PUSHOVER ANALYSIS FOR ASSESSMENT OF STRUCTURAL BEHAVIOR OF HIGH RISE BUILDING

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ABSTRACT. The paper discuss about need of non linear analysis in current scenario, in which, the construction of high rise buildings has been started in moderately developed cities after metro cities. In high rise structures, higher modes are predominant that can be considered only in Non-Linear analysis and pushover analysis helps to find out critical load for sections, effect on stiffness due to different types of loading can be calculated for individual members as well as the structure as a whole. There is no provision in Indian standards for pushover analysis, so the paper helps in evaluating the difference in various parameters during elastic (conventional) and inelastic (pushover) analysis. The paper performs static, dynamic and pushover analysis on G +20 storied regular building model and compares the result obtained to find out differences in the values of nodal displacement, beam end forces, storey drift and column moments in case of static, dynamic and pushover analysis and emphasizes on the requirement of non-linear analysis procedures.

Keywords: Pushover analysis, Regular building, Dynamic analysis.

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LITERATURE STUDY

Khoshnoudian et al. [1] modified the (CMP) analysis procedure to estimate the seismic demands of one-way asymmetric-plan tall buildings with dual systems. An analysis of 10, 15 and 20-story asymmetric-plan buildings is carried out, and the results from the modified consecutive modal pushover (MCMP) procedure are compared with those obtained from the modal pushover analysis (MPA) procedure and the nonlinear time history analysis (NLTHA).

Raju et al. [2] discussed the behavior of five storied RC framed building subjected to earthquake located in seismic Zone -V briefly using SAP 2000 software. Author also discussed that the pushover analysis is a useful tool for accessing inelastic strength and deformation demands and for exposing design weakness. The pushover analysis is a relatively simple way to explore the non linear behaviour of buildings.

Dhileep et al. [3] explained the practical difficulties associated with the non linear direct numerical integration of the equations of motion leads to the use of non linear static pushover analysis of structures. High frequency modes and non linear effects may play an important role in stiff and irregular structures. The contribution of higher modes in pushover analysis is not fully developed. In this paper an attempt is made to study the behavior of high frequency model responses in non linear seismic analysis of structures.

INTRODUCTION

Pushover Analysis

Pushover analysis is an approximate analysis method in which the structure is subjected to monotonically increasing lateral forces with an invariant height-wise distribution until a target displacement is reached. Pushover analysis consists of a series of sequential elastic analyses, superimposed to approximate a force-displacement curve of the overall structure.

A two or three dimensional model which includes bilinear or trilinear load-deformation diagrams of all lateral force resisting elements is first created and gravity loads are applied initially. A predefined lateral load pattern which is distributed along the building height is then applied. The lateral forces are increased until some members yield.

The structural model is modified to account for the reduced stiffness of yielded members and lateral forces are again increased until additional members yield. The process is continued until a control displacement at the top of building reaches a certain level of deformation or structure becomes unstable. The roof displacement is plotted with base shear to get the global capacity curve. In pushover analysis; the target displacement for a multi degree of freedom (MDOF) system is usually estimated as the displacement demand for the corresponding equivalent single degree of freedom (SDOF) system.

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ANALYSIS

Design Parameters

Table 1 Preliminary data for analysis

DESIGN PARAMETERS		
1	Type of Structure	Multi-storey Rigid Jointed PlaneFrame
2	Number of Storey	Twenty
3	Seismic Zones	III
4	Floor Height	3.0 m
5	Depth of Foundation	2.0 m
6	Building Height	62.0 m
7	Plan Size	20.6 m x 20.5 m
8	Total Area	422.3 sq m
9	Column Section	ISWB 600A
10	Beam Section	ISWB 600
11	Wall Thickness	0.20 m
12	Thickness of slab	125 mm
13	Imposed load	2.00 kN/ m^2
14	Floor finish	1.00 kN/ m^2
15	Specific Weight of RCC	25.00 kN/ m^3
16	Code Provisions	As per IS 1893 (Part 1):2016
17	Type of Soil	Type -II, Medium soil
18	Static Analysis	Equivalent Static Method
19	Dynamic analysis	Response Spectrum Method
20	Pushover Analysis	Displacement Coefficient Method
21	Software Used	STAAD.Pro for Static, Dynamic, Pushover Analysis

Procedure of finding out results

Pushover analysis in STAAD is a static, non-linear procedure in accordance with FEMA specification. Basically, in this method, the magnitude of the lateral push load is increased progressively according to a predefined loading pattern until either loading or the deflection reaches the described level.

Pushover analysis, currently implemented in STAAD, is limited in application to buildings that are regular and do not have adverse torsional or multimode effects. The capacity curve is generally constructed to represent the first mode response of the structure based on the assumption that the fundamental mode of vibration is the predominant response of the structure. Three different columns i.e. Concentric, Uniaxially Eccentric and Biaxaially

Eccentric, are selected and various post-processing results are obtained, observed and compared.

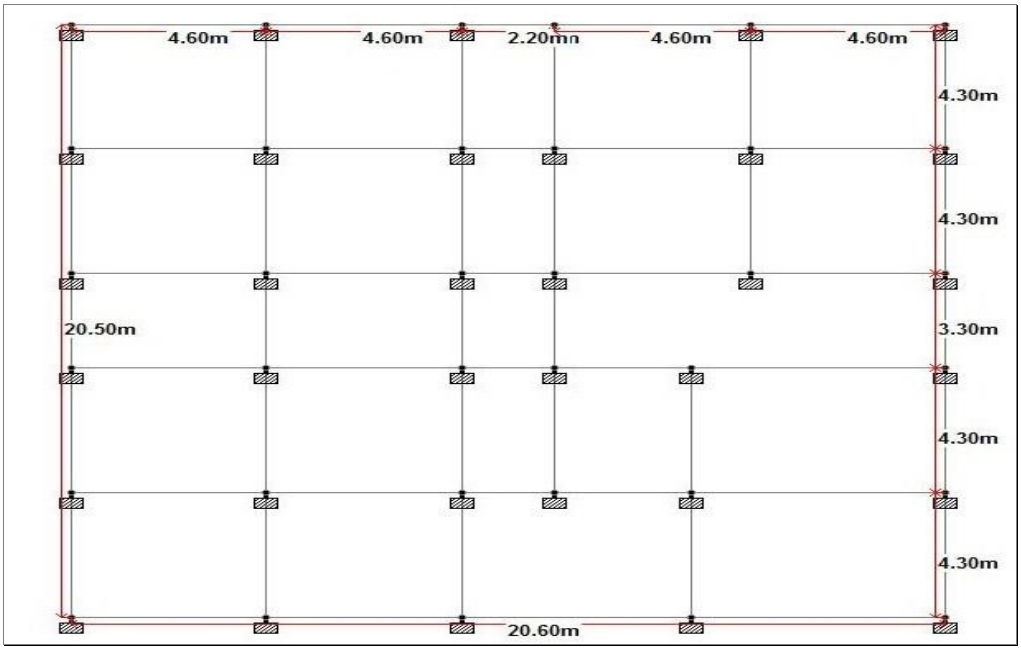

Figure 1 Working Plan of Building under Consideration

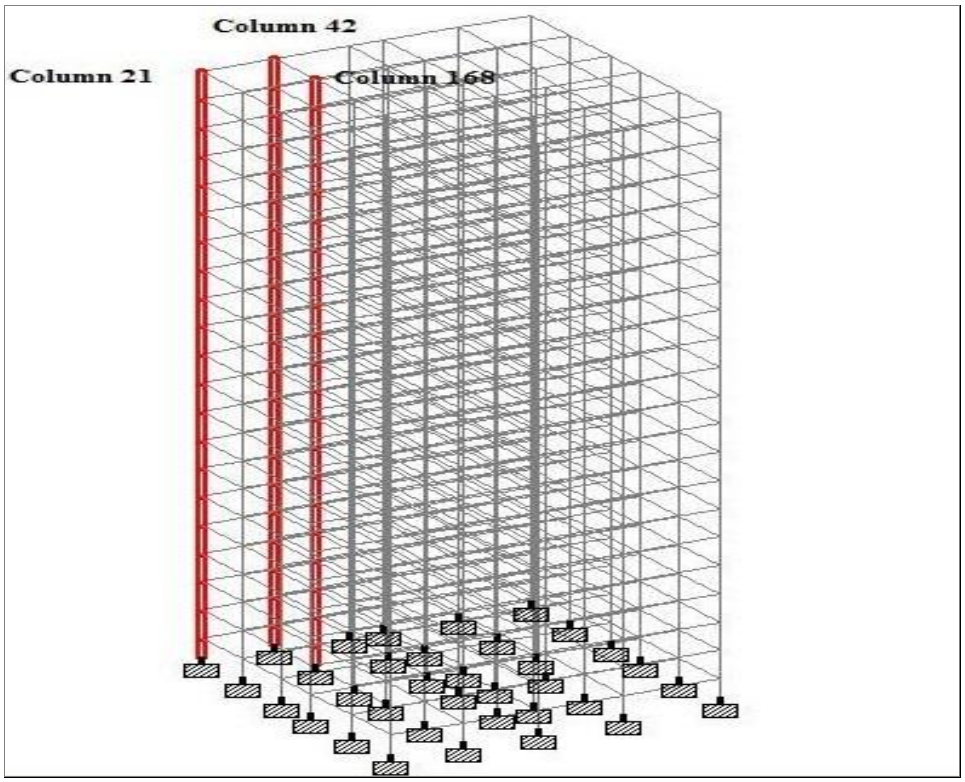

Figure 2 Location of Selected Columns

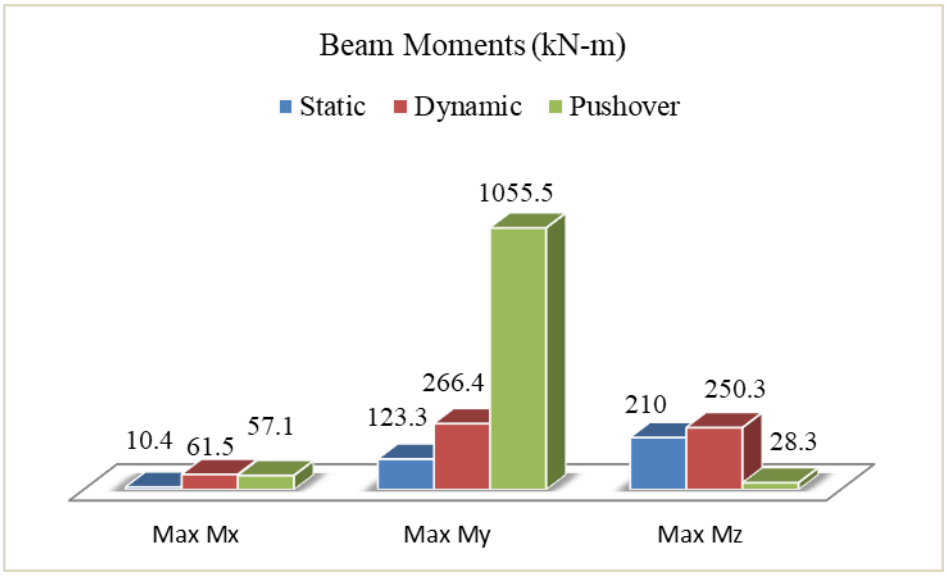

Figure 3 Comparison of beam moments, Zone – III

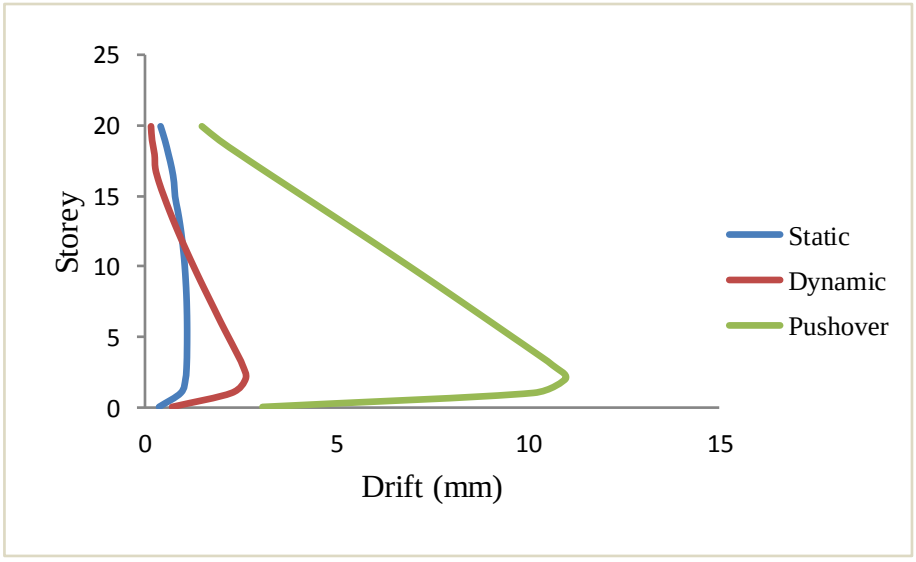

Figure 4 Comparison of story drift, Zone – III

Moment in Y direction is minimum for static analysis and maximum for pushover analysis. The numerical value is nearly 4 times for pushover analysis as compared to dynamic analysis. Maximum storey drift in case of pushover analysis is 4.15 times greater than dynamic analysis.

Storey Drift in pushover analysis is 3.2 to 4.15 times higher as compared to static and dynamic analysis. This observation shows that the existing structures can badly fail in drift criteria in case of severe horizontal forces developed by Earthquake of greater intensity.

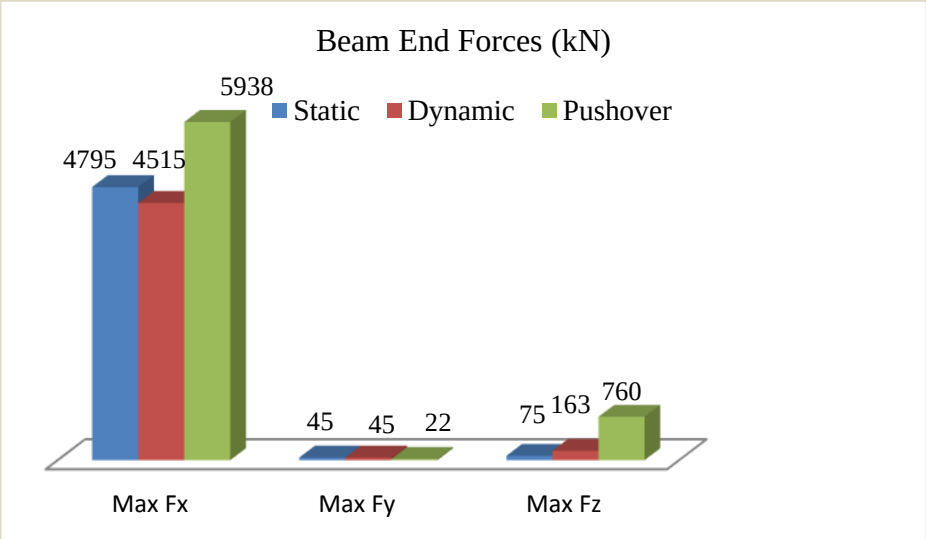

Figure 5 - Comparison of beam end forces, Zone – III

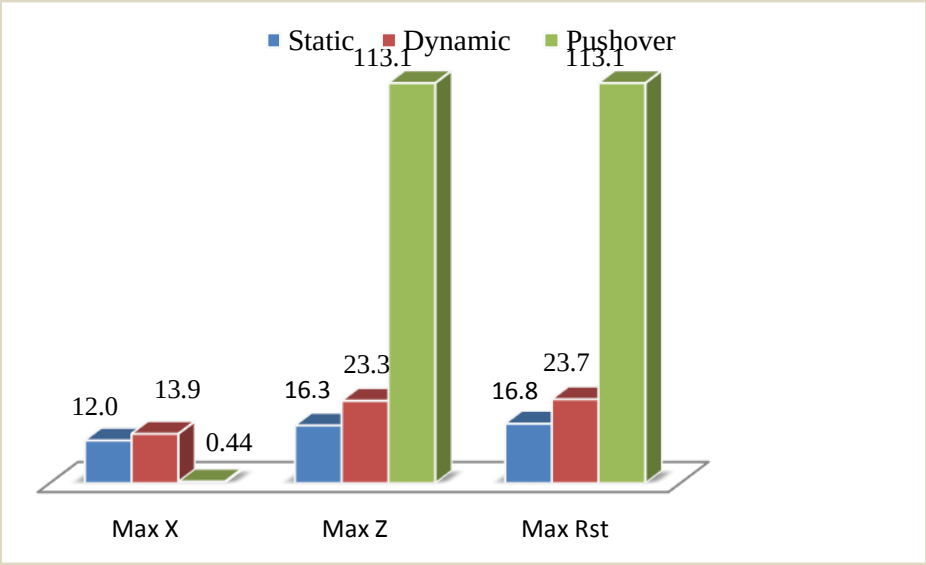

Figure 6 - Comparison of Nodal Displacements, Zone – III

Axial force in x direction has least value for dynamic analysis and maximum for pushover analysis. The numerical value for pushover analysis is 1.25 times as compared to static analysis and 1.3 times as compared to dynamic analysis.

Nodal Displacement in Pushover analysis is 3 to 5 times more as compared to Static and Dynamic analysis. This observation shows that displacement in Non-Linear zone is very large as compared to linear zone.

CONCLUDING REMARKS

The conclusions are basically drawn on the basis of structural behavior under Linear and Non-Linear conditions. after performing static, dynamic & pushover analysis, the above

observations demonstrate a lot of variations in result values in case of pushover analysis as compared to static and dynamic analysis. Because of large deformations, as observed, additional moments are generated and the same is not being taken care off in the linear analysis, which must be considered to avoid any damage due to these additional moments.

So Pushover analysis can be recommended for structures of greater importance but it should always be accompanied by some other methods of analysis such as static and dynamic analysis so as to obtain comparative results. This will also help in controlling the economical aspects.

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