Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 46 No. 1 (2025)

Design and Analysis of High Rise Building With Shear Wall and Overhead Water Tank Using Etabs

Ashok Kumar Suluguru[1], Suraj Prabhakar Sangam[2], Akella Naga Sai Baba[3]

[1]*Associate Professor, Civil Engineering Department, Malla Reddy Engineering College, Maisammaguda, Hyderabad, Telangana State, 500100, India*

[2]*Research Scholar, Civil Engineering Department, Malla Reddy Engineering College, Maisammaguda, Hyderabad, Telangana State, 500100, India*

[3]*Assistant Professor, Department of Civil Engineering, Malla Reddy Engineering College, Maisammaguda, Hyderabad, Telangana State, 500100, India*

Abstract: **-** The shear wall system is one of the most widely used lateral load-resisting construction solutions. A shear wall is among the greatest structural elements to withstand lateral forces. Shear walls, also known as structural walls composed of reinforced concrete, are crucial elements used in building construction that can resist earthquakes. Because of their great plane stiffness and strength, shear walls are very helpful in many structural engineering applications. They may be used to support heavy horizontal loads and gravity loads simultaneously. When seismic forces are applied to a structure, flexural elements are often used to keep the whole thing from collapsing. Since the properties of these seismic shear walls influence how the structures act, it is essential to assess the walls' seismic reaction precisely.

This study examines a 26-story building with an above-water tank and a shear wall condition system using ETABS software. To help with the study, the response spectrum analysis technique is used. Results like time period, model stiffness, storey bending, and shear are analysed for the G+25 building model.

Keywords*: Shear wall, gravity loads, seismic forces, earthquake load, storey drift, lateral displacement, base shear, storey shear, storey bending.*

1. Introduction

Shear walls are vertical stiffening elements intended to resist wind or seismic lateral loads. The design and location of shear walls have a significant impact on their structural behaviour when exposed to lateral loads. The structure acts as a horizontal diaphragm, distributing lateral stresses parallel to the force of action until they reach the shear walls. As deep beams that respond to shear and flexure to prevent overturning, these shear walls withstand horizontal stresses due to their extreme stiffness. Tension, bending, and direct shear are also necessary for a core that is eccentrically positioned in relation to the building forms.

Water is essential to the existence of all living beings. Portable water is essential to preserving human health. Because every individual and community has to have access to portable water, water storage is essential. Most of the time, water is stored in tanks and then piped to each settlement.
The current examination takes a gander at the benefits of building diversion, story float, shear, and bowing of designs without shear walls at different focuses on multistory structures with customary and sporadic calculations. With and without a shear wall scenario, the G+25 building model is examined, taking into account the water tank's condition.

2. Retrofitting with shear wall

The vertical components of the horizontal structure that resists force are known as shear walls. Regularly, wood outline stud walls are covered with pressed wood or one more sort of underlying sheathing material. The shear wall can withstand stresses along its entire length if the sheathing is securely fastened to the stud wall framework.

Shear walls that have been planned and built. Correctly are strong and rigid enough to resist horizontal forces.
1. Often used for non-ductile reinforced concrete frame structure retrofitting.
2. Precast concrete elements or cast-in elements may be used as the additional components.
3. It is preferable for new components to be added to the building's exterior.
4. Avoiding inside mouldings is not recommended within the building.

Retrofitting with shear wall

3. Methodology used

Response spectrum analysis

This strategy is otherwise called the modular methodology or the mode superposition technique. Its fundamental thought is that the reaction of a construction is the result of the superposition of a few vibration modes, every one of which responds with a particular recurrence, modular damping, and mutilated structure.

IS-1893(Part-l):2002 mandates response spectrum analysis for irregular and high-rise constructions. When it comes to estimating member forces and drifts in structural systems, the response spectrum method of seismic analysis makes significant gains in terms of computational efficiency. The method simply uses smooth spectra, which are the average of several seismic motions, to calculate the highest values of the drifts and member forces in each mode. enough modes to be captured so that the analysis must account for at least 90% of the building's participating mass in each of the two orthogonal primary horizontal directions. Using the ground motion spectra and building characteristics that have been provided, the base shear for each mode is determined through analysis. Storey forces, drifts, and accelerations are then statistically combined for each mode by employing the SRSS combination.

4. Design considerations and model in Etabs

The current research uses ETABS to analyse a G+ 10-story structure located in a seismic zone V.

The primary factors taken into account for the study are: 1. Building Utility: Residential Building

2. Number of Storeys: 26 Storeys (Building G+25)

3. Concrete grade ~~: M30

4. HYSD Fe415 is the grade of reinforcing steel.

5. Type of construction: a building with an RCC frame

6. Beam dimensions: 230 mm by 600 mm

7. Column dimensions: 230 mm by 600 mm

8. Slab thickness: 150 mm, 200 mm

9. Shear wall thickness: 230 mm

10. Each portion's tank measurements

a. Length: 10 meters b. Width: 12 meters c. Height: 6 meters

11. Building height: 78 meters; 12. Height of the remaining story: 3 meters; 11. Height of the bottom story: 4 meters

14. The live load is 5 KN/m2.

15. The dead load is 2 KN/m2.

16. Concrete density: 25 KN/m3.

17. The following loads are taken into account in buildings: dead, live, floor, earthquake, and wind loads.

18. Earthquake Zones: Zone V

19. Type of site: III

20. Significance coefficient: 1.5

21. Factor of response decrease Δ: 5

22. Damping Ratio: 5 percent

23. Classification of Structure B

24. The average wind speed is 44 m/s.

25. Response spectrum analysis is the method of analysis.

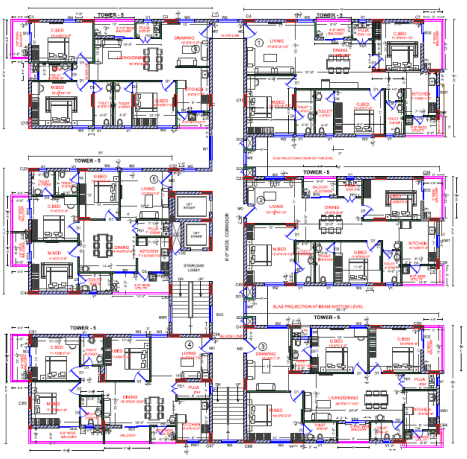
The code for wind design is IS 875: 1987 (Part 3).

The IS 456:2000 RCC design code is number 27.

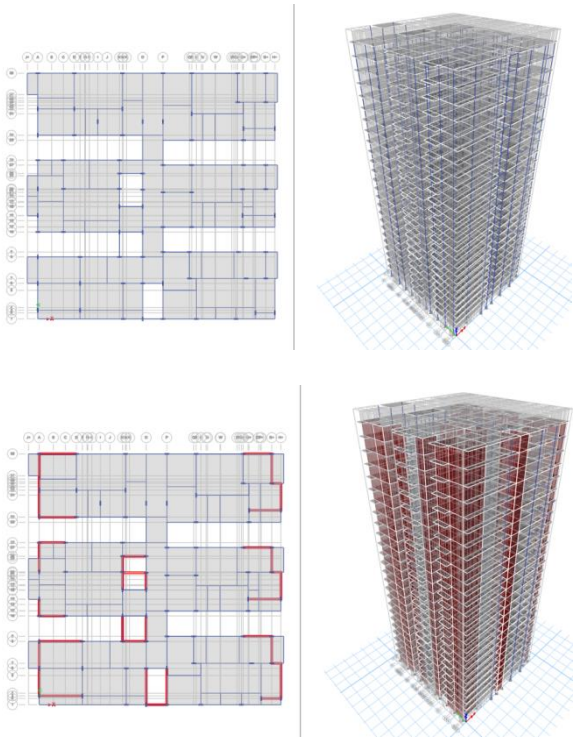
The IS 800: 2007 steel design code is 28.

The seismic design code is IS 1893: 2002 (Part 1).

Typical floor plan Used

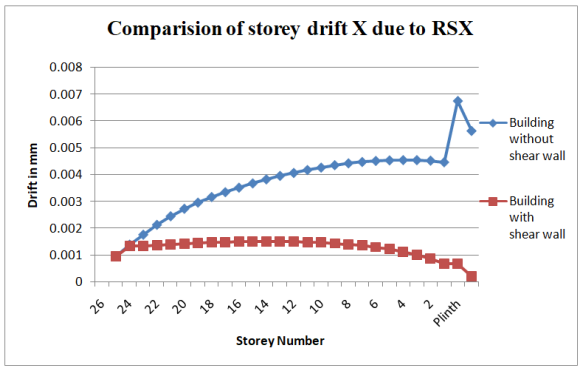


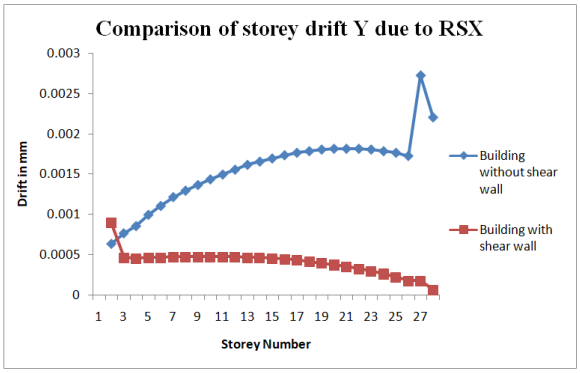
Models in ETABS

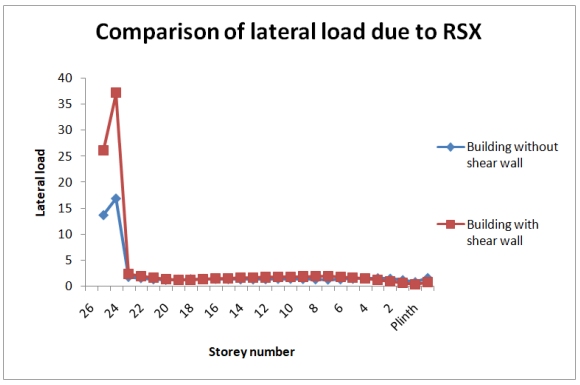


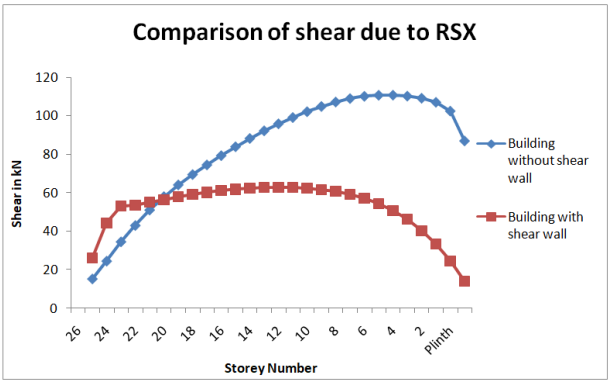
5. Results and analysis

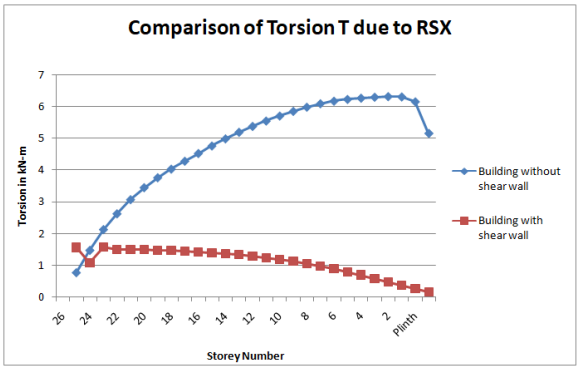
RSX Results

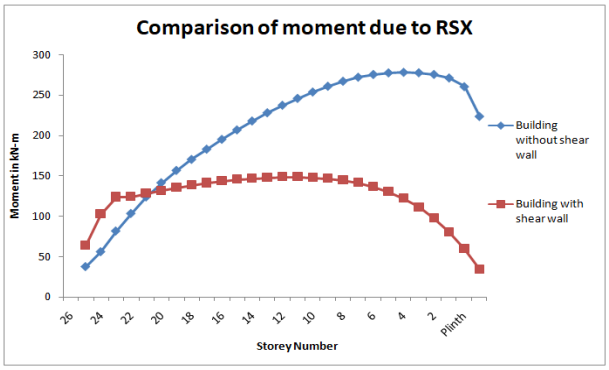


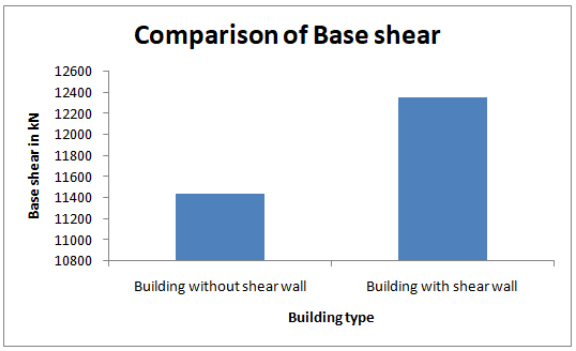


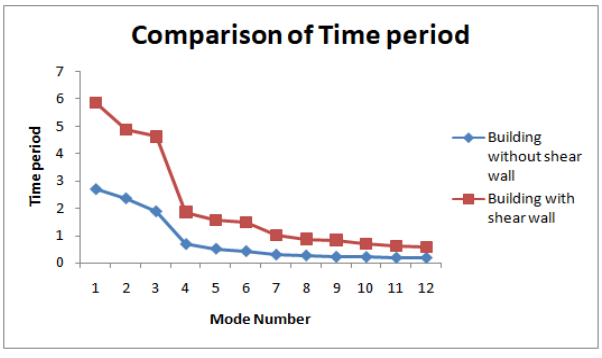

Comparison of lateral load due to RSX
Lateral load
Storey number
Building without shear wall
Building with shear wall
Plinth

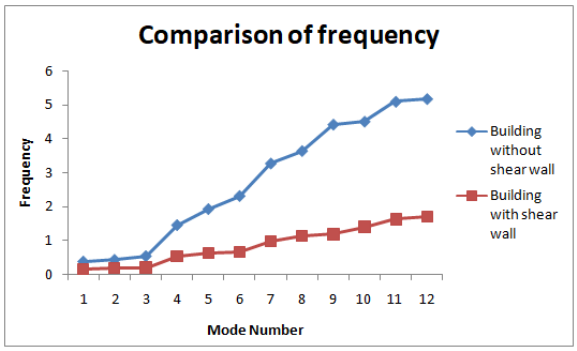

Comparison of shear due to RSX
Shear in kN
Storey Number
Building without shear wall
Building with shear wall
Plinth


Comparison of Torsion T due to RSX
Torsion in kN-m
Storey Number
Building without shear wall
Building with shear wall
Plinth

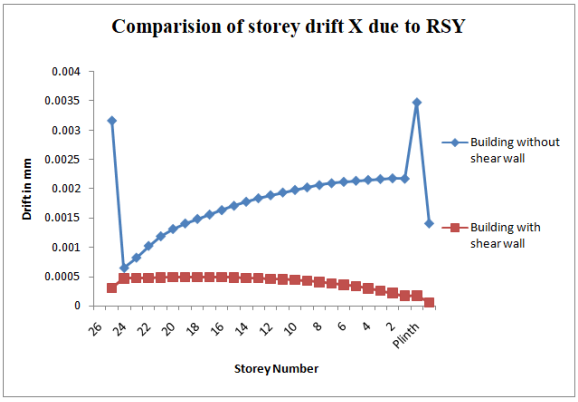

Comparison of moment due to RSX
Moment in kN-m
Storey Number
Building without shear wall
Building with shear wall
Plinth

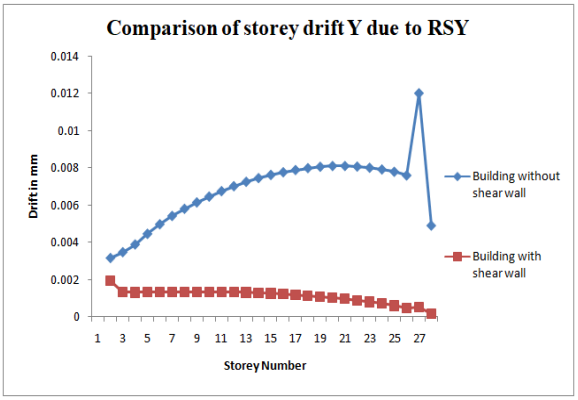

Comparison of Base shear
Base shear in kN
Building without shear wall
Building with shear wall
Building type

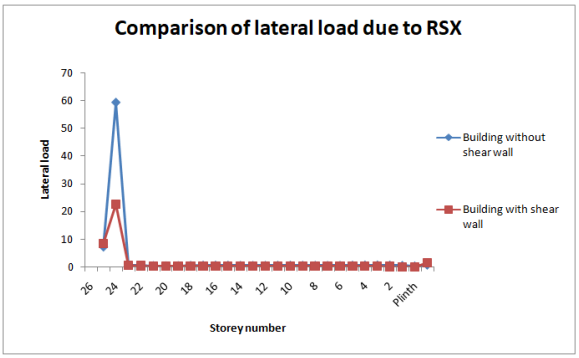

Comparison of Time period
Time period
Mode Number
Building without shear wall
Building with shear wall

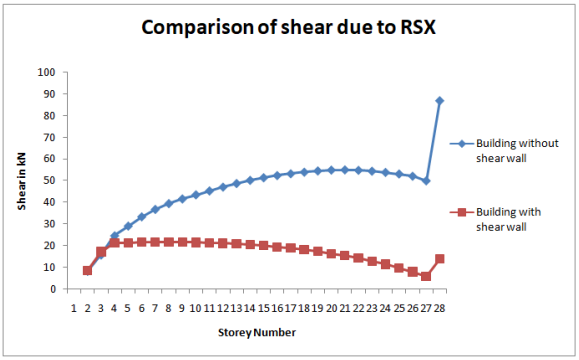

Comparison of frequency
Frequency
Mode Number
Building without shear wall
Building with shear wall

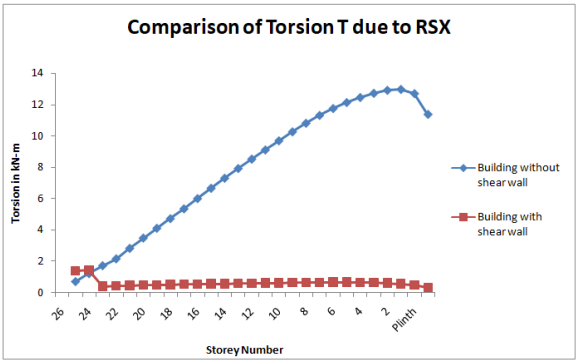
RSY Results

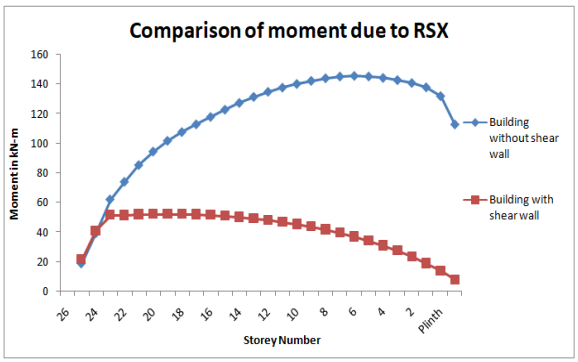

Comparision of storey drift X due to RSY
Drift in mm
Storey Number
Building without shear wall
Building with shear wall

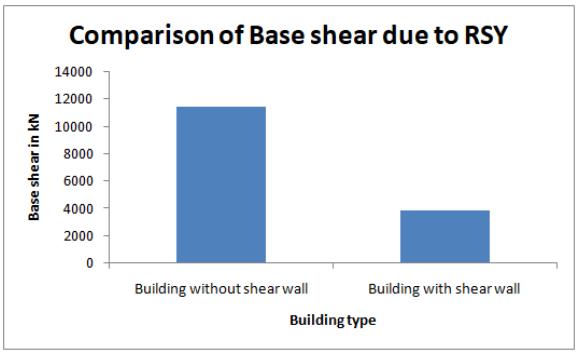

Comparison of storey drift Y due to RSY
Drift in mm
Storey Number
Building without shear wall
Building with shear wall

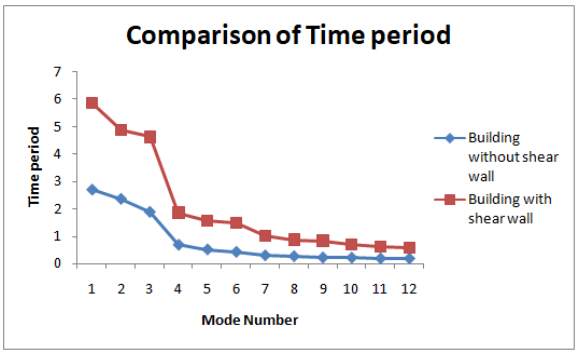

Comparison of lateral load due to RSX
Lateral load
Storey number
Building without shear wall
Building with shear wall

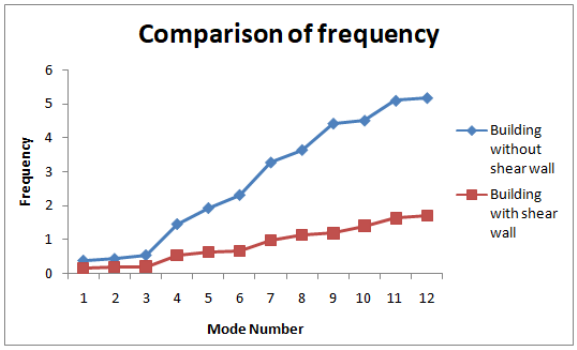

Comparison of shear due to RSX
Shear in kN
Storey Number
Building without shear wall
Building with shear wall


Comparison of Torsion T due to RSX
Torsion in kN-m
Storey Number
Building without shear wall
Building with shear wall


Comparison of moment due to RSX
Moment in kN-m
Storey Number
Building without shear wall
Building with shear wall







6. Conclusions

This investigation yielded the following conclusions:

1. Due to the fact that the total weight of the existing structure won't change very much, shear walls could be used in place of the various strengthening or retrofitting methods that are available.

2. The shear-wall frame's and the braced frame's seismic responses are significantly influenced by where the shear wall is located. The shear walls and brace component's central location is advantageous because it reduces frame actions by reducing drift and horizontal deflection.

3. There is less tale drift in both the X and Y directions from the top story to the bottom story. structures with shear walls had less story drift, while structures without shear walls exhibited higher story drift.

4. The greatest shear value was recorded when there was no shear wall construction as compared to one with a shear wall casing.

5. The building without a shear wall had the most story bending in comparison to the other structures.

6. The shear wall scenario has a lower torsion value than the reaming model when the building torsion increases from level 26 to story 1. When shear walls are not used in construction, base shear less values are obtained.

8. Because of the weight of the shear walls and the water load from the tank, the building structure's deflection values grow in an attempt to minimise them. Shear walls are the most efficient technique to create a structural design that is resistant.

Refrences

[1] Kirtan. T, N. Jayaramappa, “Comparative Study of Multi Storey RC Frame With Shear Wall and Hexagrid System” Paripex- Indian Journal of Research, Volume: 06, Issue: 01, pp. 814-817, ISSN 2250-1991, January 2017.

[2] Jayesh Venkolath, Rahul Krishnan K, "Optimal Diagrid Angle of High-Rise Buildings Subjected to Lateral Loads" International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 09, pp. 841-846, e-ISSN: 2395 -0056 p-ISSN: 2395-0072, September 2016

[3] V. Abhinav, Dr. S. Sreenatha Reddy, M. Vasudeva Naidu, Prof. S. Madan Mohan, "Seismic Analysis of Multi Story RC Building with Shear Wall Using STAAD.Pro" International Journal of Innovative Technology and Research (IJITR), Volume: 4, Issue: 5, pp. 3776-3779, ISSN 2320 –5547, August 2016

[4] Nandeesh K C, Geetha K, " Comparative Study of Hyperbolic Circular Diagrid Steel Structure Rehabilitated at Core With Shear Wall And Steel Braced Frames" International Journal of research in Engineering and technology (IJRET), Volume: 05, Issue: 07, pp. 317- 323, eISSN: 2319-1163, p-ISSN: 2321-7308, July 2016

[5] Md. Samdani Azad, Syed Hazni Abd Gani, "Comparative Study of Seismic Analysis of Multi-story Buildings with Shear Walls and Bracing Systems" International Journal of Advanced Structures and Geotechnical Engineering (IJASGE), Volume: 05, Issue: 03, pp. 72-77, ISSN 2319-5347, July 2016

[6] Priyanka Soni, Purushottam Lal Tamarkar , Vikky Kumhar, "Structural Analysis of Multi-storey Building of Different Shear Walls Lcation and Heights" International Journal of Engineering Trends and Technology (IJETT), Volume: 32, pp. 50-57, February 2016

[7] Shubham R. Kasat, Sanket R. Patil, Akshay S. Raut, Shrikant R. Bhuskade, "Comparative study of MultyStorey Building Under the action of shear wall using ETAB Software" International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT), ISSN: 2348-8352, pp. 124-128, 2016

[8] C. V. Alkuntel, M. V. Dhimate, M. B. Mahajan, S. Y. Shevale, S. K. Shinde and A. A. Raskar, "Seismic Analysis of Multi-storey Building having Infill wall, shear wall and Bracing" Imperial Journal of Interdisciplinary Research (IJIR), Volume: 02, Issue: 06, pp. 1522-1524, ISSN: 2454-1362, 2016

[9] Saket Yadav, Dr. Vivek Garg, "Advantage of Steel Diagrid Building Over Conventional Building" International Journal of Civil and Structural Engineering Research (ISSN), Volume: 03, Issue: 01, pp. 394-406, September 2015