PUSHOVER ANALYSIS OF BUILDING WITH INFILL WALL

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***Abstract*— Due to its simplicity, 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 FEMA – 440 guidelines. This paper aims to conduct the non-linear static analysis (Pushover Analysis) of reinforced concrete building. 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 of the structure.**

***Index Terms*—SAP2000, infill wall, Pushover analysis, soft storey**

I. INTRODUCTION

The Concept of seismic design is to provide building structure with sufficient strength and deformation capacity to sustain seismic demands imposed by ground motion with adequate margin of safety. Even if the probability of occurrence of earthquake within the life span of structures is very less, strong ground motion would generally cause greater damage to the structure. For designing the structures for this combination having less probability and extreme loading, a criterion is adopted in such a way that a major earthquake, with a relatively low probability of occurrence is expected to cause significant damage which may not be repairable but not associated with loss of life Performance based seismic design is gaining popularity from last decades. Many countries are separate document over this method such as FEMA, ATC etc. But Indian codes are still silent over this method. Even the IS 1893(part I): 2007 draft doesn't talk about performance based seismic design.

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.

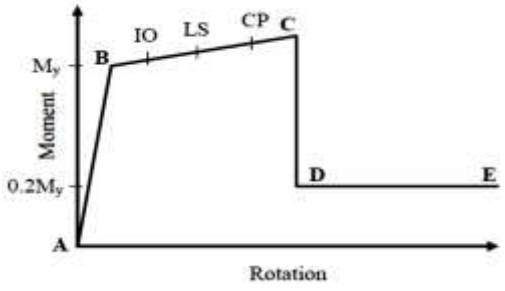

Fig 1: Performance Level of Pushover Analysis

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 1 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
SHEAR WALL	230 mm
GRADE OF CONCRETE	M20
GRADE OF STEEL	Fe 500
INFILL WALL	230 mm

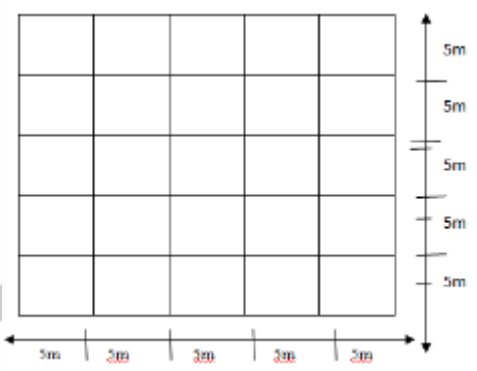

Figure 2: PLAN of G+15 and G+20 building

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Different models of G+15 and G+20 RC building are made such as, building with infill with one soft storey, building with infill with two soft storey and building with full 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	G15-BARE
	Infill wall with 1 soft storey	G15-INFILL-1S
	Infill wall with 2 soft storey	G15- INFILL-2S
G+20	Bare frame	G20-BARE
	Infill wall with 1 soft storey	G20-INFILL-1S
	Infill wall with 2 soft storey	G20- 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 2

Free vibration analysis: Free vibration analysis is carried out to determine the frequencies and mode shapes of all models. It is clearly observed that period for different models changes abruptly. The time period and corresponding mode shapes are shown in Table 3.

Table 3: Fundamental time period for G+15 and G+20 building

PARAMETER	WITHOUT INFILL	INFILL WITH ONE SOFT STOREY	INFILL WITH TWO SOFT STOREY
TIME PERIOD(sec)	3.04947	1.41208	1.60833

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PARAMETER	WITHOUT INFILL	INFILL WITH ONE SOFT STOREY	INFILL WITH TWO SOFT STOREY
TIME PERIOD(sec)	4.1612	1.212	1.3839

V. PUSHOVER ANALYSIS

After applying target displacement in push-over analysis is carried out by using displacement control method and corresponding base shear v/s displacement is found out as follows,

V.1 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 location of plastic hinges are shown in fig 5

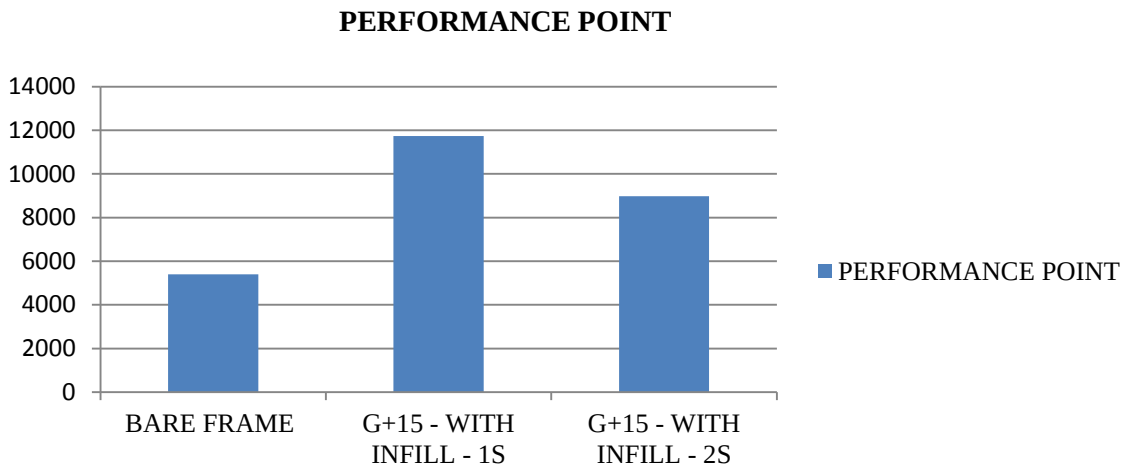

Figure 3: Performance point for G+15 building

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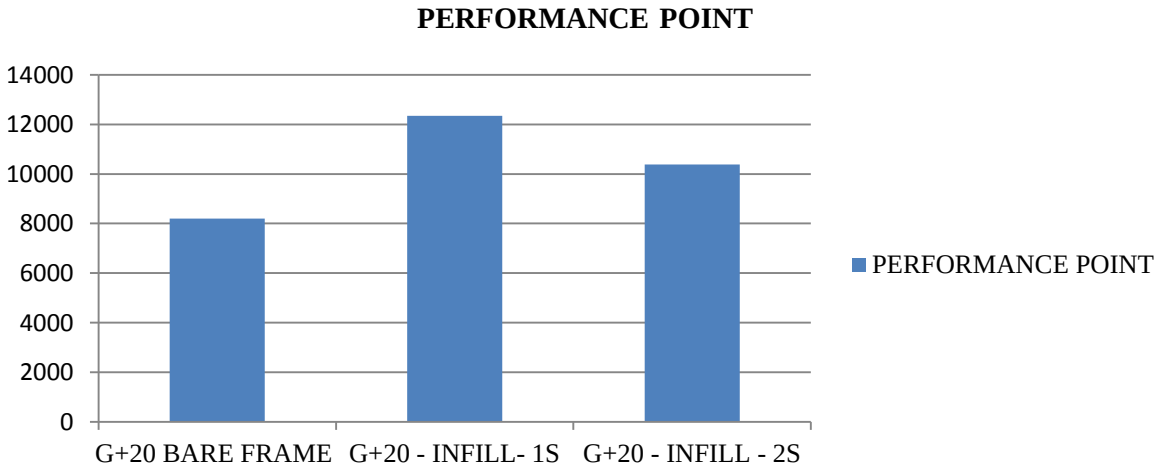

Figure 4: Performance point for G+20 building

VI. RESULT AND DISCUSSIONS

From fig 4 and 5, some results are drawn are as follows:

The fundamental time period of building increases due to provision of infill wall as provision of shear wall increases the global stiffness of building.

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.

Location of plastic hinges shows that the building with two soft storey reaches to the damage level earlier than building with one soft storey.

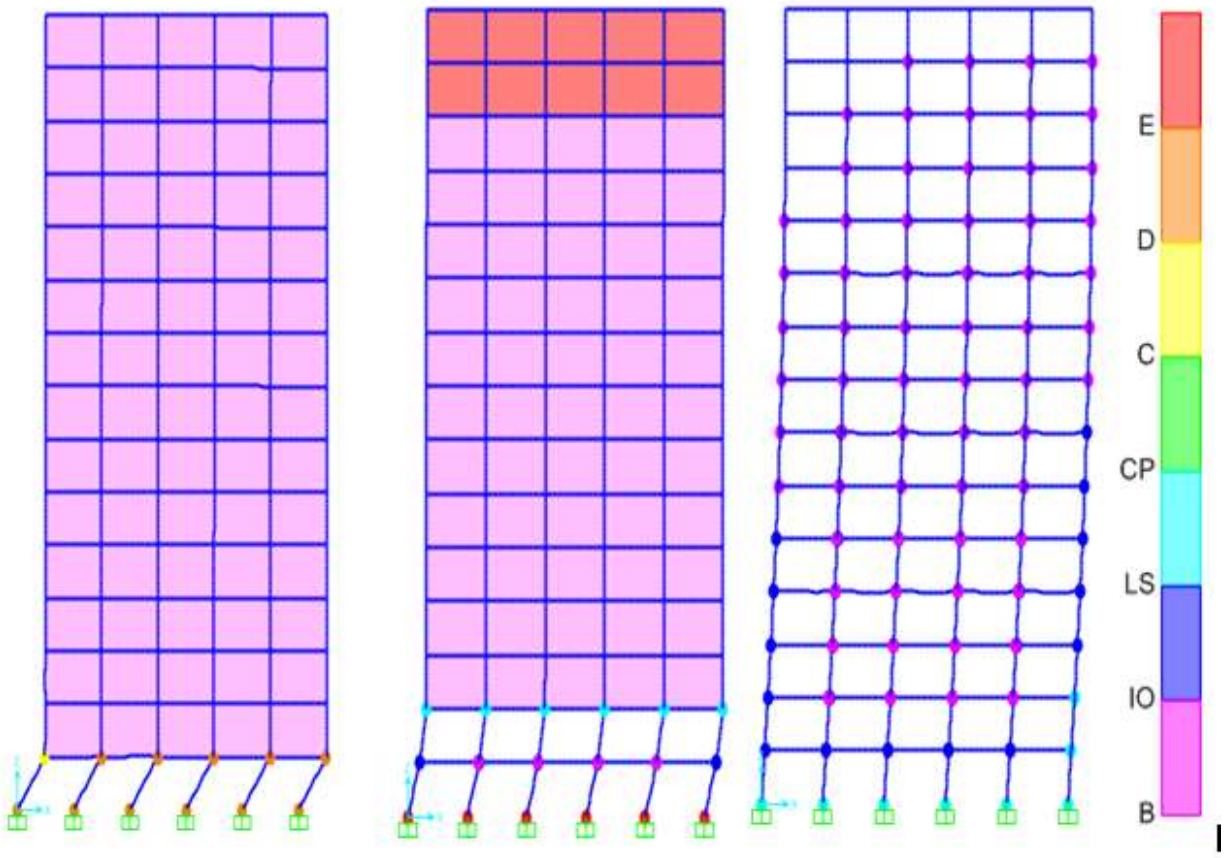

Figure 5: Location of plastic hinges for G+15 & G+20 building.

VII. CONCLUSION

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

1) The fundamental time period of building increases due to provision of infill wall as provision of infill wall increases the global stiffness of building.
2) The pushover analysis is a relatively simple way to explore the non linear behaviour of buildings.
3) The behaviour 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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