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Torsional Irregularity of Building

K.Archan¹, S.Devi²

P.G. Student, Department of Civil Engineering, Adhiyamaan College of Engineering College, Hosur, India¹

Associate Professor, Department of Civil Engineering, Adhiyamaan College of Engineering College, Hosur, India²

ABSTRACT: Numerous attempts on research and development for aseismic structures that can withstand seismic hazards and lend some ground resistance in earthquake haven't yielded any satisfactory conclusions. Even though after decades of study and implementation of advanced designing, execution and maintenance tactics in high rise structures, many construction aspects have found a new ways to deal with structural hazards, yet the concerns of seismic hazards are relatively found unanswered. These seismic hazards are prime matter of concrete in earthquake prone zones or the seismic zones worldwide. In this paper, a three-dimensional 14 storey RC structure is analysed by pushover analysis using ETABS software. From the analysis, storey drift, overturning moment, time period are obtained and torsional irregularities ratio are calculated.

KEYWORDS: Seismic analysis, Pushover analysis, Torsional irregularities ratio, Time period

I. INTRODUCTION

Many buildings in the present scenario have irregular configurations both in plan and elevation, which in future may subject to devastating earthquakes. In this case, it is necessary to identify the performance of the structures to withstand against disaster primarily due to earthquake. Irregularities are not avoidable in construction of buildings; however the behaviour of structures with these irregularities during earthquake needs to be studied and adequate precautions are to be taken. A detailed study of structural behaviour of the buildings with irregularities is crucial for style and behaviour in earthquake.

Major structural collapse occurs when a building is under the action of dynamic loads which include both Earthquake and Wind loads. In these trendy days, most of the structures are involved with architectural importance and it is highly impossible to plan with regular shapes. These irregularities measure to blame for structural collapse of buildings underneath the action of dynamic hundreds. The irregularity in the building structures may be due to irregular distribution in their mass, strength and stiffness along the height of buildings.

Torsional irregularity to be thought of to exist once the utmost level drift, computed with design eccentricity, at one end of the structures transverse to an axis is more than 1.2 times the typical of the level drifts at the two ends of the structure as shown in figure.

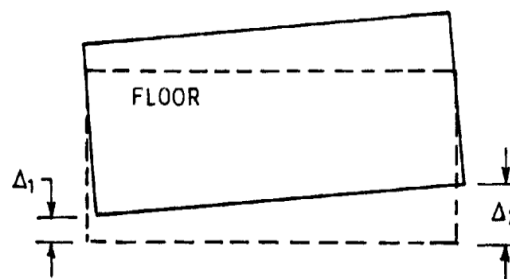


Fig.1.Torsional Irregularity

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II. PUSHOVER ANALYSIS

This study is carried out to check the effect of the irregular building in G +14 storey in seismic zone 3. The analysis is carried out with pushover analysis and the results are obtained and tabulated in terms of story drift, overturning moment, time period and torsional irregularity ratio.

A. PUSHOVER ANALYSIS

Pushover analysis is a non-linear static structure analysis, which enables presenting structure behaviour caused by different types of loads resulting from an earthquake. It is a non-linear analysis to assess the structural capacity under static horizontal loads growing until the collapse of the structure. The results of the pushover analyses are capability curves known by the variation of the bottom shear in perform of the displacement of an effect purpose on the structure. This method helps to note the sequence of cracks, yielding, plastic hinge formation and local/global failures in which a structure modelled with non-linear properties and permanent gravity loads is subjected to associate in nursing progressive lateral load.

1. Storey Drift:

Storey drift is the drift of one level of a multistory building relative to the level below. Interstory drift is the difference between the roof and floor displacement of any given story as the building sways during the earthquake, normalized by the story height.

2. Torsional Irregularities:

To be considered when floor diaphragms are rigid in their own plan in relation to the vertical structural elements that resist the lateral forces. Torsional irregularity to be considered to exit when the maximum storey drift computed with design eccentricity, at one end of the structures transverse to an axis is more than 1.2 times the average of the storey drifts at the two ends of the structure.

$$D_{avg} = (R1+R2)/2$$
$$(D_{max}/D_{avg}) < 1.2$$

Where,

D_{max} = Highest value of the full drift within the earthquake thought of direction.

D_{avg} = Average of drift between two storeys.

3. Time period

A time period (denoted by 'T') is the time needed for one complete cycle of vibration to pass in a given point. As the frequency of a wave increases, the time period of the wave decreases. The unit for time period is 'seconds'. It is related to frequency (f) given by

$$T = 1/f.$$

4. Overturning Moment

Overturning moments are those applied moments, shears and uplift forces that seek to cause the footing to become unstable and turn over. Resisting moments are those moments that resist overturning and seek to stabilize the footing. These overturning checks are performed for overturning about each edge of the footing.

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III. ANALYTICAL WORK

A. STRUCTURAL DESCRIPTION

The structural descriptions are as follows:

DESCRIPTION	PARAMETERS
Type of structure	Multi storey building
Number of stories	G+14
Dimensions of the building	Plot size = 40mx35m = 1400m ² Built up area=34mx26m=884m ² Free space=515m ²
Materials	M30 concrete HYSD415 reinforcement
Floor height	3m
Size of column	Rectangular column = 450x350mm Circular column = 350mm
Size of beam	400x350mm
Depth of slab	125mm
Thickness of wall	230mm
Characteristic strength of concrete, f_{ck}	30 N/mm ²
Unit weight of concrete	25 kN/m ³
Unit weight of brick masonry	19kN/m ³
Modulus of elasticity of brick masonry	14000N/mm ²
Poissons ratio of brick masonry	0.2
Damping ratio	5%
SEISMIC DATA	
Type of soil	Medium
Seismic zone	3
Importance factor	1
Zone factor	0.36
Response reduction factor	3 for Ordinary Moment Resisting Frame

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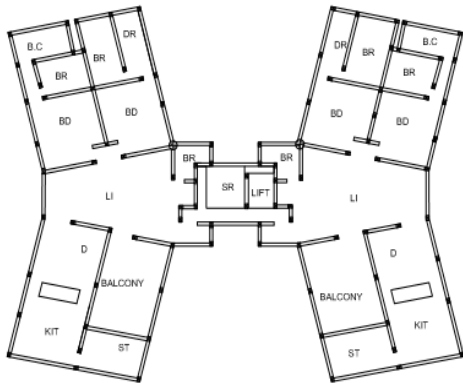


Fig.2. Plan view of the building in Auto Cad

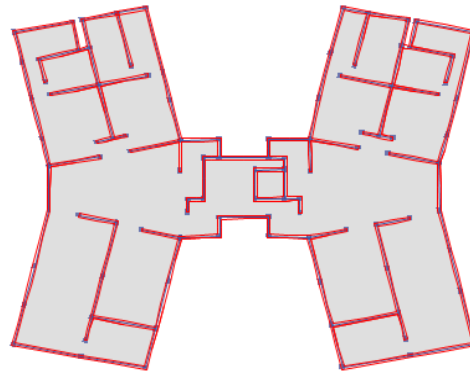


Fig.3. Floor plan of building in ETABS

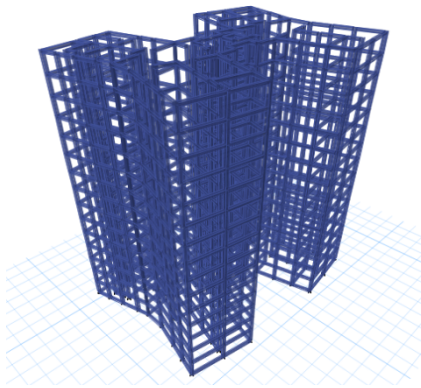


Fig.4. Framed view of a structure

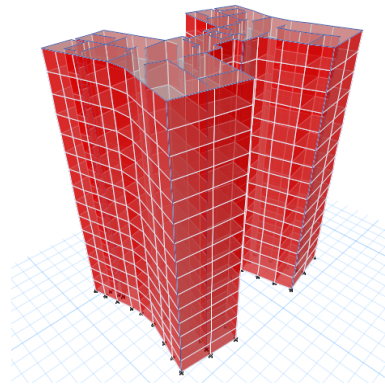


Fig.5. 3D view of a structure

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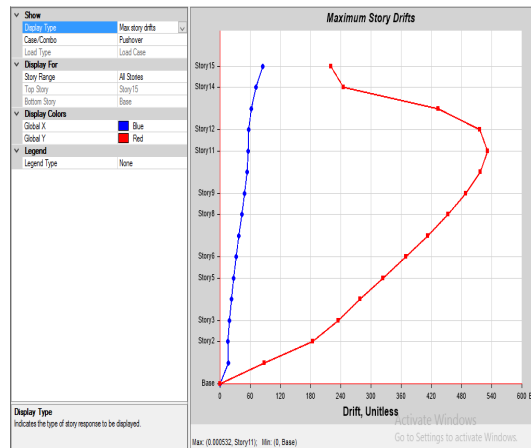
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IV. RESULTS AND DISCUSSION

1.Storey Drift:



Graph.1. Maximum storey drift

Story	Elevation (m)	Location	X-Dir	Y-Dir
Story15	45	Top	0.000085	0.00022
Story14	42	Top	0.000072	0.000246
Story13	39	Top	0.000062	0.000434
Story12	36	Top	0.000056	0.000516
Story11	33	Top	0.000056	0.000532
Story10	30	Top	0.000054	0.000517
Story9	27	Top	0.000049	0.000488
Story8	24	Top	0.000043	0.000453
Story7	21	Top	0.000038	0.000413
Story6	18	Top	0.000032	0.00037
Story5	15	Top	0.000027	0.000324
Story4	12	Top	0.000022	0.000279
Story3	9	Top	0.000019	0.000234
Story2	6	Top	0.000015	0.000184
Story1	3	Top	0.000017	0.000088
Base	0	Top	0	0

TABLE: 1 Maximum storey drift values

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2. Torsional Irregularities ratio:

$$D_{avg} = (R1+R2)/2$$

$$(D_{max}/D_{avg}) < 1.2$$

Where,

D_{max} = Highest value of the full drift within the earthquake thought of direction.

D_{avg} = Average of drift between two storeys.

Calculations:

Along X-axis

Storeys between	R1	R2	D_{max}	D_{avg}	(D_{max}/D_{avg})
Storey 14 & 15	8.5×10^{-5}	7.2×10^{-5}	7.2×10^{-5}	7.2×10^{-5}	0.917
Storey 12 & 13	6.2×10^{-5}	5.6×10^{-5}	5.6×10^{-5}	5.9×10^{-5}	0.949
Storey 10 & 11	5.6×10^{-5}	5.4×10^{-5}	5.4×10^{-5}	5.5×10^{-5}	0.981
Storey 8 & 9	4.9×10^{-5}	4.3×10^{-5}	4.3×10^{-5}	4.6×10^{-5}	0.934
Storey 6 & 7	3.8×10^{-5}	3.2×10^{-5}	3.2×10^{-5}	3.5×10^{-5}	0.914
Storey 4 & 5	2.7×10^{-5}	2.2×10^{-5}	2.2×10^{-5}	2.45×10^{-5}	1.02
Storey 2 & 3	1.9×10^{-5}	1.5×10^{-5}	1.5×10^{-5}	1.7×10^{-5}	0.882
Storey 0 & 1	1.7×10^{-5}	0	0	0	0

Along Y-axis

Storeys between	R1	R2	D_{max}	D_{avg}	(D_{max}/D_{avg})
Storey 14 & 15	0.00022	0.000246	0.000246	2.33×10^{-4}	1.055
Storey 12 & 13	0.000434	0.000516	0.000516	5.24×10^{-4}	0.984
Storey 10 & 11	0.000532	0.000517	0.000532	5.24×10^{-4}	1.01
Storey 8 & 9	0.000488	0.000453	0.000488	4.7×10^{-4}	1.03
Storey 6 & 7	0.000413	0.00037	0.000413	3.91×10^{-4}	1.05
Storey 4 & 5	0.000324	0.000279	0.000324	3.01×10^{-4}	1.07
Storey 2 & 3	0.000234	0.000184	0.000234	2.09×10^{-4}	1.1
Storey 0 & 1	0.00088	0	0	0	0

So the torsional irregularity for both directions does not exit.

D_{max}/D_{avg} should not more than 1.2 in both the directions. So the structure column section should not be revised.

3. Time period

Mode	Period
	sec
1	0
2	0.113
3	0.114

TABLE:2 Time period values

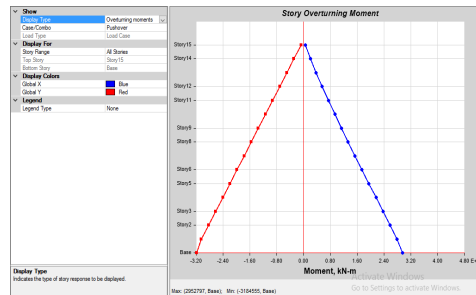
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4. Overturning Moment



Graph.2. Overturning Moment

Story	Elevation (m)	Location	X-Dir (kN.m)	Y-Dir (kN.m)
Story15	45	Top	50476.5734	-71966.5177
Story14	42	Top	209635.1136	-283949.4898
Story13	39	Top	378897.2128	-496083.9122
Story12	36	Top	556809.3436	-708263.6241
Story11	33	Top	742082.1722	-920478.2703
Story10	30	Top	933539.0915	-1132720
Story9	27	Top	1130107.564	-1344986
Story8	24	Top	1330817.212	-1557273
Story7	21	Top	1534800.691	-1769579
Story6	18	Top	1741294.728	-1981904
Story5	15	Top	1949641.331	-2194253
Story4	12	Top	2159290.423	-2406637
Story3	9	Top	2369811.376	-2619084
Story2	6	Top	2580950.517	-2831706
Story1	3	Top	2792681.184	-3044746
Base	0	Top	2952796.71	-3184555

TABLE:3 Overturning moment values

V. CONCLUSION

- In this structure, the storey drift is maximum in the storey 11 i.e.) 0.000532mm and minimum in the base i.e.) 0, when comparing to IS 1893 (part -1) 2002 codes the maximum drift is 0.18mm.
- The torsional irregularity does not occurred in the X and Y direction. The torsional irregularity ratio along X direction are 0.917, 0.949, 0.981, 0.934, 0.914, 1.02, 0.88, 0 and along Y direction are 1.05, 0.984, 1.01, 1.03,

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1.05, 1.07, 1.1, 0 which is less than 1.2. Hence the torsional irregularity of the building is within the limit in both the directions.

- In X-axis, the maximum overturning moment is 2952797kN-m at base. In Y-axis, the minimum overturning moment is -3184555 kN-m at base.
- Time period of these systems is less i.e.) 0.113 and 0.114 when comparing to IS 1893 (part-1) 2002 codes the time period is 0.694s.

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