

(A High Impact Factor, Monthly Peer Reviewed Journal) Vol. 5, Issue 2, February 2016

A Comparative Study on Equivalent Static Pushover Analysis and Response Spectrum Pushover Analysis

Md.Riyajuddin Basha¹, Shaik Yajdani²

Master of Engineering Student, Department of Civil Engineering, Andhra University, Visakhapatnam,

Andhra Pradesh, India¹

Assistant Professor, Department of Civil Engineering, Andhra University, Visakhapatnam, Andhra Pradesh, India²

ABSTRACT: Every Civil Engineering structure or building is unique in nature unlike other engineering products which are produced in a massive scale using the same technique again and again. The present Project is an effort to understand Pushover Analysis. In this Work ten storey building is analysed in the SAP analysis and design software. 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 the present study, the non-linear response of RCC frame using SAP2000 under the loading has been carried out with the intention to investigate the relative importance of several factors in the non-linear analysis of RCC frames. This includes the variation in load displacement graph.

KEYWORDS: push over analysis, types of analysis, comparison of analysis

I. INTRODUCTION

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 analysis, 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.

Purpose Of Doing Pushover Analysis

The pushover is expected to provide information on many response characteristics that cannot be obtained from an elastic static or dynamic analysis. The following are the examples of such response characteristics:

• Estimates of the deformations demands for elements that have to form inelastically in order to dissipate the energy imparted to the structure

• Consequences of the strength deterioration of individual elements on behavior of the structural system.

• Identification of the critical regions in which the deformation demands are expected to be high and that have to become the focus through detailing.

• Identification of the strength discontinuous in plan elevation that will lead to changes in the dynamic characteristics in elastic range.



(A High Impact Factor, Monthly Peer Reviewed Journal)

Vol. 5, Issue 2, February 2016

• Estimates of the inter story drifts that account for strength or stiffness discontinuities and that may be used to control the damages and to evaluate P-Delta effects.

• Verification of the completeness and adequacy of load path, considering all the elements, all the connections, and stiff non-structural elements of the structural systems.

II. OBJECTIVE OF THE PRESENT STUDY

In the present study, modeling of the RCC frame under the loads has been analyzed using SAP2000 software. The frame is analyzed using SAP2000 software up to the failure and the load deformation curves. In this study auto defined hinges are used in beams and columns. The frame has been analyzed and results have been analysed.

A structure is analysed in the Equivalent Static Pushover Analysis and Response Spectrum Pushover Analysis and the results are compared. The analysis is performed in the zone II and zone V for study of the Response Spectrum Pushover Analysis and Equivalent Static Pushover Analysis of the structure in different zone. In this thesis the displacement, drift, story shear, lateral forces, shear force, bending moment, ATC-40 pushover curve and the hinge formation results are analysed and compared.

III. SPECIFICATIONS

Loadings

Dead loads : Finishes : (Floor finish= 1.5 kN/m^2) Wall load : Internal wall: 11 KN/m² External wall: 12 KN/m² Parapet: 6 KN/m² Live loads: 2.5 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 30 Steel Grade : Fe 500 Soil Condition Medium **Importance Factor of Structure:** Importance factor =1 **Zone factors** Seismic Zone II : 0.10 g Seismic Zone V: 0.36 g **General Building Configuration** 10 Storey building, Un-symmetric with respect to both orthogonal directions in plan, 27 m x 27 m plan dimensions

Assumed Sectional Dimensions

Zone	Туре	Beam(mmXmm)	Column(mmXmm)	slab(mm)
V	RSPA	640X300	450X450	115
v	ESPA	640X300	450X450	115
п	RSPA	320x230	350x350	115
11	ESPA	320x230	350x350	115

RSPA- Response Spectrum Pushover Analysis **ESPA**- Equivalent Static Pushover Analysis



(A High Impact Factor, Monthly Peer Reviewed Journal)

Vol. 5, Issue 2, February 2016



Center Line Diagram



Floor Wise Maximum Floor Level Drift





(A High Impact Factor, Monthly Peer Reviewed Journal)

Vol. 5, Issue 2, February 2016

Maximum Floor Level Displacement in two zones and two methods



Time Period participation and Mass participation in the structures in two zones



Maximum Storey Shear and Lateral Loads two zones and two methods



Performance Evaluation of Building Models

	Zona	Туре	Base Shear(V)	Displacement(D)	Spectral	Spectral
	Zone				Acceleration (Sa)	Displacement (Sd)
	II	RSPA	-2175.392	-0.057	0.000017	0.047
		ESPA	-2108.275	-0.058	0.000012	0.048
	V	RSPA	6609.389.	0.03	0.044	0.024
	v	ESPA	6609.389.	0.03	0.044	0.024



(A High Impact Factor, Monthly Peer Reviewed Journal)

Vol. 5, Issue 2, February 2016

Graph representing different Performance Points



Hinge Formation

Hinge Formation								
Zone	A-IO	IO - LS	LS-CP	CP to E	Total			
II RSPA	748924	0	0	0	748924			
II ESPA	537284	0	0	0	537284			
V RSPA	3583744	599523	0	7589	4190856			
V ESPA	3583743	59522	0	7591	3650856			

Graph representing number of Hinge Formations





(A High Impact Factor, Monthly Peer Reviewed Journal)

Vol. 5, Issue 2, February 2016

V. CONCLUSIONS

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.

- 1. The RC Zone-II RSPA frame which is analyzed for the static nonlinear pushover cases can carry lower base force and it fails at higher displacement whereas the RC frame Zone-V ESPA carry higher base force and at lesser displacement it fails.
- 2. Consideration of Zone-V ESPA to Zone-II RSPA increases base shear capacity at performance point along X and Y directions, respectively for ten storey building.
- 3. 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.
- 4. Results of pushover analysis show an increase in initial stiffness, strength, and energy dissipation of the higher in ESPA, compared to the RSPA, despite the zone factors reducing ductility capacity of structure.
- 5. 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.
- 6. But as the height of the structure increases the hinge formation is varying and the Response Spectrum Analysis gives higher values
- 7. There is no effect of the Zone factor on the performance point for same section as the time period of action of the earthquake force decreases and the intensity of the earthquake increases.
- 8. The hinges formed in the Zone II RSPA is more by 28 percent to the Zone II ESPA formed hinges. So it can be concluded that RSPA is giving the good hinge formation results.
- 9. Similarly the hinges formed in the Zone V RSPA is more by 13 percent to the Zone V ESPA formed hinges. So it can be concluded that RSPA is giving the good hinge formation results.

REFERENCES

- 1. "STATIC PUSHOVER VERSUS DYNAMIC COLLAPSE ANALYSIS OF RC BUILDINGS" by A.M. Mwafy, A.S. Elnashai in May 2000
- "EFFECTS OF PLASTIC HINGE PROPERTIES IN NONLINEAR ANALYSIS OF REINFORCED" by Mehmet Inel, Hayri Baytan Ozmen in Jan 2006
- 3. "EVALUATION OF DIFFERENT TYPES OF PUSHOVER" by Armagan KORKMAZ, Mustafa DUZGUN in June 2006
- "COMPARISON OF STATIC AND DYNAMIC PUSHOVER ANALYSIS IN ASSESSMENT OF THE TARGET DISPLACEMENT" by Fayaz R. Rofooei, Nader K. Attari, Ali Rasekh, Amir H. Shodja in September 2006
- 5. "RATIONAL USE OF INELASTIC RESPONSE IN SEISMIC DESIGN" by A.M. Mwafy in 2008
- "SEISMIC EVALUATION OF REINFORCED CONCRETE FRAMES USING PUSHOVER ANALYSIS" by Sofyan. Y. Ahmed in July 2010
 "SEISMIC EVALUATION AND RETROFITTING OF RC BUILDING BY USING ENERGY DISSIPATING DEVICES" by S. I. Khan,
- Prof. P. O. Modani in June 2013
 8. "COMPARATIVE STUDY OF SEISMIC RESPONSE FOR SEISMIC COEFFICIENT AND RESPONSE SPECTRUM METHODS" B. Srikanth, V.Ramesh in October 2013
- 9. "DESCRIPTIVE STUDY RCC STRUCTURES OF RIGID JOINTS" by Yousuf Dinar, Md. Imam Hossain, Rajib Kumar Biswas, Md. Masud Rana in January 2014
- 10. "COMPARATIVE STUDY ON PUSHOVER ANALYSIS OF REINFORCED CONCRETE BUILDING" by May Soe Aung Dr. Zaw Min Htun in May 2014
- 11. "PUSHOVER ANALYSIS OF G+3 REINFORCED CONCRETE BUILDING WITH SOFT STOREY" Akshay V. Raut, Prof. RVRK Prasad in August 2014
- 12. "NON-LINEAR STATIC ANALYSIS OF G+6 STOREYED RC BUILDINGS WITH OPENINGS IN INFILL WALLS" by Praveen Rathod, Dr. S. S. Dyavanal in September 2014
- 13. IS 456:2000 Indian Standard PLAIN AND REINFORCED CONCRETE DESIGN CODE OF PRACTICE Fourth Revision.
- 14. SP16:1980 Design Aids for Reinforced concrete, Bureau of Indian Standards, New Delhi.
- 15. SP22:1982 Hand Book on codes for Earthquake Engineering, Bureau of Indian Standards, New Delhi.
- 16. IS 875 1987 -PART I to V CODE OF PRACTICE FOR DESIGN LOADS.
- 17. IS1893:2002 Part I Criteria for Earthquake Resistant Design.