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Comparative Analysis of Vertical Irregularities at various Floor Level

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Abstract: The behaviour of a building during an earthquake depends on several factors such as stiffness, adequate lateral strength, ductility and configuration. The buildings with regular geometry and uniformly distributed mass and stiffness in plan as well as in elevation suffer much less damage compared to irregular configurations. The aim of this study is to evaluate the seismic behavior of RC building having different types of irregularities, mainly vertical geometric irregularity and stiffness irregularity. For this study, 01 Regular building model and other 04 vertically irregular buildings (stepped buildings) at different levels are modeled and analyzed. To study the behavior of the irregular structures, response spectrum analysis is conducted. From analysis it is found that As the mass increases from top to bottom model time period also increases. Modal time period is less for the structure having irregularity on 2/3 of floor height. In systematic irregular structure pattern storey shear distribution in model having irregularity up to 1/2 of total height of structure is excellent than other models. Horizontal displacements in systematic Irregular structures are less than regular structure in same zone and loading conditions.
Keyword: Structural Parameters, Irregularities, Axial force, Displacement, Base shear.

I. INTRODUCTION

During earthquake, structural failure starts off-evolved at factors of weak spot this weak spots arises due to structural discontinuity in mass, stiffness and structural geometry. Buildings which have any one or all of this discontinuities are termed as Irregular structures contribute large number of building constructions. most of building failure are found to be due to some kind of irregularity in building. Changes in structural mass variation or geometric variation affects the behavior of building during earthquake. Mean while framing material also affect the seismic behavior of vertically irregular building.

To study the effect of structural irregularity during earthquake in rcc and steel framing the building model is prepared as per IS 1893:2002 (part1)

II. AIM

To Study the effect of systematic Vertical Irregularity in Building.

III. OBJECTIVE

The objectives of project are as follows

A. To study the parameters of displacement, Forces and Moments
B. To Study Behaviour of models various types of floor wise Irregularity during Earthquake.
C. To Study effect of Various Systematic Irregularities with Same Location and material

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.

V. STRUCTURAL PARAMETERS

Table 1 Detail Structural Parameters

Parameter	Value
Live load	3 kN/m2
Density of concrete	25 kN/m3
Thickness of slab	130 mm
Depth of beam	300 mm
Width of beam	230 mm
Dimension of column	300 x 400 mm
Thickness of outside wall	230 mm
Thickness of inner side wall	100 mm
Height of floor	3.05 m
Earthquake zone	II
Damping ratio	0%
Type of soil	II
Type of structure	Special moment resisting frame
Response reduction factor	5
Importance factor	1.5
Roof treatment	1 kN/m2
Floor finishing	0.50 kN/m2
Number of Storey's	06

VI. MATERIAL PROPERTIES:

Table 2 material properties

Material	Concrete	Steel
Grade	M 25	Fe 415
Mass Density	2549.3	7849
Unit Weight	25	76.97
Modulus of Elasticity	25,000,000	20,000,000
Poisson's Ratio	0.15	0.3

VII. MODEL NOMENCLATURE

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

Table 3 Model Description

Model Description	Label
Regular Building	R1
Model With Set back at 1st storey	R2
Model With Set back at 1st, and 2nd storey	R3
Model With Set back at 1st, 2nd, 3rd storey	R4
Model With Set back at 1st, 2nd, 3rd,4th storey	R5

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VIII. 3D VIEW OF MODELS

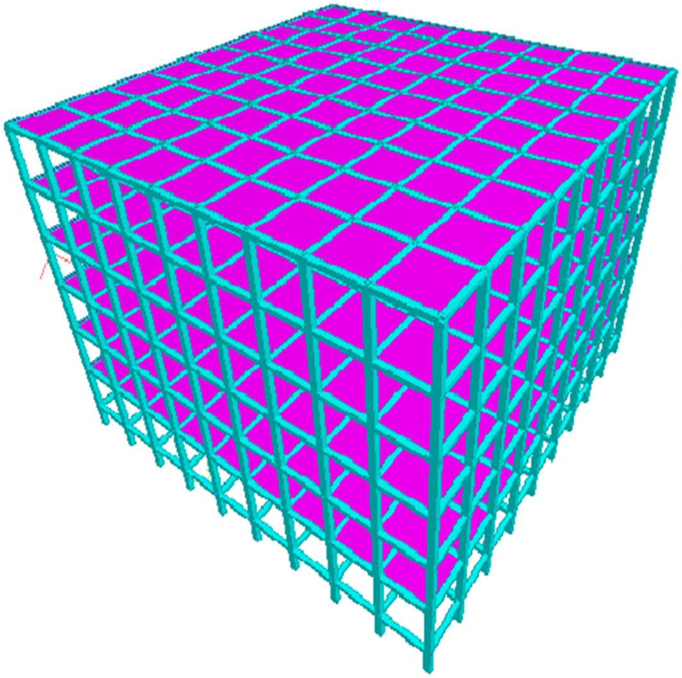

Fig.01 3D VIEW OF MODEL R1

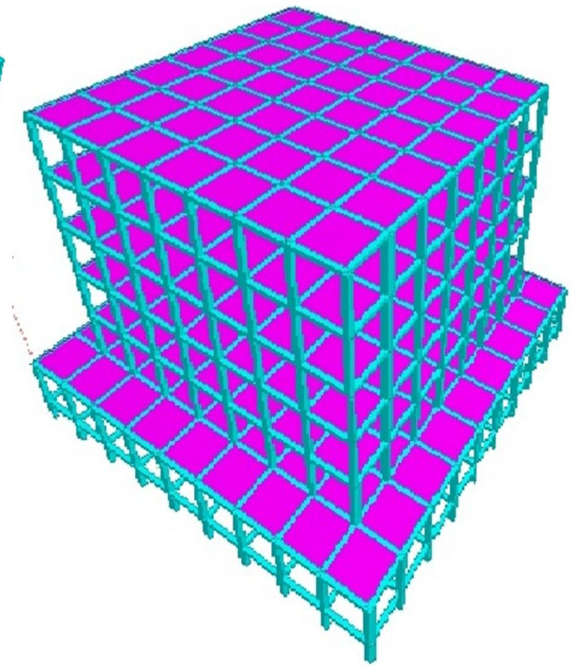

Fig.02 3D VIEW OF MODEL R2

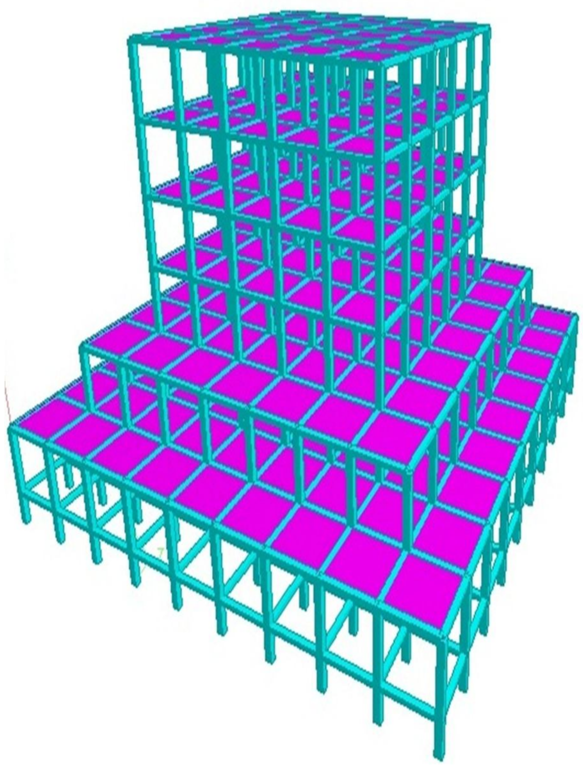

Fig.03 3D VIEW OF MODEL R3

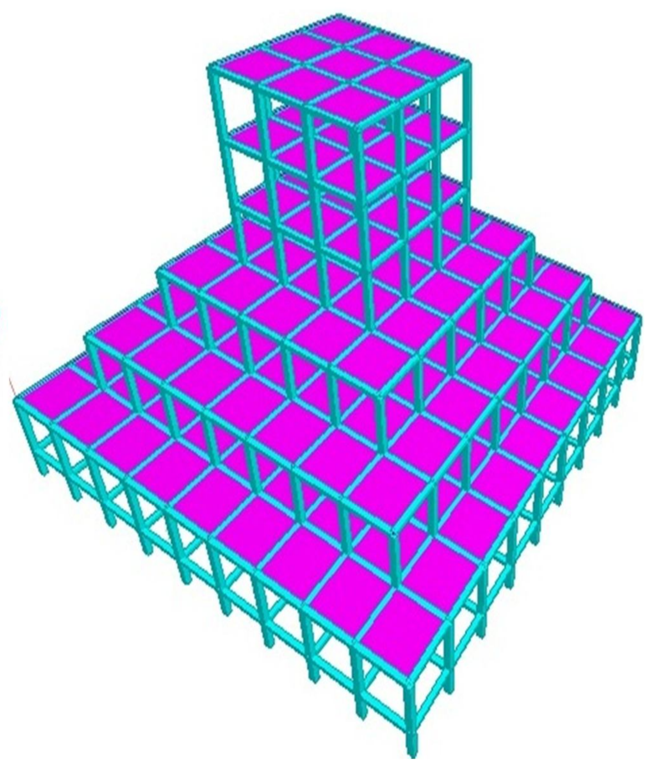

Fig.04 3D VIEW OF MODEL R4

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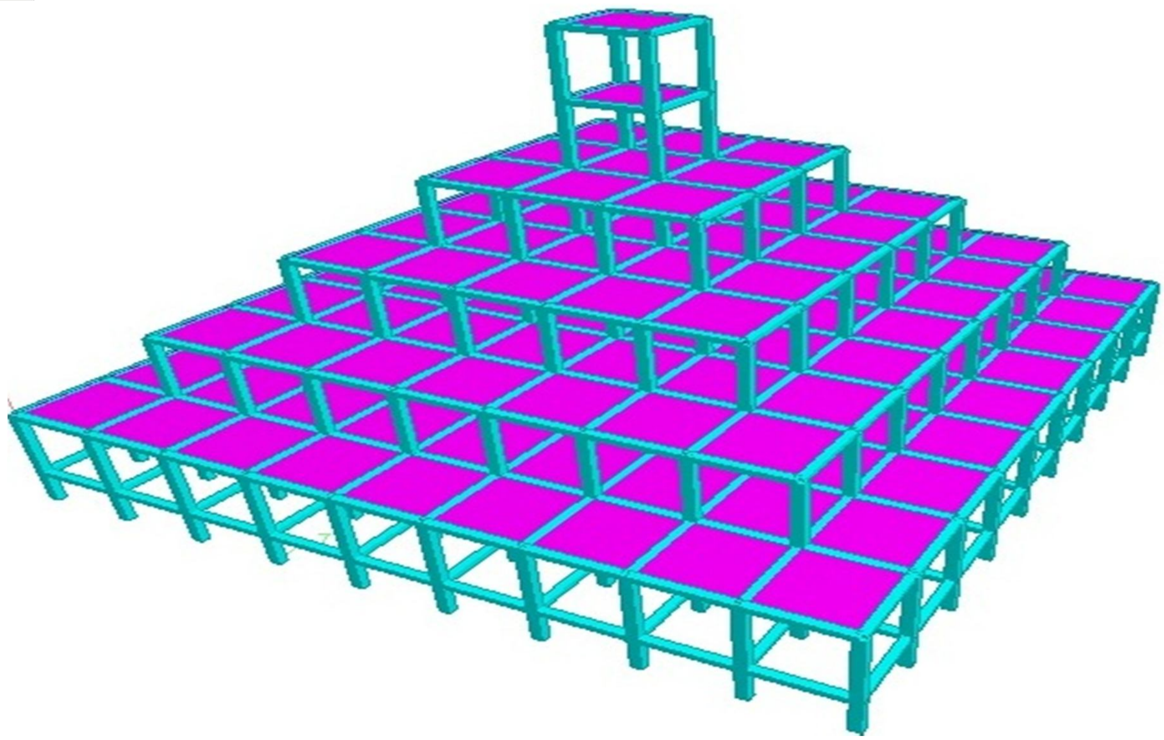

Fig.01 3D View of Model R5

IX. RESULTS FOR ALL MODELS

A. Axial Forces

Table 4 Axial Force comparison for all models

Sr No	Parameter	R1	R2	R3	R4	R5
01	Fx	20.33	14.965	13.101	10.82	9.401
02	Fy	6111.946	3276.336	1763.046	1099.42	1092.46
03	Fz	20.429	15.584	13.807	11.501	9.91

B. Maximum Displacement

Table 5 Maximum Displacement of all models

Sr No	Parameter	R1	R2	R3	R4	R5
01	X	36.756	34.768	34.273	32.827	21.022
02	Y	0.178	0.17	0.171	0.167	0.094
03	Z	32.134	30.361	29.894	28.578	18.244
04	Resultant	46.297	38.433	35.373	33.129	21.229

C. Maximum Beam Moments

Table 6 Maximum moments

Sr No	Parameter	R1	R2	R3	R4	R5
01	Mx	3.223	2.403	2.483	2.001	1.385
02	My	78.187	49.785	43.927	39.824	30.064
03	Mz	112.958	69.049	50.034	42.738	34.193

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D. Base Shear and Storey Shear for all Models

Table 7 Base shear and storey shear for all models

Sr No	Storey level	R1	R2	R3	R4	R5
01	06	328.358	221.744	147.976	83.392	15.513
02	05	248.634	168.371	112.931	64.427	12.796
03	04	166.33	112.637	75.548	43.1	58.139
04	03	100.515	68.067	45.654	66.944	95.586
05	02	51.187	34.663	43.639	66.282	94.640
06	01	18.347	19.936	25.746	39.105	55.836
07	00	0.405	0.449	0.579	0.88	1.256
Total		913.775	625.567	452.074	364.13	333.767

E. Modal Frequency and Time Period

Table 8 modal frequency and time period for all models

Sr No	Mode	Frequency					Time Period				
		R1	R2	R3	R4	R5	R1	R2	R3	R4	R5
01	01	0.579	0.626	0.726	0.932	1.246	1.728	1.596	1.378	1.073	0.803
02	02	0.694	0.793	1.011	1.517	1.96	1.441	1.261	0.989	0.659	0.51
03	03	1.429	1.816	1.966	1.832	2.12	0.7	0.551	0.509	0.546	0.472
04	04	1.76	1.956	2.427	2.273	2.64	0.568	0.511	0.412	0.44	0.379
05	05	2.12	2.393	2.446	2.459	3.029	0.472	0.418	0.409	0.407	0.33
06	06	2.131	2.623	2.652	2.995	3.036	0.469	0.381	0.377	0.334	0.329

X. DISCUSSION

A. Comparisons of Reactions for all Models

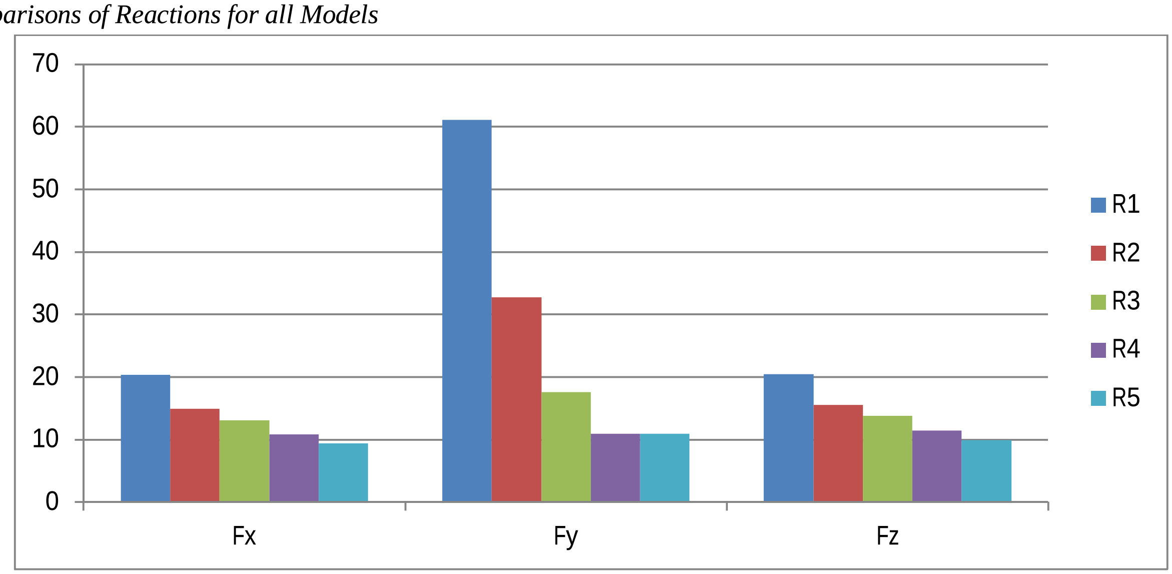

Fig. 6 Reaction comparison of all models

From above graph of reactions comparison we can see that Fx of R5 is nearly half of R1 from this it is observed that though the structure has irregularity on top floors still they have less horizontal effect as mass also reduces. Also in Fy magnitude of R5 changes with huge difference with compared to other but R5 and R4 are nearly same though they have different irregularity patterns. (for plotting graph magnitude of Fx has been converted to 61.11 x 10^2 Kn)

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B. Comparison of Displacement

From table 5 of displacement comparison it is observed that with reduction in mass there is also reduction in displacement quantity in X-direction for R1 it is 36.756 which slightly reduces 34.768 for R2 and 34.827 for R3 but has major change for quantity of R5 (21.022). their is no major change in the quantities of Y-direction except R5 whose quantity is approximately half of R1. Similarly, for resultant displacement value of R2 reduces by 17 % then after in a small reduction for R3, R4 but has 54.14% reduction in R5.

C. Comparison of Moments

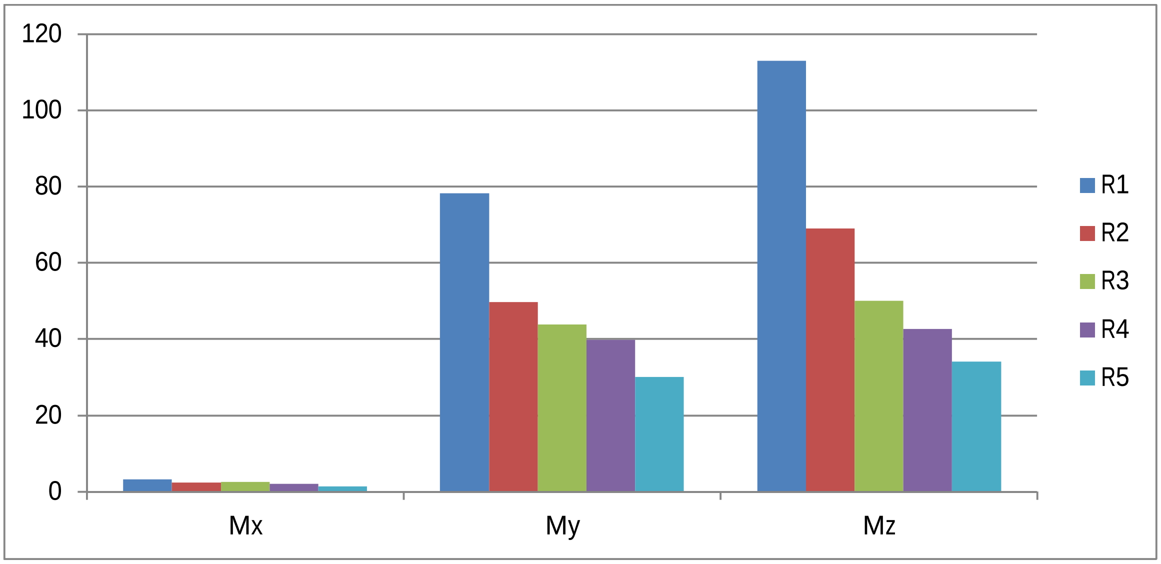

Fig. 7 Moment comparison of all models

Above graph of comparison in all three directions shows that quantities of both Mx and My reduces as the mass reduces towards top but there is huge reduction of 69.73% in Mz for model R5 compared to R1

D. Comparison of Storey shear for all Models

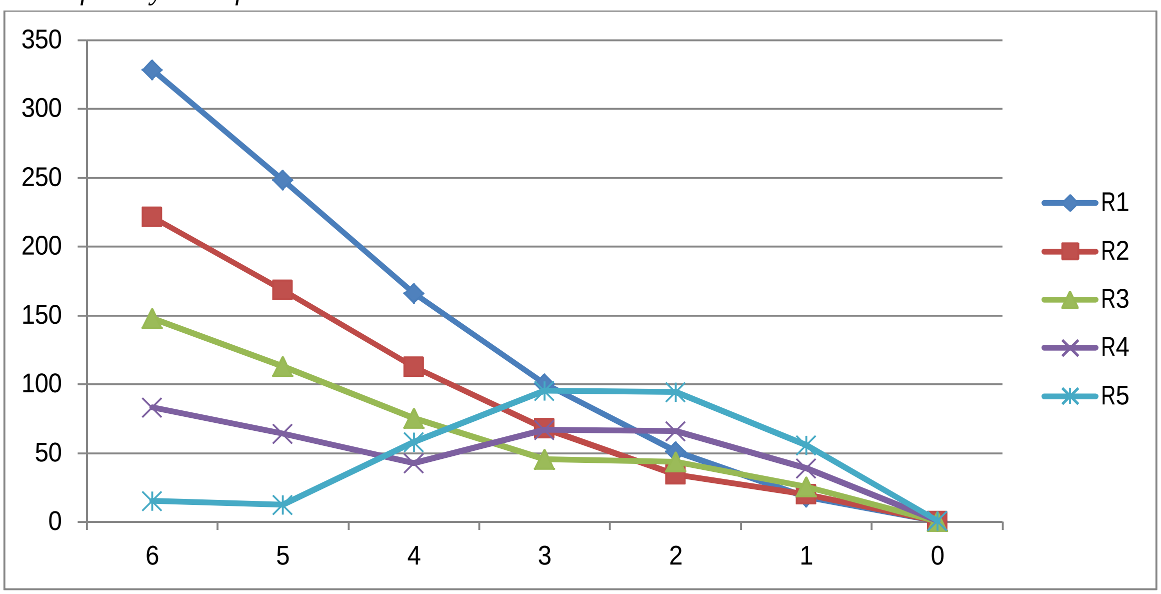

Fig. 8 Storey Shear Comparison for all models

Above graphs of for all models shows that there is liner reduction in storey shear for model R1 and R2 but for R3 it is linear upto 3rd storey from top and varying for bottom 3 storey's. For R4 and R5 the distribution of storey shear has varying pattern which has less intensities for top storey's and has high intensities for middle three storey's which again reduces to Zero at bottom storey start point.

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E. Comparison of modal Frequency for all Models

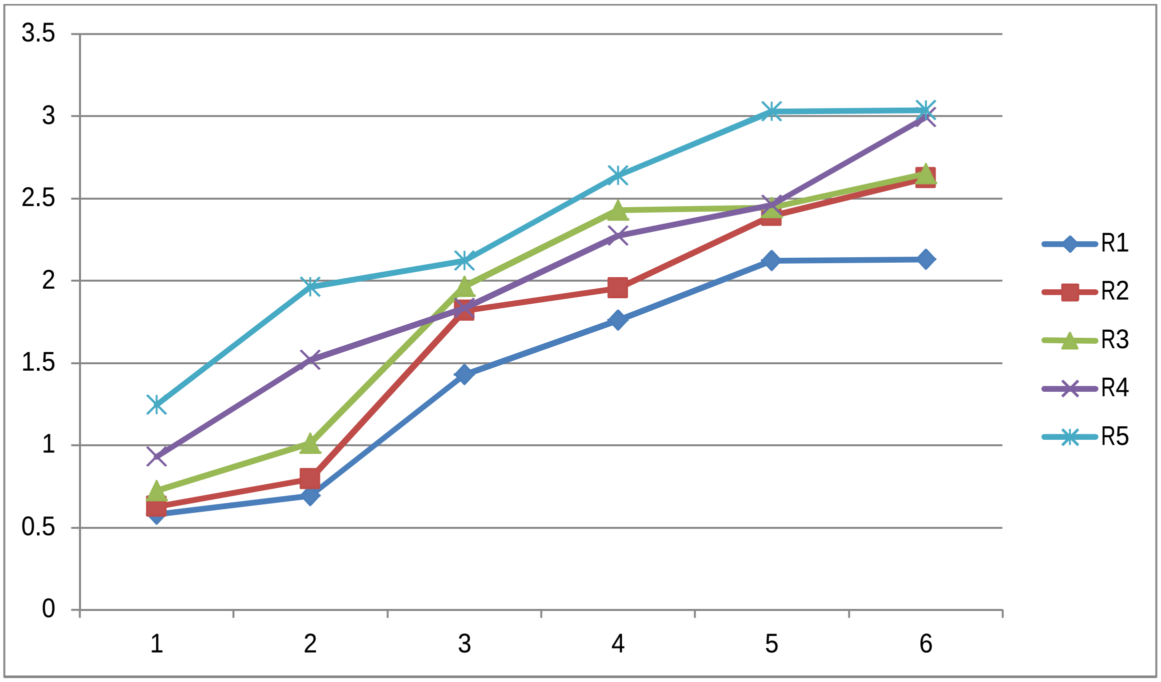

Fig.9 Frequency comparison for all models

From comparison of above frequency graphs one can see that model R5 requires more frequency that model R1 whereas model R4 has a little liner pattern , but model R2 and R3 has sudden changes in frequency pattern between 2^{nd} to 4^{th} mode.

F. Comparison Of Modal Time Period For All Models

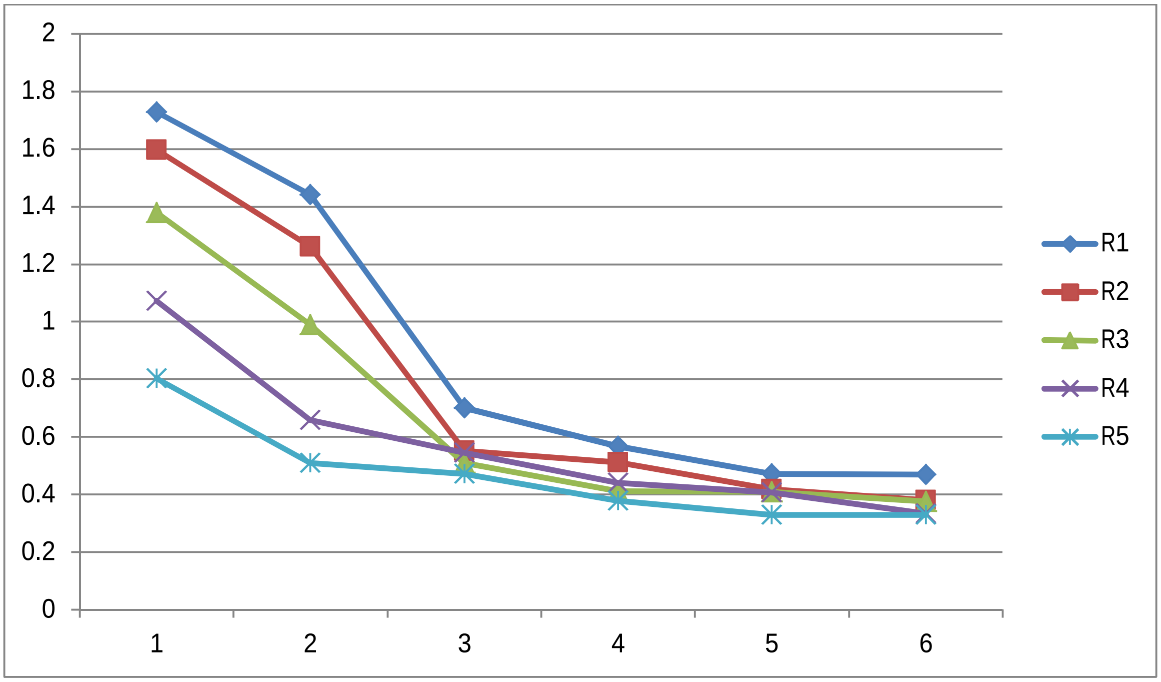

Fig. 10 Comparison for Time period of all models

From the above graph it is observed that model R1 requires highest modal time period than all other. While model R5 requires the lowest time period than all others. Model R4 shows linear reduction pattern after mode 2, model R2 and R3 changes their time period pattern suddenly after 3^{rd} mode which is little linear for remaining modes.

XI. CONCLUISONS

A. Mass irregularity effect reactions and moment to a large extent.
B. Horizontal displacements in systematic Irregular structures are less than regular structure in same zone and loading conditions.
C. Though there is irregularity in framing systematic arrangement helps to reduce axial forces and moments in beams
D. Buildings with large base to height ratio do well in earthquake though they have any mass or geometric irregularity.
E. Though the building is irregular floor wise mass reduction affects the total value of base shear in a significant manner.
F. Storey shear for regular structure is in linear format on other side for irregular structure non linear.
G. Continuously reducing floor mass towards upper floors reduces the intensity of base shear distribution but in a sudden format.
H. In systematic irregular structure pattern storey shear distribution in model having irregularity up to 1/2 of total height of structure is excellent than other models
I. regular structure requires less frequency than irregular structure
J. As the mass increases from top to bottom model time period also increases.
K. Modal time period is less for the structure having irregularity on 2/3 of floor height.

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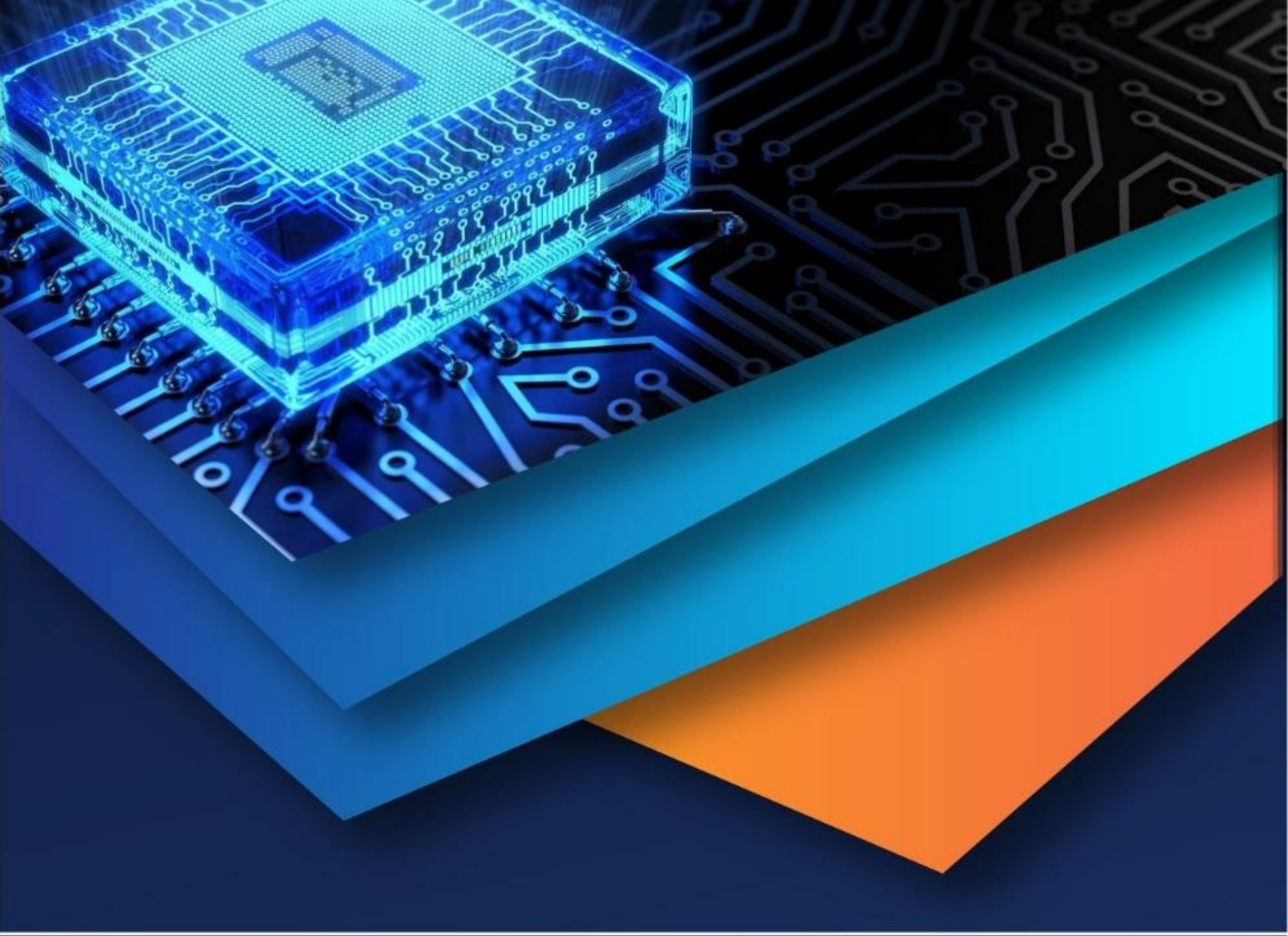

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