Frequently Asked Questions

Question 01:

Explain in detail about the Seismic Design & Detailing of Wooden Structures.

Answer:

- Wood has higher strength per unit weight and is, therefore, very suitable for earthquake resistant construction.
- But heavy cladding walls could impose high lateral load on the frame. Although seismically suitable, use of timber is declining in building construction even where it used to be the prevalent material on account of vanishing forests due to population pressure.
- Timber buildings may only be used in those areas and countries where it is still abundantly available or in unavoidable situations only. Some construction details only differ for hollow blocks, which are also indicated as necessary.
- The typical features of earthquake damage to wooden buildings are as follows:

(i) Roof tiles easily slide down during earthquakes, if they are not properlyfastened to the roof. Falling roof tiles may hurt people

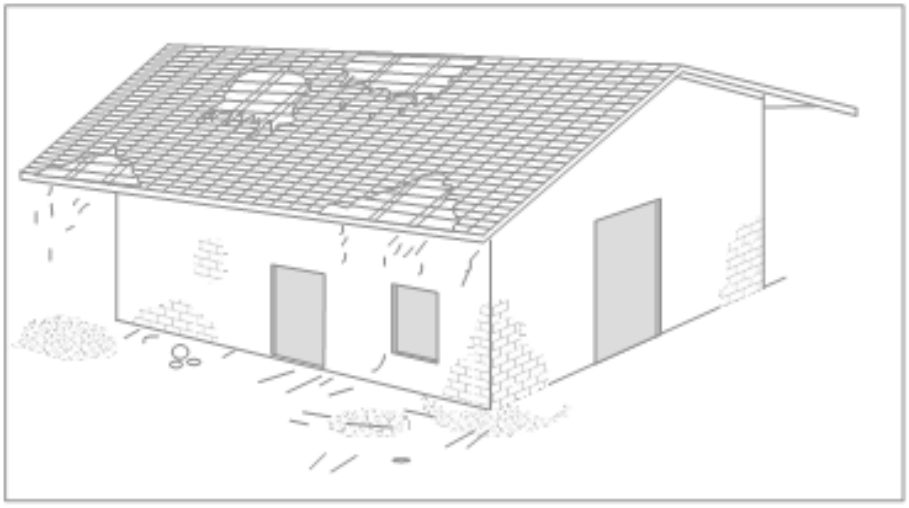


Fig 6.1 Falling of roof tiles

(ii) The failure of the joints connecting columns and girders frequently occurs,accompanying the falling of finishes. As the inclination of the building increases, its restoring force against distortion decreases due to the structural deterioration and roof weight, and finally becomes negative which results in the complete collapse of the building.

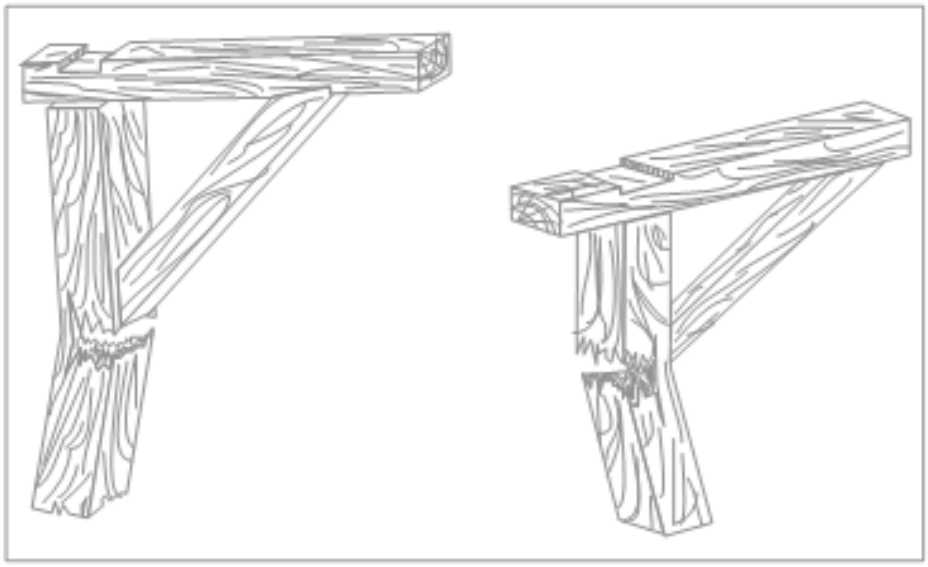


Fig 6.2 Rupture of columns at the connection of knee brace and column

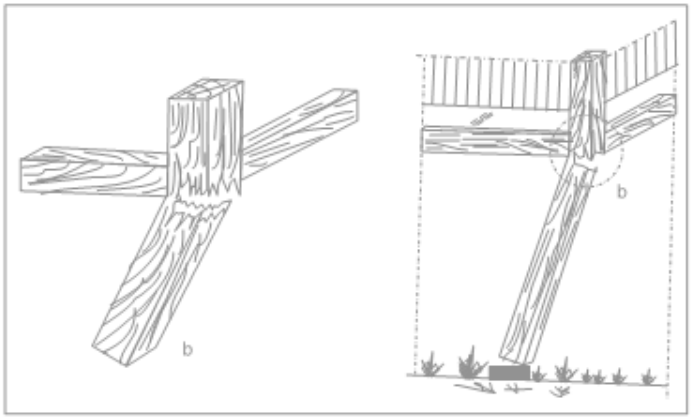
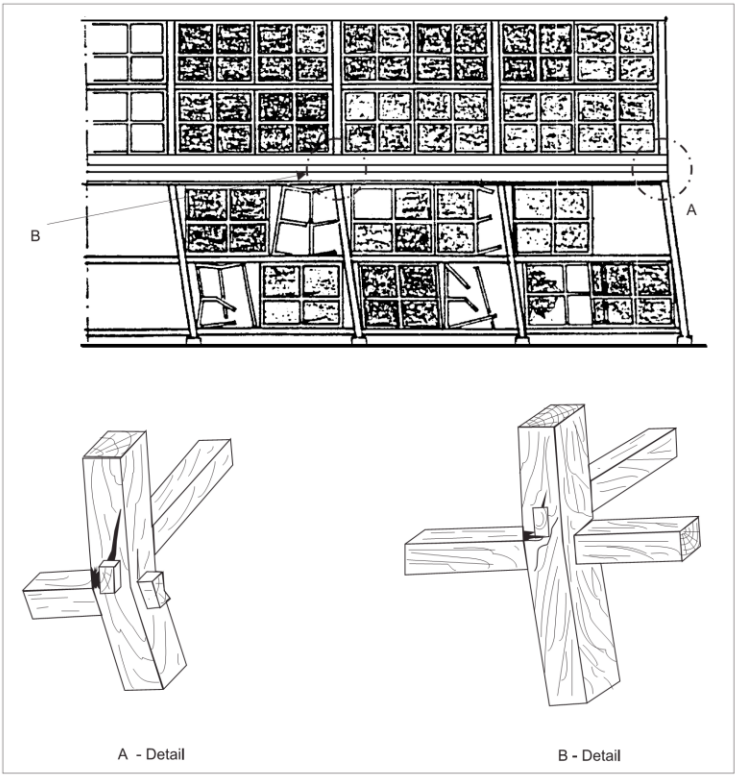


Fig 6.3 Rupture of columns due to large notching at the connection of girder and column

(iii) In the case of two storey buildings, the first storey usually suffers severer damage than the second storey. It is often seen that the first storey falls down while the second storey is undamaged.



(iv) Damage is considerably influenced by the ground condition on whichthe building stands. In general, the softer the subsoil, the severer thedamage to the building. The damage due to differential settlements of foundations is also observed for buildings on soft ground.

(v) Sliding of the building as a whole is sometimes seen when there are noanchor bolts connecting the sill to the foundation.

(vi) Other types of damage in wooden buildings are failure of wooden gable frames, and failure due to rupture of bottom chordsof roof truss.

(vii) The most crucial destruction of wooden buildings has been due to fire resulting from electrical short circuiting or kitchen fires during the earthquake shaking and spreading into conflagration thereafter. Precautions against fire are most important in case of wooden buildings.

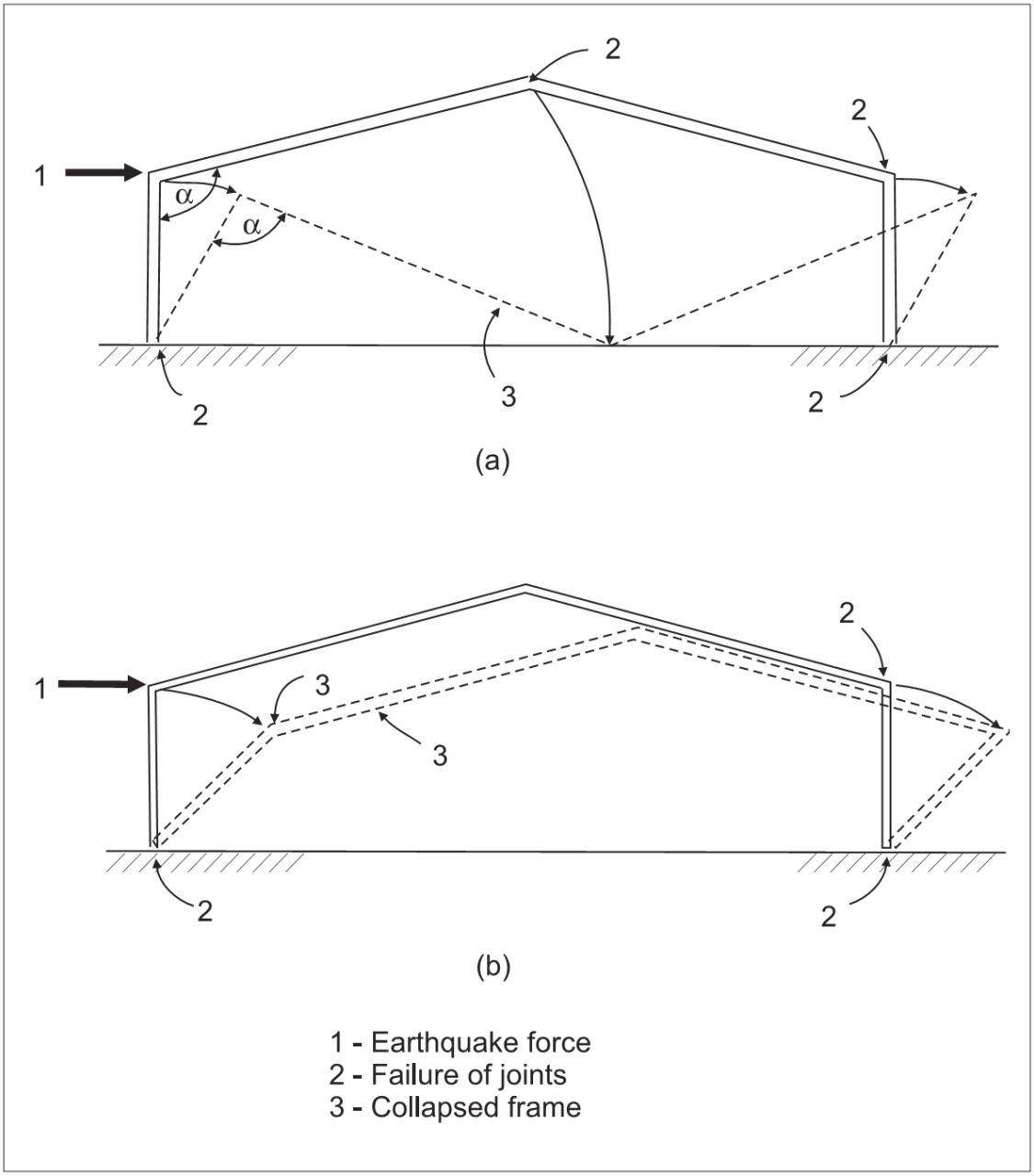


Fig 6.6 Failure modes of gable frame

Question 02:

What are the typical properties of wooden structures?

Answer:

There are large varieties of timbers in use in various countries. It will therefore not be practicable to present their strength properties here. But it will be pertinent to mention that these depend on a number of factors as follows:

(i) Wood specimen

(ii) Direction of loading relative to grain of wood

(iii) Defects like knots, checks, cracks, splits, shakes and wanes

(iv) Moisture content or seasoning

(v) Sapwood, pith, wood from dead trees and dried wood conditions

(vi) Location of use, viz inside protected, outside, alternate wetting and drying.

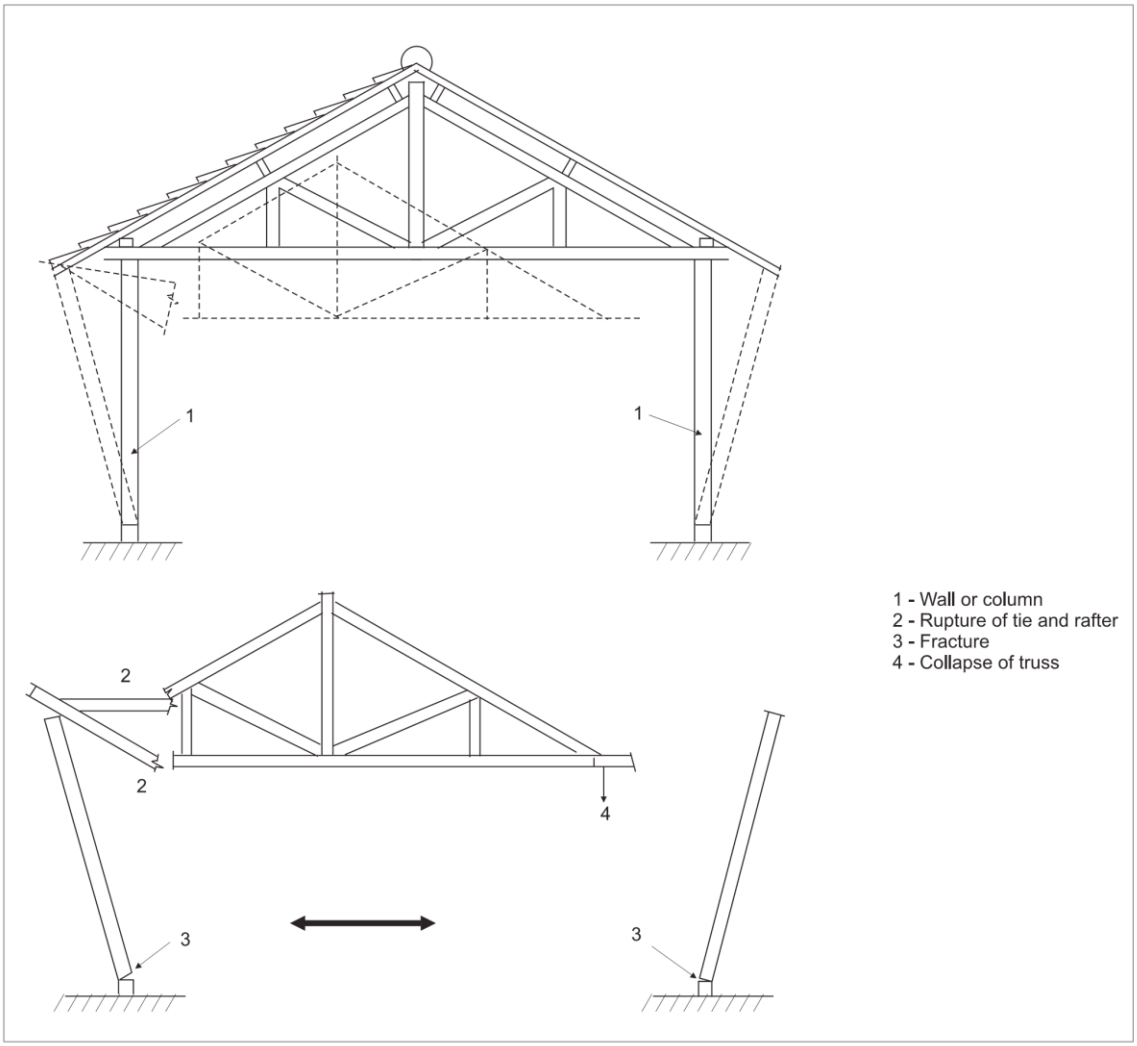


Fig 6.7 Failure due to rupture of bottom chord of roof truss

Question 03:

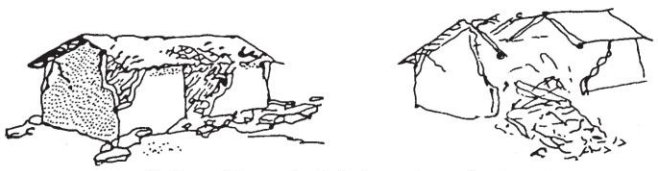
Explain in detail about the Seismic Design & Detailing of Earthen Structures.

Answer:

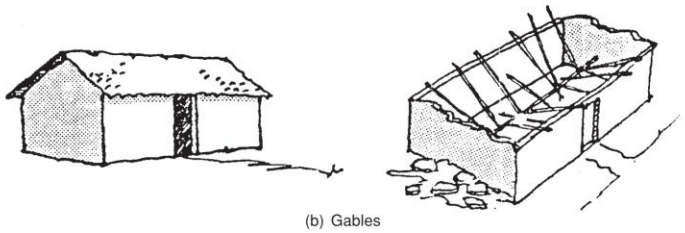
- Earthen construction has been, is and will continue to be a reality.
- Even though this material has clear advantages of costs, aesthetics, acoustics and heat insulation and low energy consumption, it also has some disadvantages such as being weak under earthquake forces andwater action.
- However, the technology developed to date has allowed a reduction in its disadvantages, stressing its most valuable advantages.
- Earthen constructions are, in general, spontaneous and a great difficulty is the dissemination of knowledge about its adequate use.

Typical Damage And Collapse Of Earthen Buildings

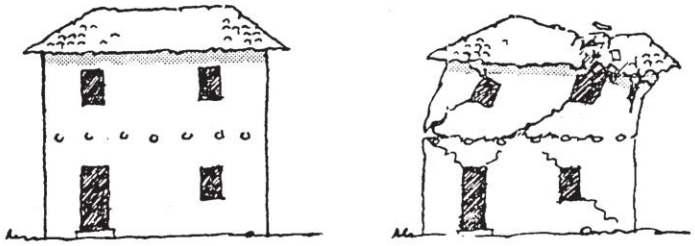
- Damage is always much more severe in two storied buildings than in one storied ones.
- However, single storied houses with flat roofs constructed in good clay have been found to be undamaged whereas at the same location two storied houses were completely ruined.



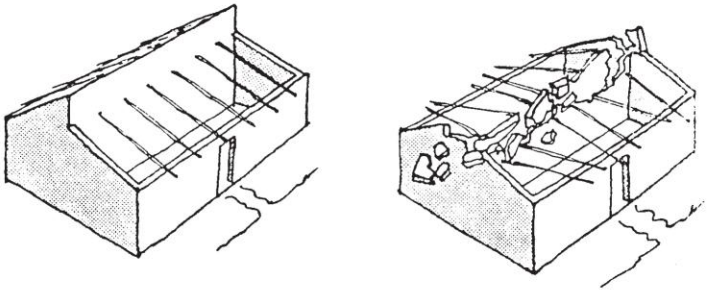
(a) Corner failure and out of plane collapse of walls



(b) Gables



(c) Two storey house damage / collapse



(d) Split level roof

Fig 7.1 Typical damages and collapse of earthen buildings (continued on next page)

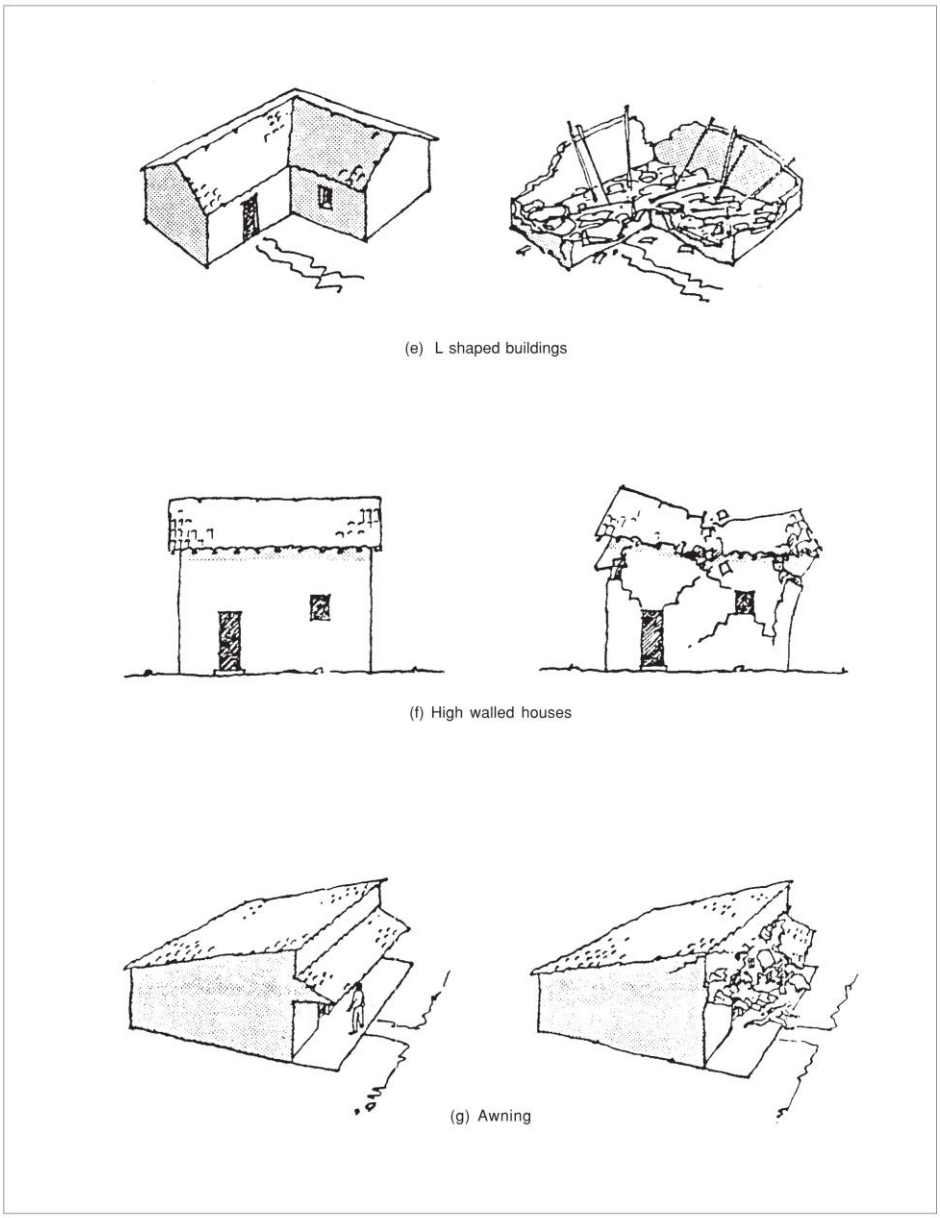


Fig 7.1 Typical damages and collapse of earthen buildings (continued from previous page)

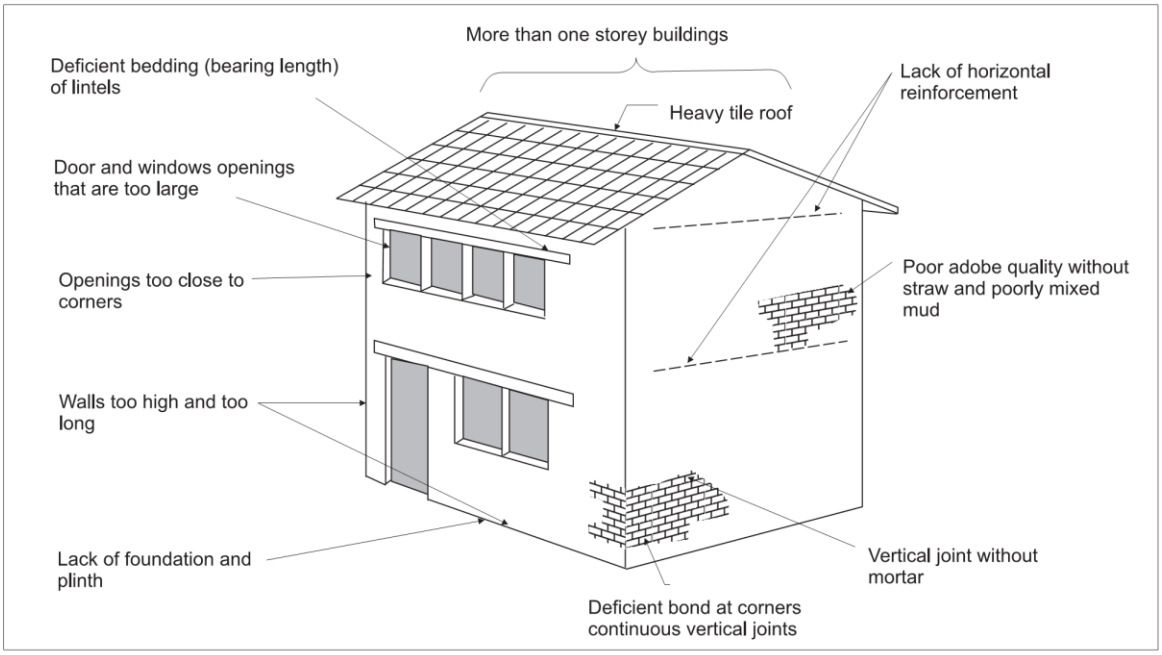


Fig 7.2 Graphic summary of causes of failure

Question 04:

What are the classification of earthen structures?

Answer:

- *Hand-formed by layers*

  1 Simple forming

  2 Earth balls, thrown and moulded as wall

- *Adobe or blocks*

  1 Cut from hardened soil

  2 Formed in mould

  3 Moulded and compacted

- Tapial or pise (rammed earth)

  1 Compacted by hand blows

  2 Mechanized or vibrating compaction

- Wood or cane structure, with wood or cane mesh enclosures plastered with mud

  1 Continuous

  2 Pre-fabricated panels

Question 05:

Illustrate the good features of earthquake resistant construction.

Answer:

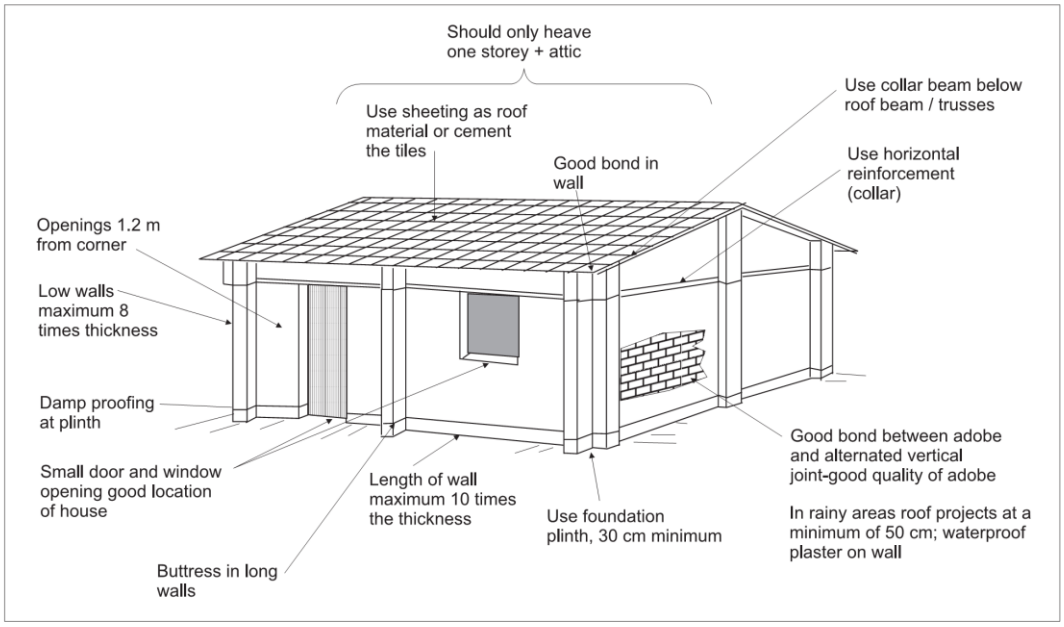


Fig 7.14 Good features of earthquake resistant construction

Question 06:

Elaborate the suitability of soil.

Answer:

The quality of materials, particularly clay content of the soil may vary somewhat for the type of construction. But in general the

following qualitative tests are sufficient for determining the suitability of a soil for earthen construction:

a. Dry strength test

Five or Six small balls of soil of approximately 2 cm in diameter are made. Once they are dry (after 48 hours), each ball is crushed between the forefinger and the thumb. If they are strong enough that none of them breaks, the soil has enough clay to be used in the adobe construction. If some of the balls break, the soil is not considered to be adequate, because it does not have enough clay and should be discarded.

b. Fissuring control test

At least eight sandwich units are manufactured with mortars made with mixtures in different proportions of soil and coarse sand. The sandwich having the least content of coarse sand which, when opened after 48 hours, does not show visible fissures in the mortar, will indicate the most adequate proportion of soil/sand for adobe constructions, giving the highest strength.

c. Strength test of adobe

The strength of adobe can be qualitatively ascertained a follows: After 4 weeks of sun drying the adobe be should be strong enough to support in bending the weight of a man. If it breaks, more clay and fibrous material is to be added.

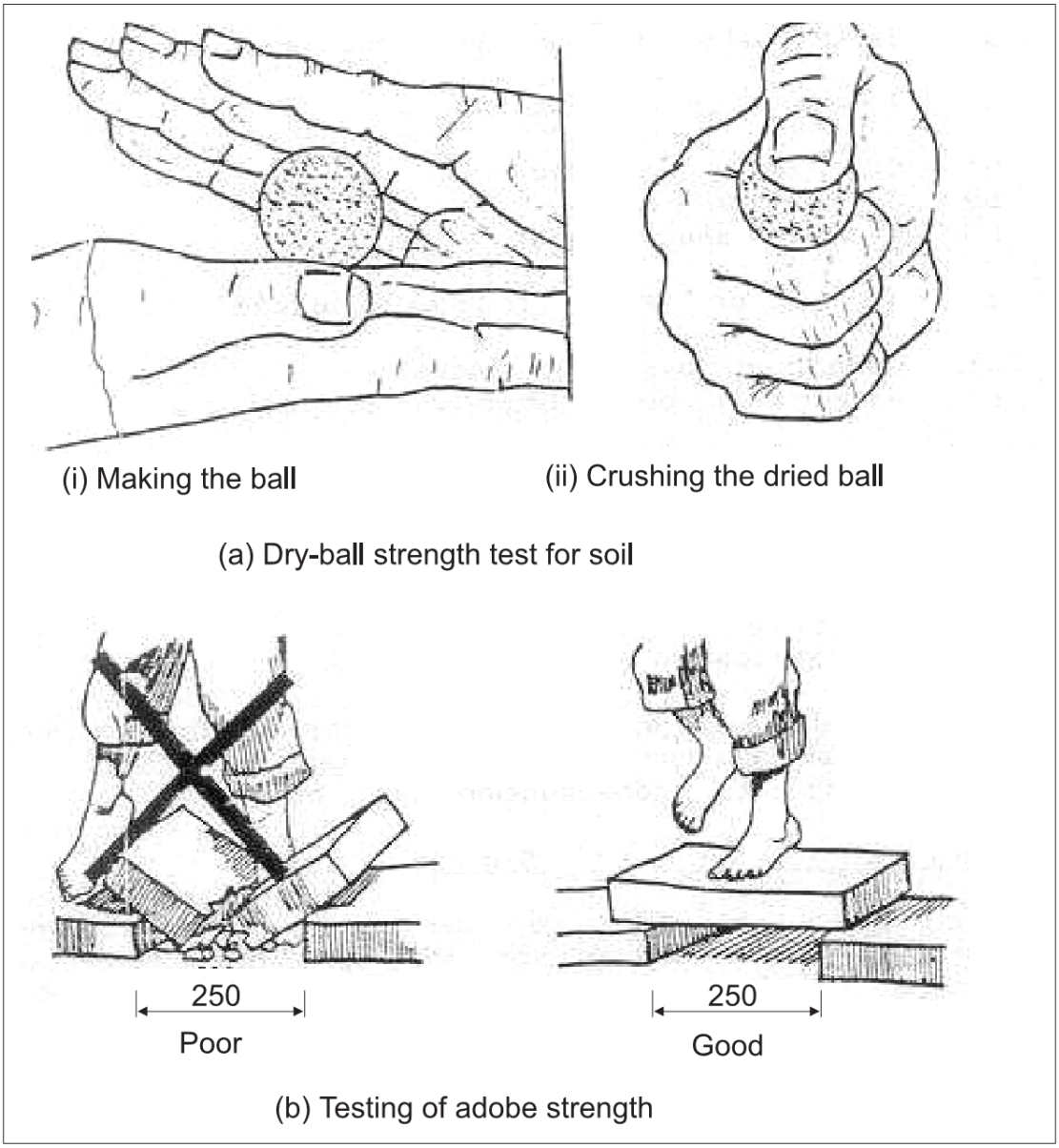


Fig 7.3 Field testing of strength of soil and adobe