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A Study of Setback Effect on Multi-Storied Building with Mass and Stiffness Irregularity

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***Abstract*- This research concerned with the compare to regular building with setback building with consider various irregularities on the seismic response of structure. Architects typically suggest irregular structures for the sake of the structure's architectural elegance. As a result, seismic responses of buildings with unusual configurations must be determined. The structural configuration of a multi-story building affects its actions during a strong earthquake. One of the most common causes of failure during earthquakes is an irregular plan or elevation configuration. As a result, irregular structures, especially those in seismic zones, are a source of concern. Since, structures normally have a combination of irregularities, predicting the seismic response based on a single irregularity cannot be accurate. It is critical to choose the form, degree, and position of irregularities in the design of structures because this contributes to the structure's usefulness and aesthetics. Therefore, the study the seismic behaviour of regular building with compare to setback building with different irregularities. we have considered 7th floor model consider with provide mass irregularity and stiffness irregularity. All frames are subjected to seismic loads and the response of the structures is analysis in ETABS software with different parameter e.g., displacement, storey drift, storey shear, storey stiffness.**

***Keywords*- Vertical geometric irregularity, Mass irregularity, Stiffness irregularity, Response Spectrum analysis, Setback, Earthquake.**

I.INTRODUCTION

Now a days, complex shaped buildings are becoming very common mainly because of its practical and aesthetic architecture. A common type of irregularity given in the buildings is vertical geometric irregularity known as setback. In the case of setback buildings, the length of the building gets reduced along its height. The setback buildings are usually provided when a relatively narrow road separates two multistorey buildings, as it permits adequate sunlight and ventilation to the lower Storey.

In particular, such a setback form provides adequate daylight and ventilation for the lower Storey in an urban locality with closely spaced tall buildings. This type of building form also provides for compliance with building bye-law restrictions related to 'floor area ratio. A common type of vertical geometrical irregularity in building structures needed from various functional and aesthetic architecture requirements, is the presence of setbacks i.e., the presence of abrupt reduction of the lateral dimension of the building at specific levels of the elevation. This building category belongs under setback building.

List of Abbreviation.

MI- Mass Irregularity	**RSI**- Regular Stiffness Irregularity
SI- Stiffness Irregularity	**SSI**- Setback Stiffness Irregularity
RMI- Regular Mass Irregularity	**SMI**- Setback Mass Irregularity

II. OBJECTIVE

- To calculate the design lateral forces on regular and irregular buildings using response spectrum analysis and to compare the results of different structures.
- To assess the influence of number of bays and bay width on the seismic behaviour of setback buildings.
- Setback buildings are characterized by staggered abrupt reductions in floor area along the height of the building, with consequent drops in mass, strength and stiffness.
- The seismic behaviour of buildings with and without setbacks was studied.
- The buildings were analyzed using response spectrum method
- The effect of setback is studied considering the parameters such as storey drifts, displacements, storey shear, and correlated with the building without a setback.

III. MODELLING AND LOADING DETAILS

In the present Study of the 7th floor model with regular and setback building model has been carried out. two type of irregularity, mass irregularity and stiffness irregularity are considered. The structural detail of regular and setback building as shown in Table 1. in setback building sudden change in geometry due to provide Setback. Also, it's geometry as shown in figure-3.

Table 2. Structural Detail Building Model.

Details	Description
No. of bays in X and Y direction	5Nos.
Spacing of bays in X and Y direction	5m
Size of Column	450 X 450 mm
Size of Beam (External)	230 X 650 mm
Size of Beam (Internal)	230 X 450 mm
floor to Floor Height	3m
Wall Thickness	230mm
Wall Load	13.8 KN/m
Live load	3KN/m^2
Material Grade (Concrete)	M-25
Material Grade (Steel)	Fe-500
Thickness of slab	125mm
Seismic Zone	III
Zone Intensity (Z)	0.16
Importance factor (I)	1
Soil Type (Medium soil)	II
Response Reduction factor	5
Damping ratio	0.05

1. Mass Irregularity:
Two types of models are analyzed in this irregularity one regular building and other setback building. In this irregularity total four model was prepared. In two regular building model and other than setback building model. Provide to some additional mass on some floor and it's mention in below table.

Table 3. Mass Variation of models.

Regular type Model	Setback Building
RMI-1-Additional L.L on 4^{th} floor = 6 KN/m^2	SMI-1-Additional L.L on 4^{th} floor = 6 KN/m^2
RMI-2 Additional L.L on $7t^h$ floor = 6 KN/m^2	SMI-2-Additional L.L on $7t^h$ floor = 6 KN/m^2

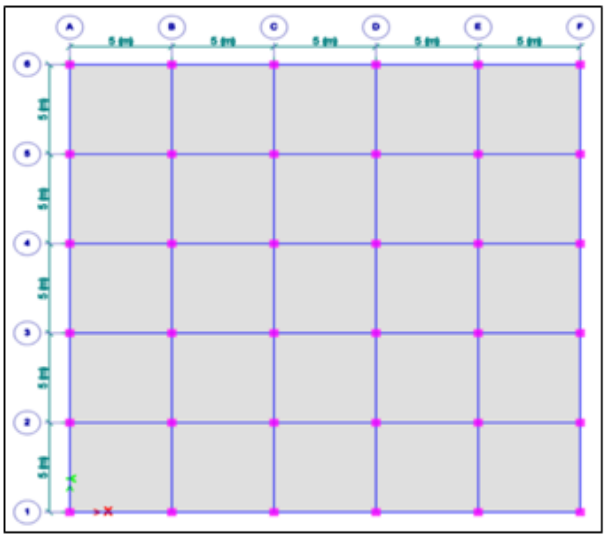

Fig 1. Plan.

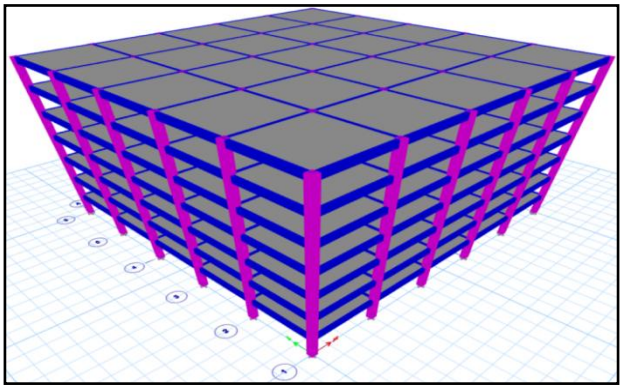

Fig 2. 3D View.

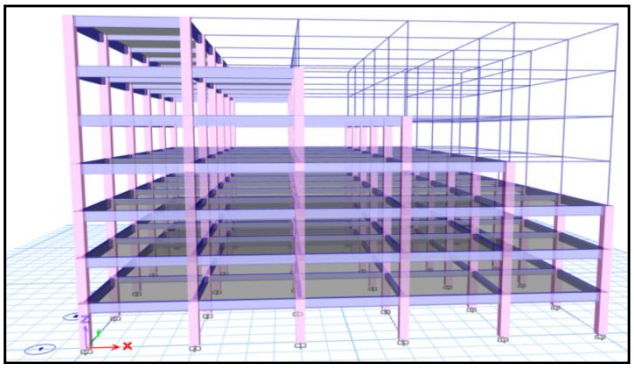

Fig 3. Setback building.

2. Stiffness Irregularity:
Two types of models are analyzed in this irregularity one regular building and other setback building. In this irregularity total four model was prepared. In two regular building model and other than setback building model.

Stiffness is inversely proportional to the length of the column, thus for as varying floor height there is variation in stiffness of the building models.in this study to change in floor height in some model. Brief details are mention in below table. The irregularity in the building is generated by increasing the height of the storey.

Table 4. Variation of floor Height.

Regular type Model	Setback Building
RSI-1–Storey1,2,3,4 height= 4m, other Storey has 3m height	SSI-1–Storey1,2,3,4 height=4m, other Storey has 3m height
RSI-2–Storey3,4,5,7 height=4m, other Storey has 3m height	SSI-2–Storey3,4,5,7 height=4m, other Storey has 3m height

IV. RESULT AND DISCUSSION

1. Mass Irregularity:
The storey displacement curve of mass irregularity model as shown in chart-1, in regular MI models sudden change in slope of the displacement curve because some additional L.L 6 KN/m2 on different. storey in different MI models. SMI-1,2 model has more displacement and storey drift as compare to other model due to provide setback irregularity. And seismic direction for all model should has been considered in X-direction.

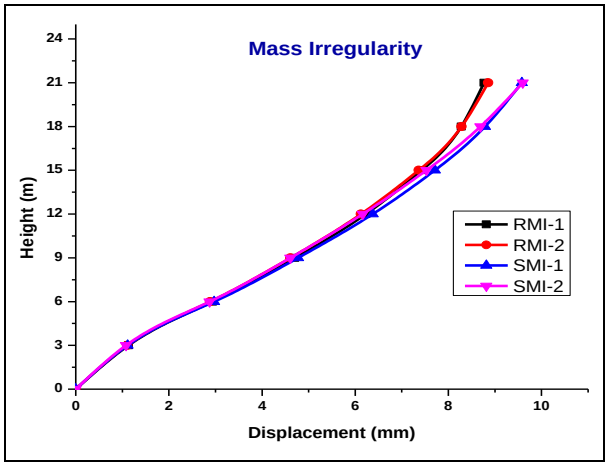

Fig 4. Chart-1 Storey Displacement.

The storey shear and stiffness curve of mass irregularity model as shown in below chart. In setback model has storey shear force and storey stiffness are less compare to regular building because in setback building, we providing vertical geometric irregularity like reduce the number of bays in vertical direction bottom to top. Storey shear is more at bottom storey for the all models.

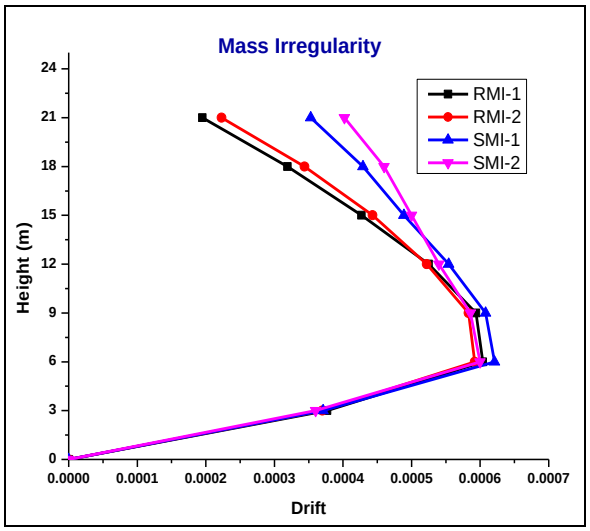

Fig 5. Chart-2 Storey Drift.

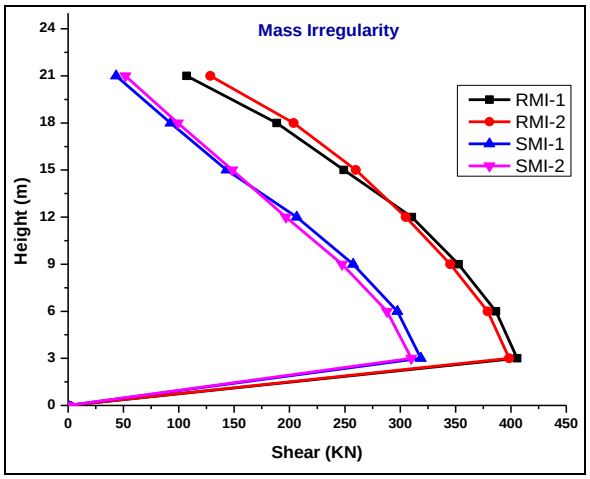

Fig 6. Chart-3 Storey Shear.

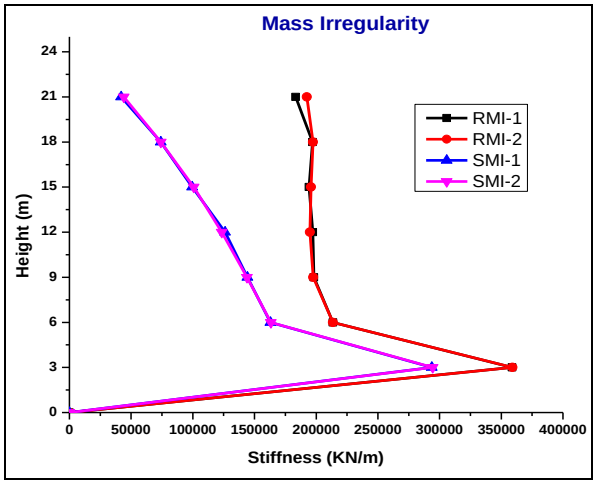

Fig 7. Chart-4 Storey Stiffness.

2. Stiffness Irregularity:

The storey displacement and drift curve of stiffness irregularity model as shown in chart-5 & 6 and SSI-1 model has more displacement as compare to RSI-1, also same as other two models. In storey drift curve the value of storey drift has sudden change due change of the column stiffness, change of the floor height due to provide stiffness irregularity.

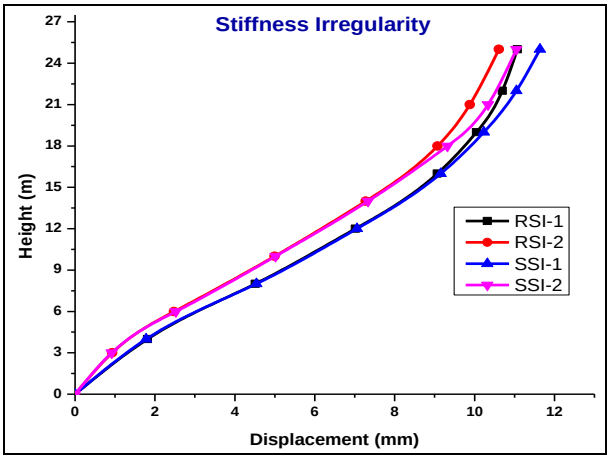

Fig 8. Chart-5 Storey Displacement.

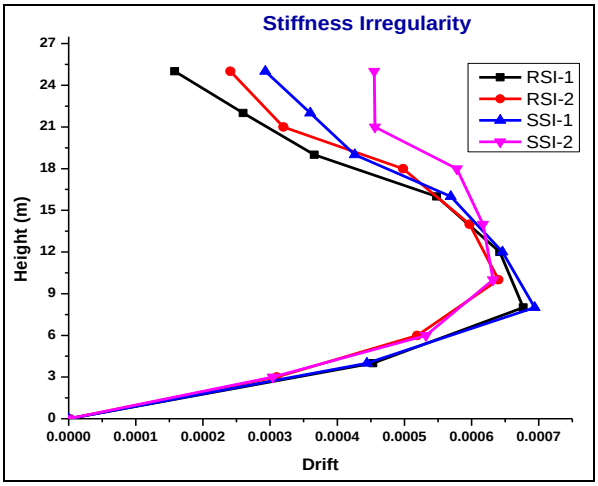

Fig 9. Chart-6 Storey Drift.

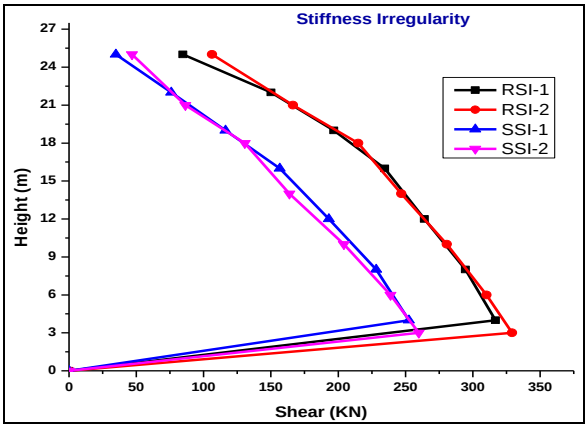

Fig 10. Chart-7 Storey Shear.

The storey shear and stiffness curve of stiffness irregularity model as shown in below chart. storey shear and storey stiffness are more in regular stiffness irregularity model.

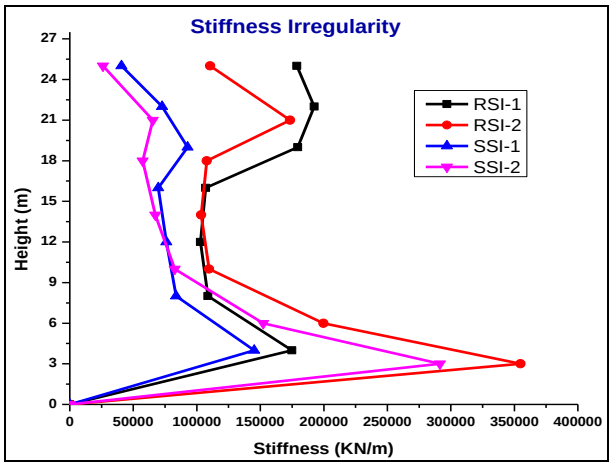

Fig 11. Chart-8 Storey Stiffness.

V. CONCLUSION

After studying the performance and behaviour of regular and setback for 7th floor model with mass irregularity and stiffness irregularity reinforced concrete building under seismic loading condition, the following conclusion are as in below point.

The storey displacement in case of setback buildings is more displacement as compare to regular building in MI and SI models.If we consider storey displacement compare between MI and SI model, so in that case SI models have more displacement as compare to MI model. If we are providing more mass in the Top Storey, it will more displacement in the top Storey and it Increase the lateral force of the building.It can be observed that there is sudden change in Storey drift because the we provide Setback in our building.

In SI model's storey drift more as compare to MI models. After some storey height drift is to be increase due to change of the column stiffness.In setback model has storey shear force is less compare to regular building because the in setback building in, we providing vertical geometric irregularity like reduce the number of bays in vertical direction bottom to top. Regular buildings are more storey stiffness as compare to setback building in MI and SI models. A sudden change in the stiffness of the building has been observed in the setback building both SI and MI.

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