SEISMIC ANALYSIS OF SHEAR WALL OPTIMIZATION FOR MULTI-STOREY BUILDING

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Abstract - *In this paper we study about the seismic analysis of the reinforced concrete building with other loading. And condition is that reinforced concrete building have four model in which first model is without the shear wall, second wall is with shear wall at corner, third model is with shear wall at the middle of the building and last one model is with shear wall at the centre of the building. All the model is exist in the Zone V and it is ordinary moment resisting frame. Model is 15 storeys building which total heights 45m. The analysis of the model is done with help of the Etabs software which is product of the Computer Structural & Inc and using the IS CODE 1893 part1 2016 by the linear time history analysis..After analysis the four model we will compare the result (base shear, storey overturning moment, mode of time period, storey stiffness) of the these model and then we can say that in the all of four model which one will provide the good result and which model we can use in the real life.*

***Key Words*:** Time history, Etabs, RC Building, Shear wall, Different position of the shear wall.

1. INTRODUCTION

Shear walls are utilized to withstand the bending moments of a building, because of lateral loads. They act as vertical cantilevers to give the essential stiffness in a building. Shear deformation are of course present but are negligible compared to bending wall rather than a shear wall. They are usually given between columns, in stairs, lift walls, etc, in the structures under seismic forces. However since recent observations have shown consistency the excellent performance of building with shear walls under seismic forces, such wall are now extensively used for all earthquake resistance designs. Shear walls are used in many buildings primarily to resist efficiently the action of lateral loads and to participate as much as possible in carrying gravity loads. They are usually conceived as vertical plates supported at the foundation and are expected to function only under the action of in-plane horizontal and vertical forces. The shear wall is build by using the concrete and the reinforcement. It is mainly provided in the structure to increase the stability and stiffness of the structure.

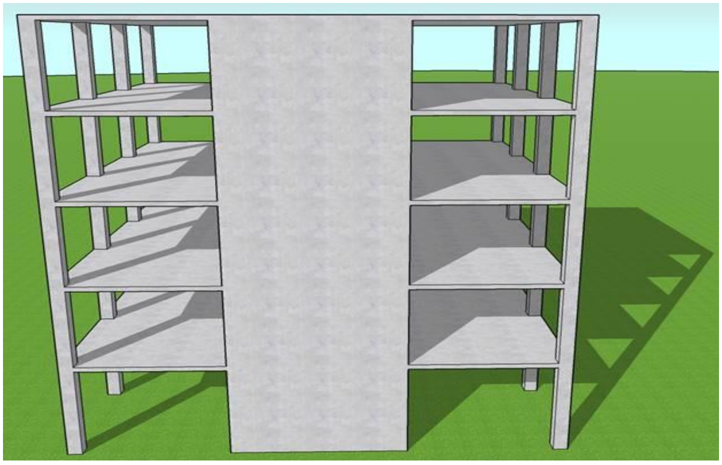

Fig -1: Shear wall in the building.

2. METHODOLOGY

In this we include the details of the model like as material property, section property, load combination, IS CODE, type of the analysis is done.

2.1. Material Property

The following material property is provided in the structure, which is given in the table:-

Table -2.1: Material Property

S.No	Material
1.	M25
2.	Mild250
3.	HYSD415

2.2. Load at the building

Table-2.2: Load

S.No	Load	Value
1.	Live (Slab)	3KN/m2
2.	Roof	2KN/m2
3.	Wall	15KN/m
4.	Parapet wall	7.5KNm
5.	Seismic	IS CODE 1892 part1:2016
6.	Type of Soil	2^{nd}
7.	Zone IV	0.24
8.	Importance factor	1.5
9.	Response Reduction factor	3
10.	Direction	EX and EY

2.3. Section Property

In the following table, the section property of the building modelling is given:-

Table-2.3: Section Property

S.No	Section	Value
1.	Beam	600mmX300mm
2.	Column	400mmX600mm
3.	Slab	150mm
4.	Shear Wall	250mm
5.	Plan Area	31.5mX31.5m
6.	Height of building	45m

2.4. Time History Analysis

Time history analysis maybe done by linear time history analysis or non linear history analysis but this model is analysis by using the linear time history analysis and data of the time history is from the file of the Etabs.

Linear time history analysis calculates the solution to the dynamic equilibrium equation for the structural behavior (displacement, member force etc.) at an arbitrary time using the dynamic properties of the structure and applied loading when a dynamic load is applied. The Modal superposition method and Direct method are used for linear time history analysis.

2.5. Load Combination

According to the IS CODE 1893 part1:2016, the following load combination is given below:-

i.1.5(DL+LL**)** **ii.**1.2(DL+LL+EX) **iii.**1.2(DL+LL-EX**)**
iv.1.2(DL+LL+EY) **v.**1.2(DL+LL-EY) **vi.**1.5(DL+EX)

vii.1.5(DL-EX**)** **viii.**1.5(DL+EY) **ix.**1.5(DL-EY**)**
x.0.9DL+1.5EX **xi.**0.9DL-1.5EX **xii.**0.9DL+1.5EY

xiii.0.9DL-1.5EY.

3. Modelling of the Building

In this paper we make four model for analysis in which first model is without shear wall, second shear wall at corner, third shear wall at the middle of the frame and last one is at the centre of the building.

3.1. Model without Shear wall (Model1)

In this model there is no shear wall provide, which plan elevation and 3D view are given below:-

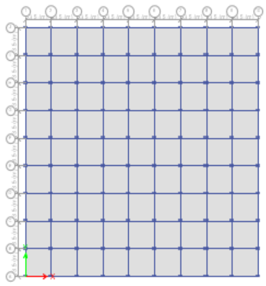

Fig-3:1.1.Plan

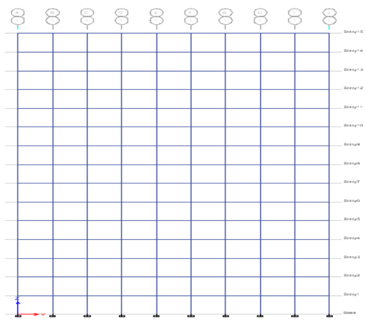

Fig-3.1.2: Elevation

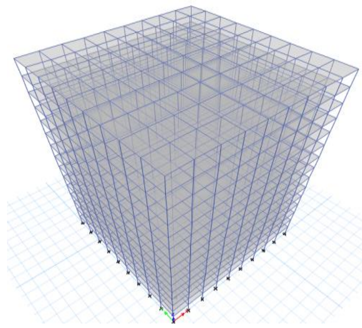

Fig-3.1.3:3D View.

3.2. Model with shear wall at the corner (Model2)

In this model we provide the shear wall at the corner of the building which thickness 250mm and width is 3.5m from column to column. The plan, elevation and 3D view are given below:-

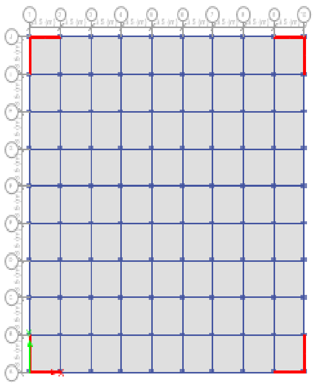

Fig-3.2.1: Plan

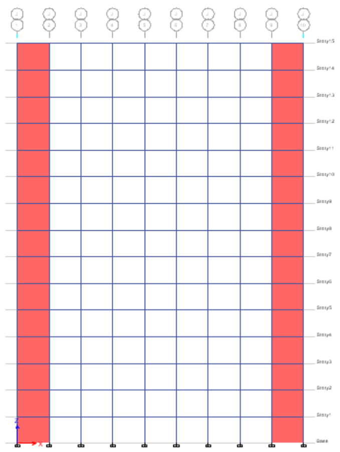

Fig-3.2.2: Elevation

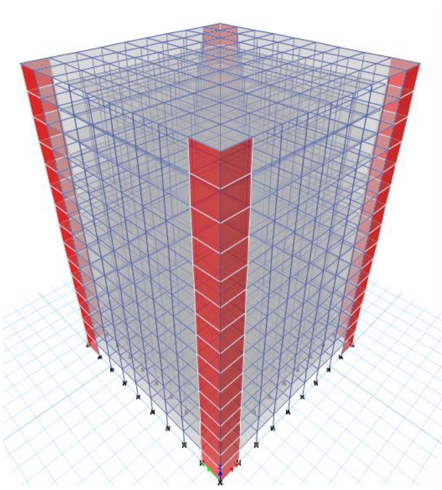

Fig-3.2.3: 3D view

3.3. Model with shear wall at the mid of the frame (Model3).

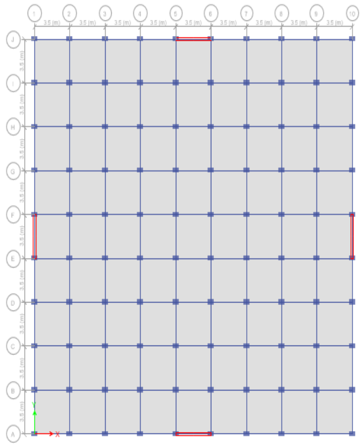

Fig-3.3.1: Plan

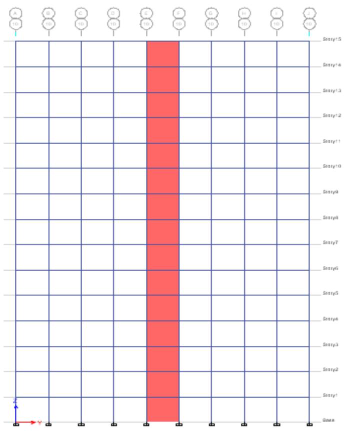

Fig-3.3.2: Elevation

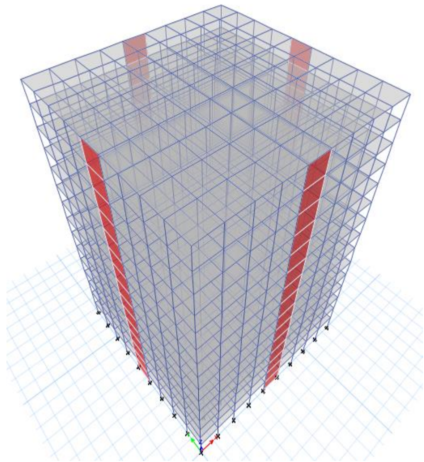

Fig-3.3.3: 3D View.

3.4. Model with shear wall at the Centre of the building (Model4).

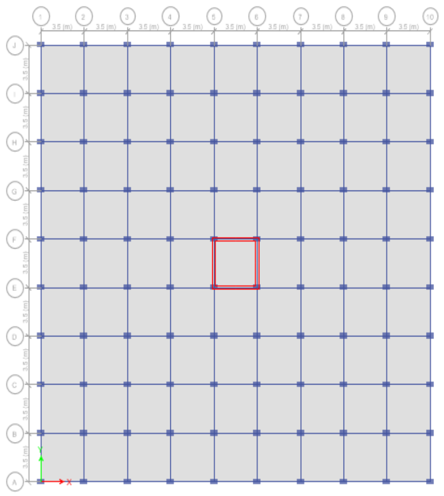

Fig-3.4.1: Plan

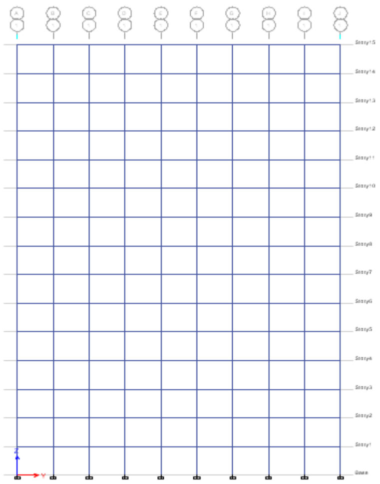

Fig-3.4.2: Elevation

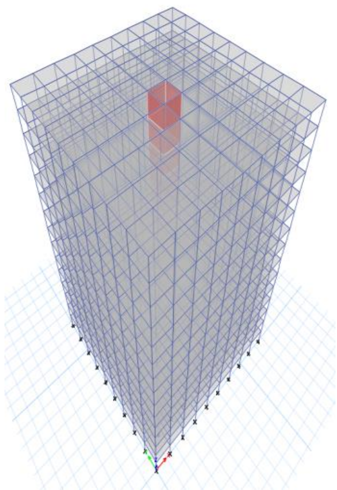

Fig-3.4.3: 3D View.

4. Result and Discussion

In the result and discussion we mainly take some analysis parameter for the comparative study. The analysis parameter is mode of time period, base shear, storey overturning moment and storey stiffness.

4.1. Base Shear

The base shear is a force which is acting at the each storey due to seismic force in the horizontal direction. The value of base shear is decreasing from top storey to bottom storey. After analysis we compare the base shear of four model which line graph and table is given below due to EX.

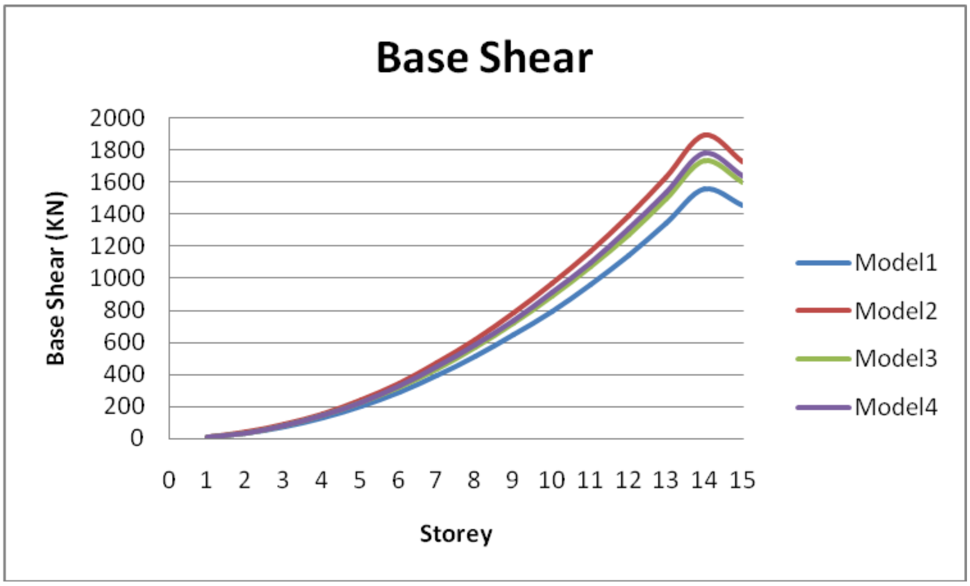

Chart-4.1: Base Shear

Table-4.1: Base Shear

Storey	Model1	Model2	Model3	Model4
Storey1	7.951	9.6522	8.8398	9.0789
Storey2	31.8041	38.609	35.3592	36.3155
Storey3	71.5592	86.8702	79.5581	81.71
Storey4	127.2163	154.436	141.4367	145.2622
Storey5	198.7754	241.3062	220.9948	226.9721
Storey6	286.2366	347.481	318.2325	326.8399
Storey7	389.5998	472.9602	433.1498	444.8654
Storey8	508.8651	617.744	565.7467	581.0486
Storey9	644.0324	781.8322	716.0231	735.3897
Storey10	795.1017	965.225	883.9792	907.8885
Storey11	962.073	1167.922	1069.615	1098.545
Storey12	1144.946	1389.924	1272.93	1307.359
Storey13	1343.722	1631.23	1493.925	1534.332
Storey14	1558.399	1891.841	1732.599	1779.461
Storey15	1450.659	1722.604	1594.695	1637.828

4.2 Storey Stiffness

Storey stiffness is the extent to which an object resists deformation in response to an applied force at the storey. The storey stiffness of the different four model is given below in the table and graph due to EX seismic force.

Table-4.2: Storey Stiffness

Storey	Model1	Model2	Model3	Model4
Storey	4203798	9534621	6805384	7472527
Storey	2844717	5303943	3992327	4491230
Storey	2704758	4229567	3365275	3733919
Storey	2651161	3716210	3091853	3354343
Storey	2611662	3429748	2955676	3141142
Storey	2577117	3252234	2880359	3012183
Storey	2545031	3131926	2832774	2927181
Storey	2513425	3041091	2797169	2864088

Storey	2479981	2960878	2764453	2808060
Storey	2441495	2873613	2727287	2746751
Storey	2392905	2759603	2674661	2662736
Storey	2325089	2588879	2585203	2528613
Storey	2217973	2311649	2411576	2294762
Storey	2017817	1851893	2052091	1879102
Storey	1460783	1076497	1292726	1134070

Chart-4.2: Storey Stiffness

4.3. Storey Overturning Moment

The storey overturning moment of the different four model is given below in the form of the table as well as line graph:-

Table-4.3: Storey Overturning Moment

Storey	Model1	Model2	Model3	Model4
Base (elevation 0m)	68.9373	103.414	87.764	94.5445
Storey 1	62.0179	93.4847	79.1744	85.3938
Storey 2	55.1497	83.591	70.6225	76.2785
Storey 3	48.4025	73.8009	62.1783	67.2678
Storey 4	41.8475	64.2011	53.9257	58.4459
Storey 5	35.5547	54.8901	45.9552	49.906
Storey 6	29.5921	45.9728	38.359	41.7454
Storey 7	24.0247	37.5567	31.2281	34.0623
Storey 8	18.9141	29.7489	24.6498	26.9524
Storey 9	14.3174	22.6531	18.7061	20.5073
Storey 10	10.2867	16.3681	13.4724	14.8127
Storey 11	6.8683	10.9857	9.0167	9.9468
Storey 12	4.1028	6.5898	5.3985	5.9798
Storey 13	2.0235	6.5898	2.6685	2.9734
Storey 14	0.6574	1.0503	0.8688	0.9804
Storey 15	0.6574	0.0309	0.0331	0.9804

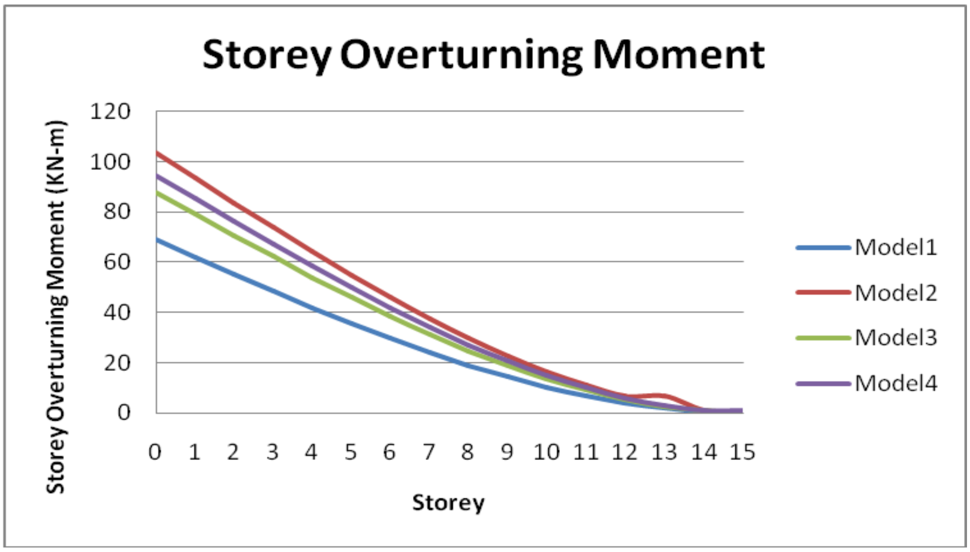

Chart-4.3: Storey Overturning Moment.

4.4. Mode of Time Period

The mode of the time period of the different four model is given below in the form the table as well as line graph:-

Table-4.4. Mode of Time Period

Mode	Model1 (Time (sec))	Model2 (Time (sec))	Model3 (Time (sec))	Model4 (Time (sec))
1	1.33	1.103	1.189	1.147
2	1.106	0.966	1.024	1.064
3	1.103	0.804	0.913	0.997
4	0.441	0.33	0.376	0.354
5	0.366	0.295	0.326	0.353
6	0.363	0.221	0.282	0.311
7	0.258	0.174	0.207	0.209
8	0.216	0.158	0.18	0.189
9	0.21	0.131	0.15	0.168
10	0.183	0.121	0.139	0.148
11	0.153	0.119	0.13	0.128
12	0.148	0.117	0.123	0.126

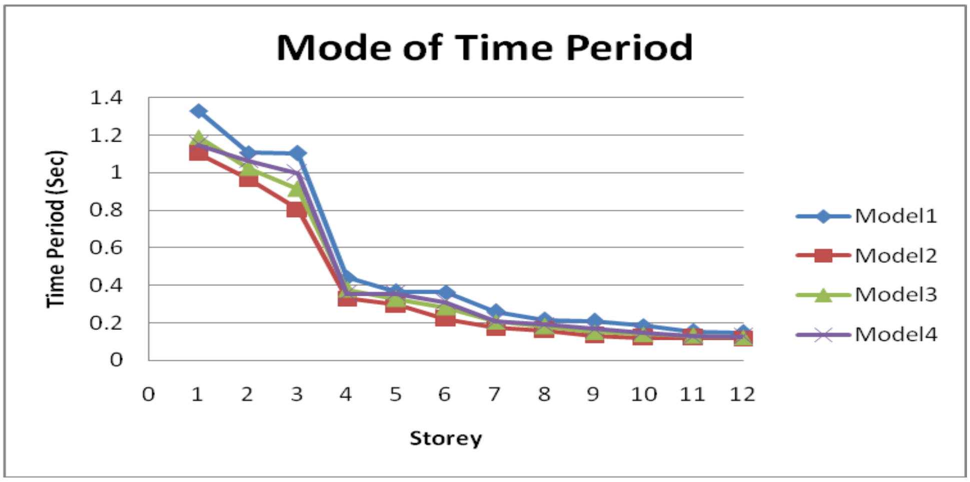

Chart-4.4: Time Period

3. CONCLUSIONS

After seismic analysis of the reinforced concrete building with different position of the shear wall of the above four model we found some conclusion which is given below that which position of the shear wall is more suitable than other:-

I. When the shear wall provided at the corner of the building then time period decrease 19% as compared to normal reinforced concrete building without shear wall. When shear wall provided at the mid of frame of building then time period decrease 11% as compared to normal reinforced concrete building. When the shear wall provided at the centre of the building then time period decrease 9% as compared to normal reinforced concrete building. After read it we find that when the shear wall provide at the corner of the building to reduce the mode of the time period as compared to the other position of the shear wall in the building.

II. When the shear wall provide at the corner of the building then storey overturning moment it increase about 30% as compared to normal building. When the shear wall provided at mid frame of the building then it increase 19.5% as compared to the normal building. When the shear wall provided at the centre of the building then it increase 26% as compared to the normal building.

III. The value of the storey stiffness in the case of the shear wall at the corner of the building is increase about 42% as compared to normal building. When the shear wall provided at the mid frame of the building then it increase the storey stiffness about 31% as compared to normal building. If the shear wall provided at the centre of the building then it increase 36% storey stiffness as compared to the normal structure.

IV. The base shear of building when that building provided shear wall at the corner is increase about 15% as compared to the normal building. When the shear wall provide at the mid of the frame in the building then it increase the base shear about 7.5% as compared to the normal building. The value of the base shear coming low at storey 15 because the total load at the storey 15 is low as compared to all storey.

REFERENCES

[1] S. R. Padol, & R. S. Talikoti (2015). Review paper on seismic responses on multistoried RCC building with mass irregularity. *International Journal of Research in Engineering and Technology (IJRET).* 4(3), 358-360

[2] S. P. Dyavappanavar, K. Manjunatha, & N. Kavya, (August, 2015). Seismic analysis of RC Multi-storied structures with shear walls at differeny. *International Research Journal of Engineering and Technology (IRJET).* 2(6), 214-21

[3] P. P. Chandurkar & P. S. Pajgade (2013). Seismic Analysis of RCC Building with and Without Shear Wall. *International Journal of Modern Engineering Research (IJMER), 3*(3), 1805-1810.

[4] Reddy, N. J., Peera, D. G., & Reddy, A. K. (2014). Seismic Analysis of Multi-Storied Building with Shear Walls Using ETABS-2013. *International Journal of Science and Research (IJSR)*. 1030-1040.

[5] Eurocode 8. (1998). Design of structures for earthquake resistance.

[6] IS CODE 1893 part1:2016 Criteria for Earthquake Resistant Design of Structures.