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RESPONSE OF R.C. BUILDING WITH SHEARWALLS AND DIFFERENT SYSTEMS OF BRACINGS

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Abstract — *Shear wall has high in-plane stiffness and strength which can be used simultaneously resist lateral loads and gravity loads. Bracing is a highly efficient and economical method of resisting lateral forces in a frame structure because the diagonals work in axial stress and therefore call for minimum member sizes in providing the stiffness and strength against horizontal shear. In this paper, Special moments resisting frame(SMRF), SMRF with Shear wall at corners of building and SMRF with four bracing systems have been investigated for the use in high rise building in order to provide lateral stiffness and finally comparing the roof displacements, story drifts and cost. For this purpose, 10 and 15 story building is selected for in Earthquake zone III and comparison id done. The analysis and design was done with the help of ETABs software. It is observed that the shear wall model have many advantages over the other two systems and the cost required is also less.*

Keywords- *Earthquake, SMRF, Bracings, Shear wall, Displacements, Drifts*

I. INTRODUCTION

Due to the increase in human population, need to preserve important agricultural production and high cost of land have all contributed to drive the residential and commercial buildings upwards in other words, vertical growth of the structures. To accommodate the continuous urban sprawl, there is a need to construct tall buildings. Due to the lateral forces acting on the building storey drift takes place which is more vulnerable as the height of the structure increases. To satisfy strength and serviceability limit stares, lateral stiffness is a major consideration in the design of tall buildings. The simple parameter that is used to estimate the lateral stiffness of a building is the drift index defined as the ratio of the maximum deflections at the top of the building to the total height. Different structural forms of tall buildings can be used to improve the lateral stiffness and to reduce the drift index. In order to minimize the effect of lateral forces on the building and to increase the lateral stiffness, some measures are adopted such as Shear walls, Bracings, etc.

II. GEOMETRY AND DESCRIPTION

For the study purpose, a regular building in horizontal and vertical geometry is selected. The building is having equal number of bays in both 'X' and 'Y' direction i.e. 5 bays and equal span of 4 meters. The plan dimension of building is 20 meters X 20 meters. The building is analyzed for three different heights i.e. 10 story and 15 story. The floor to floor height of each story is kept same i.e. 4 meters and the foundation dept is assumed of 2.4 meters and plinth height of 0.6 meter. The buildings are assumed to be fixed at the base. The floors of all buildings act as rigid diaphragms. The building was planned as a shopping complex and for that purpose, shops and passage area is provided so that there may not be any inconvience for horizontal and vertical circulations. The staircase and lift core is assumed to be situated isolated to the building and hence it is not taken into account during analysis and design.

In this project, six buildings are considered for the analysis as one building is taken as Special Moment Resisting Frame, then four buildings with different types of RC bracing in the outer bays and last building with Shear wall at corners and comparison is done between six different models.

The building is assumed to be located in Amravati which comes under Earthquake zone III and from clause 6.4.2 of IS 1893 2002, its zone factor is adopted as 0.16. As per Table 6, Clause 6.4.2 of IS 1893 2002, a commercial building is categorized in other building (structure having less importance than those structure mentioned in the same clause) and therefore the importance factor for Static analysis is taken as 1.0. All the building models are assumed to be SMRF and hence the response reduction factor for all models is taken as 5 from Table 7, Clause 6.4.2 of IS 1893 2002.
The plan of the building models are given below:
Model 1 –Special Moment Resisting Frame
Model 2 – SMRF with Single diagonal bracing
Model 3 –SMRF with Story height knee bracing
Model 4 –SMRF with Inverted V bracing
Model 5 – SMRF with Cross (X) bracing
Model 6 – SMRF with Shear walls at corners of building

2.1 Preliminary Data:

Table1.PreliminaryData

Sr. No .	PARAMETERS	VALUES	UNITS
1	Grade of concrete	25	N/mm^2
	Grade of steel	415	N/mm^2
2	Density of concrete	25	kN/m^3
3	Density of brick wall	20	kN/m^3
4	Floor to floor height	4.0	m
5	Bottom story height	2	m
6	Parapet height	1	m
7	Beam sizes		
	B1	230 x 380	mm^2
8	Thickness of slab	125	mm
9	Wall thickness		
	External wall	230	mm
	Internal wall	115	mm

Table 2. Loading Data

Sr. No.	PARAMETERS	VALUES	UNITS
1	Live Load	4	kN/m2
2	Roof Live Load	1.5	kN/m2
3	Floor Finish Load	1.87	kN/m2
4	Wall load		
	a) External wall		
	Ground floor	19.41	kN/m
	All above floors	16.65	kN/m
	b) Internal wall	8.33	
5	Parapet load	4.6	kN/m

2.2 Plan Details:

Columns, beams and walls are shown in plan below. The plans of the buildings are developed with the help of AutoCAD software.

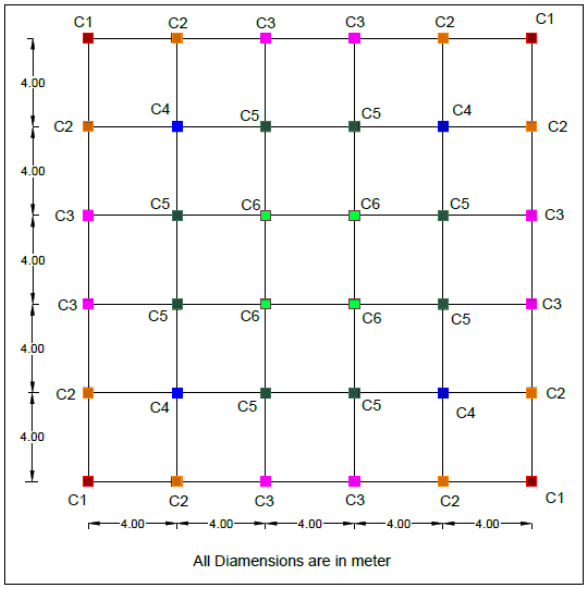

Fig1. Plan of SMRF and Bracings models for column

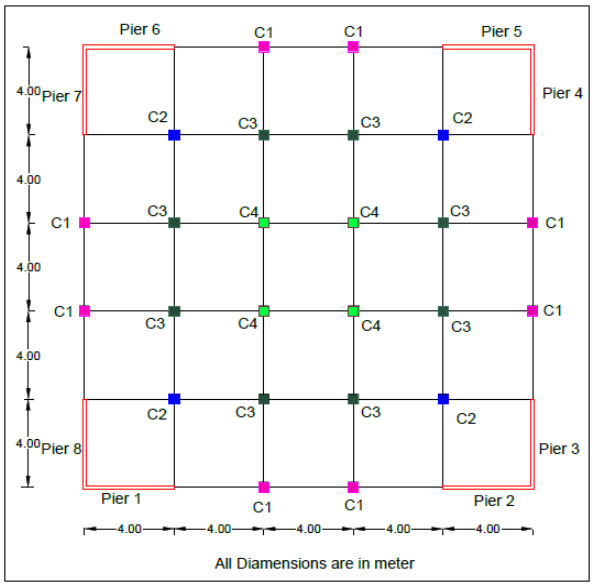

Fig2. Plan of Shear wall model for column and shear wall

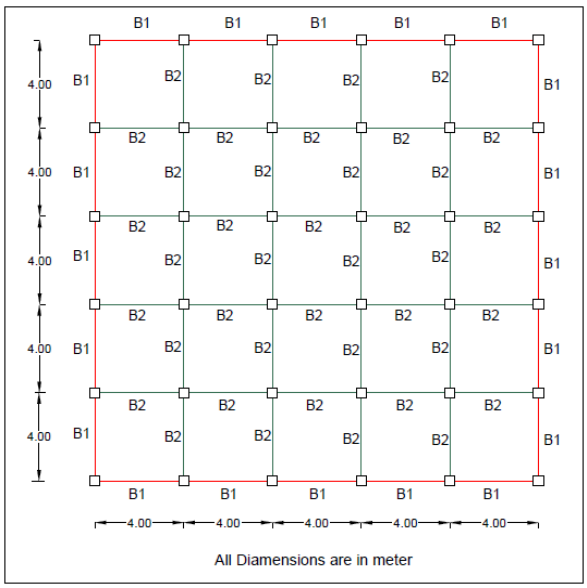

Fig3. Plan of SMRF and bracings models for beam

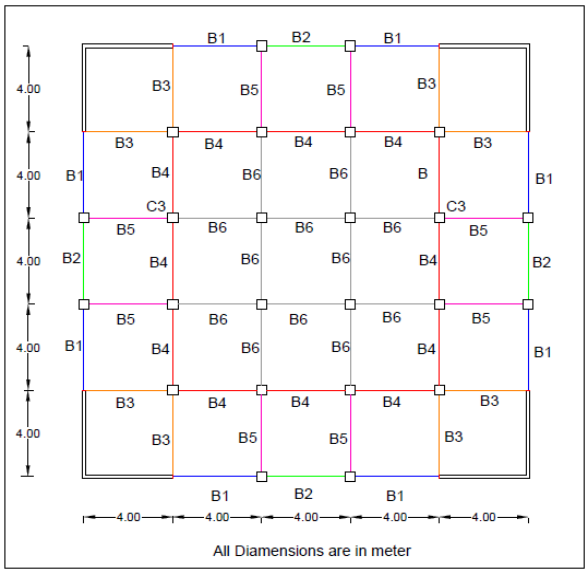

Fig4. Plan of Shear wall model for beam

III. RESULTS AND DISCUSSIONS

In this paper, two buildings i.e. G+9 and G +14 for zone III have been analyzed by Seismic Coefficient Method by using ETABS v9.7.4 software. The results regarding the lateral displacements and storey drifts for G+9 and G+14 for zone III has presented below.

3.1 Lateral Displacements:

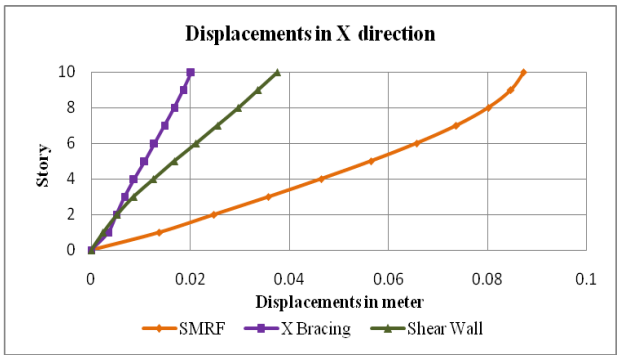

Fig 5. Displacement curve comparison for G+9

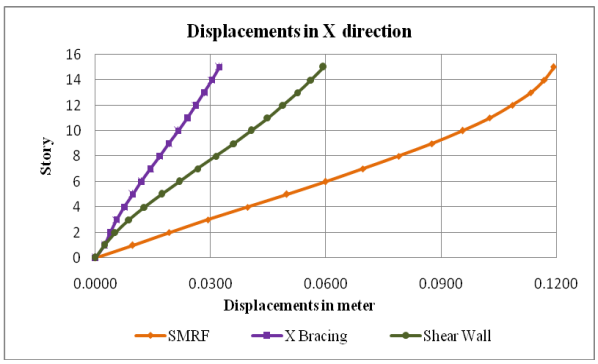

Fig 6. Displacement comparison curve for G+14

From above Fig. 5 and 6 it is observed that displacements in X bracing model is less than Shear wall model and SMRF model.

3.2 Story Drifts:

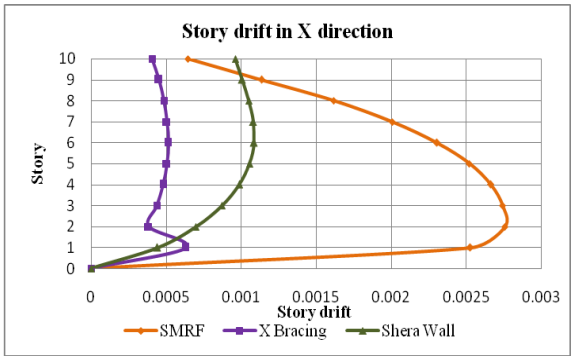

Fig 7. Story drift comparison curve for G + 9

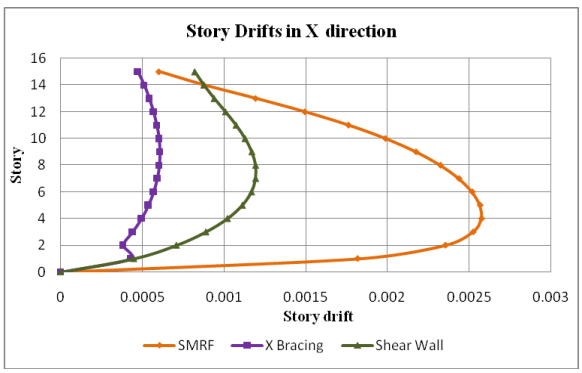

Fig8. Story drift comparison curve for G+14

From above Fig. 7 and 8 it is observed that maximum drifts in X bracing models are minimum than Shear wall models and SMRF models.

3.3 Cost Comparison:

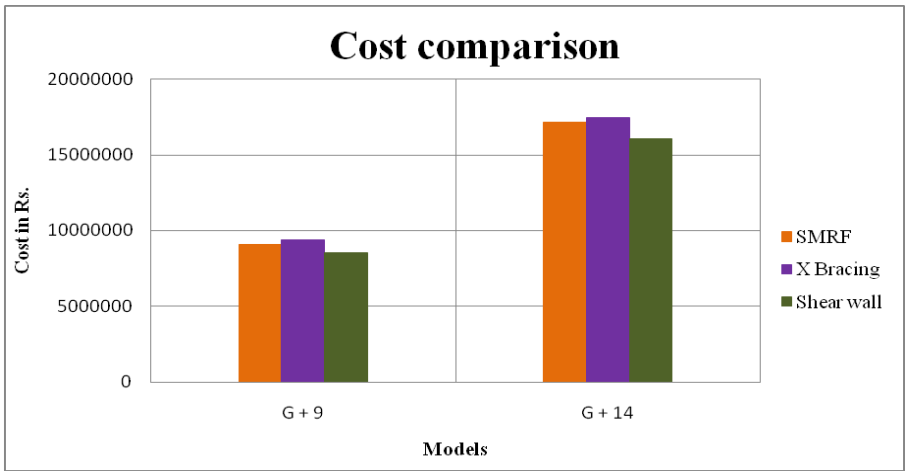

Fig9. Cost comparison for Steel and Concretes

In the figure 9, it is observed that cost of steel and concrete calculated for beams, column, bracing and shear wall is found to be least in the model when shear wall is provided at corners of the building.

The cost difference between the three lateral load resisting systems can be clearly understood by the following tables.

Table 3: Cost comparison for G + 9 story building

MODELS	SMRF	X bracing	Shear Wall
COST IN RS.	9080145	9391592	8530442
% COST MORE OR LESS		3.43	6.05
REMARK		more than SMRF	less than SMRF
% COST SAVED IN SHEAR WALLWITH RESPECT TO X BRACING			9.17

Table 4: Cost comparison for G + 14 story building

MODELS	SMRF	X Bracing	Shear Wall
COST IN RS.	17154109	17428436	16065559
% COST MORE OR LESS		1.60	6.35
REMARK		more than SMRF	less than SMRF
% COST SAVED IN SHEAR WALLWITH RESPECT TO X BRACING			7.82

IV. CONCLUSION

The analysis and design was done in Etabs and from that graphs were prepared in order to compared the different models and the following conclusion are made:

- From the study, it is observed that for (G+9) and(G+14) , the lateral displacements and story drifts is minimum in case of X bracing model when compared between different systems of bracing.

- Also the lateral displacement and story drifts for (G+9) and (G+14) are found to be the minimum when comparison is done between SMRF (Special Moment Resisting Frame), bracings and Shear wall model.
- From the analysis, it is found that the value base shear in x-bracing model is maximum than SMRF and Shear Wall model.
- The roof displacement values and story drifts are within permissible limits in all the models
- The value of displacement of Shear wall model for (G+9) story building is 57.27 % less than the Special moment resisting frame.
- The value of displacement of Shear wall model is 50.21 % for G+14 story building less than the Special moment resisting frame.
- For G+9 building, the cost of shear wall model is 9.17 % less than that of X bracing model.
- For G+14 building, the cost of shear wall model is 7.82 % less than that of X bracing model.
- The cost required for X bracing model is more than SMRF by a constant rate for 10 and15 story.
- The economy is achieved in Shear wall model from other two lateral loads resisting system and is found that the percentage of cost saved is increasing as the height of the building increases.

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