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Shear Wall Analysis and Design Optimization in Instance of High-Rise Buildings using ETABS

Ega Shabarinath[1], Mr. MD. Parvez Affani[2]
Global Institute of Engineering and Technology

Abstract: Today's tall buildings are becoming more and more slender, leading to the possibility of more sway in comparison with earlier high-rise buildings. improving the structural systems of tall buildings can control their dynamic response. With more appropriate structural forms such as shear walls and tube structures and improved material properties. The general design concept of the contemporary bearing wall building system depends upon the combined structural action of the floor and roof systems with the walls. The floor system carries vertical loads and, acting as a diaphragm, lateral loads to the walls for transfer to the foundation. Lateral forces of wind and earthquake are usually resisted by shear walls which are parallel to the direction of lateral load. These shear walls, by their shearing resistance and resistance to overturning, transfer the lateral loads to the foundation. In the present study a 45 storey high rise building, with podium up to 4th floor level is considered. After podium level (4th floor level), there is no sudden change in plan because if there is any sudden change it may result in the stiffness/torsional irregularities of building if a small seismic forces or any other less magnitude horizontal force strike the structure. The optimization techniques which are used in this project are firstly considered the size of shear wall is same throughout the building and then analysis is done from the result the failed shear wall dimensions are increased to resist the whole structure, in this way the optimization was done for number of time till the whole structure comes to stable to resist the forces. In this present project shear wall design and optimization is done by using the software Etabs and the shear walls are arranged in such a way to resist the lateral forces in zone III region throughout the structure according to Indian codes.
Keywords: Storey Drifts, shear wall, Storey Stiffness, base shear

I. INTRODUCTION

A shear wall is stiffer in its principal axis than it is in the other axis. It is considered as a primary structure which provides relatively stiff resistance to vertical and horizontal forces acting in its plane. Under this combined loading condition, a shear wall develops compatible axial, shear, torsional and flexural strains, resulting in a complicated internal stress distribution. In actual structural systems, the shear walls may function as a coupled system instead of isolated walls depending on their arrangements and connections. Two neighboring wall panels can be considered coupled when the interface transfers longitudinal shear to resist the deformation mode. This stress arises whenever a section experiences a flexural or restrained warping stress and its magnitude is dependent on the stiffness of the coupling element. Depending on this stiffness, the performance of a coupled section will fall between that of an ideal uniform element of similar gross plan cross-section and the combined performance of the independent component parts. The location of a shear wall significantly affects the building function, such as natural ventilation and daylighting performance. The performance requirements vary for buildings of different functions.

II. METHODOLOGY

A four storied reinforced concrete building is considered. Beam length in transverse direction (x) are 4 m (3 members), 2m and 3m and beams in longitudinal direction (z) are 4m and 3m. Figure (a) shows the load. Story height of the building is taken as 3m (same for each floor). Figure (b) shows frames of the four story Reinforced Concrete Residential building. Cross section of the beam is 350x350 mm and cross section of the column is 450x 450 mm. The wall loads are taken as 6.21 KN/m2 and 12.45 KN/m2 for every inner and outer walls respectively. A slab load of 3.75 KN/m2 is taken for analysis. A floor finish load of 1.5 KN/m2is applied on all beams of RC building and considered for analysis as per IS 875 (part1). A liveload of 2 KN/m2 is provided as per IS 875 (part2). Below table shows the gravity loads taken for the building. The structure is then analyzed and designed for live load, seismic load as per IS-1893:2002 and dead load consisting of self-weight of beams, columns and slabs and floors. Following figures show the different type of loads acting on the building. A four-story symmetrical reinforced concrete residential building was analyzed for seismic loadings in ETABS software. For doing the comparative study, dimensions of beam and columns are taken as 350mm x 350mm and 450mm x 450mm respectively. Story height is takenas 3m for each storey and beam length is taken as 4m, 2m, 3m in longitudinal direction and 4mand 3m in transverse direction.

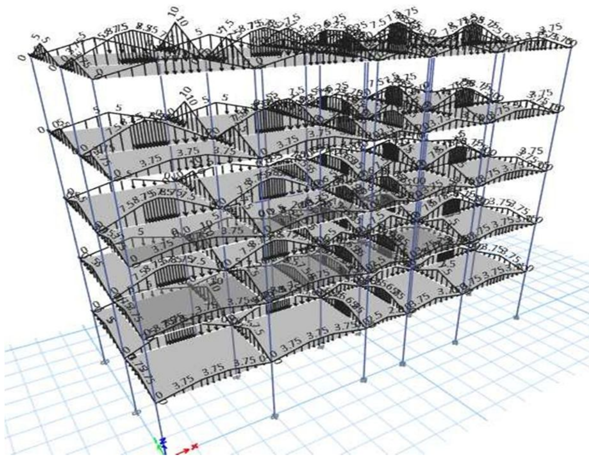


Figure A: Dead Load

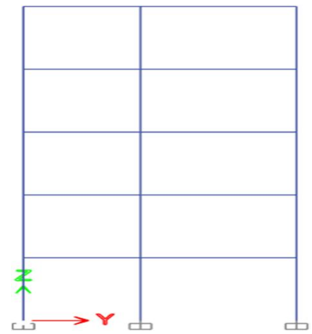


Figure B: Frames of the four story

Earthquakes generate waves which move from the origin of its location with velocities depending upon the intensities and magnitudes of the earthquake. The impact of earthquake onthe structure depends on the stiffness of the soil medium, stiffness of the structure, height and location of the structure etc. The earthquake forces are prescribed in IS 1893:2002 (Part 1).

The building zone comes under zone 5. And the calculation of seismic base shear was done as per IS 1893:2002 (part 1). The base shear or total design lateral force along with any principal direction shall be determined by the following expression

$$V_B = A_h \times W$$

Where, V_B = Design base shear

A_h = Design horizontal seismic coefficient based on fundamental time period and type of soil W = Seismic weight of the building

The design horizontal seismic coefficient, **Ah = ZISa /RSg**

Where,

Z = zone factor, for maximum considered earthquake and service life of the structure in a zone.The factor Z in the denominator is used so as to reduce the maximum considered earthquake zone factor to factor for design basic earthquake (DBE)

I = importance factor, depending upon the functional use of structures, characterized by hazardous consequences of failure, post-earthquake functional needs, historical value or economic importance (table 6 of IS 1893 (Part 1):2002)

R = response reduction factor, depending on the perceived seismic damage performance of thestructure, characterized by ductile or brittle deformations. However, the ratio (I/R) shall not begreater than 1.0. Value for buildings is given in table 7 of IS 1893 (part 1):2002.

Sa/Sg = Average response acceleration coefficient, Sa/Sg is determined on the basis of approximate fundamental natural period of vibration on both directions.

Natural period of vibration,

$$T_a = 0.09 \times h / \sqrt{d}$$

As per IS 1893:2002 (part-I) earthquake loads are calculated. Structure belongs to seismic zone5.

III. RESULTS AND DISCUSSION

Comparison Of Shear Forces

	Beam(KN)					Column(KN)				
	Ground	First	Second	Third	Fourth	Ground	First	Second	Third	Fourth
Corner	99.5	102.71	99.93	92.810	87.11	7.122	20.12	20.41	19.49	34.29
Centre	101.53	104.71	102.24	95.485	90.203	18.219	25.954	23.94	21.39	28.177
Front	70.647	69.625	70.239	70.633	73.382	17.56	23.737	21.512	18.78	21.798

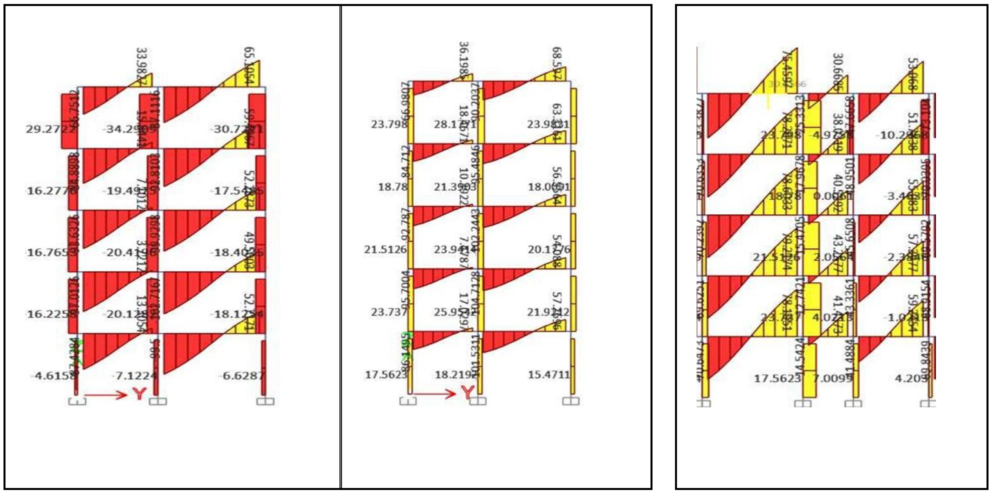


Fig. 1 : Comparison Of Shear Forces

Comparison Of Bending Moments

	Beam (KN-m)					Column(KN-m)				
	Ground	First	Second	Third	Fourth	Ground	First	Second	Third	Fourth
Corner	79.278	85.434	80.293	68.293	55.186	21.260	21.635	23.012	18.979	48.1154
Centre	79.976	86.090	81.484	70.7366	57.614 8	27.481	39.535	34.511	31.7355	35.762
Front	79.976	86.090	46.675	47.827	45.886	27.481	36.176	30.703	27.54	29.938

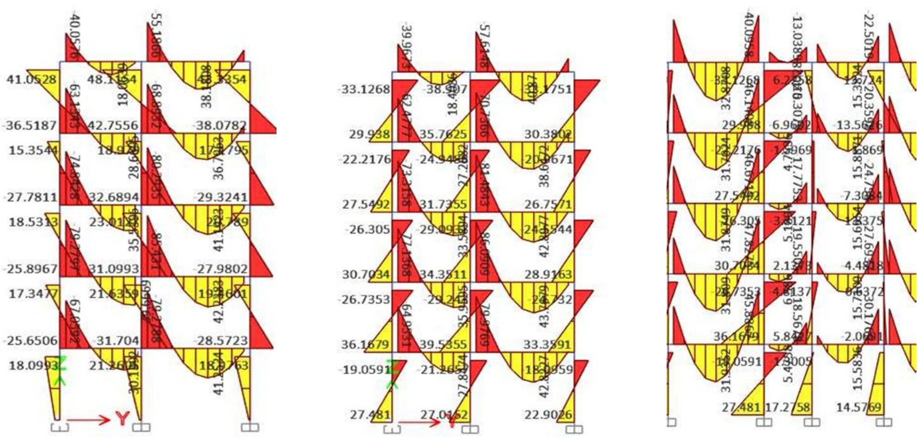


Fig. 2 : Comparison of Bending Moments

Comparison of Axial Loads

	ColumnsKN-m				
	Ground	First	Second	Third	Fourth
Corner	728.3868	584.90	444.99	302.58	155.518
Centre	815.112	653.305	496.914	338.136	175.496
Front	962.88	765.97	561.88	362.459	174.118

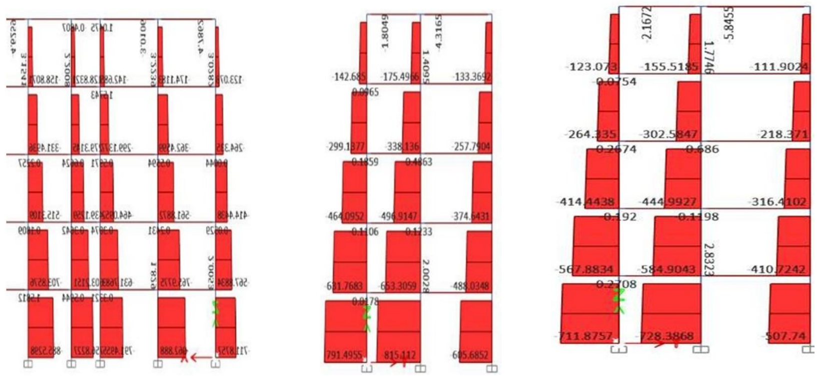


Fig. 2 : Comparison Of AXIAL LOADS

IV. RESULT

The structure was analyzed as standard moment opposing construction in ETABS 2018 Software. Joint coordinate command is utilized to produce the coordinates and to indicate the joints of the structure by starting the particulars/specifications of the plan. Member incidence command is utilized to indicate the connectivity between joints. The columns and beams are demonstrated utilizing beam elements. Member properties must be determined for every member. From the analysis, maximum design loads, moments and shear on every member was obtained. From these quantities, we design the main structure and further construction is considered. Furthermore, after analyzing the structure, we get the accompanying outcomes. The shear power acting in the corner radiates is most extreme from the outset floor.

For example

102.7 KN and that of the corner sections is at the fourth floor for example 34.29 KN.

The shear power acting in the middle shafts is greatest at the main floor

For example

104.71 KN and that of focus sections is at the fourth floor for example 28.17 KN.

The shear power acting in fringe radiates is most extreme at the fourth floor for example 73.38 KN and that of the fringe segments is at fourth floor for example 23.79 KN. The twisting second following up on corner radiates is greatest from the start floor for example 85.43 KN-m and that of the corner sections is greatest at fourth floor for example 48.12, KN- m. The twisting second following up on focus radiates is greatest from the start floor for example 86.09 KN-m and that on focus segments is greatest from the start floor for example 39.53 KN- m. The twisting second following up on fringe radiates is greatest from the start floor

For example 86.09 KN-m and that of the fringe segments is greatest from the outset floor for example 36.16 KN-m.

The torsional power following up on corner radiates is greatest at fourth floor for example 0.334 KN and that of the corner segments is greatest from the start floor for example 0.594 KN. The torsional power following up on focus radiates is greatest at ground floor for example 0.374 KN and that of the middle segments is greatest from the start floor for example 0.5908 KN. The torsional power following up on fringe radiates is greatest at second floor for example 0.21 KN and that of the fringe segments is greatest from the start floor for example 0.597 KN. By utilizing ETABS the investigation and configuration work can be finished inside specified time. The task gives the certainty to complete undertaking of High-Rise structures or Multi Story Building. By noticing consequences of plan data, we can embrace various sizes of parts at various members of the design. The given storey in the Residential Building is discovered safe when design is done with the analysis by utilizing ETABS Software.

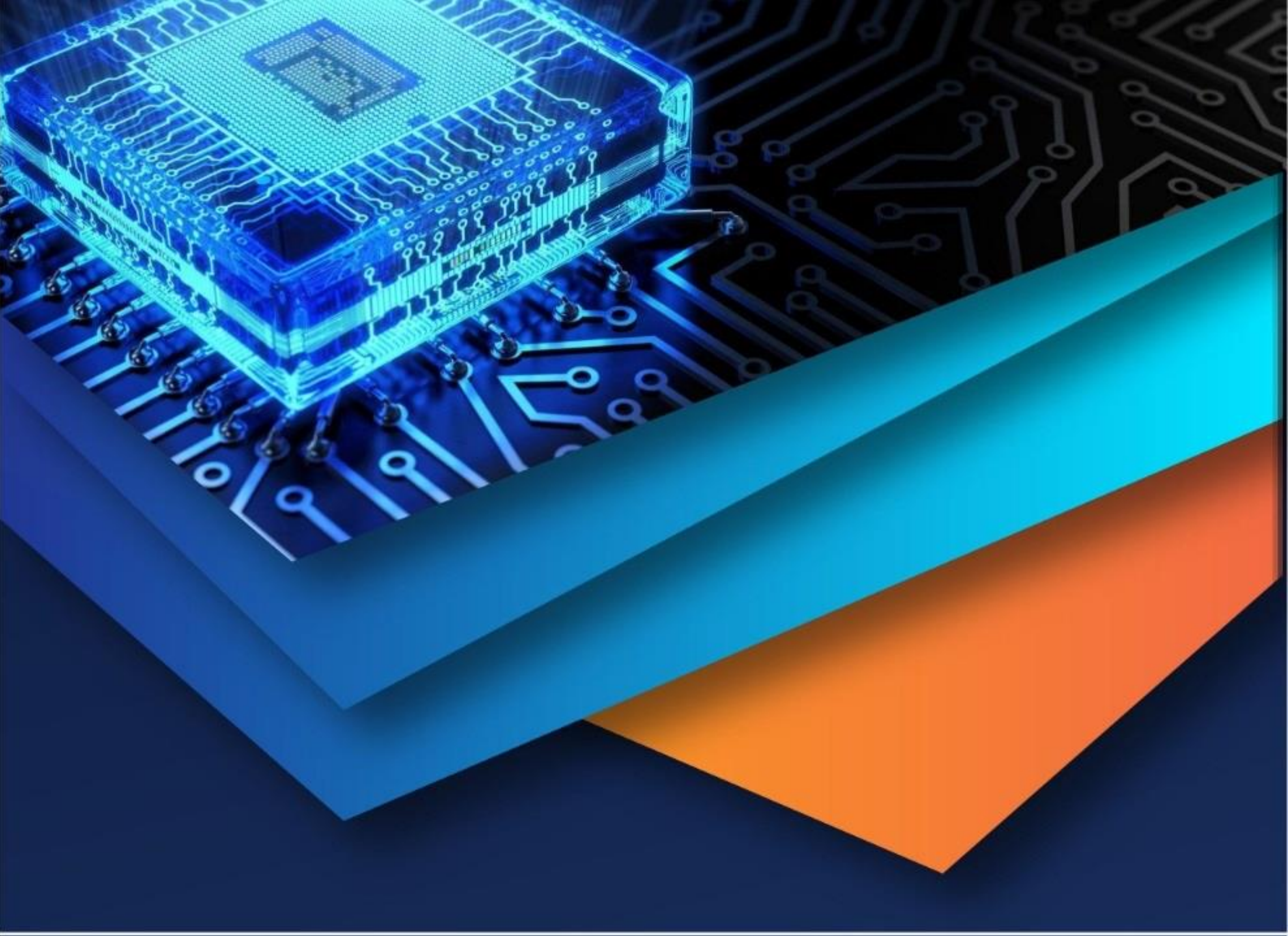
V. CONCLUSION

1) ETABS is a crucial programming device that takes into account multi-story building analysis and plan designing. ETABS is a 3D displaying programming for any sort of structural analysis and plan designing. Utilizing this Program one can perform both steel structure and RC Structure.
2) ETABS gives users to Graphic information and change for smooth and fast model creation for a construction which is very helpful for the engineers to directly get the knowledge of the building whether the materials taken are proper or not. As the software gives the total interpretation of the structure, the new advancement occurring in the software will be more beneficial for the engineers, as it will save their time and energy used for the paper work of the same.

3) Creation of a 3D model including the use of plan perspectives and elevations, 3D model of any sort of confounded design can be made effectively. Towers and skyscraper's structure will be designed thoroughly in this software which saves a lot of paper work which used to do before this software was invented. There is also need to develop more custom software's like ETABS and models to test the structural adequacy of various complex design with more accuracy.
4) This software will lead the civil engineers to next dimensions of seeing through the object much before it is constructed practically. It will give the idea of how the structure will perform for various types of loadings and burdens applied/given on a particular part of the whole structure. It will save engineers time and cost required to get a paper-based knowledge/calculation which has lots of error, rather software like ETABS will do the calculations effortlessly and efficiently.
5) Future structural engineers need to learn software's like ETABS in their initial stage of learning about civil engineering to get expertise and professional in the structural field which will help them to be a better engineer and will be advantageous for the betterment of the engineers.

REFERENCES

[1] Abhay Guleria. Structural Analysis of a Multi-Storied Building using ETABS for different Plan Configurations, International Journal of Engineering Research & Technology (IJERT). 2014; 3(5):2278- 0181. ISSN: IJERTV3IS051552 www.ijert.org.
[2] Balaji UA. Mr. Selvarasan ME. B Design and analysis of multistoried building under static and dynamic conditions using Etabs, International Journal of Technical Research and Applications.
[3] Mahesh N, Patil Yogesh N. Sonawane, Seismic Analysis of Multistoried Building, International Journal of Engineering and Innovative Technology (IJEIT). 2015; 4(9).
[4] IS: Indian Standards Criteria for Earthquake Design of Structures, 1893-2002.
[5] IS. 456. Indian Standards (plain and reinforced concrete code of practice), (Fourth Revision), 2000.
[6] Raghunandan MH and Suma (2015): Seismic Pounding between Adjacent RC Buildings with and without Base Isolation System, International Journal of Research in Engineering and Technology, Volume: 04 Issue: 06 | June-2015.
[7] Sukumar Behera, (2012): Seismic Analysis of Multi-storey Building with Floating Column, National Institute of Technology Rourkela, May-2012.
[8] Hiten L. Kheni, Anuj K. Chandiwala (2014): Seismic Response of RC Building with Soft Stories", International Journal of Engineering Trends and Technology (IJETT) – Volume 10 Number 12 - Apr 2014
[9] Sagar R Padol, Rajashekhar S. Talikoti (2015): Review Paper on Seismic Responses of Multi-story R.c.c Building with Mass Irregularity", IJRET: International Journal of Research in Engineering and Technology, Volume: 04 Issue: 03 | Mar-2015.
[10] D. R. Panchal and P. M. Marathe (2011): Comparative Study of R.C.C, Steel and Composite (G+30 Storey) Building", Institute of Technology, Nirma University, Ahmadabad, December, 2011.
[11] H. J. Shah and S. K. Jain, "Design Example of a Six Storey Building," IITK-GSDMA.
[12] B. Umamaheshwara and P. Nagarajan, (August 2016) "Design Optimization and Analysis of Shear Wall in High Rise Buildings Using ETABS," International Journal for Research in Applied Science & Engineering Technology, vol. 4, no. 8, pp. 480-488.
[13] C. V. Lavanya, E. P. Pailey and M. Sabreen, (April 2017) "Analysis and design of g+4 residential building using ETABS," International Journal of Civil Engineering and Technology, vol. 8, no. 4, p. 1845–1850.
[14] P. Agarwal, M. Shrinkhande, (2012) earthquake resistance design of structures, PHI learning Pvt.
[15] Mr.N.B. Baraskar&Prof.U.R.Kawade. R. Kawade. Kawade. Kawade. Kawade. Kawade (2015): Structural Performance of RC Structural wall system Over conventional Beam Column System in G+15 storey Building", International Journal of Engineering Research and General Science Volume 3, Issue 4, July-August, 2015.
[16] Miss. Rupali A.Dhote, Asst. Prof. G. B. Bhaskar (2016): Design& Analysis of Soft Storey Building due to wind & Earthquake", International Journal for Technological Research in Engineering Volume 3, Issue 9, May-2016.
[17] Pardeshi Sameer, Prof. N. G. Gore (2016), "Study of seismic analysis and design of multi storey symmetrical and asymmetrical building "Volume: 03 Issue: 01.
[18] Ali Kadhim Sallal (2018) "Design and analysis ten storied building using ETABS software-2016" Volume 4; Issue 2; May 2018; Page No. 21-27
[19] Pushkar Rathod, Rahul Chandrashekar, (Oct – 2017) "seismic analysis of multistoried building for different plans using ETABS 2015" Volume: 04 Issue: 10



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