SEISMIC ANALYSIS OF A TALL RC BUILDING WITH SHEAR WALL AND BRACING SYSTEM

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Abstract: The major concern in the design of the Tall structures is that the structure need to have enough lateral stability to oppose lateral forces and to control drift and displacement. Presently, shear wall and steel bracings in RC tall structures is the most prominent framework to oppose lateral forces because of earthquakes, wind forces, blasting forces and so on. Situating of shear wall and bracings significantly impact the overall performance of the building and for effective and efficient performance of building, it is important to position shear wall and bracings in a perfect area. In this project, a G+25 storey RC Tall building, along with shear wall and bracings are considered for the analysis. The performance of building is assessed and analyzed based on the procedures that are prescribed in Indian Standard 1893:2002 Code Book and parameters studied are story displacement, story drift, Base shear and natural time period utilizing Equivalent static and Response spectrum strategy. The shear wall and bracings are given at various locations and endeavor has been made to find the ideal location of the same. The overall analysis of models is done utilizing the Etabs2013 software.

Keywords: Shear wall, Bracing system, Displacement, Drift, Base Shear, Equivalent static method, Response spectrum method

I INTRODUCTION

GENERAL

The building of height greater than 45m and less than 250m intended for residential, and commercial building is termed as Tall building. In the past twenty-eight years, some serious earthquakes happened at intervals of 5 to 10 years, have caused extreme harms. For safety of the structures, it is important that structures ought to have satisfactory lateral stability, strength, and sufficient ductility.

Shear walls are the vertical elements of lateral force resisting system and are provided along the width and length of the building. For a building upto 25 stories rigid frames are considered to be economical, if rigid frames are combined with shear wall, the height can go up to 50 stories or more. The behavior of the shear wall depends on the factors like thickness of wall, type of material used, length of the wall and positioning in the frame.

Bracings are designed with the primary purpose to resist wind and earthquake forces.. The advantages of using steel bracing is it doesn't not much add the structural weight, it is comparatively cost-effective, is easy in application with sufficient strength and rigidity. Hence retrofitting reinforced concrete in a frame using steel bracing system is very much effective and attractive.

A) OBJECTIVES OF STUDY

- To carryout analysis of a G+25 storey tall RC building with shear walls and bracing system using ETABS2013.
- To carry out the lateral load analysis on various buildings models with shear wall and bracings as per Indian standard codes.
- To perform and compare the analysis results of the building by Equivalent static and Response spectrum analysis method.
- To study the significant effects of shear walls and steel bracings in tall RC building considering parameters like displacement, time period, storey drift and base shear.
- To find out the ideal location of shear wall and bracing system in a tall RC building.
- To compare the seismic response of various models of building having shear walls and bracing system in the structure

B) SCOPE OF STUDY:

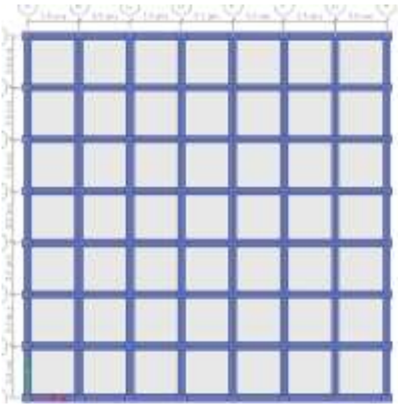
- Only RC buildings with square plan have been considered.
- RC shear wall and X type of steel bracing is studied.
- Comparison on the effect of placement of shear wall and bracing system is studied.
- Linear elastic analysis and linear dynamic analysis was done on the structures.
- Column was modelled as fixed to the base.
- Stiffness due to infill wall was not considered however loading due to infill wall is taken into account.
- Soil structure interaction effect is ignored.

II. MODELING & ANALYSIS METHODS

- 3D modeling for analysis of all models using ETABS 2013 Software package.
- The building is analyzed by using Equivalent Static Analysis (ESA) and Response Spectrum Analysis (RSA)

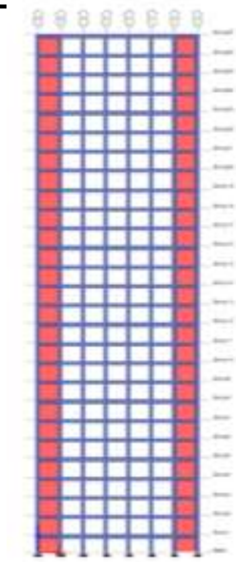
A) DESCRIPTION OF SAMPLE BUILDING MODELS

Model	**Building frame details**
M1	Bare Frame
M2	Shear Wall at Corner
M3	Shear Wall at Sides of building
M4	Shear Wall at Core of building
M5	Shear Wall at Corner+Core of building
M6	Shear Wall at Sides+Core of building
M7	Bracings at Corner of building
M8	Bracings at Side of building
M9	Bracings at Core of building
M10	Bracing at Corner+Core of building
M11	Bracing at Sides +Core of building
M12	Bracings at Corner And Shear Wall at Core of building
M13	Bracings at Sides And Shear Wall at Core of building
M14	Shear Wall at Corner And Bracings at Core of building
M15	Shear Wall at Sides And Bracings at Core of building



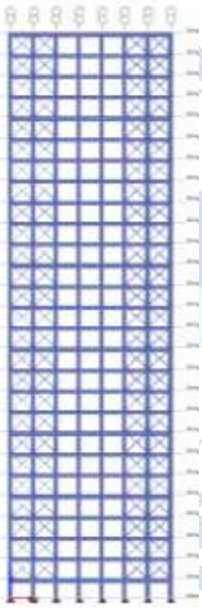
MODEL 1 : BARE FRAME MODEL PLAN VIEW

MODEL 1 : BARE FRAME MODEL 3D VIEW



MODEL 2: SHEAR WALL MODEL ELEVATION

MODEL 2 : SHEAR WALL MODEL 3D VIEW



MODEL 7 : BRACING MODEL ELEVATION

MODEL 7 : BRACING MODEL 3D VIEW

C) DESIGN AND MATERIAL DATA

Number of storey	G+25
Plan area	24.5m x24.5m = 600.25m^2
Storey height	3.2m
Size of Beam	500X700mm
Size of Column	500X700
Thickness of Slab	150mm
Density of masonry	20 kN/m^3
Grade of concrete	M30
Grade of reinforcement	Fe 500
Bracing steel	Fe 345
Width of shear wall and infill wall	230mm
Bracing	ISA 150x150x15
Wall load	20x0.23x(3.2-0.5) = 12.42 kN/m^2
Live load	3 kN/m^2
Floor Finish	1 kN/m^2
EARTHQUAKE PARAMETERS	
Seismic zone	Zone V
Importance Factor (I)	1
Soil type	II (Medium)
Response reduction factor (R)	5

III. RESULTS & DISCUSSIONS

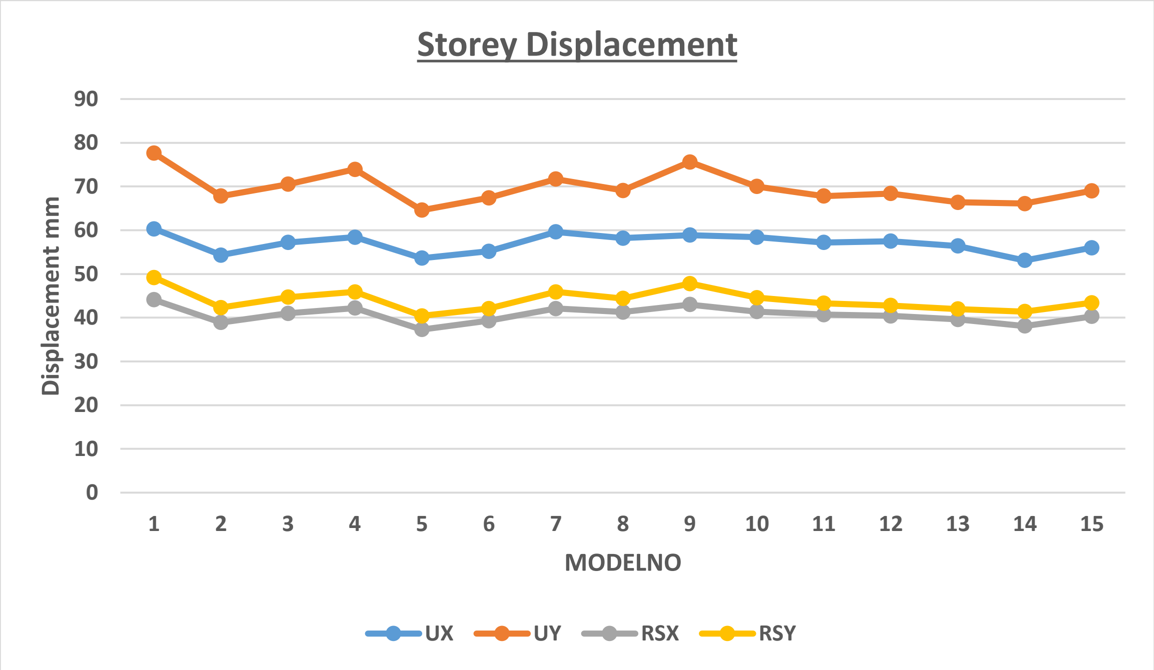
A) GENERAL

In this chapter, the results of the seismic analysis of analytical building models with shear wall and bracing system along with the bare frame are presented and discussed. The results are for building models computed using the equivalent static and response spectrum analysis method. The analyses of all the models are achieved through the ETABS2013 software package.

Results of seismic parameters such as lateral displacements, storey drifts, base shear and natural time period for the different building models for each of the above analyses method are presented and compared.

B) DISPLACEMENT

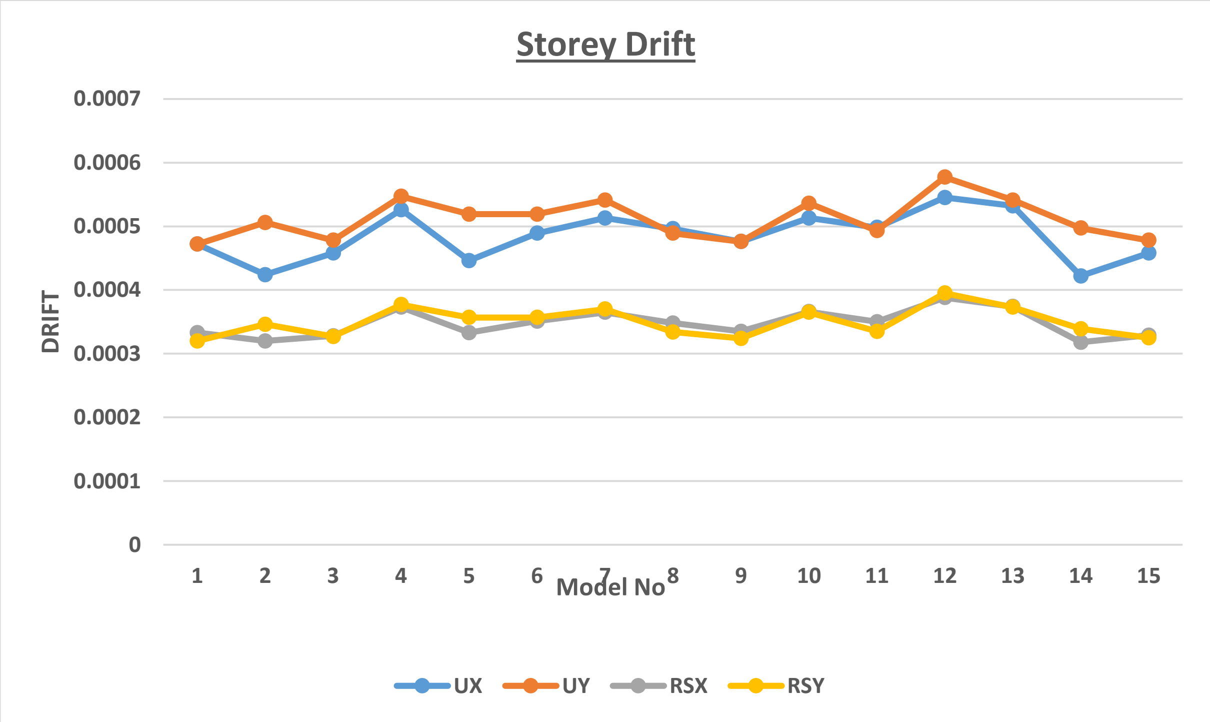
DISPLACEMENT				
MODEL NO	EQUIVALENT STATIC METHOD		RESPONSE SPECTRUM METHOD	
	UX	UY	RSX	RSY
1	60.3	77.6	44.1	49.2
2	54.3	67.8	38.9	42.3
3	57.2	70.5	41	44.7
4	58.4	73.9	42.2	45.9
5	53.6	64.6	37.3	40.4
6	55.2	67.4	39.3	42.1
7	59.6	71.7	42.1	45.9
8	58.2	69.1	41.3	44.4
9	58.9	75.6	43	47.8
10	58.4	70	41.4	44.6
11	57.2	67.8	40.7	43.3
12	57.5	68.4	40.4	42.8
13	56.4	66.4	39.6	42
14	53.1	66.1	38.1	41.4
15	56	69	40.3	43.4



C) Storey drift

STOREY DRIFT				
MODEL NO	EQUIVALENT STATIC METHOD		RESPONSE SPECTRUM METHOD	
	UX	UY	RSX	RSY
1	0.000472	0.000472	0.000333	0.000320

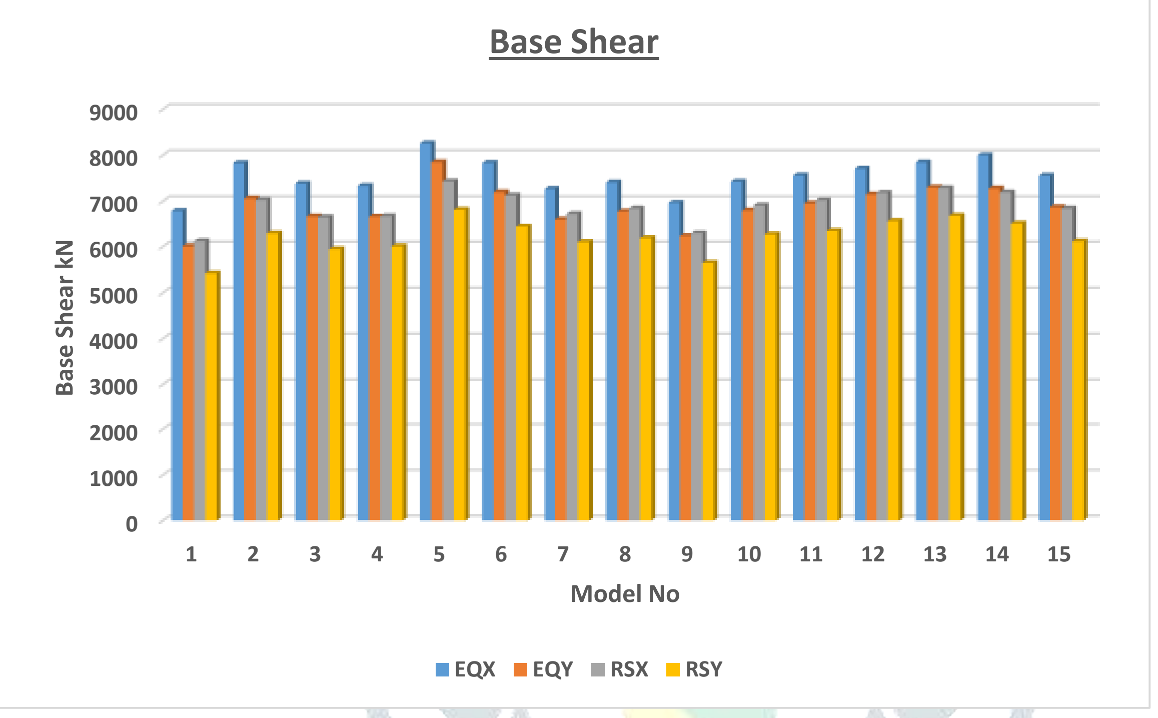
2	0.000424	0.000506	0.000320	0.000346
3	0.000458	0.000478	0.000328	0.000327
4	0.000526	0.000547	0.000373	0.000377
5	0.000446	0.000519	0.000333	0.000357
6	0.000489	0.000519	0.000351	0.000357
7	0.000513	0.000541	0.000365	0.000370
8	0.000946	0.000489	0.000348	0.000334
9	0.000476	0.000476	0.000335	0.000324
10	0.000513	0.000536	0.000366	0.000365
11	0.000498	0.000493	0.000350	0.000335
12	0.000545	0.000577	0.000388	0.000395
13	0.000532	0.000541	0.000374	0.000373
14	0.000422	0.000497	0.000318	0.000339
15	0.000458	0.000478	0.000329	0.000325



D) BASE SHEAR

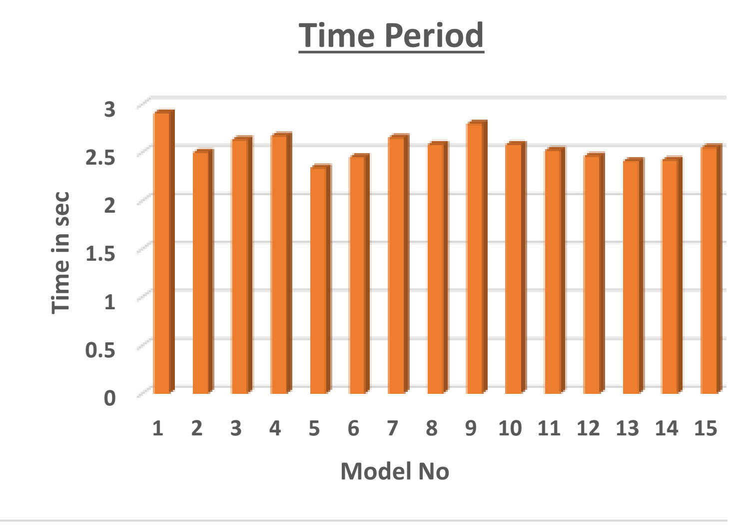
BASE SHEAR(kN)				
MODEL NO.	**EQX**	**EQY**	**RSX**	**RSY**
MODEL 1	6793.16	6009.15	6121.70	5421.34
MODEL 2	7829.71	7064.24	7033.04	6289.69
MODEL 3	7385.53	6673.97	6659.01	5945.84
MODEL 4	7334.67	6671.70	6680.05	6008.01
MODEL 5	8257.38	7851.79	7434.30	6820.64
MODEL 6	7833.43	7198.72	7128	6452.16
MODEL 7	7270.58	6609.53	6728.30	6097.49

MODEL 8	7410.98	6780.64	6846.06	6188.25
MODEL 9	6969.61	6232.64	6291.81	5649.88
MODEL 10	7426.36	6803.07	6914.07	6266.80
MODEL 11	7561.24	6955.70	7023.36	6342.08
MODEL 12	7707.48	7152.51	7185.79	6574.67
MODEL 13	7844.48	7304.16	7289.78	6690.61
MODEL 14	7999.62	7279.44	7197.35	6520.83
MODEL 15	7556.48	6876.67	6848.18	6116.70



E) Time Period

TIME PERIOD(seconds)	
MODEL NO.	TIME
MODEL 1	2.91
MODEL 2	2.50
MODEL 3	2.63
MODEL 4	2.67
MODEL 5	2.34
MODEL 6	2.45
MODEL 7	2.65
MODEL 8	2.58
MODEL 9	2.80
MODEL 10	2.58
MODEL 11	2.52
MODEL 12	2.46
MODEL 13	2.41
MODEL 14	2.42
MODEL 15	2.55



IV CONCLUSIONS

1. From the outcomes, it is concluded that shear wall models are more effective in reducing lateral displacement as the drift initiated are much less than in braced frame and bare frame. The storey drift of Shear wall and steel braced models are within the limits according to the provision 7.11.1 of IS-1893 (Part-1):2002.
2. The results obtained by equivalent static analysis are more when compare to the Response Spectrum Analysis.
3. Use of shear wall adds altogether more weight to the building compare to the bracing system.
4. Minimum fundamental time period resulted for model M5 (shear wall at corners and core) to be 2.34sec. In bracing models, it is recorded as 2.52seconds for M11 and whereas in the dual system models, M13 shows a time period of 2.41 seconds.
5. Maximum base shear for shear wall observed in the model M5 with 21.55% increment. In the bracing models, M11 shows 11.30% increase while in dual system, model M14, shear wall at corners and bracings at core shows an increase of 17.75%
6. Minimum reduction in displacement is seen for shear wall model M5 with reduction % of 11.11. The bracing model M11 shows 5.14% reduction and whereas the dual system model M14 shows the best of all with 11.94%reduction.
7. Finally, it can be concluded that location of shear wall and brace member has significant impact and placing shear wall at the corners with centre (M5) is more favorable
8. In bracing models, bracing placed at sides with core of the building (M11) proves to be effective arrangement of bracing.
9. The dual system model with shear wall at corners and bracings at core (M14) workout to be the effective one compare to other dual models

V SCOPE OF FUTURE STUDY

1. Other structural system such as Tubular system can be used to study the effect of same with shear wall and bracing system. Study on Beam-Column junction can be made for better ductility.
2. Introduction of plastic hinges can be made and analyze can be performed on the models.
3. The same building models can be analyze using Time history and push over analysis methods and the results can be compared of.
4. Instead of regular plan building models, irregular and asymmetric building models can be made to analyze and check for the results.
5. Study on Introduction of Base Isolation system can be made. This system means to protect a structure against earthquake forces

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