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Seismic Performance of High Rise Building with Normal and Oblique Column

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***Abstract*— The earthquakes are one of the damaging natural hazards to the building. Many researchers and design engineers trying to increase the lateral load resisting capacity of the building. In this present study the innovative technique is to use the oblique column instead of normal column. Oblique column are columns at an angle to the predefined line. For oblique columns the seismic performance should be studied, to check its adaptability. Hence statement of project is "Seismic Performance of High Rise Building with Oblique Column." This project is an attempt to study linear seismic behavior of building with oblique and normal column. The analysis is carried out in ETABS software.**

Keywords* — *oblique column, response spectrum analysis, ETABS.

I. INTRODUCTION

Due to urbanization, increase in population and small per capita area, the needs of high rise buildings become much more vital. By the several architectural features and style, further complex high-rise buildings are appearing [4]. For this, numerous construction practices are implemented in order to enhance the seismic performance of the building. The newest technology of "weak beam and strong column" is given more importance and hence the columns in a seismic resistant structure play important role in measuring the overall strength of the building against the effect of seismic forces [7]. Catering to the need of aesthetics and seismic resistance of the high rise building, the innovative technique of oblique columns was used instead of normal columns. This practice is one of the best unique lateral load resisting systems for today's tall buildings.

The column which is neither parallel nor at right angles to a stated line means that is they are slanted or rotated at an angle then it is called an oblique column[9]. Since the external loads lead to flexural and shear forces on the inclined column, the performance of the building differs from the conventional column. Due to the unique compositional characteristics of oblique columns, it provides distinguished architectural aesthetics in existing cityscapes [2].

The study focuses on the seismic performance and effectiveness of oblique columns with different inclinations and to compare the variation in different parameters like storey drift, storey displacement, storey stiffness, storey shear etc.

II. OBJECTIVES

• To investigate the effect of inclination of oblique columns on seismic response of high rise structure.

• To study the linear seismic behaviour of high rise building with oblique column and with normal column.

III. METHODOLOGY

Response spectrum method is a linear dynamic analysis method which compute the contribution from each natural mode of vibration to specify the likely maximum seismic response of an essentially elastic structure. Response spectrum analysis provides understanding of dynamic behaviour by measuring pseudo-spectral acceleration, velocity, or displacement as a function of structural period for a given time history and level of damping. It is practical to envelope response spectra such that a smooth curve represents the peak response for each realization of structural period [5].

ETABS software is used for modelling and model analysis. The data for building model is as given below in problem statement. The data collected for load and seismic parameters by referring IS codes. In this project the building with normal column and oblique column for different inclinations are modelled and analysed using response spectrum analysis.

IV. PROBLEM STATEMENT

A 12 storey reinforced concrete building is considered for study. The plan dimensions are 25m long, 25m wide and total height is 36m. The storey height of each floor is 3m and the slab thickness is 150mm. For design the M35 concrete and Fe500 steel have been used. The thickness of 230mm and 150mm considered for the exterior and interior wall. The residential building is assumed to be situated on medium soil in seismic zone V.

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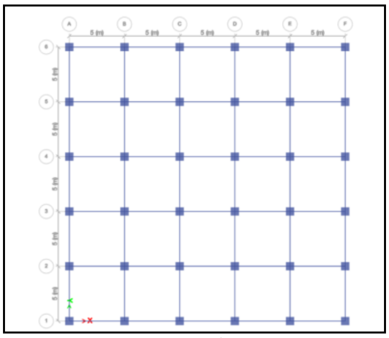

Fig. 1 – Plan of building

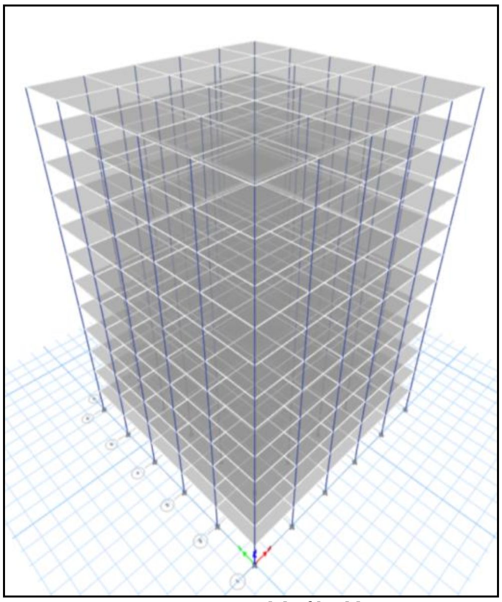

Fig. 2 – 3D model of building

TABLE I. MODEL DESCRIPTION

1.	Model 1: 12 storey building with normal column
2.	Model 2: 12 storey building with column inclination 88°
3.	Model 3: 12 storey building with column inclination 86°
4.	Model 4: 12 storey building with column inclination 84°

TABLE II. PRELIMINARY DATA

Number of storey	12
Support Condition	Fixed
Spacing between frames in X direction	5m
Spacing between frames in Y direction	5m
Floor Height	3m
Grade of Concrete	M35
Grade of Steel	Fe500
Soil Type	Type II
Seismic Zone	Zone V (Z=0.36)
Importance Factor	1
Type of Building	SMRF (R=5)

TABLE III. LOAD PATTERN

Load Type	**Load Value**
Live load on floor	3kN/m^2
Live load on roof	1.5kN/m^2

The beam and column sections used for modeling are listed in table IV below. The slab sections were modeled in ETABS by using thin shell.

TABLE IV. SECTION PROPERTIES TABLE TYPE STYLES

Section Property	**Dimensions**
Beam	350mm x 500mm
Column	750mm x 750mm
Slab	Thickness 150mm
External wall	Thickness 230mm
Internal wall	Thickness 150mm

A. Models in ETABS

The models as described in table I was modeled in the ETABS software. In each model only the inclination of exterior columns are changed whereas the internal columns are conventional or normal columns. The elevation of each model is as given below.

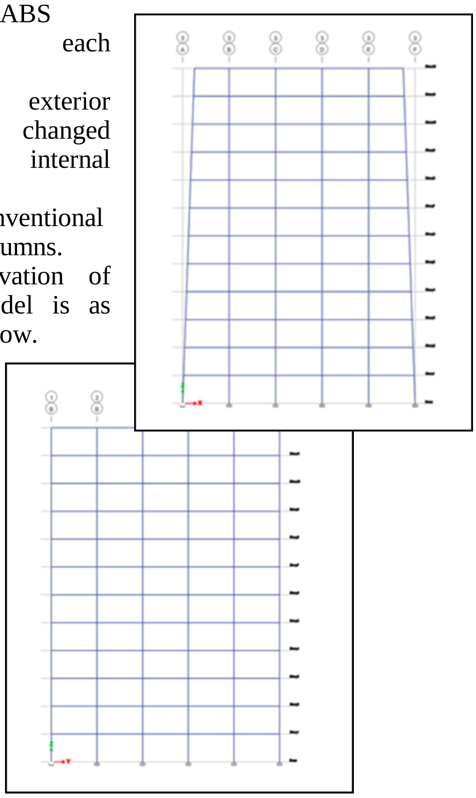

Fig. 3 - Elevation of Model 1

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Fig. 4 - Elevation of Model 2

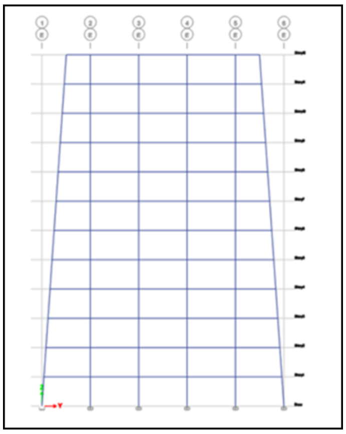

Fig. 5 - Elevation of Model 3

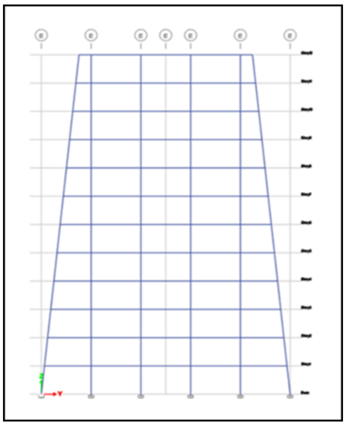

Fig. 6- Elevation of Model 4

V. ANALYSIS RESULTS

The modeling and seismic analysis for all building models were carried out using the ETABS software. The output results obtained from response spectrum analysis are as tabulated below in table V. The parameters which are to be studied are time period, maximum storey shear, maximum storey displacement, maximum storey drift and maximum storey stiffness.

TABLE V. RESPONSE SPECTRUM ANALYSIS RESULTS FOR DIFFERENT PARAMETERS

Sr. no	**Parameters**	**Inclination (in degree)**	**X direction (RSX)**	**Y direction (RSY)**
1.	Time Period (sec)	90º	1.408	1.408
		88º	1.258	1.258
		86º	1.115	1.115
		84º	0.961	0.96
2.	Max. Displacement (mm)	90º	26.73	26.68
		88º	24.12	24.17
		86º	21.15	21.16
		84º	18.07	18.07
3.	Max. Story drift	90º	0.001091	0.00109
		88º	0.00104	0.001042
		86º	0.000978	0.000979
		84º	0.000905	0.000904
4.	Max. Story Shear (kN)	90º	3594.48	3594.48
		88º	3740.29	3760.41
		86º	3946.47	3946.46
		84º	4248.33	4248.45
5.	Max. Story Stiffness (kN/m)	90º	2585974	2585985
		88º	2765521	2765540
		86º	3043598	3043576
		84º	3474368	3474483

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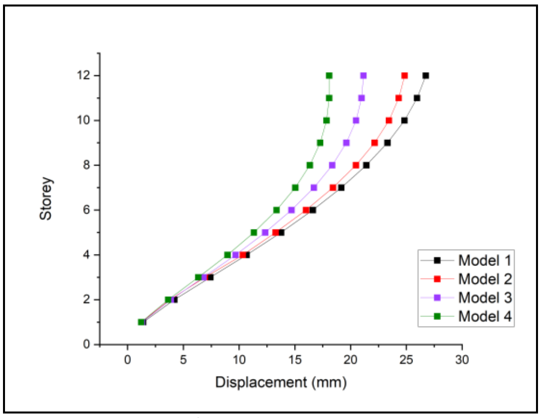

Fig. 7 - Plot of maximum storey displacement

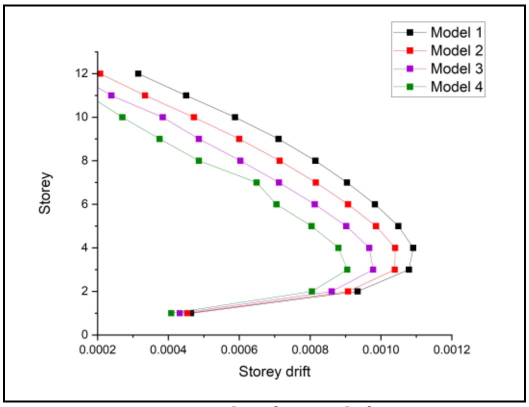

Fig. 8 - Plot of storey drift

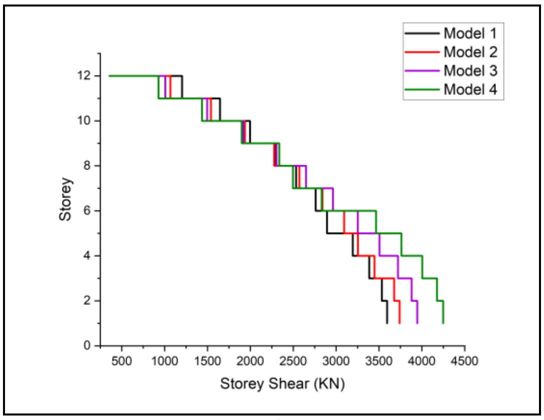

Fig. 9 - Plot of storey shear

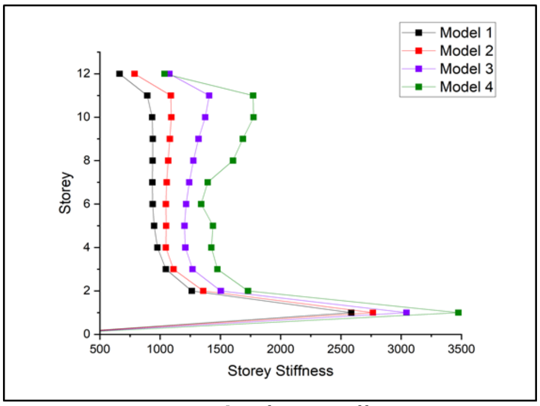

Fig. 10 - Plot of storey stiffness

VI. CONCLUSION

1. The behaviour of high rise building with oblique column is studied.
2. From modal analysis it is studied that the time period is less for building with oblique columns. This reflects more stiffness of the structure.
3. As symmetrical square shape building is considered for analysis hence the results of RSX and RSY are nearly equal.
4. From response spectrum analysis, for model 2 (88°), model 3 (86°) and model 4 (84°) shows that the reduction in storey displacement by 7.08%, 20.81% and 32.38% than the model with normal column.
5. From response spectrum analysis, for model 2 (88°), model 3 (86°) and model 4 (84°) shows that the reduction in storey drift by 4.67%, 10.35% and 17.04% than the model with normal column.
6. Hence among considered building models the model 4 (84°) shows better control over storey drift and story displacement.
7. The maximum storey shear values for model 2 (88°), model 3 (86°) and model 4 (84°) increases by 4.56%, 9.79% and 18.19% respectively than model 1 (90°).
8. The Storey stiffness values for model 2 (88°), model 3 (86°) and model 4 (84°) increases by 6.94%, 17.69% and 34.3% respectively than model 1 (90°).
9. Hence, the building with oblique columns shows better seismic performance than building with normal column.

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