UN HABITAT
FOR A BETTER URBAN FUTURE

HOW TO BUILD A SAFER SHELTER

A guide to households on how to build a shelter that is safer against natural forces

Prepared by UN-HABITAT for
INTERNATIONAL FEDERATION OF THE RED CROSS (IFRC)

DFID

Facsimile of Letter of President of IFRC

WHAT THIS GUIDE IS FOR: HOW TO BUILT A SAFE SHELTER

Yearly, in the rainy season, rains, floods, storms, like cyclone Nargis last year, threaten your lives, your assets and especially your shelters. Remember how storms can affect your shelters:

A well built shelter will better protect your family and your assets against these forces.

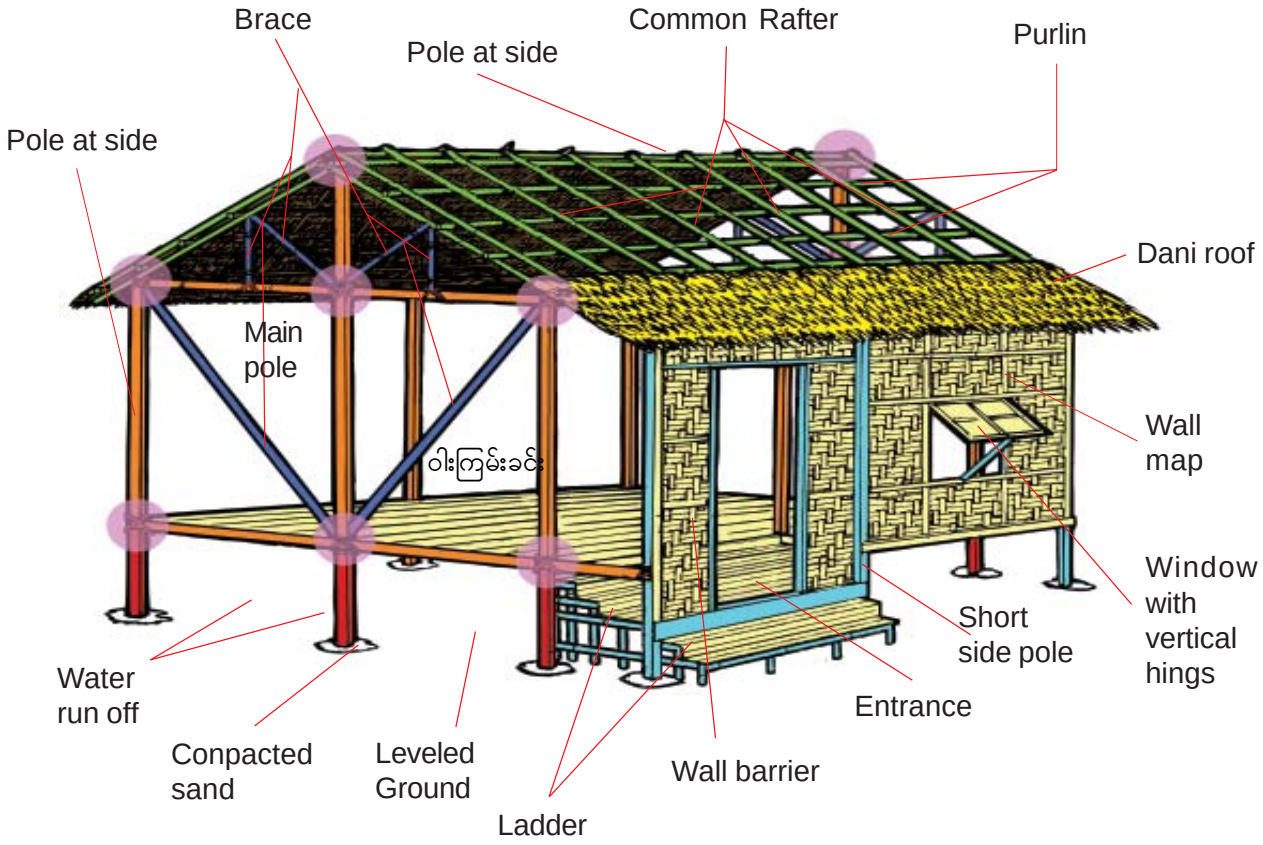
When well constructed, your shelters will be less damaged. They can serve you for more years. In this way you will make best use of the grants you received for constructing an upgraded shelter.

When you upgrade an existing shelter or construct a new house, you have to understand the main points of how to construct safe shelters and follow the rules, as explained in this guide. The principles apply to **every kind of shelter**: if constructed with timber, with jungle wood or bamboo. Get advice and support from of a person aware of these rules (e.g. a skilled carpenter) when you select the materials and construct your safer shelter.

Discuss with your community, seek advice from a skilled persons, select the materials carefully, choose the right location and follow these rules when constructing your house.

THE PRIMARY PARTS OF A SAFER SHELTER

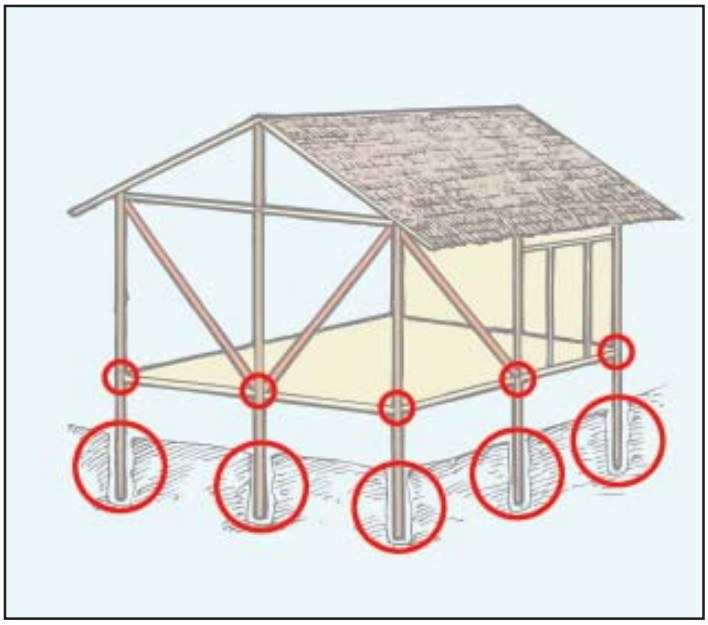
To make a shelter more resistant against storms, **some** parts of the house are very important, like: footings, posts, braces, the main frame and the roof frame. For them select good quality material. Do not use already deteriorated material. Ensure that these parts are well fixed and connected. Such costly material is **not** required for the non-structural parts (secondary rafters, floor, walls, doors and windows): you can use less costly material. Improve in next years, when more resources are available.



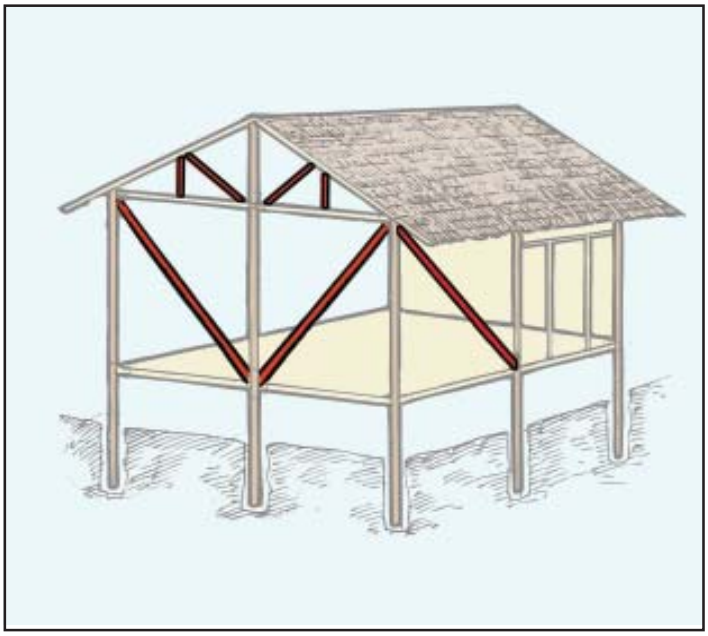
Nr	Part	Title	Required quality
1		Main frame	Very strong material
2		Footings	Very good construction
3		Main junctions	Very good fixings
4		Braces	Good quality material
5		Roof structure	Fair quality timber
6		Non-structural	Secondary quality
7		Roof covering	Thatch, nipa palm CGI-sheets
8		Walls, floor	Bamboo splits and mats

Your shelter will protect you better against storms if you pay attention to these principles:

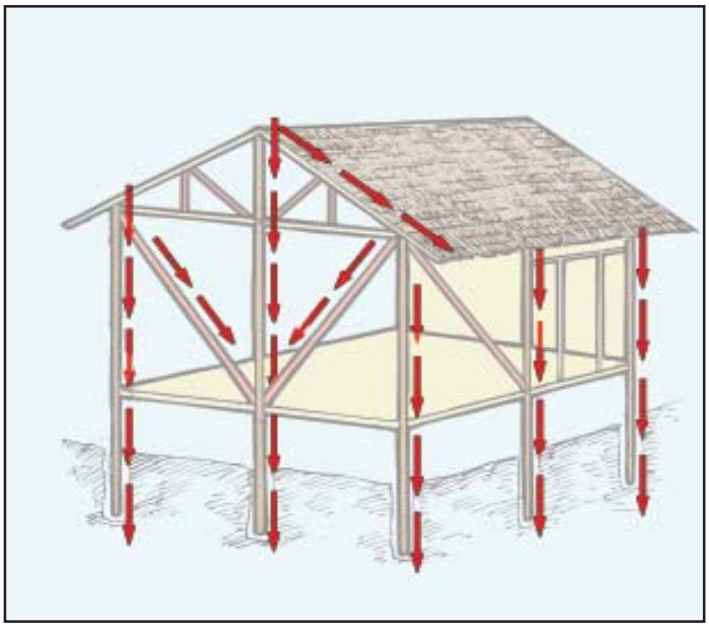
A = ANCHORING
Every part must be tied back to a secured spot which can resist to all applied forces.



B = BRACING
Every part must be held rigid, so the shelter
can not shift, tilt or rotate.

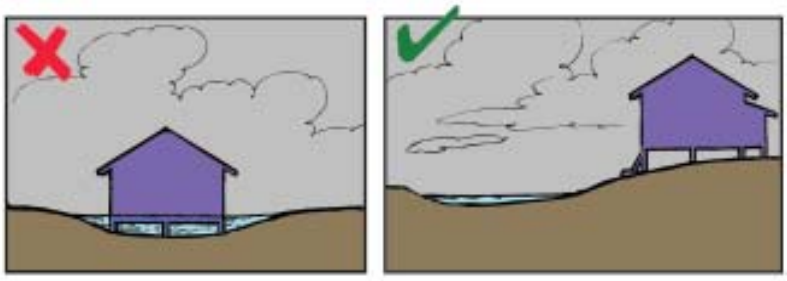


C = CONTINUITY
In the chain of strength from roof to ground, every part must be well connected to the other.

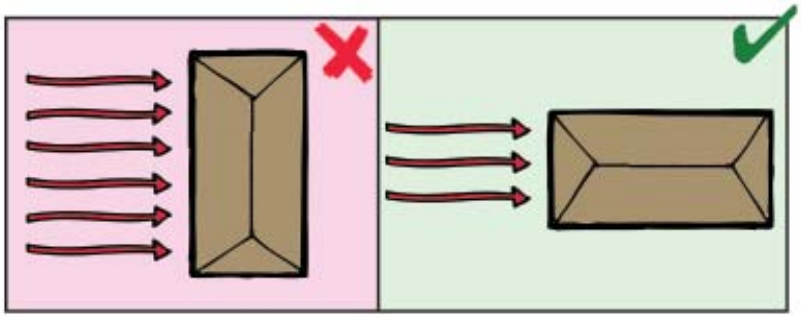


SELECT A SAFE LOCATION AND THE RIGHT ORIENTATION FOR YOUR SHELTER

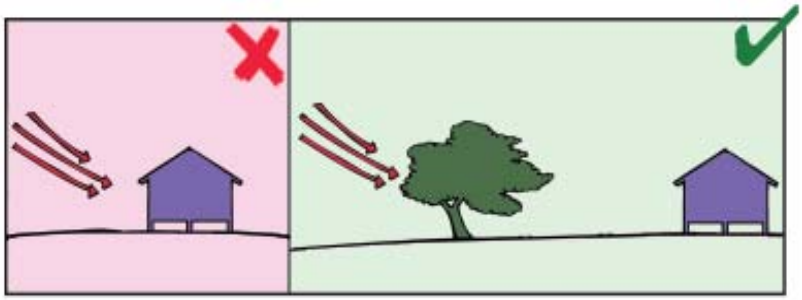
1. **Locate the house on the highest spot in your plot**
   Avoid shallow lower spots and ensure drainages, so water can flow off from the footings



2. **A square type house with the short, ridge side facing the winds.**
   Length and width should be approximately the same size. The main winds should not attack the long side.



3. **Trees: a threat if too close a protection when at the right distance**
   Cut branches of trees too close to the roof – but plant trees at some distance to break the wind forces.



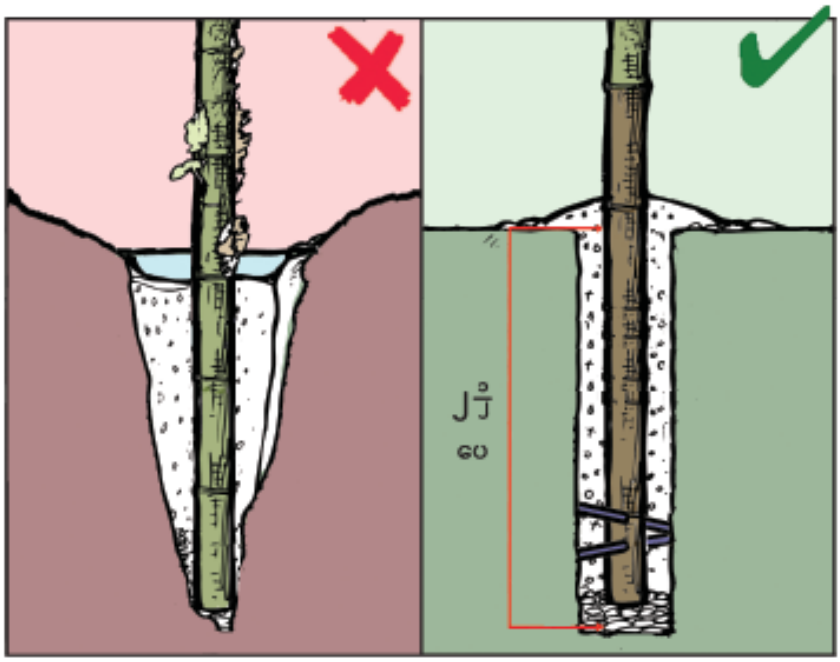
4. **Elevate your house against floods**
   Rising floods threat the lives of young and elderly family members, endanger your assets and might uplift or shift your shelter, if the posts are not well an chored in the footings. Thus you have to:

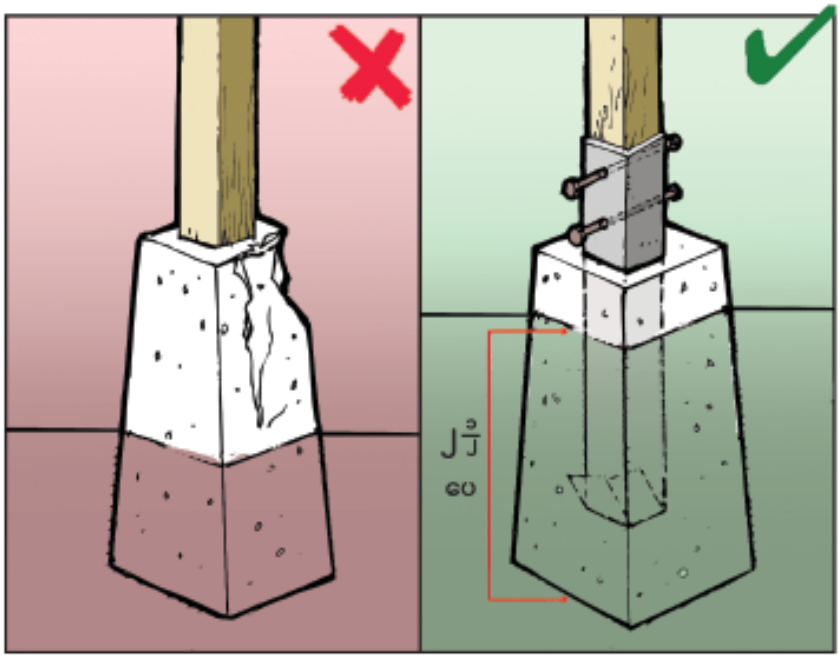
   - Elevate the shelter on stilts, so that the plinth of the floor is at least **3 feet** above ground.
   - Drain the ground under your house.
   - Avoid that material stocked under the floor blocks the water to run off.
   - Compact solid earth around the footings, to avoid standing water.
     Do not worry: a strong built house, even when elevated, will resist against the winds.

ENSURE SHELTER IS WELL ANCHORED ON SOLID FOOTINGS DEEP IN GROUND

With solid footings your shelter will not be swayed and can resist against storms and floods.

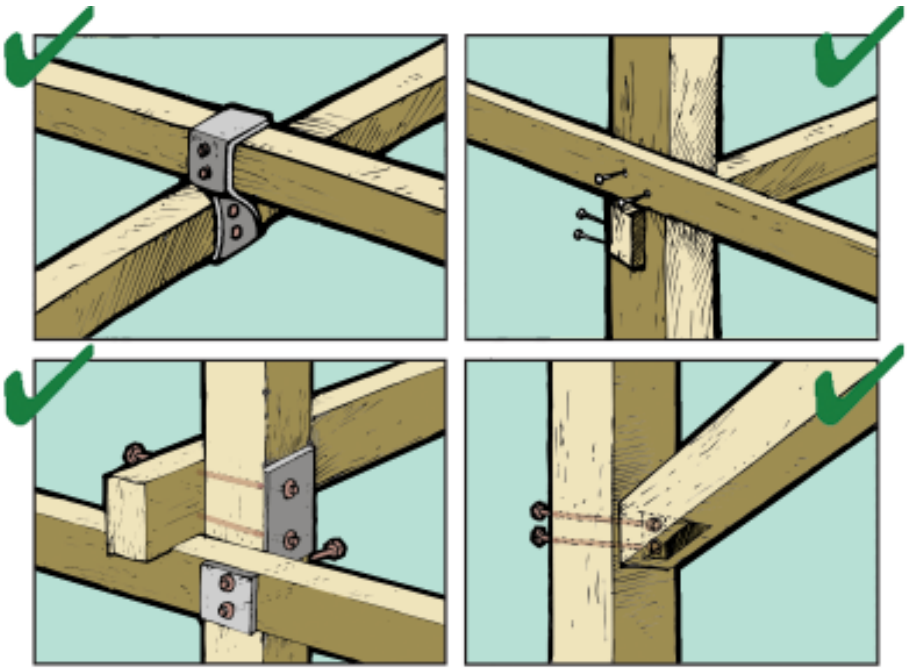
- Compact the soil under the entire shelter.
- Ensure the footings are at least **2 foot 6 inch** deep.
- Excavate the holes for the footings vertically: use spades, not shovels.
- Lay gravel or sand at the bits of the footings.
- Compact the holes with sand or clay.
- Apply two crossed sticks at the bottom of the posts (to avoid posts to be pulled-off).
- Ensure proper drainage, so no water is standing around the footings.
- Protect posts against fungi and insects: cover with earth oil or bituminous paint; smoke bamboo.
- On concrete cones, fix timber posts with 2 bolts through a L-shaped clam.
- Brush and check footings before the rainy season; eventually repaint or replace.



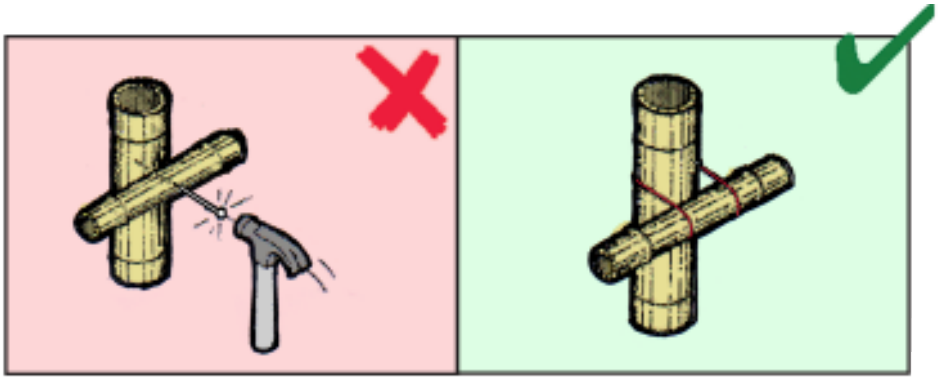


WITH A STRONG, WELL TIGHTENED FRAME THE SHELTER CAN RESIST STORMS

Only when the main frame, the core of the shelter, is strong, the shelter is stable and can protect you.
Typical details that improve the strength of the main frame



- **Select suitable material**: continuous, solid pieces of good quality material
- **Choose good quality**: good timber, strong toddy palm, seasoned bamboo,
- **Avoid weak material**: do not use inferior, deteriorated or burnt material.
- **Protect material**: apply earth-oil or bituminous paint; sea soned / smoked bamboo, anti-rust paint.
- **Ensure strong joists** of posts, tie beams and rafters: connect with braces; underlay joists with cleats
- **Prepare the joists**: e.g.: cut notches into timber; ears of fish mouths into bamboo.

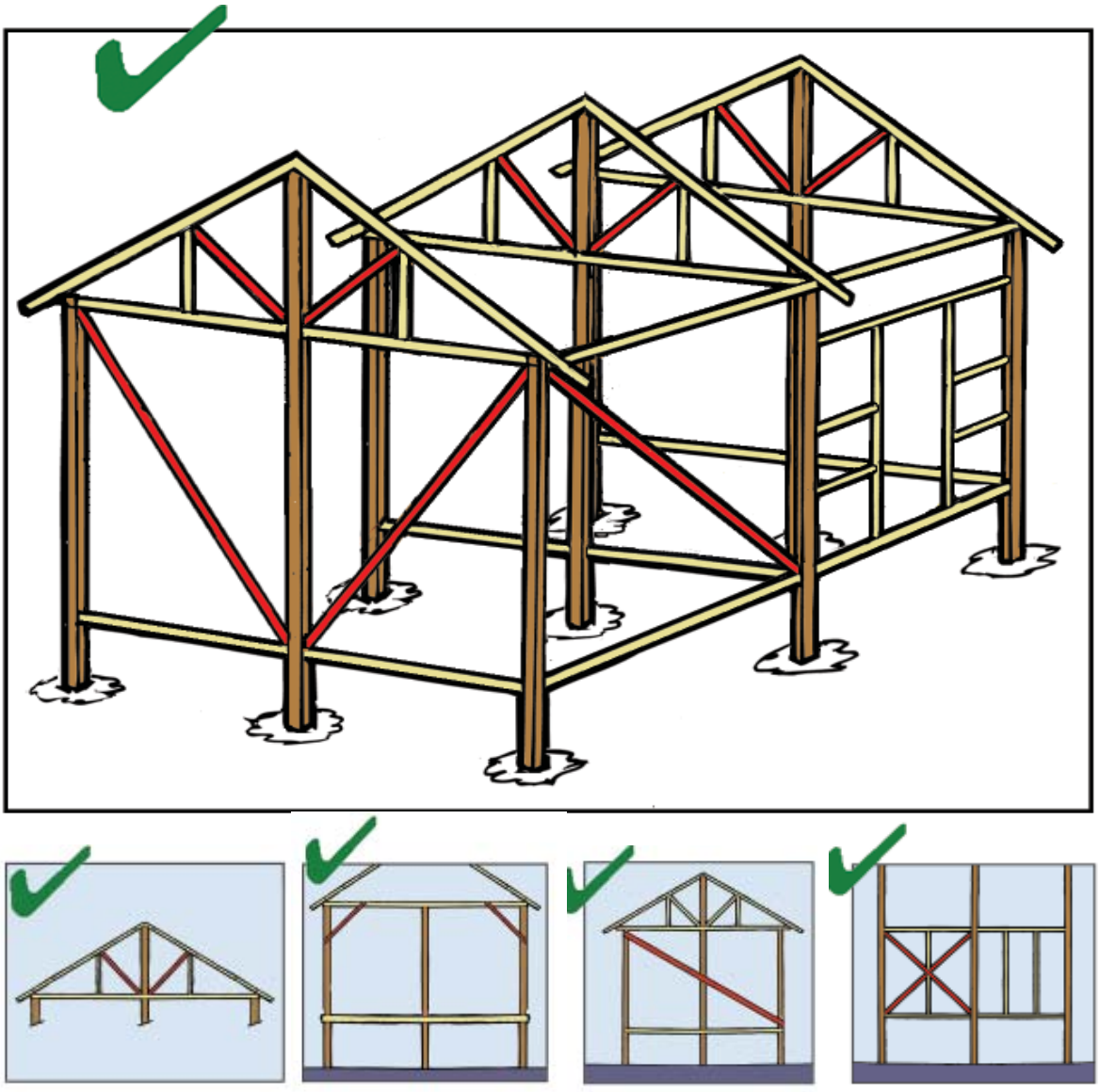


- **Apply right method for joists**: for timber, toddy palm etc: bolts, nuts ands washers, **not** only nails
  for bamboo: nylon ropes, strong coconut fibre ropes or binding wire. Fix the ropes correctly.
- **Work carefully**: when nailing, avoid to split bamboo; nail straight, not diagon to surface of timber.
- **Check before and after rainy season:** re-tighten bolts or ropes, replace rotten nails and add new ones.

APPLY BRACES TO STRENGHTEN THE FRAME AGAINST STORM FORCES

Braces prevent the frame to bend, twist, rotate or tilt under the forceful pressure of strong wind forces.

Possible applications of braces

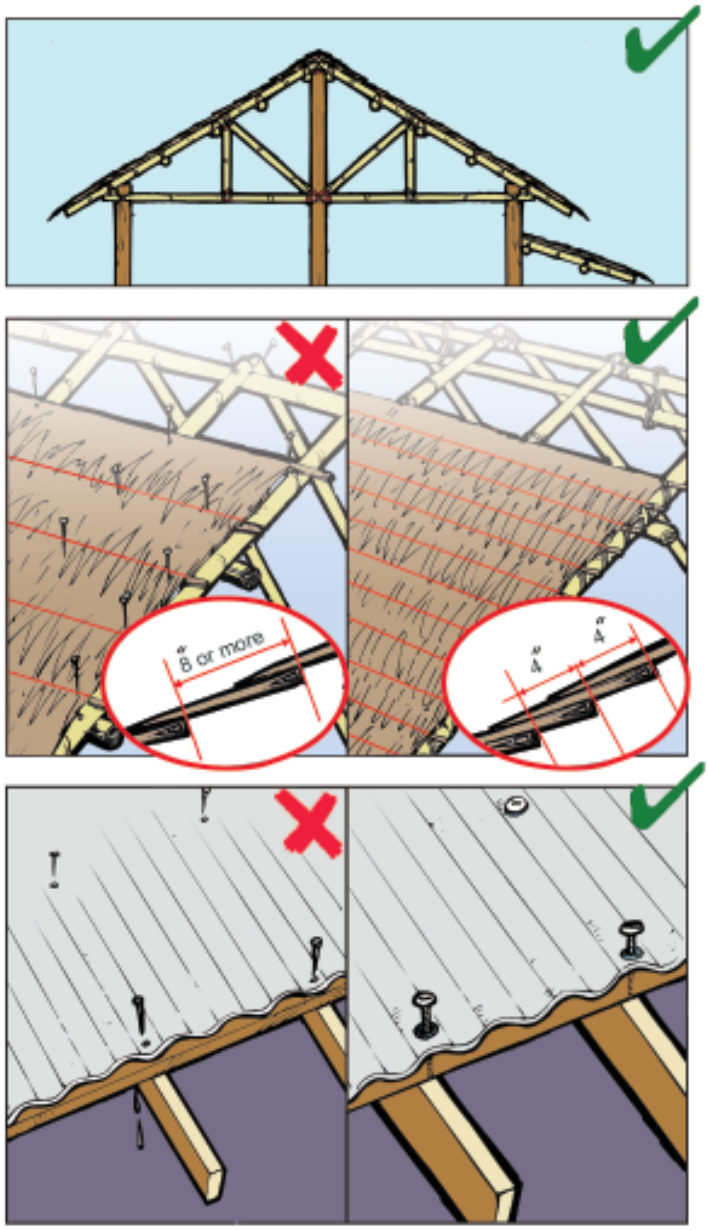


- **Main frame**: in minimum one brace at the wall of the short and one at the long side.
- At least one brace, **better two** crossed braces per each side.
- **Roof frame**: in minimum a brace between tie beam and main rafter; eventually between the posts.
- Braces to be connect between joints of the **main frame**; not only to the non-structural construction.
- Short diagonal braces can do, but **long braces** from junction to junction are better.
- Nail braces sideways to the posts; do not try to apply nails diagonally.

TIGHTEN COVER WELL TO A SOLID ROOF FRAME TO AVOID LEAKS / BLOW OFF

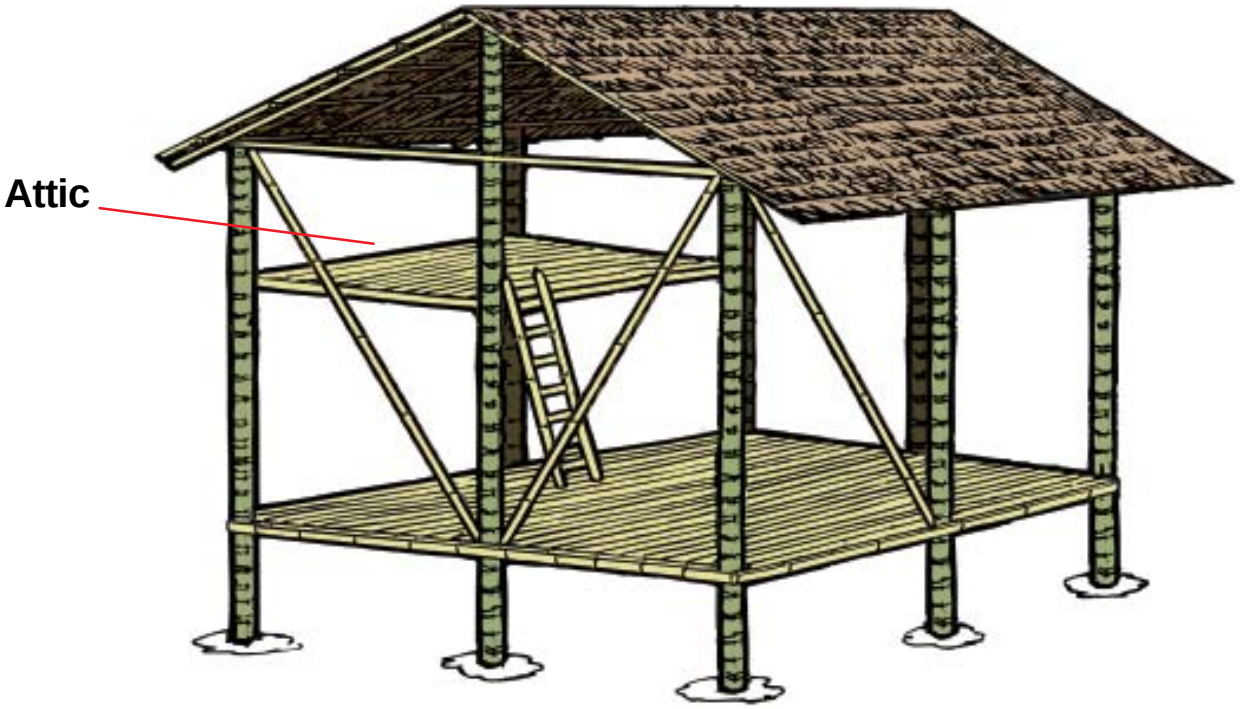
Moderate winds tear leaks into the roof cover. Heavy storms blow off parts of the roof (e.g. CGI sheets) which can injure persons. Strong cyclones can swag the roof or blow off the entire roof.

- **Steep pitch**: minimal **30 degrees**: When house is 12 ft wide, roof to be at least 3.1/2 ft high.
- **Roof surface** not to be too large. Disconnect the roof of porch and kitchen from the main roof.
- **Roof projection** should not exceed 18 inches on all sides.
- **Strong roof frame**: use good materials; add braces; connect the roof frame well to the posts.
- **Fix roof cover very strongly** to the frame as storms easy blow off parts of the roof:
- **Thatch or *dani* roofing**: lay from side to ridge a sheet at least every 4" and fix with bamboo strips.
- **CGI-sheets:** fix with screws or better J-hooks at top of the ondulation.
- **Lattice**: to avoid blow off, lay a lattice on top of the cover and attach it well (nails all way trough).



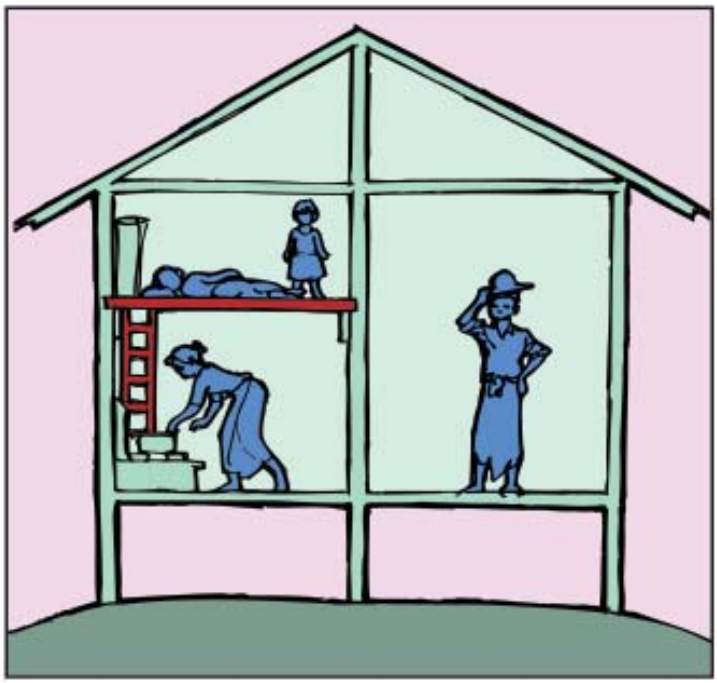
CONSTRUCT AN ATTIC AS A REFUGE WHEN THE FLOODS RISE

Small people, like children and elderly, have to escape first when the flood level rises higher.



An attic between four posts, under a part of the roof frame, is a safe refugee for them.
Also: ensure that the path to a secure place for evacuation is free so you can escape even at night.

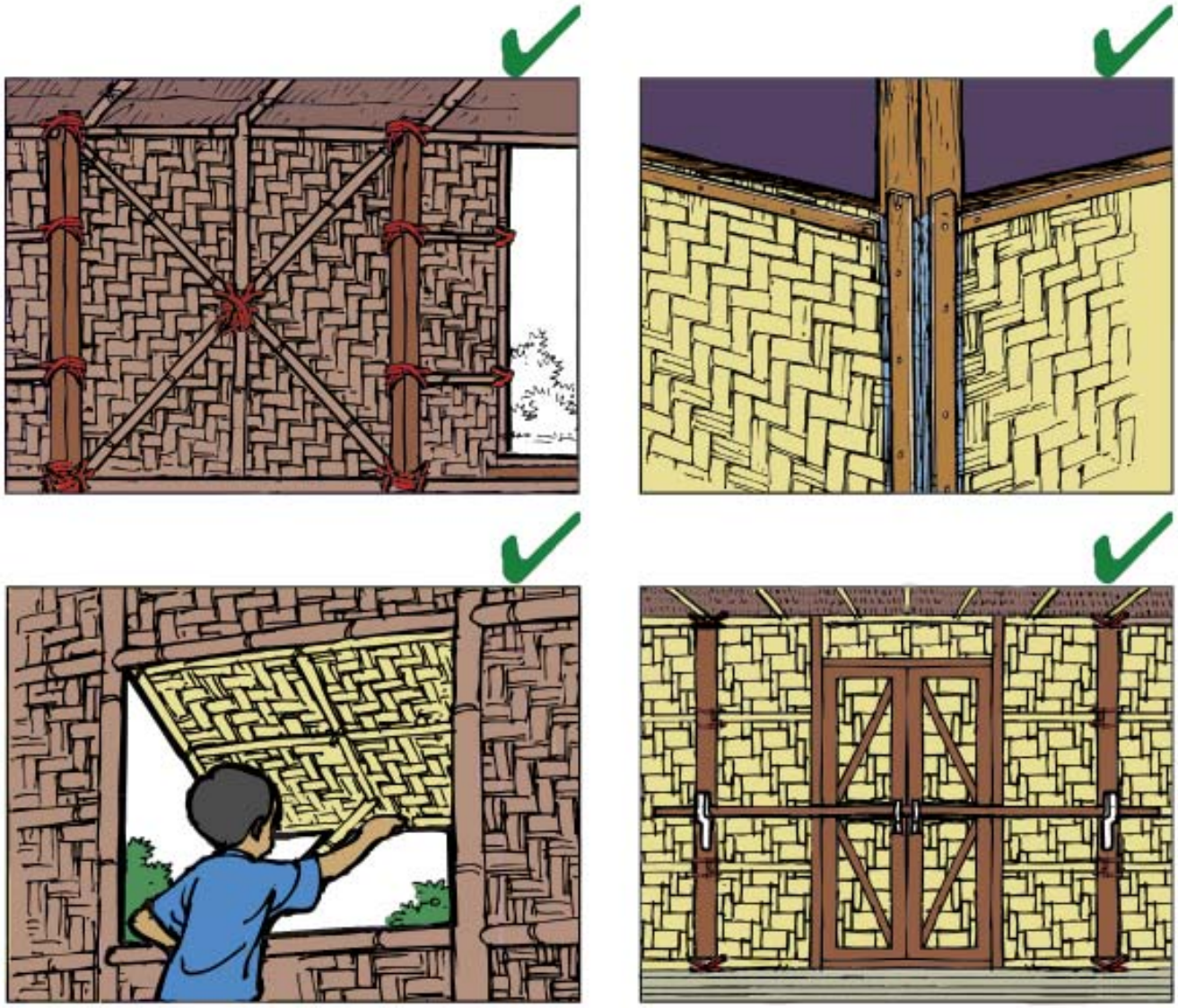
More detail in parts of Attic



Note: an attic has to be added to the attached Bill of Quantity of the model house.

WALLS, DOORS and WINDOWS THAT PROTECT AGAINST STORMS AND RAINS

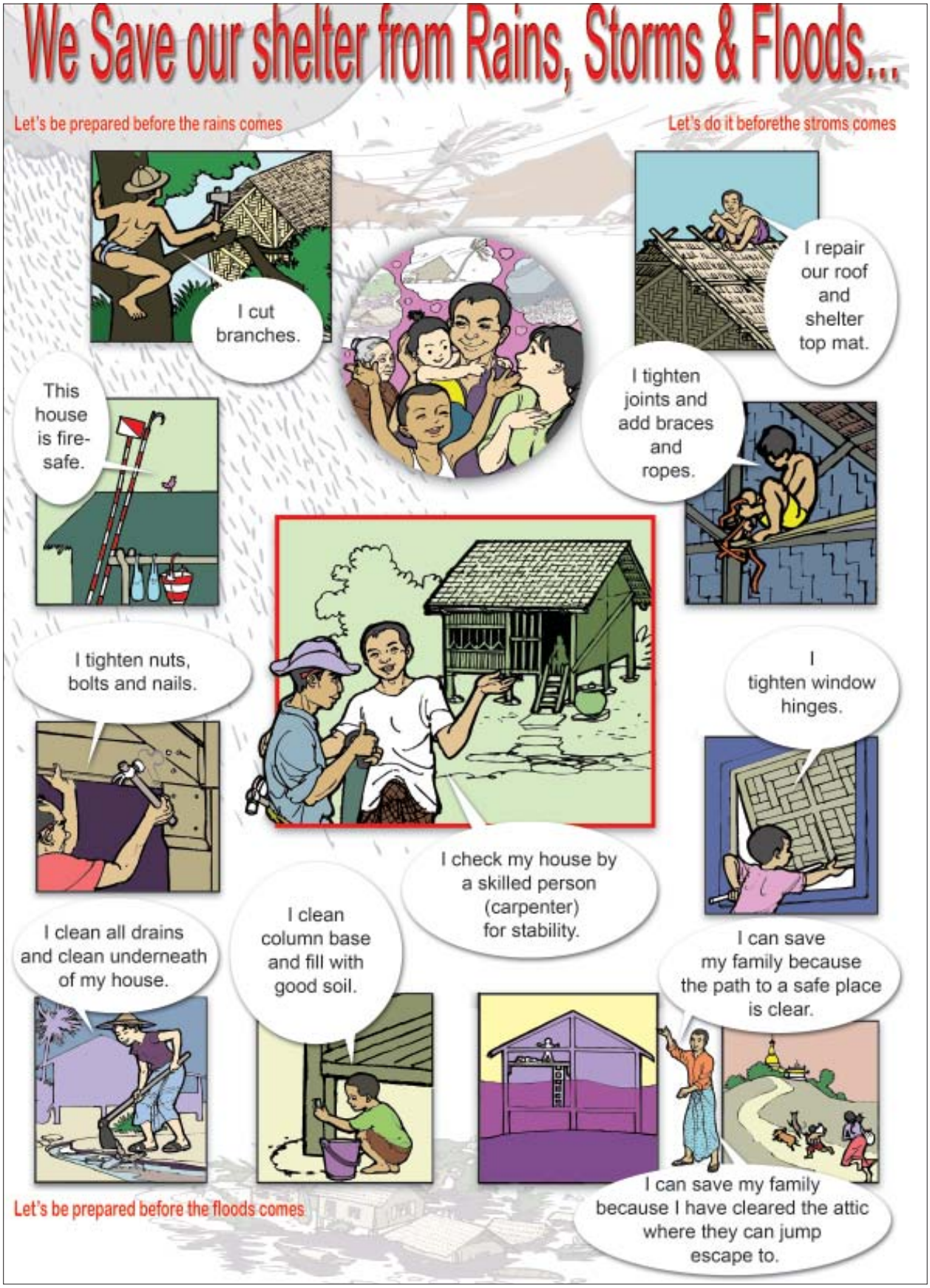
If the winds can easily blow through the house, the roof might get blown off.
Bamboo mats allow sufficient ventilation:
Here some details worth to be noted



- **Floor deck**: nail mat of split bamboo to the floor joists.
- **Close the walls** with bamboo mats or other materials, even with tarpaulin
- **Avoid large openings**:
- **Tighten wall mats** well to posts and wall barriers.
- Cut bamboo mats at corners; **do not bend** around as winds can attack the un-tight wall mats
- Shut doors and windows down **vertically** (hinges at top frame); avoid windows that open sideways.
- In times of storms, enforce the doors with a strong bar that locks the door from inside.
- Check and re-tighten the fixings before and after each rainy season.
- Less costly materials can be used for these non-structural parts of the shelter.

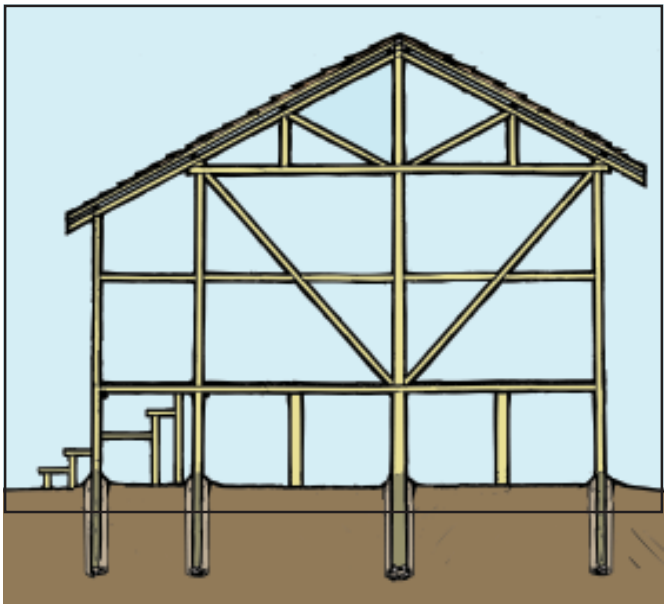
EXTEND LIFE OF YOUR SHELTER THROUGH MAINTENANCE AND PREPARATION

A shelter that is well maintained by the whole family remains solid even through many years, especially when some important points are followed up during the dry season, especially before the next rains.

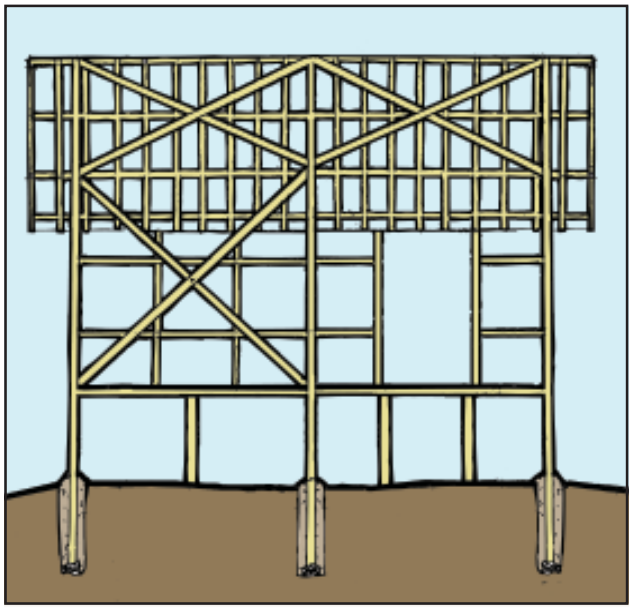


A GOOD EXAMPLE: THE STRONG MRCS MODEL HOUSE MADE WITH BAMBOO

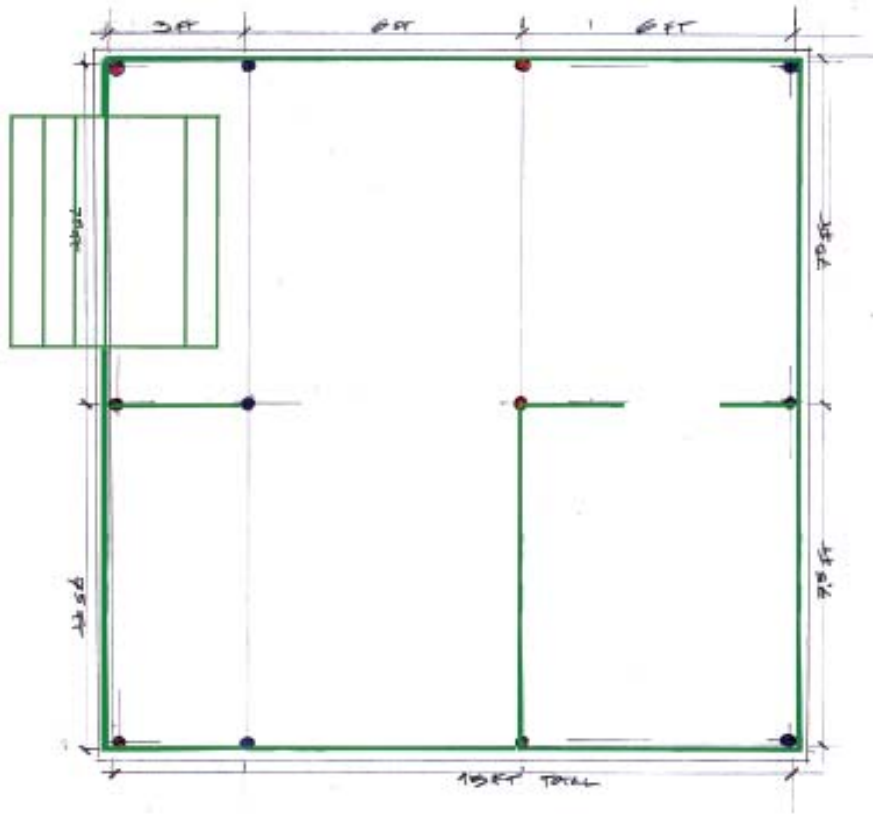
This 225 sq.model house is designed for families of 4 to 5 persons a ft model house. It has one large and one small room and a small porch to the front. Later a kitchen can be added on the back and, at some distance, a latrine. It is build with good quality, well seasoned bamboo and covered with *dani.*



Side view



Front view



Plan view

LIST OF MATERIALS, SIZES AND QUANTITIES FOR THE IFRC MODEL HOUSE

Carefully select material at supplier. Control quality, sizes and lengths of material, avoid waste. Prices vary according to location. Transport and labour costs will have to negotiated separately. cost

Nr	Part / Item	Type	Specification	Unit	Qty	Unit Cost	Total
1	**Roof frame**						
1.01	Ridge Pole	Medium seasoned bamboo (WaYa)	diameter 2.5"	18 ft	2		
1.02	Purlin			18 ft	7		
1.03	Principal Rafter			11 ft	6		
1.04	Common rafter		diameter 2"	12 ft	22		
1.05				8 ft	22		
1.06	Roofing	Dani	18" wide	100 pc.	4.5		
1.07	Tying wire	Thin bamboo strip	22", 14" long	Viss	1.5		
2	**Wall frame**						
2.01	Pole in Centre	Toddy palm timber	6" * 2"	18 ft	3		
2.02	Pole at Side			15 ft	6		
2.03	Shorter poles at entrance	Beetlenut Pole	diameter 4"	13 ft	3		
2.04	Tie-Beam	Medium seasoned bamboo (WaYa)	diameter 2.5"	13 ft	3		
2.05	Wall barrier			15 ft	13		
2.06	Wall of bamboo strip		diameter 5"	6 ft	10		
2.07	Wall panels	7 Bamboo mats	15' + 15' + 15'	Sq. ft	315		
3	**Floor frame**						
3.01	Joist	Medium seasoned bamboo (WaYa)	diameter 2.5"	15 ft	10		
3.02				13 ft	10		
3.03				4 ft	10		
3.04	Beam			15 ft	5		
3.05	Beam			7.5 ft	3		
3.06	Floor	Wafa Bamboo Matting	15' * 15'	Sq. ft	225		
3.07	Support Pole	Toddy palm timber	6" * 2"	3 ft	15		
4	**Braces**						
4.01	Principal rafter to tie beam	Medium seasoned bamboo (Wa Ya)	diameter 2.5"	12 ft	3		
4.02	Main pole to tie beam			11 ft	6		
4.03				8.5 ft	4		
4.04				21 ft	2		
4.05				7.5 ft	4		
5	**Materials for Fixation**						
5.01	Nails	Metal nails for wood	3" / 3.5" / 4"	Viss	2		
5.02		Metal nails for wood	2.5" / 2" / 1.3/4"		2		
5.03	Rope	Nylon Rope	diameter 8 mm		1		
	Total Material Costs						
	Costs for Transport						
	Costs for Labour						
	Grand Total Costs						

CHECKLIST OF POINTS FOR THE CONSTRUCTION OF A SAFER SHELTER

Nr	Point	To check	OK	Remarks
1	**Location**	Highest spot of plot Small side towards wind Cut branches of trees		
2	**Elevation**	Floor **3** ft above ground Drainage ensured Ground not congested		
3	**Footings**	2.5 ft to 3 ft deep Posts well fixed Posts treated with oil		
4	**Main Frame**	Good materials Same diameters all over Solid joints		
5	**Braces**	Along short side Along long side In roof frame		
6	**Roof frame**	Pitch minimal 30 degree Eave all sides max. 18" Canopy roof detached		
7	**Roof Cover**	Well fixed CGI: not only with nails Lattice on top		
8	**Attic**	Added to shelter Ladder in place Free path to secure place		
9	**Walls**	No large openings Windows: vertical fixings Doors well locked		
10	**Maintenance**	Ground cleaned, dewatered Joints re-tightened Roof leaks repaired		