Pushover Analysis of Setback Building

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Abstract

Pushover analysis is a nonlinear static analysis used mainly for seismic effect on building. At the time of Earthquake or seismic vibration maximum framed and R/C building damaged and their response depends on the distribution of mass, stiffness, and strength. This effects is in one or both direction in horizontal and vertical. In multi-storey framed buildings, damage from earthquake ground motion generally initiates at locations of structural weaknesses portion like beam and column joint present in the lateral load. In this case generally irregular multi storey buildings are setback at one side. Reason behind this damage is different distribution of mass of the building. In some cases, these weaknesses may be created by discontinuities in stiffness, strength or mass between adjacent storeys. It also depends on the height of the building , this sudden variation cause many disastrous effect for the people and environment.There are many examples of failure of buildings in past earthquakes due to such vertical discontinuities (like BHUJ Earthquake 2000 in Gujrat). A common type of vertical geometrical irregularity in building structures arises from reduction of the lateral dimension of the building at specific levels of the elevation. This building category is known as the setback building.

Keyword setback building; pushover analysis; irregularity; target displacement; lateral load profile; time history analysis.

Introduction

This behaviour of multi-storey framed buildings during strong earthquake motions depends on the distribution of mass, stiffness, and strength and geometry of the building. Setback of building is also done when we provide the separation between two parts of the building. Such discontinuities between storeys are associated with sudden variations in the frame geometry along the height. There are many examples of failure of buildings in past earthquakes due to such vertical discontinuities.

Fig. 1.1: Typical Setback building at India

Fig. 1.2: Multi Storey Building affected by Earthquake at India

In this building sudden earthquake motion are spread in bottom to top of the building and number of nearest buildings are also going to damage but this building setback at side of building and also disturbed other building. A common type of vertical geometrical irregularity in building structures arises is the presence of setbacks, *i.e*. the presence of reduction of the lateral dimension of the building at specific levels of the elevation. This building category is known as 'setback building'. Now a days this type of building are popular in urban and metro cities. In particular, such a setback form provides ventilation and daylight and also provides light weight or mass become reduces in this building , it is also called "Setback Framed Structure". This type of building form also provides for bay-law restriction from 'floor area ratio' (practice in India). Their are many examples of this type of building:

Fig. 1.3: Typical Setback building at India

Scope Of The Study

In the future, it protects the building from torsion and also protect multi stored building (above 20 storey) and guide for construct high storey building restricted by collapse and setback. Irregular building are restrictedly protected by damage on weak portion of building. Although different storey numbers (up to 20 storeys), bay numbers (up to 12 bays) and irregularity are considered, the bay width is restricted, to 6m and storey height to 3m

Pushover Analysis

This procedure is mainly used to estimate the strength of existing structure and the seismic demand for this structure subjected to selected earthquake. Pushover analysis is defined as an analysis wherein mathematical and model analysis is consider for every element of the structure and using following method for that:-

a) Target Displacement

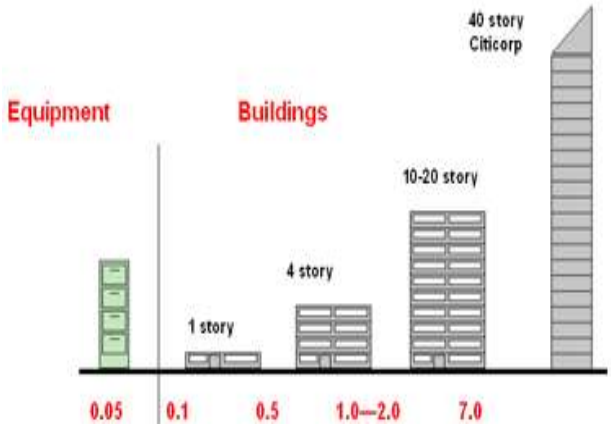
b) Analytical Method

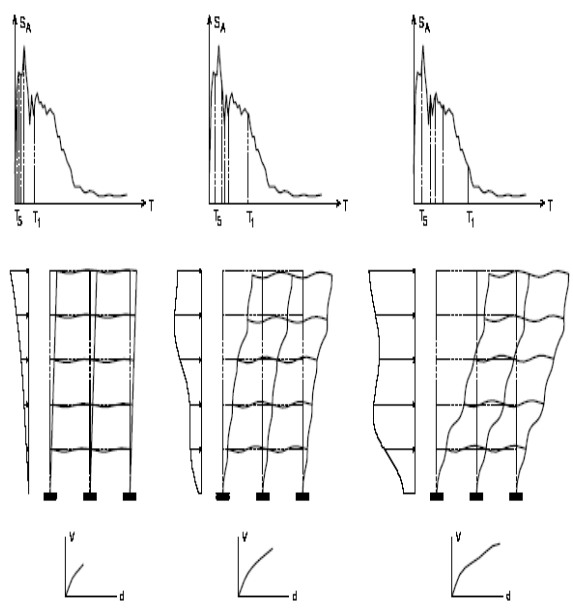
c) Response Spectrum Analysis

d) Deflection and Flexible Material

e) Adaptive Pushover Analysis

Target displacement is the maximum displacement of the building at roof expected under selected earthquake ground motion. The analysis used for accounting geometrical nonlinearity, inelastic material property and the distribution of forces.





Adaptive Pushover Analysis

- **Response Spectra**

The response spectral values depends upon the following parameters,

- Energy release mechanism
- Epicentre distance
- Focal depth
- Soil condition
- Richter magnitude
- Damping in the system
- Time period of the system
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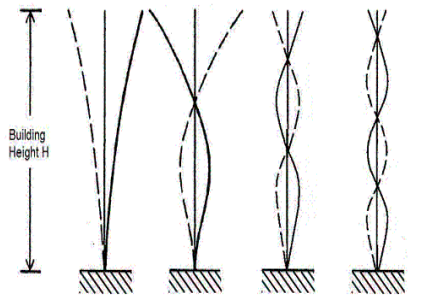

Mode Shape	Mode 1	Mode 2	Mode 3	Mode 4
Period	5 Sec	0.6 Sec	0.25 Sec	0.09 Sec
Mass Participation	63.1%	19.6%	6.9%	3.6%

Fig. 1.4: Mode of frequency depends on period

Pushover analysis is a nonlinear procedure which is used to account the seismic demand for buildings, it is depend on the height of the building. In which building are replaced by no. of control nodes and provide supports on the building, hinged also provide. Use FEMA356 code and also use IS-1893 code for providing load and other factors for earthquake. The relation between control node and base also provided. Provide all the loads (Seismic, Dead and Live load, other type of pressure if applicable) and then proceed for process. The formation of curve is single; it is most important thing in this analysis. It is also called capacity curve or pushover curve. The capacity curve is the basis of 'target displacement'. So the pushover analysis may be carried out twice:

(a) First time till the collapse of the building to estimate target displacement and

(b) Next time till the target displacement to estimate the seismic demand

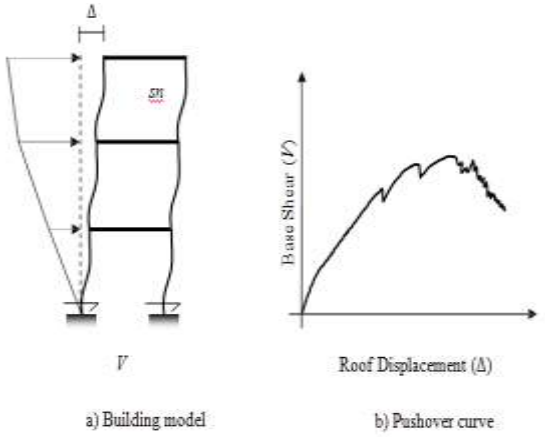

Fig 1.5 schematic representation of the pushover analysis procedure.

Linear and Nonlinear Dynamic Analysis Results For 20-Story Building B.1 natural mode shapes of 20-storey building variants

Figs B.1 to B.5 present the elastic mode shapes of the four 20-storey building models considered in the present study (namely R-20-4, S1-20-4, S2-20-4 and S3-20-4). All of these four building models have four bays.

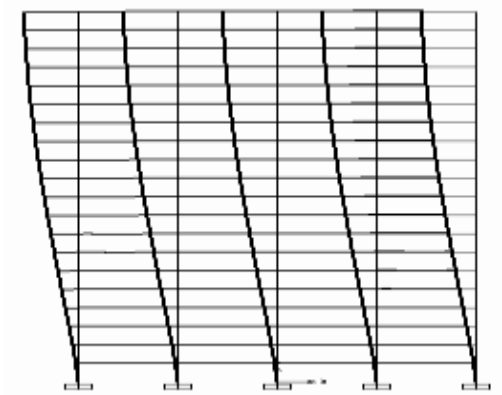

Fig. B.1: First mode shape of R-20-4 building model

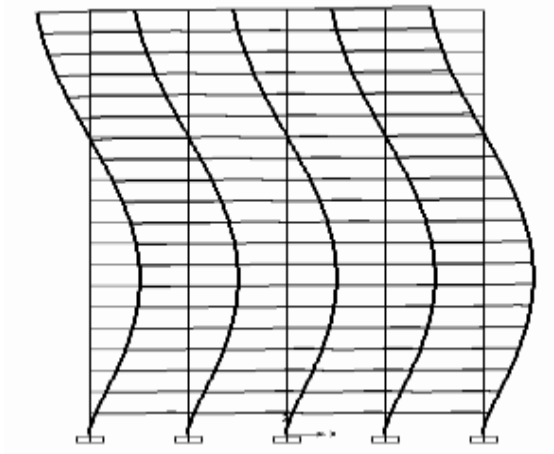

Fig. B.2: Second mode shape of R-20-4 building model

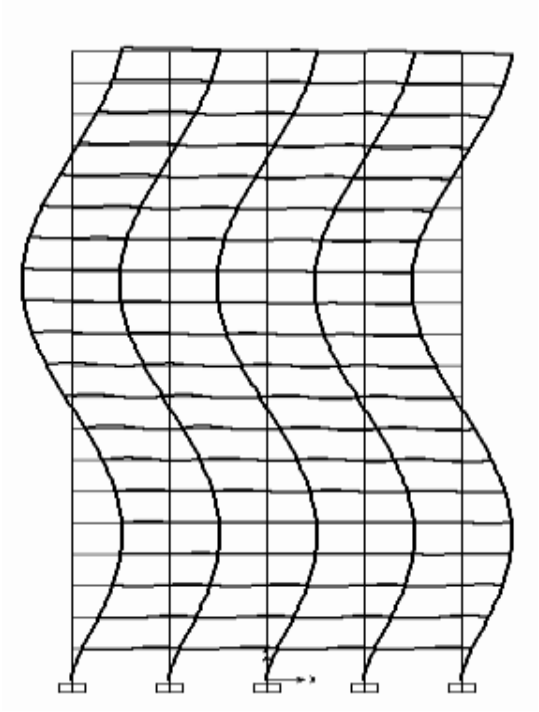

Fig. B.3: Third mode shape of R-20-4 building model

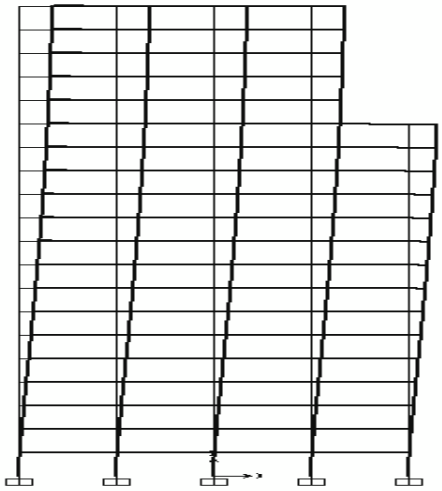

Fig. B.4: First mode shape of S1-20-4 building model

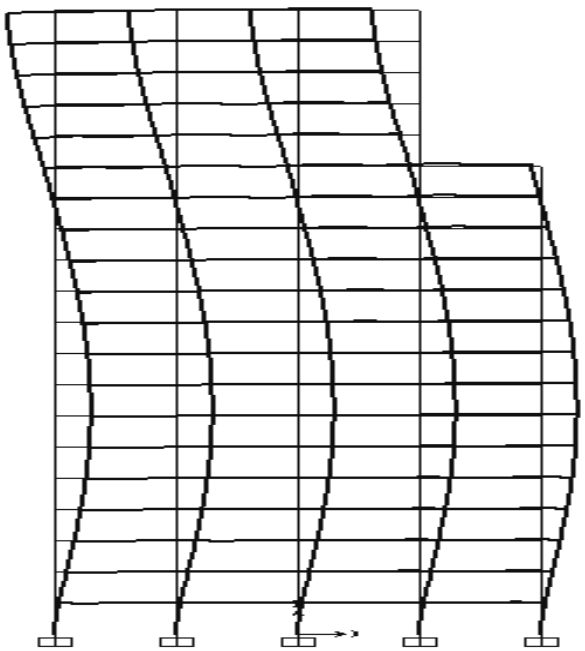

Fig. B. 5: Second mode shape of S1-20-4 building mode

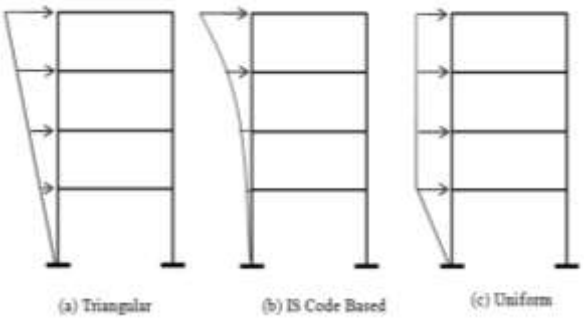

Fig. 1.6 : Lateral load pattern for pushover analysis as per FEMA 356

Conclusions

Based on the work presented in this thesis following point-wise conclusions can be drawn:

1. A detailed literature review on setback buildings conclude that displacement depends on the geometrical profile of building and concentrated in the neighbourhood of the setbacks.
2. As the shape of the triangular load pattern and first mode shape are same for medium rise regular buildings and close for high-rise and setback buildings, the capacity curves are similar for almost all the building.
3. FEMA 356 suggests that pushover analyses with uniform and triangular load pattern will connect all solution for displacement and shear. Results presented here support this statement for regular buildings. However, this is not true for high rise irregular setback building.
4. Mass distribution are depends on the geometry of building and Response spectra give the frequency and pattern of distribution of seismic motion of the building and it also depends on height of the building.
5. Upper bound pushover analysis severely underestimates base shear of setback and regular building frames.

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