Analysis of Seismic Response of a Unsymmetrical Building(G+13) Using ETABS

Sonu Rani Nirmalkar[1], Aman Gautam[2], Vijay Kumar Shukla[3]

[1]M.Tech Scholar, Vishwavidyalay Engineering College, Ambikapur, Sarguja Chattisgarh
[2]M.Tech Scholar, Vishwavidyalay Engineering College, Ambikapur, Sarguja Chattisgarh
[3]Assistant Professor, Vishwavidyalay Engineering College, Ambikapur, Sarguja Chattisgarh

Abstract:
From the past records of earthquake, there is increase in the demand of earthquake resisting building which can be fulfilled by providing the shear wall systems in the buildings.In this we have considered an unsymmetrical plan under earthquake load and wind load. There are two models have taken to analyze: - 1. Bare frame structure and 2. Shear wall Structure. Shear walls are generally provided for full height of the frame. Shear wall systems are one of the most used lateral load resisting systems in high-rise buildings. The earthquake and wind load are applied in an unsymmetrical building located at zone-III. A comparative analysis has been done between building having bare frame and shear wall structure. The complete analysis is done using E-TABS Software. Lateral displacement, Time period and story drift are calculated in both the cases. It was observed that Multistoried Buildings with shear wall is more able to resist lateral loads as compared to without shear wall.

Key words: -Seismic analysis, Unsymmetrical plan, Lateral displacement, Storey drift, Time period, E-TABS

1. INTRODUCTION

There are many changes has been developed in construction as compared to past construction process. There is also need of multi-storey structure and the analysis and design of these structures is very complex in nature. The analysis of such structure can be done with the help of various software.

It would be ideal if all buildings have their lateral load resisting elements symmetrically arranged and earthquake ground motions would strike in known directions. Due to scarcity of land in big cities, architects often propose irregular buildings to utilize maximum available land area and to provide adequate ventilation and light in various building components. In this thesis work we are analyzing a G+13 building. We have taken the unsymmetrical geometry of building to analyze by using E-TABS Software.

In this we have considered two models: - i) Bare frame structure, ii) Shear wall structure.

2. LITERATURE REVIEW

P.P Chandurkar and Dr. P.S. Pajgade (June 2013) have discussed the seismic analysis of G+9 building with four models, 1 model is bare frame and another are the of dual type by using E- TABS v9.5.0. They have considered the location of building in ZONE-II, ZONE-III, ZONE-IV and ZONE-V.

Determination of different parameters such as horizontal displacement, storey drift and total cost required for ground floor are calculated in both the case replacing column with shear Wall.

M.Pavani, G.Nagesh Kumar *et al* (Jan.2015) They have described the design and optimization of shear wall. The complete work is done in ETABS software. They conclude the arrangement of shear wall in such a way that it can able to resist the lateral forces in zone-III region according to Indian standard code.

S. Rahman, S. A. Hossain (2021) have considered existing buildings of different stories as 8, 10, 13 storey to analyze the seismic effect of building. The analysis is done on ETABS v9.6. They have observed the different parameters storey shear, base shear, and storey drift for different buildings. They conclude that increase of extra storey in structure provides extra shear force, moment and deflection in column and beam. Base shear was also increased with increase in storey numbers.

SS, Raghu K (2022) have discussed the comparative study of wind load and seismic load. They considered G+8 building at various seismic zones to analyze and whole analysis is done in ETABS v 18.1.1 software. They determined the parameters such as storey displacement, storey drift and storey shear etc. They conclude that the maximum storey displacement, storey shear and storey drift is found to be maximum in zone V when compared to other seismic zones since zone factor is highest for zone V.

3. Problem Identification

In this, the analysis of G+13 multi-storied building with unsymmetrical planned of floor area 3384.24sq feet is considered.
In this work two models are considered which are as follows-
(i) Bare frame structure
(ii) Shear wall frame structure
Analysis of whole problem is completely done in E-TABS and gives comparative result between different parameters such as storey drift, lateral displacement and time period, frequency and base shear and storey shear.
Details of size and geometry of various structural components for both framing are shown in table no.3.1.
Basic Wind and seismic loading condition for both systems are shown in table no 3.2.

Table.3.1 Structural Data and Material Properties

S.No.	Structural Data	Properties
1	Concrete Grade	M30
2	Type OF Material	Isotropic
3	Mass Per Unit Volume	2.5KN/m^3
4	Modulus of Elasticity	27 KN/m^3
5	Poisson's Ratio	0.2
6	Concrete Strength	30 Mpa
7	Wall Thickness	200 mm

8	R C wall above door in structural wall system	200mmx900 mm
9	Slab Thickness	125 mm
10	Sunk Slab Thickness	145 mm
11	Stair Slab Thickness	150 mm
12	Tensile Reinforcement	500
13	Shear Reinforcement	500
14	Number of Stories	G+13
15	Depth of Foundation	2m
16	Storey Height	3m
17	Beam size in Conventional (system (B1)	200mmx600 mm
18	Beam size in Conventional	200mmx450 mm
19	Column size in Conventional system (C1)	200mmx380 mm
20	Column size in Conventional system (C2)	200mmx600 mm
21	Column size in Conventional system (C3)	200mmx800 mm
22	Column size in Conventional system (C4)	200mmx1150 mm

Table 3.2 Seismic, wind, Dead, Live Loading Parameters

S. No.	Parameter	Value
1	**Seismic coefficient as per IS :1893-2000**	
	Seismic zone	III
	Seismic Zone Factor	0.16
	Soil Type	II (Medium)
	Importance Factor (I)	1
	Response Reduction Factor	3
2	**Wind Coefficient as per IS :875**	
	Risk Coefficient (k1)	1
	Terrain Category , Height , Structure Size (K2)	2
	Structure Class	B
	Topography Factor (K3)	1
	Location	Jabalpur
	Basic Wind Speed	47 m/s
3	**Dead Load**	

	SDL (Super imposed dead load)on all Slabs	1.5 KN/M2
	SDL (Super imposed dead load) on sunk & Stair case	4 KN/M2
4	**Live Load**	
	Live Load on Slab or FLoors	2 KN/M2
	Live Load on Sunk Slab, Stair Slab	2 KN/M2

4. METHODOLOGY

The E-TABS software is used to develop 3D model and to carry out the analysis. The lateral loads to be applied on the buildings are based on the Indian standards. The study is performed for seismic zone III as per IS 456 (Dead load, Live Load) IS 1893:2002 (Earthquake load), IS875: 1987(Wind Load). G+13 storied building analyzed for seismic and wind forces. G+13 storied building analyzed with bare frame and shear wall structure. There is need to study parameters as Lateral displacement, Story shear, Story drift.

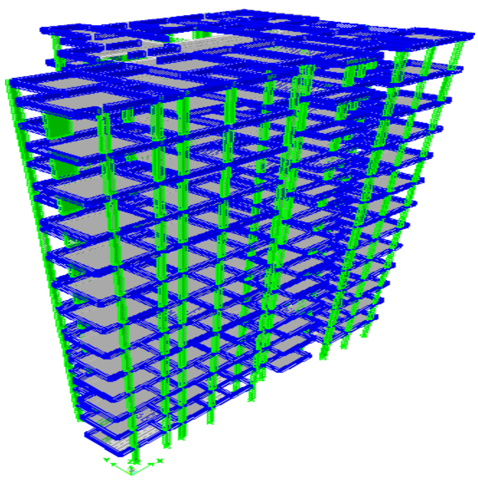

Figure 4.2 MODEL-1 floor plan of Bare Frame (Beam Column Frame) Structure

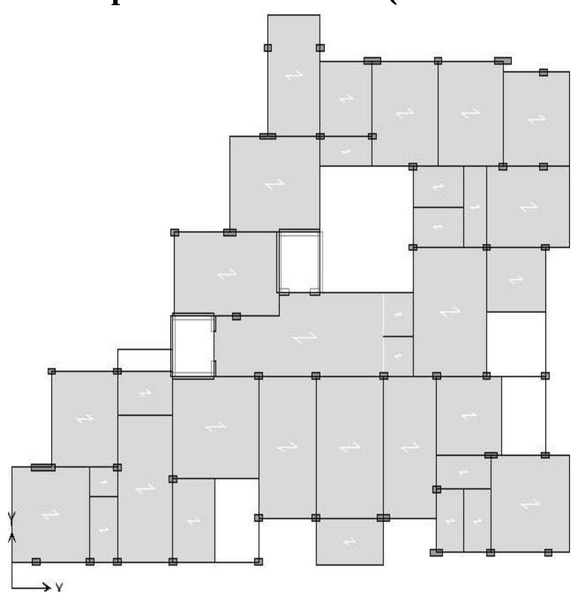

Figure 4.3 3D Model of G+13 Storied Bare Frame System Building

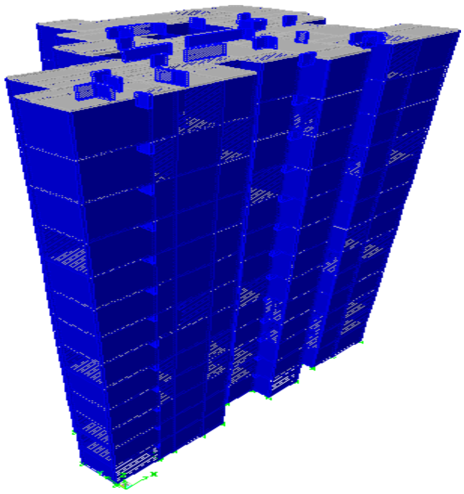

Figure 4.4 MODEL-2 floor plan showing RC Structural Wall (shear wall) System.

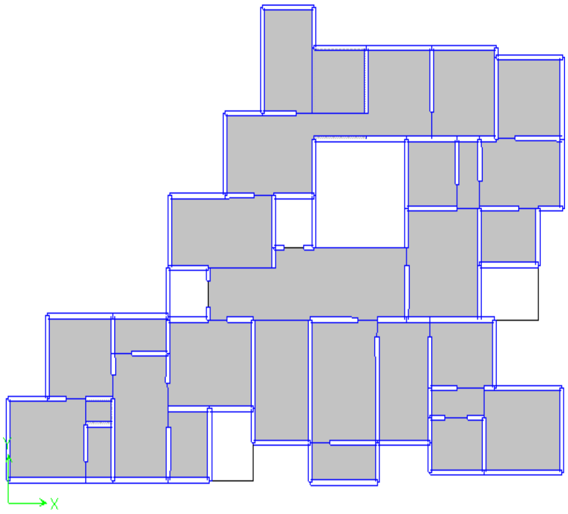

Figure 4.5 3D Model of G+13 Storied RC Structural Wall

5. RESULT:

5.1 Comparative analysis of model-1 & 2 subjected to wind loading: -

5.1.1 Comparative analysis of storey drift index due to wind loading

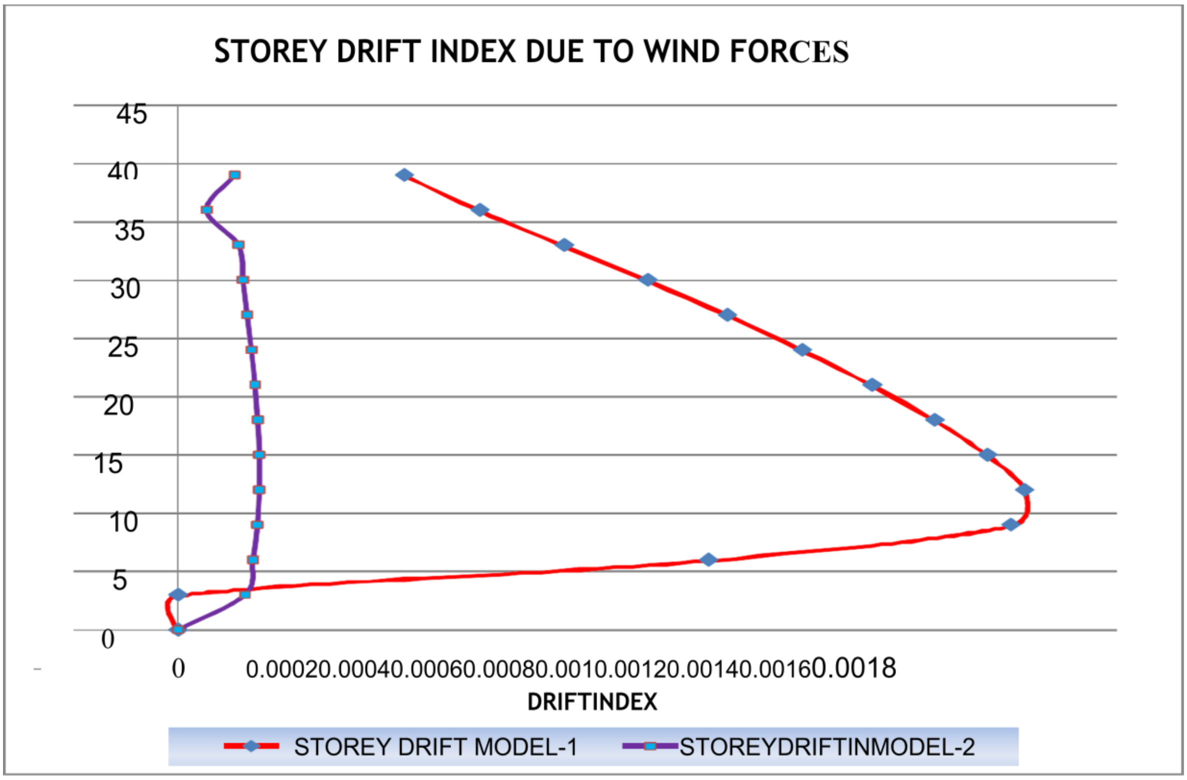

Figure-5.1 Graphical comparative representation of storey drift index due to wind force

5.1.2 Comparative analysis of lateral displacements due to wind loading

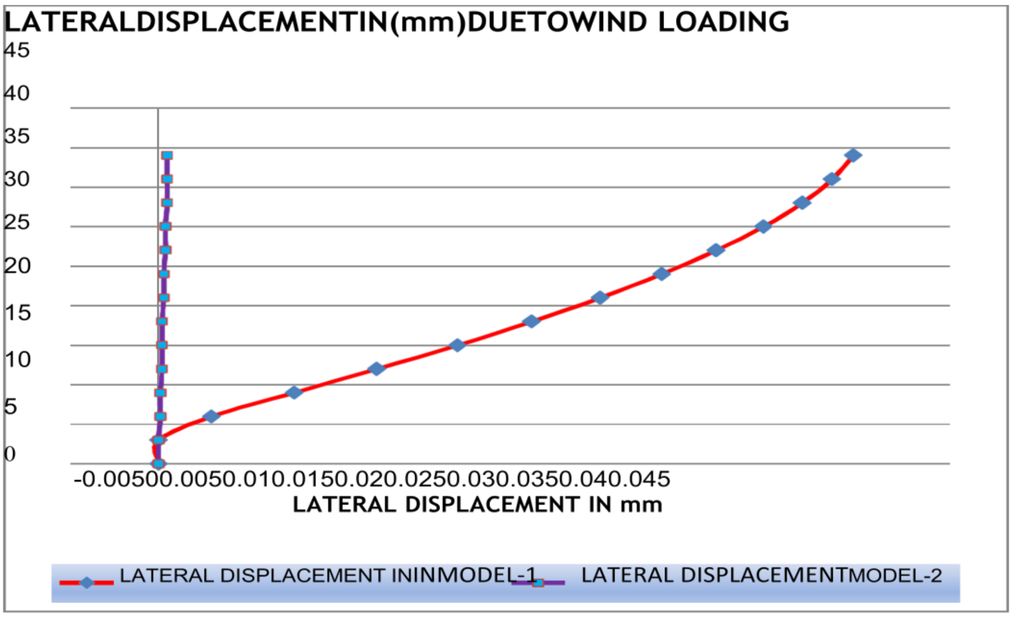

Figure-5.2 Graphical comparative representation of lateral displacements due to wind force

5.2 Comparative analysis of model-1 & 2 subjected to earthquake loading: -

5.2.1 Comparative analysis of storey drift index due to earthquake loading

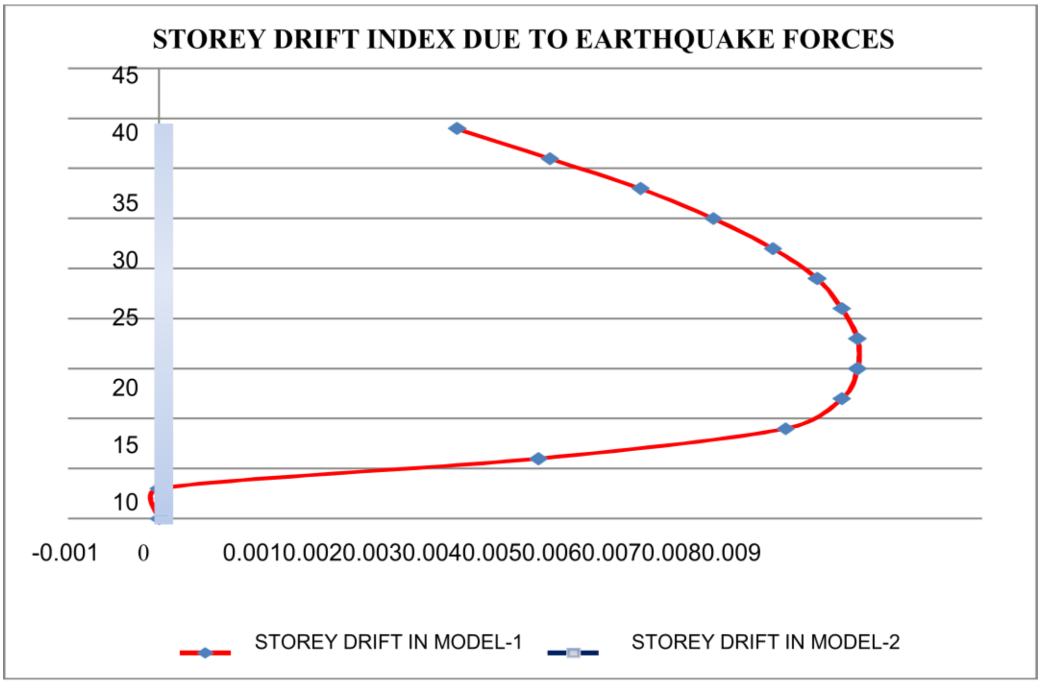

Figure-5.3 Graphical comparative representation of storey drift index due to earthquake forces

5.2.2 Comparative analysis of lateral displacements due to earthquake loading

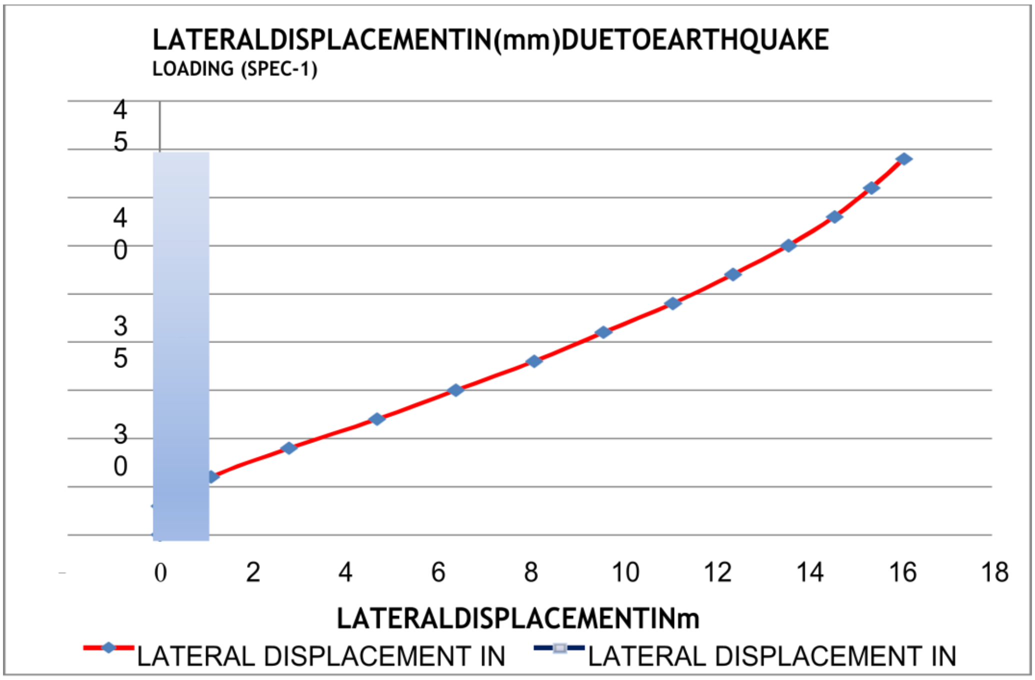

Figure-5.4 Graphical comparative representation of lateral displacements due to earthquake force

6. CONCLUSION AND FUTURE SCOPE

6.1 Conclusion:

From the above result it is concluded that the model-2 is stiffer against lateral loads as compare to model-1. Also, it is concluded that shear wall frame structure is more reliable against lateral displacements and storey drift index. Shear wall structures are more safe compare with bare frame in the case of worst loading**.**

6.2 Future Scope:

The analysis of also needed in Y-direction of the frame accordingly shear wall frame in other direction. The design of various members of the frame and the walls is required for various load combinations given the IS codes. The analysis of shear wall can be done with different position. One can also analysis the same by taking infill wall in place of bare frame to check the effect of stiffness.

REFERENCE:

1. M.S. Aainawala 1 , Dr. P.S. Pajgade 2 " Design of Multistoried R.C.C. Buildings with and Without Shear Walls" 1 Assistant Professor, 2 Professsor, Deptt. Of Civil Engg. Prof. RamMegha Institute of Technology and research Badnera, Amravati, Maharashtra India. International Journal of Engineering Sciences & Research Technology, July 2014;
2. Aainawala,3[7] pg. 498-510.
3. M.D. Kevadkar 1 , P.B. Kodag 2 " Lateral Load Analysis of R.C.C. Building" 1 M.E. Structure Student, 2 Assistant Professor, Deptt. of Civil Engg. Singhad College of Engineering ,Pune, India. International Journal of Modern Engineering Research,June2013 Vol-3,Issue 3,
4. pp1428-1434.
5. Tarun Shrivastava 1 , Anubhav Rai 2 Yogesh Kumar Bajpai 3 " Effectiveness of Shear Wall- Frame Structure Subjected to Wind Loading in Multi-Storey Building" 1 M-Tech Student, 2 Asst.Prof., Deptt. of Civil Engg. 3 HOD Deptt. of Civil Engg. Gyan Ganga Institute of Technology and Sciences Jabalpur Madhya Pradesh. International Journal of Computational Engineering Research, Feb.2015, ISSN(e):2250-3005, Vol-5, Issue 02, pp20-28.
6. N.B. Baraskar 1 , U.R. Kawade 2 "Structural Performance of RC Strucutral Wall System Over Conventional Beam Column System in G+15 Storey Building" 1PG Student, 2Associate Professor, Deptt. of Civil Engg. Pad. Dr. Vithalrao Vilke Patil College of Engineering, Ahmednagar, Maharashtra India. International Journal of Engineering Research and Gernal Science Vol.3 Issue 4, August2015.pp639-654.
7. M.Pawani 1 , G. Nagesh Kumar 2 , Dr. Sandeep Pingale 3 " Shear Wall Analysis and Design Optimization in Case of High Rise Buildings Using Etabs (Software)" International Journal of Scientific & Engineering Research, Vol-6, Issue 1, Jan.2015,pp549-559."Seismic Analysis of An Unsymmetrical Multi-storey Building with Response Spectrum Method using E-TABS"
8. Anuj Chandiwala "Earthquake Aanalysis of Building Configuration With Different Position of Shear Wall" Adhoc Lecturer in Sarvajanic College of Engineering & Technology , Athvalines, Surat, Gujrat, India.
9. Prof. S.S. Patil, ,Miss. S.A. Ghadge, ,Prof. C.G. Konapure, , Prof. Mrs. C.A. Ghadge " Seismic Analysis of High-Rise Building by Response Spectrum Method",Department of Civil Engineering, W.I.T. College of Engineering Solapur Maharashtra,Student, W.I.T. College of Engineering, Solapur

Maharashtra,Department of Civil Engineering. S.T.B. College of Engineering, Tuljapur, Maharashtra.

10. Anshuman. S, Dipendu Bhunia 2 , Bhavin Ramjiyani 3 " Solution of Shear Wall Location in Multi-Storey Building" Anshuman. S 1 , Dipendu Bhunia 2 , Bhavin Ramjiyani Assistant Professor, Civil Engineering Group, BITS Pilani, Rajasthan, India - Assistant Professor, Civil Engineering Group, BITS Pilani, Rajasthan, India. - Higher Degree student, Civil Engineering Group, BITS Pilani, Rajasthan, India.
11. P. S. Kumbhare 1 , A. C. Saoji 2 " Effectiveness of Reinforced Concrete Shear Wall for Multi-storeyed Building" 1 -Post Graduate Student in Structural Engineering, 2 -Associate Professor, Civil Engineering Department, Babasaheb Naik College of Engineering, Pusad- 445215, Maharashtra ,Sant Gadge Baba Amravati University, Amravati, Maharashtra 444602.
12. Romy Mohan 1 , C. Prabha 2 ,"Dynamic Analysis of RCC Building With Shear Wall" M- Tech student, department of civil engineering M A college of engineering , Kothamangalam, 2 lecturer department of civil engineering M A college of engineering Kothamangalam,.
13. P.P. Chandurkar 1 , Dr, P.S. Pajgade 2 ,"Seismic Analysis of RCC Building with and without Shear Wall" 1 post graduate student in structural engineering, Department of civil Engineering, Prof. 2 , megha institte of technology and research bandera."Seismic Analysis of An Unsymmetrical Multi-storey Building with Response Spectrum Method using E-TABS"
14. Alfa Rasikan 1 , M.G. Rajendran "Wind Behavior of buildings with and without Shearwall" Department of civil Engineering Karunya University, Coimbtore.
15. Bryan Stafford Smith and Alex Coull " Tall Building Structures: Analysis andDesign" 2011 Reprint Edition , Wiley India Pvt. Ltd.
16. Pankaj Agrawal & Manish Shrikhande " Earthquake Resistant Design of Structures" 11 th Edition ,PHI Learning Private Limited Delhi-110092 2013.
17. P.C. Varghese " Advance Reinforced Concrete Design" Second Edition, PHI LearningPrivate Limited Delhi-110001 2012.
18. S.R.Damodaraswamy, S.Kavitha "Basics of Structural Dynamics and Aseismic Design" 5 th Printing Agust 2012, PHI Learning Private Limited Delhi-110001 2012.
19. Anil k. Chopra "Dynamics of Structures – Theory and Applications to EarthquakeEngineering" 3 rd Edition Pearson Publishers.
20. Madhujit Mukopadhyay "Structural Dynamics Vibrations & systems" 1 st Edition Reprint 2013, Ane Books Pvt.Ltd.
21. T.K Dutta " Seismic Analysis of Strucutres" 1 st Edition, John Wiley & Sons Pte. Ltd.
22. 20. Bungale S. Taranath " Structural Analysis and Design of Tall Building" Text book of Mc- Graw Hill International Edition.