COMPARATIVE SEISMIC EVALUATION OF RESPONSE OF RC BUILDING WITH SHEAR WALL FRAME AND DIFFERENT BRACING SYSTEMS

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Abstract - *In the presents study the seismic evaluation of G+14 storey RC building using shear-wall and different kinds of bracing systems are carried out. The proposed model buildings are square shaped buildings. All structural members are designed in accordance with EURO CODE 8. The frame type of proposed model building used is the special RC moment resisting frame. In this study, response spectrum analysis technique is used for dynamic analysis. The analysis and design of the structure are carried out through the use of ETABS v 2015 software program. In this study shear-wall and different bracing systems are used to understand seismic response of the proposed buildings. The storey drifts, base shear, and maximum storey displacement results are compared.*

***Key Words*: Response spectrum, base shear, Seismic, Story displacement and Story drift.**

1. INTRODUCTION

The demands of high-rise buildings are increasing from time to time in metro cities due to the rapid growth of populations, cost of land, and limitation of spaces. As the height of the building increases, horizontal loads because of earthquake and wind loads becomes the governing loads. To withstand the lateral loads due to seismic loads and wind load to raises the stiffness's of the structure or to increase the capacity of the building to resist the lateral load. The characteristics of the building at the time of earthquake shake mostly based on the stiffness, strength, and distribution of weight in both directions of the building. To decrease the impact of seismic loads shear-walls and steel braces are utilized as a part of the building. These can be utilized for enhancing the seismic response of the structure. The primary concern of structural design is the safety of the structure during a major earthquake, it is essential to guarantee adequate lateral stiffness to resist the seismic load. The introduction of different steel braces and shear wall on to reinforced concrete buildings to improve rigidity have been discovered effective and efficient [1]. Most commonly reinforced concrete shear walls are utilized in RC buildings due to good performance to resist earthquake loads, whereas different steel braces are frequently utilized in steel buildings due to the fact that steel braces are very effective and efficient techniques to withstand horizontal loads in a frame building [6]. In the past two decade bracing systems are utilized as retrofitting measures for tall buildings, however, recently many researchers have investigated that steel bracings are a viable alternative for RC shear wall in new buildings with the proper connections.

Patil, desai and khurd (2016) carried out comparative analysis and design of 15 story RC building with shear wall and different types of bracing . The modeling and analysis of the structure was done in ETABs software. Shear wall and different steel bracing systems are good in reduction of roof displacement and maximum story drift [2].

S.R. Thorat and P.J. Salunke (2014) discussed about "seismic response of braced concrete frames compared with that of shear frames". They also studied the location of shear wall and brace elements. The location of shear wall and braced frame has important role on seismic response of the building [3].

Viswanth, Prakash and Desai (2010) investigated the effect of the distribution of steel bracing along the height of RC frame on seismic performance of rehabilitated building in 4, 8, 12 and 16 storied building with various types of steel bracing . They recommended to using X-type steel bracing system in order to increasing the stiffness of the structure and decreasing the maximum story drift of the structures [4].

Karthik reddy and kala kondepudi (2015) investigated comparative study on behavior of multi-storeyed building with different types and arrangements of bracing systems . Four different kinds of bracing systems have been examined for the utilization in tall building to give lateral stiffness [5].

2. METHODOLOGY

To determine the seismic parameters of G+14 storey RC buildings like maximum story displacement, story drift and base shear. Equivalent static and Response spectrum method of analysis were carried out using ETABs 2015 .

3. MODELING

In the present paperwork, G+14 story Reinforced concrete building with shear wall and different types of bracing systems are considered.

Three types of models are considered for the analysis as given below:

Model 1: bare frame model (unbraced frame model)

Model 2: model frame building with shear wall and different bracing systems at corner of the model buildings

Model 3: model frame building with shear wall and different bracing system at 3rd and 5th bays of the model buildings.

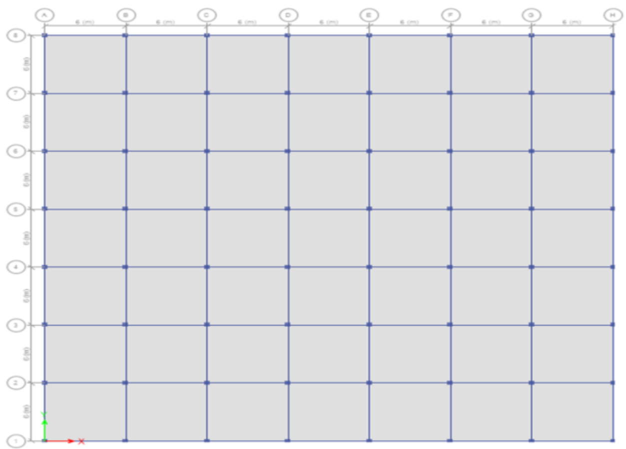
Table 1: Description of Members used

Number of stories	15	
Storey height	3.5 m	
Plan dimension	42 m*42 m	
Number of bays in x and y direction	7	
Width of bays in x and y direction	6 m	
Slab thickness	0.15 m	
Size of beam	400 mm*600 mm.	
Size of bracing section	600 mm* 300 mm * 15mm	
Thickness of shear wall	0.3 m	
Size of column	1-10 storey 11-15 storey	600 mm* 600 mm 400 mm* 400 mm

Table 2: Material properties used for analysis

Material properties	
Grade of concrete	C-40
Grade of steel(rebar)	S-500
Density of reinforced concrete	25 kN/m2
Modulus of elasticity of concrete	35GPa for C-40
Modulus of elasticity of steel	200GPa
Density of reinforcing steel	7850 kg/m
Coefficient of thermal expansion	10*10-6 per º C
Poisons ratio of concrete	0.2
Poisons ratio of steel	0.3

Figure 1: plane view of 15 storey model building



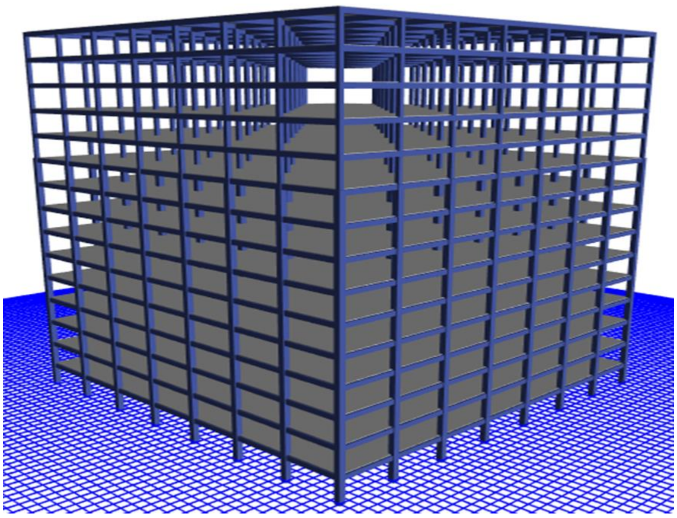
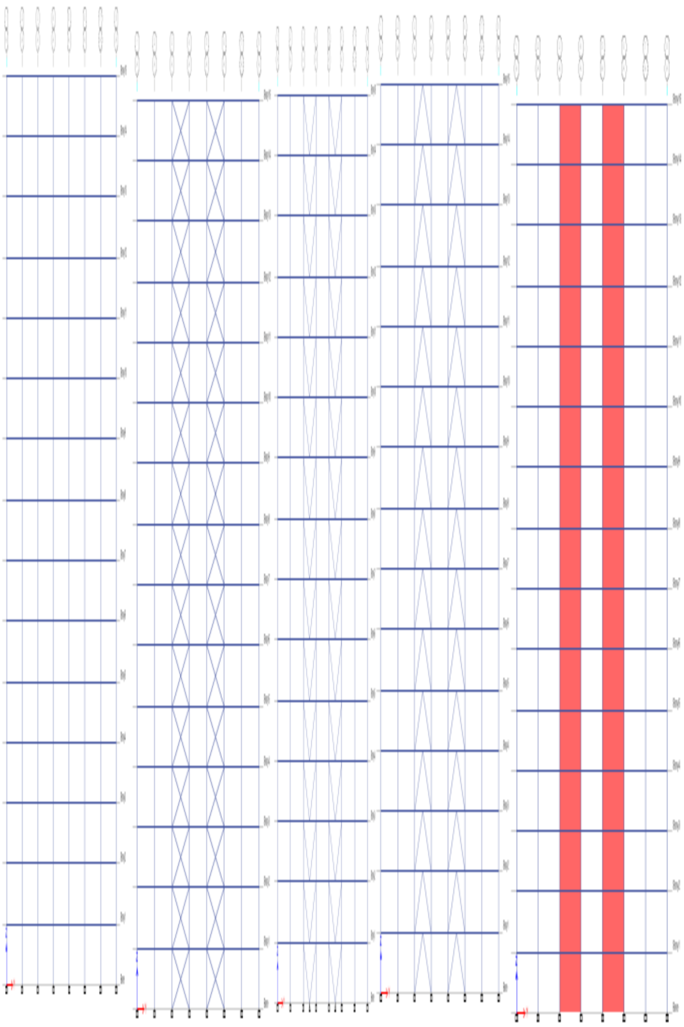


Figure 2: 3-D view of bare frame model buildings



a/ bare frame b/ X- braced frame c/ V-braced frame d/ INT V-braced fame e/ shear wall

Figure 3: elevation view of RC frame building with shear wall and different bracing systems.

Loads: - The loads considered in this structural analysis are dead loads, live loads and seismic loads.

Wall load- 7.2 kN/m (Assumed).

Live load and Floor load- 4 kN/m^2 & 1.5 KN/m^2

Earthquake load: - The Seismic loads EQx and EQy are given in Load patterns directly using Code EN 1998-1: 2004. Seismic load used in the analysis is given in table below.

Table 3: seismic load used in the analysis

Subsoil class	B
Behavior factor, q	Depends on the types of the structural systems
Seismic zone	V
Bedrock acceleration ratio ($\alpha_0 = a_0 /g$) (ratio of design bedrock acceleration to acceleration of gravity)	0.2g
Importance factor, I	1
Damping factor	5%

4. RESULT AND DISCUSSION

The linear static analysis and response spectrum analysis are carried out using analysis software ETABS2015. The response of bare frame, shear wall and different bracing systems results are obtained and results are compared. The response parameter considered in this study is Maximum roof displacement, Maximum story drift, base shear and time period. The reduction in every one of these responses at each story level is found out and reduction rate in percentage (%) is calculated.

4.1 Maximum story displacement

The maximum story displacements of 15 story bare fame model building, with shear wall and different types of bracing systems analysis results are given below in the table and graph respectively.

Table 4: maximum story displacement (mm) of model2 buildings

story	bare frame	X-bracing	V-bracing	INT V-bracing	shear wall
15	41.568	35.589	35.503	34.398	29.444
14	40.405	33.487	33.547	32.509	27.124
13	38.411	31.129	31.303	30.317	24.757
12	35.701	28.578	28.846	27.891	22.356
11	32.383	25.893	26.226	25.297	19.942
10	28.567	23.095	23.496	22.555	17.54
9	26.45	20.851	21.282	20.434	15.26
8	24.111	18.482	19.026	18.173	13.004
7	21.544	16.053	16.675	15.837	10.799
6	18.76	13.568	14.245	13.433	8.666
5	15.769	11.044	11.749	10.977	6.632
4	12.577	8.51	9.209	8.495	4.741
3	9.198	6.014	6.662	6.031	3.047
2	5.676	3.629	4.162	3.649	1.624
1	2.219	1.457	1.806	1.454	0.56

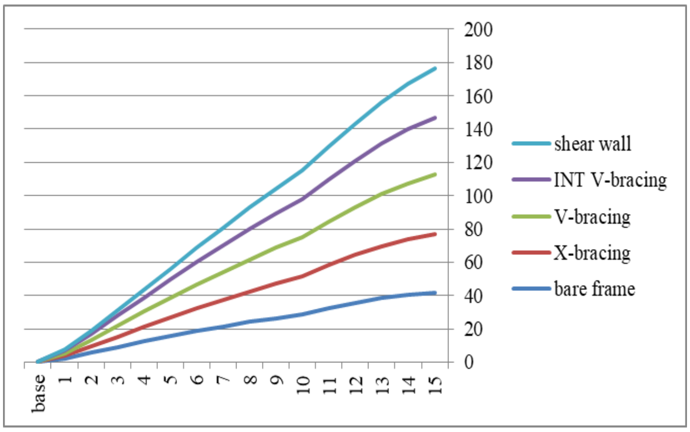


Figure 4: maximum stor displacements of model2 buildings

Table 5: maximum story displacements (mm) of model 3buildings

story	bare frame	X-bracing	V-bracing	INT V-bracing	shear wall
15	41.568	33.301	34.215	33.793	30.041
14	40.405	31.599	32.545	32.176	27.98
13	38.411	29.609	30.567	30.21	25.841
12	35.701	27.383	28.336	27.957	23.621
11	32.383	24.972	25.898	25.482	21.33
10	28.567	22.388	23.263	22.799	18.99
9	26.45	20.315	21.182	20.722	16.714
8	24.111	18.091	18.977	18.48	14.411
7	21.544	15.782	16.664	16.142	12.103
6	18.76	13.394	14.254	13.718	9.811
5	15.769	10.945	11.762	11.225	7.572
4	12.577	8.466	9.212	8.694	5.442
3	9.198	6.007	6.644	6.175	3.498
2	5.676	3.64	4.116	3.738	1.846
1	2.219	1.466	1.726	1.493	0.616

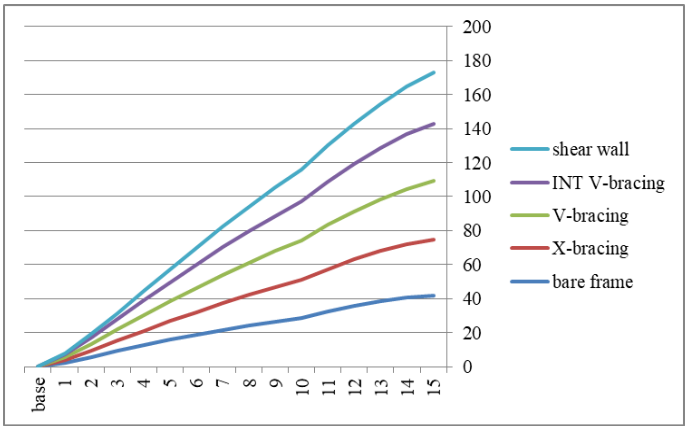


Figure 5: maximum storey displacements of model 3buildings

4.2 STOREY DRIFT

Story drift of 15 storey RC frame building with shear wall and different bracing types are given in graph as follow

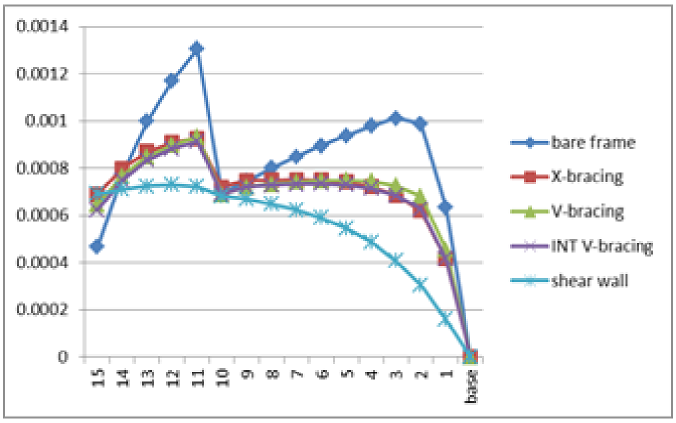


Figure 6: average maximum storey drift of model 2 Buildings

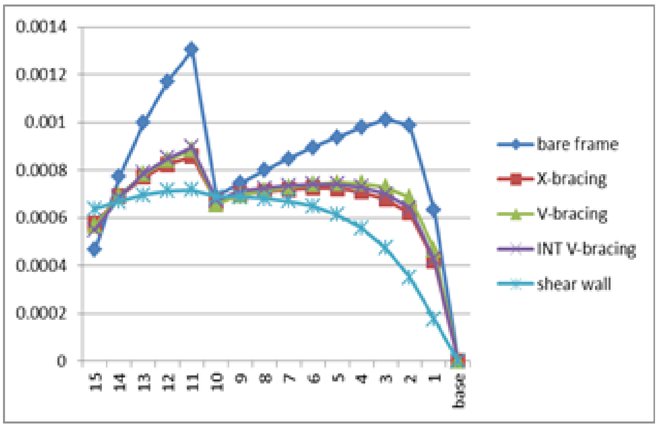


Figure 7: average maximum storey drift of model 3 buildings

4.3 BASE SHEAR

The bases shears obtained from response spectrum analysis are given below.

Table 6: base shear force for model2 buildings

structural types	shear force in KN
bare frame	7245.8
X-frames	9004.7
V-brace	8752.7
INT V-brace	9025.0
shear wall	10927.8

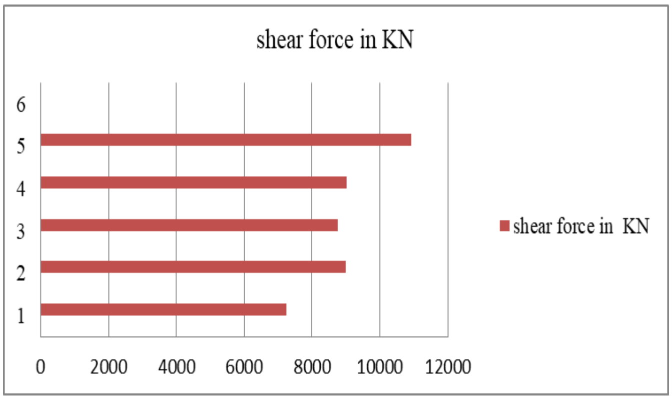


Figure 8: base shear for model 2 buildings

Table 7: base shear for model 3 buildings

structural types	shear force KN
bare frame	7245.8
X-frames	8755.9
V-brace	8463.2
INT V-brace	8729.3
shear wall	11338.5

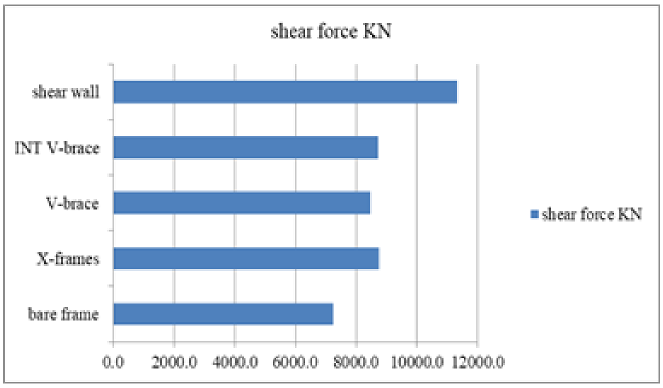


Figure 9: base shear force for model 3 buildings

4.4 TIME PERIODE

The fundamental time period of 15 story model buildings are given in the table and figure below.

Table 8: time period for model 2 buildings

structural types	Time period in seconds
bare frame	2.318
X-frames	1.932
V-brace	1.989
INT V-brace	1.928
shear wall	1.559

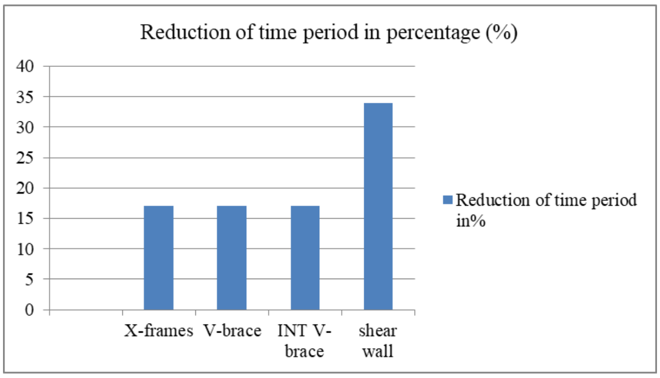


Figure 10: reduction of time period in percentage for model 2 buildings

Table 9: time period for model 3buildings

structural types	Time period in seconds
bare frame	2.318
X-frames	1.875
V-brace	1.925
INT V-brace	1.867
shear wall	1.617

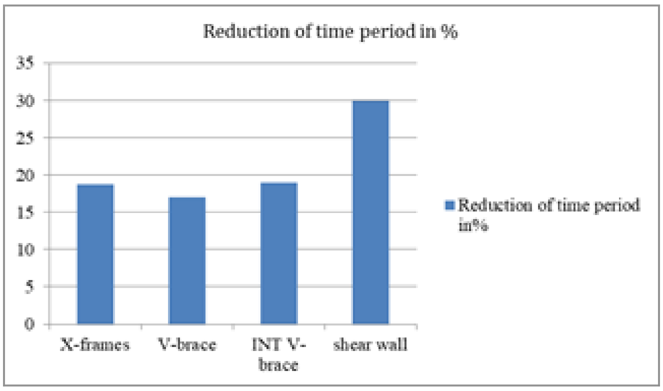


Figure 11: Reduction of time period in percentage for model 3buildings.

5. CONCLUSIONS

Based on the analysis results and discussion the following conclusions are drawn

- ✓ Providing shear wall and different bracing systems at different location can affect the lateral stiffness and strength of reinforced concrete frame buildings.
- ✓ Providing shear wall and different bracing system in proper location severely reduces the maximum storey displacement and storey drift.
- ✓ Steel bracing system can be utilized as an alternative to replace shear wall on new buildings be side using it as retrofitting.
- ✓ Generally when steel bracing is introduced to the building the lateral stiffness and strength of the building increases

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