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Effect of Core wall on Torsional and Dynamic Behaviour of High –Rise Flat Slab Structure

Supriya S[1], H.S Narashimhan[2]

[1]*PG Student, Department of Civil Engineering, Malnad College of Engineering, Hassan, Karnataka, India*
[2]*Associate Professor, Department of Civil Engineering, Malnad College of Engineering, Hassan, Karnataka, India*

Abstract:- *From last two decades there is a high increase in the high-rise buildings and modern trend is towards high rise structures. In tall buildings with increase in height lateral loads have prime consideration. From the effect of gravity resulting most common loads are dead load, live load and snow load. Buildings are also subjected to lateral loads caused by wind and earthquake. Due to the lateral loads develop high stresses, produce sway movement or vibrations. Flat slab is mostly used system to avoid the beam-column clogging, and it is very economical. Flat slabs directly transfer the loads to columns without beams. But flat slabs are not efficient in transfer the lateral loads. Punching shear strength around the column-slab connections always possess a problem. Punching shear is a type of failure of reinforced concrete slabs subjected to high localized forces. When the total shear force exceeds the shear resistance of the slab, the slab will be pushed down around the column is termed as punching shear in flat slabs. This results in the column breaking through the portion of the surrounding slab.*

Key words: Flat slab, Shear wall, Torsional irregularity, Storey drift, Equivalent static Method, Time history dynamic analysis

1. INTRODUCTION

During the design of buildings, many external effects such as earthquake, wind, snow should be considered. The earthquakes are the most unpredictable and devastating among the natural disasters and in recent years however, a trend of high-rise buildings with complex planning and irregular vertical elevations are trending in a big way but which is a difficult task to evaluate the seismic behaviour of irregular buildings.

Torsion in buildings during earthquake is caused due to various reasons and the most common is unsymmetrical distribution of mass and stiffness along the height of building. For practical purposes, major seismic codes distinguish between irregularity in plan and elevation, but it must be realized that quite often structural irregularity is the result of a combination of both.

2. METHODOLOGY

In the present study, an high-rise/tall structure has been considered as per the specifications of IS 16700-2017 and it is analysed by taking it as 4 models for better understanding using ETABS 2015 using equivalent static and time history dynamic analysis.

Model 1- Beam slab system irregular structure.

Model 2- Flab slab system irregular structure without core wall.

Model 3- Flab slab system irregular structure with core wall location

Model 4- Flab slab system irregular structure with core wall location

For the above models, the torsional behaviour is studied and conclusions are made with respect to safety of tall structural systems considered.

2.1 Material Properties

Table 1:- Material Properties

Grade of Concrete, f_{ck}	M-50
Grade of Steel, f_{st}	Fe-500
Young's- Modulus- steel, Es	2, 10,000 MPa
Young's - Modulus - concrete, E_c	35,355 MPa
Ultimate strain in bending, Ɛcu	0.0035

2.2 Model Description

Table 2:- Material Properties	
Number of bays along X Dir	10
Number of bays along Y Dir	10
Bay width along X and Y Direction each	5m
Number of stories	60
Storey Height	3 and 4Mtrs
Storey Height at Ground floor	4 and 5Mtrs
Beam Dimension	300X600MM
Column Dimension	400X900MM
Slab Thickness	150MM

2.3 Analysis

The modelling and analysis of the building is carried out using ETABS 2015 and the method of seismic analysis now considered is Equivalent Static Method and Time History Analysis.

2.4 Model Details with Plan and Elevation

1) **Model 1:-** Beam slab system irregular structure

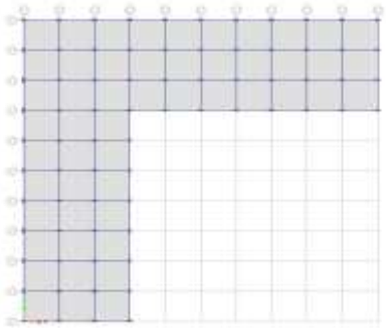


Fig- 1 Plan View of Model 1

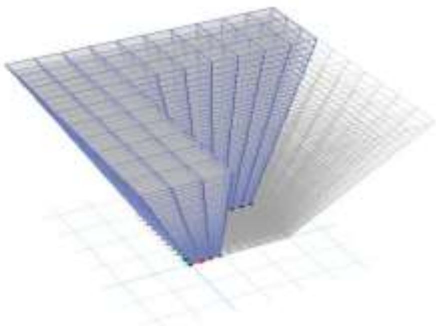


Fig- 2 3D View of Model 1

2) **Model 2:-** Flab slab system irregular structure without core wall

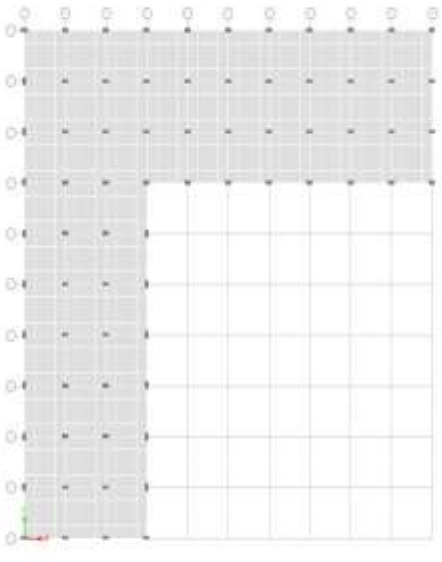


Fig- 3 Plan View of Model 2

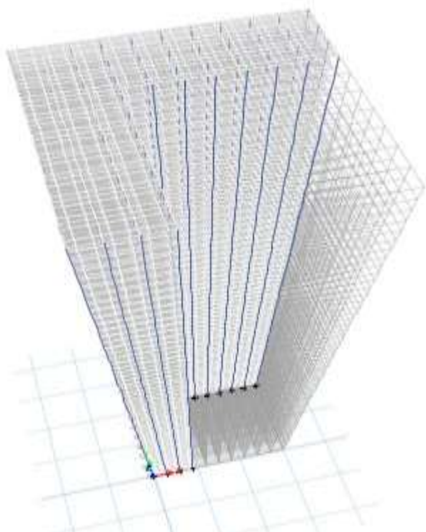
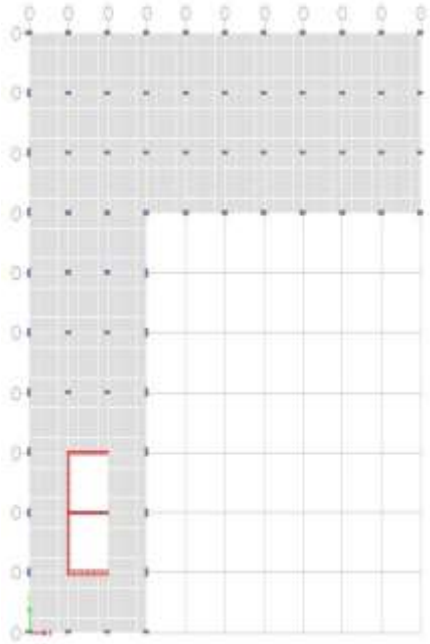


Fig- 4 3D View of Model 2

3) **Model 3:-** Flab slab system irregular structure with core wall location



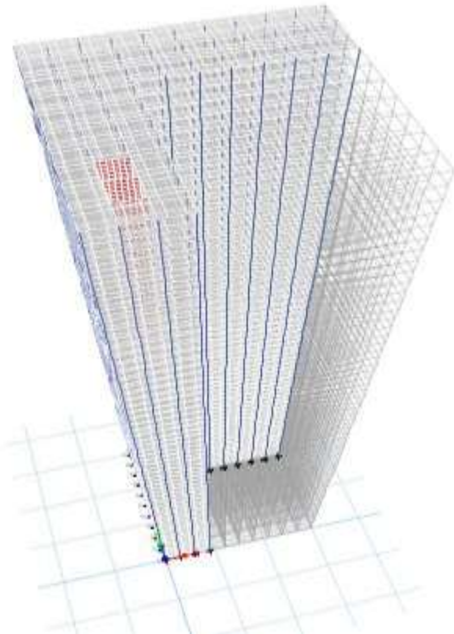
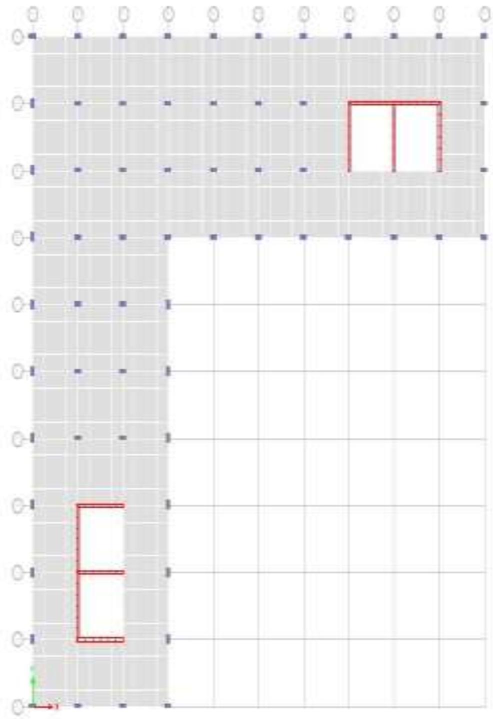


Fig-5 Plan view of Model 3 **Fig-6 3D view of Model 3**

4) **Model 4:-** Flab slab system irregular structure with core wall location



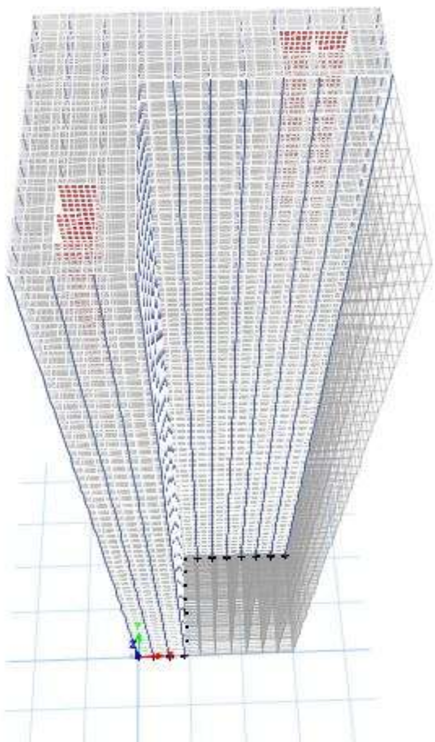


Fig-7 Plan view of Model 3 **Fig-8 3D view of Model 3**

3. RESULTS AND DISCUSSION

Results for 240 m height tall buildings

3.1 Lateral load analysis: Equivalent Static analysis as per IS 1893- 2016

Equivalent Static analysis has been carried out as per IS 1839-2016 for high seismic zone and results are extracted and presented in the form of tables and graphs.

3.1.1 Base Shears

Table 3 Maximum Base Shear

Maximum Base Shear (kN)			
RC Frame	Flat Slab	Flat Slab with SW-1	Flat Slab with SW-2
Model 1	Model 2	Model 3	Model 4
11849	10380	10534	10689

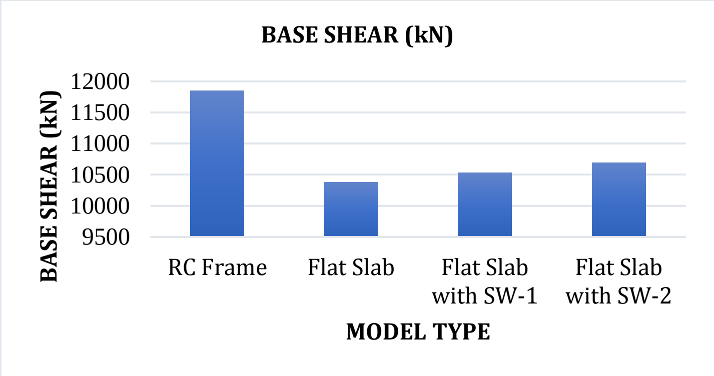


Figure 9 Maximum Base Shear

From base shear response of all the structural systems, it is observed that, conventional RC frame structural system has relatively large base shear compared to all other structural systems. With the removal of beams from the structural system about 12% reduction in base shear is observed in flat slab structural system.

Table 1 Torsional Moment

Torsional Moment (kN-m)			
RC Frame	Flat Slab	Flat Slab with SW-1	Flat Slab with SW-2
456261	400149	402193	410769

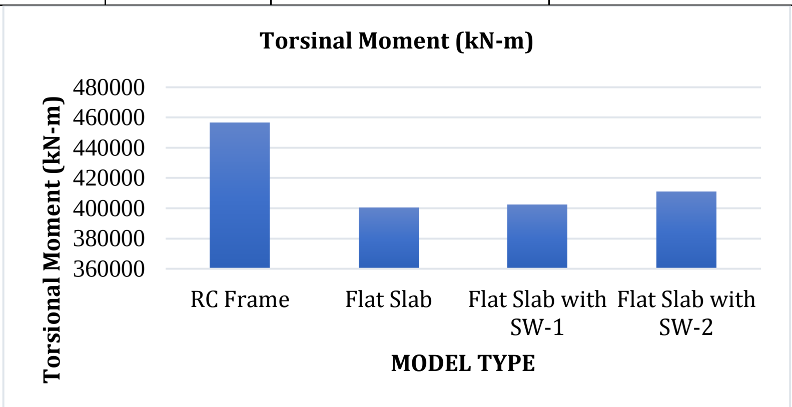


Figure 10 Torsional Moment

Similar to Base Shear, torsional moment at the base of the structure is found to be around 10% more in RC frame with respect to all other structural systems.

3.2 Dynamic Time History Analysis

Dynamic time history analysis has been carried out for ELCENTRO earthquake and key results are presented and summarised in this section. Peak Responses

Table 3 Time History Response Summary Chart - ELCENTRO

Models	Peak Acceleration (m/s^2)		Peak Displacements (mm)	
	X Dir.	Y Dir.	X Dir.	Y Dir.
Model 1	2.59	2.61	336	374
Model 2	2.59	2.61	466	466
Model 3	3.02	2.60	374	435
Model 4	2.87	2.88	372	377
Model 5	2.59	2.61	439	470
Model 6	2.55	2.97	417	448
Model 7	2.54	2.81	373	421
Model 8	3.09	2.93	379	386

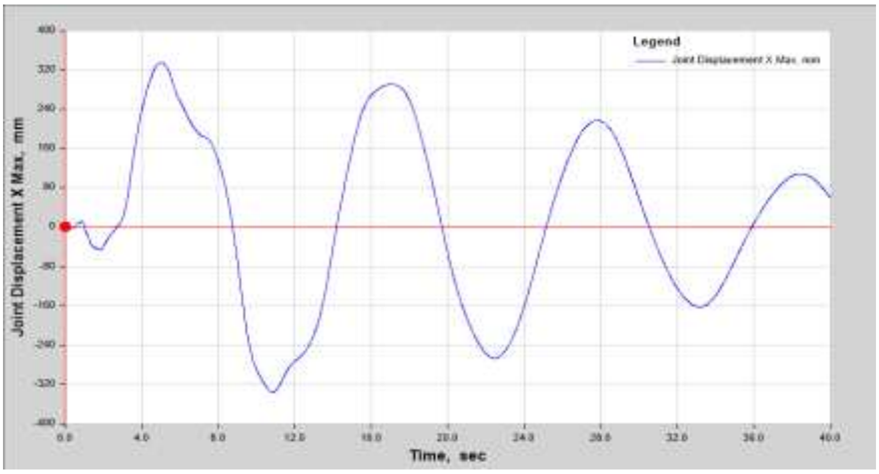


Figure 11 Typical Peak Displacement Response

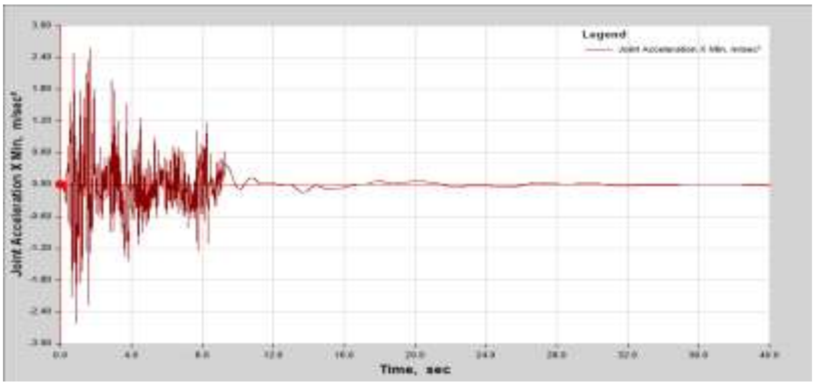


Figure 12 Typical Peak Acceleration Response

3.2.1 Torsional Irregularity Ratios

Table 6 Torsional Irregularity Ratio – THX – 4 m (Storey Height)

Model No.	Type of Structural Systems	Deflection mm (X -Direction) (THX)			
		Min	Max	Ratio	Torsional Effect
Model 1	RC Frame	236	336	1.42	No
Model 2	Flat Slab	358	446	1.25	No
Model 3	Flat Slab (SW– 1)	325	374	1.15	No
Model 4	Flat Slab (SW– 2)	238	372	1.56	Yes

Table 7 Torsional Irregularity Ratio – THY – 4 m (Storey Height)

Model No.	Type of Structural Systems	Deflection mm (Y -Direction) (THX)			
		Min	Max	Ratio	Torsional Effect
Model 1	RC Frame	287	374	1.30	Yes
Model 2	Flat Slab	364	466	1.28	No
Model 3	Flat Slab (SW– 1)	210	435	2.07	Yes
Model 4	Flat Slab (SW– 2)	243	377	1.55	Yes

Due to dynamic time history effect, Model 4 fall in to torsional irregularity type of structural system along X direction, but with respect to Y direction Model 3 and 4 has the torsion effect.

Table 8 Torsional Irregularity Ratio – THX – 5 m (Storey Height)

Model No.	Type of Structural Systems	Deflection mm (X -Direction) (THX)			
		Min	Max	Ratio	Torsional Effect
Model 1	RC Frame	307	439	1.43	307
Model 2	Flat Slab	231	417	1.81	231
Model 3	Flat Slab (SW– 1)	234	373	1.59	234
Model 4	Flat Slab (SW– 2)	169	379	2.24	169

Table 9 Torsional Irregularity Ratio – THY – 5 m (Storey Height)

Model No.	Type of Structural Systems	Deflection mm (Y -Direction) (THX)			
		Min	Max	Ratio	Torsional Effect
Model 1	RC Frame	305	470	1.54	305
Model 2	Flat Slab	212	448	2.11	212
Model 3	Flat Slab (SW– 1)	170	421	2.48	170
Model 4	Flat Slab (SW– 2)	162	386	2.38	162

Due to dynamic time history effect, Model 3 and 4 falls in to torsional irregularity type of structural system along X direction but with respect to Y direction all the structural systems will fall under the torsional irregular category.

4. CONCLUSIONS

Following conclusions are made from results and discussion

- With the increase in storey height from 4 m to 5 m, a change in the overall vibrational characterises of the tall structural system has been observed. Unlike in 240 m height building, Conventional RC frame structure has more time period than all other tall structural system.
- For the displacement and drift results and discussions it can be concluded that, for tall structural system additional structural component like shear walls are necessary to limit reduce the displacements and drifts.
- With respect to torsional irregularity, the core wall has significant effect. From the results of torsional irregularity ratio from both equivalent static and dynamic analysis it can be concluded that, core will (shear walls) will induce additional torsional effect on floors in tall structural systems along both X and Y direction.
- With introduction of core wall in both the extreme locations more torsion will be induced.
- Also, with the increase in the floor height from 4 to 5 m, the effect of torsion will have impact on the overall performance of the structure.
- Hence from the present study, it can be concluded that, for tall structural systems, in addition of core wall, other structural components like outrigger, belt truss, cap truss has to be incorporated to limit the displacements, drifts and torsional rotation of the building.

References

1. Adarsh A, Rajeeva S V, " Seismic analysis of multi storey reinforced concrete buildings having torsional irregularity", International Journal of Research in Engineering and Technology, 2017
2. Mario Stefano, " A review of research on seismic behaviour of irregular building structures since 2002", Bulletin of Earthquake Engineering, 05/2008
3. Mohammed Fatir, "Relative study of seismic analysis between flat slab and grid slab of RCC structures with different masonry infills in two different zones", International Journal of Research in Engineering and Technology, 2016
4. Murulidhar G.B, " Comparision of Performance of Lateral load resisting systems in multi storey flat slab building", International Journal of Research in Engineering and Technology, 2016
5. Proceedings of the International Symposium on Engineering under Uncertainity; Safety assessment and management(ISEUSAM-2012)", Springer Nature,2013
6. Recent Advances in Structural Engineering Volume 1", Springer Nature America, Inc, 2019
7. Recent Advances in Structural Engineering Volume 2", Springer Nature America, Inc, 2019