Comparative study of a multi – storied building with and without shear wall between Mid – rise and High – rise building by using STAAD.Pro

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Abstract - *In the past, most structures built on hilly terrain withstood disasters and other natural disasters; however, due to changes in techniques and methods, as well as the enormous level of structures on the surface, the stability of soil, wind loads, and seismic loads should be considered; for this purpose, only a committee is formed, and Indian standards are formed, and they are revised whenever it is recommended. To achieve results, the advancement of technology/software systems is used. Many software's, such as SAP2000, Staad - Pro, Revit Structural, E-tabs, Tekla, and others, are available to reduce manual calculation and time, resulting in accurate values. Now, for this project, we will use Staad - Pro software to generate structural drawings of G+5 and G+10, and by applying Dead Load, Live Load, Seismic Load, and Wind Load to the structure, we will obtain Storey drift values and conduct a comparative study between the four models.*

Key Words: Key Staad – Pro, Storey, Loads, Beams, Columns, yield strength, Compressive strength, Deflection, Structure, moments, Storey Drift, Shear wall, multi storey building with and without shear wall, Base shear, Seismic analysis, lateral loading, axial load.

1. INTRODUCTION

Design Engineers created an application for design analysis and design software in 1997 to get accurate results in less time and to reduce the need for manual calculation. Later, in 2005, Bentley Systems purchased the application from research Engineers, renamed it Staad/Staad Pro, and released it internationally.

We can easily apply load cases and check the shear failure conditions in this staad pro. We can estimate the maximum heights of buildings using this application, and most construction companies are currently taking the height up to 30 floors (Known value) (in Andhra Pradesh), which gives more space in the floor wise within less space of land.

2. MAIN OBJECTIVES FOR THE STUDY

Some of the objectives for the study are as follows:

1) Identify the load case with the greatest storey drift value.

2) To determine the maximum storey drift values in which model and for which height of the building the maximum value is found.

3) Whether it is in safe (or unsafe) construction condition.

4) To determine whether the design can withstand the combined earthquake and wind forces.

5) Designing the structure as an under reinforced section rather than an over reinforced section.

3. RESEARCH METHODOLOGY

Inputting the job Information:

Generating the 3D model geometry. There are two methods to create a structure in STAAD PRO.

a) Using the "STAAD PRO Editor"

b) Using the Graphical User Interface (GUI)

We created the entire structure using the Graphical User Interface (GUI) because it is the simplest way to create by using nodes and beams, and for some of the load calculations, such as storey drift values and load cases, we used the Staad editor method. We used Staad editor because the number of load cases was greater, and for software calculations, we used commands such as Perform Analysis, Change, Print Storey drift, and so on.

As shown in fig 1, the nodes and beams are created in STAAD Pro.

Fig -1: Reference of Auto cad drawing plan

Assigning the material:

As after creating the beams and columns we will assign material to them as we require. Our design is concrete design hence we have assigned the concrete material to the beams and columns

Specifying member properties:

The size of the beams and columns is one of their properties (width, depth of cross-section, Beta - Angle). So, using this command, we entered the various properties (such as circular, rectangular, and square) and assigned these properties to the specified members, as shown in fig 2,3.

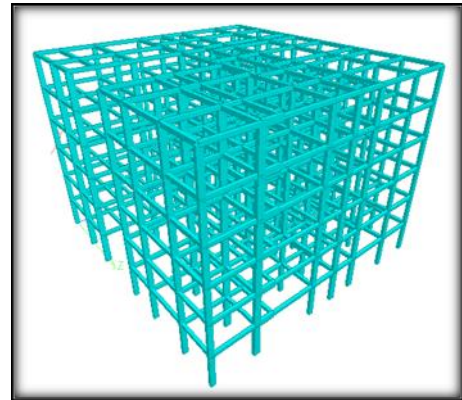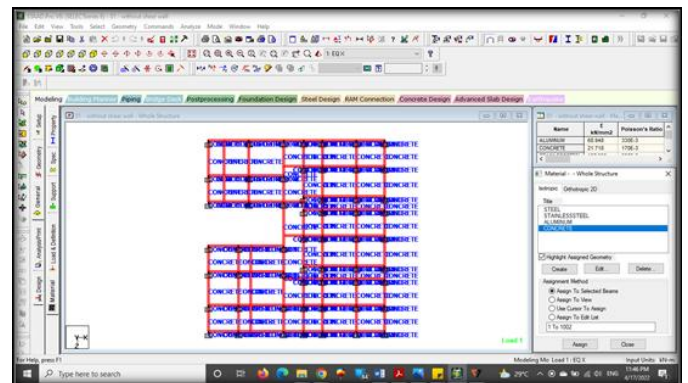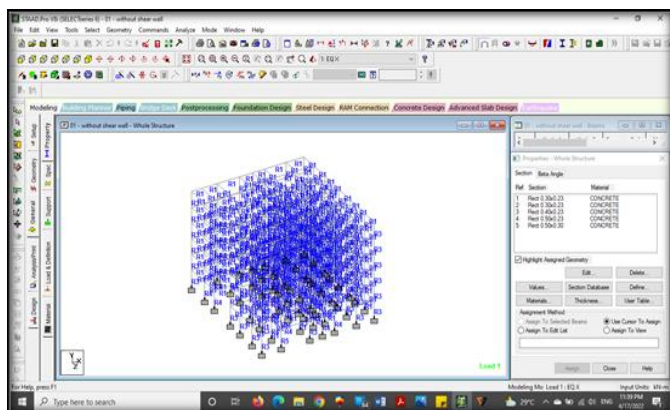**Fig -2**: Materials after assigning to the beams and columns

Fig -3: 3D – Rendering model

Specifying material constants:

we assigned the concrete material, we have the concrete constants by default and do not need to use this command separately. If we need to change the constants, we can use the command shown in fig 4.

Fig -4: Assigning materials to the members

Specifying Supports:

The supports are first created (as we did with fixed supports) and then assigned to all of the structure's lowermost nodes where we will design the foundation, as shown in fig 5.
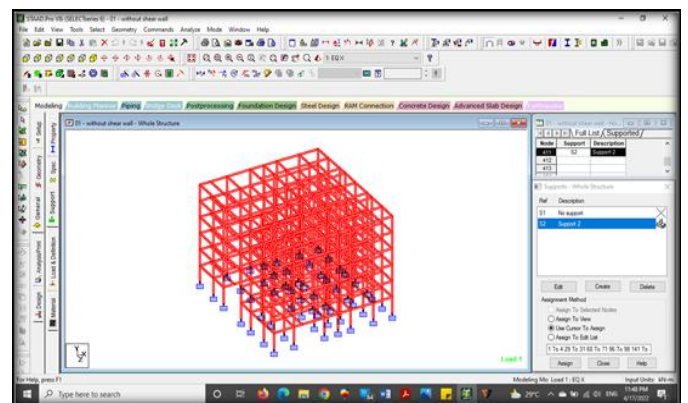

Fig -5: Supports for the column at all the end nodes

Specifying Loads:

This is done in following two steps:

a) First, all load cases must be created in accordance with Indian standards.

b) Then they are assigned to the appropriate members and nodes.

IS Codes considered for the Design:

(i.)   IS 456 – 2000

(ii.)   IS 875 Part – 1 (Dead Load)

(iii.)   IS 875 Part – 2 (Live Load)

(iv.)   IS 875 Part – 3 (Wind Load)

(v.)   IS 875 Part – 5 (Load Combinations)

(vi.)   IS 1893 Part – 1 (Earth quake Load)

The STAAD PRO can generate any type of load and assign it to a structure. It is also capable of imposing a dead load on the structure. Before creating specific load cases, some load definitions are created in accordance with IS codes (As Seismic or wind load). Here are some of the loads that we have assigned.

Dead Load:

The load coming on framed structure due to self-weight of beams, columns, slabs or walls. This load will act as uniformly distributed load over the supporting beams as shown in fig 6.
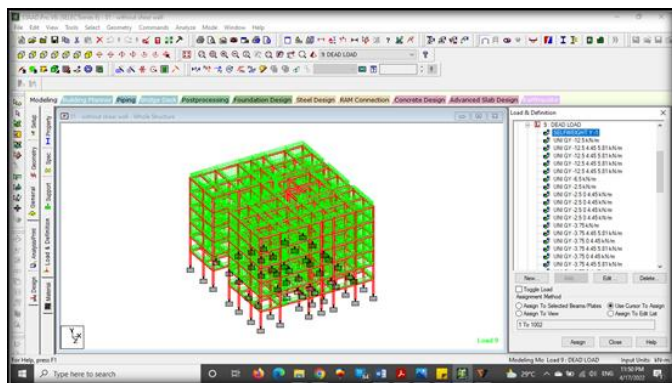
Fig -6: Dead Load (Self weight)

Live Load:

The live load comes on structure due to extra necessary things in the house. There will be different Live Loads acting in the structure due to different uses of building. As here we have used various types of different live loads in our structure.

Wind Load:

Wind Load is defined as the wind speed acting on the structure, and wind load values will be considered in accordance with IS code.

Sesimic Load:

Seismic loading is a fundamental concept in earthquake engineering that refers to the application of earthquake-generated agitation to a structure. It occurs at a structure's contact surfaces, whether with the ground, adjacent structures, or gravity waves.

Dimensions & Loads Considered (fig 2 & fig 7):

Column Size	-	0.23 m x 0.23 m, 0.3 m x 0.23 m,
	-	0.4 m x 0.23 m, 0.5 m x 0.23 m,
	-	0.5 m x 0.3 m, 0.5 m x 0.4 m,
	-	0.6 m x 0.5 m, 0.7 m x 0.5 m
Beam Size	-	0.23 m x 0.23 m, 0.3 m x 0.23 m,
	-	0.4 m x 0.23 m, 0.5 m x 0.3 m,
	-	0.6 m x 0.4 m,
Grade of Concrete	-	M30
Grade of Steel	-	Fe – 415 (HYSD Bars)
Height of the Structure	-	G+5 – 18m (Mid – rise Building)
	-	G+10 – 33m (High –rise Building)
Shear wall thickness	-	0.15m (Mid – rise Building)
	-	0.5m (High –rise Building)

Dead Load:

Self weight	-	-1
Wall Load	-	-12.5 Kn/m (9" Wall) (External walls)
	-	-6.5 Kn/m (4" Wall) (Internal walls)
	-	-2.5 Kn/m (4" Wall) (Parapet walls)
Slab Load	-	-3.75 Kn/m (150mm thickness)
Floor finish Load	-	-1 Kn/m

Live Load:

Floor Load	-	-2 Kn/m (Residential)

Wind Load:

P_d	-	1509.759 (@18m)
P_d	-	1650.31 (@33m)
Structure Class	-	B

Seismic Load:

Zone	-	2 (Medium Soil)
Zone factor	-	0.10
R	-	3 (OMRF)

Load Combinations:

The load combinations were generated using the auto load combinations command. We can generate loads based on the Indian code and they are as follows:

(i.)   1.5 (D.L + L.L)

(ii.)   1.5 (D.L $\pm$ EQ X)

(iii.)   1.5 (D.L $\pm$ EQ Z)

(iv.)   1.5 (D.L $\pm$ Wind X)

(v.)   1.5 (D.L $\pm$ Wind Z)

(vi.)   1.2 (D.L + L.L $\pm$ EQ X)

(vii.)   1.2 (D.L + L.L $\pm$ EQ Z)

(viii.)   1.2 (D.L + L.L $\pm$ Wind X)

(ix.)   1.2 (D.L + L.L $\pm$ Wind Z)

Total 19 Load Combinations add these loads by selecting it. These combinations do not need to be assigned to individuals. As soon as all of the loads have been assigned to the structure, we will proceed to the next step.
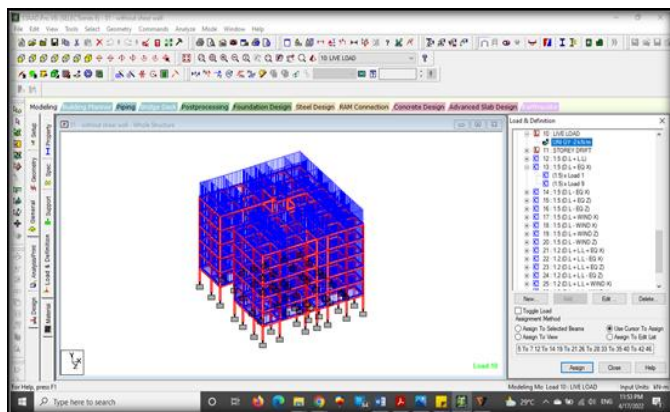

Fig -7: Assigning Live Load to the beams in X & Z direction

Specifying the analysis type:

Before performing the load analysis, we must specify the analysis command, which must be of the linear static type. We will add this command after selecting statics check.

Post-Analysis print command:

We need to obtain member end forces and support reactions, which are written in the output file. By clicking on post-analysis, a dialogue box will open, and by clicking define command, we can add the commands we need and assign them to members who will be analyzed.

Run Analysis:

The structure will be analyzed in relation to the loads, and this command will also indicate whether there are any warnings or errors. Mode of Post-Processing: 'In this mode, we can see results. The structure with values can have deflection, bending moment, shear forces, and reactions on supports. The figures below are for Dead Load. We can also see figures under Live Load or any other category that we want.

After performing all structural analyses on our structure, we designed it to determine the steel used for column and beam reinforcement. We will define parameters for our design by selecting the code IS: 456 2000 for the concrete design.

We will now issue commands for the design of beams and columns after we have received all of these inputs. Once added, these are chosen and assigned to the structure's appropriate components. The structure is then analyzed once more in preparation for report generation.

3. CONCLUSIONS

(i.)   Model 1 has a maximum storey drift value for the Load Case 1.5 (D.L + EQ X).

(ii.)   Model No. 2,4 has a maximum storey drift value for the Load Case 1.5 (D.L + EQ X)

(iii.)   Model 3 has a maximum storey drift value for the Load Case 1.5 (D.L - EQX)

By comparing the values we can observe that the load case of 1.5 (D.L + EQ X) gives the maximum storey drift value and can be considered as main load case and for Mid – rise buildings the shear wall is not necessary and when compared to the High – rise building the shear wall is necessary.

4. Comparison of Results:

We get results from analyzing the values in STAAD Pro, in which we can see the Shear forces and Bending Moment values. We can also see the values of different models in Tables 1–4 (shown below).

Table -1: G+5 without shear wall

	Beam	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	435	12 1.5 (D.L + L.L)	304.526	-18.382	22.829	-0.277	-38.136	-43.762
Min Fx	592	12 1.5 (D.L + L.L)	-272.102	-36.414	45.612	-0.373	-87.012	-97.636
Max Fy	600	12 1.5 (D.L + L.L)	-5.203	69.53	1.742	-0.041	-1.387	53.674
Min Fy	444	12 1.5 (D.L + L.L)	-1.128	-52.139	1.625	-0.492	-1.579	-46.057
Max Fz	320	12 1.5 (D.L + L.L)	-127.268	-23.989	62	-0.223	-93.811	-46.907
Min Fz	384	12 1.5 (D.L + L.L)	-5.2	-1.47	-13.972	-3.502	13.726	-4.222
Max Mx	328	12 1.5 (D.L + L.L)	-2.373	34.427	1.628	17.445	0.262	41.3
Min Mx	192	12 1.5 (D.L + L.L)	-0.609	11.569	-0.146	-15.49	0.367	43.782
Max My	320	12 1.5 (D.L + L.L)	-127.268	-23.989	62	-0.223	92.188	25.059

Table -2: G+5 with shear wall

	Beam	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	43	12 1.5 (D.L + L.L)	475.101	-9.398	3.184	1.087	-7.073	-26.376
Min Fx	304	12 1.5 (D.L + L.L)	-328.468	-15.124	3.88	0.435	-6.992	-35.559
Max Fy	68	12 1.5 (D.L + L.L)	78.376	41.736	-19.972	1.344	26.783	61.995
Min Fy	147	12 1.5 (D.L + L.L)	16.72	-51.875	5.36	-0.13	-10.895	-149.257
Max Fz	427	12 1.5 (D.L + L.L)	4.67	1.148	36.908	-0.298	-48.576	0.718
Min Fz	527	12 1.5 (D.L + L.L)	19.807	-0.469	-22.229	-0.522	39.483	-0.948
Max Mx	54	12 1.5 (D.L + L.L)	-251.323	-8.332	-2.782	3.047	2.116	-14.005
Min Mx	339	12 1.5 (D.L + L.L)	-68.969	-1.226	-8.379	-5.099	8.169	-5.273
Max My	427	12 1.5 (D.L + L.L)	4.67	1.148	36.908	-0.298	48.492	-2.302

Table -3: G+10 without shear wall

	Beam	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	556	12 1.5 (D.L + L.L)	3026.637	5.835	-1.019	0.272	-8.716	7.866
Min Fx	704	12 1.5 (D.L + L.L)	-32.564	25.974	-3.145	-1.188	5.06	18.872
Max Fy	594	12 1.5 (D.L + L.L)	-1.884	146.298	1.097	-80.004	-1.456	269.116
Min Fy	776	12 1.5 (D.L + L.L)	-8.609	-143.584	6.459	15.87	7.006	209.618
Max Fz	586	12 1.5 (D.L + L.L)	2585.948	49.911	72.295	-0.226	-111.886	75.185
Min Fz	696	12 1.5 (D.L + L.L)	142.109	41.177	-23.289	0.458	25.306	58.647
Max Mx	720	12 1.5 (D.L + L.L)	-26.334	-52.536	-4.156	17.073	5.966	-53.47
Min Mx	692	12 1.5 (D.L + L.L)	7.388	140.412	-2.609	-85.61	2.261	249.564
Max My	586	12 1.5 (D.L + L.L)	2564.743	49.911	72.295	-0.226	105	-74.549

Table -4: G+5 with shear wall

	Beam	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	630	12 1.5 (D.L + L.L)	2657.256	-8.385	7.646	-0.437	-10.133	-12.028
Min Fx	547	12 1.5 (D.L + L.L)	-1083.91	11.442	-11.044	1.019	-16.032	-26.328
Max Fy	160	12 1.5 (D.L + L.L)	15.966	129.08	1.027	-0.042	-0.594	113.536
Min Fy	414	12 1.5 (D.L + L.L)	-3.069	-155.686	-0.515	-3.82	0.719	125.04
Max Fz	260	12 1.5 (D.L + L.L)	-2.183	16.175	37.953	0.888	-49.257	22.908
Min Fz	1604	12 1.5 (D.L + L.L)	-533.817	10.637	-16.071	0.103	22.549	12.709
Max Mx	807	12 1.5 (D.L + L.L)	-27.756	-52.509	-1.079	8.722	1.554	-61.191
Min Mx	658	12 1.5 (D.L + L.L)	-1.441	82.411	0.383	-8.649	-0.606	86.589
Max My	260	12 1.5 (D.L + L.L)	-53.763	16.175	37.953	0.888	64.603	-25.617

We can also the above values in the graphical representation as represented in below Chart 1.
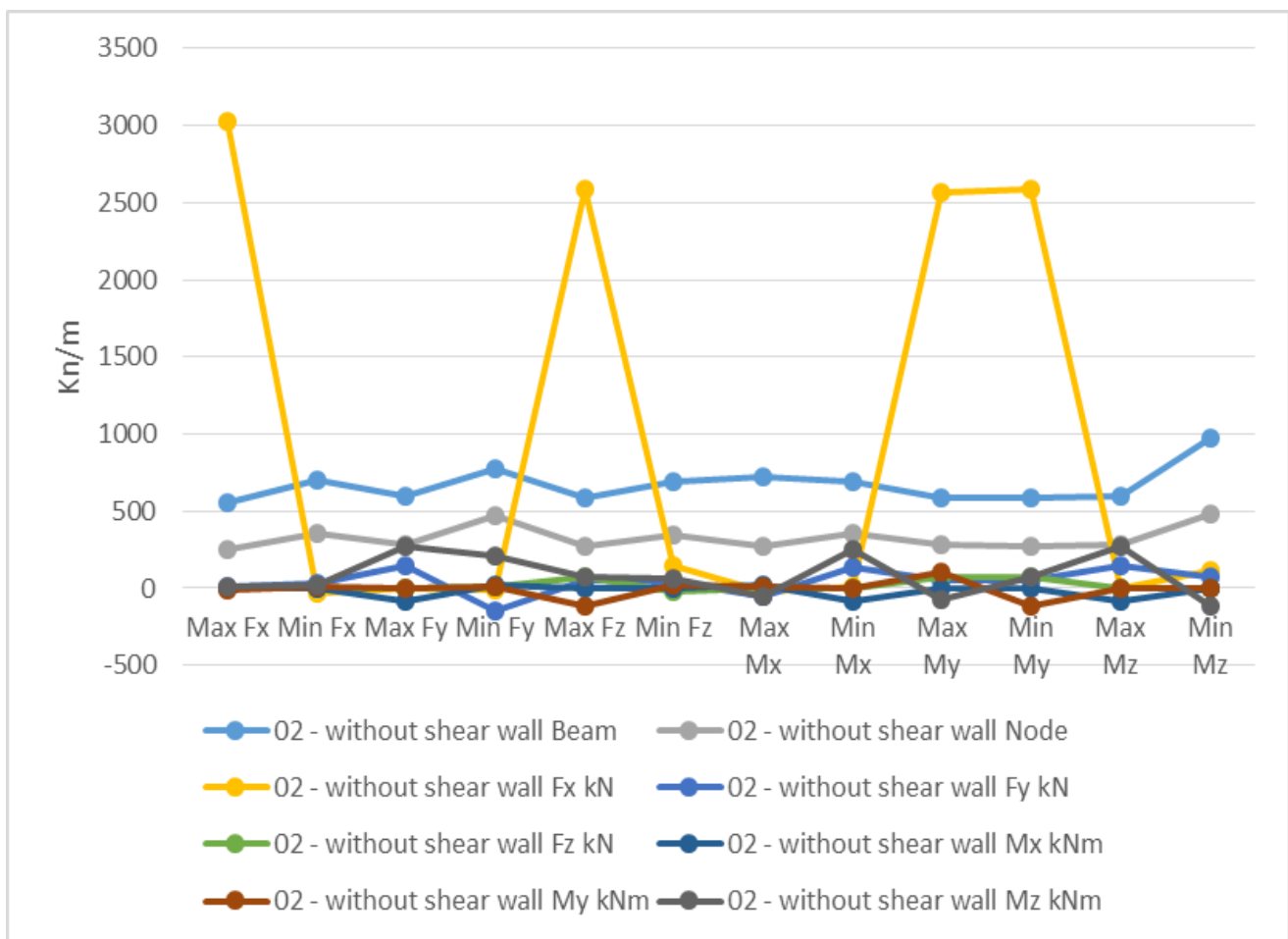

Chart -1: Graphical representation of Shear forces and Bending Moment values

for mid-rise structures The storey drift value of the structure with shear wall provided building seems to be greater than the storey drift value of the structure without shear wall, and the storey drift value of the structure without shear wall is greater than the structure with shear wall for high rise buildings. We can also see the storey drift values and comparison in Chart 2.

Chart -2: Graph for comparing the storey drift values between Mid-rise and High-rise building with and without shear wall

REFERENCES

[1] Pankaj Yadav, and Rishabh Joshi, "Effect of Height and Position of Shear Wall on G+5 Multi-Storey Building for Zone III", International Journal of Recent Technology and Engineering (IJRTE), Vol. 8 Issue 3, September 2019, pp.5452-5456.

[2] P.Kalpana, R.D. Prasad, and B. Kranthi Kumar, "Analysis of Building with and without Shear Wall at Various Heights and Variation of Zone III and Zone V", International Journal of Engineering Research and Application, Vol. 6, Issue 12, (Part -2) December 2016, pp.05-11.

[3] Maikesh Chouhan, and Ravi Kumar Makode, "Dynamic Analysis of Multi-Storeyed Frame-Shear Wall Building Considering SSI", Internnational Journal of Engineering Research and Applications (IJERA), Vol. 6, Issue 8, (Part -1) August 2016, pp.31-35.

[4] V.ABHINAV, Dr. S.SREENATHA REDDY, M.VASUDEVA NAIDU, and 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 No.4, Issue No.5, August – September 2016, pp.3776 – 3779.

[5] Varsha R. Harne, "Comparative Study of Strength of RC Shear Wall at Different Location on Multi-storied Residential Building", International Journal of Civil Engineering Research, Vol. 5, No. 4 (2014), pp. 391-400.

[6] Ashok Thakur, Arvinder Singh, "Comparative Analysis of a Multistoried Residential Building with and Without Shear Wall using STADD Pro", International Journal of Recent Research Aspects, Vol. 1, Issue 1, June 2014, pp. 54-57.

[7] Himalee Rahangdale, and S.R.Satone, "Design And Analysis Of Multistoried Building With Effect Of Shear Wall", International Journal of Engineering Research

and Applications (IJERA), Vol. 3, Issue 3, May-Jun 2013, pp.223-232.

[8] S. V. Venkatesh, and H. Sharada Bai, "Effect of Internal & External Shear Wall on Performance of Building Frame Subjected to Lateral Load", International Journal of Earth Sciences and Engineering, Vol. 04, No 06 SPL, October 2011, pp. 571-576.

[9] Anand, N., Mightraj, C., and Prince Arulraj, G., "Seismic Behaviour of RCC Shear Wall Under Different Soil Conditions", Indian Geotechnical Conference – 2010, GEO trendz, December 16–18, 2010, IGS Mumbai Chapter & IIT Bombay

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