Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 3, March -2017

Comparative Study of Lateral Load Resisting Systems for Irregular Shape of Building for Different Soils

Jaykishan Makavana[1], Asst Prof Vinay Anand[2]

[1]*Post Graduate Student, Department of Civil Engineering, School of Engineering, R K University, Gujarat, India*
[2]*Aassistant Professor, Department of Civil Engineering, School of Engineering, R K University, Gujarat, India*

Abstract — *For earthquake resistant design the normal building should be able to resist minor, moderate, sever shaking. In the circumstances of the building, simple shape configuration building transfer the earthquake force in the direct path to the base while in complex shape building, the load transferring path is indirect which leads to generation of stresses at the corners. Structure designers need to design and build a structure in which the damage to the structure and its structure component by earthquake is minimized. From the past studies and structure designer's researches, they found various lateral load resisting systems; like Shear wall systems, Bracing systems, Flat slab systems, etc. Here 15 Storey T-Shape building is considered for analysis. In present study five different models are used for analysis, I) Bare Frame, II) Moment resisting frame with steel bracings at corners (MFBR), III) Moment resisting frame with RC Shear wall at corners(MFSW), IV) Flat slab with steel bracings at corners(FSBR), V) Flat slab with RC Shear wall at corners(FSSW). All models analyzed for three types of soils, I) Hard Soil, II) Medium Soil, III) Soft Soil as per IS 1893 (Part-1):2002. All the models were analyzed using Finite Element Method based software ETABS 15.0.0 subjected to lateral and gravity loading in accordance with IS provisions. The main parameters considered in this study to compare the seismic performance of different models for linear static analysis are; Top storey displacements, Storey drift ratios, Storey shears and for dynamic analysis are; Torsional moments, Time Period and Response Spectrum.*

Keywords *– ETABS 15.0.0, Lateral Load Resisting Systems, Shear Wall, Bracing, Flat Slab, Lateral Displacement, Base Shear, Storey Drift, Time Period.*

I. INTRODUCTION

1. SHEAR WALL

Shear wall is a structural member used to resist lateral forces i.e. parallel to the plane of the wall. For slender walls where the bending deformation is more, Shear wall resists the loads due to Cantilever Action for short walls where the shear deformation is more it resists the loads due to Truss Action**.** In other words, Shear walls are vertical elements of the horizontal force resisting system.

In building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes. Examples are the reinforced-concrete wall. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and occupants; create powerful twisting (torsional) forces. This leads to the failure of the structures by shear.

Shear walls are especially important in high-rise buildings subjected to lateral wind and seismic forces. Generally, shear walls are either plane or flanged in section, while core walls consist of channel sections. They also provide a adequate strength and stiffness to control lateral displacements.

2. BRACING

Braced frames act in the same manner as shear walls, but they may offer lower resistance depending on their design and construction. Bracing generally takes the form of steel rolled section, circular bar section, or tubes. Vibration may cause the bracings to elongate or compress. Ductility is very important in designing the bracings.

The main function of the bracing in structures is; the lateral forces due to wind, earthquake and crane surge etc are transmitted efficiently to the foundation of the building. A system of lateral or diagonal bracing is provided to prevent the building from twisting under the action of wind.

3. FLAT SLAB

A flat slab is a two-way reinforced concrete slab that usually does not have beams and girders, and the loads are transferred directly to the supporting concrete columns.

The column tends to punch through the slab in Flat Slabs, which can be treated by three methods:

1. Using a drop panel and a column capital in flat slab
2. Using a drop panel without a column capital in flat slab

3. Using a column capital without drop panel in flat slab

II. METHODOLOGY

1. PRELIMINARY DATA FOR MODEL GENERATION

Table 1. Preliminary data for model generation

Shape of buildings	Rectangle, T-Shape, L-Shape
Each bay size	5m
Number of storeys	15
Floor to Floor height	4m for Ground storey & 3m for Other storeys
Beam size	(230x450) mm
Column size (External)	(230X500) mm
Column size (Internal)	(300X300) mm
Slab thickness	150 mm
Drop	250 mm
External wall thickness	230 mm
Internal wall thickness	115 mm
Height of parapet wall	1 m
Thickness of parapet wall	115 mm
Terrace water proofing	1.5 kN/m2
Floor finish	0.6 kN/m2
Live load	3 kN/m2 (As per IS : 875 (Part 2) – 1987, Table-1, Page 7)
Thickness of Shear wall	300 mm (As per IS 13920 : 1993, Clause 9.1, Page 12)
Steel Bracing	ISMB500

Table 2. Material Property

Concrete Grade	M25
Steel reinforcement Main & Secondary	Fe415
Steel for bracing	Fe345
Unit weight of Concrete	25 kN/m3
Unit weight Brick masonry	20 kN/m3

Table 3. Seismic Data

Seismic Zone	IV (Z=0.24)
Response reduction factor	5
Importance factor	1
Soil condition	Hard, Medium and Soft as per IS 1893 (Part 1) : 2002
Damping	5%

2. LOAD COMBINATION

1. 1.5 (DL+LL)
2. 1.5 (DL+LL) + EQX
3. 1.5 (DL+LL) – EQX
4. 1.5 (DL+LL) + EQY
5 1.5 (DL+LL) - EQY
6. 1.5 (DL+EQX)
7. 1.5 (DL-EQX)
8. 1.5 (DL+EQY)
9. 1.5 (DL-EQY)
10. 0.9 DL + 1.5 EQX
11. 0.9 DL – 1.5 EQX
12. 0.9 DL + 1.5 EQY
13. 0.9 DL – 1.5 EQY
14. 1.2 (DL+LL+EQX)
15. 1.2 (DL+LL-EQX)
16. 1.2 (DL+LL+EQY)
17. 1.2 (DL+LL-EQY)

3. PLAN & 3D VIEW OF MODELS

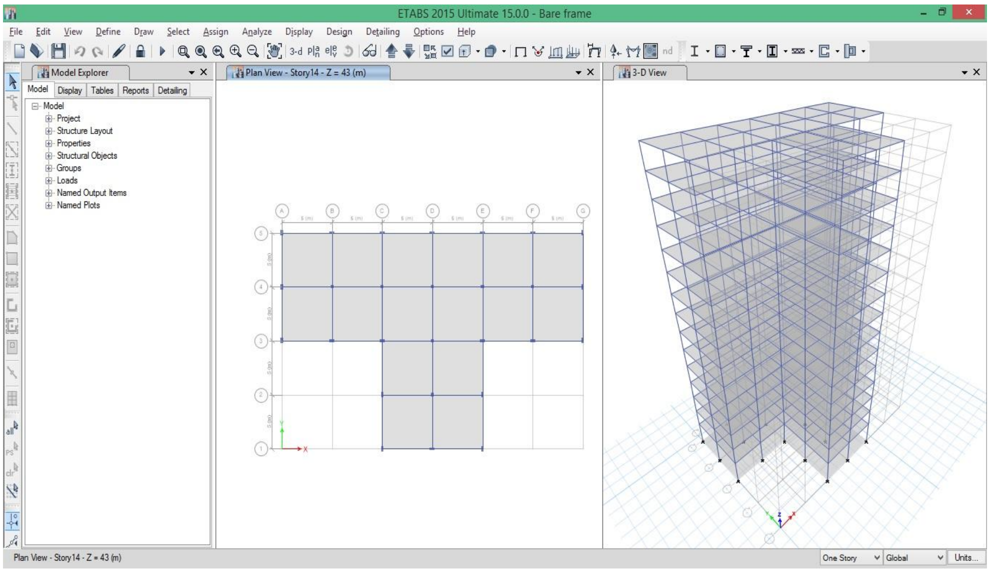


Figure 1. Plan & 3D view of Model-1 (Bare Frame)

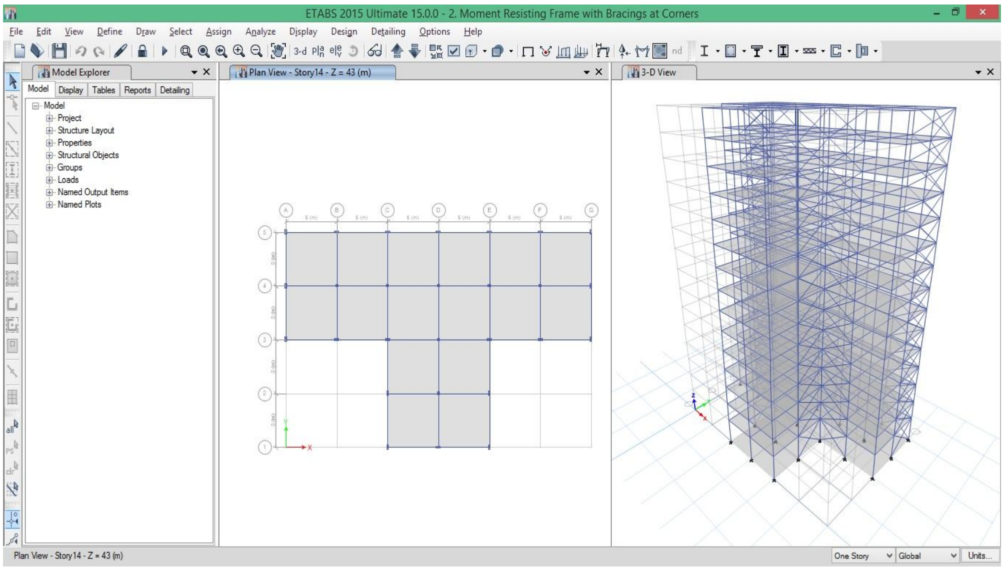


Figure 2. Plan & 3D view of Model-2 (Moment Resisting Frame with Brcings – MRBR)

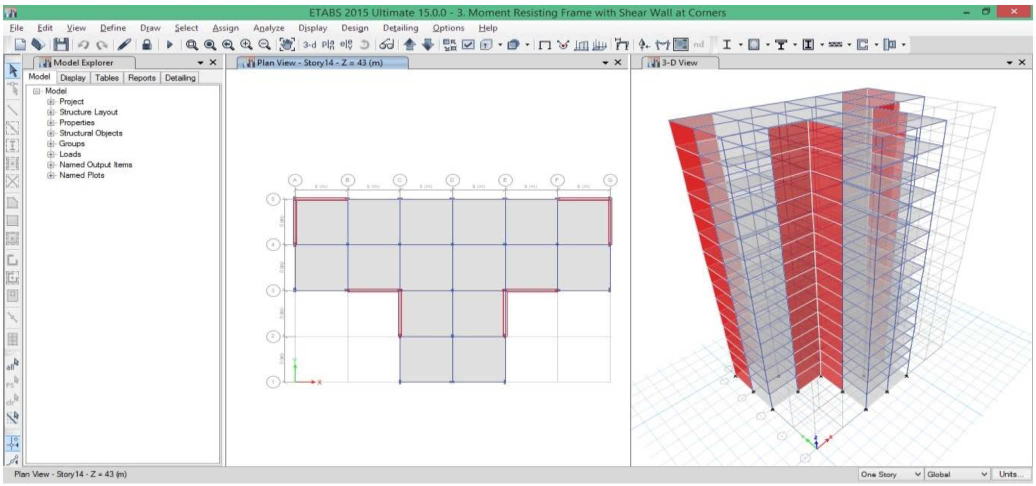


Figure 3. Plan & 3D view of Model-3 (Moment resisting frame with Shear wall – MRSW)

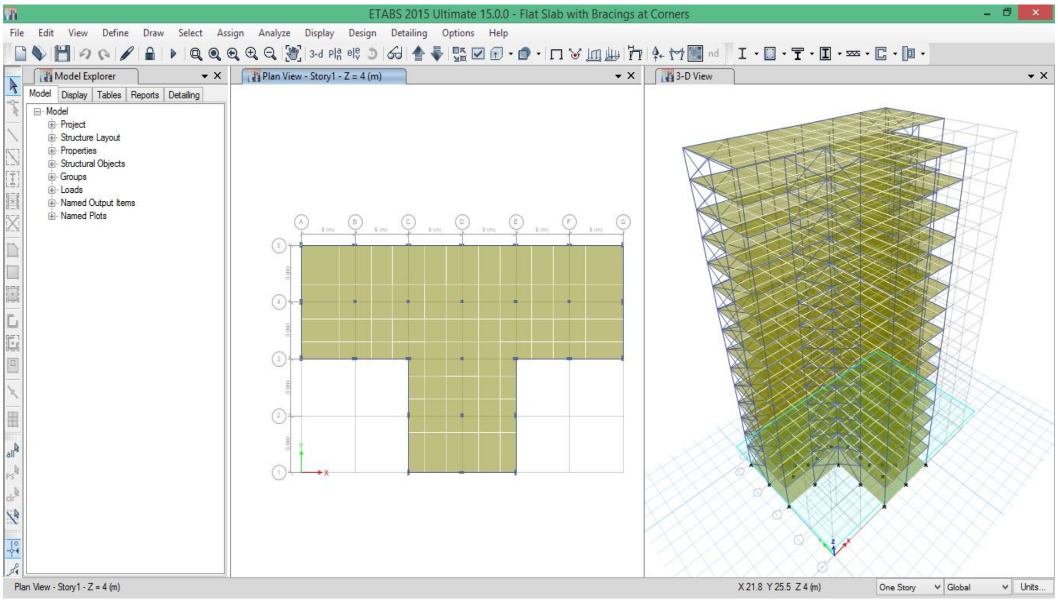


Figure 4. Plan & 3D view of Model-4 (Flat slab with Bracings – FSBR)

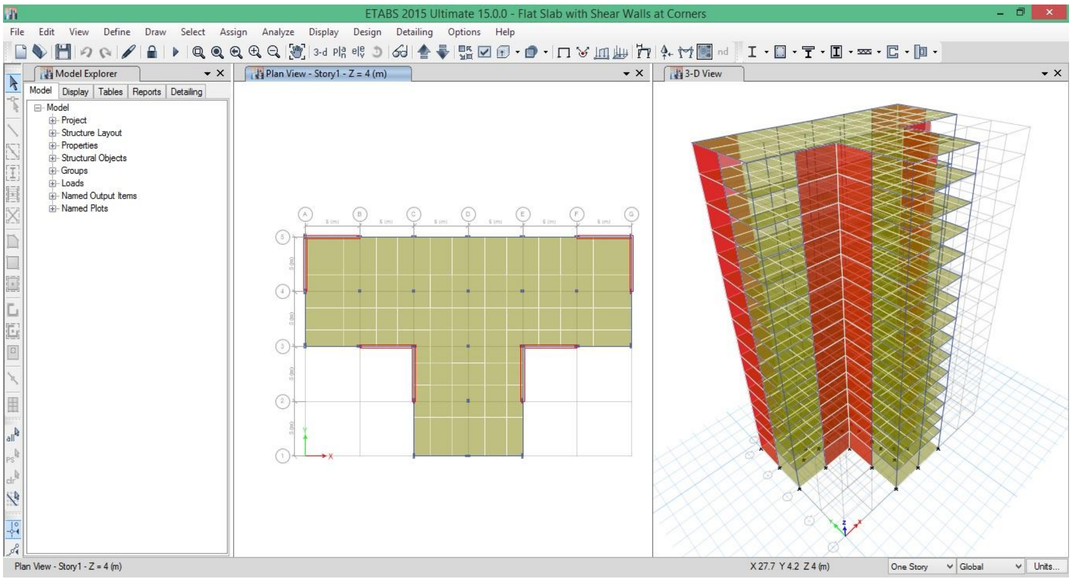


Figure 5. Plan & 3D view of Model-5 (Flat slab with Shear wall – FSSW)

III. RESULTS

1. TOP STOREY DISPLACEMENT

Table 4. Top storey displacement in both X & Y direction

Lateral Load Resisting Systems	Hard Soil		Medium Soil		Soft Soil	
	X	Y	X	Y	X	Y
1. Bare Frame	100.2	123.8	136.3	164.3	167.4	199.2
2. MRBR	47.1	42.8	64	58.2	78.6	71.6
3. MRSW	35.3	23.1	48	33.9	58.9	43.2
4. FSBR	55.4	39.5	75.1	56.6	92	71.4
5. FSSW	37.7	20.8	51.1	31.7	62.7	41.1

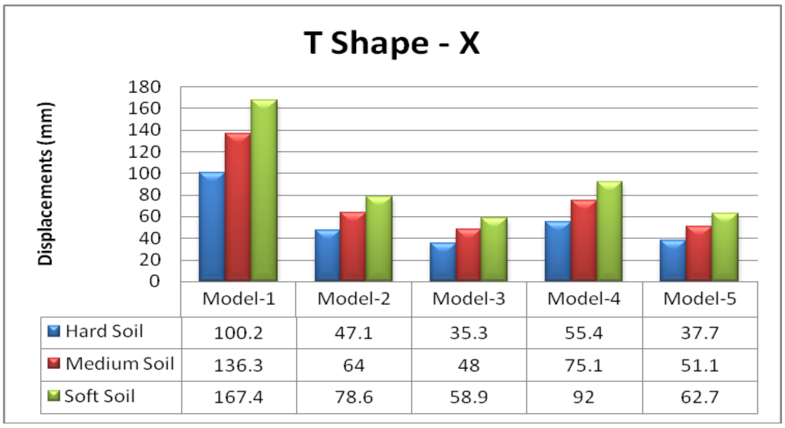


Figure 6. Top storey displacement in X-direction

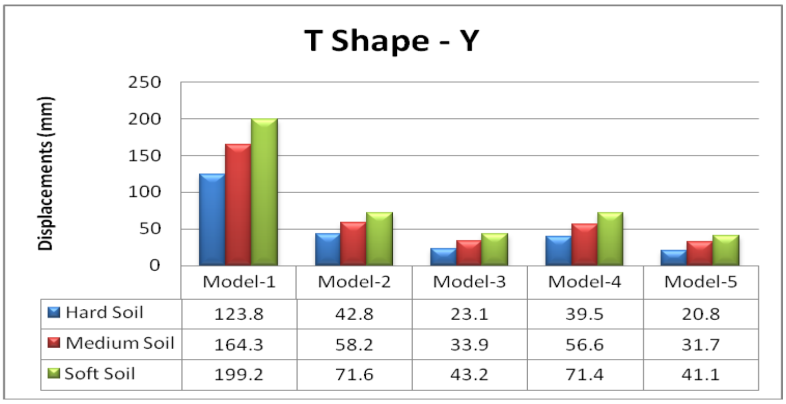


Figure 7. Top storey displacement in Y-direction

2. STOREY DRIFT

Story drift is the displacement of one level relative to the other level above or below. Software value of story drift is given in ratio.

Story drift ratio = (difference between displacement of two stories / height of one storey).

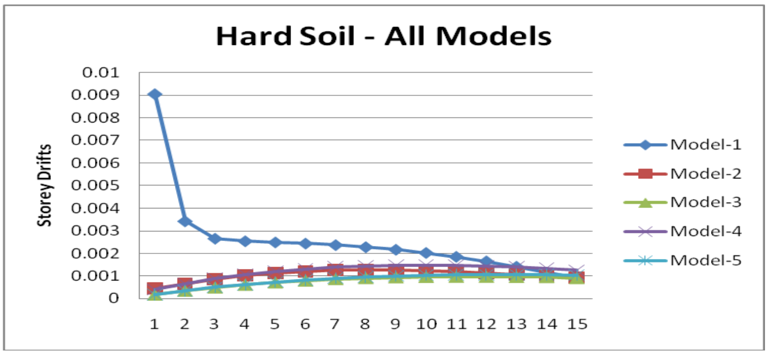


Figure 8. Storey drif for hard soil – All Models

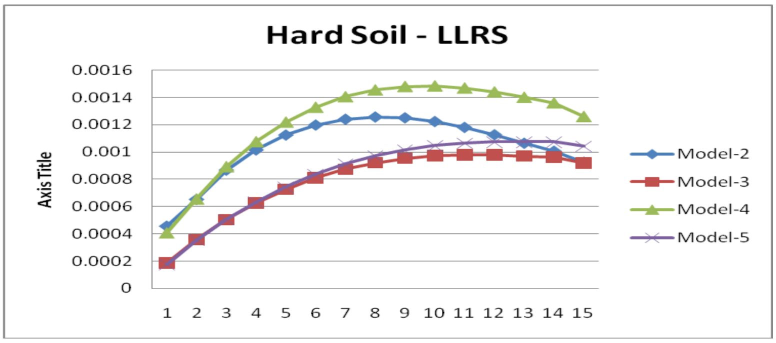


Figure 9. Storey drif for hard soil – LLRS

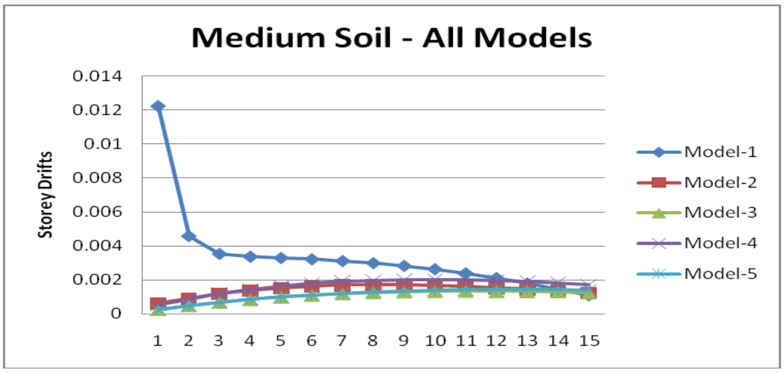


Figure 10. Storey drif for medium soil – All Models

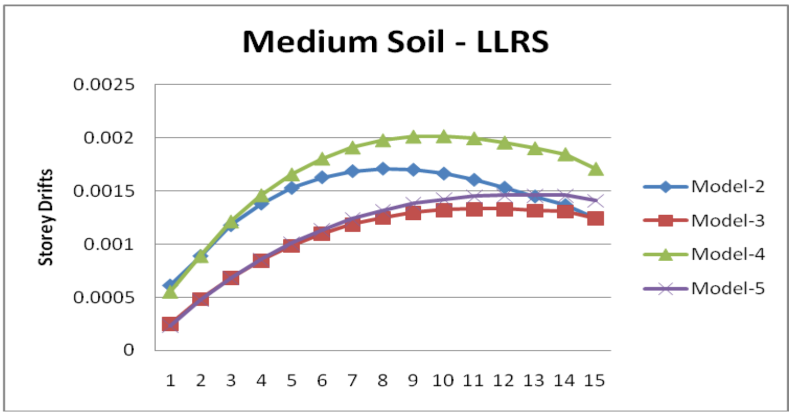


Figure 11. Storey drif for medium soil – LLRS

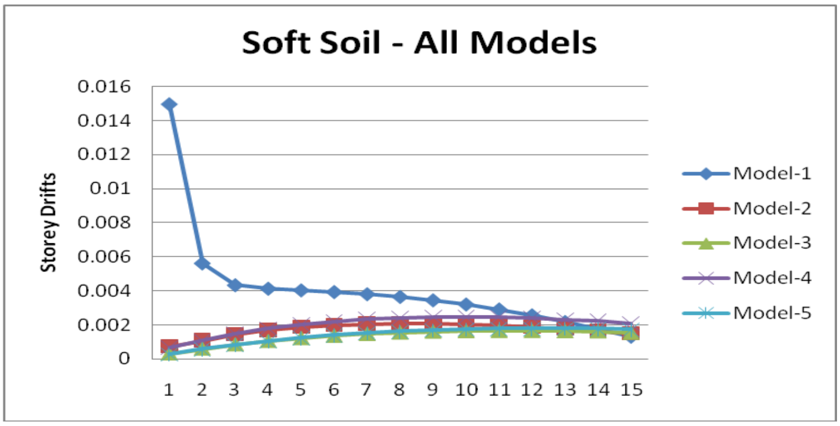


Figure 12. Storey drif for soft soil – All Models

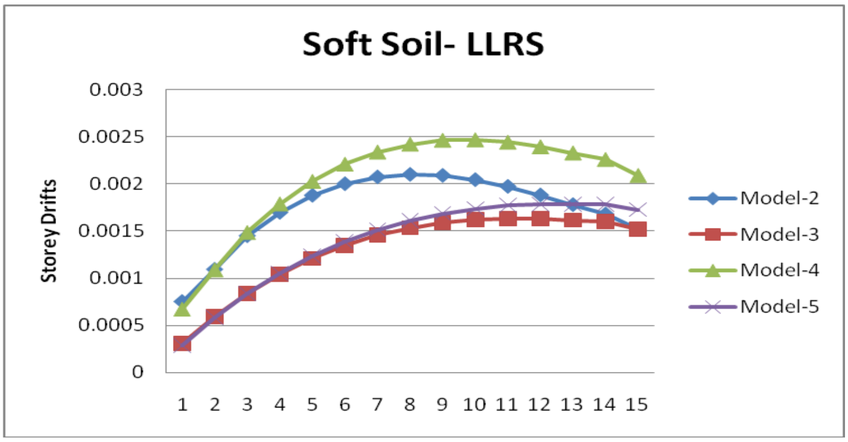
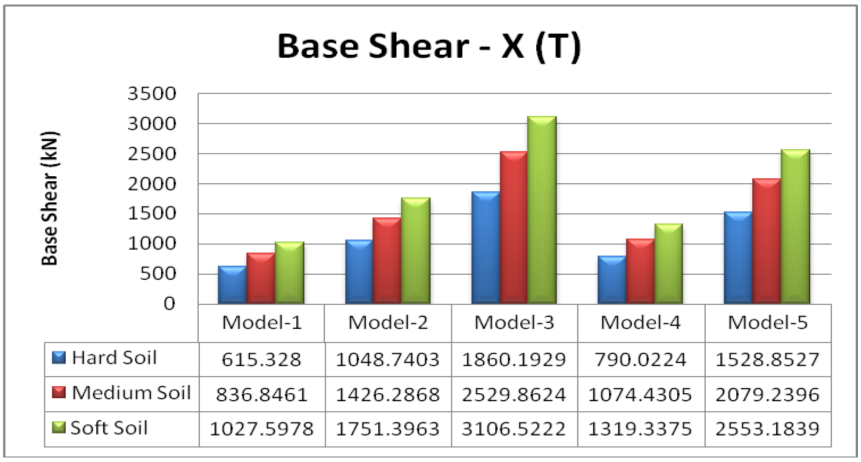


Figure 13. Storey drif for soft soil – LLRS

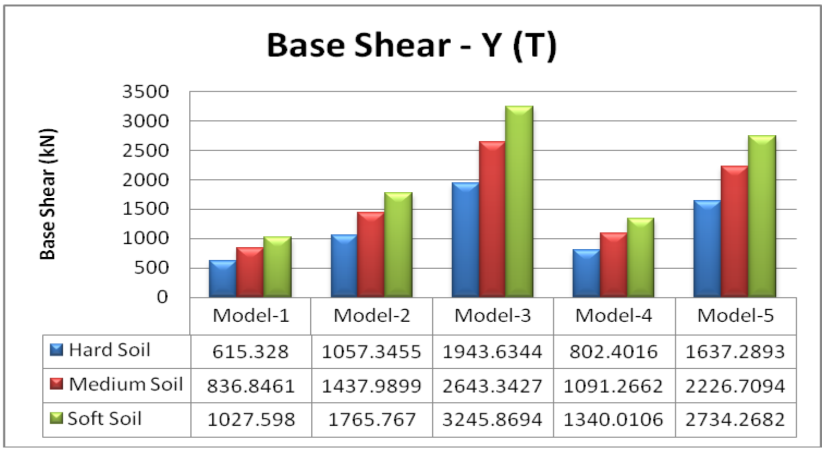
3. BASE SHEAR

Base Shear is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure.



	Model-1	Model-2	Model-3	Model-4	Model-5
Hard Soil	615.328	1048.7403	1860.1929	790.0224	1528.8527
Medium Soil	836.8461	1426.2868	2529.8624	1074.4305	2079.2396
Soft Soil	1027.5978	1751.3963	3106.5222	1319.3375	2553.1839

Figure 14. Base shear in X-direction

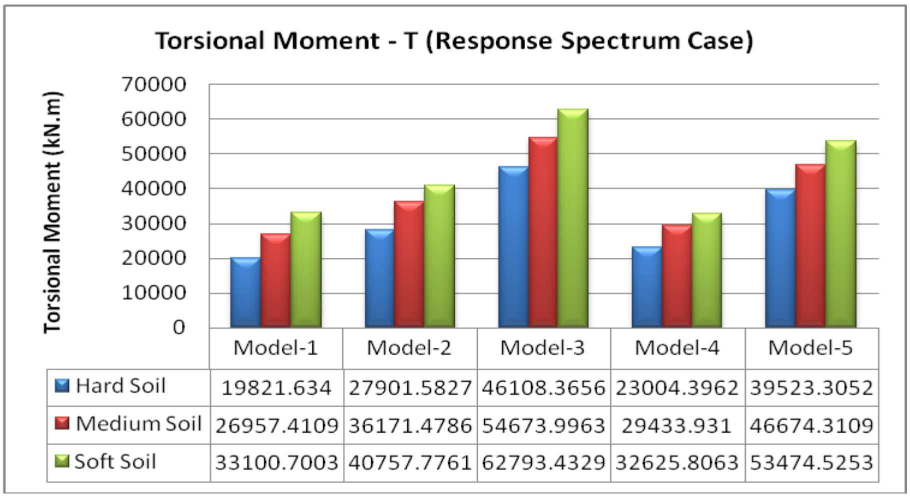


	Model-1	Model-2	Model-3	Model-4	Model-5
Hard Soil	615.328	1057.3455	1943.6344	802.4016	1637.2893
Medium Soil	836.8461	1437.9899	2643.3427	1091.2662	2226.7094
Soft Soil	1027.598	1765.767	3245.8694	1340.0106	2734.2682

Figure 14. Base shear in Y-direction

4. TORSIONAL MOMENT

Maximum torsional moment occurs at bottom storey. So here data collected are from Storey-1 for Response Spectrum case.



	Model-1	Model-2	Model-3	Model-4	Model-5
Hard Soil	19821.634	27901.5827	46108.3656	23004.3962	39523.3052
Medium Soil	26957.4109	36171.4786	54673.9963	29433.931	46674.3109
Soft Soil	33100.7003	40757.7761	62793.4329	32625.8063	53474.5253

Figure 15. Torsional Moment

5. TIME PERIOD

Fundamental natural period is first longest modal time period of vibration. The results of natural time period for various LLRS are presented in charts for all types of soils.

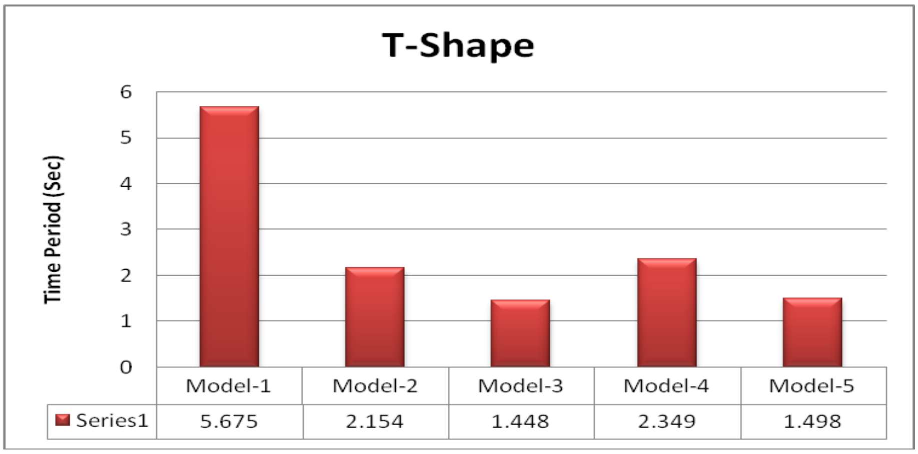


Figure 16. Time period

6. STOREY ACCELERATION

Maximum storey acceleration occurs at top storey for Response Spectrum case. So here data collected are for top storey.

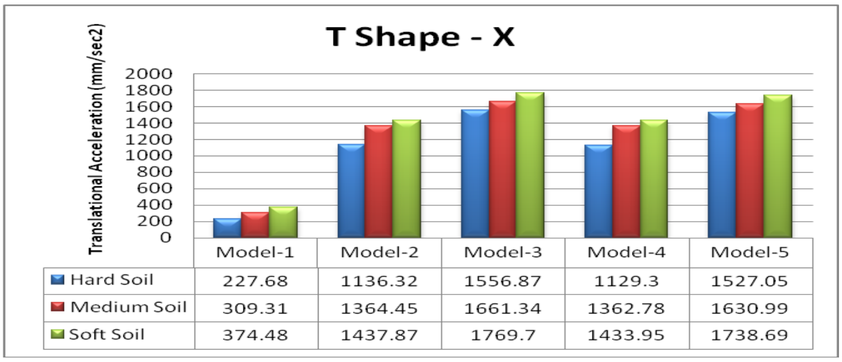


Figure 17. Storey acceleration in X-direction

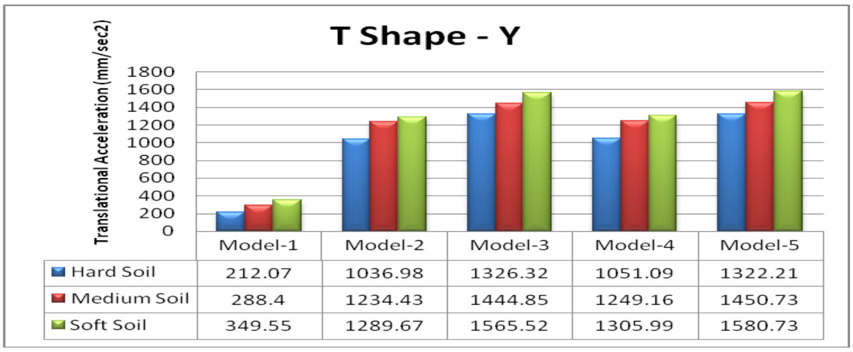


Figure 18. Storey acceleration in Y-direction

IV. CONCLUSION

The following conclusion are drawn from the present study

- The reduction in top storey displacement for Model-5 (FSSW) is about 83.19%, 80.70% and 79.36% for Hard soil, Medium soil and Soft soil respectively when compared to bare frame. Hence Flat slab with shear wall at corners is effective in reducing the lateral displacement.

- The reduction in storey drift for Model-5 (FSSW) is about 13.98%, 25.98% and 33.30% for Hard soil, Medium soil and Soft soil respectively when compared to bare frame. Hence Flat slab with shear wall at corners effectively counteract the seismic forces and reduce the storey drift.
- Model-3 (MRSW) and Model-5 (FSSW) are showing higher Base shear among all models for all types of soil.
- Model-3 (MRSW) is showing higher Torsional moment among all models for all types of soils. Model-5 (FSSW) is showing less Torsional moment compare to Model-3 (MRSW).
- The time period for Moment resisting frame without any LLRS is comparatively more than other buildings. The considerably reduction in time period is found for Model-2 (MRBR), Model-3 (MRSW), Model-4 (FSBR) and Model-5 (FSSW).
- The natural time period for Model-3 (MRSW) and Model-5 (FSSW) is 74.48% and 73.60% respectively less compare to Bare frame.
- Translational acceleration is higher and almost same for Model-3 (MRSW) and Model-5 (FSSW) for all types of soils.
- So overall, Model-3 (MRSW) and Model-5 (FSSW) both are better option for LLRS in T-Shape buildings for all types of soil condition (Hard, Medium and Soft).

REFERENCES

[1] *Mohd Atif, Prof. Laxmikant Vairagade and Vikrant Nair,* "Comparative Study On Seismic Analysis Of Multistorey Building Stiffened With Bracing And Shear Wall", International Research Journal of Engineering and Technology (IRJET), Volume.02, Issue.05, August 2015, eISSN: 2395-0056, pISSN: 2395-0072

[2] *Shachindra Kumar Chadhar and Dr. Abhay Sharma,* "Comparative Study of RC Moment Resisting Frame of Variable Heights with Steel Bracing and Shear Wall", International Journal of Civil and Structural Engineering Research, Vol. 3, Issue 1, pp: (220-221), Month: April 2015 - September 2015, ISSN 2348-7607 (Online)

[3] *Rasool.Owais and Tantray. Manzoor Ahmad,* "Comparative Analysis between Different Commonly used Lateral Load Resisting Systems in Reinforced Concrete Buildings", Global Journal of Researches in Engineering: Civil And Structural Engineering, Volume 16 Issue 1 Version 1.0 Year 2016, Online ISSN: 2249-4596 & Print ISSN: 0975-5861

[4] K. G. Patwari and L. G. Kalurkar, "Comparative study of RC Flat Slab & Shear wall with Conventional Framed Structure in High Rise Building", International Journal of Engineering Research, Volume No.5 Issue: Special 3, pp: 612-616

[5] *Muralidhar G.B and Swathi Rani K.S,* "Comparison Of Performance Of Lateral Load Resisting Systems In Multistorey Flat Slab Building", International Journal of Research in Engineering and Technology (IJRET), eISSN: 2319-1163 pISSN: 2321-7308

[6] *Divya C. Bhuta and Umang Pareekh,* "Comparative Study on Lateral Load Resisting System in Tall Building", International Journal of Science Technology & Engineering (IJSTE)| Volume 2, Issue 11, May 2016, ISSN (online): 2349-784X

[7] *Prathith Hegde and Dr. Akshatha Shetty,* "Seismic Anallysis Of A RC Frames Using Lateral Load Resisting Systems", International Journal of Technical Research and Applications, Volume 4, Issue 3 (May-June, 2016), PP. 197-200, e-ISSN: 2320-8163

[8] *Nischay J and M.R.Suresh,* "Comparative Study Of The Performance Of Tall Structure With Diagrid And Shear Wall Systems Subjected To Seismic Loading", International Research Journal of Engineering and Technology (IRJET), Volume:03, Issue: 07, Jul-2016, e-ISSN: 2395 -0056, p-ISSN: 2395-0072

[9] *Pooja Biradar, Kishor Kulkarni and Nikhil Jamble,* "Seismic Performance of High Rise Flat Slab Building with Various Lateral Load Resisting Systems", Bonfring International Journal of Man Machine Interface, Vol. 4, Special Issue, July 2016, ISSN 2277-5064

[10] IITK Earthquake Tips

[11] IS 456:2000, "Code of practice for plain and reinforced concrete", Bureau of Indian Standard, New Delhi, India.

[12] IS 1893:2002, "Indian Standard Criteria for Earthquake Resistance design of structures Part-1-General provisions and building", Bureau of Indian Standard, New Delhi, India.

[13] IS 875 (Part 1, part 2, part 3) - 1987 "Code of Practice for Design Loads for Buildings and Structures" for Dead Load, Imposed Load, and Wind Load respectively.

