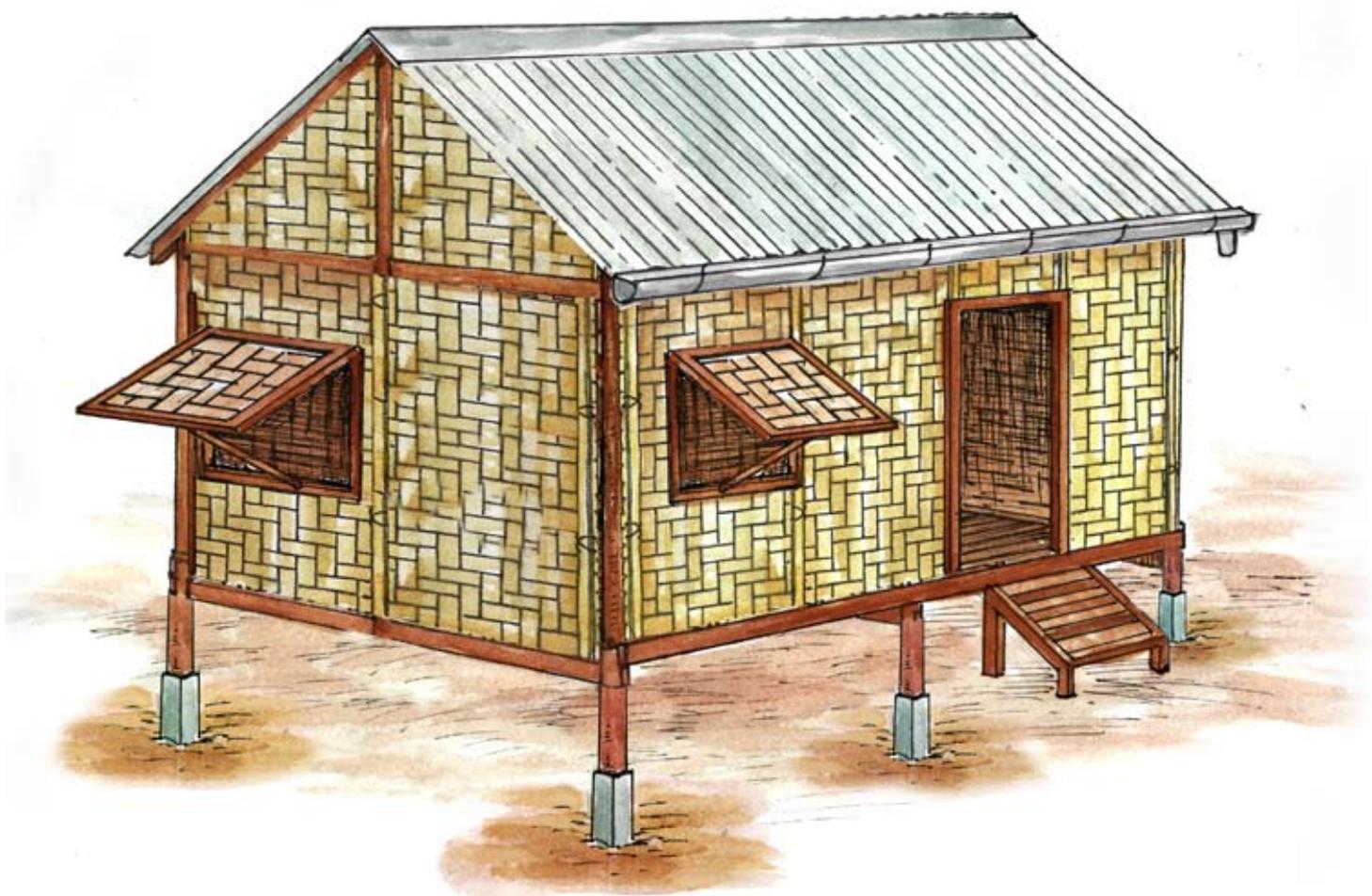


# LOW COST, LOW TECH DISASTER PROOF SHELTER



**act:onaid**

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## About the project

Building Disaster Resilient Communities is a joint project of Action Aid, Dan Church Aid (DCA) and People in Need (PIN) funded by Disaster Preparedness Programme of The European Commission Humanitarian Aid & Civil Protection (DIPECHO).

The Project approach focuses on building the institutional capacity of relevant sub-national structures responsible for Disaster Preparedness and Risk Reduction. Under the project, provincial, district and commune level staffs receive training on the principles of Disaster Risk Reduction (DRR), Hazard Vulnerability and Capacity Assessments (HVCA), DRR and Emergency Preparedness and Response Plans (EPRP). The training is then put into practice by undertaking HVCA at the village/ commune levels and developing DRR action plans that will be integrated later into the local planning process (e.g. Commune Investment Plan).

As part of the project, ActionAid, DCA and PIN also test and document various Community Based Disaster Risk Reduction Models such as: integration of DRR into primary schools curriculums, development of Early Warning Systems with the use of mobile phones, development of low cost/ low tech shelter rehabilitation manual and Draught Resistant Agricultural Techniques.

## Foreword

Shelter rehabilitation after disaster is one of the most expensive humanitarian interventions. According to data collected by PIN, the average cost estimates in rural Cambodia for basic house reconstruction vary between 400-500 USD - far beyond financial capacity of the majority of poor people living in the disaster prone rural areas. A lack of financial resources is not the only reason why people are unable to build houses that are able to survive seasonal tropical storms and flooding each year. Rather, recent evidence from PIN's post-2011 flood assessments confirm that it is in fact a lack of knowhow and skills to build more resistant shelter as main reason why so much damage to housing was observed.

In 2013, together with Collective Studio, academics and students from Architecture Department of Royal University of Fine Arts and University of Technology in Phnom Penh, partner NGOs in Pursat, local artisans and target households, PIN prepared simple, illustrative manual on how to build stronger and more disaster resilient houses.

Most of the proposed methods have been tested in many disaster prone countries such as Pakistan, Bangladesh, Burma as well as in Cambodia. Under the "Building Disaster Resilient Communities" project funded by DIPECHO, thirty two poor, vulnerable families were selected for houses upgrade in Pursat province. During the reconstruction process, PIN and Collective Studio's artisans trained local builders and community members how to apply simple DRR measures to improve the strength of houses, i.e.: foundation, walls, roof and shutters.

Our primary focus was on the cheapest methods so the poorest could afford them. However, the manual presents also more expensive ones for gradual upgrade of the house if and when funds become available.

Unfortunately, the project duration did not allow the project team to generate clear evidence how much more resistant the houses were after applying these methods. More rigorous evaluation will be conducted in November 2014 and its results presented in the second, revised version of the manual.

By making the manual in both, colour and black and white versions, we hope to disseminate it all over Cambodia. Please contact us by e-mail or visit our office to receive hard copy.

November 2013

Piotr Sasin  
Country Director/ Programme Manager- DRR & Emergency Response  
People in Need- Cambodia

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**Published by:**  
People in Need

**Compiled by:**  
collective studio (Giacomo Butte, Eva Lloyd )

With the additional support of Kimseng Meas and the involvement of Royal University of Fine Arts students (Pay Dalin, Danith, Meas Amnan) and from the Institute of Technology of Cambodia (Vantheav Chan Som Onsamrith).

**Illustrations by:**  
Sak May

Local partners in the project:  
EPDO - (Environmental Protection and Development Organization)  
SORF - (Support Organization for Rural Farmers)  
AK (Anakot Kumar)  
PK (Ponleu Kumar)

With the involvement of the builders and families of Krokor, Bakan and Phum Kravanch district.

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Main parts

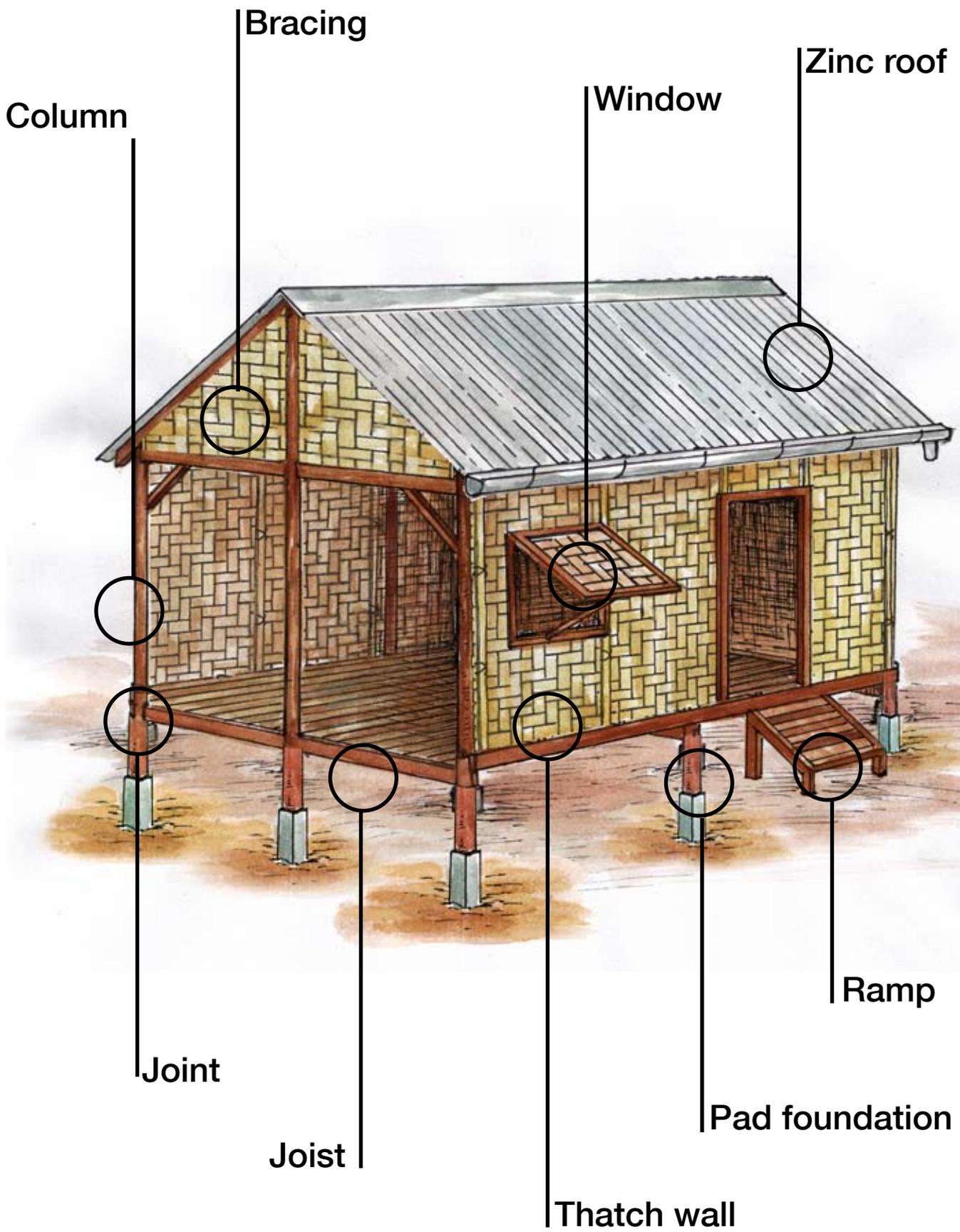
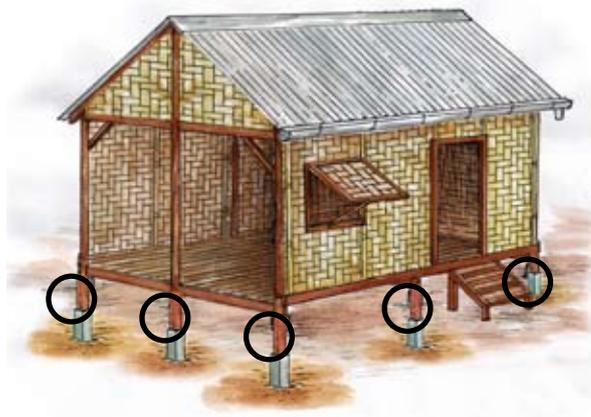


Illustration adapted from: "How to build a safer shelter"; UN-HABITAT

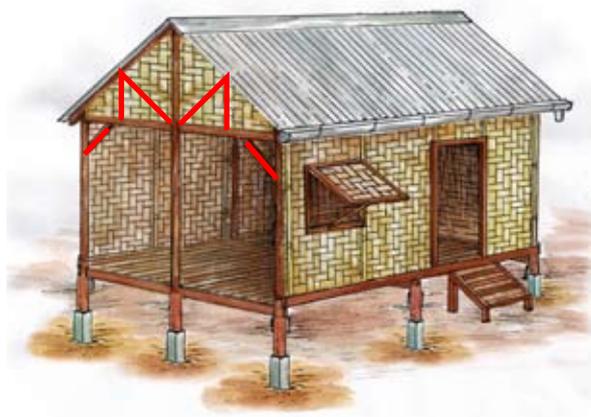
**Foundations.**

Good foundations help to lift and protect the house from ground moisture and insects. In addition foundations anchor the house to the ground providing more stability.



**Cross bracing.**

The structure must be rigid in all its parts. Cross-bracing helps to avoid tilting and shifting.



**Continuity.**

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

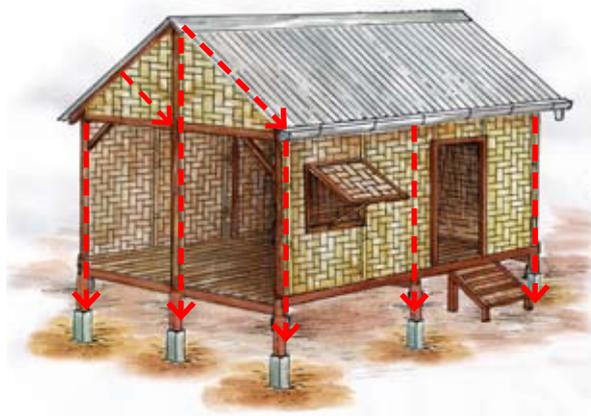
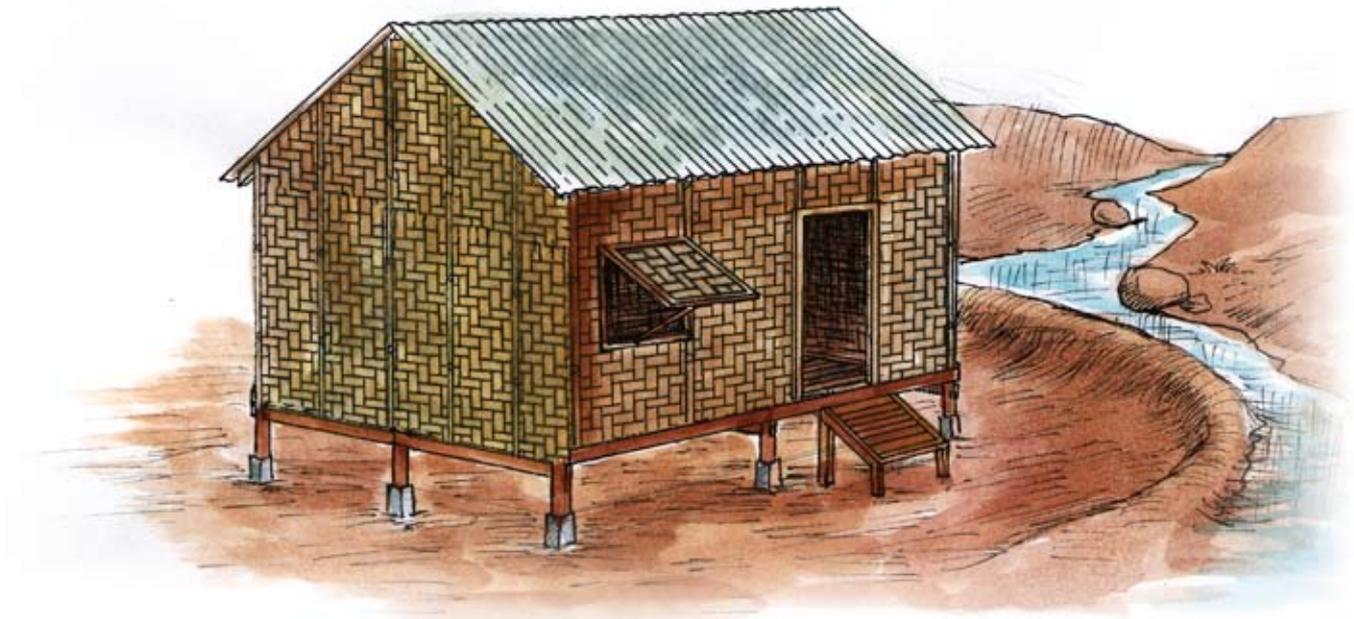
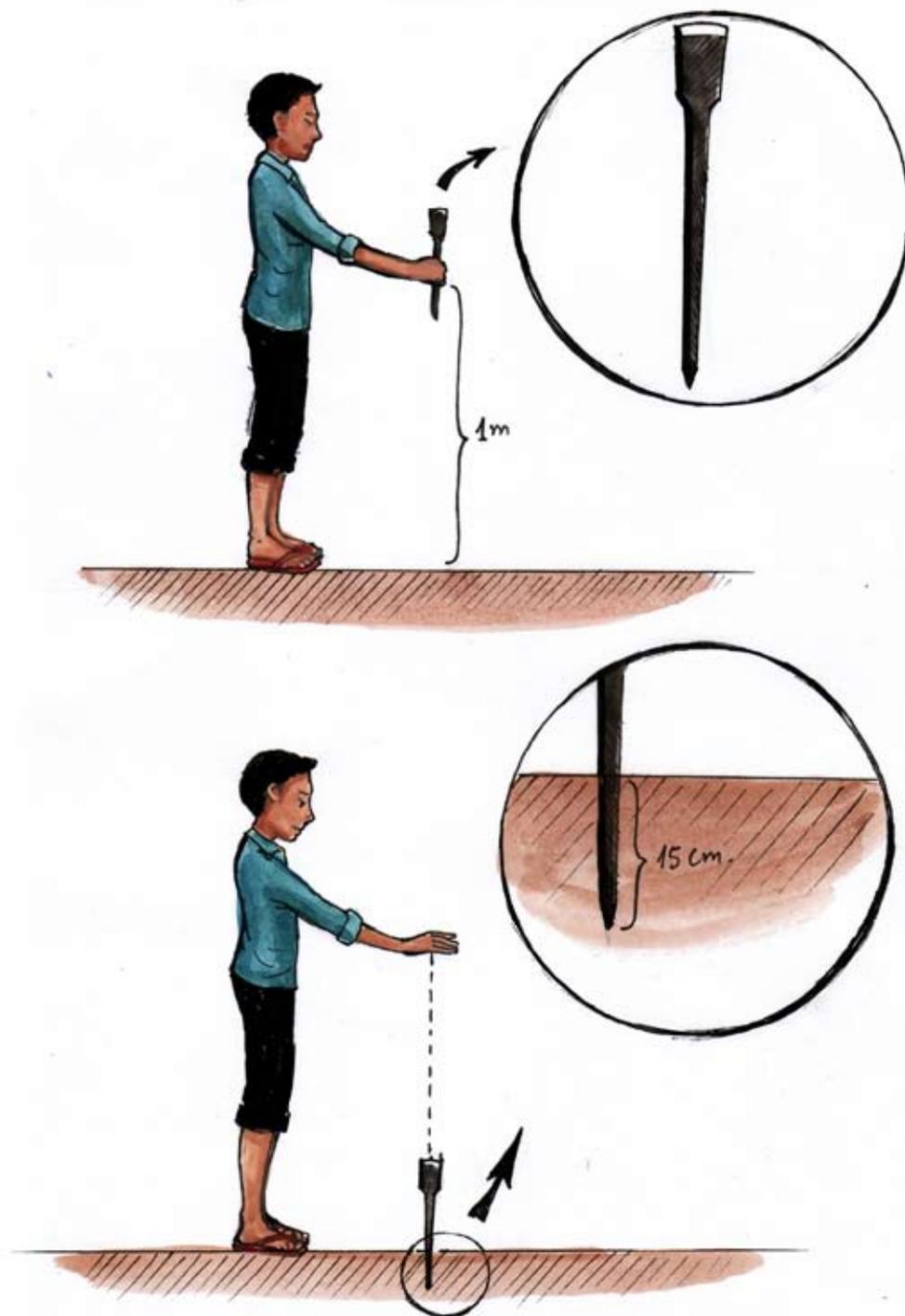


Illustration adapted from: "How to build a safer shelter"; UN-HABITAT



# SITE CONSIDERATIONS



Soil testing:

Drop a metal bar of 1 Kg from 1m.

If the bar penetrates more than 15cm then the soil needs to be compacted.

It is Important to choose and locate the house in a safe place protected from wind and water.



low trees and bushes can protect from the wind



locate the house far enough from big trees that might fall during storms



locate the house on the highest point of the site

WIND



Orient the house with the shorter side along the main wind direction.

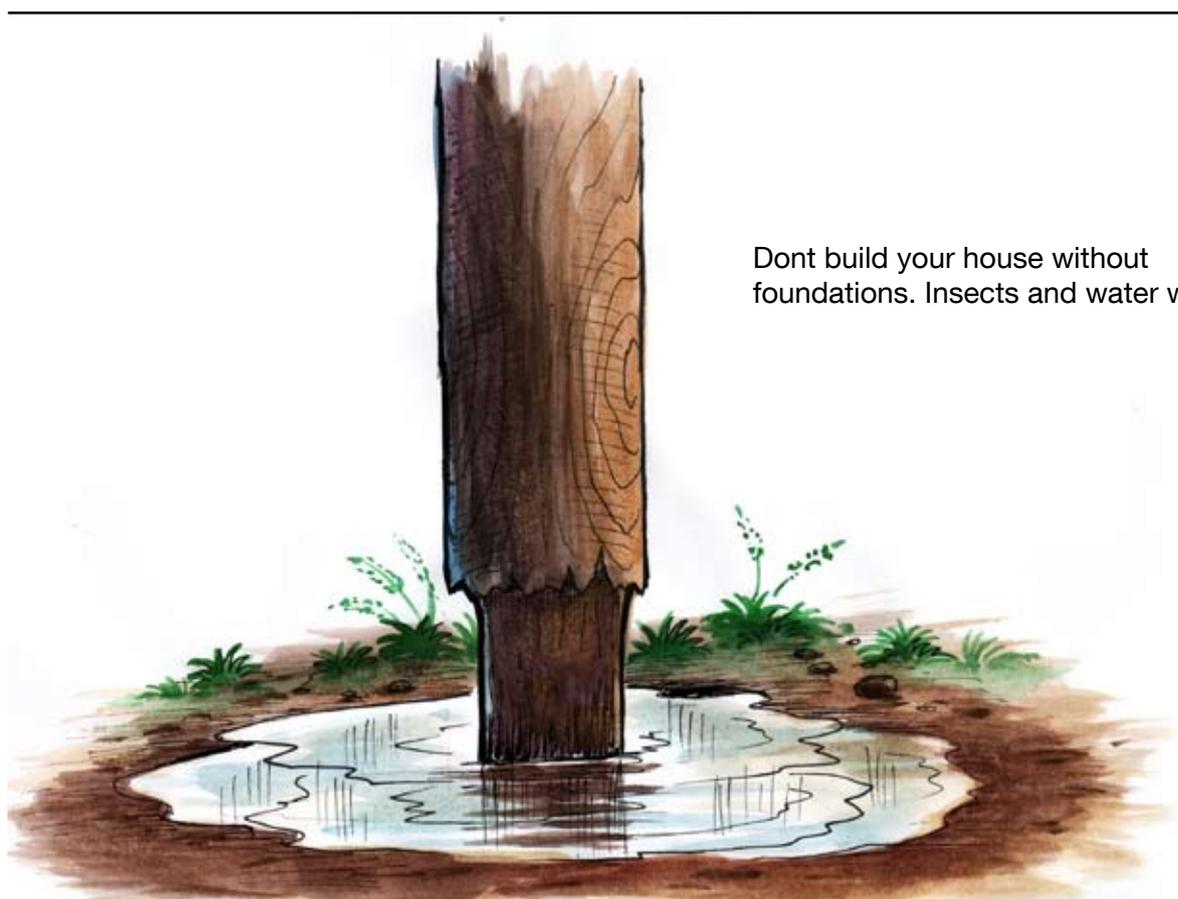
This will make the house more resistant to the wind force.

WIND

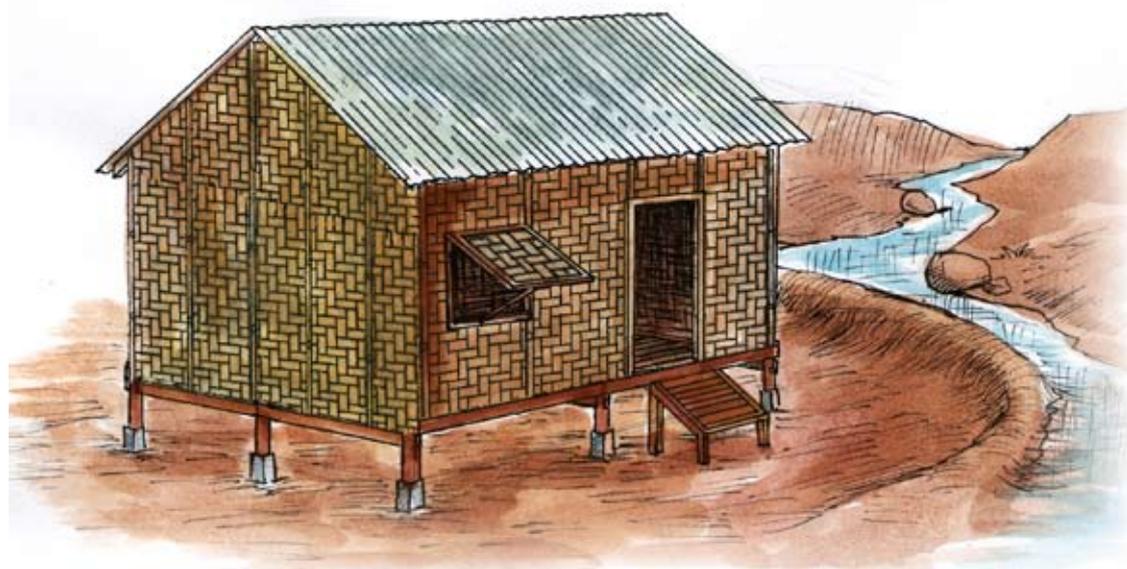




# FOUNDATIONS



Don't build your house without foundations. Insects and water will ruin the wood.

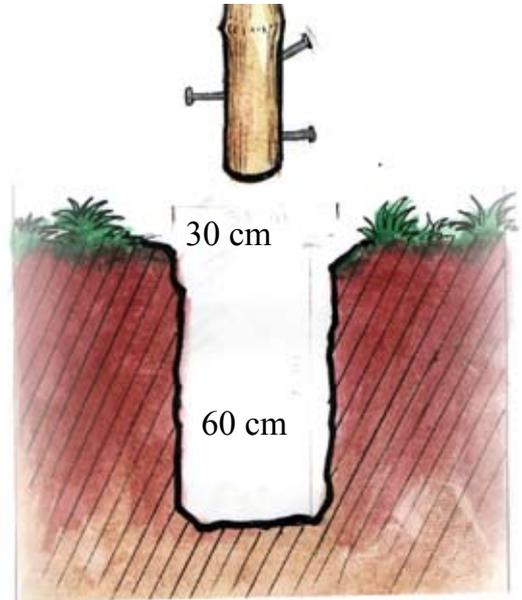


Build on a dry site or create slopes to keep the site dry.

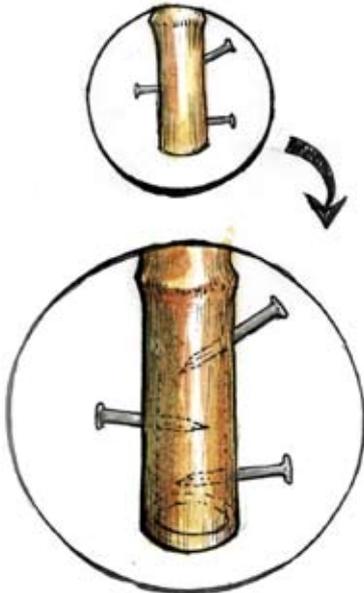
## Foundation

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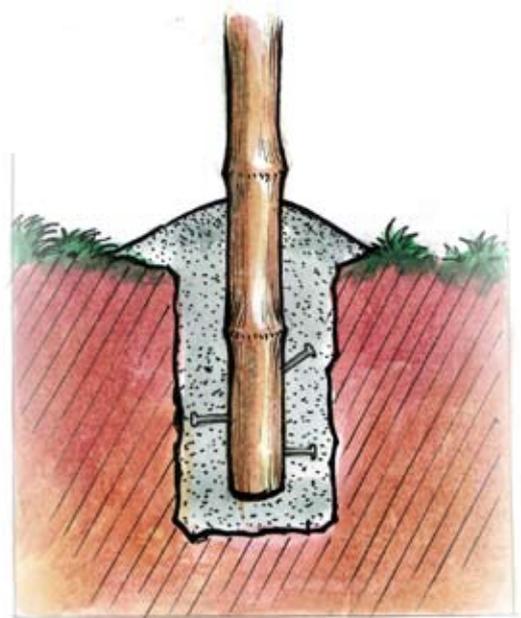
If you don't have a better choice, this is a simple way to anchor a wooden pole in the ground.



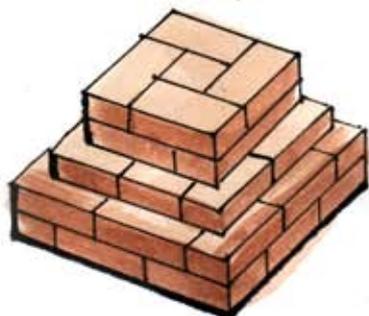
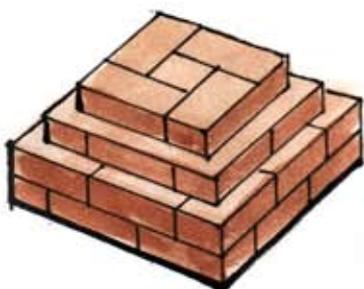
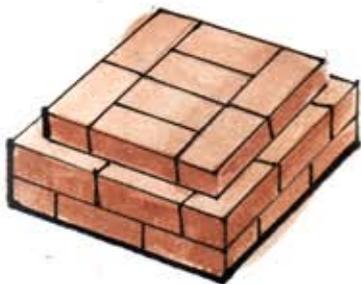
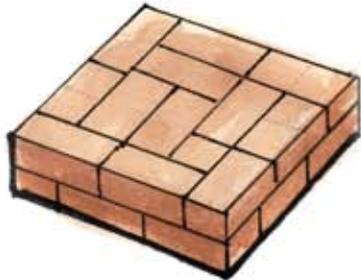
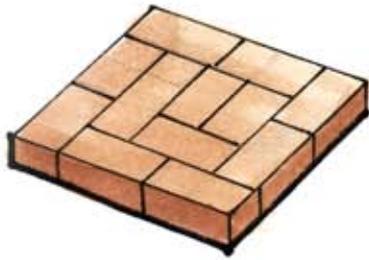
Dig a hole 30 cm by 60cm



Add nails to increase resistance



Fill the hole with cement - sand - aggregate



**Brick pad footing:**

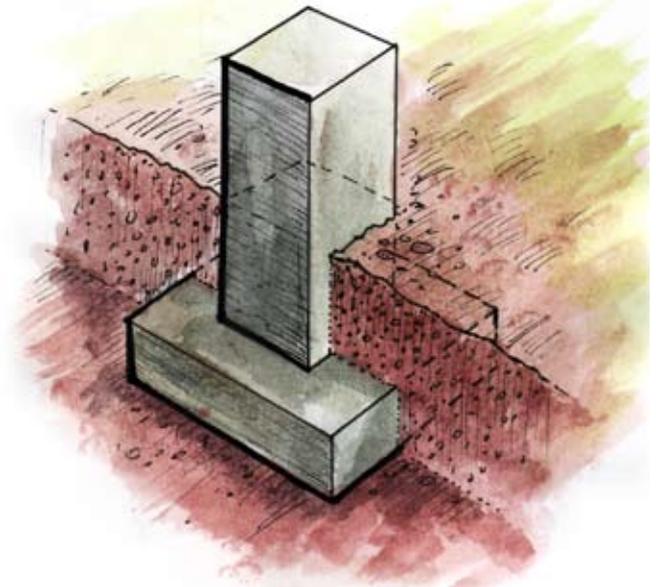
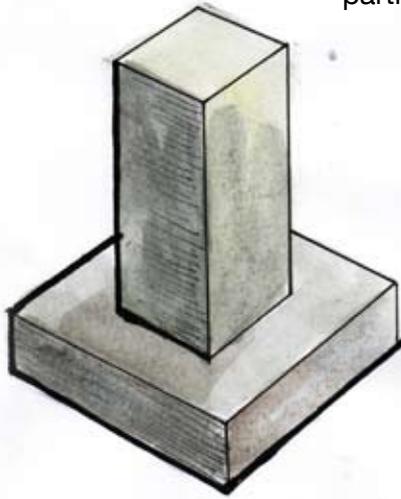
for small shelters brick pad footings can be a solution to lift the wooden poles from the ground.

Build each footing with 4-5 layers of solid brick using a mortar mix of: 3 part of sand, 1 part of cement

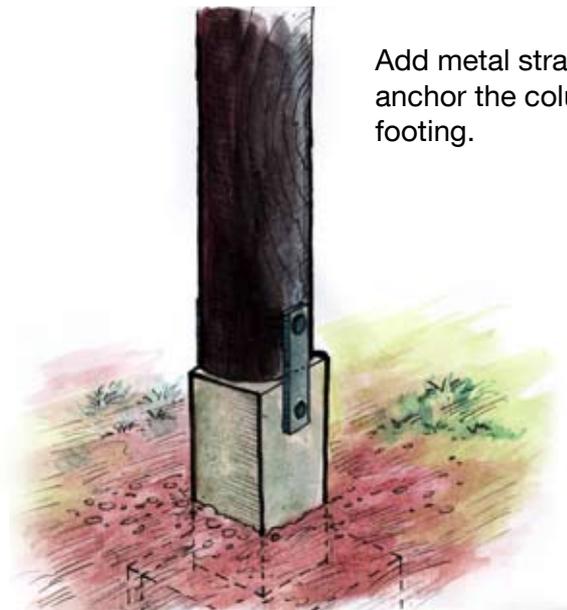


**Concrete footing:**

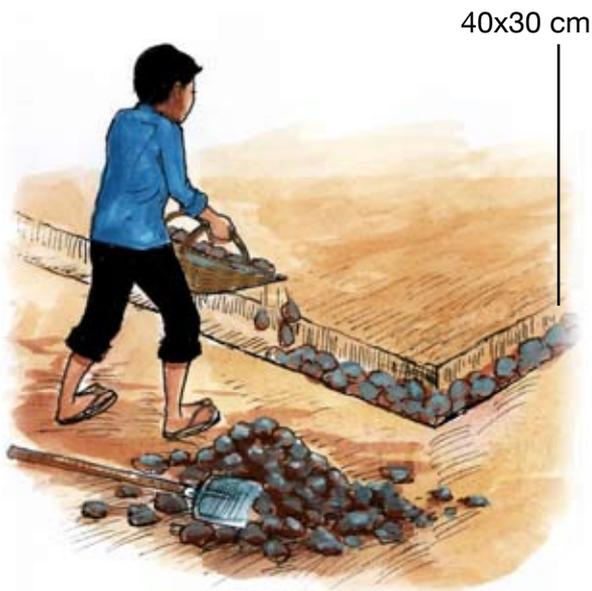
if you can buy a precasted concrete pad footing, partially dig the footing underground.



Try lifting the footing to check if it is stable enough.



Add metal straps to anchor the column to the footing.



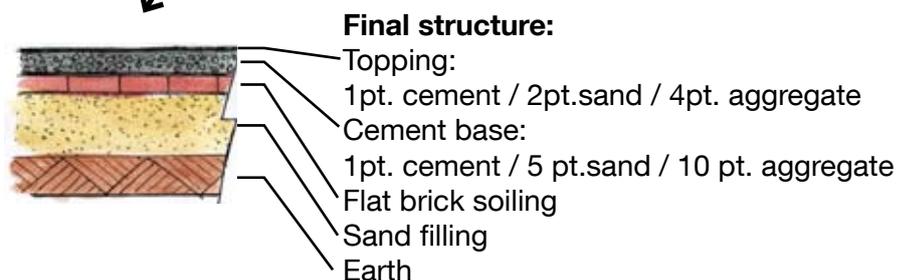
Strip footing:  
Dig a trench 40cm deep and 30 cm wide.  
Fill it with stones.

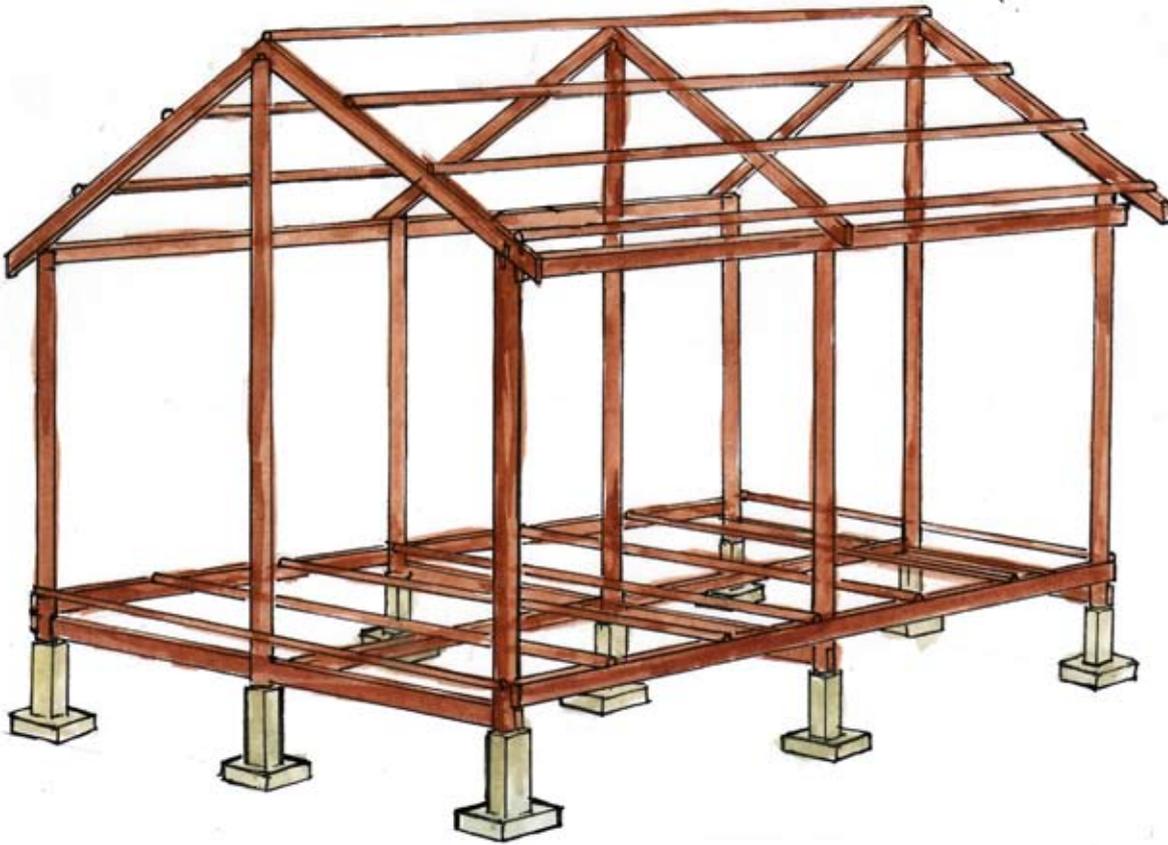


Build a brick wall.

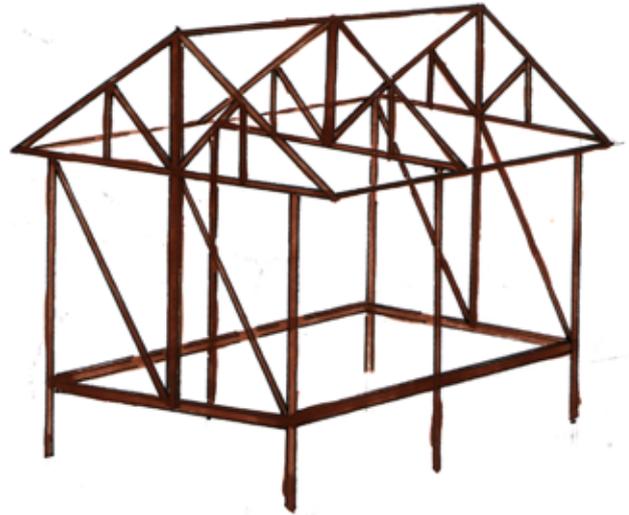


Fill the internal space using soil.  
After filling compact it.

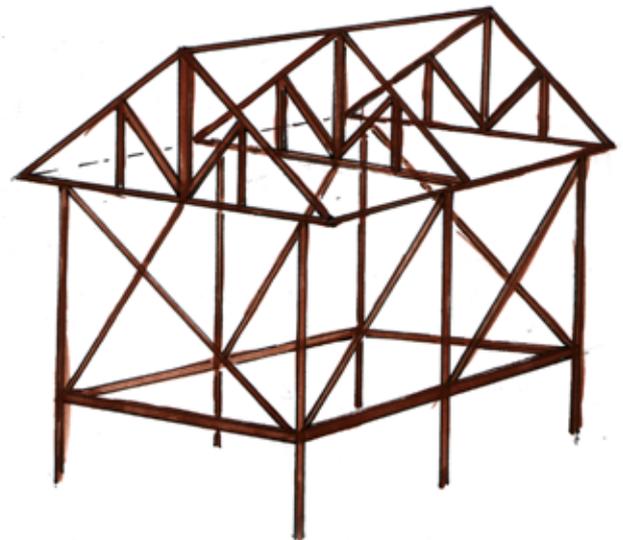
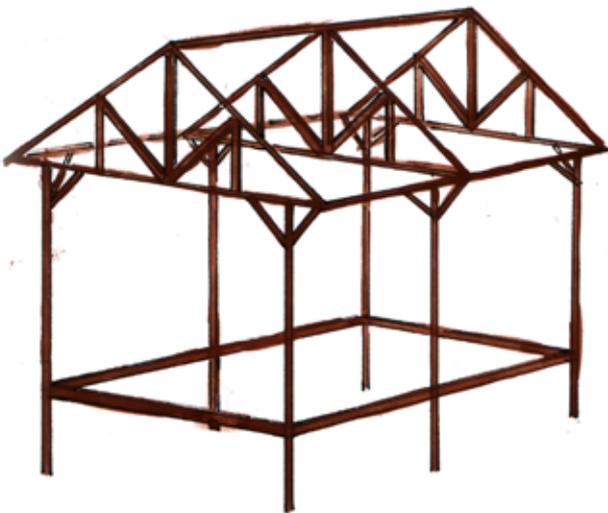




# STRUCTURE

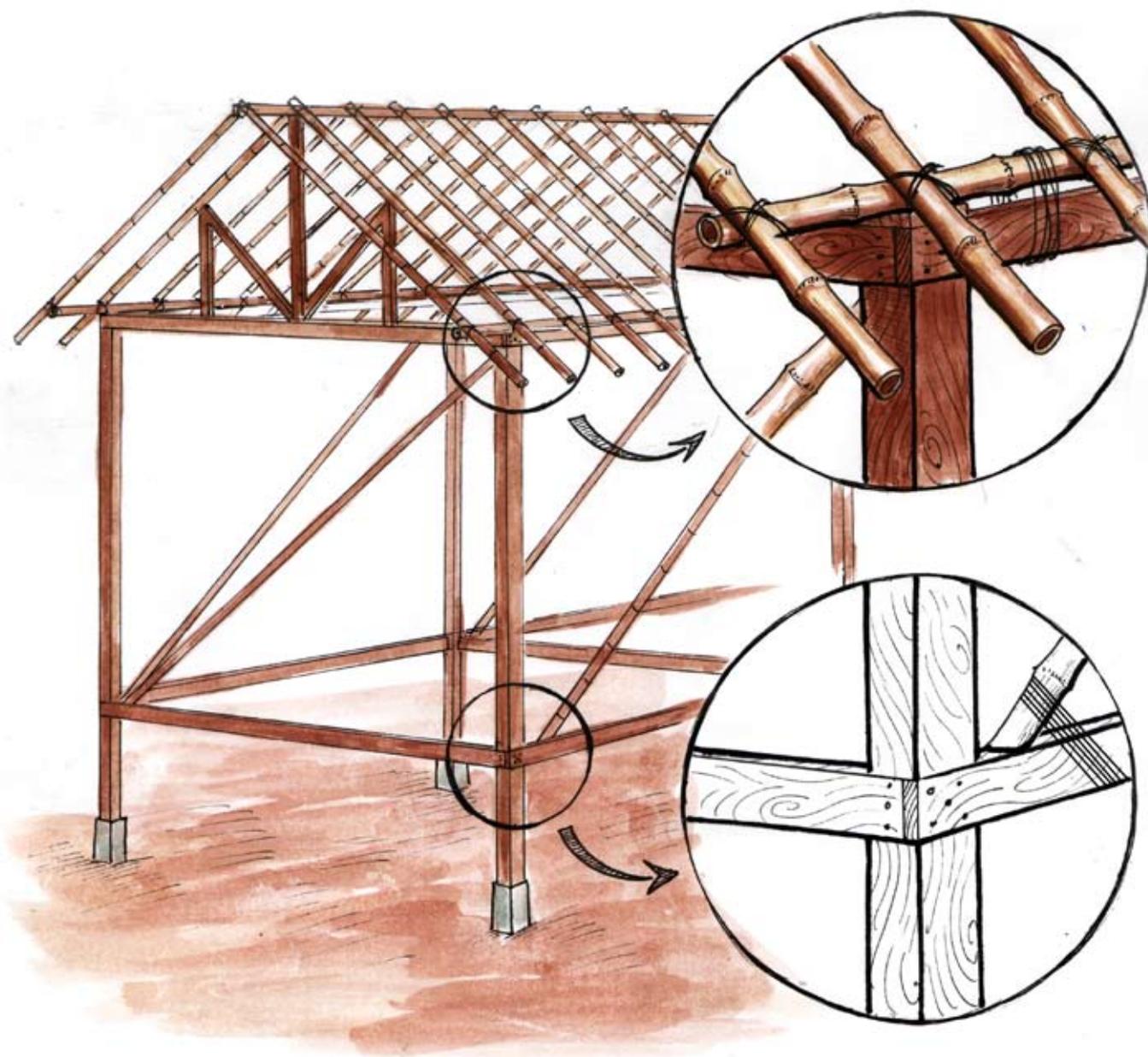


Bracing:  
Every part must be held rigid, so the shelter can not tilt or rotate.  
There are different ways to do so depending on your resources.

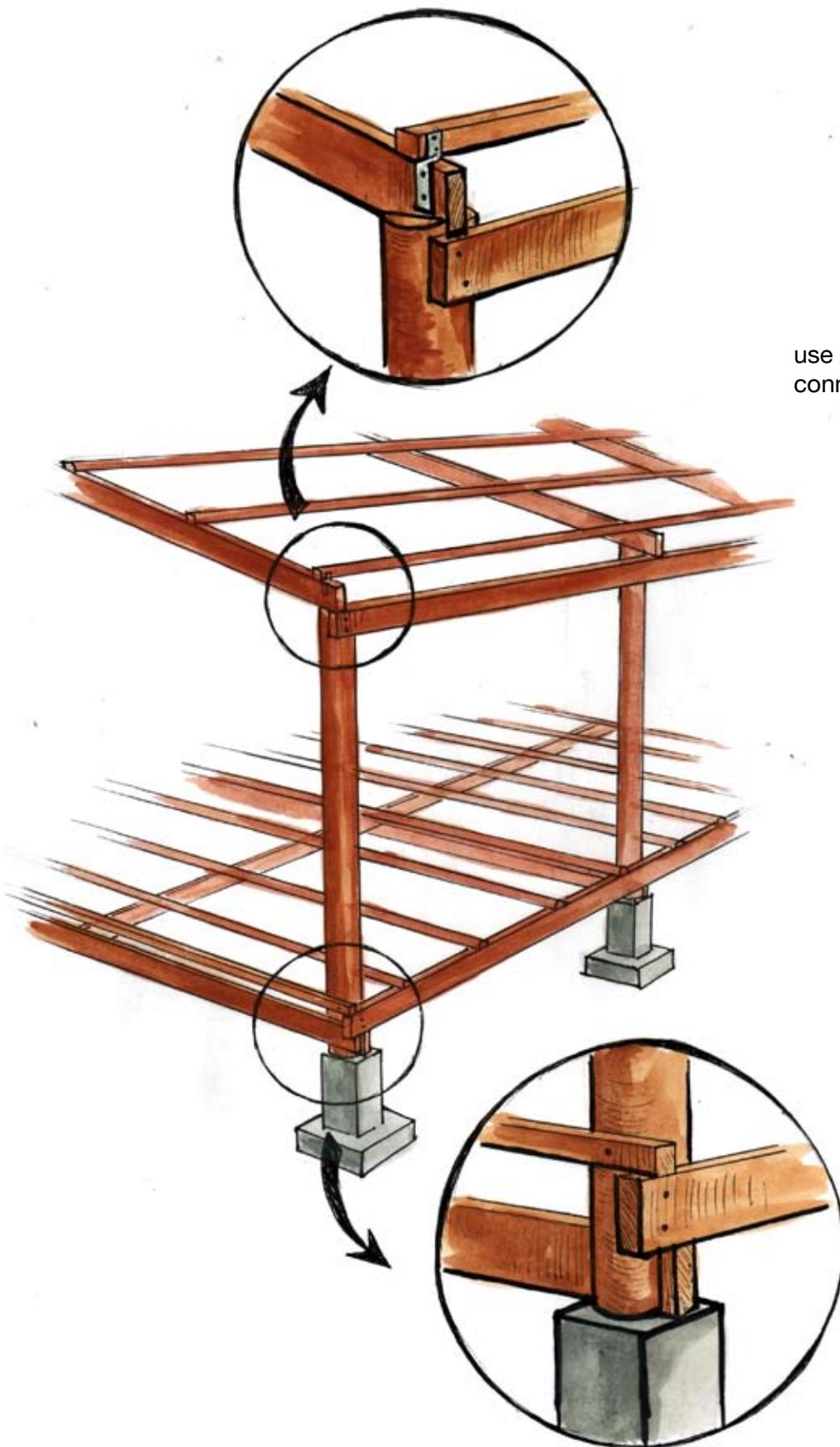


Corner joints are very important.  
Make sure all parts are well tied together.

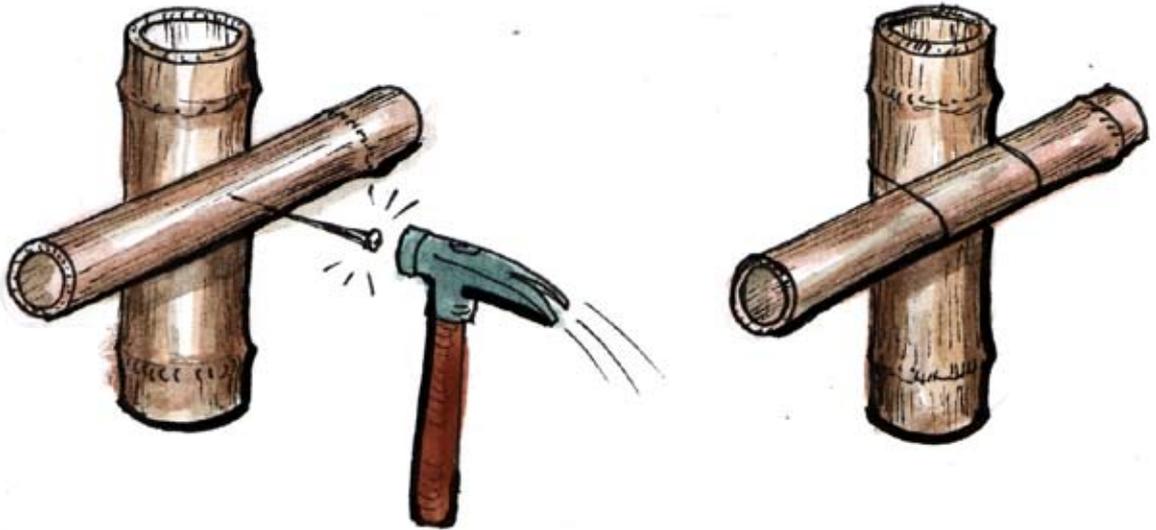
If you are joining wood to bamboo it is better  
to tie the bamboo instead of using nails.



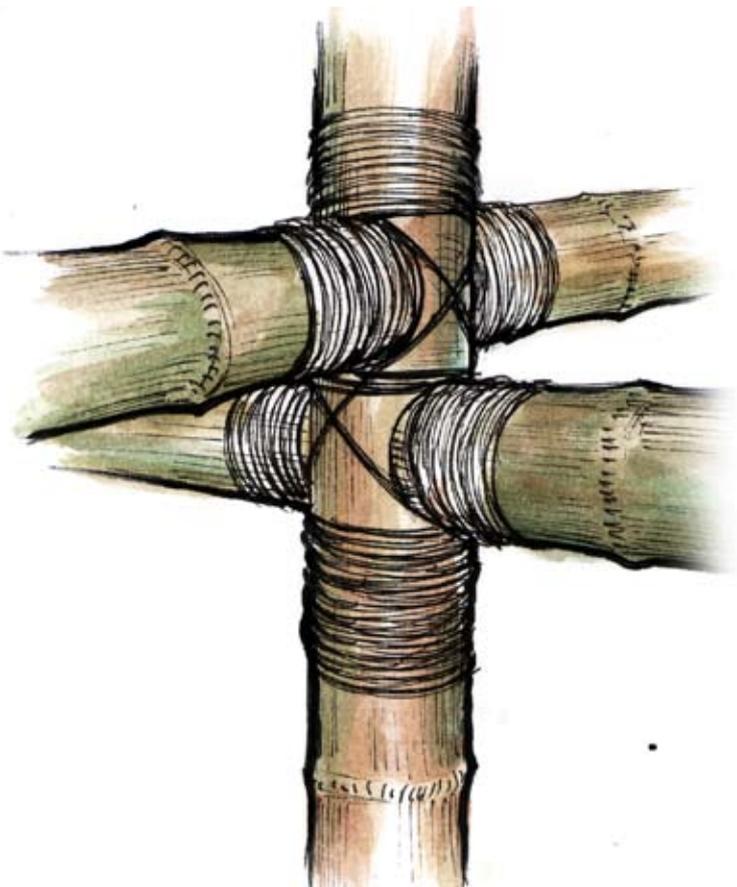
In a column-beam joint, carving the column  
helps to make the joint stronger.

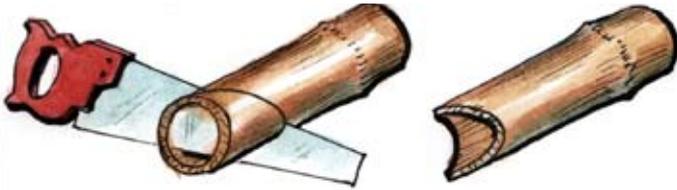


use metal strap with screws to connect wooden parts for the roof.

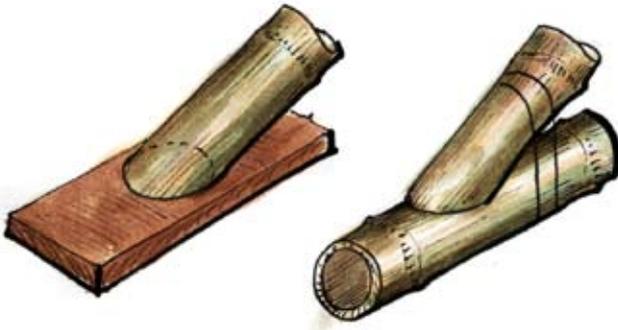


It is better to tie bamboo pieces instead of using nails that could break the bamboo pieces.





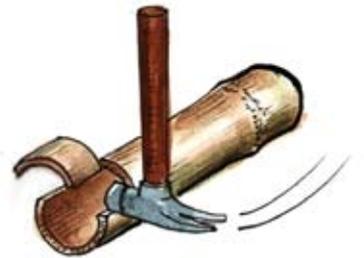
A possible bambo to bamboo joint.



1

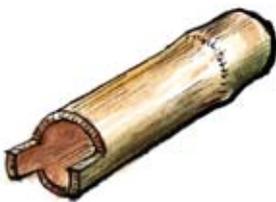


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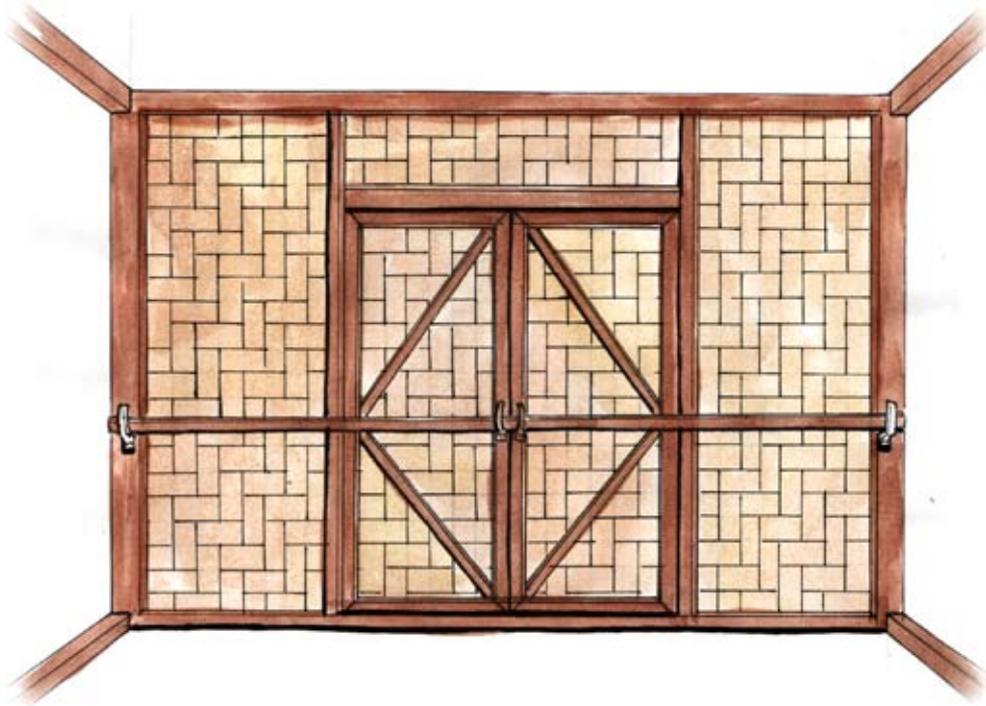
A possible bambo to wood joint.



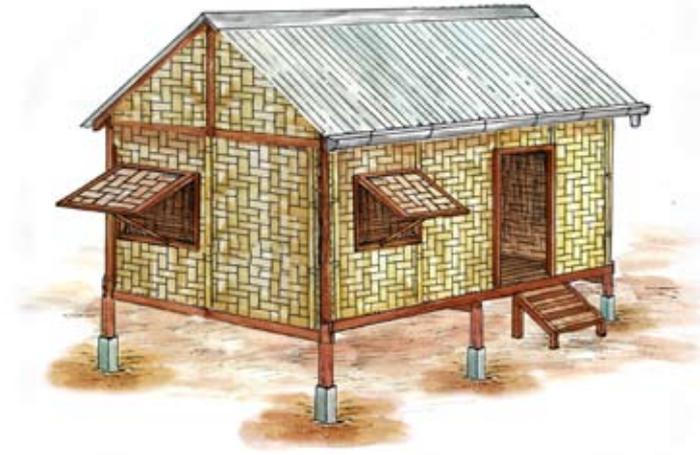
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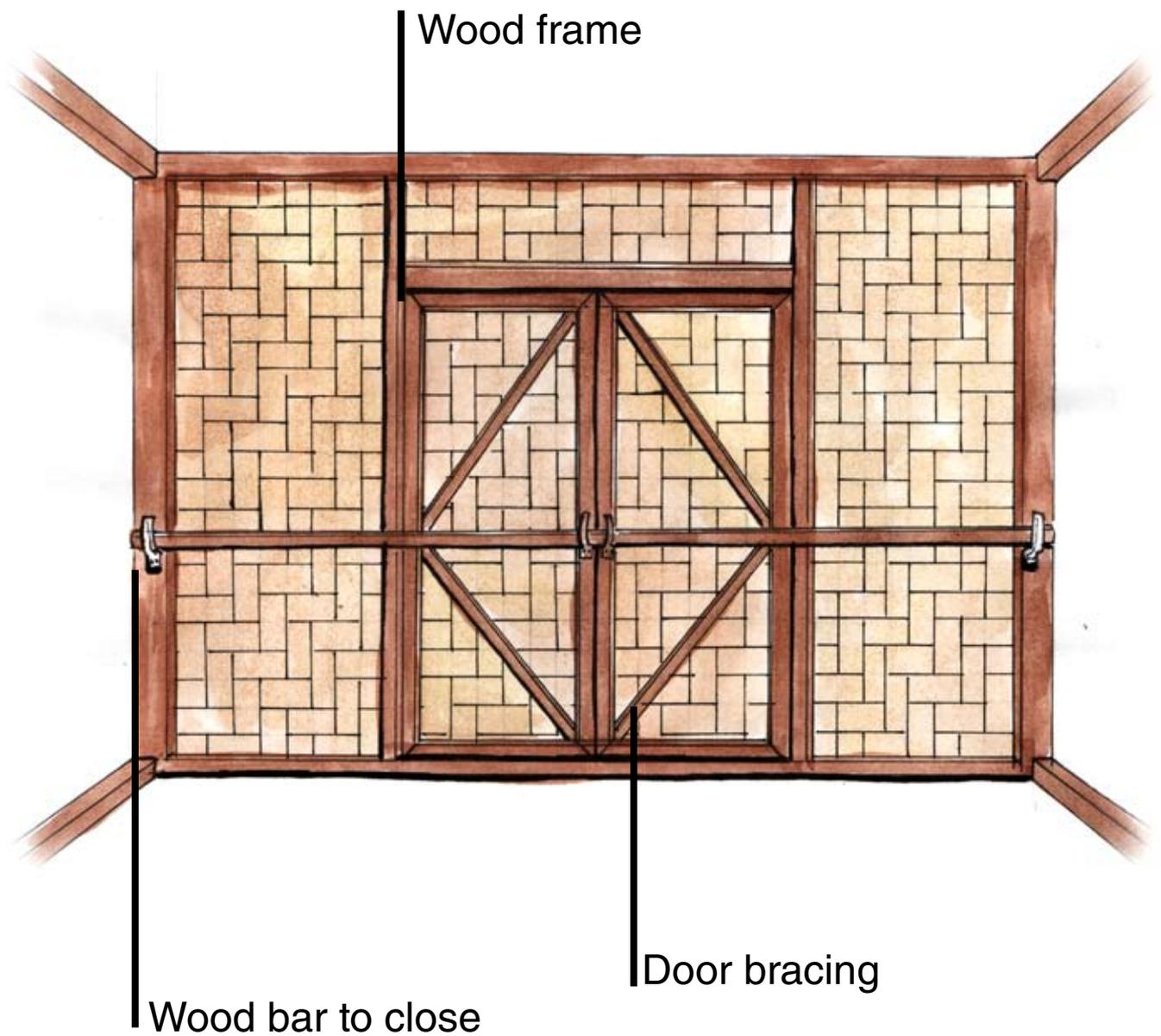
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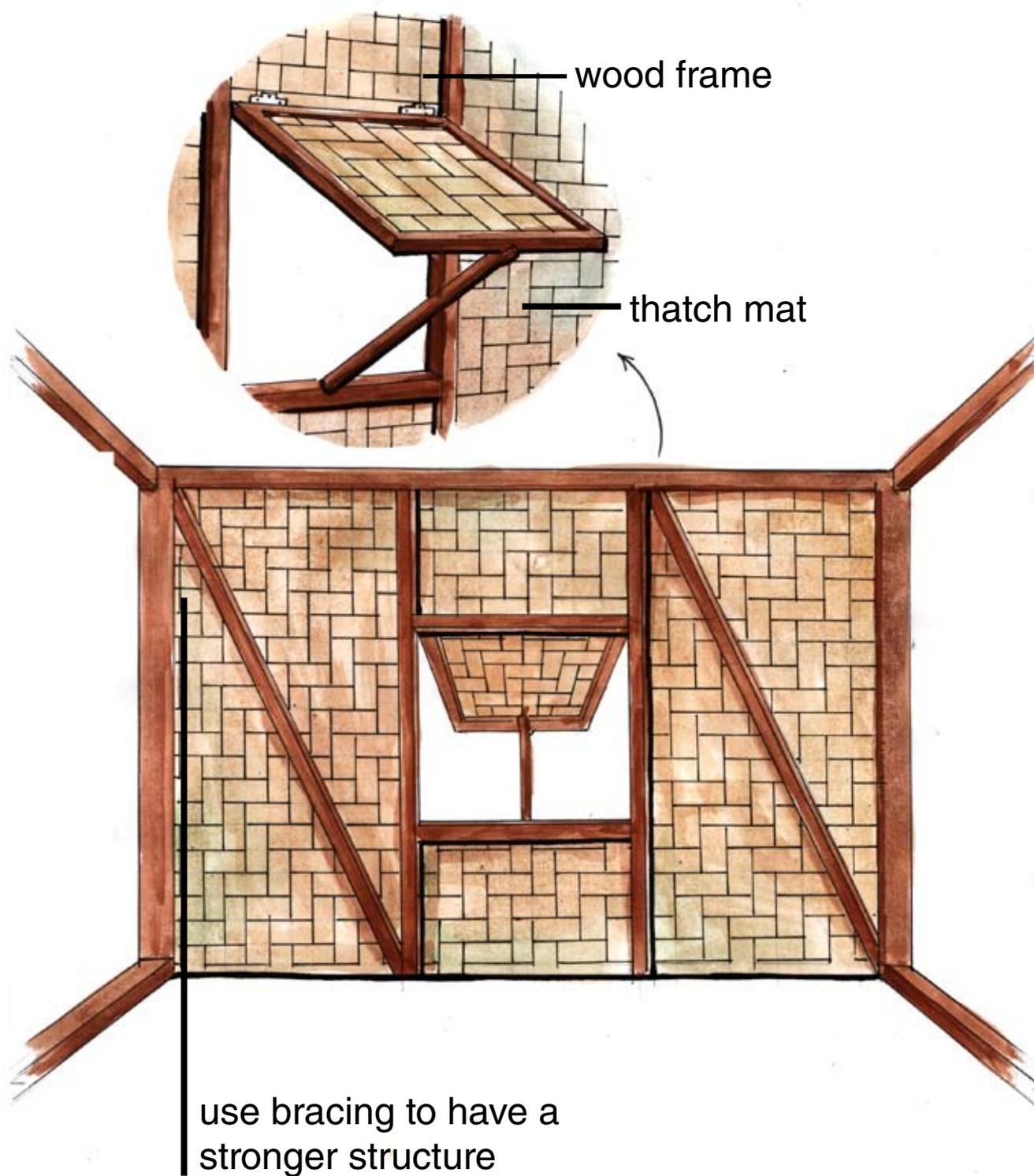


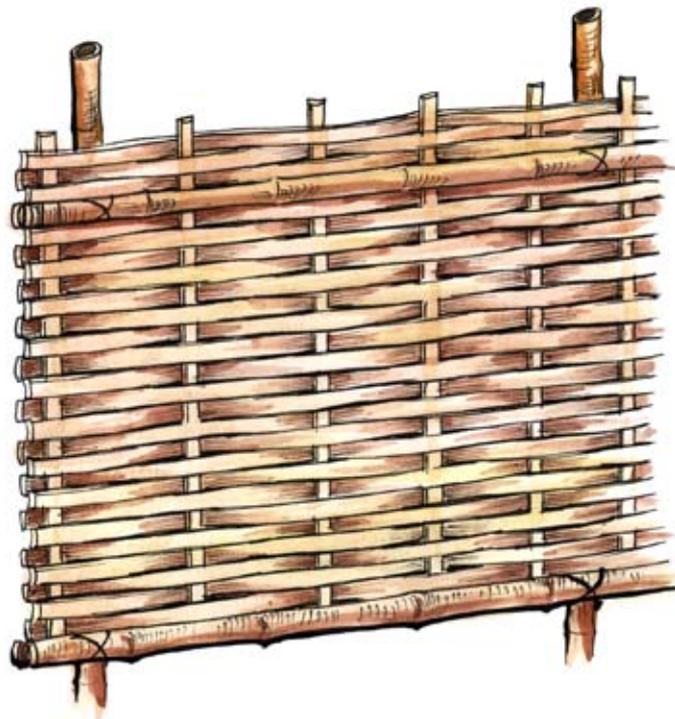
# DOORS AND WINDOWS



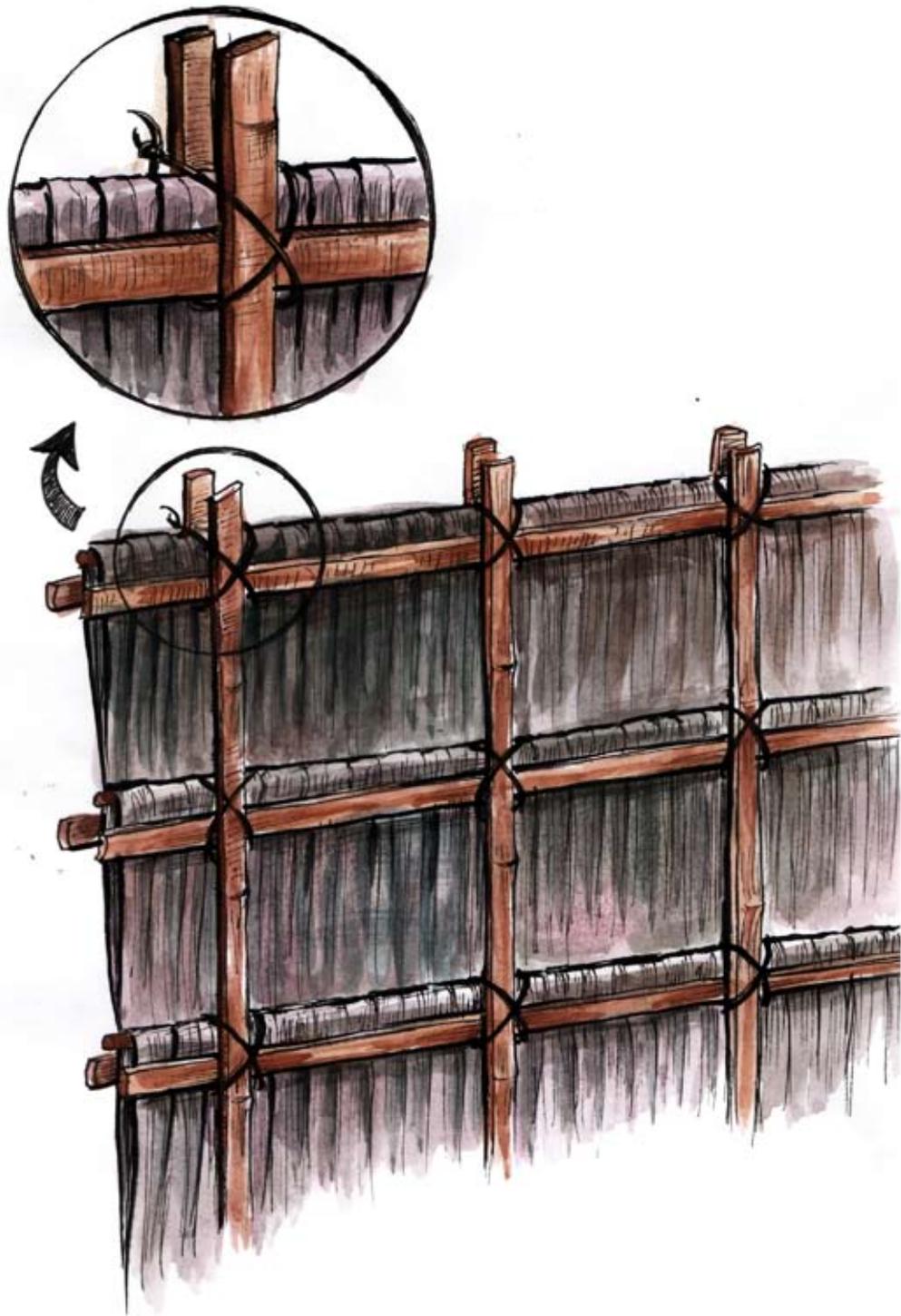
Windows and doors are important because they provide ventilation and natural light.





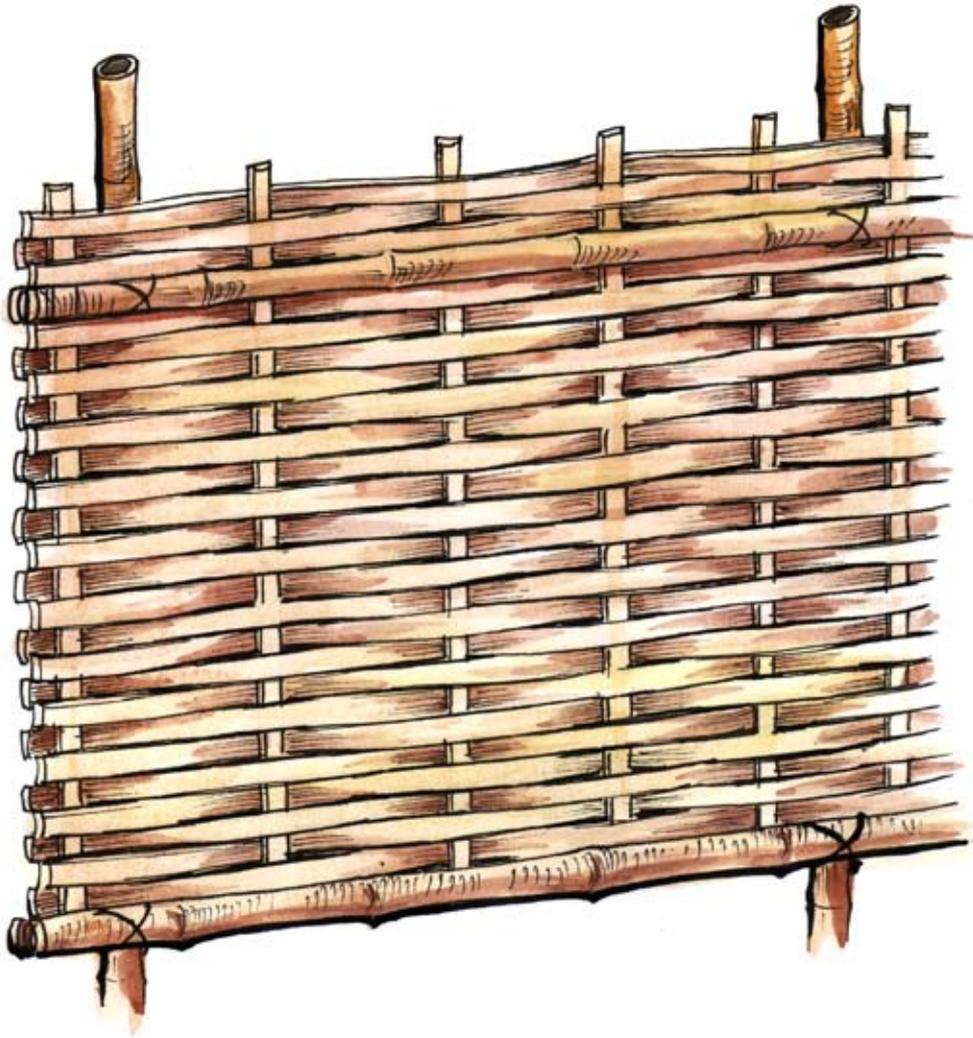


# WALLS



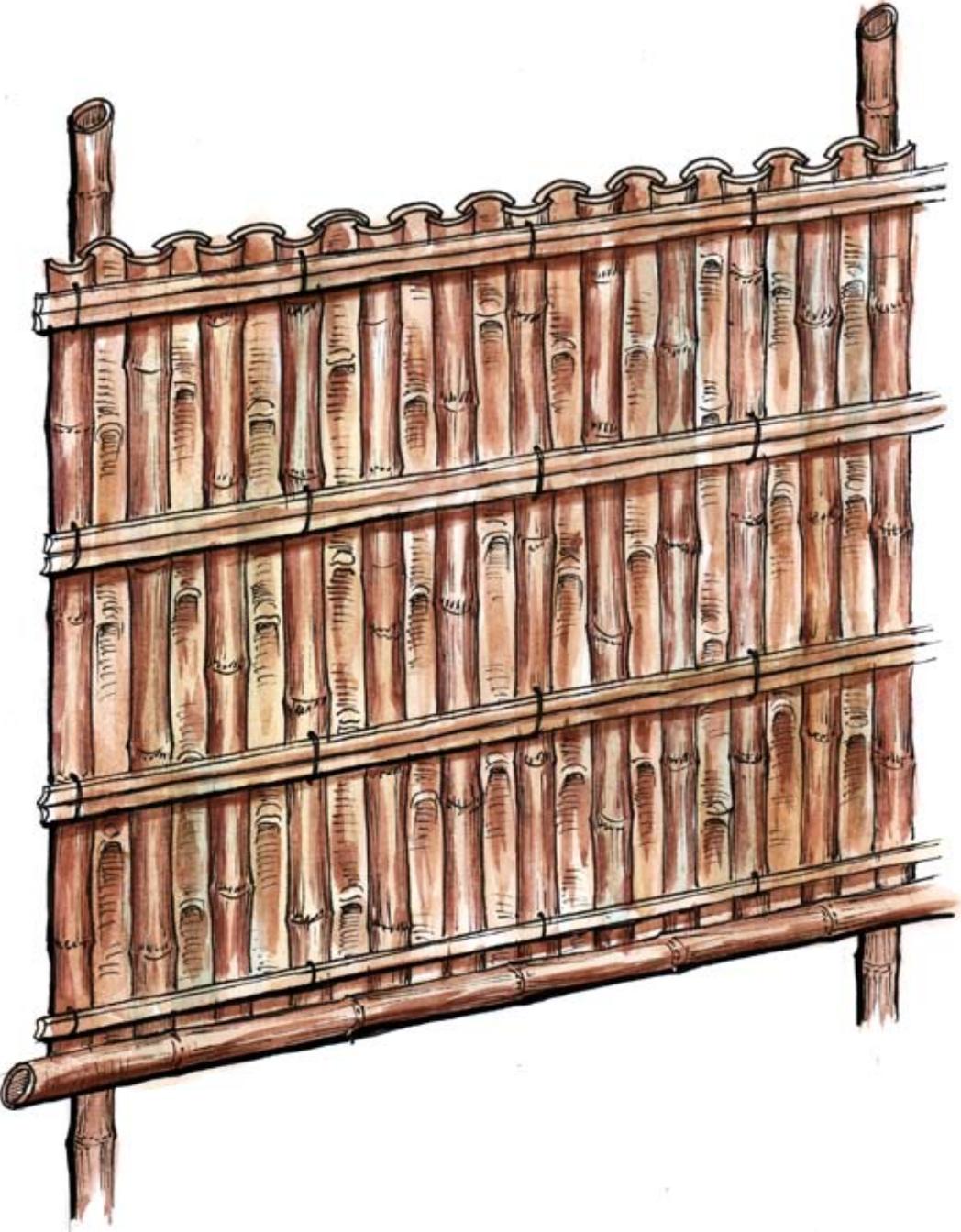
Wall made using leaves mounted on a bamboo frame.

Another option for the wall.  
You can use wood strips or bamboo strips.



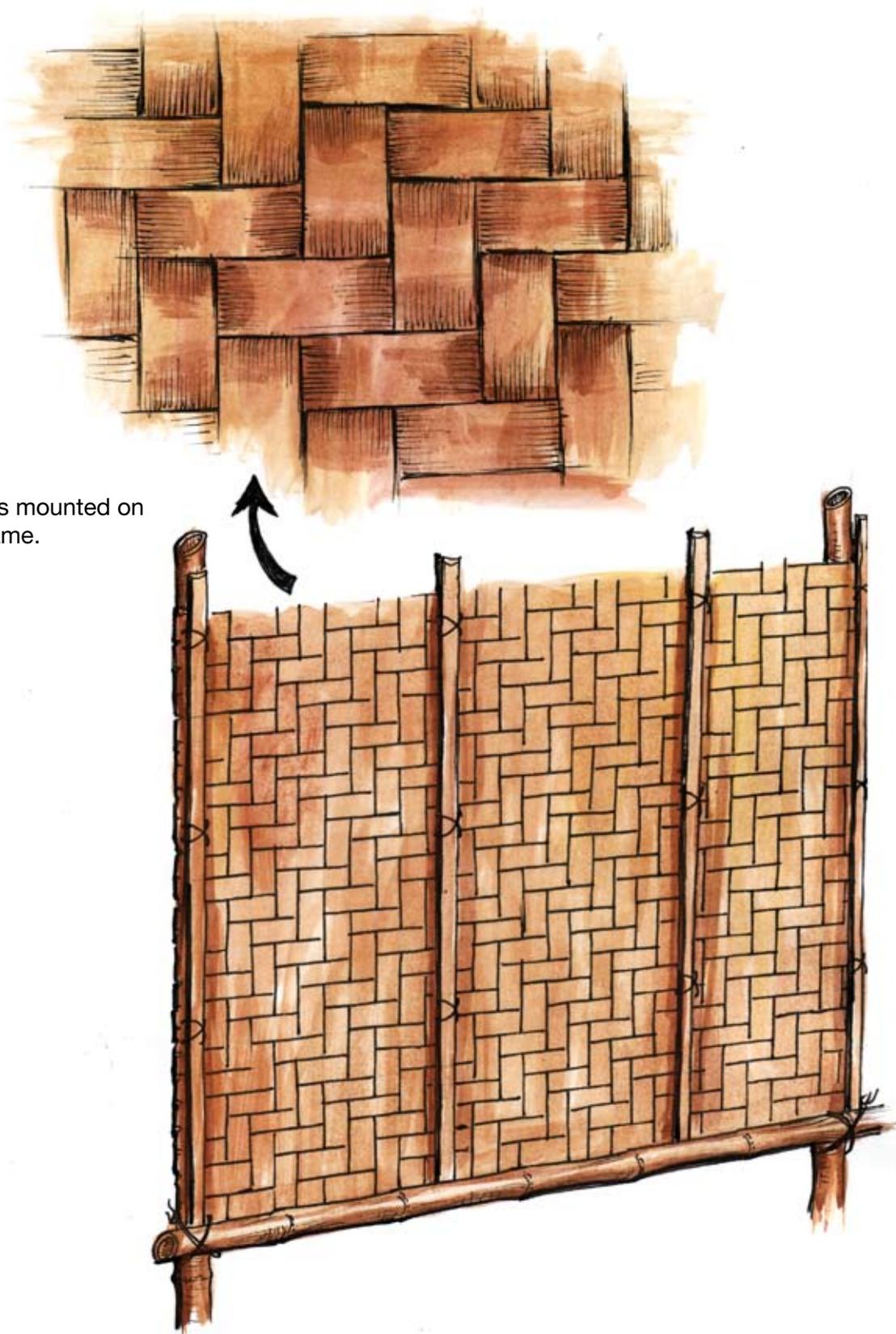
Wall with bamboo strips nailed to the frame.

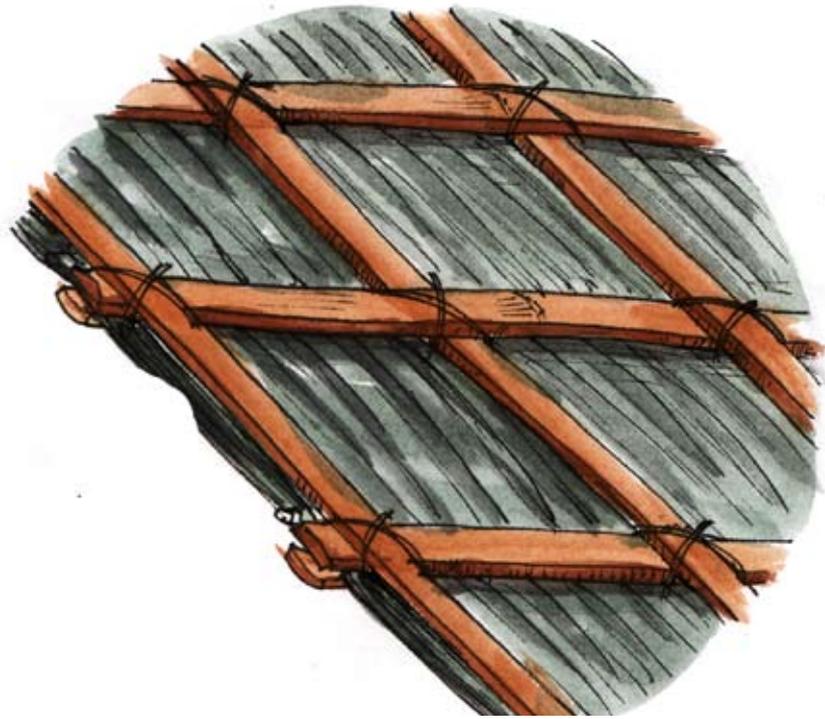




This wall uses half cut bamboo fixed on both sides by bamboo stripes

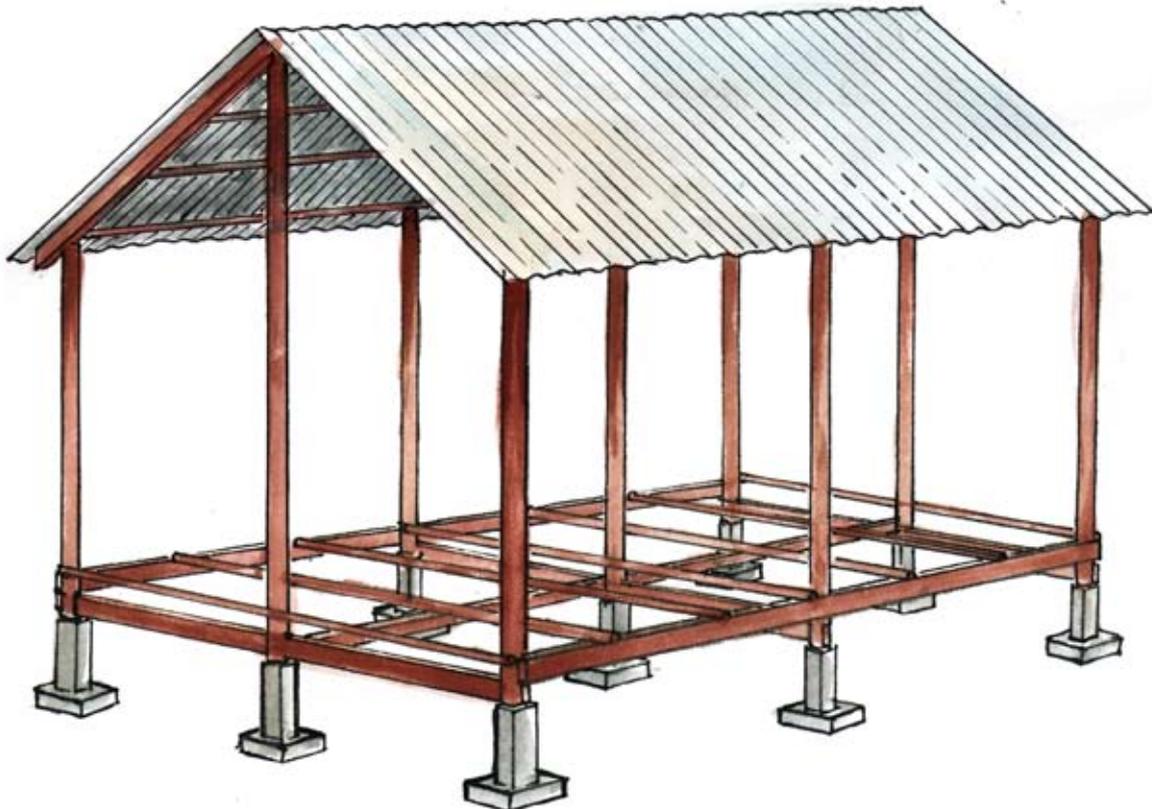
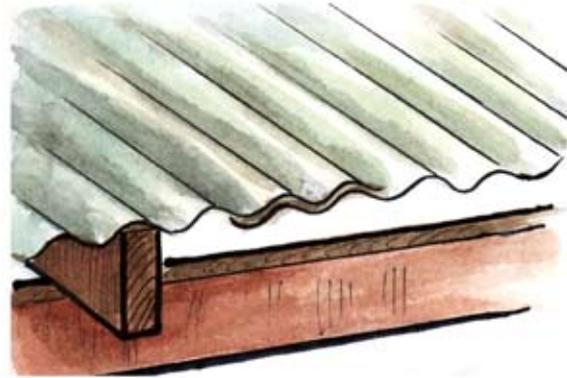
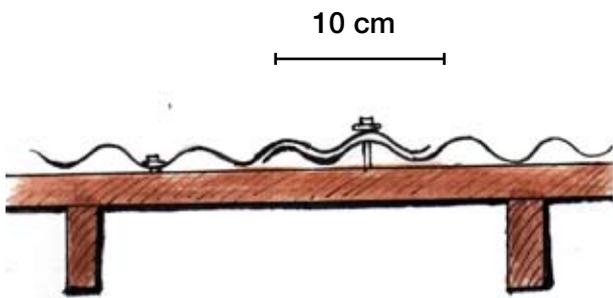
Woven mats mounted on bamboo frame.

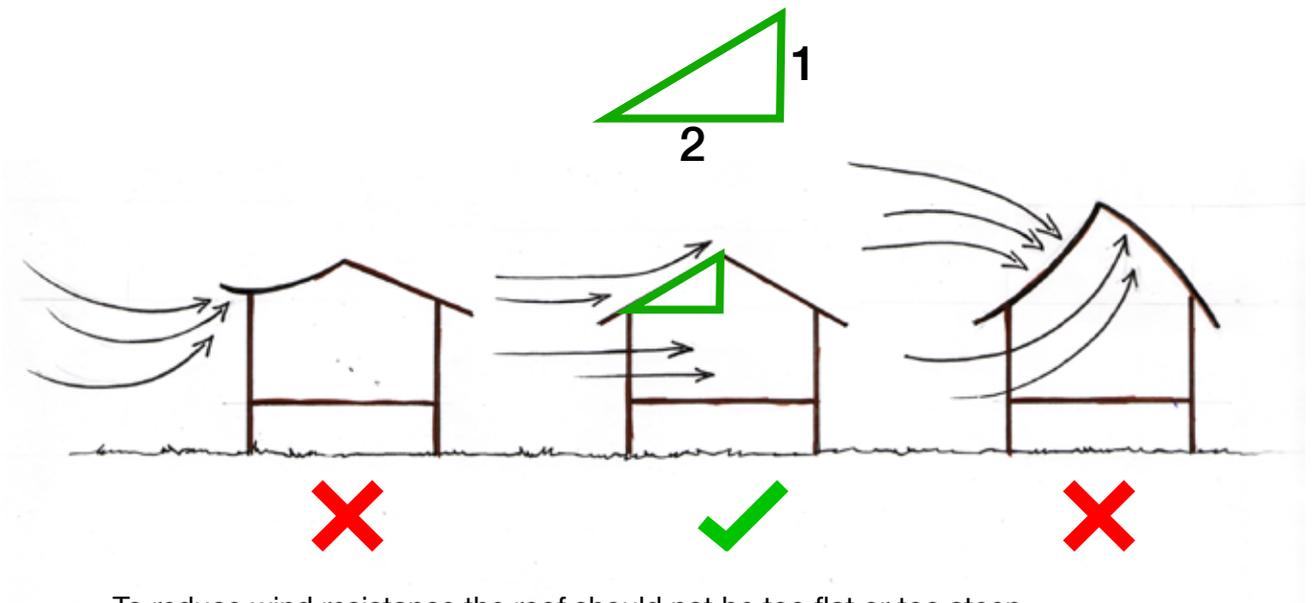




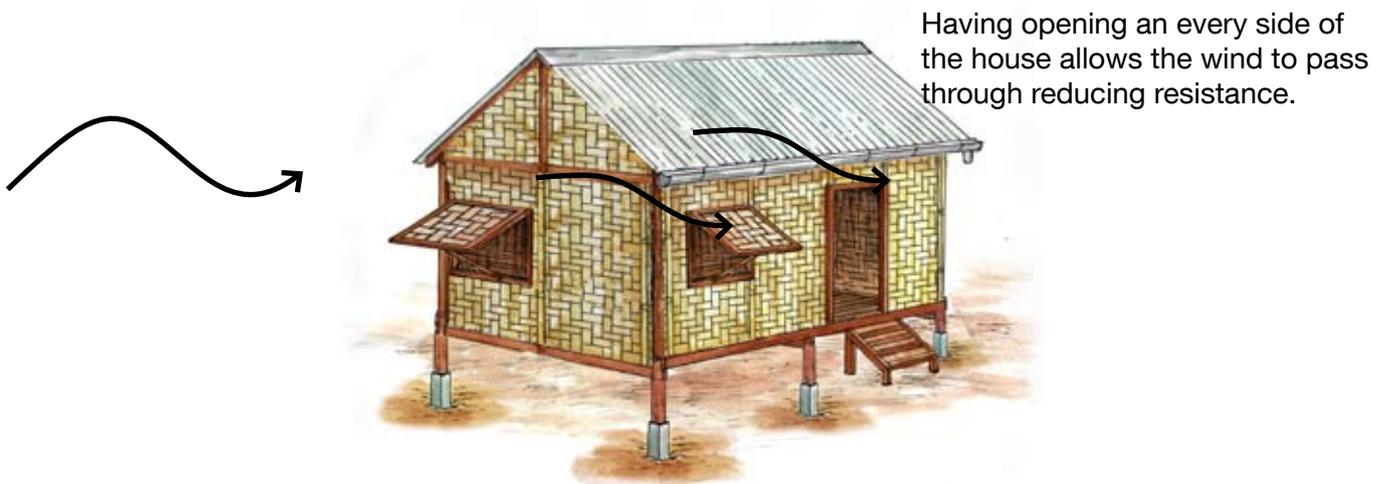
# ROOF

Overlap zinc sheeting by 10 cm.





To reduce wind resistance the roof should not be too flat or too steep. A 30 degrees angle is optimal.

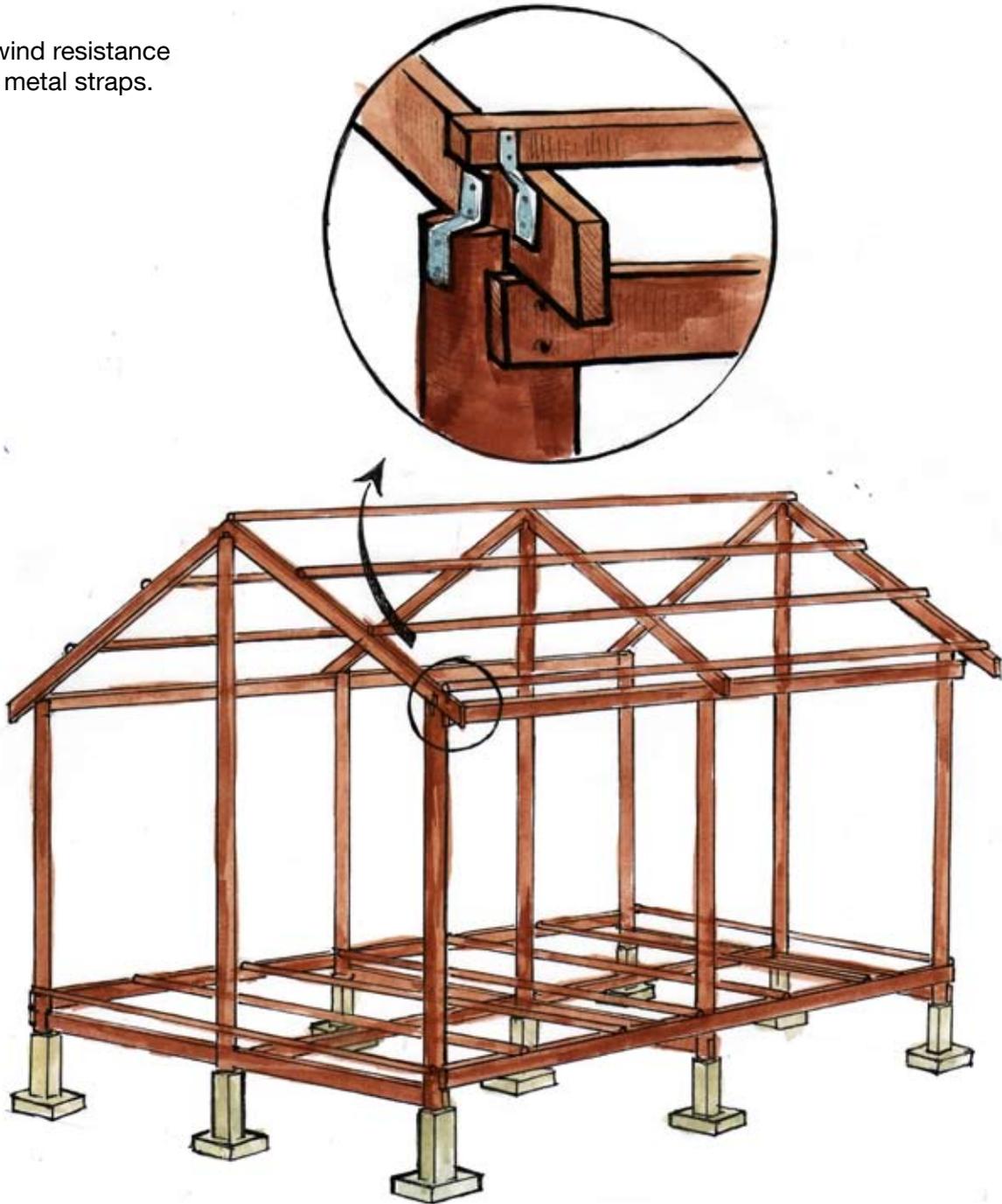


Having opening an every side of the house allows the wind to pass through reducing resistance.

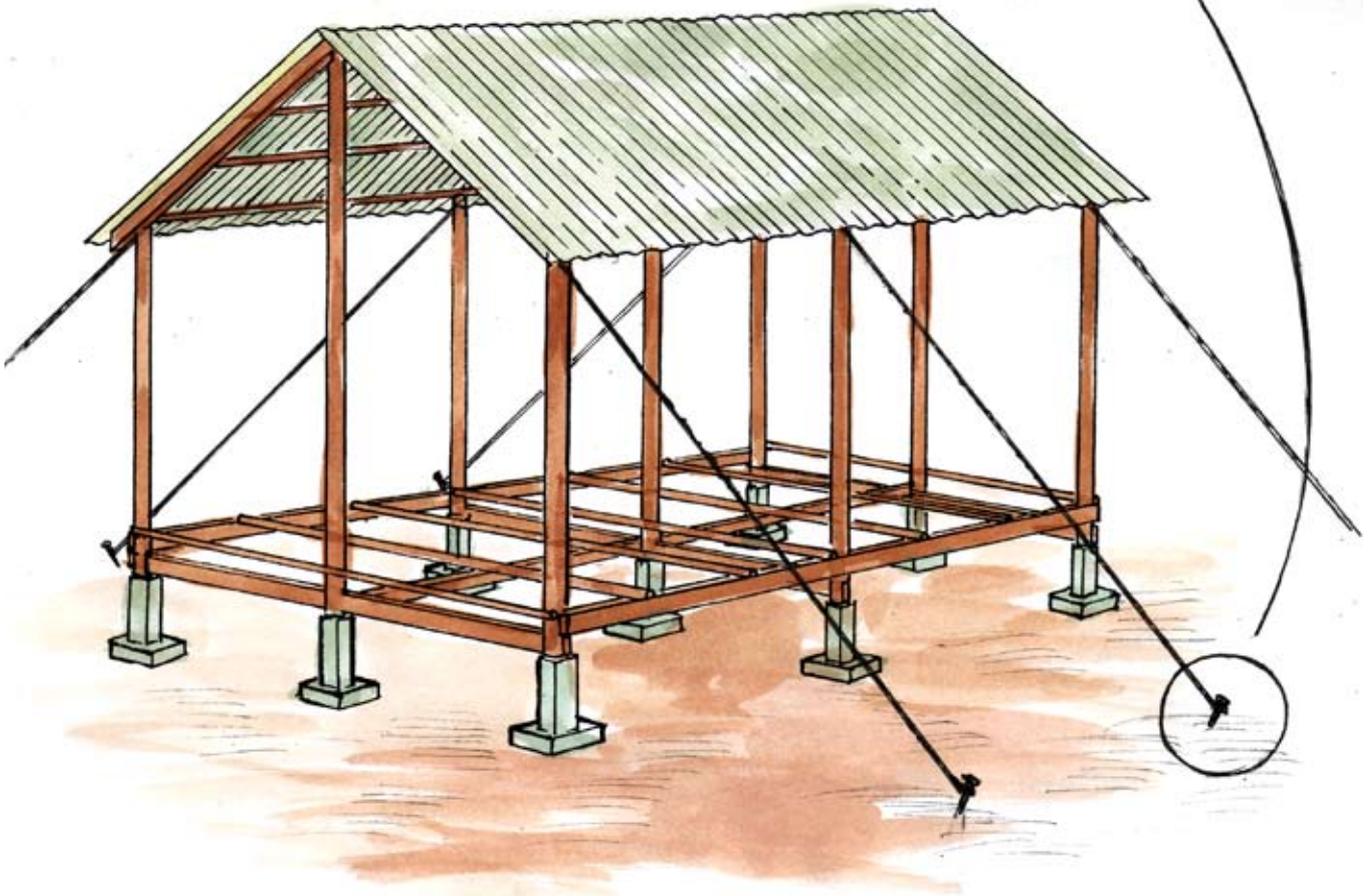
## Roof

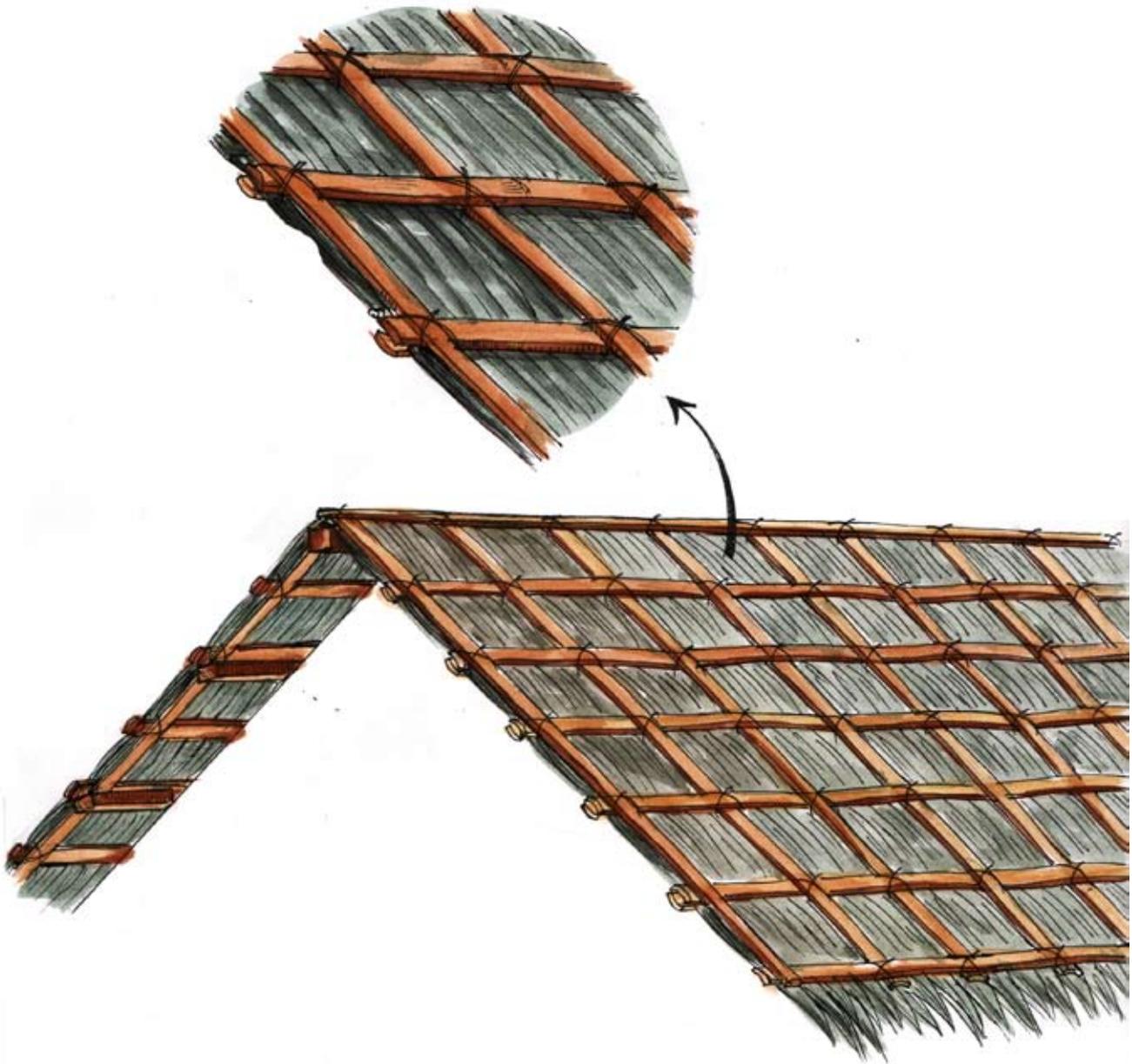
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To increase wind resistance  
You can add metal straps.

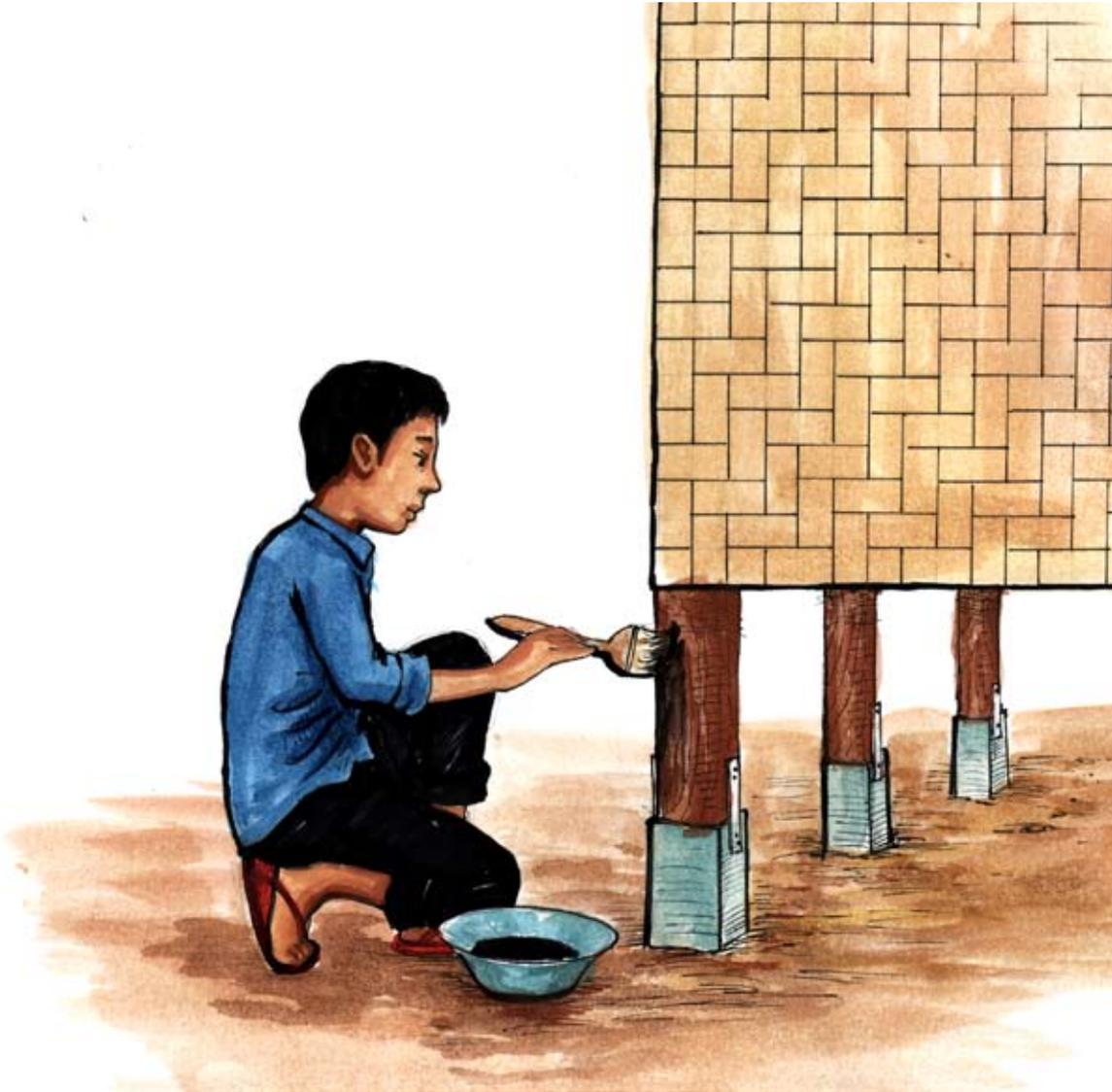


For wind prevention, the house can be tied to the ground using metal cables.



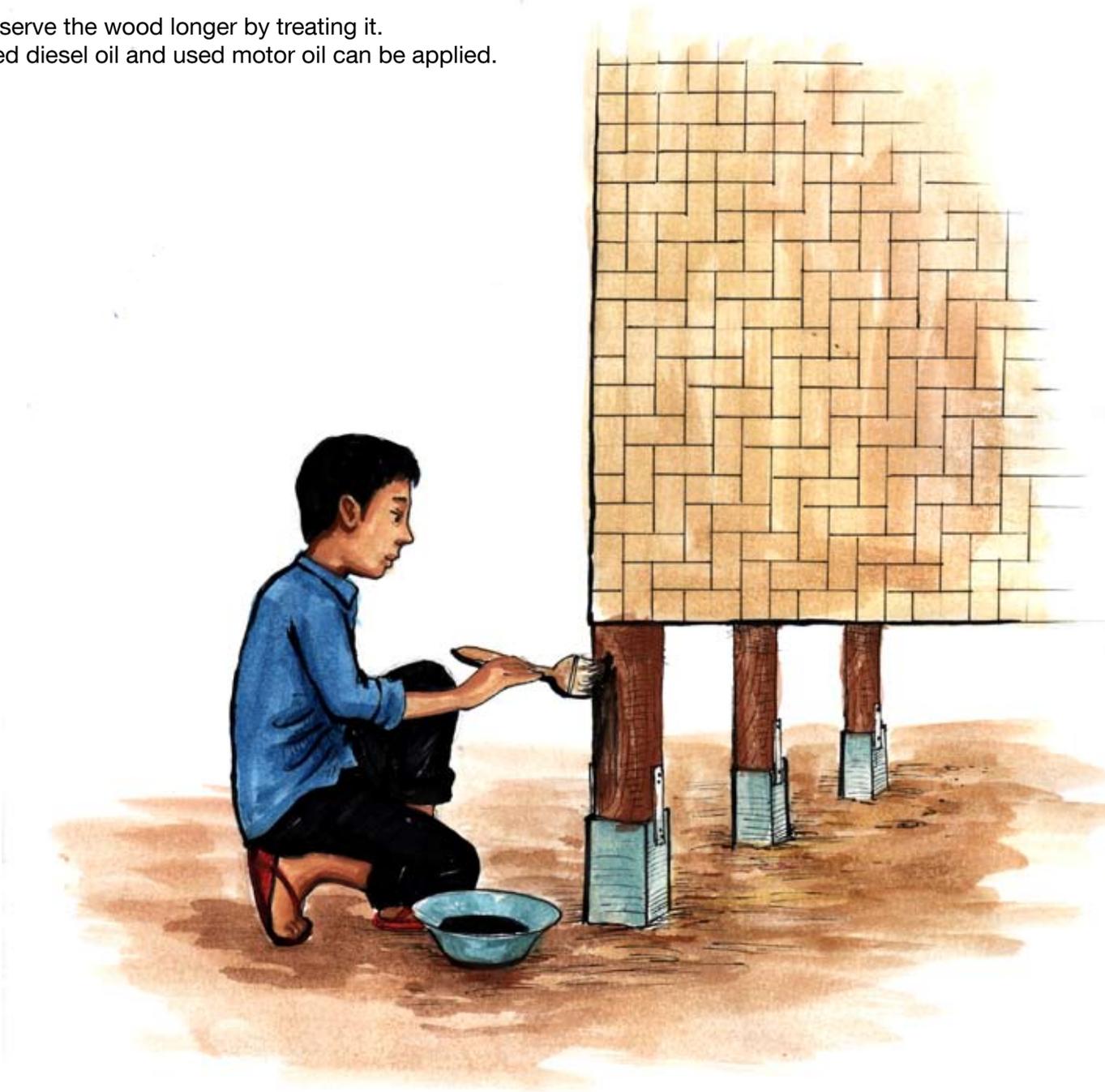


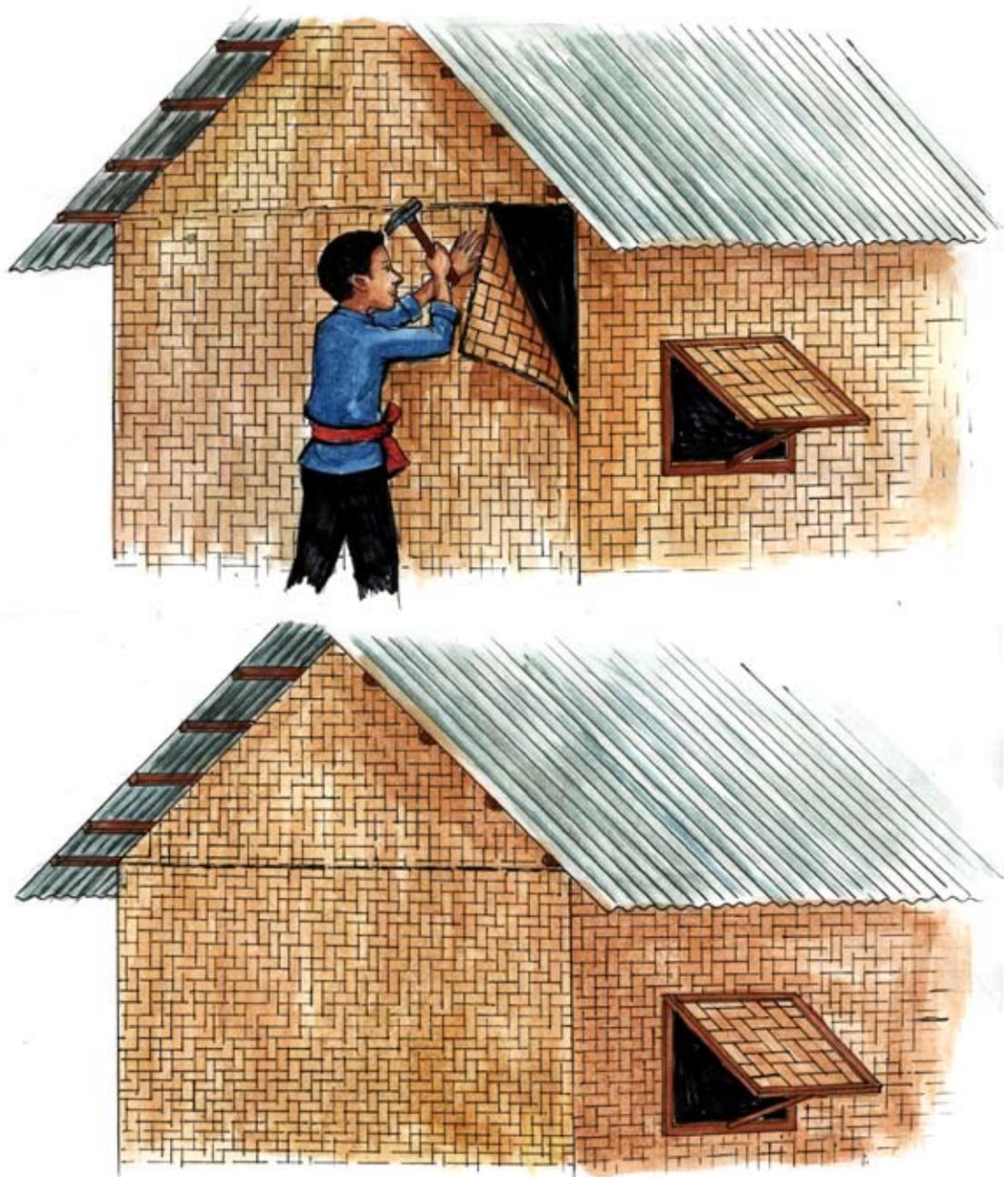
You can reinforce a thatched roof by adding bamboo stripes on the top and tying them to the main structure.



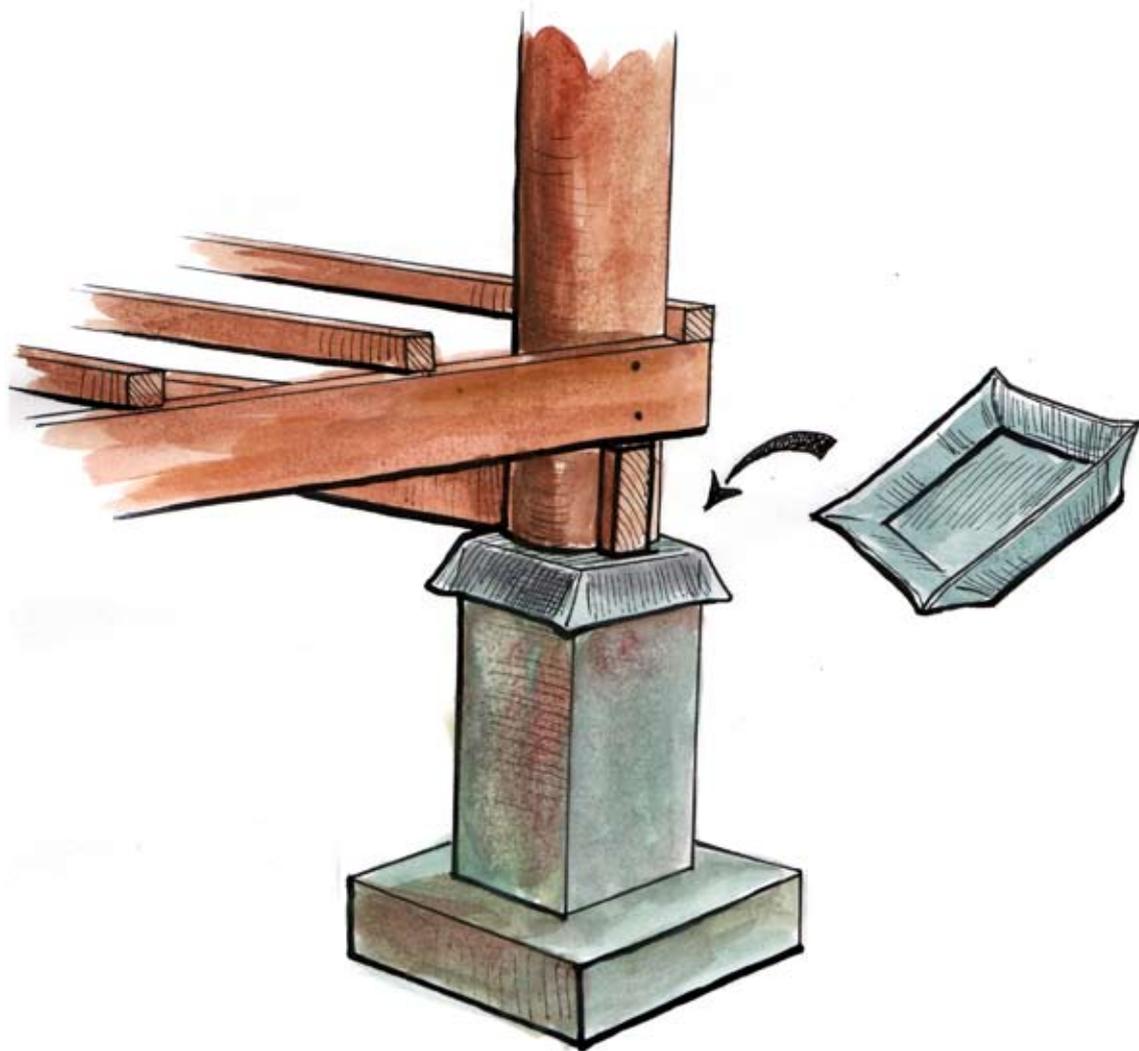
# MAINTENANCE

You can preserve the wood longer by treating it.  
A mix of used diesel oil and used motor oil can be applied.

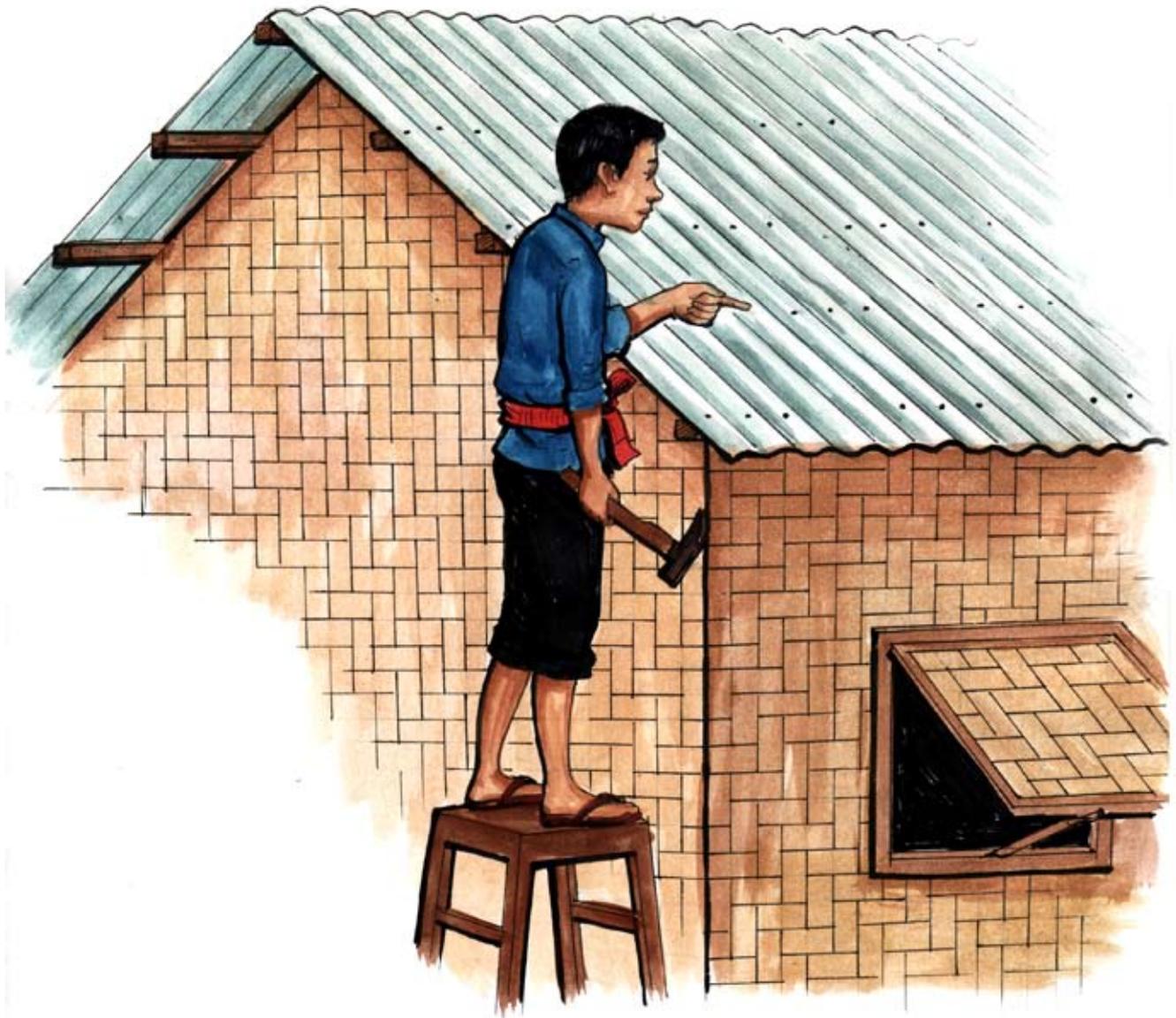




Make sure the mats for the walls are well tied to the structure.



You can reduce termite and rats presence in the house by placing metal caps under columns.



Regularly check the condition of the roof.  
Replace and repair screws that are coming off.



## Bill of quantity:

### House size 6m x 4m

Part	Specification (sizes in mm)	Qty
Pad foundation	Precast concrete	9
Column	Round column diameter 150mm x 2500mm	6
	Round column diameter 150mm x 3000mm	3
Floor beam	120x50x3000	6
	120x50x4000	3
Floor joist	80x50x4000	14
Bamboo strip for floor	20x3000	210
Bamboo poles for vertical support	2500mm	6
Bamboo for window frame	1000mm	6
Bamboo for bracing	2700mm	6
Bamboo for bracing	3000mm	6
Roof beam	120x50x3000	4
	120x50x4000	3
Common rafter	80x50x2500	6
Roof purlin	50x50x6000	8
Zinc sheeting	700X2500	20
Roof nails	160 ca	
Wood nails	different sizes	120
Gutter	6000	2
Metal sheet for roof gable	600x6000	1
Hurrican straps	40mm wide, 500mm long 1.5mm thick	6



## **People In Need**

Address: # 83, St 150,  
Sangkat Phsar Depot 2,  
Khan Toul Kork,  
P.O Box 620,  
Phnom Penh, Cambodia

PIN-Cambodia Website:  
[www.clovekvtisni.cz/en/humanitary-aid/country/cambodia](http://www.clovekvtisni.cz/en/humanitary-aid/country/cambodia)