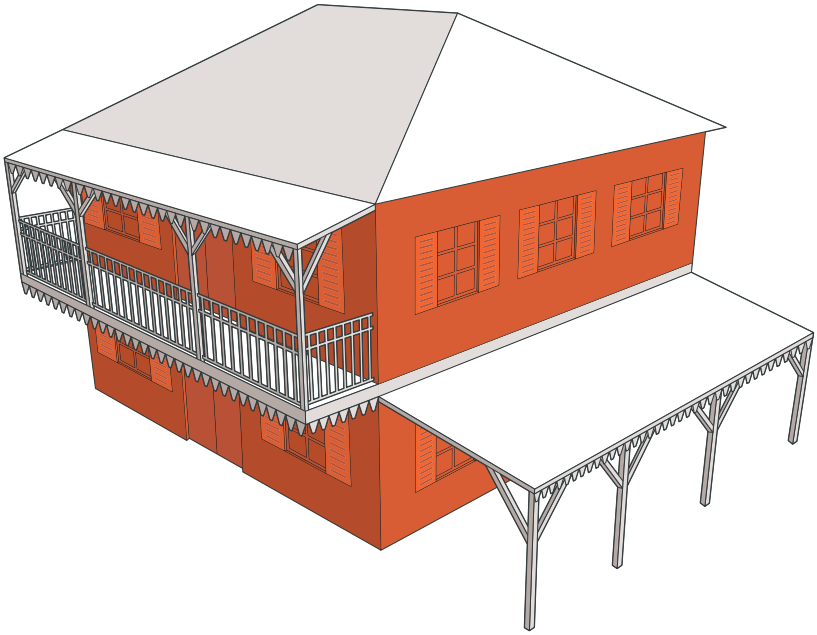
BUILD WELL!

TIMBER STRUCTURES



Practical Information Sheet

Professionals

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

Saint-Martin
Caraïbe Française
French Caribbean

N°5

Contents

FOREWORD

This practical information sheet provides instructions for implementation of timber structures. It presents the special points with a direct influence on the resistance of the structure to wind and earthquakes. Implementation details with regard to other requirements of a timber structure are not covered.

FAILURE MODES UNDER THE EFFECTS OF WIND OR EARTHQUAKES

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 been 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 1: Cross-section probably not substantial enough (CAUE)

■ Pull-out or failure of the assemblies

The fasteners are pulled out or torn. This may be due to faulty installation and unsuitable assembly methods.

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

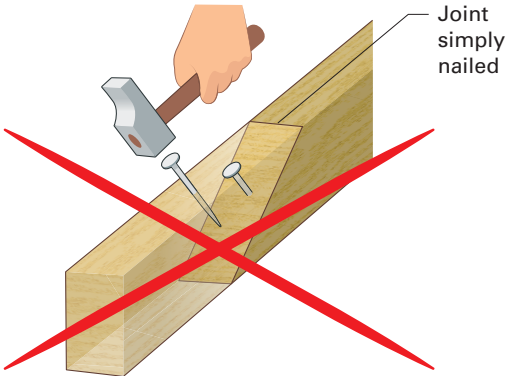


Figure 2: Joints that are simply nailed should be avoided

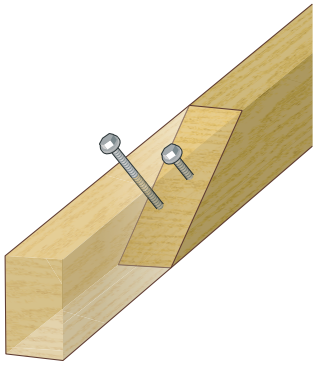


Figure 3: Screwed joint

- Pull-out or failure of the anchors

If the fastener is not suitable for the support, it may be pulled out at the same time as the framing elements.

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

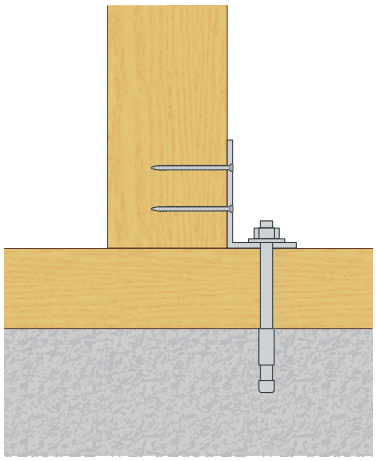


Figure 4: Example of an anchor bolt in concrete

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 accompanying label. For this information to be usable, it must be specified in a precise format, namely the format associated with the CE mark.

Figure 5: Logo that must be displayed on products bearing the CE mark

Timber

Given 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 significant influence on the durability of the frame.

Timber used for structural elements must satisfy class 4 requirements (in accordance with NF EN 1995-1 and AN) and have anti-termite protection.

Timber used for non-structural elements must satisfy class 3 requirements (in accordance with NF EN 1995-1 and AN) (through natural durability or treatment).

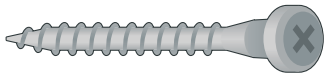
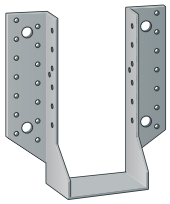
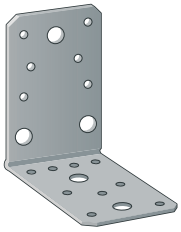
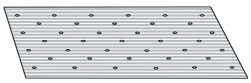
The use of EN 636-2-type plywood panels, P5- and P7-type particleboards and fibreboards for structural purposes is not permitted.

Metal joining and fixing systems

The assembly and fastening systems of the timber structure are made of galvanised steel validated for use in service class 2: Z275-type coating. It should be noted that using assemblies made of stainless steel improves durability.

Reinforced concrete structures

The timber structure rests on reinforced concrete structures (foundations, bottom floor slab, etc.) defined in the corresponding NF DTUs (Unified Codes of Practice). It is important to ensure that these structures do not display any significant damage (particularly cracking and visible rebar corrosion).

Choice of materials	
Hex head bolt Fields of application: hangers, mixed reinforced brackets.	
Anchor bolts Fields of application: wall tie fixings.	
Screws Field of application: hangers	
Structural timber screws Field of application: assembly of timber elements.	
External flange hangers Fields of application: joists, purlins, wall rail beams, rafter stops.	
Structural bracket Fields of application: purlins, rafters.	
"Hold Down" tension tie for timber frame wall posts	
Perforated plate for assembly or assembly reinforcement	

BRACING OF FLOORS BY PLYWOOD BOARDS

The floor can be stabilised in its plane by the use of plywood or OSB3/OSB4 boards on the joists covering the entire floor surface.

To ensure the floor is sufficiently rigid, the following characteristics must be observed:

- the thickness is a minimum of 12 mm for plywood boards and 18 mm for OSB3/OSB4;
- the dimensions of the boards are greater than or equal to 120 x 240 cm in the main span;
- the boards shall have no openings, holes or defects/faults;
- the boards shall be fitted in a staggered arrangement (joints must not be aligned);
- the boards shall be screwed down around their entire perimeter. The screws shall be spaced a maximum of 15 cm apart and placed 1 to 1.5 cm from the edges;
- the width of the joints between boards is approximately 1 mm/m of board length;
- the joists and bridging have a thickness of 5 cm minimum.

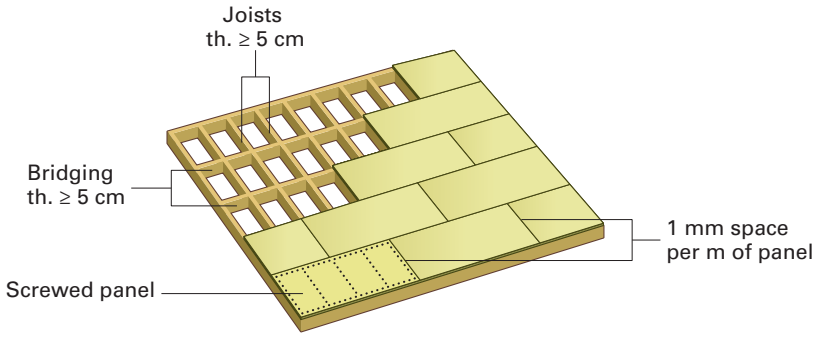


Figure 6: Bracing using plywood boards

BRACING OF WALLS USING TIMBER BRACES

The wall can be stabilised in its plane by the use of braces across the intermediate studs and attached to the end studs.

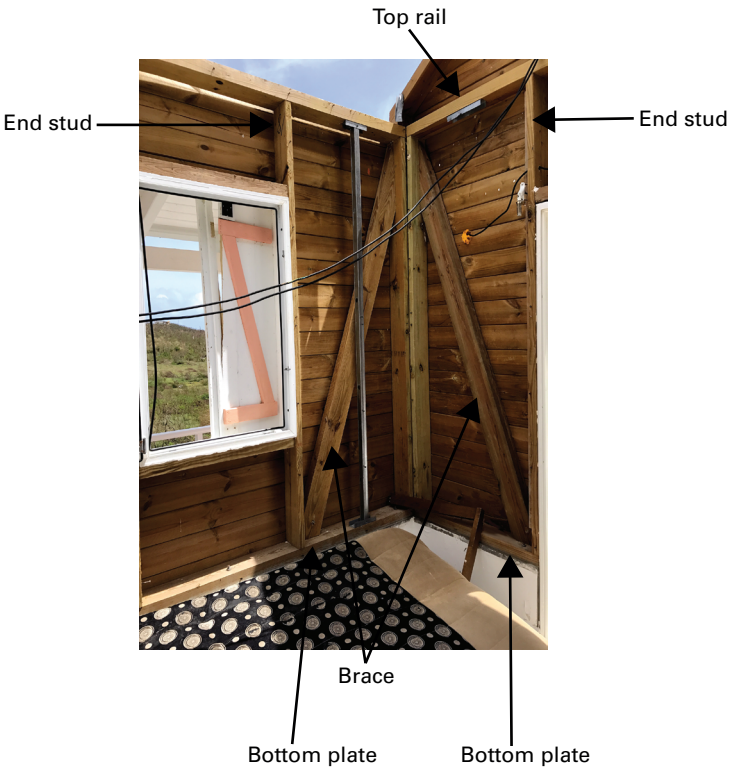


Figure 7: Example of braces (CAUE)

The end studs and bottom plates are made of solid timber or reconstituted solid timber.

To ensure the walls are sufficiently rigid, the following characteristics must be observed:

- the width between studs at the end of the brace varies between 1.2 and 1.8 m. The height of the braces varies from 2.7 to 3 m;
- the intermediate studs are a minimum of 5 cm in thickness;
- the plates are the same width as the studs.

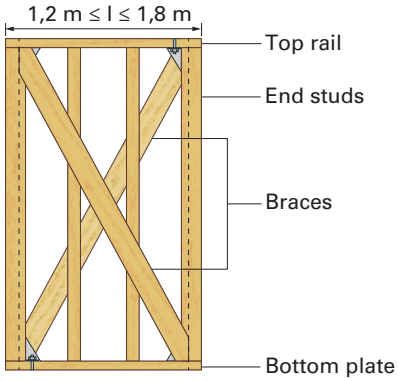


Figure 8: Two crossed braces

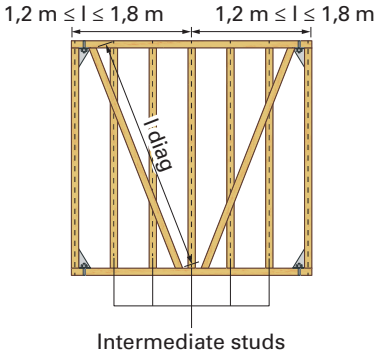


Figure 9: Two non-crossed braces with intermediate studs

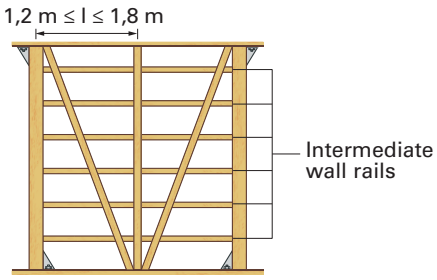


Figure 10: Two non-crossed braces with intermediate wall rails

EXAMPLE OF BRACE SIZING

To illustrate, the tables below give the strengths for C24 service class 3 timber of the braces and the end studs according to their commercial cross-section areas.

Brace cross-section area (cm^2)	Strength of the brace $F_{d,max}$ (kN)
2,2 x 19	15
3,6 x 15	45
3,6 x 19	58
4,6 x 15	77

Stud cross-section area (cm^2)	Strength of the stud $F_{m,max}$ (kN)
10 x 10	109
12 x 12	157
8 x 15	118
15 x 15	242

Based on these permissible forces, the choice of cross-section for the braces and end studs leads to the wind-resistance capacity of the bracing:

$$F_{max} = \min \begin{cases} F_{d.max} \; II \sqrt{l^2 + h^2} \\ F_{m.max} \; II \; h \end{cases}$$

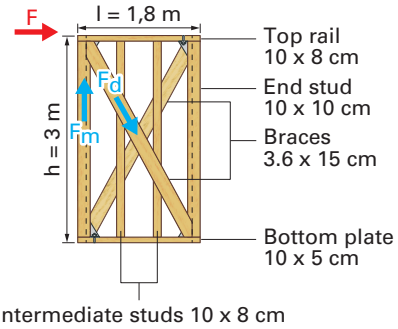


Figure 11: Example of bracing with resistance capacity F = 23 kN

REINFORCEMENT OF WALL FASTENERS

Structural assemblies created using metal fasteners must have CE marking, a European technical assessment and technical specifications from the supplier.

The use of tension-type nails, even spiral nails is prohibited. Tension type assemblies can be built using lag screws or bolts possibly combined with flats or angle irons.

Reinforcement of wall connections

The connection between the studs and the top rail or bottom plate can be reinforced by installing a metal plate with screws.

At the corners:

- the connection between two walls can be reinforced by installing a timber connection,
- the connection between two top rails or two bottom plates can be reinforced by installing a metal plate with screws.

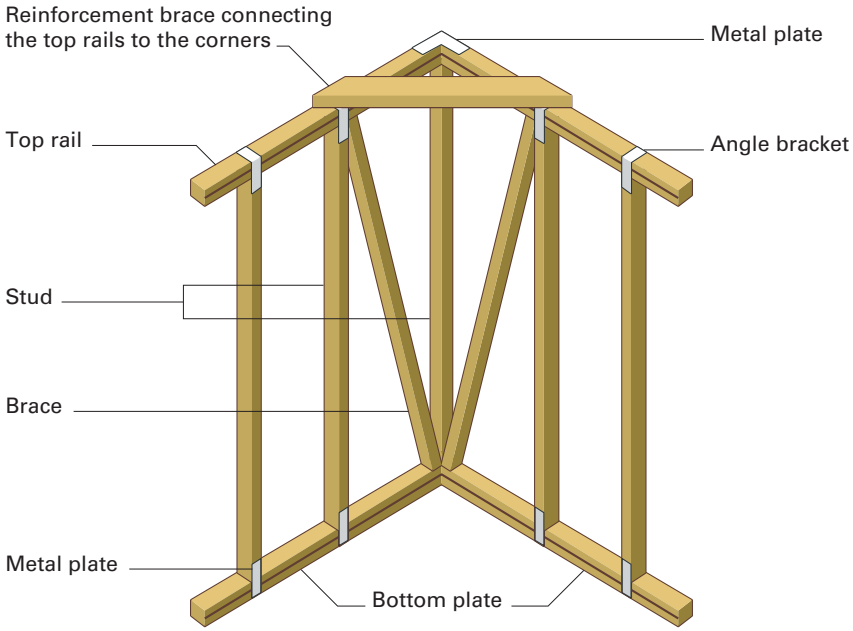


Figure 12: Reinforcement of wall connections

If the top rails or bottom plates need to be joined in order to be continuous, the join must be made at studs using a metal plate and screws.

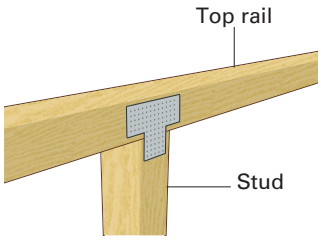


Figure 13: Reinforcement of joins at studs

For two crossed braces:

- the braces are connected to the end studs by a single skew notch joint held by 2 nails, dimensions 3.1 x 70 mm.

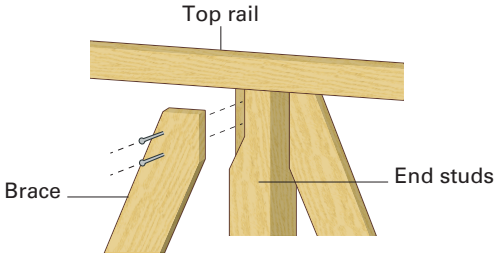


Figure 14: Brace connection - end stud in the case of two crossed braces

- the braces are connected to the intermediate studs by a cut-out in the stud and 2 spiral or barbed nails, dimensions 6x100 mm. A metal strip and 2 screws, diameter 5 mm can be installed to reinforce the stud.

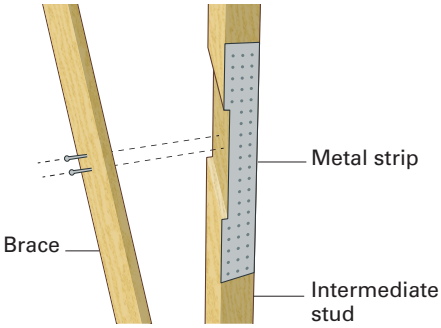


Figure 15: Brace connection - intermediate stud in the case of two crossed braces

For a single brace or two non-crossed braces:

- the braces are connected to the end studs by a double skew notch joint (with front stop in the top rail and bottom plate) held by 2 screws, dimensions 6 x 120 mm.

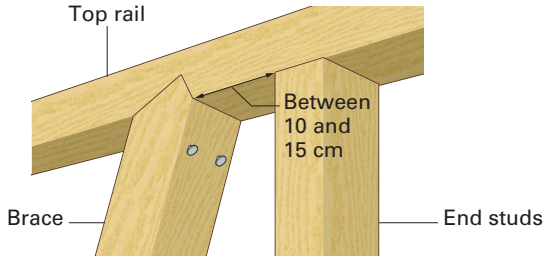


Figure 16: Brace connection - end stud in the case of a single brace or two non-crossed braces

- the braces are connected to the intermediate studs by 2 screws, dimensions 6 x 120 mm.

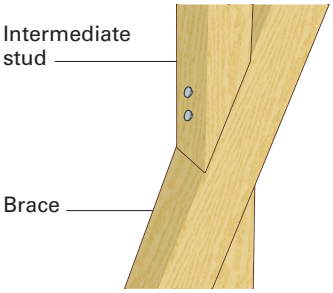


Figure 17: Brace connection - intermediate stud in the case of a single brace or two non-crossed braces

Attachment of the floor to the wall

The bridging is fastened to the floor joists by 2 screws. The floor joists are fastened to the top rail of the wall of the lower level by angle brackets, thickness 2.5 mm minimum.

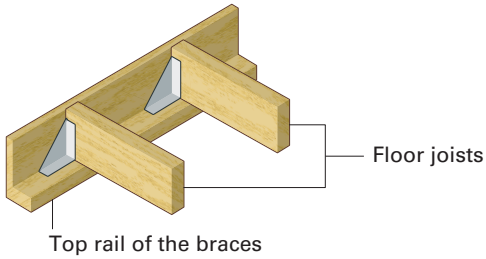


Figure 18: Installation of the joists on the top rail of the lower level

Attachment of the structure to the foundations

The braces are fastened to the intermediate studs or wall rails and to the top rail and bottom plate by 2 screws.

Anchoring the end studs requires the installation of anchor housings (angle brackets or metal hangers) with a minimum thickness of 3 mm. The anchor housing is attached:

- on the vertical inner surface of the end stud by nails or bolts;
- in the reinforced concrete ties using metal anchors, diameter 16 mm maximum through the bottom plate.

The bottom plate is anchored using anchor bolts distributed along its length every 60 cm.

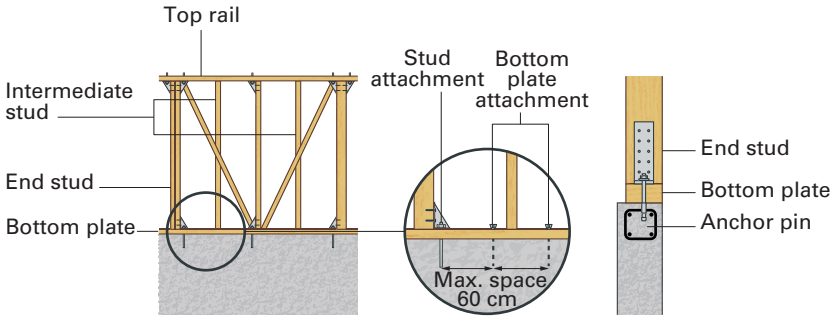


Figure 19: Brace anchorage

The intermediate studs are anchored by angle brackets attached to the bottom plate.

MAINTENANCE

Maintenance should be carried out on the timber frame components once a year as the hurricane season approaches. At that time, an inspection should be performed to ensure that there has been no premature degradation.

- 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 assemblies and fasteners show no 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 elements must not be laid directly on the ground as this can cause soiling and moisture absorption.

Suitable supports are also necessary to avoid permanent distortion.

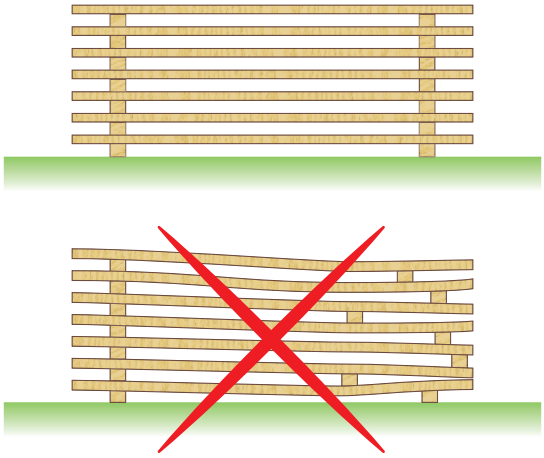


Figure 20: Storing timber components

Glossary

Bottom plate: piece of timber in the lower part and horizontal to the braces.

Braces: construction elements that provide horizontal structural stability.

Bridging: rigid wooden part connecting two joists and holding them a fixed distance apart.

Joist: long piece of timber, the two ends of which are resting on the weight-bearing walls or on a beam to make a rigid structure.

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

Stud: element positioned vertically to the braces.

Top rail: piece of timber in the upper part and horizontal to the braces.

Traditional joinery assembly: traditional assembly where the forces are transmitted via contact surfaces without the use of mechanical connectors (e.g. skew notch or tenon joints).

References

NF DTU 31.2 (P21-204-1) Travaux de bâtiment – Construction de maisons et bâtiments à ossature en bois – Partie 1 : Cahier des clauses techniques (CCT) (Building works – Timber frame houses and buildings construction – Part 1-1: Contract bill of technical model clauses.

Règles Antilles – révision 1992.

Guide de construction parasismique et paracyclonique de maisons individuelles à structure en bois aux Antilles – Secteur pilote Innovation Outre-Mer, 2011.

Eurocode 5: Design of timber structures.

Eurocode 8: Design of structures for earthquake resistance.

✓ *Note: All dimensions are given by default. A timber structure designer may waive these subject to calculations in accordance with NF DTU 31.2.*

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

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PRACTICAL GUIDE ON POST-HURRICANE REPAIRS

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