iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 Issue: VII Month of publication: July 2020

DOI: http://doi.org/10.22214/ijraset.2020.7052

Seismic Performance of RC Set Back Building on Sloping Ground

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***Abstract**: From various studied it was found that buildings with any type of irregularity gets more damage than a regular building. Indian code provides various provisions to compensate the seismic design of irregular building. It is generally believed that the buildings with regular shapes have a dominant fundamental mode participation during seismic response and as the irregularity increases the contribution of higher mode increases. Accordingly, Various previous studies have proposed methodologies to quantify vertical irregularity of the buildings in terms of their fundamental mode properties. In the present work various models with unique type of vertical irregularities were analyzed with the help of Staad Pro. And an comparatively stable model amongst all were find out.*
Keywords: Slope, Axial force, Displacement, Base shear.

I. INTRODUCTION

The economic growth and rapid urbanization in a hilly region has accelerated development of infrastructure and construction activities. Because of which, population density in the hilly region has increased. Therefore, there is popular and pressing demand for construction of multi-story building in hilly region. Hill buildings are different from those in plains; they are very irregular in horizontal and vertical plains. Hence, they are susceptible to severe damage when affected by earthquake ground motion. In this study the 3D analytical model of G+25 storey building is to be generated of step setback building for zone iv and zone v case with varying slopes. Building models are analyzed by STAAD. Pro software

II. AIM

To Analyze and Design multi-storey building in with set back on sloping ground

III. OBJECTIVE

The main objectives of our work are as follows :-

A. Compare various parameters such as base shear, displacement, axial force, bending moment for various models.
B. To study the building resting on sloping ground.
C. To create the models of building resting on various slopes (0^0, 5^0,10^0 , 20^0, 30^0)
D. To carry out equivalent static analysis for buildings on sloping ground.
E. To carry out dynamic analysis by using Response spectrum method for building on sloping ground.

IV. GENERAL STUDY

A. Seismic Behaviour Of Buildings On Slopes In India

North and north-eastern parts of India have large scales of hilly region, which are categorized under seismic zone IV and V. In this region the construction of multi-storey RC framed buildings on hill slopes has a popular and pressing demand, due to its economic growth and rapid urbanization.

This growth in construction activity is adding increase in population density. While construction, it must be noted that Hill buildings are different from those in plains i.e., they are very irregular and unsymmetrical in horizontal and vertical planes, and torsionally coupled. Since there is scarcity of plain ground in hilly areas, it obligates the construction of buildings on slopes. During past earthquakes, reinforced concrete (RC) frame buildings that have columns of different heights within one storey, suffered more damage in the shorter columns as compared to taller columns in the same storey.

B. *Response Spectrum Method*

According to the IS 1893 (part I)-2012, high rise and irregular building must be analyzed by response spectrum method using design spectra shown. There is significant computational advantage using response spectrum method of seismic analysis for prediction of displacement and member forces in structure. It is analysis method which measures the contribution from each natural mode of vibration to indicate the likely maximum seismic response of essentially elastic structure. It provides insight into dynamic behavior 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 envelop spectra such that a smooth curve represents the peak response for each realization of structural period.

V. STRUCTURAL PARAMETERS

Table 1 Detail Structural Parameters

Parameter	Value
Type of Building:	RCC Framed Structure
Number of storey	10 (Ground + 8)
Plan Size	25 m X 30 m
Floor to floor height	3 m.
Height of plinth	1.5 m above G.L.
Depth of foundation	3.0 m. below G.L.
External walls	150 mm thick
Internal walls	150 mm thick
Height of parapet	1.0 m
Materials	Reinforced concrete for the columns and beams
Concrete	M25
Steel	Fe500
Slab Thickness	125 mm
Elastic Modulus of concrete	$5000\sqrt{fck}$
Size of Beams	230 mm X 430 mm
Size of Columns	230 mm X 460 mm
Density of Concrete	25 kN/m^3
Density of brick masonry	20 kN/m^3
Type of frame	SMRF
Seismic zone	II
Response reduction factor	5
Importance Factor	1

VI. CASE COMBINATION

Table 2 case combination

DESCRIPTION	ABBRIVATION
Regular Concrete Structure	S1
Sloping structure at 5^0	S2
Sloping structure at 10^0	S3
Sloping structure at 20^0	S4
Sloping structure at 30^0	S5

VII. GEOMERTY OF MODELS

1) Plan of Model

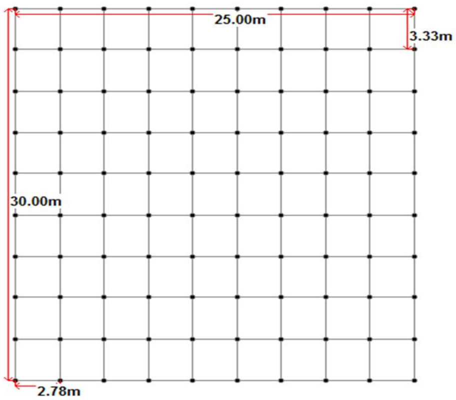
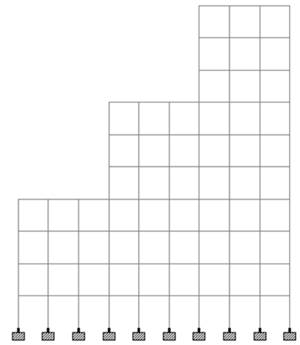
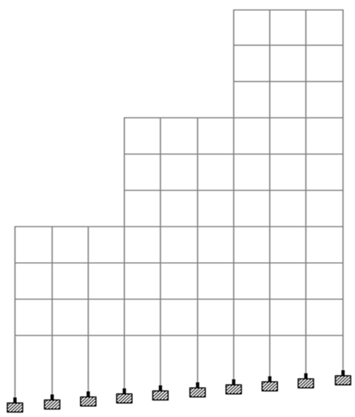


Fig no. 1: Plan of the Building

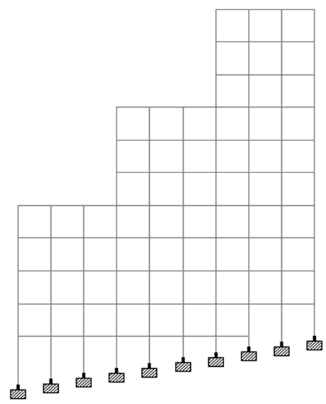
2) Side Views of all models



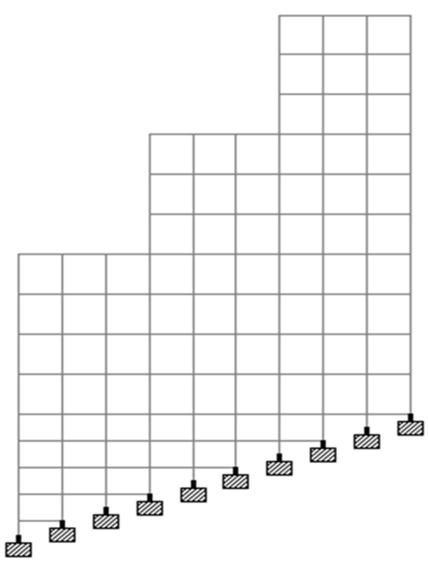
Model 1: 0^0 (S1)



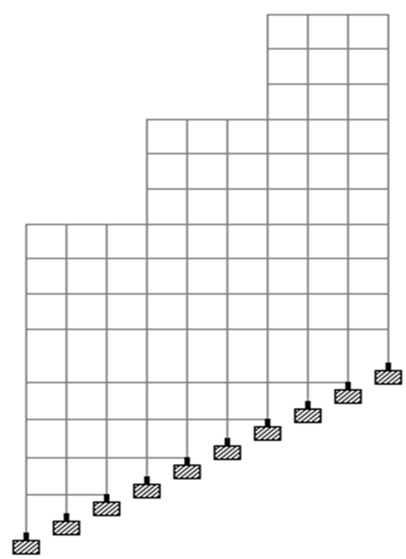
Model 2: 5^0 (S2)



Model 3: 10^0 (S3)



Model 4: 20^0 (S4)



Model 5: 30^0 (S5)

VIII. RESULTS FOR LOW RISE MODELS (G+4)

A. Zone IV

1) Step Setback Building

Table 3: Base shear results for zone iv step setback building

Angle	Base Shear (kN)	
	X-Direction	Z-Direction
0^0	4042.27	4030.72
5^0	4071.76	4065.8
10^0	4146.5	4136.02
20^0	4154.93	4154.74
30^0	4210.66	4267.51

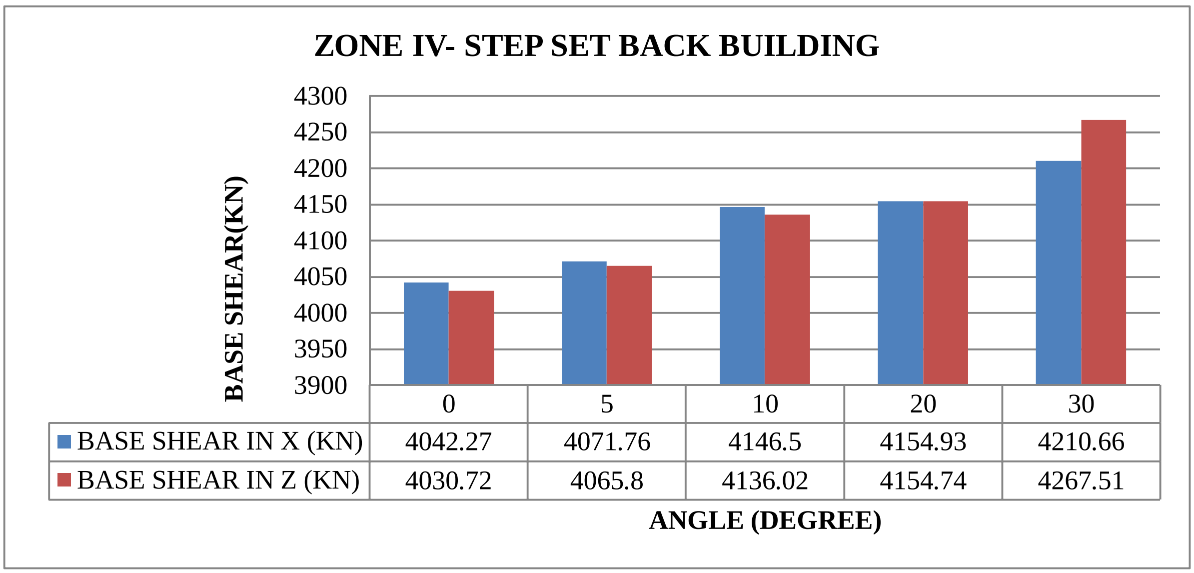


Fig 2 Base shear comparison in Zone-IV

In zone IV, it is observed that both the values of base shear in x and z directions are quite similar in case of step setback building. Base shear is low at flat ground i.e. on 0^0 and then it is rising gradually up to 5^0 slopes, after that again rises for 10^0 and 20^0 but has high value for 30^0 Slope.

B. Zone V

1) Step Setback Building

Table 4 : Base shear results for zone v step setback building

Angle	Base Shear (kN)	
	X-Direction	Z-Direction
0^0	6066.73	6061.48
5^0	6108.3	6102.53
10^0	6219.74	6207.89
20^0	6070.47	6066.91
30^0	6318.97	6401.26

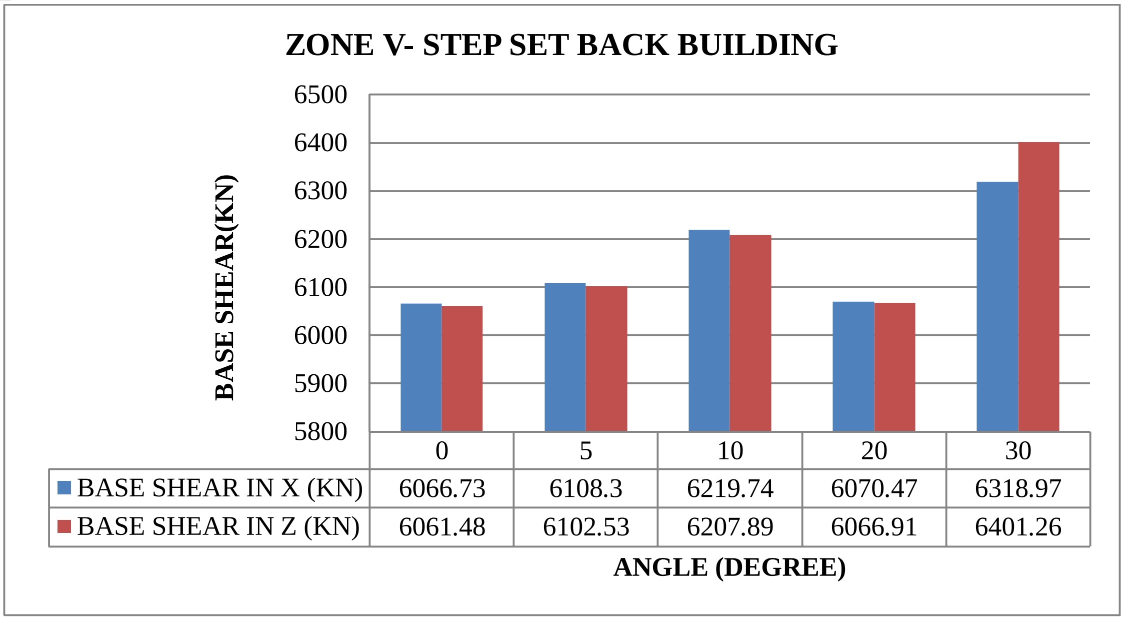


Fig 3 Base shear comparison in Zone-V

2) *Displacement (storey drift):* Story drift is difference in a lateral deflection between two adjacent stories. It is the drift of one level of a multistory building relative to the level below. Following are the maximum values of displacement from different load cases. The results are carried out for step setback building in each zone and graphs are plotted.

Table 5 Storey displacement In Zone-IV

Angle	Max Displacement(mm)
	Step Set Back
0^0	28.062
5^0	32.664
10^0	26.667
20^0	30.974
30^0	76.415

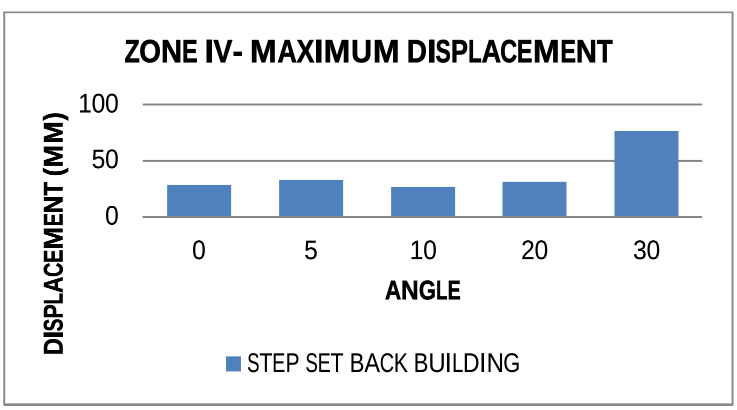


Fig 4 graph of storey displacement in Zone-IV

From the above graph in zone IV it is observed the magnitude of displacement on 30^0 slope is greatest as compared to other slopes. Whereas for 10^0 Slope the value of displacement is lea than all other slopes.

C. Zone V

Table 6 Displacement results for zone v

Angle	Max Displacement(mm)
	Step Set Back
0^0	42.036
5^0	48.986
10^0	39.94
20^0	40.693
30^0	114.622

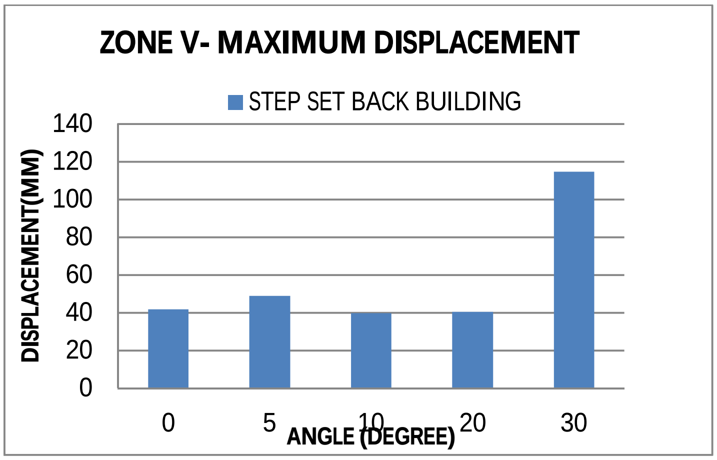


Fig 5 graph of storey displacement in Zone-V

And From the above graph in zone V it is observed that the magnitude of displacement on 30^0 slope is greatest as compared to other slopes. So at or beyond 30^0 slope the structure is not safe in displacement.

D. Time Period

It is the time needed for one complete cycle of vibration to pass a given point. It is a time taken to complete one vibration. Following are the results in each zone.

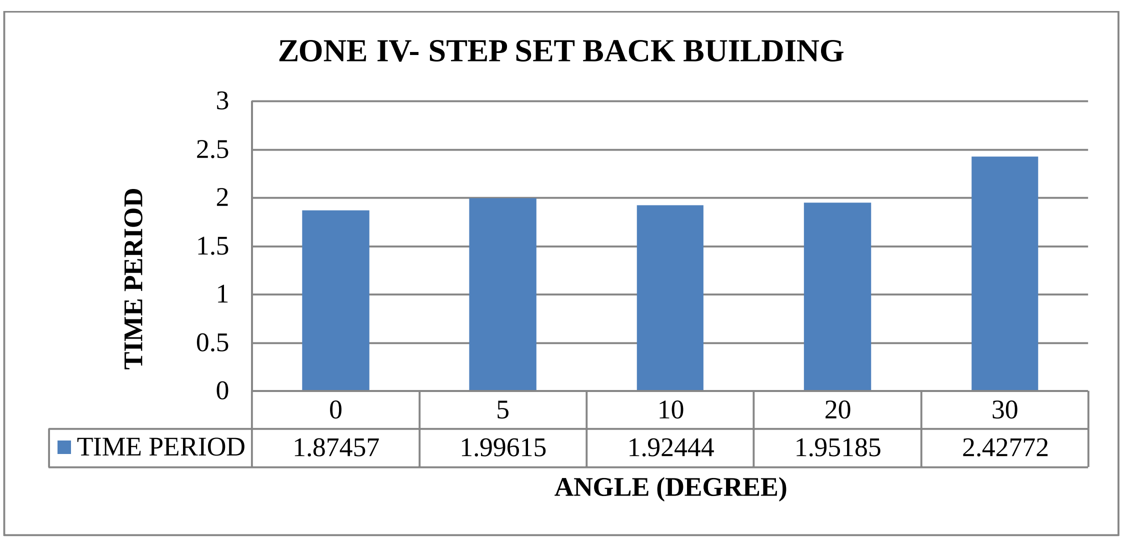


Fig 5 graph of time period in Zone-IV

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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
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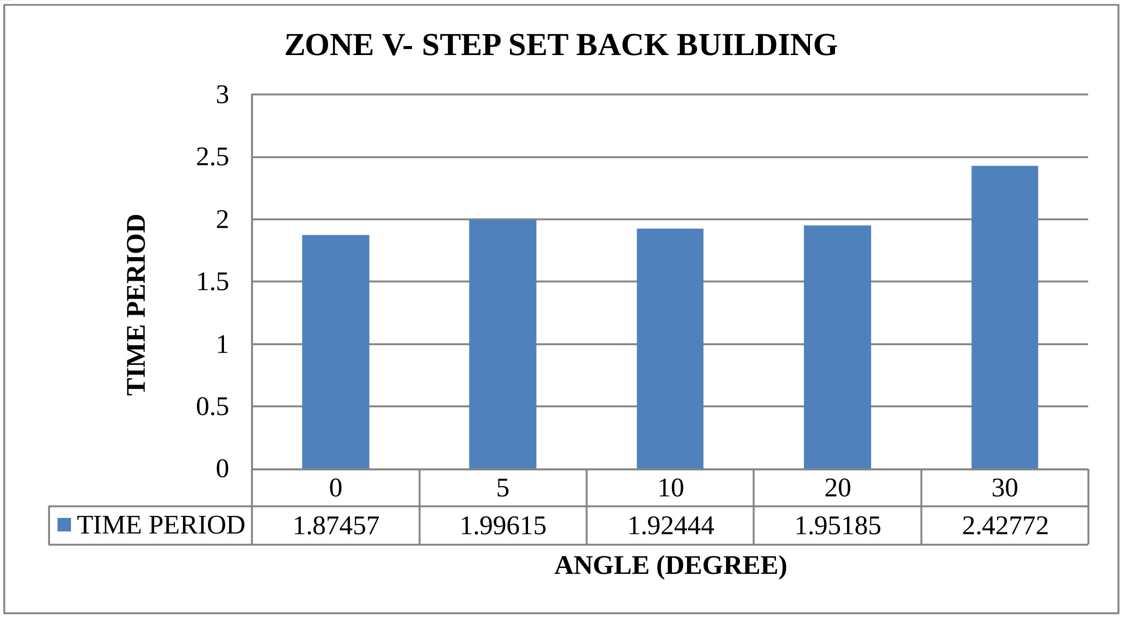


Fig 7 graph of storey displacement in Zone-V

It is observed that in both zones buildings on plane ground has less time period than building on sloping ground. Whereas in sloping condition buildings with 0^0 have less time period amongst all others.

E. Column Axial Forces

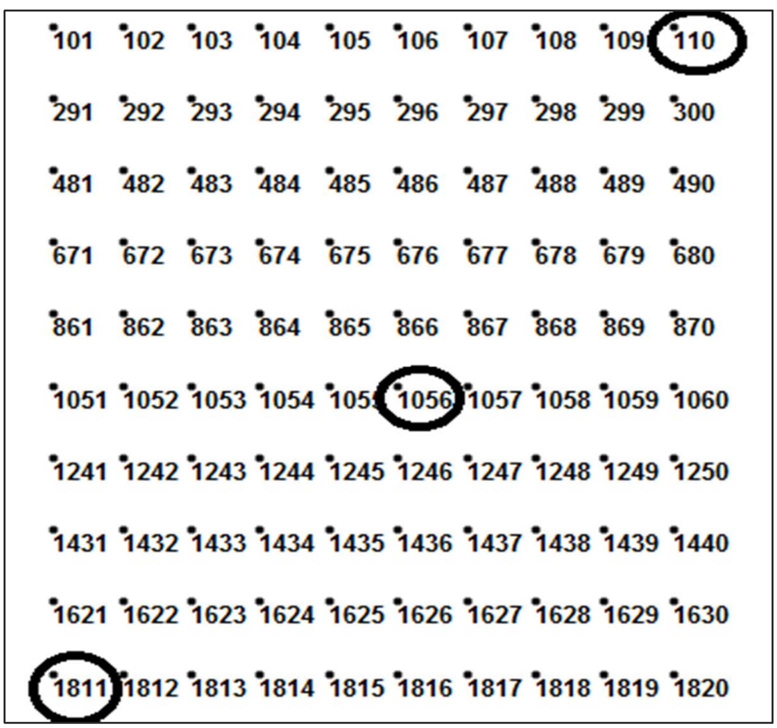
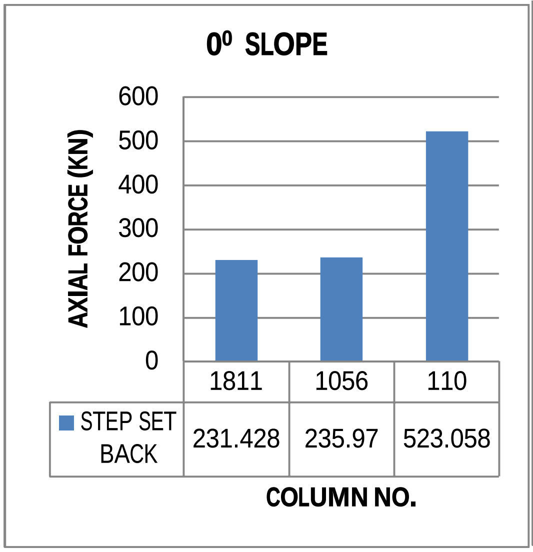
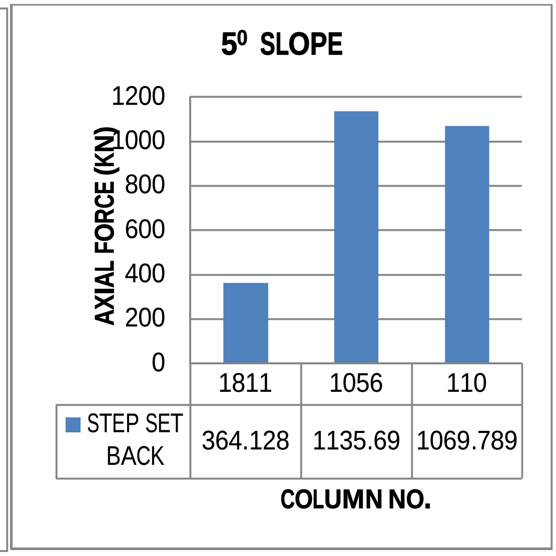


Fig 8 Selected columns for axial force and bending moment

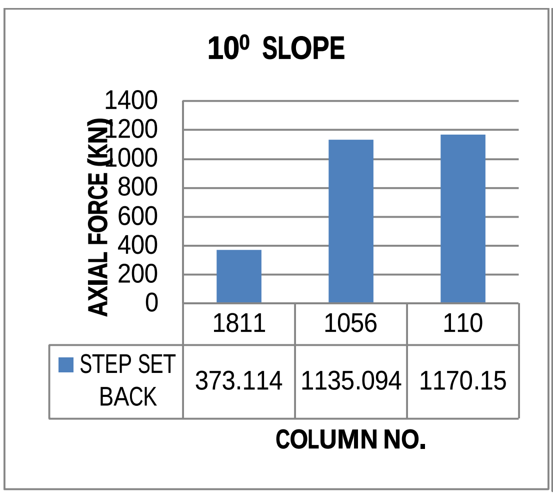
As shown in above fig 8 selected columns for analysis of axial force and bending moment. By using graph comparative study between set back and step set back building located on slope of specific angles is carried out. This gives following results along with magnitude of the axial forces and bending moment.

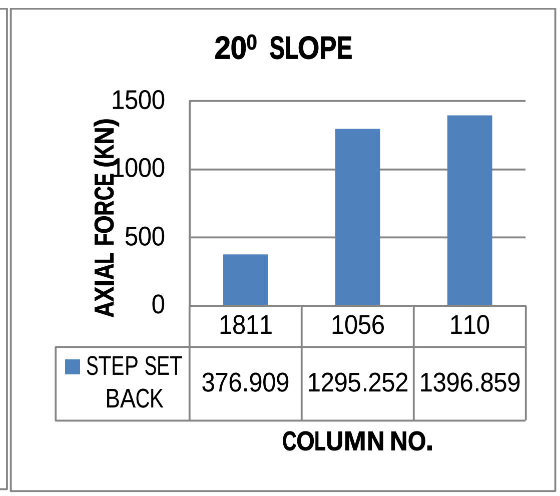
1) Zone IV





It is observed that in zone IV magnitude of the column at the middle is high at 50 as compare to other two. Axial force at 0^0 is very low.





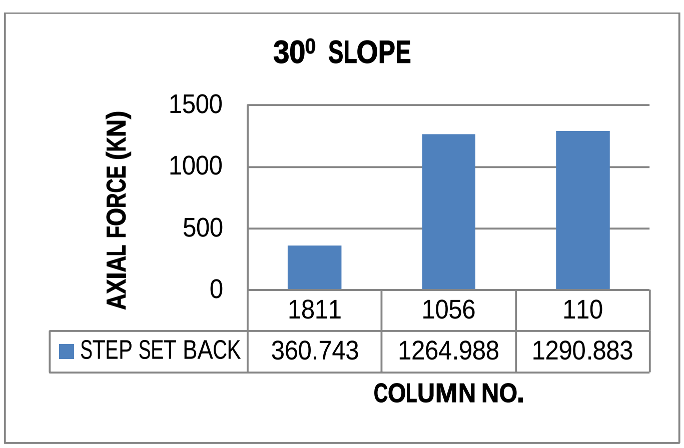


Fig no. 9: Graphs showing comparison for axial forces in column in zone IV

The value of axial forces for 0^0 slope are lowest and have highest values for buildings on 20^0 and 30^0.

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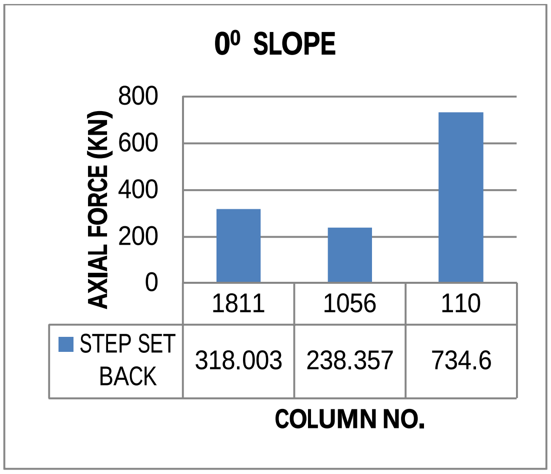
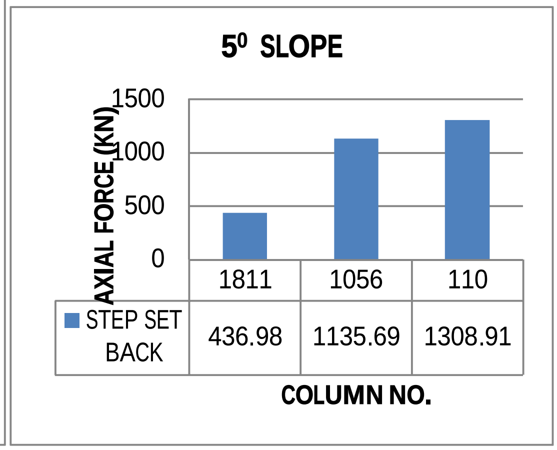
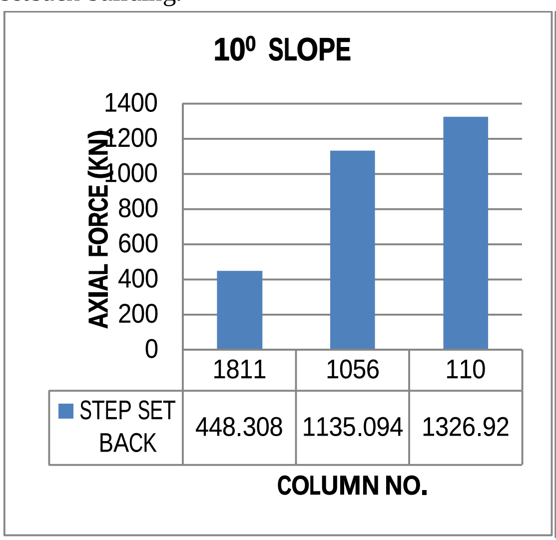
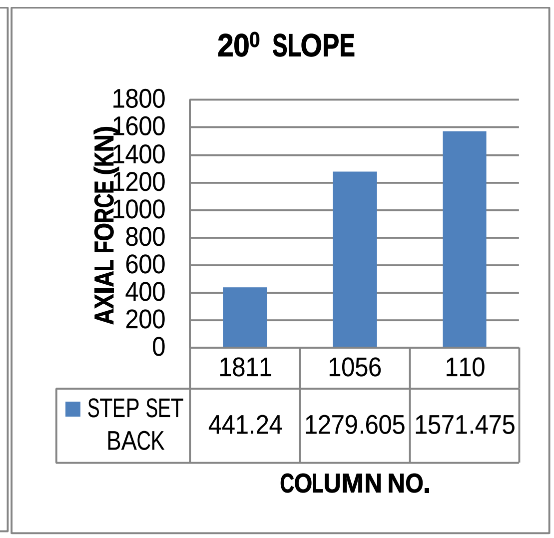
2) Zone V





It is observed that in zone V the magnitude of the column at the middle is high as compare to other two. Axial force at 0^0 is very low in case of step setback building.





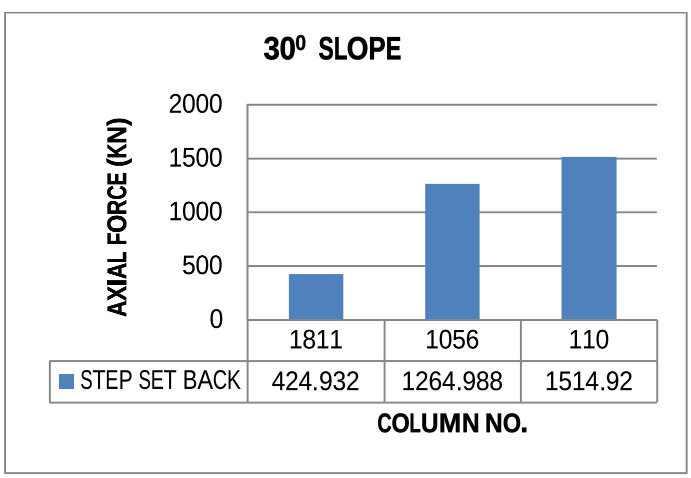


Fig no.10 : Graphs showing comparison for axial forces in column in zone V

The value of axial forces at various slopes respectively are quite similar, there is not so difference in it same as there in zone IV.

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F. Beam Bending Moment

1) Zone IV

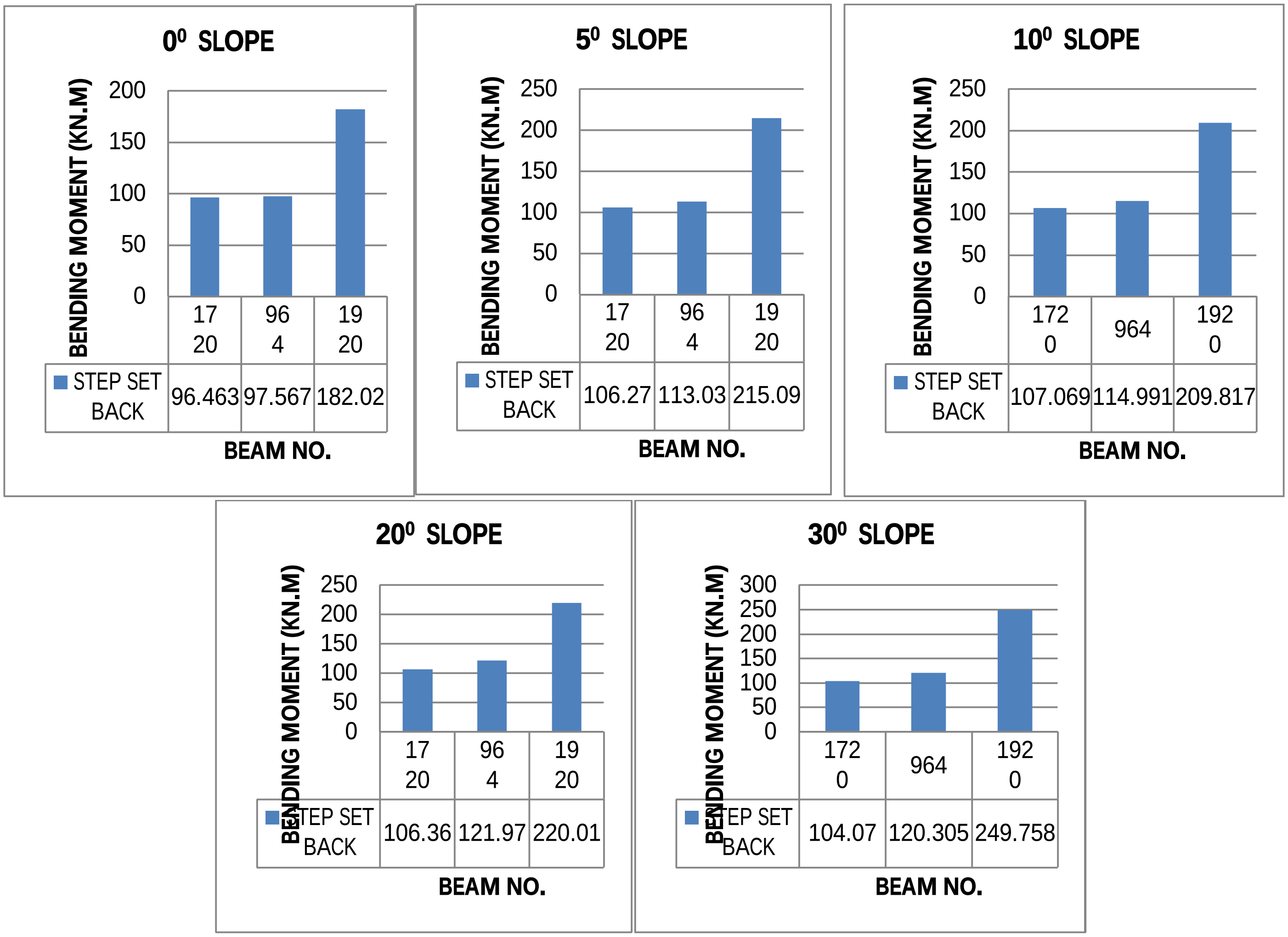
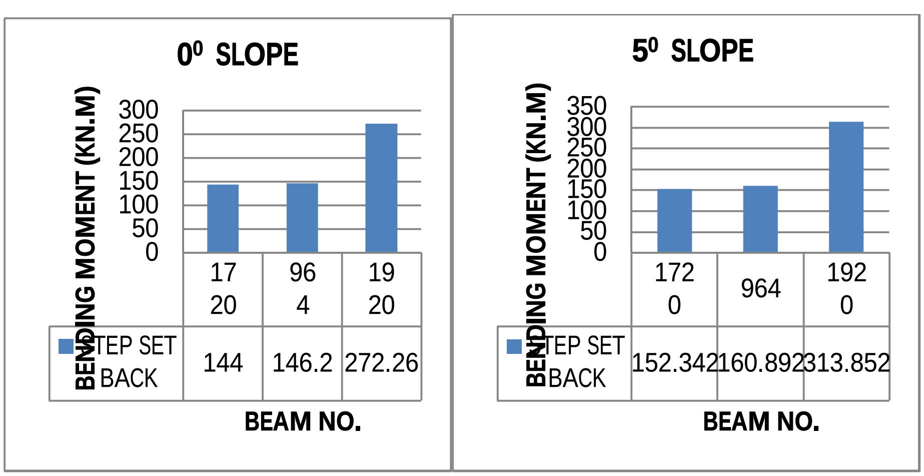


Fig no. 11 : Graphs showing comparison for bending moment in beam in zone IV

In beam analysis for bending moment in zone iv it is observed that bending moment is maximum in slope of angle 30 degree for beam no. 1920 and minimum in slope of angle 0 degree for beam no. 1720.

2) Zone V



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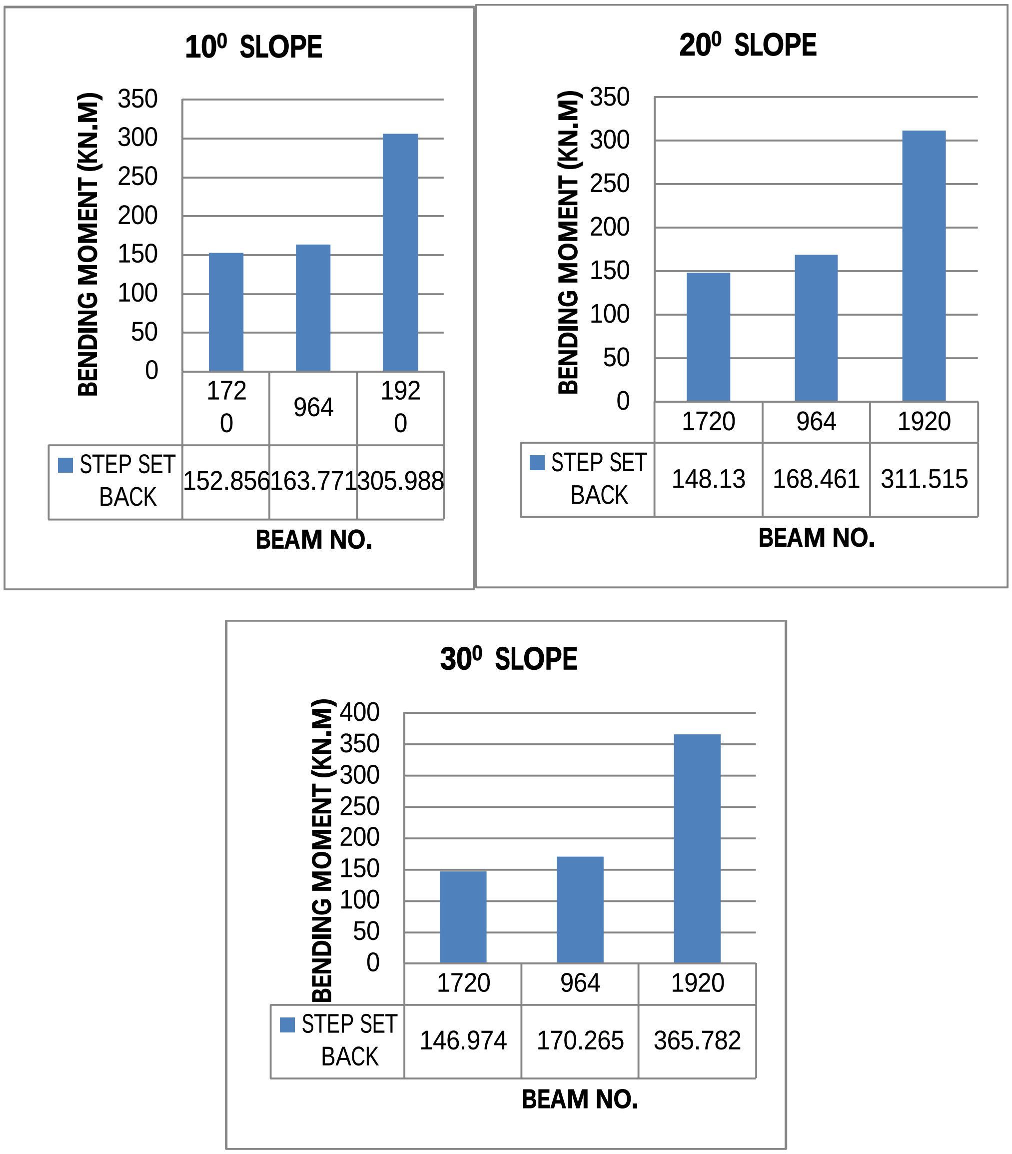


Fig no. 12 : Graphs showing comparison for bending moment in beam in zone V

In beam analysis for bending moment in zone v it is observed that bending moment is maximum in slope of angle 30 degree for beam no. 1920 and minimum in slope of angle 0 degree for beam no. 1720.

IX. CONCUISONS

A. Provisions of tie beams prove to be the effective for construction as it reduces the base shear, displacement and counteract the forces.

B. For base shear 0^0 to 20^0 slope are effective for construction than the other.

C. For displacement step setback at 10^0 building proves most effective in zone IV and zone V.

D. For time period it is observed that 0^0 Sloping ground gives less results than other slopes.

E. Overall for construction of building on sloping ground step setback building with slopes 5^0 and 10^0 proves most effective than other slopes.

X. ACKNOWLEDGEMENT

No undertaking of the magnitude involved in the preparation of this project can be accomplished alone. Many have contributed till the successful acknowledge the assistance of the following individuals and would like to thank each one of them. I am Very thankful to Dr. S.K.Deshmukh my guide and Principal C.O.E & T, Akola. They were constant source of encouragement to all of us. I am Also thankful to Prof. R M.Phuke my Co-guide and H.O.D. civil dept

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VII July 2020- Available at www.ijraset.com

REFERENCES

[1] Ajay Kumar Sreerama, Pradeep Kumar Ramancharla, "Earthquake behavior of reinforced concrete framed buildings on hill slopes", (USMCA 2013), Report No: IIIT/TR/2013/-1

[2] Dr. R. B. Khadiranaikar and Arif Masali, (Jun 2014), "Seismic performance of buildings resting on sloping ground−A review", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), ISSN: 2320-334X, Volume 11, Issue 3.

[3] Miss. Chaitrali Arvind Deshpande, (Oct 2014), "Effect of Sloping Ground on Step Back and Set back Configurations of R.C.C. Frame Building", International journal of engineering research & technology (IJERT), ISSN: 2278-0181, Vol. 3 issue 10.

[4] Miss. Chaitrali Arvind Deshpande, Prof. P. M. Mohite, (Oct- 2014), "Effect of Sloping Ground on Step- Back And Setback Configurations of R.C.C.Frame Building", ISSN: 2278-0181, Vol. 3 Issue 10.

[5] Miss. Pratiksha Thombre, Dr. S. G. Makarande, (Jun 2016), "Seismic Analysis of Building Resting on Sloping Ground", JETIR ISSN 2349-5162, Vol 3 Issue 6.

[6] Mohammed Umar Farooque Patel, A. V. Kulkarni, Nayeemulla Inamdar, (Mar 2012), "A Performance study and seismic evaluation of RC frame buildings on sloping ground", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), ISSN: 2278-1684, P 51-58.

[7] Mr. A. R. Vijaya Narayanan, Rupen Goswami and C. V. R. Murty, "Performance of RC Buildings along Hill Slopes of Himalayas during 2011 Sikkim Earthquake", Indian Institute of Technology Madras, Chennai, India.

[8] Mr. Achin Jain, Dr. Rakesh Patel, (Aug 2017), "Analysis of Building Constructed on Sloping Ground for Different Types of Soil",International Journal For Technological Research In Engineering, Volume 4 Issue 12, August-2017, ISSN (Online): 2347- 4718.

[9] Mr. B. G. Birajdar, S.S. Nalawade, (Aug 2004), "Seismic Analysis of Buildings Resting on Sloping Ground", 13th World Conference on Earthquake Engineering Vancouver, B.C, Canada, Paper No. 1472.

[10] Mrs. Vrushali S. Kalsait, (July 2015) "Design of Earthquake Resistant Multistoried Building on A Sloping Ground", Vol.2 Issue 7.

[11] Narayan Kalsulkar and Satish Rathod, (Jun 2015), "Seismic Analysis of RCC Building Resting on Sloping Ground with varying Number of Bays and Hill Slopes", International Journal of Current Engineering and Technology, Vol.5,No. 3.

[12] Rajkumar Vishwakarma, Anubhav Rai, (Mar 2017) "Analysis of a RCC frame Tall Structure using Staad Pro on Different Seismic Zones Considering Ground Slopes", ISSN: 2395-0072, 04 Issue: 03.

[13] Rayyan-Ul-Hasan Siddiqui, H. S. Vidyadhara, (Oct 2013), "Seismic Analysis of Earthquake Resistant Multi Bay Multi Storeyed 3D - RC Frame", International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 2 Issue 10.

[14] Sujit Kumar, Dr. Vivek Garg, Dr. Abhay Sharma, (August 2014) "Worked on Effect of sloping ground on structural performance of RCC Building under Seismic Load", ISSN: 2348-4098, Vol. 2 Issue 6.

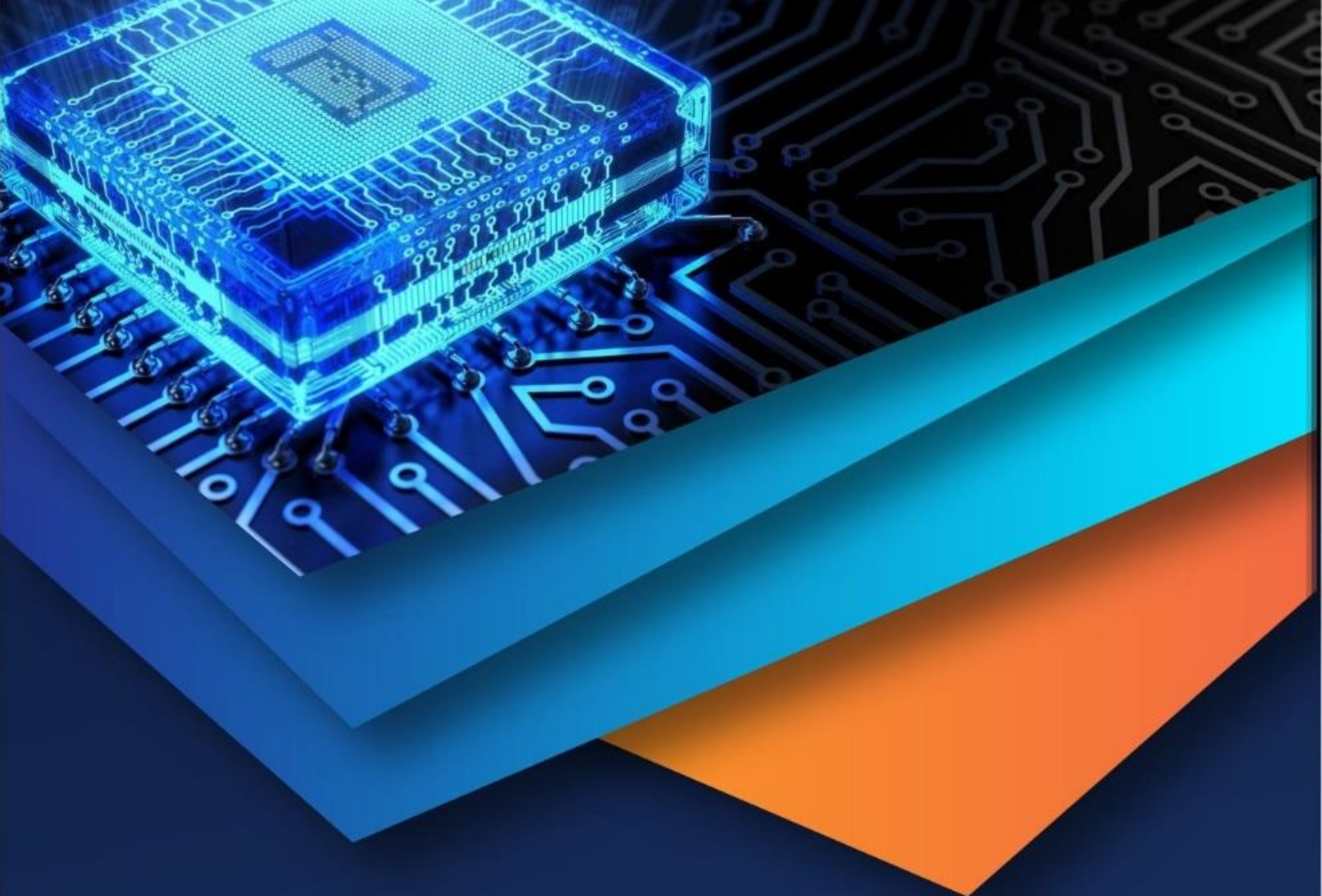
IS codes:

[1] IS 456-2000, "Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards.

[2] IS 875: PART I, "Code of Practice for Design Loads (Other than Earthquake) Dead Loads".

[3] IS 875: PART II, "Code of Practice for Design Loads (Other than Earthquake) Imposed Loads".

[4] IS Code: 1893-2012, "Criteria for Earthquake Resistant Design of Structures (Part I) General Provision and Buildings, Bureau of Indian Standards.



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