Critical Study of Seismic Excitation Angle on a RC Frame Building

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Abstract— As earthquakes are hazardous because of strong ground shaking, destroys things that people have constructed and also the epicentre where the greatest damage takes place is not known and due the scarcity of plain ground in hilly regions leads to construct buildings on a sloping ground. Compare to normal buildings, seismic behavior of buildings on a sloping ground are different. Building on a sloping ground has a higher base shear and higher displacement than building resting on a plain ground so for all the possible critical angle forces the response of the building should be determined. Thus we have under taken our final year project on the basis of Critical Study of Seismic Excitation Angle on A RC Frame Building. In our project a G+5 storey building, study has been made about the effect of slope angle variation on a RC frame building which is resting on a flat ground& sloping ground. The values of different degrees have been used for slope angle variation for obtaining critical response of the building which is situated in Zone V. The parametric study is performed to find out axial forces, bending moment, storey drift and displacement in columns and the maximum axial forces, bending moment, storey drift and displacement occurred is called as the critical angle. The seismic analysis is performed as per Equivalent Static Force Method.

Keywords: STAAD PRO, Seismic Analysis, Hilly region, RC building, Equivalent Static Force Method

I. Introduction

An earthquake is the shaking of the earth's surface resulting from a sudden release of energy in the earth's lithosphere that creates seismic waves. In most of the earthquakes, the epicenter is the point which is not known where the greatest damage takes place. It is a vibration that travels through the earth's crust, the movement that causes vibrations occurs when two sides of a fault slide suddenly. Earthquakes are hazardous and destroy things that people have constructed like buildings and due to collapse of buildings there is loss of human lives. The growth of urban population is steadily increasing the requirements of house due to which a widespread construction on a flat ground in vertical direction and also people have started construction on a hilly region due to scarcity of plain ground. The construction of building on a hilly area have asymmetrical plan, elevation and also the behavior of building is different. Thus the challenge for engineers is to design a seismic resistant building.

The growth of urban population is steadily increasing the requirements of house due to which a widespread construction on a flat ground in vertical direction and also people have started construction on a hilly region due to scarcity of plain ground. Buildings situated in hilly areas are much more vulnerable to seismic environment. Analysis of hill buildings is somewhat different than the buildings on leveled ground, since the column of such building rests at different levels on the slope. As foundation is laid on the sloping ground there is no height variation at storey level. In this type of building forces are not equally divided. Therefore shorter length column takes large moment and short column effect takes place. In India, there are 5 earthquake prone zones – regions that are extremely susceptible to seismic activity. The mountainous Himalayan regions such as northern and north-eastern are more prone to being affected by frequent earthquakes. The north-eastern part of the country is not only located at the centre of one of the most active earthquake prone regions of the country, but is also exposed to very high damage. Some of the major earthquake in hilly region are 1897 Assam Earthquake, 1934 Nepal–Bihar earthquake, 2011 Sikkim earthquake, April-May 2015 Nepal earthquake, June 2015 Dibrugarh earthquake, 2016 Manipur earthquake and so on.

Equivalent static force method: It is also known as seismic co-efficient method. The seismic co-efficient method is studied for preliminary design of the building. An assumption is made that there should be a perfect fixity should be between structure and foundation. The structure should be rigid.

II. Methodology

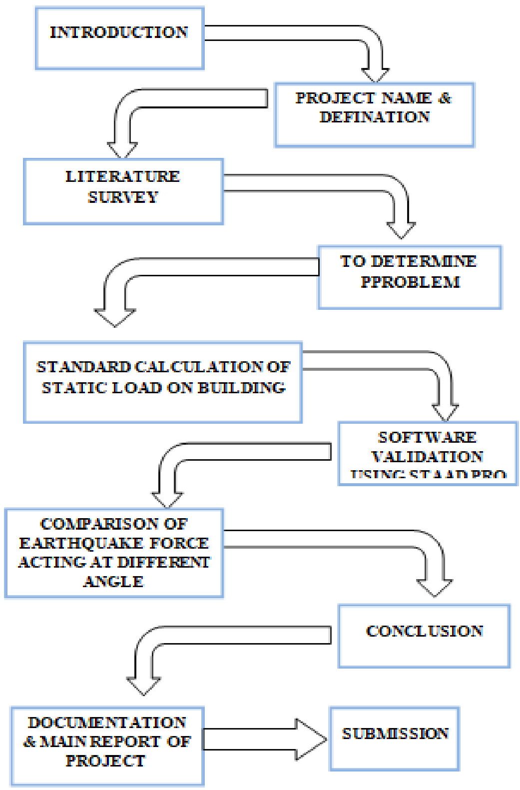
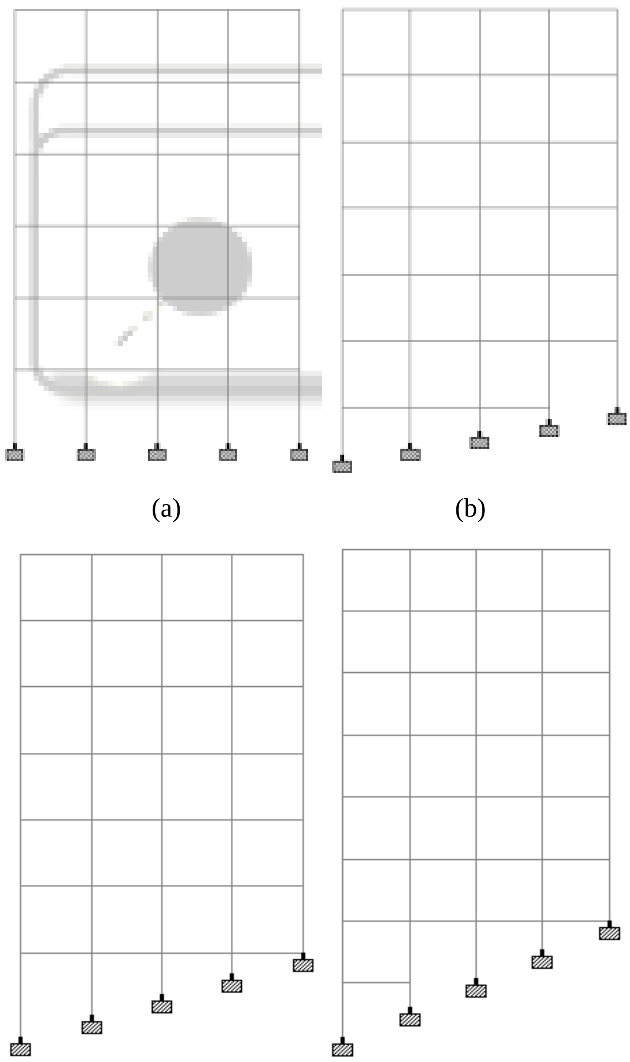


Fig. 1: Methodology

III. FRAME STRUCTURE AND DESIGN DETAILS

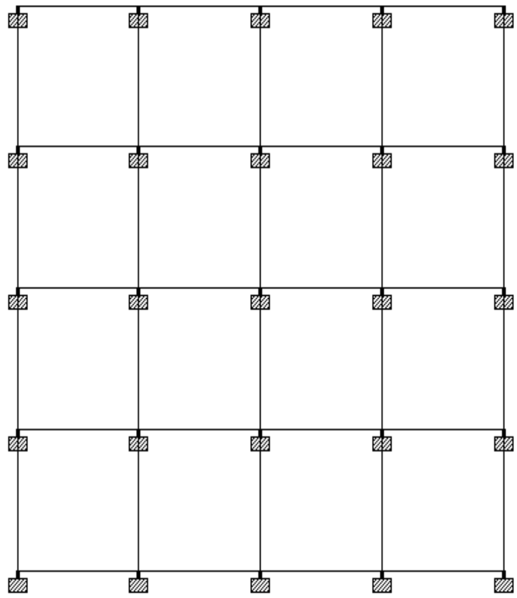
Details of the design are assumed.
The necessary values for seismic analysis are taken from the IS Code 1893:2002 (Part 1).

Live load	4.0 KN/m^2
Floor finish	1.0 KN/m^2
Water proofing	1.5 KN/m^2
Zone	5
Earthquake Load	As per IS-1893 (Part1)-2002
Type of soil	Medium Soil
Storey height	Typical floor +G.F = 3m
Floors	G.F + 5
Slab thickness	100mm
External wall thickness	230mm
Internal wall thickness	230 mm
Plaster on both side	12.5mm
Column size	(0.4*0.4) m
Column size	(0.6*0.6) m
Beam	(0.5*0.5) m
Support	Fixed



(a) (b)

(c) (d)



(e)

Fig. 1: (a) 0 degree- Model 1 (b) 10 degree- Model 2 (c) 20 degree- Model 3 (d) 30 degree- Model 4 (e) Plan of building

IV. RESULTS

A. *Maximum Axial Force from all models*

Degree	Axial Force
0	1423.775
10	1652.078
20	1492.388
30	1464.56

Table. 1: Maximum Axial Force

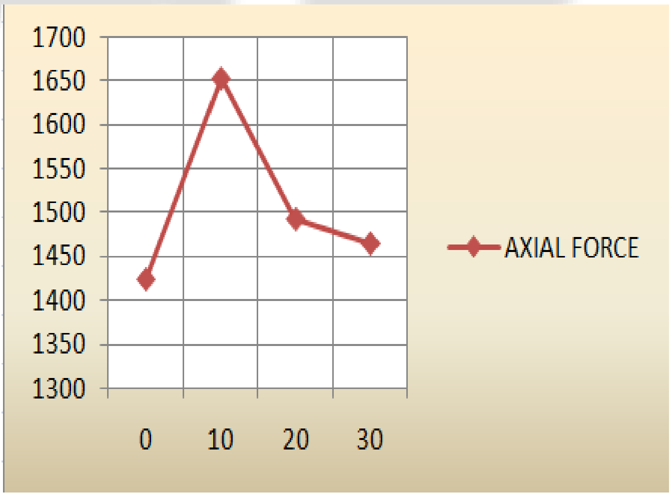


Fig. 2: Axial Force on models

B. *Maximum Bending Moment from all models*

Degree	Bending Moment
0	146.384
10	146.798
20	128.98
30	125.282

Table 2: Maximum Bending Moment

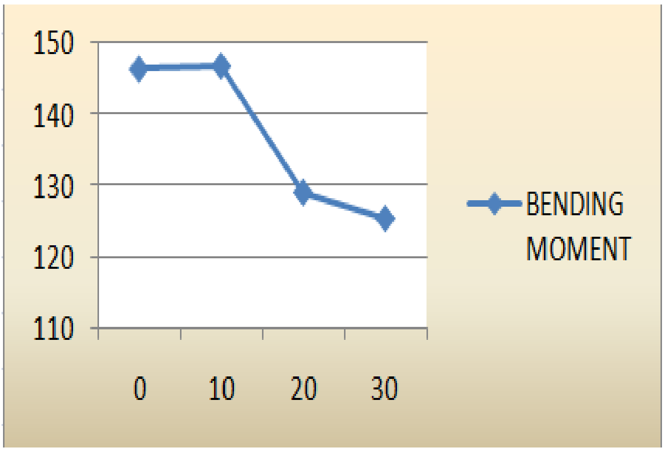


Fig. 3: Bending Moment of models

C. Maximum Displacement from all models

Degree	**X**	**Y**
0	26.977	0.626
10	35.607	0.786
20	25.623	0.489
30	25.408	0.461

Table. 4: Maximum Storey Drift

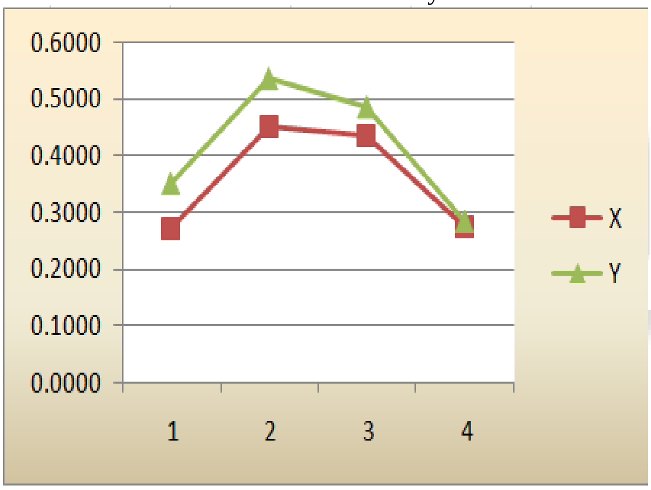


Fig. 5: Storey Drift of models

V. CONCLUSION

- As the Slope angle increases Axial force and Bending Moment increases.
- Among all 4 models, Displacement in X and Y direction is maximum in Model – 2 and minimum in Model 4.
- Among all 4 models, Storey Drift in X and Z direction is maximum in Model – 2 and minimum in Model 4.
- Among all 4 models, Axial force is maximum in Model – 2 and minimum in Model 1.
- Among all 4 models, Bending Moment is maximum in Model – 2 and minimum in Model 4.
- So it is concluded that Model-2 and Model-3 is said to be critical.

ACKNOWLEDGEMENT

We would like to highly acknowledge and pay respect to all associates with the project at different stages in presenting the report of our project on "CRITICAL STUDY OF SEISMIC EXCITATION ANGLE ON A RC FRAME BUILDING."We are very thankful to our guide Prof. Vikunj Tilva, We are also thankful to Dr. Bhavinkumar Ganpatbhai Patel, Head of dept., and the entire civil engineering dept. for the continuous direct and indirect support.

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