Keeping in view the past earthquakes, explain various reasons of failure of RCC framed buildings. ①

A large number of reinforced concrete multistoreyed frame buildings were heavily damaged and many of them collapsed completely in the past Earthquakes like in Bhuj earthquake of 2001 etc.

☆ Various Reasons of Failure of RCC Framed Buildings

1. Ignorance of Architects and Structural Engineers about the contents of the relevant earthquake resistant Building codes like IS 456, IS 875, IS 1893, IS 4326, IS 13920 etc.

2. Softness of Base Soil

(i) Amplification of the ground motion at the base of the building

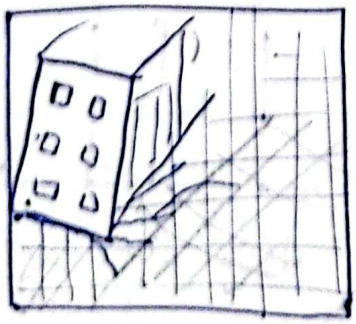
(ii) Absence of ~~raft or piles~~ foundation raft or piles

(iii) Relative displacement between the individual column foundations vertically and laterally, in the absence of either the foundation structs or the plinth beams,

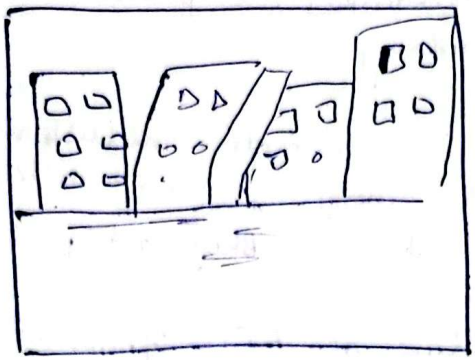
(iv) Resonance, or semi-resonance of the whole building with the long period ground waves.

(v) In the absence of the beams at plinth, or ground level, the length of ground storey column gets increased, which increases the flexibility of the ground storey and thus increases the ~~chance~~ chance of buckling.

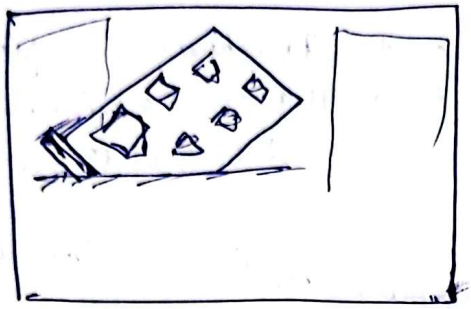
(vi) If the soil is sandy and water table is high, it may liquify. Thus, the liquefaction of soil may have adverse effects.



The Building sank due to soil liquefaction. The displaced soil caused a bulge in road.



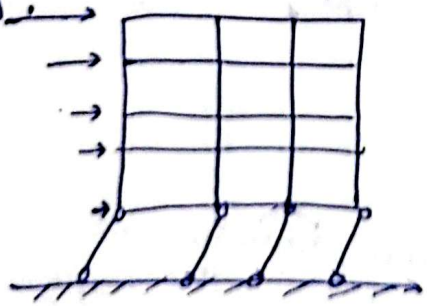
Inclined building sank unevenly and leans against a neighbouring building



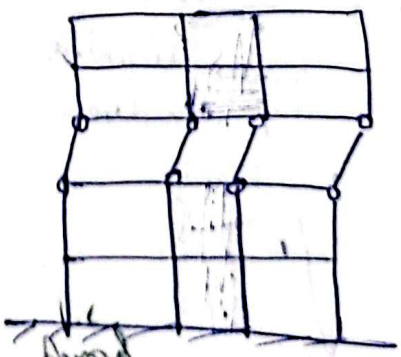
The solid building tilted as a rigid body and raft foundation rises above the ground

③ SOFT-FIRST STOREY. : Soft-first storey is the open ground storey. It is also called stilt floor. & ~~(stilt floor) used in most cases severely damaged or collapsed R.C. buildings introduced~~ severe irregularity & sudden change of stiffness between the ground storey and upper storeys since they have infilled brick walls which increases the lateral stiffness of the frame by a factor of 3 to 4 times.

Such a building is called a building with 'soft ground storey'.



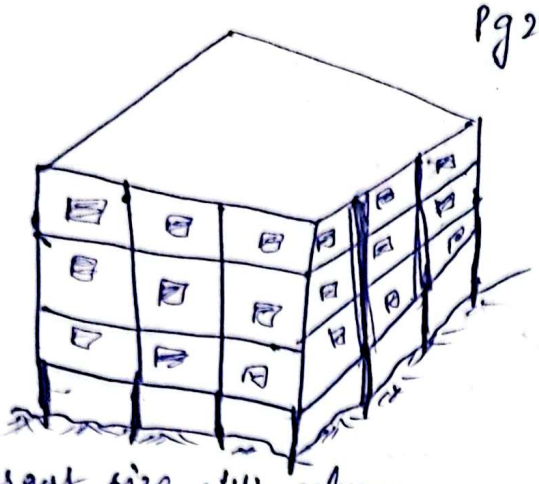
Avoid Soft-storey Ground Floors.



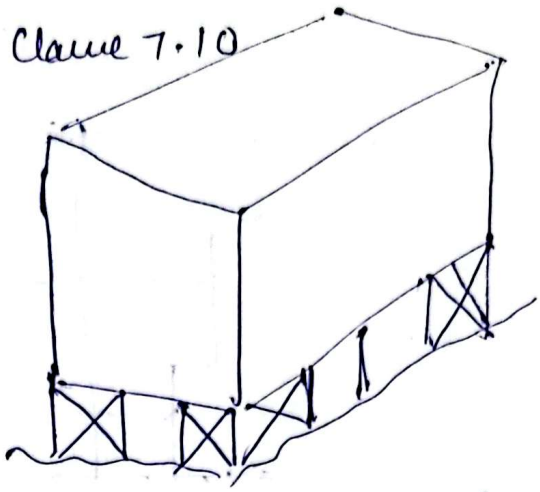
Avoid soft-storey upper floors.

Recommendations

Pg 27. Clause 7.10

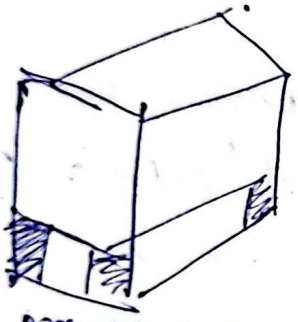


largest size stiff columns

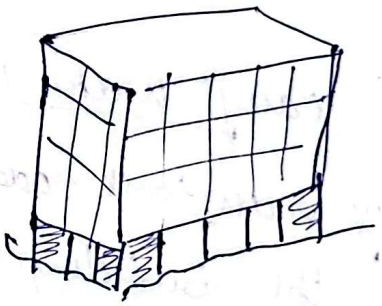


Bracings in the columns of open ground storey

Remedial measures for Soft Storey



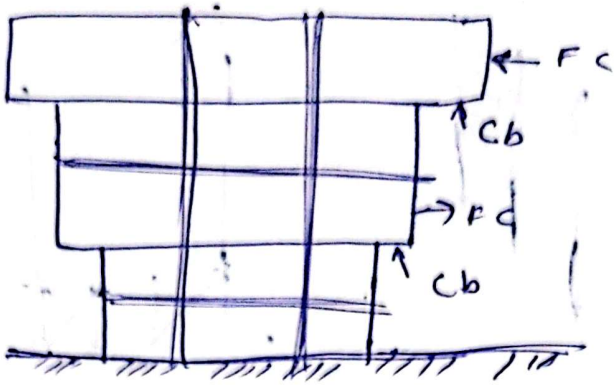
providing R.C. Shear wall



Providing Brick infills b/w columns

(4) **Bad Structural System**

The structural system adopted using floating columns is very undesirable in earthquake zone of moderate to high intensity as in zone III, IV, & V, since it will induce large vertical earthquake forces even under horizontal earthquake ground motion due to overturning effects.

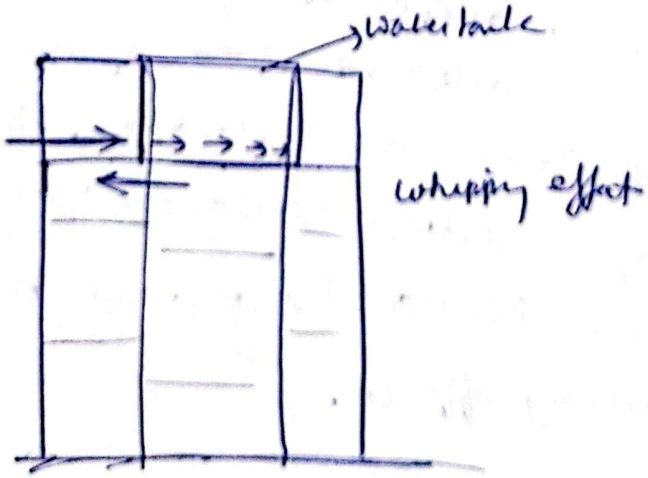


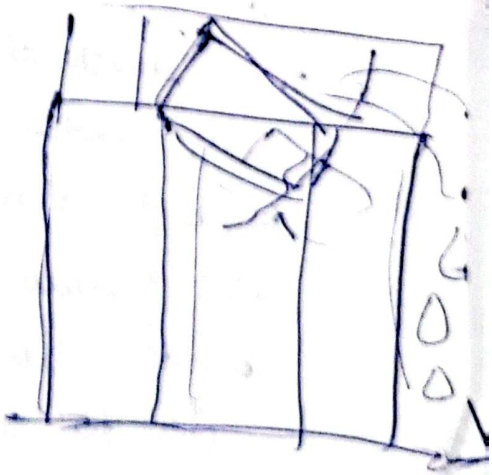
Fc Floating column
Cb - Cantilever Beams

(* write more from Pg 18. Irregularity Type & diagram from Pg 15, 20)

5) **Heavy Water Tanks on the Roof**

Heavy water tanks add large lateral inertial forces on the building frames due to the so called "whipping effect" under seismic vibrations, but remain unaccounted for in the design.



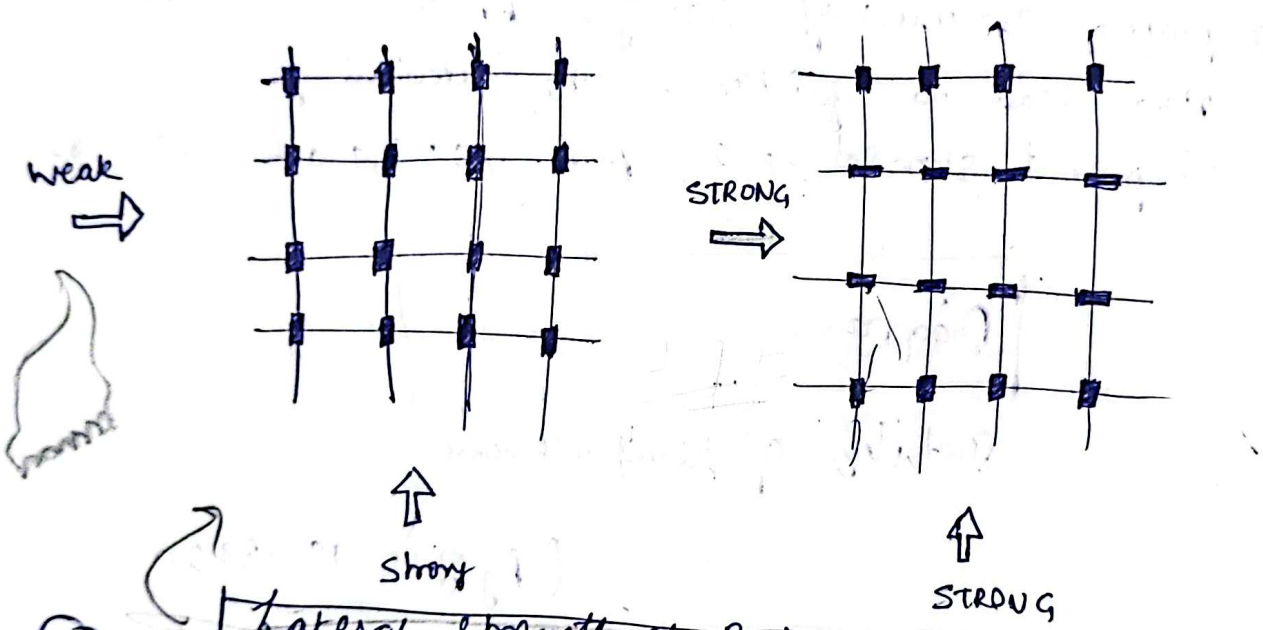


Lack of Earthquake resistant Design

The buildings are not designed for earthquake forces as per IS 1893. Many a times, the structural designers ignored the seismic forces in design.

- most of the buildings designed against lateral load in transverse direction, collapse in the longitudinal direction.

- The figure below shows the proper arrangement of columns which would give adequate seismic resistance along both axes of the building.



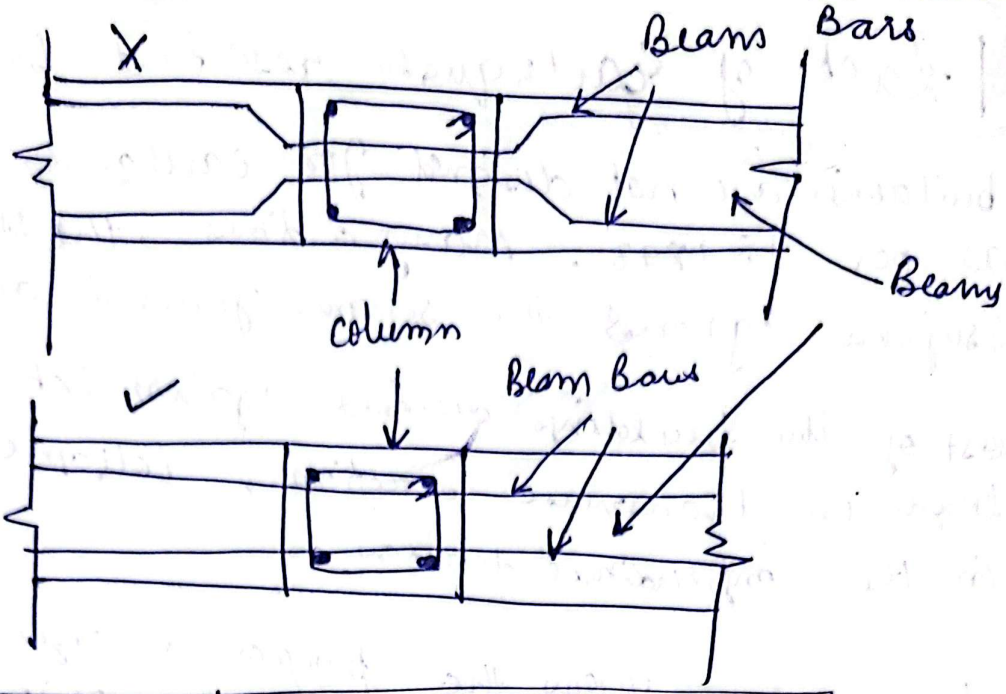
Lateral strength of Building frame

Top

~~The inadequate detailing point of view,~~ inadequate structural dimensioning of beams & columns & improper installation of reinforcement in Beam-column joints is another reason of failure.

Improper Dimensionings of Beams & Columns

... procedure



9.//

(8) **Improper Detailing of Reinforcement**

Improper detailing of reinforcement in the column, also leads to failure. The detailing of reinforcement should be as per IS: 13920 & IS-456.

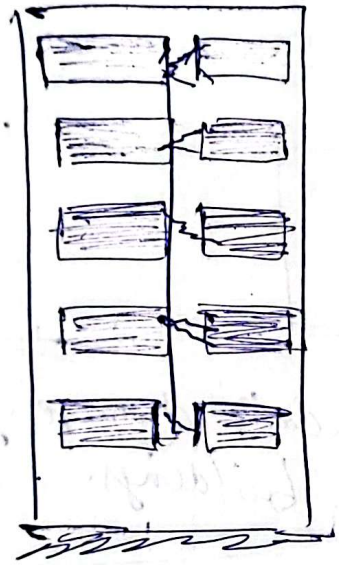
Diagram.

Detailing of reinforcement

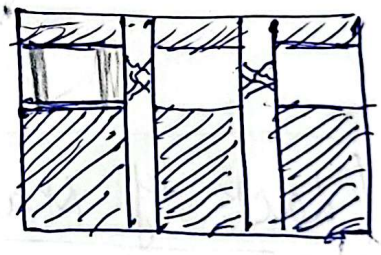
(Pg 7 IS 13920)

~~Detailing~~

9. **Short column Detailing** In some situations the column is surrounded by walls on both sides such as upto the window sills and then in the spandrel portion above the windows, but it remains exposed in the height of windows. Such a column behaves as a short column under lateral earthquake loading where the shear stresses become much higher than normal length columns and fails in shear..

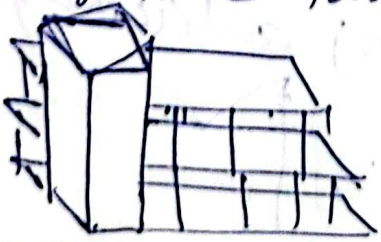


Damage to buildings due to short column effects on columns



10. **Torsional failure**

Torsional failure are seen to occur when the symmetry is not planned in the location of the lateral structural elements. Large torsional shears are caused in building columns causing there torsional shear failure.



Unsymmetrical building

(write from IS1893. Draw diagrams pg 18, 19)

(11) Pounding damage of Adjacent buildings

Severe damage leading to collapse are been due to severe impact b/w 2 adjacent buildings under earthquake shaking.

(write from IS4326 pg 21)

Pounding damage of adjacent buildings

(12) Lack of stability of Infill walls

The infill walls are sometimes not properly attached either to column or the top beams for stability against out of plane bending under horizontal eqn earthquake forces. This leads to widespread falling and cracking

(3.) Poor Construction Quality.

- Another reason for failure can be the improper construction quality of the R.C. buildings e.g. bad quality of concrete in the columns, inadquate cover of reinforcement ~~etc~~., poor quality sand ~~& aggregates~~.
  - improper quantity of cement in mix
  - improper mixing of all ingredient
  - inadequate curing before striking the form work.