Repair and retrofitting of buildings in cyclone prone areas

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Table of Content

Effect of lateral load.

Dead Load

(Safe)

Dead Load

Lateral Load
(Wind or Earthquake)

Repair

- Actions taken for patching up superficial defects
- Mostly includes cosmetic works only

Retrofitting

Preparing a structure in scientific manner to withstand forces of natural hazards.

Up gradation of existing building for increasing the resistance against natural hazards.

Types of Building

- Engineered building.

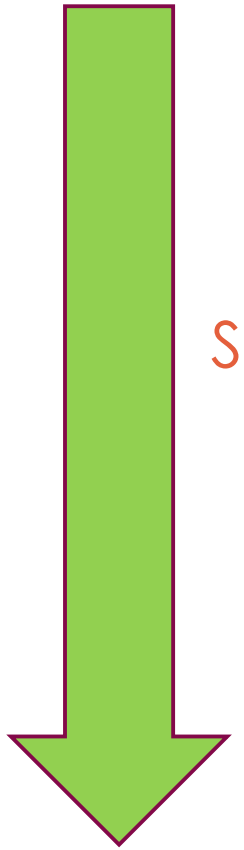
Buildings which has been designed and constructed as per Indian Standards specifications including wind and earthquake.

- Semi Engineered building.

Buildings made intuitively from structural materials such as burnt clay bricks laid in cement or lime mortar without proper design.

- Non-Engineered building.

Buildings constructed using non standard materials including agriwaste and local construction company.



Safety

Masonry Building

Retrofitting for Masonry buildings

A) Fixing of cracks.

B) Stitching junctions of walls by ferro cement plates.

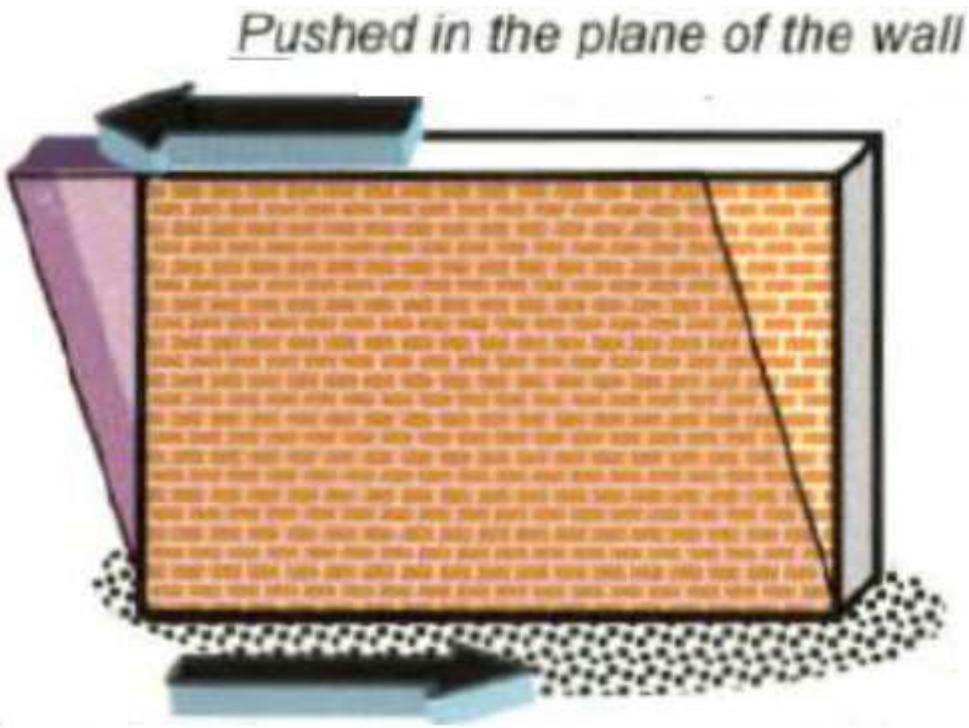
C) Strengthening of walls by horizontal belts.

D) Strengthening of walls by vertical belts.

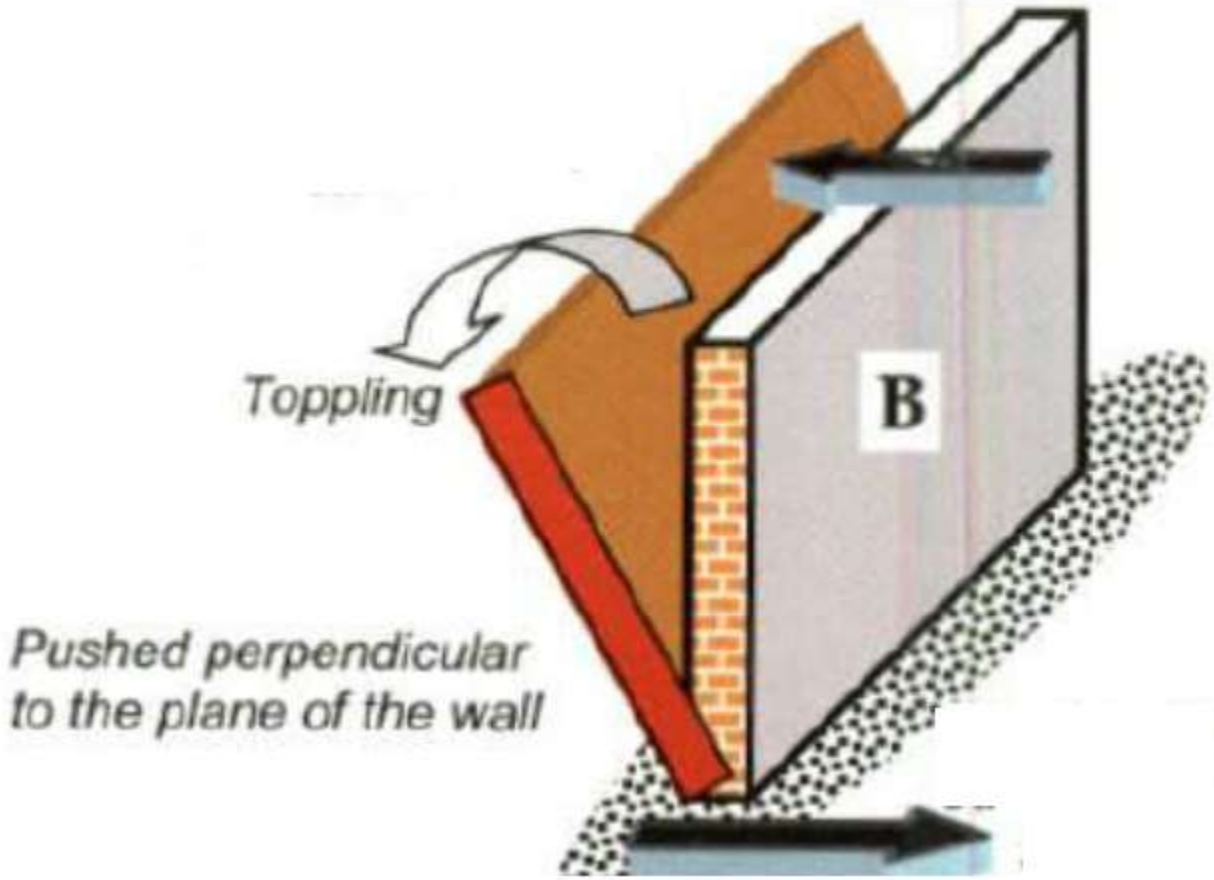
E) Strengthening around doors/ windows.

F) Control on length of wall.

G) Control on opening.

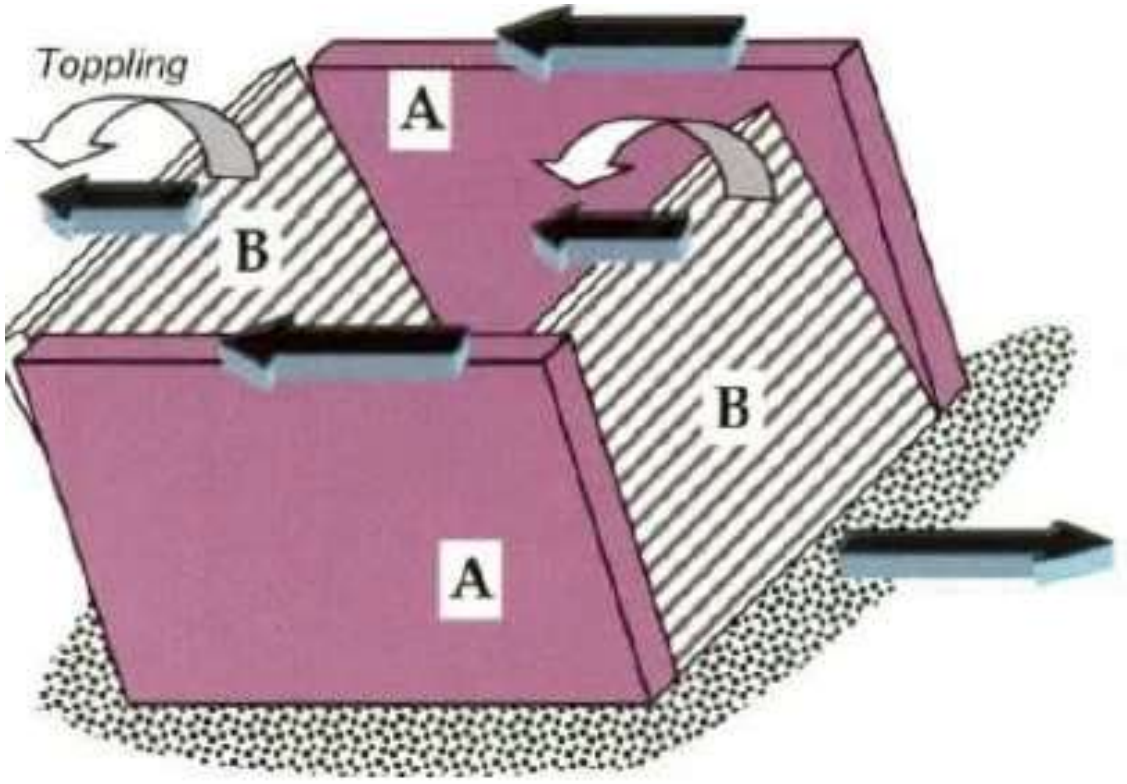


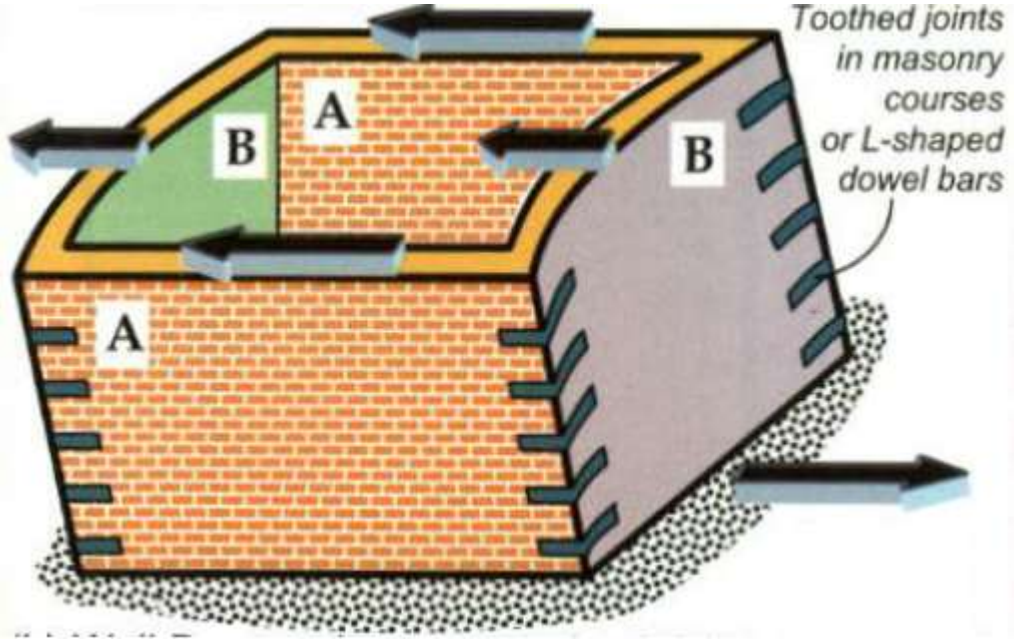
Strong Direction

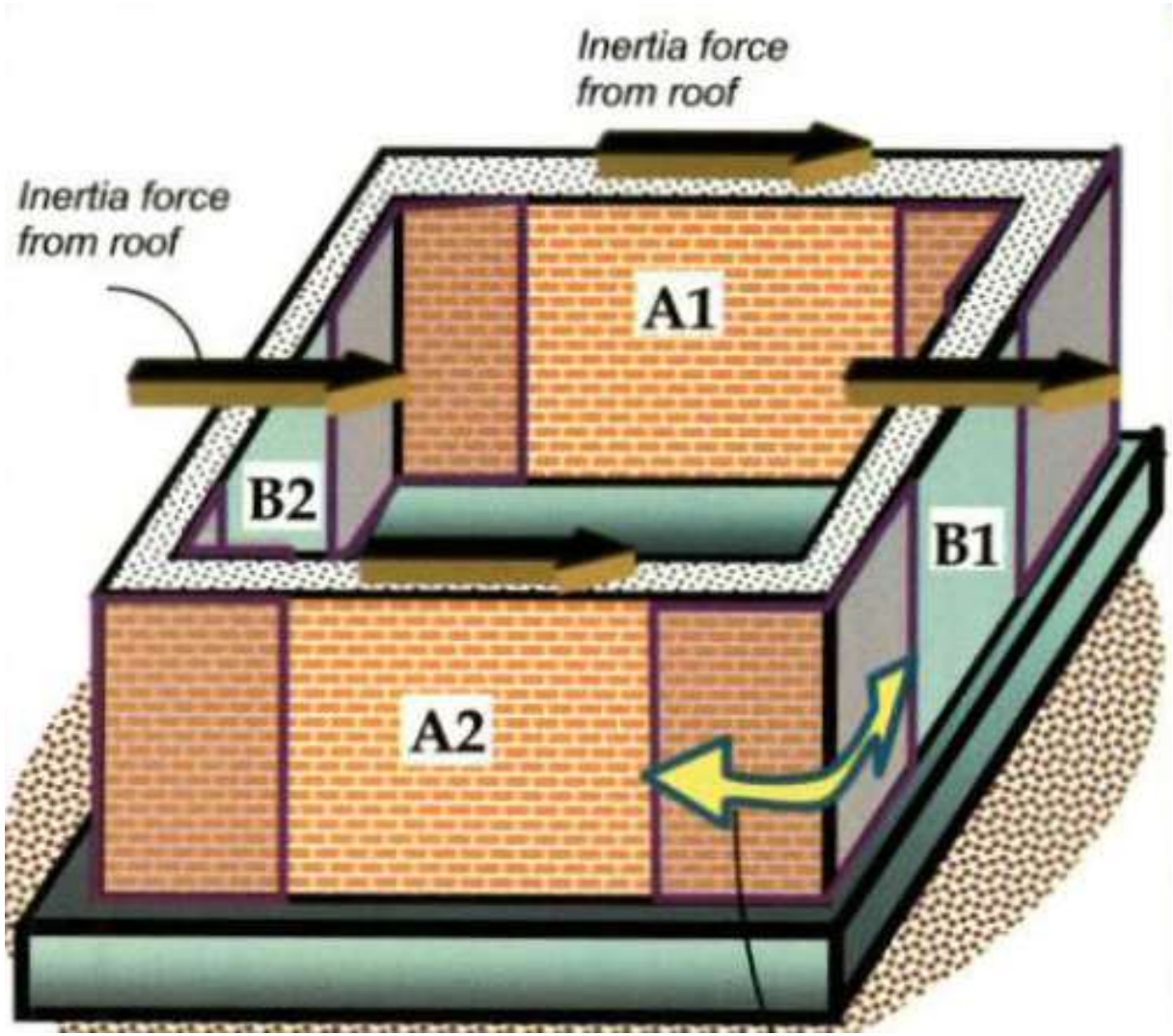


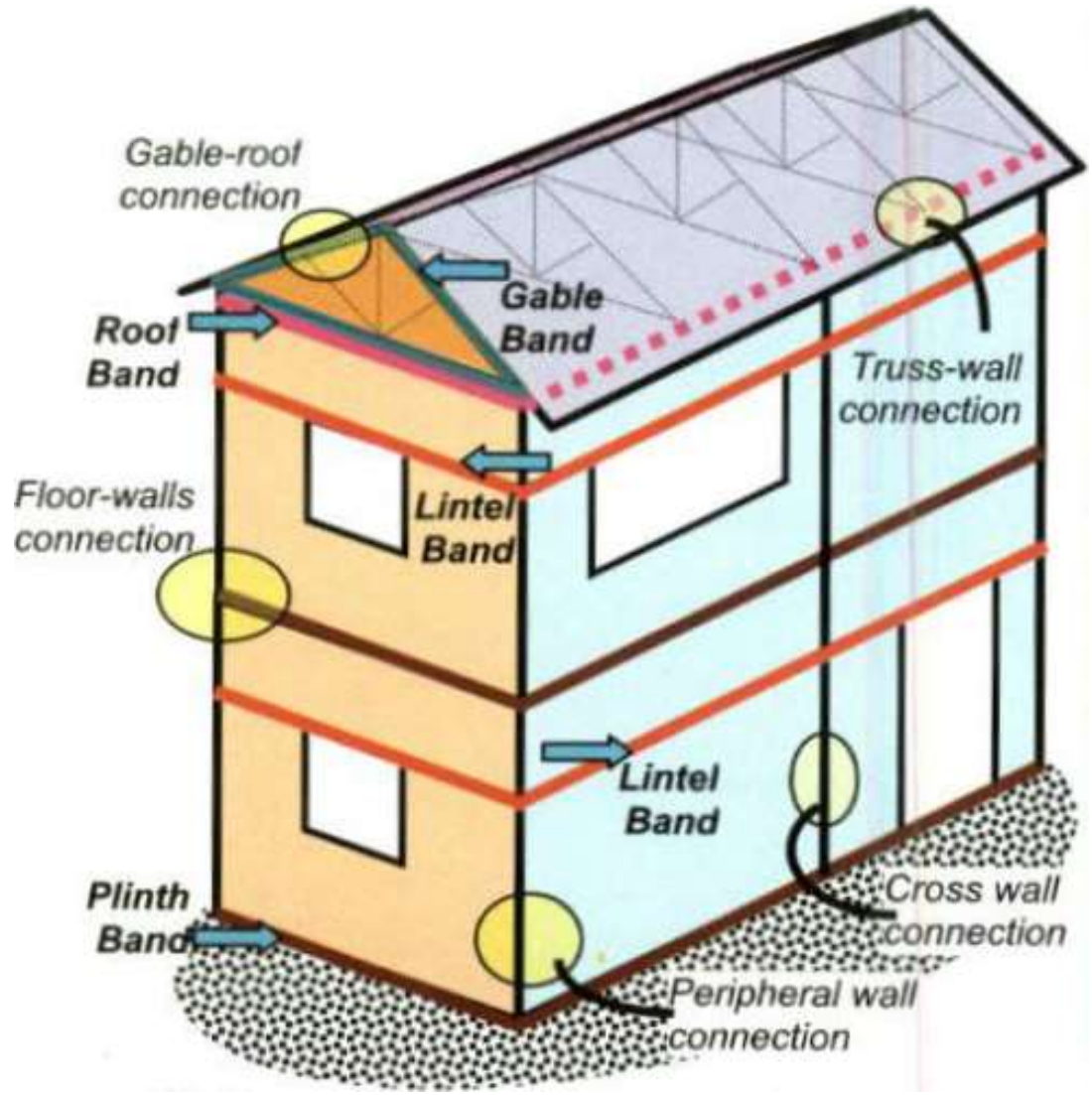
Weak Direction

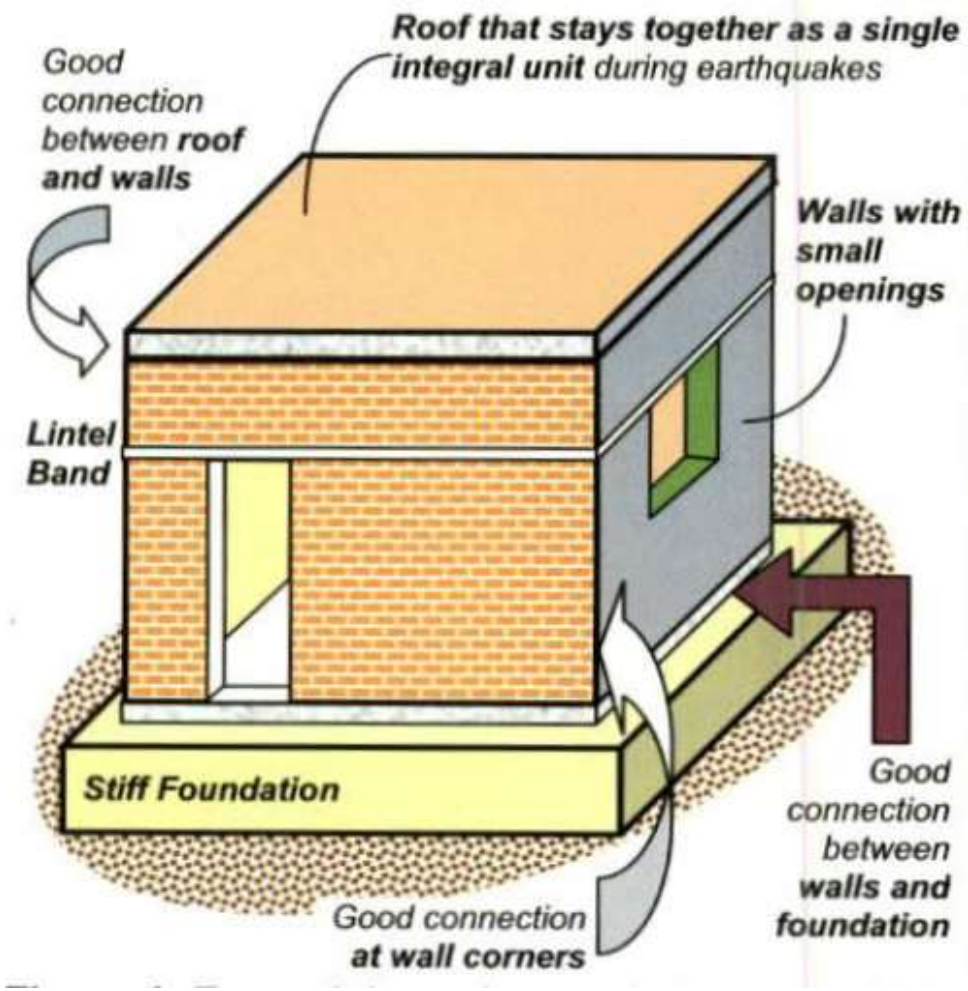
Concept of box action.




A
B
B
A
Toothed joints
in masonry
courses
or L-shaped
dowel bars

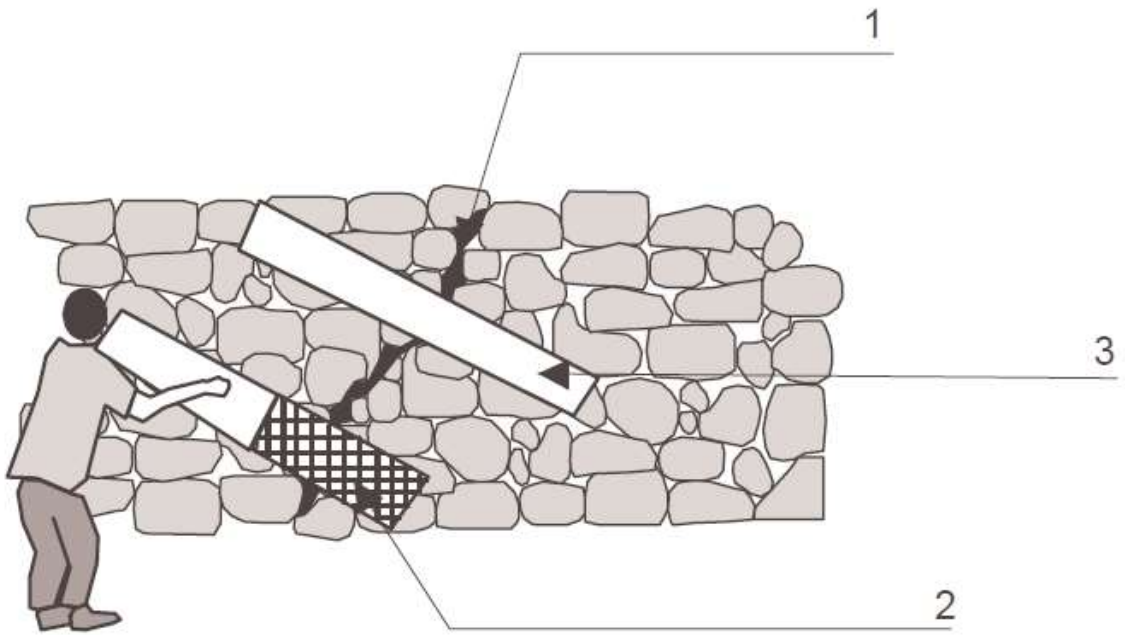

Inertia force
from roof
Inertia force
from roof
A1
B2
B1
A2


Gable-roof
connection
Gable
Band
Roof
Band
Truss-wall
connection
Floor-walls
connection
Lintel
Band
Lintel
Band
Plinth
Band
Cross wall
connection
Peripheral wall
connection


Roof that stays together as a single integral unit during earthquakes
Good connection between roof and walls
Walls with small openings
Lintel Band
Stiff Foundation
Good connection between walls and foundation
Good connection at wall corners

Retrofitting of Masonry building

A) For a crack more that 5 mm,

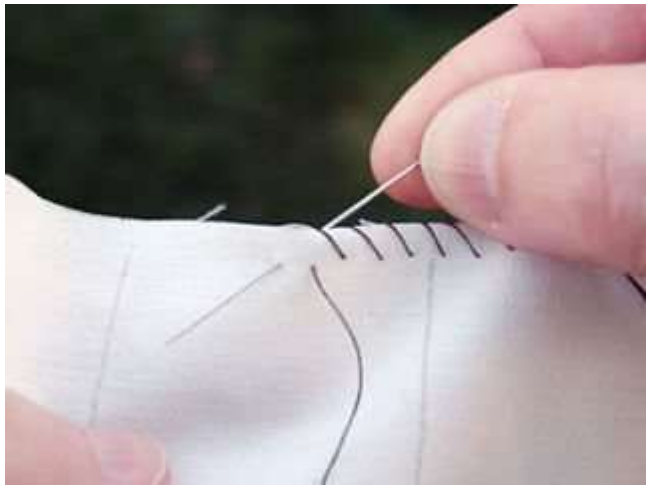


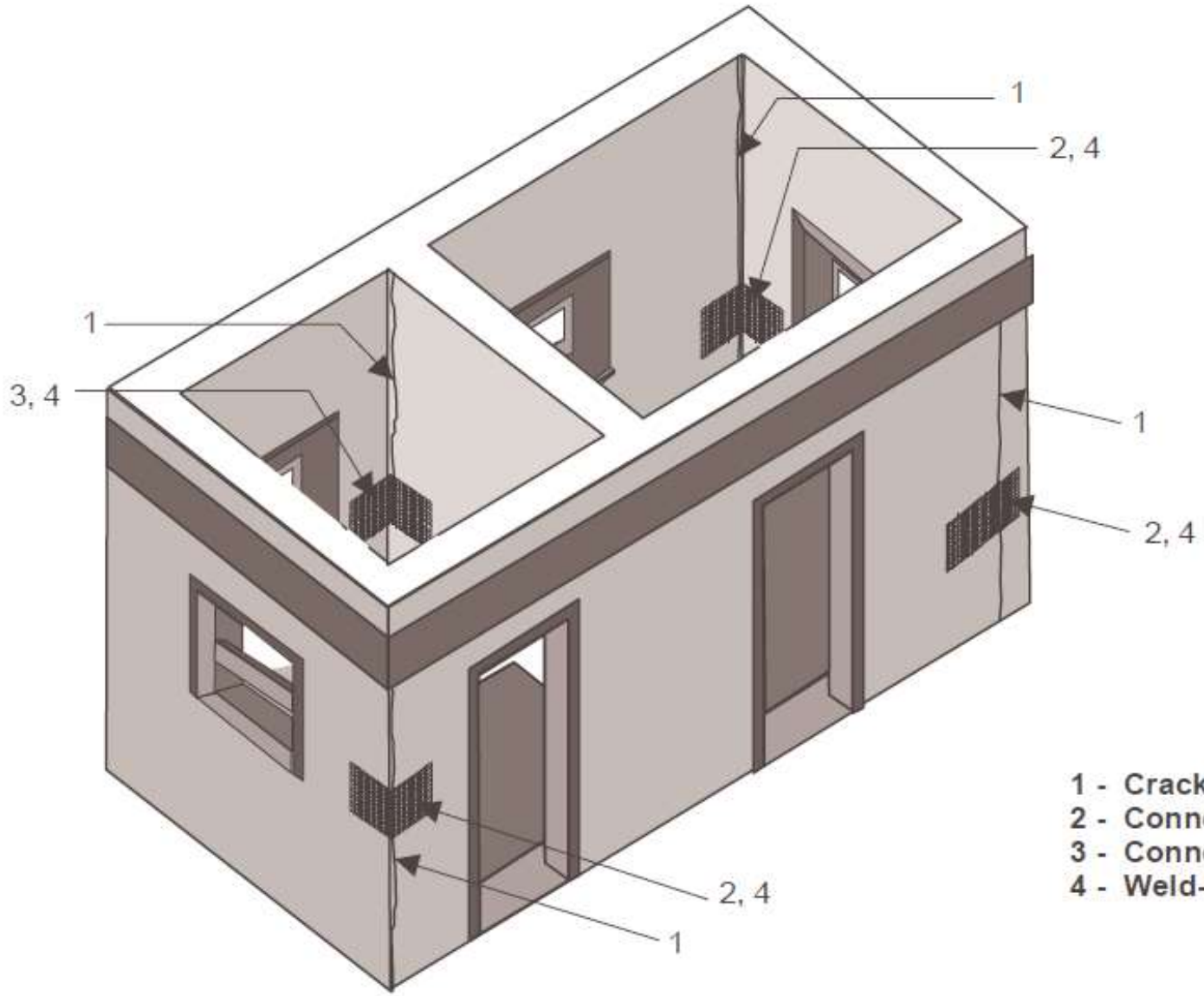
1) Wide Crack 2) Wire mesh 3)Plaster

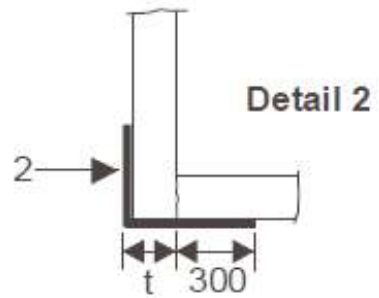
B) Stitching junctions of walls by ferro cement plates.

Ferro cement plates must be installed in a length of 300mm on each side of crack on inside and (wall thickness +300 mm) on outside.

Ferro cement plate must be of size 25mm x 25 mm with 35 mm thick micro cover concrete.







1 - Crack Filling
2 - Connecting Corners
3 - Connecting walls at T-junction
4 - Weld-Mesh or other reinforcement

C) Strengthening of walls by horizontal belts

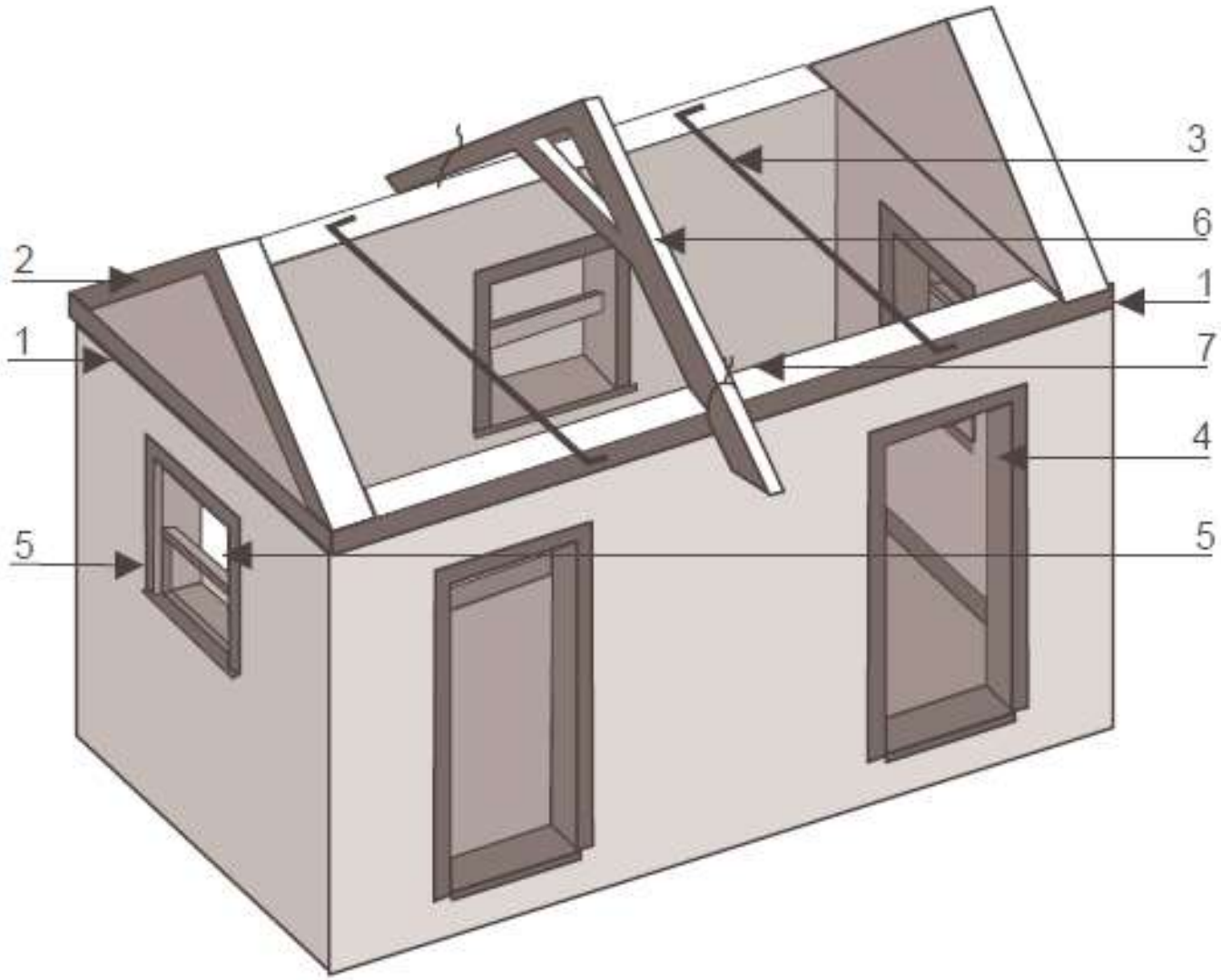
Horizontal belts ensures integral action in case of buildings which did not incorporate horizontal bands at the time of initial construction.

Such belt should be

(i) Width : 300 mm along the walls with continuity at corners and junctions.

(ii) Reinforcement : Welded mesh with 10 nos. long wires G10 spaced at about 30 mm with transverse wires spaced at 300 mm.

(iii) Covering (micro concrete) : 35 mm thickness.



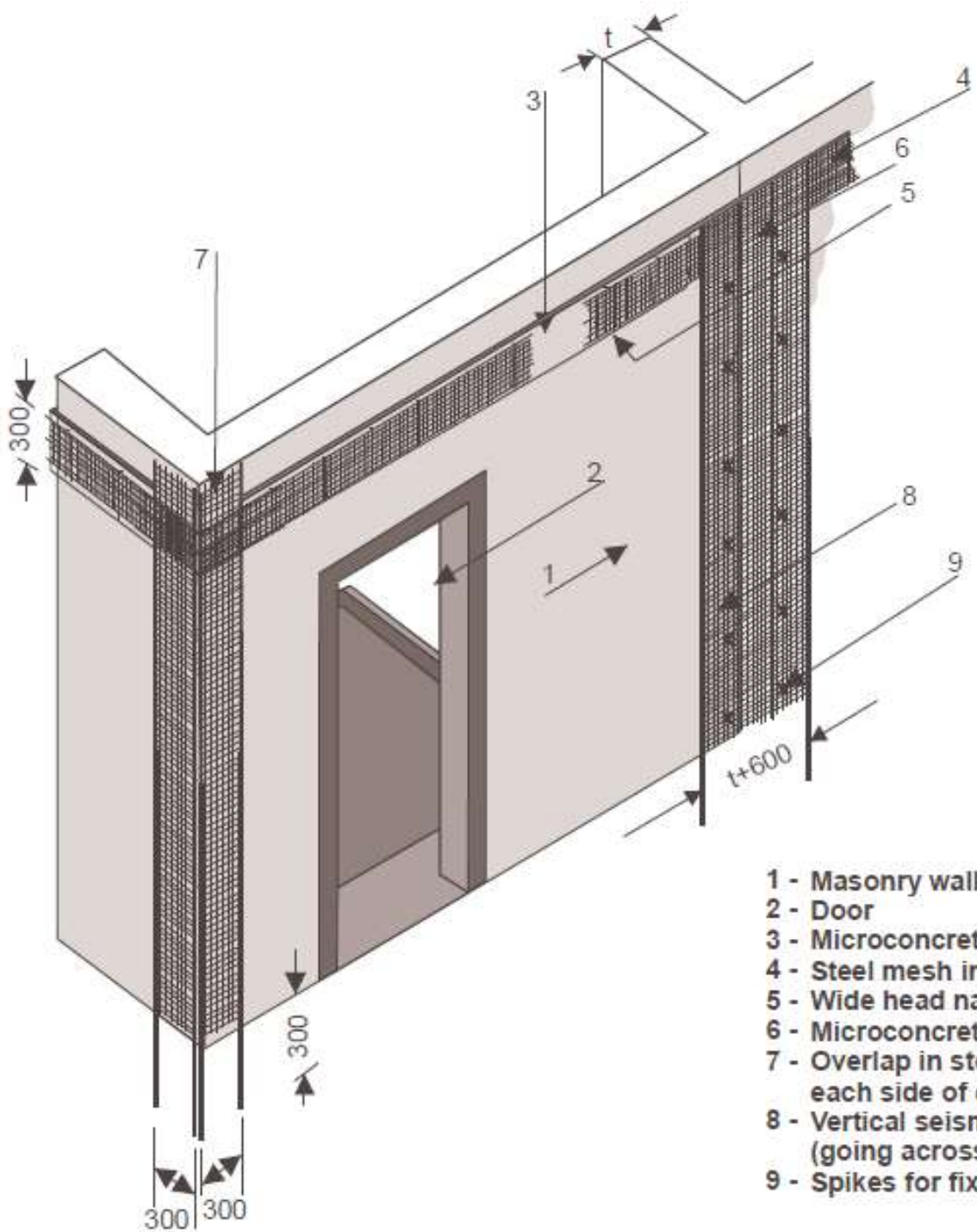
1 - Horizontal belt above openings and below roof at eave level
2 - Gable belt on gable wall
3 - Tie at eave-band level
4 - Door
5 - Window
6 - Rafter with collar tie
7 - Tying of rafter with band

D) Strengthening of walls by vertical belts.

The vertical steel reinforcement at corner and near opening shall be provided in a similar to horizontal belts.

The width of belt at corner maybe 300 mm on either face while at T junctions it wall thickness plus 600 mm.

The spacing of such wires shall be 30mm and thickness of micro concrete may be 35 mm.

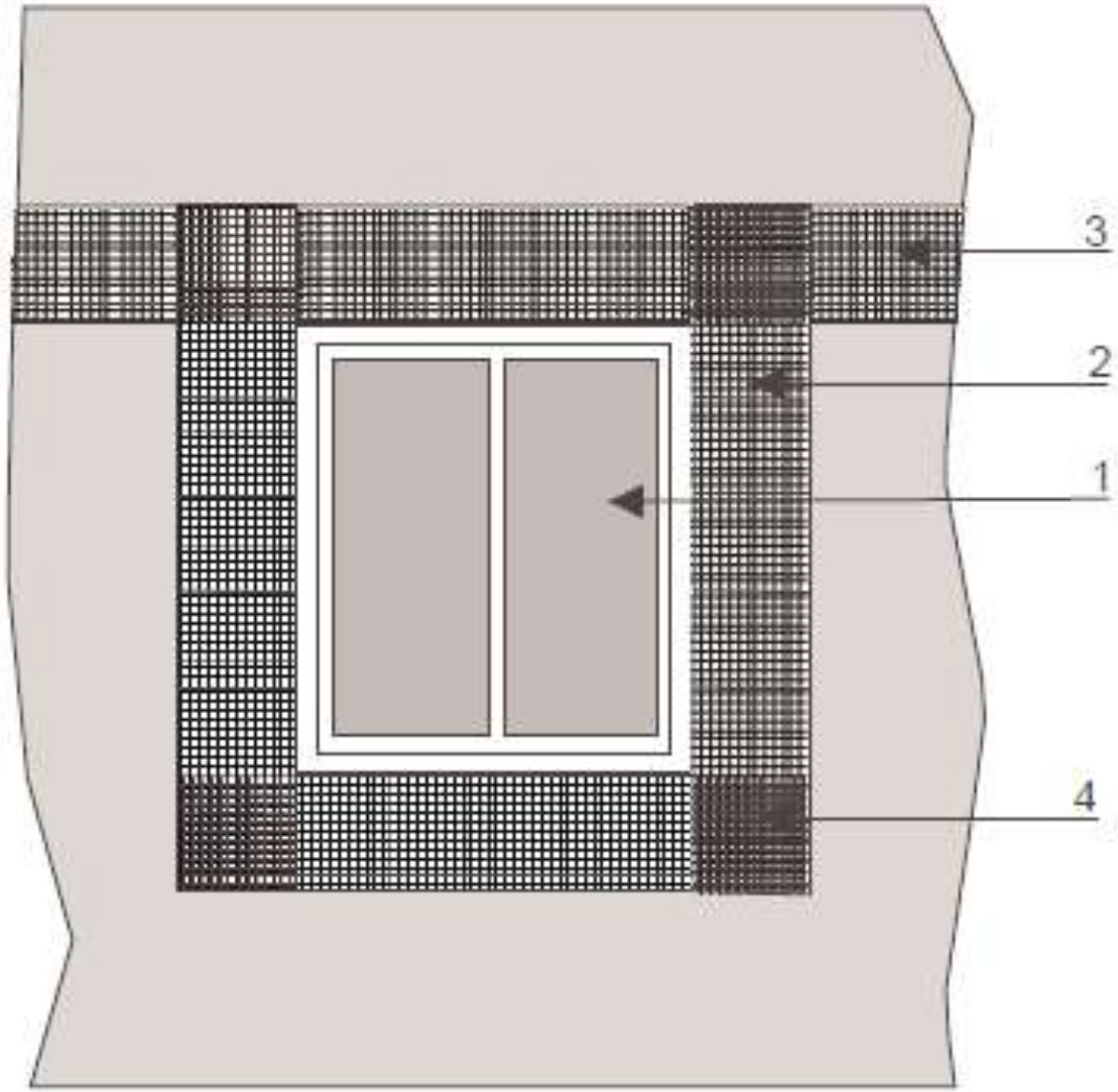


1 - Masonry wall
2 - Door
3 - Microconcrete first layer
4 - Steel mesh in belt
5 - Wide head nails 150 long
6 - Microconcrete second layer
7 - Overlap in steel mesh, 200mm each side of corner
8 - Vertical seismic belt at junction (going across horizontal belt)
9 - Spikes for fixing mesh

E) Strengthening around doors/ windows.

Belts needs to be provided at jambs and around the doors opening to strengthening as they are more vulnerable in building.

Image Source :CPWD, Mumbai



1 - Window
2 - Mesh of Ferro-cement
3 - Horizontal Belt
4 - Overlap of Mesh

Installation of belts.

(i) Remove plaster , rack out mortar joints to about 20 mm depth. Clean the surface and wet it with water.

Apply neat cement slurry and apply first coat of 12-16mm thickness microconcrete, roughen the surface.

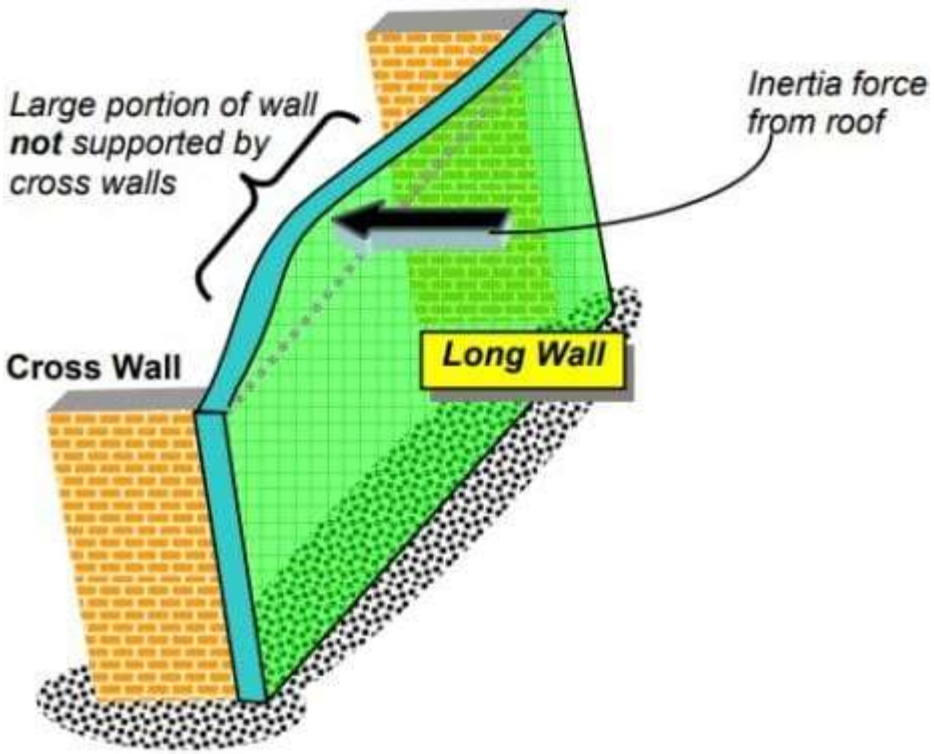
(ii) Fix the mesh with 150 mm long nails (having large heads) at 300 mm apart when first coat is still green.

(iii) Apply the second coat of microconcrete of about 20 mm thickness ensuring a clear cover of about 12 mm for steel

F) Control on length of wall.

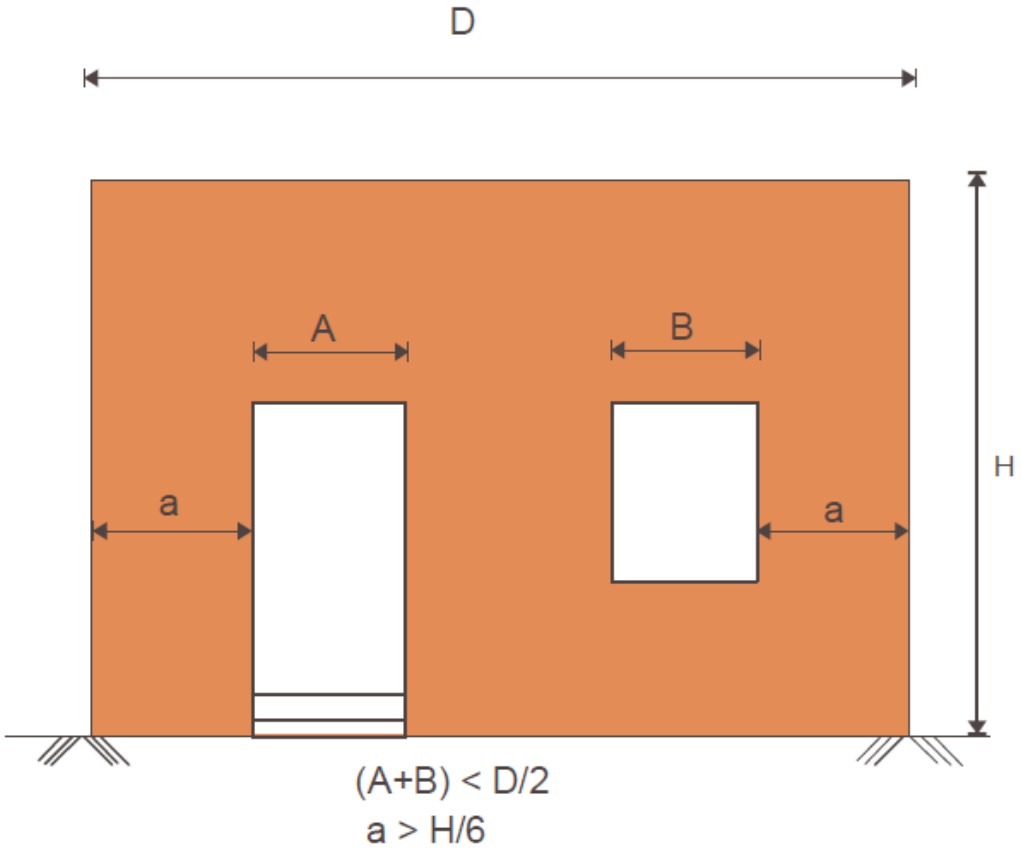
The maximum length of wall should not exceed 4m in case of stone buildings and 5 m in case of walls with rectangular masonry units.

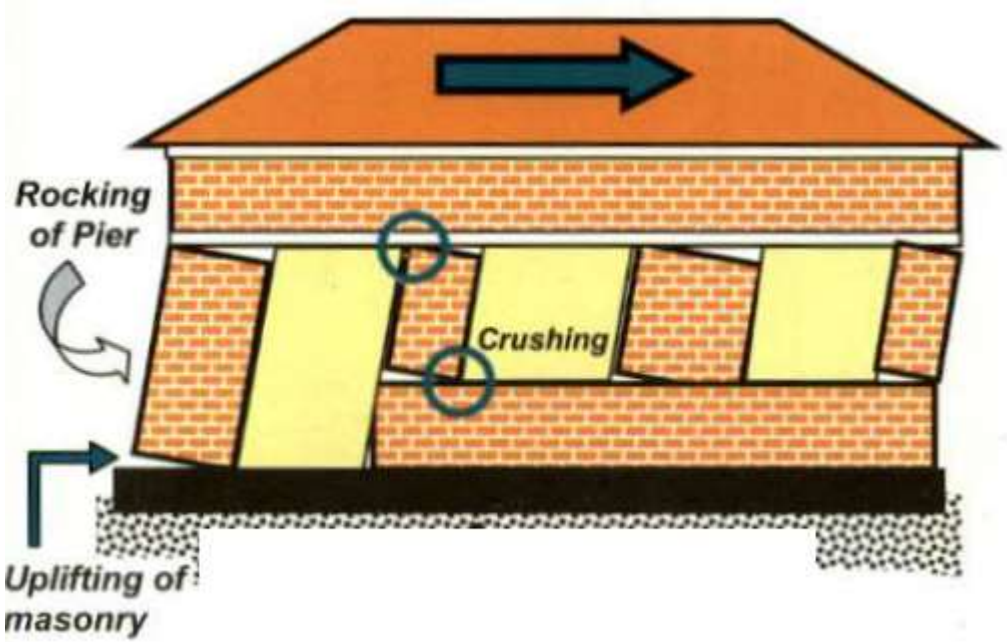
In case wall length exceeds 5 m, it should be strengthen using buttress or pilaster spaced less than 4m.



G) Control on opening :

There should be prefably be one door and window in one wall opening with Total Length of opening < fifty percent of wall length in a story





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Thank You

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