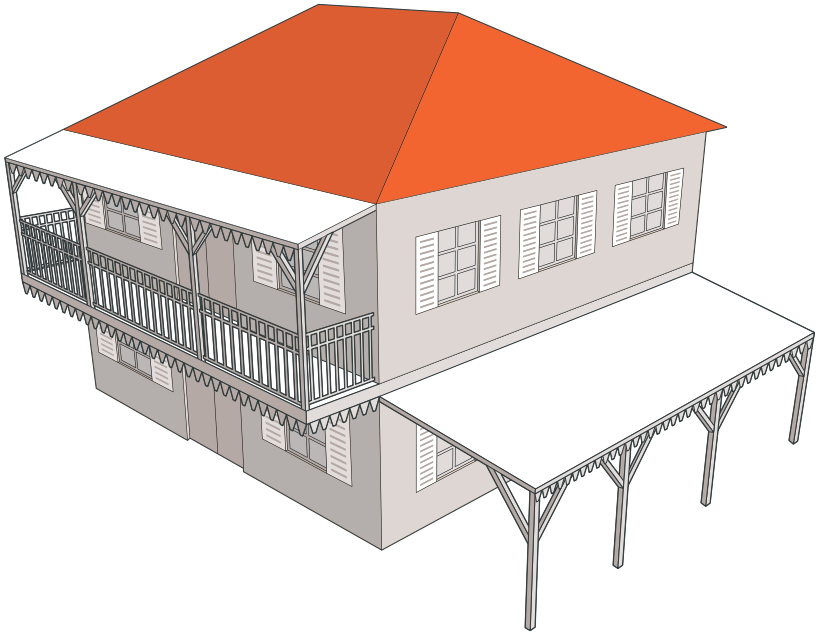
BUILD WELL!

TIMBER FRAME



Practical Information Sheet

Professionals

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

Saint-Martin
Caraïbe Française · French Caribbean

N°2

Contents

FOREWORD

This practical information sheet provides indications on installing timber frames. It presents individual points that have a direct influence on how well the frame will stand up to the effects of wind and seismic activity. Details on how to implement the other timber frame requirements are not covered here.

Figure 1: Exposed structure that survived

FAILURE MODES UNDER THE EFFECTS OF WIND AND SEISMIC ACTIVITY

If timber frames are not designed properly, they may exhibit three possible failure modes caused by the effects of wind and seismic activity.

- **Failure of structural elements that have been weakened or overloaded**

The structural elements have broken. This can be due to unsuitable design, the use of materials that are not strong enough or incorrect dimensioning.

✓ *Make sure you choose a suitable design, especially where dimensioning of the components is concerned.*

Figure 2: Cross-section not substantial enough

Figure 3: Purlin spacing too wide

Figure 4: No bracing

- Ripping out or breaking of joints

The joint components have been ripped out or torn. This can be due to installation errors or using unsuitable assembly methods.

✓ *Make sure you choose assembly components that are suitable and supervise their installation.*

Figure 5: Bad assembly

Figure 6: Bad panel-to-purlin fixing

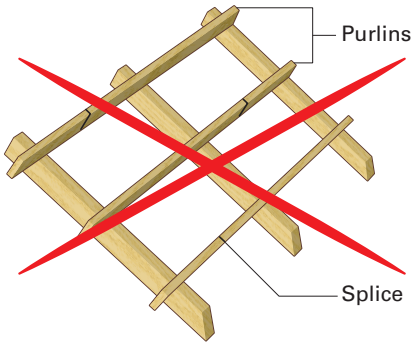


Figure 7: Splices outside bearing points to be avoided

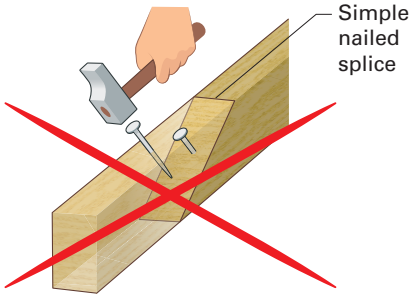


Figure 8: Simple nailed splices to be avoided

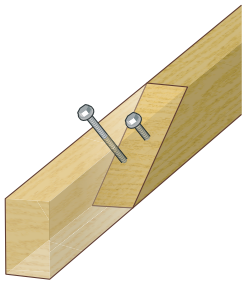


Figure 9: Screwed connection

- Ripping out or breaking of the anchors

If the fixing used is not suitable for the material it is used on, it is possible that it will be ripped out at the same time as framework elements.

✓ *Choose suitable fixings for the material they are used on.*

Figure 10: Bad frame-to-wall tie fixing

Figure 11: Improper attachment (flats poorly anchored)

Figure 12: Bad maintenance

Figure 13: Improper assembly of the masonry and lack of bracing on a hip roof frame

CHOICE OF MATERIALS

Choosing the right building materials and products is of prime importance to the safety and durability of the buildings. This information sheet provides selection criteria for choosing these products. The performance levels meeting the criteria must be specified by the manufacturer and marked directly on the product or the label accompanying it. For this information to be usable, it must be specified in a precise format, namely the format associated with the CE mark.

Figure 14: Logo that must be displayed on products bearing the CE mark

Timber

Because of the marine environment on the Island of Saint-Martin, only the following should be used as structural components:

- softwood;
- tropical hardwood;

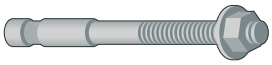
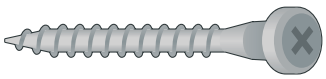
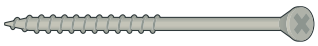
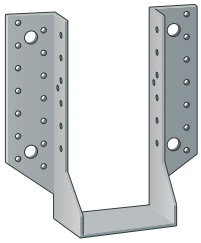
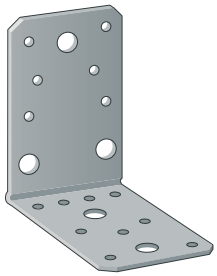
for which the maximum moisture content is less than or equal to 20%. Choosing the right timber has a considerable influence on the durability of the frame.
Timber used for the structural elements must meet class 4 requirements (in accordance with NF EN 1995-1 and AN) and have anti-termite protection.
Timber used for the non-structural elements must meet class 3 requirements (in accordance with NF EN 1995-1 and AN) (through natural durability or treatment).
The use of EN 636-2 type plywood panels, P5 and P7 type particleboards and fibreboards for structural purposes is not permitted.

Roof

The roof is made up of metal sheets (see the information sheet on metal roofs).

Metal joining and fixing systems

Timber structure joining and fixing systems must be made of steel with a zinc coating validated for class 2 service use: type Z275 coating. It should be noted that using assemblies made of stainless steel improves durability.

Choice of materials	
Hex head bolts Fields of application: purlin hangers, mixed reinforced brackets.	
Anchor bolts Fields of application: wall tie fixings.	
Screws Fields of application: purlin hangers	
Structural wood screws Field of application: timber component assembly..	
Purlin hangers Fields of application: beams, purlins, stringer beams and rafter abutments.	
Structural brackets Fields of application: purlins, rafters.	

MAIN FRAME COMPONENTS

The framework is comprised of:

- trusses;
- rafters or purlins.

To ensure that the frame is sufficiently rigid, the following characteristics should be adhered to:

- The trusses should have a span of no more than 10 m and be spaced no more than 3 m apart.
- The elements making up the trusses should comply with the following dimensions:
  - the cross-section of the king post should be at least 15 x 15 cm;
  - the cross-section of the principal rafters should be at least 8 x 25 cm;
  - the cross-section of the struts should be at least 8 x 15 cm;
  - the cross-section of the tie beams should be at least 2*5 x 15 cm;
  - the struts should form an angle of no more than 45° with the king post.

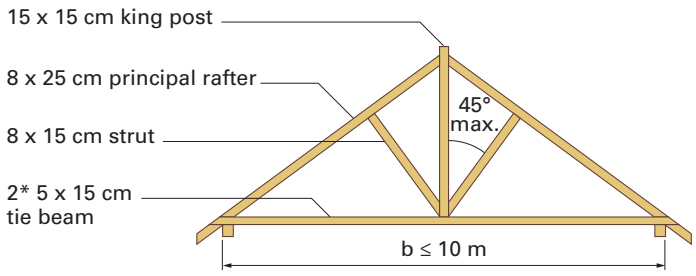


Figure 15: Components of a main (king post) truss

- The distance between the tie beam-to-principal rafter joint and the bearing point should be less than or equal to a third of the distance between the king post-to-principal rafter joint and the bearing point.

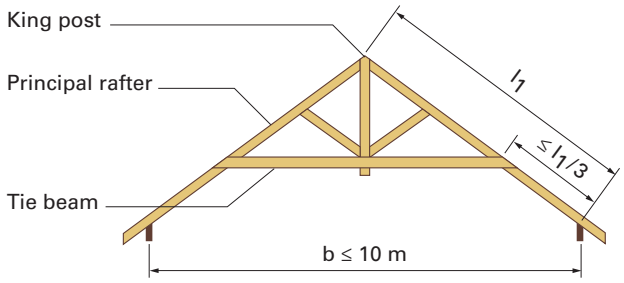


Figure 16: Example of a raised tie truss

- The purlins should be no more than 0.8 m apart. The spacing between the 4 purlins at either end should be reduced by half.

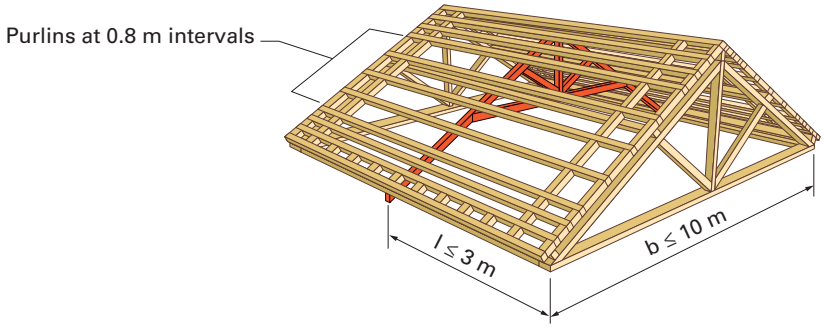


Figure 17: Spacing between the common purlins (to be removed from the diagonal elements in red)

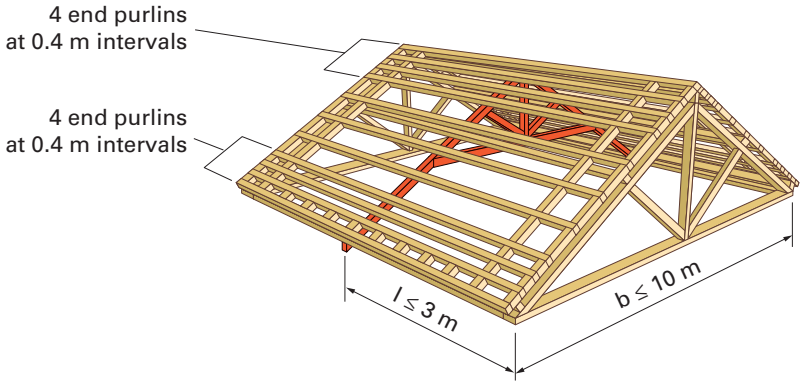


Figure 18: Spacing between the first 4 purlins at either end (to be removed from the diagonal elements in red)

- The rafters should be no more than 0.6 m apart. The spacing between the first 4 rafters at either end should be reduced by half.

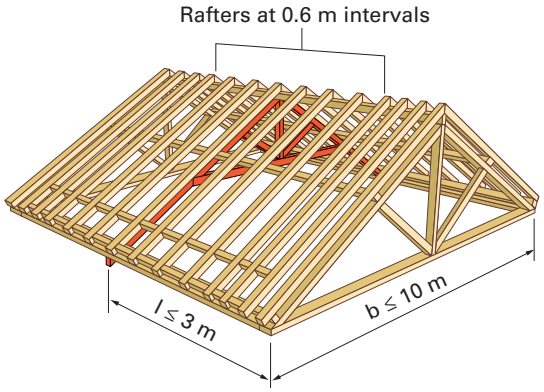


Figure 19: Spacing between the main rafters at either end (to be removed from the diagonal elements in red)

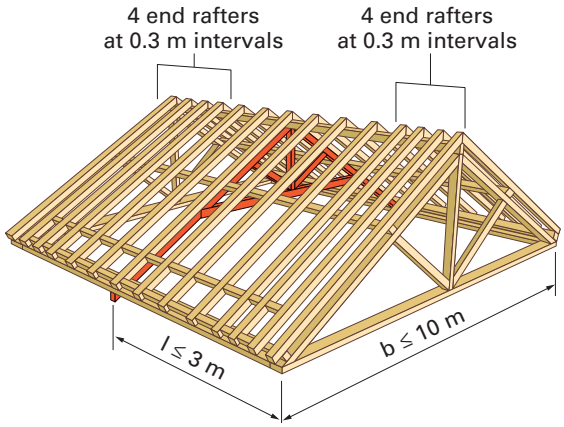


Figure 20: Spacing between the first 4 rafters at either end (to be removed from the diagonal elements in red)

Although hip roof frames are generally more stable, they are more expensive to build than gable roof frames.

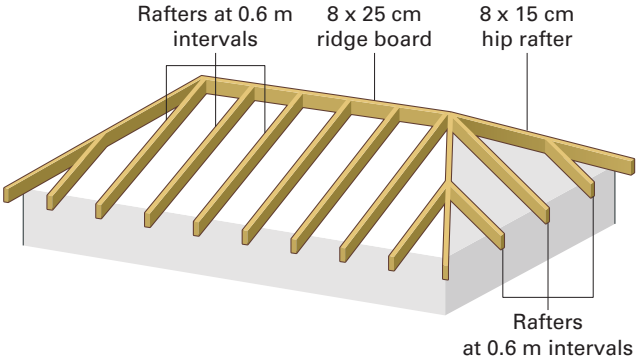


Figure 21: Example of a hip roof frame

FRAME FIXING REINFORCEMENT

General

Structural joints created with metal components are subject to CE marking, a European Technical Assessment and a technical specification by the supplier.

Nails of any type, including twist nails working under tension, should never be used. Joints that work under tension can be made using coach screws or bolts and these can be combined with plates or corner braces where necessary.

Carpentry joints (housed joints, notch joints, mortise and tenon joints, etc.), which essentially work through contact, are forbidden when assembling the main elements constituting the bracing. These assemblies must include additional metal assembly parts. These could be metal rods (plate bolts, nuts, screws, etc.), which may be used in conjunction with brackets and hangers.

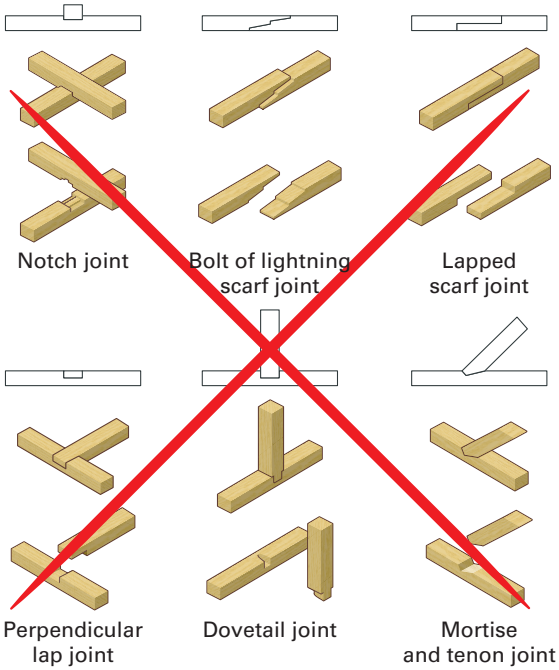


Figure 22: Examples of carpentry joints that require devices to hold them in position even when the loads are inverted

Truss assembly joints

The following joints are needed to build a main truss:

1. Assemblage arbalétrier - poinçon
2. Assemblage contrefiche - poinçon
3. Assemblage entrait moisé - arbalétrier
4. Assemblage entrait moisé - poinçon

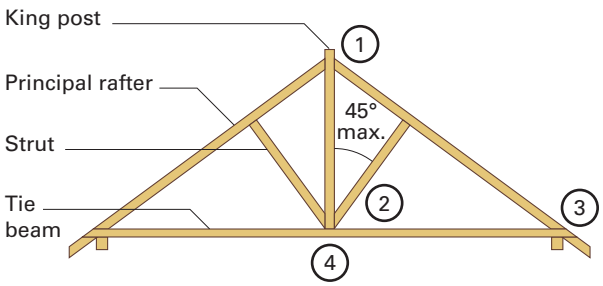


Figure 23: Truss assembly joints

① The principal rafter / king post joint is made using a housed joint and tenon, reinforced by a horizontal bolt with a diameter of 10 mm.

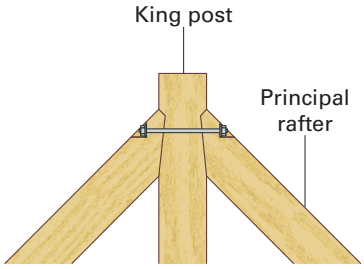


Figure 24: Making the principal rafter / king post joint more secure using a bolt

② The strut / king post joint is made using a housed joint reinforced by a bolt with a diameter of 8 mm.

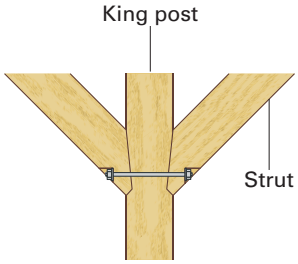


Figure 25: Making the strut / king post joint more secure using a bolt

③ The double tie beam / principal rafter joint is made using a housed joint reinforced by a vertical bolt with a diameter of 10 mm or, in the case of a double tie beam, by a joint using 2 bolts with diameters of 8 mm each.

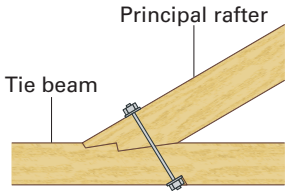


Figure 26: Making the tie beam / principal rafter joint more secure using a bolt

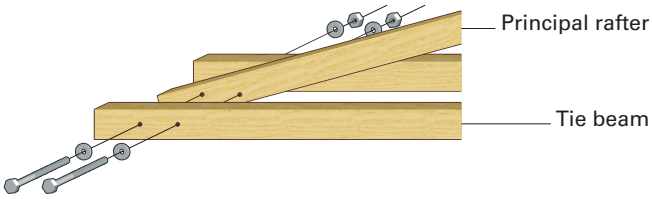


Figure 27: Strengthening the double tie beam / principal rafter joint using two bolts

④ The double tie beam / king post joint is made using a simple housed joint reinforced by 2 bolts with diameters of 8 mm each.

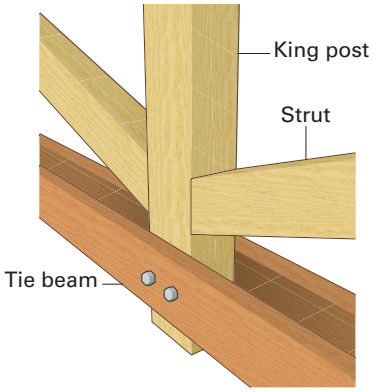


Figure 28: Strengthening the double tie beam / king post joint using two bolts

Purlin-to-principal truss rafter fixing

The purlin-to-principal truss rafter joint can be reinforced by using metal hangers, brackets and reinforced metal corner braces..

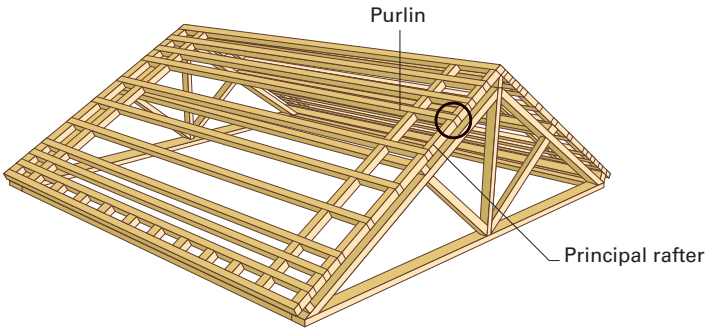


Figure 29: Purlin-to-principal rafter joint
(to be removed from the diagonal elements in red)

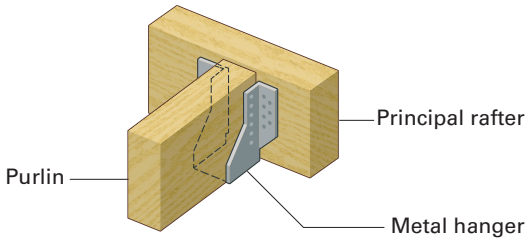


Figure 30: Purlin-to-principal rafter joint using metal hangers

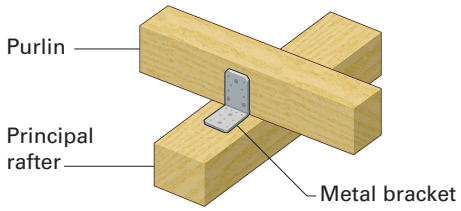


Figure 31: Purlin-to-principal rafter joint using metal brackets

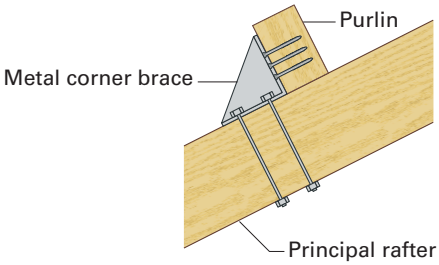


Figure 32: Purlin-to-principal rafter joint using metal corner braces

Simple purlin splicing with nails mid-span should be avoided. If splicing is unavoidable, it should only be done over bearing points.

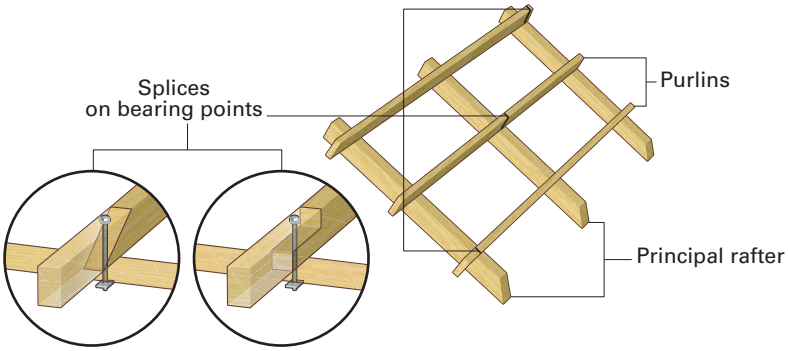


Figure 33: Purlin splicing over bearing points, if unavoidable

Rafter-to-ridge board joints

Rafter-to-ridge board joints can be reinforced by using through-bolts or coach screws with a diameter of 8 mm.

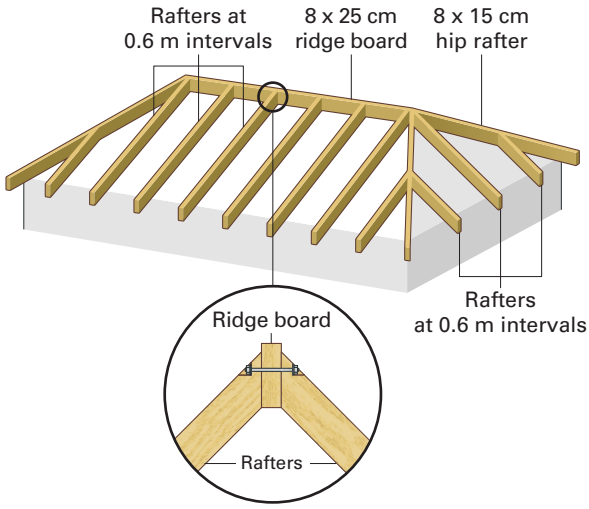


Figure 34: Rafter-to-ridge board joints using bolts

Rafter-to-hip rafter joints

Rafter-to-hip rafter joints are made using a single 8 mm diameter coach screw or two 6x120 mm screws.

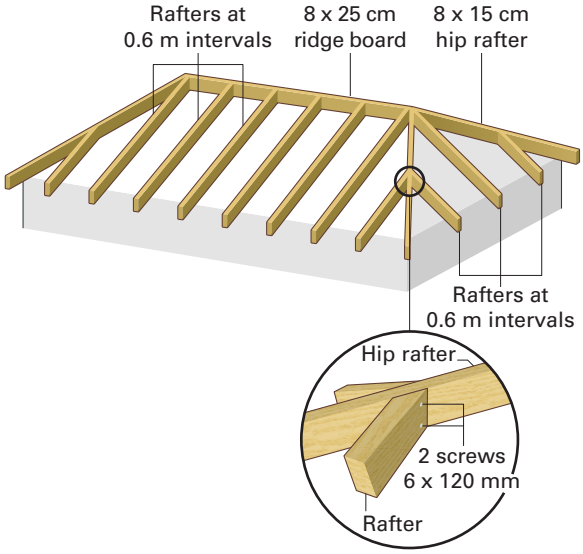


Figure 35: Rafter-to-ridge board joints using bolts

Anchoring the frame to the walls

The frame must be supported on the horizontal wall ties at the top of the wall. The timber frame anchoring points to the concrete should be made using anchor bolts.

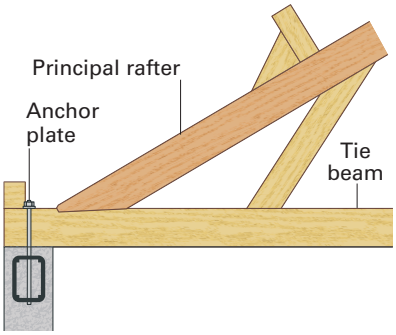


Figure 36: Anchoring the frame to the concrete using anchor bolts

BRACING WITH WOOD-BASED PANELS

The frame can be stabilised horizontally by installing plywood panels or water-repellent roofing under-panels onto the rafters and purlins and covering the entire surface of the roof slopes.

To ensure that the frame is sufficiently rigid, the following characteristics should be adhered to:

- minimum panel thickness should be 10 mm for the plywood panels and 14 mm for the water-repellent roofing under-panels;
- the dimensions of the panels should be greater than or equal to 120 x 240 cm over the main span;
- the panels should not have any openings, holes or defects/faults;
- the panels should be staggered (the joints should not be in alignment);
- the perimeter of the panels should be covered. The screws should be spaced no more than 15 cm apart and 1 to 1.5 cm from the edges;
- the width of the gaps between the panels should be approximately 1 mm/m along the length of the panels;
- 50 x 80 mm battens should be fixed on top of the panels in line with the panel gaps. The screws should be no more than 15 cm apart.

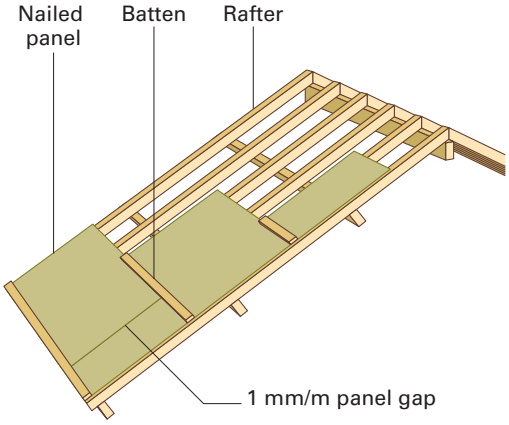


Figure 37: Bracing with wood-based panels

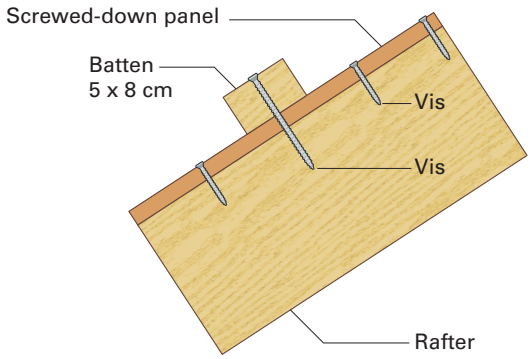


Figure 38: Attaching the batten to the rafter through the panel

BRACING WITH DIAGONAL TIMBER BRACES

The frame can also be stabilised horizontally by fitting diagonal braces between the rafters or purlins.

To ensure that the frame is sufficiently rigid, the following characteristics should be adhered to:

- the cross-section of the diagonal braces should be at least 8 x 10 cm;
- the diagonal braces should be connected to the frame components using 2 annular ring or twist nails with a maximum diameter of 3.1 mm.

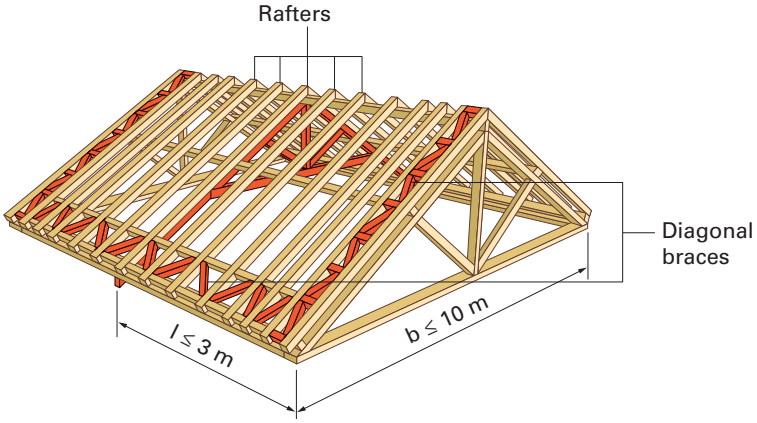


Figure 39: Diagonal braces fitted between rafters

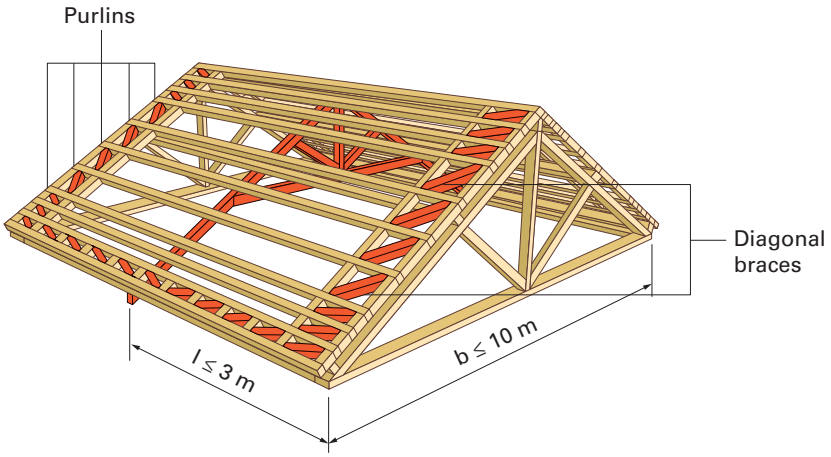


Figure 40: Diagonal braces fitted between purlins

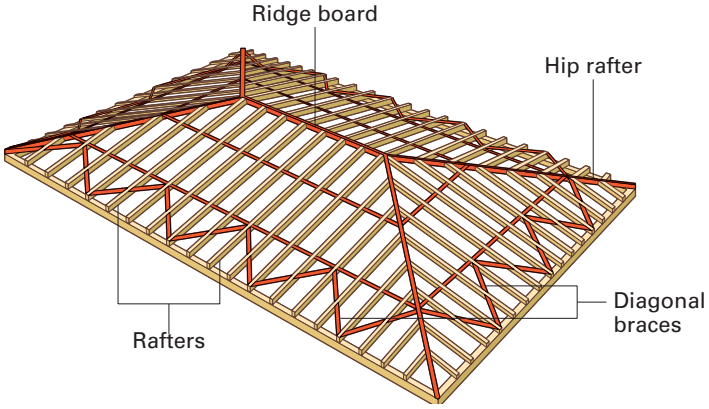


Figure 41: Diagonal braces used on a hip roof frame

MAINTENANCE

Maintenance should be carried out on the timber frame components once a year as the hurricane season approaches. The components should be inspected at the same time to make sure there is no premature damage.

- Check that the timber components do not show any signs of humidity or damage (fungus or insect), especially in those areas with the greatest humidity (post bases, assemblies in which several pieces of timber are in contact, etc.).
- Check that the timber components do not have any major defects (distortion, splitting).
- Check that the joints and fixings are not showing signs of corrosion.
- Pay particular attention when checking the stability of the frame bracing.
- Make sure the joints are tight (bolts tight, no protruding screw heads or points).

If you do detect a problem, change the fixings immediately and, if necessary, the timber component as well.

STORAGE

Components at the building site should be stacked and stored away from moisture (rain, condensation, etc.). Ideally, the components should be stored in an inclined position in a well-ventilated, sheltered area.

The timber must not be laid directly on the ground as this can cause soiling and moisture absorption.

It is also important that the timber be properly supported to prevent permanent distortion.

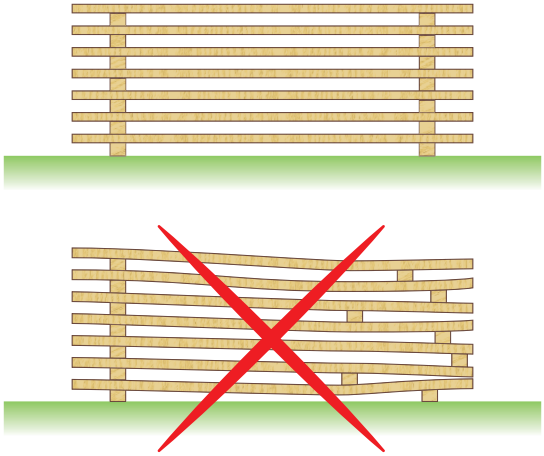


Figure 42: Storing timber components

Glossary

Bracing: constructions that provide horizontal structural stability.

Frame joint: traditional joint in which the forces are transmitted through the contact surfaces; this type of joint does not have any mechanical connectors (for example, housed joint, tenon).

Housed joint: notched joint between two pieces of timber.

Moisture: mass of water in the timber expressed as a proportion of its dry mass.

King post: vertical central component of a traditional frame truss. The king post supports the tie beam at its base.

Principal rafter: main sloping timber of a frame truss that supports the roof (purlins + roof).

Purlin: horizontal component of a loft frame made out of timber or metal. The purlins rest on the principal truss rafters and provide support for the rafters or rigid roofing panels.

Tie beam: horizontal component that forms the base of a frame truss and prevents the principal rafters from spreading outwards.

Truss: vertical assembly of components that forms the triangular framework of a timber frame: all frames comprise several trusses arranged at right angles to the axis of the loft. The trusses provide support for the horizontal purlins, which in turn carry the rafters and the roof.

References

NF DTU 31.3 (P 21-205) Charpentes en bois assemblées par connecteurs métalliques ou goussets (Timber structures connected with metal plate fasteners or gussets).

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Eurocode 5 : Design and calculation of timber structures

Eurocode 8 : Calculation of structures for earthquake resistance

✓ *Note: all dimensions are given by default. Timber structure designers can be exempted with the proviso that their calculations comply to Eurocode 5 and NF DTU 31.3.*

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

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