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Comparative Analysis of Design Parameters for Multistoried Framed Structure under Seismic Excitation

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Abstract: **In present study, Multistoried Framed Structure has been analyzed for different parameters of seismic forces and results so obtained have been compared to understand the effect of seismic forces under static and dynamic analysis. The various design parameters such as beam moments, and storey drift have been evaluated for both static and dynamic analysis.**

In this work Multistory Rigid Jointed Steel Framed Regular Building Modal has been analyzed by static, dynamic and pushover procedures. The post processing results obtained are compared to get some important concluding remarks. This study will emphasize on the requirement of non-linear analysis procedures with the existing linear analysis procedures provided by various codal provisions. Present study will help in evaluating the difference in various parameters during elastic (conventional) and inelastic (pushover) analysis.

Keywords: **Seismic, Axial Force, Story Drift, Linear, Non-linear (pushover).**

1. INTRODUCTION

Pushover analysis has been the preferred method for seismic performance evaluation of structures by the major rehabilitation guidelines and codes because it is conceptually and computationally simple. Pushover analysis allows tracing the sequence of yielding and failure on member and structural level as well as the progress of overall capacity curve of the structure. The expectation from pushover analysis is to estimate critical response parameters imposed on structural system and its components as close as possible to those predicted by nonlinear dynamic analysis. Pushover analysis provides information on many response characteristics that cannot be obtained from an elastic static or elastic dynamic analysis. In general, linear procedures are applicable when the structure is expected to remain nearly elastic for the level of ground motion or when the design results in nearly uniform distribution of nonlinear response throughout the structure. As the performance objective of the structure implies greater inelastic demands, the uncertainty with linear procedures increases to a point that requires a high level of conservatism in demand assumptions and acceptability criteria to avoid unintended performance. Therefore, procedures incorporating inelastic analysis can reduce the uncertainty and conservatism. This approach is also known as "pushover" analysis.

In the present scenario 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.

Non-Linear analysis 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 study will help in evaluating the difference in various parameters during elastic (conventional)

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and inelastic (pushover) analysis. The second order analysis (inelastic) will be helpful to use material stiffness properties of various members in a more effective way, that can also affect the economical aspect in case of big projects.

2. LITERATURE REVIEW

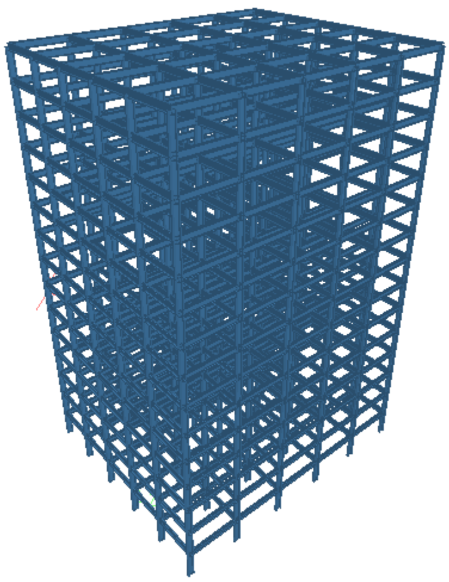
[1] Faramarz Khoshnoudian et. al (2012) The aim of this paper is to modify the (CMP) analysis procedure to estimate the seismic demands of one-way asymmetric-plan tall buildings with dual systems. An analysis of 10, 15 and 20-story asymmetric-plan buildings is carried out, and the results from the modified consecutive modal pushover (MCMP) procedure are compared with those obtained from the modal pushover analysis (MPA) procedure and the nonlinear time history analysis (NLTHA). **[2**] **P. Polu Raju et al. (2012)** In this paper the behavior of five storied RC framed building subjected to earthquake located in seismic Zone- V is discussed briefly using SAP 2000 software. This document highlights a higher degree of damage in a five storied building is expected during an earthquake. **[3] Dhileep. M et al. (2011)** 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. **[4] Oscar Moller et al. (2009)** explained the Performance-based design in earthquake engineering implies consideration of the uncertainties in the structure. **[5] Mehdi Poursha et al. (2008)** FEMA and Modal pushover analysis (MPA) are addressed in the current study and compared with inelastic response history analysis. These procedures are applied to medium high-rise (10 and 15 storey) and high-rise (20 and 30 storey) frames; efficiency and limitations of them are elaborated.

3. STRUCTURAL MODELLING AND ANALYSIS

A) Modeling of building frames:

In this work, G+15 storied regular building modal has been analyzed by static, dynamic and pushover procedures. This building has the plan area of 30 m x 25 m with a storey height 3.0 m and depth of foundation is 2.0 m. All the analyses are performed using the parameters for the designing as per the IS 1893 (Part 1): 2002 and FEMA 356: 2000. The post processing result obtained are presented in the form of tables and compared in form of bar charts to get some important

Concluding remarks.



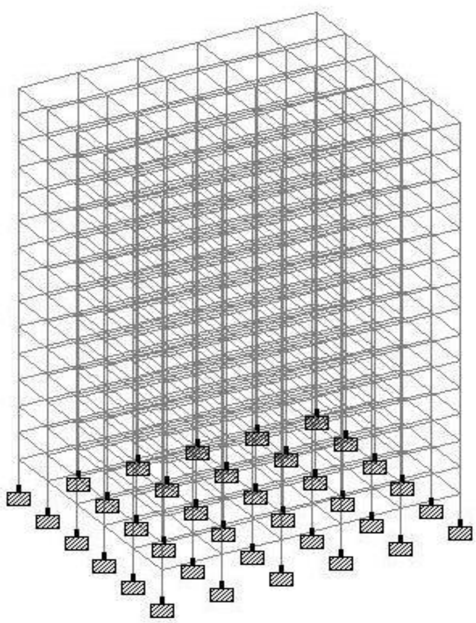


Fig: Rendered Isometric View **Fig: Isometric View**

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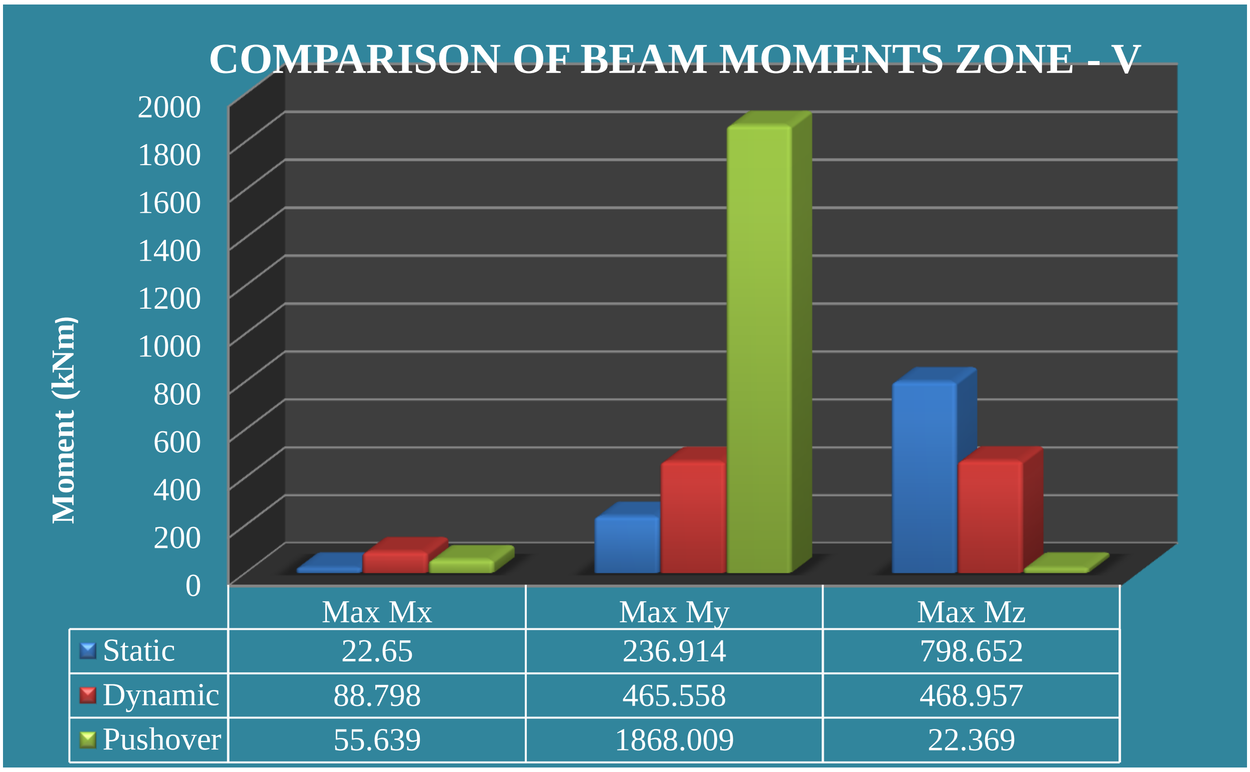
B) Analysis case:

- Static Analysis
- Dynamic Analysis
- Push Over Analysis

4. METHODOLOGY

Three different columns i.e. **Concentric**, **Uniaxially Eccentric** and **Biaxaially Eccentric**, are selected and various post-processing results are obtained, observed and compared for them.

COMPARISON OF BEAM MOMENTS ZONE – V				
Moment (kN-m)	**Beam**	**Static**	**Dynamic**	**Pushover**
Max Mx	847	22.650	88.798	55.639
Max My	1256	236.914	465.558	1868.009
Max Mz	99	798.652	468.957	22.369



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Summary of Storey Drift Zone –V
Static Analysis

Storey	Height (m)	L/C	Absolute Displacement (mm)	Storey Drift (mm)	Drift Limit (mm)
Ground Floor	3	7	0.326	0.326	12
1	6	7	2.326	2.174	24
2	9	7	4.635	2.323	36
3	12	7	9.756	2.517	48
4	15	7	12.396	2.632	60
5	18	7	15.325	2.712	72
6	21	7	18.910	2.832	84
7	24	7	22.635	2.845	96
8	27	7	25.116	2.932	108
9	30	7	28.965	2.945	120
10	33	7	31.258	2.972	132
11	36	7	34.698	2.858	144
12	39	7	39.365	2.532	156
13	42	7	41.229	2.500	168
14	45	7	47.698	2.200	180
15	48	7	51.339	2.432	192

Summary of Storey Drift Zone -V
Dynamic Analysis

Storey	Height (m)	L/C	Absolute Displacement (mm)	Storey Drift (mm)	Drift Limit (mm)
Ground Floor	3	9	0.865	0.865	12
1	6	7	4.932	4.324	24
2	9	7	8.328	4.474	36
3	12	7	12.798	4.578	48
4	15	7	15.469	4.968	60
5	18	7	19.132	3.013	72
6	21	7	25.463	3.132	84
7	24	7	28.904	3.016	96
8	27	7	35.109	3.640	108
9	30	7	38.310	3.267	120
10	33	7	42.090	3.187	132
11	36	7	44.081	3.014	144
12	39	7	50.417	2.846	156
13	42	7	56.132	2.346	168
14	45	7	60.132	2.219	180
15	48	7	66.217	1.081	192

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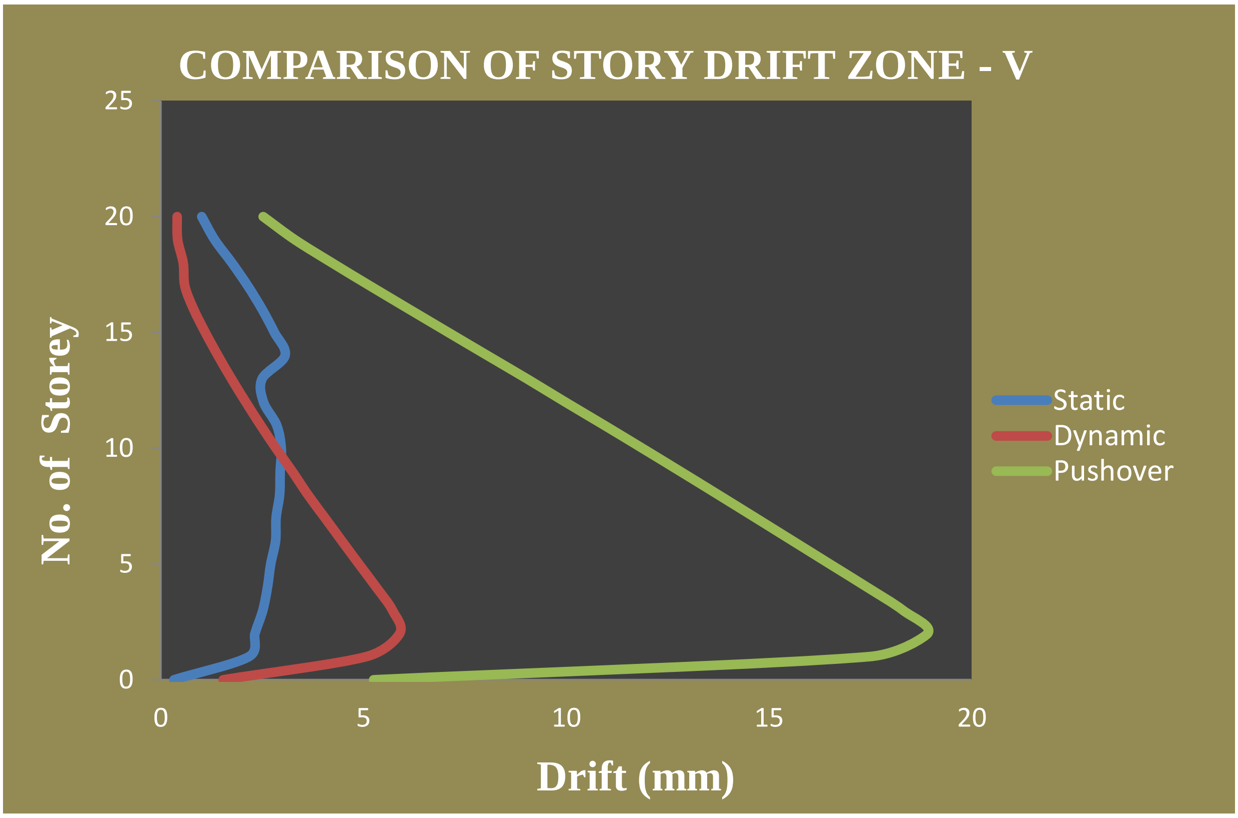
Summary of Storey Drift (Zone -V) Nonlinear Analysis					
Storey	**Height (m)**	**L/C**	**Absolute Displacement (mm)**	**Storey Drift (mm)**	**Drift Limit (mm)**
Ground Floor	3	3	3.269	3.269	12
1	6	3	15.326	10.461	24
2	9	3	21.231	14.321	36
3	12	3	31.465	14.451	48
4	15	3	41.446	13.614	60
5	18	3	61.328	12.068	72
6	21	3	72.164	11.039	84
7	24	3	81.321	10.498	96
8	27	3	94.361	9.468	108
9	30	3	103.216	9.329	120
10	33	3	128.31	8.965	132
11	36	3	132.316	8.456	144
12	39	3	143.316	8.014	156
13	42	3	155.269	7.945	168
14	45	3	164.320	7.456	180
15	48	3	182.45	7.014	192



5. CONCLUSIONS

The conclusions are basically drawn on the basis of structural behavior under Linear and Non-Linear conditions. After performing Static, Dynamic & Pushover analysis; the results are tabulated and summarized. Following are the major concluding remarks obtained-

1) Moment in Y direction in Pushover analysis is 3 to 4 times more as compared to Static and Dynamic analysis.

2) Storey Drift in Pushover analysis is 3 to 5 times more 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 Earthquakes of greater intensity.

So the above observations suggest a lot of variation in Pushover analysis results as compared to Static and Dynamic analysis. Because of large deformations observed in Pushover analysis, 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 is 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 help in controlling the economical aspects.

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