Nonlinear Dynamic Time History Analysis of Multistoried RCC Residential G+23 Building for Different Seismic Intensities

Pruthviraj N Juni[1], S.C. Gupta[2], Dr. Vinubhai R. Patel[3]

[1]M.tech Student: Structural Engineering With Specialization In offshore Structures, UPES, Dehradun , India
[2]Associate Dean (COES), UPES, Dehradun, India
[3]Ph. D. Structural Engg, Zarna Associate, Vadodara, Gujarat, India

Abstract— *In this paper study of nonlinear dynamic time history analysis of Twenty three storied RCC residential building considering different seismic/earthquake intensities is carried out and response of such building due to earthquake is studied. The building under consideration is modeled with the help of SAP2000V.14.00 software. Five different time histories have been used considering seismic intensities V, VI, VII, VIII, IX and X on Modified Mercalli's Intensity scale (MMI) for developing the relationship between seismic intensities and seismic responses. The outcome of the study shows similar variation pattern in Seismic responses i.e. base shear and storey displacements with intensities V to X. From the study it is recommended that analysis of multistoried RCC building using Time History method became necessary to ensure safety against earthquake force.*

Keywords— Multistoried buildings, Scaling, Seismic responses, Time history analysis.

I. INTRODUCTION

All over the world, there is a high demand for construction of tall buildings due to increasing urbanization and spiraling population, and earthquakes have the potential for causing the greatest damages to those high rise structures. Since earthquake forces are random in nature and unpredictable, the engineering tools need to be sharpened for analyzing structures under the action of these forces. Earthquake loads are required to be carefully modeled so as to assess the real behavior of structure with a clear understanding that damage is expected but it should be regulated. Analyzing the structure for various earthquake intensities and checking for multiple criteria at each level has become an essential exercise for the last couple of decades (Romy and Prabha, 2011).

Earthquake causes different shaking intensities at different locations and the damage induced in buildings at various locations is also different. Therefore, it is necessary to construct a structure which is earthquake resistance at a particular intensity of shaking a structure, and not so much the magnitude of an earthquake. Even though same magnitudes of earthquakes are occurring due to its varying intensity, it results into dissimilar damaging effects in different regions. Therefore, it is necessary to study variations in seismic behavior of multistoried RCC frame building for different seismic intensities in terms of various responses such as lateral displacement and base shear. It is necessary to understand the seismic behavior of buildings having similar layout under different intensities of earthquake. For determination of seismic response it is necessary to carry out seismic analysis of the structure using different available methods (Duggal, 2010).

II. STRUCTURAL MODELING AND ANALYSIS

The finite element analysis software SAP 2000 Nonlinear is utilized to create 3D model and run all analyses. The software is able to predict the geometric nonlinear behavior of space frames under static or dynamic loadings, taking into account both geometric nonlinearity and material inelasticity.

2.1 Problem Statements

2.1.1 Structural plan:

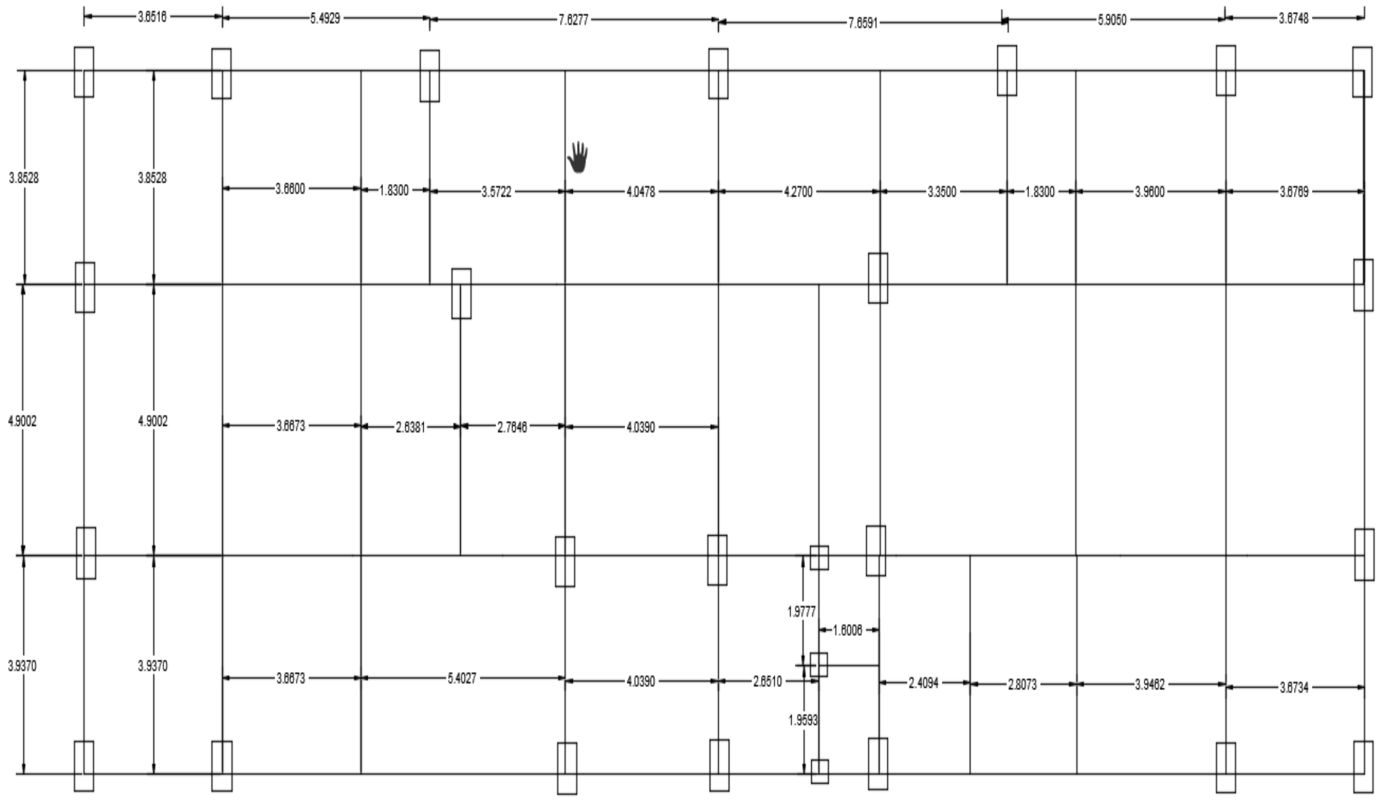


FIGURE 1: STRUCTURAL PLAN

2.1.2 Architectural Plan

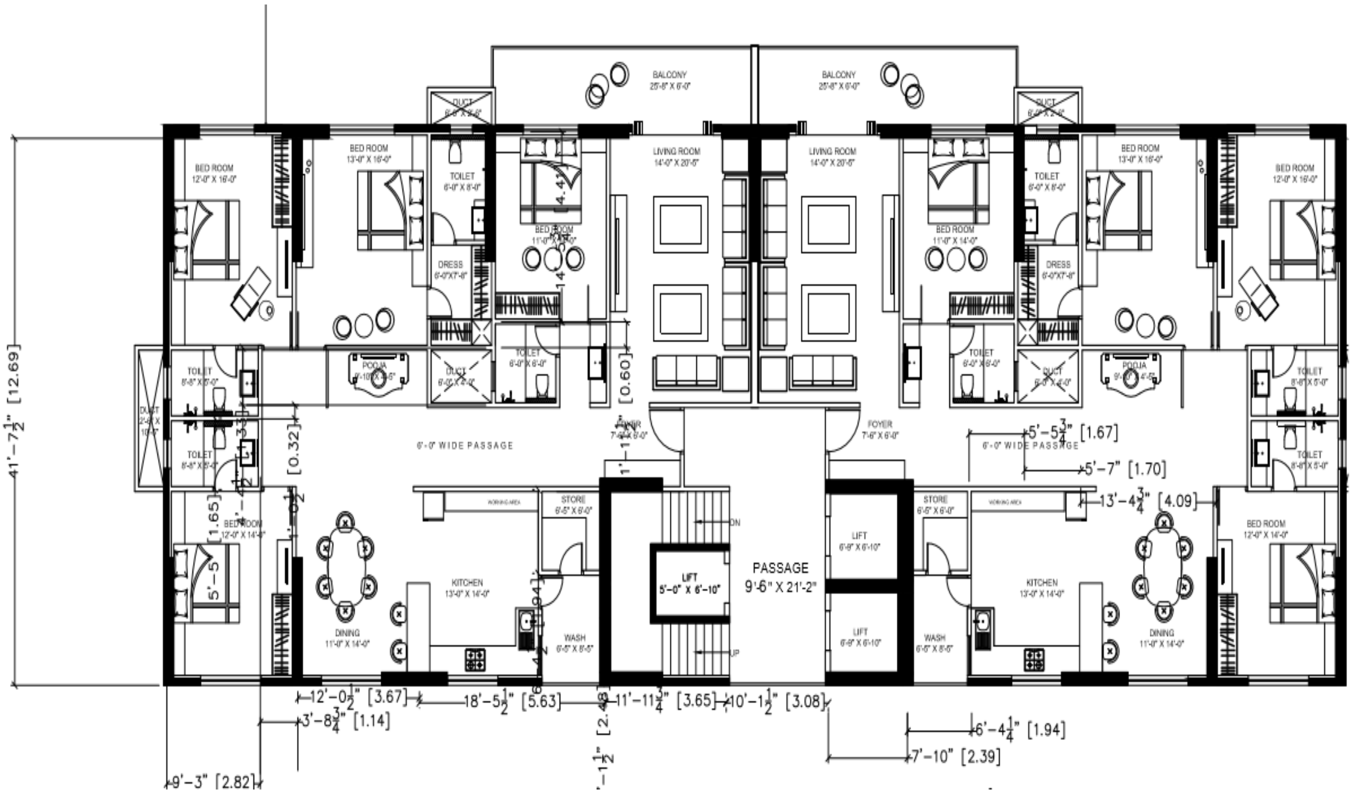
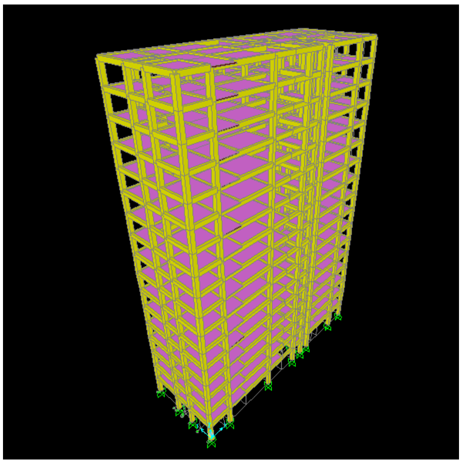
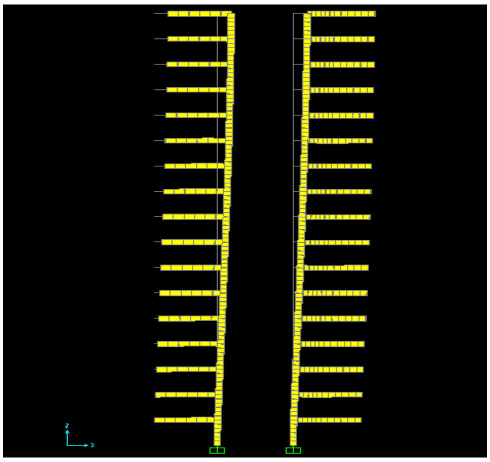


FIGURE 2: ARCHITECTURAL PLAN



3 D MODEL IN SAP



DISPLACEMENT MODEL IN SAP

FIGURE 3

TABLE 1
DIFFERENT TIME HISTORY CONSIDERED FOR STUDY

S.No.	EQ	Date	Magnitude Richter Scale	P.G.A.G
1	Bhuj, India	26-Jan-01	6.9	0.11
2	Koyana, India	11-Dec-64	6.5	0.489
3	Anza, USA	25-Feb-80	4.7	0.11
4	Nahanni, Canada	23-Dec-85	6.9	0.489
5	Northbridge, USA	17-Jan-94	6.7	0.489

III. MATERIALS AND METHODS

TABLE 2
MATERIALS

Material/Section	Grade/Size	Unit	Material/Section	Grade/Size	Unit
Concrete grade	M30		**slab thickness**	0.15	m
Steel grade	Fe500		**wall thickness**	0.23	m
E (concrete)	27386.12788	N/mm2	**Density of concrete**	25	kN/m3
E (steel)	210000	N/mm2	**Density of brick work**	20	kN/m3
Beam	0.4 x 0.6	m	**live Load**	3	KN/m2
Column	0.6 x 0.6	m			

Software : *SAP2000 V.14.00*

IV. RESULTS AND DISCUSSION

Results obtained from the analysis are tabulated in below Tables .Graphical representations of variations in results are shown in Figures. The graph shows that similar variations in seismic responses namely base shear and displacement with intensities V to X.

TABLE 3
VARIATIONS IN BASE SHEAR FOR X DIRECTION

S.No.	Intensity MMI	Base Shears (kN)				
		Bhuj	Koyana	Anza	Nahanni	Northbridge
1	V	666.48	866.424	904.38	1011.48	904.93
2	VI	1666.4	1948.38	2004.48	2211.43	2103.49
3	VII	2665.954	3004.98	3218.32	3400.59	3411.98
4	VIII	3998.391	4108.4	4900.32	5109.66	5003.4
5	IX	5998.39	6211.389	6811.43	7098.42	6911.3
6	X	8331.1065	9013.42	10004.39	11049.61	10940.11

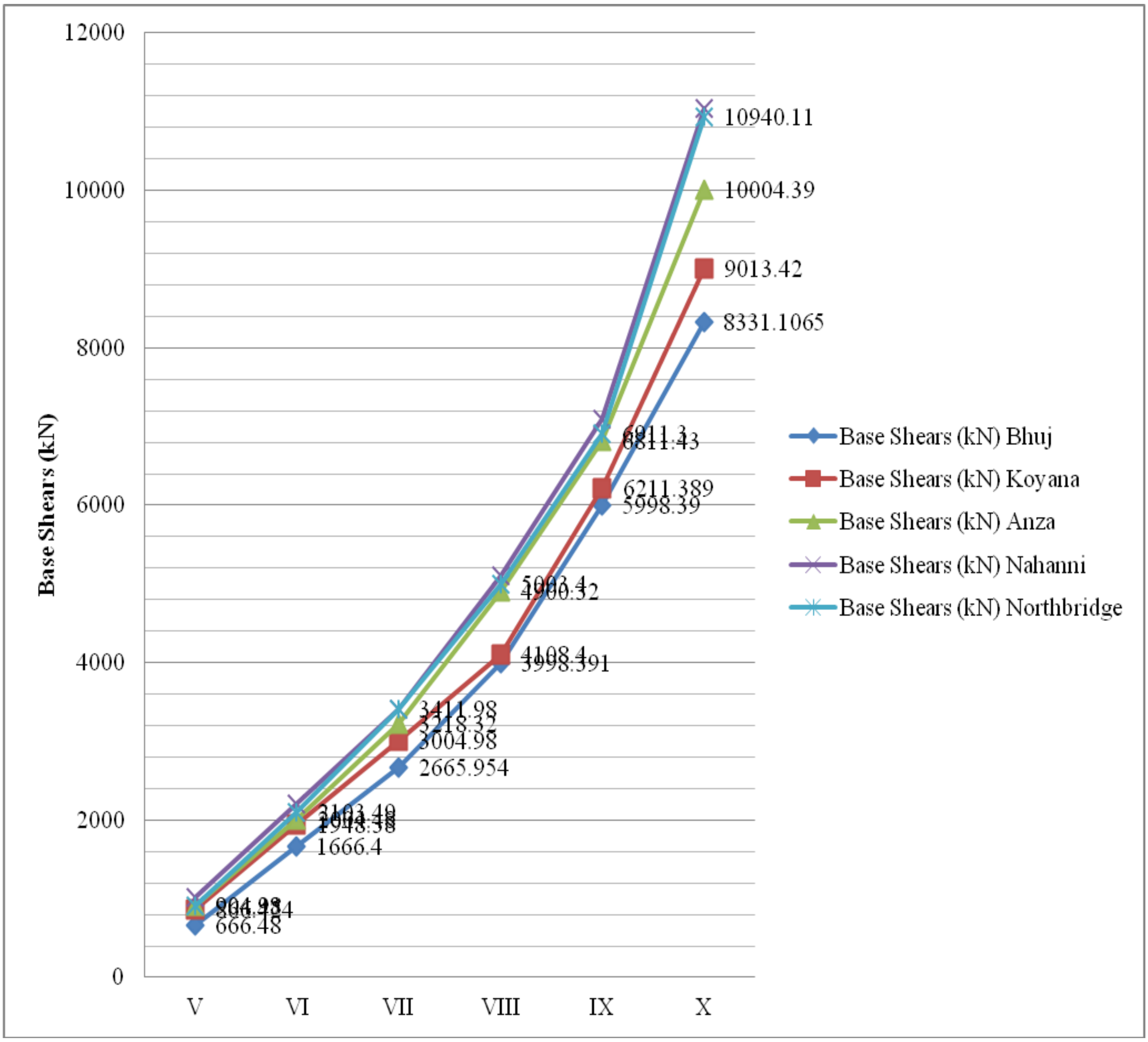


FIGURE 4: VARIATIONS IN BASE SHEAR FOR X DIRECTION

TABLE 4
VARIATIONS IN BASE SHEAR FOR Y DIRECTION

S.No.	Intensity MMI	Base Shears(kN)				
		Bhuj	Koyana	Anza	Nahanni	Northbridge
1	V	888.651	920.44	1102.43	1390.11	1750.39
2	VI	2221.62	2444.92	2780.44	3001.29	3640.11
3	VII	3554.62	3842.46	4100.39	4400.41	4711.39
4	VIII	5331.9	5711.39	6008.82	6344.92	6748.31
5	IX	7997.86	8211.79	8411.99	8791.79	9124.48
6	X	11108.142	11209.4	11600.11	12001.92	12409.18

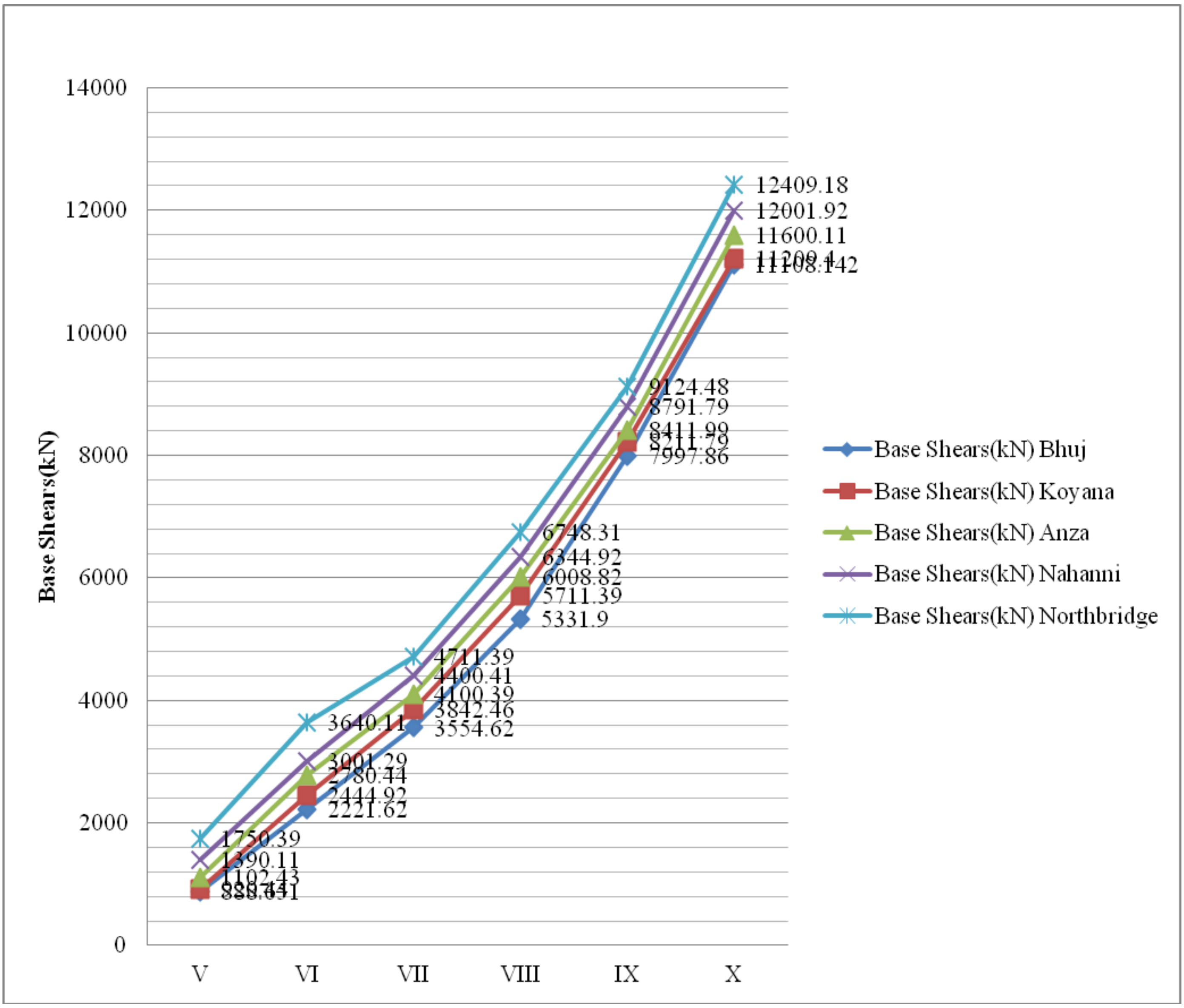


FIGURE 5: VARIATIONS IN BASE SHEAR FOR Y DIRECTION

TABLE 5
VARIATIONS IN ROOF DISPLACEMENT FOR Y DIRECTION

S.No.	Intensity MMI	Displacement (mm)				
		Bhuj	Koyana	Anza	Nahanni	Northbridge
1	V	0.28	0.31	0.51	0.59	0.52
2	VI	0.6	0.68	0.8	0.83	0.78
3	VII	1	1.69	2.1	2.92	2.5
4	VIII	3.1	3.61	3.92	4.52	4.11
5	IX	5.9	6.11	7.28	7.99	7.48
6	X	6.8	7.21	8.11	9.78	9.22

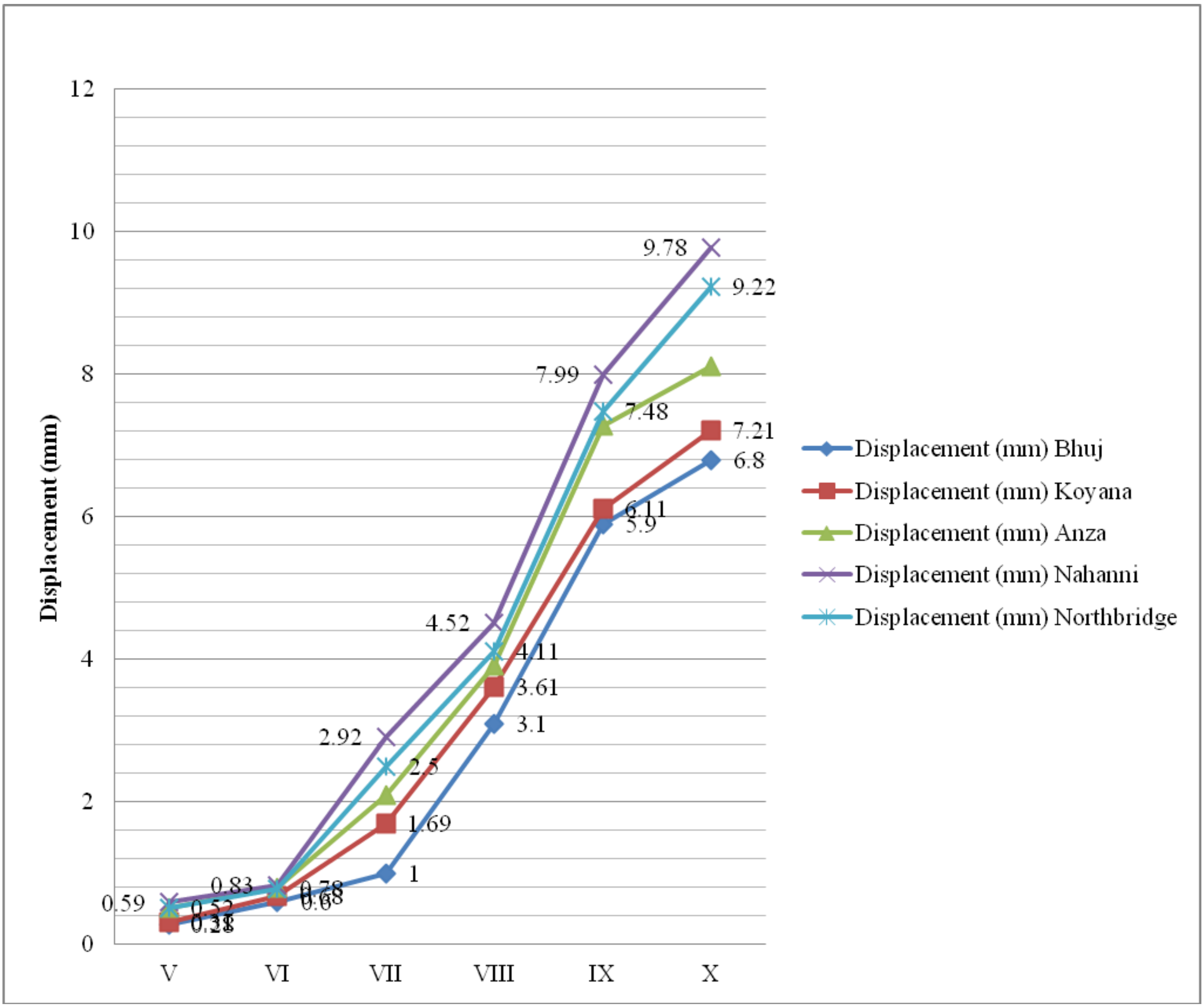


FIGURE 6: VARIATIONS IN ROOF DISPLACEMENT FOR Y DIRECTION

TABLE 6
VARIATIONS IN ROOF DISPLACEMENT FOR X DIRECTION

S.No.	Intensity MMI	Displacement (mm)				
		Bhuj	Koyana	Anza	Nahanni	Northbridge
1	V	0.53	0.629	0.739	0.811	0.844
2	VI	1.02	1.24	1.439	1.591	1.433
3	VII	2.06	2.93	2.811	3.318	3.12
4	VIII	4.09	4.5	4.426	6.019	5.811
5	IX	8.92	9.21	8.298	12.48	11.129
6	X	9.2	10.03	12.37	14.11	13.482

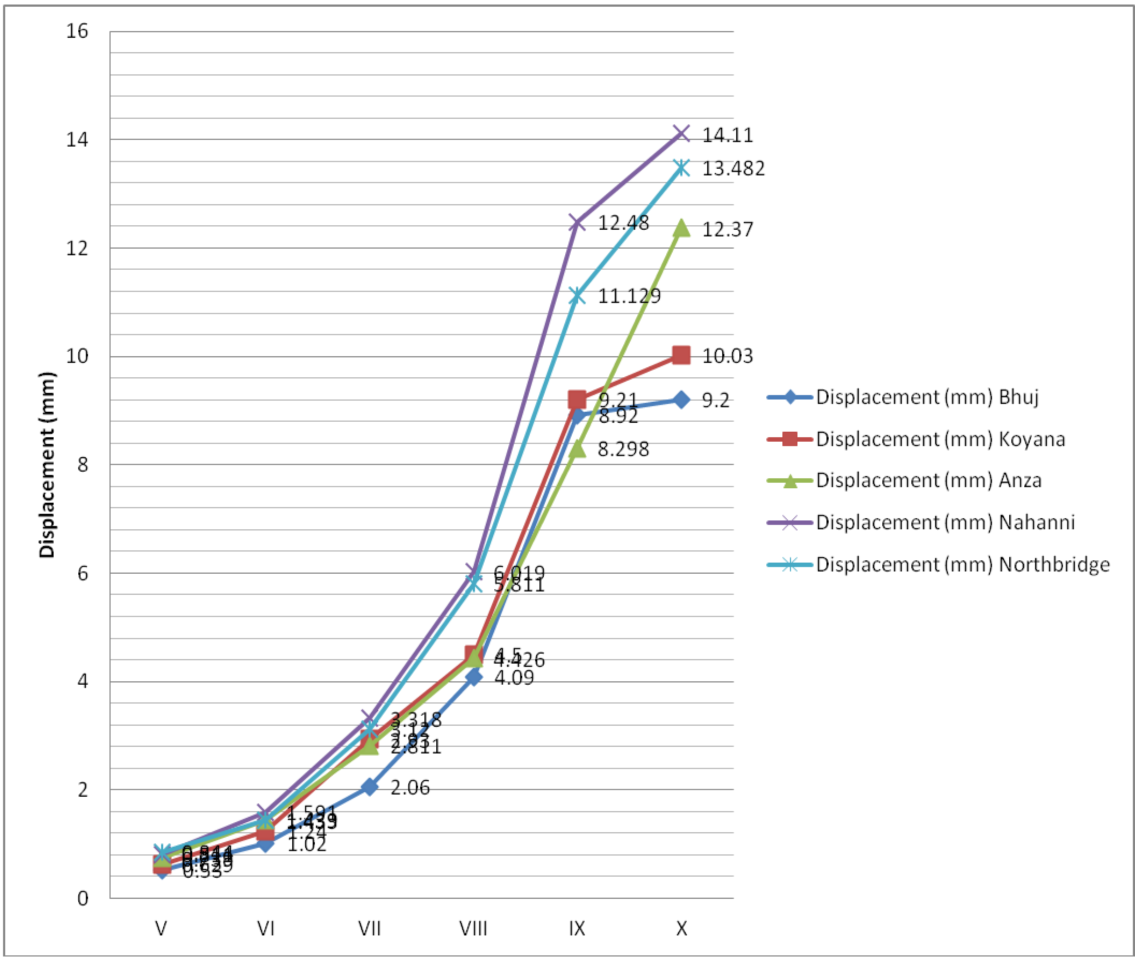


FIGURE 7: VARIATIONS IN ROOF DISPLACEMENT FOR X DIRECTION

V. CONCLUSION

1. The seismic responses namely base shear, storey displacements and storey drifts in both the directions are found to vary in similar pattern with intensities (V to X) for all the Time Histories and both the models considered for the study.
2. The values of seismic responses namely base shear, storey displacement and storey drifts for all the Time Histories and both the models are found to be of increased order for seismic intensities varying from V to X.

3. The maximum value of base shear, storey displacement and storey drift (X and Y directions) for seismic intensities of VI, VII, VIII, IX and X are found to be nearly more by 2.50, 4.005, 7.56, 16.83, and 17.35 times, respectively as compared to seismic intensity of V for both the models (i.e., with and without soft story) and for all the time histories.
4. As Time History Analysis is a realistic method used for seismic analysis, it provides a better check to the safety of structures analyzed and designed bythe method specified in IS code.

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