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Dynamic Analysis of Irregular Building under Lateral Load with Combination of shear wall with Friction Dampers and Bracings

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ABSTRACT

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The application of the shear wall system in reinforced concrete (RC) buildings has become widely used to minimize seismic consequences. Besides, the buildings using concentrated steel bracings system are used for the same reasons in steel structures buildings. Both of the systems have significance of the structural performance. Although both systems are used for same the reasons, their effect shows unequal variations and behaviour against seismic load. This is for the reason that the values of response factors are miscellaneous for varying structural systems. This study contains a numerical approach to show dissimilarity between the shear wall system and steel bracing system.

Earthquake is the natural calamity, it produce strong ground motions which affect the structure. Small or weak motions that can or cannot be felt by the humans. Provision of shear walls and bracings are installed to can enhance the lateral stiffness, ductility, minimum lateral displacements and safety of the structure. Storey drift and lateral displacements are the critical issues in seismic design of buildings.

Keywords : Irregular building ,Damper ,Steel Bracing , Dynamic Analysis , Story Drift , Story Displacement.

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.

Fig 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.

The use of shear wall structure has gained quality in high rise building structure, particularly within the construction of service flat or office/ industrial tower. it's been well-tried that this method provides economical structural system for multi construction building within the vary of 30-35 storey's (MARSONO & SUBEDI, 2000). Within the past thirty years of the record service history of tall building containing shear wall component, none has folded throughout robust winds and earthquakes (FINTEL, 1995).

Fig 2. Design of Shear walls

II. 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.

III. LITERATURE SURVEY

Meshra and Munde (2018) the primary main aim of the project was 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 dynamical shear wall location. Three completely different cases of shear wall position for a building was analysed. associate degree earthquake load was calculated by the unstable constant technique victimization IS 1893 (PART–I): 2002. STAAD professional V8i software was 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.

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.

Vishal N et. Al. (2020) In order to study the structural behaviour of a 20-storey building with vertical setback irregularity was modelled and analysed by response spectrum method considering with and without Construction Sequence Analysis (CSA) using different structural systems in CSI ETABS V16 as per BIS 1893:2016 (Part 1). Finally, results such as axial force, shear force, bending moment are drawn for the structural members and response such as storey displacement, storey shear and storey drift are plotted and compared for each structural system.

Results stated that for response spectrum in X-direction, maximum displacement at top storey is decreased by 49% for dual system and by 30% for braced system similarly for response spectrum in Y-direction, maximum displacement at top storey is decreased by 55% for dual system and by 24% for braced system when compared with moment frame system. Higher the stiffness greater the base shear. Dual system has performed well in both horizontal direction for response spectrum. Base shear at the ground level was found around 75% more in dual system and 55% more in braced system when compared with moment frame system. Provision of shear wall and bracings to the building has considerably reduced the drift of storey which is also within the permissible drift limitation. Time period obtained from mode shape of dual system was 1.25 seconds which is nearly half than that of moment frame system which proves will act safe during earthquake excitation. For all the three structural systems, axial force in exterior column was found to be more in conventional analysis than CSA and for in interior column the axial force was more in CSA than the conventional analysis. Bending moment in beam has shown a gradual increase from bottom storey to 2/3rd of the building height and thereafter the value has decreased considerably when analyzed in Construction Sequence Analysis. This may be due to the fact that bottom storeys are involved in numerous cycles of analysis in CSA than the conventional method. The column shear force from the bottom storey is more in CSA and it gradually decreased at the top by slight variation for all the structural systems.

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.

IV. 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.

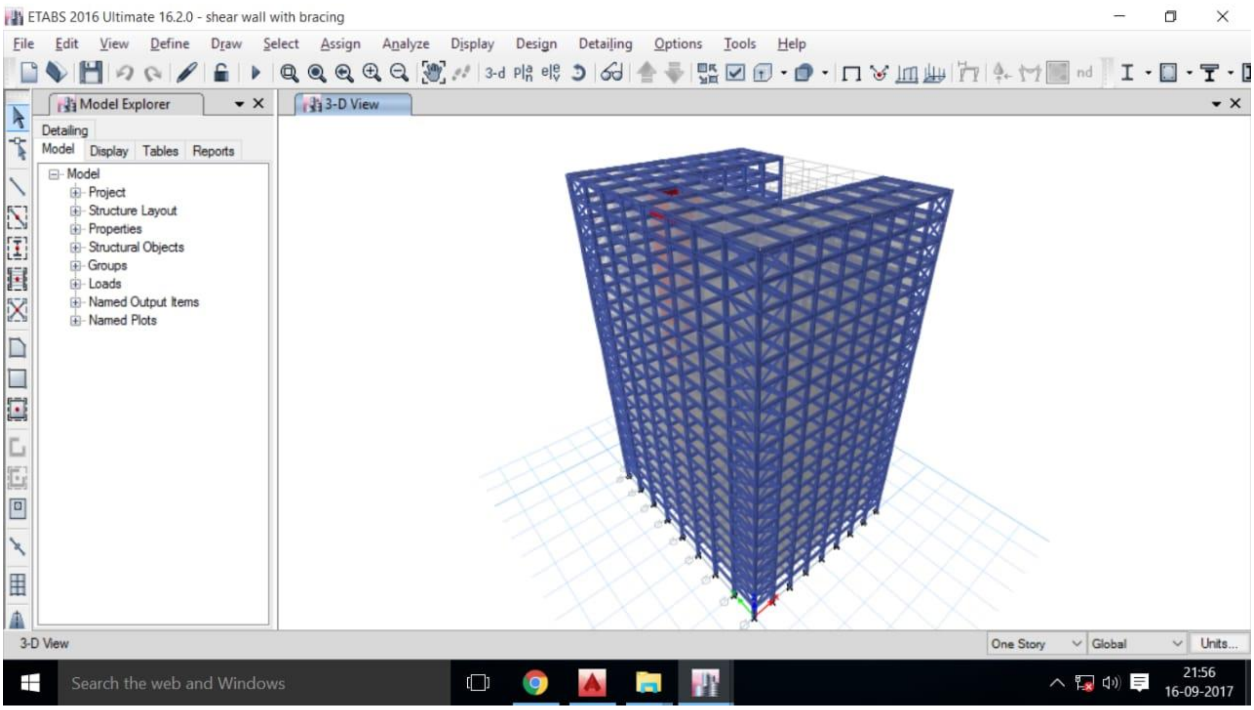

Fig 3. Modelling of Frame

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

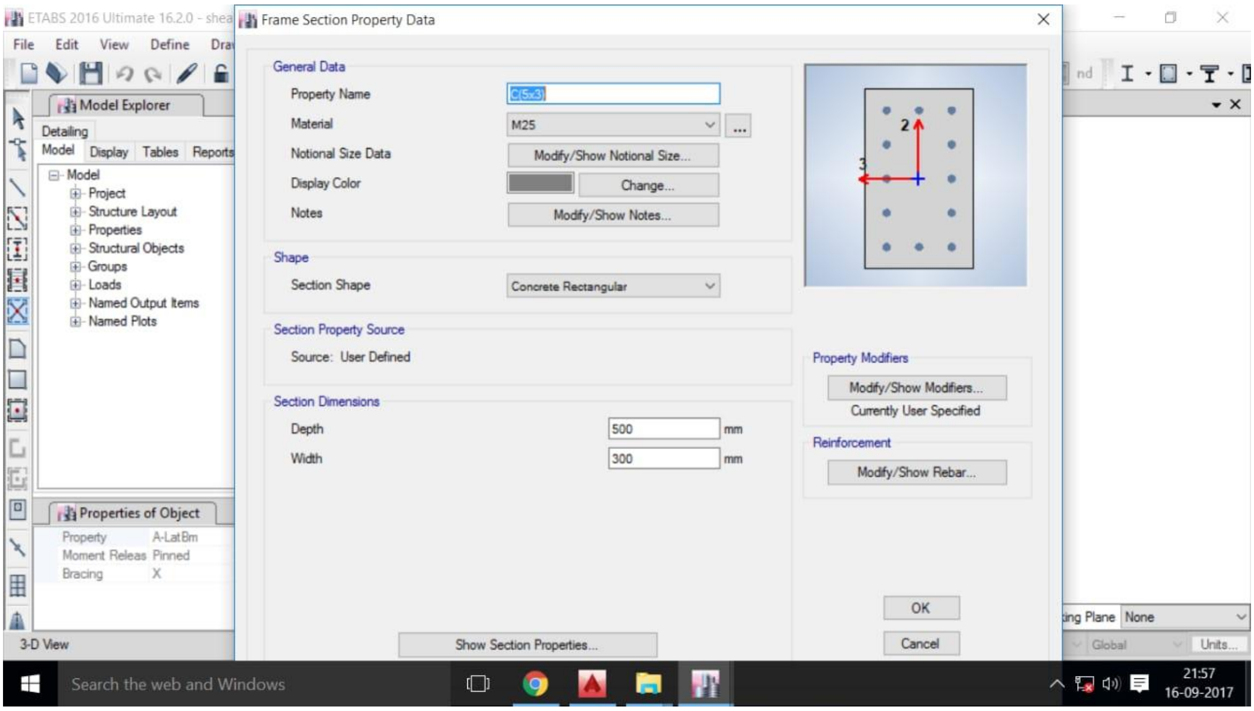

Fig 4 Assigning Sections Material

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

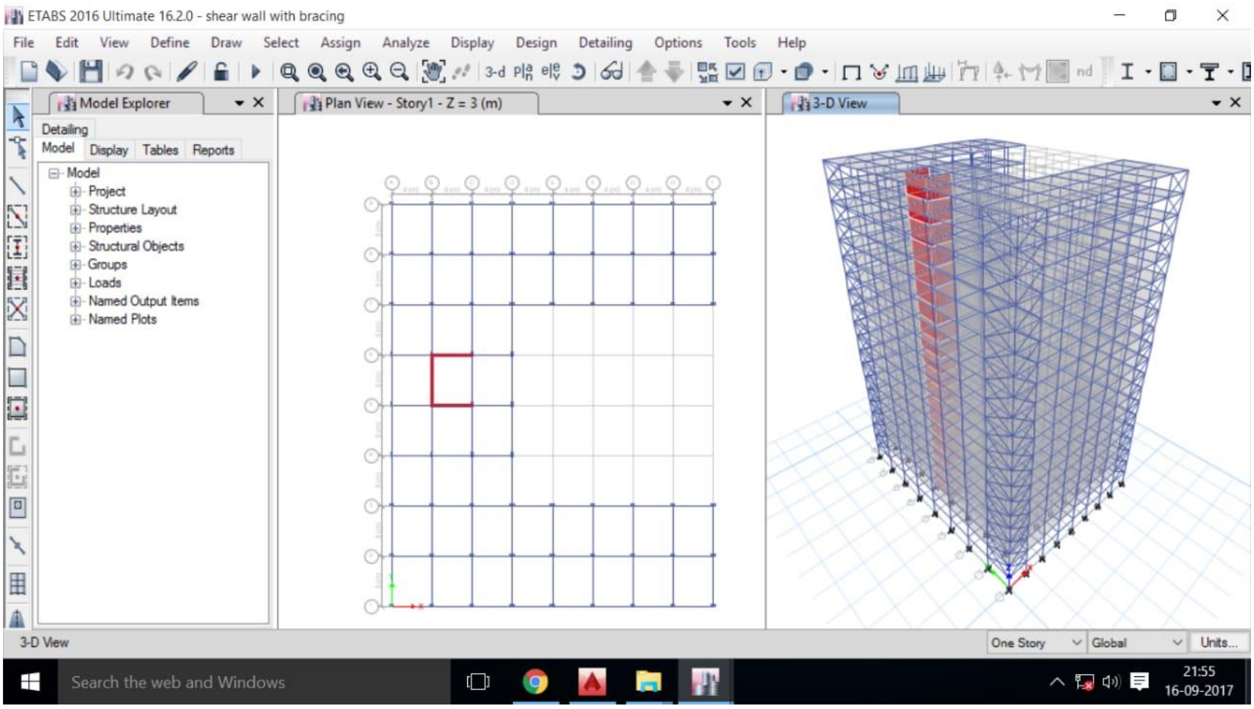

Fig 5 Model A Structure Shear wall with bracing

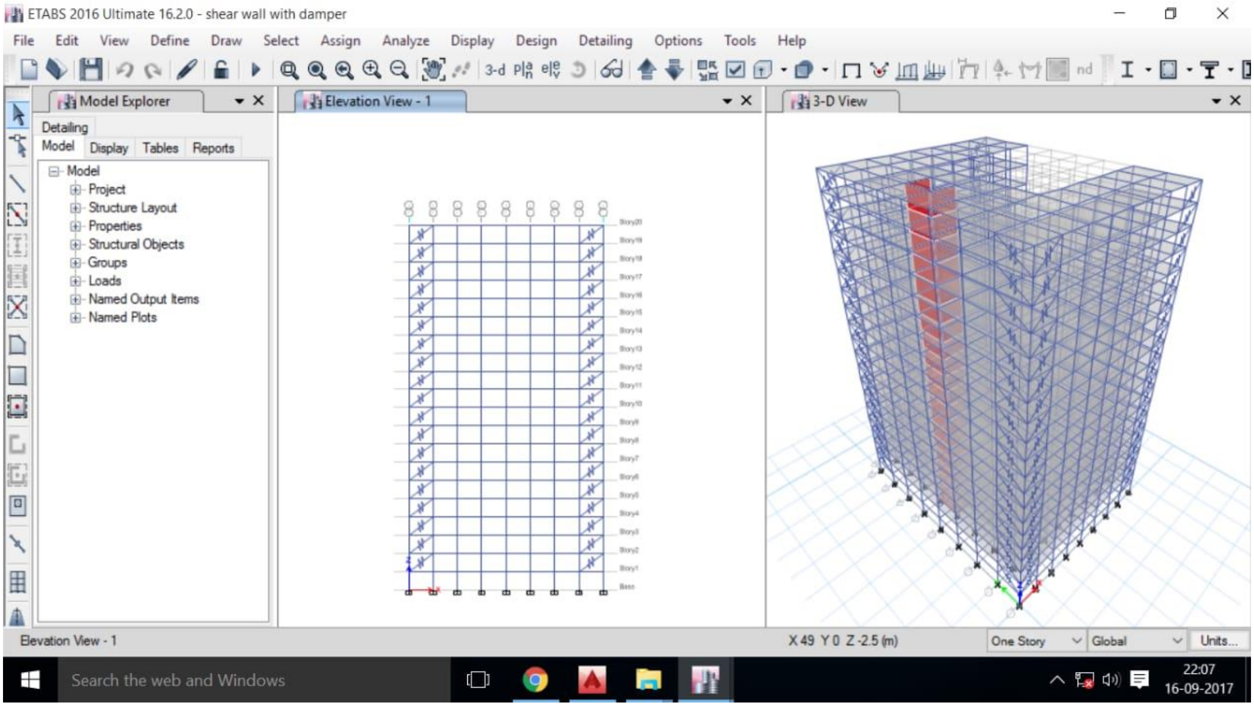

Fig 6 Model B Structure Shear wall with Damper

Step 5 Designing New Wall Stack

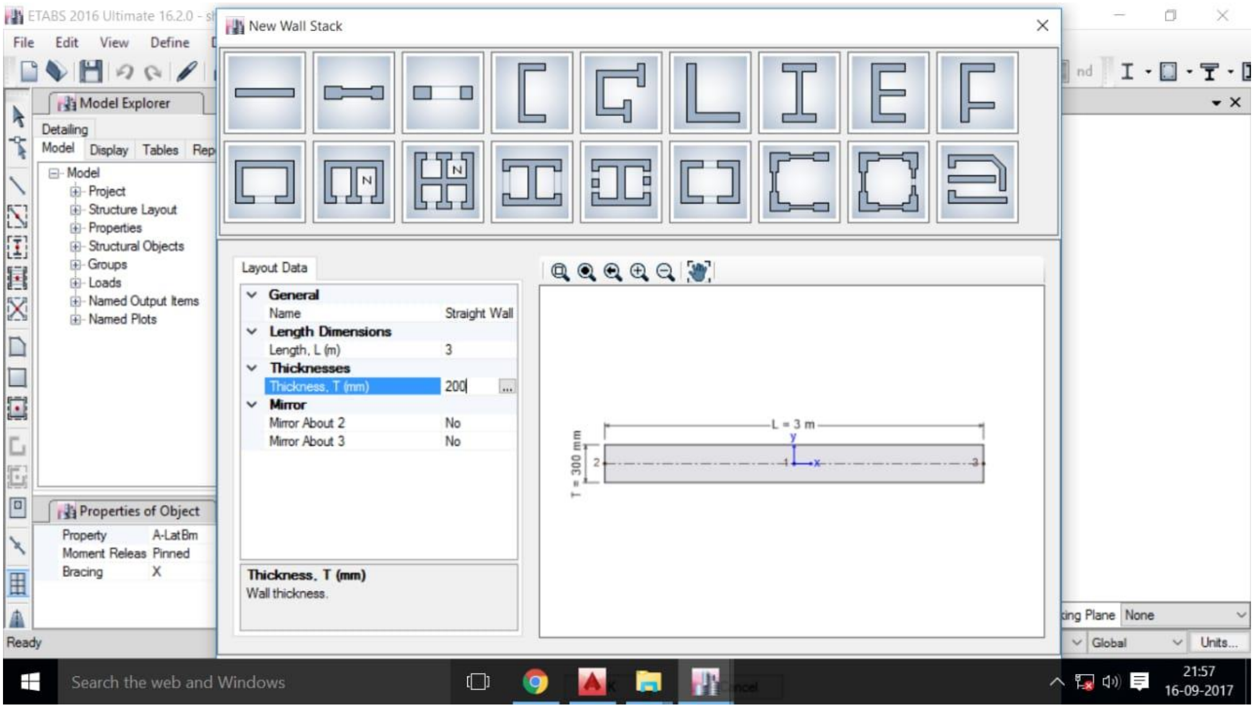

Fig 7 Designing New wall Stack

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

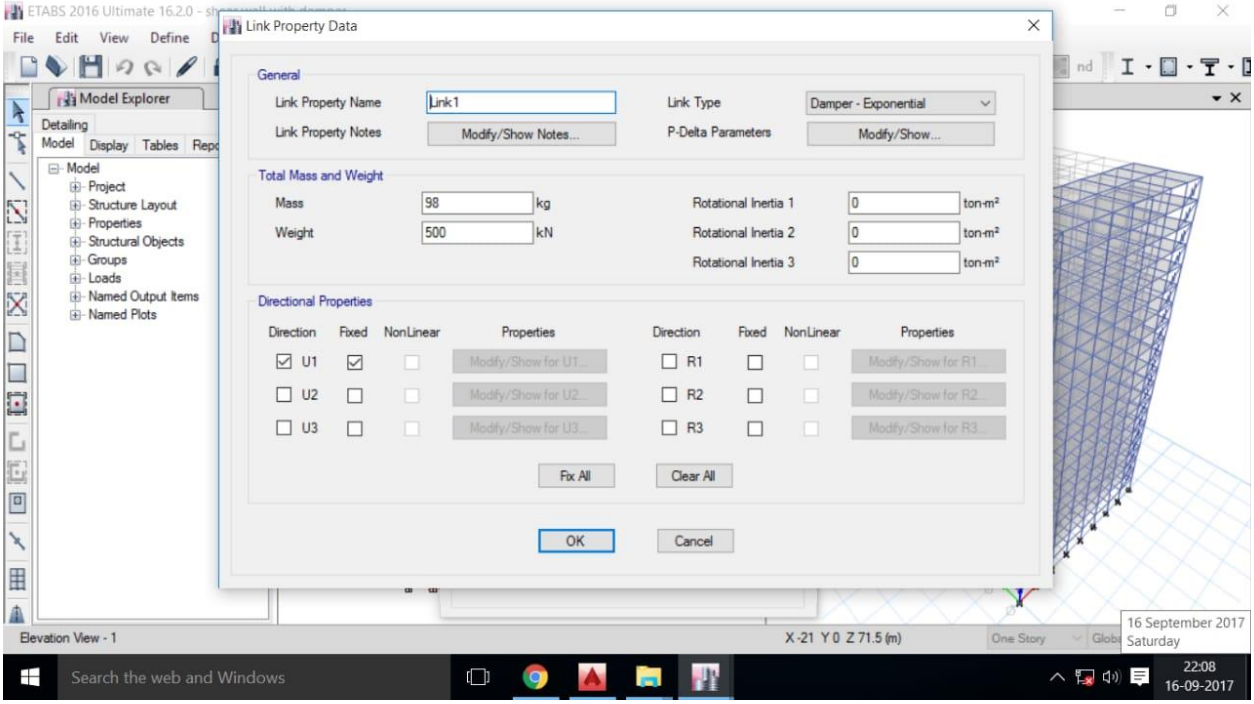

Fig 8 Assigning Seismic load as per IS 1893-2016

Step-6 Mode Shape for Modal period analysis

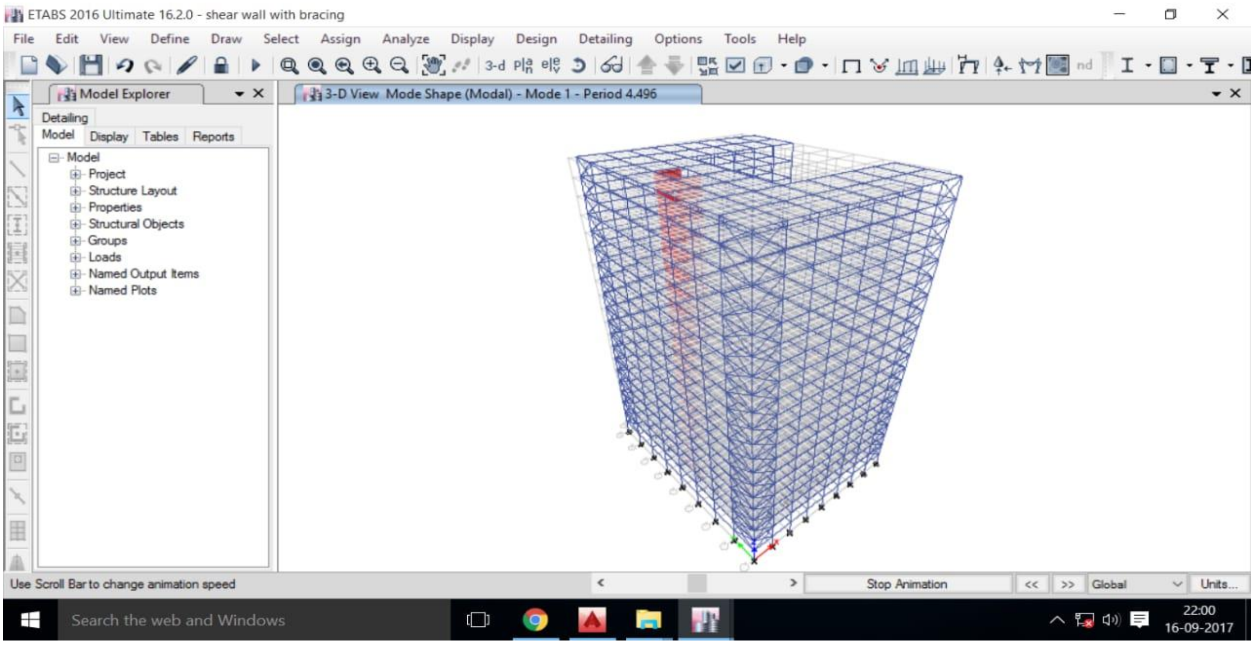

Fig 9 Period Spectrum with nodal displacement

Step 7 Structural Analysis

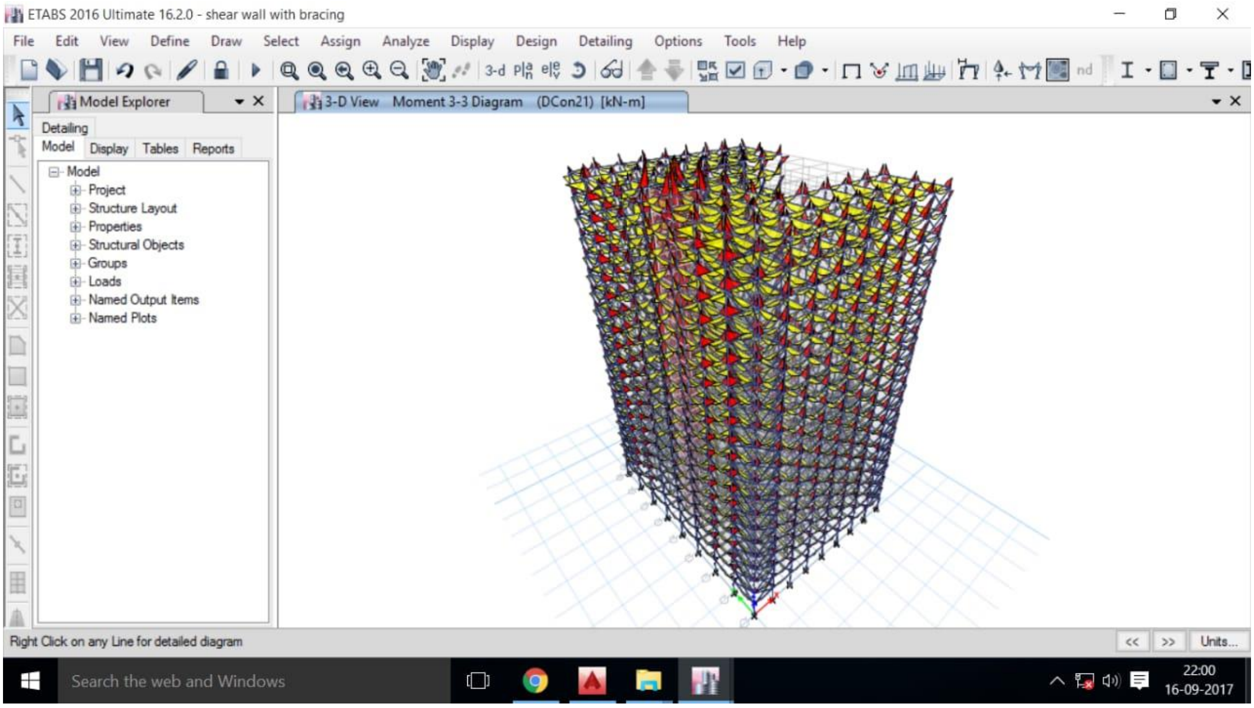

Fig 10 Structure Analysis

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

Step-8 To determine cost analysis as per S.O.R. 2017.

Analysis results:

Bending Moment kN-m

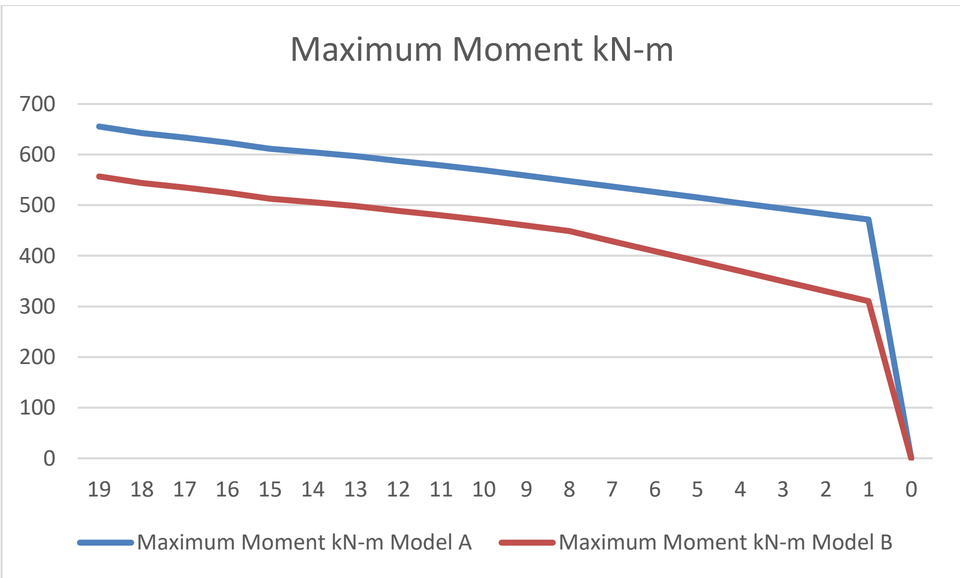

Fig 11. Maximum Moment kN-m

Shear Force kN

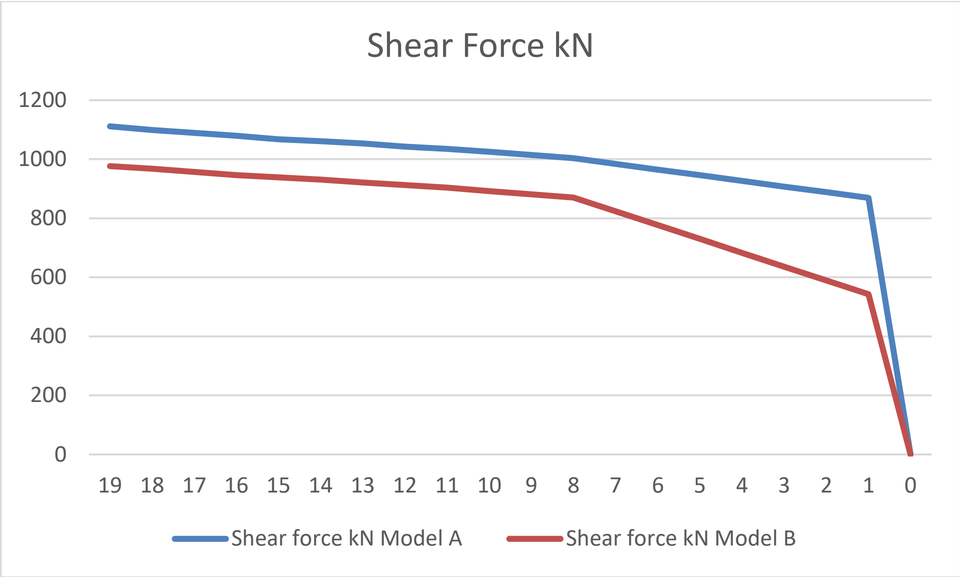

Fig 12 Shear Force kN

Axial Force kN

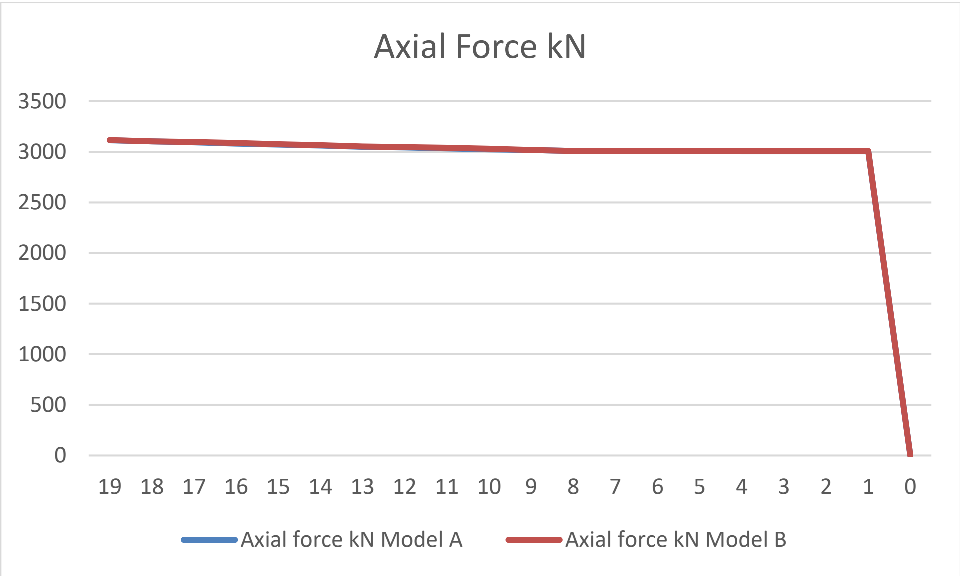

Fig 13 Axial Force kN

Plate Stresses

Table 1 Plate Stresses

Plate	SQX N/mm2	SQY N/mm2	MX kNm/m	MY kNm/m	MXY kNm/m	SX N/mm2	SY N/mm2	SXY N/mm2
227	4.64	-4.164	-3849.3	-1029	1755.2	-0.425	-1.175	-0.705
225	2.623	-4.318	-3868.6	-1475.2	1751.9	-0.428	-1.146	-0.705
232	2.828	-5.411	-3994.8	-901.88	1592	-0.445	-1.48	-0.675
219	2.698	-6.222	-3890.7	-434.28	1579.8	-0.444	-1.535	-0.669
229	2.723	-6.098	-3834	-100.93	1575.4	-0.441	-1.585	-0.674
222	2.884	-5.097	-3856.6	-89.016	1567.5	-0.439	-1.572	-0.682
221	-0.645	0.793	39.758	235.432	17.402	-1.069	-4.724	-0.348
233	1.276	0.612	-76.489	-448.37	17.355	-1.083	-4.81	-0.32
235	1.318	0.511	12.902	77.455	0.475	-1.078	-4.78	-0.293

Joint Analysis

Table 2 Joint Analysis

Node	X-Trans mm	Y-Trans mm	Z-Trans mm	Absolute mm	X-Rotan rad	Y-Rotan rad	Z-Rotan rad
159	-3.777	-553.48	0.245	553.488	0.164	0	0
160	-3.777	-553.48	-0.245	553.488	-0.164	0	0
140	4.388	-552	-0.245	552.015	-0.163	0	0
139	4.388	-552	0.245	552.015	0.163	0	0
150	0.307	-550.53	-0.244	550.526	-0.163	0	0
149	0.307	-550.53	0.244	550.526	0.163	0	0
162	-4.672	-346.46	-0.054	346.495	-0.098	-0.002	0.095
161	-4.672	-346.46	0.054	346.495	0.098	0.002	0.095
157	-2.876	-346.29	0.056	346.305	0.097	-0.002	-0.095
158	-2.876	-346.29	-0.056	346.305	-0.097	0.002	-0.095
137	5.276	-345.19	0.054	345.233	0.097	-0.002	-0.095
138	5.276	-345.19	-0.054	345.233	-0.097	0.002	-0.095
141	3.497	-344.72	0.055	344.736	0.097	0.002	0.095
142	3.497	-344.72	-0.055	344.736	-0.097	-0.002	0.095
152	-0.601	-343.93	-0.055	343.931	-0.097	-0.002	0.095
151	-0.601	-343.93	0.055	343.931	0.097	0.002	0.095
147	1.213	-343.62	0.054	343.617	0.097	-0.002	-0.095
148	1.213	-343.62	-0.054	343.617	-0.097	0.002	-0.095

Cost Analysis

Table 3: Cost Analysis

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

Inferences: Here it can said that shear wall structure with steel bracing structure is comparatively 6.5% economical in comparison to structure with shear wall along with dampers.

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.

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