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Seismic Response of Set-Back Structure

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***Abstract*— A structure can be considered as irregular, if it has irregular distributions due to irregular geometrical configurations i.e. set-back, strength, mass and stiffness. Different codes recommend different limits for these irregularities like as per IS 1893:2002, when the horizontal dimension of the lateral force resisting system in any storey is more than 150% of that in an neighboring storey is termed as irregular geometric configuration i.e. set-back, storey in a building is said to contain mass irregularity if its mass exceeds 200% than that of the neighboring storey. If stiffness of a storey is less than 60% of the neighboring storey, in such a case the storey is termed as weak storey, if stiffness is less than 70% of the storey above or less than 80% of the combined stiffness of the three stories above, then the storey is termed as soft storey.**

In reality, many existing buildings contain irregularity due to visual and functional requirements. In particular, such a set-back form provides for suitable daylight and ventilation for the lower storey in an urban locality with narrowly spaced tall buildings.

This set-back affects the mass, strength, stiffness, center of mass and center of stiffness of building as compare to regular building. Dynamic characteristics of such buildings differ from the regular building due to changes in geometrical and structural property. Many researchers have measured the behavior of set-back buildings by taking into account different approaches like geometric, mass, stiffness irregularity and different methods of seismic analysis. But value of critical set-back ratio for which the structure is less prone to earthquake forces has not been reported. Hence, it is require study and specifying some upgrading in codal provisions for appreciative the behavior of set-back buildings. In this present paper lateral storey displacement of different three types of models (nine cases) with constant in bay length i.e. 5x5m and with change in storey height is examined. Nodal displacement criteria were considered for the best value of critical set-back ratio. The most favorable value of set-back ratio comes out to be A/L=0.75 and H=8/25 where nodal displacement value are affect structure in small amount with comparison to other set-back ratio values.

***Index Terms*— IS 1893, Nodal displacement, Set-Back structure, Vertical irregularity**

I. INTRODUCTION

The presence of set-backs i.e. the presence of immediate reduction of the lateral dimension of the building at specific levels of the elevation is a very common kind of vertical geometrical irregularity in building structures which needed from various functional and aesthetic architecture requirements. This building type belongs under set-back building. This type of building form also provides for compliance with building bye-law restrictions related to 'floor area ratio'. In particular, such a set-back delivers sufficient daylight and ventilation for the lower storey in an urban locality with closely spaced high rise buildings.

As per IS:1893:2002, a structure is said to be a set-back structure if ratio between A/L>0.25 as shown below:

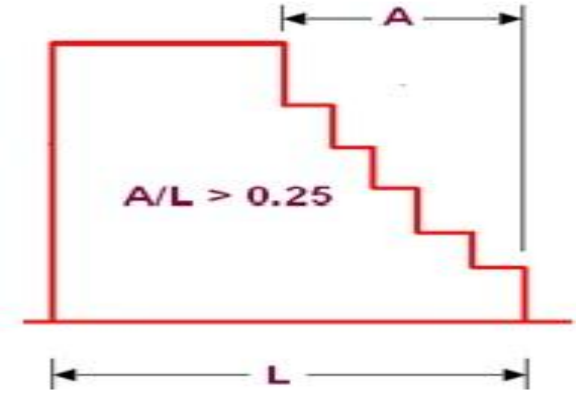

Fig: 1 A/L ratio as per IS:1893-2002

The set-back structure is characterized by staggered sudden reductions in floor area along the height of the building, with subsequent drop in mass, stiffness and strength. Height change in stiffness and mass render the dynamic characteristics of these buildings dissimilar from the regular building. The rising number of damage after seismic ground motion has provided powerful sign that set-back buildings show poor behavior though they were designed according to the current seismic codes. This poorer seismic performance has been attributed to the combine action of non-uniform distribution of mass, stiffness, and strength along the height of set-back frames and to concentration of inelastic action at set-back level.

So effective procedures to estimate seismic deformation demands i.e. damage in set-back frames is certainly needed. Many investigations have been performed to understand the behavior of irregular structures as well as set-back structures and to ascertain method of improving their performance. It is possible to evaluate the seismic performance of set-back structure accurately using STAAD. Pro. V8i software.

II. SET-BACK STRUCTURE ANALYSIS METHOD & MODELS

A. Analysis Method: The analysis is done on the structure whose related member properties are known. The ways for the seismic assessment of the building requires an appreciative of equivalent lateral force procedure also

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acknowledged as equivalent static procedure. The seismic stability of the building under the various load combinations in accordance with IS 456-2000. A deep knowledge of STAAD Pro V8i software is necessary for the analysis of structure because the structure was modeled in this software and post analysis data obtained from it has been used in the design of the structure.

B. Modeling: The present study is based on buildings which is irregular in elevation. Three models are taken for the study. Model 1 (M1), Model 2 (M2) and Model 3 (M3) have 5x5m bay length, 3.5m floor height and 87.5m total height i.e. 25 storey as shown in figures and detail of all models are presented in table below:

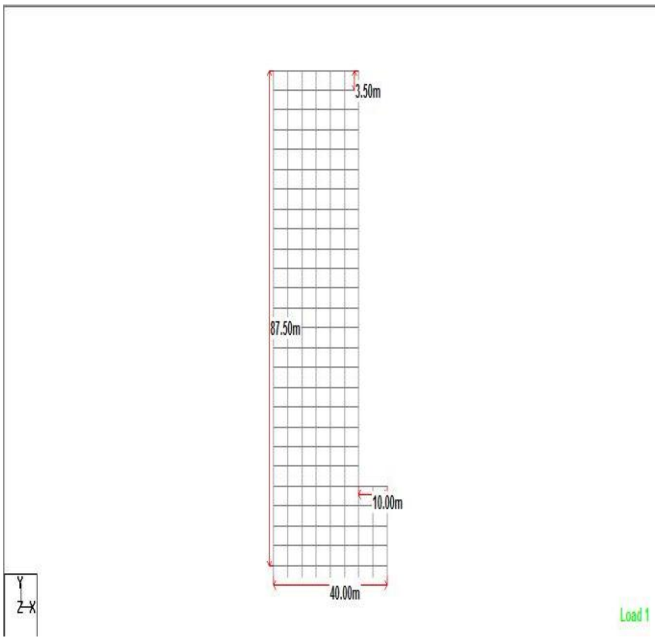


Fig: 2 Elevation of Set-back building M1

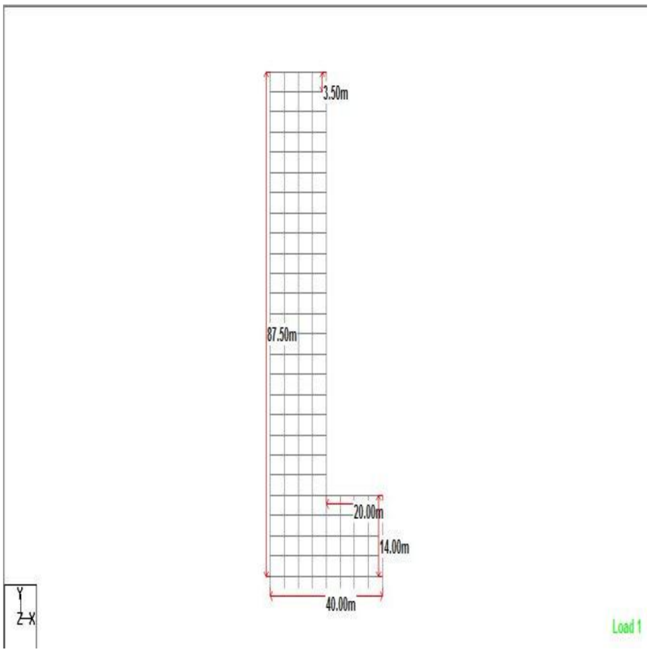


Fig: 3 Elevation of Set-back building M2

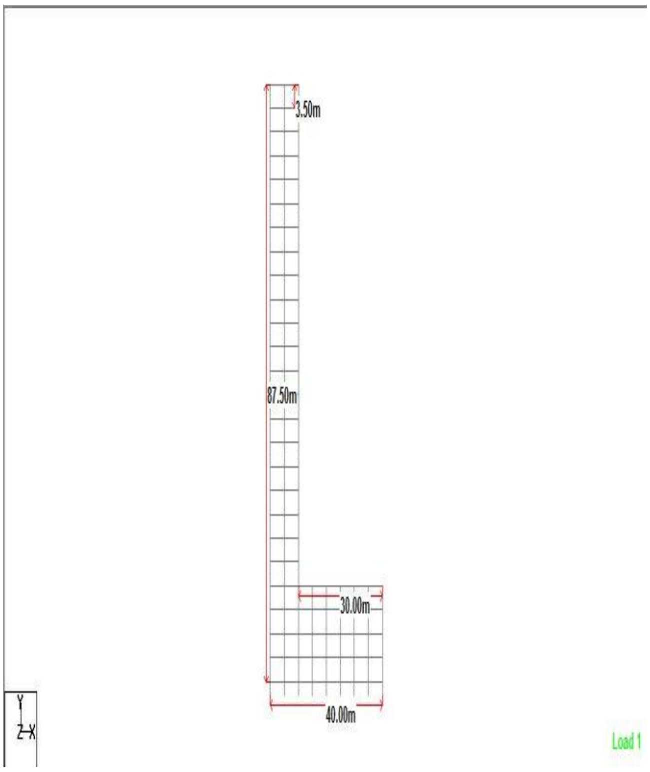


Fig: 4 Elevation of Set-back building M3

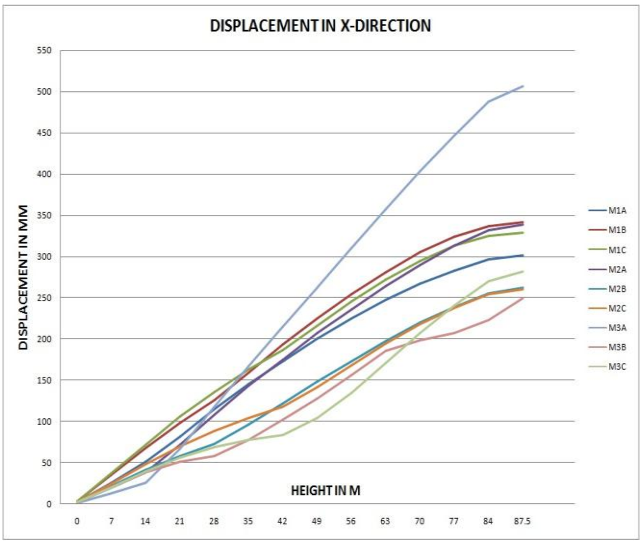
S.No.	A/L ratio	Along Height
1	A/L=0.25	H=4/25 (M1 A)
		H=8/25 (M1 B)
		H=12/25 (M1 C)
2	A/L=0.50	H=4/25 (M2 A)
		H=8/25 (M2 B)
		H=12/25 (M2 C)
3	A/L=0.75	H=4/25 (M3 A)
		H=8/25 (M3 B)
		H=12/25 (M3 C)

Table 1 Description of models

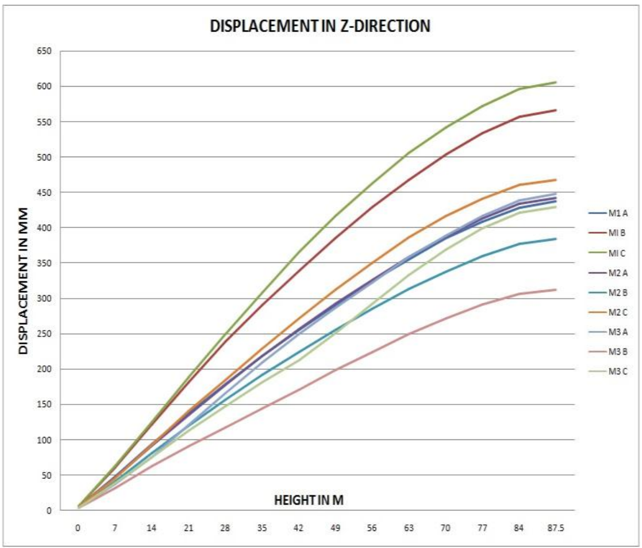
As per above table total nine models are prepared and dynamic analysis is performed.

III. RESULTS AND DISCUSSION

Results are obtained for all the nine models in graphical form. For various set-back ratios (M1, M2, M3) the values of lateral displacement of nodes in both X and Z direction are presented below:



Graph: 1 Nodal displacement in X-direction



Graph: 2 Nodal displacement in Z-direction

IV. CONCLUSIONS

In an attempt to understand the earthquake response of set-back structures, dynamic analysis was undertaken. The analytical studies involved design of different building geometries were taken for the study Depending on result obtained for all the models variations in lateral displacement of nodes presented in Result & Discussion above.

Following conclusion can be representing from the obtaining results:

1. The optimum value of critical set-back ratios mostly A/L and H comes out to be at A/L=0.75 and H=8/25. Above value complies with the criteria given in IS:1893-2002 for consider the structure to be irregular.
2. From the obtained results it may be concluded that the irregular structures have to be treated with proper understanding and by following the codal provisions given in the code.
3. It may also be examined that a the revision of seismic codes provisions for geometric vertical irregularities seems to be necessary to specify more restrictive limits or apply more exact logical procedures to calculate the seismic performance of set-back structures under the seismic excitations, mainly for structures with critical set-back ratios.

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