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SEISMIC ANALYSIS OF MULTISTORIED BUILDING ON SLOPING GROUND WITH GROUND SOFT STOREY AND MIDDLE SERVICE SOFT STOREY

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Abstract*— in this G + 13 Building analysis and comparison is carried out between the building on sloping ground having slopes of different angle and that of the flat ground building. The analysis is carried out using etabs The soft story perform poorly during earthquakes further Due to the diverse configurations of buildings in hilly areas, these buildings become highly irregular and asymmetric, due to variation in mass and stiffness distributions on different vertical axis at each floor. Buildings on hill slope are characterized by unequal column heights within a story, which results in drastic variation in stiffness of columns of the same storey.

Keywords— sloping ground, Ground Middle soft story, shear wall in x and y direction, EQX, EQY, RSX, RSY

INTRODUCTION

Earthquake is the most disastrous and unpredictable phenomenon of nature. When a structure is subjected to seismic forces it does not cause loss to human lives directly but due to the damage cause to the structures that leads to the collapse of the building and hence to the occupants and the property. Mass destruction of the low and high rise buildings in the recent earthquakes leads to the need of investigation especially in a developing country like India. Structure subjected to seismic/earthquake forces are always vulnerable to damage and if it occurs on a sloped building as on hills which is at some inclination to the ground the chances of damage increases much more due to increased lateral forces on short columns on uphill side and thus leads to the formation of plastic hinges. Structures on slopes differ from those on plains because they are irregular horizontally as well as vertically. In north and north-eastern parts of India have large scale of hilly terrain which fall in the category of seismic zone IV and V. Recently Sikkim (2011), Doda (2013) and Nepal earthquake (2015) caused huge destruction. In this region there is a demand of construction of multi-storey RC framed buildings due to the rapid urbanization and increase in economic growth and therefore increase in population density. Due to the scarcity of the plain terrain in this region there is an obligation of the construction of the buildings on the sloping ground.

1.2 BEHAVIOUR OF BUILDING IN HILL SLOPE

The behavior of a building during an earthquake depends on various factors like stiffness, lateral strength and configurations of the building. Buildings in hill slope have a typical structural configuration. Subsequent floors in building step back (Figure 3) towards the hill slope, resulting in unequal column height at a particular Story. This causes stiffness irregularity in both the directions. . Building in hill slope with symmetric plan, when subjected to tremor in along-slope direction are not subjected to torsion, but the shorter columns on uphill side of a Story attract more lateral force, which are usually higher than their capacity and may result in shear failure.

I. OBJECTIVES

1. To study the behaviour of the building on flat ground and sloping ground with soft story having different angles
2. To perform linear static analysis and dynamic linear analysis i.e. equivalent static method and response spectrum method on the building
3. To study different parameters of the building after analysis such as time period, story displacement and base shear

Methodology

Design data

Number of story	13	Density of brick masonry	20kN/m³
Spacing in x direction	5	Poisson's Ratio of concrete	0.2
Spacing in y direction	5	Floor finishes	1.0kN/m²
1st floor height	3	Imposed loads	3.5KN/ m²
Typical floor height	3.5	Roof live	1.5 KN/ m²
Grade of concrete	M30 and M40	Zone –V	V
Grade of steel	Hysd 500	Zone factor	0.36
Thickness of wall (tw)	0.20m	Importance factor, I	1.0
thickness of slab (ts)	0.15m	Response reduction factor, R	5.00
Density of Reinforced Concrete	25kN/m³	Soil type	Type II (Medium soil)

Member properties

Grade of concrete	Member	Size in MM	Story
M40	Column	1000 x 1200	1st
M40	Column	450 x 600	2nd to 13th
M30	Beam	230 x 500	All Story
M30	Slab	150	All Story

Model Description

Model number	Description
MODEL 1	Bare Frame Model however masses of brick infill walls are considered (o degree) flat ground
MODEL 2	Model with ground and middle soft story(o degree) flat ground
MODEL 3	Model with ground and middle soft story with shear wall parallel to x direction(o degree) flat ground
MODEL 4	Model with ground and middle soft story with shear wall parallel to y direction(o degree) flat ground
MODEL 5	Bare Frame Model however masses of brick infill walls are considered (5 degree)
MODEL 6	Model with ground and middle soft story(5 degree)
MODEL 7	Model with ground and middle soft story with shear wall parallel to x direction(5 degree)
MODEL 8	Model with ground and middle soft story with shear wall parallel to y direction(5 degree)
MODEL 9	Bare Frame Model however masses of brick infill walls are considered (10 degree)
MODEL 10	Model with ground and middle soft story(10 degree)
MODEL 11	Model with ground and middle soft story with shear wall parallel to x direction(10 degree)
MODEL 12	Model with ground and middle soft story with shear wall parallel to y direction(10 degree)
MODEL 13	Bare Frame Model however masses of brick infill walls are considered (15 degree)
MODEL 14	Model with ground and middle soft story(15 degree)
MODEL 15	Model with ground and middle soft story with shear wall parallel to x direction (15 degree)
MODEL 16	Model with ground and middle soft story with shear wall parallel to y direction (15 degree)

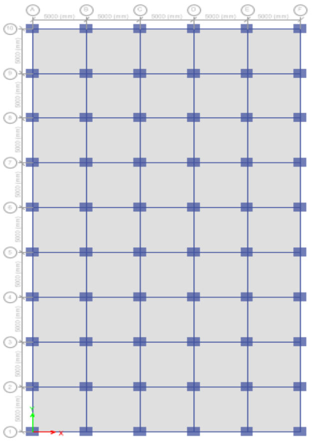

Figure 1 plan

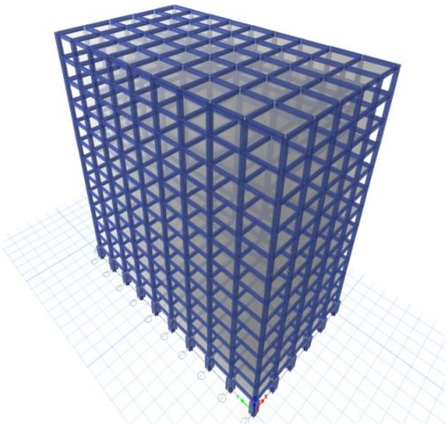

Figure2 Bare frame

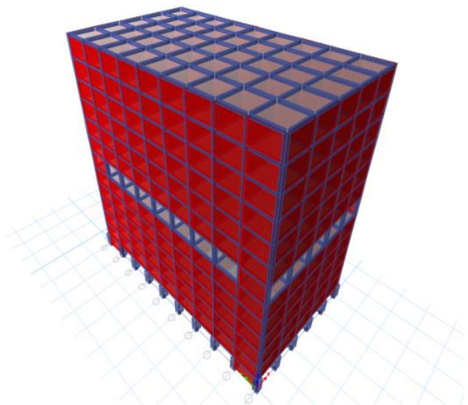

Figure3 GROUND MIDDLE SOFT STOREY

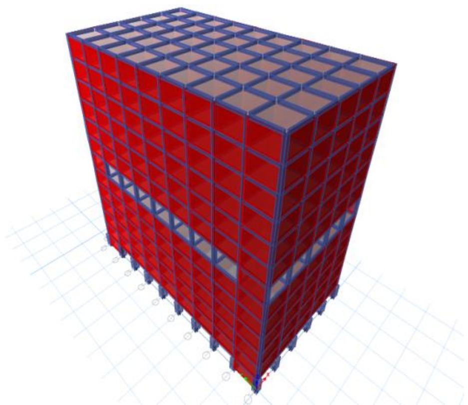

Figure 4 GROUND MIDDLE SOFT STOREY WALL IN X DIRECTION

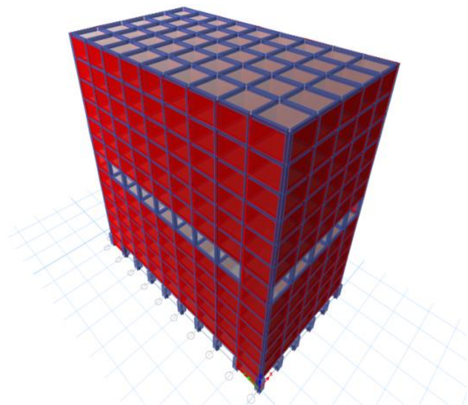

Figure 5 GROUND MIDDLE SOFT STOREY WITH SHEAR SHEAR WALL IN Y DIRECTION

These same models are modelled for the different angle of slope i.e., 5, 10 and 15 degree

Analysis

The analysis of building is carried out using ETABS, equivalent static method and response spectrum method were used .

In equivalent static method estimate the first mode response period of the building from the design response spectra. Use the specific design response spectra to determine that the lateral base shear of the complete building

Response spectrum analysis this approach permits the multiple modes of response of a building to be taken into account.. Computer analysis can be used to determine these modes for a structure. Following are the types of combination methods in response spectrum method

Results and Discussion

TABLE 1 Fundamental Time Period (Sec)

O degree Model	Time period	10 degree Model	Time period
MODEL 1	2.662	MODEL 9	2.691
MODEL 2	0.655	MODEL 10	0.699
MODEL 3	0.651	MODEL 11	0.681
MODEL 4	0.634	MODEL 12	0.663
5 degree Model	Time period	15 degree Model	Time period
MODEL 5	2.678	MODEL 13	2.701
MODEL 6	0.684	MODEL 14	0.718
MODEL 7	0.67	MODEL 15	0.693
MODEL 8	0.651	MODEL 16	0.674

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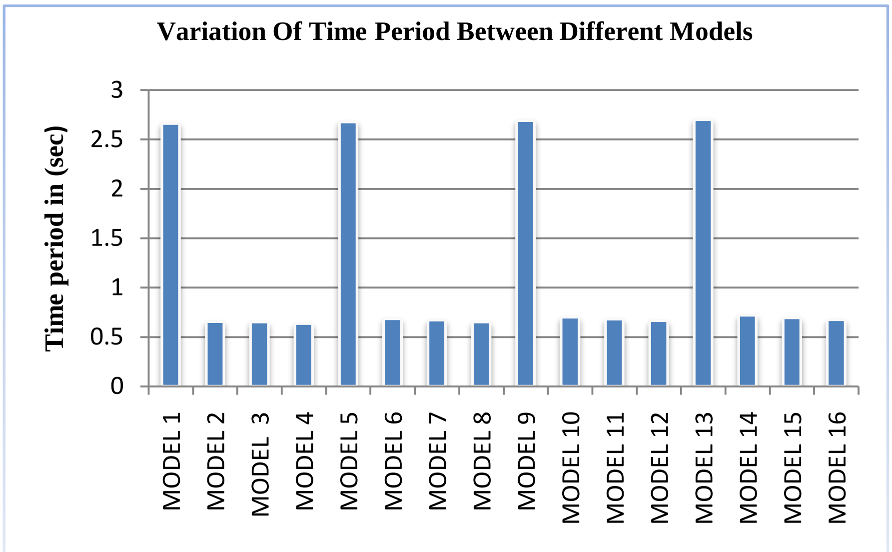

FIGURE 6

As the angle of slope is increased the time period also increased . The time period For bare frame was 2.662 when compared with different angle the % increase was 0.60 (5^0), 1.08 (10^0),1.40 for (15^0)

For model with ground and middle soft story the percentage increase was 4.42 (5^0) , 6.71 (10^0) , 9.61 for (15^0)

For model with ground and middle soft story with shear wall in x direction the percentage increase was 2.91 (5^0), 4.60 (10^0), 5.80 for (15^0)

For model with ground and middle soft story with shear wall in y direction the percentage increase was 2.68 (5^0), 4.57 (10^0), 6.30 for (15^0).

These percentage was all with respect to 0 degree i.e. on flat ground

2 **Maximum displacements**

TABLE 2 the Maximum storey displacements with respect to ground level are presented in tables

Model no	EQX	EQY	RSX	RSY
MODEL 1	62.9	63.6	48.9	49.3
MODEL 2	16.1	15.2	14.1	13.1
MODEL 3	13.4	14.7	11.7	12.8
MODEL 4	15.4	11.7	13.3	13.1
MODEL 5	63.2	64.1	50.9	52.7
MODEL 6	16.4	15.7	14.2	14.3
MODEL 7	14.5	15.2	12.7	13.3
MODEL 8	15.7	12.7	13.6	12.7
MODEL 9	62.7	63.8	50.5	53.6
MODEL 10	16.4	15.9	14.3	15.2
MODEL 11	13.9	15.2	12.4	13.5
MODEL 12	15.7	12.4	13.7	13.3
MODEL 13	62.1	63.4	51	54.8
MODEL 14	16.4	16.1	14.4	16.1
MODEL 15	13.9	15.3	12.5	13.8
MODEL 16	15.7	12.5	13.9	14.5

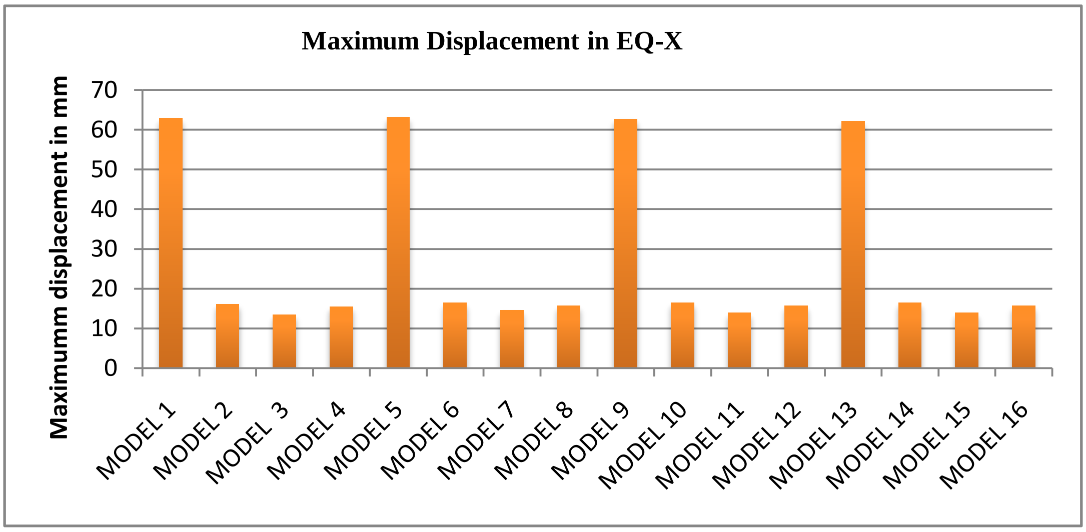

FIGURE 7

The percentage increase or decrease is compared with respect to 0 degree for displacement along EQX following are the details

For bare frame the percentage was 0.47% (5^0) ,-0.317 (10^0), -1.270 (15^0)

For ground middle soft storey the percentage was 1.86(5^0) 1.86 ($10^{0)}$1.86 (15^0)

For Ground middle soft storey with shear wall in x direction the percentage was 8.20 (5^0) 3.73 ($10^{0)}$ 3.73(15^0)

For Ground middle soft storey with shear wall in y direction the percentage was 1.94 % for all the respective angles

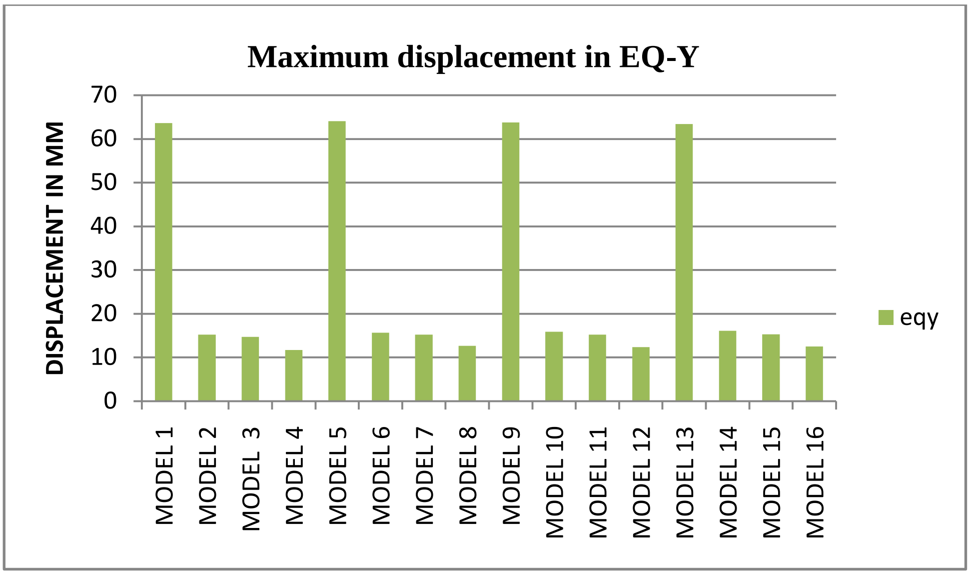

FIGURE 8

The percentage increase or decrease is compared with respect to 0 degree for displacement along EQY following are the details

For bare frame the percentage was 0.786 (5^0), 0.314(10^0), -0.314 (15^0)

For Ground middle soft storey the percentage was 3.28 (5^0), 4.60 (10^0) 5.92(15^0)

For Ground middle soft storey with shear wall in x direction the percentage was 3.40(5^0), 3.40, (10^0) 4.08(15^0)

For Ground middle soft storey with shear wall in y direction the percentage was 8.54(5^0), 5.98, (10^0) 6.83(15^0

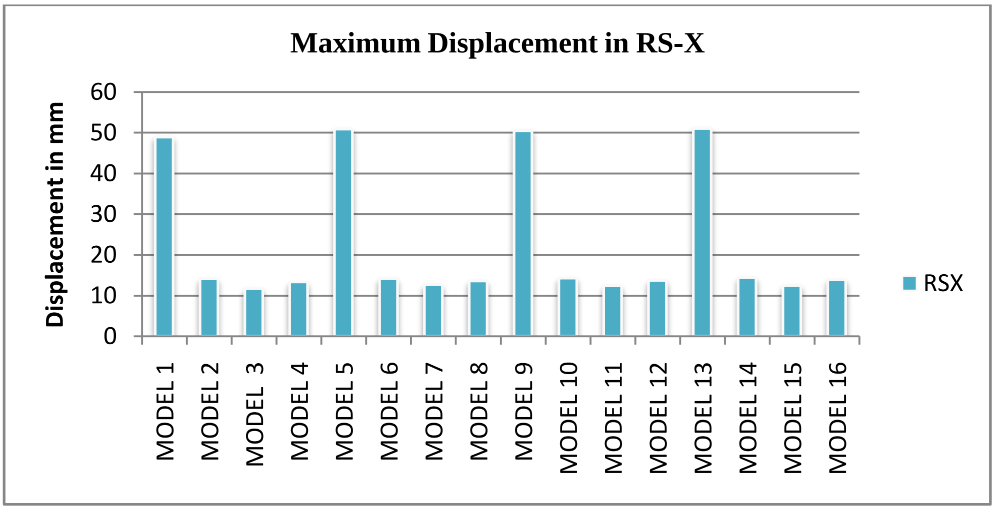

Figure 9

The percentage increase or decrease is compared with respect to 0 degree for displacement along RSX following are the details

For bare frame the percentage was 4 (5^0), 03.27(10^0), 4.29(15^0)

For Ground middle soft storey the percentage was 0.70 (5^0), 1.41(10^0) ,2.12(15^0)

For Ground middle soft storey with shear wall in x direction the percentage was 8.54(5^0), 5.98, (10^0) 6.83(15^0)

For Ground middle soft storey with shear wall in y direction the percentage was 2.2(5^0), 3, (10^0) , 4.5(15^0

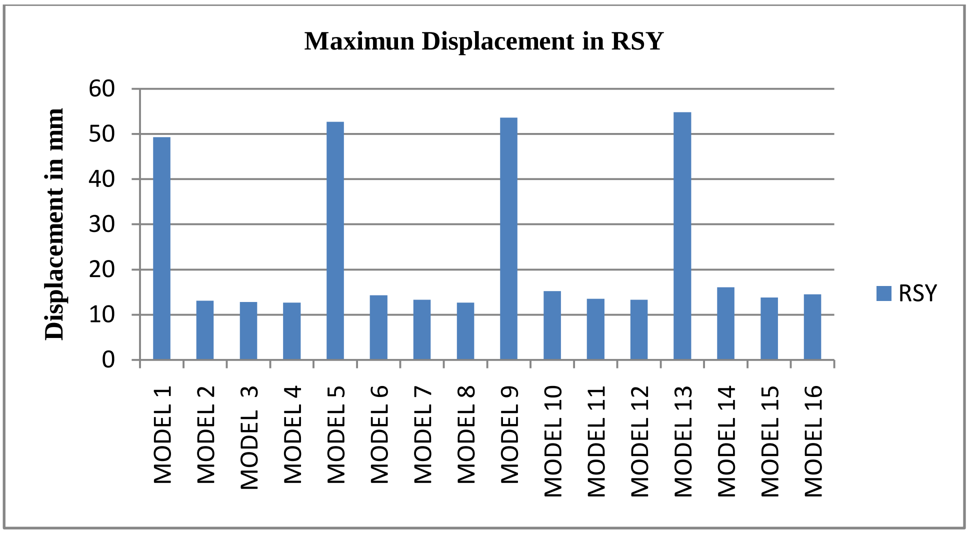

Figure 10

The percentage increase or decrease is compared with respect to 0 degree for displacement along RSY following are the details

For bare frame the percentage was 6.89 (5^0), 08.72(10^0), 11.1(15^0)

For Ground middle soft storey the percentage was 9.1 (5^0), 16(10^0) ,22.9(15^0)

For Ground middle soft storey with shear wall in x direction the percentage was 3.9(5^0), 5.4, (10^0) 7.8(15^0)

For Ground middle soft storey with shear wall in y direction the percentage was -3.053(5^0), 1.5, (10^0) , 10.68 (15^0)

4 BASE SHEAR

TABLE 3

MODEL NO.	EQX (KN)	RSX(KN)	EQY(KN)	RSY(KN)
MODEL 1	4018.122	4022.124	3895.228	3897.601
MODEL 2	16662.91	16724.16	16362.13	16378.89
MODEL 3	20061.83	20062.9	16772	16864.01
MODEL 4	17203.26	17223.12	20061.83	20093.17
MODEL 5	4008.541	4083.257	4159.547	3954.867
MODEL 6	16587.2	16624.94	16231.07	16261.93
MODEL 7	19409.41	19417.88	16654.79	16679.76
MODEL 8	17111.97	17148.71	20491.06	20529.04
MODEL 9	4105.736	4107.111	3971.974	3970.966
MODEL 10	16449.42	16482.81	16002.84	16047.48
MODEL 11	20267.4	20383.38	16526.76	16574.33
MODEL 12	16976.43	17009.71	20678.35	20722.74
MODEL 13	4134.144	4147.161	3991.967	4006.111
MODEL 14	16322.4	16363.93	15723.05	15791.16
MODEL 15	20141.59	20173.25	16379.9	16442.93
MODEL 16	16842.36	16892.75	20858.4	20930.66

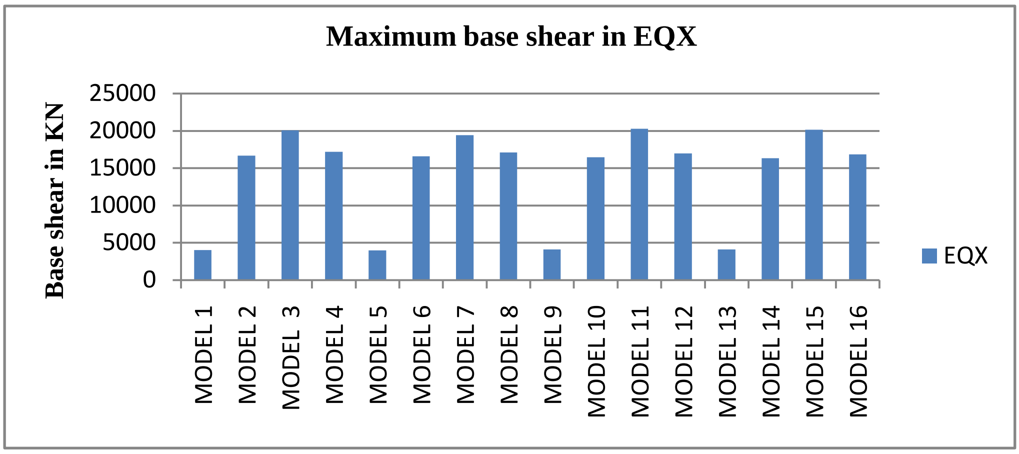

Figure 11

The percentage increase or decrease of base shear is compared with respect to 0 degree along EQX following are the details

For bare frame the percentage was 1.62 (5^0), 2.1(10^0), 2.887 (15^0)

For Ground middle soft storey the percentage was -0.45 (5^0), -1.27(10^0) ,-2.04(15^0)

For Ground middle soft storey with shear wall in x direction the percentage was- 3.2(5^0), 1.02, (10^0) 0.39 (15^0)

For Ground middle soft storey with shear wall in y direction the percentage was -0.53(5^0), -1.31, (10^0) , -2.098 (15^0)

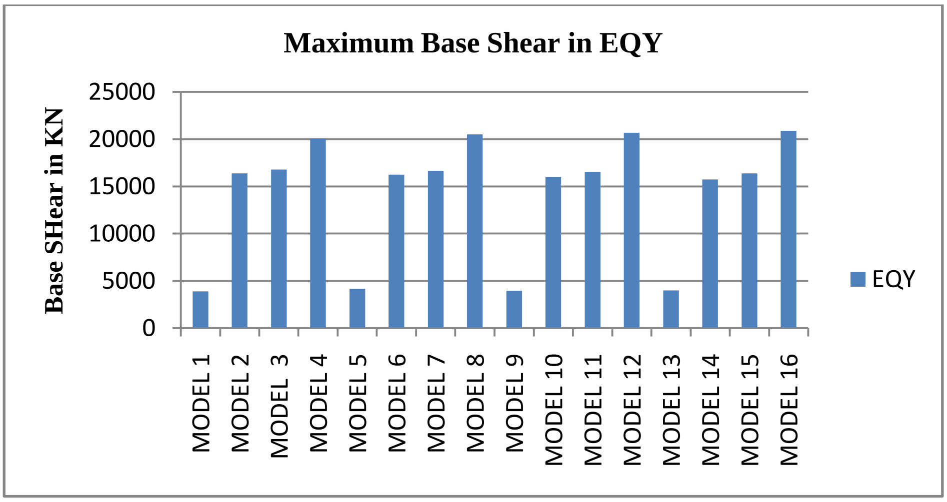

Figure 12

The percentage increase or decrease of base shear is compared with respect to 0 degree along EQY following are the details

For bare frame the percentage was 1.51 (5^0), 1.95(10^0), 2.46(15^0)

For Ground middle soft storey the percentage was -0.80 (5^0), -2.20(10^0) ,-3.905 (15^0)

For Ground middle soft storey with shear wall in x direction the percentage was- 0.69(5^0), 1.46, (10^0) -2.33 (15^0)

For Ground middle soft storey with shear wall in y direction the percentage was -2.143(5^0), -3.075, (10^0) , -3.972 (15^0)

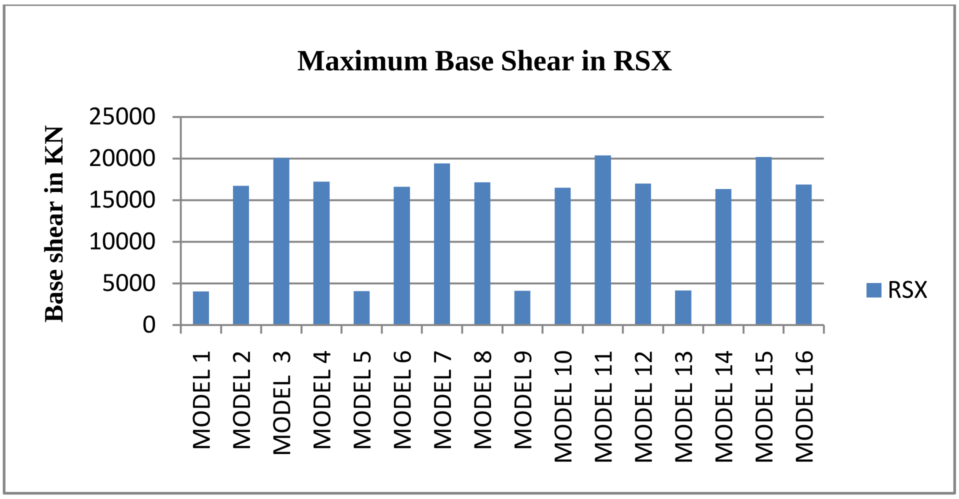

Figure 13

The percentage increase or decrease of base shear is compared with respect to 0 degree along RSX following are the details

For bare frame the percentage was 3.40 (5^0), 2.113 (10^0), 3.107(15^0)

For Ground middle soft storey the percentage was -0.59 (5^0), -1.44(10^0) ,-2.15 (15^0)

For Ground middle soft storey with shear wall in x direction the percentage was- 3.21(5^0), 1.605, (10^0) 0.533 (15^0)

For Ground middle soft storey with shear wall in y direction the percentage was -0.43(5^0), -1.24, (10^0) , -1.972 (15^0)

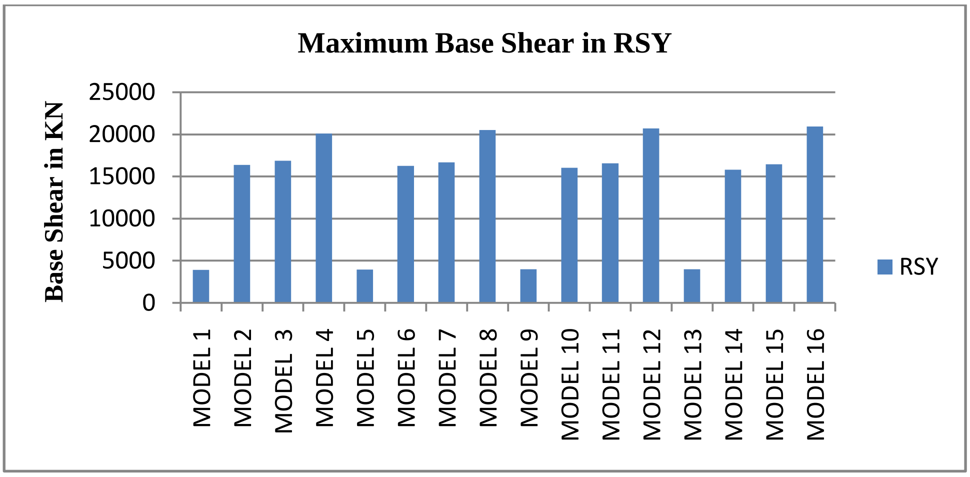

Figure 14

The percentage increase or decrease of base shear is compared with respect to 0 degree along RSX following are the details

For bare frame the percentage was 2.84 (5^0), 1.87 (10^0), 2.797(15^0)

For Ground middle soft storey the percentage was -0.71 (5^0), -2.02 (10^0),-0.03 (15^0)

For Ground middle soft storey with shear wall in x direction the percentage was- 1.09(5^0), -1.71, (10^0) -2.533 (15^0)

For Ground middle soft storey with shear wall in y direction the percentage was 2.16 (5^0), 3.13, (10^0) , 4.165 (15^0)

CONCLUSIONS

1) It has been seen that the value of time-period is slightly changes when slopes of the building changes i.e. time-period increase with increase in slope.
2) When effect of masonry infill is considered, the seismic base shear drastically increases as compare with that of bare frame.
3) The maximum story displacement is found to be decreasing for higher angles

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REFERENCES

1) Birajdar.B.G,"Seismic analysis of buildings resting on sloping ground", 13thWorld Conference on Earthquake Engineering, Vancouver, B.C., Canada, Paper No. 1472, 2004.
2) S.M.Nagargoje and K.S.Sable," Seismic performance of multi-Storyed building on sloping ground", Elixir International Journal, 7 December 2012. fecf
3) Prashant D, Dr. Jagadish Kori G " Seismic Response of one way slope RC frame building with soft Story" International Journal of Emerging Trends in Engineering and Development Issue 3, Vol.5 (September 2013).
4) Rayyan-Ul-Hasan Siddiqui and , H. S. Vidyadhara "Seismic Analysis of Earthquake Resistant Multi Bay Multi Storyed 3D - RC Frame" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 2 Issue 10, October – 2013.
5) Ravikumar C M,*, Babu Narayan K S "Effect of Irregular Configurations on Seismic Vulnerability of RC Buildings" Architecture Research 2012,2(3):20-26DOI: 10.5923/j.arch.20120203.01.
6) Dr. S. A. Halkude et al "Seismic Analysis of Buildings Resting on Sloping Ground With Varying Number of Bays and Hill Slopes" International Journal of Engineering Research and Technology ISSN: 2278-0181, Vol.2 Issue 12, December-2013
7) Shivanand.B1, H.S.Vidyadhara2 1 DESIGN OF 3D RC FRAME ON SLOPING GROUND P.G. Student, Department of Civil Engineering, Poojya Doddappa Appa college of Engineering, Gulbarga, 585102 2Associate Professor, Department of Civil Engineering, Poojya Doddappa Appa college of Engineering, Gulbarga, 585102 .
8) IS456:2000. "Indian Standard Code of Practice for Plain and reinforced concrete",Bureau of Indian Standards , New Delhi .
9) IS 875:2000. "Code of practice for design loads part2 :Imposed Loads", Bureau of Indian Standards, New Delhi .
10) IS 1893-2000.Criteria forEarthquakeResistant Design Of Structures , Part-1 General Provision and Building .Bureau of Indian Standards , New Delhi .
11) IS 13920:1993."Indian Standard Code of the practice for the detailing of Reinforced Concrete Structures subjected to seismic Forces" Bureauo of Indian Standards