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Analysis of a Tall Structure Considering Shear Wall with Dampers and Bracings Considering Lateral Load Using ETABS

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ABSTRACT

Seismic analysis is mandatory in every case of structure analysis whether it's related to any soil condition or geography. Architectures and structure engineers together have created marvels in form of unique structures whether its time from ancient Pyramids to Transamerica Pyramid in San Francisco. This structures are not always about cosmetic interests as even such structures are meant to be stable against different forces and economical aspects. High rise buildings and skyscrapers are designed with different technologies to resist heavy winds and seismic forces and such technologies include leaning at different angles, twisting shapes or creating free shapes for aerodynamics.
Shear-wall are considered as the lateral load resisting members capable of resisting vibration from the ground or lateral forces. In this investigation, the results of maximum response in terms of base shear, displacement, forces are evaluated. The aim of this research designing and analysis of tall structures with shearwall in combination with bracings and dampers to improve the dynamic of the building. The seismic analysis of G+18 storey RCC building is considered considering seismic zone V, for analysis and design etabs software is utilized.

Keywords : Structure, etabs, analysis, materials, dampers, bracing, seismic and shearwall.

I. INTRODUCTION

Generally shear wall are often outlined as structural vertical member that's able to resist combination of shear, moment and axial load elicited by lateral load and gravity load transfer to the wall from alternative support. Reinforced concrete walls, that embrace raise wells or shear walls, area unit the same old requirements of Multi story Buildings Style by coinciding centre of mass and mass centre of the building is the ideal for a Structure. Shear walls have terribly high in-plane stiffness and strength, which may be wont to at the same time resist massive horizontal masses and support gravity masses, creating them quite advantageous in several structural engineering applications. associate degree introduction of shear wall represents a structurally economical resolution to stiffen a building structural system as a result of the most operate of a shear wall is to extend the rigidity for lateral load resistance.

Figure 1. Damage on building due to earthquake

In trendy tall buildings, shear walls are usually used as a vertical structural component for resisting the lateral masses that may be elicited by the impact of wind and earthquakes. Shear walls of varied cross sections i.e. rectangular shapes to a lot of irregular cores like channel, T, L, barbell shape, box etc. will be used.

Provision of walls helps to divide AN enclose area, whereas of cores to contain and convey services like elevator. Wall openings are inevitably needed for windows in external walls and for doors or corridors in inner walls or in elevate cores. The dimensions and placement of openings might vary from architectural and useful purpose of view.

Objectives of the Study

The main aim of this study are as follows:

1. To evaluate conventional steel bracing & damper system under the shear wall system for seismic loadings.
2. To design multi storied irregular building with seismic loading combinations.
3. To compare the behavior of steel bracing and damper system under lateral load and review the performance.
4. To study advantages/disadvantages of steel bracing and damper system.
5. To evaluate and study the best suitable location for bracing and damper with shear wall under dynamic loading conditions.

II. Literature Review

Meshram and Munde (2018) the main aim of the projectwass to work out the solution for shear wall location in multi-storey building. It's administrated to work out the strength of RC shear wall of a high-rise building by dynamicalshear wall location. Three completely different cases of shear wall position for a building were analysed and associate degree earthquake load was calculated by the unstable constant technique victimisation IS 1893 (PART–I): 2002.STAAD professional V8i software is used for the analysis of structures. The structures area unit compared on four completely different parameters specifically joint displacement, axial force, bending moment and base shear.

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Analysis results concluded that time period decreases as the mode frequency increases for all model. Maximum lateral displacement increases as storey height increases for all models. Minimum lateral displacement of the building reduced due to the presence of shear wall placed at the model with shear wall at center in comparison to all models. The maximum base shear observed in model with central shear wall as compare to other models in x and y direction. Hence, it was said that building with central cross section shear wall was more efficient than all other types of shear wall.

Sandeep Singla et. al. (2019) the research paper presented comparative analysis of earthquake resisting techniques on a G+10 story building with the help of different types of Shear walls & Bracings, using software. The comparison was done between an un-Resisting structure, parallel shear walls, L-shaped shear wall, diagonal bracings, X-shaped bracings & V-shaped bracings. The use of shear walls and bracings helps to strengthen then structure to make it more Earthquake resistant. The analysis was done on a G+10 building for seismic zone III as per IS 1893:2002 codal provisions. The software used to carry out this analysis was Staad pro v8. It was found out that shear walls and bracing contribute largely in reducing the deflection by increasing the strength and stiffness of the building.

Results stated that the displacement observed in the models, which are without shear walls & bracings is more as compared to the models having shear walls and bracings at different locations. It has been observed that the Max deflection is significantly reduced after providing the shear walls or bracings in the RC frame in X-direction as well as in Z-direction. It is also been observed that Story shear effectively decreased by introducing Shear Walls and Bracings at different locations. The best location of shear wall in multi-storey building was parallel shear walls. And the best type of bracings that can be used is cross bracing. The lateral deflection of column for building with cross bracing was reduced maximum as compared to all models. The least story shear is found in the model with cross bracing. The shear force is maximum at the ground level & the bending moment is maximum at roof level. By providing shear walls and bracings to the high-rise structure, seismic behavior will be affected to a great extent and also the stiffness and the strength of the buildings is increased. Finally, it is concluded that, optimization using cross bracings is the best procedure, in present work mode for maximum earthquake resistance.

Mahajan and Vyas (2019) the research paper conducted response spectrum analysis of structural frame models using SAP 2000 vs. 19. Accurate modeling of all models consist various elements is very important in earthquake analysis. In present study, frame element is modeled with elastic flexural hinge using elastic model and shear wall is design as area element providing concrete property. G+10 building with bare frame and Shear wall frame structure was considered for the analysis. Four different building models with bay width of 6m in X-direction and story height equal to 4m were considered. The column section defined for the frame satisfies both the requirement for strength and stiffness. All the selected models were designed with M-25, M-30 grade of concrete are used and Fe-415 grade of reinforcing steel as per Indian standards. Four different models were considered namely structure with bare frame, regular shear wall structure, irregular shear wall structure and regular shear wall with varying thickness.

The base shear in irregular shear wall structure was found less as compare to other models due to vertical irregularity of the shear wall. The storey drift of regular shear wall was comparatively lesser than other model due to its regularity. The storey force distribution of regular shear wall is comparatively lesser than other models because of symmetrical cross-section plan of shear wall.

Mallesh et. al. (2019) the research focused to analyze the behaviour of the Buildings with Plan Irregularities under Earthquake loads. frames with unsymmetrical plan configuration of L shape was taken and G+15 storey building is modelled in ETABS 2016 software with seismic zone V and Medium soil type, and that irregular structure to be converted to regular structure with the provision of expansion joint. Where three case to be considered one with Bare Frame Sections with and without Expansion Joint, Shear Wall Frame Sections with and without Expansion Joint and Shear Wall and Bracing Frame Sections with and without Expansion Joint these models was analysed under response spectrum method.

Results stated that the storey displacement values of the bare frame 8% and 4%, bare frame with shear wall 30% and 19%, Frame section with shear wall plus bracings 59% and 34%, Reduced with the provision of expansion joint in comparison to models without expansion joint, along X and Y directions respectively. The storey drift values of models without expansion joint of bare frame, bare frame with shear wall and bare frame with shear wall plus bracing were found to be having lesser values than that of the models with expansion joint. The storey force values of models with expansion joint were found to be having lesser values than that of the models without expansion joint. The storey stiffness values in the bare frame, bare frame with shear wall and bare frame with shear wall plus bracing with expansion joint was found to be slight lesser in comparison to that of their respective models without expansion joint. The base shear values in the bare frame with shear wall and bare frame with shear wall plus bracing with expansion joint was found to be less in comparison to that of their respective models without expansion joint. The results concluded that the regular frame structure performs better than the irregular frame structure in plan.

III. Methodology

For this research work following steps should be followed:

Step-1 Firstly literature survey should be done to determine the past research and need of study.

Step-2 To Select modelling and Geometry of the work in ETABS.

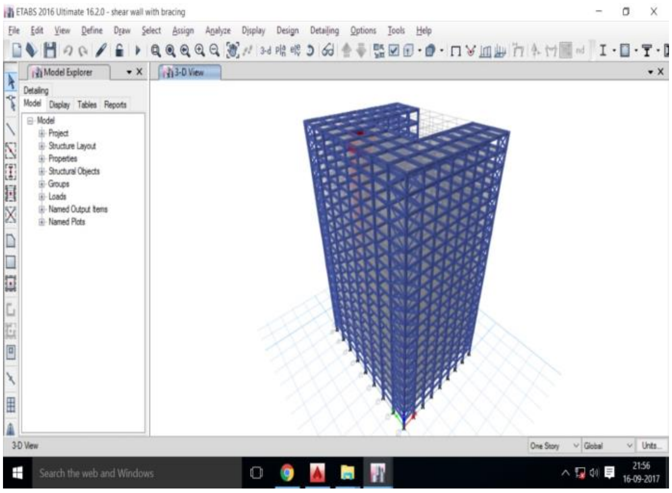

Figure 2 Modelling of Frame

Step-3 To Assign sectional material database in a building frame (G+18) using ETABS.

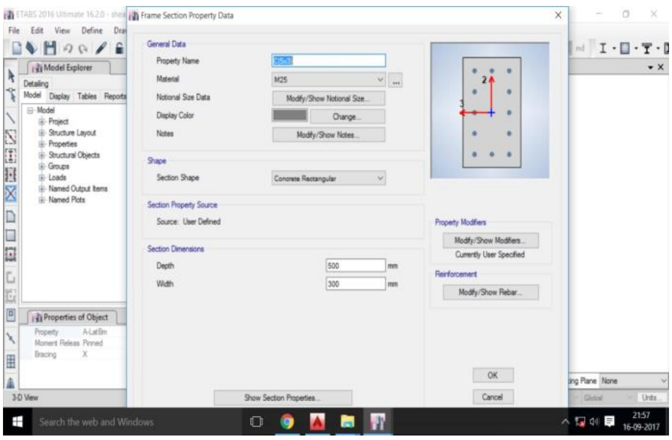

Figure 3 Assigning Sections Material

Step-4 Designing Model as Structure with shear wall along with bracing

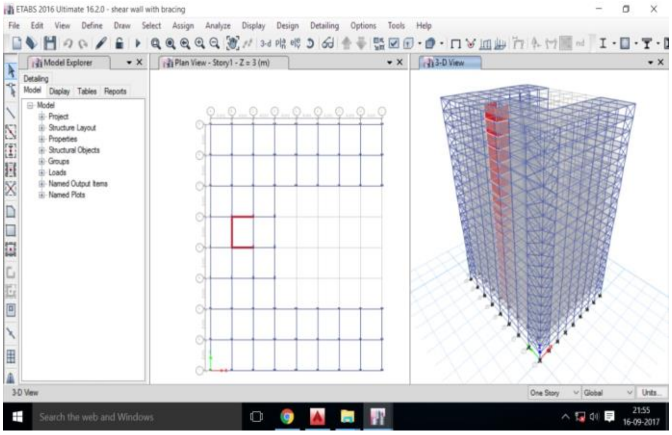

Figure 4 Model A Structure Shear wall with bracing

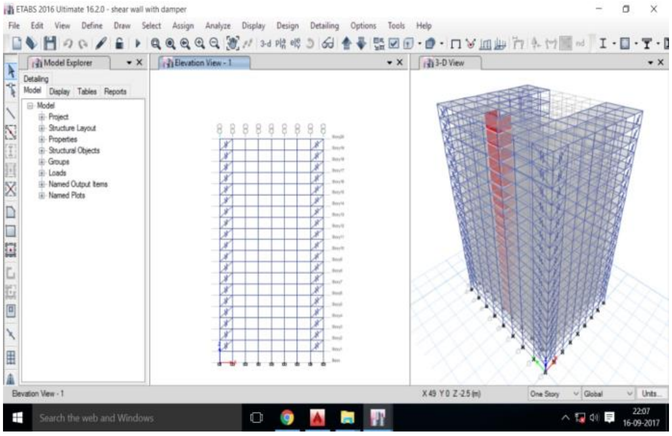

Figure 5 Model B Structure Shear wall with Damper

Step 5 Designing New Wall Stack

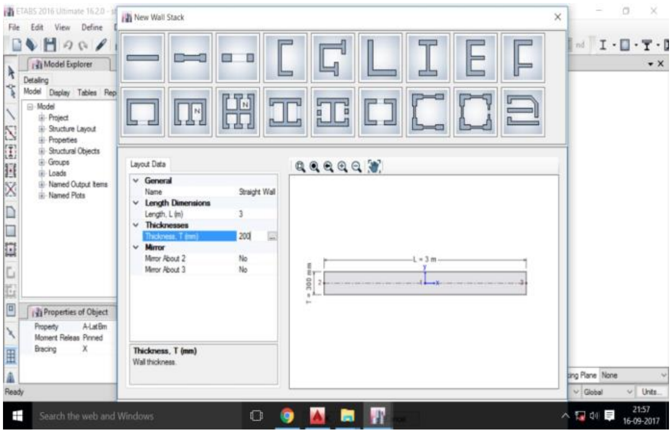

Figure 6 Designing New wall Stack

Step-5 Link Property Data (response spectrum) dynamic analysis as per I.S. 1893-I:2016.

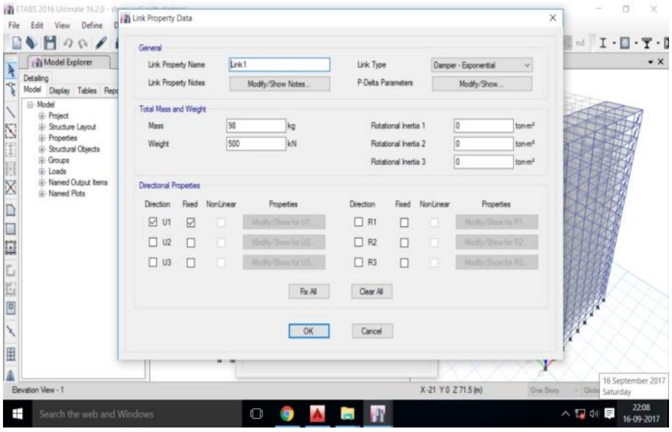

Figure 7 Assigning Seismic load as per IS 1893-2016

Step-6 Mode Shape for Modal period analysis

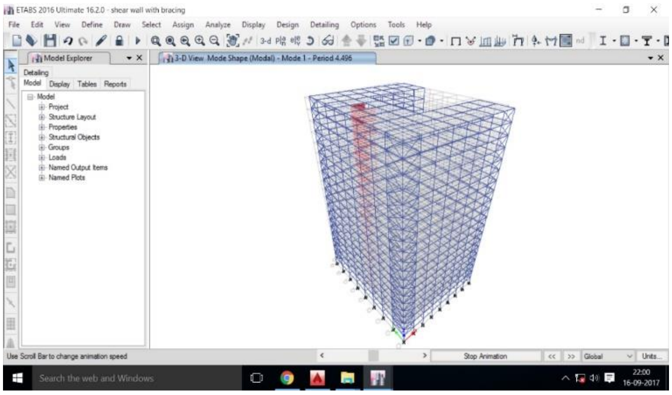

Figure 8 Period Spectrum with nodal displacement

Step 7 Structural Analysis

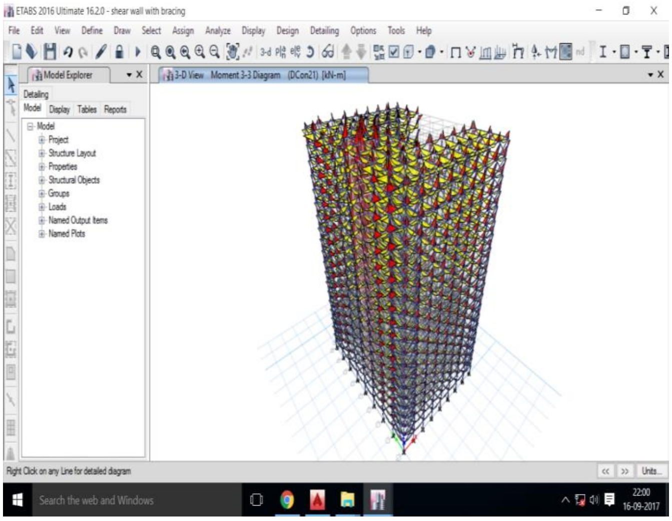

Figure 9 Structure Analysis

Step-7 To compare the results with structure with bracing and Dampers.

Step-8 To determine cost analysis as per S.O.R. 2019.

Table 1 Geometrical Sections

SR.NO.	PARAMETER	DESCRIPTION
1.	AREA	500M^(2)
2.	NO.OF FLOOR	G+18 FLOOR
3.	HEIGHT OF EACH FLOOR	3 METER
4.	GRADE OF CONCRETE	M25
5.	GRADE OF STEEL	Fe 500
6.	COLUMN SIZES	400X600
7.	BEAM SIZES	300x500

IV. ANALYSIS RESULT

Maximum Moment kN-m		
Storey	Model A	Model B
19	655.51	556.84
18	642.68	544.01
17	633.78	535.11
16	623.53	524.86
15	611.73	513.06
14	604.83	506.16
13	597.23	498.56
12	587.33	488.66
11	578.93	480.26
10	569.43	470.76
9	558.33	459.66
8	547.43	448.76
7	536.65	428.98
6	525.87	409.2
5	515.09	389.42
4	504.31	369.64
3	493.53	349.86
2	482.75	330.08
1	471.97	310.3
0	0	0

Shear force kN		
Storey	Model A	Model B
19	1111.29	976.56
18	1098.46	967.66
17	1089.56	957.41
16	1079.31	945.61
15	1067.51	938.71
14	1060.61	931.11
13	1053.01	921.21
12	1043.11	912.81
11	1034.71	903.31
10	1025.21	892.21
9	1014.11	881.11
8	1003.21	870.21
7	984.08	823.43
6	964.95	776.65
5	945.82	729.87
4	926.69	683.09
3	907.56	636.31
2	888.43	589.53
1	869.3	542.75
0	0	0

Axial force kN		
Storey	Model A	Model B
19	3114.13	3115.92
18	3104.63	3103.09
17	3093.53	3096.19
16	3080.7	3087.29
15	3071.8	3075.49
14	3061.55	3065.24
13	3049.75	3053.44
12	3042.85	3046.54
11	3035.25	3038.94
10	3025.35	3030.54
9	3016.95	3019.44
8	3007.45	3008.54
7	3007.3	3008.51
6	3007.15	3008.48
5	3007	3008.45
4	3006.85	3008.42
3	3006.7	3008.39
2	3006.55	3008.36
1	3006.4	3008.33
0	0	0

Cost Analysis						
Case	**Concrete**	**Rebar**	**Concrete rate**	**Rebar rate in Kg**	**Total Cost of concrete**	**Total cost of rebar**
Model A	561.43	18043.4	4200	73.67	2358006	1329257.28
Model B	542.55	16700.5	4200	73.67	2278710	1230328.78

V. CONCLUSION

From the present investigation it has been observed that the natural frequencies of vibration of a structure with rigid diaphragm.

- It has been observed that the changes in the forces due to the presence of rigid diaphragm is effective.
- It can be concluded that due to introduction of steel bracing and dampers, structure become more stable and stiffer in comparison.

Joint Analysis:

As observed in chapter above, in comparative analysis it is determined that slab stiffness resist force and provide a linear distribution of resultant forces through joints. In our study it is observed that unbalance force in joints are minimized in steel bracing structure case by approx. 6.80%.

Bending Moment:

Bending moment in members of a structure determine its reinforcement requirement. In our study it is observed that value of bending moment decreases with structure with dampers stiffness comparing to structure with steel bracing

Shear force:

Shear force are the unbalance forces act near the joint of beam and column, in this study our motive was to justify the decreament of unbalance forces at the joint which we observed in the process of analysis thus we can state that rigid diaphragm is effective in resisting unbalance forces.

Support Reactions:

Support reactions are the reaction which is transmitting building load to the soil or strata beneath.

This determine the amount load to be distributed to the soil.

As observed in above chapter Frame with consideration of dampers stiffness provides a variation of 0.98 to 1.02 times in vertical support reactions as compared to frame with steel bracing however Effect of slab stiffness on vertical support reactions is found to be insignificant Change in torsional moment and bending moment at support due to introduction of pre-tensioning slab is found to be insignificant for given load case.

Plate stresses:

The application of external forces to a body produces an internal state of stress. Stress is measured in units of force per unit area, and can be thought of as the intensity of the internal forces acting at a particular point in the body. Here in this study it is observed that stresses induced in both cases are generally same as loading provided is same.

The conclusions which are made from the present investigation for the Joint Analysis having rigid diaphragm From the present investigation it has been observed that the natural frequencies of vibration of a structure with rigid diaphragm. It has been observed that the changes in the forces due to the presence of rigid diaphragm is effective. It can be concluded that due to introduction of dampers, structure become more stable and stiffer in comparison. It can be said that P-delta analysis results in observing overturning moment and rotational forces using analysis tool ETABS.

In this study it can be said as per above results that structure with dampers is comparatively more economical and have balanced design for safety.

Future Scope

In this study symmetrical building geometry has been considered which can be extended to unsymmetrical in future.

In this study G + 19 structures has been considered. The study can be extended to more tall structures.

This study performs seismic load analysis (P-delta) and in further study wind load analysis can be included.

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