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"Dynamic Analysis of vertical varying irregular Building with Response spectrum"

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Abstract: Vertical irregularities are one of the essential motives of failures of systems during earthquakes. The effect of vertically irregularities within the seismic overall performance of systems will become definitely vital. Peak-wise changes in stiffness and mass render the dynamic traits of those buildings exceptional from the ordinary building. The irregularity within the building structures may be due to irregular distributions in their mass, strength and stiffness along the height of building. Whilst such buildings are built in high seismic zones, the analysis and design turns into more complexes. The main objective of the analysis is to study the behaviour of flat slab system in vertical irregular multi-storied building against different forces acting on it during earthquake. The analysis is carried out using STAAD Pro2007 software. Flat slab system are modelled and analysed for the dynamic loading. The analysis is made between in the four type of G+10 storey building with vertical geometric irregularity & mass irregularity increasing toward top & decreasing toward top. Total 12 modelled are studied and there results were compared. To know the effect of Geometric irregularity on the shape (vertical geometric) irregular constructing the geometry is changed through reducing the no. of bays in X-direction vertically downward. Comparison in made between flat slab shear stresses, Bending Moment, node displacement, Base shear, Story drift & the result are brought out.

Keywords: Flat slab, Response Spectrum Analysis, Geometric Vertical Irregularity

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I. INTRODUCTION

During an earthquake, failure of structure starts off-evolved at factors of weak spot. This weak point arises due to discontinuity in mass, stiffness and geometry of structure. The systems having this discontinuity are termed as irregular systems. Irregular structures contribute a massive portion of city infrastructure. Vertical irregularities are one of the essential motives of failures of systems during earthquakes. The effect of vertically irregularities within the seismic overall performance of systems will become definitely vital. Peak-wise changes in stiffness and mass render the dynamic traits of those buildings exceptional from the ordinary building. The irregularity within the building structures may be due to irregular distributions in their mass, strength and stiffness along the height of building. Whilst such buildings are built in high seismic zones, the analysis and design turns into more complexes. The main objective of the analysis is to study the behaviour of flat slab system in vertical irregular multi-storied building against different forces acting on it during earthquake. The analysis is carried out using STAAD Pro2007 software. Flat slab system with shear wall are modeled and analysed for the dynamic loading. The analysis is made between in the four type of G+10 storey building with different geometric vertical irregularity. Total 12 modeled are studied and there results were compared. To know the effect of Geometric irregularity on the shape (vertical geometric) irregular building the geometry is changed by reducing the no. of bays in X-direction vertically downward, as per the IS 1893:2002 (part-1).

The particular types of irregularity considered include:
Vertical Mass Irregularity
Vertical Geometric Irregularity

Following are the objectives.
1. To prepare various model with Vertical Geometric irregularities in STAAD Pro2007 software,
2. To prepare various model with mass irregularities in STAAD Pro2007 software,
3. To perform response spectrum analysis on all model prepared in STAAD Pro2007 software,
4. To obtain and compare results based on parameters i.e. displacement, drift, base shear and different stresses on flat slab.

II. METHOD OF ANALYSIS

2.1 Code-based procedure for seismic analysis Main features of seismic method of analysis based on Indian standard 1893(Part 1): 2002 are described as follows (a) Equivalent static lateral force method (b) Response spectrum method (c) Square roots of sum of squares (SRSS method) (d) Complete Quadratic combination method (CQC) (e) Elastic response spectrum methods

(a) Equivalent Static Analysis All design against seismic loads must consider the dynamic behaviour of the load. Regular structures were analysis by equivalent linear static methods and it's generally adequate. Most codes of practice allow this method for regular, low- to medium-rise buildings. It starts with an estimation of base shear load and its distribution on every storey calculated via the use of formulas given in the code. equivalent static analysis can consequently work well for low to medium-rise buildings without extensive coupled lateral-torsional modes, in which simplest the first mode in each course is considered. Tall buildings (over, say, 75 m), wherein 2nd and higher modes can be vital, or buildings with torsional consequences, are a lot much less appropriate for the technique, and require more complex methods to be used in these situations.

(b) Response Spectrum Method The representation of the most response of idealized single degree freedom system having certain period and damping, throughout earthquake ground motions. The maximum response plotted in against two of un-damped natural period and for various damping values and may be expressed in terms of maximum absolute acceleration, most relative velocity or maximum relative displacement. For this motive response spectrum case of analysis have been executed in line with IS 1893.

III. MODEL AND ANALYSIS

Table 1 Design parameters

S.No	Particulars	Dimension/Size/Value
1	Model	G+10
2	Seismic Zones	IV_{th}
3	Floor height	3m
4	Depth of foundation	1.5m
5	Building height	33.5M
6	Columns	Storey 1-5: 700mmX700mm Storey 6-10 : 500mmX500mm
7	Cantilever Beam	500mmX2000mm
8	Thickness of slab	200mm
9	Type of soil	Medium soil Type-II
10	Live load	$1.5KN/M^2$
11	Dynamic Analysis	**Response Spectrum Analysis**
12	Natural Period of Building	$Ta = 0.075\ h^{0.75}$
13	Zone factor Z	0.24
14	Response Reduction factor (RF)	1
15	Importance factor (I)	1
16	Rock and soil factor (SS)	1
17	Type of structures	2
18	Damping Ratio	0.05

Table 2 Modeling

Model-A	Flat slab regular multi-storeyed building consist of 6x4 bay up to top floor Without Mass irregularities.
Model-A1	Flat slab regular multi-storeyed building consist of 6x4 bay up to top floor With Mass irregularity increasing towards top.
Model-A2	Flat slab regular multi-storeyed building consist of 6x4 bay up to top floor With Mass irregularity decreasing towards top
Model-B	Flat slab irregular multi-storeyed building consists of 6x4 bays up to 5 floors. 2x2 bay up to top floor (corner position) Without Mass irregularities
Model-B1	Flat slab irregular multi-storeyed building consists of 6x4 bays up to 5 floors. 2x2 bay up to top floor (corner position) floor With Mass irregularity increasing towards top.
Model-B2	Flat slab irregular multi-storeyed building consists of 6x4 bays up to 5 floors. 2x2 bay up to top floor (corner position) floor with Mass irregularity decreasing towards top
Model-C	Flat slab irregular multi-storeyed building consists of 6x4 bays up to 5 floors. 2x2 bay up

	to top floor (center position) Without Mass irregularities.
Model-C1	Flat slab irregular multi-storeyed building consists of 6x4 bays up to 5 floors. 2x2 bay up to top floor (center position) floor With Mass irregularity increasing towards top
Model-C2	Flat slab irregular multi-storeyed building consists of 6x4 bays up to 5 floors. 2x2 bay up to top floor (center position) floor with Mass irregularity decreasing towards top.
Model-D	Model-D: Flat slab irregular multi-storeyed building consists of 6x4 bays up to 5 floors. 2x2 bay up to top floor (edge position) Without Mass irregularities
Model-D1	Flat slab irregular multi-storeyed building consists of 6x4 bays up to 5 floors. 2x2 bay up to top floor (edge position) floor With Mass irregularity increasing towards top.
Model-D2	Flat slab irregular multi-storeyed building consists of 6x4 bays up to 5 floors. 2x2 bay up to top floor (edge position) floor with Mass irregularity decreasing towards top.

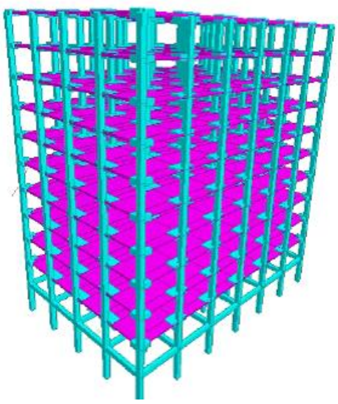

Figure 1 Flat Slab regular building

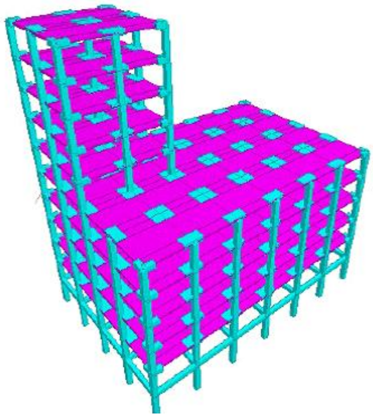

Figure 2 Flat Slab irregular building at Edge

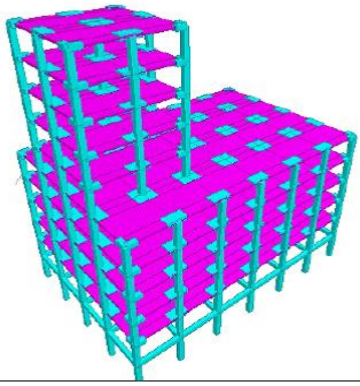

Figure 3 Flat Slab irregular Building at Corner

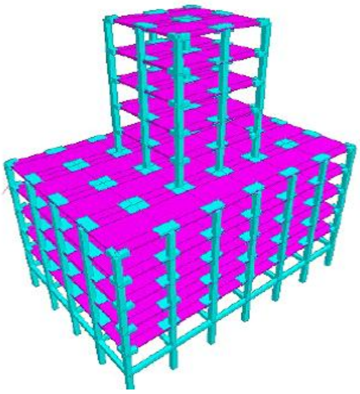

Figure 4 Flat slab irregular building at center

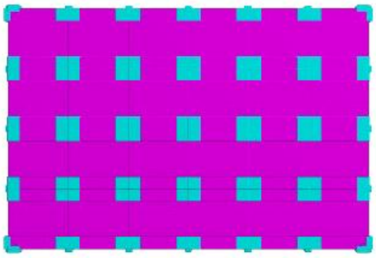

Figure 5 Plan of Flat slab Building

IV. RESULT

The different cases were studied for regular building (6X4 bays up to top floor) and geometric vertical irregular building (6X4 bay up to 5th floor & 2X2 bay up to 6th to top floor) at edge, center and corner without mass irregularity and with mass irregularity increasing toward top & decreasing toward top. To study the effectiveness of all these models, the plate center stresses, plate corner stresses, and flat plate principal stresses, Von Mis stresses, Tresca Stresses, Node displacement, Base shear, and storey drift are worked out and results are presented in figures.

Graph 1 Center Shear Stresses for regular building
Graph 2 Center Shear Stresses for irregular building at Edge
Graph 4 Center Shear Stresses for irregular building corner
Graph 3 Center Shear Stresses for irregular building at Center
Graph 8 Corner Shear Stresses for regular building at Center
Graph 7 Corner Shear Stresses for irregular building at Center
Graph 6 Corner Shear Stresses for irregular building at Edge
Graph 5 Corner Shear Stresses for regular building
Graph 12 Principal Stresses for irregular building at Corner
Graph 11 Principal stresses for irregular building at center
Graph 10 Principal Stresses for irregular building at Edge
Graph 9 Principal Stresses for regular building
Graph 13 Von mis stress for regular building
Graph 16 Von mis Stress for irregular building at Corner
Graph 15 Von mis Stresses for irregular building at Center
Graph 14 Von mis stress for irregular building at Edge
Graph 17 Tresca Stresse for regular building
Graph 18 Tresca stresse for irregular building at edge
Graph 19 Tresca stresses for irregular building at Center
Graph 20 Tresca stresses for irregular building at Corner
Graph 22 Center bending Moment for irregular building at Edge
Graph 21 Center bending Moment for regular building
Graph 24 Center bending moment for irregular building at Corner
Graph 23 Center bending Moment for irregular building at Center
Graph 26 Node displacement for irregular building at Edge
Graph 25 Node displacement for regular building
Graph 28 Node displacements for irregular building at Corner
Graph 27 Node displacements for regular building at Center
Graph 29 Story Shear for regular building
Graph 30 Story shear for irregular building at edge
Graph 32 story shear for regular building at corner
Graph 31 Story shear for regular building at center
Graph 34 Story drift for regular building at Edge
Graph 33 Story drift for regular building
Graph 36 Story drift for regular building at corner
Graph 35 Story drift for irregular building at center

V. CONCLUSION

Response spectrum analysis results provides a more realistic behaviour of structure response and hence analysis of Regular building, Irregular buildings at edge , center & corner position with flat slab system with mass irregularity increasing toward top & mass irregularities decreasing toward top is carried out and the following conclusions are drawn from the study :

1. Flat slab Centre shear stresses & Corner shear stresses SQX and SQY more decrease when building irregular at corner with mass irregularity decreasing towards the top.
2. The flat slab Principal, Von mis & Tresca top and bottom stresses more decreases when building irregular at edge without mass irregularity.
3. Flat slab Center & Corner bending moment Mx , My & Mxy shows the least value when the building irregular at the edge without mass irregularity.
4. Total base shear decreases toward top of the floor when building irregular at corner without mass irregularity.

5. Node displacement in X direction will be more restricted when building irregular at the corner with mass irregularity decreasing toward top.
6. The values of storey drift are found to be within permissible limit i.e. not more than 0.004 times the storey height as per norms according to IS 1893:2002 Part-1.
7. it's concluded that the Structure with vertical irregularity at the corner is suitable for the effect of Dynamic load on the performance of building.
8. it's concluded that the value of flat slab shear stresses (center & corner), principal, von Mis, & Tresca stresses & bending moment (center & corner) increases with some certain amount and base shear and node displacement also increases when mass irregularity increasing toward the top while these all above parameter decrease with decreasing the mass irregularity toward the top.
9. When compare Flat slab system in Regular building with irregular at Edge, Center & Corner positions without mass irregularity & with mass irregularity increasing & decreeing toward top and the result in terms of plate shear stresses, principal stresses, von mis & tresca stresses, Bending Moment, node displacement, Base shear& story drift the Building having irregular at the corner with mass irregularity decreasing toward top i.e. model-C2 show good results which brought out in graphical form.

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