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SEISMIC ANALYSIS OFF R.C.C.MULTISTOREY BUILDING WITH VERTICAL IRREGULARITIES

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Abstract: In last some years, it has been observed that, the high rise buildings are failed due to the various seismic and vertical failures in geometry. Hence we need more investigation on the structures with vertical irregularities under seismic. The effect of lateral load on structure with vertical irregularities should be examined to reduce failure of structure. This study summarizes the studies done on the seismic analysis of RCC building structure with different vertical irregularities. From the study, it has been concluded that the structure with vertical irregularity failed under seismic loading and need to find specific code or special design for such structures. The performance of a high rise building during a strong earthquake motions depends on the distribution of stiffness, strength and mass along both vertical and horizontal directions. If there is discontinuity in stiffness, strength and mass between the adjoining storeys of a building then such a building is called as irregular building. The present study focuses on vertical irregular G+11 reinforced structures (RC) building under seismic loading. Total four buildings are modeled and analyzed in software called as STRUCTURAL ANALYSIS AND DESIGN Pro (STAAD-PRO). Out of four buildings, one building is regular and 3 buildings are irregular. Different seismic responses like lateral story displacement, story shear force and story bending moment are obtained. By using these seismic response comparison has been made regular and irregular building. The results indicate a conclusion that, a building structures with stiffness irregularity provides instability during seismic loading. To overcome this instability or rather say that to control instability, an appropriate amount of stiffness is very vital in RC building.

Index Terms **- Irregularity, Mass Irregularity, R.C.C Structure, Seismic analysis, Vertical Irregularity**

I. INTRODUCTION

In last some years, it has been observed that, the high-rise buildings are failed due to the various seismic and vertical failures in geometry. Due to unavailability of land for the construction, the high-rise buildings are the only option. In the high raised buildings or Skyscrapers, it has been seen that the structure collapse rate of such types of building had increased up to 50%. For the failure of such structures, vertical irregularity was the main reason. In failure of many structures with vertical irregularity, seismic irregularity plays a vital role. There are different types of vertical irregularities given below-

1. Stiffness Irregularity (soft story)
2. Mass Irregularity
3. Vertical Geometric Irregularity
4. In Plane Discontinuity in vertical elements resisting lateral force
5. Strength Irregularity (weak story)
6. Floating or Stub column
7. Irregular modes of oscillation in two principal plan section

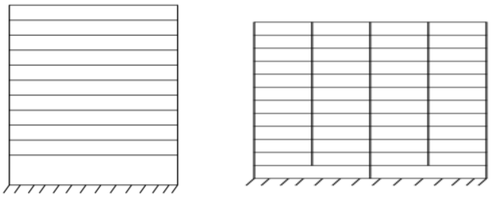


Fig. (a): Stiffness Irregularity

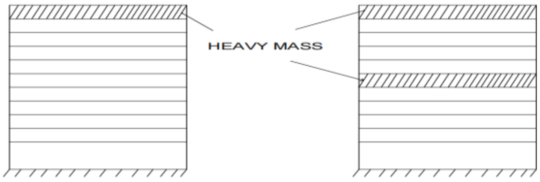


Fig.(b): Mass Irregularity

II.Literature Review

H.M.S.C. Rathnasiri et.al [1] compared the performance of the existing methods on quantifying the degree of irregularity for the selected irregular buildings and they proposed index can easily quantify the degree of irregularity in vertically irregular RC moment-resisting frames compared to the existing irregularity quantification methods.

Vahid Mohseniana and Ali Nikkhoo[2] have considered seismically assess vulnerability of RCtunnel-form buildings considering effects of irregular mass distribution. They found modal responses are not affected by building's height and patterns of mass distribution in elevation.

Rajkuwar Dubal et.al[3] worked on application of Performance based seismic design method for soft storey RC building frames(10 storey's) and did Push over analysis and found that significance of PBSD method in frames having soft story at lower floor level compared to higher ones. They have concluded that the time period for vertical irregular frame with soft story was less than the frame design by conventional methods.

R.Ismail et.al[4] was worked on the performances and behavior of regular and geometric irregular seven floors RCC framed structure under seismic motion. They have checked the building for the stress and displacement. From the result it has been seen that there was not much lateral movement in structure hence structure with vertical irregularity was good and safe
.

Shaikh Abdul Aijaj Abdul Rahman & Ansari Ubaidurrahman Salik [5] has considered frame structure with mass irregularity. The heavy mass provided on 3rd and 7th floor. They have checked the structure for displacement and from result it has been concluded that the structure with vertical mass irregularity failed under seismic loading.

Panagiotis G. Asteris et.al [6] investigate the effect of the vertical geometric irregularities on the fundamental periods of masonry infilled structures, through a large set of infilled frame structure cases and found that an attempt to quantify the reduction of the fundamental period due to the vertical geometric irregularities has been made through a proposal of properly reduction factor.
A.S.Bhosle, Robin Davies and Pradip Sarkar[7] investigate seismic performance of building with vertical stiffness and mass irregularities.They have provided open ground and floa6]ting columns in the building. From the result it has been concluded that the building with floating column and open ground found to be more vulnerable and also need special design code for the structure with vertical irregularity.

Amy Coffield, Hojjat ADELI [8] has modeled structure and analyzed using the Applied Element Method, which allows the structure to be examined duriobserving roof deflection and acceleration to determine the effect of geometric irregularity under extreme blast loading conditions and concluded that concentrically braced frame provides somewhat of a higher level of resistance to blast loading for irregular structures and geometric irregularity has an impact on the response of a structure subjected to blast loading.

Mahsa Amiri, Masood Yakhchalian[9] have Intensity measures (IMs) are typically utilized to make connection between the prediction of engineering de-mand parameters and the results obtained from seismic hazard analysis. An optimal IM has four desired features including efficiency, sufficiency, scaling robustness and predictability.

S. Gerasimidis,C.D. Bisbos , C.C. Baniotopoulos[10] presented an extensive parametric study on the response of irregular steel frames in case of initial damage, expressed by the total removal of their columns, one in turn. Also, special attention is given to the influence of vertical geometric irregularity through comparative results.ng and through structural failure. A plastic hinge analysis is performed as well as a comparative analysis

III. Methodology

The steps followed in the present study to achieve the above mentioned objectives are as follows:

- Select different types of regular and vertically irregular structure model of 11 storeys assuming bay width of 3 m in vertical direction and 5m in horizontal direction and different irregularities.
- Perform structural analysis with the help of STAAD-PRO for each of the 4 building models considered in this study.
- Analyze and compare the result of the seismic analysis for different models.
- Presenting the output in the form of graphs and tables.

Detail discussion on the results with the help of graphs and tables considering all included parameters

III.1. STRUCTURAL MODELLING

Total four different building geometries,one regular and three irregular are considered in the present study. Figure given below represents the elevaton of all 4 different geometries of a typical four storey building.The buildings are three dimensional, with the vertical irregularity in the direction of setback i.e. X, in the other horizontal direction the building is just repeating its geometric configuration.The same building configurations are repeated in all the cases considered in this study.Vertical irregular frames are named as M1, M2 andM3 depending on different regularities.

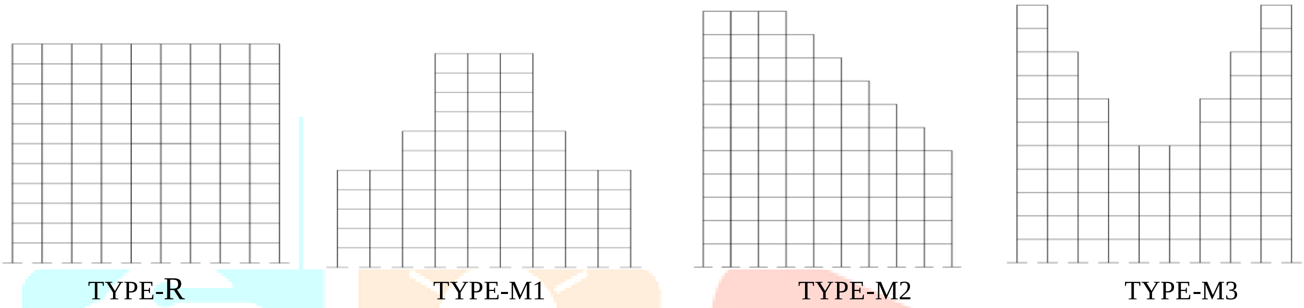


FIG-1 Building cofiguration with vertical irregularities

Gravity (dead and imposed) load and seismic load corresponding to seismic zone V of IS 1893:2002 are considered for the design. Ordinary moment resisting frame is considered in all the cases having response reduction factor (RF) as 5. All building frames are assumed to be locatedon medium soil. All buildings are general type structure.The various seismic parameters are summarized below in the table

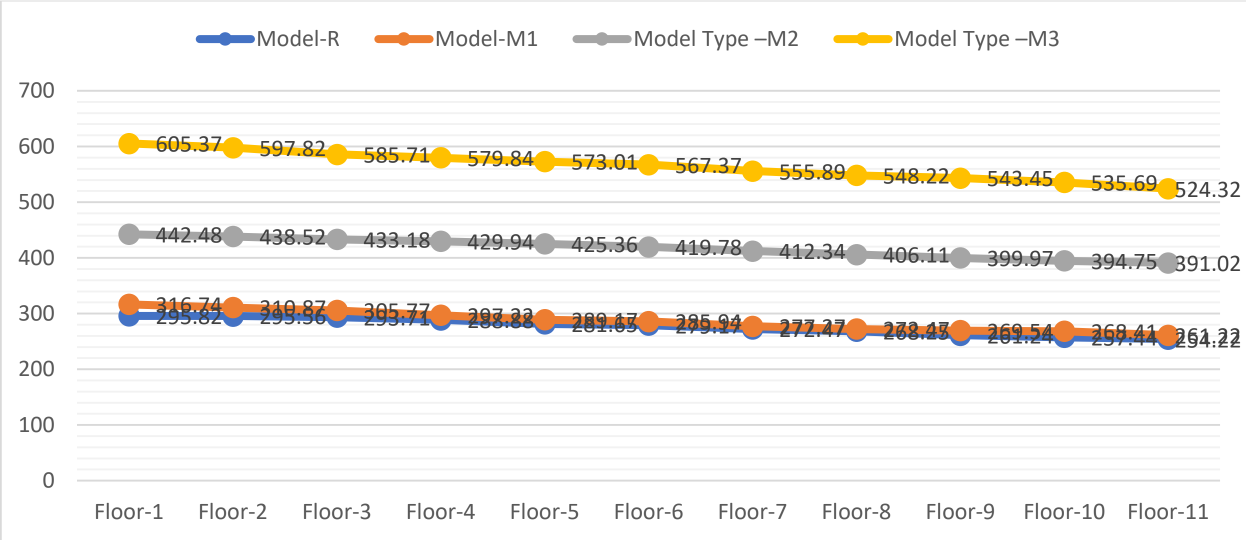
Building type	Beam dimension(mm)	Column dimension(mm)
11 storey building - R	300 x 450	350 x 450
11 storey building-M1	300 x 450	350 x 450
11 storey building-M2	300 x 450	350 x 450
11 storey building-M3	300 x 450	350 x 450

SEISMIC PARAMETERS	**VALUES**
Zone factor	0.36
Responsereduction factor(RF)	5
Importance factor(I)	1
Rock & soil site factor	1
Type of structure	1

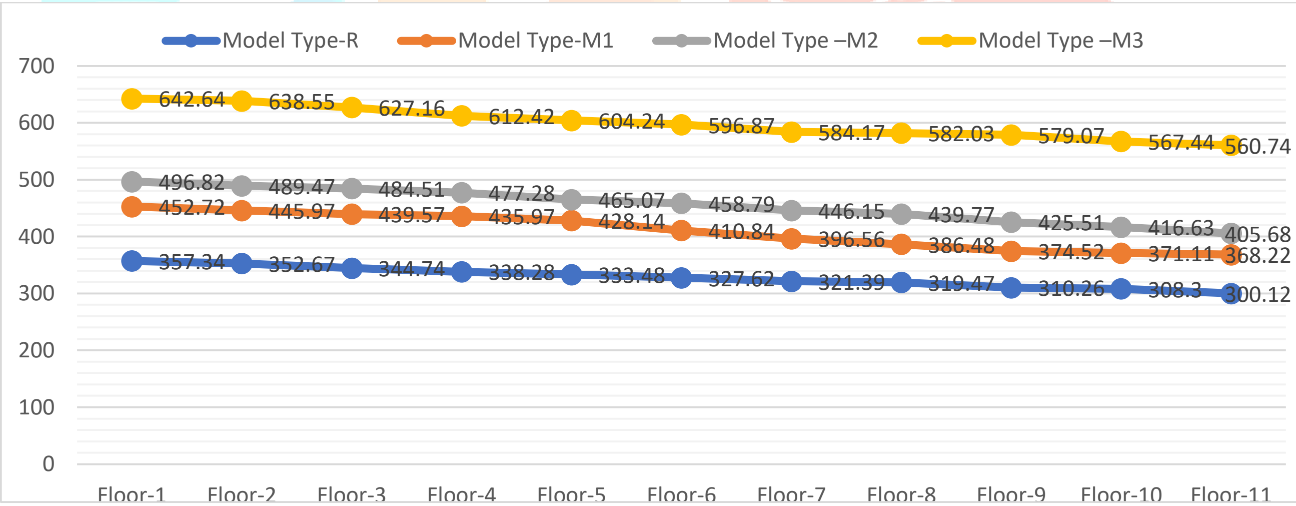
Table1: Parameters taken in Seismic Analysis

The slab thickness is taken as 120mm for all the buildings. M25 grade of concrete is assummed for above study. According to IS-456 Yield strngth of main as well as shear reinforcment is taken as 415000 kn/m^2 for all the models. The unit weight of concrete is taken as 25 kn/m^3. The above structures are modelled by using the mentioned software STAAD-PRO V8i. For all the above structures,supports are taken as fixed. Member loadis considered as 12.45kn/m^2. Dead load at slab is taken as 3.125kn/m^2. Dead load at paraphet wall is taken as 2.43kn/m^2.The live load is taken as 1.5 kn/m^2 for all the models above.Floor finish load is taken as 0.6 kn/m^2. All load case are genrated based on Indian codes. Wind load combinations are not considered in this study.

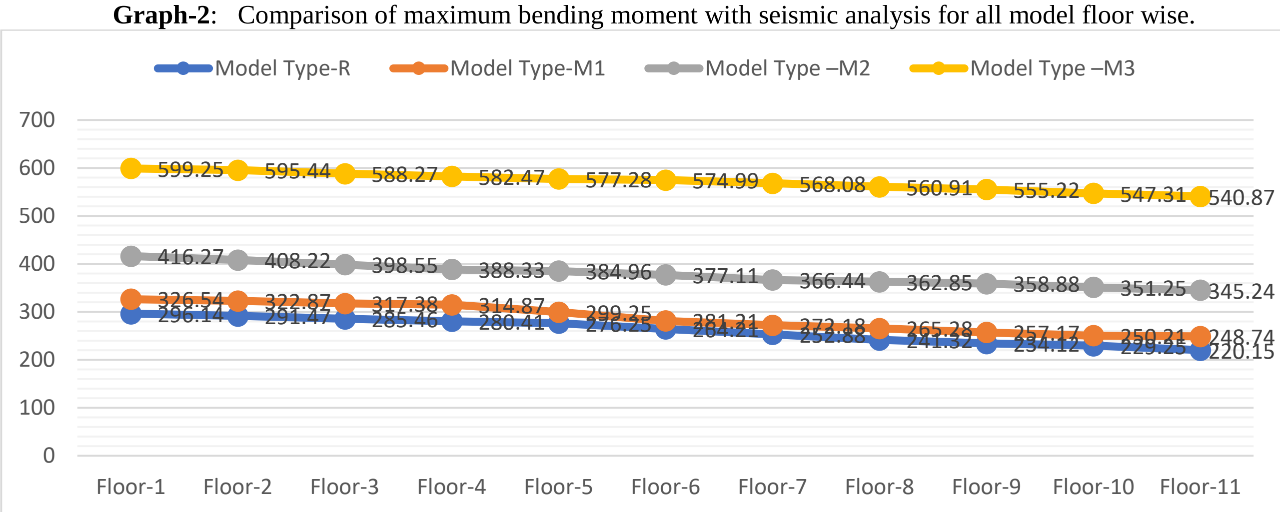
IV. Results



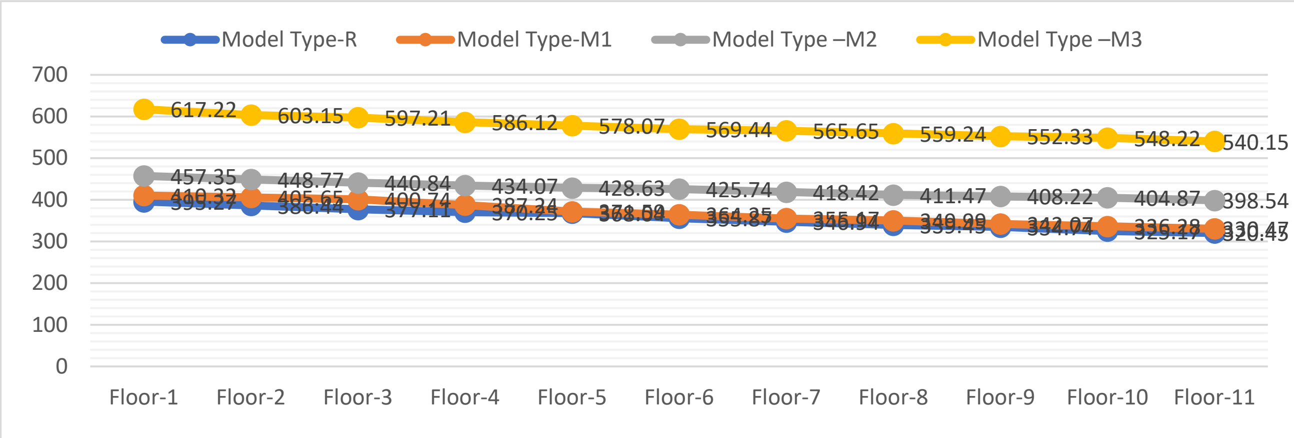
Graph-1: Comparison of maximum bending moment without seismic analysis for all model floor wise.



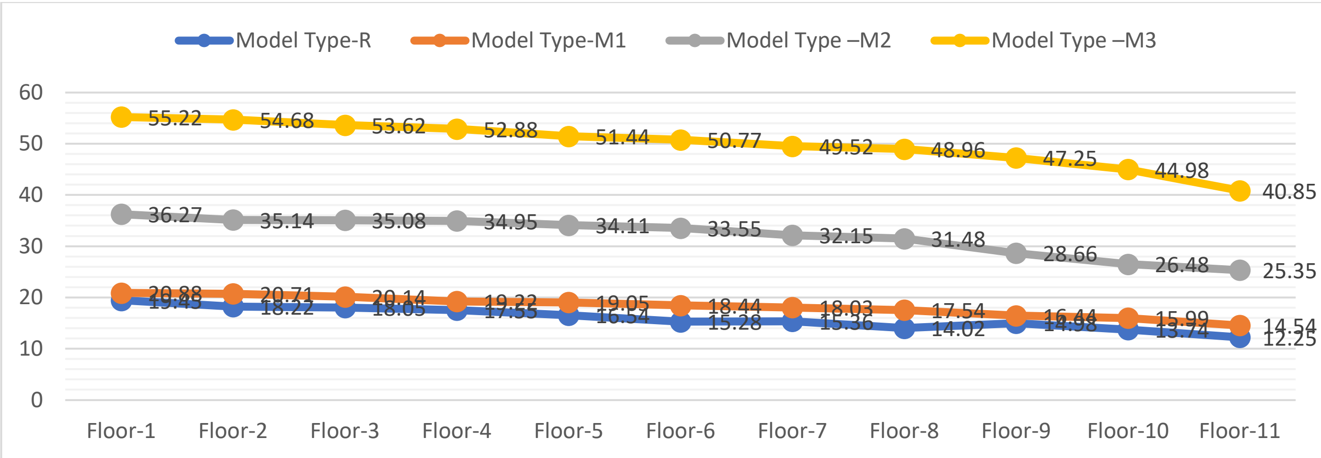
Graph-2: Comparison of maximum bending moment with seismic analysis for all model floor wise.



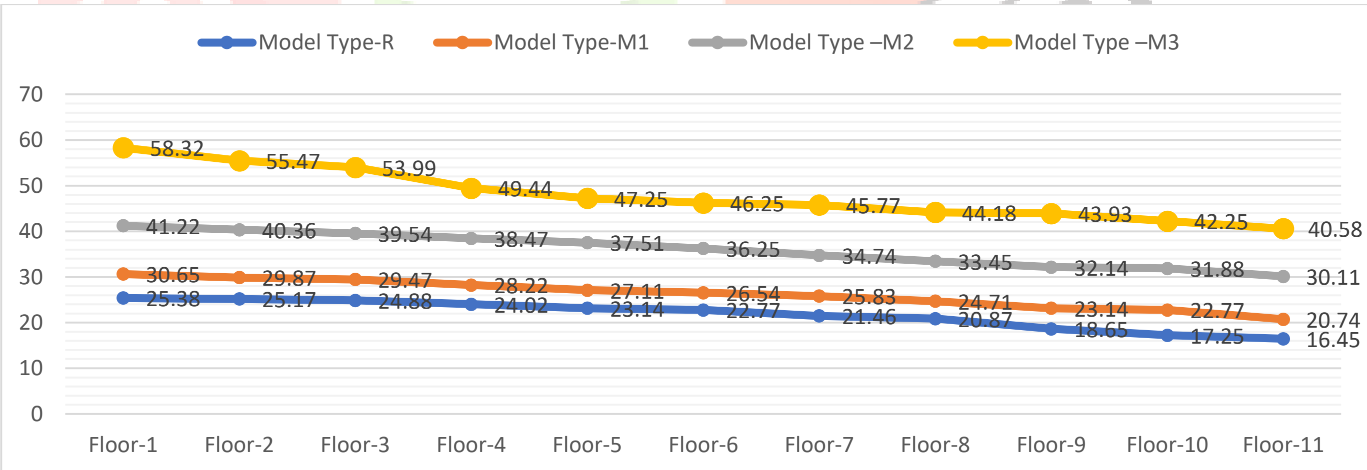
Graph-3: Comparison of maximum shear-force (FX) without seismic analysis for all model floor wise.



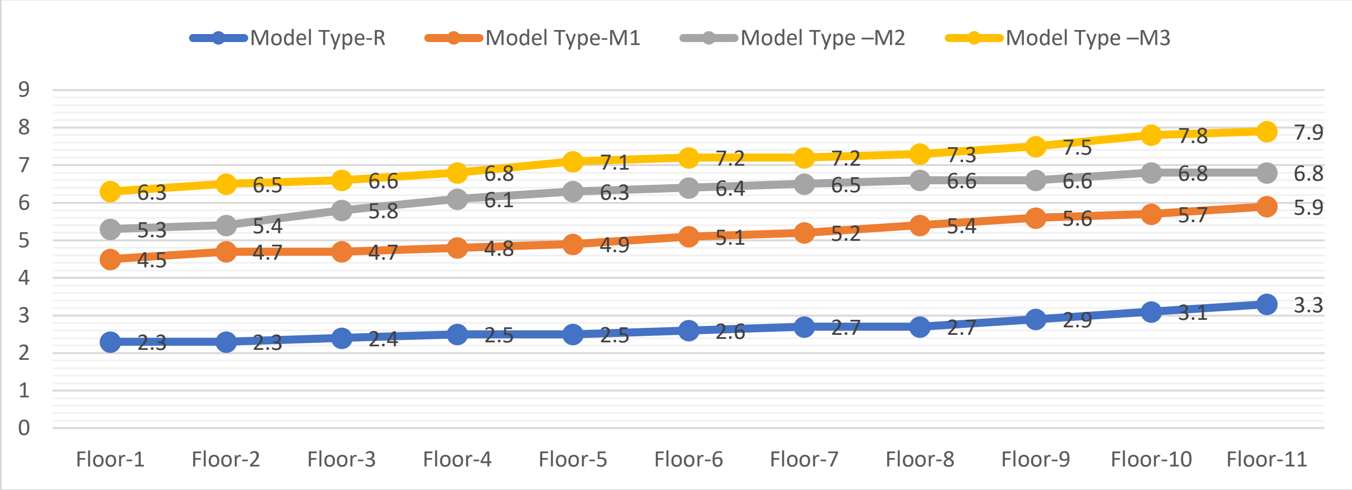
Graph-4: Comparison of maximum shear-force (FX) with seismic analysis for all model floor wise.



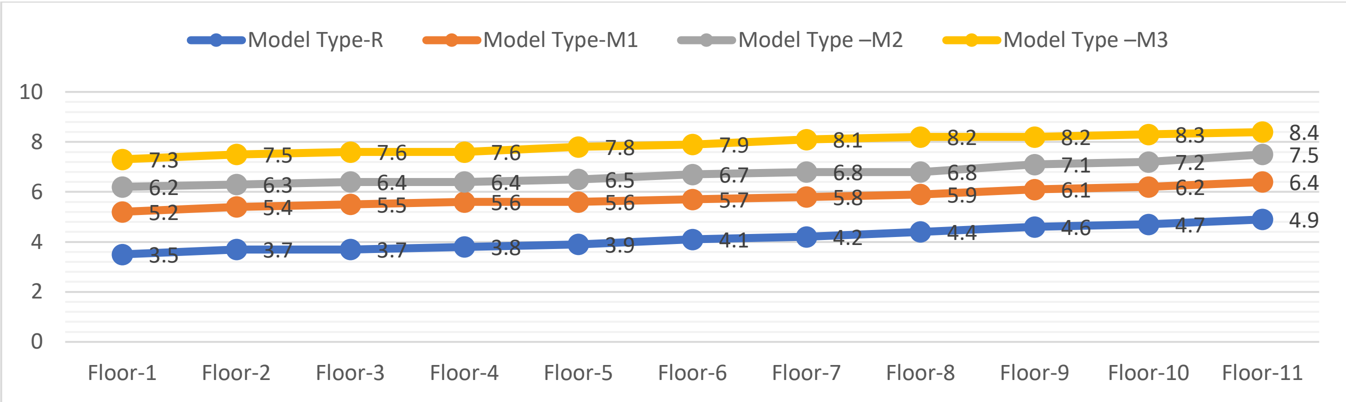
Graph-5: Comparison of maximum shear-force (FY) without seismic analysis for all model floor wise.



Graph-6: Comparison of maximum shear-force (FY) with seismic analysis for all model floor wise.



Graph-7: Comparison of Lateral displacement (mm) without seismic analysis for all model floor wise.



Graph-8: Comparison of Lateral displacement (mm) with seismic analysis for all model floor wise.

V. Conclusion

It has been seen that for the structure with vertical irregular frames with soft story has less time period (time period analysis) than the frames design by conventional method. The structure with mass irregularity failed under seismic loading. The frame with floating ground and open space needs special design code for such structures. Also, the geometrical irregularity has impact on structure under blast loading. Also from the above study, it has been observed that the structure with vertical stiffness, geometrical and mass irregularity affected under seismic loading.

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