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Analysis and Design of G+6 Building in different Seismic Zones of India

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Abstract*: The analysis is performed to study the effect of sloping ground on structural force, for this purpose totally 08 models are analyzed 04 in Low seismic Zone intensity (Zone-2) and 04 in Very severe seismic intensity (Zone-5) out of 04 model in each zone 02 are RCC framed and 02 are Steel Framed, 01 of which is on sloping ground having slope of 10^0 for both RCC and Steel Framed structure, from the results it is found that steel structures behave better than RCC structure in both zone and on both ground conditions

Keywords: RCC, Steel, Slope.

I. INTRODUCTION

From past earthquake data it can be seen that hilly area are more prone to seismic activity; e.g. northeast region of India. In hilly regions, traditionally material which is locally available, like brunt brick, stone masonry and dressed stone masonry, bamboo, timber reinforced concrete, etc., are used for the construction of houses. A scarcity of plain ground in hilly area compels the construction activity on sloping ground. Hilly buildings constructed in masonry with mud mortar/cement mortar without conforming to seismic codal provisions have proved unsafe and, resulted in loss of life and property when subjected to earthquake ground motions.

II. AIM

To Analyze and Design multi-storey building in different seismic zones with sloping ground.

III. OBJECTIVE

The objectives of project are as follows :-

A. To study behavior of RCC and Steel frame on sloping ground
B. To study behavior of RCC and Steel frame in various seismic zones.
C. To find the most vulnerable framing system amongst all frames conditions.
D. To find various parameters for all frames Such as, Axial forces, Bending Moments, Displacements and compare them.

IV. METHODOLOGY

The methodology for present work is as mentioned below :-

A. In the first phase general parameters of project will be finalized Such as, Aim, Objectives and need of this work.
B. Then Various Literatures will be studied regarding the process of work.
C. Detail step by step procedure will be then decide for easy going of work
D. Detail information will be collected regarding sloping ground types of framing material and loading and their combinations.
E. All general parameters regarding material, their constants, and loading intensities will be decided at this step.
F. Now after doing all above steps No of models and their shapes patterns will be now fixed.
G. Suitable method of analysis (Seismic Co-efficient Method) will now be selected.
H. Suitable type of software (STAAD PRO.) Will be selected for Analysis.
I. After Analyzing all models comparative results will be plotted.
J. Based on obtained results final conclusions will be drafted.
K. At last all references will be made available for future work.
L. Based on obtained results final conclusions will be drafted.

V. DESIGN DATA

1) Live load : 3.0 kN/m2 at typical floor
: 1.5 kN/m2 on terrace
2) Floor finish: 0.50 kN/m2
3) Location : Zone II and Zone V
4) Earthquake load : As per IS-1893 (Part 1) - 2002
5) Depth of foundation below ground : 1.5 m (Regular Case)
6) Type of soil : Type II, Medium as per IS:1893
7) Storey height : Typical floor: 3.05 m,
8) Floors : G.F. + 6 upper floors
9) Walls : 230 mm thick brick masonry walls.
10) Beam size :- 230mm x 300mm,
11) Column size :- 300mm x 400 mm,
12) Slab thickness :- 130mm
13) Unit weight of concrete :- 25 Kn/m^3
14) Unit weight of brick masonry :- 19 Kn/m^3

VI. MATERIAL PROPERTIES

A. Concrete

All components unless specified in design: M25 grade all
*E*c = 5000 *fck* N/mm^2
= 5000 *fck* MN/m^2
= 20000 N/mm^2.

B. Steel

HYSD reinforcement of grade Fe 415 confirming to IS: 1786 is used throughout.

VII. MODEL NOMENCLATURE

Each model according to its specific floor condition are labeled as follows :-

Table 1 Model Description

MODEL	ZONE II	ZONE V
Regular Concrete Structure	RC1	RC2
Regular Steel Structure	RS1	RS2
Sloping Concrete Structure	SC1	SC2
Sloping Steel Structure	SS1	SS2

The angle for sloping ground will be taken as 10^0.

VIII. PLAN AND SIDE VIEW OF MODELS

A. Plan Of Model

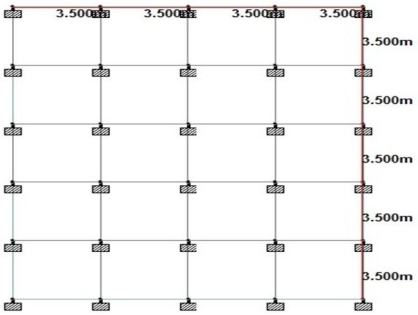

Fig. 01 Plan of model

B. Side View

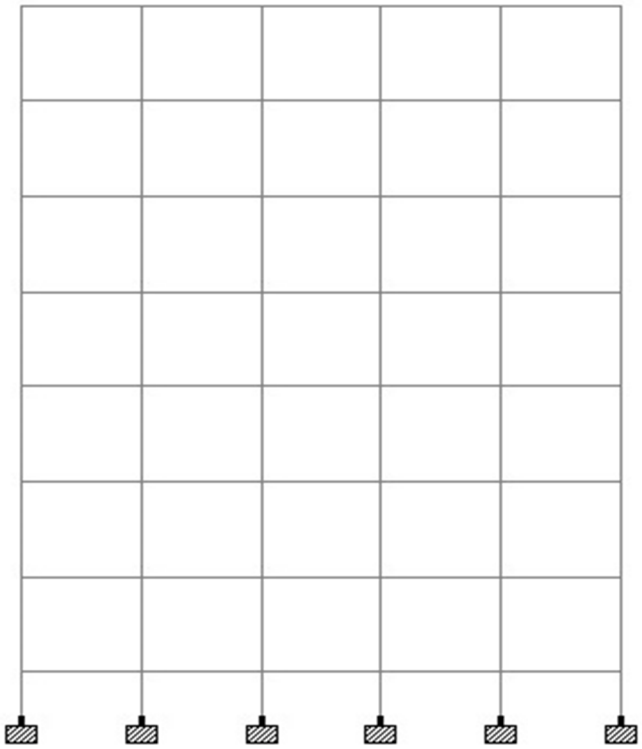

Fig. 02 Side View regular Structure

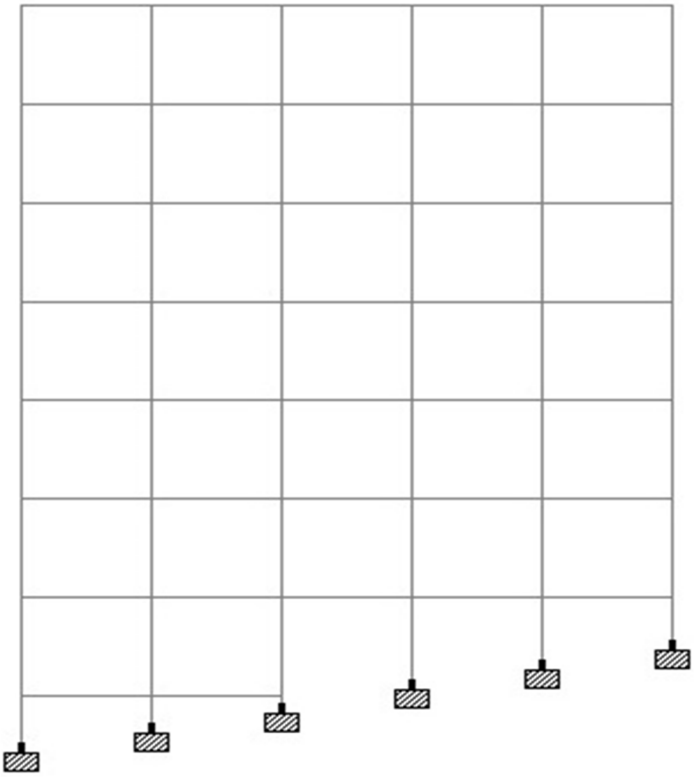

Fig. 03 Side View of Sloping Structure

IX. RESULTS FOR ALL MODELS

A. Results for all models in Zone-2

1) Reactions

Table 2 Maximum Reactions for all models of Zone-2

Sr No	Parameter	RC1	RS1	SC1	SS1
01	Fx	19.779	37.496	54.251	37.123
02	Fy	2892.661	2755.822	2886.949	2846.333
03	Fz	18.666	21.236	77.011	64.46

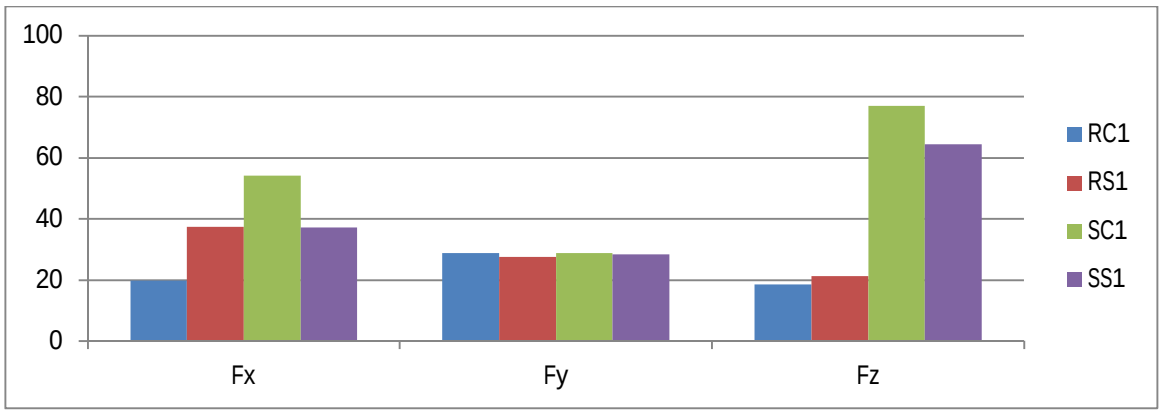

Fig. 4 Comparison of reactions for all models of zone 2

From above graph it can be observed that RCC structure has maximum values of forces in all direction on sloping ground meanwhile it has lowest values in case of plane ground.

2) Mode Frequency and Time Period

Table 3 Mode frequency and Time period for all models of Zone-2

Sr No	Mode	Frequency				Time Period			
		RC1	RS1	SC1	SS1	RC1	RS1	SC1	SS1
01	1	0.47	0.418	0.535	0.457	2.126	2.395	1.868	2.186
02	2	0.677	0.866	0.757	0.786	1.478	1.154	1.32	1.272
03	3	1.508	0.937	1.731	0.861	0.663	1.067	0.578	1.161
04	4	2.1	1.089	2.359	1.207	0.476	0.918	0.424	0.829
05	5	2.621	1.326	2.645	1.244	0.382	0.754	0.378	0.804
06	6	2.802	1.394	3.18	1.391	0.357	0.717	0.314	0.719

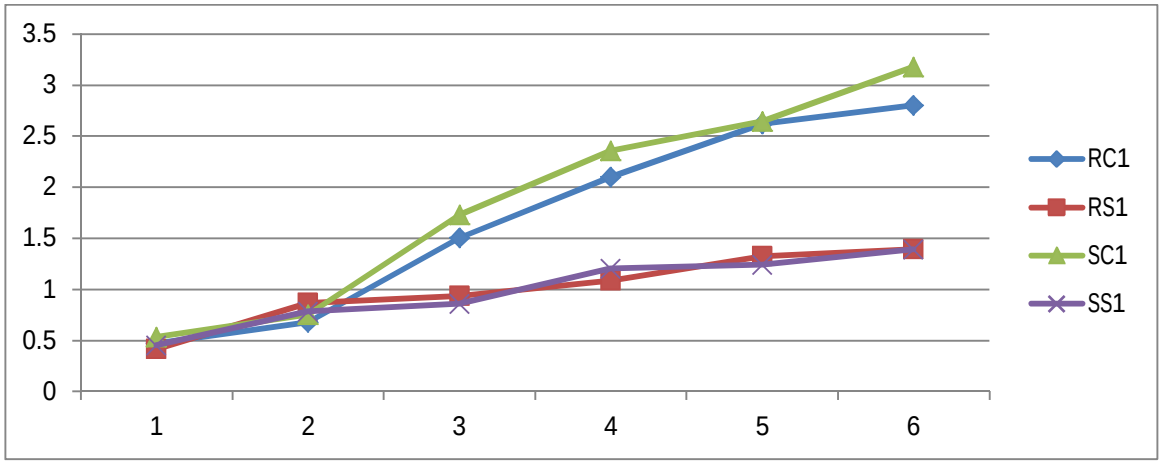

Fig. 5 Comparison of Frequencies for all models of zone 2

Above graph shows that frequency requirement for steel structures on sloping ground and on plane ground requires less whereas RCC structure has values on higher sides.

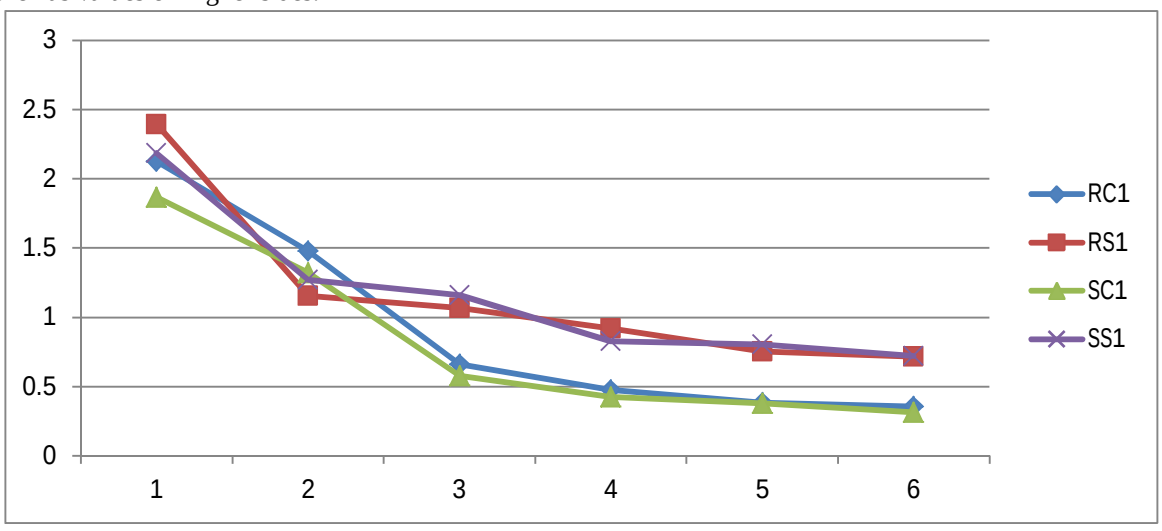

Fig. 6 Comparison of Time Period for all models of zone 2

Above graph shows that time period required for RCC structure is less than all others and also shows a linear decrement in requirement of time period from mode 1 to 6. The graph also shows that steel structures on plane and sloping ground has the high time period than RCC structures.

3) Displacement for all Models in zone-2

Table 4 Maximum Displacement for all models of Zone-2

Sr No	Parameter	RC1	RS1	SC1	SS1
01	X	48.281	28.558	42.49	37.242
02	Y	0.266	0.316	0.253	0.213
03	Z	41.287	64.283	32.177	56.119
04	Resultant	51.39	64.461	46.012	60.966

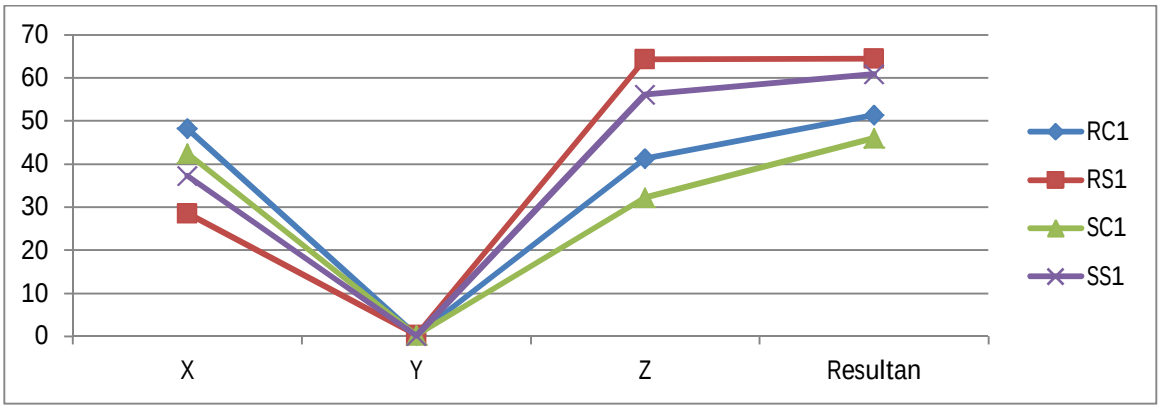

Fig. 7 Comparison of Maximum Displacement for all models of zone 2

Graph shows that steel structures has less displacement in X direction but shows maximum values in Z direction and resultant values. Whereas steel structures on sloping ground has higher values of displacement in but direction but minimizes in Z direction from all this discussion it can be conclude that steel structures are better than RCC structure from displacement point of view.

4) Beam End Forces for all models in zone-2

Table 5 Maximum moments for all models of Zone-2

Sr No	Parameter	RC1	RS1	SC1	SS1
01	Mx	1.443	0.015	74.713	0.031
02	My	38.808	39.605	88.841	63.583
03	Mz	70.736	134.692	69.594	112.292

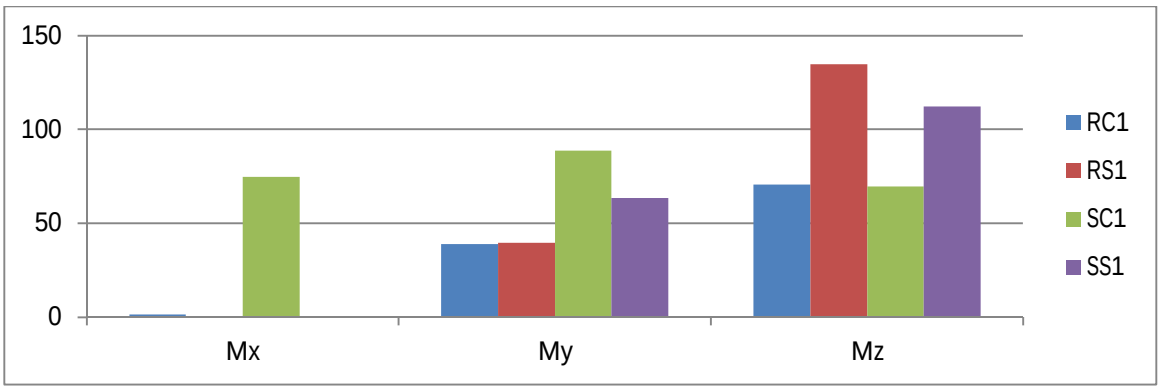

Fig. 8 Comparison of Maximum Moment for all models of zone 2

Above graph shows that Steel Structures on plane ground and Concrete structures on sloping ground attains maximum values of moment in X, Y, and Z direction all models have negligible values of Mx caused by Mx moment at a particular point.

5) Base Shear and Storey Shear for all models of Zone-2

Table 6Base Shear and Storey for all models of Zone-2

Sr No	Storey Level	RC1	RS1	SC1	SS1
01	07	84.359	83.952	82.923	81.777
02	06	72.97	70.451	71.728	68.409
03	05	52.162	50.361	51.274	48.902
04	04	34.838	33.635	34.251	32.661
05	03	20.999	20.274	20.641	19.686
06	02	10.644	10.276	10.463	9.979
07	01	3.774	3.634	3.671	3.534
08	00	0.077	0.014	0.033	0.023
Total Base Shear		279.822	272.607	274.998	264.951

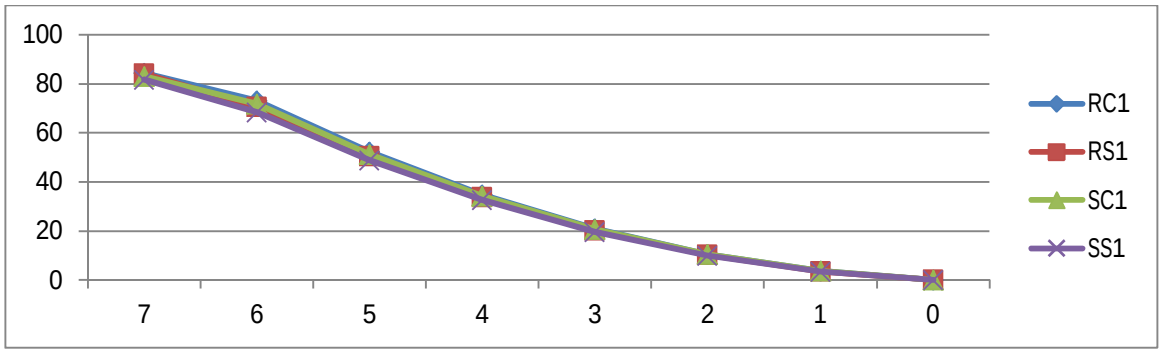

Fig. 9 Comparison of Storey Shear for all models of zone 2

Though there is variation in Base shear values of all models but Graph of storey shear represents the similar pattern of storey shear and for bottom 3 storey's they are almost coinciding with each others. It can also be seen that base shear are storey shear values are less for steel structure on both plane and sloping ground. It can also be seen that for same loading and zoning conditions steel structures has less mass/weight of structures than RCC structures which results in minimizing values of base shear.

B. Results for all models in Zone-5

1) Reactions

Table 7 Maximum Reactions for all models of Zone-5

Sr No	Parameter	RC1	RS1	SC1	SS1
01	Fx	69.914	70.56	159.988	107.604
02	Fy	3137.895	2859.148	3090.609	2956.595
03	Fz	63.363	64.448	253.477	179.878

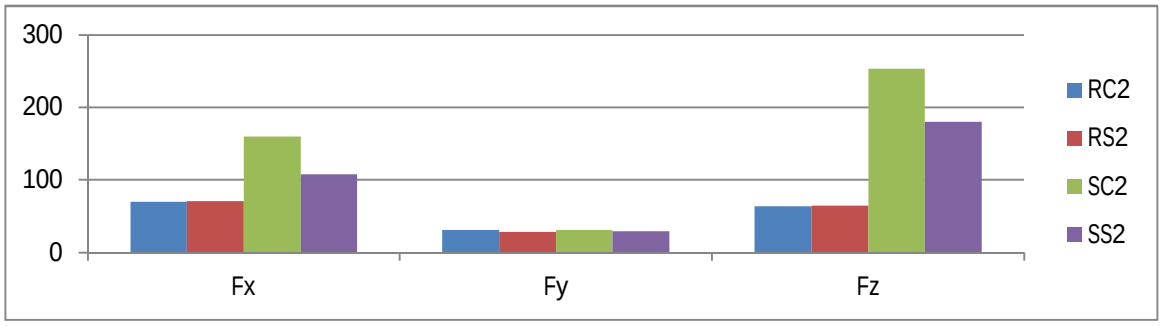

Fig. 10 Comparison of reactions for all models of zone 5

While comparing reactions in severe zone RCC structures shows higher values of reactions on sloping ground whereas on plane ground Steel structures shows lower values.

2) Mode Frequency and Time Period

Table 8 Mode frequency and Time period for all models of Zone-5

Sr No	Mode	Frequency				Time Period			
		RC2	RS2	SC2	SS2	RC2	RS2	SC2	SS2
01	1	0.47	0.589	0.535	0.618	2.126	1.699	1.868	1.619
02	2	0.677	1.299	0.757	1.092	1.478	0.77	1.32	0.916
03	3	1.508	1.506	1.731	1.216	0.663	0.664	0.578	0.822
04	4	2.1	1.681	2.359	1.738	0.476	0.595	0.424	0.575
05	5	2.621	2.193	2.645	1.779	0.382	0.456	0.378	0.562
06	6	2.802	2.203	3.18	2.04	0.357	0.454	0.314	0.49

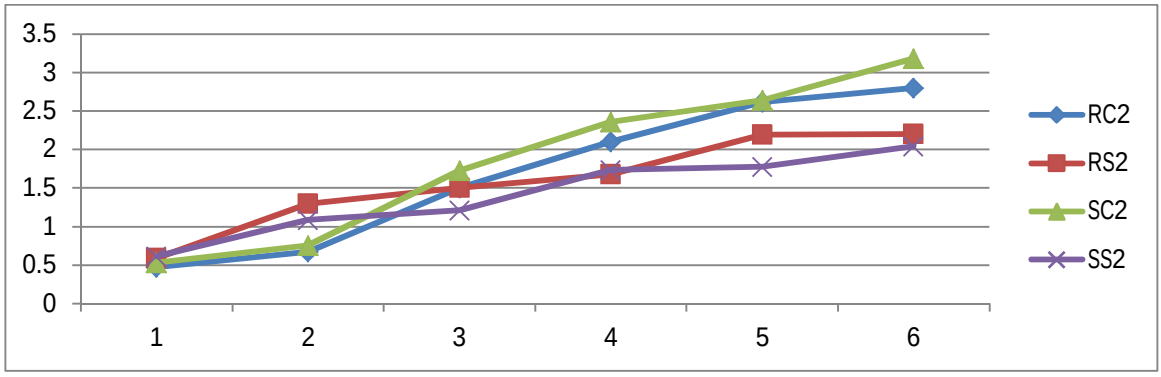

Fig. 11 Comparison of Frequency for all models of zone 5

Though frequency requirement for RCC structure is same for structures on plane and sloping ground it changes it values for steel structures on pane an sloping grounds. In both case steel structures has lower frequency than RCC structures.

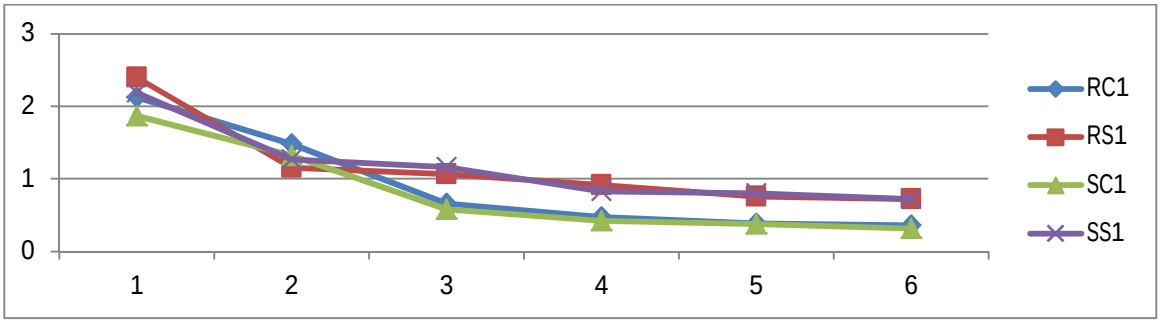

Fig. 12 Comparison of Time Period for all models of zone 5

In above comparative graph time period for steel structures and RCC structures in respective cases are same. RCC structure shows less time period than steel structures. This is might be because of material properties of steel and concrete.

3) Displacement

Table 9 Maximum Displacement for all models of Zone-5

Sr No	Parameter	RC2	RS2	SC2	SS2
01	X	174.224	40.047	153.927	69.645
02	Y	0.958	0.79	0.909	0.683
03	Z	148.12	108.606	119.688	105.37
04	Resultant	175.821	108.993	155.759	109.028

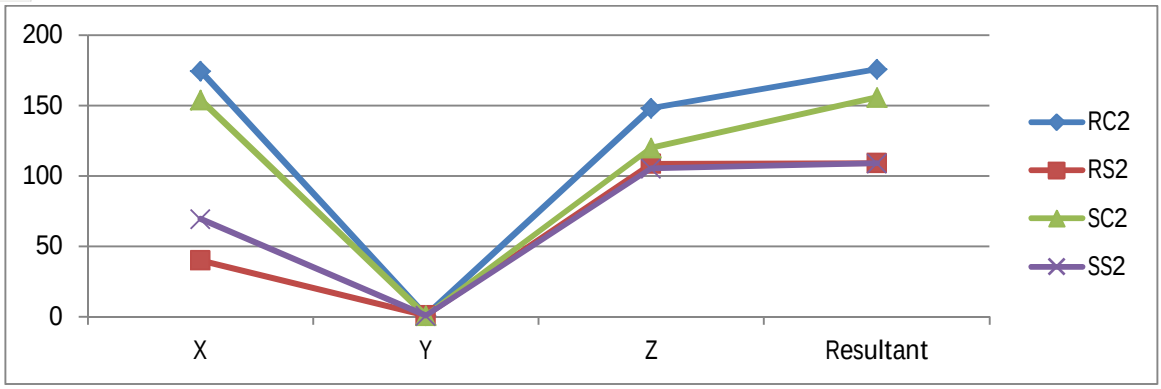

Fig. 13 Comparison of Displacement for all models of zone 5

In case of displacement values for zone 5 steel structures show comparatively lower values than RCC structures from this it can be concluded that steel structures behaves good in severe zones than RCC structures.

4) Beam End Forces

Table 10 Maximum moments for all models of Zone-5

Sr No	Parameter	RC2	RS2	SC2	SS2
01	Mx	3.103	0.051	6.527	0.081
02	My	131.546	97.704	301.602	156.653
03	Mz	122.131	242.687	171.224	283.783

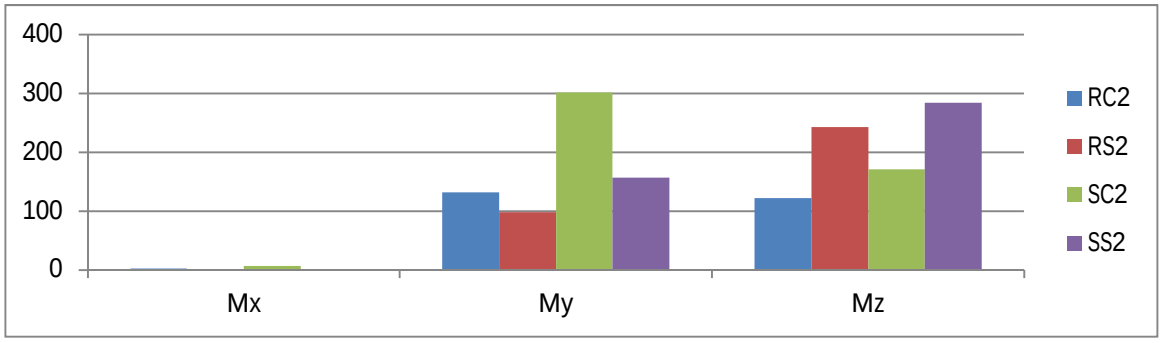

Fig. 14 Comparison of Beam Moments for all models of zone 5

Moment comparison in severe zone represents higher values of Mx, My for concrete structures on sloping ground while lower values Mz on plane ground. While steel structures has lowest values on plane ground and highest values for Mz on Sloping ground

5) Base Shear and Storey Shear

Table 11 Base shear and storey shear for all models of Zone-5

Sr No	Storey Level	RC2	RS2	SC2	SS2
01	07	303.691	302.226	298.521	294.396
02	06	262.692	253.624	258.221	246.273
03	05	187.782	181.3	184.586	176.045
04	04	125.417	121.087	123.282	117.578
05	03	75.595	72.986	74.308	70.87
06	02	38.318	36.995	37.666	35.923
07	01	13.585	13.116	13.216	12.722
08	00	0.277	0.05	0.121	0.01
Total Base Shear		1007.357	981.384	989.994	953.824

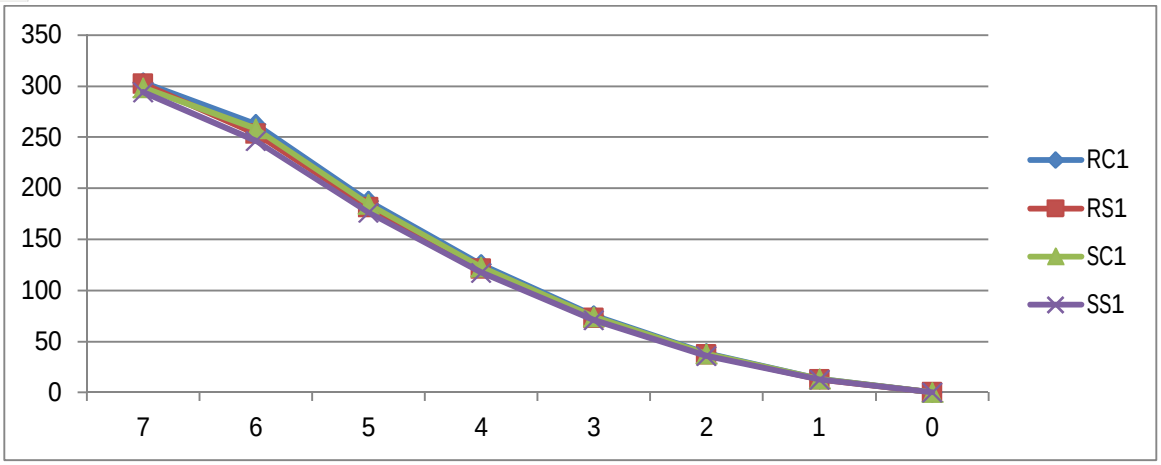

Fig. 15 Comparison of reactions for all models of zone 5

Storey shear distribution for all models in severe zones are also similar as in low risk zone here also steel structures on sloping ground has lower values of base shear and shows lower curve in storey shear graph. While RCC structure on plane ground shows highest values of Base shear and because of this it is the highest curve amongst all models. So that it can be conclude that steel structures behaves good in both plane and sloping ground in severe zone.

X. CONCLUISONS

A. In low intensity zone and in very severe seismic zone steel structure reduces axial forces than RCC structures on plane ground and also on sloping ground.

B. In concern with modal frequency and time period RCC structure behave better than steel structures on both plane and sloping ground in low seismic zone but in severe seismic zones steel structure behaves excellent than RCC structure.

C. In both low and very severe seismic zones steel structures have less displacement values than RCC structures on both plane and sloping ground.

D. In both low and very severe seismic zones steel structure reduces the intensity of vertical moments than RCC structures but has high values of Horizontal moments.

E. In both low and very severe seismic zones for the same structural configurations and loading conditions steel structure can be designed efficiently and has comparatively lower value of Seismic base shear.

F. At last from all above conclusions it can be concluded that steel structures are efficient and better in both low and very severe seismic zones in any type of ground conditions.

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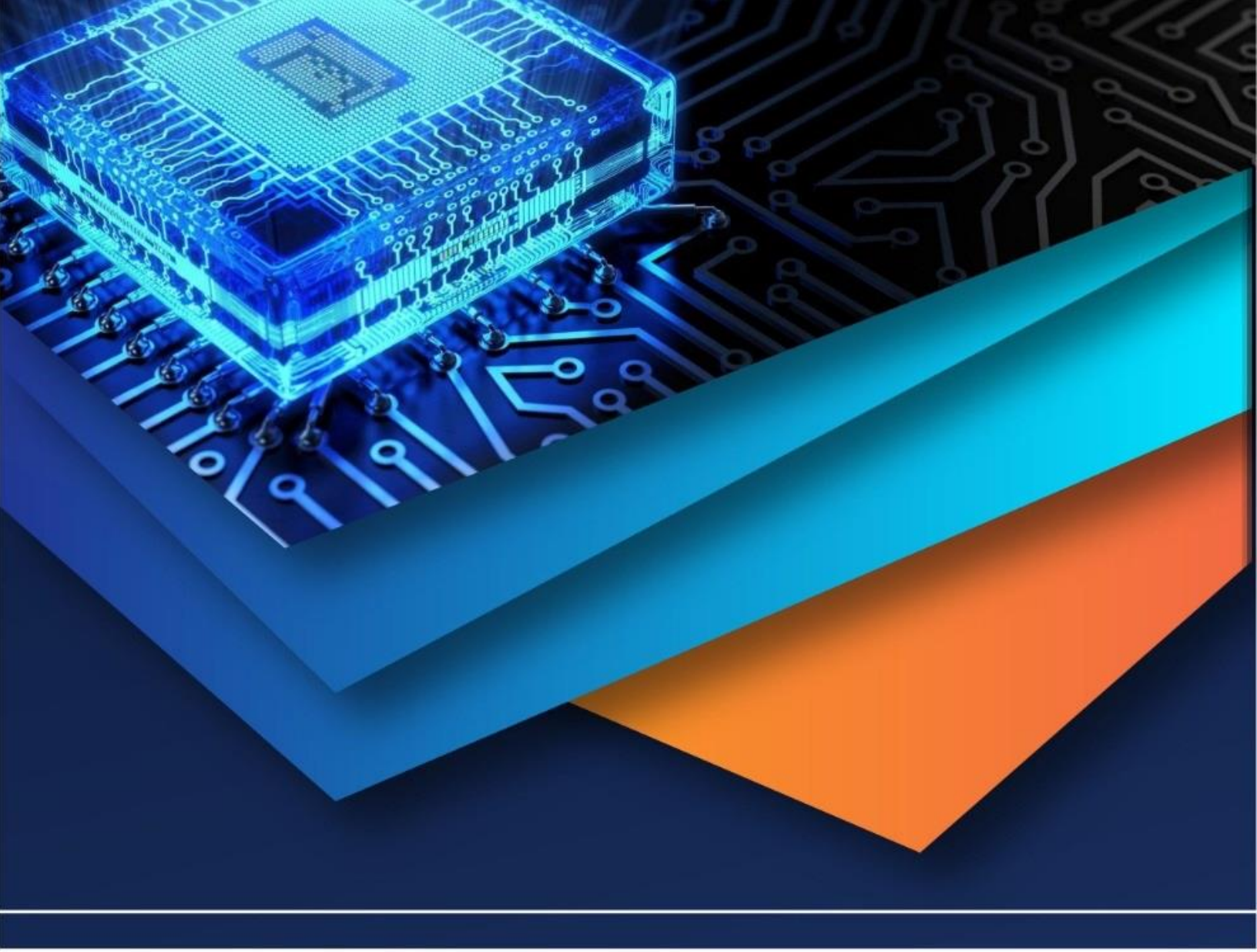

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