Assessment of Torsional Irregularity of Multy-Storey Building By Using Etabs Software

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Abstract- *Damage reports on recent earthquakes have indicated that torsional motions often cause significant damage to buildings, at times leading to their collapse. The objective of this work aimed a better understanding of the torsional behaviour of building systems. In this analysis both symmetric and asymmetric structures with plan irregularity are compared. Symmetric structures have centre of mass coinciding with the centre of rigidity and the torsion effect in such structures occurs out of accidental eccentricity whereas in asymmetric structures have irregular distribution of mass and stiffness and its centre of mass and centre of rigidity do not coincide and hence causes the torsional effect on the structures which is one of the most important factor influencing the seismic damage of the structure. To assess the torsional effect on the structures in the present study different types of structures(G+20) having same perimeter area are considered and strengthened by introduction of with and without shear wall .A simple linear comparison based on eccentricity is also carried out for the structures. Structures with asymmetric distribution of mass and stiffness undergoes torsional motions during earthquake. The performance of the structures is assessed as per the procedure prescribe in IS 1893:2002. Equivalent loads and Earthquake load are considered for the analysis of the structure. The analysis of the structural models is carried out using ETABS 2016 software.*

Keywords- Torsional irregularity, Displacement, Drift, base shear, Shear wall.

I. INTRODUCTION

During earthquake ground motions, structures much of the time will encounter torsional vibration in addition to lateral oscillations. A significant torsional reaction hotspot is due to asymmetrical distribution of mass or horizontal load opposing components in the plan of the structure which is usually refers to eccentricity of mass or rigidity. Distinctive sorts of torsional reaction can take place in regular structures if there should arise an occurrence of irregular ground movement along the base of the structure or inelastic performance of opposing component or loss of strength of such a component.

The torsional irregularity is an imperative parameter which measures the stretch out of torsion impact on the structures. It can be interpreted as the proportion of highest drift to the mean drift of the individual story. Torsional irregularity should be considered when maximum story drift at one side of the structure transverse to a axis is more than 1.2 times the mean of the story drift at the two closures of the structure. $\Delta 1$ and $\Delta 2$ are the story drift (or inter-story drifts) at the two closures of the structure. Relative eccentricity is generally considered the main factor influencing the torsional effects.

II. OBJECTIVE

1. To study the influence of different plan configurations of a structures (like Square, C, L shape buildings).
2. To study the torsion effect on building by following parameters are :
   (a) considering zone V of earthquake and medium soil type.
   (b) By introducing the position of shear wall.
3. To study the structural response for torsional irregularities.
4. To find parameters like storey displacement ,base shear and relative storey drifts.

III. LITERATURE REVIEW

Rahila Thaskeen, Shinu Shajee (2016) [1] The objective of their work aimed at enhanced understanding of the torsional behaviour of building systems. In the analysis both symmetric and asymmetric structures with plan irregularity were compared. To assess the torsional effect on the structures they modelled 4 types of structures having same outer perimeter area and strengthened by introduction of shear wall cores. A simple linear comparison based on eccentricity is also carried out for G+12 and G+17 structures. The analysis of the structural models is carried out using ETABS software. From their investigation on reviews they concluded that the eccentricity shows the tendency of a structure for torsional effects. Model IV (C- shaped structure) had the maximum tendency for torsional effects with higher value of eccentricity. The highest torsional irregularity ratio was found maximum for model IV which was the C shape structure and it is seen that the rigidity centre of model IV is intense at outside the structure. The drift and displacement values yielded values, indicating the dependence of the stiffness and mass concentration on the structure. Strengthened model yielded shorter-period which permitted smaller drift limits and longer-period structures that is the ideal symmetric structure allowed larger drift limits.

Lohith Kumar, Batu Abera Areda, Dereje Tolosa and Gangadhar N (2017) [2] presented 10,15,20 storey building of regular and irregular plan with all zone and all soil type models. And analyse the performance of all models for re-entrant corner irregularity and Torsional irregularity.

Arvindreddy and R.J.Fernandes (2015) [3] presented a review about the Seismic analysis of RC regular and irregular frame structures. They considered 2 types of reinforced concrete structures with regular and irregular 15 story structures and analysed for static and dynamic methods. Directly they taken six models. One is of general structure and remaining are unpredictable structural models. From their investigation on reviews they concluded that, the static analysis strategy demonstrate lesser story displacements when compared with response spectrum analysis. This variation may be because of nonlinear distribution of force.

O. A. Mohamed and O. A. Abbass (2015) [4] explains review about the Consideration of torsional irregularity in Modal Response Spectrum Analysis. The motivation behind their work is to determine the impacts of torsional irregularity on seismic reaction as per ASCE 7–10, when MRSA is utilized for count of seismic forces and drifts. They discussed about why torsional irregularity must be represented, notwithstanding when MRSA is utilized. From their investigation on reviews they concluded that the torsional irregularity of building diaphragm or floor frameworks prompts increased structural reactions including bending moments and drift and should be represented in the computational model to maintain a strategic distance from structural failures and building pounding effects.

Turgut Ozturk , Zubeyde Ozturk and Onur Ozturk (2015) [5] presented a review about the seismic behavior analysis of multi-story reinforced concrete buildings having torsional irregularity. The purpose of their work is to understanding of the characteristics of an earthquake and correct determination of the behavior of buildings under earthquake excitation turn out to be the most important requirement to build earthquake resistant buildings. From the results they explains that the torsional irregularity can occur in the buildings that have regular geometrical shape and regular rigidity distribution. The reason of this irregularity which is called hidden torsional irregularity, is due to lack of rigidity along the extern axes. It is essential that shear wall locations and cross-sectional areas must be properly selected, and the shear walls must be symmetrical in the plan in order to prevent torsional irregularity.

IV. MODELLING

The analysis of 20 storey building is carried out using ETABS 2016.0.0 software situated in zone V. Lateral displacement, storey drift, storey shear and torsional irregularity is compared for all models.

A. Details of models

TABLE I DETAILS OF BUILDING MODEL

Depth of foundation	3m
Floor to floor height	3m
Building dimension	9m x 9m
Type of steel	Fe-500
Grade of concrete	M-25
Column size	400mm x 650mm
Beam size	300mm x500mm
Thickness of masonry wall	150mm
Slab thickness	125mm
Live load	$3.5 KN/m^2$
Seismic zone, Z	V
Importance factor, I	1.5
Response reduction Factor, R	5
Soil type Medium	Medium
Building Height	63m

B. Model type

Table2 Types of Model

model	Type
1	Square shape
2	L shape
3	C shape
4	L shape with one shear wall at centre
5	c shape with two shear wall at each corner
6	C shape with 3 shear wall at each corner in and one is at centre
7	C shape with one shear wall at centre

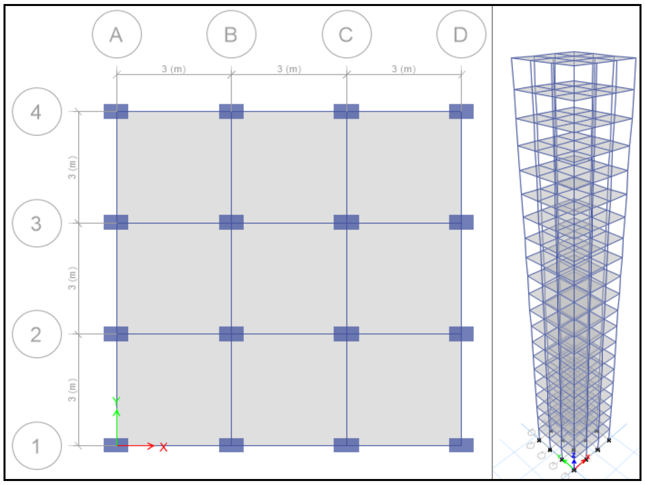

fig 1. Plan and 3D view of Model 1

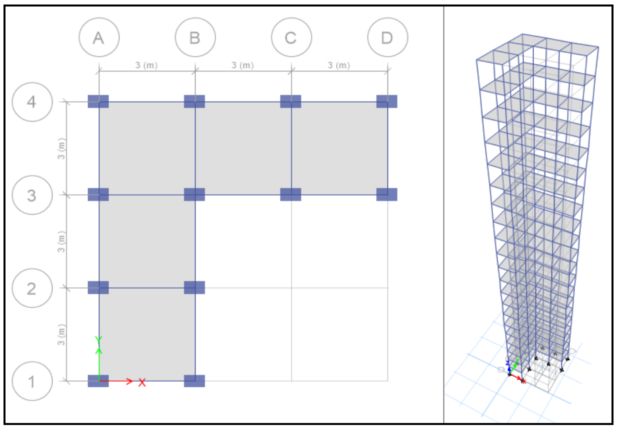

Fig.2 Plan and 3D view of Model 2

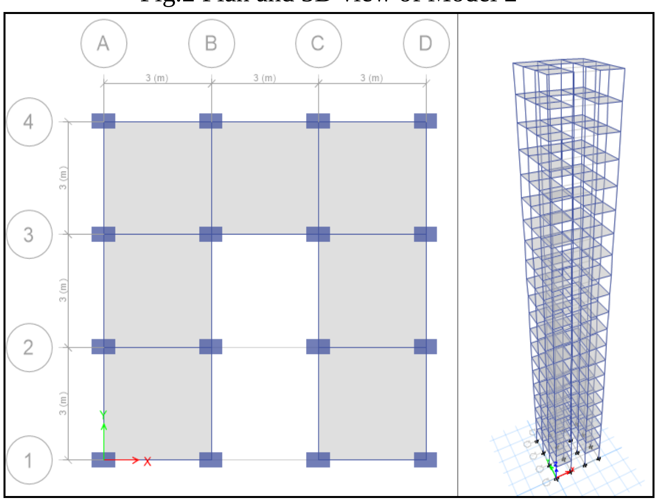

Fig.3 Plan and 3D view of Model 3

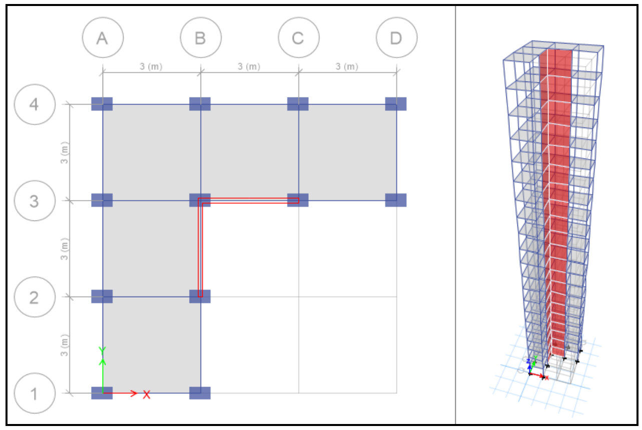

Fig.4 Plan and 3D view of Model 4

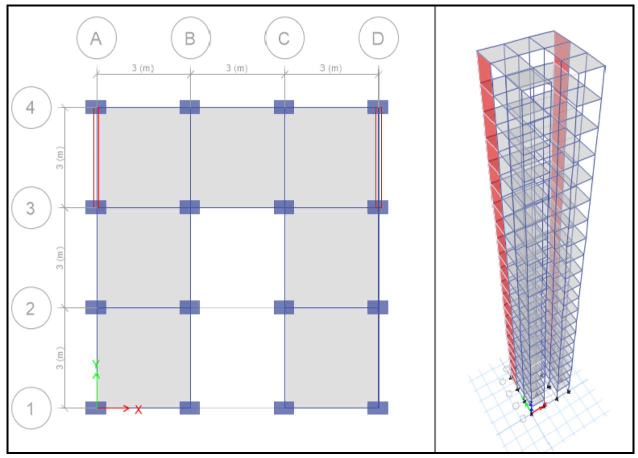

Fig.5 Plan and 3D view of Model 5

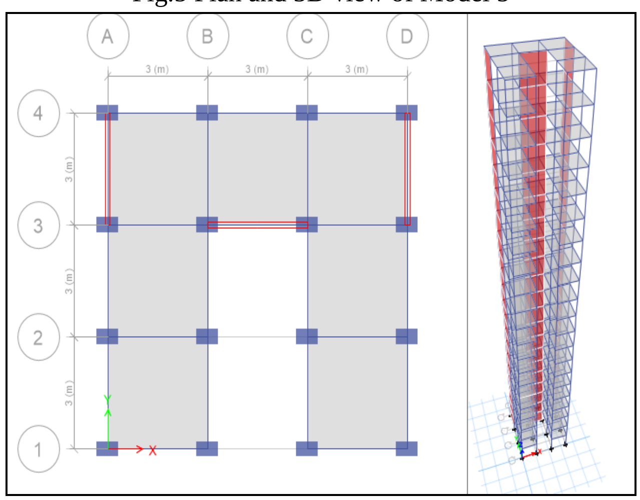

Fig.6 Plan and 3D view of Model 6

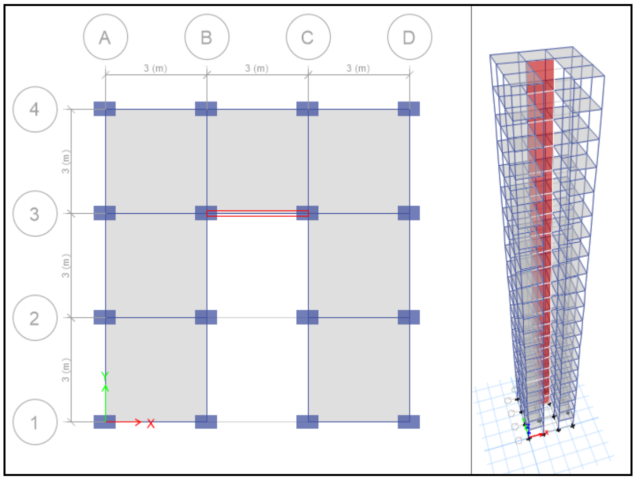

fig.7 Plan and3D view of Model 7

V. RESULTS AND DISCUSSIONS

Storey displacement, storey drifts, and torsional irregularity values are taken from the software. The comparison between the models with and without shear walls and core walls for the parameters mentioned above presented in tables and figures below.

A. Maximum storey displacements

The maximum lateral displacement values for all the models in zone V for Equivalent lateral force method and response spectrum analysis along X and Y direction tabulated in table III and graphical representation in Fig.8.

TABLE III
MAXIMUM DISPLACEMENT IN X AND Y DIRECTION

Model	U_X	U_Y
1	62.682	72.813
2	85.45	70.086
3	91.431	69.238
4	63.081	60.238
5	83.201	63.73
6	71.061	64.862
7	80.74	70.537

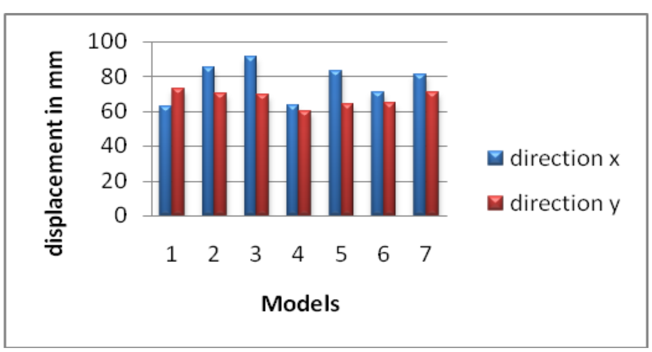

Fig.8 Maximum storey displacement

The storey displacement of all models are shown in fig.8. It shows an increase in storey displacement along the height of the structure. Model 3(C-shaped structure) shows maximum displacement along x direction. The strengthened model 6 (C-shaped structure with 3 shear wall) shows less displacement compare to model 3.

B. Maximum storey drifts

The maximum storey drift values for all the models in zone V for Equivalent lateral force method and response spectrum analysis along X and Y direction tabulated in table IV and graphical representation in Fig.9.

TABLE IV
MAXIMUM DRIFT RATIO IN X AND Y DIRECTION

Model	Drift in X direction	Drift in Y direction
1	0.00084	0.000785
2	0.001201	0.001092
3	0.001351	0.0007430
4	0.00103	0.001007
5	0.001125	0.000974
6	0.001035	0.000992
7	0.001214	0.000753

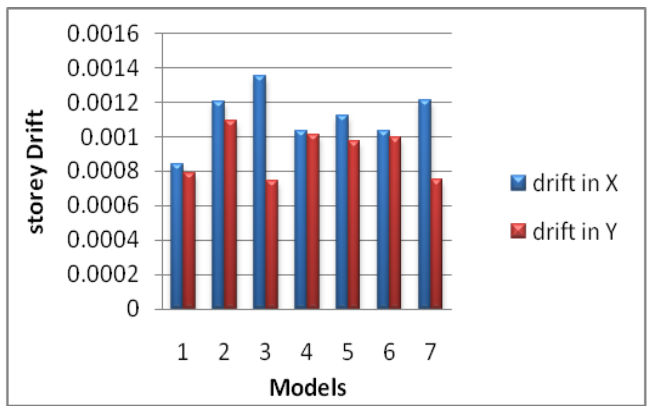

Fig.9 MAXIMUM DRIFT RATIO IN X AND Y DIRECTION

The code recommends a maximum permitted drift value of 0.004H where H is storey height (H=3m) and the permissible drift value is 0.012. Along X direction model 3 and 7 (c-shaped structure) holds higher value than permissible. After application of shear wall we reduce the drift values as shown in model 5 and 6.

C. Torsional irregularity

The table and Fig below shows the time period for the different models.

TABLE VI
TORSIONAL IRREGULARITY in X and Y direction

	Torsional irregularity	
Model	x direction	Y direction
1	1	1
2	1.166	1.141
3	1.237	1
4	1.029	1.016
5	1.225	1.009
6	1.153	1.01
7	1.186	1.01

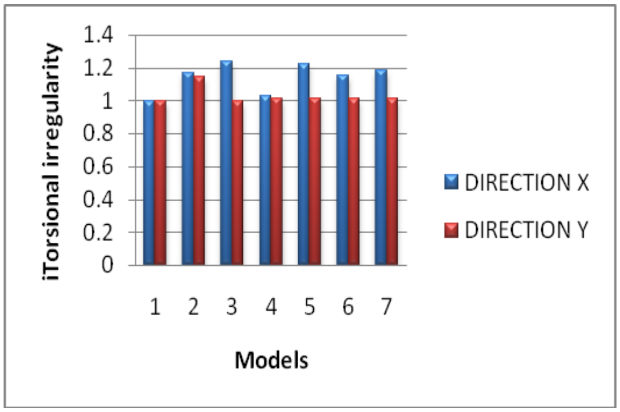

Fig. 11 TORSIONAL IRREGULARITY in X and Y direction

Torsional irregularity should be considered when maximum story drift at one end of the structure transverse to an axis is more than 1.2 times the average of the story drift at the two ends of the structure. Table VI shows Torsional irregularity for different types of model. It is observed that the torsional irregularity of model 3 and model 5 has exceeded the specified limit for response spectrum method and for remaining models the torsional irregularity value has been reduced due to introduction of shear walls.

VI. CONCLUSIONS

1. The displacement is more in model 3 compare to model5,6,7. the model 3 is C-shaped building without shear wall and the model5,6,7 are C-shaped building with shear walls.
2. Positions of shear walls in building influenced the displacement due to seismic actions.
3. Model 3(C-shaped building) holds higher value of drift , after introducing shear wall in model 5,6,7 drift values decreases.
4. Model 3 (L-shaped structure) have within permissible limit of $\Delta Max / \Delta Avg < 1.2$, when appling shear wall model 4 (L-shaped structure with shear wall) again reduce maximum and average storey drift value.
5. In this study it is found that model 3 building shows less displacement compare to other models for both earth quake and wind forces.
6. The permissible limit of $\Delta Max / \Delta Avg < 1.2$ as per IS 1893(part-1):2002.
7. Hence it can be said that the proper location of shear walls results in good, useful and efficient performance of building subjected to lateral forces i.e earth quake.

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REFERENCES

[1] Rahila Thaskeen and Shinu Shajee (2016) " Torsional Irregularity of Multi-storey Structures" International Journal of Innovative Research in Science, Engineering and Technology ISSN(Online) : 2319-8753, Volume 5, Issue9.

[2] Lohith Kumar, Batu Abera Areda, Dereje Tolosa and Gangadhar N (2017) " Seismic effect of Re-entrant and Torsinal Irregularities on multi-storey Buidings" International Research Journal of Engineering and Technology (IRJET) ISSN: 23950072, Volume4, Issue4, Apr-2017.

[3] Arvindreddy and R.J.Fernandes (2015) " Seismic analysis of RC regular and irregular frame structures" International Research Journal of Engineering and Technology (IRJET) ISSN: 23950056, Volume2, Issue5.

[4] O. A. Mohamed and O. A. Abbass (2015) " Consideration of torsional irregularity in Modal Response Spectrum Analysis" WIT Transactions on the Built Environment, ISSN: 1743-3509, Volume 152.

[5] Turgut Ozturk , Zubeyde Ozturk and Onur Ozturk (2015) " Seismic behavior Analysis Of Multi-Story Reinforced Concrete Buildings Having Torsional Irregularity" Challenge Journal Of Structural Mechanics, Volume 1.

[6] IS 1893 (Part 1) (2002), “Criteria for earthquake resistant design of structures”, Part 1 General provisions and building, Fifth revision, Bureau of Indian standards.