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Comparison of Response Spectrum Method and Seismic Coefficient Method for G+10 Building Resting on Sloping Ground

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Abstract: Earthquakes are the most destructive natural hazards throughout human history. Hundreds of thousand people lost their lives and loss of billions of dollars' properties occurred in these disasters. Construction of building on sloping ground in an earthquake prone area is a difficult task as building on sloping ground behaves differently. This paper compares three types of building configuration namely regular, step-back and step-back set-back, resting on three different slopes as 0, 10 and 20 degrees. The research concludes that both static and dynamic check should be performed before designing building on sloping ground.
Keywords: Earthquake, sloping ground, Step-Back, Step-Back Set-Back, Response Spectrum method, Seismic Coefficient method

I. INTRODUCTION

Earthquake is a sudden movement of earth crust, which originates naturally at or below the surface of crust. The earthquake occurs at shallow depths (2-8km) are mostly small. The occurrence of earthquake with magnitude greater than 6 is rare. About 90% of all earthquakes result from tectonic events, primarily movements on the faults. The remaining is related to volcanism, collapse of subterranean cavities or manmade effects.

There are different methods for analyzing earthquake forces in a building such as seismic coefficient method, response spectrum method, time history method, p-delta effect, pushover analysis etc.

A. Seismic Coefficient Method

All design against seismic loads must consider the dynamic nature of the load. However, for simple regular structures, analysis by equivalent linear static methods is often sufficient. This is permitted in most codes of practice for regular, low-to medium-rise buildings. It begins with an estimation of base shear load and its distribution on each story calculated by using formulas given in the code. Equivalent static analysis can therefore work well for low to medium-rise buildings without significant coupled lateral-torsional effects, are much less suitable for the method, and require more complex methods to be used in these circumstances.

B. Response Spectrum Method

The representation of the maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. The maximum response plotted against of un-damped natural period and for various damping values and can be expressed in terms of maximum absolute acceleration, maximum relative velocity or maximum relative displacement. For this purpose, response spectrum case of analysis has been performed according to IS 1893.

II. LITERATURE REVIEW

Balaji U & Selvarasan M. E. studied a residential building G+13 storied. The building was analyzed for earthquake loads using ETABS. Assuming that the material properties were linear, static and dynamic analysis was performed. These non-linear analyses were carried out by considering severe seismic zones and the behavior was assessed by taking types II soil condition. Different response like displacement & base shear were calculated and it was observed that displacement increased with the building height.

Anirudh Gottala, shaik Yajdhani et al studied static and dynamic analysis of G+9 multistoried building. Linear seismic analysis was done by static method (Seismic Coefficient Method) and dynamic method (Response Spectrum Method) using STAAD-Pro as per the IS-1893-2002-Part-1. Parameters such as Bending moment, Axial force, Torsion, Displacement, Nodal displacement, beam and column end forces etc. were calculated. The authors concluded that, values for Moments are 35 to 45 % higher for Dynamic analysis than the values obtained for Static analysis. Nodal Displacements are 50% higher for Dynamic analysis than the values obtained for

Static analysis. Mohit Sharma, Savita Maru studied static and dynamic analysis with the help of STAAD-Pro software using the parameters for design as per the IS 1893-2002-part-1for the zones-2 and 3. G+30 storied regular building was analyzed. These buildings had the plan area of 25m x 45m with a storey height 3.6m each and depth of foundation was 2.4 m and total height of chosen building including depth of foundation was 114 m. The authors concluded that, Moments and Displacement at different points in the beam was 10 to 15% and 17 to 28 % higher for Dynamic Analysis than the values obtained for Static Analysis for moment and displacement at same point.

A. S. Patil and P. D. Kumbhar [9] studied nonlinear dynamic analysis of a ten storied RCC building considering different seismic intensities and seismic response of the building was studied. The building under consideration was modeled with the help of SAP 2000 Software. Five different time histories had been used considering seismic intensities V, VI, VII, VIII, IX and X on Modified Mercalli's Intensity scale (MMI) for establishment of relationship between seismic intensities and seismic responses. Authors concluded that, similar variation patterns were observed in Seismic responses such as base shear and storey displacements with intensities V to X. From the study it was recommended that analysis of multistoried RCC buildings using Time History method was necessary to ensure safety against earthquake force.

III. METHODOLOGY

In this paper we are studying the behavior of different types of building configuration resting on sloping ground such as step-back and step-back set-back on different 10-degree and 20-degree slopes.

The data assumed and used for this research is listed in the following table:

TABLE I
Design Data For Rcc Building

Sr. No.	Seismic Parameters	
	Parameter	Value
1	Zone IV	0.24
2	Building	G+9
3	Framing	SMRF
4	Importance Factor	1
5	Soil Type	Hard (1)
6	Damping	5%
7	Beam Size	450X600 mm
8	Column Size	600X600 mm
9	Slab Thickness	150 mm
10	Live Load	2 KN/m^2
11	Response Spectrum Method	SRSS
12	External Wall	230 mm
13	Internal Wall	115 mm
14	Plan Size	30X20 m
15	Floor Height	3.0 m

Following are the building configuration used in this research:

A. Regular Building

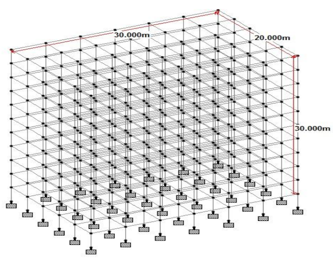

Fig. 1. 3D View of Regular Building

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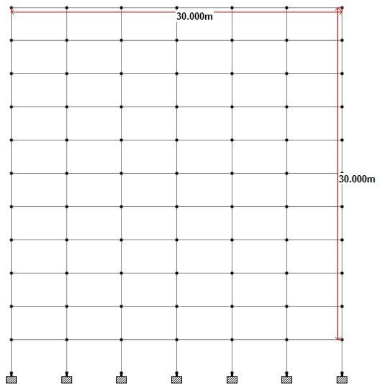

Fig. 2. Front View of Regular Building

B. 10 Degree Step-Back Building

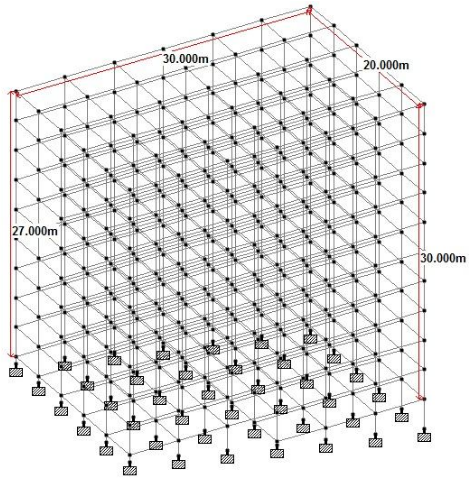

Fig. 3. 3D View of 10 Degree Step-Back Building

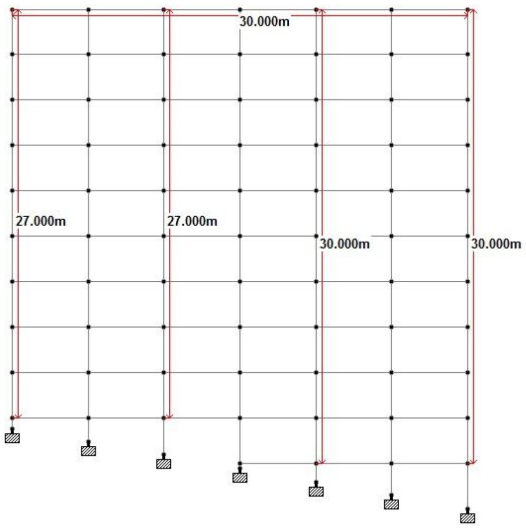

Fig. 4. Front View of 10 Degree Step-Back Building

C. 20 Degree Step-Back Building

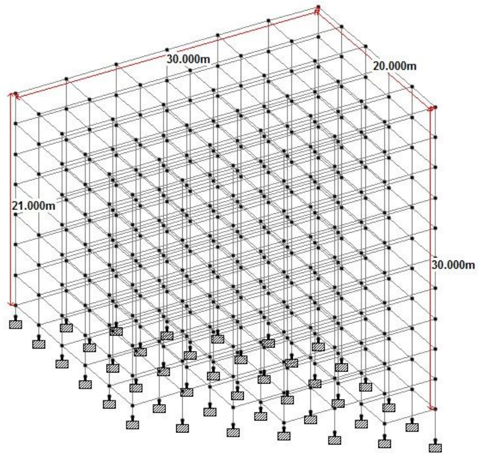

Fig. 5. 3D View of 20 Degree Step-Back Building

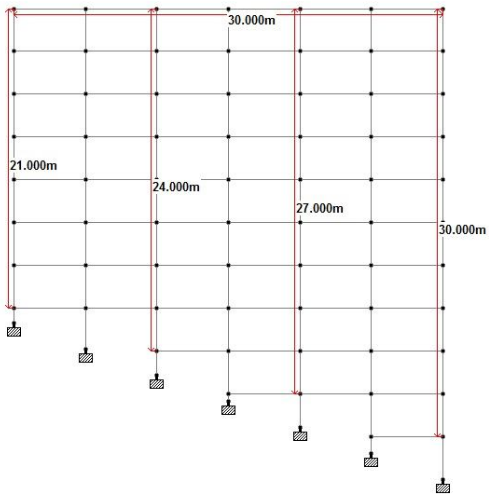

Fig. 6. Front View of 20 Degree Step-Back Building

D. 10 Degree Step-Back Set-Back Building

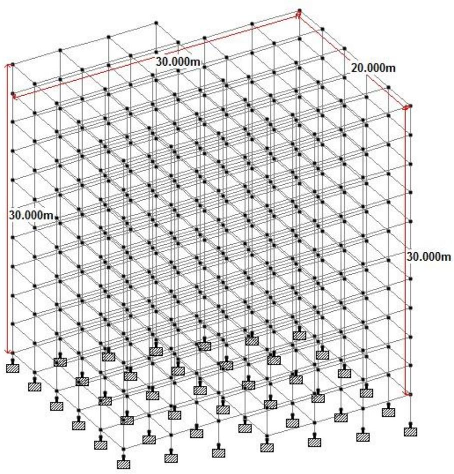

Fig. 7. 3D View of 10 Degree Step-Back Set-Back Building

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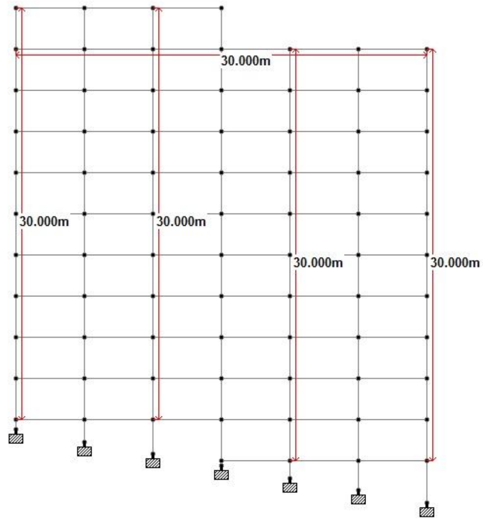

Fig. 8. Front View of 10 Degree Step-Back Set-Back Building

E. 20 Degree Step-Back Set-Back Building

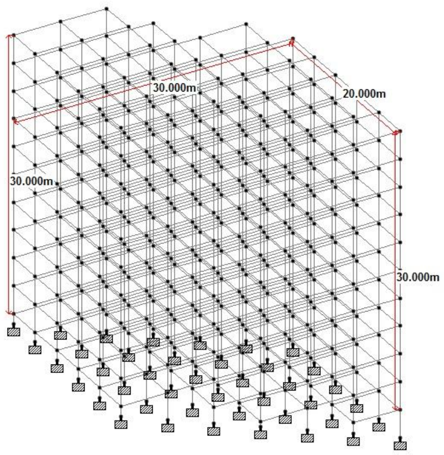

Fig. 9. 3D View of 20 Degree Step-Back Set-Back Building

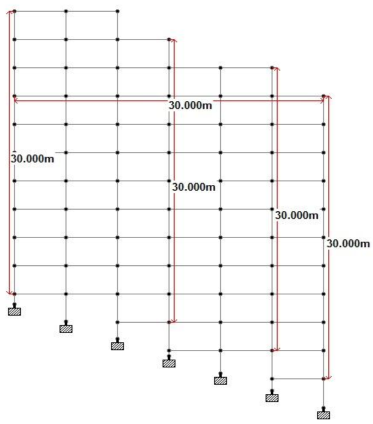

Fig. 10. Front View of 20 Degree Step-Back Set-Back Building

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IV. RESULTS

The following results were obtained from the analysis

A. Displacements

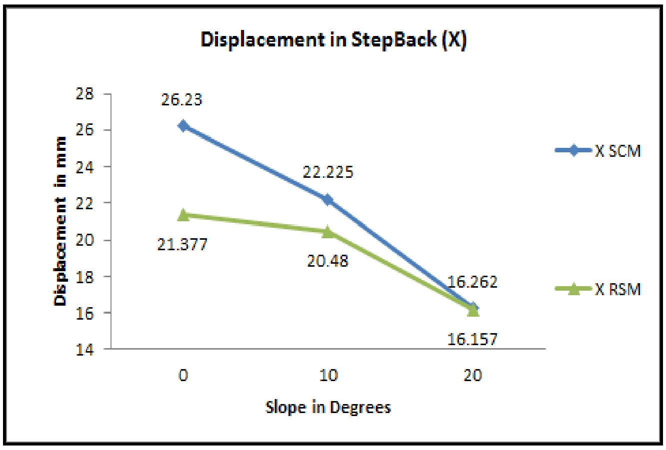

Fig.11. Comparison of Displacement in RSM vs SCM in SB in X

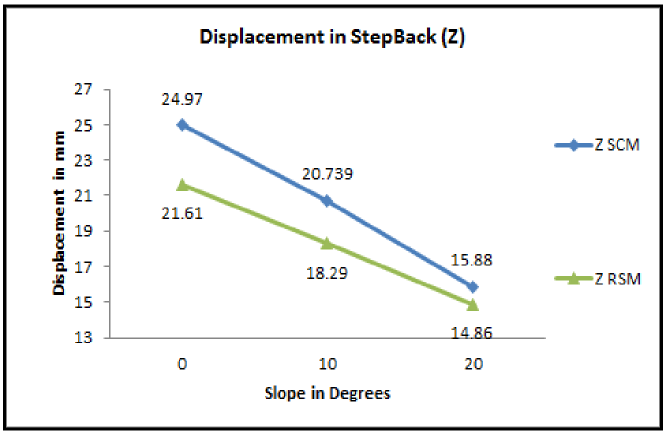

Fig. 12. Comparison of Displacement in RSM vs SCM in SB in Z

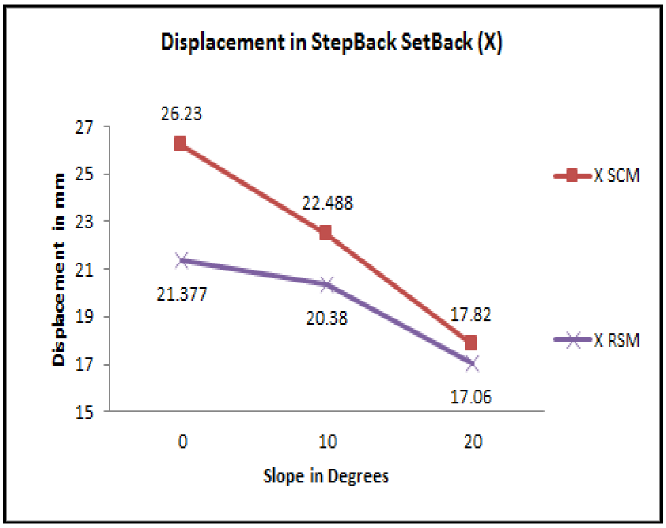

Fig. 13. Comparison of Displacement in RSM vs SCM in SBSB in X

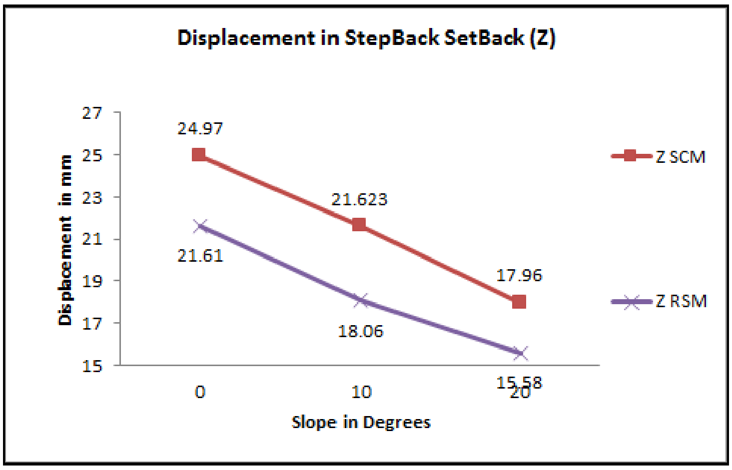

Fig. 14. Comparison of Displacement in RSM vs SCM in SBSB in Z

B. Base Shear

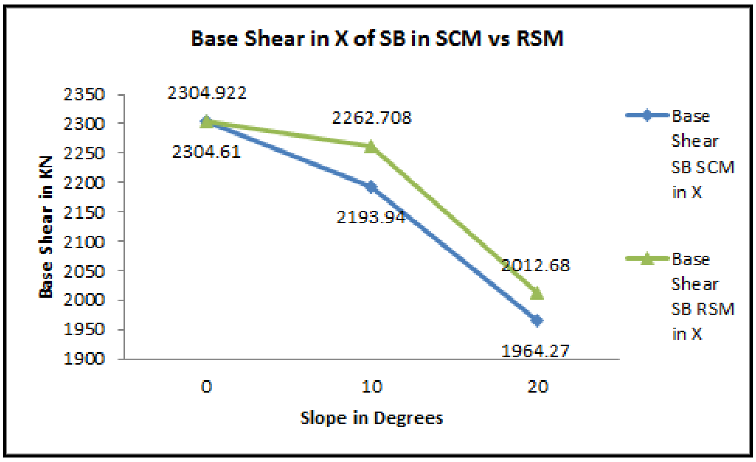

Fig. 15. Comparison of Base Shear in RSM vs SCM in SB in X

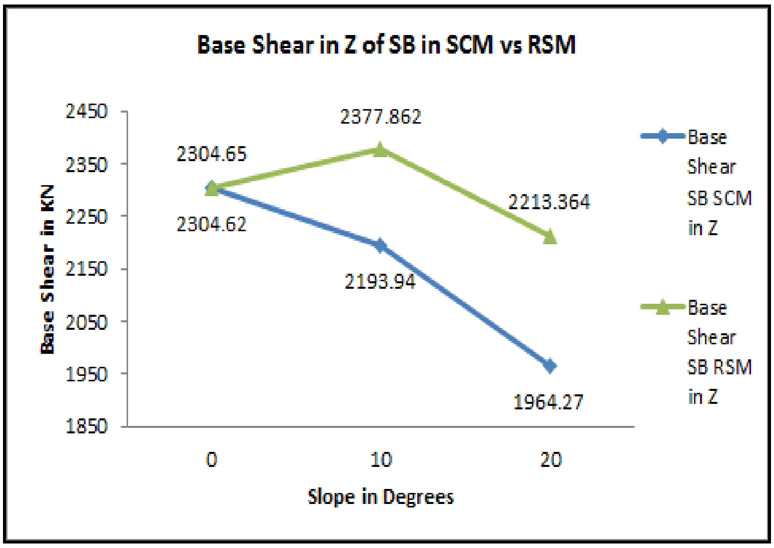

Fig. 16. Comparison of Base Shear in RSM vs SCM in SB in Z

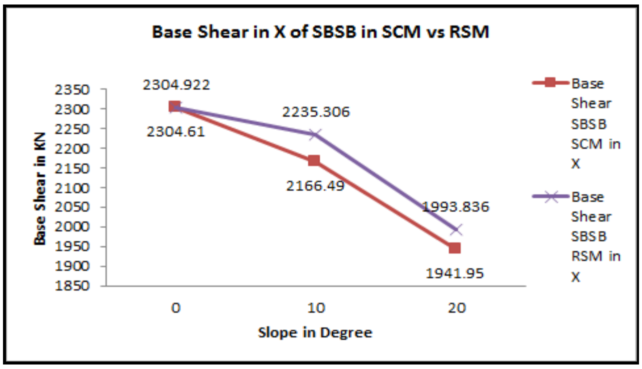

Fig. 17. Comparison of Base Shear in RSM vs SCM in SBSB in X

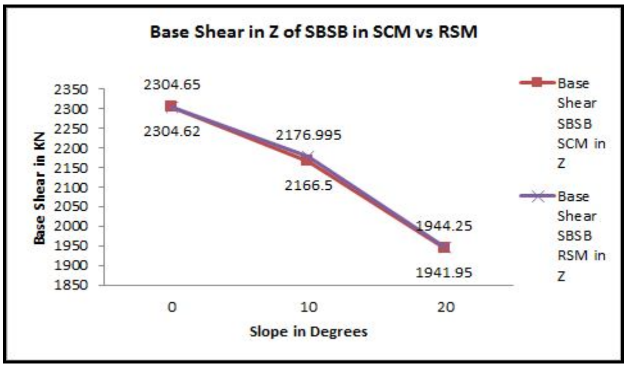

Fig. 18. Comparison of Base Shear in RSM vs SCM in SBSB in Z

V. CONCLUSIONS

The following conclusions can be drawn from the above results:

A. It is recommended to use dynamic analysis for building resting on sloping ground.
B. Displacement in static analysis were more than that in the dynamic analysis.
C. Base shear is less in static analysis than in the dynamic analysis.
D. Displacement reduces as the slope increases in step-back building configuration.
E. Same as step-back configuration in step-back set-back configuration displacement reduces with increase in slope but at a slow rate.
F. Base shear is more in step-back configuration than in step-back set-back configuration.

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