

# Comparative Study of Static and Dynamic Seismic Analysis of a Multistoried Building under Pushover Analysis

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**ABSTRACT:** The behavior of a building during earthquakes depends critically on its overall shape, size and geometry. Progressive collapse refers to a phenomenon in which local damage in a primary structural element leads to total or partial structural system failure. For structural design and assessment of reinforced concrete members, the non-linear analysis has become an important tool. The method can be used to study the behavior of reinforced concrete structures including force redistribution.

In this thesis, ten storied building will be analysed and compared in seismic zone-II using Equivalent Static Method and Response Spectrum Method which then Pushover Analysis will be assigned in both methods. The Base shear according to performance point of view will be compared with designed base shear for safety point of view in structures.

**KEYWORDS:** Response Spectrum Method, Equivalent Static Method, Pushover Analysis.

## I. INTRODUCTION

Structures suffer significant inelastic deformation under a strong earthquake and dynamic characteristics of the structure change with time so investigating the performance of a structure requires inelastic analytical procedures accounting for these features. Inelastic analytical procedures help to understand the actual behaviour of structures by identifying failure modes and the potential for progressive collapse. Inelastic analysis procedures basically include inelastic time history analysis and inelastic static analysis which is also known as pushover analysis.

Pushover analysis can be performed as force-controlled or displacement-controlled. 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.

Using this method, structures with predictable seismic performance can be produced. The three basic elements of this method are:-

Capacity: - It represents ability of the structures to resist the seismic demand.

Demand: - It represents the earthquake ground motion.

Performance: - It is an intersection point of capacity spectrum and demand spectrum. The performance of a building is depended upon the performance of the structural and the non-structural components.

After obtaining the performance point, the performance of the structures is checked against these Performance levels.

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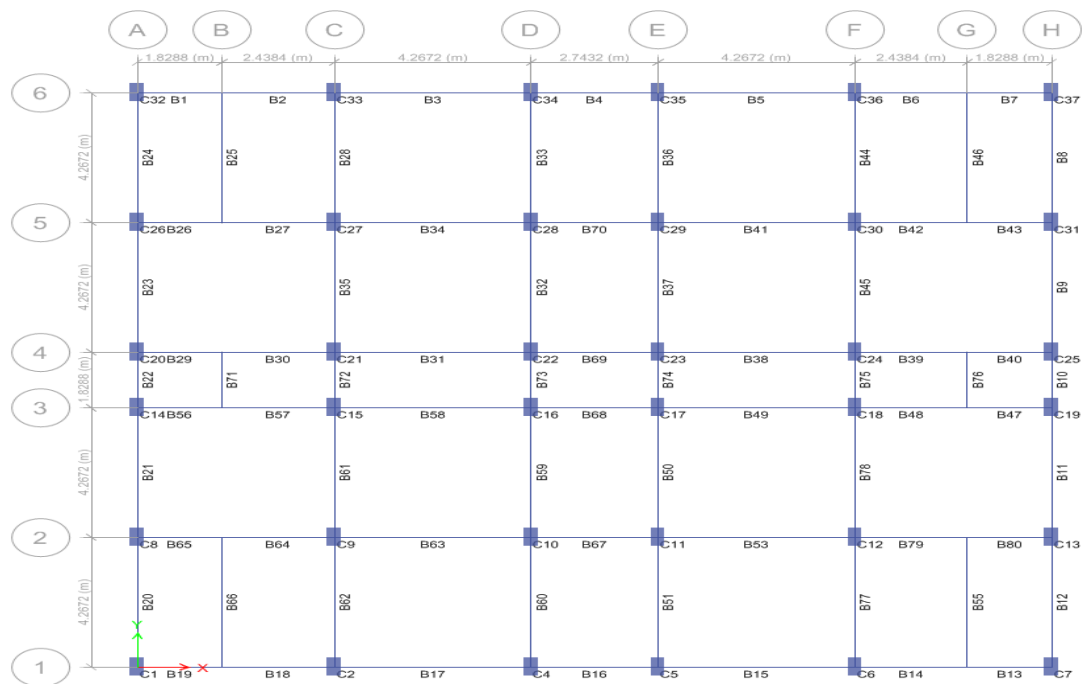
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## II. RELATED WORK

The nonlinear static procedure (NSP) or pushover analysis described in FEMA-273, ATC-40 documents are used. The analysis is performed in seismic zone-II 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. SPECIFICATIONS



CENTRE LINE PLAN

### Loadings

- > Dead loads :
  - Finishes :( Floor finish=1.5 KN/m<sup>2</sup>)
  - Wall load:
    - > External wall: 12 KN/m<sup>2</sup>
    - > Internal wall: 6 KN/m<sup>2</sup>
    - > Parapet: 6 KN/m<sup>2</sup>
- > Live loads: 3 KN/m<sup>2</sup> on all floors
- > Reinforced Concrete Elements : 25kN/m<sup>3</sup>
- > Lateral loads : Earthquake load as per IS 1893(Part 1): 2002

### Material Properties

- > Concrete Grade : M 30
- > Steel Grade : Fe 415

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### Soil Condition

> Medium

### Importance Factor of Structure:

> Importance factor =1

### Zone factors

> Seismic Zone II : 0.10 g

### General Building Configuration

> 10 Storey building, Un-symmetric with respect to both orthogonal directions in plan.  
> 19.8 m x 18.9 m plan dimensions

### Assumed Sectional Dimensions

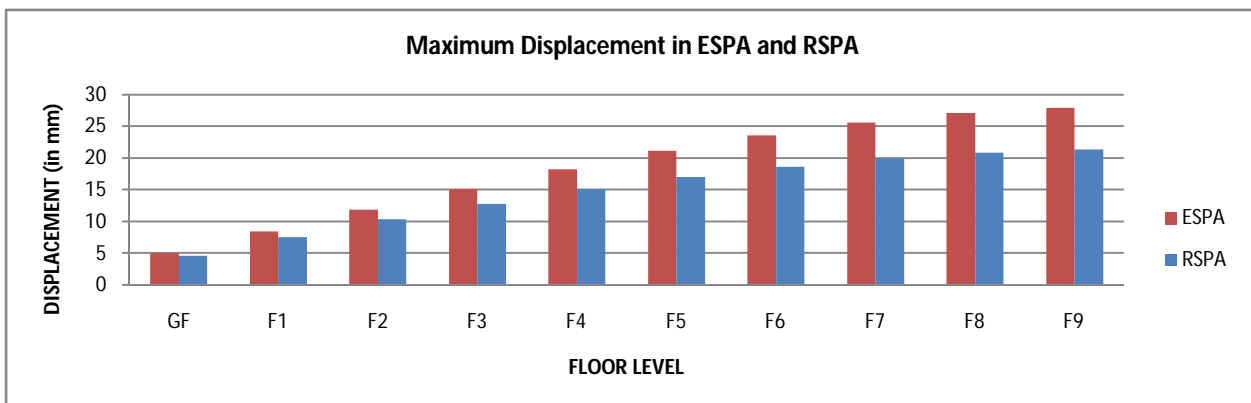
Zone	Type	Beam(mmXmm)	Column(mmXmm)	Slab(mm)
II	Res	450x230	300x600	120
	Stat	450x230	300x600	120

Res- Response Spectrum Method

Stat- Equivalent Static Method

## IV. EXPERIMENTAL RESULTS

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

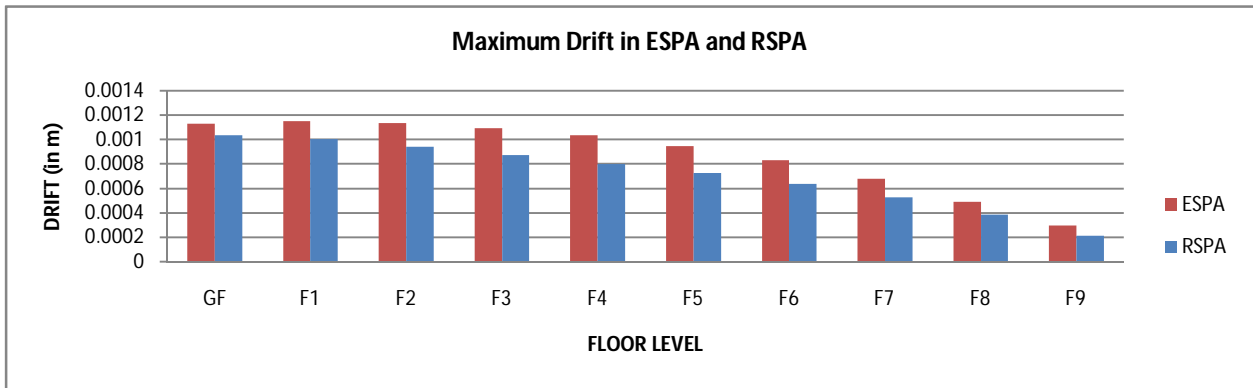


Floor wise maximum drift in Equivalent Static Method and Response Spectrum Method

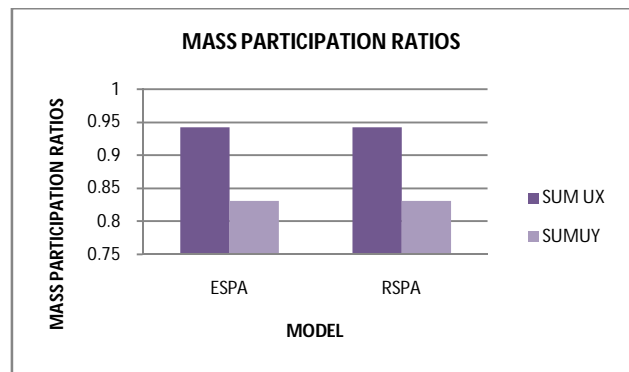
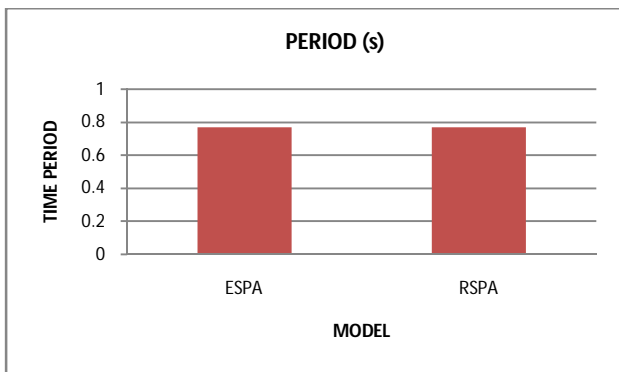
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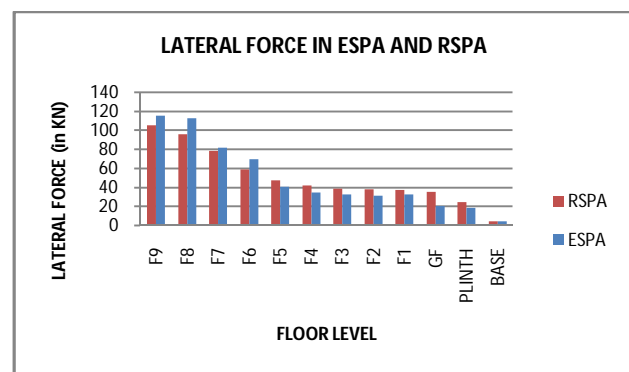
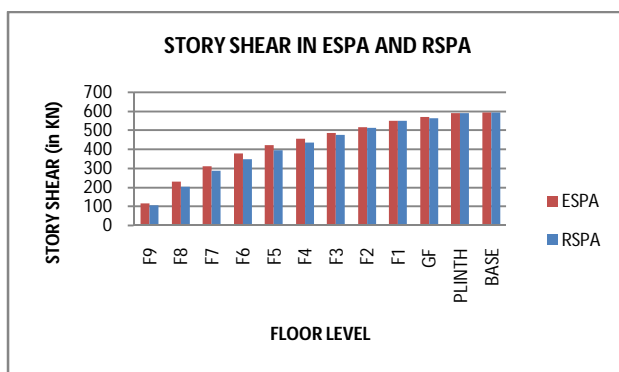
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Time period and mass participation of structure in Equivalent static method and Response Spectrum Method



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



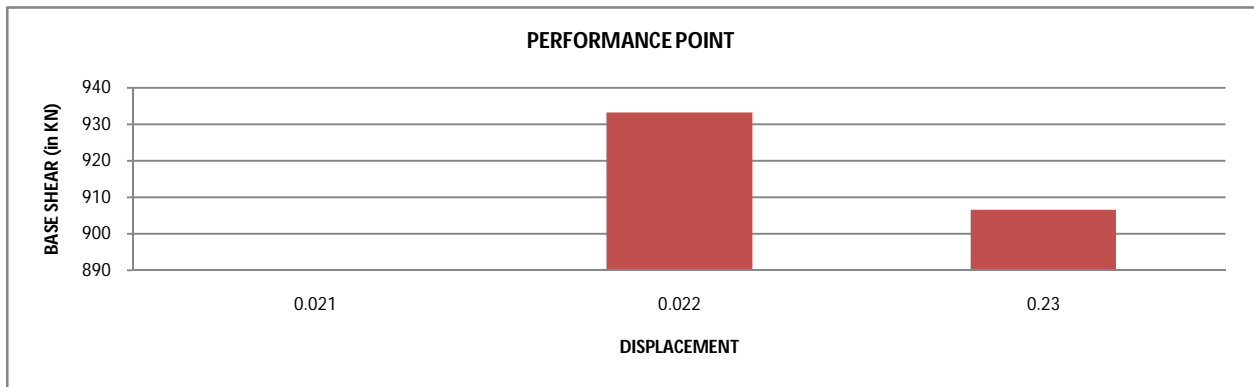
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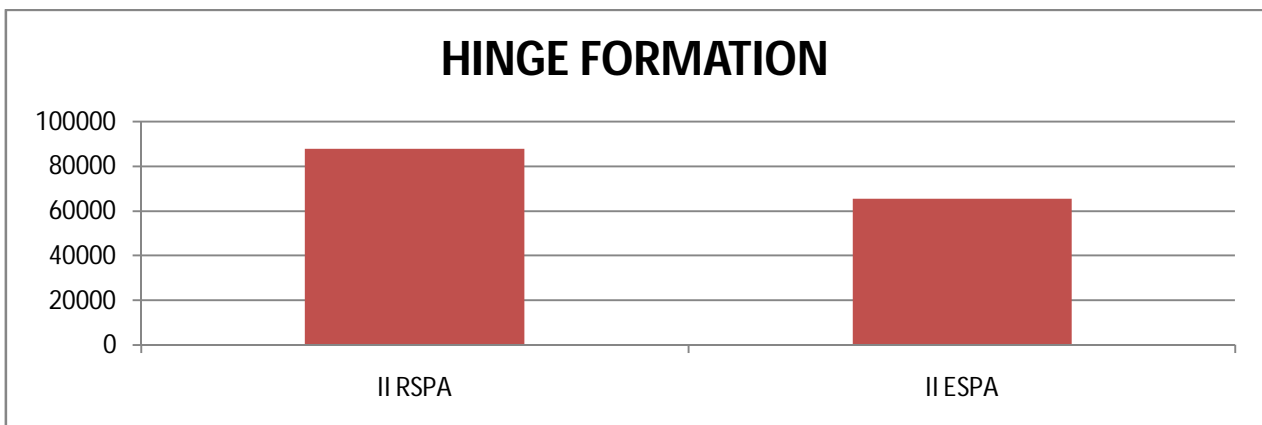
Performance evaluation of Building Models

Zone	Type	Base Shear(V)	Displacement(D)	Spectral Acceleration(S <sub>a</sub> )	Spectral Displacement(S <sub>d</sub> )
II	Res	933.232	0.023	0.014	0.018
	Stat	906.438	0.022	0.019	0.018

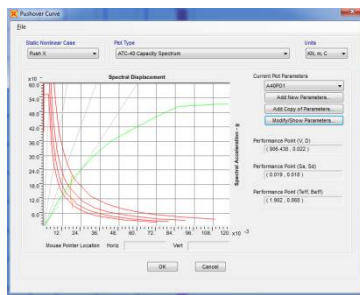


Hinge formation

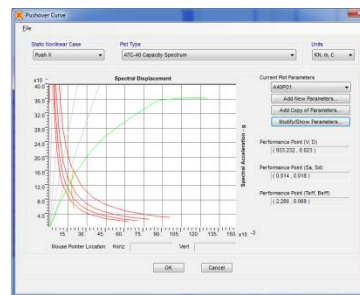
Hinge formation					
Zone	A-IO	IO-LS	LS-CP	CP-E	Total
II RSPA	86064	1754	10	0	87828
II ESPA	64176	1328	5	0	65509



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



Response Spectrum Method



Equivalent Static Method

## V. CONCLUSIONS

1. Results of 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, despite the zone factors reducing ductility capacity of structure.
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. 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.
5. The maximum displacements of the building obtained from Equivalent Static Analysis are higher compared to Response Spectrum Analysis.
6. 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 good hinge formation results.
7. 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.
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

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