PART-B

Earthquake Resistant construction :-

* Earthquake :-

→ It is the vibration of earth produced by the rapid release of accumulated energy from the source (focus)

↳ It is usually cause when rock under ground suddenly breaks along a fault.

↳ This sudden release of energy causes seismic waves, that make the ground shake.

* Effects of earthquake :-

1. Shear failure
2. Twisting effecting
3. In foundation
4. vertical faces
5. Make the structure crack & failure.

(c) Building Configuration :-

1. In order to minimize torsion and stress concertration, provision given in (2) to (4) should be complied with as relevent.

2. The building should have a simple rectangular plan and by symmetrical both with respect to mass and rigidity so that the centres of mass and rigidity of the building coincide with each other in which case no separation section other than expansion joints are ~~necessary~~.

(3) If symmetry of the structure is not possible in plan, elevation or mass, provision shall be made for torsional and other effects due to earth quake forces in the structural design or the parts of different rigidities may be separated

through crumple section. the length of such building between separation sections shall not preferably exceed three times the width.

(4) Building having plans with shapes like L, F, E, & 'y' shall preferably be separated in to rectangular parts by Providing separation section at appropriate places the building with small lengths of projections forming L, F, E or y shapeneed not be provided with separation section

In such causes the length of the projection may not exceed 15 to 20% of the total dimension of the building in the direction of the projection. similarly for buildings with minor asymmetry in plane elevation separation sections may be omitted.

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*. Strength of various directions:—

The structure shall be designed to have adequate strength against earth quake effect along both.

the near axes. The design shall also be safe considering the reversible nature of earthquake forces.

*. Foundations:

The structure shall not be founded on such loose soils which will subside or liquefy during an earthquake resulting in large differential settlement

Ductility:-

The main structural elements & their connection shall be designed to have a ductile failure. This will enable the structure to absorb energy during earthquakes to avoid sudden collapse of the structure providing reinforced steel is masonry is equitical.

Damage to Non-structural Parts:-

Suitable details shall be carried out to connect the non-structural parts with the structural framing so that deformation of the structures

frame leads to min. damage of the non-structural elements.

Fire safty:

Fire frequently follows an earthquake and therefore, buildings shall be constructional to make them fire resistant.

3. Building characteristic :-

The general principle in 1 to 9 shall be observed in construction of earthquake resistant building.

1. Lightness :-

Since the earth equake force is a function of mass, the building shall be as light as possible consistent with structural safety and functional requirement. Roofs upper storeys of building in particular, should be designed as light as possible.

2. Continuity of construction :-

(i) It's for as possible, the part of the building should be tied together in such a manner that the building act as one unit.

(ii) For parts of building between separation or example sectional

or expansion joints, Flear slabs shall be continuous throught as for as possible. concrete slabs shall be rogidly connected ore integreally cast with the support beams.

(iii) Additions and alterations to the structures shall be accompanied by the provision of separation or example sections between the new and the existing structures as for as possible, unless positive measure are taken to establish continuty between the existing and new construction.

3. Projecting and suspended parts:

Projecting part shall be avoided as for as possible. If the projecting part cannot be avoided they shall be properly reinforced firmly tied to the main structure and their design shall be in accordance with IS 1893: 2002.

(ii) ceiling plaster shall preferably be avoided when it is unavoidable the plaster shall be as thin as possible.

(iii) Suspended ceiling shall be avoided as far possible where provided they shall be light, adequately framed and secured :-

4. Building configuration
5. Strength in various Directions
6. foundations.
7. Ductility
8. Damage to Non-structural part:-
9. Fire Safty

* An earthequake resistant building has the following four virtues:-

(1) Good structural configuration:-

It's size, shape and structural system carrying load are such that they ensure a direct and smooth flow of inertia force to the ground.

② Lateral Strength :-

The maximum lateral shear force that it can resist is such that the damage induced in it does not result in collapse.

③ Adequate Stiffness :-

It's lateral load resisting system is such that the earthquake induced deformation in it do not damage its contents under low to moderate shaking.

④ Good Ductility :-

It's capacity to undergo large deformation under severe earthquake shaking even after yielding strategies.

* Lintel band :-

It is a band provided at lintel level on all load bearing internal external, longitudinal and cross wall the specification of the band are given below :-

* Selection and reinforcement of all band :-

The band shall be made of reinforced concrete brick work eg cement mortar not leaner than 1:3 the band shall be of the full width of the wall not less than 75 mm in depth and reinforced with steel as indicated the following table

Sl no (1)	Building (category (2)	No. of storey (3)	Reinforcement to be provided in all storey (4)
1	B	(i) I to 3 (ii) 4	a, b, c, f, g a, b, c, d, f, g
2	C	(i) 1 & 2 (ii) 3 & 4	a, b, c, f, g a to g
3	D	(i) 1 & 2 (ii) 3 & 4	a to g a to h
4	E	1 to 3	a to h

Where,

a = masonary mortar

b = Lintel Band

c = Roof band & gable band

d: vertical steel at corners and junctions of walls

e: Vertical steel at jambs of openings.

f = Bracing band where necessary &

h = Dowel bars

b Lintel band is provided in panel or partition wall also will improve their stability during severe earthquake

② Plinth band :-

It is a band provided at plinth level of walls on top of the foundation wall. This is to be provided where strip footings of masonary other than reinforced concrete or reinforced masonary are used & the soil is either soft or uneven in its properties

as frequently happens in hill roads where used, its section may be kept same as 11 course. This band will serve as damp proof course as well.

③ Roof band:-

It is a band provided immediately below the roof or floors. The specification of the band are given in L-table such a band need not be provided under reinforced concrete or brickwork slab resting on bearing walls provided that the slabs are continuous over the intermediate wall upto the crumple sections if any & cover the width of end work full or at least 3/4 of the wall thickness.

④ Gable band:- It is a band provided at the top of gable masonary below the purlins the specifications of the band

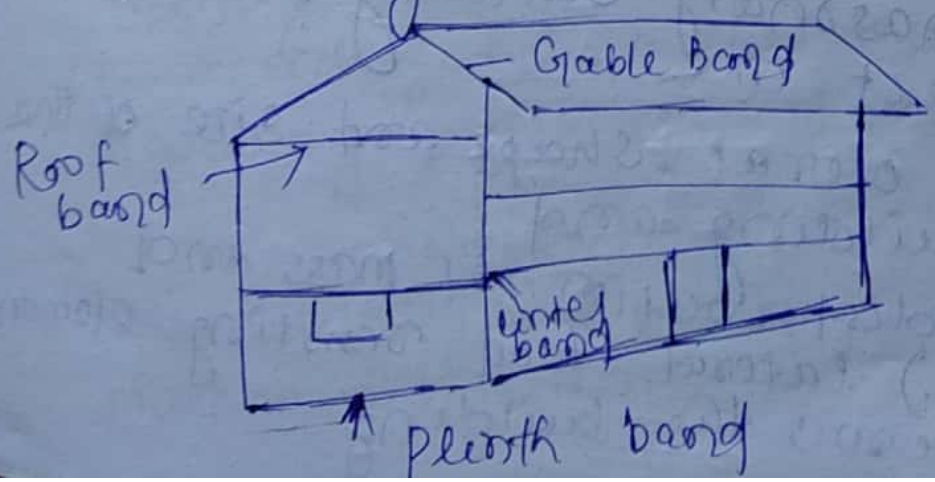
are given in 'I'-table This band shall be made continuous with the roof band at the eaves level.

Why are horz band are necessary in masonary building?

Role of horz bands: Horz band are the most important earthquake resistant feature in masonary building

↳ The band are provided to hold a masonary building as a single unit by tying all the walls together & are similar to closed belt provided around cardboard boxes.

↳ There are 4 types of band in typical masonary building, namely gable band, roof band, lintel band plinth band named after their location of building.



* Why should masonary building have simple structural configuration.

1. Box action in masonary buildings :-

↳ Brick masonary buildings have large mass and hence attract large horizontal forces during earthquake shaking.

↳ They develop memercoes creaces. under both compressive and tensile forces caused by earth quake shaking.

↳ The focus of earth quake resistant masonary building construction is to ensure that these effect are sustained without major damage or collapse.

↳ Approximate choice of structural configuration can help achieves this.

↳ The structural configuration of masonary building includes aspect like

(a) overal shape and size of the building and

(b) distribution of mass and (horz.) lateral load resisting element across the building.

↳ large, tall, long and unsymmetric buildings perform poorly using earth quake.

↳ A strategy used in making them earth quake resistant is develop good box action between -ing all the elements of the building i.e between roof, walls and foundation.

↳ Loosely connected roof to unduely slender wall threats to good seismic behaviour.

↳ For example, a horizontal band ~~introduce~~ produce at the lintel level ties the wall together and helps to make them behave a single unit

4. Influence of Openings

Openings are functional necessities in building

↳ However, location and size of opening wall assume significance in deciding the performance of masonary building in earthquake

↳ To understand this, consider a four wall system of a single storey masonary building

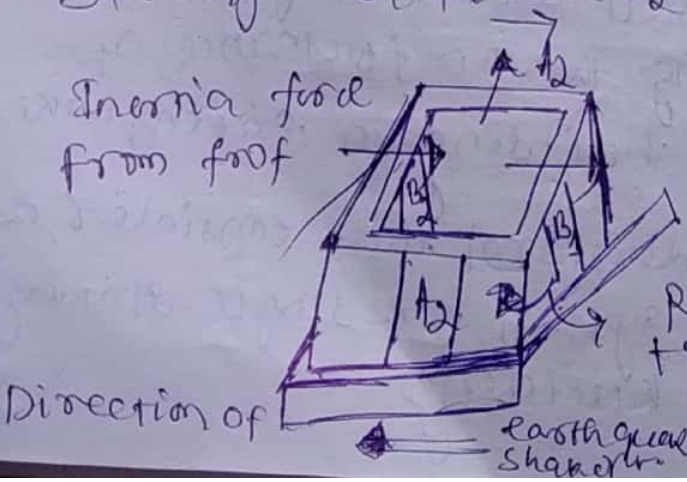
↳ During earthquake shaking, inertia forces act on the strong direction of some walls and/or the weak direction of other.

↳ Walls shaken in the weak direction seek support from the other wall i.e wall B_1 and B_2 seek support from walls A_1 and A_2 for shaking in the direction shown in figure.

↳ To be more specific wall B_1 pull wall A_1 and A_2, while wall B_2 pushe against them.

↳ At the next instance, the direction of shaking could to the horz. direction perpendicular to that shown in fig.

↳ Then wall A to B change their roles, walls B_1 & B_2 becomes the strong and A_1 and A_2 weak.



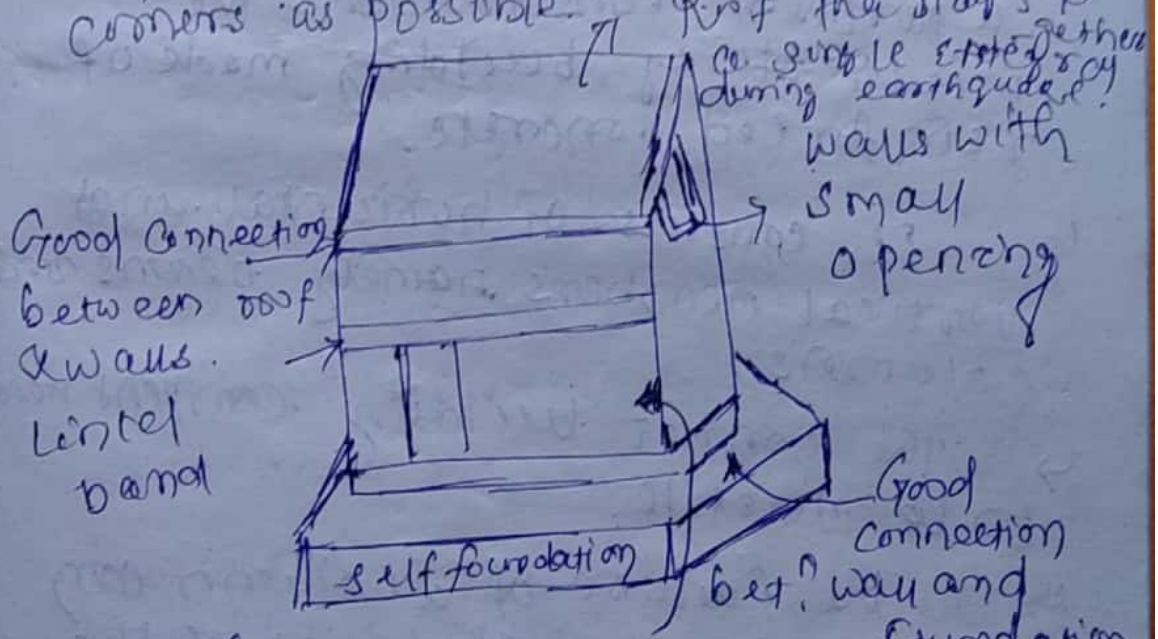
↳ Thus load transfer occurs from the Aterial (the masonary walls meeting of corners must have good interlocking.

↳ Thus walls transfer load to each other at their junctions & through the lintel bands and roof)

↳ For this reason openings near the wall corner are detrimentary to good seismic performance.

↳ Opening too close wall corners hamper the Flow of forces from one wall to another.

↳ Further, Larger openings as small as possible and as far way from the corners as possible.



Good connection of wall corner

A box action in masonary buildings
(Essential requirement to ensure fig Box in masonary buildings)

are small, say up to 15-20% of the length of building in that direction.

↳ Inclined staircase in masonary building offer another concern.

↳ An integrally connected staircase slab acts like a cross breeze between floors and transfer large horizental forces at the roof and lower level.

↳ These are areas of potential damage in masonary buildings if not accounted for in staircase design and construction.

↳ To overcome this, sometimes staircases are completly separated & built on a separate reinforced concrete structure.

↳ Adequate gap is provided bet? staircase tower & the masonary buildings to ensure that they do not pound each other during strong earthquake shaking.