Frequently Asked Questions

<u>Question 01:</u>

What is the role of building configuration and opening sizes in seismic design?

<u>Answer:</u>

<u>Building Configuration:</u>

- The extent of damage to a building depends much on the strength, ductility, and integrity of a building and the stiffness of ground beneath it in a given intensity of the earthquake motions.
- Almost any building can be designed to be earthquake resistant provided its site is suitable. Buildings suffer during an earthquake primarily because horizontal forces are exerted on a structure that often meant to contend only with vertical stresses
- An important feature is regularity and symmetry in the overall shape of a building.
- A building shaped like a box, as rectangular both in plan and elevation, is inherently stronger than one that is L-shaped or U shaped, such as a building with wings.
- An irregularly shaped building will twist as it shakes, increasing the damage.

<u>Opening size:</u>

- In general, openings in walls of a building tend to weaken the walls, and fewer the openings less the damage it will suffer during an earthquake.
- If it is necessary to have large openings through a building, or if an open first floor is desired, then special provisions should be made to ensure structural integrity.

<u>Question 02:</u>

What are horizontal and vertical reinforcement in walls and what is their importance?

<u>Answer:</u>

Horizontal reinforcement in Walls

- Horizontal reinforcing of walls is required for imparting to them horizontal bending strength against plate action for out of plane inertia load and for tying the perpendicular wall together.
- In the partition walls, horizontal reinforcement helps preventing shrinkage and temperature cracks. The following reinforcing arrangements are necessary.

Horizontal bands or ring beams:

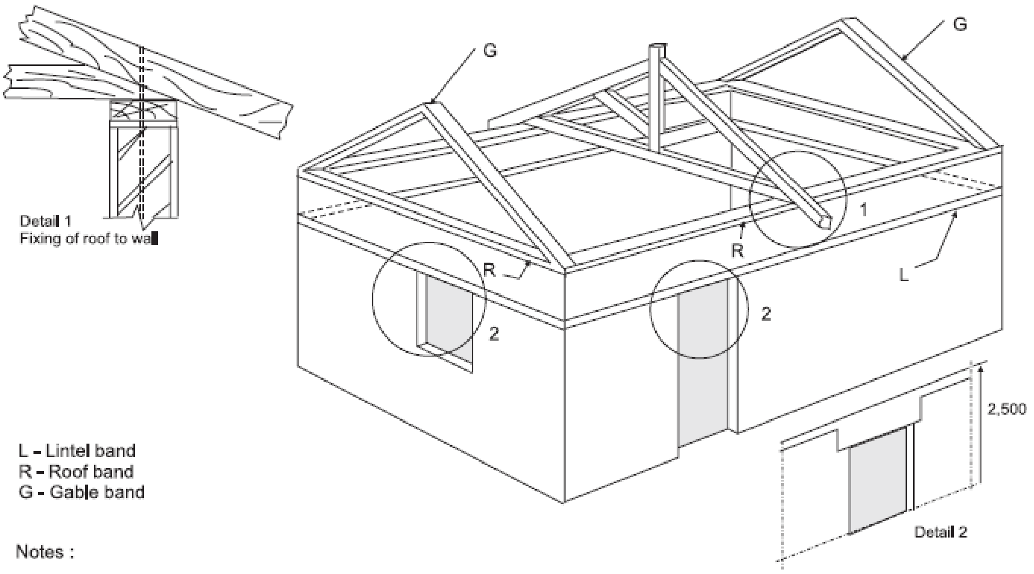
- The most important horizontal reinforcing is through reinforced concrete bands provided continuously through all load bearing longitudinal and transverse walls at plinth, lintel, and roof-eave levels, also at top of gables according to requirements as stated hereunder:

Horizontal bands or ring beams

(i) Plinth band: This should be provided in those cases where the soil is soft or uneven in their properties as it usually happens in hill tracts. It will also serve as damp proof course. This band is not too critical.
(ii) Lintel band: This is the most important band and will incorporate in itself all door and window lintels the reinforcement of which should be extra to the lintel band steel. It must be provided in all storeys.

(iii) Roof band: This band will be required at eave level of trussed roofs, and also below or in level with such floors, which consist of joists and covering elements so as to properly integrate them at ends and fix into the walls.

(iv) Gable band: Masonry gable ends must have the triangular portion of masonry enclosed in a band, the horizontal part will be continuous with the eave level band on longitudinal walls.



Notes :

1 As an alternative to the gable masonry, a truss or open gable may be used and opening covered with light material like sheeting, mat, etc.

2 If the wall height up to eave level is less than or equal to 2.5m, the lintel level band may be omitted and the lintels integrated with the eave level band as shown at detail 2.

<u>Vertical reinforcement in Walls:</u>

- The need for vertical reinforcing of shear walls at critical sections was established. The critical sections were the jambs of openings and the corners of walls.
- The amount of vertical reinforcing steel will depend upon several factors like the number of storeys, storey heights, the effective seismic coefficient based on seismic zone, importance of building and soil foundation type.
- The steel bars are to be installed at the critical sections, that is the corners of walls and jambs of doors right, from the foundation concrete and covered with cement concrete in cavities made around them during masonry construction.
- This concrete mix should be kept 1:2:4 by volume or richer.

<u>Question 03:</u>

What are inertia forces? Elaborate.

<u>Answer:</u>

- Buildings are fixed to the ground. As the base of a building moves the superstructure including its contents tends to shake and vibrate from the position of rest, in a very irregular manner due to the inertia of the masses.
- When the base of the building suddenly moves to the right, the building moves to the left relative the base, as if it was being pushed to the left by an unseen force which we call the Inertia Force.
- Actually, there is no push at all but, because of its mass, the building resists any motion.
- The process is much more complex because the ground moves simultaneously in three mutually perpendicular directions during an earthquake.

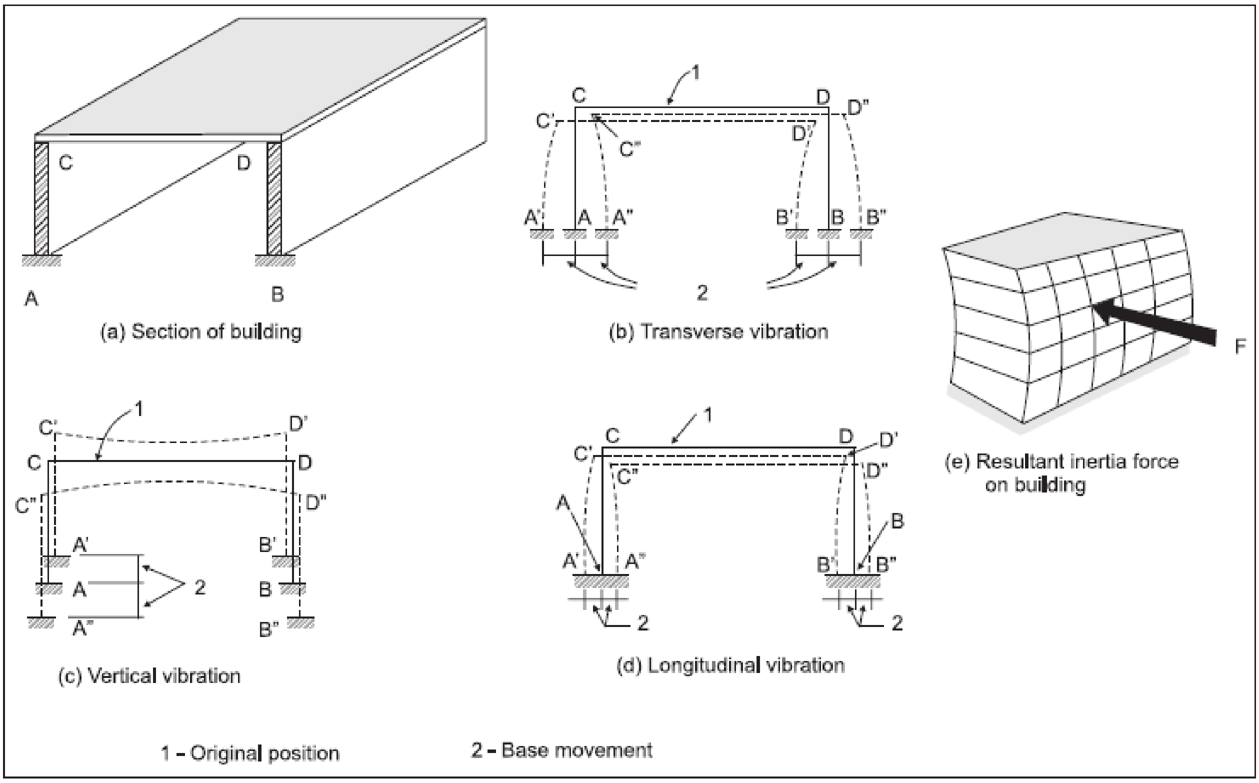


Fig 2.1 Seismic vibrations of a building and resultant earthquake force

Question 04:

What are seismic loads? Discuss in detail.

Answer:

- The resultant lateral force or seismic load is represented by the force F. The force F is distinctly different from the dead, live, snow, wind, and impact loads.
- The horizontal ground motion action is similar to the effect of a horizontal force acting on the building, hence the term, Seismic Load.
- As the base of the building moves in an extremely complicated manner, inertia forces are created throughout the mass of the building and its contents.
- It is these reversible forces that cause the building to move and sustain damage or collapse.
- Additional vertical load effect is caused on beams and columns due to vertical vibrations.
- Being reversible, at certain instants of time the effective load is increased, at others it is decreased. The earthquake loads are dynamic and impossible to predict precisely in advance.

Question 05:

Explain the concept of ductility, deformity and damageability.

Answer:

- Desirable properties of earthquake-resistant design include ductility, deformability and damageability. Ductility and deformability are interrelated concepts signifying the ability of a structure to sustain large deformations without collapse.
- Damageability refers to the ability of a structure to undergo substantial damage, without partial or total collapse.
- This is desirable because it means that structures can absorb more damage, and because it permits the deformations to be observed and repairs or evacuation to proceed, prior to collapse. In this sense, a warning is received and lives are saved.

- Ductility:
- Formally, ductility refers to the ratio of the displacement just prior to ultimate displacement or collapse to the displacement at first damage or yield. Some materials are inherently ductile, such as steel, wrought iron and wood.
- Other materials are not ductile (this is termed brittle), such as cast iron, plain masonry, adobe or concrete, that is, they break suddenly, without warning.
- Brittle materials can be made ductile, usually by the addition of modest amounts of ductile materials, Such as wood elements in adobe construction, or steel reinforcing in masonry and concrete constructions.
- For these ductile materials to achieve a ductile effect in the overall behavior of the component, they must be proportioned and placed so that they come in tension and are subjected to yielding.
- Deformability:
- Deformability is a less formal term referring to the ability of a structure to displace or deform substantial amounts without collapsing.
- Besides inherently relying on ductility of materials and components, deformability requires that structures be well-proportioned, regular and well tied are avoided and forces are capable of being transmitted from one component to another even through large deformations.
- Ductility is a term applied to material and structures, while deformability is applicable only to structures. Even when ductile materials are present in sufficient amounts in structural components such as beams and walls, overall structural deformability requires that geometrical and material instability be avoided.

Damageability:

- Damageability is also a desirable quality for construction, and refers to the ability of a structure to undergo substantial damages, without partial or total collapse.

- A key to good damageability is redundancy, or provision of several supports for key structural members, such as ridge beams, and avoidance of central columns or walls supporting excessively large portions of a building.

- A key to achieving good damageability is to always ask the question, if this beam or column, wall connection, foundation, etc. fails, what is the consequence?

- If the consequence is total collapse of the structure, additional supports or alternative structural layouts should be examined, or an additional factor of safety be furnished for such critical members or connections.