

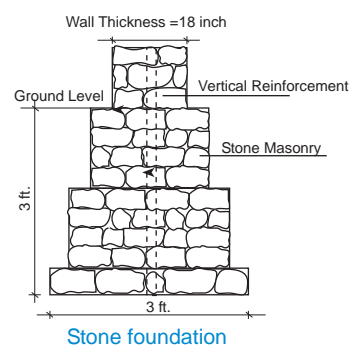
You can make your NEW HOUSE safer against EARTHQUAKE !

Follow 10 recommendations!

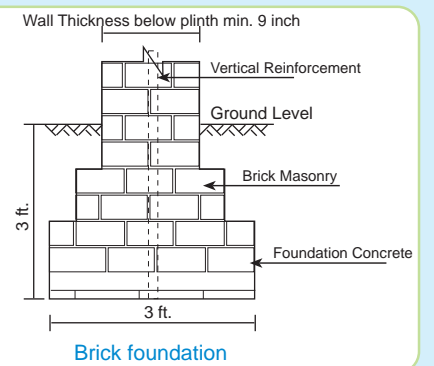
1

Foundation

- Depth and width: Depth and width of foundation should not be less than 1½ ft. in any case. Preferably, the width and height should be 3ft. wide and 3 ft. deep below ground level.
- Foundation structure: Foundation for stone wall and brick wall should be as shown in the picture
- Foundation band: A band in foundation as shown in section 2 is preferable



Stone foundation

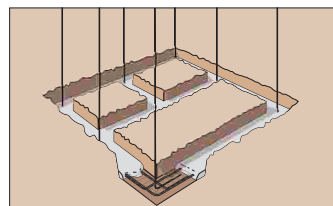


Brick foundation

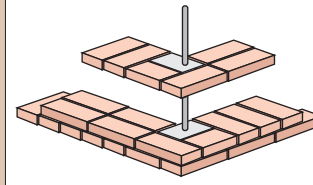
2

Vertical Reinforcement

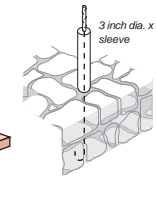
- Vertical reinforcement (steel rebar) should be placed in the wall at all corners, junctions of walls and adjacent to all doors and windows
- All vertical reinforcements at corners and junctions should start from the foundation
- Vertical reinforcements adjacent to doors and windows can start from the plinth band (see section 3 below)
- Size of vertical reinforcements: for corners and junctions, provide at least ½ inch (4 sutar) dia. bar and for sides of openings – at least 3/8 inch (3 sutar) dia. bar.
- A concrete core of about 2 inch dia. should be provided around the reinforcement bar; in case of stone masonry a pipe casing as shown in the picture can be used for easy placement of concrete around vertical bars
- In case of mud mortar, timber posts or wooden planks can be used in place of reinforcement bars



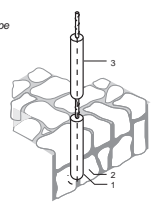
Vertical reinforcement starting from foundation band



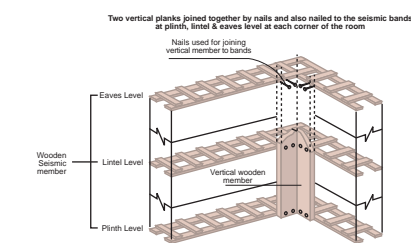
Concrete core around vertical bar



Concrete core for stone wall



Use of pipe sleeve to create uniform void for reinforcement as per following steps:
 1. Place pipe sleeve around reinforcement
 2. Build masonry around the pipe sleeve
 3. Lift the pipe sleeve leaving hollow in masonry
 4. Fill the void with concrete
 5. Repeat process



Timber post as vertical reinforcement in mud mortar

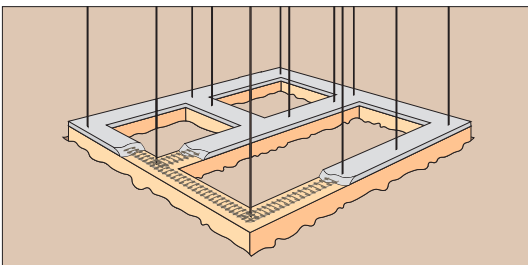


Vertical reinforcement in stone wall

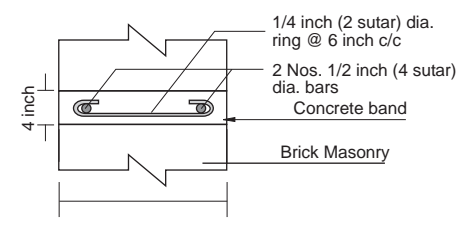
3

Plinth

- Plinth height: Plinth should be at least 1ft above the ground level
- Plinth band: A concrete band with reinforcement bars inside as shown in the picture should be provided
- Detail of band: Minimum thickness of plinth should not be less than 4 inch and width equal to wall thickness. A minimum 2 bars of ½ inch (4 sutar) dia. as main reinforcement and 1/4 inch (2 sutar) dia. rings @ 6 inch apart should be used.



Plinth band and vertical reinforcement

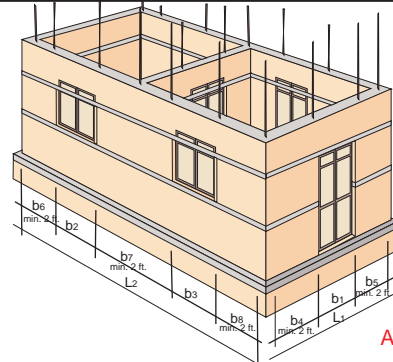


Detail of plinth band

4

Doors and Windows

- Location of doors and windows: Doors and windows should be placed at least 2 ft. away from the wall corner.
- Total length of doors and windows: The cumulative length of doors and windows in a wall should not be more 50% of length of the wall.
- Gap between two openings: The wall distance between any two openings (doors and/or windows) should not be less than 2 ft.



Appropriate location of doors and windows

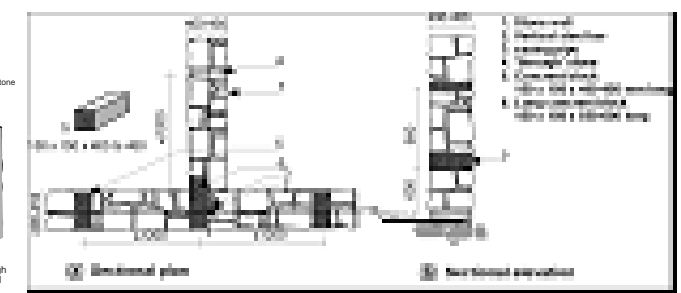
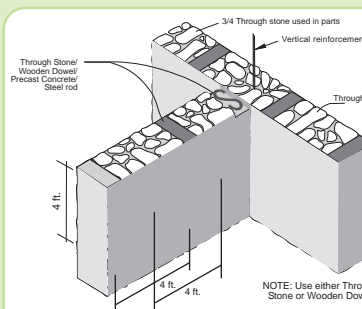
b4, b5, b6, b7, b8 > 2 ft.
 b1 < 50% of L1
 b1 + b3 < 50% L2

5

Walls

Stone Wall

- Wall Thickness: Thickness of walls should be equal to or more than 1½ ft.
- For stone-masonry, the inner and outer wythes of the wall should be interlocked with long stones; no large space between two wythes should be left for filling with pebbles or mortar. Avoid round and small pieces of stones.
- Through stones: 'Through' stones of full length equal to wall thickness should be used in every 2 ft. lift at not more than 4 ft. apart horizontally



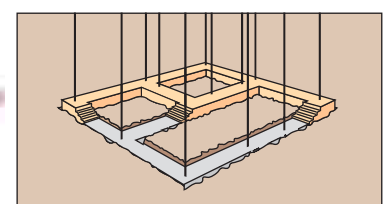
Through stones in stone masonry wall

Brick Wall

- Wall thickness: Thickness of walls should be a minimum of 9 inch for 1 story house and 14 inch for 2 story buildings
- Laying of bricks: Bricks should be laid staggered so that the vertical joints don't form a continuous line. At corners or at wall-junctions, through vertical joints should be avoided by properly laying the bricks. Never make a vertical "teeth". See picture for proper brick laying at such strategic places.
- Stepped construction: Stepped wall construction is better than toothed when there is need for future extension or continuation of work



Stepped brick wall construction in place of footed construction



View of stepped wall construction

Block Wall

- Solid blocks are preferable as compared to hollow blocks
- Thickness of wall: Thickness of block wall should be 8 inch when solid blocks are used.
- Special corner blocks: Special corner blocks with openings at side are required for placing vertical reinforcements



Vertical reinforcement in block wall

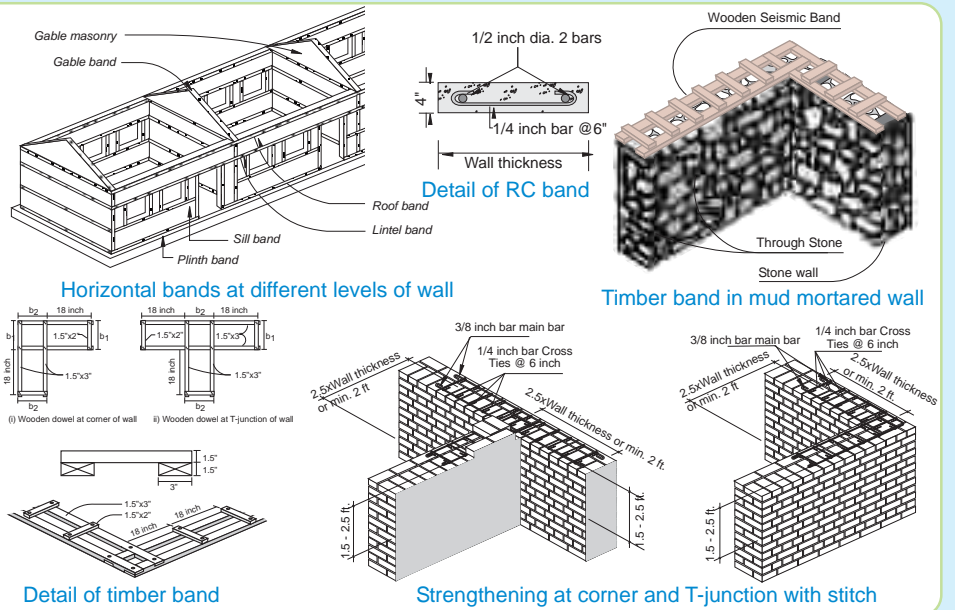


Special corner block for placing vertical reinforcement

6

Bands and Corner Strengthening

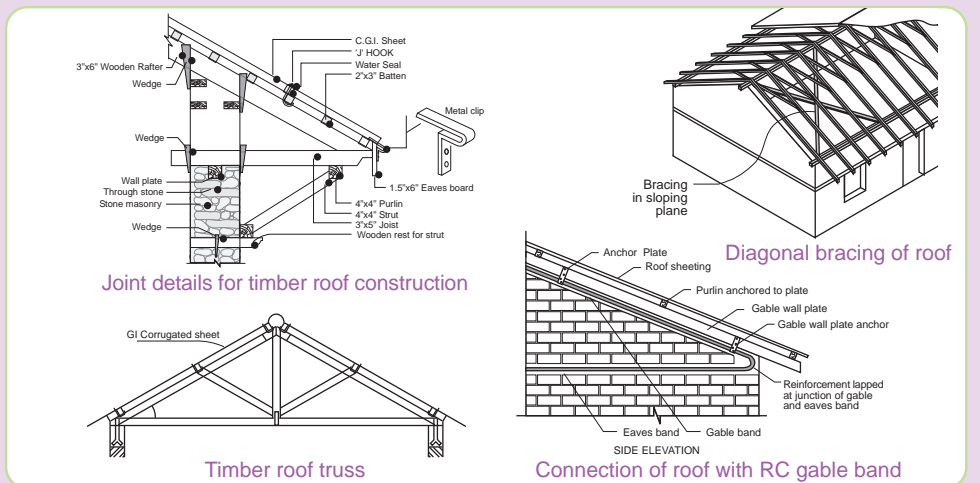
- Horizontal bands:** Horizontal bands should be provided throughout the entire wall at following locations:
 - DPC level (Plinth level) – Plinth band
 - Below window level (Sill level) – Sill band
 - Above door and window (Lintel level) – Lintel band
 - Roof (Eaves level) - Wall plate
 - Gable (Triangular gable wall) – Gable band
- Corner strengthening:** If the vertical distance between two consecutive horizontal bands is more than 3 ft., all corners and T-junctions should be strengthened by using reinforced concrete stitches as shown in the picture
- Timber band and stitch:** In case of mud mortar wall, timber can be used as horizontal band or stitch as shown in the figure



7

Roof

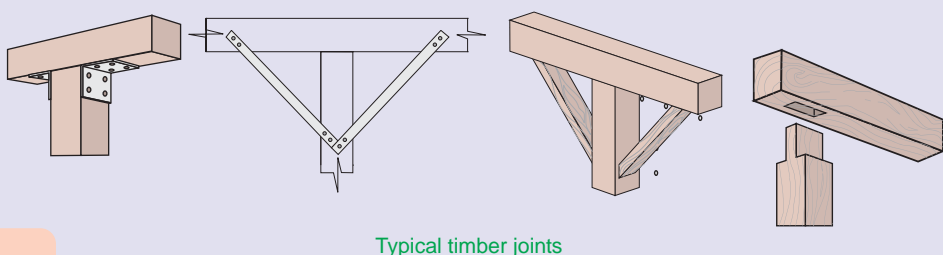
- In case of CGI sheet roof, the timber beams or joists should be tied with wall plates with reinforcement bar, binding wire, bolts or with lashes
- Rafters should also be tied properly
- Timber members should be joined properly with appropriate joinery or with metal straps
- Diagonal bracing should also be done



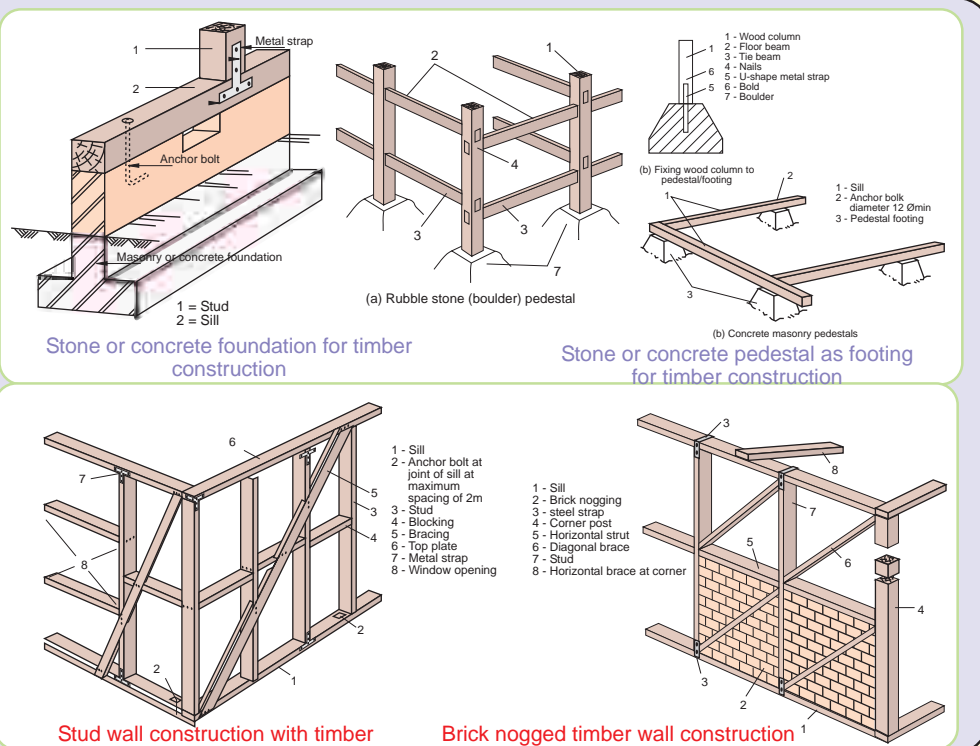
8

Timber Construction

- **Foundation for timber construction:** Timber posts or timber sill should be properly connected to the stone or concrete foundation as shown
- **Stud wall construction** (timber frame with plank or CGI or any other sheathing): Timber frame should be properly joined together with proper timber connections and metal strap and should be braced diagonally
- **Brick or stone nogged timber construction:** In such construction also, the timber members should be properly joined and braced together
- **Timber joints:** Proper timber joints should be made by using different carpentry joints and by use of nails and metal straps



Typical timber joints



9

Number of Story in a House

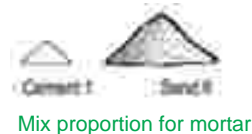
- In mud mortar, no house should be more than 1 story
- In cement mortar, house can be of 2 story

10

Good Quality Materials

- **Brick** – Well burnt, regular sized bricks should be used
- **Stone** – Dressed stones are preferable than rubbles and rounded stones
- **Timber** – well seasoned hard wood without knots should be used for structural members; timber treatment such as use of coal tar or any other preservative can prevent timbers from being decayed and attacked by insects

- **Mortar** – cement mortar should not be leaner than 1:6 (1 cement and 6 sand); preferably it should be 1:4 (1 cement and 4 sand)
- **Concrete** – the concrete mix for bands, stitches, slab, beams, columns should not be leaner than 1:2:4 (1 cement, 2 sand and 4 aggregate)



Mix proportion for mortar



Mix proportion for concrete

This publication has been prepared for assisting in rural reconstruction of earthquake affected areas and is believed to be helpful in assuring the enhanced earthquake safety of rural houses. This will provide easy and ready to use solutions for common rural houses. This construction checklist is for one or two storied rural housing units, the provisions mentioned here are only for such houses. If the house is other than this, standard provisions for those specific types should be followed. For further details related to the provisions mentioned in this checklist, detail guidelines can be followed.



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