

Static and Dynamic Seismic Analysis of A Multi Storied Building by Pushover Analysis

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ABSTRACT: In this modern industrial era we can see large construction activities happening everywhere. Hence there will be a shortage of land space, so construction of tall structures has been initiated up to overcome this problem. Earthquakes are one of the greatest damaging natural hazards to the building, the design and construction of tall structures which is capable of resisting the adverse effects of earth quake forces is the most important. Therefore there is a vital need for seismic assessment of structures. The theory of performance based seismic engineering by means of pushover analysis is a modern and accepted tool to earthquake resistant design due to its simplicity and better seismic assessment of existing and new structures. It gives better understanding of the structural behavior during the strong earthquake motion.

In the present work, ten stored building was analyzed and compared in seismic zone-IV using Equivalent Static Method and Response Spectrum Method. Results of pushover analysis shows an increase in initial stiffness, strength, and energy dissipation of the higher in Equivalent Static method compared to the Response Spectrum Method, despite the zone factors reducing ductility capacity of structure.

KEYWORDS: Response Spectrum Analysis, Static Earthquake Analysis, Pushover Analysis

I. INTRODUCTION

Earthquakes are conceivably the most unpredictable and devastating of all natural disasters. They not only cause great damage in terms of human casualties, but also have a remarkable economic impact on the affected area. The apprehension about seismic hazards has led to an increasing awareness and demand for structures designed to withstand seismic forces. We can't keep away from future earthquakes, but consciousness and safe building construction practices can positively reduce the level of damage and failure. With the purpose of strengthening and resisting the buildings for upcoming earthquakes, pushover analysis which is becoming a popular tool for seismic performance evaluation of existing and new structures.

Pushover analysis is an approximate analysis method in which the structure is subjected to permanent vertical load and gradually increasing lateral load at very large strains up to failure. The purpose of pushover analysis is to evaluate the structural performance by estimating the strength and deformation capacities using static, nonlinear analysis and comparing these capacities with the demands at the corresponding performance levels. The fundamental procedure of this method is to perform a sequence of elastic static analysis under monotonically increasing lateral loads in each of its principle directions to stimulate the loading history of the structure during collapse.

Pushover analysis is a performance based approach where it necessitates in the determination of performance point from the two estimated quantities namely seismic demand and seismic capacity. Seismic demand gives a

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explanation of the earthquake effects whereas seismic capacity shows the ability of the structure to resist these earthquake effects. Pushover analysis can be done using software packages such as SAP2000 and ETABS.

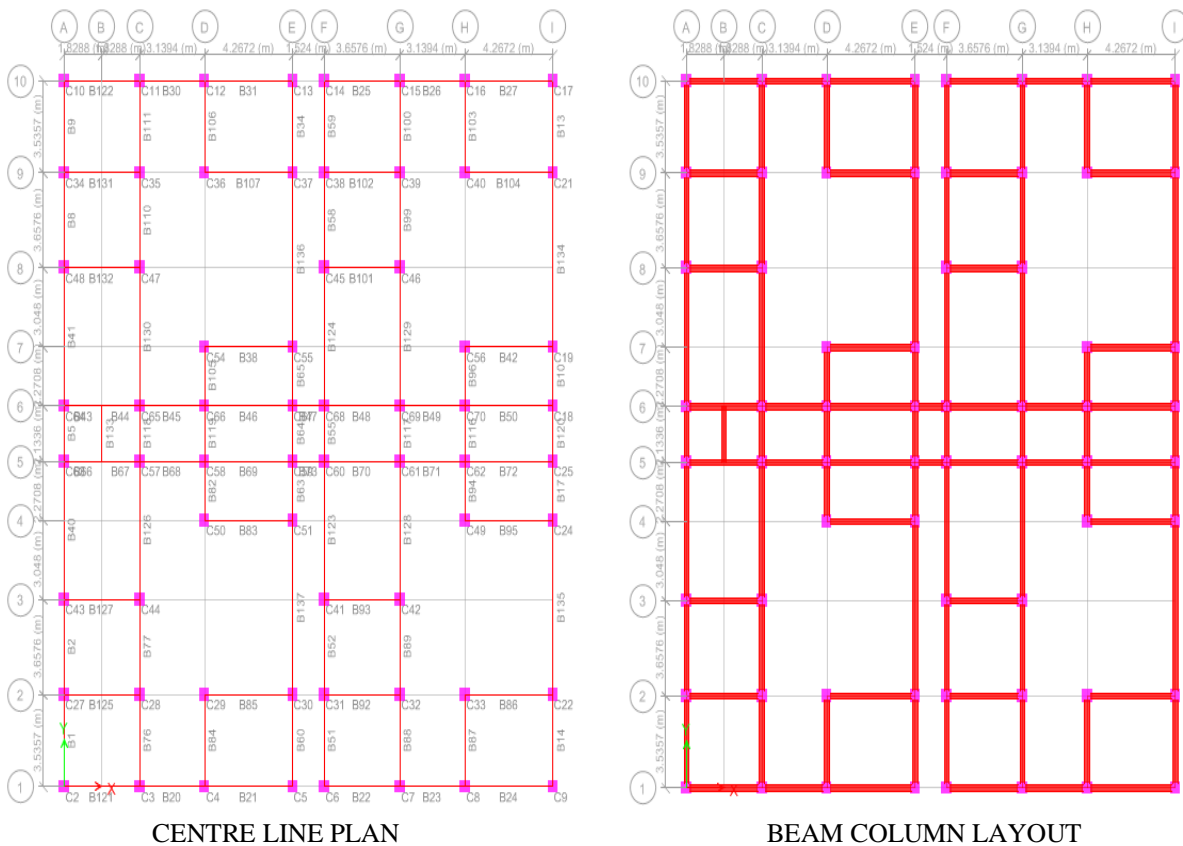
In present study ten storey building has been modeled analyzed and the results obtained from the analysis are compared in terms of seismic responses.

II. RELATED WORK

The nonlinear static procedure (NSP) or pushover analysis described in FEMA-273, ATC-40 documents are used. The analysis is performed in seismic zone-IV for study of comparing Equivalent Static Method and Response Spectrum Method from IS 1893:2000. In this thesis, the displacement, drift, story shear, lateral forces, shear force, bending moment, ATC-40 capacity spectrum pushover curve and hinge formation results are analysed and compared.

The modelling of RCC ten story frame have been analysed using SAP2000 software where the frame is analysed upto failure and load deformation curves are formed

III. SPECIFICATION



Loadings

- Dead loads :
- Finishes :(Floor finish=1.5 KN/m²)
- Wall load:

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- External wall: 13 KN/m²
- Internal wall: 5 KN/m²
- Parapet: 5 KN/m²
- Live loads: 3 KN/m² on all floors
- Reinforced Concrete Elements : 25kN/m³
- Lateral loads : Earthquake load as per IS 1893(Part 1): 2002

Material Properties

- Concrete Grade : M 25
- Steel Grade : Fe 415

Soil Condition

- Medium

Importance Factor of Structure:

- Importance factor =1

Zone factors

- Seismic Zone IV : 0.24 g

General Building Configuration

- 10 Storey building, Un-symmetric with respect to both orthogonal directions in plan.
26.1 m x 22.2 m plan dimensions

Assumed Sectional Dimensions

| Zone | Type | Beam(mmXmm) | Column(mmXmm) | Slab(mm) |
|------|------|-------------|---------------|----------|
| IV | Res | 230x450 | 350x350 | 120 |
| | Stat | 230x450 | 350x350 | 120 |

Res- Response Spectrum Method

Stat- Equivalent Static Method

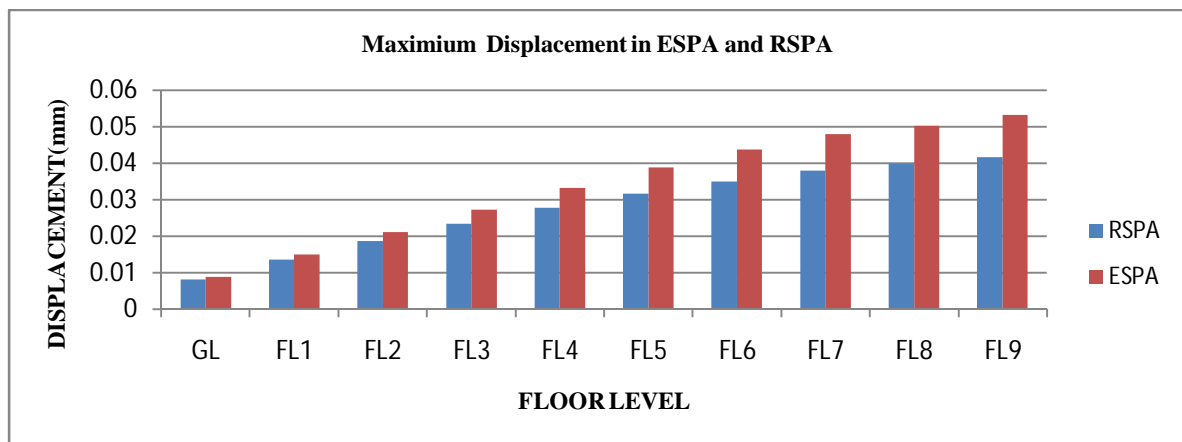
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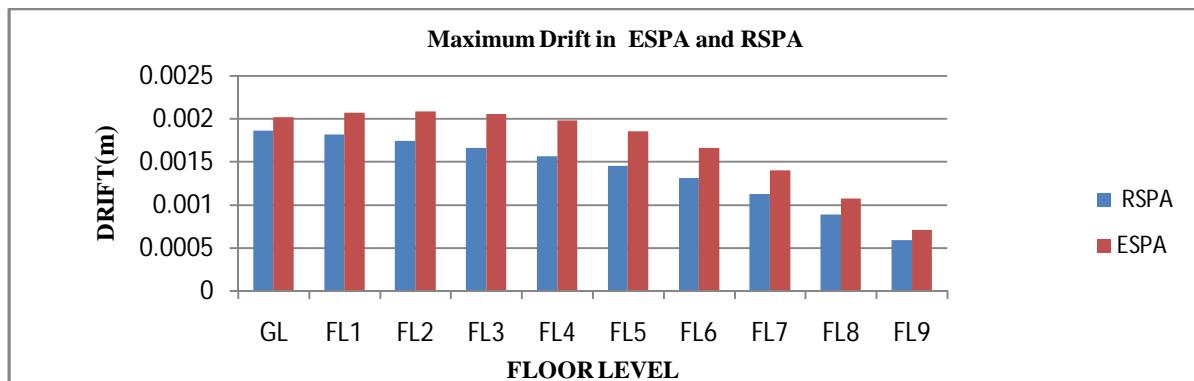
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IV. RESULTS

1 . Floor wise maximum displacement in Equivalent Static Method and Response Spectrum Method



2 . Floor wise maximum drift in Equivalent Static Method and Response Spectrum Method

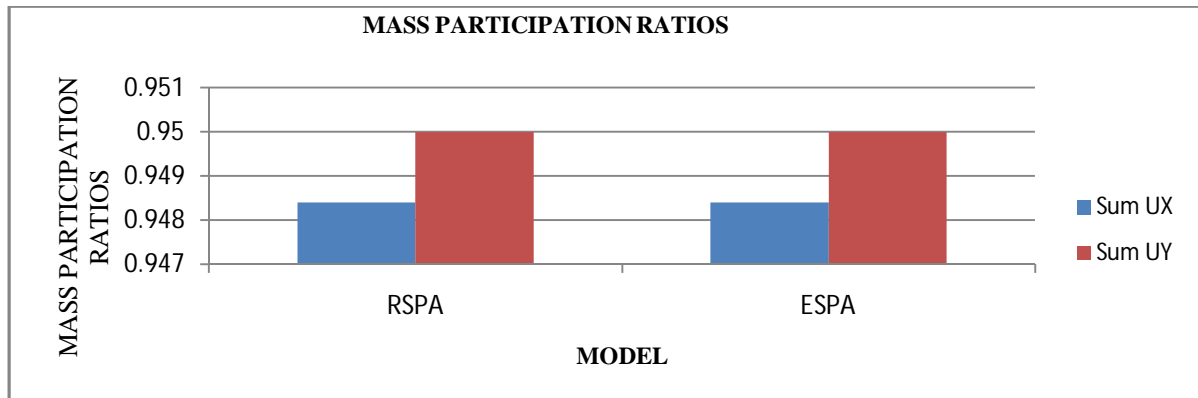


3 . Mass participation of structure in Equivalent static method and Response Spectrum Method

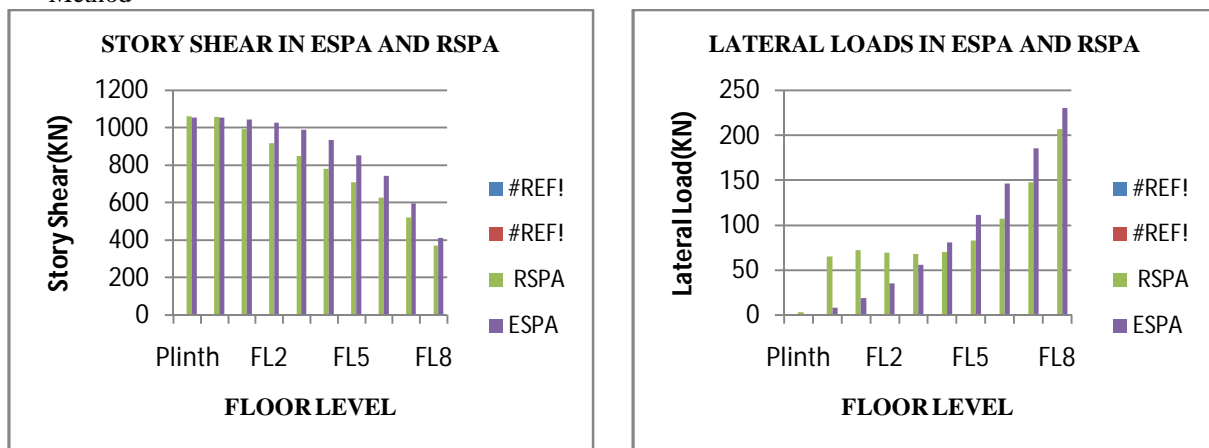
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4 . Maximum Storey Shear and Lateral Loads acting on the structure in Equivalent Static Method and Response Spectrum Method



5 . Performance evaluation of Building Models

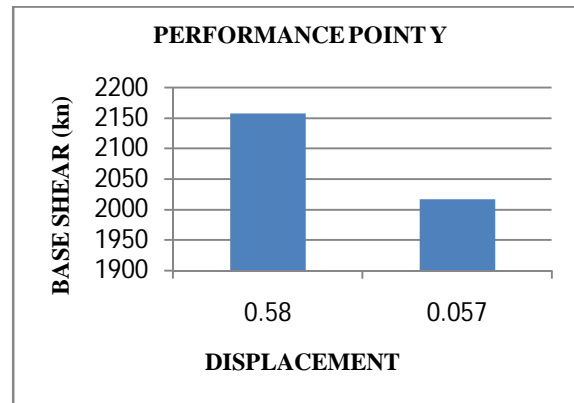
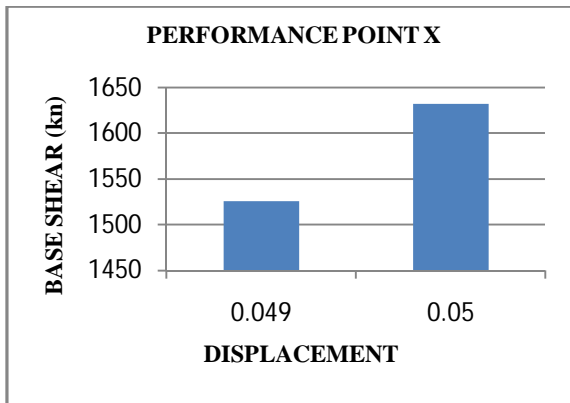
| Direction | Type | Base Shear (V) | Displacement(D) | Spectral Acceleration (Sa) | Spectral Displacement (Sd) |
|-----------|------|----------------|-----------------|----------------------------|----------------------------|
| Res | X | 1525.77 | 0.049 | 0.017 | 0.04 |
| | Y | 1632.244 | 0.05 | 0.017 | 0.041 |
| Stat | X | 2158.311 | 0.58 | 0.22 | 0.049 |
| | Y | 2017.022 | 0.057 | 0.021 | 0.046 |

6 . Performance evaluation of Building Models

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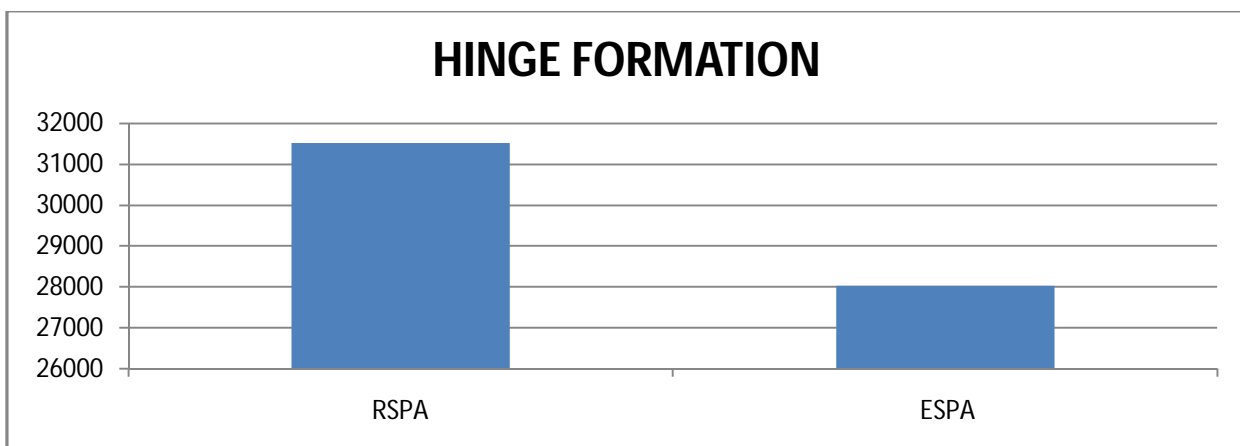
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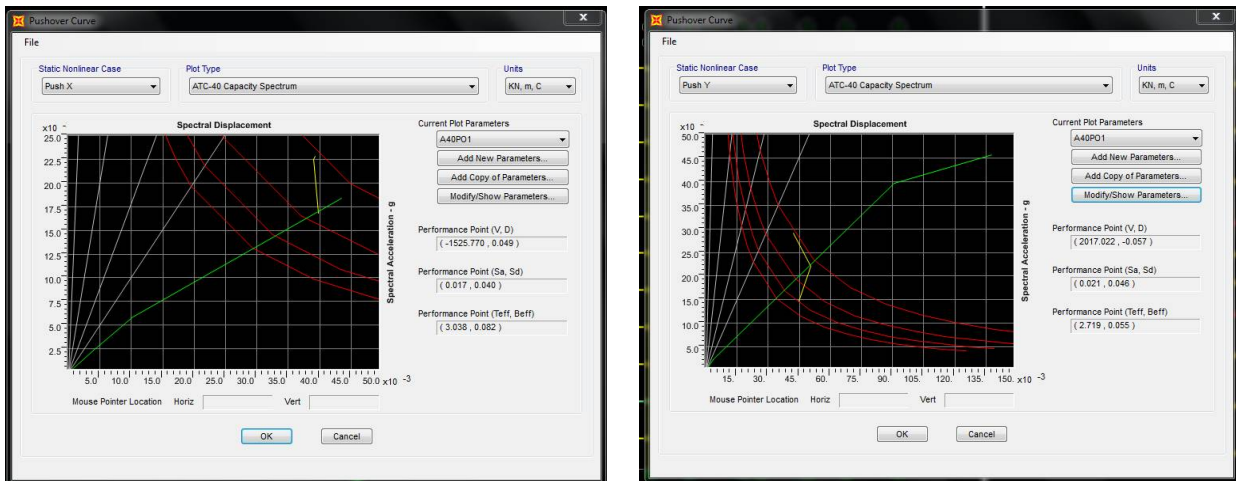


7 . Hinge Formation

| ZONE | Hinge Formation | | | | Total |
|-------------|-----------------|---------|-------|---------|-------|
| | A-IO | IO - LS | LS-CP | CP to E | |
| RSPA | 31507 | 10 | 0 | 2 | 31519 |
| ESPA | 27843 | 149 | 5 | 23 | 28020 |



8 . ATC-40 Capacity spectrum curve of Response Spectrum Method and Equivalent Static Method



V. CONCLUSIONS

1. Despite the zone factors reducing ductility capacity of structure it is observed that pushover analysis show an increase in initial stiffness, strength, and energy dissipation of the higher in Equivalent Static method compared to the Response Spectrum Method.
2. Plastic hinges formation starts from beams in case of all RC frame and the beam ends and base columns of lower stories, and then propagates to upper stories
3. The Response Spectrum frame which is analyzed for the static nonlinear pushover cases can carry lower base force and it fails at higher displacement.
4. The maximum displacements of the building obtained from Equivalent Static Analysis are higher compared to Response Spectrum Analysis.
5. The hinge formed in the Response Spectrum Method is more when compared to Equivalent Static Method formed hinges. So it can be concluded that Response Spectrum Method is giving the good hinge formation results
6. At lower story structures the structures are safe under the design of Equivalent Static Pushover Earthquake Analysis. The hinge formation is good way of failure approach when compared to the Response Spectrum Pushover Earthquake Analysis.
7. Since base shear increases with increase of mass and number of story of the building, the base shear obtained in Pushover Analysis is much more than the base shear obtained from Equivalent Static Method and Response Spectrum Method.
8. According to performance point of view, base shear is more than design base shear obtained in Response Spectrum Method and Equivalent Static Method. So, it is confirmed that structure is safe.
9. The pushover analysis is relatively simple way to explore the non-linear behavior of buildings and it is an elegant tool to visualize the performance level of a building under a given earthquake.
10. As the height of the structure increases the hinge formation is varying and the Response Spectrum Analysis gives higher values.

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