International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 11 | November - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

Study on Wind Analysis of Multi-Storied Building with Different Shapes and Different Terrain Category

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ABSTRACT:

An In all over the world developing countries there is a heavy need of tall building for the use of commercial as well as residential building. So, the new materials and construction techniques are used in structures. Different kinds of structures that are being used such as high-rise structures like towers, chimney, buildings etc. In case height of structure is greater than 6m the intensity of wind load will be acting on the structure. Due to this the swaying effects are there on the structure. However, for taller buildings the effect is more crucial. In this project there are 36 columns. By using a commercial software, we found the Mass irregular column having a highest reaction as compared to the other building. The vertical column having less reaction due to the decrease of height. In this G+30 the wind effect more critical than seismic effect therefore more 90 m height the analysis of wind load is extremely important in future point of view. More important to analyze the irregular structure for the wind load. When irregularity is occurred, there is lot of wind effect is occurred. Due to wind deflection is occur therefore, wind load is more critical for the tall buildings.

KEYWORDS:

G+30, Regular and Irregular structures, Wind force, STAAD PRO V8i.

I. INTRODUCTION

In modern world the new materials and construction techniques are used in structures. There are different kinds of structures that are being used such as high-rise structures like towers, chimney, buildings etc. In case height rise structure is greater than 6m the intensity of wind load will be acting on the structure. Due to this load the swaying effects are there on the structure. When the height of structure is more than 12m the intensity of the wind load will be even more. In recent scenario the population in cities is increasing.

Therefore, we need tall buildings to fulfill requirement of living of people. As the height of the building increases, the building becomes more flexible, low in damping and light in weight. Such structure influences more under the wind pressure. Wind forms the predominant source of load in free standing tall structures. The structure experiences aerodynamic forces due to wind on tall structure are divided into two categories as shown in the Figure 1.

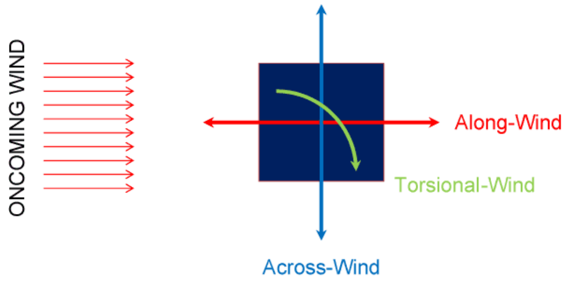


Figure 1

1. Along-wind effect: The drag force acting in the direction of the mean wind.
2. Across-wind effect: The lift force acting perpendicular to the direction.

The wind load is the most crucial factor that determined design of all building over 5 storey. The building taller than 5 storey generally requires additional steel and lateral systems. The action of natural wind, gusts and other aerodynamic forces will be affecting a tall building continuously. The structure deflects from a mean position and oscillate continuously.

II. METHODOLOGY

The proposed work is planned to be carried out in the following manner

- Literature Survey
- Study of IS 456-2000 for design of regular and irregular buildings, IS 875(Part 3)-1987 for with analysis.
- Study of Limit State Design Method.
- Preparation of Commercial Software (Select Series 4) models for regular and irregular structures
- Analysis and Design of high rise building by using IS 456-2000 and IS 875(Part 3)-1987.
- Preparation of Comparative results on the basis of Design.

III. MODELING AND ANALYSIS

Regular Building

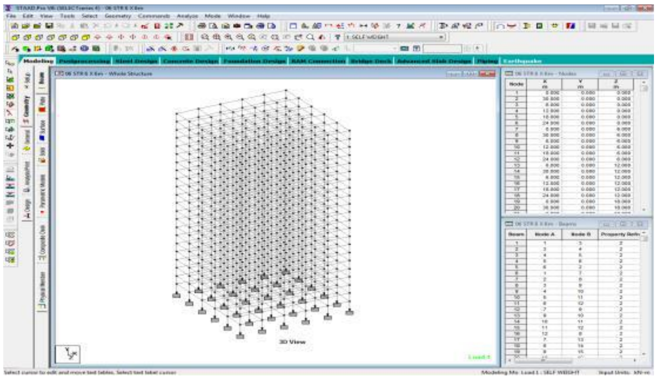


Figure 2: Geometry of Regular Building

Remark: This fig. shows the 3D view of regular building. The foundation nodes considering at 3m depth which is to be fixed by fixed support. The height of the building is 63m above the ground. The building is analyse for the G+20 storey for the wind effect on the building.

Mass Irregular Building

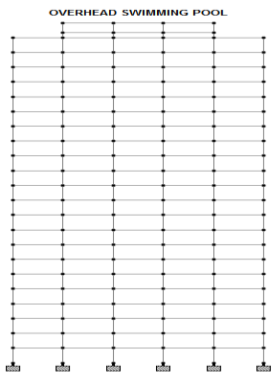


Figure 3: Geometry of Mass Irregular Building

Remark: This fig. shows the geometry of mass irregular building which at the top floor consisting swimming pool for the variation of the load at the floors. Due to this swimming pool what will be effects are taking place are shown in results through reactions, B.M., S.F. and deflection.

Stiffness Irregular Building

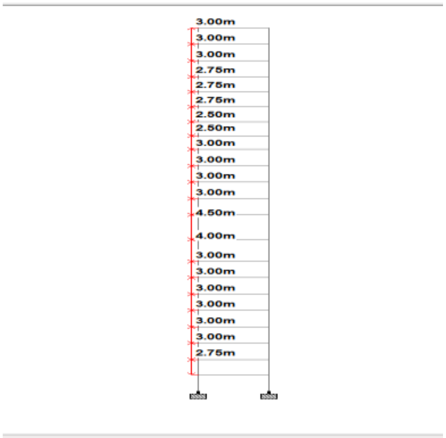


Figure 4 : Geometry of Stiffness Irregular Building

Remark: This fig shows the geometry of stiffness irregular building with different floor height. Fig shows the height of each floor separately. When the floor height is changes there B.M. and S.F. is suddenly decreases and increases.

Vertical Irregular Building

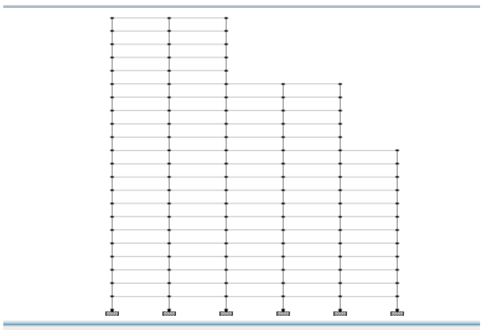


Figure 5 : Geometry of Vertical Irregular Building

Remark: The above fig. shows the front view of the vertical irregular building G+10, G+15 and G+20 with fix support at the base of the building. The height of each floor is 3.00m respectively. With single grid 6 X 6m each.

IV. RESULTS AND DISCUSSION

Table-1: Reactions from Column (KN)

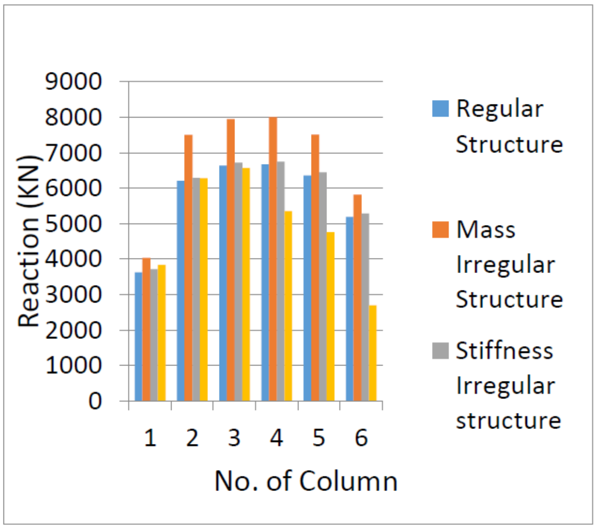
Column No.	Regular Structure	Mass Irregular Structure	Stiffness Irregular structure	Vertical Irregular Structure
1	3630	4032	3708	3839
2	6202	7498	6287	6278
3	6637	7945	6718	6572
4	6665	8006	6746	5352
5	6360	7504	6443	4754
6	5185	5814	5279	2698
7	6878	6726	6961	6858
8	10261	11245	10303	10084
9	10822	11952	10854	10308
10	10850	12157	10882	8774
11	10418	11438	10459	7806
12	8470	8572	8568	4746
13	7190	7204	7267	7122
14	10658	11875	10687	10465
15	11251	12453	11269	10677
16	11280	12760	11298	9006
17	10815	12199	10845	7966
18	8807	9091	8896	4800
19	7191	7233	7269	7085
20	10659	11873	10689	10462
21	11252	12309	11271	10678
22	11281	12510	11300	9006
23	10816	12055	10847	7969
24	8808	9087	8898	4834
25	6792	6882	6871	6668
26	10171	11350	10210	10001

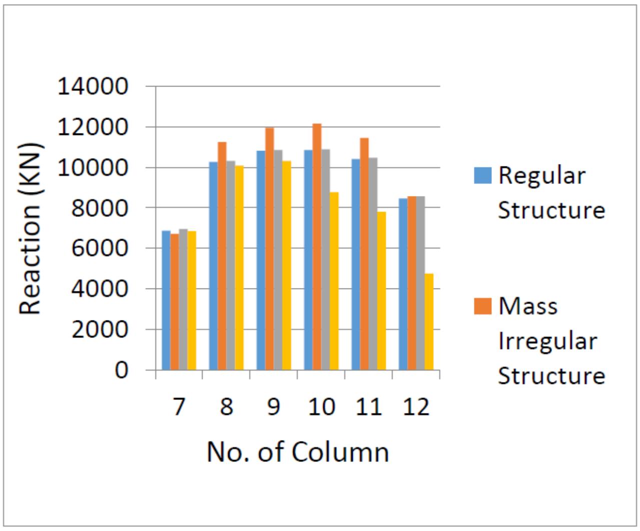
27	10731	11856	10759	10233
28	10759	11911	10787	8681
29	10321	11340	10366	7724
30	8384	8677	8478	4745
31	5376	5578	5470	5069
32	7971	9052	8069	7650
33	8419	9446	8512	7883
34	8446	9456	8541	6545
35	8127	8982	8225	5800
36	6931	7330	7041	3680

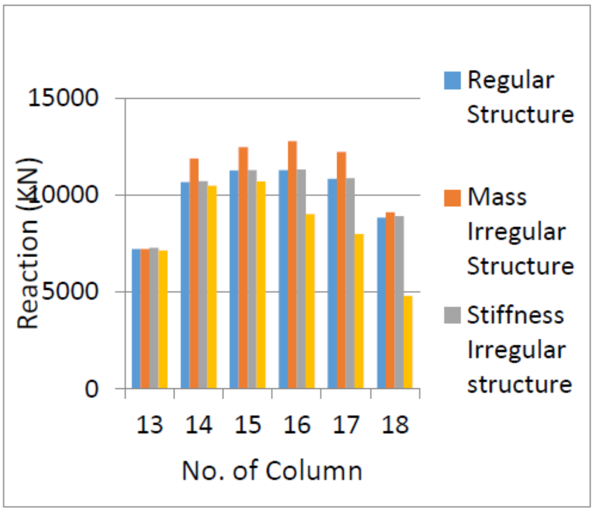
Table-2: Central Span Bending Moment (KN-m)

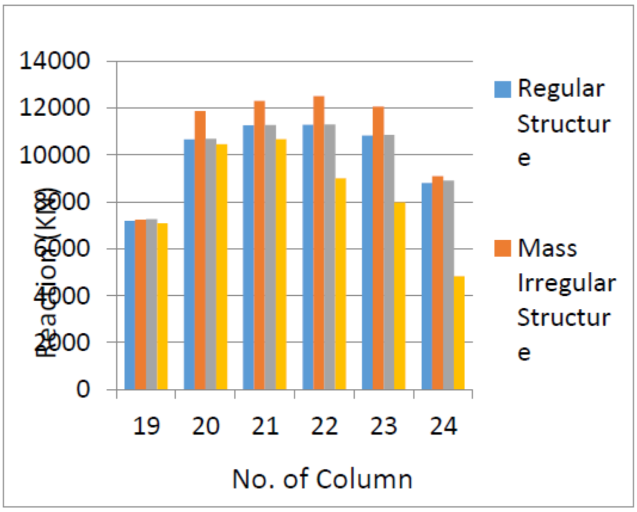
Floor No.	Regular Structure	Mass Irregular Structure	Stiffness Irregular Structure	Vertical Irregular Structure
G	0	0	0	0
1	182	180	171	158
2	170	169	169	151
3	163	162	165	146
4	155	153	158	153
5	147	153	150	155
6	144	155	146	156
7	144	156	156	155
8	143	157	185	156
9	142	158	153	156
10	140	158	141	153
11	138	158	136	145
12	136	158	134	144
13	134	157	129	146
14	132	156	126	145
15	130	155	126	142
16	127	154	124	152

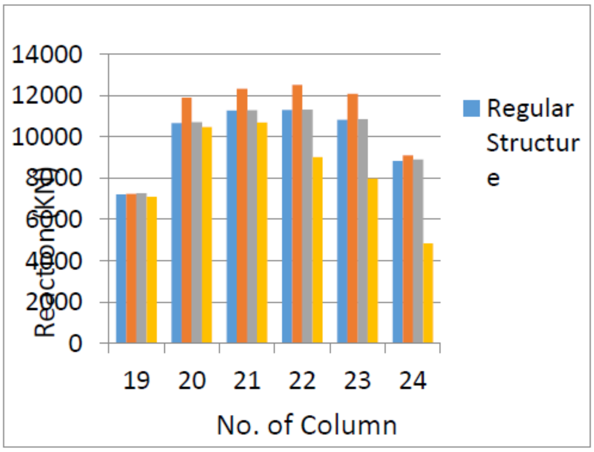
17	124	152	122	127
18	121	150	120	127
19	121	149	121	119
20	122	147	121	112

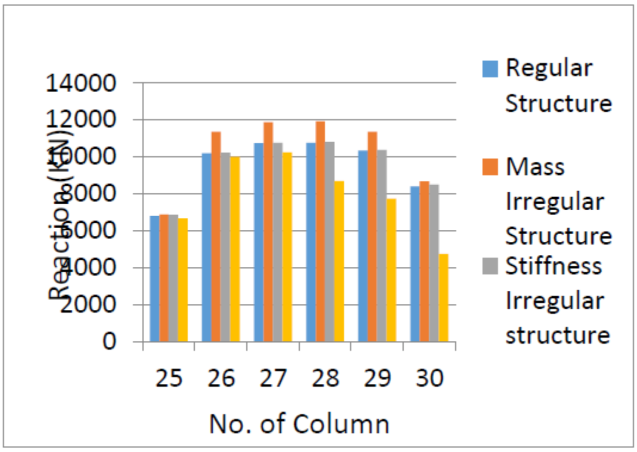












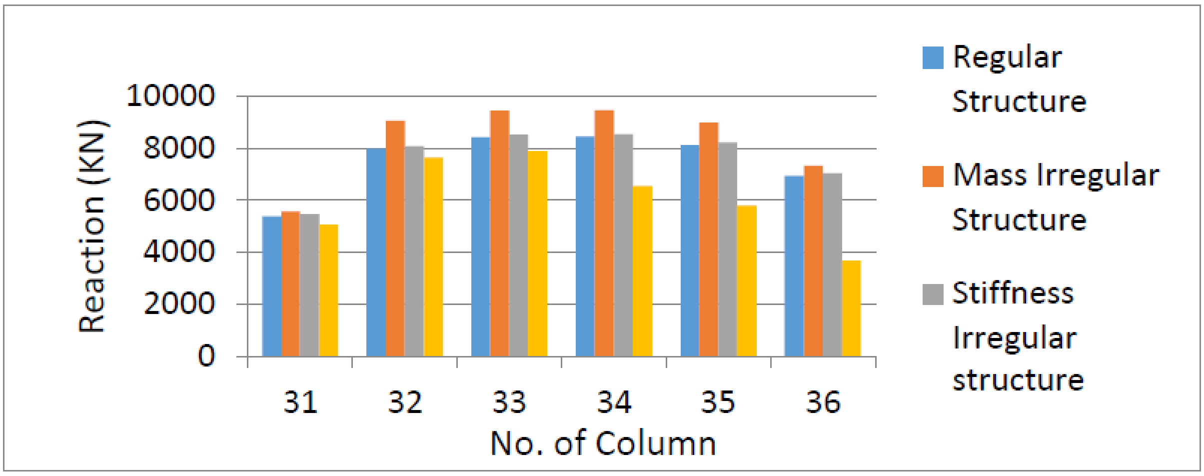


Figure 6 : Comparison of Reactions (KN)

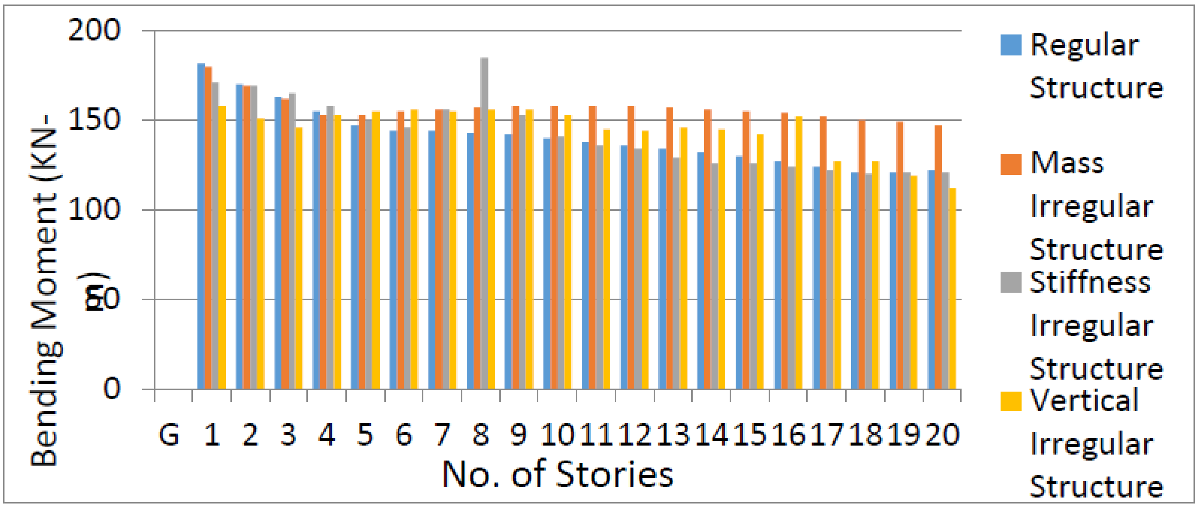


Figure 7 : Comparison of Central Span Bending Moment (KN-m)

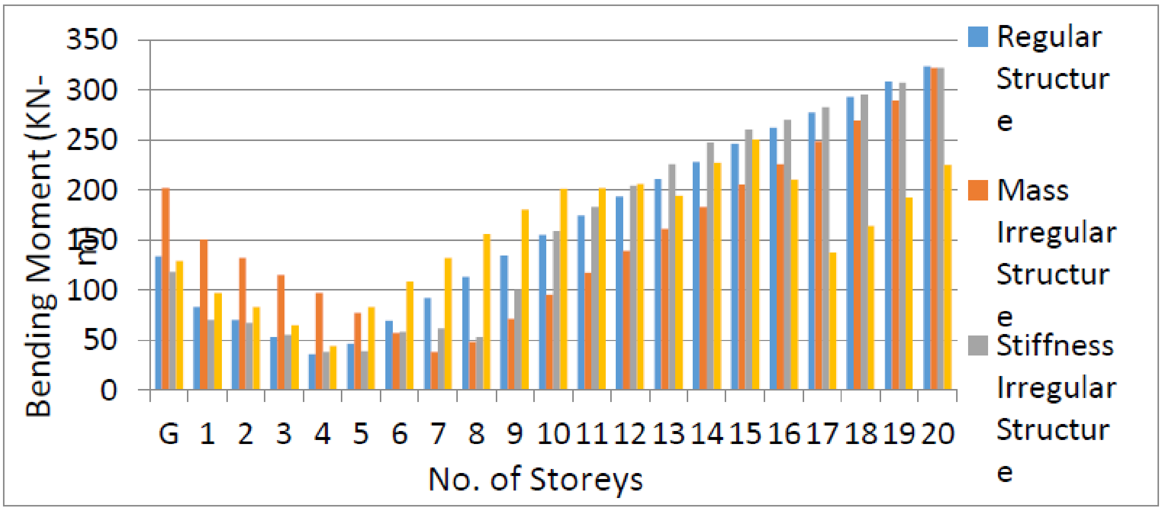


Figure 8 : Comparison of X-Direction Windward Bending Moment (KN-m)

Figure 9 : Comparison of X-Direction Leeward Bending Moment (KN-m)

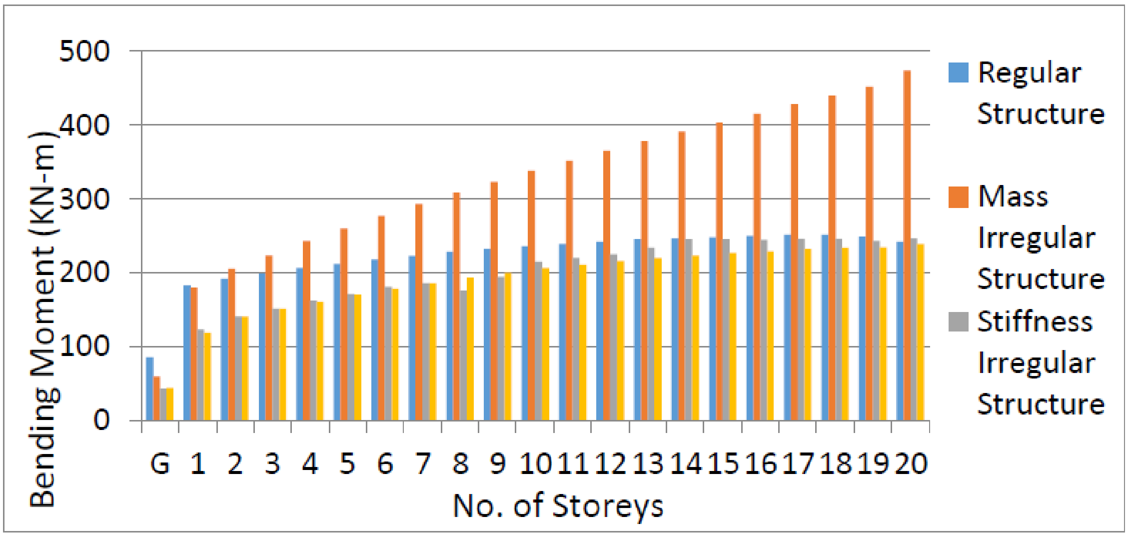


Figure 10 : Comparison of Across wind Direction (Z-direction) Bending Moment (KN-m)

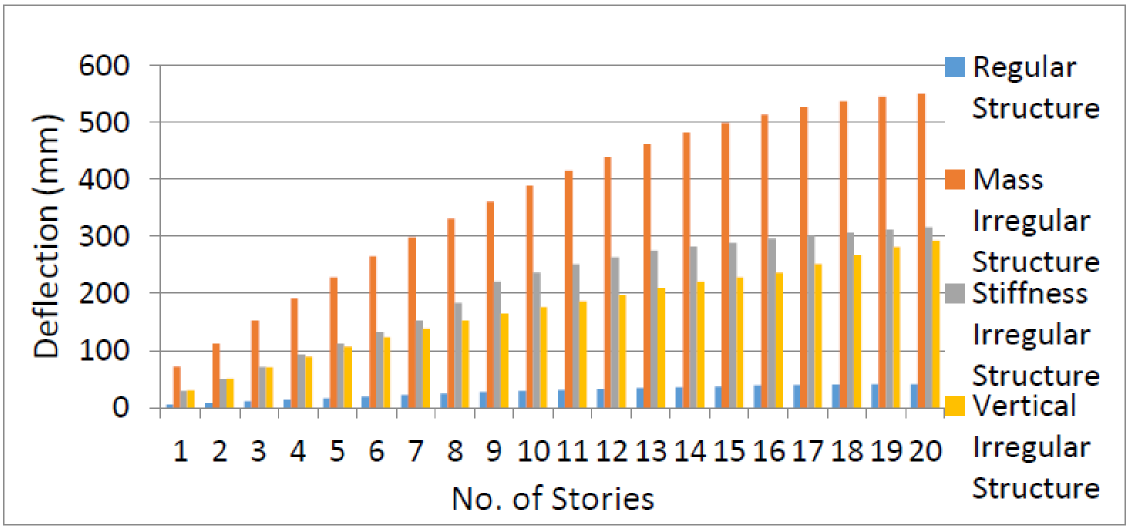


Figure 11 : Comparison of Deflection (mm) in X-Direction

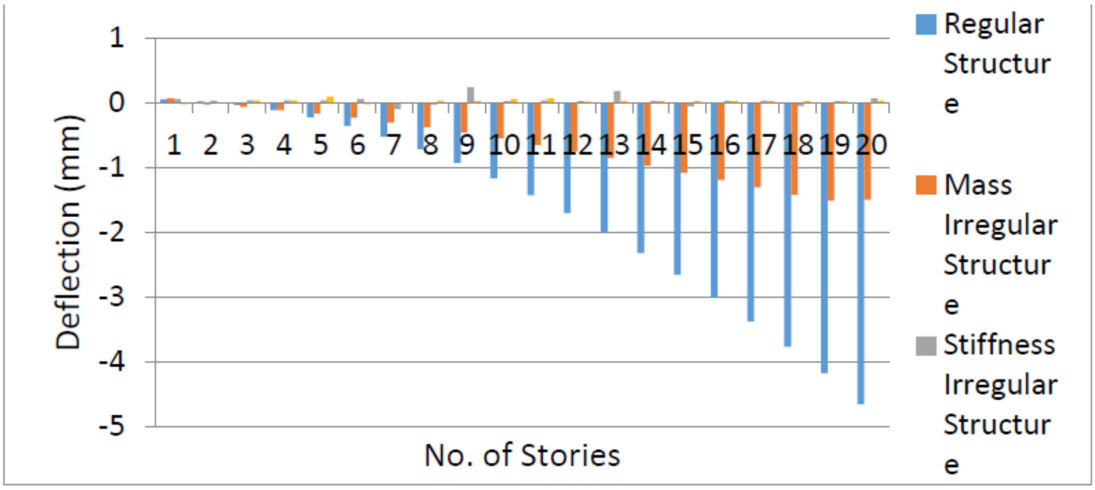


Figure-12: Comparison of Deflection (mm) in Z-Direction

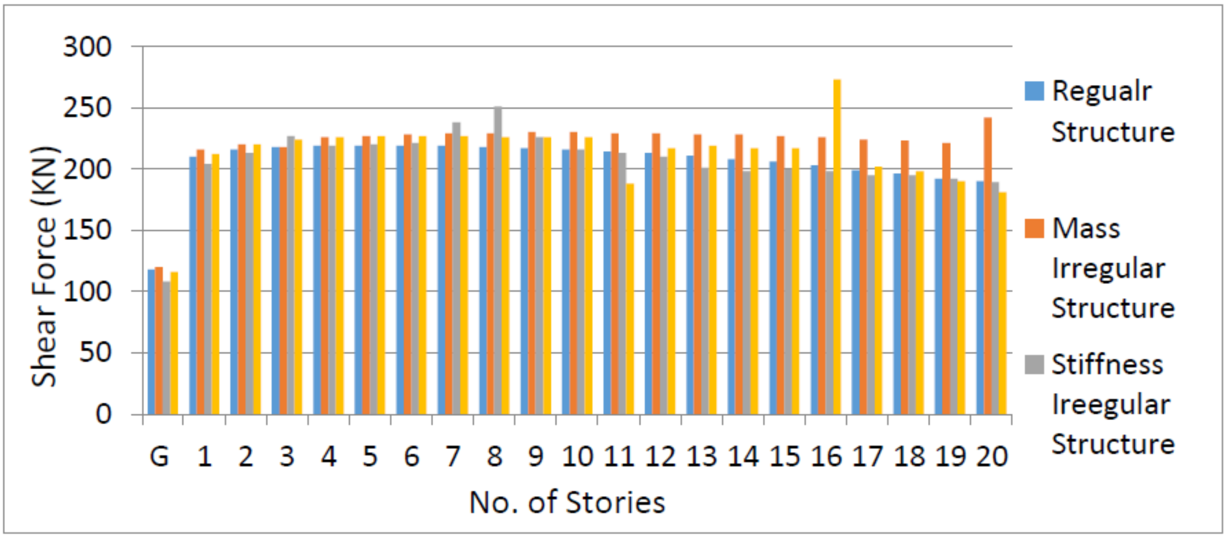


Figure 13: Comparison of Shear Force (KN)

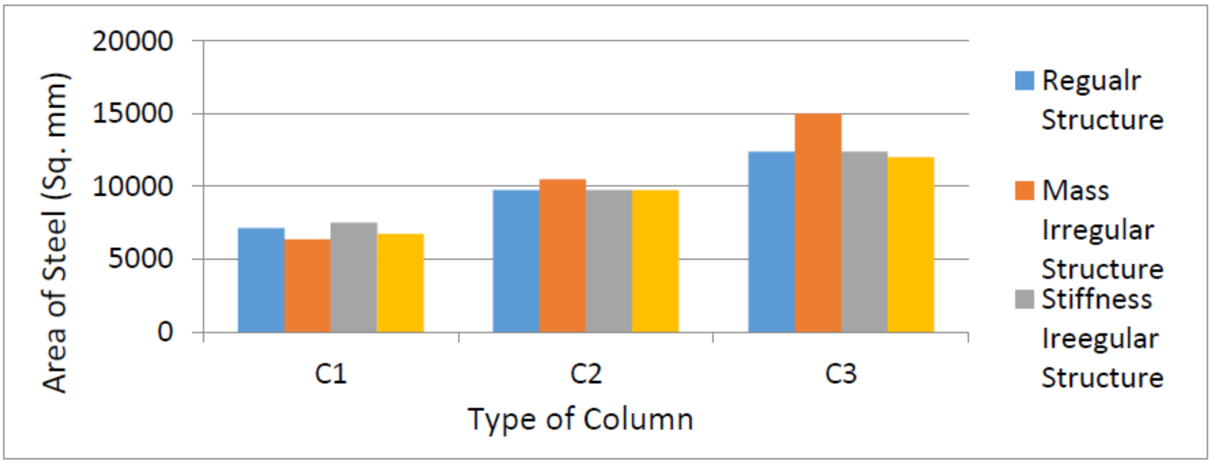


Figure 14: Comparison of Area of steel (Sq. mm) required in column

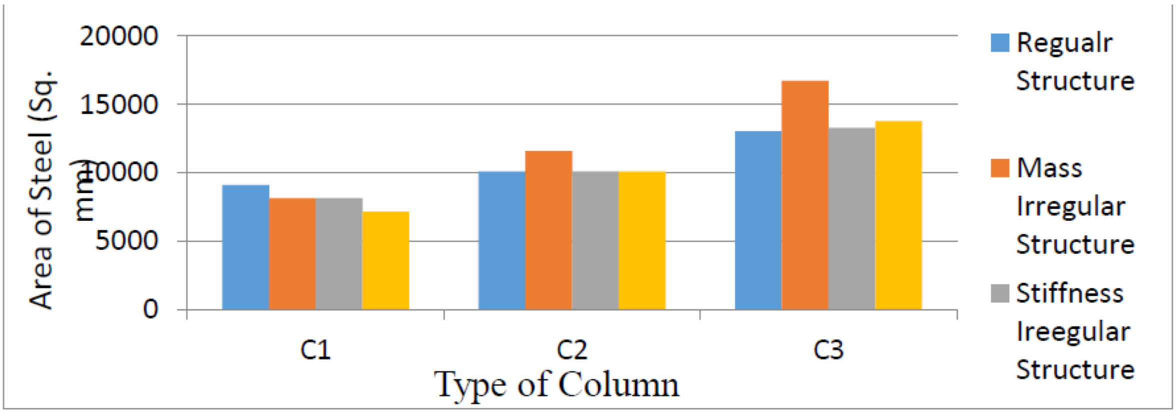


Figure 15: Comparison of Area of steel (Sq. mm) provided in column

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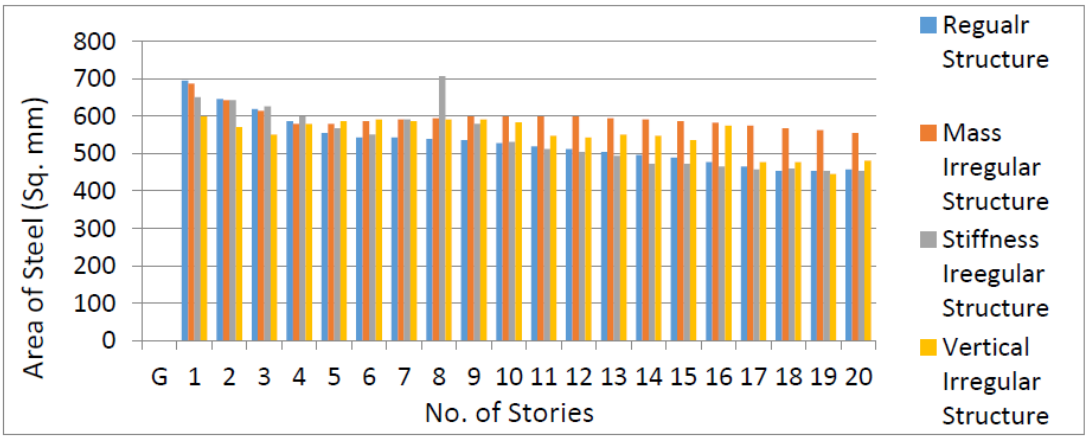

Figure 16: Comparison of Area of steel required (sq. mm) at the Middle span of Beam in a building

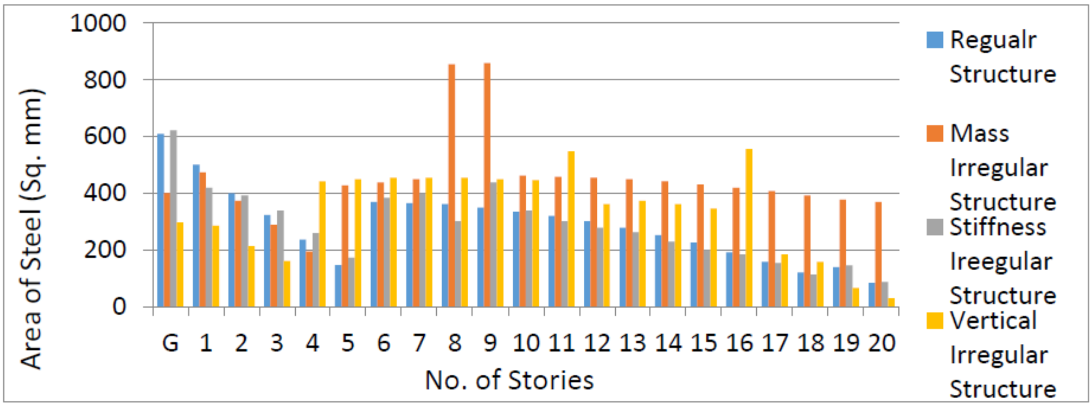

Figure 17: Comparison of Area of steel required (sq. mm) at the Left end span of Beam in a building

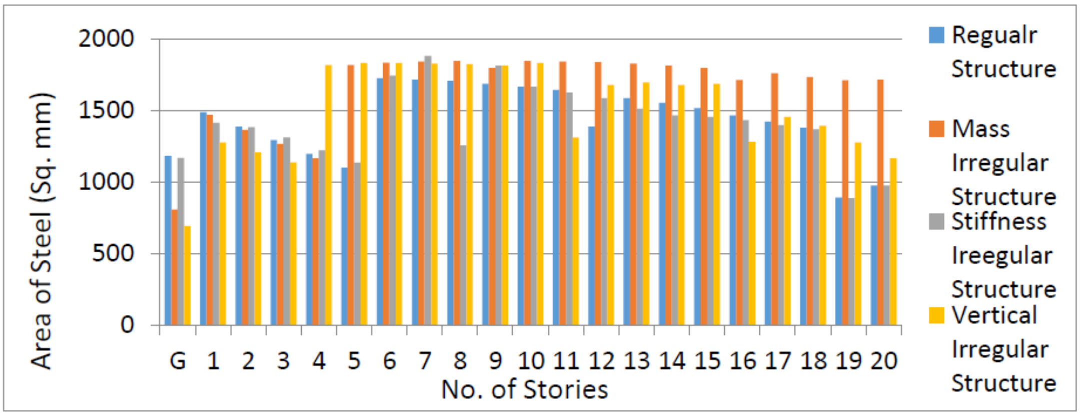

Figure 18: Comparison of Area of steel required (sq. mm) at the Right end span of Beam in a building

V. CONCLUSION

- The axial force having maximum in mass irregular building as compared to the other type of building. The mass irregular building having a maximum load on top floor. Therefore, axial force on the particular column where mass is heavy. In case of vertical irregular building having less axial force because of variation of height of building. Stiffness irregular and regular building having almost same axial force as compared to the mass and vertical irregularity.
- The maximum B.M. is occur in mass irregular building as compared to the other type of building. In the middle span as the height of the building increases the B.M. is decreases. In case of stiffness irregular building the stiffness irregularity is happened there is sudden increase and decrease in the B.M. due to change in the floor height. Due to the wind pressure on the ground floor beam having 0 KN-m B.M. If wind load is not considered then there is some mid span B.M. is occur. Due to all the moment are transferred in the end of the beam. Therefore, at the ground floor requirement of steel is 0 mm2 but, for the holding of stirrups/lateral tiles the minimum steel is provided.
- In case of windward side B.M. the maximum B.M. is occur on the stiffness irregular building as compared to the other type of building. In first five storey of mass irregular building having more B.M. as compared to the other building.
- Due to the swaying effect the leeward side B.M. is more as compared to the windward side of B.M.
- In case of across the wind direction maximum B.M. is occur in mass irregular building and minimum B.M. is occur in vertical irregular building.
- In case of deflection maximum swaying effect is occur in mass irregular building as compared to the other type of building and the minimum effect is occur on the regular building. The mass irregular

building having more deflection therefore there is need of lateral tiles at the top floor as compared to the other type of building.

- In case of across the wind direction the negative deflection is occur in regular building and maximum positive deflection is occur in the stiffness irregular building. But the intensities of the deflection is less therefore, there is not important to provide any lateral protection.
- As the height is increases the S.F. decrease. The maximum S.F. is occurred in the mass irregular building as compared to the other type of building. In vertical irregular building after the G+15 the S.F. is suddenly increases and then again decreases as the increase of height increases.
- The depth of raft slab in mass irregular building is more as compared to the other type of building.
- The axial force is more in mass irregular building therefore, size of column is more as compared to the other type of building.
- The S.F. in column is more in leeward side column as compared to the windward side column. The B.M. in column is also more in leeward side B.M. as compared to the windward side B.M.

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