Inelastic static analysis of building with infill wall

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Abstract – The earthquakes in the Indian subcontinent have led to an increase in the seismic zoning factor over many parts of the country. Also, ductility has become an issue for all building that was designed and detailed using earlier versions of the codes. Under such circumstances, seismic qualification of building has become extremely important. The structural engineering profession has been using the nonlinear static procedure (NSP) or pushover analysis. Modeling for such analysis requires the determination of the nonlinear properties of each component in the structure, quantified by strength and deformation capacities, which depend on the modeling assumptions. Pushover analysis is carried out for either user-defined nonlinear hinge properties or default-hinge properties, available in some programs based on the FEMA-356 and ATC-40 guidelines. This paper aims to evaluate the zone –V selected reinforced concrete building to conduct the non-linear static analysis (Pushover Analysis). The pushover analysis shows the pushover curves, capacity spectrum, plastic hinges and performance level of the building. The non-linear static analysis gives better understanding and more accurate seismic performance of buildings of the damage or failure element.

Keywords – SAP2000, Infill wall, Pushover analysis,

I. Introduction

To perform a pushover analysis, a lateral load versus deformation curves for the member is required. The results from a pushover analysis will give the load versus deformation curves. Moreover, the pushover analysis gives only curve of the base shear versus roof displacement behavior of a building. The actual performance of a building may differ from the calculated performance, since the load versus deformation curves and the earthquake levels used in the analysis are estimates. The structural engineering profession has been using the nonlinear static procedure (NSP) or pushover analysis described in FEMA-356 and ATC-40, when pushover analysis is used carefully it provides useful information that cannot be obtained by linear static or dynamic analysis.

II. Pushover Analysis

The pushover analysis of structure is static non-linear analysis under permanent vertical load and gradually increasing lateral load. This lateral load represents forces induced by earthquake. The structure performance level is based on the roof drifts. The performance levels of a structural element are represented in the load versus deformation curve. The purpose of the pushover analysis is to evaluate the expected performance of a structural system in earthquake ground motion.

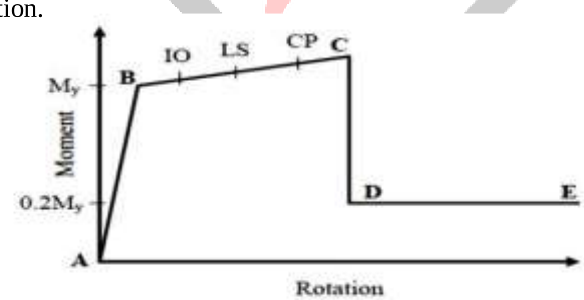

Fig 1: Performance Level of Pushover Analysis.

III. Methodology

To carry out the seismic analysis of building with and without infill wall, the building with G+15 and G+ 20 storeys are considered. Following data of building along with different components and their sizes are summarized as shown in Table 1. And the figure 2 shows the plan of the RC building taken for analysis. .

Table 1: Building Details

Member	**Size**
BEAM	230 X 480 mm
COLUMN	600 X 600 mm
SLAB	150 mm
GRADE OF CONCRETE	M20
GRADE OF STEEL	Fe 500
INFILL WALL	230 mm

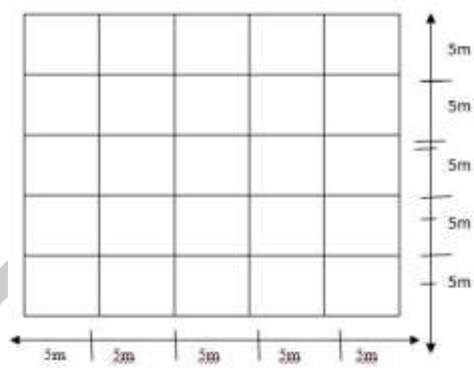

Fig 2: Plan of G+15 and G+20 Building.

Different models of G+15 and G+20 RC building with infill with one soft storey, building with infill with two soft storey and building without infill wall are analyzed For pushover analysis as per the FEMA–356 and FEMA–440 and the outcomes of these analyses are explained in performance evaluation.

Table 2: Building Details with abbreviations

Building Model(Storey)	Description	Abbreviation
G+15	Bare frame	BARE
	Infill wall with 1 soft storey	INFILL-1S
	Infill wall with 2 soft storey	INFILL-2S
G+20	Bare frame	BARE
	Infill wall with 1 soft storey	INFILL-1S
	Infill wall with 2 soft storey	INFILL-2S

IV. Performance Evaluation

The main objective of this study is to examine the behaviour of building for different location of infill wall; the pushover analysis is carried out using finite element method based SAP 2000 software. The comparison is made between the structural responses of different building models within the different location of infill wall as shown in table 3.

Pushover Analysis - After applying target displacement in push-over analysis is carried out by using displacement control method and corresponding performance point and target displacement is find out.

Performance Point

The performance of the structure to the design seismic event can be accessed from the point where the demand and capacity curves intersect. The structure is considered to survive the design if the capacity curve intersects the demand curve, and collapse if the curves do not intersect. Such performance point is carried out from fema-440 method. Performance points of building are as shown in fig.3 & 4 and target displacement are shown in fig 5.

Table 3: Performance point for G+15 and G+20 building (ATC-40).

Model	G+15	G+20
	Performance Point	Performance Point
BARE	6257.15	9088.54
INFILL-1S	11655.76	16908.82
INFILL-2S	8794.67	12694.27

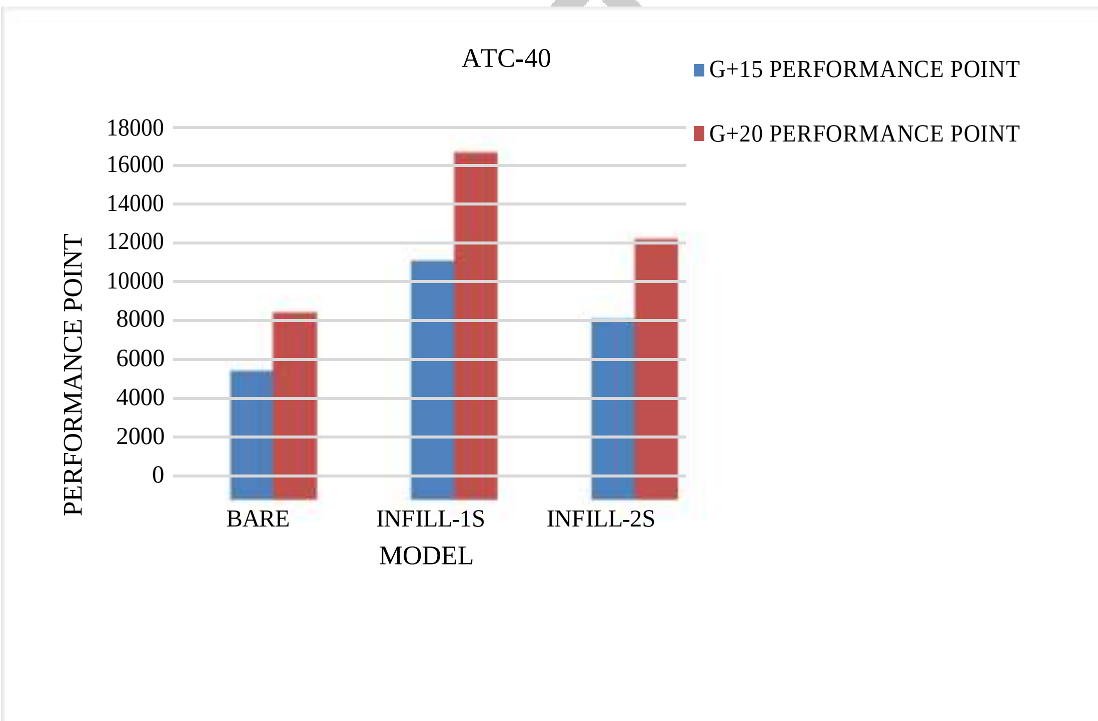

Figure 3: Performance Point for G+15 and G+20 Building.

Table 4: Performance Point for G+15 and G+20 Building (FEMA-440).

Model	G+15	G+20
	Performance Point	Performance Point
BARE	5399.82	8195.3
INFILL-1S	11744.1	12297.41
INFILL-2S	8906.16	10354.77

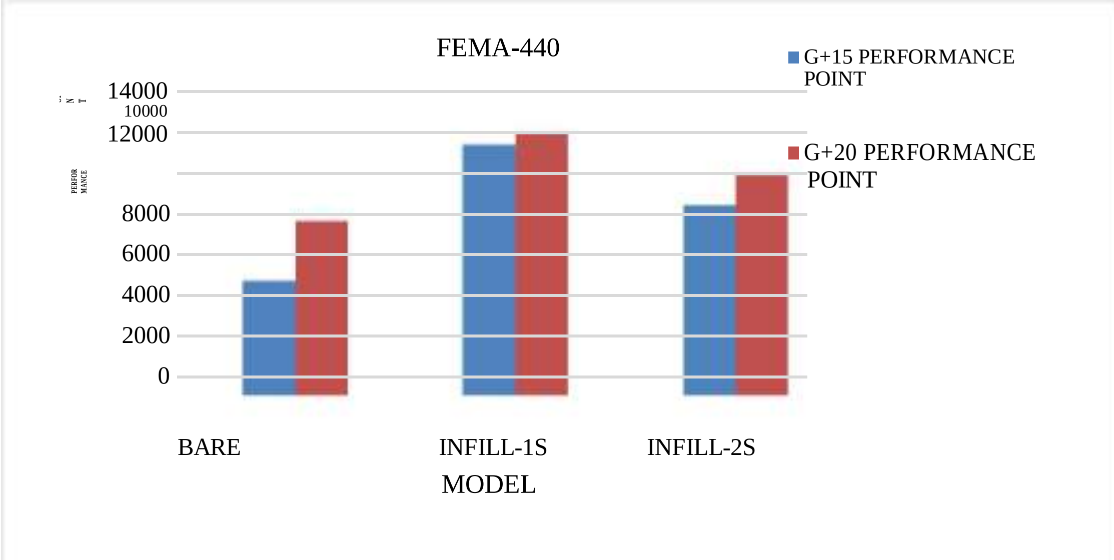

Figure 4: Performance Point for G+15 and G+20 Building.

Table 5: Target Displacement for G+15 and G+20 Building (FEMA-440).

Model	G+15	G+20
	Target Displacement	Target Displacement
BARE	8651.38	13014.66
INFILL-1S	7939.79	11069.54
INFILL-2S	8578.83	12978.4

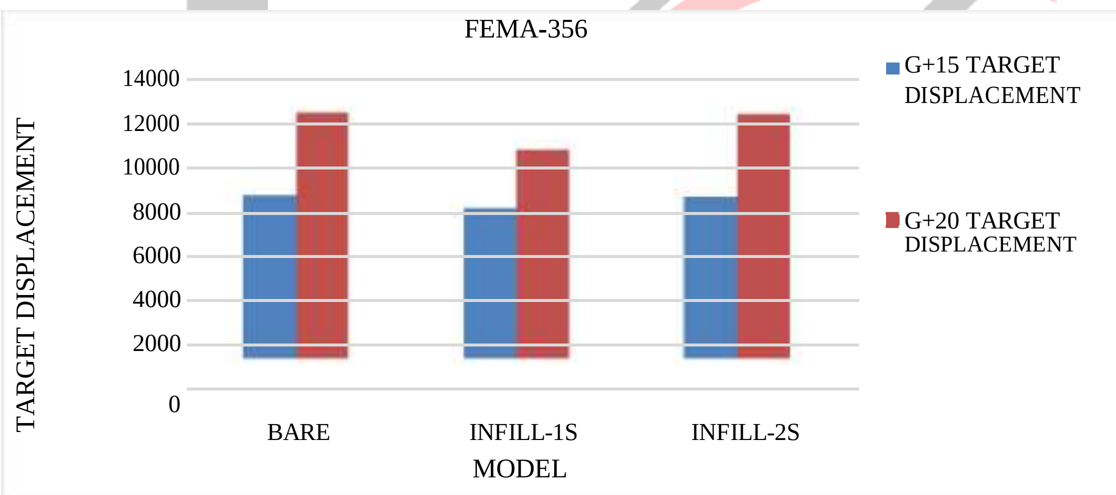

Figure 5: Target Displacement for G+15 and G+20 Building (FEMA-440)

V. Result and Discussions

From fig 3, 4 and 5, some results are drawn are as follows:
Among different locations as mentioned above building with infill with one soft storey proves better in increasing the stiffness of building. And after applying target displacement pushover analysis is carried out and it is found that building with infill performs well than bare frame. The building with infill with one soft storey performs well than two soft storey and bare frame. As the height of building increases the performance point of building also increases. The target displacement is maximum in BARE and minimum in infill wall with one soft storey.

VI. Conclusion

The performance of reinforced concrete frames was investigated using the pushover analysis. These are the conclusions drawn from the analyses:

1) The pushover analysis is a relatively simple way to explore the non linear behaviour of buildings.
2) The behavior of properly detailed reinforced concrete frame building is adequate as indicated by the intersection of the demand and capacity curves and the distribution of hinges in the beams and the columns. Most of the hinges developed in the beams and few in the columns but with limited damage.

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