HURRICANE RESILIENT WOODEN HOUSES

safer building and retrofitting guidelines

Habitat for Humanity®

USAID
FROM THE AMERICAN PEOPLE

HURRICANE RESILIENT WOODEN HOUSES

safer building and retrofitting guidelines

Author of text and drawings
Arch. Celia Izquierdo Pérez
celia.izquierdo.perez@gmail.com
Technical Advice
Arch. Javier Cidón Martínez
Language Advice
Salina Solomon
Mariah Travis
Coordination and Editing
Arch. Javier Cidón Martínez
Dr. Paulette Grifiths
Supporting Organization
Habitat for Humanity International
Regional area office for Latin America and the Caribbean
ICHaB. Unesco Chair on Basic Habitability.

These guidelines were produced for the urban disaster risk reduction project BRACED (Building Resilience and Capacities for Emerging Disasters) which was implemented by Habitat for Humanity in Portmore, Jamaica from 2014 to 2017. It was funded by USAID-OFDA (Office of United States Foreign Disaster Assistance).

Cover pictures taken in Newlands and Naggo Head, Portmore, Jamaica

1st Edition. Kingston, Jamaica, August 2017.

INDEX

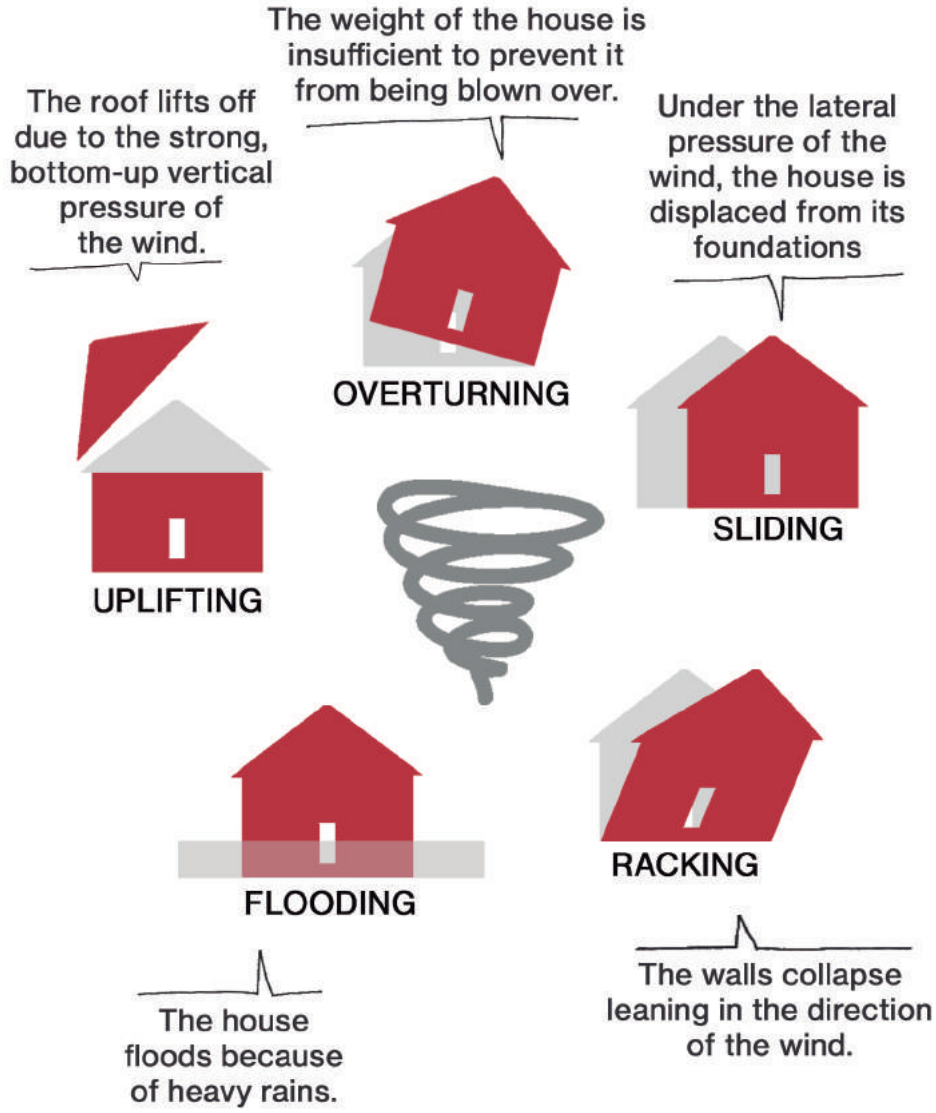
INTRODUCTION

These guidelines are easy to understand and are aimed to explain in a simple way **key solutions** to prevent wooden houses from being damaged in the event of a hurricane. The target audience is both building professionals and community members interested in safer building.

This publication explains through sketches the main vulnerabilities of light buildings facing strong winds and rains, and proposes some **low cost technical improvements** to make houses more resistant and safer. The recommendations given here are useful for both the construction of new housing and the reinforcement of existing ones.

The concept of **resilience** is about adaptation, and it goes beyond building resistant homes. Resilience is also about how to quickly recover from damage. The final pages of this manual propose some tips about what to do just before the storm, in case our house is still not safe enough.

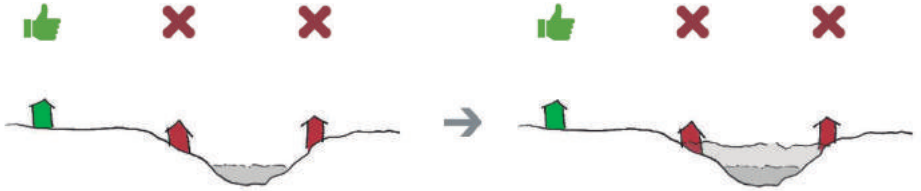
WIND IMPACTS ON HOUSING



SAFE LOCATION

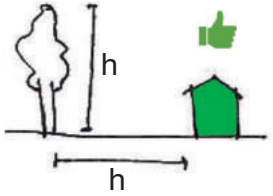
in order to avoid

The first thing to take into account when we start building a new house, is **WHERE** to build it. It is very important to choose a safe location for our house. This decision will reduce our exposure to hazard.

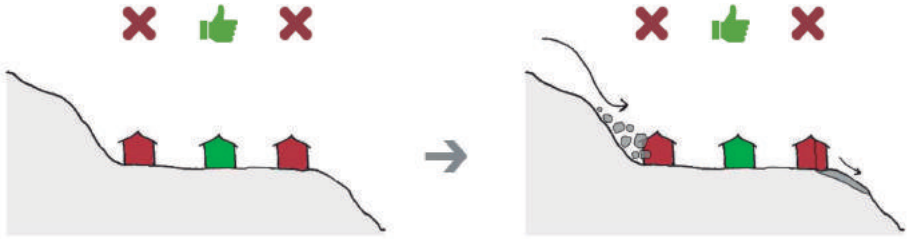


We have to keep our house at a safe distance from the water bodies. If we build too close to rivers, heavy rains caused by tropical storms will cause floods that may affect our house.

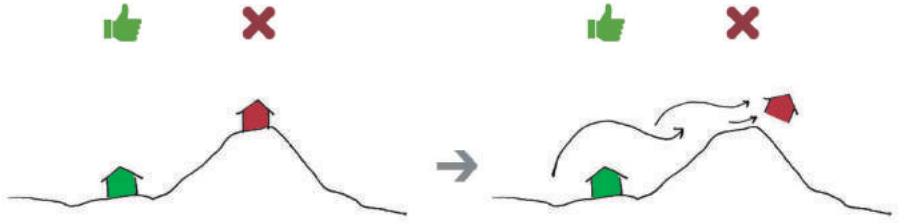
If we build close to the sea, storm surges and heavy waves will destroy our house.



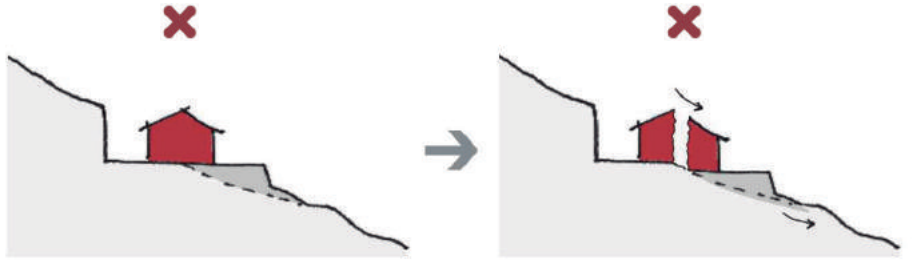
Trees can protect our house from the wind, by slowing down its speed, but be carefull, we cannot build our house too close to trees because they could fall on our house and destroy it.



If we build our house on a slope, we have to be aware of landslide risk as our house can be pushed down the hill. Also, if we place our house too close to a hillside, a landslide can destroy and bury our house.



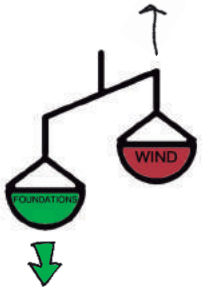
If the house is located at the top of the hill it is much more exposed to winds.



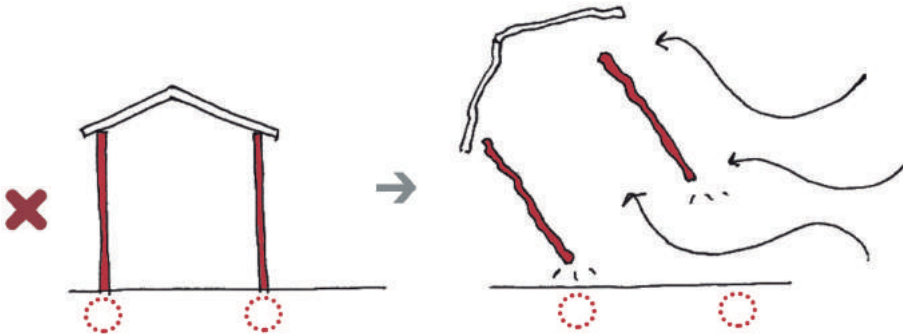
If the soil on our land is composed of filling material, we should avoid placing the foundation of the house on the filled area as this kind of soil is not yet compact enough to support the structure and it could slide down.

HEAVY FOUNDATIONS

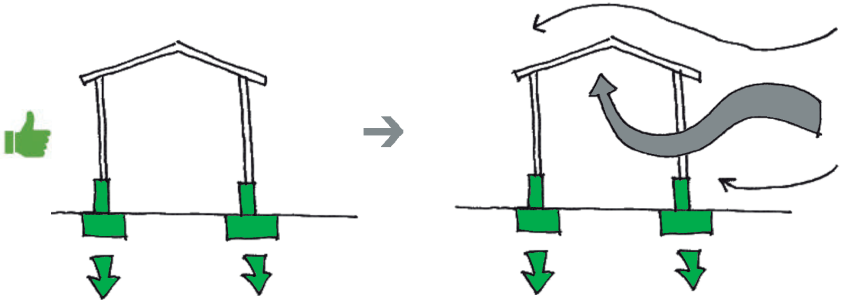
in order to avoid



We need to make sure that our house foundations are **STRONGER THAN THE WIND**. Our foundations must be very heavy so that the wind will not blow our house down.

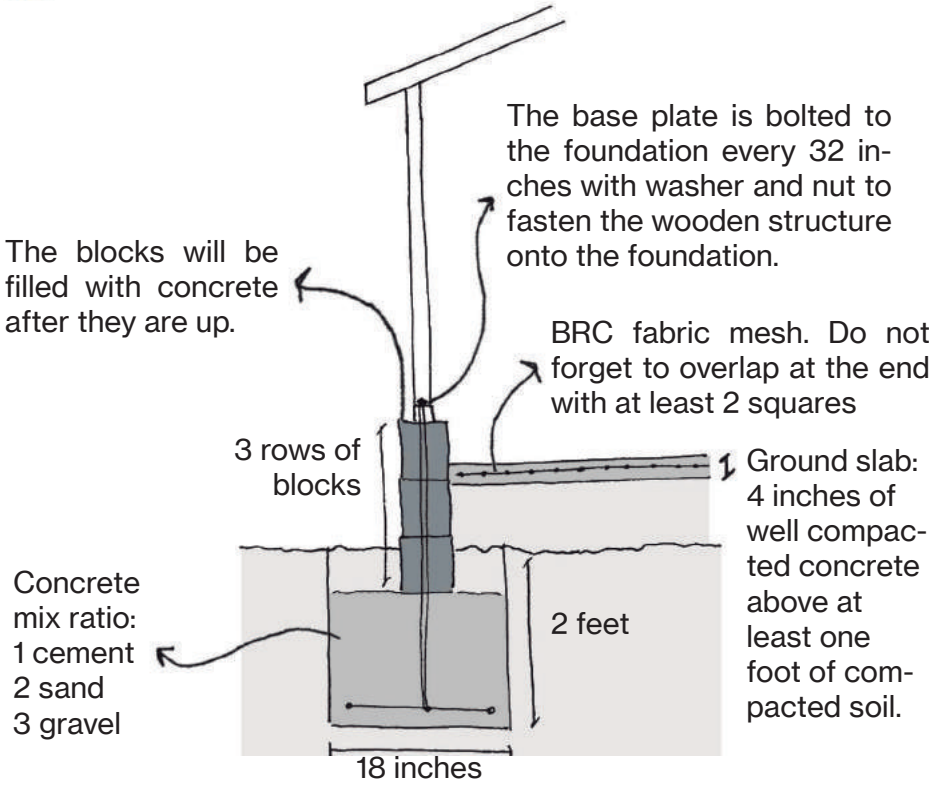


If we have no foundations, or they are weak, or they are not properly anchored to the walls, they will not prevent our house from being overturned or from sliding.

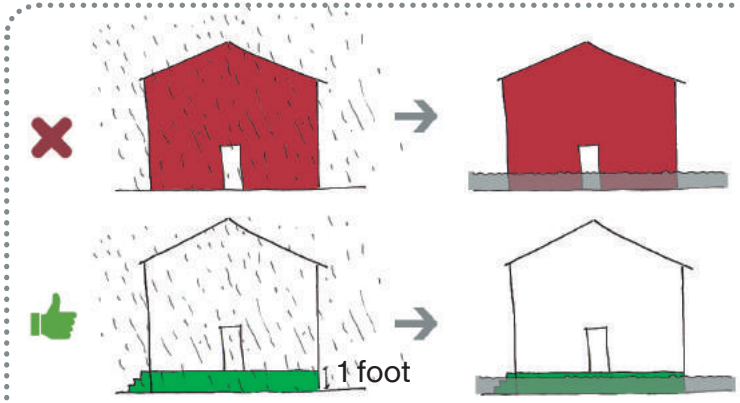


We should make sure our foundations are the right size to resist lift wind force. If our foundations are heavy and well connected to walls, even strong wind will not overturn our house.

How to build a strong foundation



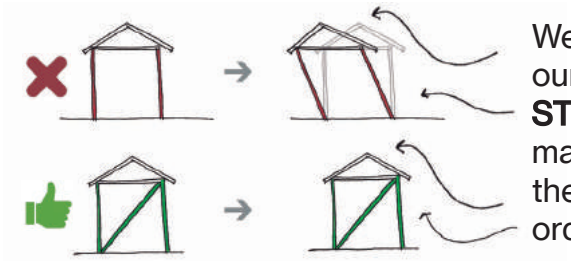
Be aware of floods!



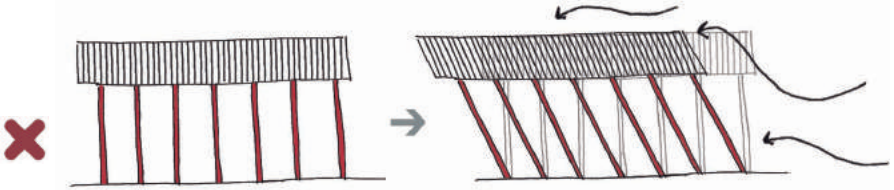
Usually hurricanes produce floods. Therefore, we should build our house on top of a platform higher than the level of previous floods.

BRACED WALLS

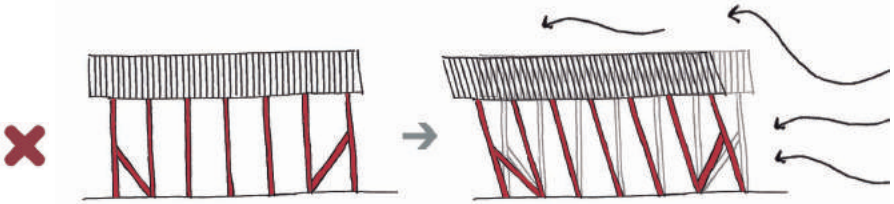
in order to avoid RACKING



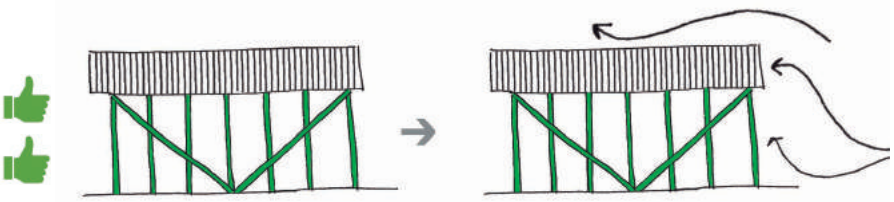
We need to ensure that our walls are **RIGID AND STRONG**. If our walls are made by light materials they must be braced in order to avoid racking.



Non rigid walls made of timber are not strong enough to resist the wind and will be pushed over

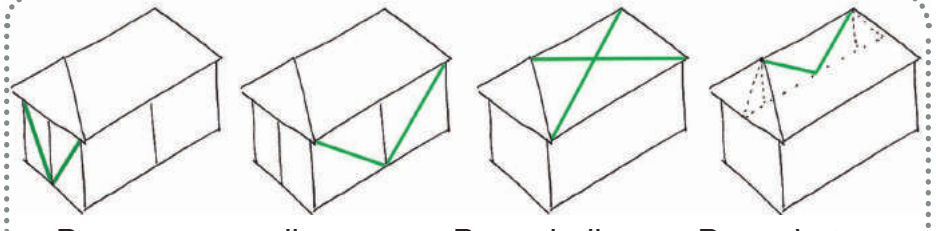


Walls can become rigid by adding braces. We need to ensure that diagonals are stronger than the wind to avoid collapsing.



Walls with strong braces that are properly anchored to foundations will make our house safer.

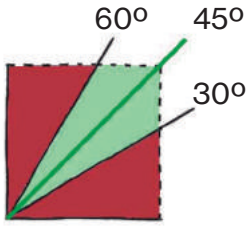
Brace it all!



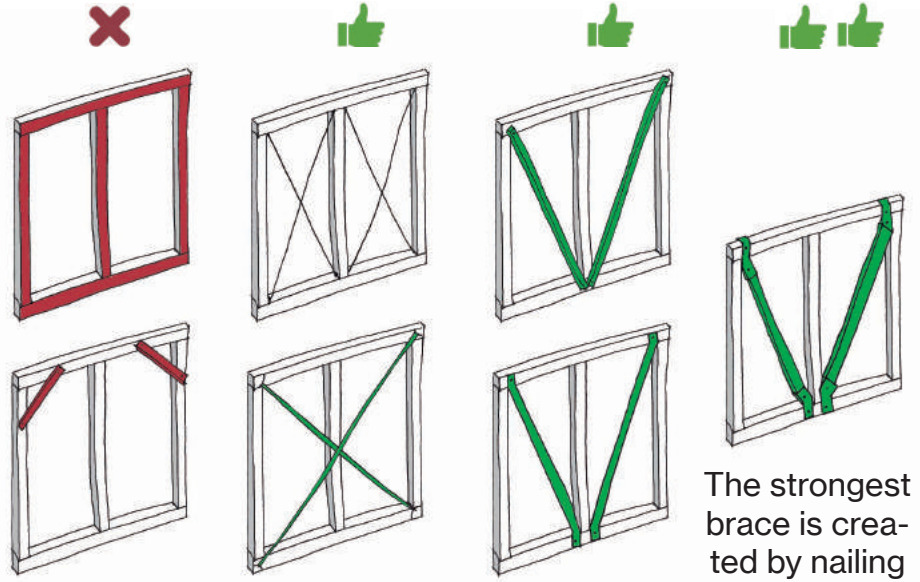
Brace every wall.

Brace bellow the roof

Brace between roof trusses



Brace at 45º. No less than 30º or more than 60º



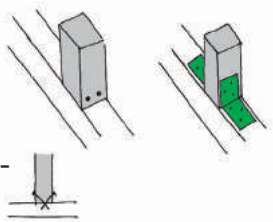
No brace or a small brace is weak.

Tie thick galvanized steel wire or use rebars

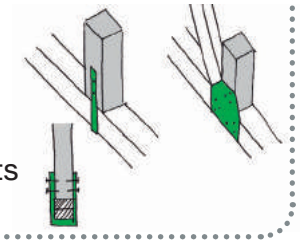
Nail timber or galvanized steel straps

The strongest brace is created by nailing timber and galvanized stell straps.

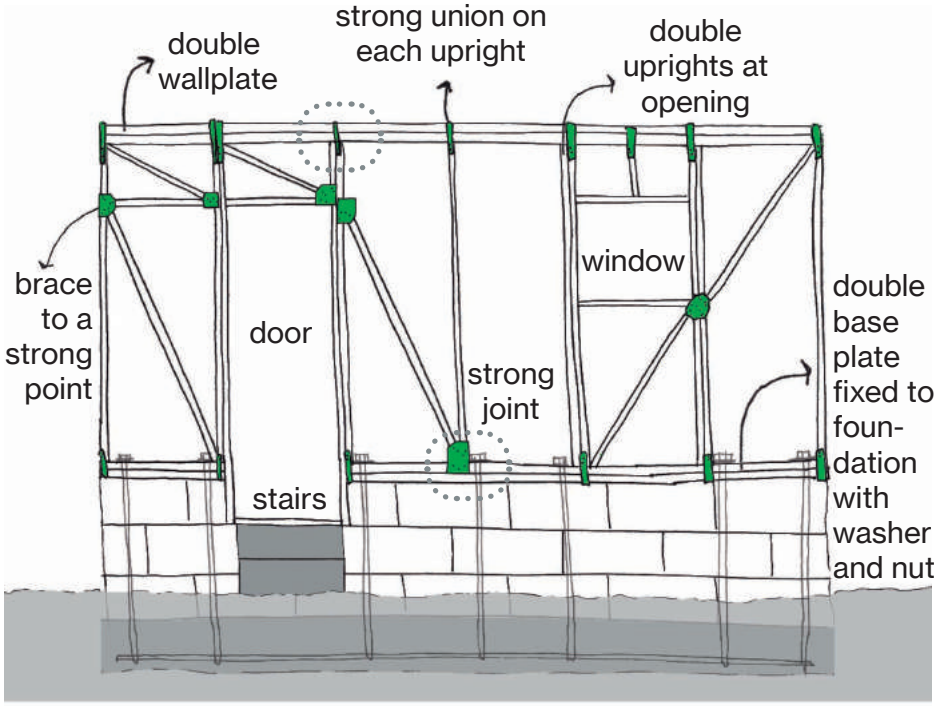
We reinforce unions with toe-nail connections or hurricane straps.



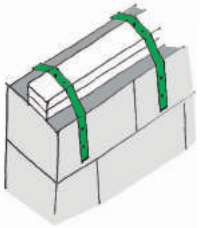
Hurricane straps that go under the base plate are the strongest. We use gusset plates for bigger joints while bracing.



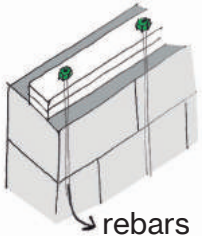
How to brace walls with openings

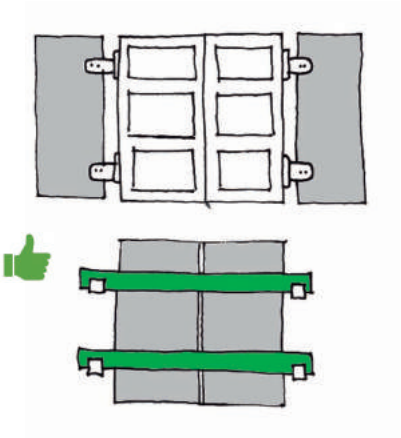


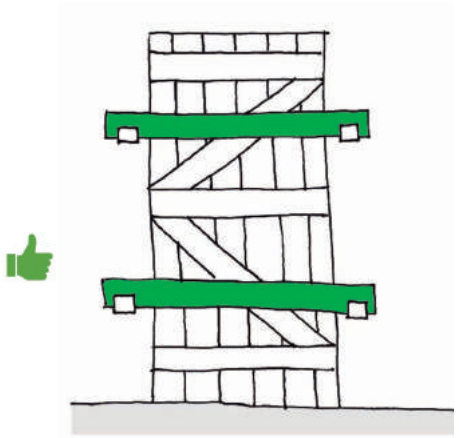
If there are no rebars to connect the baseplate to the foundation, we can use hurricane straps.



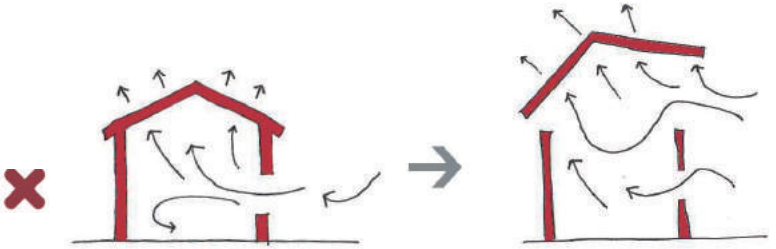
If there are rebars, we use washer and nut to tie baseplate to the foundation every 32 inches.



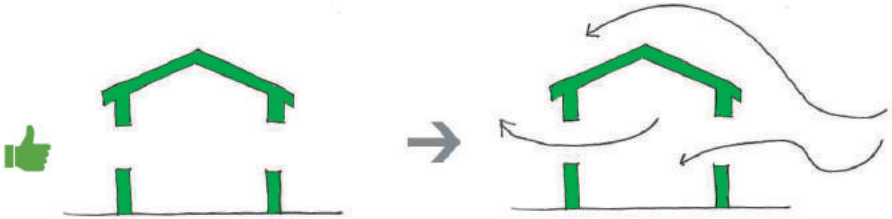




We should close our doors and windows using shutters and reinforce with wood or even metal, in order to resist wind pressure. If we cannot ensure that every door and window is protected, a smart strategy is to allow the wind to flow freely by keeping doors and windows open.



When wind enters our house through an opening, and cannot find a way out, it increases pressure on the roof.

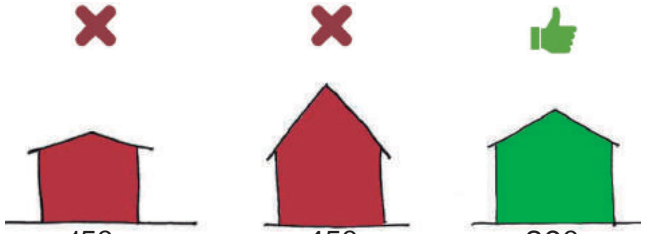


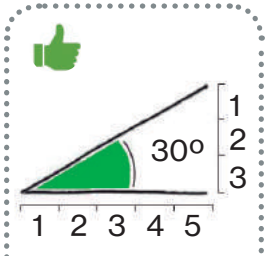
Opening opposite windows and doors will allow the wind to pass through and reduce the pressure inside our house.

STRONG ROOFING

in order to avoid UPLIFTING

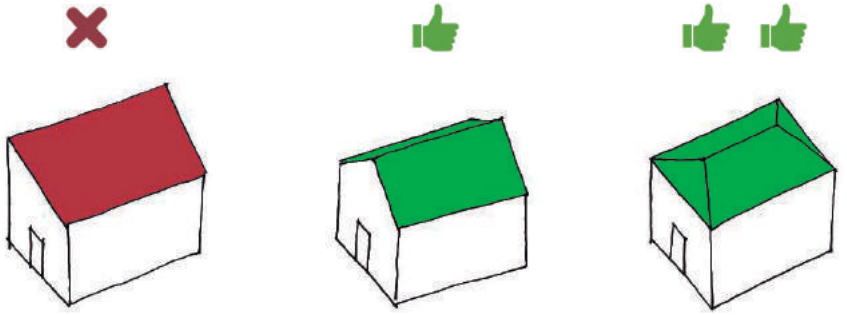
The shape of our roof is critical for its resistance because of **AERODYNAMICS.**





The best roof pitch is 30º

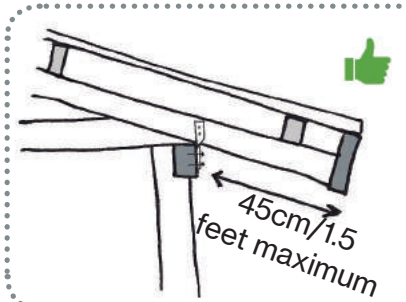
Flatter roofs are more likely to be blown off by the wind.



The pitched roof is the weakest shape and therefore is not recommended. The gable roof is a little better but the strongest one is the hipped roof because it is the most aerodynamic.

If the eave is too long it is easier for the wind to lift the roof of our house.

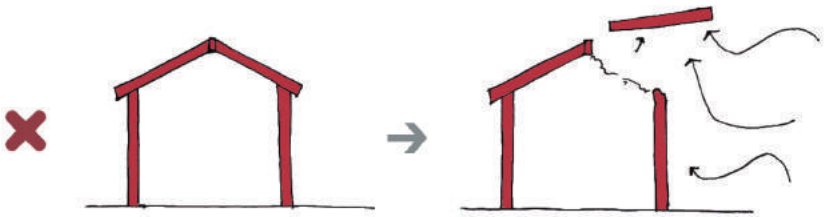
If the eave is short it will be more difficult for the wind to lift our roof.



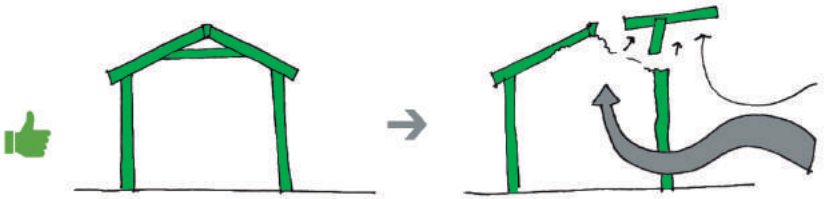
Keep eaves short to prevent the roof from being blown off and long enough to protect the walls from rain

We should not extend the main roof of our house to cover a veranda or car port, because if wind blows this roof off it will also blow the main roof off.

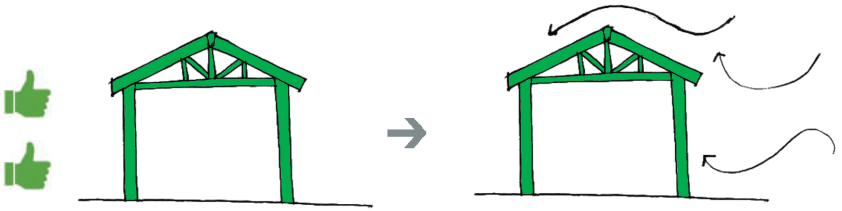
Verandas and car ports should have a separate roof so the wind will lift this roof only, and our main roof will not be affected.



If our roof is not properly reinforced and does not have strong unions, even weak wind can lift it off.

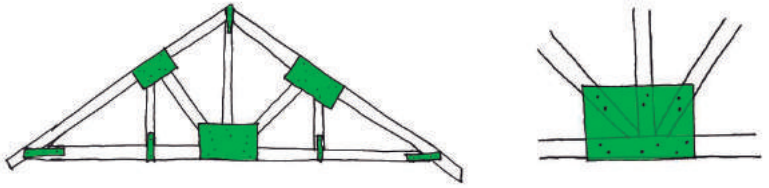


If our roof has a small reinforcement, it will not resist strong winds and it will be lifted off as well.



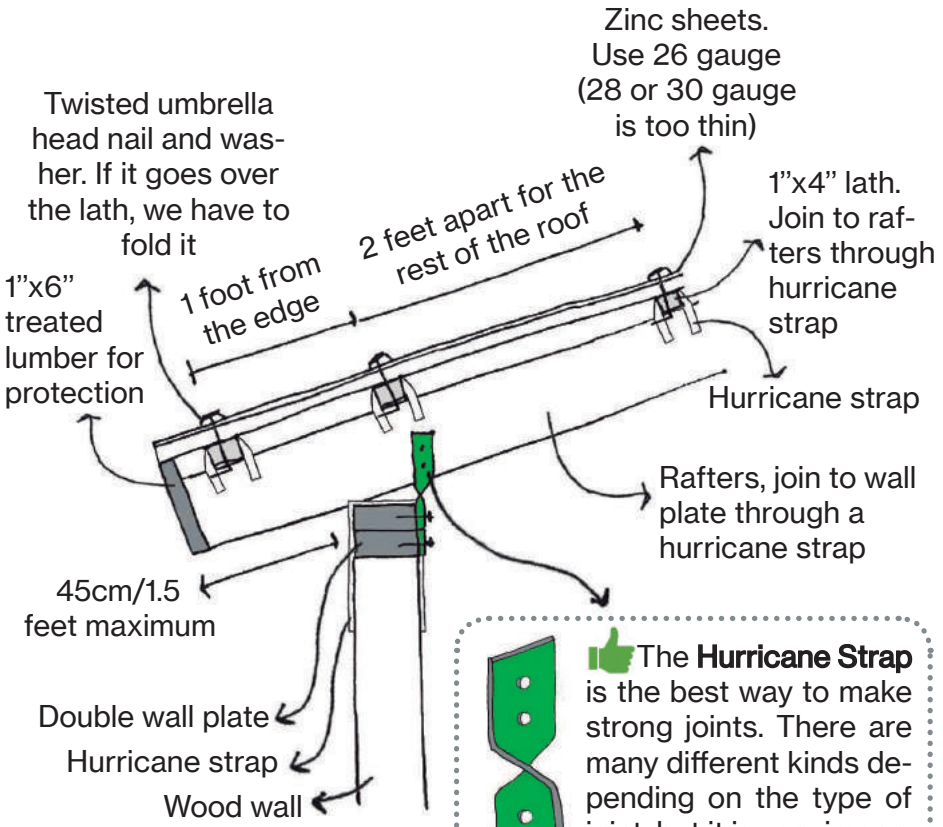
If our roof structure is composed of trusses with good reinforcements and strong unions, even cyclone winds will not destroy the roof or the house.

Reinforcing the **wooden roof structure**



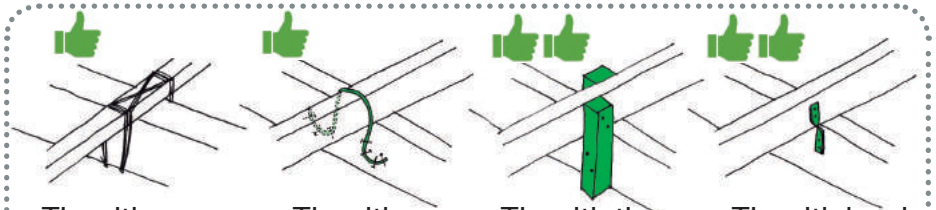
We have to ensure that the joints of our trusses are strong, therefore, we make these connections with steel.

How to build a strong roof



The **Hurricane Strap** is the best way to make strong joints. There are many different kinds depending on the type of joint, but it is very important to always use them.

We can make our **joints stronger**



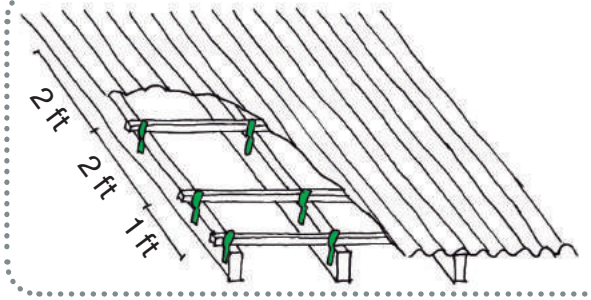
Tie with rope, nylon or thick galvanized wire

Tie with rebar and nails

Tie with timber cleats

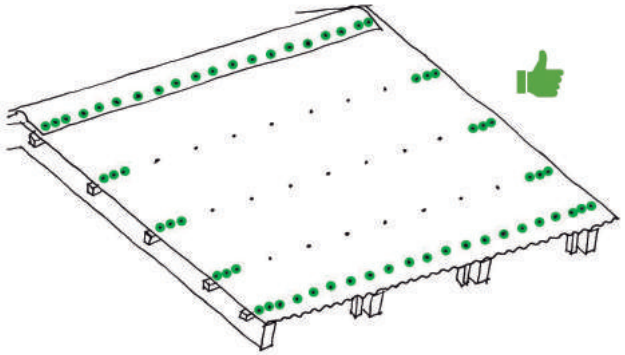
Tie with hurricane straps

Control the **spacing** of our **laths**

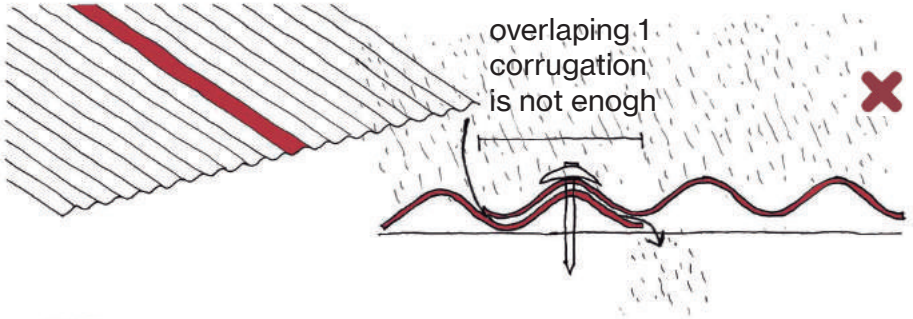


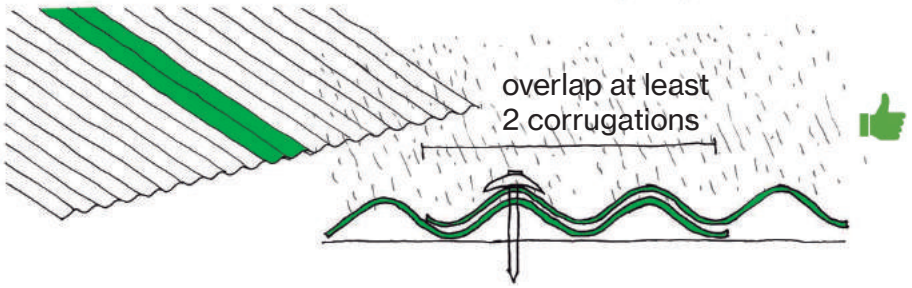
We have to give our laths less space on **the edge** in order to reinforce our roof.

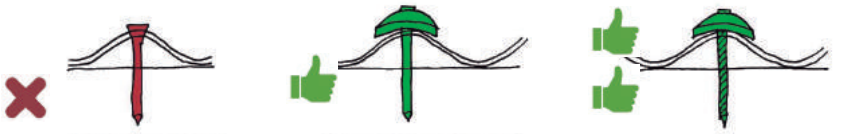
Reinforcing **the edges** of our roof with more nails will make it more difficult for the wind to lift.



Be aware of the rain and **overlap** your sheets.

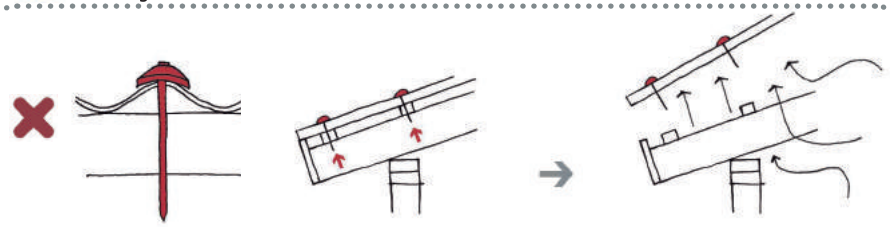




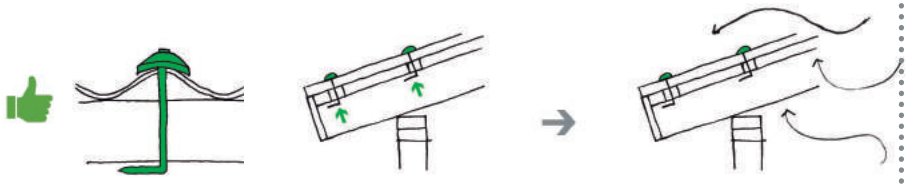


Regular nail | Umbrella head nail and washer | Twisted umbrella head nail and washer

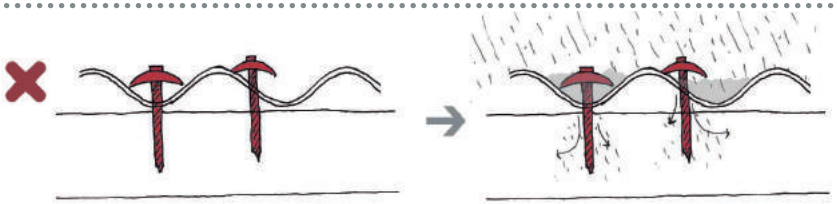
Fold your nails



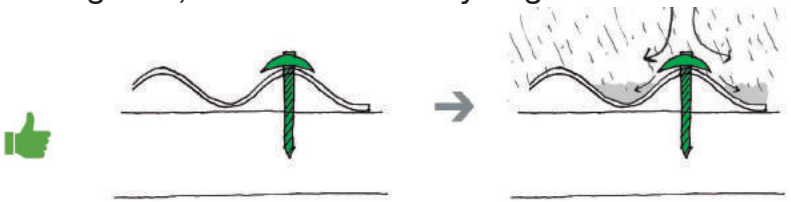
If we do not fold the nails it is easier for the wind to blow our roof away.



If we fold the nails we have more resistance against the wind, therefore, a more secure roof.



If we put the nail in the lowest or middle part of the corrugation, water is more likely to get inside the house.

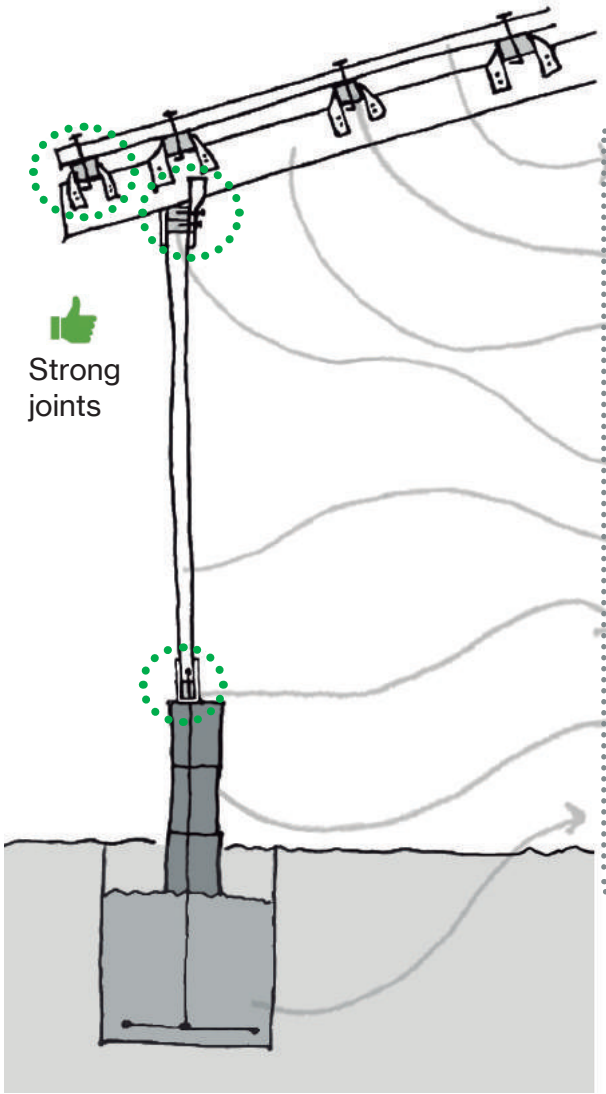


We have to nail the highest part of the corrugation to protect our house from heavy rains.

TIE BOTTOM-UP

in order to avoid

Every element of our house must be linked to the others as a **CHAIN**, so if the wind comes, all the pieces of the house will resist together.



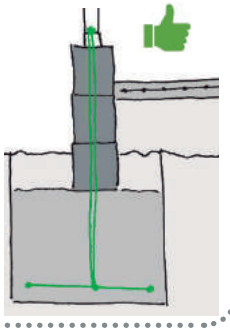
Strong joints

Building chain

- zinc sheets
- laths
- rafters
- wallplate
- walls
- base plate
- blocks
- foundations

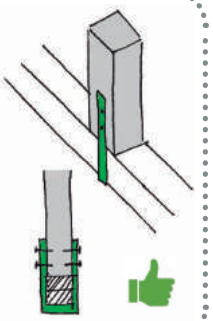
foundations
blocks
base plate

This connection has to be tied with washer and nut. It is made out of steel rebar. *Page 11*



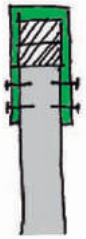
base plate
walls

This connection is made out of a hurricane strap and bolts. We have to put a double base plate. *Page 14*



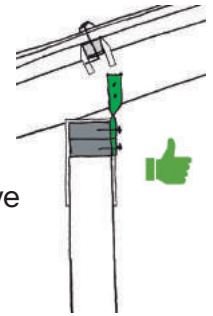
walls
wallplate

This connection is also made of a hurricane strap and bolts. We have to put a double wallplate. *Page 14*



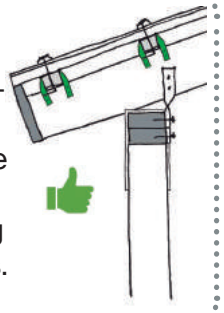
wallplate
rafters

This connection is made of a twisted hurricane strap and bolts. We have to connect every rafter. *Page 19*

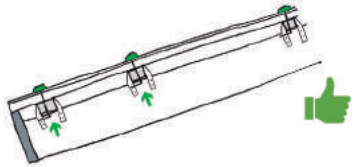


rafters
laths

This connection is made with a hurricane strap and bolts. We have to be aware of the spacing between laths. *Page 19*



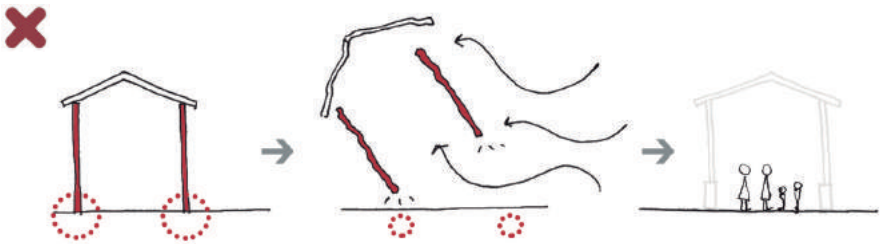
laths
zinc sheets



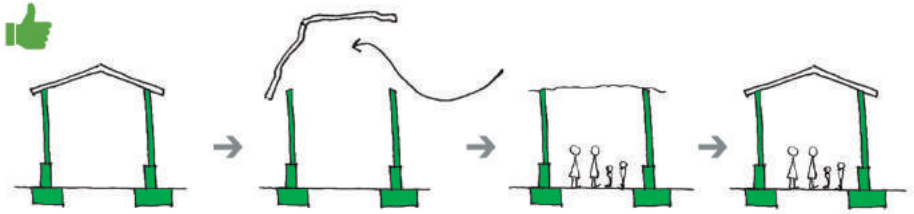
This connection is made of a twisted umbrella head nail and washer. We have to fold the nail. *Page 21*

INVESTMENT PRIORITIES

When our house needs repairs, it is important to go little by little, and **REPAIR THE MOST IMPORTANT PARTS FIRST.** If not, we may invest in repairs that do not help us in the event of a disaster.



If we start investing by improving **only the roof**, but our house does not have good foundations or they are not well connected to the walls, even if the roof is good, if a hurricane strikes, the entire house will be lifted and after the hurricane we will have **nowhere to live**. We will have to rebuild our entire house.



In this case we have decided to invest first in **retrofitting walls** and connecting them to our **strong foundations**.

Our roof is not good enough to resist the the wind during the hurricane so it blows away.

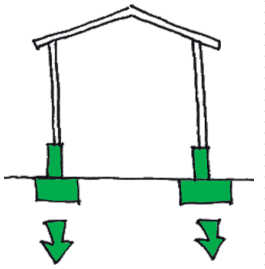
After the emergency we can buy a tarpaulin which is cheap and good enough to cover ourselves for a while.

Later on, we will have resources to rebuild a new permanent and resilient roof.

Order of priorities when investing

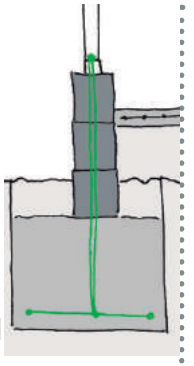
1. Foundations

The first thing to invest in are strong and heavy foundations that will keep our house in place during a hurricane.
We can put more weight on the foundations to make it stronger



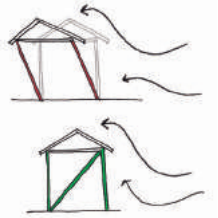
2. Tie your walls

Once we have strong foundations, we have to make sure your walls are strong and tieded down.



3. Brace your walls

It is important to build strong walls or reinforce them in order to have a more stable house. Without bracing, our walls are too weak to withstand a hurricane, we have to make sure we brace them.

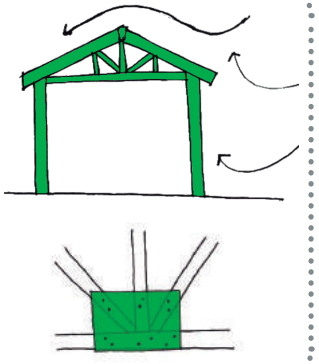


4. Tie your roof

Remember we have to tie our roof down to our strong walls with hurricane straps, to keep it safe during the huricane.

5. Safer roof

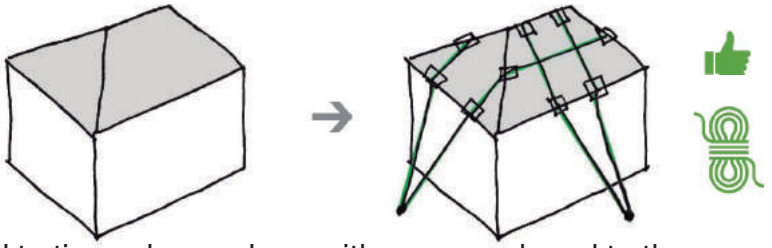
It is important to reinforce our roof with strong connections, to make it strong and heavy to resist the wind force.



WHAT TO DO JUST BEFORE THE STORM

Once we are informed that a hurricane is coming, and especially if we think our house is not resistant enough, we can follow some tips that will **PROTECT OUR HOUSE** and **OURSELVES** in a short amount of time.

1. Tie your house down

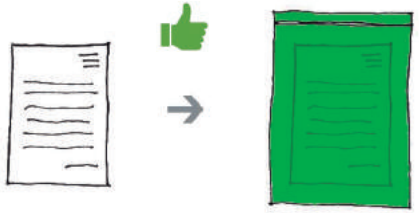


We need to tie our house down with ropes anchored to the ground.

2. Cut big branches

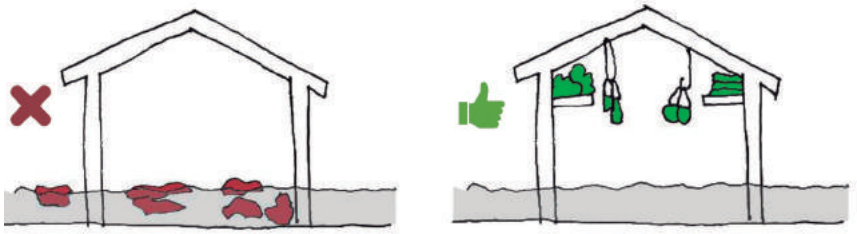
If there is any tree close to our house that could damage it, we will cut the branches in order to prevent the tree from being pulled down onto the house by the wind.

3. Safe important documents



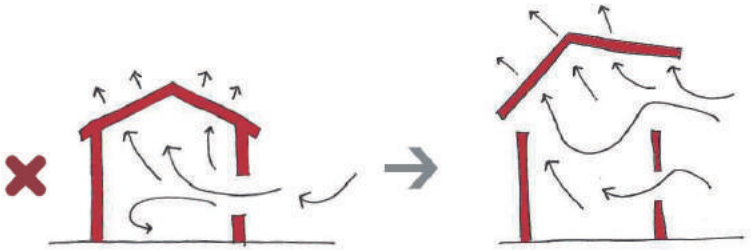
If we have any important things e.g. documents, it is better to put them in a plastic bag to protect them from floods.

4. Put important things high above ground

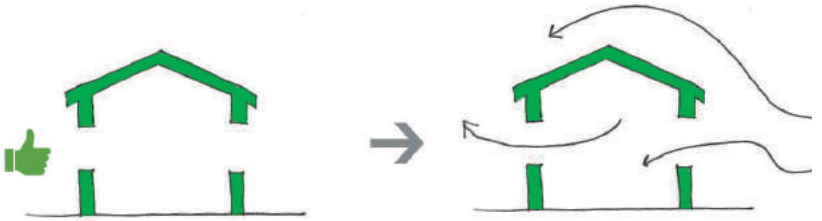


Before the emergency we must put our important things in a safe place. High above the ground is usually safer from floods.

5. Open doors and windows



When wind enters our house through an opening, and cannot find a way out, it increases pressure on the roof.



During the storm, we should open windows and doors to allow the wind to pass through and reduce pressure inside our house.

6. Evacuate

If we feel our house is not safe enough, we should evacuate to a safer location.

BIBLIOGRAPHY

Jamaica National Building Code. Jamaica Bureau of Standards. Jamaica, 2014. http://www.bsj.org.jm/

Shelter safety handbook. Some important information on how to build safer. International Federation of Red Cross and Red Crescent Societies (IFRC). Switzerland, 2011. http://www.ifrc.org/PageFiles/95526/publications/305400-Shelter%20safety%20handbook-EN-LR.pdf

Building with winds. Construction guide for Cyclone and windstorm prone areas. UN-Habitat. Mozambique, 2008 https://www.sheltercluster.org/sites/default/files/docs/Building%20with%20Winds.pdf

8 build back safer key messages. Shelter Cluster Philippines. Philippines, 2014 https://www.sheltercluster.org/sites/default/files/docs/8_key_messages_posters_final_v1.1_light.pdf

Shelter and Component Testing. OFDA transitional shelters: materials, techniques and structures. International Hurricane Research Center. U.S, 2012 https://www.usaid.gov/sites/default/files/documents/1866/WOW12-2012-02%20%28USAID-OFDA%29_FINAL%20REPORT.pdf

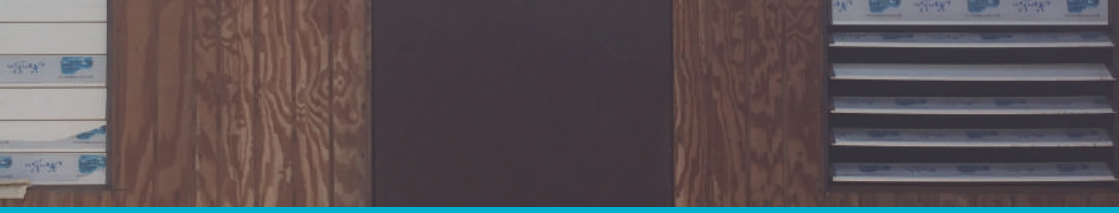
The safe roof retrofit .Construction Resource & Development Centre, Construction Industry Council. Jamaica, 2008.

IFRC Shelter Kit Training package. International Federation of Red Cross and Red Crescent Societies (IFRC), 2011.

Make the right connections. A manual on Safe Construction Technique. CRDC and SSI - OAS/USAID Caribbean Disaster Mitigation Project (CDMP).

Making Your Roof Hurricane Proof. Office of Disaster Preparedness and Emergency Management (ODPEM), Jamaica, 2009 https://www.youtube.com/playlist?list=PL3358CD53663EFB17

Hurricanes: How to build a safer wooden house. Jamaican Red Cross and French Red Cross. Jamaica, 2008 https://www.youtube.com/watch?v=vp7FxW0Ze6Y



we build strength, stability and self-reliance through shelter

Habitat for Humanity®