COMPARISON OF SEISMIC ANALYSIS OF MULTISTORIED BUILDING WITH SHEAR WALL AND X BRACING

Tejaswini M L[1], Kishor K N[2], Harsha D H[3]

[1]Assistant Professor, Department of Civil Engineering, MVJ College of Engineering, Bangalore, India 560067
[2,3]PG Scholar, Department of Civil Engineering, MVJ College of Engineering, Bangalore, India 560067

---***---

Abstract - Multi-*storey building would be the greater part influenced by quake constrains to seismic prone areas. The major concern in the design of the multi-storey building is the structure to have enough lateral stability to resist lateral forces, buckling, to control lateral drift and displacement of the building. The application of the shear wall system in Reinforced Concrete (RC) buildings has been widely used to minimize seismic consequences. Besides, the buildings with 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 reasons, their effect shows unequal variations and behaviour against seismic load.*
In this project, G+9 storey building, along with shear wall and bracings are being considered for the analysis. The performance of building will be evaluated on the basis of following parameters –Storey displacement, Storey drift, Base shear. In this work, the shear walls and bracings are provided at different locations with the overall analysis to be carried out using Etabs9.7 software.

Key Words: ETAB, Seismic analysis, Bracings, Shear wall.

1. INTRODUCTION:

An earthquake is a sudden movement of earth's crust, which originate naturally at or below the surface. In the previous twenty-eight years, considerable severe earthquakes occurred in the world at intervals of 5 to 10 years, have caused severe damages. Socio investment misfortunes have been expanded in the planet because of foundation about new urban communities to seismic tremor inclined zones. Among all the natural hazards, earthquake is most dangerous. For safety of the buildings, it is necessary that structures should have adequate lateral stability, strength, and sufficient ductility. In place to secure structures against harms previously, advancing earthquakes to extend edifices alternately should change their applications, concentrating on available states for structures and making them safe against quake may be a greater amount crucial. This work focuses on comparison of seismic analysis of G+9 building with bracings and shear walls. The performance of the building is analyzed in Zone V.
For my study I considered bare frame, shear wall at corners, shear wall at sides, shear wall at center, bracings at corners, bracings at sides and bracings at center are considered.

1.1 Shear Wall

Shear divider is a structural framework made for propped panels would otherwise called shear panels to counter the impacts of parallel load acting on the structure. Generally, shear divider is characterized as structural part equipped will stand up to consolidation of shear wall. Wind seismic loads need aid practically as a relatable point loads that shear dividers are planned to convey. Shear dividers stand up in-plane loads need aid connected along its tallness. RC Multi-Storey structures need aid sufficient for opposing both different and level load. Shear walls resist two types of forces: Shear forces and Uplift forces. Shear forces are generated in stationary buildings by accelerations resulting from ground movement and by external forces like wind and waves. Uplift forces exist on shear walls because the horizontal forces are applied to the top of the wall.

1.2 Bracings

Support Frames Rigid wrapping systems are not constructive for structures taller than around 30-stories in light of the way that the shear afflict piece of the redirection in view of the turning of segments are makes the buoy be inordinately large. An approve packaging attempts to improve the eligibility of an unyielding corner by in every way that really matters taking out the bowing of segments and supports. This is expert by including web people, for instance, diagonals or chevron underpins. This was even shear is right now basically consume by the web and not by the segments. The systems pass on the parallel shear over whelming by the level of section of midpoint movement mulling over just about an absolute cantilever lead.

2. LITERATURE REVIEW

1) Dharanya (A),et, al.(2017)

In this study they analyze the multi-storey building with soft story which in present highly seismic area has been analyzed. In this performance the shear wall and bracings are be compared. Equivalent static method of analysis should be performed with the help of ETABS software. the main parameters are used to compared lateral displacements, base shear, story drift, axial force, shear force and time period. In this study they are taken a G+4 story residential RC building with soft story has to be analyzed with shear wall and cross bracings. The building located in zone 5.After discussion it is concluded that of the structure lateral stability is more than the bracings of the structure. The natural time period of structure also highly reduced after placing shear walls and bracings.

2) Divya , et, al.(2017).

In this paper they analyze the seismic behavior of shear wall and bracings system in RC frame structure. This research work focus on review of comparison of shear wall and bracing system by response spectrum method with the help of STAAD-PROVsi software. This analysis is helpful for in order to minimize the damage due to earthquake, and also the cost and effectiveness of shear wall. The main parameters are used to analyze this structure is base shear, natural time period, story drift. The structure which has to be analyzed is symmetrical G+10 residential building. After this analysis they concluded that lateral displacement and deflection of the building reduces by using shear wall and bracing systems, shear wall construction will provide large stiffness of the building. The lateral displacement of the building is reduced by the use of X-type of bracings. The lateral deflection of column in the of shear wall provided at canter is much reduced as compared to other location of SW. The X-type of concrete bracings is found to be most efficient in terms if storey displacement

3) Madan, et, al. (2015)

In this study they concluded that seismic evaluation with shear walls and braces for buildings. For an R.C.C building, The response of combination of braces and shear walls has been applied to regular R.C.C building. The R.C.C building consisting of different combinations of shear wall and R.C braces for 10, 15 and 20 storied frames were considered in this study. The dynamic analysis is of the building was carried out by three dimensional modeling using STAAD-PRO software and earthquake loads as per 15-1893:2002 (part-1). The main parameters are used to compared are time period, displacement, story drift. The conclusion of this study was the shear walls reduced the maximum lateral displacement at the top 20, 15 and 10 story the frames more compared to the braces reduced the maximum displacement in the same frame. The shear walls in middle bay and braces in the outer bays were the most effective arrangements for lateral load resistance in the elastic range

4) S.R Throat and P.J Salunke(2014)

They conducted or studied about seismic behavior of multi-story shear wall frame versus braced concrete frames. Both static (seismic coefficient method) and dynamic (response spectrum method) procedures are used determine the seismic design forces for this buildings. The STADD-PROVsi is used for dynamic analysis and stiffness analysis of this structure. Axial forces and moments in the members and floor displacements are main parameters of this structure. The structure is 15-strory building; it has total 8 plane frames in both the all directions. The X, K, IV-type of braces is used in this structure. The building is assumed to be located in seismic zone-3, story height is 4.5m. After analyzing the structure, more column axial force is inducing in braced frame than shear wall frame. Columns and beam moments in braces frame structure is much less than shear wall frame structures. The lateral displacements of frames are very much efficient in braced elements. Drift and horizontal deflection in braced frame is much less than shear wall frame

3. OBJECTIVES

The main objective of this project is to check and compare the seismic response of multi-storied building by using shear wall and steel bracings.

- To validate the results of shear wall and bracings with available literature results.
- To model G+9 storey building with shear wall and bracings using ETABS software.
- To study storey displacement, storey drift, storey shear of both bracings and shear wall.

- To model building in seismic Zone V.
- To study shear wall and bracings at various locations in R.C. Building modelled in E-TABS software.

4. METHODOLOGY

Methodology considered in this project is as follows:

- Modelling of the G+9 storey building using ETABS v9.7 software.
- Shear wall and bracings location at centre, corner and sides of the building.
- Parameters considered in this project are storey displacement, storey drift, and storey shear.
- Seismic zones considered in this project in Zone V.

5. PARAMETERS CONSIDERED

Parameters considering in this project are as follows:

No of stories	G+9
Thickness of slab	200 mm
Beam size	200mmx600mm
Column size	600mmx600mm
Wall thickness	230mm
Bracings	ISA110mmX110mmX10mm
Grade of concrete	M40-column,M25-beams,M20-slabs
Live load	3KN/m^2
Floor finish load	1KN/m^2
Zones	V

5. BUILDING MODELS OF ZONE V

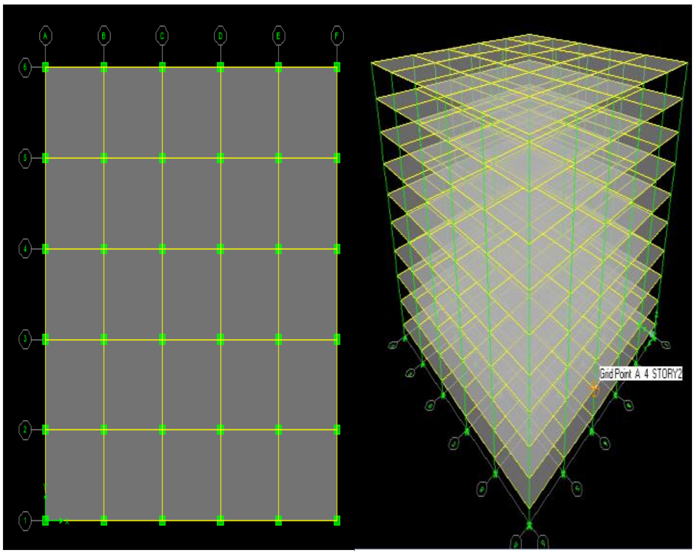


Fig 1: Bare Model

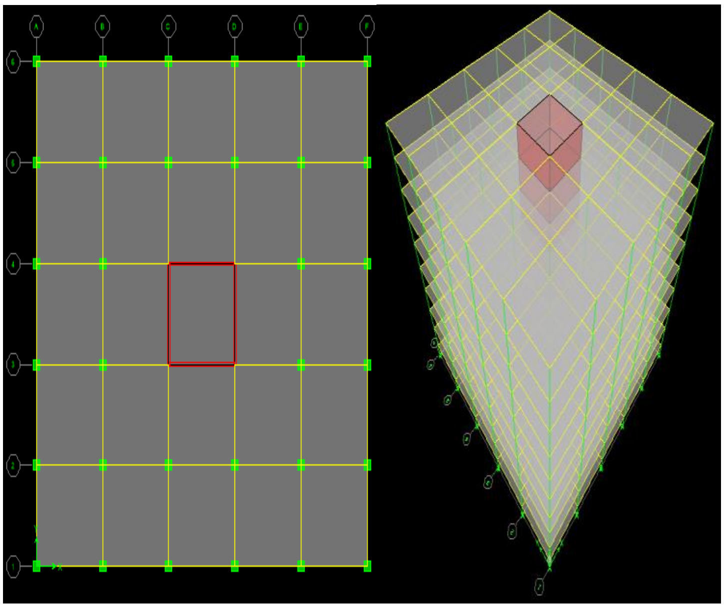


Fig 2: Shear Wall at center

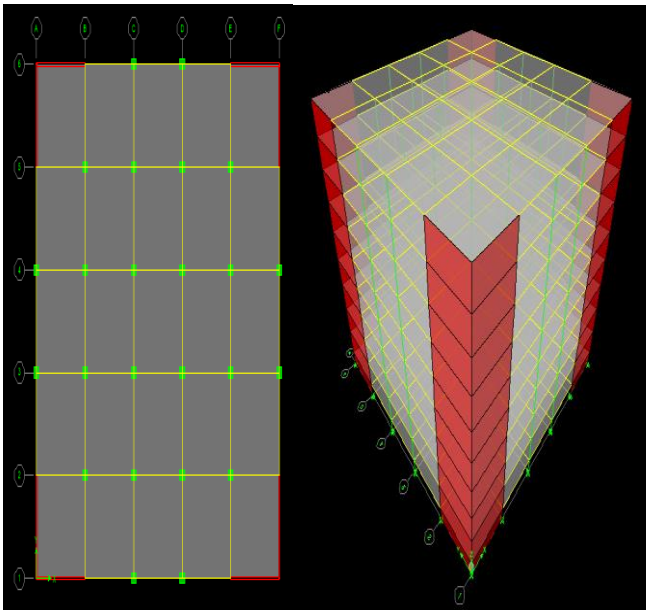


Fig 3: Shear Wall at Corner

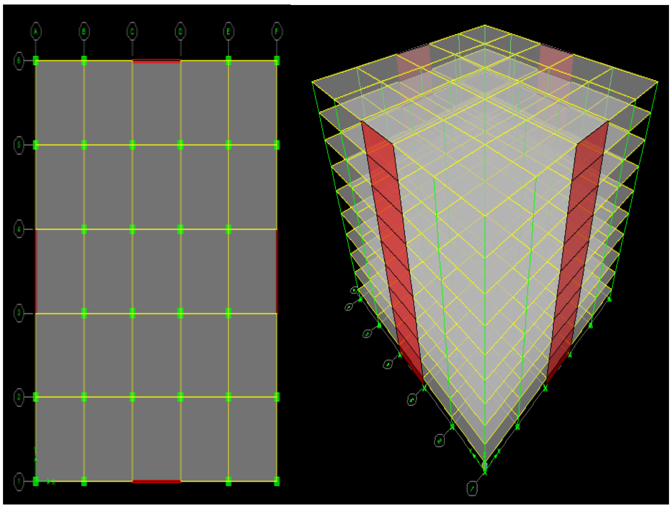


Fig 4: .Shear Wall at Sides

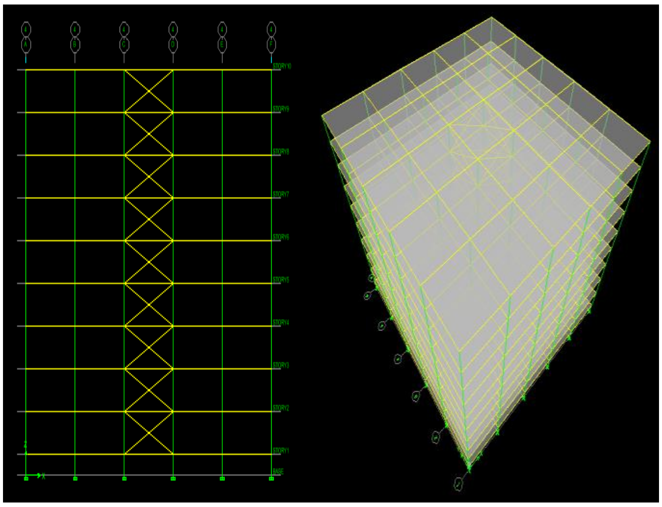


Fig 5: Bracings at Center

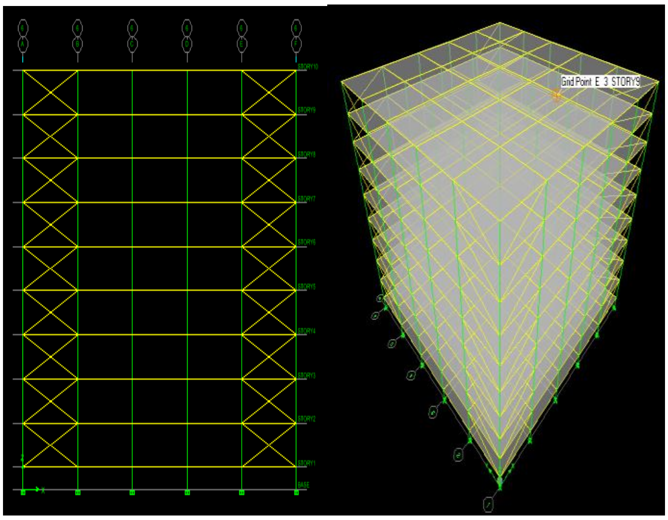


Fig 6: Bracings at Corner

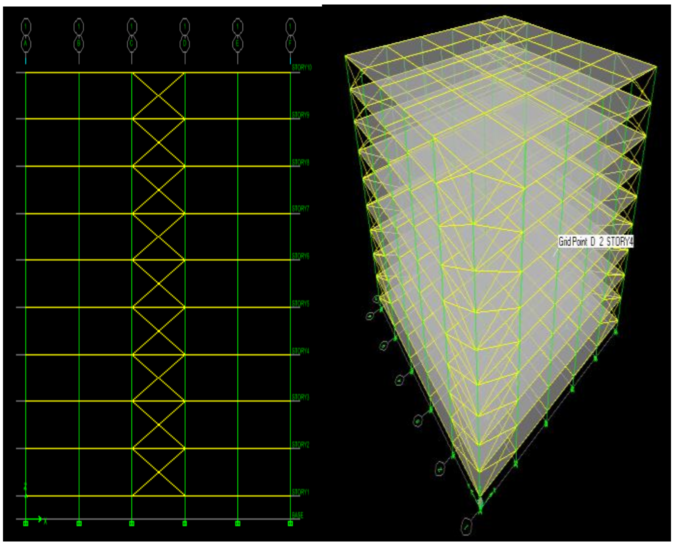


Fig 7: Bracings at sides

6. RESULTS AND DISCUSSIONS

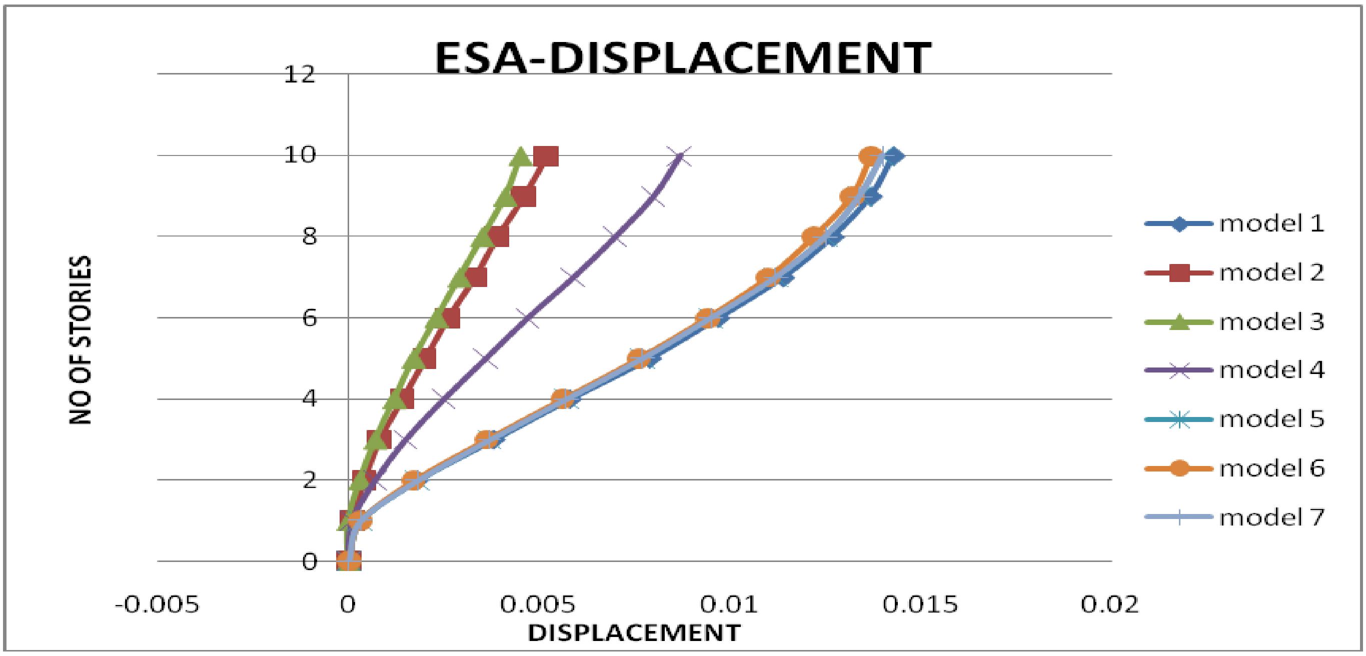
The results have been compared with bare frame model of storey drift, storey displacement, storey shear with shear wall at corner, shear wall at sides, shear wall center, bracings at corner, bracings at sides and bracings at center.

COMPARISION OF DIFFERENT ARRANGEMENTS

6.1 Displacement - Building (Equivalent Static Analysis)

TABLE 6.1.1 DISPLACEMENTS (M) –EQX

NO OF STORIES	model 1	model 2	model 3	model 4	model 5	model 6	model 7
10	0.0143	0.0052	0.0045	0.0087	0.014	0.0137	0.014
9	0.0137	0.0046	0.0041	0.008	0.0134	0.0132	0.0134
8	0.0127	0.0039	0.0035	0.007	0.0125	0.0122	0.0125
7	0.0114	0.0033	0.0029	0.0059	0.0112	0.011	0.0112
6	0.0097	0.0026	0.0023	0.0047	0.0095	0.0094	0.0095
5	0.0079	0.002	0.0017	0.0036	0.0077	0.0076	0.0077
4	0.0058	0.0014	0.0012	0.0025	0.0057	0.0056	0.0057
3	0.0038	0.0008	0.0007	0.0015	0.0037	0.0036	0.0037
2	0.0018	0.0004	0.0003	0.0007	0.0018	0.0017	0.0018
1	0.0003	0.0001	0	0.0001	0.0003	0.0003	0.0003



Graph 1: Storey displacement V/S Storey in X-direction

By plotting above graphs of storey displacement V/S number of storeys in X direction for zone-v and medium soil type (soil-II). From above graphs, it was observed that the bare frame is having maximum values when it's compared with SW at center and bracings at center, SW at corners and Bracings at corners, SW at sides and bracings at sides.

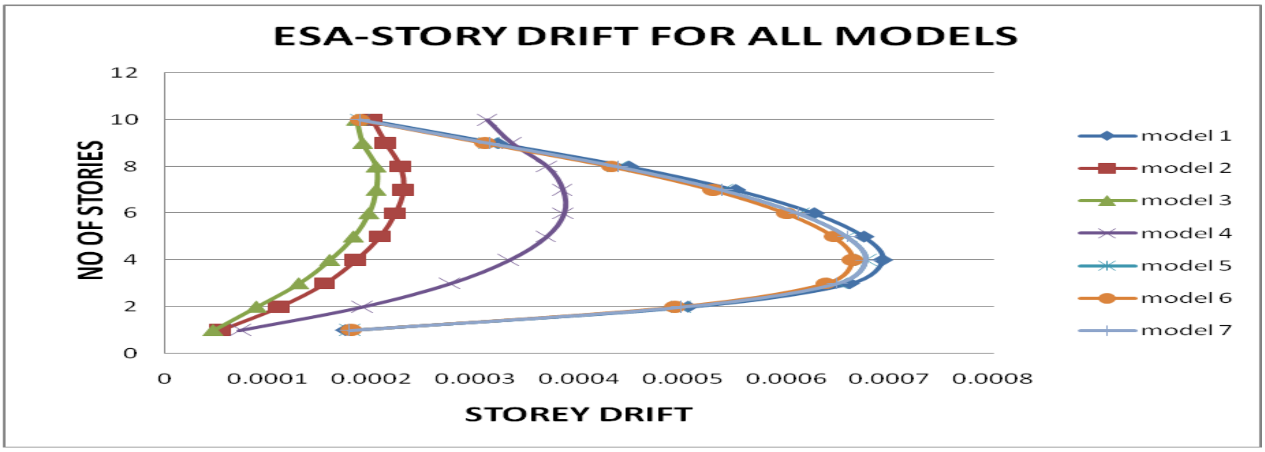
From table 6.1.1 it clearly shows that the storey displacement is decreased in model with SW and bracings. And also SW buildings give less value compared to bracing buildings.

6.2 Study of Story Drift (Equivalent Static Analysis)

The results of Different models with different stories is compared as follows

TABLE 6.2.1 INTER STORY DRIFT

NO OF STORIES	model 1	model 2	model 3	model 4	model 5	model 6	model 7
10	0.000194	0.0002	0.000185	0.000311	0.000188	0.000188	0.000188
9	0.000321	0.000213	0.000191	0.000335	0.000313	0.000309	0.000313
8	0.000448	0.000227	0.000204	0.000369	0.000437	0.000431	0.000437
7	0.000551	0.00023	0.000204	0.000384	0.000538	0.000529	0.000538
6	0.000627	0.000222	0.000197	0.000385	0.000612	0.0006	0.000612
5	0.000675	0.000207	0.000182	0.000368	0.000659	0.000646	0.000659
4	0.000693	0.000184	0.000159	0.000332	0.000677	0.000664	0.000677
3	0.000661	0.000154	0.000129	0.000275	0.000649	0.000638	0.000649
2	0.000505	0.00011	0.000088	0.00019	0.000498	0.000492	0.000498
1	0.000174	0.000053	0.000046	0.000072	0.000178	0.000179	0.000178



Graph 2: Storey drift V/S Storey in X-direction

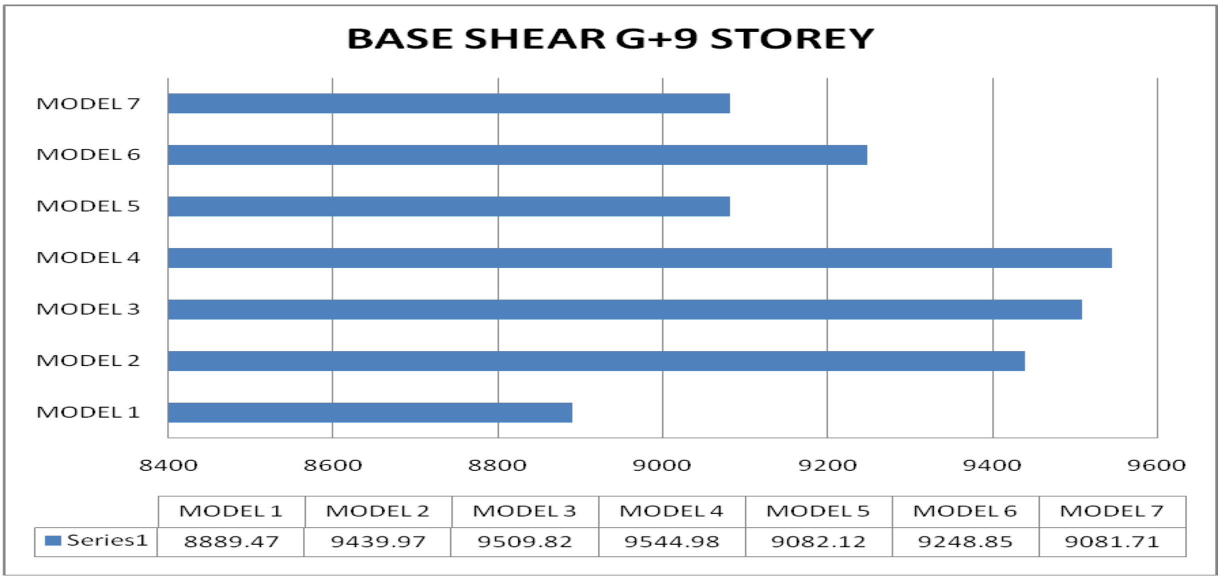
By plotting the graphs of storey drift V/S number of storeys in X direction for Zone V for a medium soil type (soil-II). From the graphs, it is observed that the bare frame model is having maximum values when it's compared with SW at center, SW at corners, SW at sides, and it is having almost similar values when it's compared with bracings at center, bracings at corners, bracings at Sides. From table 6.2.1 it clearly shows that the storey drift is decreased in models with SW and similar with bracings. And the above graphs shows that shear wall models have fewer values when it's compared to bracings models.

6.3 Study of Base Shear (Equivalent Static Analysis)

The table below shows different base shear values for G+9 storey different models

TABLE 6.3.1 BASE SHEARS (ESA)

G+9 STOREY						
MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5	MODEL 6	MODEL 7
8889.47	9439.97	9509.82	9544.98	9082.12	9248.85	9081.71



Graph 3: comparison of base shear v/s models.

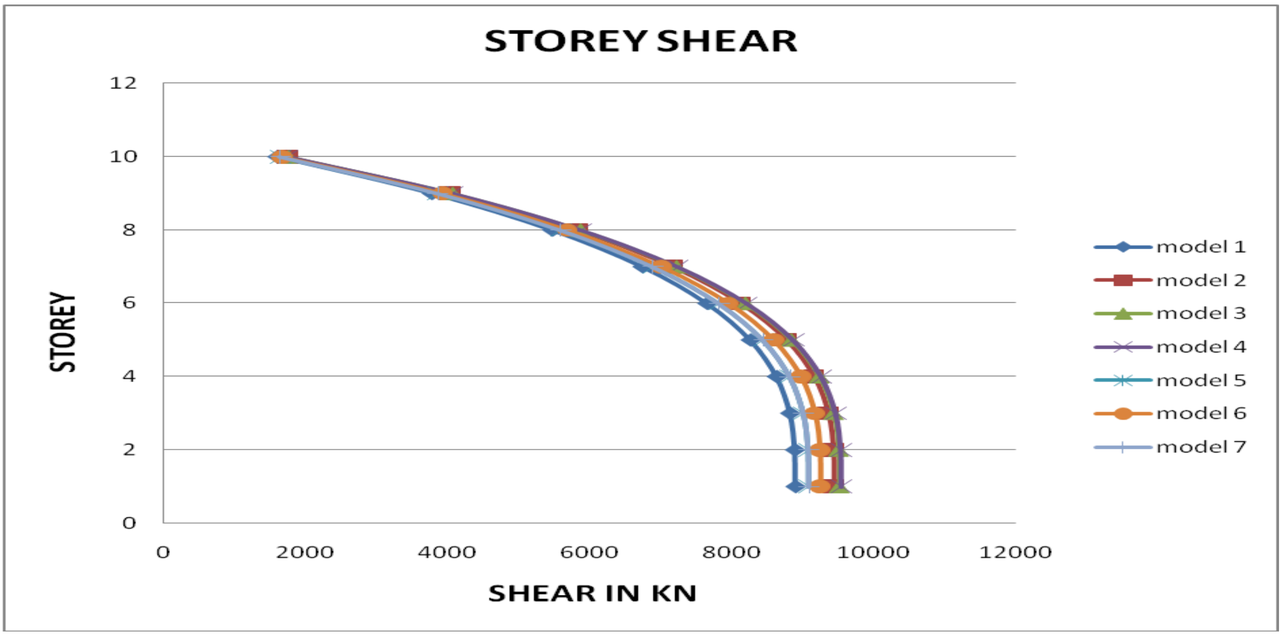
The model one (bare frame) shows the higher base shear value compared to other models. As the base shear values is mainly due to the huge space or area and hence the higher loadings. The SW models have more base shear compared to bracing models.

6.4 Study of storey shear (Equivalent Static Analysis)

The table below shows different storey shear values for G+9 storey different models.

TABLE 6.4.1 STOREY SHEARS (ESA)

NO OF STORIES	model 1	model 2	model 3	model 4	model 5	model 6	model 7
10	1598.22	1745.84	1750.31	1738.06	1632.71	1662.41	1632.63
9	3772.85	4040.65	4064.63	4066.5	3854.51	3924.91	3854.34
8	5465.9	5827.26	5866.43	5879.3	5584.29	5686.37	5584.04
7	6737.57	7169.2	7219.78	7240.91	6883.55	7009.42	6883.23
6	7648.06	8130.01	8188.75	8215.79	7813.79	7956.69	7813.43
5	8257.56	8773.19	8837.4	8868.4	8436.51	8590.81	8436.12
4	8626.27	9162.27	9229.79	9263.19	8813.22	8974.42	8812.81
3	8814.38	9360.78	9429.99	9464.61	9005.41	9170.14	9005
2	8882.1	9432.25	9502.06	9537.12	9074.6	9240.6	9074.19
1	8889.47	9439.97	9509.82	9544.98	9082.12	9248.25	9081.71



Graph 4: Storey shear V/S Storey in X-direction

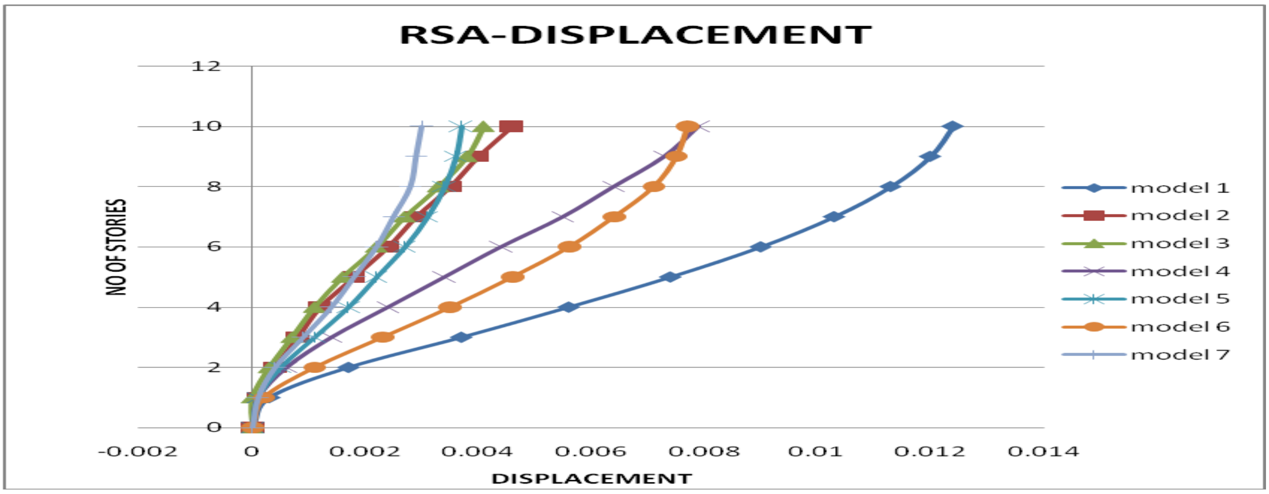
By plotting the above graphs of the storey shear V/S number of storeys in X direction for zone-V for medium soil type (soil-II). From this graph, it was observed that the bare frame is having a minimum values when its compared to with SW at corners, SW at sides, SW at center, bracings at corners, bracings at sides, bracings at center. From table, it clears that the storey shear was increased in model with shear walls compared with bracings.

6.5 Study of Displacement (Response Spectrum Analysis)

The displacement in m for earthquake in X direction for different storey are resulted as below

TABLE 6.5.1 DISPLACEMENTS (M) –RSA

NO OF STORIES	model 1	model 2	model 3	model 4	model 5	model 6	model 7
10	0.0124	0.0046	0.0041	0.0079	0.0037	0.0077	0.003
9	0.012	0.004	0.0038	0.0073	0.0036	0.0075	0.0029
8	0.0113	0.0035	0.0033	0.0064	0.0034	0.0071	0.0028
7	0.0103	0.0029	0.0027	0.0055	0.0031	0.0064	0.0025
6	0.009	0.0024	0.0022	0.0044	0.0027	0.0056	0.0022
5	0.0074	0.0018	0.0016	0.0034	0.0022	0.0046	0.0018
4	0.0056	0.0012	0.0011	0.0024	0.0017	0.0035	0.0014
3	0.0037	0.0008	0.0007	0.0014	0.0011	0.0023	0.0009
2	0.0017	0.0004	0.0003	0.0006	0.0005	0.0011	0.0004
1	0.0003	0.0001	0	0.0001	0.0001	0.0002	0.0001



Graph 5: Storey displacement V/S Storey in X-direction (RSA)

The response spectrum analysis shows that the same percentage variation as the static analysis but with the lower values. The displacement of model 1 is having greater values compared to other models. The SW models are great displacement compare to bracing models. Found, there are no greater variations of these models. This is because of that the same stiffness in the model for the respective loads.

6.5. Discussion of results

Storey displacement was decreased in model with SW and bracings. Shear wall at center it is decreased by 63.63%, shear wall at corner by 68.53%, shear wall at sides by 34.16 %, bracings at center by 2.14 %, bracings at corner by 4.14 %, bracings at sides by 2.14%.

Storey shear is increased in the model with the SW and bracings. SW at center is increased by 9.23%, SW at corner by 9.51%, SW at sides by 8.76%, bracings at center by 2.15%, bracings at corner by 4.01%, bracings at sides by 2.15%.

Base shear is increased in the model with the SW and bracings. SW at center is increased by 6.19%, SW at corner by 6.97%, SW at sides by 7.37%, bracings at center by 2.16%, bracings at corner by 4.04%, bracings at sides by 2.16%.

7. CONCLUSION

- Providing SW elements are more efficient in reducing lateral displacement of structure as a drift and horizontal deflection influence in SW are much less when compared with bare frame and bracing systems.
- The location of SW at corners, SW at sides and bracing at corners has more significant effect on the seismic response than the bare frame.
- Locations of the SW at corners are effective in reducing the actions influence in frame with the less deflection and the drift.
- When it comes to the storey drift, decreased in model with the shear wall and similar/ increased with the bracing model systems.
- There is a noticeable variation in the storey drift in the 4^{th}storey, as the huge difference in the stiffness that happens due to stiffness variation from bracing to the SW. This is within the allowable limit h/250.
- The base shear values are based on the loads and masses of the building. It also subjected to the zone and the importance priority of the structure. As the regular model one is showing high base shear value and the reduction is found in the other models, The SW models have more base shear compared to bracing models, And SW at corner and SW at sides have more base shear compared to other models.

From the above discussion and results it is found that providing shear wall at corners gives more strength when compared to bare frame and bracing type models.

REFERENCES

1. Dharanya A, Gayathri S, Deepika M(Comparison Study of Shear Wall and Bracings under Seismic Loading in Multi-Storey Residential Building) International Journal of ChemTech Research BCODEN (USA): IJCRGG, Vol.10 No.8, pp 417-424, 2017

2. S.R. Thorat and P.J. Salunke(Seismic Behavior of Multistory Shear Wall Frame Versus Braced Concrete Frames) International Journal of Advanced Mechanical Engineering. ISSN 2250-3234 Volume 4, Number 3 (2014), pp. 323-330

3. S. K. Madan, R. S. Malik, V. K. Sehgal(Seismic Evaluation with Shear Walls and Braces for Buildings). World Academy of Science, Engineering and Technology International Journal of Computer and Information Engineering Vol:9, No:2, 2015

4. Pallavi G. A, Nagaraja C(comparative study of seismic analysis of multi-storeyed building with shear wall and bracings. IJRET: eISSN: 2319-1163 | pISSN: 2321-7308. Volume: 06 Issue: 08 | Aug-2017

5. Divyashree M1, Bhavyashree B N2, Gopi Siddappa3(comparison of bracings and shear wals as seismic strengthening methods to buildings with plan irregularities) IJRET: eISSN: 2319-1163 | pISSN: 2321-7308 Volume: 03 Special Issue: 06 | May-2014 | RRDCE – 2014

BIOGRAPHIES

Tejaswini M L

Assistant Professor, Department of Civil Engineering, MVJ College, Bangalore 560067.

She has completed her PG in structural engineering from MVJ College. She is having 5 years of experience in teaching field and now pursuing her PhD work.

Kishor K N

PG Student, Structural Engineering,

MVJ College, Bangalore 560067

He has completed his under-graduation From Reva Institute of Technology and management, Bangalore-560064

Harsha D H

PG Student, Structural Engineering, MVJ College, Bangalore 560067 He has completed his under graduation From siddaganga Institute of Technology, Tumakur -572103