BHATAR METHOD FOR SEISMIC DESIGN

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Abstract - Methodology for seismic design of R/C buildings presented in the paper is BHATAR technique. BHATAR is a dry stone masonry structure reinforced with horizontal timber reinforcement bands. Tradition method is adopted with stones but this project aims at performing the same method with use of bricks. The area would be the same to improve our structures and design them in a far better way so as to avoid any collapsing when they are hit by natural calamities with BHATAR technique. As a result of installation of seismic bands in Bhatar method, bending stresses in the walls due to out-of-plane earthquake effects are reduced and the chances of wall elimination are reduced.

Keywords : Bhatar method, seismic excitation, critical points

Introduction :

The definition of a method for design and evaluation of the seismic resistance of R/C building structures is a wide and complex problem. The seismic force or the acceleration would cause damage to structural elements and the integral structural system. For this purpose, it is necessary to develop a clear and concise procedure that will enable a fast and simple way for coming to the desired results and thus for the stability of the structures, we use BHATAR method. Bhatar is a dry stone masonary structure reinforced with horizontal timber reinforcement seismic bands .It is a traditional construction known since centuries. Very old construction have resisted through the years and various earthquakes. For seismic resistance in either new / existing masonry buildings (typically) or towers (chimneys etc.) with openings like windows or doors, it is a very good idea to have all openings at the same level and connect all lintel beams with one another, creating a "band" of reinforcement just above and below the openings.

- This will ensure better participation of the structure as a whole, to seismic excitation in any direction.
- This will enhance the shear capacity of the wall (generally speaking, due to reduced effective height of infill participating in seismic response).

Aim and Objectives :

Analysis of weak and critical points that allows stress to develop under lateral load at instantaneous rate and make structure to collapse by reducing its IS designed strength value. This is done by installing bands called seismic bands having L > B i.e along the structure height .The seismic band allows structure to act homogeneous , restricts random movement, binds all critical and control points together and produces a single way or unidirectional relative movement under the effect of forces produces by seismic activity.

Working of Bhatar method :

Timber bands (with cross pieces) act as seismic bands which prevent the walls from falling apart in an earthquake .

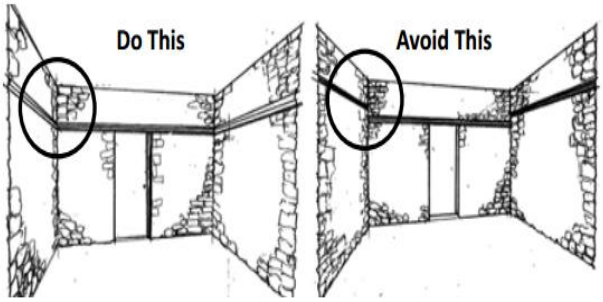
Without bands, the structures stability is questionable. With bands walls of the structure held tightly. Seismic bands act as a belt to the structure.

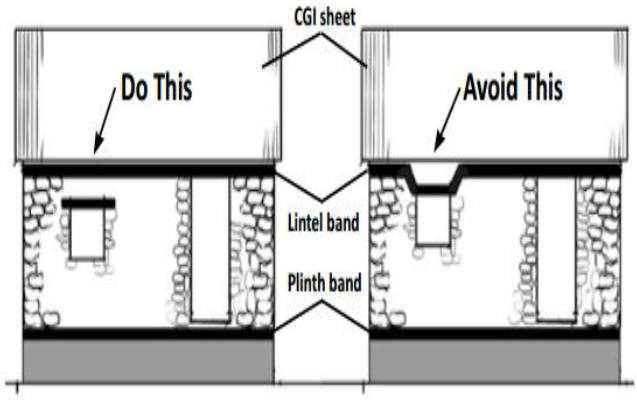
❖ Tradition method is adopted with stones but this project aims at performing the same method with use of bricks , this has following **advantages** :

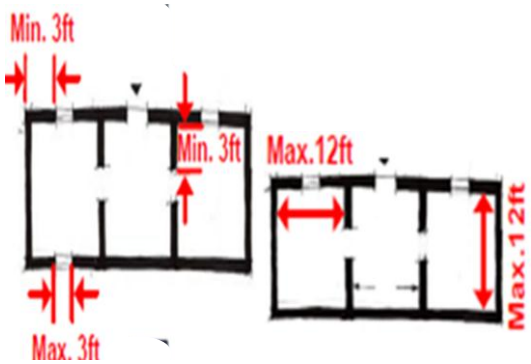
- Due to uniform dimensions of bricks structure becomes more reliable and active against earthquake.
- Thickness of wall reduces hence availability of more space.
- Structure has earthquake resisting seismic bands at its superstructure level also.
- These seismic bands are more economic than present adopted techniques.
- Dressing cost of stones and use of skilled labor is eliminated.
- Timber reinforced masonry construction is traditional in parts of the affected area.
- Brick masonry reinforced with horizontal ladders (bands) to improve the integrity of the wall and to tie the walls together.
- Brick masonry must be constructed with through brick and well packed, using flat or dressed bricks.
- Timber bands are provided at regular intervals of max 2ft.
- Timber bands must have cross pieces at every 3ft horizontally and good joints and overlapping.
- Confined masonry consists of load bearing brick or block masonry or in situ concrete panels surrounded by horizontal and vertical „confining" elements made from reinforced concrete.
- Wall panels are built first and then the reinforced concrete columns poured afterwards. The wall should be built with toothing to ensure a good connection with the concrete column.
- Walls should also be tied to columns with horizontal reinforcement.

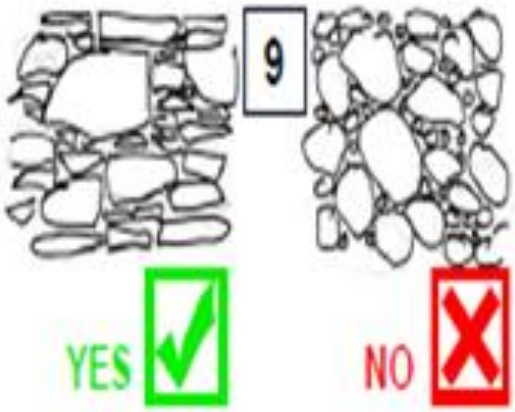
Basic rules :

- No walls must be longer than 12 feet without being connected to another wall.
- Openings should be minimum 3 feet from corners or other opening.
- Windows must be smaller than 3 feet.
- Walls must be maximum 18 inches thick.
- Walls must not be higher than 10 feet.
- Use blue pin or Cedar for the beam.
- Use galvanized nails (with zinc layer) for all work except inside the house (so they do not rush).
- Use flat or dressed stones for your masonry. Don't use round rubbles.
- All walls must be connected to each other with proper stone masonry and timber beams.
- Place through stones every two feet. They make the wall stronger.
- The timber beam act as 'seismic band'. A seismic band must be continuous, like a loop or a belt. Seismic bands should always be continuous; an offset in elevation is not acceptable.
- RC seismic bands should always remain level without any dips or changes in height.





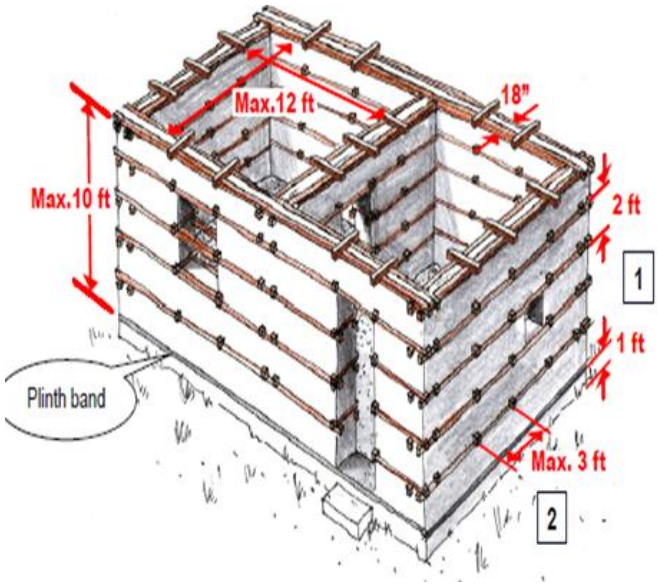


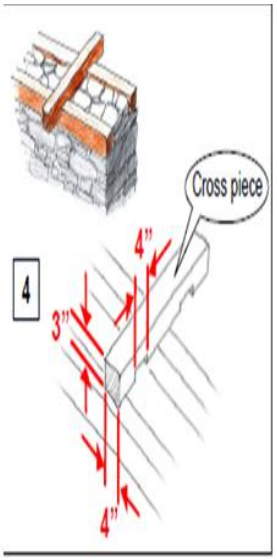


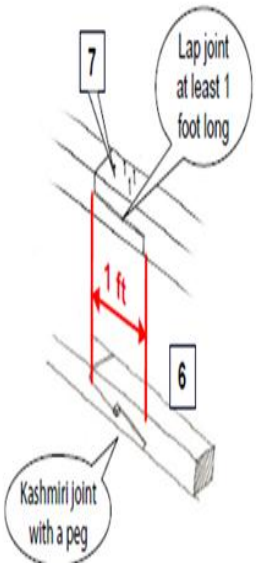
Installations

Walls :

- Place the wall beams every 2 feet, above the plinth band.
- Place cross pieces at a maximum distance of 3 feet from each other.
- If timber beams are too short, connect them with a long lap joint.
- Don't connect the beams all on the same vertical line, but spread the connection points.
- Raise all walls together to avoid vertical joints which create weak corners.





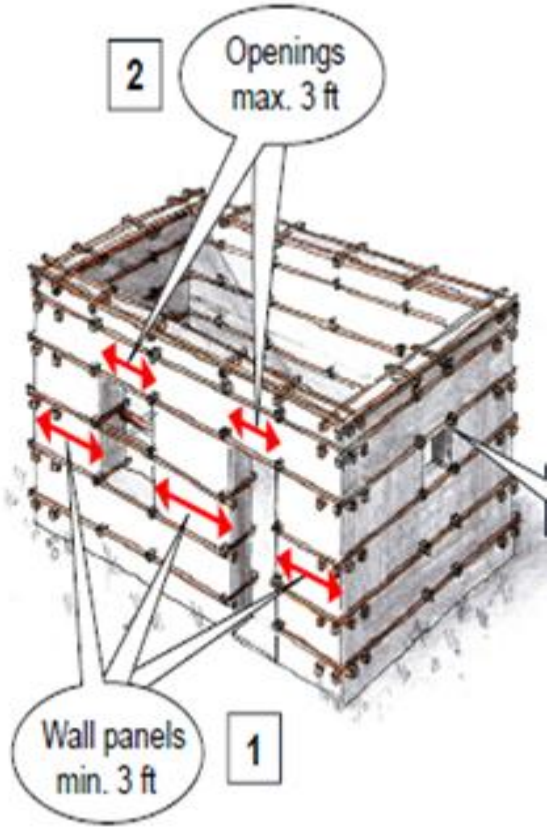


Connections :

- Minimum size of beam is 3" high by 4"wide.
- Beams must be hooked together in the corners. Cut a notch of 1" into all four corner beams. Add 2 nails (3") for more security.
- Keep 4" of wood after all notches for strength.
- Cross pieces help to hold beams and walls together. You need notches only on the cross pieces, but not on the main beam.
- Where the internal walls connect, only notch the internal wall beams, not the main beams
- Joints must be 1 foot long. For the lap joints use four 3" nails to secure each joint. For Kashmiri joints, use peg.
- If you use a lap joint, the nails must be galvanized. They will not rust.

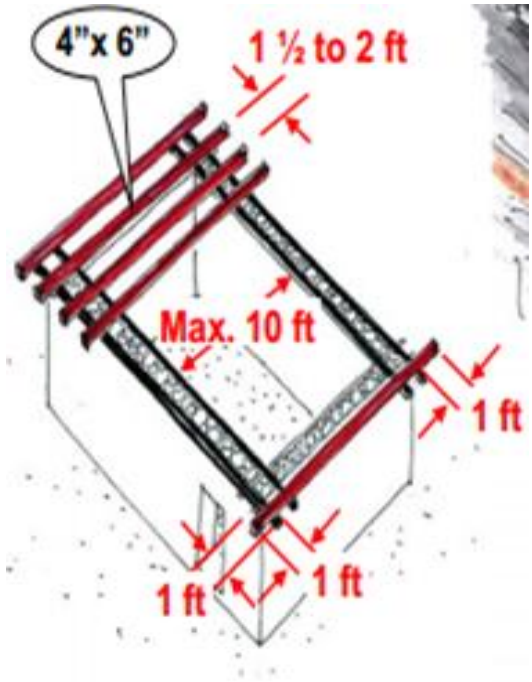
Windows and Doors:

- Distance between openings should be minimum 3 feet.
- Windows and doors must not be wider than 3 feet.
- Place the windows between the beams.
- If you need a taller window, let the beams pass through.
- Place cross pieces on both sides of window and doors.
- Don't trim the ends of the beams to place your door.
- For lintel add two pieces of wood in between the existing beams to support stones above. It must pass at least 1 foot into masonry on each side of the opening.



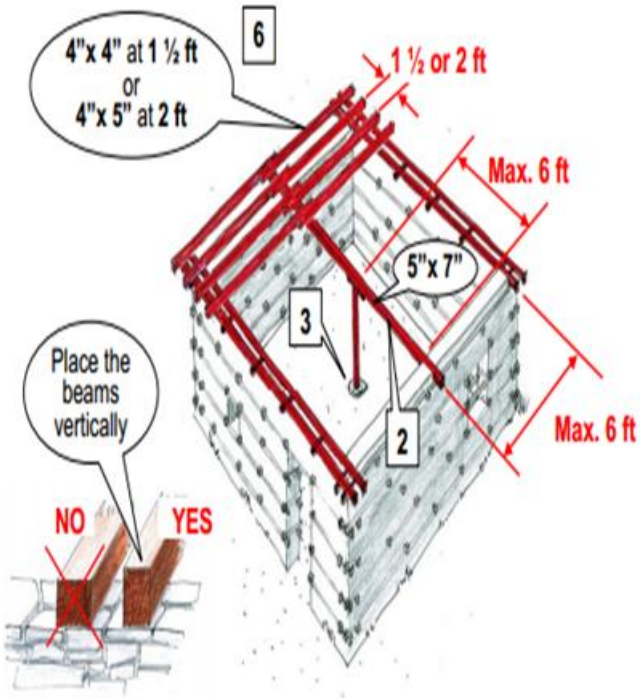
Flat heavy roof with earth cover :

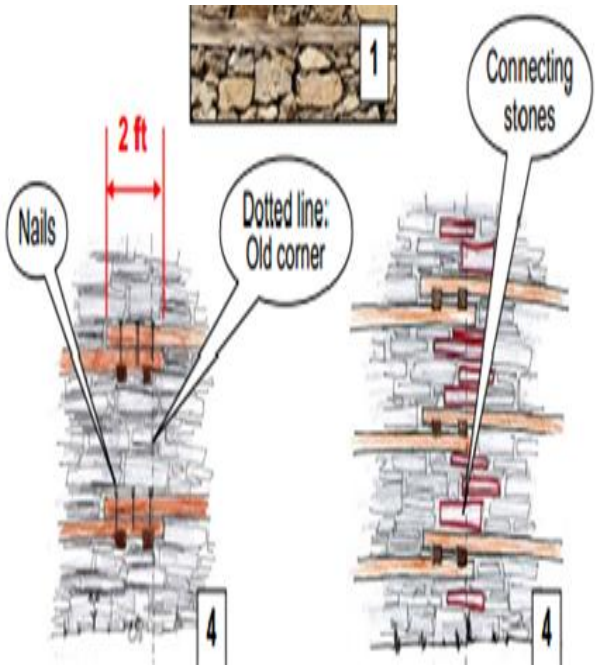
- Let the top beams stick out of the wall 1 foot on each side. Connect them with nailed cross pieces.
- And the 4" * 6" roof beams and let them too stick out 1 ft on each side (also over the retaining back wall if there is) to protect the wall against rain.
- Nail the planks on the roof beams leaving a half inch gap between each.
- Place flat stones along the edge of the roof to contain the earth.
- Add twigs and small branches in a layer 4 to 6 inch thick.
- Cover with earth 4 to6 inch thick
- Avoid to make the earth cover thicker over the years!



Flat heavy roof for big rooms :

- If you want to cover a big room, you don't need an independent timber structure.
- Place a beam 5" * 7" through the middle of the room and support it in the center with a post.
- Don't plant the post in the ground, but put it on a flat stone.
- If the central beam is not long enough, join it on top of the beam with a long lap joint .
- Add a capital underneath and fix to the beam with pegs and straps.
- Add 4" * 4" top beams if you place them 1.5 feet apart, or 4" * 5" if you place them at 2 feet.





Adding a room

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

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