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Pushover Analysis of Vertically Regular and Irregular Steel Structure

Ajinkya Hasabe[1], R.D.Patil[2]

[1]M. Tech. student, Dept. of Civil-structural Engineering, RIT, Maharashtra, India
[2]Professor, Dept. of Civil-structural Engineering, RIT, Maharashtra, India

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Abstract - *In last decades Steel structure has played an important role in construction Industry. It is necessary to design a structure to perform well under seismic loads. During an earthquake, failure of structure starts at points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. Vertical irregularities are one of the major reasons of failures of structures during earthquakes. In this paper we are going to perform push over analysis of regular steel building and buildings having irregularities such as mass and stiffness using ETAB 2016 software.*

Key Words: Vertical irregularity, pushover analysis, storey drift

1. INTRODUCTION

Now days, as in the urban areas the space available for the construction of buildings is limited. So in limited space we have to construct such type of buildings which can be used for multiple purposes such as lobbies, car parking etc. To fulfill this demand, buildings with irregularities is the only option available. A performance based seismic analysis can be used for various purposes such as assessment of large structures, design verification of new construction, evaluation of an existing structure to identify damage states for various amplitudes of ground motions. So, the effect of vertically irregularities in the seismic performance of structures becomes really important. In this paper three models are considered of which one is regular and other two having mass and stiffness irregularity. Pushover analysis of these models is carried out using ETABS 2016 software and results are compared.

1.1 Vertical Irregularity

Vertical irregularity results from the uneven distribution of mass, strength, stiffness along the elevation of a building structure. Mass irregularity results from a sudden change in mass between adjacent floors, such as mechanical plant on the roof of a structure. Stiffness irregularity results from a sudden change in stiffness between adjacent floors, such as setbacks in the elevation of a building. IS 1893 (Part1): 2016 gives details about vertical irregularities in structure.

1.2 Types of Vertical Irregularities

1) Mass Irregularity-

Mass irregularity shall be considered to exist, when the seismic weight of any floor is more than 150 percent of that of the floor below.

2) Stiffness Irregulariy (Soft Storey)-

Soft storey is a storey whose lateral stiffness is less than that of storey above.

3) Geometric Irregularity- Vertical geometric irregularity shall be considered to exist, when the horizontal dimension of lateral force resisting system in any storey is more than 125 percent of the storey below.

2.1 Modeling and Analysis

To study the seismic response of Steel structure, G+8 multi-storied buildings with mass irregularity, stiffness irregularity and one regular building are considered. The modeling and analysis of work is done by using ETABS software.

The basic material properties used are as follows:

- Modulus of Elasticity of steel, Es = 20,0000 MPa
- Modulus of Elasticity of concrete, Ec = 27386.12 MPa
- Grade of concrete = M20

Details of models:

Table -1: Parameters considered for modeling

Type of Building	Steel
No. of story	G+8
Height of floor	3m
Type of building	Residential
Seismic zone	4
Importance factor	1.2
Response reduction factor	5
Type of soil	Medium soil
Grade of steel	Fe345

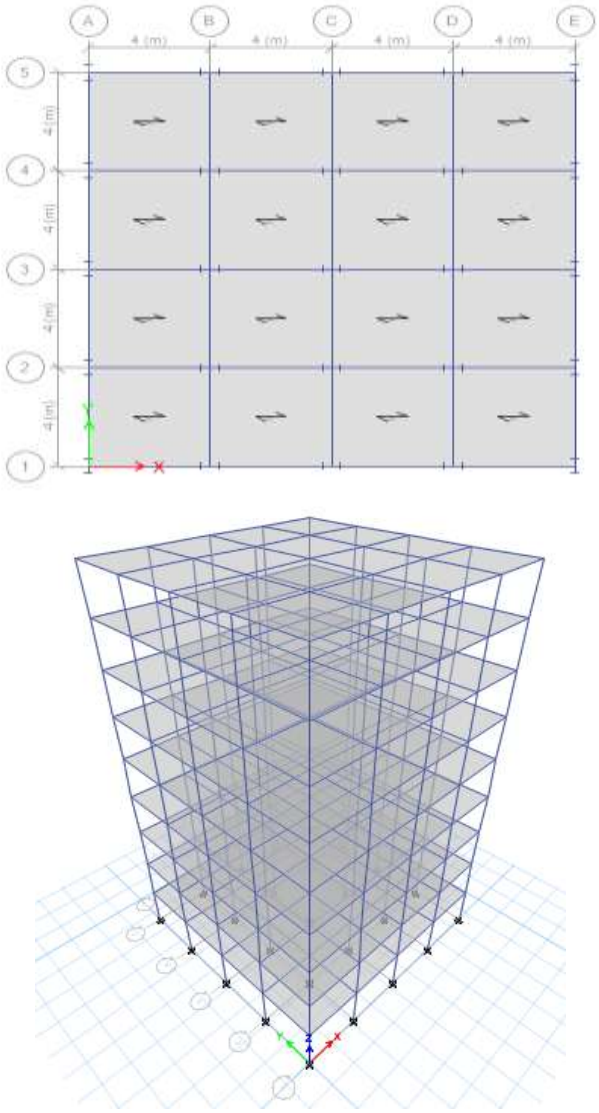

Fig no. 1 Plan and Elevation of building

2.2 Result

Table- 2 Comparison of displacement along push x

Storey no.	Regular	Mass Irregular	Stiffness Irregular
1	0.15	0.089	0.137
2	0.314	0.188	0.285
3	0.47	0.284	0.427
4	0.608	0.372	0.62
5	0.725	0.446	2.088
6	0.821	0.513	1.033
7	0.893	0.558	1.011
8	0.986	0.618	1.107
9	1.177	0.741	1.286

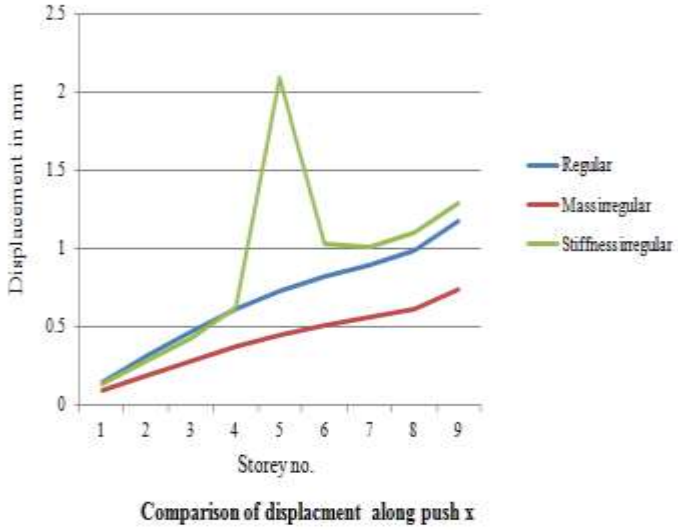

Chart-1 Comparison of displacement along push x

Table-3 Comparison of storey shear along push x

Storey no.	Regular	Mass Irregular	Stiffness Irregular
1	56.9081	33.4477	51.8852
2	50.5728	30.2447	45.5875
3	44.2374	27.0417	39.2898
4	37.9021	23.8387	32.9921
5	31.5667	20.6357	26.6944
6	25.2313	17.4326	25.0813
7	18.896	11.8915	18.7836
8	12.5606	8.6885	12.4859
9	6.2253	3.1473	6.1882

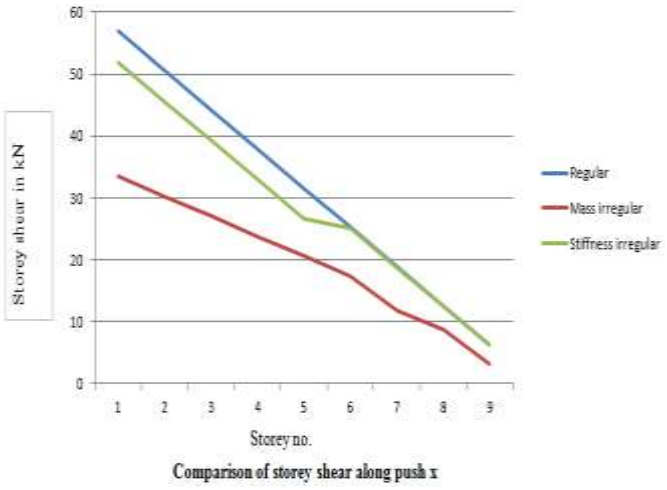

Chart-2 Comparison of storey shear along push x

Table-4 Comparison of displacement along push y

Storey no.	Regular	Mass irregular	Stiffness irregular
1	44.087	43.182	44.643
2	123.262	121.77	124.22
3	208.027	207.398	208.725
4	286.638	288.631	286.679
5	354.673	360.806	355.078
6	410.556	421.335	413.16
7	454.003	467.756	459.787
8	485.81	501.7	494.391
9	508.572	524.71	519.264

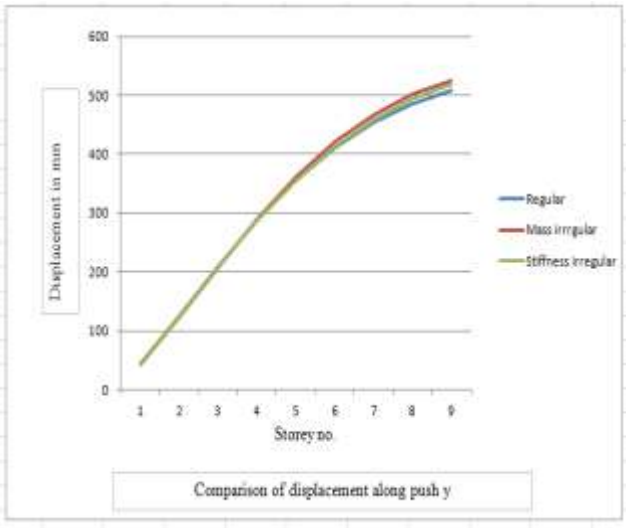

Chart-3 Comparison of displacement along push y

Table-5 Comparison of storey shear along push y

Storey no.	Regular	Mass irregular	Stiffness Irregular
1	9163.601	8858.611	8858.6107
2	8143.453	8010.294	8010.2937
3	7123.305	7161.977	7161.9766
4	6103.158	6313.66	6313.6596
5	5083.01	5465.343	5465.3426
6	4062.862	4617.026	4617.0256
7	3042.714	3149.458	3149.4579
8	2022.566	2301.141	2301.1409
9	1002.418	833.5733	833.5733

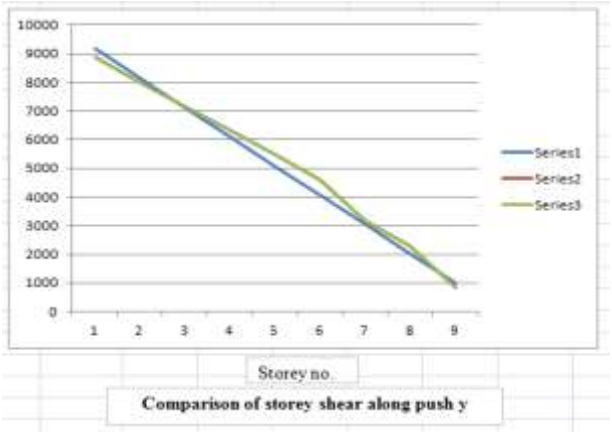

Chart -4 Comparison of storey shear along push y

3. CONCLUSION

From the above result it is observed that due to mass and stiffness irregularity story shear and displacement goes on increasing as compare to regular structure.

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BIOGRAPHIES

Mr. Ajinkya S. Hasabe, PG Student, M.Tech, Structural Engineering, at Rajarambapu Institute of Technology, Rajaramnagar. Graduated from Shivaji University, Kolhapur.

Prof. R.D.Patil is currently working as a Assistant Professor in Dept. of Civil Engg., Rajarambapu Institute of Technology, Rajaramnagar.