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General Provisions as per IS code 1893-2002 in Earthquake Resistant Buildings

Importance :-

Ground vibrations during earthquakes cause forces and deformations in structures. Structures need to be designed to withstand such forces and deformations.
Earthquake or seismic codes help to improve the behavior of structures so that they may withstand the earthquake effects without significant loss of life and property.
Countries around the world have procedures outlined earthquake codes to help design engineers in the planning, designing, detailing and constructing of structures.

An earthquake resistant building has four virtues in it, namely —

a) Good structural configuration —
Its size, shape and structural system carrying loads are such that they ensure a direct and

smooth flow of inertia forces to the ground.

b) Lateral strength :-
The maximum lateral (horizontal) force that it can resist is such that the damage induced in it does not result in collapse.

c) Adequate stiffness :-
Its lateral load resisting system is such that the earthquake - induced deformation in it do not damage its contents under low to moderate shaking.

d) Good ductility -
Ductility means the ability to sustain significant inelastic deformation before collapse.
A ductile material gives sufficient warning before collapse - thus saving many lives.

Indian seismic (Earthquake) Codes -
Seismic codes are unique to a particular region or country. They take into

account the accepted level of earthquake risk, building topologies and materials and methods used in construction.

IS 1893 :- IS 1893 is the main code that provides the seismic zone map and specifies seismic design force. This force depends on the mass and seismic coefficient of the structure.

IS 4326 ; 1993 :- This code covers general Principles for earthquake resistant buildings. Selection of materials and special features for design and construction are deal with for the following types of buildings such as

- timber constructions
- masonry constructions using rectangular masonry units
- Buildings with prefabricated reinforced concrete roofing / flooring elements.

IS 13827 , 1993 :- Guidelines in IS 13827 , 1993 deal with empirical design

and construction aspects for improving earthquake resistance of earthen houses and buildings of low strength masonry.

IS 13920, 1993 :-

In India, reinforced concrete structures are designed and detailed as per the Indian code IS 456 (2002). However, structures located in high seismic regions require ductile design and detailing. Provisions for the ductile detailing of monolithic reinforced concrete frame and shear wall structures are specified in IS 13920 (1993).

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Ductile Detailing of Reinforced Concrete Buildings :-

Introduction :-

One of the most important property which an earthquake resistant structure must have is ductility.
A ductile material is the one which can undergo large elongations (strains) while resisting loads. Ductility means the ability to sustain significant inelastic deformations before collapse.
Ductile material gives sufficient warning before collapse thus saving many lives.
To have sufficient ductility, the designer should pay attention to detailing of reinforcement. Provision for ductile detailing in the members of reinforced concrete buildings are given in IS: 13920: 1993 titled "Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic forces".

Codal Provisions of IS: 13920: 1993.
OR
General Specifications :-

Specifications →

* To develop the required bond strength and to protect the reinforcement against corrosion, cover to reinforcement is provided.

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* The design and construction of reinforced concrete buildings shall be governed by IS : 456 : 2000
* for all buildings which are more than 3 storeys in height, the minimum grade of concrete shall be m20.
* steel reinforcement of grade Fe 415 or less shall be used.

Ductility Requirements in Buildings :

Ductility can be defined as the ability of material to undergo large deformation without rupture before failure.
Each design code recognizes the importance of ductility in design because if a structure is ductile, its ability to absorb energy with critical failure increases. Ductility behavior allows a structure to undergo large plastic deformations with little decrease in strength.
In general, ductility is increased by
* An increase in compression steel content.
* An increase in concrete compressive strength
* An increase in ultimate concrete strain.

~~And~~ Ductility is decreased by —
* An increase in tension steel content.
* An increase in steel yield strength.
* An increase in axial load.

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Necessity

~~Necessity~~ of Ductile Detailing :-

Ductile detailing is provided in structures so as to give them adequate toughness and ductility to resist severe earthquake shocks without collapse.

Ductile detailing is provided for the following structures.

i) The structures are located in seismic zone IV and V.
ii) The structure is located in seismic zone III and is an industrial structure.
iii) The structure is located is seismic zone III and is more than 5 storey high.

Ductility Criteria for Earthquake Resistant Buildings

The Performance criteria in most earthquake code Provisions require that a structure be able —

* Resists of earthquakes of minor intensity without damage
* Resists moderate earthquakes with minor structural and some non-structural damage.
* Resists major catastrophic earthquake without collapse.

Hazard Resistant Construction

(1) Symmetry eccentric loading –

A load or force upon a ~~force~~ portion of a column or pile not symmetric with its central axis, thus producing bending.

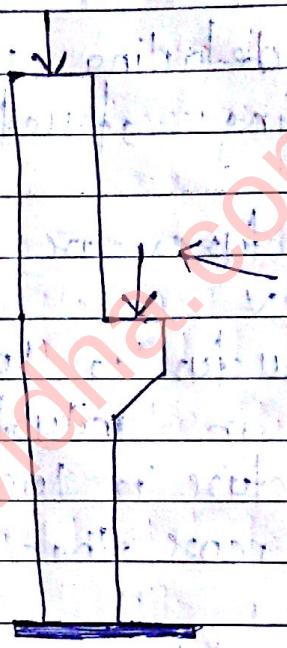

Fig- eccentric load

(2) Framed Structures :-

This type of structure is suitable for multistoried buildings and industrial buildings.

They may consist of –

(1) Light framing member which must have diagonal bracing such as wooden frames or walls for lateral load resistance.
Steel multistoried building or industrial frames are of two type

(2) The rigid or semi rigid jointed frames – These frames are of reinforced concrete or steel. The walls are also rigid and may be of reinforced concrete or of reinforced brick work.

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Building Configuration OR Simple Configuration —

The behaviour of building during earthquake depends on its shape, size and geometry. A good building configuration can result in less damage during earthquakes. The various components of building configuration are given below —

(1) Symmetry — The building as a whole or its various blocks should be kept symmetrical about both the axis.

(2) Simplicity and Regularity — The building should have a simple rectangular plan.

(3) Simple building without much projections and suspended parts behave well during earthquake

(4)

(5) Size of the building — Buildings with one of their dimension much larger or smaller than the other two do not perform well during earthquakes. Thus the buildings length should not be more than three times its width. If longer lengths are needed to separate blocks with separation should be provided.

Shear wall :-

Reinforced concrete (RC) buildings have vertical plate like RC walls called shear walls in addition to slabs, beams and columns. These are like wide beams which are vertically placed. These walls start at foundation level and are continuous through out the building height. Their thickness can be as low as 150 mm or as high as 400 mm in high rise buildings. ~~Properly designed and detailed RC~~ These are provided in multistoried buildings.

Properly designed and detailed RC buildings with shear walls have shown very good performance in past earthquakes.

* The provisions for design of shear walls are given in IS 13920 : 1993 and given :-

* shear walls should be provided along both length and width.
* Door or windows openings may be provided in shear wall but they should be small in size and symmetrically located.
* shear walls in buildings must be symmetrically placed.
* steel bars should be provided in vertical and horizontal grids in shear walls.