Pushover Analysis of Building with Shear Wall

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Abstract:
The earthquake in the Indian subcontinent has severe damages, the ductility of building is main issue for all the buildings. In such a cases, seismic performance of building has become an extremely important. The structural engineers are using nonlinear static pushover analysis. 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.

Keywords: SAP2000, shear wall, Pushover analysis, Structural joints

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.

III. METHODOLOGY
To carry out the seismic analysis of building with and without shear wall, the building with G+15 and G+ 20 story’s 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. These G+15 and G+20 storey buildings are analyzed for different location of shear walls using time history analysis.

Table 1: Building Details

<table>
<thead>
<tr>
<th>MEMBER</th>
<th>SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEAM</td>
<td>230 X 480 mm</td>
</tr>
<tr>
<td>COLUMN</td>
<td>600 X 600 mm</td>
</tr>
<tr>
<td>SLAB</td>
<td>150 mm</td>
</tr>
<tr>
<td>SHEAR WALL</td>
<td>230 mm</td>
</tr>
<tr>
<td>GRADE OF CONCRETE</td>
<td>M20</td>
</tr>
<tr>
<td>GRADE OF STEEL</td>
<td>Fe 500</td>
</tr>
<tr>
<td>INFILL WALL</td>
<td>230 mm</td>
</tr>
</tbody>
</table>

FIGURE 1: PERFORMANCE LEVEL OF PUSHOVER ANALYSIS

FIGURE 2 PLAN OF G+15 AND G+20 BUILDING.
Shear wall is provided for the G+15 and G+20 building for understanding the behaviour of provision of shear wall in multi-storied building during earthquake. The different locations of shear walls which are used are as follows and different location of shear wall are as shown in fig. 2.

IV. PERFORMANCE EVALUATION
The main objective of this study is to examine the behavior of building for different location of shear 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 shear wall.

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 4 and Figure 3.

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,

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. 5. The locations of plastic hinges for different location of shear wall are as shown in fig 6.
VI. 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 shear wall as provision of shear wall increases the global stiffness of building.
2. The pushover analysis is a relatively simple way to explore the nonlinear behavior of buildings.
3. 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.

VII. REFERENCES
[9]. Shahabodin, Zaregarizi, Comparative investigation on using shear wall and infill to improve seismic performance of existing building, The 14th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China.