Key messages and recommendations for self-construction: PRINCIPLES TECHNICAL ASSISTANCE AND BASIC CONSTRUCTION PRINCIPLES

Shelter Cluster Ecuador
ShelterCluster.org

PROFESIONAL SUPPORT

1. A house can be built of various construction materials: reinforced concrete and masonry (bricks or blocks), adobe, timber, bamboo, wattle & daub or mixed construction materials and techniques. The quality of any building relies both on its construction materials and its construction technique. If one of these is weak or wrong the building can become dangerous! For this reason, get professional assistance.

2. The present key messages result from typical constructive weak points observed in the areas affected by the 26.04.2016 earthquake in Ecuador. They should help to explain basic principles for a better construction of 1 and 2 storey houses, but they do not replace or exclude professional support.

3. Before repairing or reconstructing a damaged house, make sure you follow the official requirements and procedures such as registration, respecting the construction codes and receiving the proper technical assistance.

4. In case of doubt or if these procedures are not clear, get some help from the local authorities.

5. Togetether with the key messages, getting professional help is very important. It will help protect the lives of the occupants and ensure a better quality for your investment.

BUILDING A SAFER HOUSE

1
A SECURE HOUSE DEPENDS ON ITS LOCATION AND SHAPE

2
UNDERSTANDING BASIC CONSTRUCTION PRINCIPLES

3A
LIGHT CONSTRUCTION MATERIALS' QUALITY : BAMBOO / GUADÚA

3B
LIGHT CONSTRUCTION MATERIALS' QUALITY : TIMBER

3A
HEAVY CONSTRUCTION MATERIALS' QUALITY : MASONRY / CONCRETE

4
BUILDING A SOLID FOUNDATION

5
SOLID WALLS AND CONFINING ELEMENTS

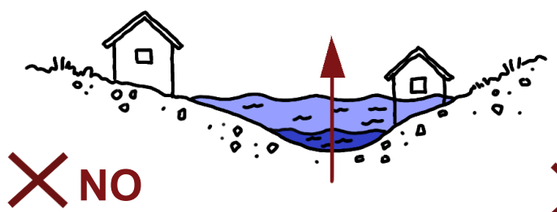
6
MAINTENANCE AND COMFORT OF THE HOUSE

Key messages and recommendations for self-construction: PRINCIPLES

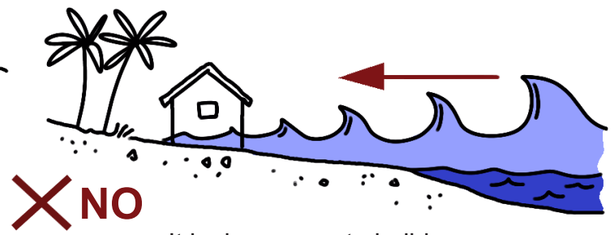
1 A SECURE HOUSE DEPENDS ON ITS LOCATION AND SHAPE

Shelter Cluster Ecuador
ShelterCluster.org

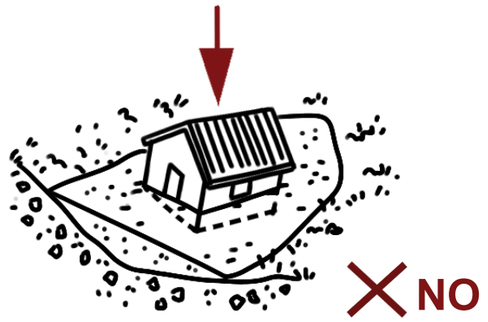
1A : ADEQUATE LOCATION



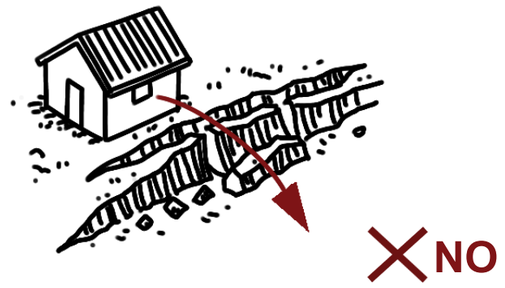
Do not build near rivers or flooding areas.



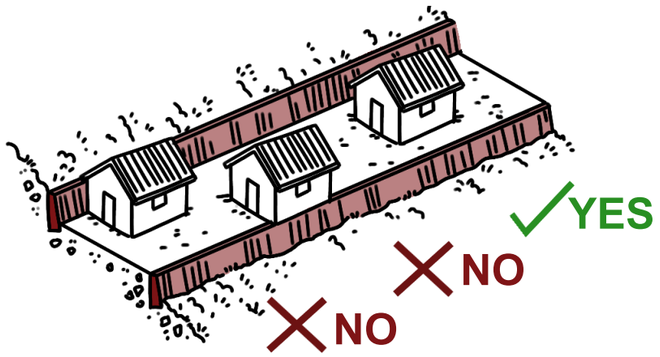
It is dangerous to build near the coast (risk of tsunamis).



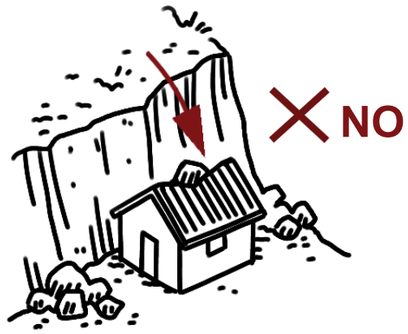
Do not build on landfills or fresh embankments.



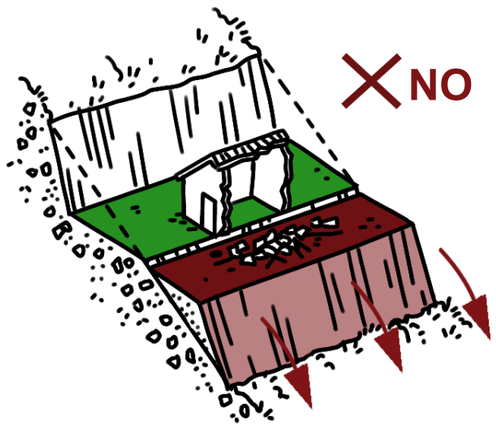
Do not build too close to a cliff.



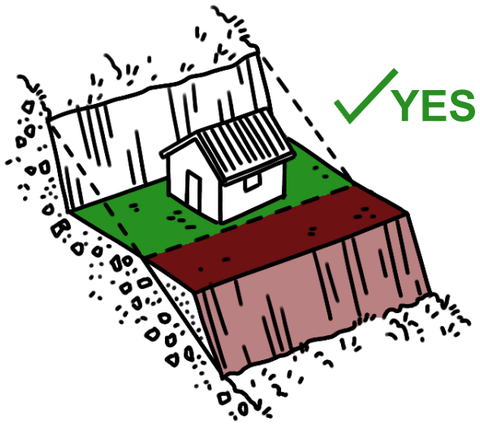
Build between retaining walls, not against nor on top of them.



Do not build under a cliff.

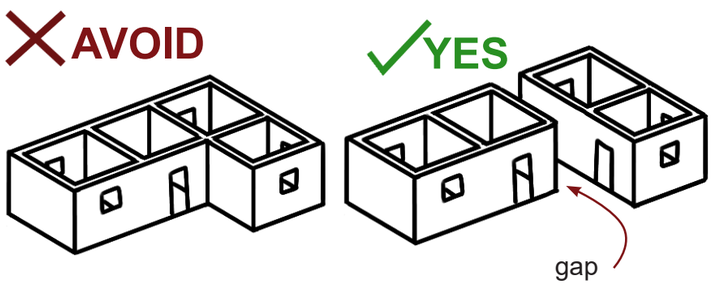


Do not build on embankments or land fills, even partially.

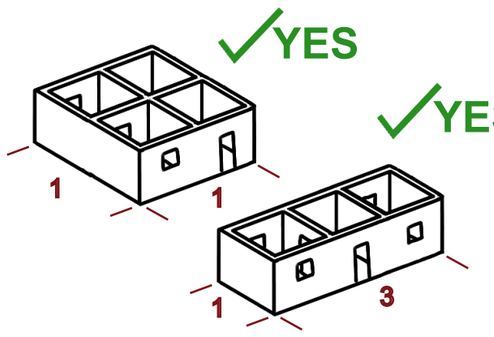


Keep good distance on each side of the house.

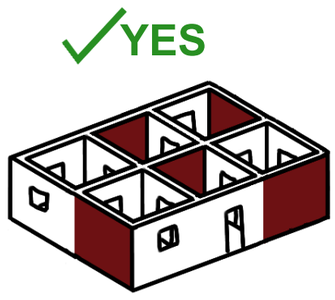
1B : FORMA DE LA CASA



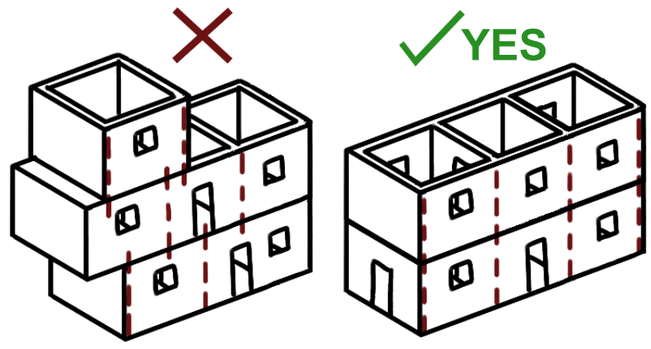
Avoid complex shapes by creating seismic gaps (minimum 10 cm / recommended 45-60 cm).



Best ratio: 1:1
Good ratio: 1:2
Maximum ratio: 1:3



Each facade must have at least one sheer wall (without openings).



Walls must be placed continuously on top of the other, from the ground to the roof!

Key messages and recommendations for self-construction: PRINCIPLES

2 UNDERSTANDING BASIC CONSTRUCTION PRINCIPLES

Shelter Cluster Ecuador
ShelterCluster.org

2A: HOMOGENOUS CONSTRUCTION

Roof, walls and floor built of light materials, such as timber or bamboo.

LIGHT CONSTRUCTIONS ARE MORE FLEXIBLE AND ALLOW MORE DEFORMATION THAN HEAVY CONSTRUCTIONS.

Get assistance from a professional to dimension adequate construction elements and proper bracing.

Light roof on 2 heavy storeys (such as masonry).

HEAVY CONSTRUCTIONS DO NOT TOLERATE DEFORMATIONS, THEREFORE THEY HAVE TO BE BUILT STRONGER.

Get professional assistance to build a seismic resistant masonry (such as reinforced or confined masonry).

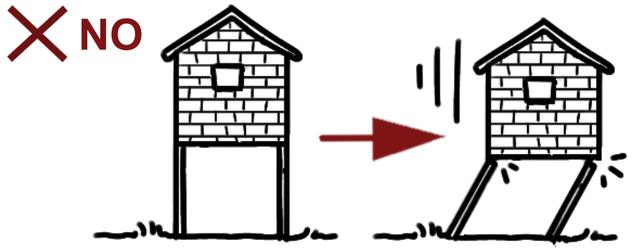
2B: MIXED CONSTRUCTION

Light roof on light 1st floor on heavy ground floor.

LESS WEIGHT ABOVE LIMITS THE AMPLIFICATION OF THE EARTHQUAKE'S FORCE.

It is better to concentrate the weight of the building near the ground.
Get professional assistance to dimension pilar sections.

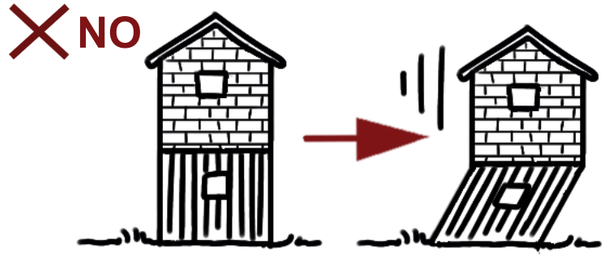
2C: RISKY CONSTRUCTION



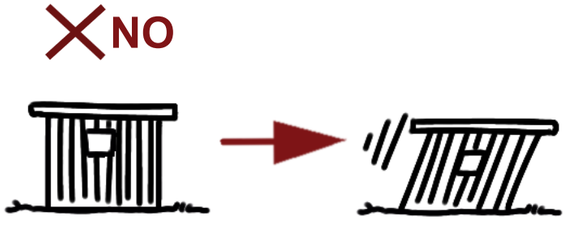
Heavy construction on light pilars (timber) or on sub standard concrete pilars (soft storey).
Risk of pilar failure!

MORE WEIGHT ABOVE CAUSES MORE EFFORTS IN THE STRUCTURE BELOW.

It is better to concentrate the weight of the building near the ground.
Get professional assistance to dimension pilar sections.



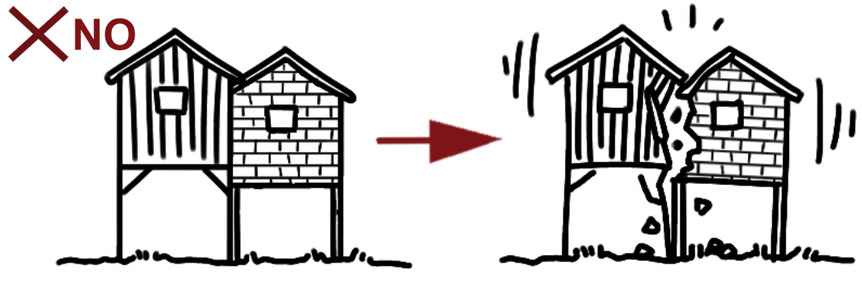
Heavy 1st floor on light ground floor (soft storey).
Risk of ground floor failure and fall of whole building!



Concrete slab (heavy) on light walls or on sub standard masonry walls or on pilars (soft storey).
Risk of soft storey failure and fall of whole building!

MORE WEIGHT ABOVE IMPLIES NEED FOR STRONGER STRUCTURE BELOW.

Get professional assistance to design a proper slab.



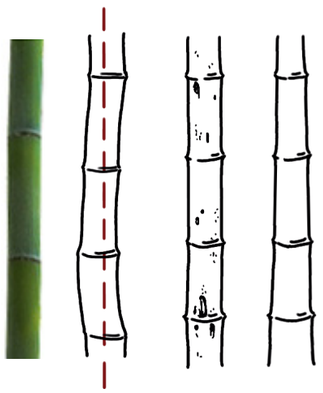
2 houses or parts of a house which are built with different techniques will behave differently in case of an earthquake.
They will colide and cause partial or total demolition.

ALWAYS LEAVE A GAP BETWEEN 2 HOUSES OR BETWEEN PARTS OF A HOUSE WHICH ARE BUILT OF DIFFERENTS TECHNIQUES.

Key messages and recommendations for self-construction: PRINCIPLES
3 LIGHT CONSTRUCTION MATERIALS' QUALITY

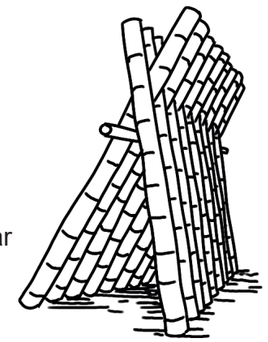
Shelter Cluster Ecuador
ShelterCluster.org

3A : BAMBOO / GUADÚA



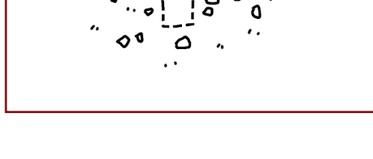
NO

Do not use green, curved bamboo, nor with parasite holes.
Only use bamboos with a similar diameter on both ends.



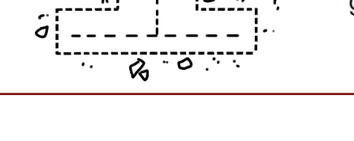
YES

Use good material:
- ripe / mature
- preserved / treated
- dried
- straight
- without holes / cracks



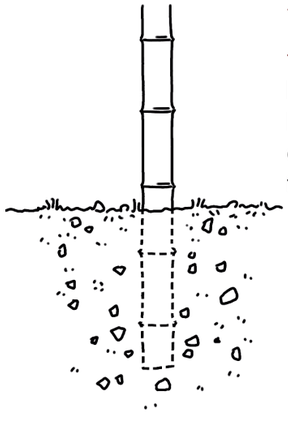
NO

Do not use nails to connect bamboo elements.



YES

Connections:
- drill holes
- use pegs or stainless threaded steel bars with bolts and washers
- fill remaining wholes



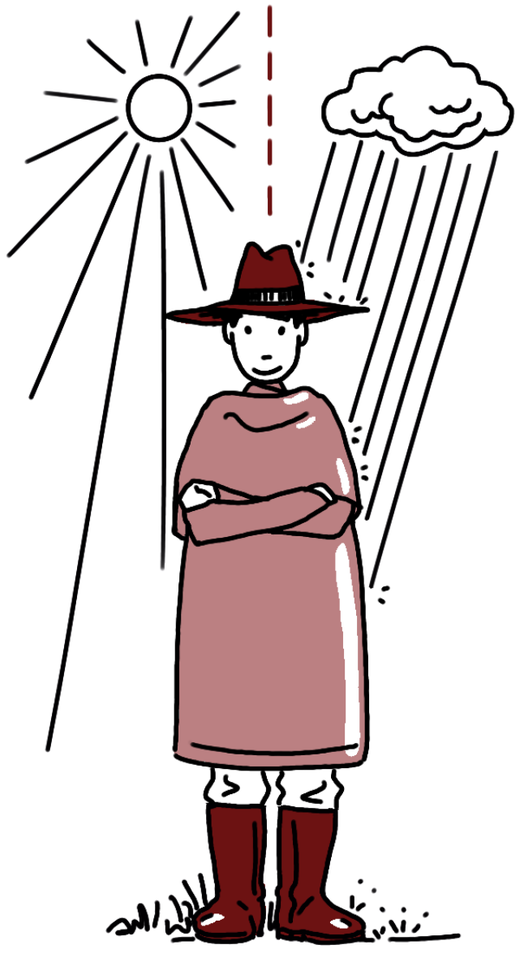
NO

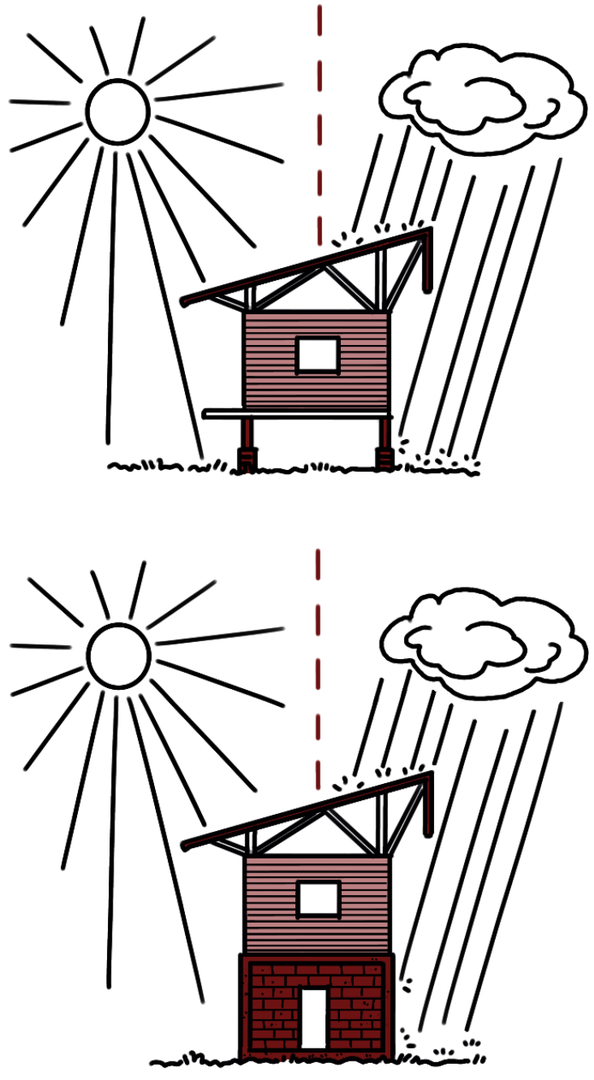
Do not burry bamboo elements into the ground.

YES

Elevate bamboo elements from the ground:
- build a strong foundation or a bedrock emerging from the ground to support the house
- isolate it from ground humidity

Bamboo must be protected from rain, sunlight and humidity from the ground. Therefore the house must have: a good hat, a good coat and good boots.





YES

1. a good hat:
wide roof eaves.

YES

2. a good coat:
split bamboo panels, easy to treat with paint, varnish or cement mortar/screed.

YES

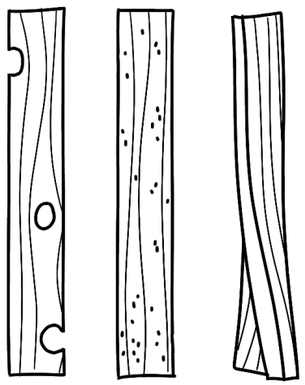
3. good boots:
foundations to isolate from groujnd humidity.

With the colaboration of INBAR (International Network for Bamboo and Rattan)

Key messages and recommendations for self-construction: PRINCIPLES
3 LIGHT CONSTRUCTION MATERIALS' QUALITY

Shelter Cluster Ecuador
ShelterCluster.org

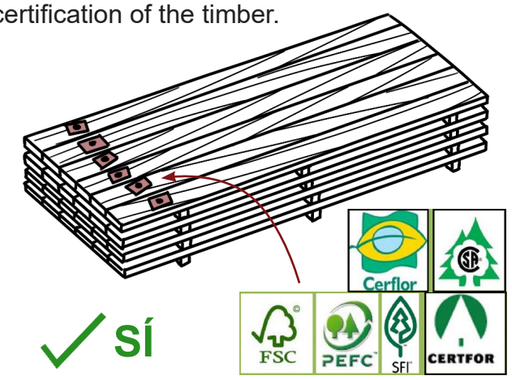
3B : TIMBER



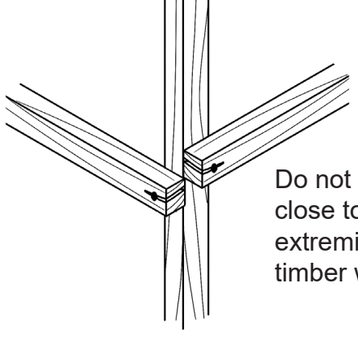
✗ NO

Do not use green (not dry) timber, nor bent or with parasite holes.

Check that timber is legal and controlled:
- if it is of uncontrolled or of unsustainable origin, it could support deforestation.
- it is a good sign if the vendor can provide a certification of the timber.

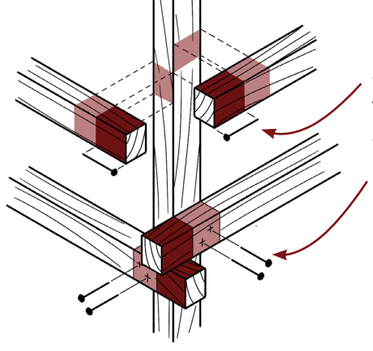


✓ SÍ



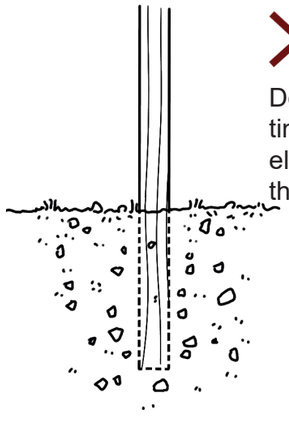
✗ NO

Do not nail too close to extremities: timber will split.



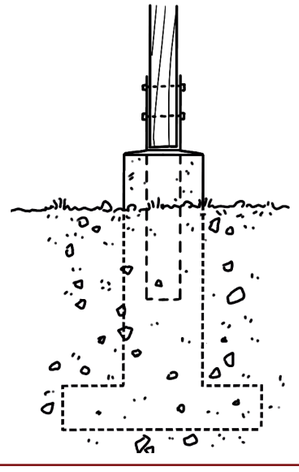
✓ YES

Nailing areas:
- leave a nail's lenght from the extremity.
- place 2 nails at each 1/3 of the timber element width.



✗ NO

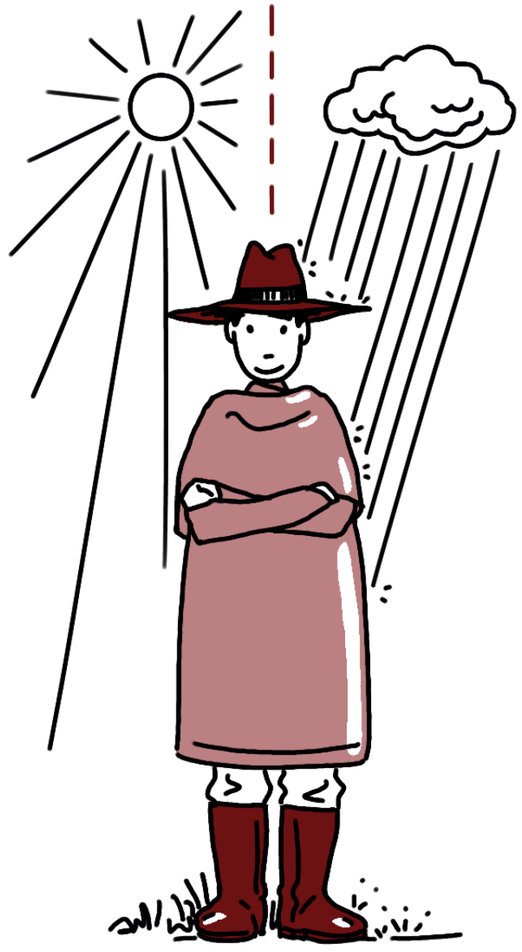
Do not burry timber elements into the ground.

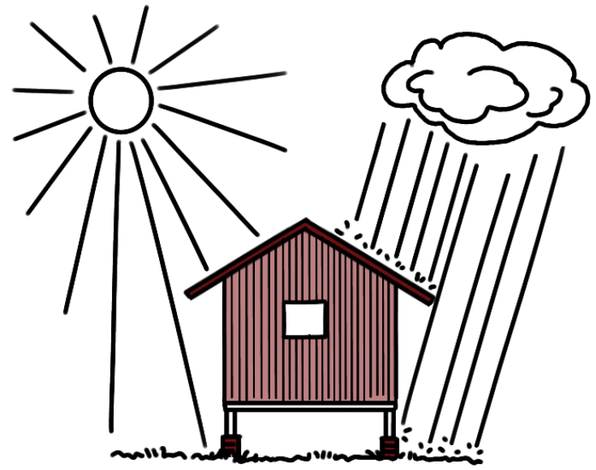


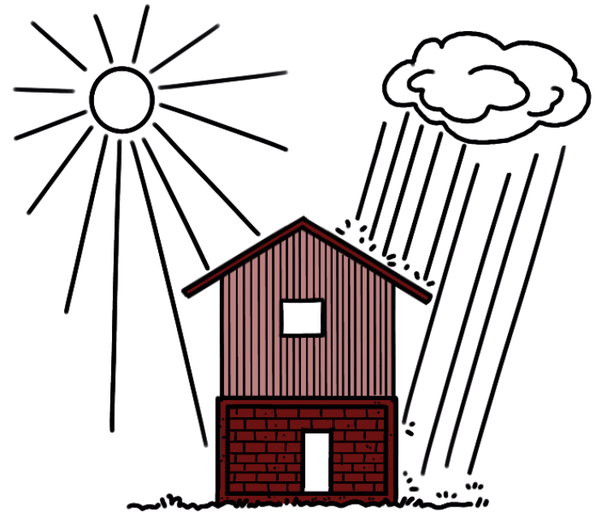
✓ YES

Elevate timber elements from the ground:
- build a strong foundation or a bedrock emerging from the ground to support the house
- isolate it from ground humidity

Timber must be protected from rain, sunlight and humidity from the ground. Therefore the house must have: a good hat, a good coat and good boots.







✓ YES

1. a good hat:
wide roof eaves.

✓ YES

2. a good coat:
split bamboo panels, easy to treat with paint, varnish or cement mortar/screed.

✓ YES

3. good boots:
foundations to isolate from groujnd humidity.

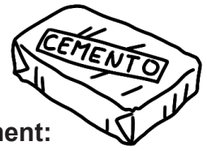
Key messages and recommendations for self-construction: PRINCIPLES

3 HEAVY CONSTRUCTION MATERIALS' QUALITY

Shelter Cluster Ecuador
ShelterCluster.org

3C : MASONRY / CONCRETE

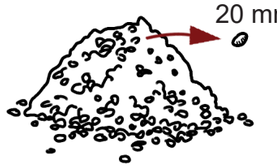
Water:
clean and without salt.



Cement:
Portland cement, new, dry bags.

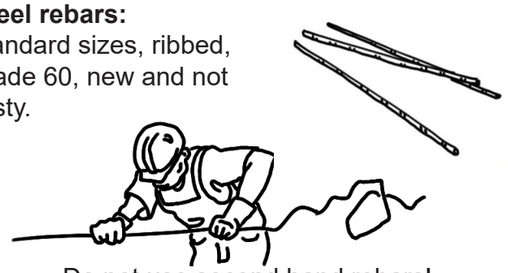
Sand:
clean, dry river sand, no beach sand!

max 18 to 20 mm



Gravel:
crushed, from hard rock and clean.

Steel rebars:
standard sizes, ribbed, grade 60, new and not rusty.



Do not use second hand rebars!

Concrete mix:

1 part cement + 2 parts sand + 3 parts gravel (max 18mm) + 3/4 part water

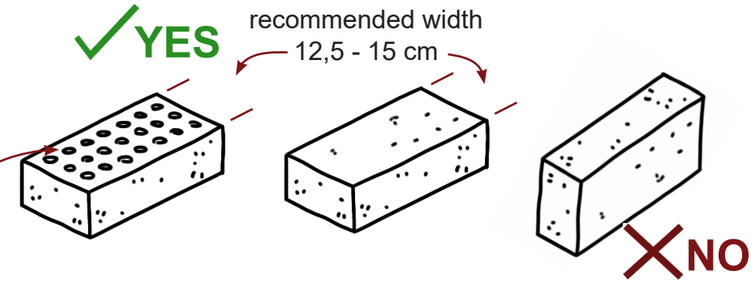
Mix for cement blocks:

1 part cement + 4 parts sand + 3 parts gravel (8-10mm) + 3/4 part water

Mix for mortar:

1 part cement + 5 parts sand + 3/4 part water

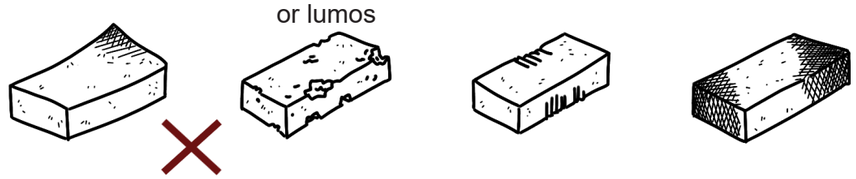
Bricks:



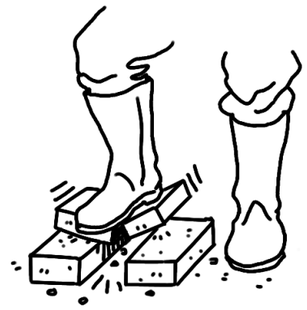
Vertical holes must be more than 50% of horizontal surface.

No bricks laid in vertical position!

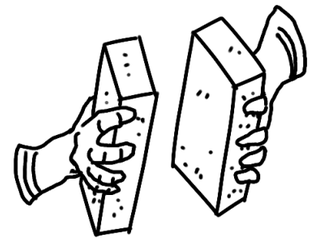
Plain and perforated bricks must be well produced and in good shape:
regular in form — no visible flaws or lumos — not warped — uniform color



Quick tests for brick quality:

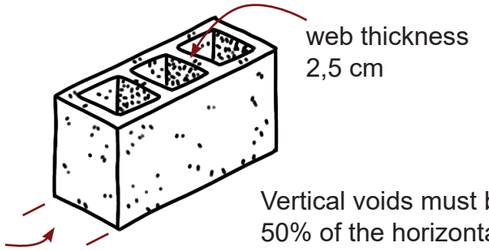


The "3 points test":
Person standing on a bricks spanning between 2 other bricks. The brick must resist!



Bricks must produce a ringing sound when struck against each other.

Cement blocks:



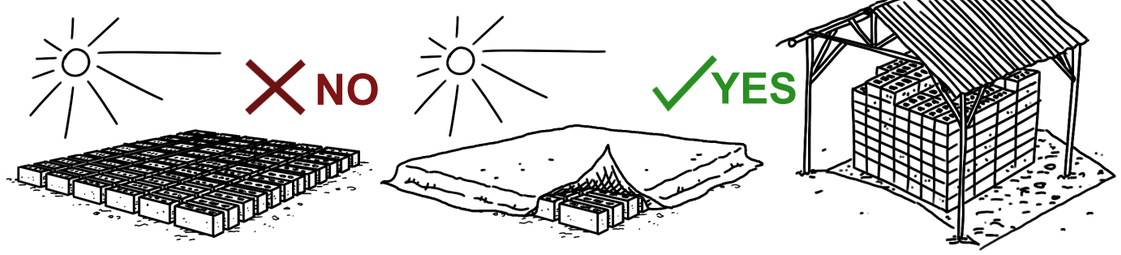
Minimum 10 cm
recommended 15 o 20 cm

Vertical voids must be less than 50% of the horizontal surface.

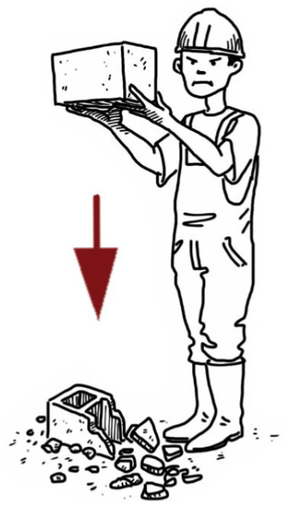
Signs of bad and good quality in the production of cement blocks:

Blocks must not be left to dry in the sun.

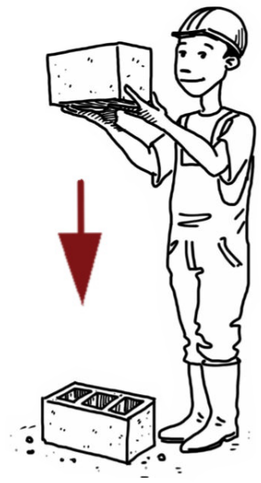
Blocks are stored under a tarpaulin or under a roof, to cure in the shade.



Quick test for block quality: the "drop test":
Drop 5 blocks from 1,5m high onto a hard surface (ex. concrete).



NO
Bad quality:
more than 1 broken.
do not buy!



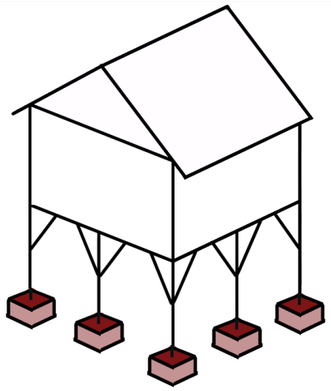
YES
Acceptable quality:
1 or less broken.

Key messages and recommendations for self-construction: PRINCIPLES

4 BUILDING A SOLID FOUNDATION

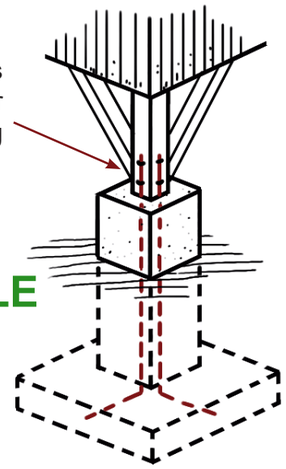
Shelter Cluster Ecuador
ShelterCluster.org

4A : ELEVATED HOUSE



A house is more solid when it is built on a strong foundation.

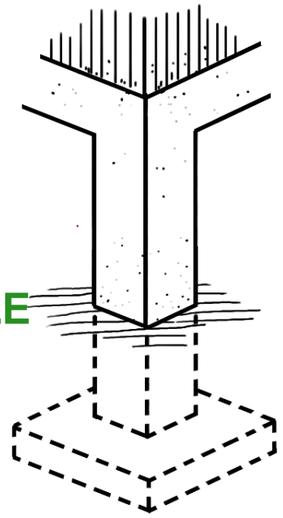
steel rebars and nails for anchoring



✓ACCEPTABLE

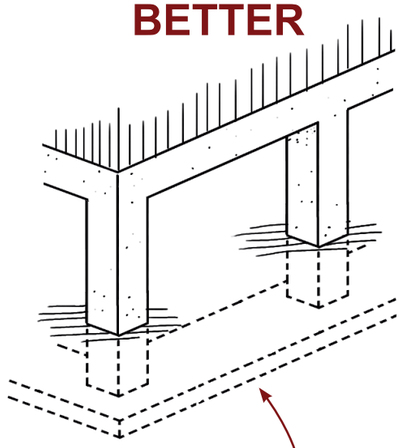
Timber pilar on punctual concrete foundation, reinforced with steel rebars.

✓ACCEPTABLE



Reinforced concrete pilar and punctual foundation.

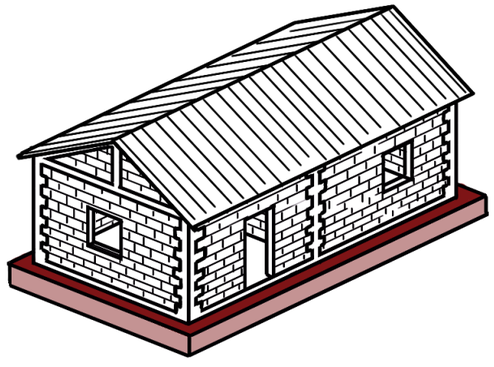
BETTER



Strip foundation for better stability.

Toothing for better anchoring between pilar and infill.

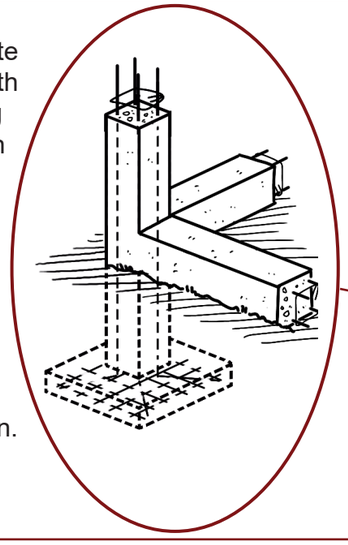
4B : HEAVY CONSTRUCTION



A house is more solid when it is built on a strong foundation.

10cm thick concrete slab, reinforced with steel rebar matting connected to plinth beam.

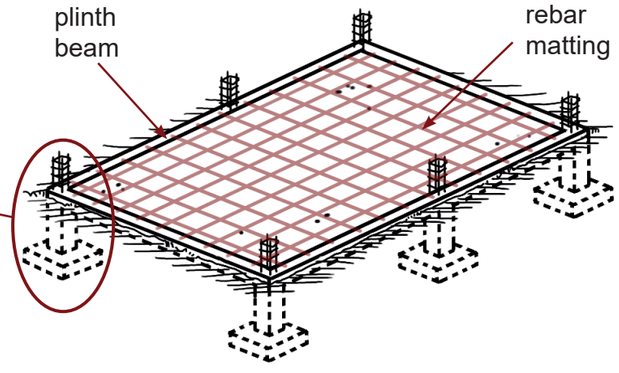
Concrete pilar and punctual foundation.



✓YES

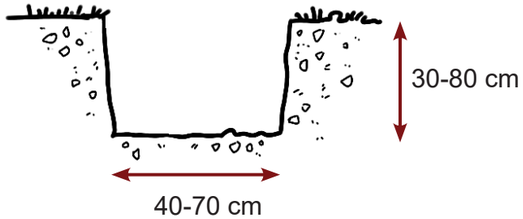
plinth beam

steel rebar matting

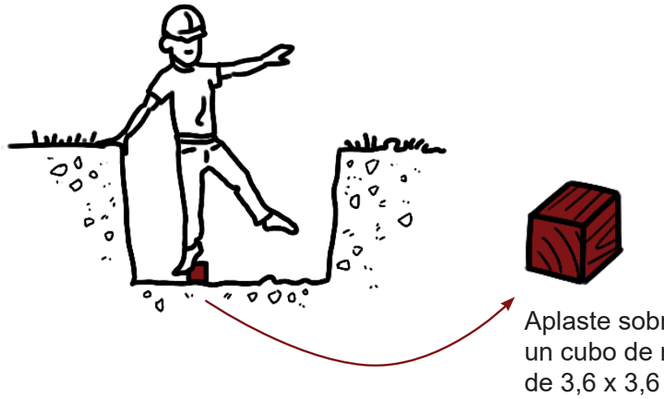


4C : TYPE OF GROUND

The foundation must rest on the firm ground.



First dig until the firm ground, then build the foundation base with adequate width.



Aplaste sobre un cubo de madera de 3,6 x 3,6 x 3,6 cm.

Quick test for ground resistance:
If the ground is firm, a wooden cube with 3,6cm length should not sink into the soil with a 65kg person standing on top of it.

It is still recommendable to conduct a formal ground study.

Key messages and recommendations for self-construction: PRINCIPLES

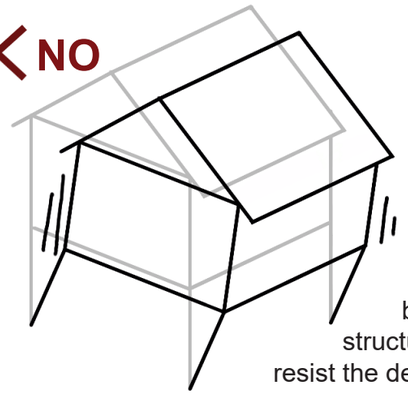
5 SOLID WALLS AND CONFINING ELEMENTS

Shelter Cluster Ecuador
ShelterCluster.org

5A: LIGHT CONSTRUCTION

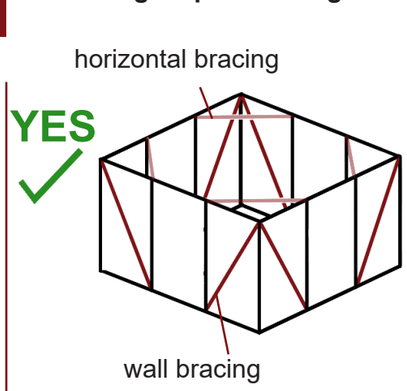
Bracing helps to strengthen the structure!

NO

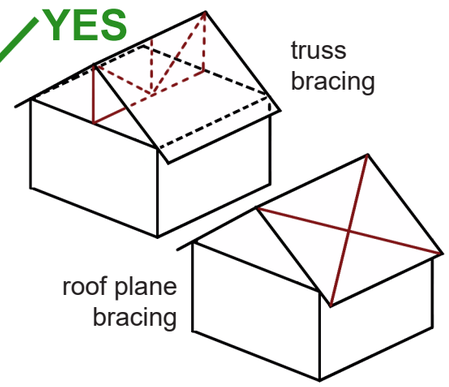


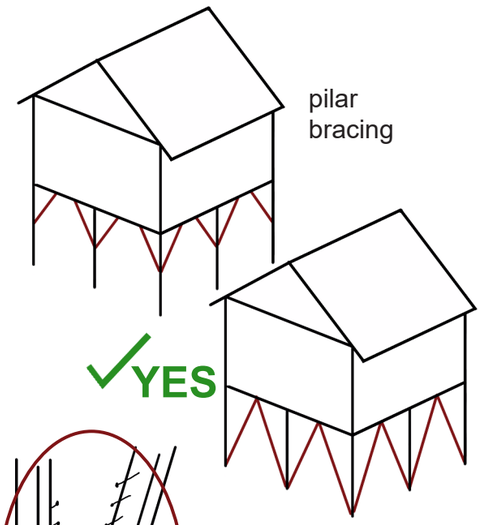
Without bracing the structure will not resist the deformation!

YES



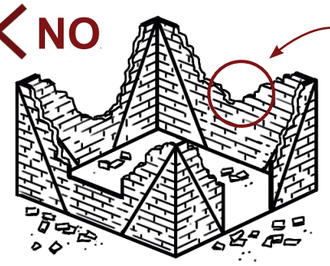
YES





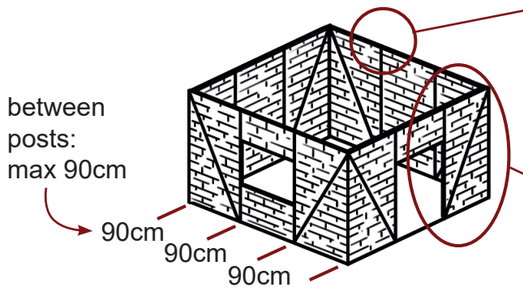
YES

NO



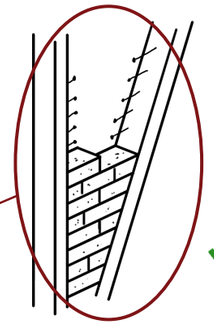
Without ringbeam the infill has little anchoring and will fall out of plane!

The ringbeam helps to keep the infill in position.



YES

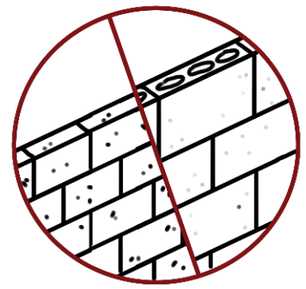
Bricks infill: better anchoring with nails or dowels fixed on structure.



YES

Incorrect and correct use of bricks and cement blocks.

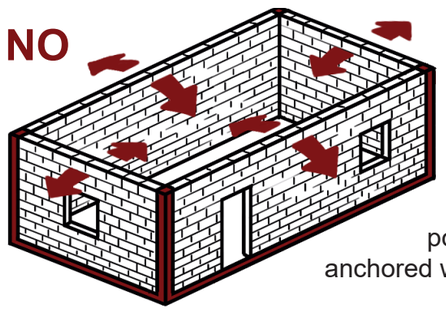
NO



No vertical bricks and no cement blocks less than 10cm in width!
Both are very unstable and dangerous!

5B : HEAVY CONSTRUCTION

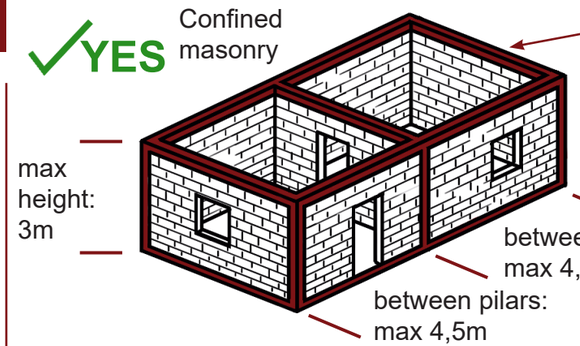
NO



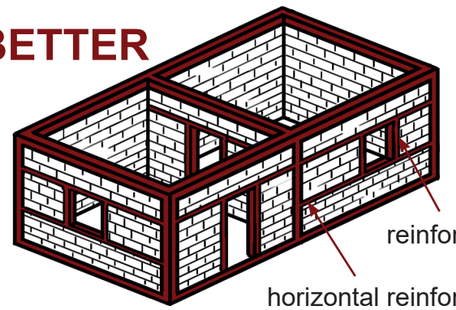
poorly anchored walls

YES

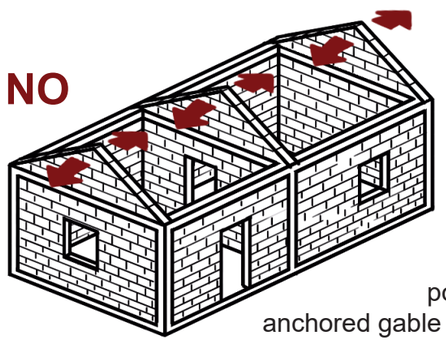
Confined masonry



BETTER

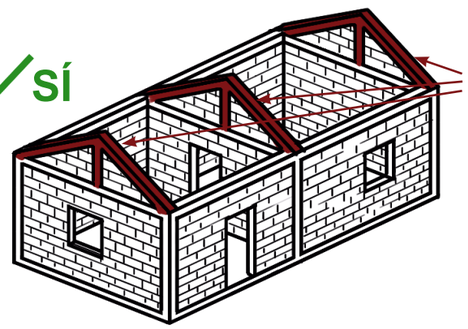


NO



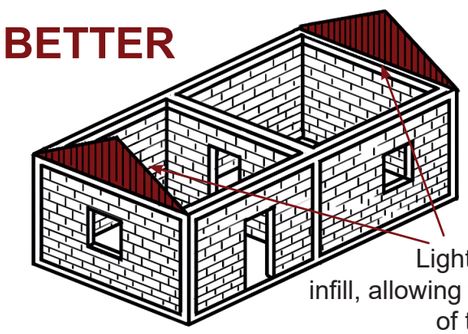
poorly anchored gable tops

SÍ



Confining elements connected to ringbeam and to pilars.

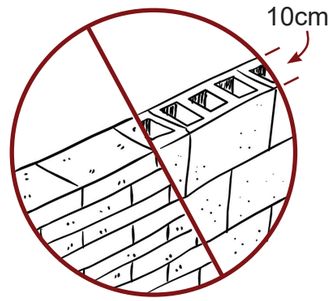
BETTER



Light gable top infill, allowing ventilation of the house.

YES

min 10cm



Use bricks in horizontal position or cement blocks minimum 10cm in width.

Key messages and recommendations for self-construction: PRINCIPLES

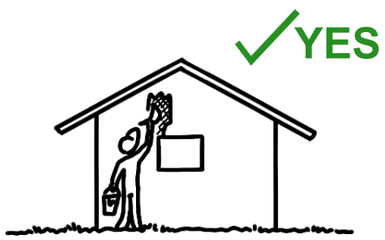
6 MAINTENANCE AND COMFORT OF THE HOUSE

Shelter Cluster Ecuador
ShelterCluster.org

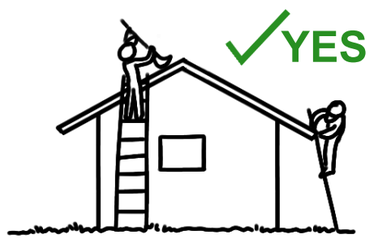
6A : BASIC MAINTENANCE

Maintenance helps extend the lifespan of a building. I should be done:
- on a daily base: checking the general good state
- on an annual base: checking more thoroughly the whole building

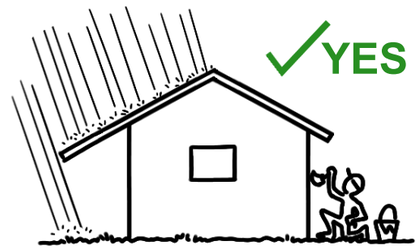
Do not leave or store timber against the walls (this would bring humidity and parasites).



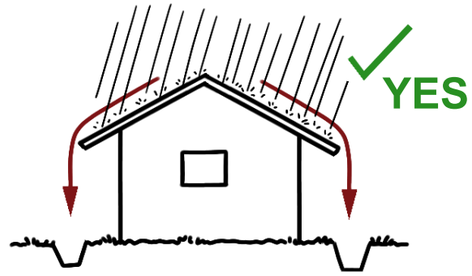
Treat timber and bamboo anually against parasites (with borate or other chemicals). Then lay an additional rainproof protection layer against water.
Paint exposed metal parts to avoir corrosion (especially in coastal areas, which carry salt in the air).



Clean the roof and the gutters.



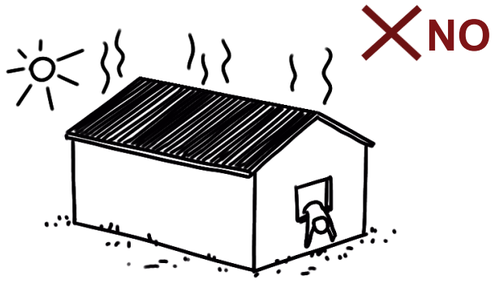
Protect walls with wider eaves or with paint.

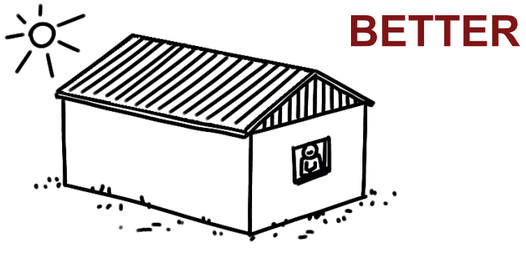


Dig gutters around the house to evacuate rain water.

Maintenance should be done for all buildings, whichever materials they are built with:
- masonry, concrete, bricks, timber, bamboo, wattle & daud, ...

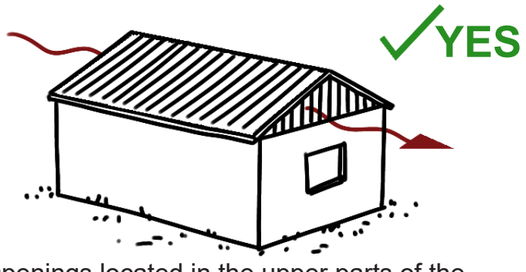
6B : COMFORT AND ENERGY



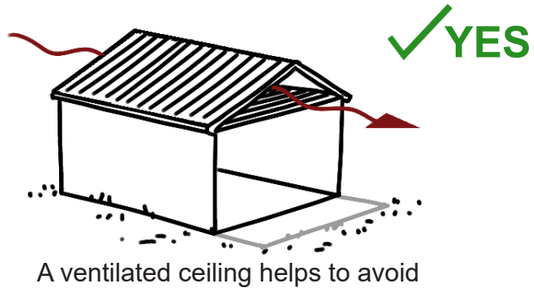


A white or light colored roof will limit the heat accumulation in the house.

Save money by living without air conditioning.



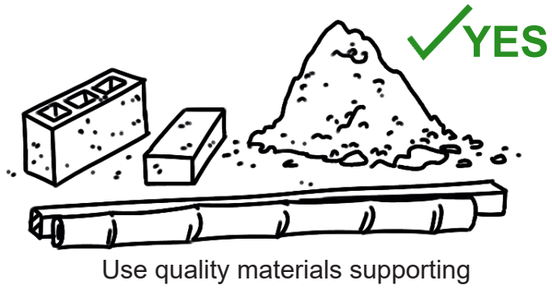
Openings located in the upper parts of the house naturally allow hot air to flow out.



A ventilated ceiling helps to avoid high temperatures in the house.

Reduce water consumption.

Rain water harvesting can help optimize domestic water consumption (cover the tank with a mosquito net or a lid).



Use quality materials supporting the local economy.