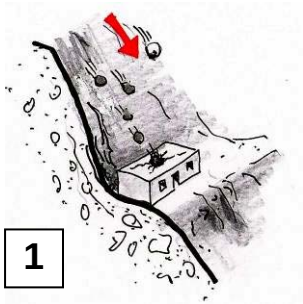
Battar construction

An illustrated guide for masons

Draft
for revision

10 April 2007

1. Site selection and form of house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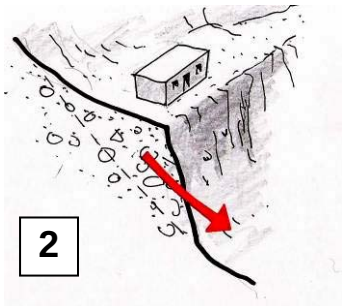
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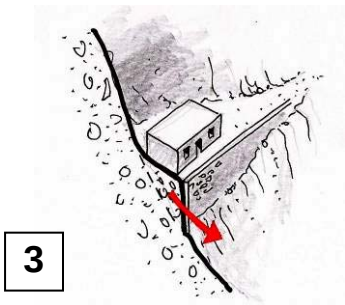
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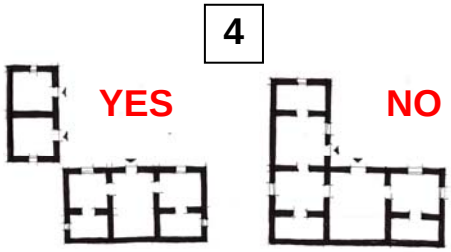
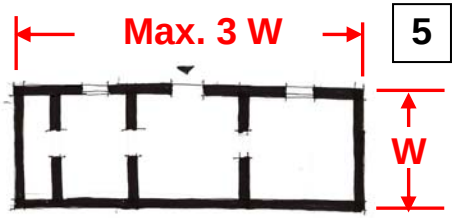
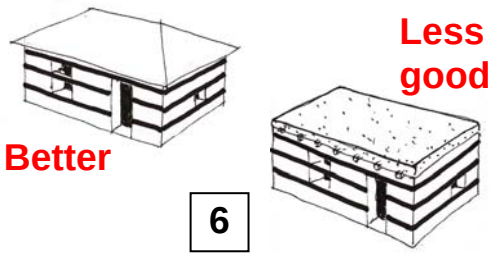
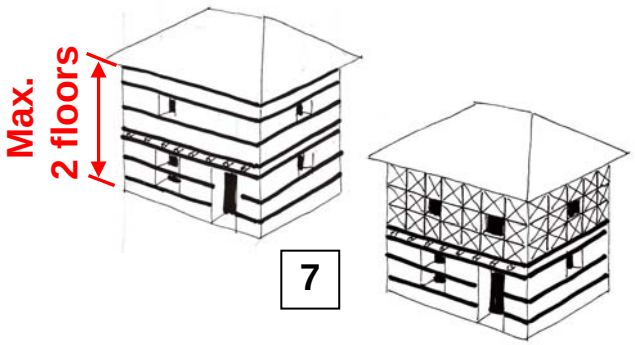
1. Don’t build too near to a steep slope: stones might fall on your house
2. Don’t build too near to a precipice: it might break off during an earthquake.
3. Don’t build too near to a retaining wall: it might break away during an earthquake

4. The house must have a simple form. If necessary, subdivide it into rectangular parts
5. The house must not be longer than 3 times its width W.
6. A light pitched roof is much better than a heavy flat roof.
7. Don’t build higher than 2 floors. Second floor can be made in Dhajji.

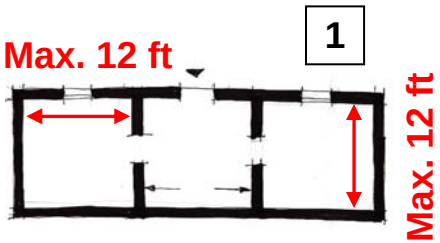


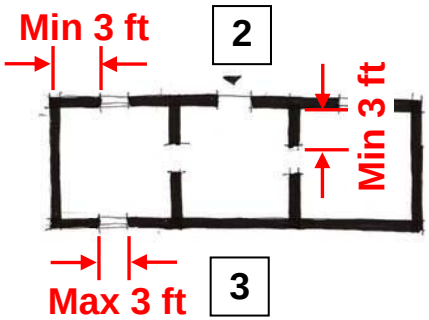


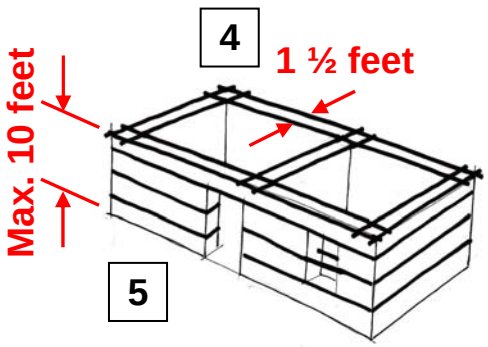




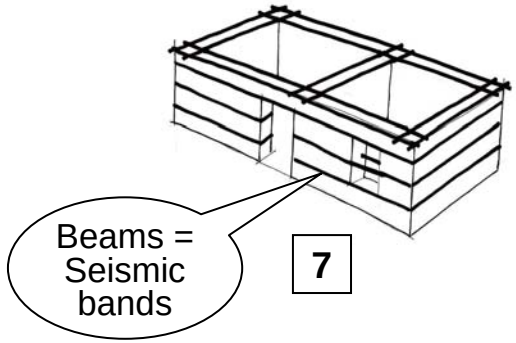
2. Basic rules

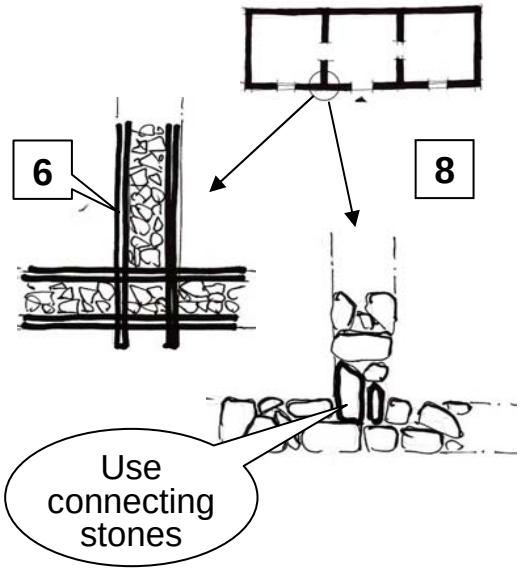


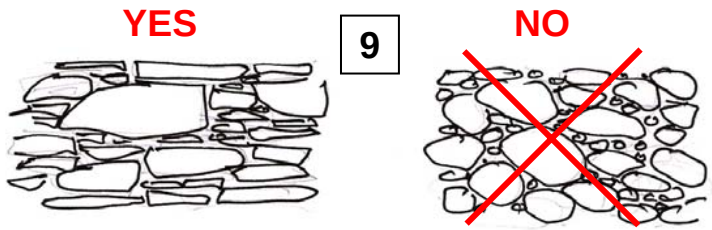




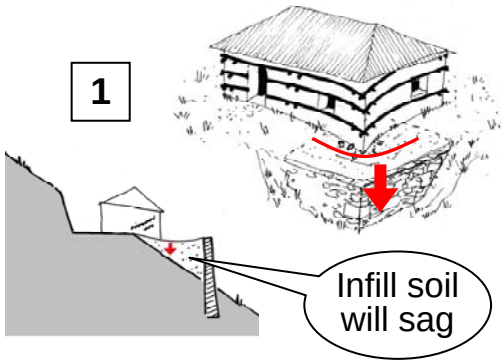
1. No wall must be longer than 12 feet without being connected to another wall.
2. Wall elements must be at least 3 ft long.
3. Windows must be smaller than 3 ft.
4. Walls must be at least 1 ½ feet thick.
5. Walls must not be higher than 10 feet.
6. Choose Blue Pine (pavich/biar) for beams.
7. The beams (battar) in the walls act as ‘seismic bands’.
8. All walls must be connected to each other through stone masonry and timber beams.
9. Use flat or dressed stones for your masonry. Don’t use round rubbles.



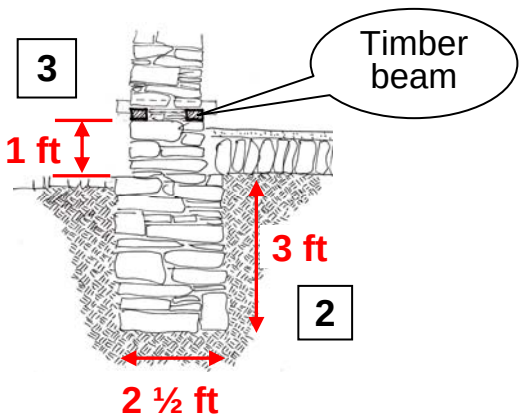


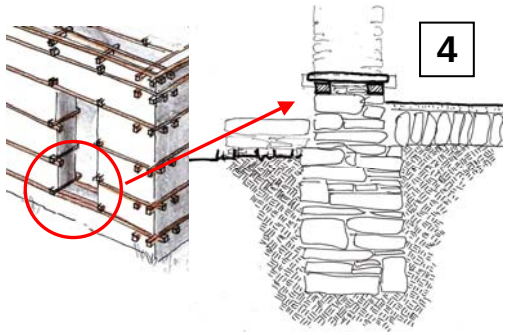


3. Foundations and first seismic band

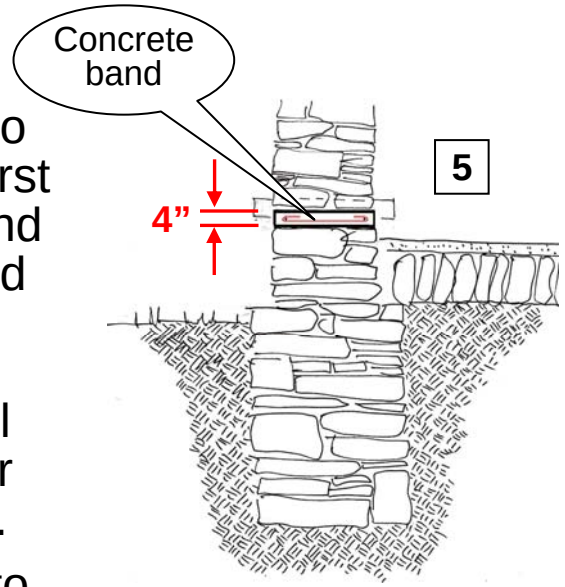


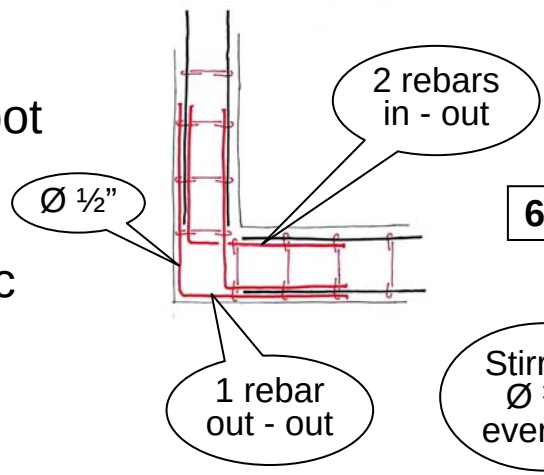
1. Build your house on soil that is all of the same quality. Don't place one part of the house on infill soil.
2. Foundations should be 2 1/2 feet large and 3 feet deep.
3. First seismic band should be placed 1 foot above the foundation (1 foot out of the ground).
4. The first seismic band will also pass under the door!

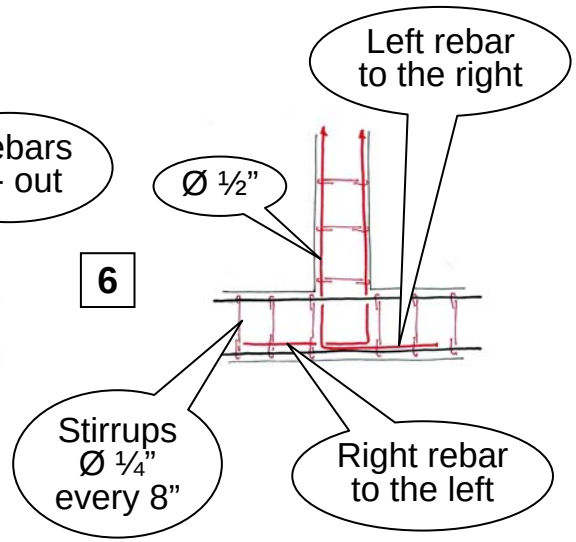




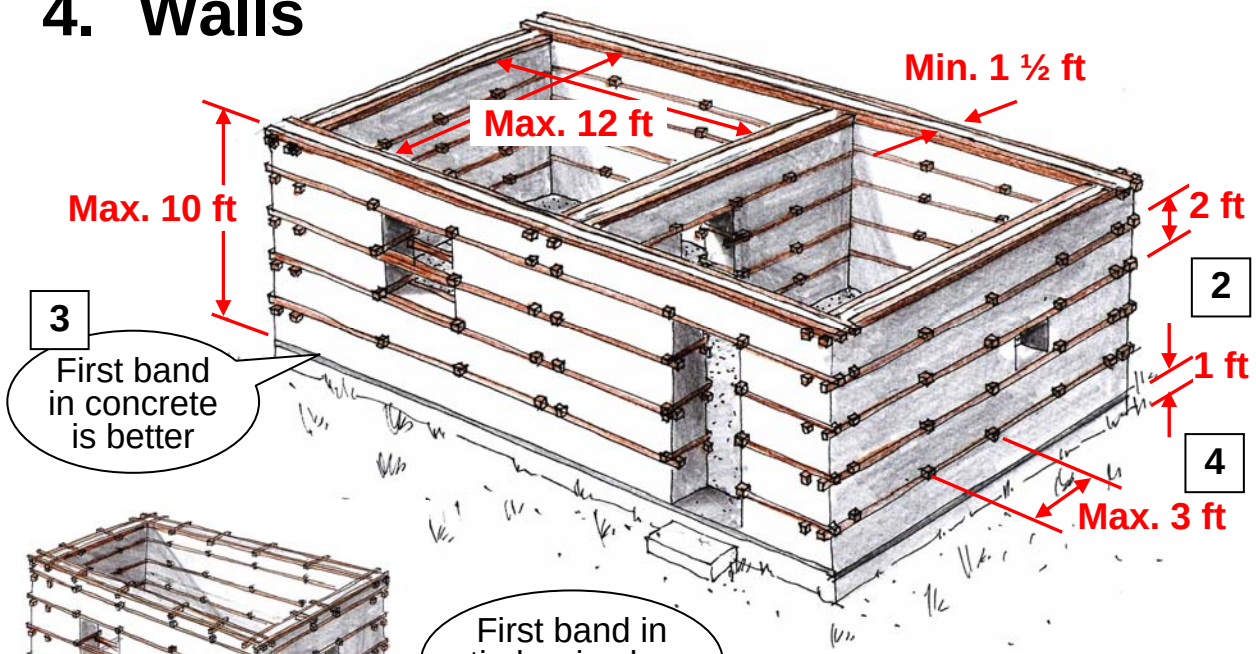
5. It is better to make the first seismic band in reinforced concrete instead of wood. It will resist better to humidity.
6. Take care to cross the corner rebars correctly.

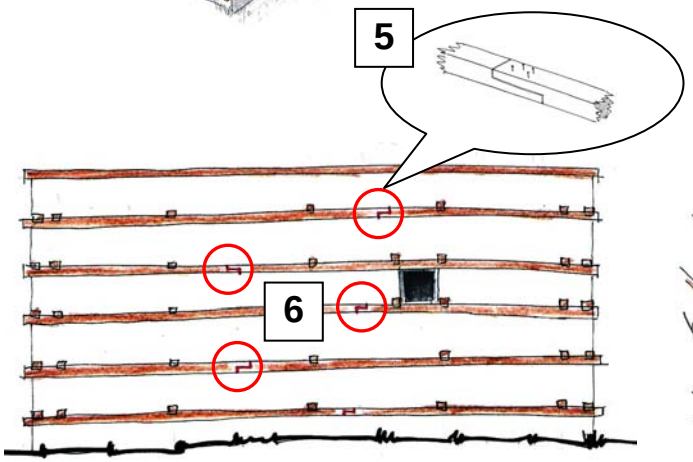


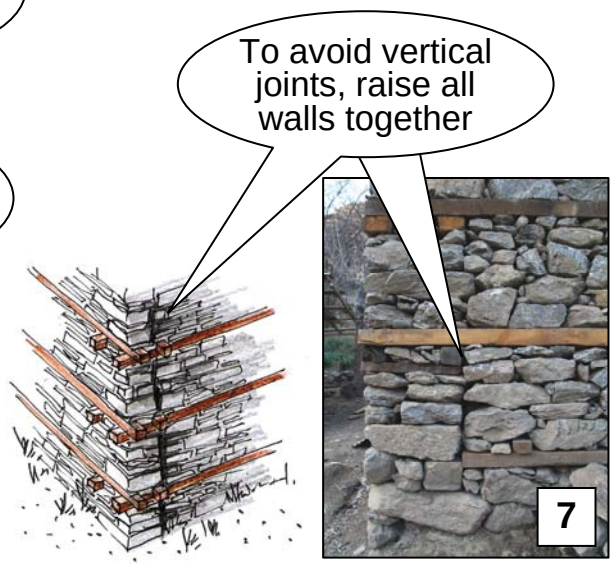




4. Walls

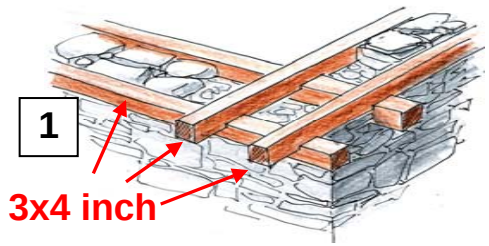


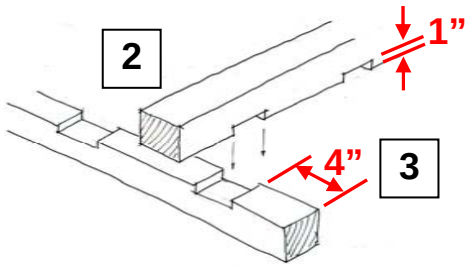


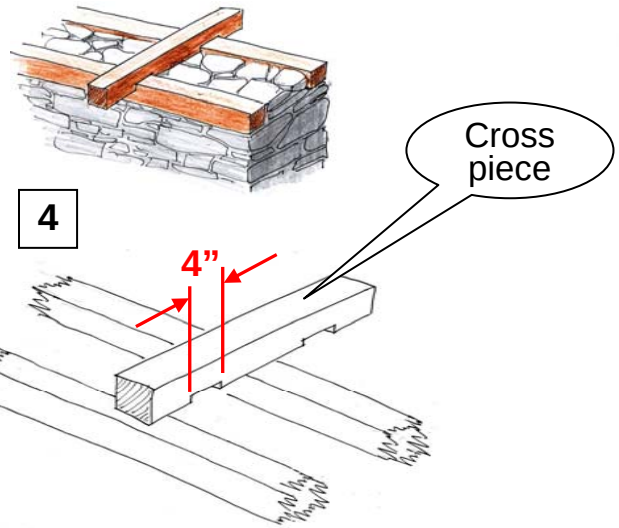


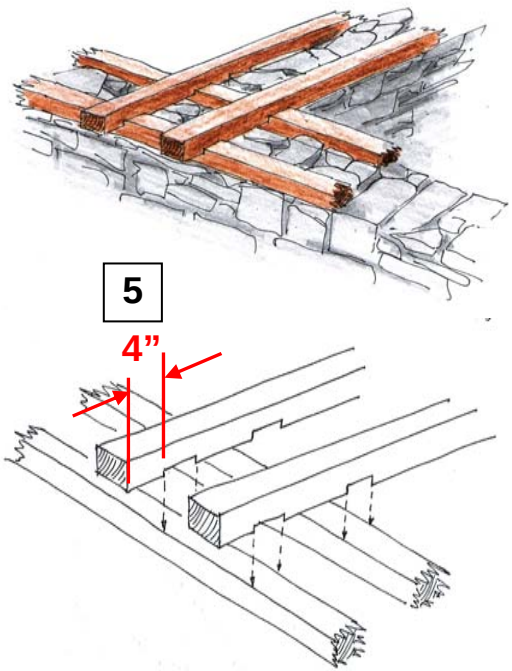
1. Place the wall beams every 2 feet, except for the first band which is only one foot above ground level.
2. It's better to make the lowest band in reinforced concrete to make it more resistant to water.
3. Place cross pieces at a maximum distance of 3 feet from each other.
4. If your beams are too short, connect them with a long lap joint (see next page).
5. Don't connect the beams all on the same vertical line, but spread the connection points. Don't connect the inner and outer beam in the same place.
6. Avoid vertical joints.

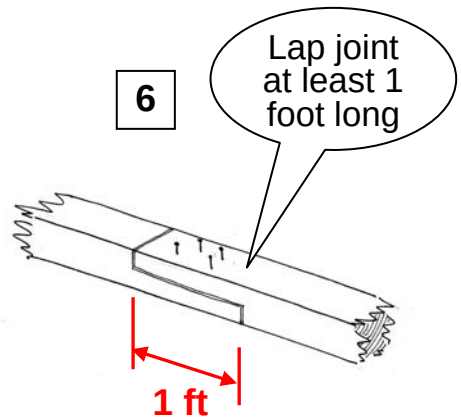
5. Connections





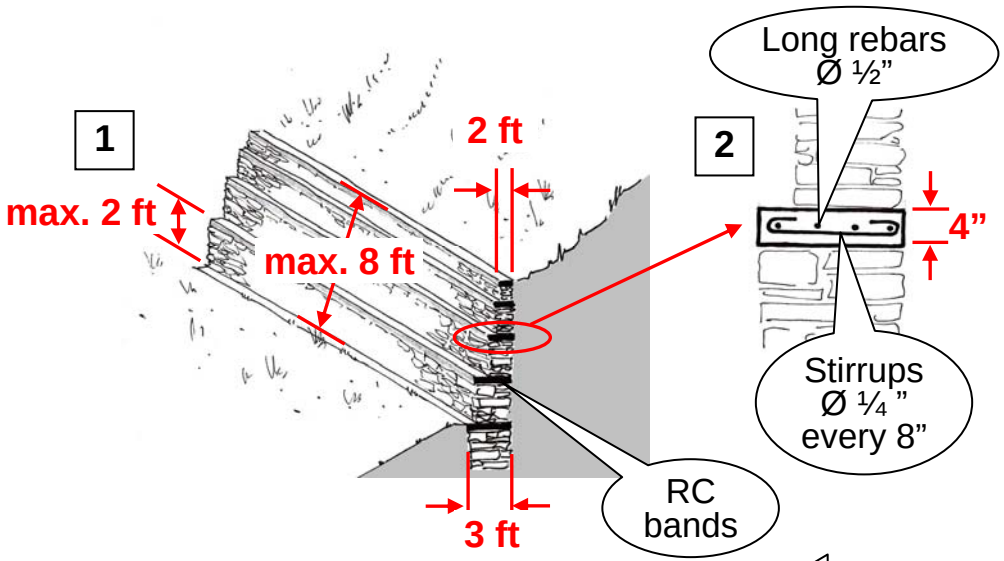


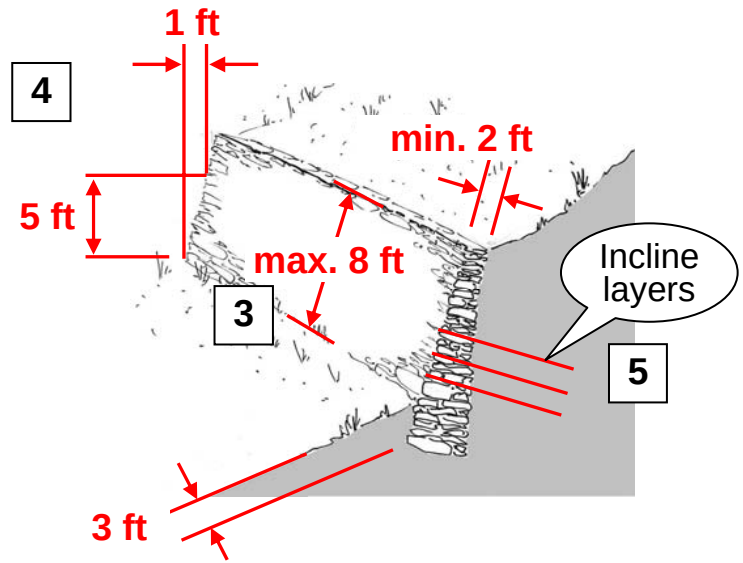




1. Minimum size of beam is 3” high by 4” large.
2. Beams must be hooked together in the corners. Cut a notch of 1 inch into all four corner beams. Add nails for more security.
3. Keep 4 inches of wood after the notch for strength.
4. Cross pieces: you need notches only on the cross pieces, but not on the main beams.
5. The same for the middle walls: Notches only on the beams sticking out, but not on the main beams.
6. Lap joints must be 1 foot long. Use four 3” nails to secure each joint.

6. Retaining walls

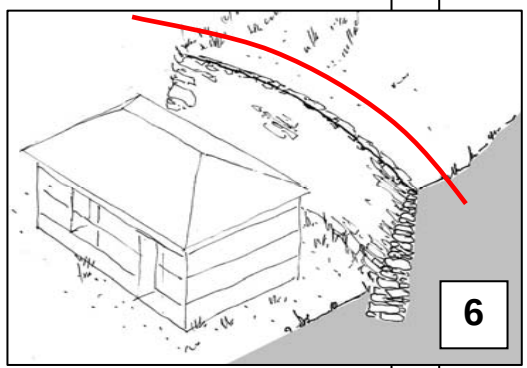




Stepped walls:

1. Don’t make the steps higher than 2 feet. The higher you go, the smaller the steps should be.
2. End each step with a reinforced concrete band.
3. Don’t make the walls higher than 8 feet.

You can choose

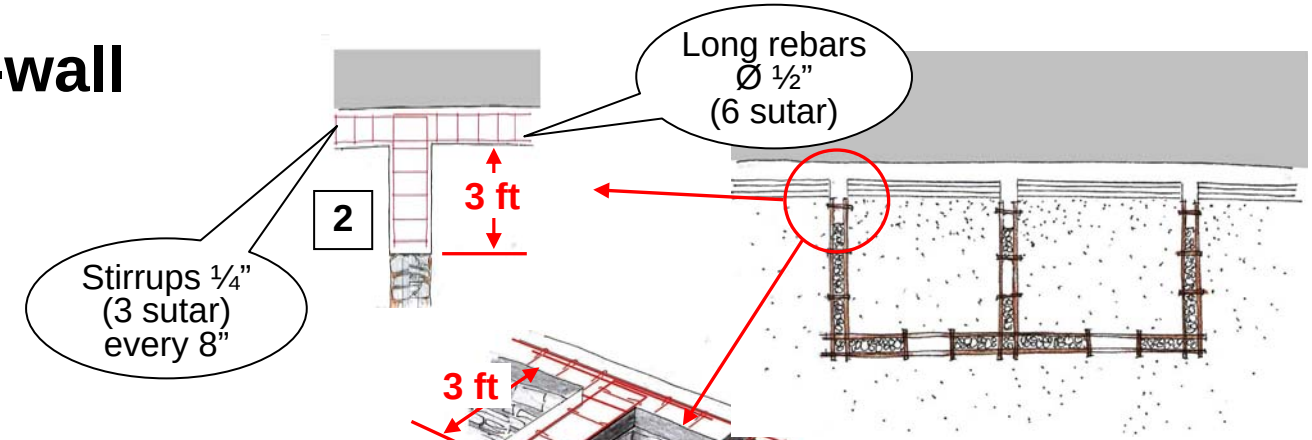


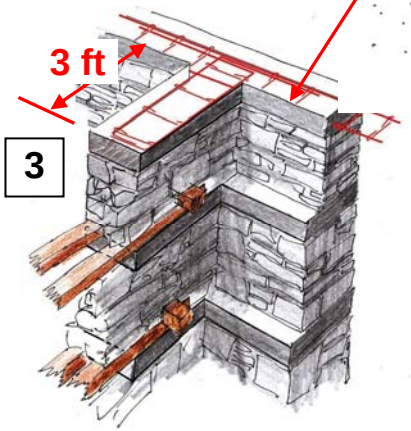
Inclined walls:

4. Incline the retaining walls towards the slope with a ratio of 1 to 5, that is 1 ft back for every 5 ft of height.
5. Incline the layers according to inclined face of the wall.
6. If you can slightly curb the retaining wall towards the slope, it becomes even stronger.

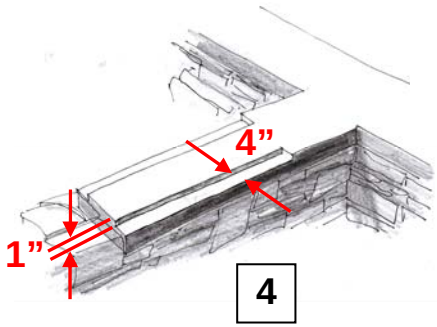
7. Retaining back-wall

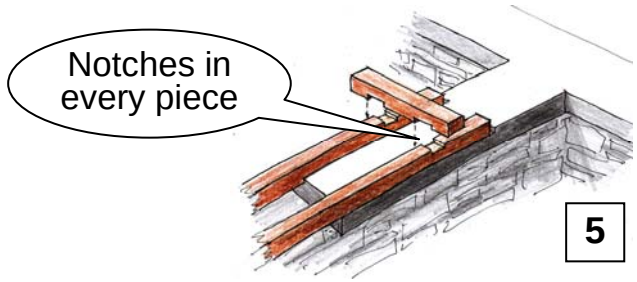
1. Build the retaining wall together with the house walls.
2. Put reinforced concrete bands into the retaining wall, at the same levels as in the house.
3. Let the concrete band enter 3 feet into the house walls.
4. Prepare notches 1”x4” into these concrete bands to lodge the timber beams.
5. Cut notches in all 3 pieces of timber.
6. Make the house walls 1 ft higher than the retaining wall so that the roof beams will not touch the ground.

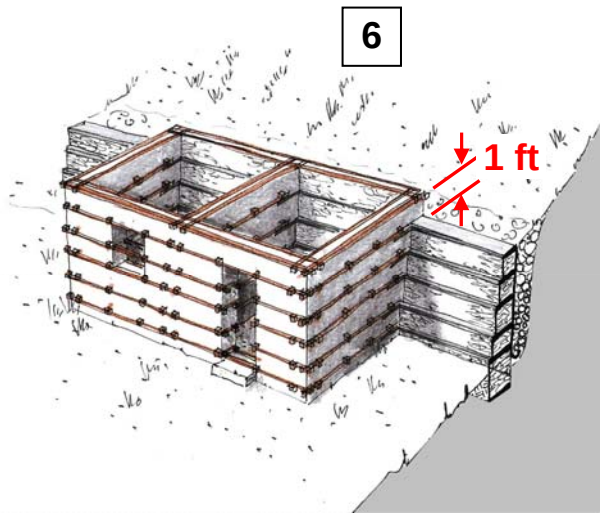




Caution:
A retaining back-wall is less save than an independent retaining wall!

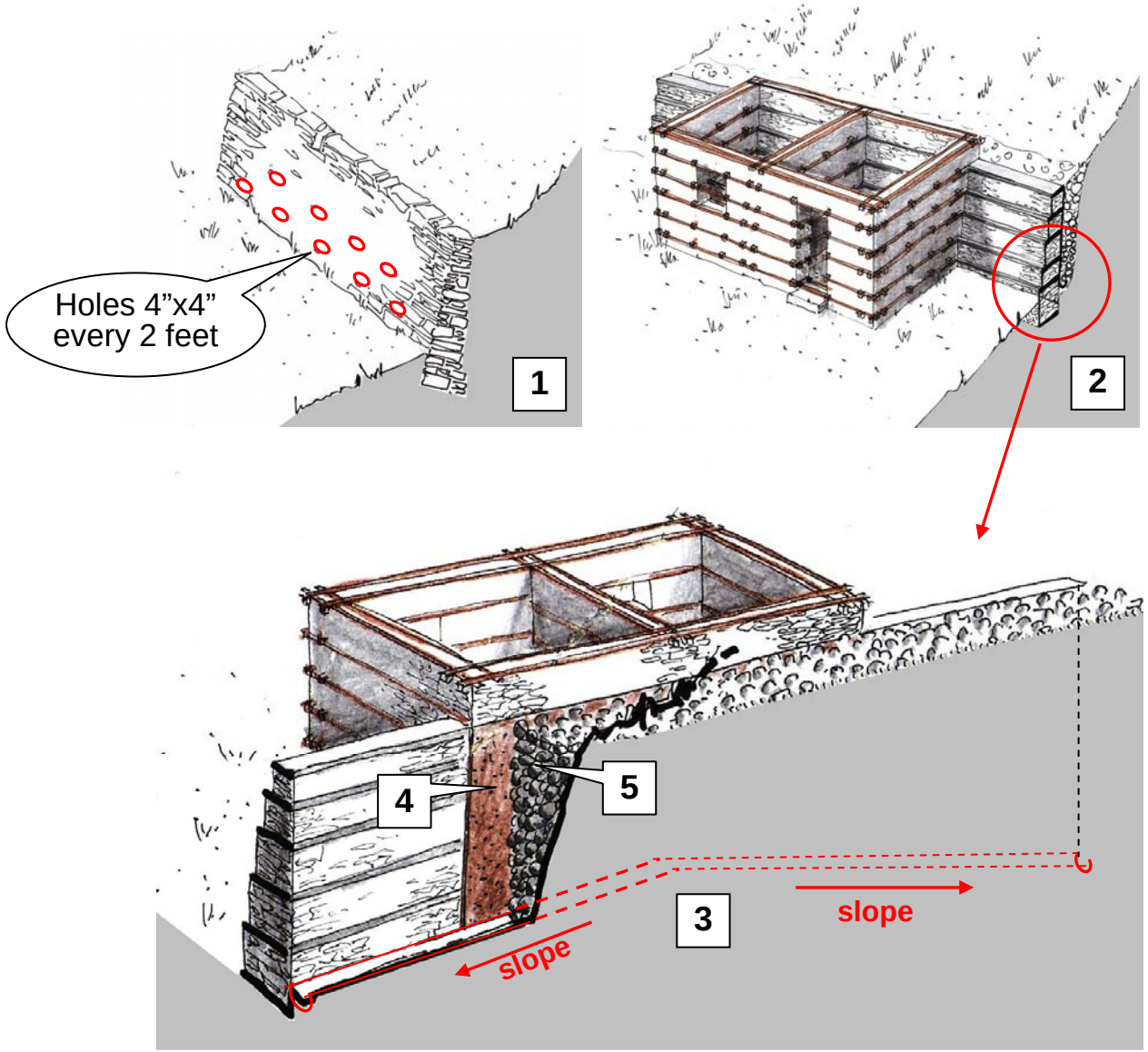






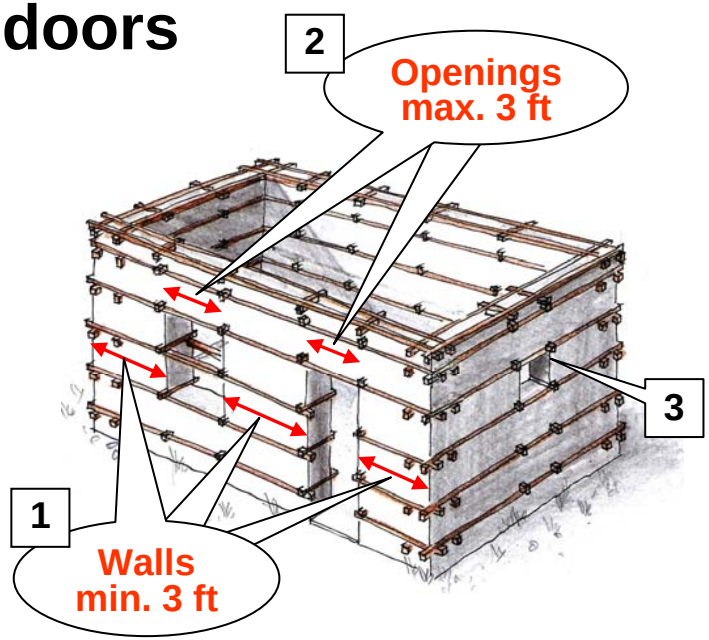
8. Drainage of retaining back-wall

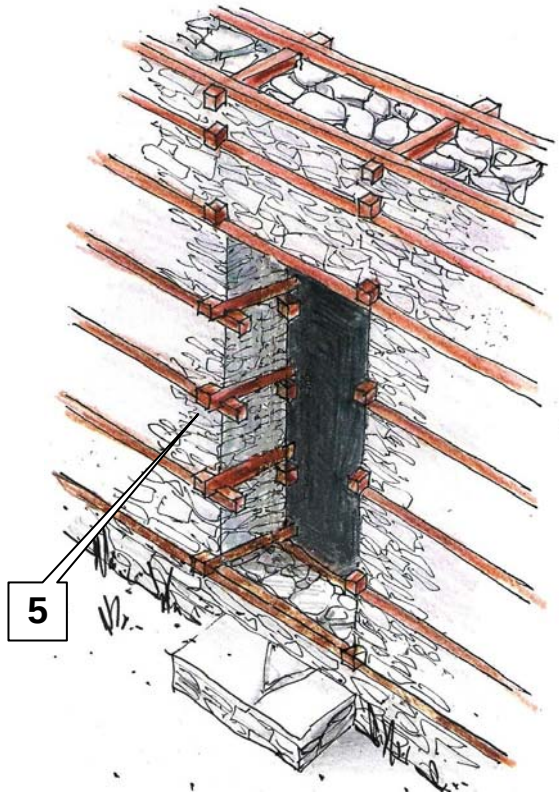
1. Retaining walls must have holes to let the water from the mountain come out.
2. If the retaining wall is also the back wall of the house, this is not possible because you don't want to have water in the house.
3. Then you have to make an channel behind the retaining wall, with slopes towards outside.
4. Plaster the backside of the house with mud to make it watertight.
5. Fill the space between house and slope with stones to let water go down into the channel.

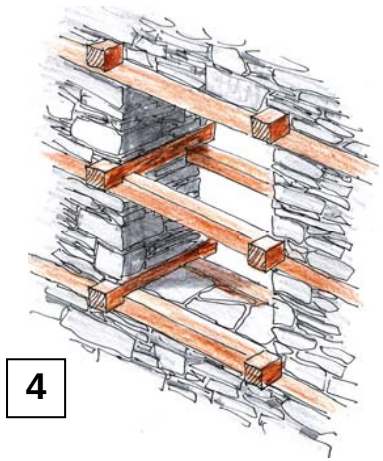


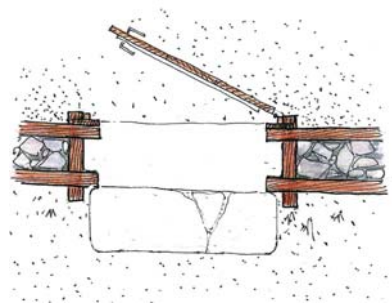
9. Windows and doors

1. Wall parts must be at least 3 feet long.
2. Windows and doors must not be larger than 3 feet.
3. Place the windows between the beams.
4. If you need a bigger window, let the beams go through.
5. Place anchor pieces on both sides of windows and doors.

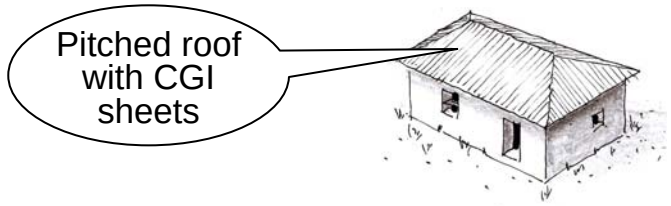




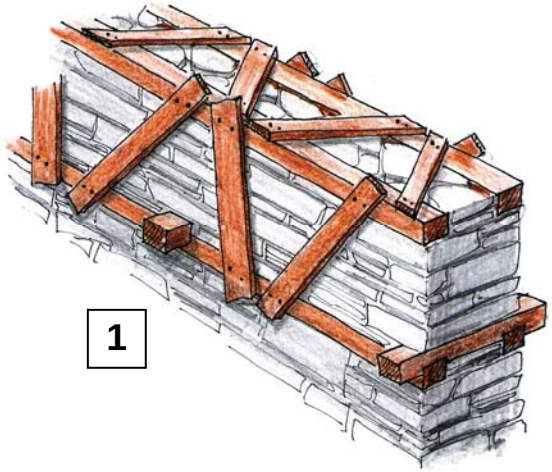


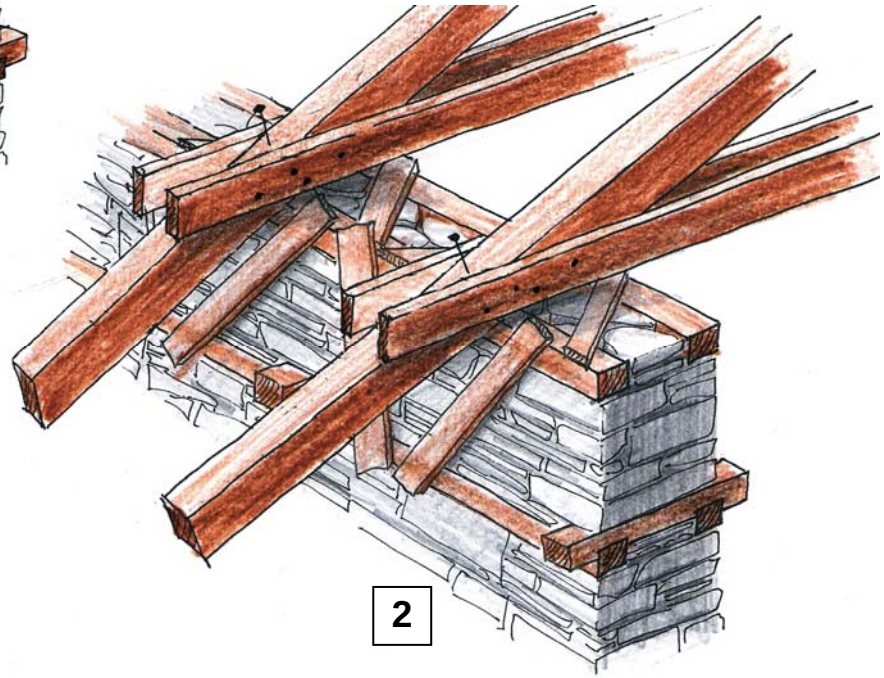


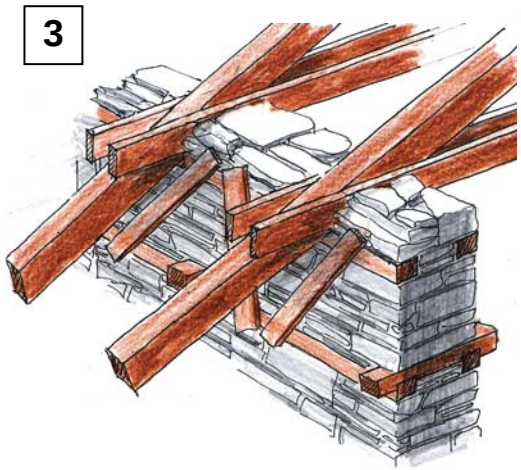
10. Pitched light roof with CGI sheets



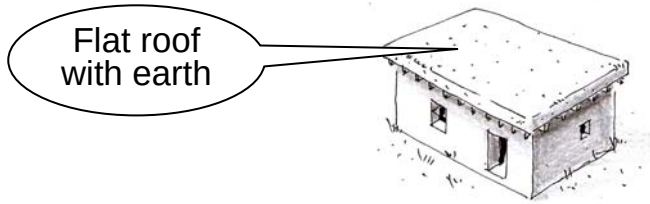
1. Attach the last pair of beams with boards to the second last pair of beams.
2. Add the rafters or trusses and nail them down with long nails.
3. Fill in the empty spaces with stones.



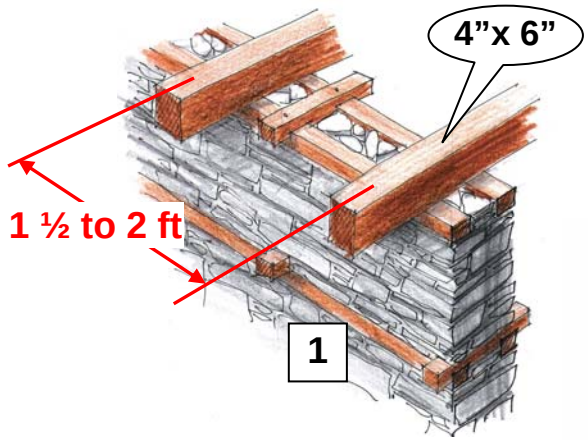


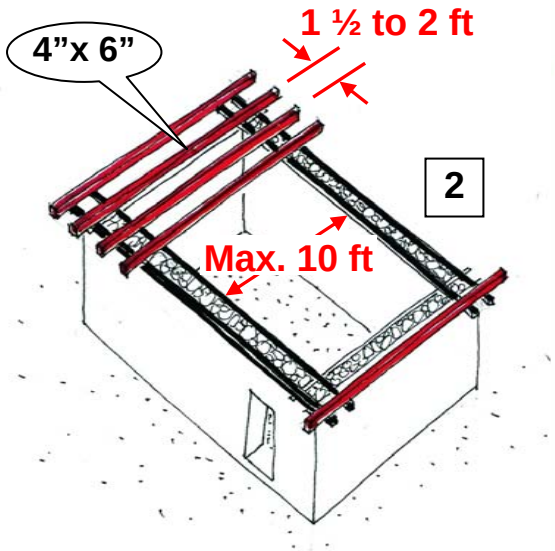


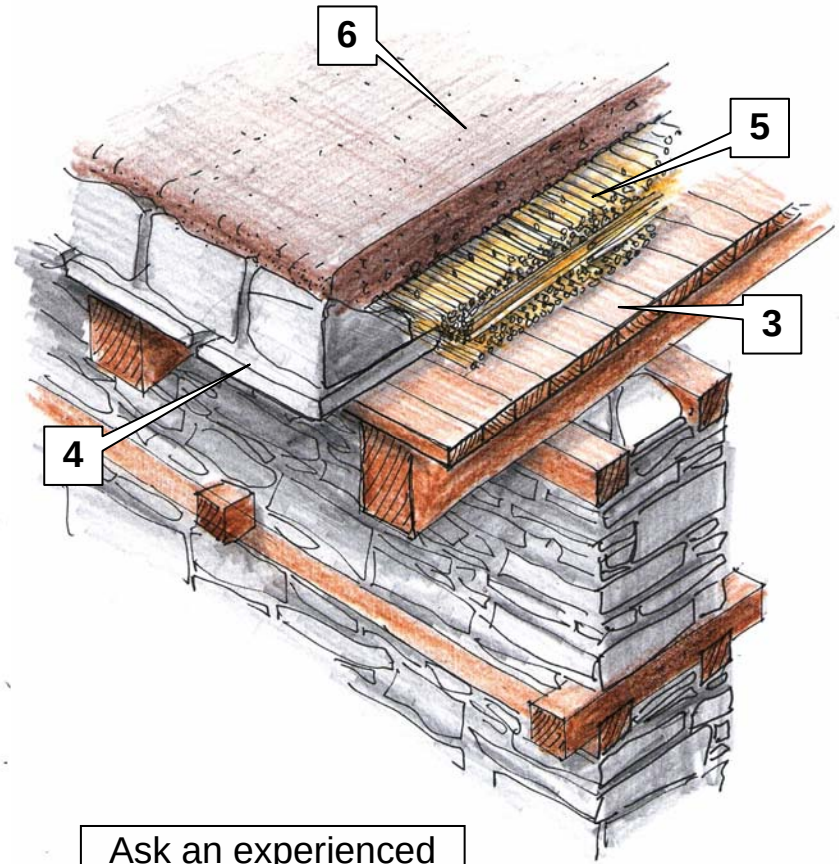
11. Flat heavy roof with earth cover



1. Place two beams on top of the wall and connect them with nailed cross pieces
2. Add the roof beams.
3. Nail the planks on the roof beams.
4. Place flat stones along the edge of the roof to contain the earth.
5. Add branches in a layer 4 to 6 inch thick
6. Cover with earth 4 to 6 inch thick.
7. Avoid to make the earth cover thicker over the years!



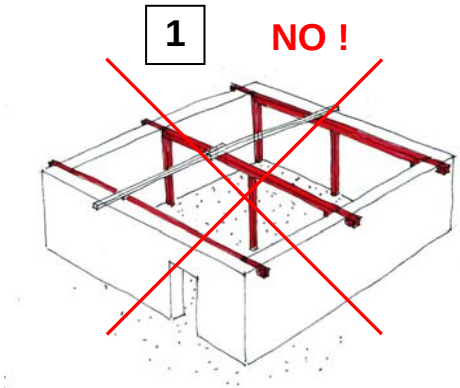


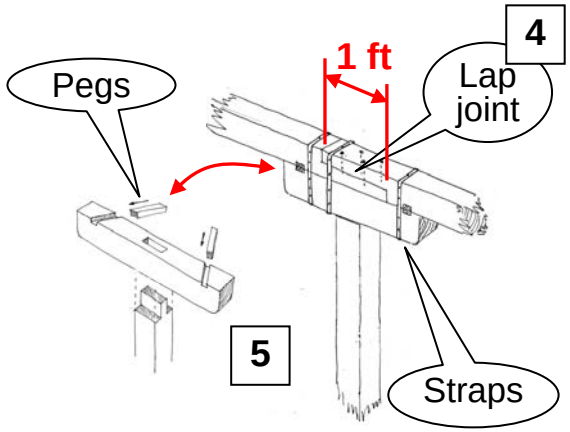


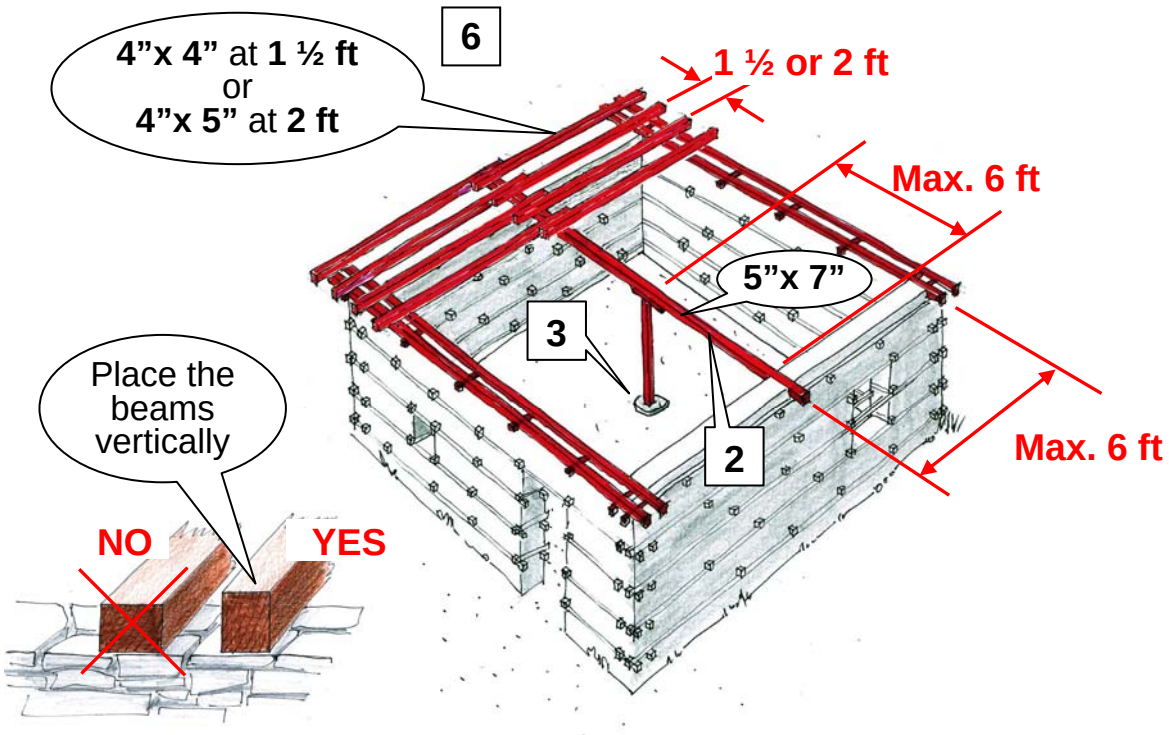
Ask an experienced builder to help you build the roof cover.

12. Flat heavy roof for big rooms

1. If you want to cover a big room, you don't need an independent timber structure.
2. Place a beam 5"x7" through the middle of the room and support it in the centre with a post.
3. Don't plant the post in the ground, but put it on a flat stone.
4. If the central beam is not long enough, join it on top of the beam with a long lap joint
5. Add a capital underneath and fix it to the beam with pegs and straps.
6. Add 4"x 4" top beams if you place them 1 ½ feet apart, or 4"x 5" if you place them at 2 feet.

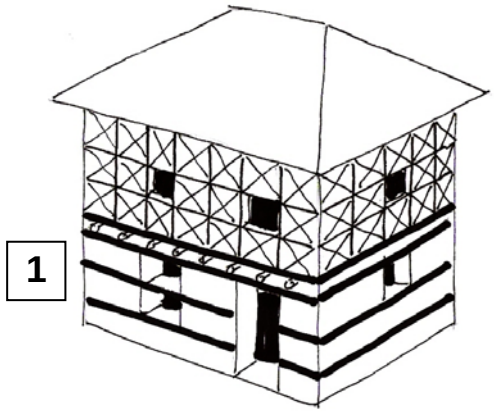


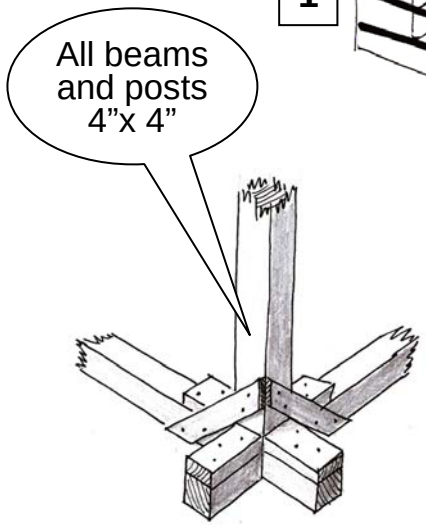


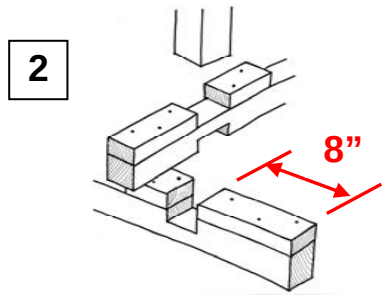


13. Adding a second floor

1. It is better to make a second floor with the Dhajji method. Dhajji construction is lighter and better against an earthquake.
2. Make the connections with great care. The resistance to earthquake depends on them.
3. You can subdivide the walls in different ways.
4. Fill the walls with stones and mud.

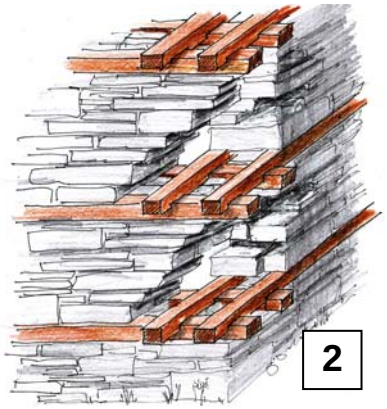


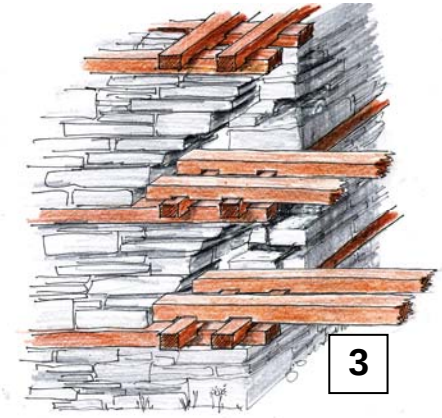


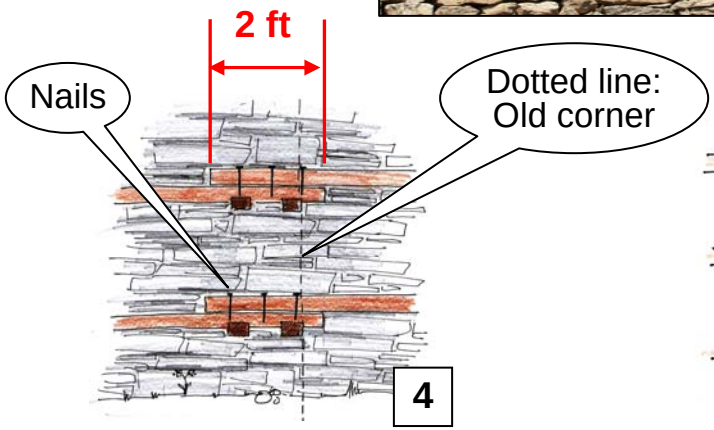


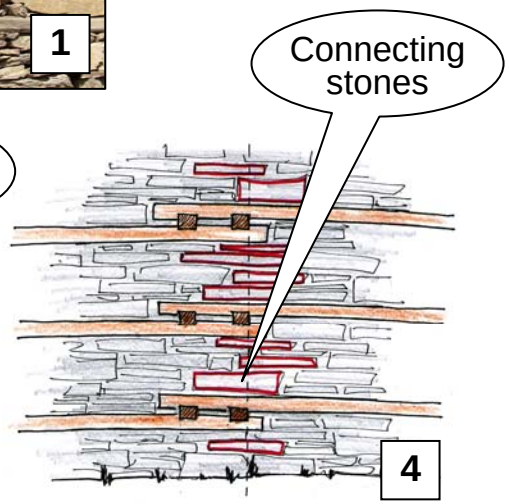
14. Adding a room

1. Don’t make continuous vertical joints. Your house will fall apart during an earthquake.
2. Open the corner where you want to add a room.
3. Connect the new beams through notches and nails.
4. Fill up tightly with stone, taking care to make them go also into the new wall.
5. If the beams go the other way, overlap the new beams by 2 ft and nail them together.









15. Think for your children

Don’t forget:

1. For every tree you cut for your house, plant 5 new ones so that your children will also be able to build their house one day.
2. Trees also protect your land against landslides: the roots of the trees are like anchors in the ground.

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