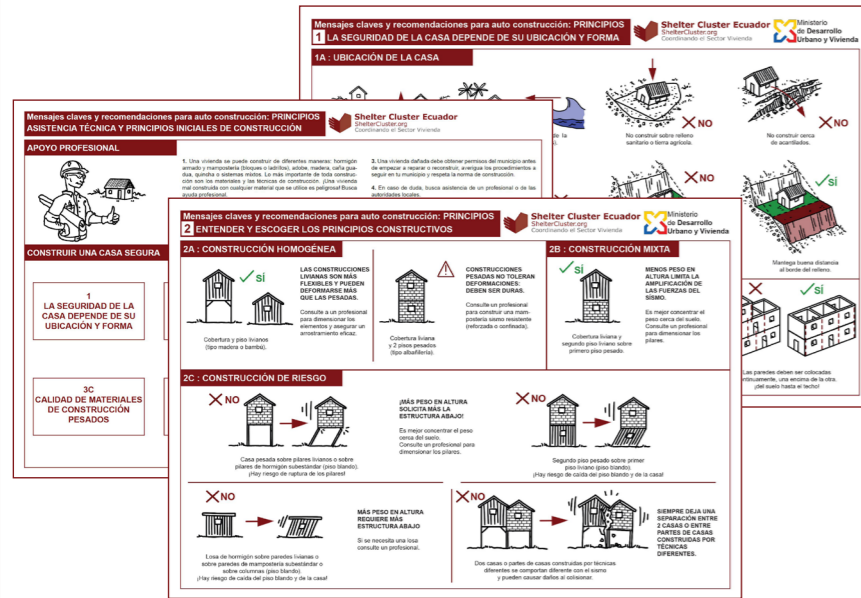


Key Messages and recommendations for self-construction: DETAILS TECHNICAL ASSISTANCE AND BASIC CONSTRUCTION PRINCIPLES



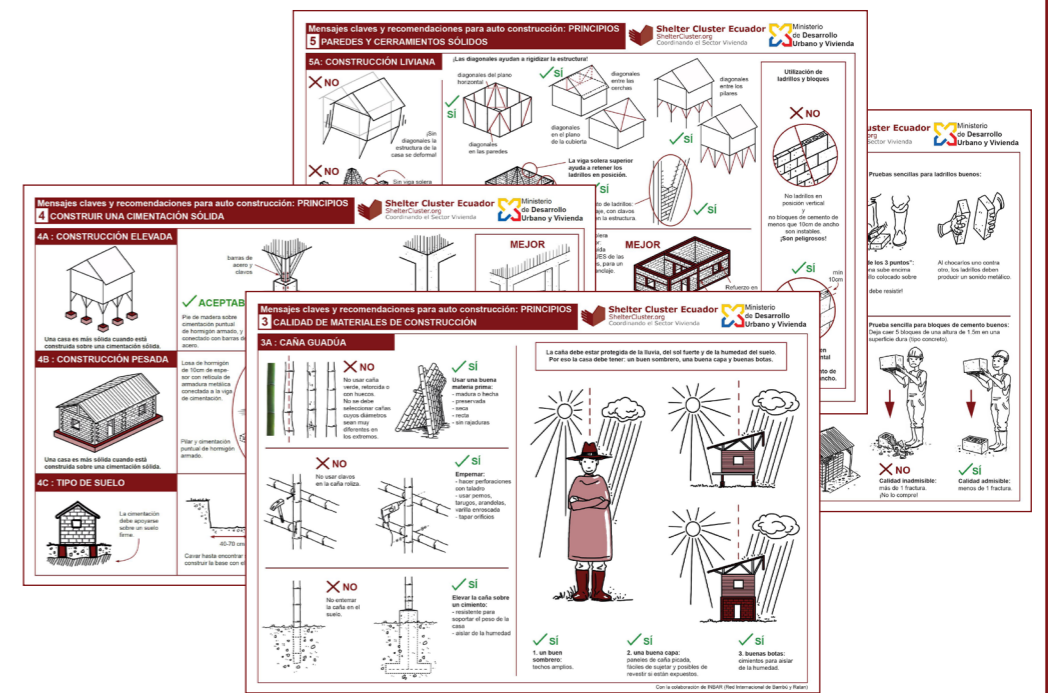
Shelter Cluster Ecuador
ShelterCluster.org

I. CONSTRUCTION PRINCIPLES



THE KEY MESSAGES I (Construction Principles) are made for non professionals in construction. They aim to improve the construction culture and habits in the areas affected by the 26.04.2016 earthquake in Ecuador, to avoid the reproduction of typical mistakes and flaws during the reconstruction process.

The key messages cover construction materials' quality, information on light- and heavy construction techniques, and insist on the importance of having professional assistance when building a house.



II. CONSTRUCTION DETAILS



This document compiles the Key Messages II.

The Key Messages II (Construction Details) complete the Key Messages I and are made for construction professionals in the communities of the affected areas.

They result from the observation of the most typical mistakes in the local construction habits, and should help to improve some important construction details.

**1
SECURITY RULES
ON THE
CONSTRUCTION SITE**

**2
BAMBOO : HINTS
FOR GOOD QUALITY
MATERIALS**

**3
BAMBOO : HINTS
FOR A BETTER
CONSTRUCTION**

**4
MASONRY :
CONCRETE FRAMES &
CONFINED MASONRY**

**5
MASONRY :
HINTS FOR A BETTER
CONSTRUCTION**



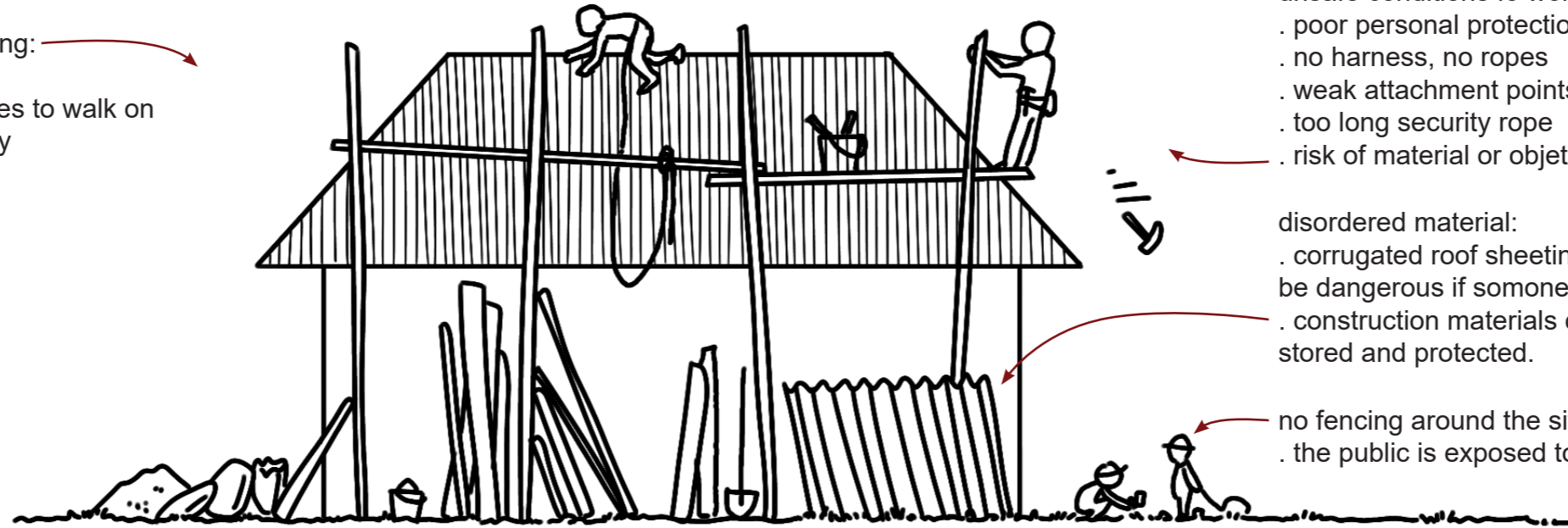
1 SECURITY RULES ON THE CONSTRUCTION SITE

1A : DANGEROUS SITE

X NO

improvised scaffolding:

- . no barriers
- . no boards or bridges to walk on
- . apparent instability



unsafe conditions for workers:

- . poor personal protection equipment
- . no harness, no ropes
- . weak attachment points
- . too long security rope
- . risk of material or objects falling

disordered material:

- . corrugated roof sheetings, boards and other materials can be dangerous if someone falls down on them
- . construction materials can be damaged if not properly stored and protected.

no fencing around the site:

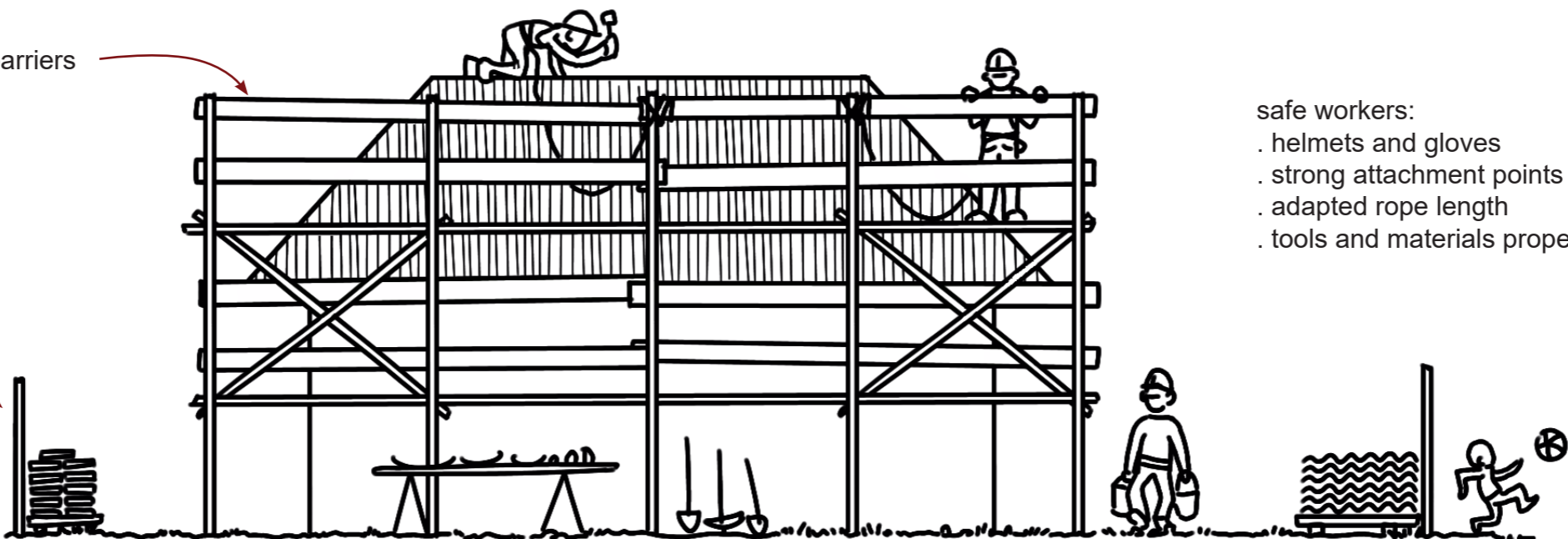
- . the public is exposed to accidents

1B : SAFE SITE

✓ YES

barriers

fencing



safe workers:

- . helmets and gloves
- . strong attachment points
- . adapted rope length
- . tools and materials properly stored and secured

storage area

circulation area

storage area

public area

no access to public area

public area



2 BAMBOO : HINTS FOR GOOD QUALITY MATERIALS

2A : HARVEST

Only use mature bamboo:

- . 4 to 6 years old
- . dark green, with barely visible nodes
- . lichens growing on the stem



Cutting the bamboo:

- . better during waning moon and first hours of the day
- . selected bamboo stems are cut close to the first node
- . cut the stem clean, avoiding damaging the fibres
- . avoid damaging the extremities of the stems when dragging them



Selecting the stems:

- . without holes or cracks caused by insects or birds
- . without ramification or branching out



2B : TREATMENT

Natural preservation:

- . leave the stem on its stump or on a stone for 3 weeks, leaving the branches and leaves intact
- . starch, sugars and humidity of the bamboo will turn to alcohol, avoiding parasite attack
- . the bamboo stems will turn from green to yellow



Chemical preservation:

- . this is done with pre-dried stems (drying is done during maximum 1 week)
- . immerse in borax salts and boric acid
- . this preservation is the most efficient and the cheapest
- . it is also more environment friendly



Method:

- . perforate the inside of the stems with a steel rebar
- . clean the stems without scratching or damaging the skin



- . put the stems into a tank filled with the preservatives
- . mix: for each 96 liters of water + 2 kg borax + 2 kg boric acid



- . leave the upper extremity of the stem close to the surface, to let out the air
- . keep immersed during 5 days at ambient temperature or 6 hours if the liquid is heated to 60°C



- . take out of the tank and place to dry upside down, to drain out the liquid



2C : DRYING

- . construction quality bamboo should have a humidity content equal to or inferior to the ambient humidity level
- . drying can be done with the ambient air or in the sun



Drying on easels:

- . resting the bamboo stems on the easels avoid contact with the ground
- . turn the stems to allow a uniform drying (every day during the first 15 days, then less frequently)
- . drying time: from 2 to 6 months, according to climatic conditions



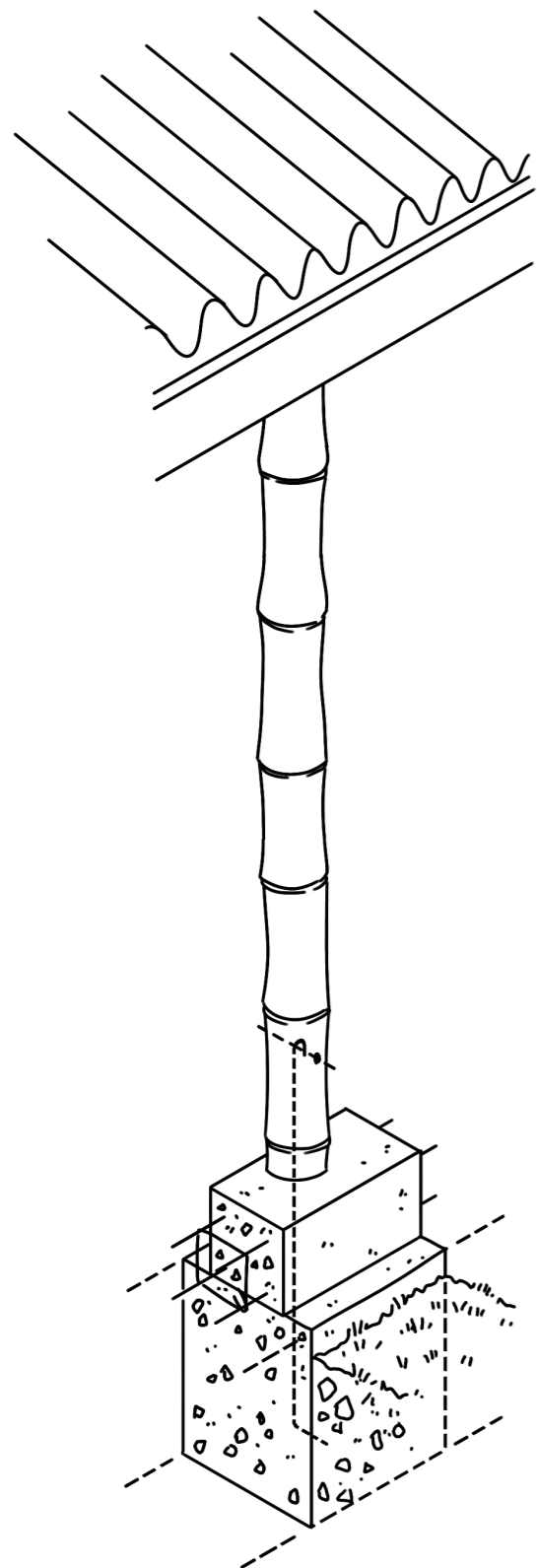
Drying and storing under a roof:

- . protect the bamboo stems by isolating them from the ground
- . use spacers to facilitate good air flow



3 BAMBOO : HINTS FOR A BETTER CONSTRUCTION

3A : CONSTRUCTION ELEMENTS



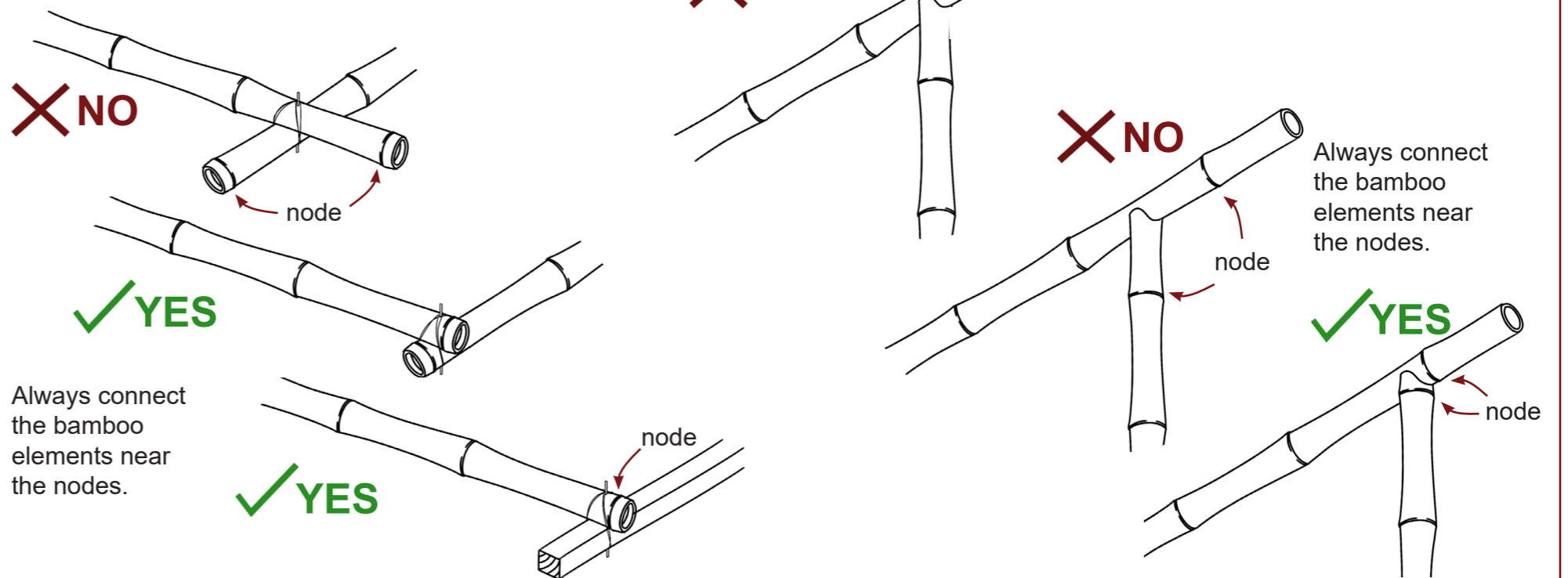
Roof with generous eaves

Bearing structure

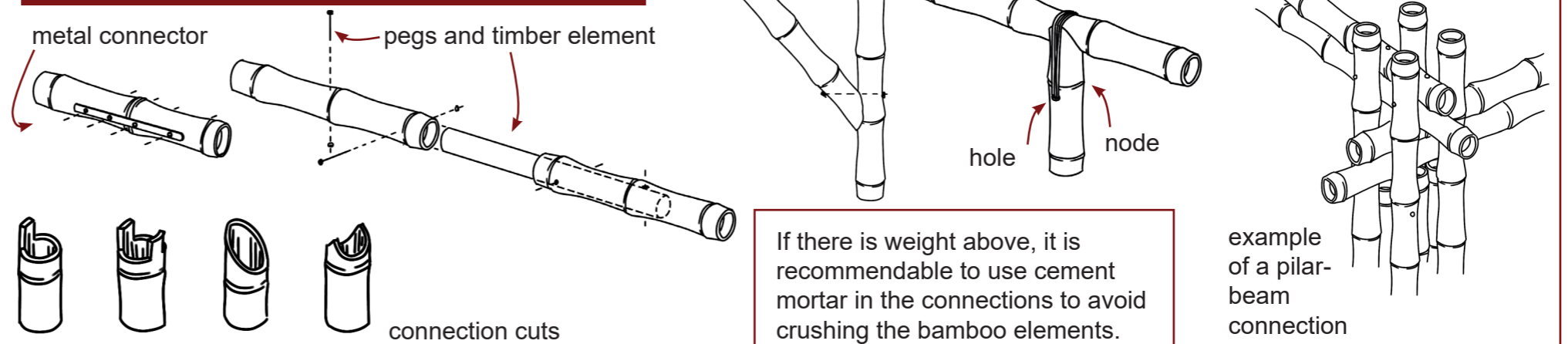
Plinth beam and flooring

Foundation

3B : CONNECTIONS AND NODES



3C : CONNECTION EXAMPLES



3D : BAMBOO PROTECTION

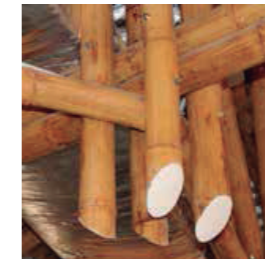


Use enameled paint for exposed metal and bamboo elements.

Protect exposed bamboo walls (with a cement, sand and lime coating, or with wattle & daub).



Seal extremity cavities with a cement, sand and lime mortar.



Cut and file protruding connecting elements and protect them against corrosion. Check every 6 months.

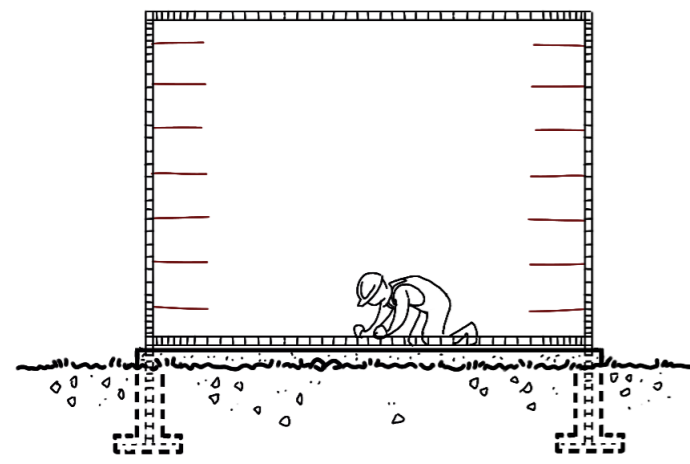




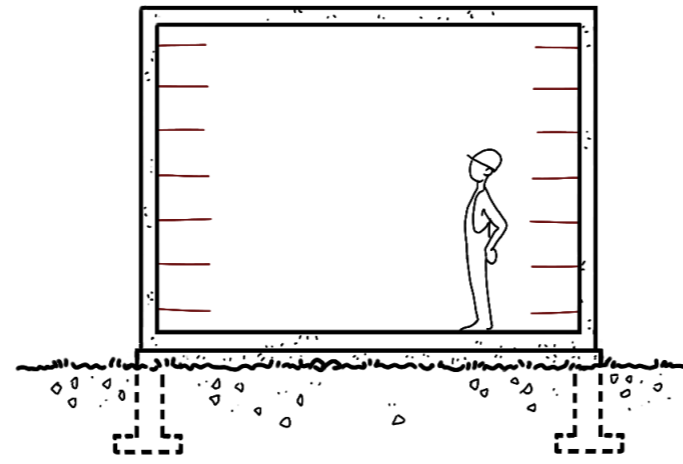
4 MASONRY : CONCRETE FRAMES & CONFINED MASONRY

4A : CONCRETE FRAMES

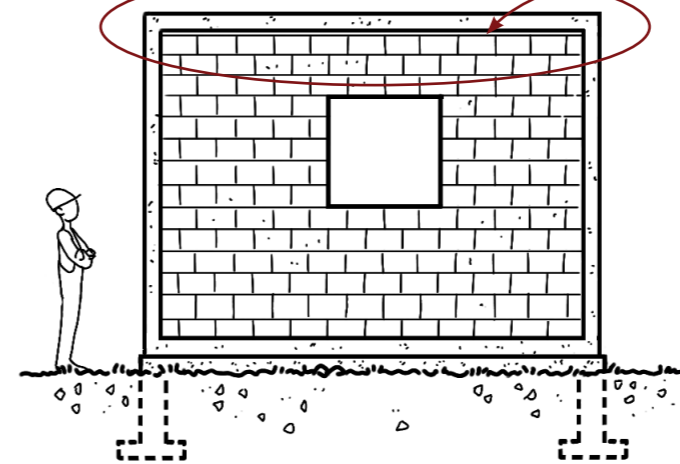
This construction technique is very frequent, but it can be dangerous if not done properly.



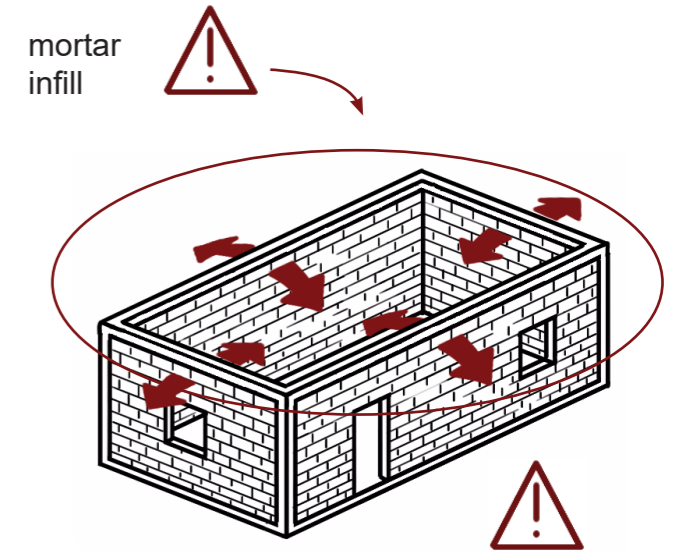
1. Construction of the steel rebar frame, with dowels for a better anchoring of the brick / block infill.



2. Construction of the formwork and pouring of the concrete, resulting in a reinforced concrete frame, and ready to receive the brick / block masonry.



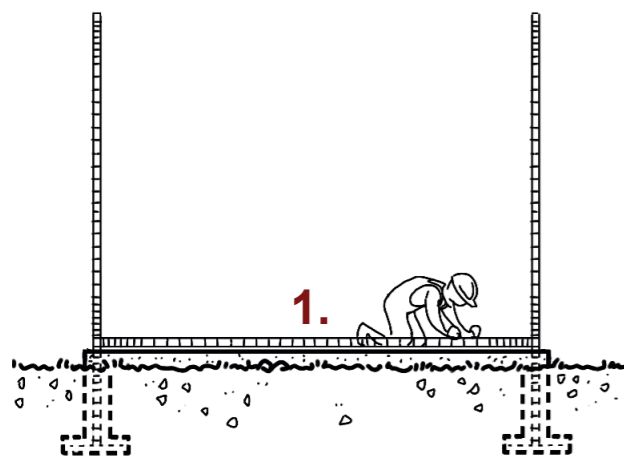
3. The brick / block infill is made, with the dowels fitting into the mortar.



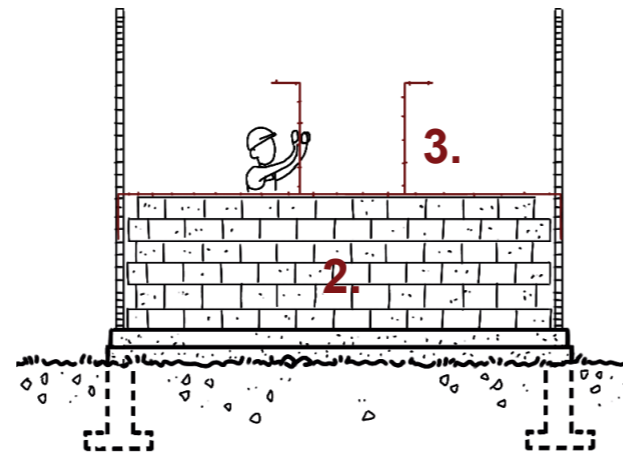
The infill is weakly anchored to the concrete frame, and may fall in case of an earthquake.

4B : CONFINED MASONRY

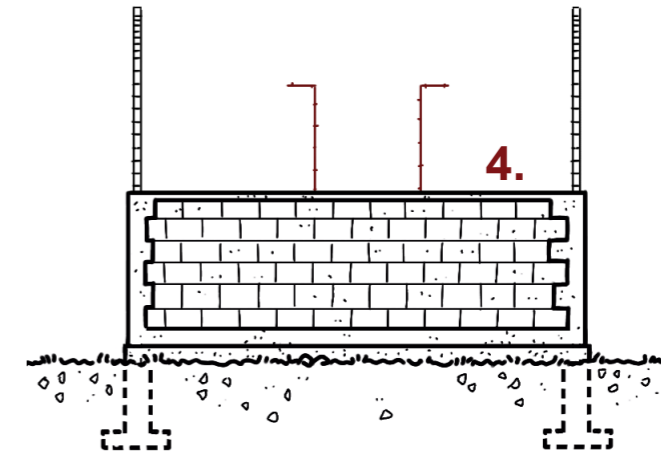
Confined masonry allows to build masonry houses which are more resistant to earthquakes.



1. The steel rebar reinforcements of the plinthbeam and pilars are prepared after the foundation and well connected to it.

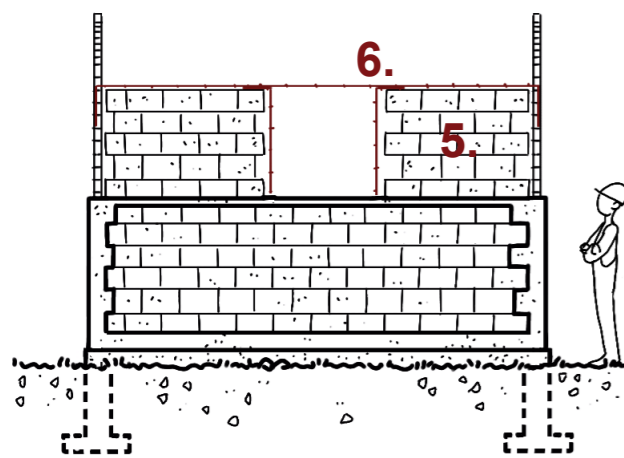


2. The brick / block masonry is built (max height 1,20m) with tothing near the rebar structures.



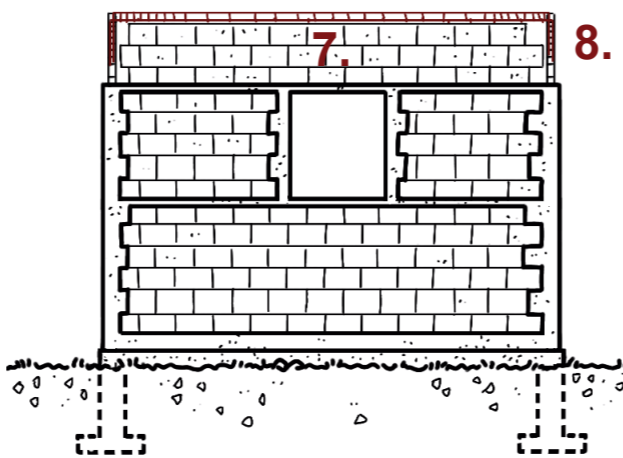
3. Construction of a horizontal intermediate steel reinforcement (seismic band) and vertical reinforcements for the wall openings.

4. Pouring of the lower 1,20m of the wall only. After the concrete has set, the next level of brick / block can be made.



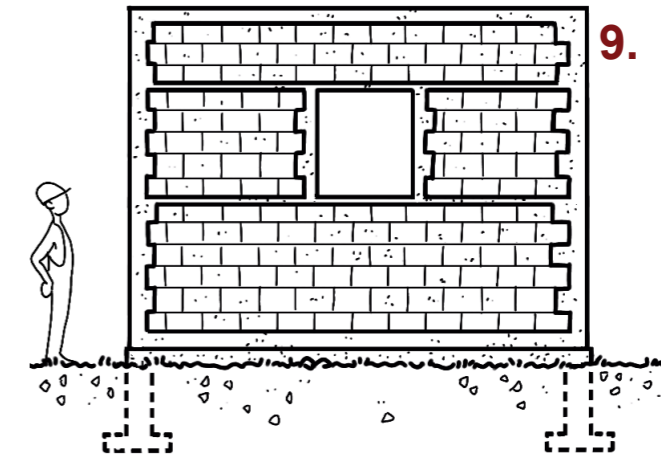
5. The second level of brick / block masonry is built (max height 1,20m) with tothing.

6. Construction of a horizontal intermediate steel reinforcement, connected to the tie-columns.



7. If necessary, a third level of masonry is made (with tothing).

8. Construction of the horizontal ring beam steel reinforcement, connected to the tie-columns.



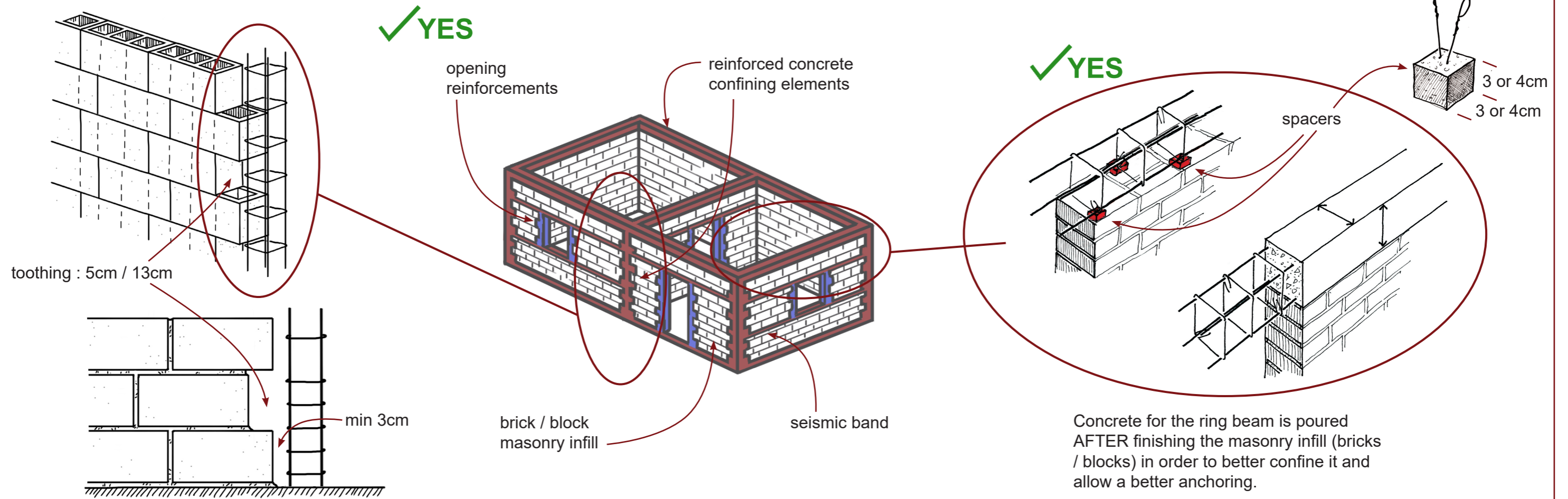
9. Only at this final stage is the concrete poured for the ring beam, in order to complete the proper confinement of the brick / block masonry (without the mortar infill).



5 MASONRY : HINTS FOR A BETTER CONSTRUCTION

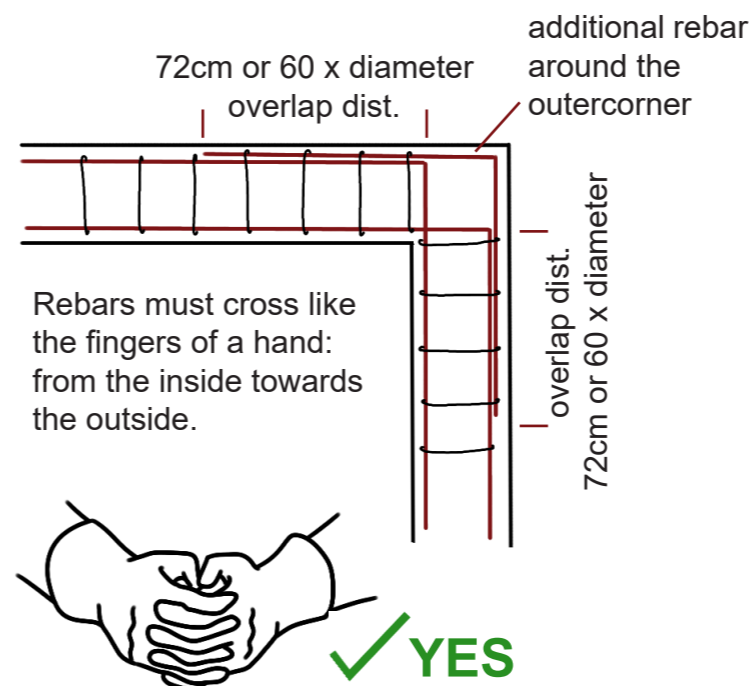
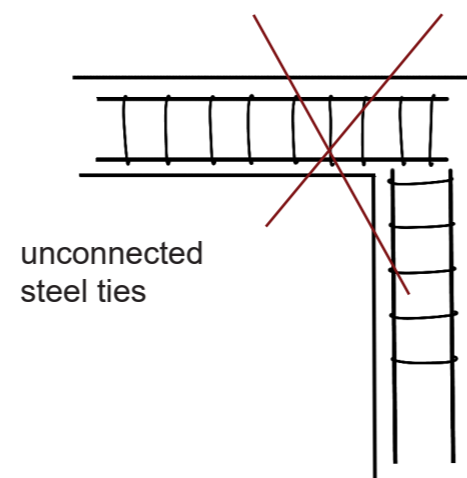
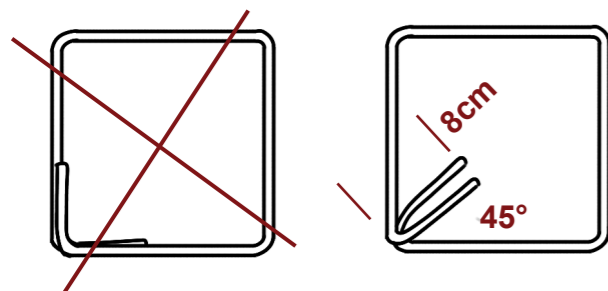
5A : ANCHORING OF THE MASONRY

It is very important to have a good anchoring between concrete confining elements and brick / block masonry: the tothing and the ring beam are clue elements for this.



5B: STEEL TIES ELEMENTS

Stirrups: always bend 8 cm at 45°



Protect rebar ends with lean concrete. Otherwise they will rust and cannot be used.

