Seismic Performance Evaluation of RC Building through Static Non Linear Pushover Analysis and Comparison by Changing the Size of Circular Column in Open Ground Storey Building

Jageshwar[1] Kamlesh Kumar Choudhary[2]
[1]M.Tech Scholar [2]Professor
[1]Department of Civil Engineering
[1,2]Saraswati Institute of Engineering & Technology, Jabalpur, India

Abstract— The prediction of inelastic seismic responses and the evaluation of seismic performance of a building structure are very important subjects while studying the performance based seismic design. The seismic performances of reinforced concrete buildings are evaluated by nonlinear static pushover analysis in this research. A finite element model that can accurately simulate nonlinear behaviour of building is formulated by considering several important effects. Both global response such as system ductility demand and local response such as inter-story drift are investigated in this research. A numerical example is performed on a 9-story reinforced concrete building has been simulated. The dimensions of the buildings have been kept constant and only the column sizes have been changed. Three different combinations of the circular column dimensions are taken and the non linear response of each is evaluated by using the pushover analysis. The buildings are designed for the gravity and seismic loadings as per IS 456: 2000 and IS 1893: 2002.

Keywords: Seismic Evaluation, Pushover Analysis, Reinforced-Concrete Buildings

I. INTRODUCTION

The sudden release of energy in the earth's crust creates seismic waves which arrive at various instance of time with different intensity levels are called as earthquake. It causes the random ground motion in all directions, radiating from epicentre, which causes structure to vibrate due to which induce inertia forces in them. Many existing structures are seismically deficient due to lack of awareness regarding seismic behaviour of structures. Due to this, there is urgent need to reverse this situation and do the seismic evaluation of existing and new structures. Pushover analysis is an incremental static analysis used to determine the force-displacement relationship, or the capacity curve, for a structural element. The analysis involves applying horizontal loads to a computer model of the structure incrementally (i.e. pushing the structure), and plotting the total applied shear force and associated lateral displacement at each increment, until the structure reaches a limit state of collapse condition. The equivalent static lateral loads approximately represent earthquake induced forces. Pushover analysis is a static nonlinear procedure in which the magnitude of the structural loading is incrementally increased. With the monotonic increase in the magnitude of the loading, weak links and the failure modes of the structure are found. As the load and displacement increases, the element (beams, columns, etc.) begin to yield and deform in elastically. The resulting graphic curve is an easy to visualize representation of the capacity of the building unlike in the case of conventional methods. 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.
- Immediate occupancy: It is a damage state due to earthquake in which limited structural damages has occurred. There are negligible chances of life threatening injury due to structural failure.
- Life safety: It is a state in which damage to the structure due to earthquake may have occurred but in which some margin against either total or partial collapse remains.
- Injuries during the earthquake may occur, but the risk of life threatening injury from structural damage is very low.
- Collapse prevention: In this state the building has experienced extreme damage with large permanent drifts.

The structure may have little residual strength and stiffness with extensive damages occurred to non-structural elements.

The paper presents the prediction of inelastic seismic responses and the evaluation of seismic performance of a building structure while studying the performance based seismic design. The seismic performances of reinforced concrete buildings are evaluated by nonlinear static pushover analysis in this research. A finite element model that can accurately simulate nonlinear behaviour of building is formulated by considering several important effects. Both global response such as system ductility demand and local response such as inter-story drift are investigated in this research. A numerical example is performed on a 9-story reinforced concrete building has been simulated. The dimensions of the buildings have been kept constant and only the column sizes have been changed. Three different combinations of the circular column dimensions are taken and the non linear response of each is evaluated by using the pushover analysis. The buildings are designed for the gravity and seismic loadings as per IS 456: 2000 and IS 1893: 2002.

II. PROBLEM FORMULATION

S.NO	CONTENT	DESCRIPTION
1	Type Of Structure	Multi story High Raised Frame (Moment Resisting Frame)
2	Seismic Zone	5
3	Zone Factor	0.36
4	Number of Storey	G+9
5	Floor Height	3.00m
6	Base Floor Height	3.3m
7	Wall Thickness	External-230mm Internal- 115mm
8	Materials	Concrete (M25for beams) and (M30for columns) reinforcement Fe500
9	Size of Column(Circular)	
	Set 1	Radius= 250mm
	Set 2	Radius= 300mm
	Set 3	Radius= 350mm
10	Size of the Beam in all Floors and Roof	450*600
11	Depth of Slab	125mm
12	Specific Weight of RCC	25KN/m3
13	Type of Soil	Medium

Table 1: Preliminary assumed data for G+9 RCC framed building

III. OBJECTIVES

In this study the seismic behavior of a frame building has been analyzed by using push over analysis. The seismic performance evaluation of the building has been carried out by changing the sizes of the columns Static type of pushover analysis is to be used in this research work where the loads consist of permanent gravity loads and incremental horizontal forces at each storey level. Capacity curves (base shear versus story total drift) obtained from static pushover analysis using commercially available software called Etabs 2015 are used for the calculation of some seismic demand parameters.

The dimensions of the buildings have been kept constant and only the column sizes have been changed. Three different combinations of the rectangular column dimensions are taken and the non linear response of each is evaluated by using the pushover analysis. The buildings are designed for the gravity and seismic loadings as per IS 456: 2000 and IS 1893: 2002.

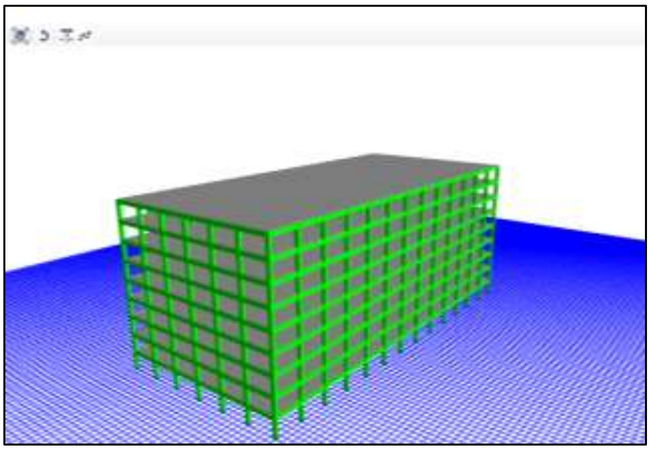

Fig. 1: 3D figure of the building frame to be analyzed using different combinations of columns.

IV. RESULTS

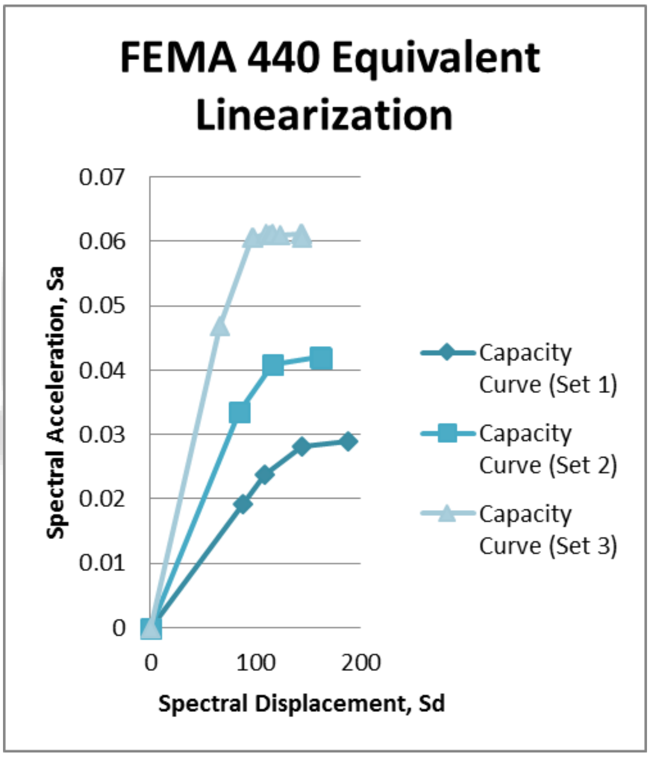

Fig. 2: Capacity Curves for the three cases of buildings

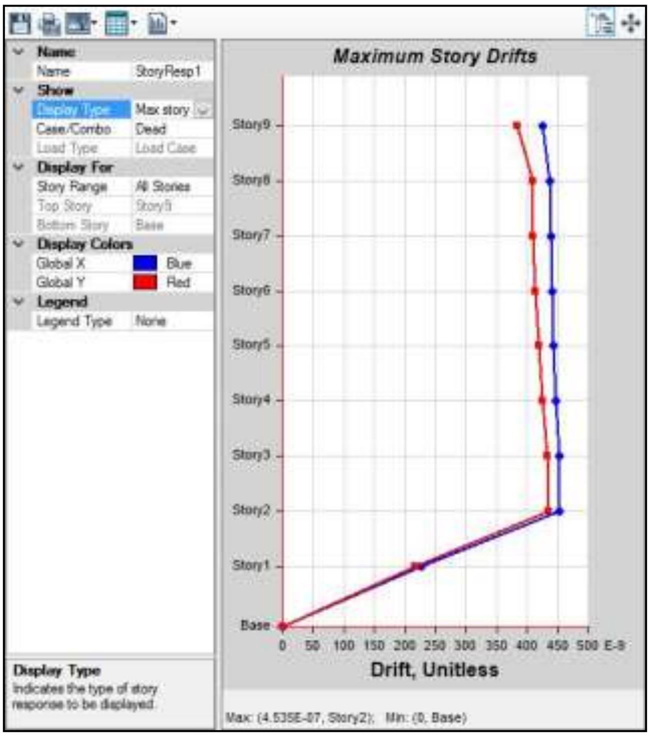

Fig. 3: Maximum story drift for the first case of building.

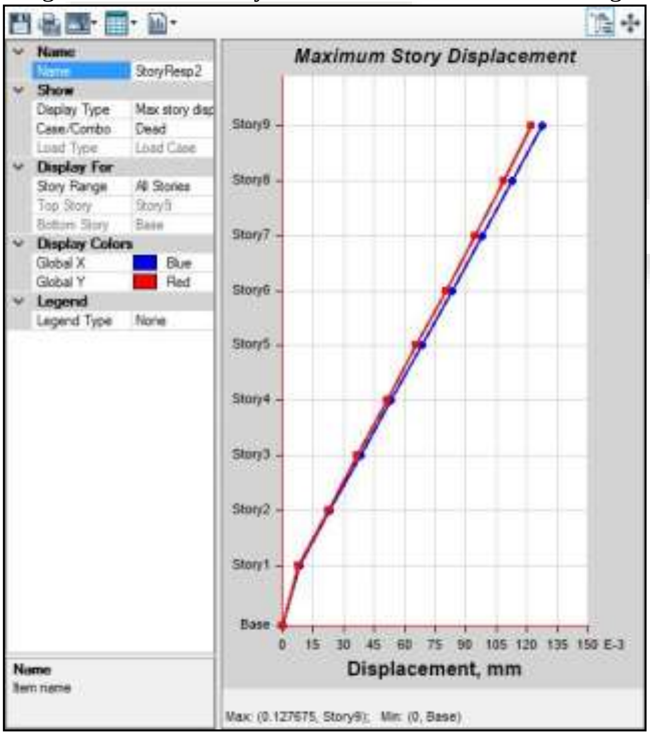

Fig. 4: Maximum story drift for the second case of building.

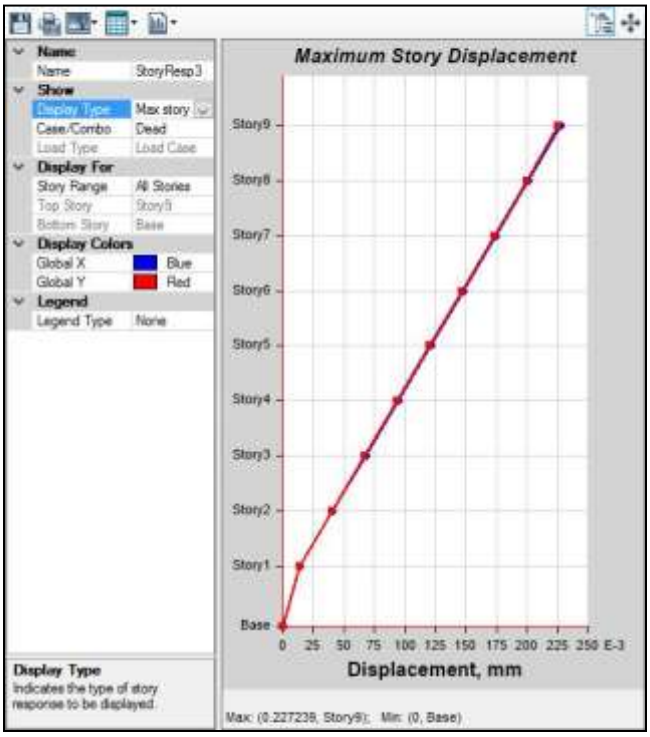

Fig. 5: Maximum story drift for the third case of building.

V. CONCLUSION

In this study the seismic behavior of a frame building has been analyzed by using push over analysis. The seismic performance evaluation of the building has been carried out by changing the sizes of the columns Static type of pushover analysis is to be used in this research work where the loads consist of permanent gravity loads and incremental horizontal forces at each storey level. Capacity curves (base shear versus story total drift) obtained from static pushover analysis using commercially available software called Etabs 2015 are used for the calculation of some seismic demand parameters.

By observing the story drift pattern it can be seen that the least drift can be observer from the third case i.e the second story shows a maximum drift of 3 whereas the other cases show a minimum story drift of 9.7 and 12.

Also, the capacity spectrum of the third case shows a better capacity spectrum than the other two. Thus, it can be concluded that case three shows better seismic performance than the other two.

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