SEISMIC ANALYSIS OF BUILDING RESTING ON SLOPING GROUND

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Abstract - *Due to shortage of flat ground, buildings are constructed in slopy ground and it is more vulnerable to structural and constructional damages due to seismic activity. Buildings in slopy ground are different from buildings in flat ground. In this study, 3D analytical model of 13 storied buildings have been modelled and analyzed by response spectrum analysis by using Etabs. Here two type configurations i.e., Setback & step back building and Step back building were considered for analysis and they are rested on 0°,10°,20° and 30° slope. From the analysis dynamic parameters obtained and have been discussed in terms of Storey displacement, Storey drift, Storey shear for buildings and results were compared. Lastly conclude that the set back and step back building configuration is highly suitable for sloping ground when compared to step back building configuration.*

Key Words: **Step back building, Set back and step back building, Response spectrum analysis (RSA), Storey displacement, storey drift, storey shear.**

1. INTRODUCTION

Earthquakes arise alongside plate margins (where in plate meets) while plate move fast, in the direction or far from other, the actions is not always so smooth. Friction causes the plates to get struck. This causes the pressure to build up of pressure released. Earthquakes are usually classified on the basis of causes of origin, depth of focus, Intensity and magnitude of earthquake. Earthquake is measured by using ritcher magnitude scale anything is greater than magnitude 7 considered as sever type of Earthquake.

Due to increase in population and rapid urbanization, the scarcity of plain ground is happened. Since structures are constructed in hilly area. The construction of building in hilly area is not easy compared to building in plain ground. In some hilly regions of the world are more prone to seismic activity, In India, North and northeast part have large sloping grounds and construction of RC building is popular in sloping ground. Earthquake causes shaking of ground so building resting on slope will experience motion at its base. Even though the base of the building moves with ground. Roof has tendency to stay in original position. But since the walls and columns are connected to it, they drag the roof along with them.

1.1 Configuration of building in hilly area

1.1.1 Step back type of configuration: The building arrangement in which horizontal plane remains same but on the lower part it will maintain slope as per terrain or topography of the area.

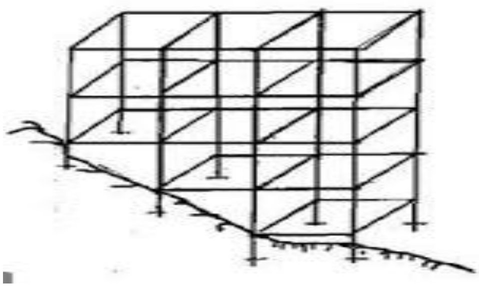

Fig 1: Step back building

1.1.2 Set back and step back type of configuration: In this building configuration the structure is arranged in stepping pattern in which the horizontal plane is not remains same along with lower part of the structure.

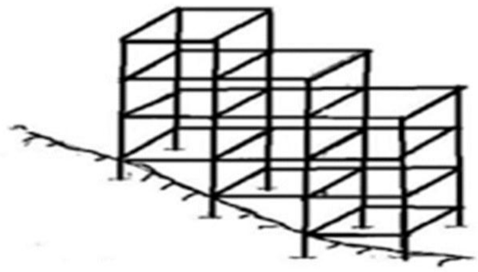

Fig 2: Set back and step back type of building

2. OBJECTIVES

1. To obtain the effectiveness of configuration of buildings including step back frames, set back and step back frames.
2. To learn the variation of storey shear, Storey displacement, Storey drift with respect to hill slope angle, storey height for different configurations of building frames
3. To study the comparison between increasing number of angles.

3. METHODOLOGY

1. Creating 3D model for analysis of R C frame multistory building configurations having different sloping angle (0°, 10°, 20°, 30°) using ETABS.
2. Seismic loading with seismic zone III, based on soil type II (medium) and response reduction factor(R) is 5, Importance factor (I) is 1.0, RC buildings with special moment resisting frame (SMRF).
3. The building is analyzed by response spectrum analysis for different configurations as per IS1893 (part1).
4. Assign loads as per codes.
5. The models are analyzed and arrive at conclusion

4. PARAMETERS CONSIDERED FOR MODELLING

Table -1: The building details are as follows..

SL NO	DETAILS	DIMENSIONS
01	Plan dimension	(36X16) m
02	Number of bays in x direction	6m
03	Number of bays in y direction	4m
04	Grade of concrete in slabs	M25
05	Grade of concrete in beams	M25
06	Grade of concrete in columns	M30
07	Grade of steel	HYSD 500
08	Beam dimension	(300X450) mm
09	Column dimension	(600X600) mm
10	Slab thickness	150mm
11	Wall thickness	230 mm
12	Height of each floor	3m
13	Wall load	11.04 kN/m2
14	Parapet wall load	2.76 kN/m2
15	Seismic zone	III
16	Soil type	Type II (Medium soil)
17	Live load	3kN/m2
18	Floor finish	1.5kN/m2

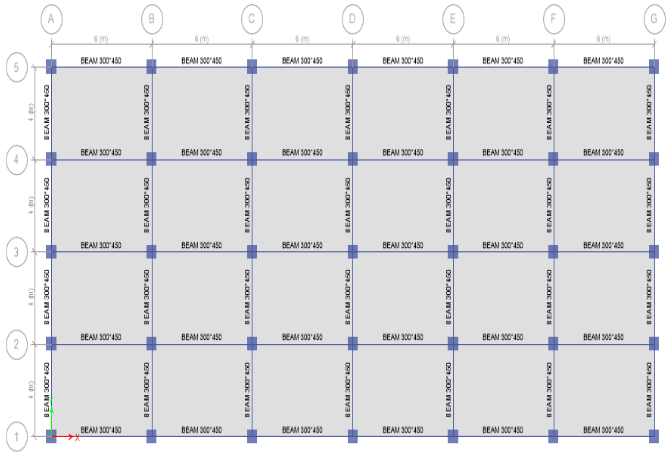

Fig 3: Plan view

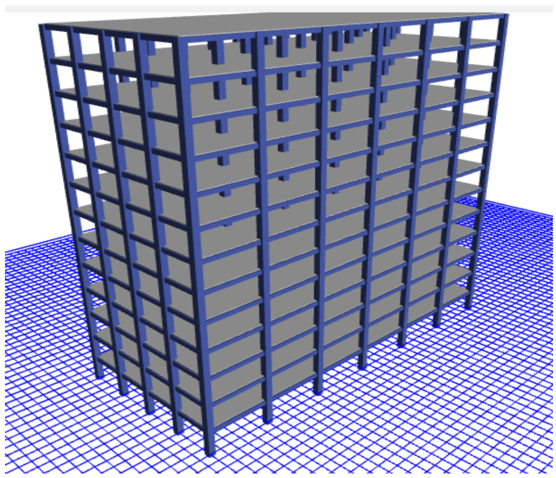

Fig 4: 3D view of step back building along 0° slope

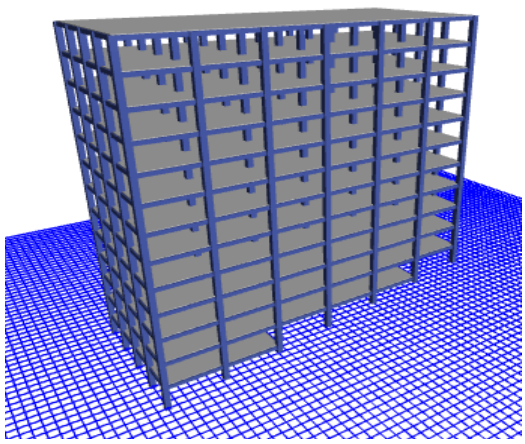

Fig 5: 3D view of step back building along 10° slope

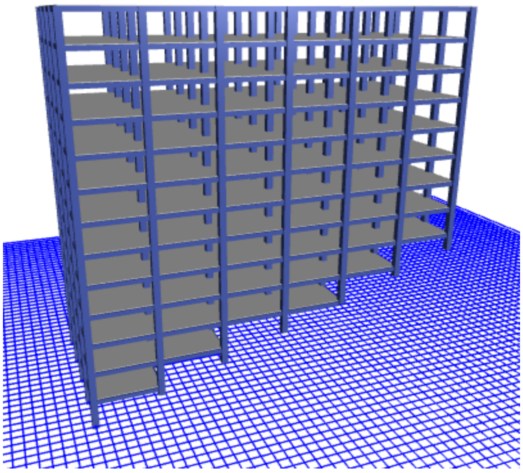

Fig 6: 3D view of step back building along 20° slope

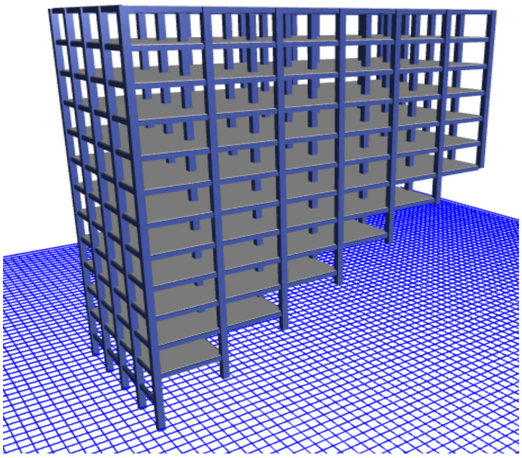

Fig 7: 3D view of step back building along 30° slope

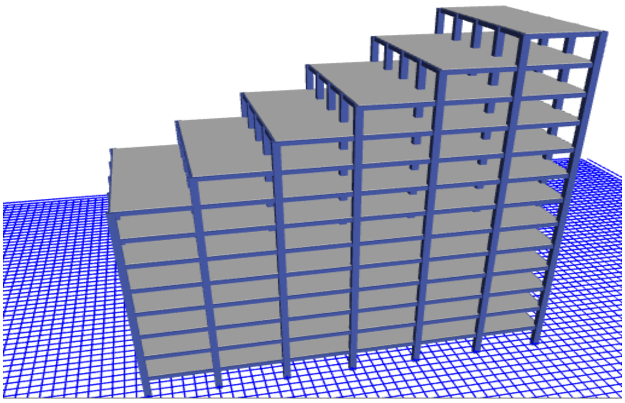

Fig 8: 3D view of Set back & step back building along 0° slope

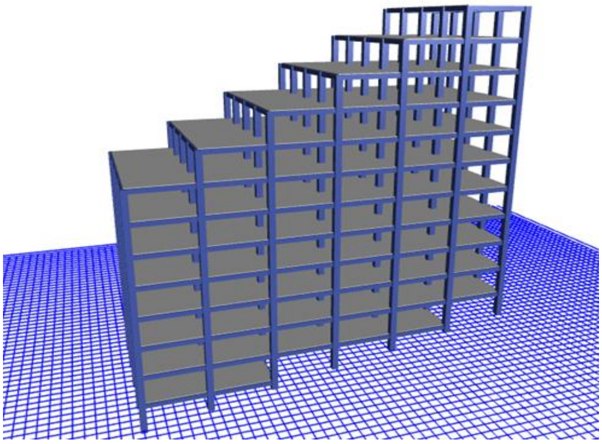

Fig 9: 3D view of Setback & step back building along 10° slope

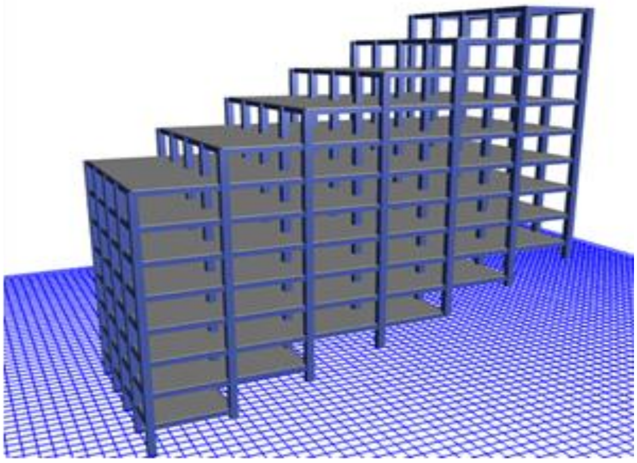

Fig 10: 3D view of Set back & step back building along 20° slope

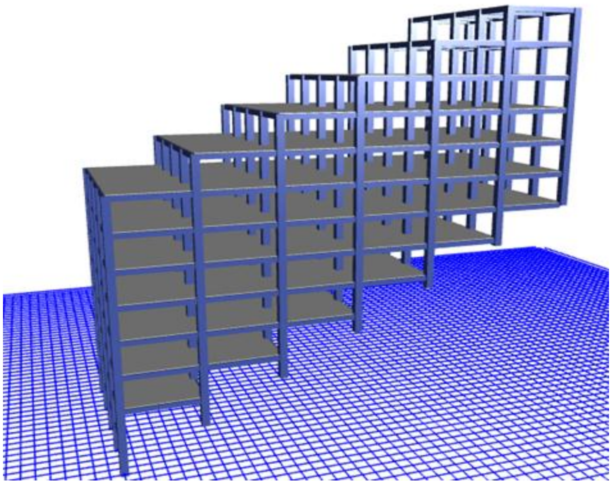

Fig 11: 3D view of Set back & step back building along 30°slope

4. ANALYSIS RESULTS

4.1 COMPARISON OF STEP BACK BUILDING AND SET BACK & STEP BACK BUILDING RESTING ON 0° SLOPING GROUND BY RSA.

4.1.1 MAXIMUM STOREY DRIFT

Storey drift of step back building has been increased by 8.35% when compared to set back and step back building.

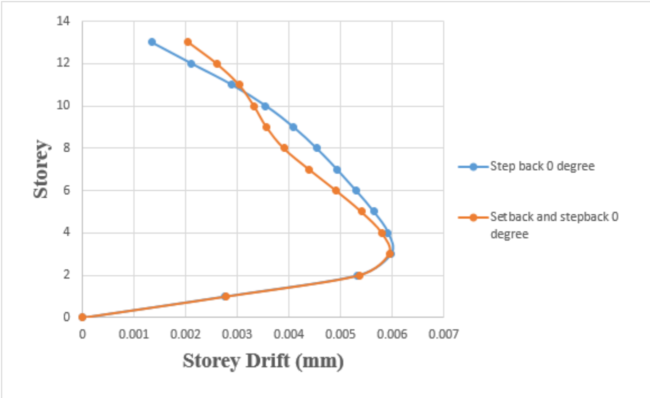

Chart -1: Variation of storey drift of step back and set back & step back buildings on 0° sloping ground by RSA.

4.1.2 MAXIMUM STOREY DISPLACEMENT

Storey displacement of step back building has been increased by 2.14% when compared to set back and step back building.

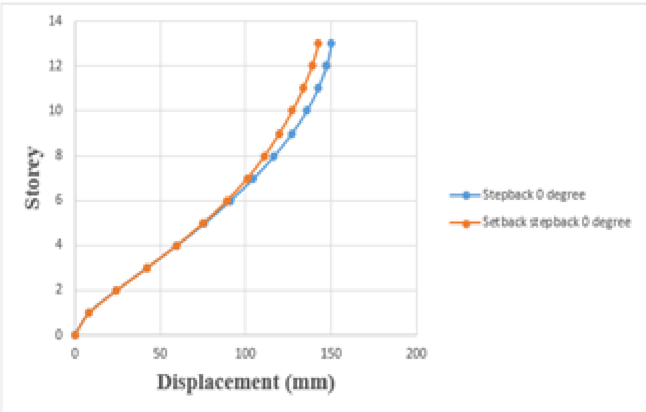

Chart -2: Variation of storey displacement of step back and set back & step back buildings on 0° sloping ground by RSA.

4.1.3 STOREY SHEAR

Storey shear of step back building has been increased by 8.82% when compared to set back and step back building.

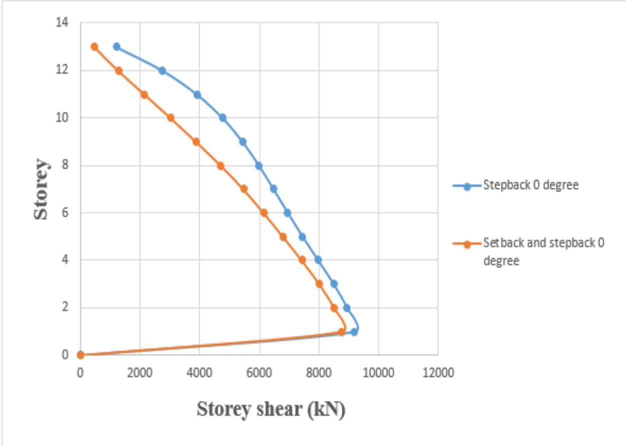

Chart -3: Variation of storey shear of step back and set back & step back buildings on 0° sloping ground by RSA.

4.2 COMPARISON OF STEP BACK BUILDING AND SET BACK & STEP BACK BUILDING RESTING ON 10° SLOPING GROUND BY RSA.

4.2.1 MAXIMUM STOREY DRIFT

Storey drift of step back building has been increased by 3.97% when compared to set back and step back building.

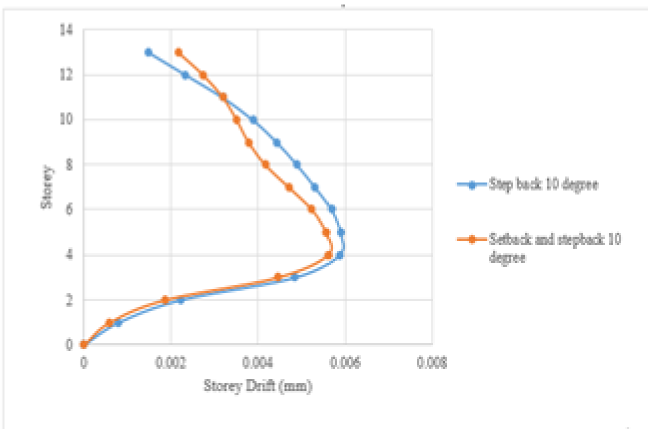

Chart -4: Variation of storey drift of step back and set back & step back buildings on 10° sloping ground by RSA.

4.2.2 MAXIMUM STOREY DISPLACEMENT

Storey displacement of step back building has been increased by 4.25% when compared to set back and step back building.

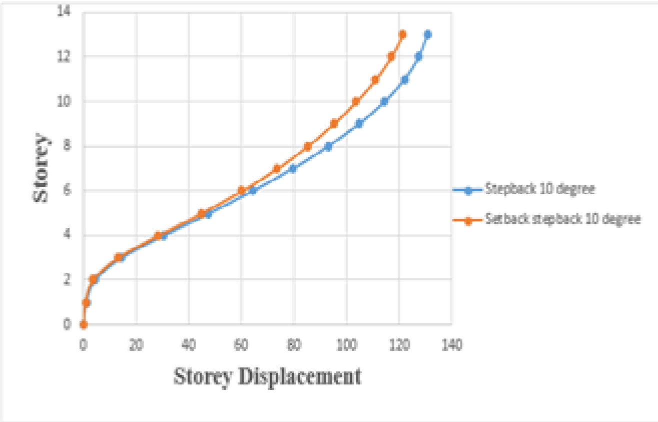

Chart -5: Variation of storey displacement of step back and set back & step back buildings on 10° sloping ground by RSA.

4.2.3 STOREY SHEAR

Storey shear of step back building has been increased by 8.82% when compared to set back and step back building.

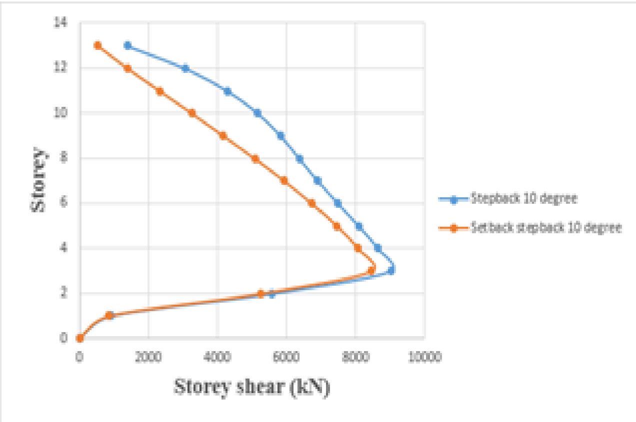

Chart -6: Variation of storey shear of step back and set back & step back buildings on 10° sloping ground by RSA.

4.3 COMPARISON OF STEP BACK BUILDING AND SET BACK & STEP BACK BUILDING RESTING ON 20° SLOPING GROUND BY RSA.

4.3.1 MAXIMUM STOREY DRIFT

Storey drift of step back building has been increased by 4.48% when compared to set back and step back building.

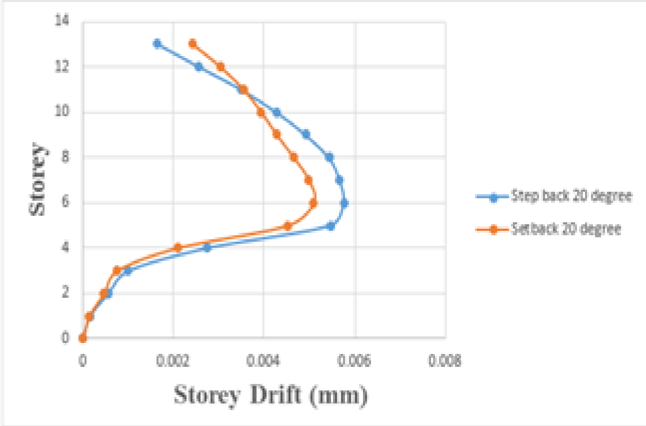

Chart -7: Variation of storey drift of step back and set back & step back buildings on 20° sloping ground by RSA.

4.3.2 MAXIMUM STOREY DISPLACEMENT

Storey displacement of step back building has been increased by 6.19% when compared to set back and step back building.

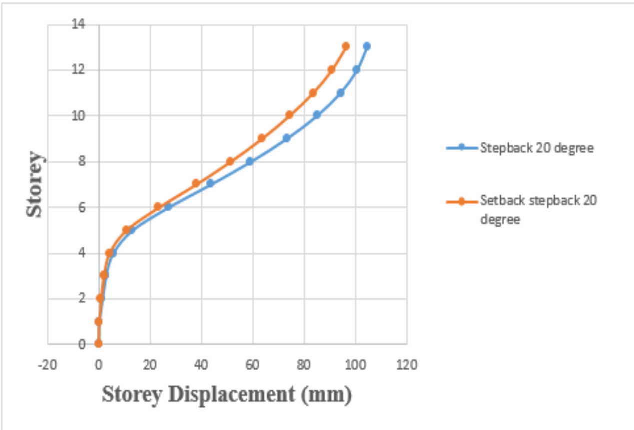

Chart -8: Variation of storey displacement of step back and set back & step back buildings on 20° sloping ground by RSA.

4.3.3 STOREY SHEAR

Storey shear of step back building has been increased by 11.89% when compared to set back and step back building.

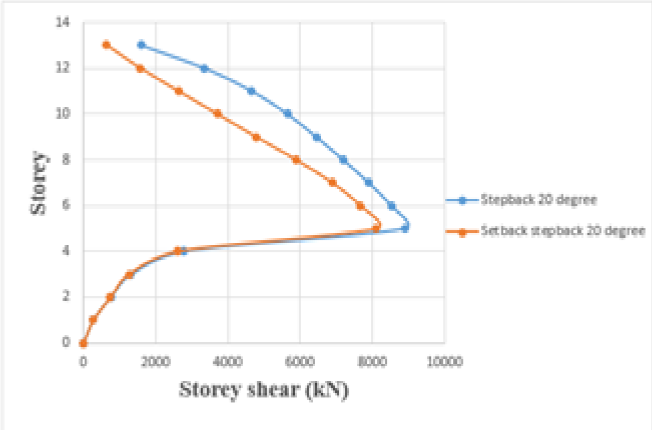

Chart -9: Variation of storey shear of step back and set back & step back buildings on 20° sloping ground by RSA.

4.4 COMPARISON OF STEP BACK BUILDING AND SET BACK & STEP BACK BUILDING RESTING ON 30° SLOPING GROUND BY RSA.

4.4.1 MAXIMUM STOREY DRIFT

Storey drift of step back building has been increased by 5.43% when compared to set back and step back building.

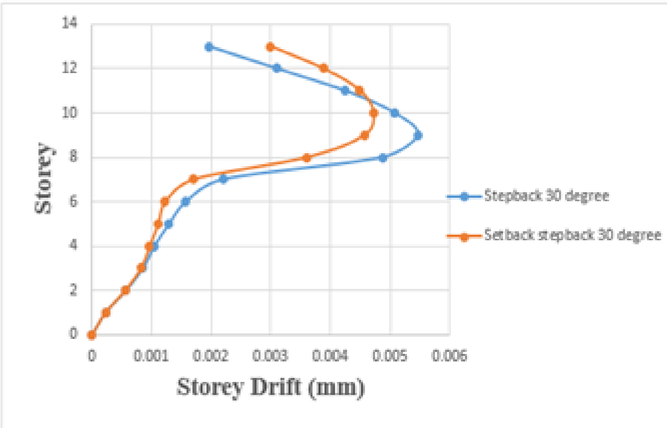

Chart -10: Variation of storey drift of step back and set back & step back buildings on 30° sloping ground by RSA.

4.4.2 MAXIMUM STOREY DISPLACEMENT

Storey displacement of step back building has been increased by 6.12% when compared to set back and step back building.

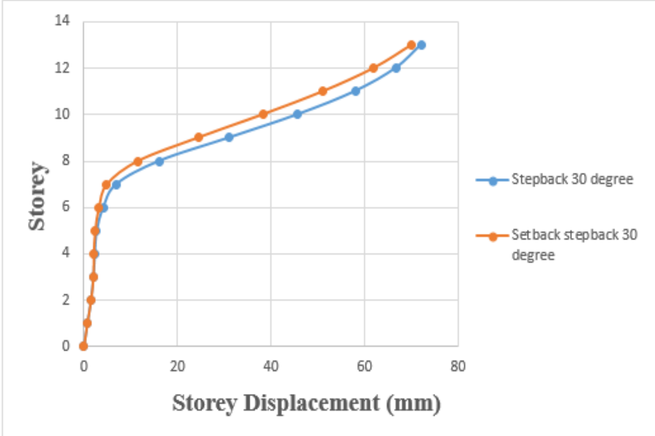

Chart -11: Variation of storey displacement of step back and set back & step back buildings on 30° sloping ground by RSA.

4.4.3 STOREY SHEAR:

Storey shear of step back building has been increased by 17.61% when compared to set back and step back building.

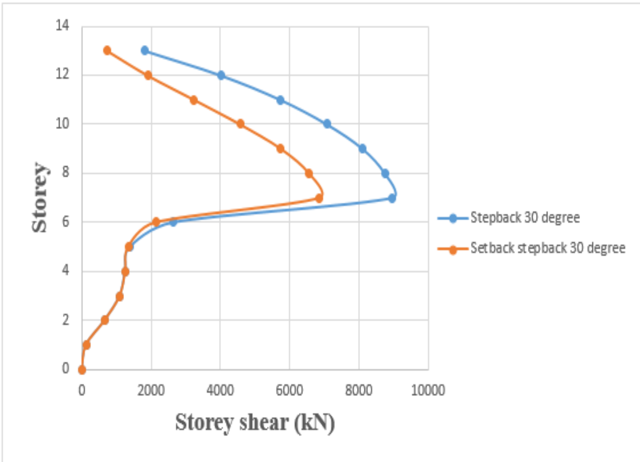

Chart -12: Variation of storey shear of step back and set back & step back buildings on 30° sloping ground by RSA.

4.5 COMPARISON OF NUMBER OF VARYING ANGLES OF STEPBACK BUILDING ON SLOPING GROUND BY RSA.

4.5.1 MAXIMUM STOREY DRIFT

Storey drift of number of varying angles of the step back building get reduced as the slope increases

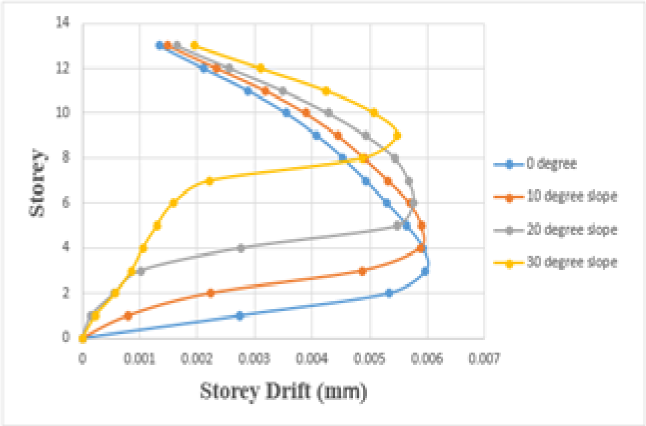

Chart -13: Variation of storey drift of step back building for number of varying angles by RSA.

4.5.2 MAXIMUM STOREY DISPLACEMENT

Storey displacement of number of varying angles of the set back building get reduced as the slope increases

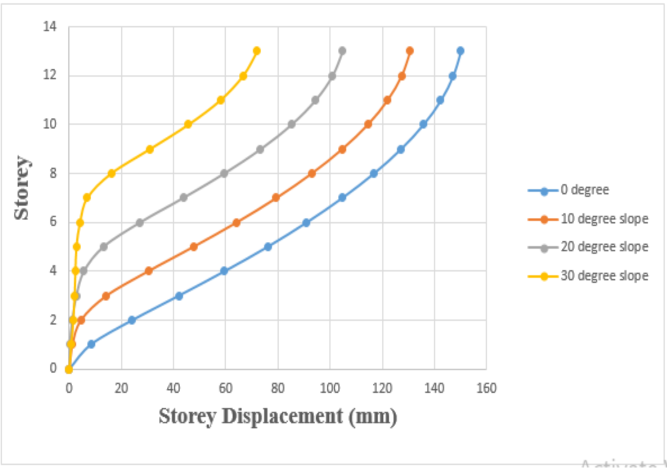

Chart -14: Variation of storey displacement of step back building for number of varying angles by RSA.

4.5.3 STOREY SHEAR

Storey shear of number of varying angles of the step back building get reduced as the slope increases.

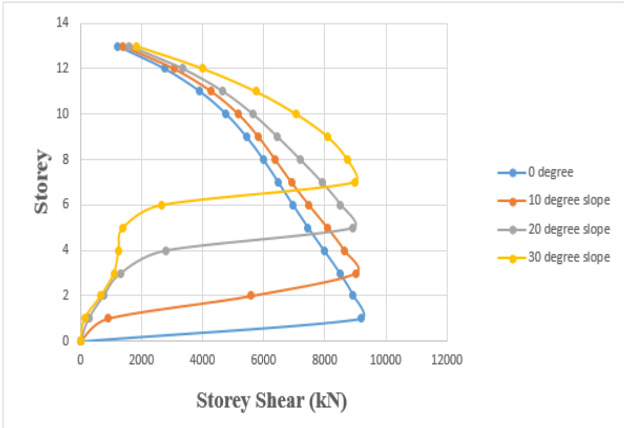

Chart -15: Variation of storey shear of step back building for number of varying angles by RSA.

4.6 COMPARISON OF NUMBER OF VARYING ANGLES OF SETBACK AND STEPBACK BUILDING ON SLOPING GROUND BY RSA.

4.6.1 MAXIMUM STOREY DRIFT

Storey drift of number of varying angles of the setback and step back building get reduced as the slope increases

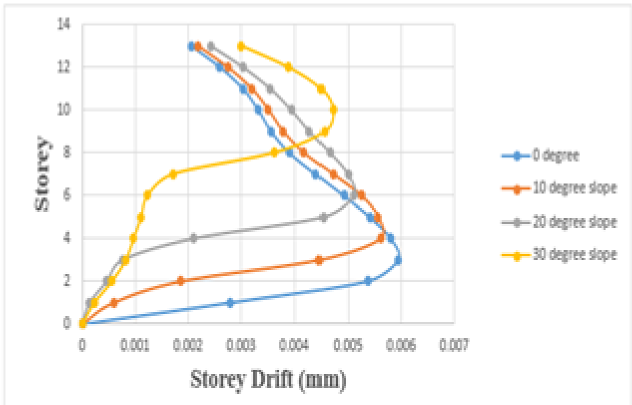

Chart -16: Variation of storey drift of set back and step back building for number of varying angles by RSA.

4.6.2 MAXIMUM STOREY DISPLACEMENT

Storey displacement of number of varying angles of the setback and step back building get reduced as the slope increases

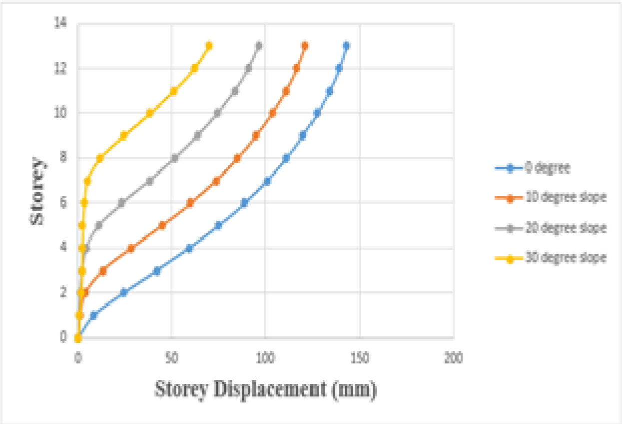

Chart -17: Variation of Storey displacement of set back and step back building for number of varying angles by RSA.

4.6.3 STOREY SHEAR

Storey drift of number of varying angles of the setback and step back building get reduced as the slope increases

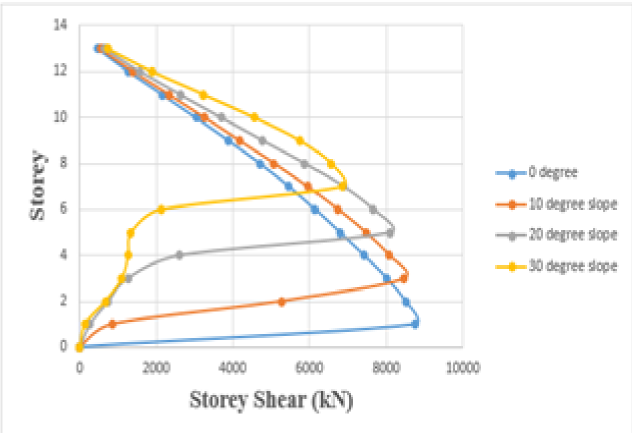

Chart -18: Variation of storey shear of set back and step back building for number of varying angles by RSA.

5. CONCLUSIONS

1. It is observed that the set back & step back type of building configuration shows the lesser value of storey drift, storey displacement, storey shear when compared to step back building configuration.

2. It is observed that the Storey displacement, story drift, story shear in all the stories of the buildings get reduced as the sloping angle increases.

3. The performance of step back building is more vulnerable to seismic activity when compare to setback and step back building.

4. Finally, it has been concluded that, out of both the configurations, set back and step back building configuration is more suitable for sloping ground.

REFERENCES

[1] B.G. Birajdar, S.S. Nalawade," SEISMIC ANALYSIS OF BUILDING RESTING ON SLOPING GROUND", 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada, August 1-6, 2004, Paper No. 1472.

[2] Narayan Kalsulkar and Satish rathod "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,June 2015.

[3] Malla Karthik Kumar ,Vanka Srinivasa Rao, Kusuma Sundar Kumar "STUDY ON EARTHQUAKE RESISTANT BUILDINGS ON GROUND SURFACE BY USING ETABS"IJLRET,Vol.2,Issue 3,March 2016.

[4] Mojahid Islam, Siddharth Pasatariya "ANALYSIS OF BUILDING ON SLOPING GROUND SUBJECTED TO SEISMIC FORCES", IJAERS, ISSN: 2349-6495, Vol-7, Issue-1, and Jan-2020.

[5] I.S. 1893 (Part 1), "CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURE GENERAL PROVISION AND BUILDING", Bureau of Indian standards, New Delhi.