SEISMIC ANALYSIS OF G+7 RESIDENTIAL BUILDING WITH AND WITHOUT SHEAR WALL

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Abstract - *In modern era, there are various techniques, being developed to build a structure earthquake resistant, such as adopting- Base isolation techniques, Active devices, Passive devices, Seismic dampers and Shear walls. Amongst of all, Shear wall systems techniques are generally used to resist the lateral forces, produced due to seismic forces, wind or earthquake. Shear walls are extremely useful in resisting the lateral or seismic forces, as it reduces the lateral sway of the building. The shear walls work on the stiffness criteria that is it provides large stiffness, strength to the building and support the gravity loads as well as seismic loads like earthquake or wind loads. The present work deals with a study on the seismic analysis of G+7 RCC framed building with the effect of shear wall (at the periphery of the building) in a high seismic zone V and the analysis as well as structural modeling is being performed using STAAD pro Software. This study includes calculating the Seismic Base shear, Storey Shear, Maximum displacement, Maximum Nodal displacements and Maximum Combined (both axial and bending) stresses. Results are then interpreted and compared for the two models, one with and other without shear wall. It was concluded that shear wall will greatly reduce the displacements and stresses arising from Seismic forces.*

Key Words: (Seismic analysis, Shear wall Earthquake resisting techniques, Seismic Base shear, Maximum Combined stresses, Maximum displacement and STAAD.Pro.

1. INTRODUCTION

This study aimed to highlight the potential of providing the Shear walls, in a high seismic area of Srinagar city, located in zone V. As, we all know shear walls are basically a reinforced concrete (RC) structures, having a vertical plate-like walls RC walls called as Shear Walls, in addition to beams, columns and slabs. Shear walls are extremely useful in resisting the lateral or seismic forces, as it reduces the lateral sway of the building. It is to be ponder, that to make a building earthquake resistant, one must increase the ductility or the stiffness. However, both the parameters cannot be met in one platform. The shear walls work on the stiffness criteria, that is it provides large stiffness, strength to the building and support the gravity loads as well as seismic loads like earthquake or wind loads. To reduce the ill effects of twisting in building, it is to be crucial that these shear walls must be in symmetrical positions. It is to be noted that, providing shear walls along the exterior perimeter of the building will be much more effective as, this type of layout increases torsional resistance. The main aim of the study is to compare a G+7 R.CC. framed building with and without shear wall for seismic analysis in seismic zone V. The results are interpreted and compared in terms of Seismic base shear, storey displacements and combined stresses.

1.1 Aims and Objectives Of Work

The prime objective of the study is to design, develop and analyse the seismic response of building with and without shear wall using STAADPro software. The Modelling will be done on the same software in a high seismic zone V considering IS: 1893(2005) , displayed automatically on the software. So, following particular objectives can be summed up as under:

- Modelling of G+7 RCC framed building with and without shear wall in Seismic zone V on STAAD-Pro Software.
- To understand the behavior and demand of shear wall in that zone(V).
- To compare the results obtained from software, in terms of parameters selected under study such as- Seismic base shear, maximum nodal displacements, maximum combined stresses, maximum bending moment and maximum storey displacements.

2. LITERATURE REVIEW

P.P.Chandurkar,Dr.P.S.Pajgade et.al:- In this paper author has compared the RCC building with and without shear wall (G+10) for seismic analysis. Author has selected 4 different models in different zones (II.III.IV and V) and has interpreted the results in terms of some parameters such as parameters, storey drift and storey displacement by using ETAB v.9.5.0 software. It was concluded that shear wall will greatly reduce the displacements arising from Seismic forces. However for G+10 (or below this value) storey building providing the shear wall will not effective, but in high rise building it is effective and well as justified and economical. Varsha

R.Harne analysed et.al:- In this, a 4 number G+6 storey building under seismic loading in Zone II was considered, for earthquake analysis using STAAD Pro software. Models were analysed with and without shear wall structure. The author has selected L type shear wall acting along the periphery and shear wall acting on the corners. After analyzing the results, a conclusion was drawn, that using shear wall along periphery will be the most efficient among all the shear walls considered.

S.S. Patil et.al: - In this author has carried the response spectrum analysis using STAAD Pro software for a high rise building with and without shear wall. Results are compared in base shear, storey drift and storey deflection and this was concluded that shear walls considerably reduces the displacements. Siddhartha

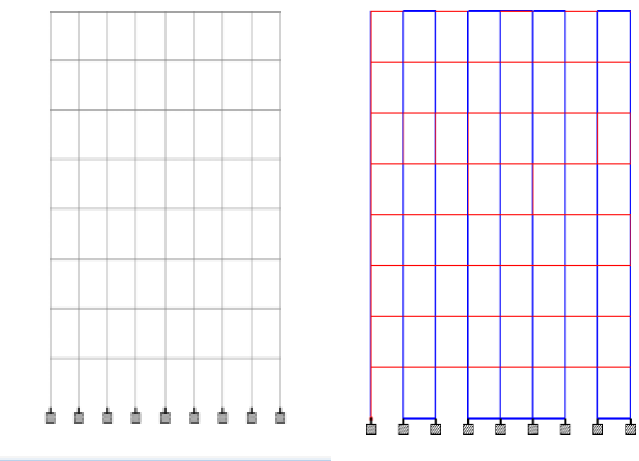
S. Ray et.al: - In this study, the author has selected two different softwares (ETABS and STAAD Pro for comparison of seismic performance of multi-storeyed structure. Analysis has been carried out using Response spectrum analysis and Equivalent static analysis. It was concluded that the displacements value is same, obtained from both softwares.

However, the comparisons of results for Shear force displayed a difference of 11.48% within permissible limits, and after obtaining a bending moment from the software, only a 3.45% difference is observed, however axial force displayed a difference of 22.34%, which is quite great than other parameters selected under study.

3. METHODOLOGY

3.1 Collection of Data and Planning

In this project I have used a G+7 storey building with same floor plan with 9 bays along X- direction and 8 bays along Z-direction respectively. The buildings are modelled using software "STAAD-PRO



(a) (b)

Fig 2: Model(a) without shear wall and Model (b) with shear wall

Table -1: Input Data for Modelling the Building

Design Parameters	**Values**
Plan Dimension	27m x 24m
Total No. of Storeys	G+7
Height of each Storey	3m
Number of bays in X- direction	9
Number of bays in Z-direction	8
Section Taken	Rectangular
Size of Beam	350mm x 350mm.
Size of Column	350mm x 500mm.
Material Used	Concrete (M20)
Density of Concrete	2.5 KN/m^2
Modulus of Elasticity of Concrete(E)	2.1785×10^7 KN/m^2
Thickness of Slab for Dead Load Calculation	150mm
Thickness of Shear Wall	120mm
Seismic Zone	V(Srinagar City)
Zone factor (Z)	0.075
Importance Factor(I) 9General Building)	1
Response Reduction Factor (SMRF)	5
Soil Type	Medium Soil
Damping Ratio	0.05
Dead Load on Floor	3.0675KN/m^2
Live Load on each Floor	2.5KN/m^2

3.2 Modelling and Designing In Staad-Pro

A base structure is modelled only with the use of columns and beams, and no additional seismic restraints are used (Fig.3). Likewise, a G+7 Model is prepared, with respect of selected zone (V), using Staad pro software where the high-rise structure is embedded & supported with shear wall on all the periphery of the building (Fig.4). After assigning the member property loads and definition is to be introduced. The Earthquake loads acting in X and in Z- directions, are to applied as per IS: 1893(2016), which is displayed automatically in the software. The dead load and live load details are already mentioned n above Input data table. It is to be noted there are total 19 Load case combinations developed by software in both models under study.

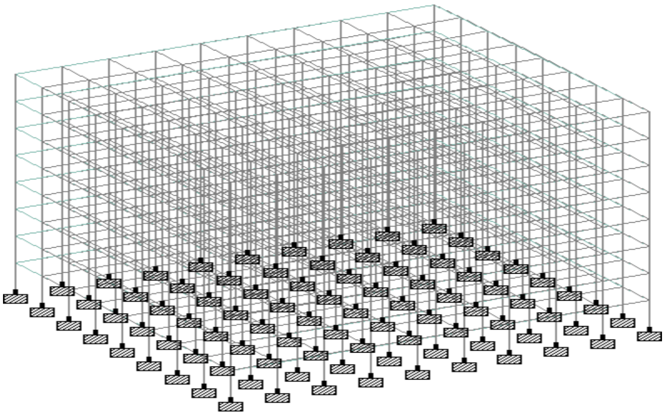


Fig 3: Model without Shear Wall

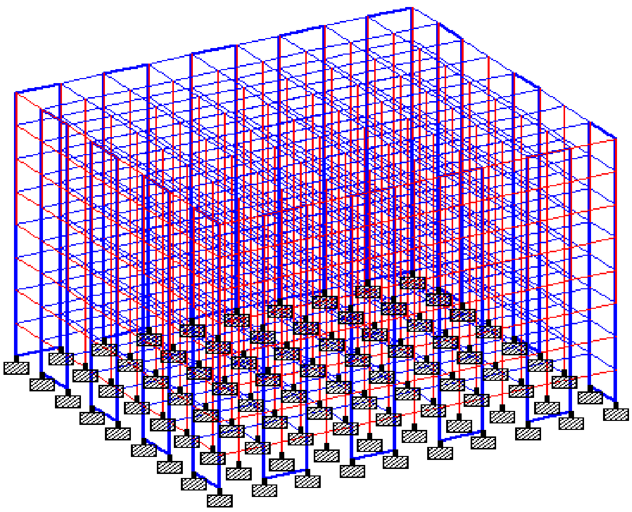


Fig:4 Model with Shear Wall.

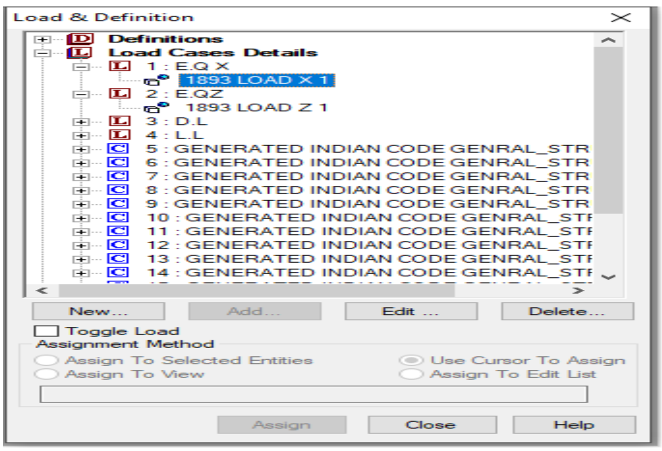


Fig: 5 Load Case Details

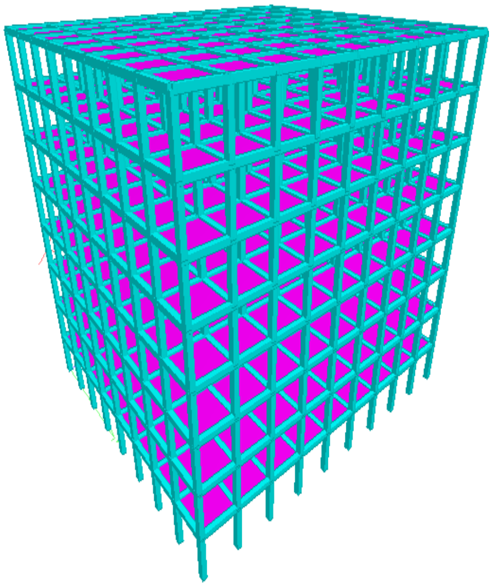


Fig: 6 *Model Without Shear Wall*

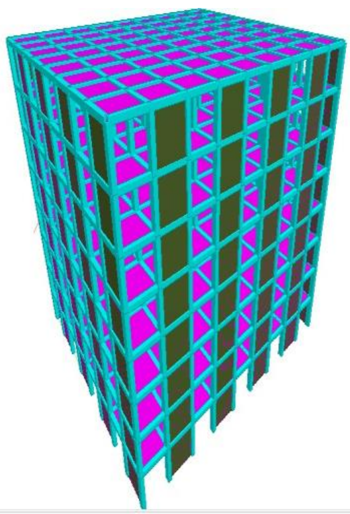


Fig. 7: *Model With Shear Wall*

Using Run Analysis Command after adding analysis /print, structure will be analysed via the post processing mode for interpreting the results. In this study the parameters I have selected is Seismic base shear, storey displacements, Maximum bending moments and Maximum combined stresses generated on the beam per storey. The software automatically displays the output file. It is also can be visualized that the structural analysis performed in the software is perfect and correct by noticing the Zero errors, displayed on the screen.

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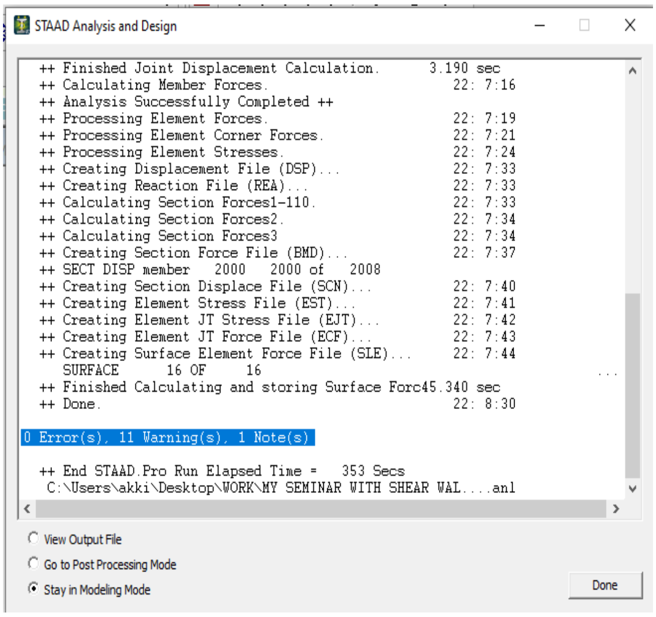

Fig 9: Output Generation for Model with shear wall

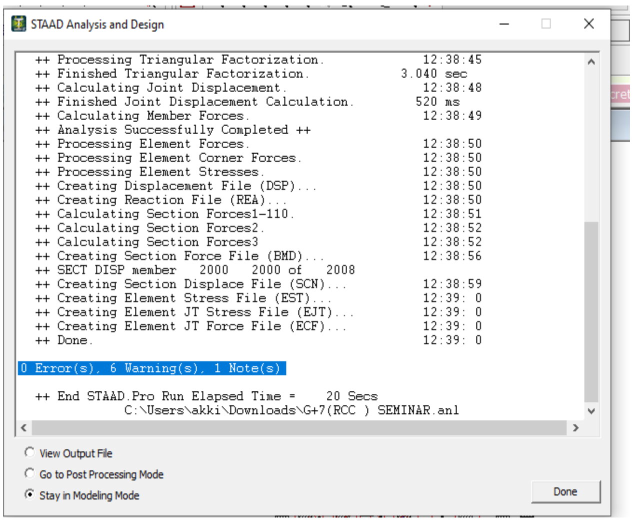

Fig 10: Output Generation for Model without shear

4.1 RESULTS AND DISCUSSIONS

4.1.1 Base Shear

Table 2: *Base Shear Values with and without Shear Wall.*

MODELS	BASE SHEAR (KN)
WITHOUT SHEAR WALL	1449.45
WITH SHEAR WALL	3219.15

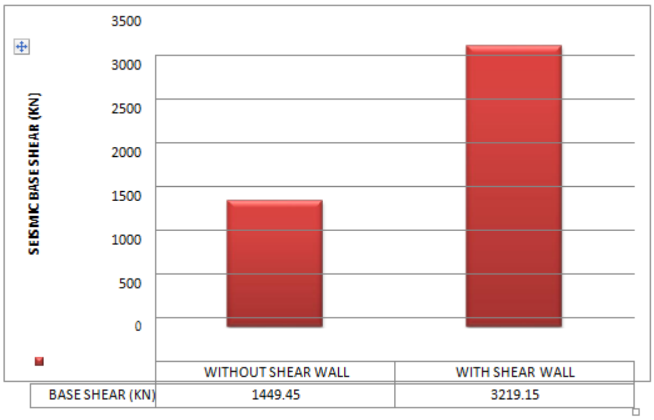

Chart -1: Base Shear

4.1.2 Storey Shear

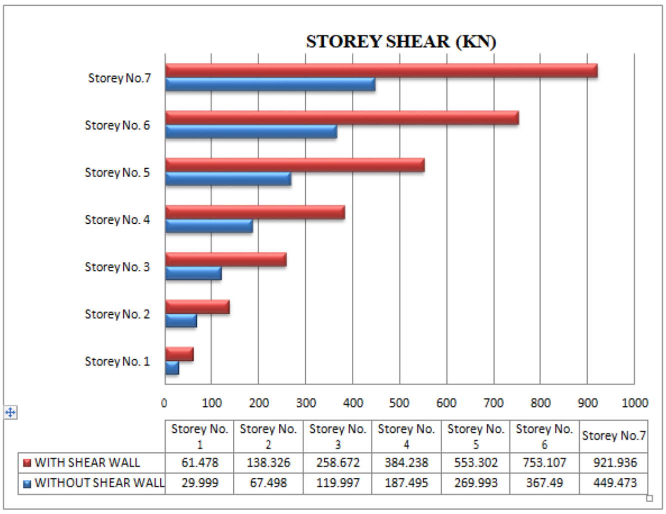

Chart -2: Storey Shear (KN)

4.1.3 Maximum Displacements

Model without Shear Wall

Table3: Maximum Lateral Displacement due to Earthquake load in X- direction without shear wall.

STOREY LEVEL	*MAX. LATERAL DISPLACEMENT(mm)*
Storey Level 1	4.908
Storey Level 2	7.821
Storey Level 3	10.646
Storey Level 4	13.271
Storey Level 5	15.556
Storey Level 6	17.325
Roof Level	18.393

Model with Shear Wall

Table4: Maximum Lateral Displacement due to Earthquake load in X- direction with shear wall.

STOREY LEVEL	*MAX. LATERAL DISPLACEMENT(mm)*
Storey Level 1	3.72
Storey Level 2	5.801
Storey Level 3	7.802
Storey Level 4	10.536
Storey Level 5	12.857
Storey Level 6	14.48
Roof Level	15.238

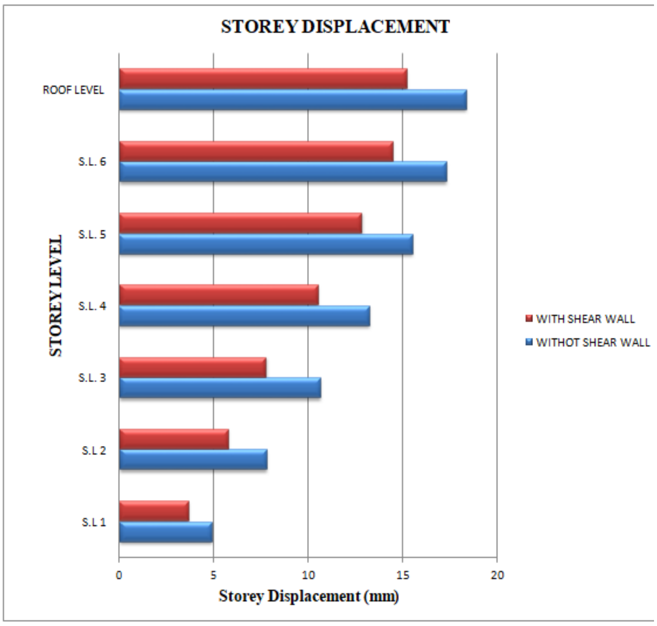

Chart -3: Maximum Lateral Displacement due to Earthquake load in X-Direction

4.1.4 Maximum Bending Moments

The maximum bending moments acting on beams can be visualized by just clicking on Postprocessing command in the software. In this regard, I have selected the respective beams with respect of per storey in reference to model with (a) and without shear wall(b), so as to understand the effect of bending moments (acting due to earthquake load in X-direction), as shown in below display results. It is to be concluded that bending moment per storey acting on beams is decreased, comparable to model without shear wall. So, shear wall reducing the bending moments per storey.

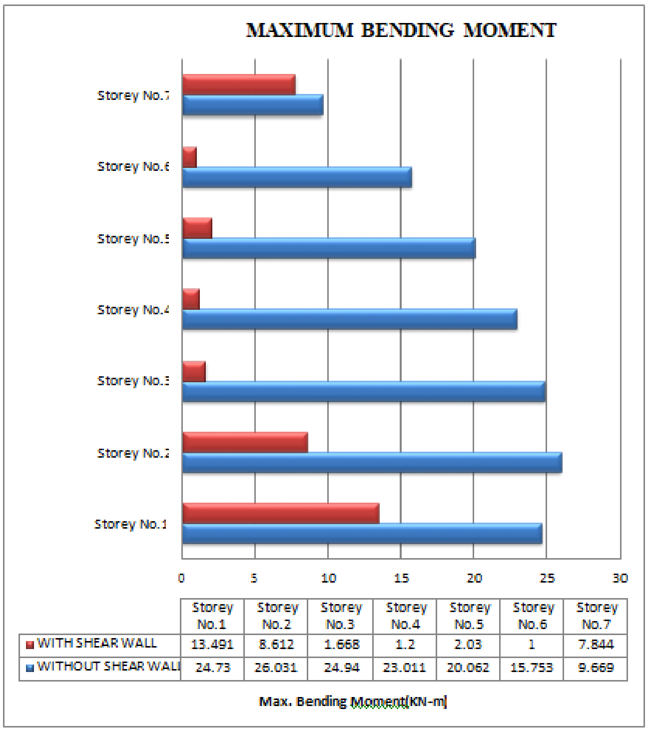

Chart -4: Maximum Bending Moment

4.1.5 Maximum Combined Stresses

The maximum combined stresses (axial and bending stresses) generated on the beam is displayed using postprocessing command in the software with shear wall (a) and without shear wallmodel(b).It is concluded that shear wall reduces the combined stresses considerably. It is to be noted that , here in the graph only tensile stresses graph is potrayed , as the RCC is weak in tension and strong in compression

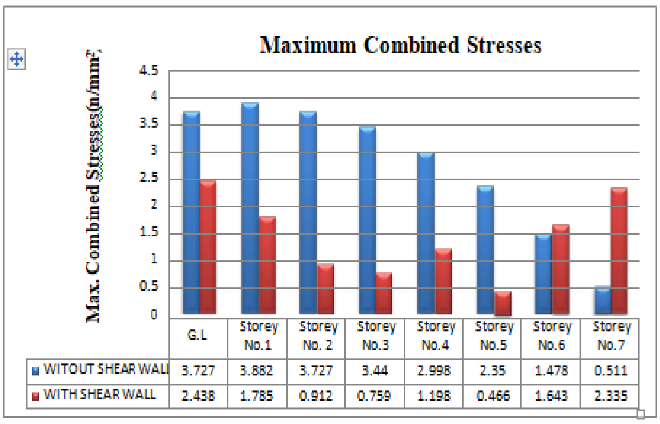

Chart -5: Maximum Combined Stresses

5. CONCLUSIONS

- The maximum Nodal displacements of the structure with shear wall are less when compared to that of without shear wall.
- The Seismic base shear and Storey shear of the structure without shear wall is less when compared to same with shear wall.
- It is to be concluded that Maximum storey displacements, Maximum bending moments generated on the beam at the end of each storey is less in a Shear wall model, comparable to model without seismic restraint .i.e. without shear wall model.
- Furthermore, the Maximum Combined, both axial as well as bending stresses generated on the beams at the periphery of each storey is less in a shear wall model than without shear wall model.
- Hence we can conclude that shear wall in building reduces maximum displacement, Stresses, Bending Moments and Seismic Base Shear. Thus, building with shear wall is better in resisting the earthquake forces compared to building without shear wall.
- Stadd.Pro is a much easier and faster way of analysing and designing a structure when compared to manual computation.

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