COMPARATIVE STUDY OF SEISMIC PERFORMANCE OF IRREGULAR RC BUILDING USING ETABS 2018 SOFTWARE.

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ABSTRACT

Vibration of ground surface due to rapid launch of electricity from earth's lithosphere gives rise to seismic waves and the phenomenon is known as earthquake. Earthquake has very harsh effects on lifestyles and assets. response of multi storey systems in the course of seismic activity relies upon on structural alignment. Irregularity either in plan or in elevation is one in every of primary reasons for failure of the shape. irregular systems placed in earthquake zones are a matter of first-rate difficulty. buildings typically own combination of irregularities. due to irregularities, structures may also in part or absolutely fall apart as they cannot face up to seismic pressure because of demand earthquake. The cutting-edge layout process stops at call for earthquake, analysis and design and therefore can't assure that the building meets targets at the beginning, therefore the clothier's technique has to be performance-based totally design. The modern-day observe stresses on sporting out overall performance based totally seismic layout for RCC structures for mixture of irregularities for horizontal and vertical irregularities and examine the overall performance of 10 storey residential condo building positioned in quarter three. The structure is designed as in step with IS 456-2000 and Earthquake examination is conducted by using dynamic analysis which includes response spectrum, time history and non-linear pushover analysis the use of ETABS 2018 software program. Pushover evaluation is done the use of default hinges for beams and columns. The reaction of the constructing is studied in phrases of pushover curve, safety ratio, ductility ratio, storey displacement & storey float.

Keywords: Irregularity, Demand Earthquake, Safety Ratio, Ductility ratio, storey displacement & storey float.

1. INTRODUCTION.

Vibration of ground surface is the cause for abrupt liberation of energy from outer most part of earth's surface gives rise to seismic waves and the phenomenon is called earthquake. Earthquake is a natural hazard and has harsh effects on life and property. Earthquakes are mainly due to two reasons, instigation by tectonic activity and volcanic eruptions. When the ground surface shakes below building foundation, the structure quaver along with neighboring earth's surface which may result in part or absolute debacle of the structure. Generally high-rise buildings are more susceptible to seismic activity than shorter buildings. Study of earthquake and seismic waves are called seismology. There are three kinds of seismic waves which are caused during seismic activity, primary waves & secondary waves and third is caused due to association of primary & secondary waves. Seismograph or Seismometer is instrument used to measure seismic waves. Seismograph & Seismometer creates the seismogram. P waves are the first waves to reach the seismogram followed by S waves. Charles Richter in 1932 wasthe first person to device the magnitude scale for measuring earthquake size and is namedafter him as Richter scale. Earthquake has a point from where seismic waves are generated and it is called epicentre. To locate epicentre, we need at least three seismic stations, P & S wave's helps to determine the location of epicentre. Buildings may be symmetric or asymmetric according to their plan, architecture and functionality, Buildings symmetric in plan and elevation is more capable in resisting earthquake loads, but buildings with irregular allocation of mass, stiffness & geometry of structure are highly susceptible to seismic activity, therefore such buildings are called irregular structure. Irregularities in building plans or heights are one of the causes of structural failure. Structures generally have combination of irregularities.

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Two kinds of irregularities are:

- **Horizontal Irregularities.**
- **Vertical Irregularities.**

1.1 Plan or Horizontal Irregularities: There are five kinds of Plan Irregularities.

a) Torsional Irregularity: Exists while the most horizontal displacement of the floor slab at one end of the floor exceeds 1.5 times, the minimum displacement within the direction of seismic force at the opposite of the same ground.

b) Re-entrant Corner: If the plan of the structure has a structural direction, the projection will exceed 1.5% of the total dimensions of the plan.

c) Floor Slab having Excessive Openings: This is existed if floor slabs have cut-out or openings greater than 50% of complete floor slab.

d) Out of Plane Offsets in Vertical factors: They are said to exist when a building has bearing walls or frames that are displaced from any floor plan along the height of the structure.

e) Non parallel Lateral Force System: This condition is said to be present when vertically aligned structural systems opposing earthquake forces are not aligned along ‘X’ & ‘Y’ direction.

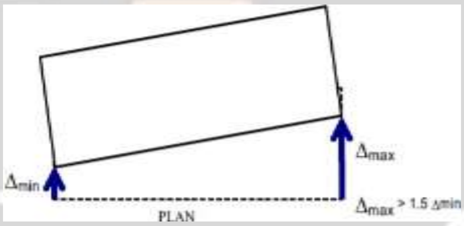


Figure 1.3 Floor plan having torsional irregularity

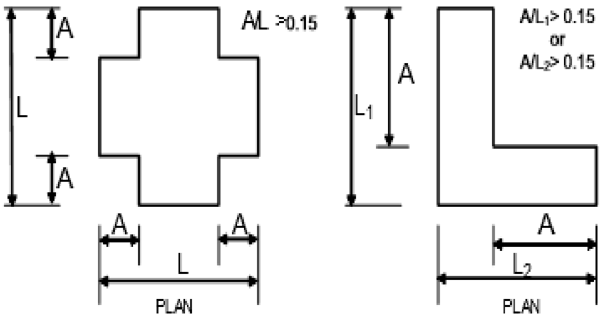


Figure 1.4 Re-Entrant Corners (IS 1893 part 1 2016)

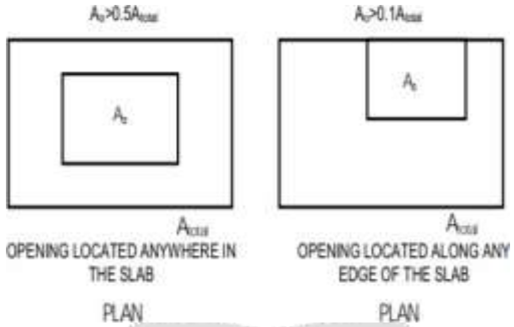


Figure 1.5 Excessive Cut – Out and Openings in Floor Slabs (IS 1893 part 1 2016)

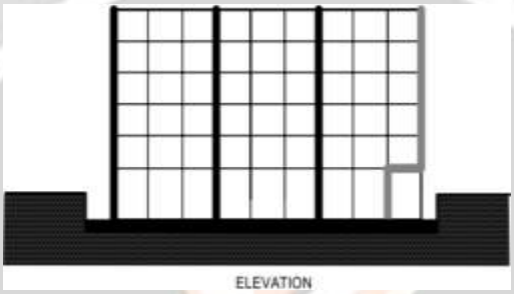


Figure 1.6 Vertical elements having Out-Of-Plane Offsets (IS 1893 part 1 2016)

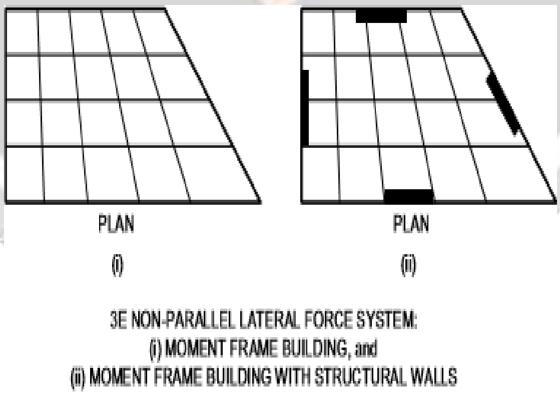


Figure 1.7 Non –Parallel Lateral Force Systems (IS 1893 part 1 2016

Vertical Irregularities:

f) Mass Irregularity: When a floor of a structure has seismic weight greater than 150 % of the floor beneath that.

g) Vertical Geometric Irregularity: If the horizontal measurement of earthquake
h) resisting systems of ground is decrease than 125
i) % of the floor underneath.
j) **C)** In-Plane discontinuity in Vertical members resisting lateral pressure: These conditionsare said to be present, when in plane offset of seismic force resisting member is extra, than 20% length of those members.

k) Strength Irregularity: When the lateral strength is lower than the floor above than this condition is said to be exist.

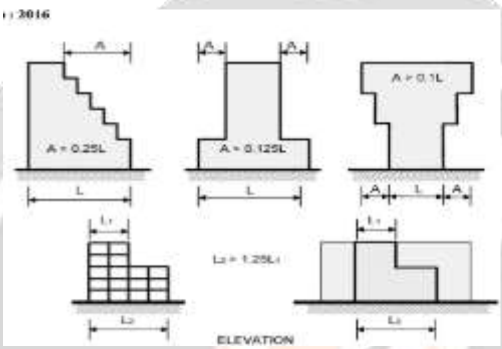


Figure 1.8 Multi storey structure having stiffness irregularity (IS 1893 part 1 2016)

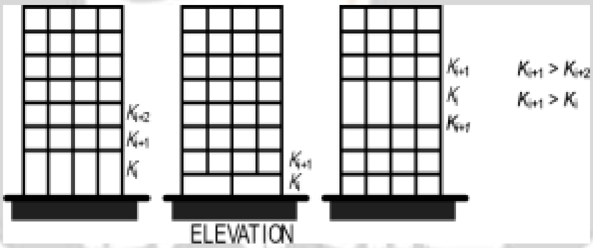


Figure 1.9 Multi storey structure having mass irregularity (IS 1893 part 1 2016)

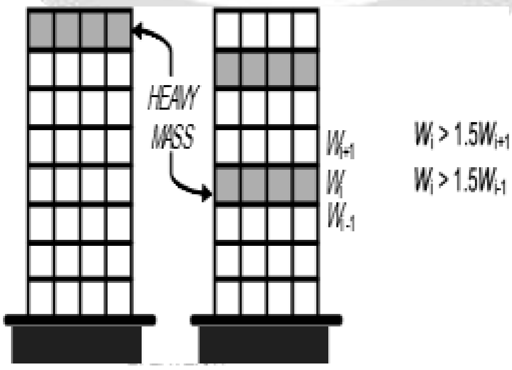


Figure 1.10 Patterns of geometric irregularities (Vertically) (IS 1893 part 1 2016)

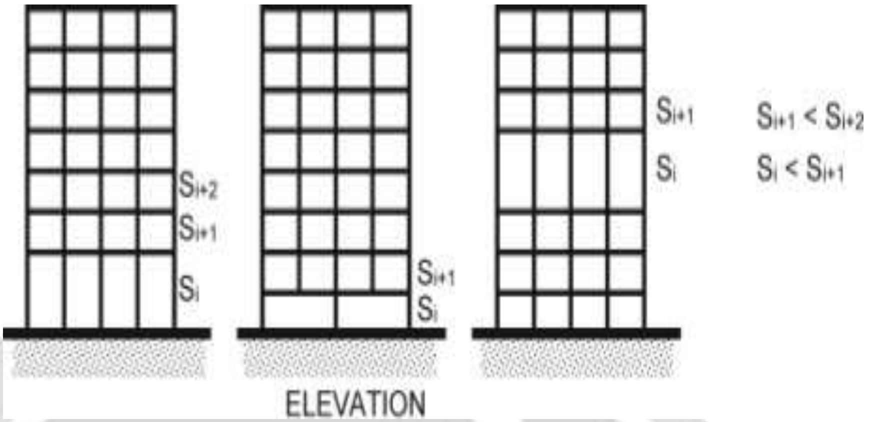
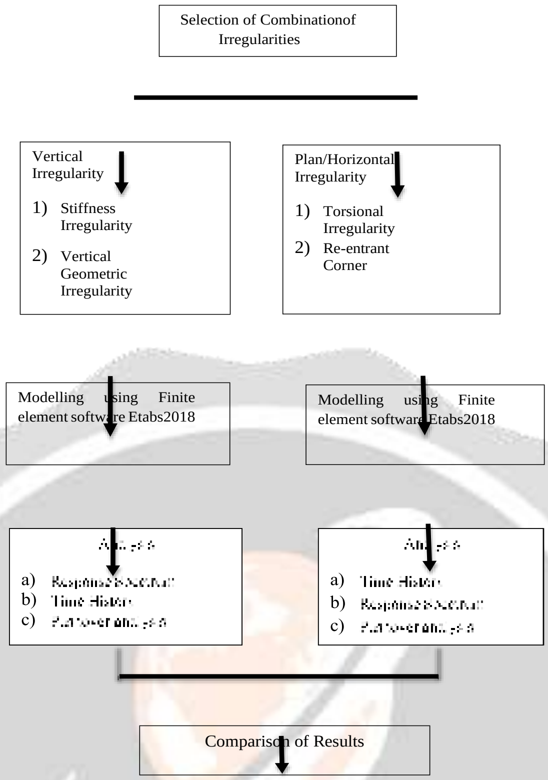


Figure 1.11 Multi storey structure having in-plane discontinuities (IS 1893 part 1 2016)

Figure 1.12 Strength Irregularity (IS 1893 part 1 2016)

METHODOLOGY



PLAN / HORIZONTAL IRREGULARITY

Structure is three-dimensional MRF with soft storey, unreinforced brick infill walls in rest of storey. Plan and 3D view is shown in figure 4.2. Building is having G+9 storeys. Columns are fixed at base. There are no walls in bottom storey and 230 mm external & internal walls in rest of storeys. Modelling of structure has been done in etabs. Re-entrant corner & torsional irregularity is taken as combination of irregularity of modelling the structure. Irregularity is induced by altering plan of the building. Equivalent static, response spectrum, nonlinear static pushover, and time history analyzes are performed on Northridge seismic data. Automatic hinge M3 was assigned to the beam and P-M2-M3 hinge to the column.

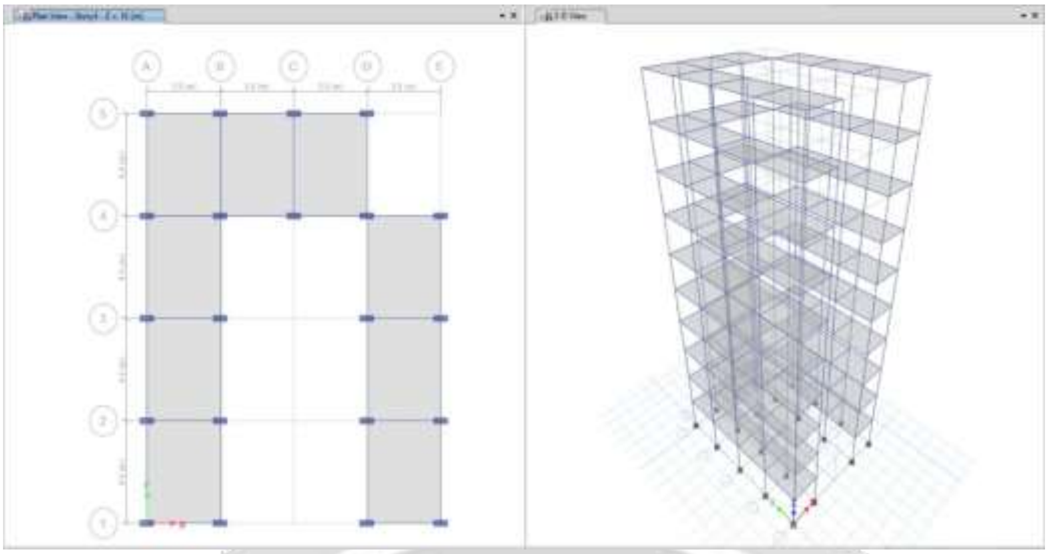


Table 4.2 Specifications of plan irregular RC Building

Geometric Details	
width along X direction width along Y direction	3.5m 4.5m
Structure	SMRF
Type of Building	Irregular along height at top storey
Bottom Storey BuildingTypical Storey Height 3rd Storey Height No. of Storeys	4.5m 3.5m 4.5m G+9 storeys
Purpose of Building	Residential
Material Characteristics	
Concrete Grade	M20
Steel Grade	Fe500
Section Characteristics	
Beam	Base to storey 9 - 0.3m*0.5m Top storey - 0.3m*0.4m
Column	0.3m*0.7m
Slab	150mm
Primary Load Cases	
Wall Load (Dead)	13.8kN/m
Live Load on Floor	3kN/m^2
Live Load On Roof	2kN/m^2
Floor Finish	1.5kN/m^2
Seismic Load In ‘X’ Direction	IS 1893 2016 Part 1
seismic Load in ‘Y’ Direction	IS 1893 2016 Part 1
Seismic Properties	
Zone Factor (Z)	0.16
Response Reduction Factor (R)	5
Importance Factor (I)	1
Soil Type	Type II
Damping Ratio	0.05
Fundamental Time Period	Along ‘X’- 0.962 s & ‘Y’- 0.848 s

RESULTS

Table 5.1 Ratio of design base shear and base shear at the performance point

Type	Design Base Shear (KN)	Shear at performance time (KN)	Safety Factor
Vertical Irregularity	561.81	972.93	1.73
Plan Irregularity	697.7	1779.76	2.25

Buildings are assessed as safe if the safety ratio is greater than or equivalent to one and seismically vulnerable if the safety ratio is below one. From the table 5.1 we can see that boththe models are safe, however building with plan irregularity is safer than structure with vertical irregularity

Table 5.2 Ductility Ratio

	Ductility Ratio
Vertical Irregularity	6.5
Plan Irregularity	2.63

Table 5.2 shows ductility ratio values for both plan and vertical irregular models. Structure with vertical irregularities has greater ductility than structure with plan irregularities.

Figure 5.1 Pushover curve for plan irregularities

Figure 5.2 Pushover for Vertical Irregularities

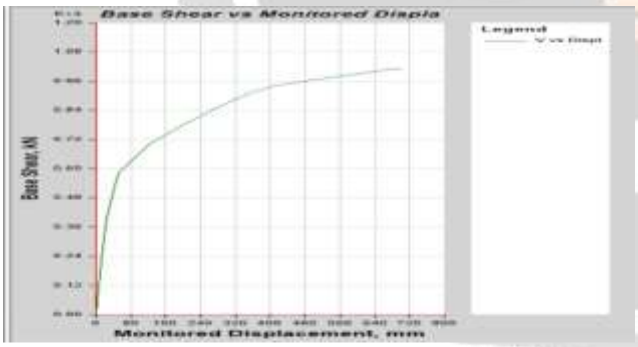
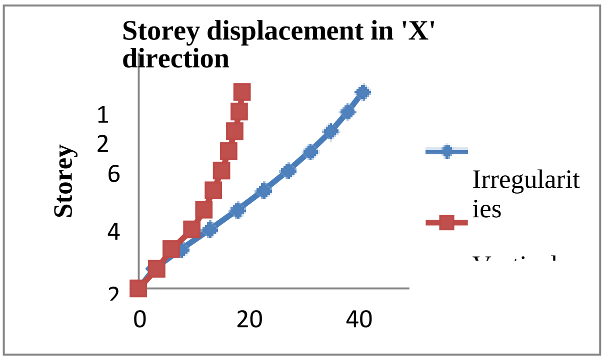
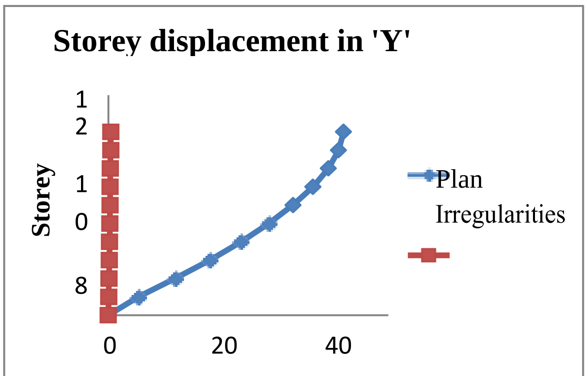


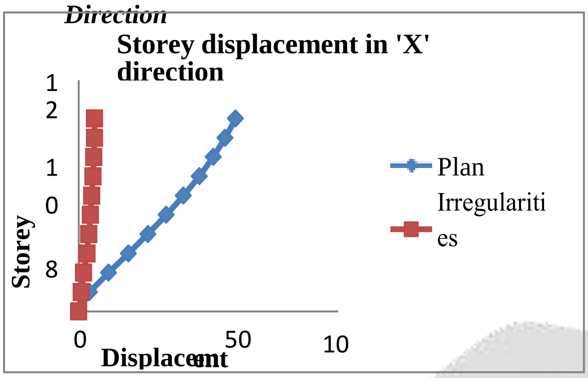
Figure 5.1 & 5.2 depict pushover curve with auto hinges. The performance points for both thestructures are within danger region.





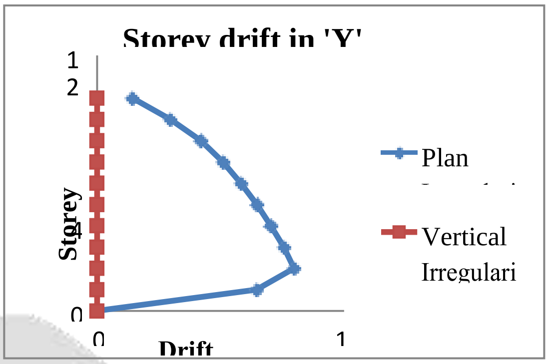
Graph 5.1 Displacement profile due to response due to

spectrum (RsX) in 'X'- Direction Direction



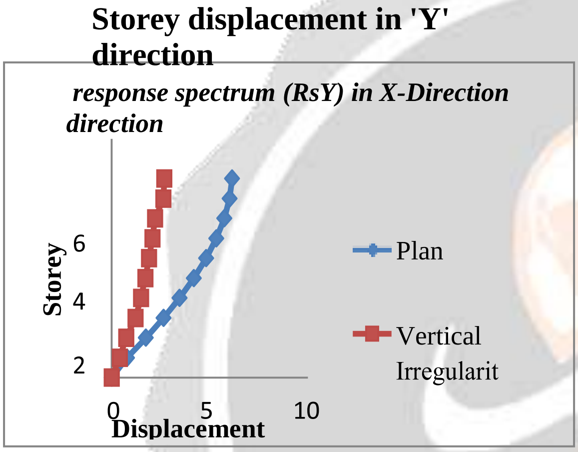
Graph 5.2 Displacement Profile

response spectrum (RsX) in 'Y'-



Graph 5.3 Displacement profile due to

response spectrum (RsY) in X-Direction direction

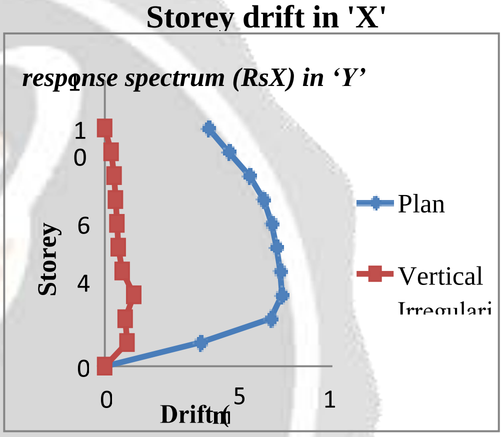


Graph 5.4 Displacement profile due response

spectrum (RsX) in 'Y'- Direction.

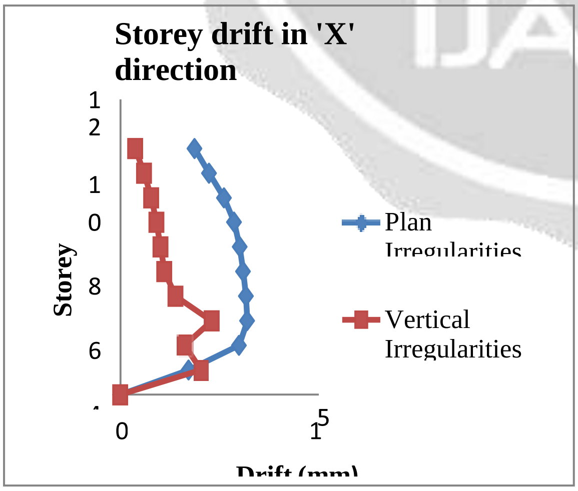
Graph 5.6 Drift profile due to

response spectrum (RsX) in 'Y'



Graph 5.7 Drift profile due to response

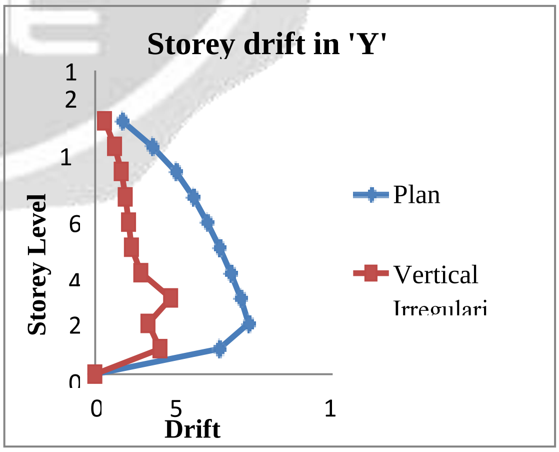
spectrum (RsY) in 'X' direction



Graph 5.5 Drift profile due

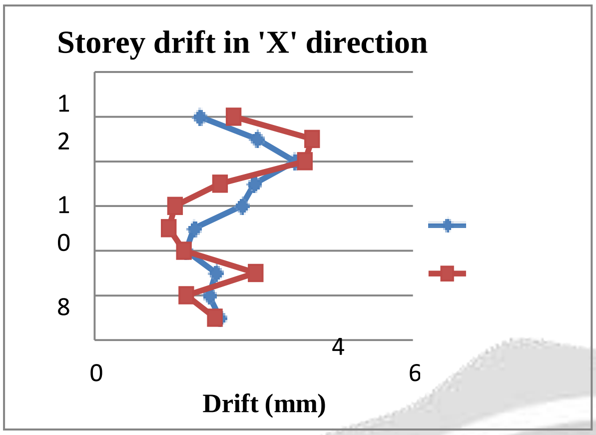
Response Spectrum (RsX) in 'X' Direction

Direction

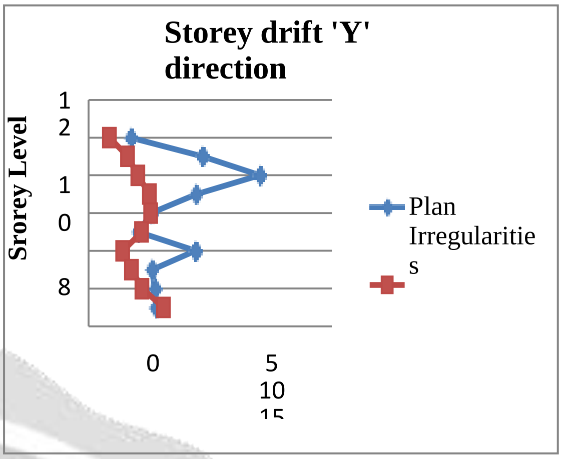


Graph 5.8 Drift profile due to Response

Response Spectrum (RsY) in 'Y'



Graph 5.9 Drift profile due to Time History analysis in 'X' direction



Graph 5. 10 Drift profile due to Time History analysis in 'Y' direction

Graph 5.1 to graph 5.4 show displacement profiles of structures at different storeys and they show that structure possessing plan irregularities has greater displacement than structure with vertical irregularities.

Graph 5.5 to graph 5.8 show drift profile of structures at different storeys and they show that structure possessing plan irregularities has greater drift than structure with vertical irregularities.

Graph 5.9 to graph 5.10 show drift profile of structures at different storeys and they show thatstructure possessing plan irregularities has greater drift than structure with vertical irregularities.

CONCLUSION

1) It is seen that from table 5.1 both vertical irregularity model & plan irregularity model, then it's concluded that Model with plan irregularity is safer than model with vertical irregularity.
2) Model with vertical irregularity is highly ductile than model with plan irregularity from table 5.2.
3) From graphs 5.1, 5.2, 5.3 & 5.4 Storey level v/s displacement it is seen that model with plan irregularity has more displacement compared to model with vertical irregularities, which shows if a building with plan irregularities with combination of torsion irregularity & re-entrant corner undergo more displacement compared to building with vertical irregularity with combination of stiffness irregularity & vertical geometric irregularity.
4) From graphs 5.5, 5.6, 5.7, 5.8, 5.9 & 5.10 storey level v/s drift it is seen that buildings with plan irregularities undergo more drift than building with vertical irregularities. It is seen that from graphs 5.5, 5.7, 5.8 & 5.9 for building with vertical irregularity at 3rdstorey there is increase in drift, as stiffness irregularity is induced at 3rd storey from this, we can say storey drift at a particular storey is more compared to other storeys of same building if stiffness irregularity is induced at that particular storey, in this case storey 3.

REFERENCES

1. IS 1893 2016 Part1. "Criteria for Earthquake Resistant Design of Structures". Bureau ofIndian Standards.
2. IS 456: 2000, "Plain Reinforced Concrete Code of Practice", Bureau of Indian Standards.

3. IS 1893 2002 Part 1. "Criteria for Earthquake Resistant Design of Structures". Bureau ofIndian Standards.
4. Craig Comartin, Mark Aschheim "A summary of FEMA 440: Improvement of NonlinearStatic Seismic Analysis Procedures". 13th World Conference of Earthquake Engineering
5. Satish Annigeri & Pramodini Naik, "Performance Evaluation of 9 Storey RC BuildingLocated in North Goa", Procedia Engineering.
6. Siva Naveen, Anitha Kumari S D & Nimmy Marian Abarham, "Analysis of Irregular Structures under Lateral Loads", Procedia Engineering.
7. Suraj Khate & Ruturaj S Meshram, "Improved Seismic Performance of RCC Building Irregular in Plan with Water Tank as Passive TMD". Advanced Technology in StructuralEngineering.
8. R Martino, E Spacone & G Kingsley "Non-Linear Pushover Analysis of RC Structures". Advanced Technology in Structural Engineering.

9 Rahul Ghosh & Rama Debbrma. "Performance Evaluation of Setback Buildings with Open Ground Storey on Plain & Sloping Ground Under Earthquake Loading & Mitigating Failure". International Journal Advanced Structural Engineering