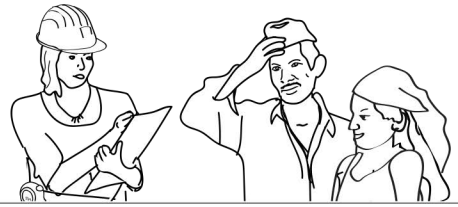
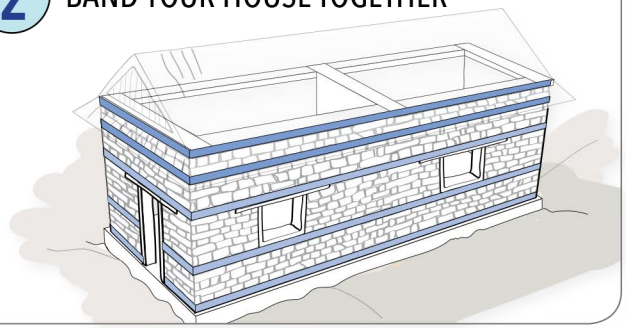
Well built **STONE** houses can better withstand earthquakes. Here are **10 TIPS ON HOW TO**

BUILD BACK SAFER

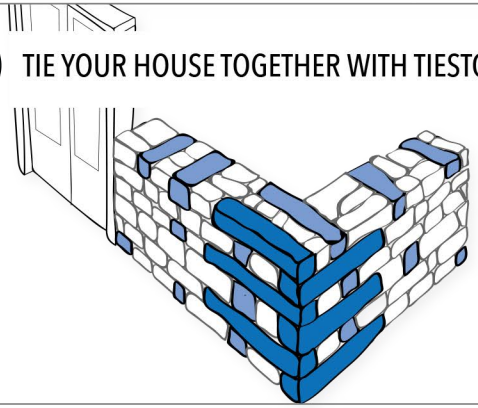
1 GET TECHNICAL ADVICE BEFORE YOU START



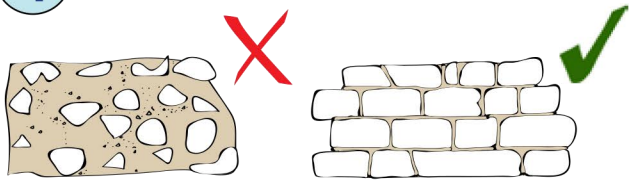
2 BAND YOUR HOUSE TOGETHER



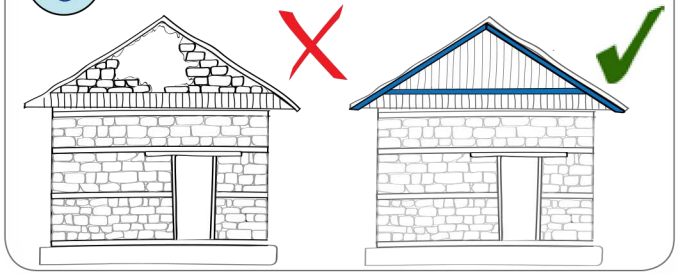
3 TIE YOUR HOUSE TOGETHER WITH TIESTONES



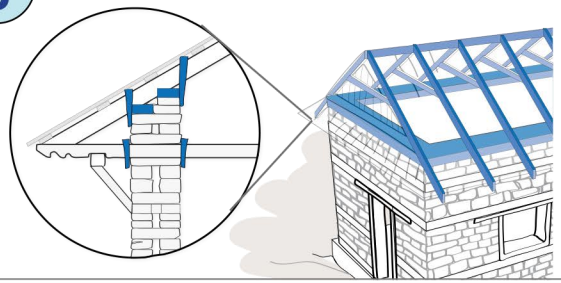
4 BUILD YOUR HOUSE WITH GOOD MATERIALS



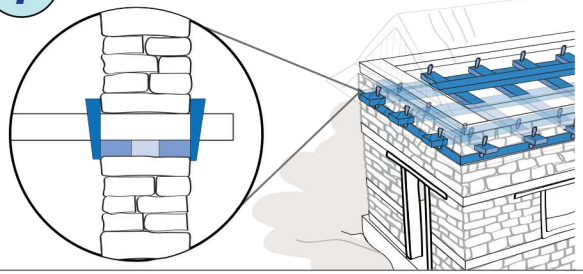
5 TIE YOUR GABLES UP



6 TIE YOUR ROOF DOWN



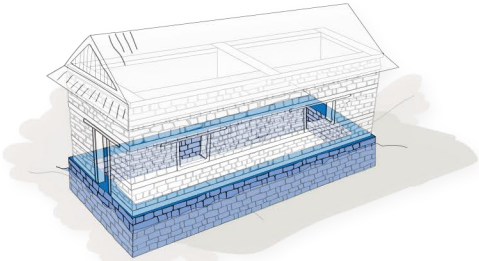
7 TIE YOUR FLOORS TO YOUR WALLS



8 BUILD A STRONG SHAPE

9 HAVE A SAFE SITE AND ESCAPE ROUTE

10 BUILD ON STRONG FOUNDATIONS



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10 KEY MESSAGES - A VISUAL INDEX

VERSION 3- 25/NOV/2015

#1 : GET TECHNICAL ADVICE BEFORE YOU START

The recommendations provided in this leaflet/poster should help you to build back safer than before in stone.

1. You can build a house out of many different materials such as stone, bricks, timber or concrete, but the most important thing is that you know how to use the materials properly or find a mason to build the house who does. **A badly built house in any material can be dangerous!**
2. These messages are based on what made houses fall down and why some stone houses stood up. They are **not intended as a substitute for training but just to help explain basic principles of strong stone houses**.
3. It is important to register your damaged home with the local authorities before you begin rebuilding, and speak to them about **building permits** and how you can follow the **building codes**.
4. The government is planning a major reconstruction assistance program which will include training in earthquake resilient construction methods.
5. Ensure you or masons helping you build your house are trained in earthquake resilient construction methods.

6. If you have any questions seek technical assistance from a trained mason or your local authority.
7. These tips are only as general guidance for small traditional houses made from stone, if you are building bigger buildings or using other materials there are many other things you must consider! **Get technical advice, use trained masons, use a trained engineer, and build back safer!**

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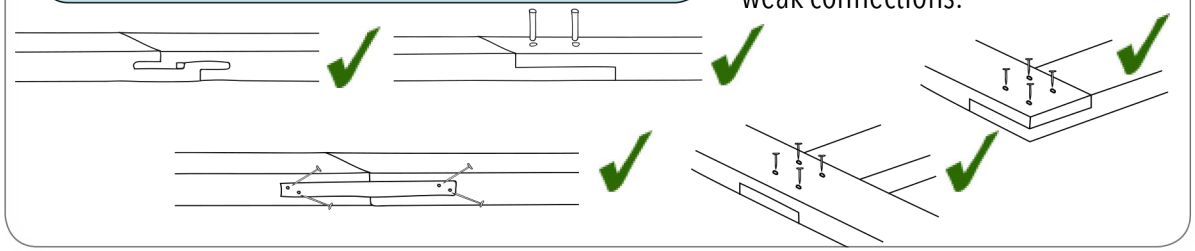
KEY MESSAGE NUMBER #1 OF 10
VERSION 3 - 25/NOV/2015

#2 : BAND YOUR HOUSE TOGETHER

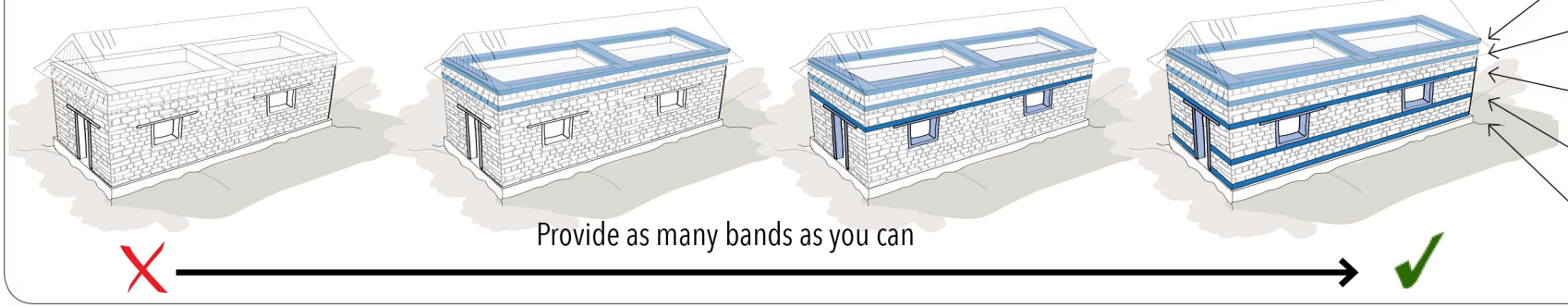
Banding prevents your walls from being pulled or pushed apart.

PROVIDE STRONG BAND CONNECTIONS

Some bands failed because of weak connections.

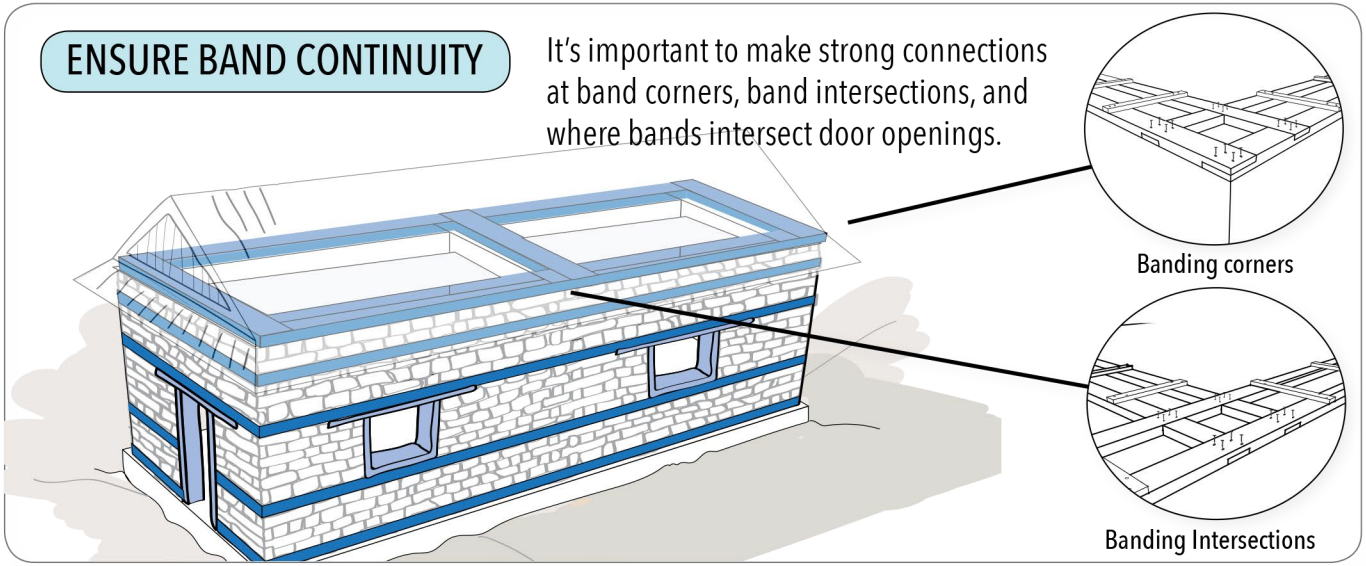


PROVIDING BANDS IS ESSENTIAL

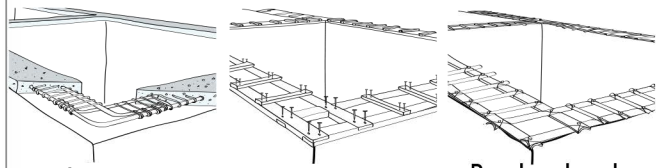


ENSURE BAND CONTINUITY

It's important to make strong connections at band corners, band intersections, and where bands intersect door openings.



USE STRONG MATERIALS FOR BANDING



Reinforced concrete band

Timber band

Bamboo band
(Strips with skin removed)

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KEY MESSAGE NUMBER #2 OF 10

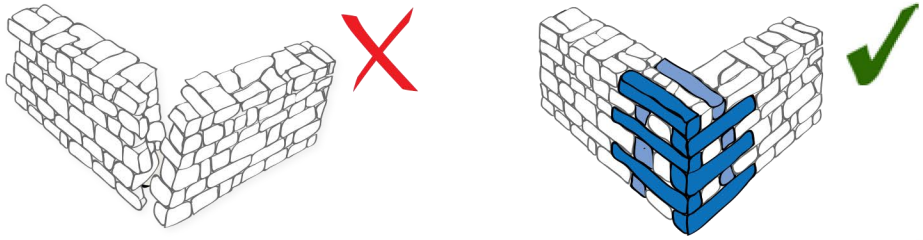
VERSION 3 - 25/NOV/2015

#3 : TIE YOUR HOUSE TOGETHER WITH TIESTONES

Tiestones (including throughstones and cornerstones) hold your walls together and reduce the risk of walls collapsing or peeling apart.

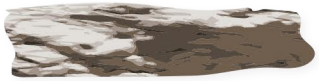
CORNERSTONES

Cornerstones strengthen your walls and help reduce the risk of corner collapse. Use them on every corner in your building.



TIESTONE MATERIALS

Choose strong materials for use as tiestones.



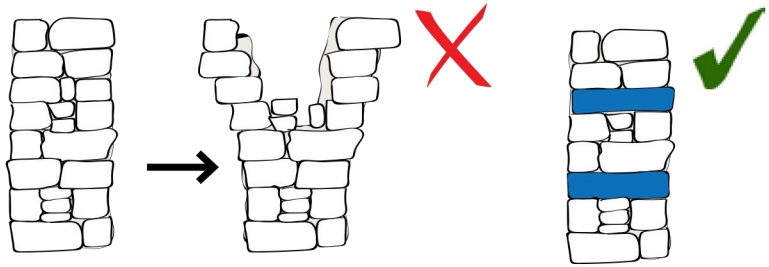
Select long flat stones for use as tiestones. Shape stones with a tool if needed.

Reinforced concrete tie

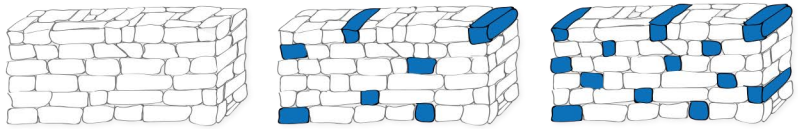
Timber dowel tie

THROUGHSTONES

Throughstones help prevent your walls from peeling apart.



Carefully select long and flat throughstones. Make sure they span the thickness of the wall.



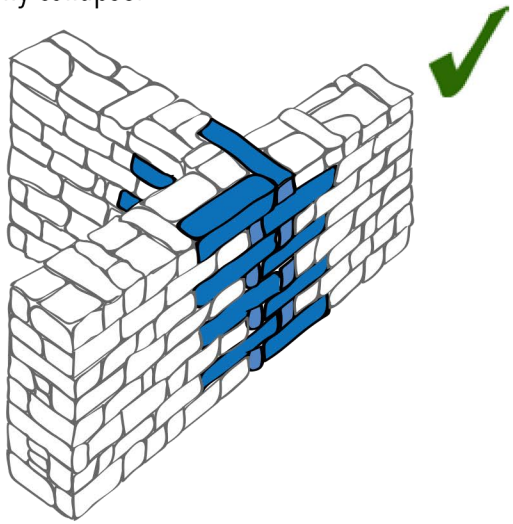
Weak

Use throughstones at a maximum 2 foot vertical and horizontal spacing.

Strong

TIESTONES AT WALLS

Tie your walls together, otherwise they can easily collapse.



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KEY MESSAGE NUMBER #3 OF 10

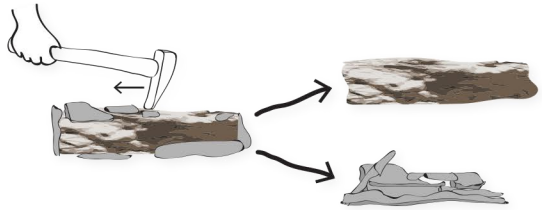
VERSION 3 - 25/NOV/2015

#4 : BUILD YOUR HOUSE WITH GOOD MATERIALS

Some houses fell down because poor quality materials were used. Using good materials in the right way is essential for a strong house.

STONE SELECTION

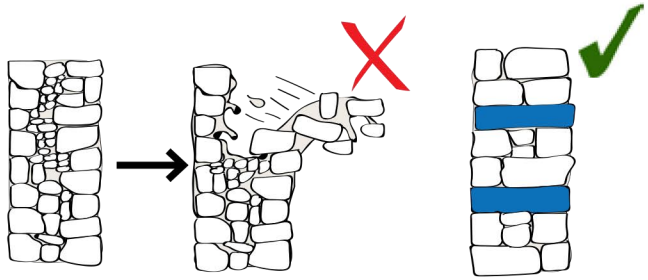
Select large rectangular stones if possible. Do not use round stones. Stones should be made rectangular.

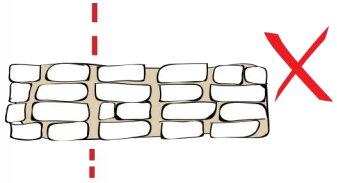


If using stones from your demolished house, clean any mortar from them.

STONE USAGE

Small stones and mud between your outer and inner wall can push your walls apart in an earthquake. Instead use well stacked larger stones between your inner and outer wall.





Large stones, no overlap

The larger the stones you use and the more they overlap the better

Small stones

Large stones, long overlap

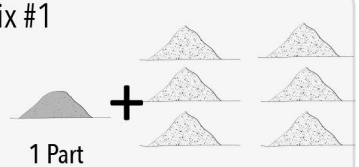
MORTAR

Mud Mortar

It's important to use good quality mud, free of Gravel. Mud should be thoroughly kneaded with water to make it similar to roti dough. Adding an amount of lime or cement or additional fibres for example cow / buffalo dung / hemp will make it stronger.
Mix any additives thoroughly.

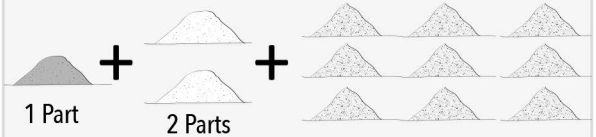
Cement Mortar Mix #1

Be careful! Cement mortar is not always safer if you don't know how to use it.



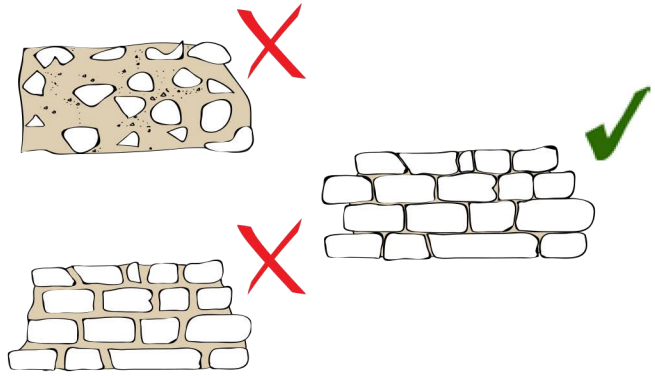
1 Part Cement + 6 Parts Sand

Cement Mortar Mix #2



1 Part Cement + 2 Parts Lime + 9 Parts Sand

Whether you use cement mortar or mud it is important to have the stones touching as much as possible. Rub the stones until they touch and minimise the gap/space between the stones as much as possible. The gap/space should be completely filled with mortar



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KEY MESSAGE NUMBER #4 OF 10
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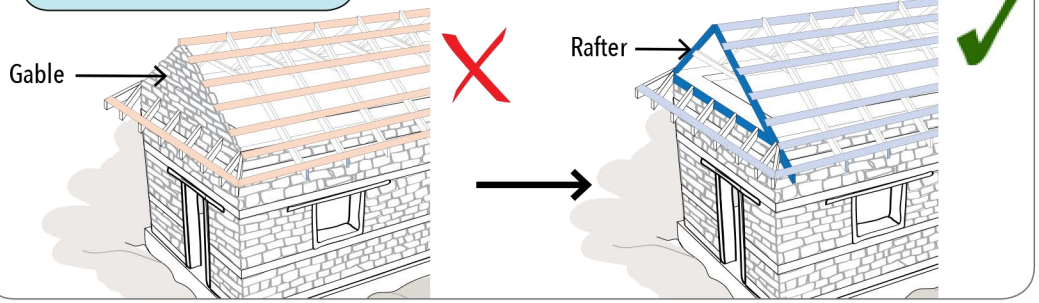
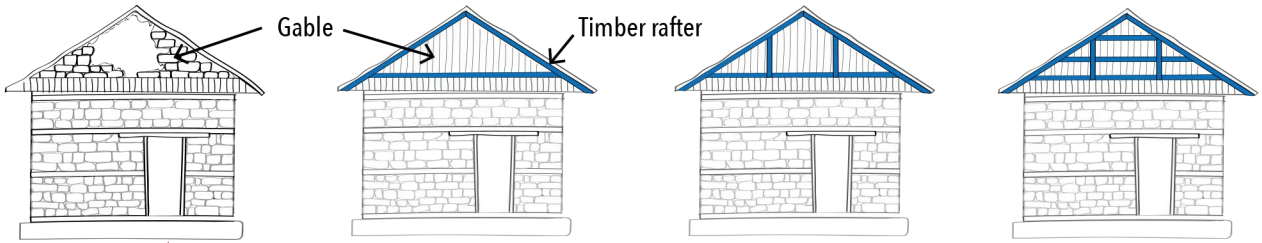
#5 : TIE YOUR GABLES UP

Many gables fell down.
Making gable materials lighter and fixing them to the roof structure can make them safer.

USE END RAFTERS

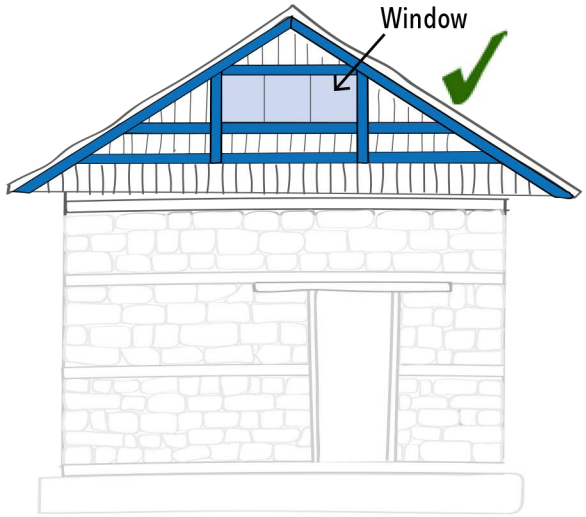


FIX YOUR GABLE TO THE ROOF STRUCTURE

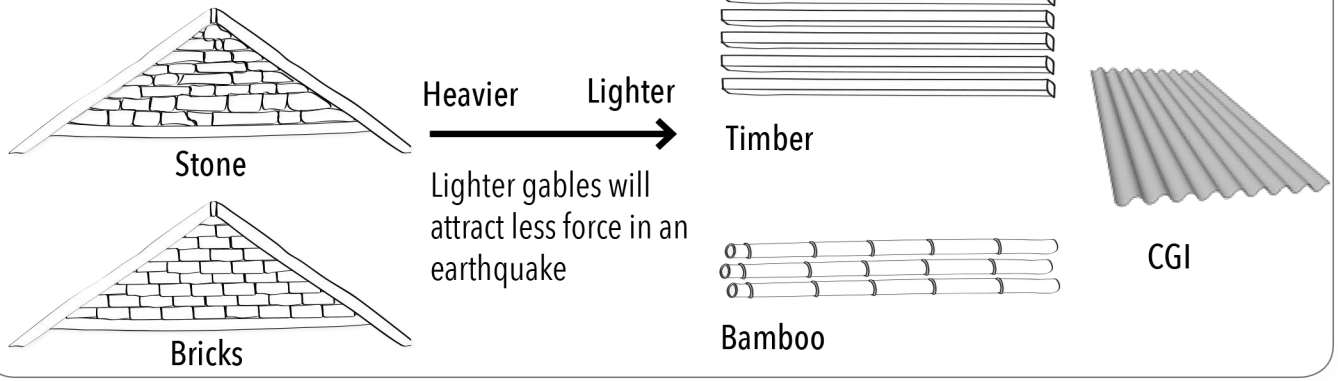


WINDOW OPENINGS

Any openings should be banded on all sides.



USE LIGHTER GABLES



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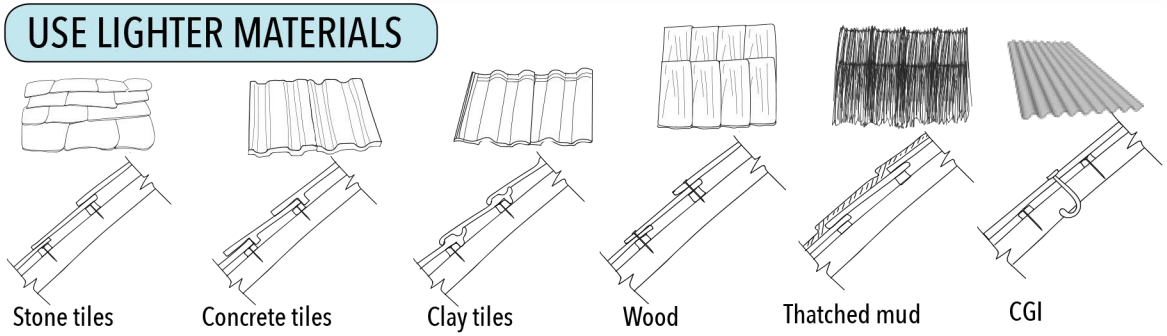
#6 : TIE YOUR ROOF DOWN

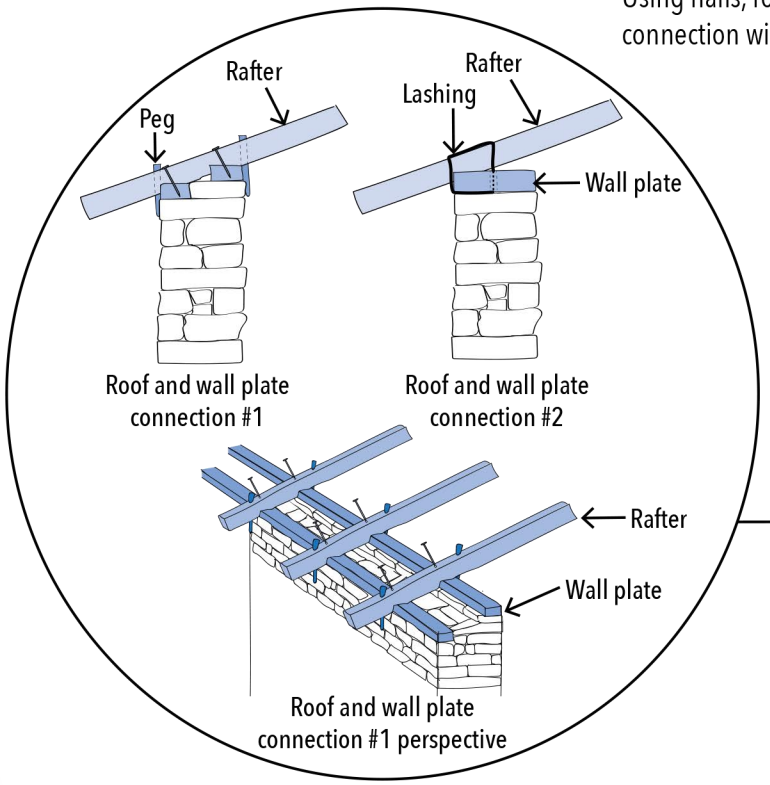
Some houses fell down because the roof collapsed pushing the walls apart.

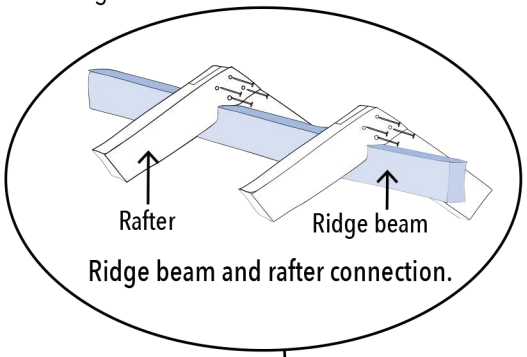
USE LIGHTER MATERIALS

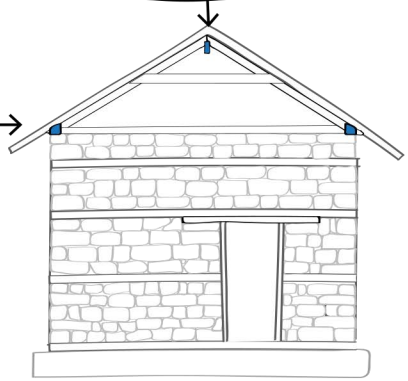


USE STRONG ROOF CONNECTIONS

Use a wall plate at the top of your walls and firmly tie your roof to it. Make sure your roofing material is connected well to frame. Using nails, rope or wire, make sure your rafters have a strong connection with the ridge beam.

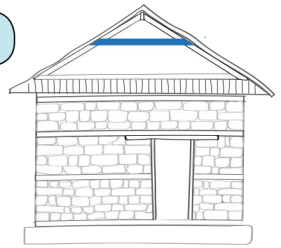




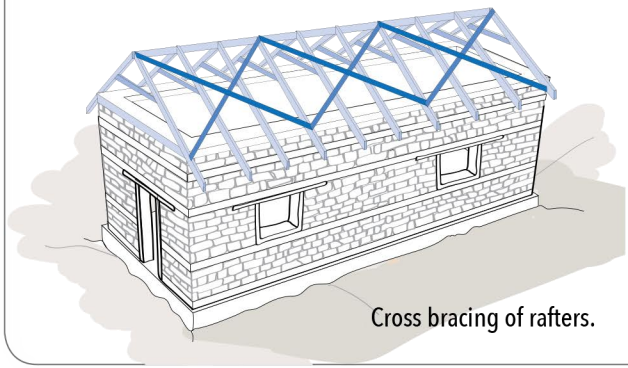


BRACE YOUR ROOF

Your roof is like the top of a box, a stiffer roof will give you a stronger house.



Collar tie



Cross bracing of rafters.

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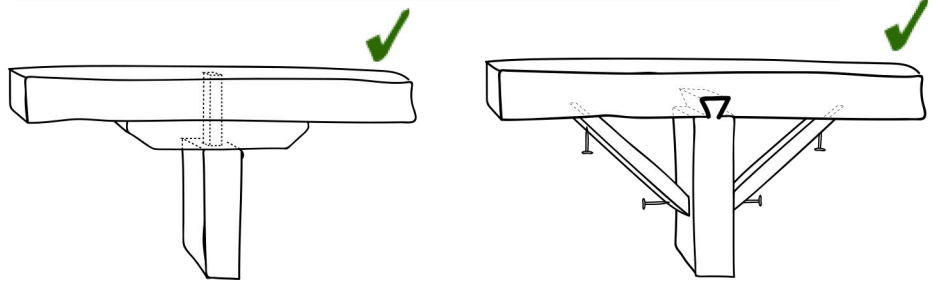
#7 : TIE YOUR FLOORS TO YOUR WALLS

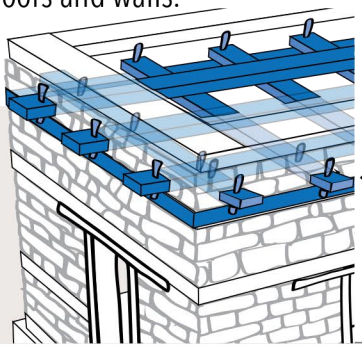
Strong floors with strong connections to the walls on all four sides can help stop your walls falling down in an earthquake.

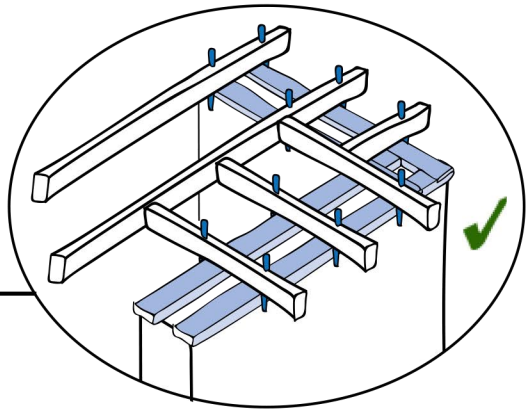
STRONG CONNECTIONS BETWEEN POSTS AND FLOORS



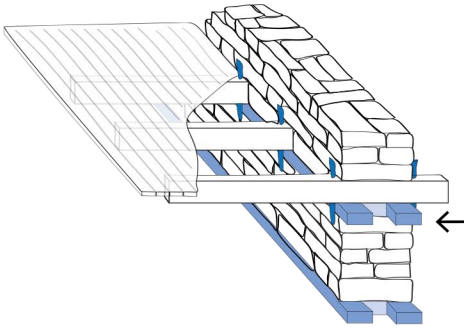
CONNECT YOUR FLOORS TO ALL YOUR WALLS

It is important to have a strong connection between your floors and walls.

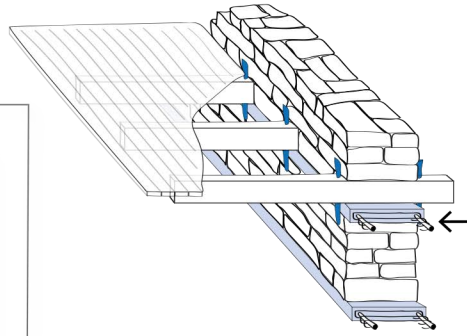




Connect joists to wall bands



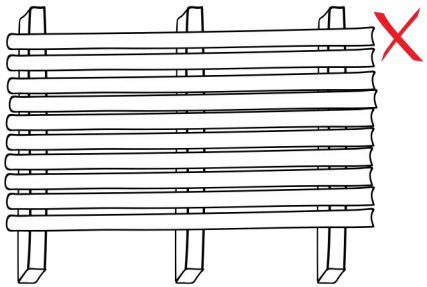
Wooden floor joists over timber band



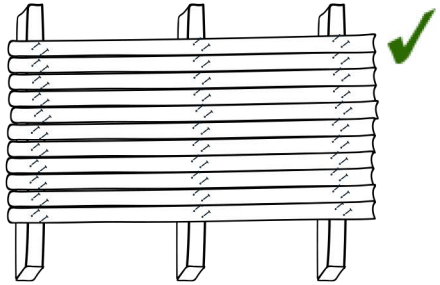
Wooden floor joists over concrete band

STRONG FLOOR

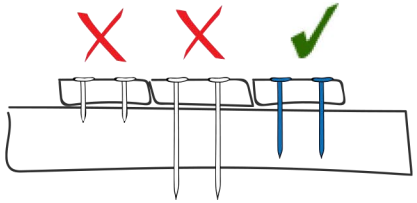
The stronger your floor, the stronger your house. Use nails, tie wire, rope or dowels.



No nails, tie wire or dowels



2 nails, diagonal



Nail sizes

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KEY MESSAGE NUMBER #7 OF 10

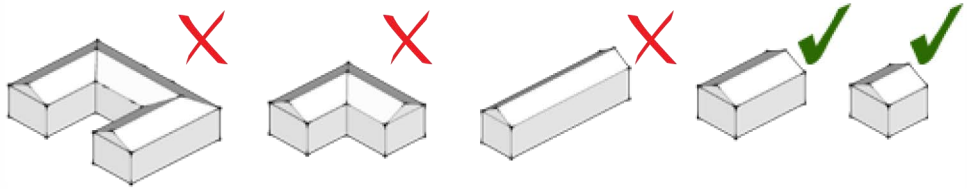
VERSION 3 - 25/NOV/2015

#8 : BUILD A STRONG SHAPE

The shape of your house and the design and construction of you walls are important for a stronger house.

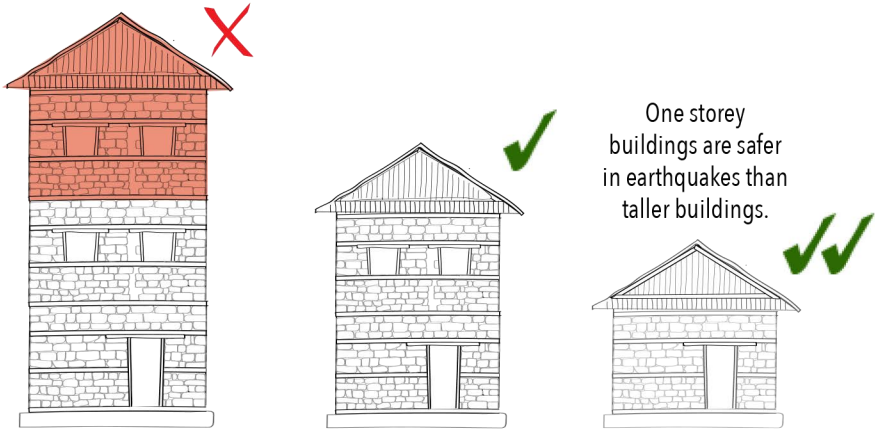
SHAPE

Use a regular shape that is not too narrow.
L and U shapes will twist during earthquakes.



HEIGHT

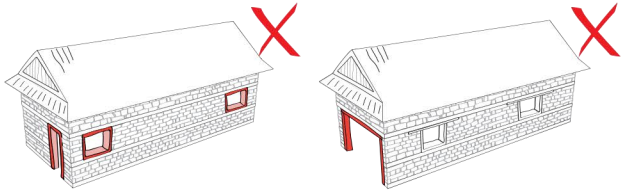
Don't build more than 2 storeys plus an attic when using stone.
If you want to build a taller building you need to get technical advice.
Floor to floor height should not exceed 9'10".



One storey buildings are safer in earthquakes than taller buildings.

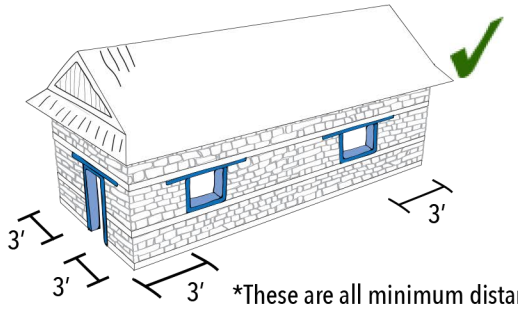
DOOR AND WINDOW OPENINGS

Large openings weaken a wall. Place openings away from corners and leave at least 3ft gap from corners and between openings.



Openings too close to a corner

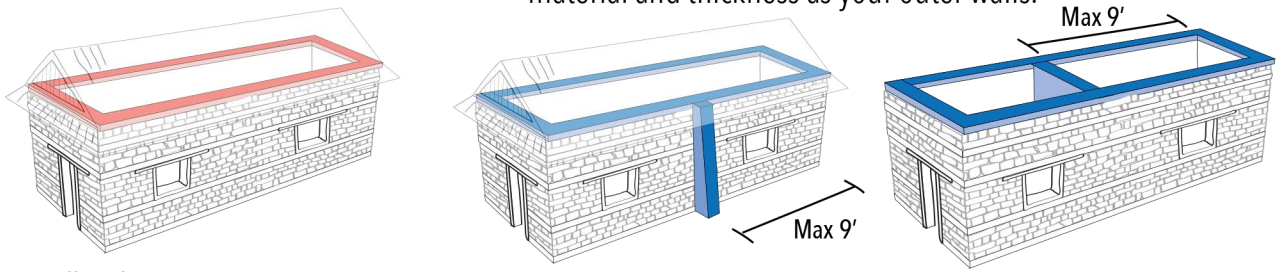
Large openings



*These are all minimum distances.

LONG WALLS NEED SUPPORT

For a longer house use regular wall supports or buttresses. It is important to build any internal walls from the same strong material and thickness as your outer walls.



Wall too long without supports

Provide buttresses

Provide internal walls

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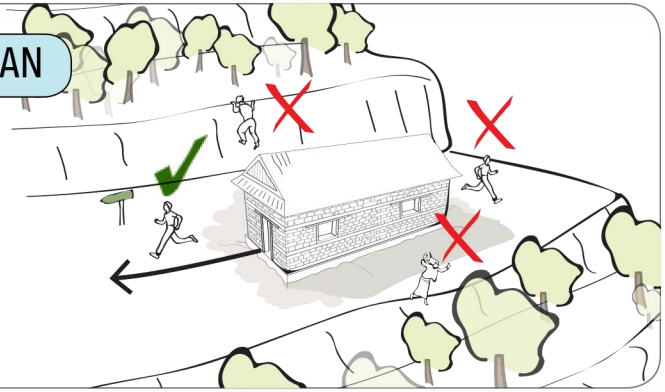
#9 : HAVE A SAFE SITE AND ESCAPE ROUTE

Choose a safe location for your house. Even if you can't choose there are still things you can do.

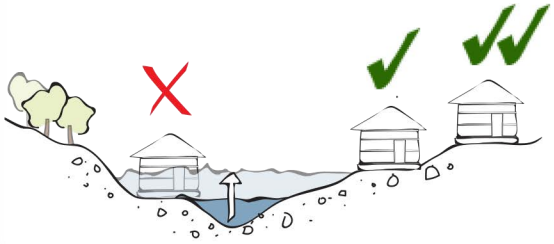
HAVE AN ESCAPE PLAN

Ensure safe escape for everybody from the site. Have a preparedness plan, which includes all occupants and family members.

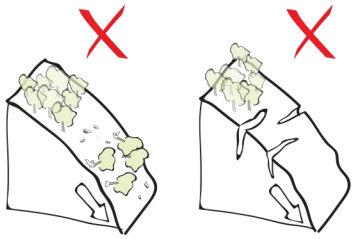


CHOOSE A SAFE SITE

Avoid flood prone areas, like the bottom of valleys or near river beds.



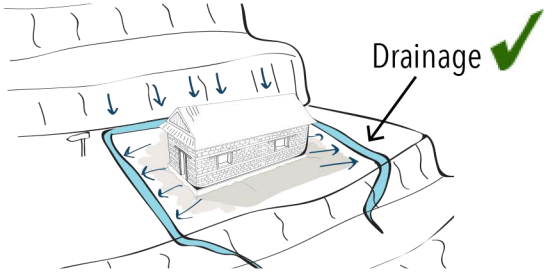
Don't build on steep slopes. Look for landslide signs (cracks, fallen trees)



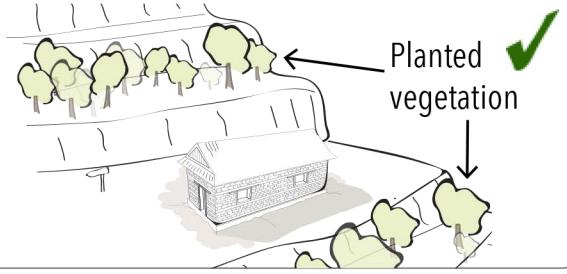
Remove damaged buildings first.

MAKE YOUR SITE SAFER

Ensure proper water drainage of the site.



Plant retaining vegetation on the slope above.



POSITION YOUR HOUSE SAFELY

Keep a safe distance between your house and slopes or cliffs.

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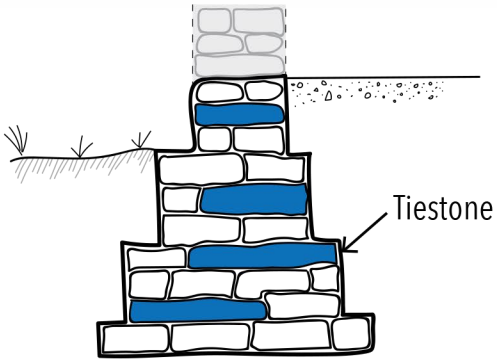
#10 : BUILD ON STRONG FOUNDATIONS

A house is stronger if it is built on strong foundations.

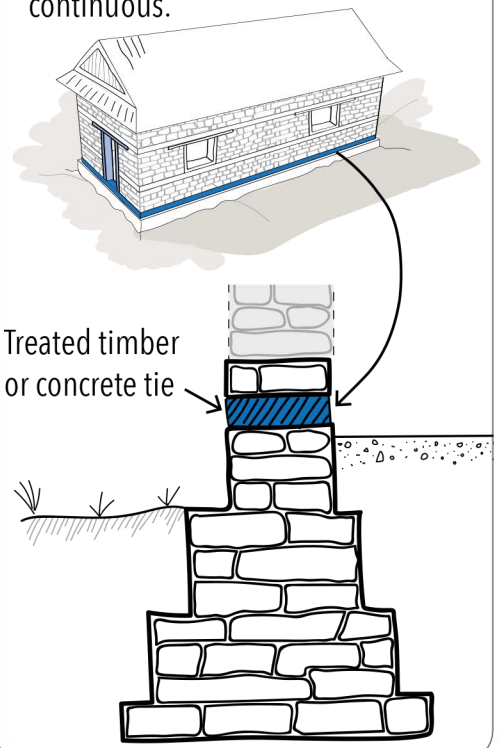
TIESTONES

Tiestones are just as essential in the foundation as they are in the wall above.



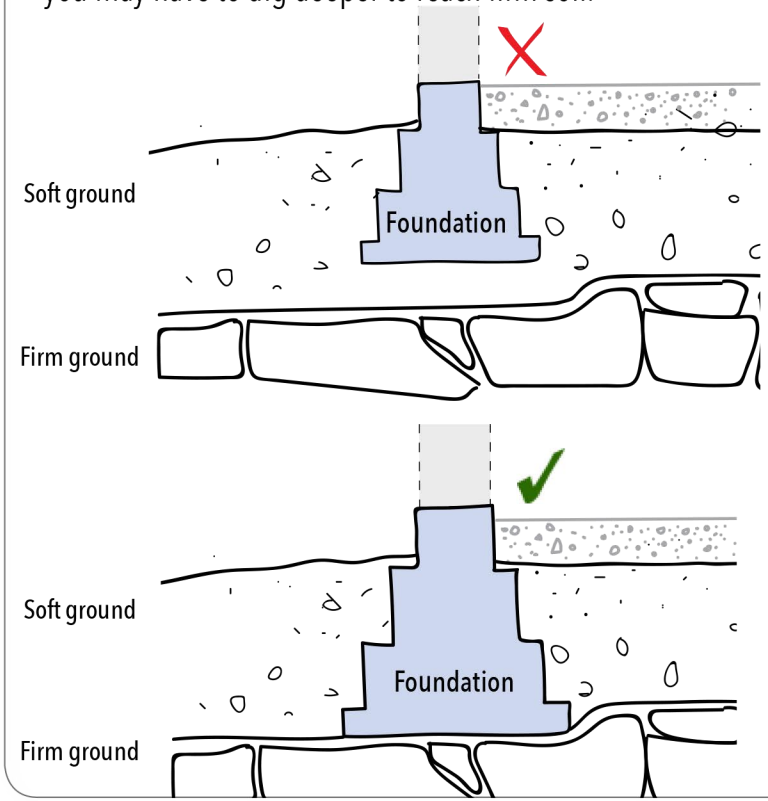
PLINTH BAND

Plinth bands add strength to the footings. Plinth bands must be continuous.



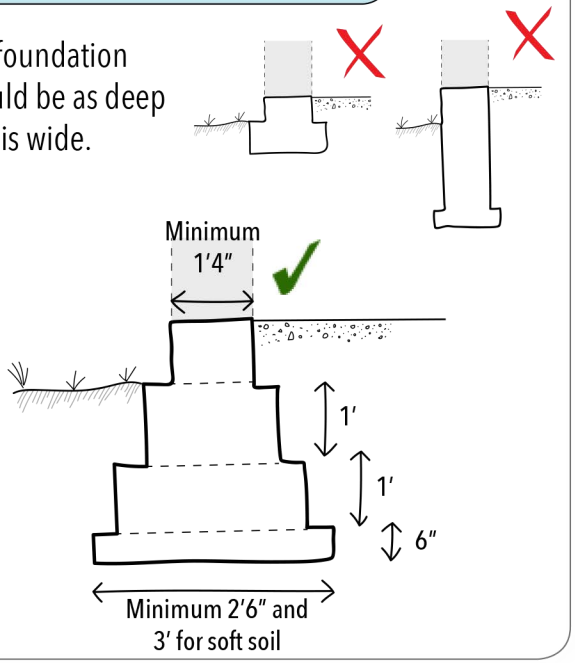
DIG TO FIRM GROUND

Foundations should be minimum 2'6" deep. For soft ground you may have to dig deeper to reach firm soil.



THE RATIO IS IMPORTANT

The foundation should be as deep as it is wide.



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