

# 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

## HOW TO BUILD A SAFER SHELTER

A Guide for Households on how to build a shelter that will provide greater protection from future severe weather conditions.

### INTRODUCTION

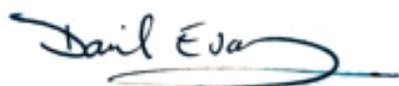
The people in Ayeyarwaddy and Yangon Districts are beginning to recover from the devastation caused by last year's cyclone Nargis. Now, many shelters are being repaired, upgraded and reconstructed. How should these shelters be built to better protect the families against the strong winds, heavy rains and high floods? UN-HABITAT, in collaboration with other agencies in the shelter Cluster, have identified the following ten main points to incorporate and ensure that every new shelter will better resist severe weather conditions and provide higher levels of protection.

- Build your house on stilts on the highest spot or your plot:
- Face the shorter side of a 'rectangular type' shelter towards where the strong winds normally blow from.
- Construct a roof with a steep slope (minimum 30 degrees), to reduce risk of being blown off.
- Limit the projection of the roof on all sides to maximum 18 inches.
- Fix the cover of the roof firmly to the frame of the roof.
- Fix rafters, purlins, tie beams and post plates firmly to the posts.
- Anchor the strong posts with solid footings to the ground.
- Strengthen your shelters against the winds with braces on each side.
- Maintain the important parts of your shelter regularly.
- Re-tighten and repair your shelter before the monsoon starts.

These rules apply to all types of shelters, whether building with bamboo and fixing with ropes or if constructing with palm trunks or timber joined by nuts and bolts. These rules do not only apply to constructions after cyclone Nargis, but to any shelter construction you and your village members engage in from now on.

This Guide explains the special features, techniques and recommendations and shows how they can easily be applied for any safe construction. Read the guide, discuss with your community, seek advice from carpenters and build a safer shelter.

A shelter that is built using the methods described in this booklet will provide increased protection from wind and rain and flood, and will enable you to sleep at night in the knowledge that you are in a strong and safer shelter.



David Evans, UN-HABITAT

## WHAT THIS GUIDE IS FOR: HOW TO BUILD A SAFER SHELTER

Yearly, during the rainy season, rains, floods and storms, like cyclone Nargis in May 2008, threaten your lives, your assets and, especially, your shelter.



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

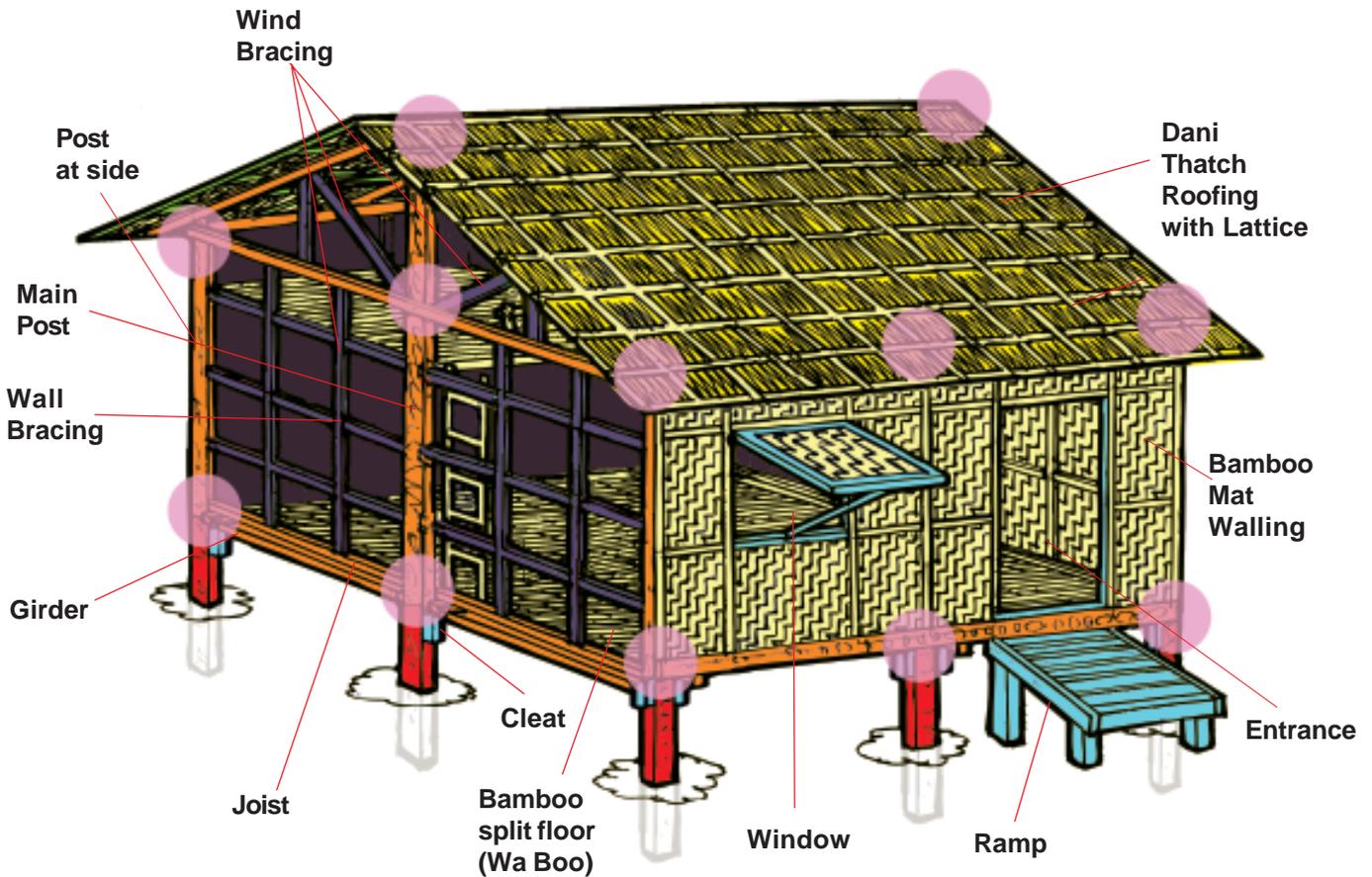
This guide is intended to assist you to make the best use of the materials you may have received for constructing or upgrading your shelter. When well constructed, your shelter is less likely to become damaged during storms and will last for many more years.

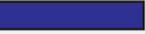
This guide provides you with the key principles important for constructing a safe shelter when you upgrade your existing shelter or build a new shelter. The construction principles outlined in this guide apply to **every kind of shelter**, whether it has been constructed with timber, jungle wood or bamboo.

Before you start building your shelter, it is recommended that you seek advice from a skilled carpenter, who is familiar with these principles to ensure that you select appropriate building materials, choose the right location for your shelter and **follow the rules provided in this guide** 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.

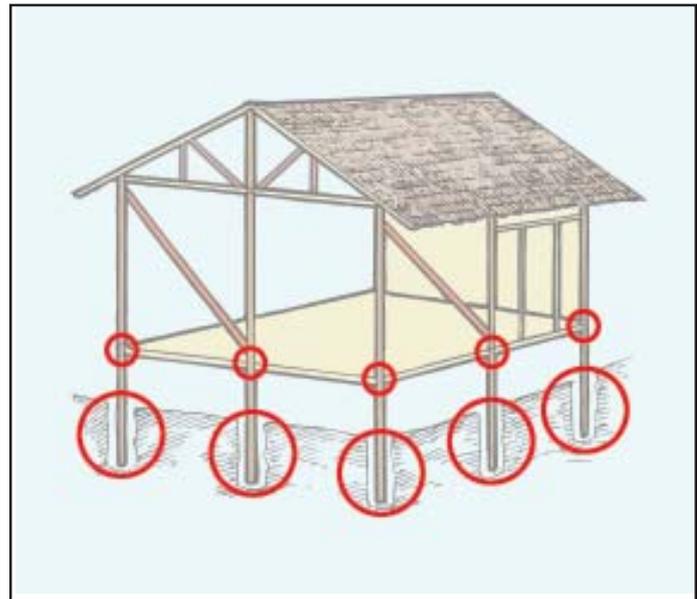


Nr	Part	Title	Required quality
1		Main frame	Very strong material
2		Footings	Very good construction
3		Main junctions	Very good fixings
4		Braces	Good quality material
5		Roof structure	Fair quality timber
6		Non-structural	Secondary quality
7		Roof covering	Thatch, nipa palm CGI-sheets
8		Walls, floor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

## Your shelter will protect you better against storms if you pay attention to the following principles:

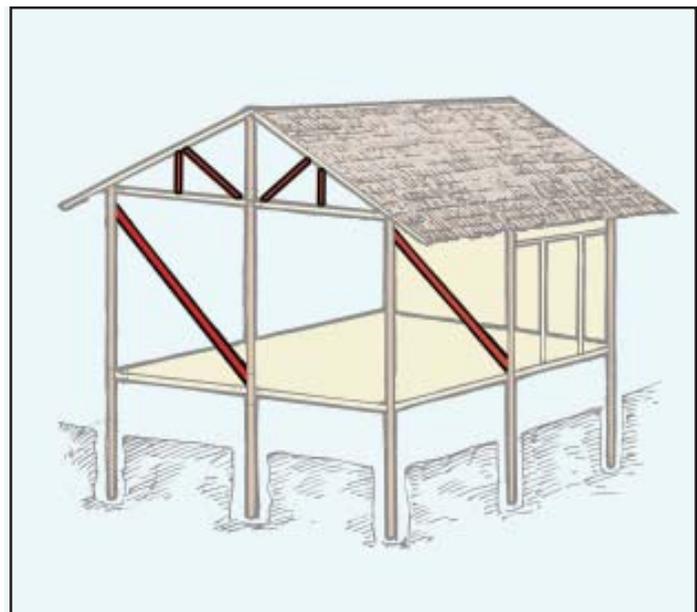
### **A = ANCHORING**

Every part must be tied back to a secured point which can resist applied forces.



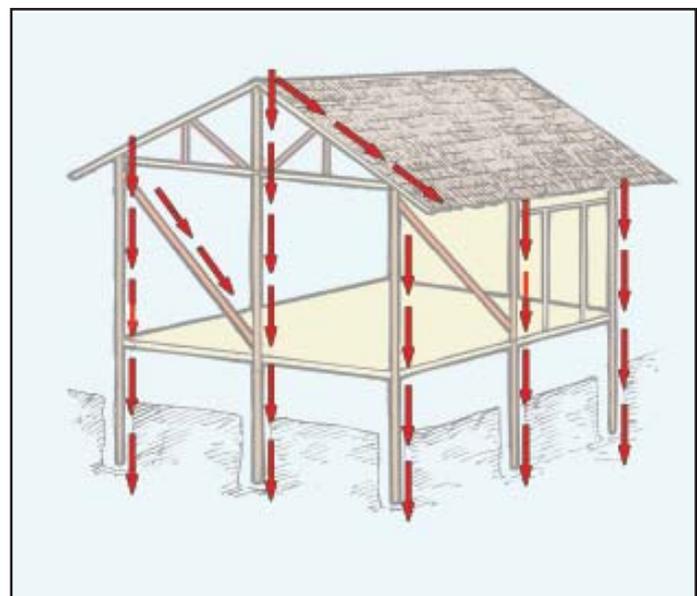
### **B = BRACING**

Every part must be held rigid, so the shelter cannot 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

### 1. Locate the shelter on the highest spot on your plot

Avoid shallow lower spots and ensure adequate drainage so that water can flow away from the footings.

### 2. Square shaped shelters are more appropriate

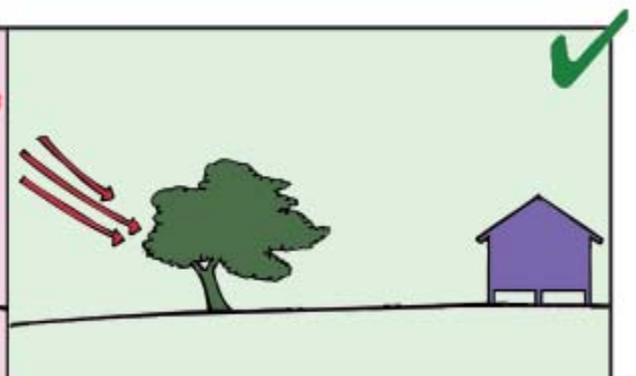
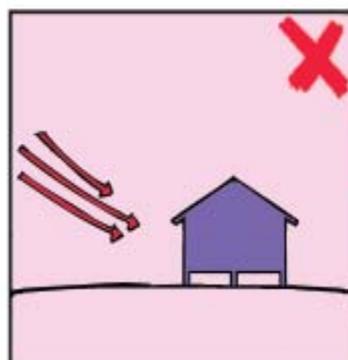
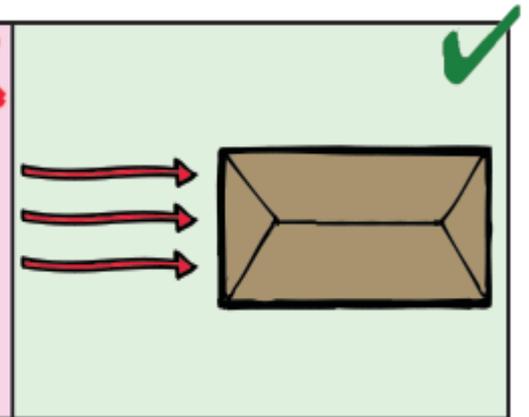
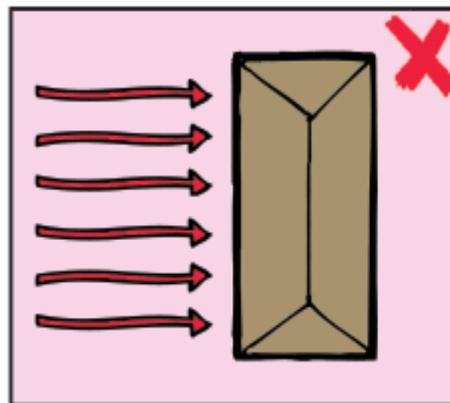
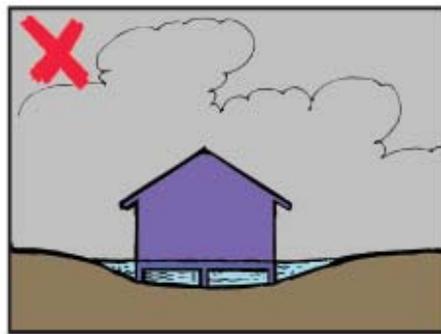
For rectangular shaped shelters, the short ridged side should face the direction of the oncoming winds.

**3. Trees are a threat if too close, but can offer protection** if located at a safe distance from your shelter. Cut tree branches that are too close to the roof. Plant trees at a safe distance to break the wind forces.

### 4. Elevate your shelter against floods

If posts are not well-anchored to the footings of your shelter, rising flood levels can threaten the lives of young and elderly family members, endanger your assets and uplift or shift your shelter. Thus, it is important to:

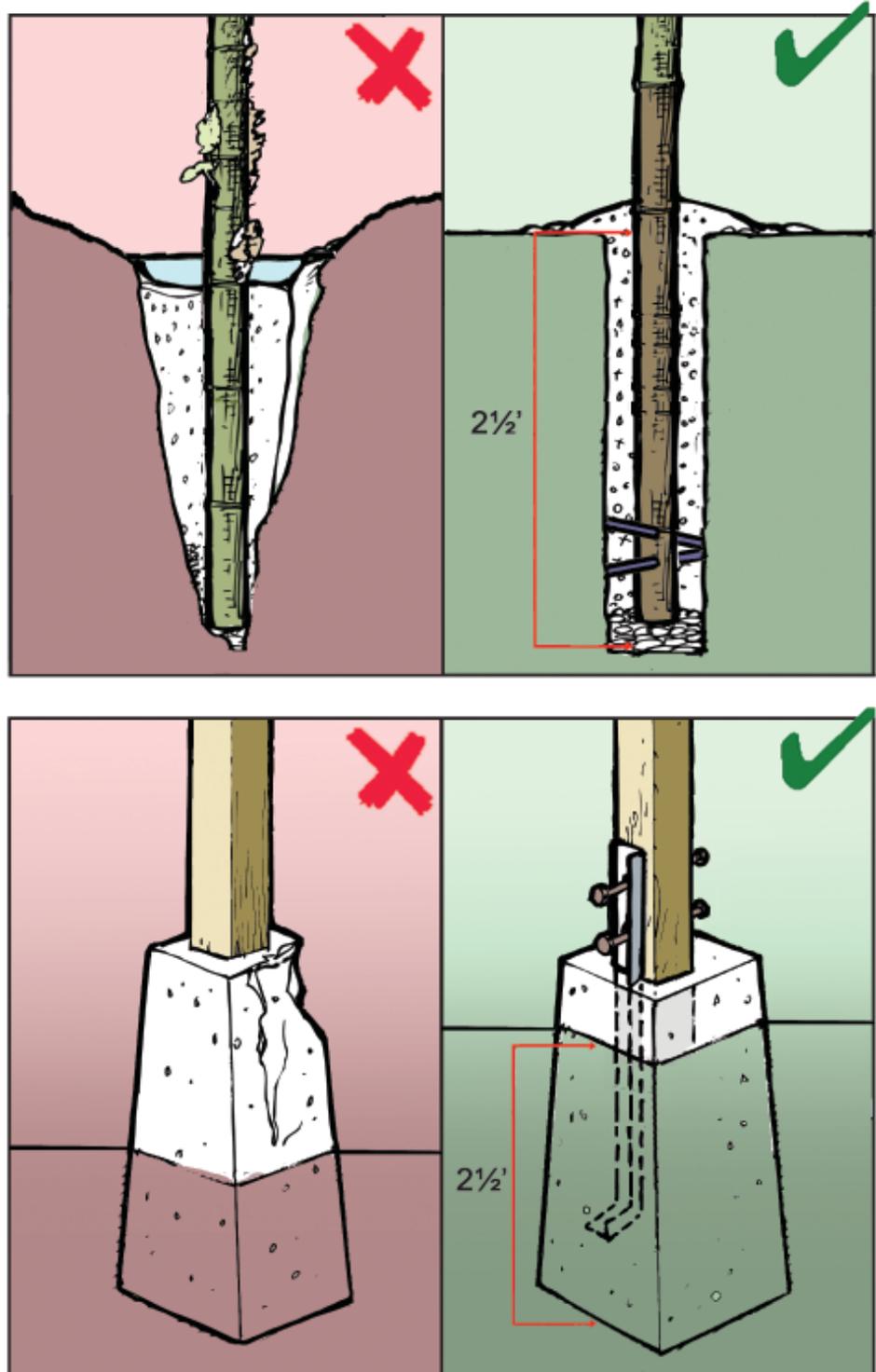
- Elevate shelter on stilts, so the shelter floor is at least **3 feet** above ground.
- Create sufficient drainage under and around your shelter.
- Avoid storing material under your shelter which may obstruct water drainage.
- Compact solid earth around the footings, to avoid standing water.



## ENSURE YOUR SHELTER IS WELL ANCHORED ON SOLID FOOTINGS

With solid footings your shelter will not sway and will better resist storms and floods.

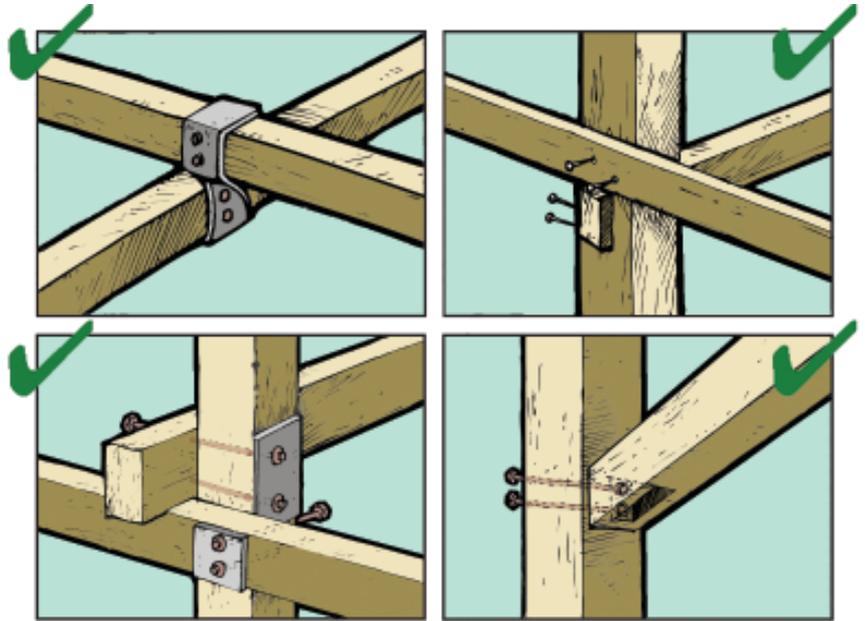
- Compact the soil under the entire shelter.
- Ensure the footings are at least **2 feet 6 inches** deep.
- Lay gravel, sand or brick pieces on the base of the footings.
- Compact the holes around the footings with sand or clay.
- Apply two crossed sticks at the bottom of the posts.
- Ensure proper drainage, so water does not pool around the footings.
- Protect posts against fungi and insects by covering the posts with earth oil, bituminous paint or smoked bamboo.
- Brush and check footings before rainy season; eventually repaint or replace.
- On concrete footings, fix timber with 2 bolts through a (L) shaped bracket.



## A STRONG, WELL TIGHTENED FRAME CAN BETTER RESIST STORMS

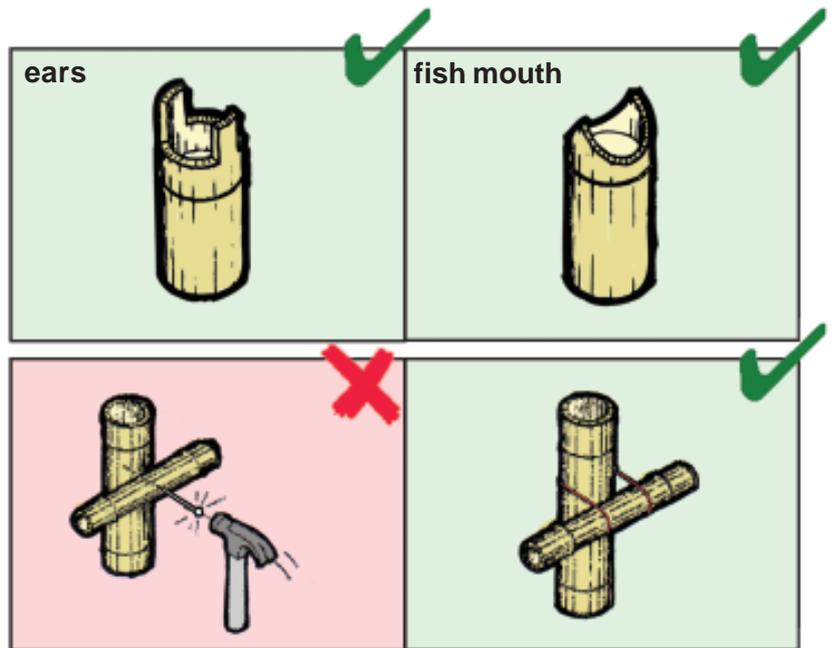
Only when the main frame (the core of the shelter) is strong, will the shelter be stable and able to protect you and your family. Typical construction techniques :

- **Select suitable materials:** continuous, solid pieces of good quality material.
- **Choose good quality materials:** good timber, strong toddy palm, seasoned bamboo.
- **Avoid weak materials:** do not use inferior, deteriorated or burnt materials.



- **Protect materials used:** apply earth-oil or bituminous paint, seasoned/smoked bamboo, anti-rust paint.
- **Ensure that the joists are strong:** the posts, the tie beams and the main rafters. Underlay joists with cleats.
- **Prepare the joists:** for example, cut notches into timber, “ears” or “fish mouth” into bamboo.

- **Apply the right method of joints:** for timber, toddy palm etc. use bolts, nuts and washers, **not** only nails. For bamboo use nylon ropes, strong coconut fibre ropes or binding wire. Fix the ropes correctly.
- **Work carefully:** when nailing, avoid splitting the bamboo and nail straight, not diagonally to the surface of the timber.



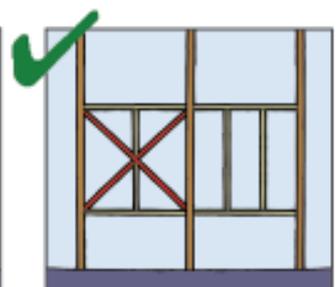
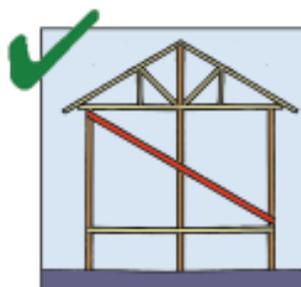
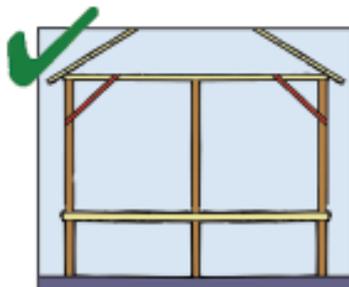
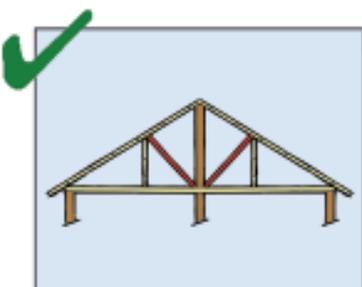
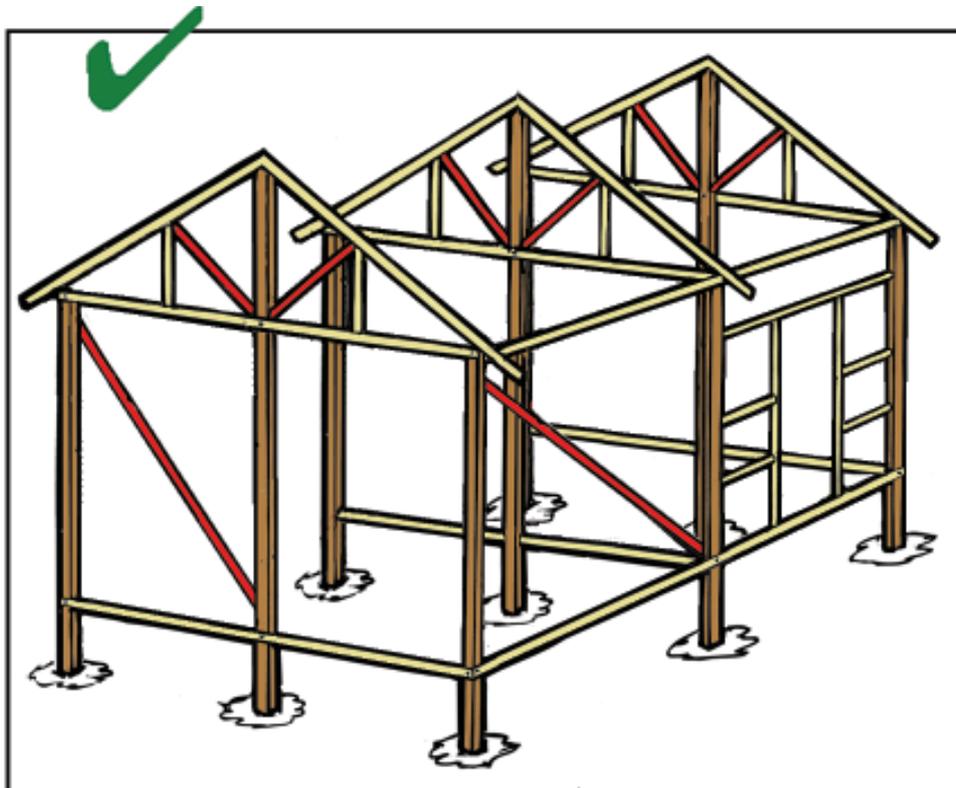
- **Check joints before and after the rainy season:** re-tighten bolts or ropes, replace rotten nails and add new ones.

## APPLY BRACES TO STRENGTHEN THE FRAME AGAINST STORMS

Braces prevent the frame from bending, twisting, rotating or tilting under the pressure of strong wind forces.

### Possible applications of braces

- **Main frame:** as a minimum, brace one of the short side walls and one of the long side walls.
- At least one brace, but preferably **two** crossed braces at each side.
- **Roof frame:** as a minimum fix a brace between the tie beam and main rafter; eventually between the posts.
- **Braces** should be connected between the joints of the **main frame**; not only to the non-structural parts.
- Short diagonal braces will do, **long braces** from junction to junction are stronger.
- Nail braces sideways to the posts. Don't hammer nails into the bracing diagonally.

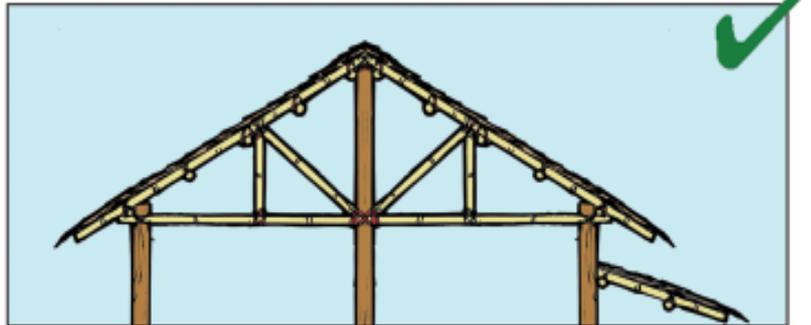


## FIX THE COVER MATERIALS WELL TO THE FRAME OF THE ROOF

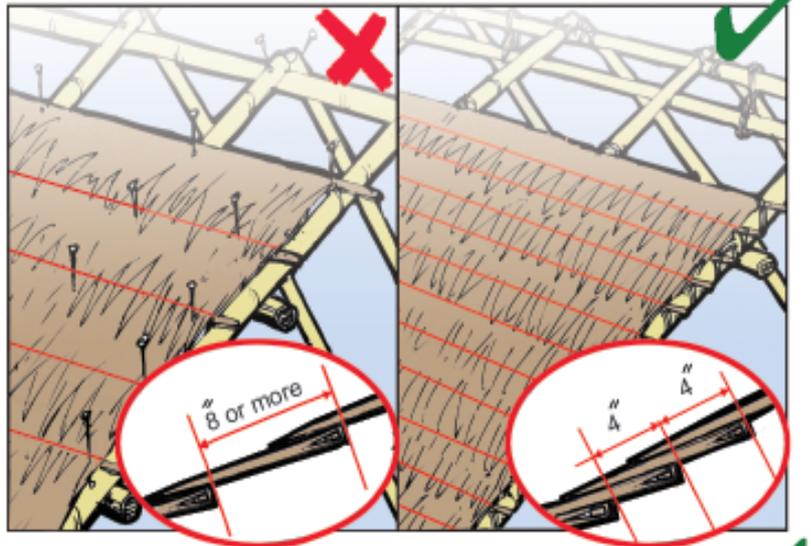
Securely connecting the roofing material to the solid roof frame will avoid water leaks and reduce the risk of roof sections blowing off.

When the roofing material is poorly connected to the roof frame, even moderate winds can cause tears which will cause water leakage. During heavy storms, sections of the roof can blow off which may injure people, e.g. CGI (steel) sheets. Strong cyclones can swag the roof or blow off the entire roof.

- **Steep pitch** at a minimum of **30 degrees**. When house is 12 feet wide, the roof should be at least 3 feet 6 inches high.



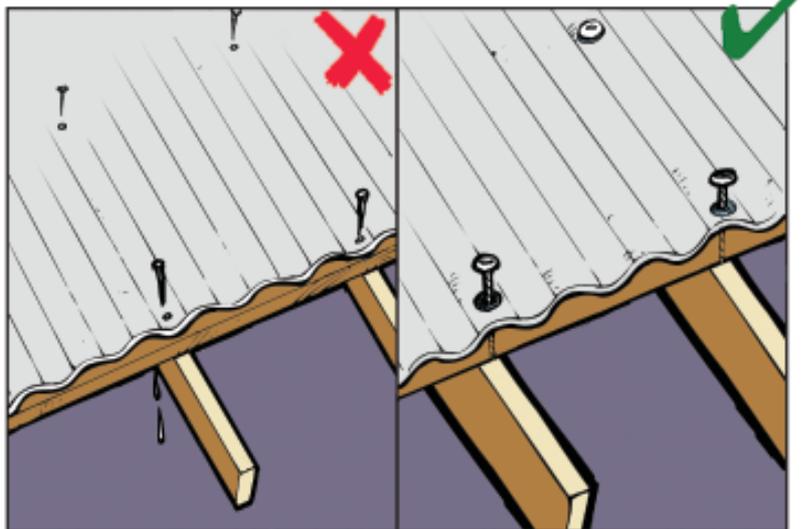
- **Roof surface** should not be too large. Disconnect the roof of porch and kitchen from the main roof.



- **Roof projection** should not exceed 18 inches on all sides.

- **Strengthen roof frame** by using good materials, adding braces and connect the roof frame well to the posts.

- **Fix roof cover strongly** to the frame as storms can blow off parts of the roof when not connected properly.



- **Lay a sheet of thatch or dani roofing** from side to ridge at least every 4 inches and fix with bamboo strips.

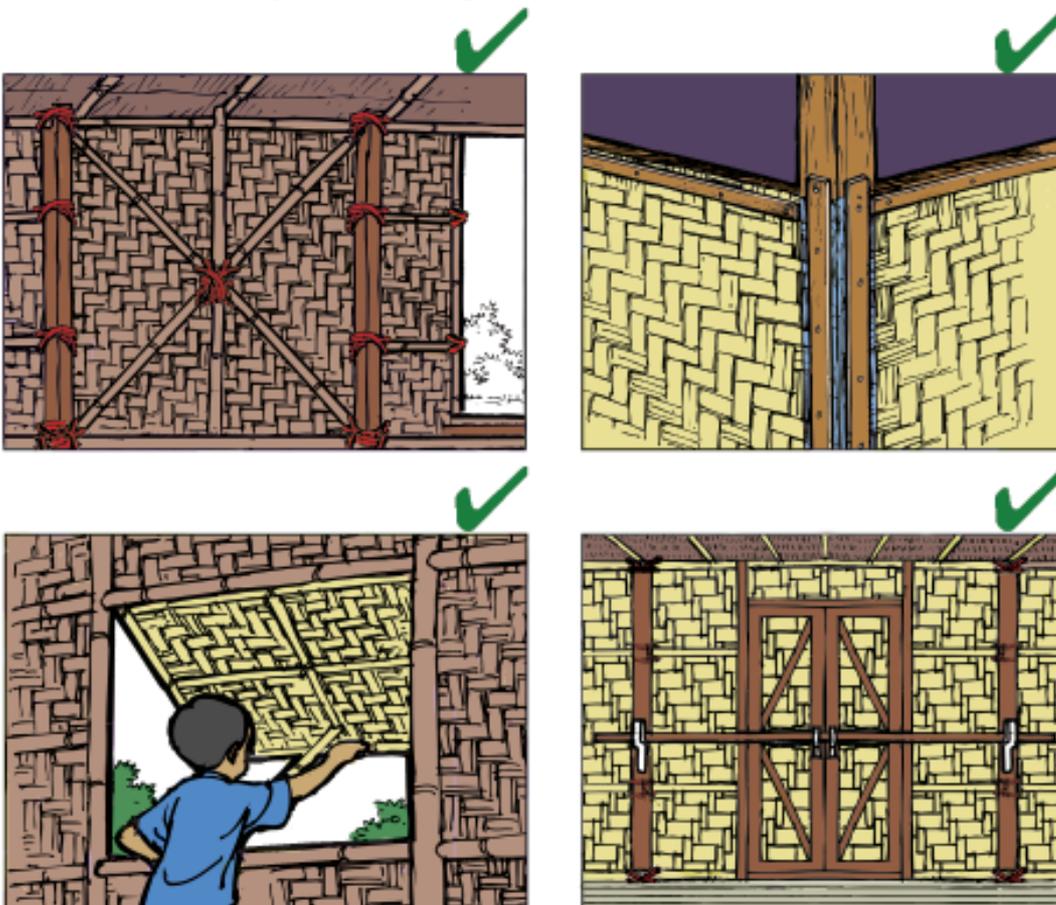
- **Place a lattice** on top of the thatch or dani roofing and secure it to the roof frame to avoid the lattice blowing off.

- **CGI (Steel) sheets should be** fixed with screws or, preferably, J-hooks at top of the ridge or undulation.

## BUILDING WALLS, DOORS AND WINDOWS THAT PROTECT

To protect the roof of your shelter from being blown off during a storm, it is important to reduce the amount of wind entering the shelter. Roofs can be blown off during storms when strong winds enter the house and lift the roof off the shelter's frame. Walls, doors and windows should be reinforced against strong winds entering the house. Here some construction techniques:

- **Floor deck** - nail mat of split bamboo to the floor joists.
- **Avoid large window openings.**
- **Close the walls** with bamboo mats or other materials (e.g. tarpaulin) which must be **tightened securely** to posts and wall barriers.
- Cut bamboo mats at corners - **do not bend** around corners.
- Shut doors and window frames down **vertically** (hinges at top frame). Avoid window frames that open sideways.

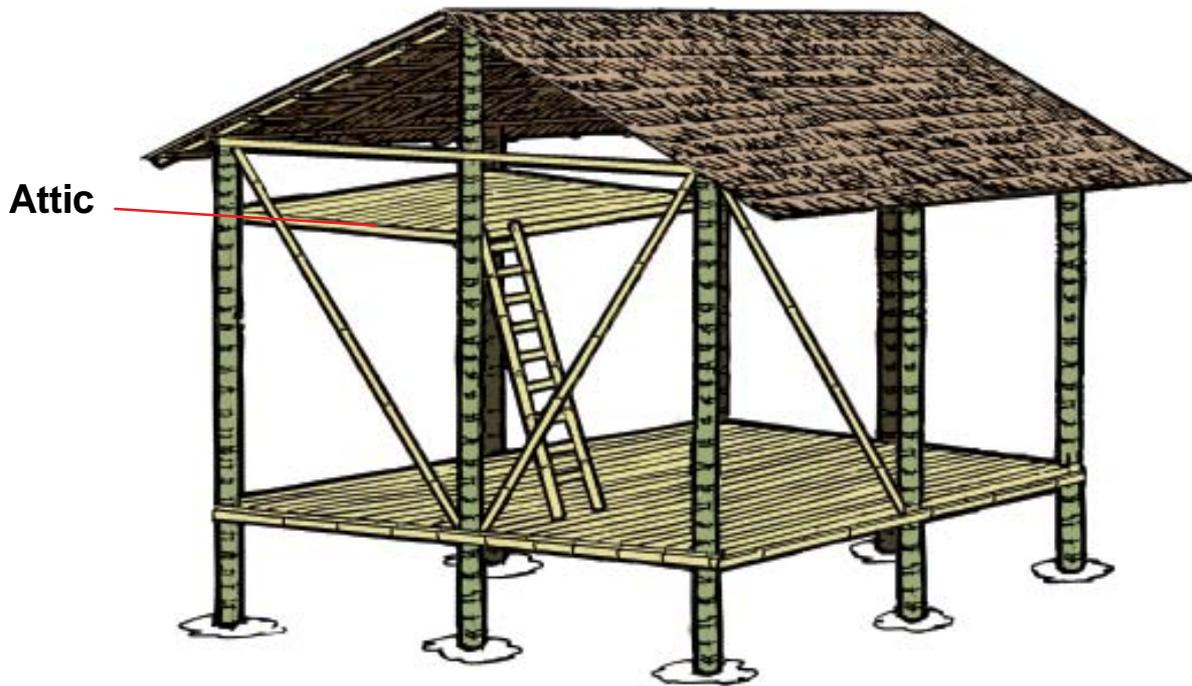


- During storms, reinforce the doors with a strong bar that locks the door from the inside.
- Check and re-tighten the fixings before and after each rainy season.
- Lighter materials can be used for non-structural parts.

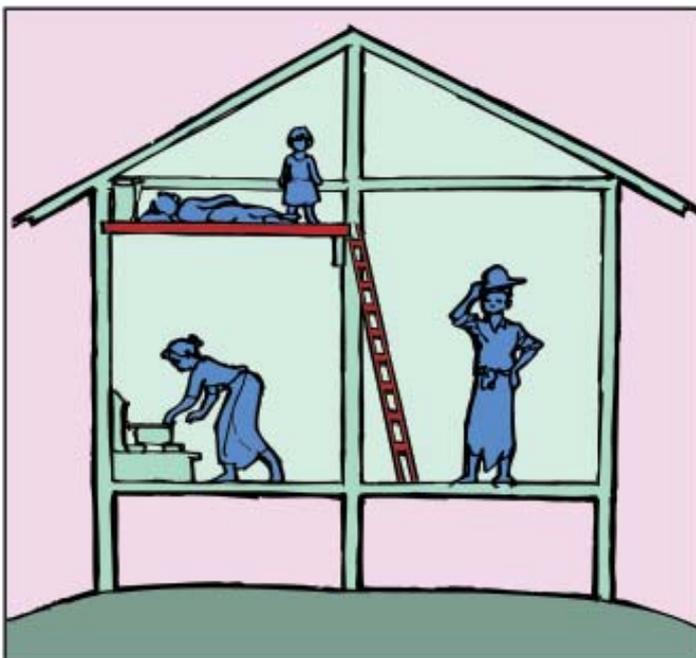
## ESTABLISH AN EVACUATION PLAN AND CONSTRUCT AN ATTIC

In preparation for evacuation during very severe storms, all household members should be made aware of a secure location to seek refuge.

Constructing an attic between four posts under a part of the roof frame can act as a safe refuge when flood waters rise above your shelter's floor level. An escape hatch should also be included in the construction of the attic.



Ensure the pathway to your chosen place of refuge is free from obstruction, so that your household and other community members can evacuate at anytime.



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

## EXTEND THE LIFE OF YOUR SHELTER WITH REGULAR MAINTENANCE

A shelter can protect your family for many years when you perform regular maintenance during every dry season, especially before the monsoon rains.

# We Protect our shelter from Rains, Storms & Floods

Let's be prepared before the rains come

Let's do it before the storms come

Let's be prepared before the floods come

I cut branches.

This house is fire-safe.

I tighten nuts, bolts and nails.

I clean all drains and clean underneath of my house.

I clean the column base and fill it with good soil.

I check the stability of my house with a skilled person (carpenter).

I tighten joints and ropes and add braces.

I repair our roof and shelter top mat.

I tighten window hinges.

I can save my family because the path to a safe place is clear.

I can save my family because I have cleared the attic where they can escape to.

**UN HABITAT** FOR A BETTER URBAN FUTURE

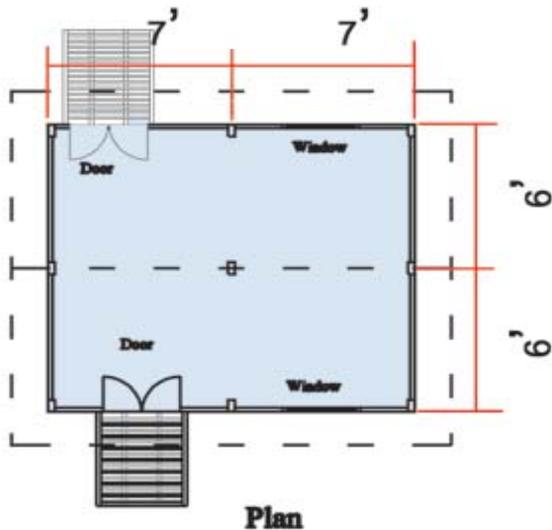
**DFID** Department for International Development

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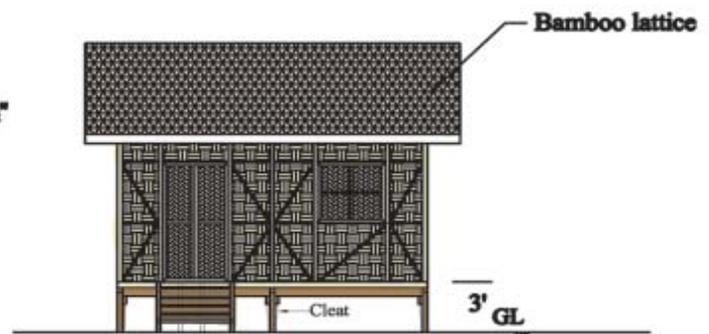
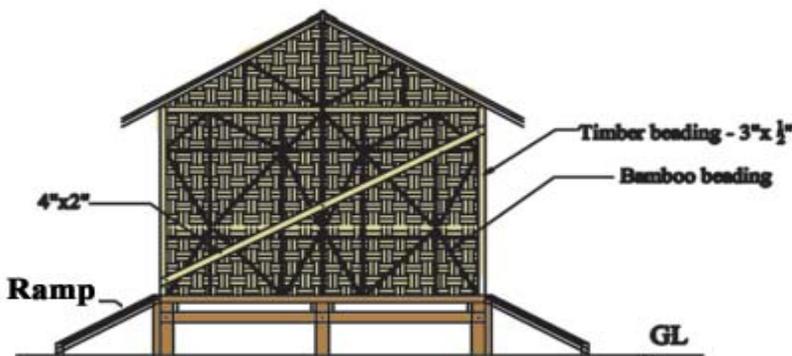
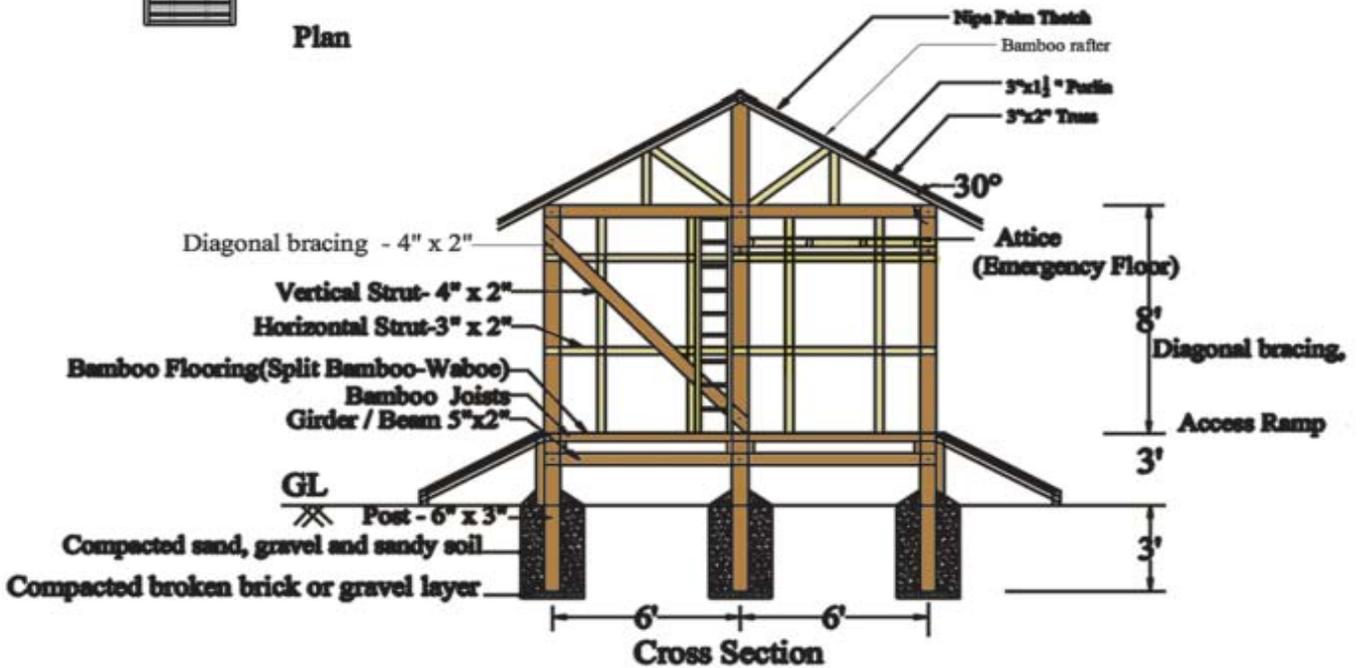
Shikharika Edgemonstrat  
Contributions: Shikharika  
Contributions: Shikharika

## THE UN-HABITAT MODEL HOUSE

This 168 sq. ft. model house is designed for families of 4 to 5 persons. In this almost square shelter, the 9 posts and the strong frame of the floor and roof are made out of toddy palm, the roof is dani.



Floor area = 14 ft x 12 ft  
 Roof slope (Pitch) = 30-Degree  
 Wall Height = 8 ft above flooring  
 Door = 6' x 3'  
 Window = 3' x 3'



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

Length=14 ft, Width= 12 ft, Wall Height = 8 ft; with Attice (Emergency Floor);

Toddy palm post, Toddy palm frame, Bamboo mat walling, Bamboo (split) flooring, Nipa palm thatch (dani) roofing

No	Particulars	Qty	L	B	H	Sub-total	Total Incl. waste	Unit	Unit Cost (Ks.)	Amount (Ks.)
		Numb.	ft	inch	inch					
<b>A</b>	<b>Toddy palm (Core house)</b>						15% waste			
1	Post ( 6" x 3") (Centre)	3	17	6	3	6.4	7.3	cft		-
2	Post (6" x 3") ( Sides)	6	13	6	3	9.8	11.2	cft		-
3	Principal Rafter/Truss (3" x2")	10	10	3	2	4.2	4.8	cft		-
4	Tie-beam (4" x 2")	3	12	4	2	2.0	2.3	cft		-
5	Truss Bracing (3" x2")	3	7.5	3	2	0.9	1.1	cft		-
6	Post plate (4"x2")	3	14	4	2	2.3	2.7	cft		-
7	Wall strut/bracing (3"x2")-Vertical	10	8	3	2	3.3	3.8	cft		-
8	Wall strut/bracing (3"x2")-Horizontal	2	11	3	2	0.9	1.1	cft		-
9	Diagonal bracing(4" x 2")	2	15	4	2	1.7	1.9	cft		-
10	Girder ( 5" x 2")	4	12	5	2	3.3	3.8	cft		-
11	Secondary Beam (4" x 2")	5	14	4	2	3.9	4.5	cft		-
12	Ramps(Surface = 4 ft x 4 ft, Slope H=4, V=2)	2	25	5	3	5.2	6.0	cft		-
13	Attice-Emergency floor 6 ft above floor	8	7	4	2	3.1	3.6	cft		-
	<b>Total Toddy Palm Wood</b>						<b>54.1</b>	cft		
	<b>Timber Inn Kayin (3rd Class, assorted)</b>						10% waste			
14	Purlin (3"x 2")	8	17	3	2	5.7	6.2	cft		-
15	Eave board ( 5" x 1 ")	1	70	5	1	2.4	2.7	cft		-
16	Facia board (5" x 1")	1	28	5	1	1.0	1.1	cft		-
17	Door chowket (Widow & Door)/frame	1	40	3	1.5	1.3	1.4	cft		-
18	Beading 32" x 0.5")	22	14	3	0.5	3.2	3.5	cft		-
19	Deck for access ramps	2	44	3	1	1.8	2.0	cft		-
	<b>Total Timber Inn Kayin (3rd Class, assorted)</b>						<b>16.9</b>	cft		
	<b>Other materials</b>									
20	Nipa palm thatch (Roofing/ridge cap)						600	pc		-
21	Bamboo common rafters, (Wayar , 19 ft or 14 taung)						22	pc		-
22	Bamboo Lattice over roof (Kha Yin-15ft)						50	pc		-
23	Bamboo Joists, (Wayar-24 ft or 18 taung)						20	pc		-
24	Bamboo ladder ( Thikewar, 30ft )						1	pc		-
25	Bamboo split floor (Wa Boe, 34 ft or 26 taung)						8.0	No		-
26	Nail ( Assorted)						8	Viss		-
27	Bamboo Mat ( Paywethaung-Class-1), 358 sq ft						358	sqft		-
28	Butt- hinge (4 ")						16	set		-
29	Door handle						4	set		-
30	Bolts/nuts/washers ( Ø=1/2", L=assorted)						55	set		-
31	Window handle						2	set		-
32	MS Strap/ Brackets , W=1",T= 0.25 " L= 6"						24	No		-
33	Earth Oil						6	gal		-
<b>E</b>	<b>Labour</b>									
	Skilled Carpenter						35	w/d		-
	<b>Grand Total Cost (In Kyat)</b>									-

## CHECKLIST: POINTS FOR THE CONSTRUCTION OF A SAFER SHELTER

Nr	Point	To check	OK	Remarks
1	Location	<ul style="list-style-type: none"> <li>- Highest spot of the plot</li> <li>- Small side towards winds</li> <li>- Cut branches of trees</li> </ul>		
2	Elevation	<ul style="list-style-type: none"> <li>- Floor 3 ft above ground</li> <li>- Drainage ensured</li> <li>- Ground not congested</li> </ul>		
3	Footings	<ul style="list-style-type: none"> <li>- 2.5 ft to 3 ft deep</li> <li>- Posts well fixed</li> <li>- Posts treated with oil</li> </ul>		
4	Main Frame	<ul style="list-style-type: none"> <li>- Good materials</li> <li>- Same diameters all over</li> <li>- Solid joints</li> </ul>		
5	Braces	<ul style="list-style-type: none"> <li>- Along short side</li> <li>- Along long side</li> <li>- In roof frame</li> </ul>		
6	Roof frame	<ul style="list-style-type: none"> <li>- Pitch minimal 30 degrees</li> <li>- Eave all sides max. 18"</li> <li>- Canopy roof detached</li> </ul>		
7	Roof Cover	<ul style="list-style-type: none"> <li>- Well fixed</li> <li>- CGI: not only with nails</li> <li>- Lattice on top</li> </ul>		
8	Attic	<ul style="list-style-type: none"> <li>- Added to shelter</li> <li>- Ladder in place</li> <li>- Free path to secure place</li> </ul>		
9	Walls	<ul style="list-style-type: none"> <li>- No large openings</li> <li>- Windows: vertical fixings</li> <li>- Doors well locked</li> </ul>		
10	Maintenance	<ul style="list-style-type: none"> <li>- Ground cleaned, dewatered</li> <li>- Joints re-tightened</li> <li>- Roof leaks repaired</li> </ul>		