

# Inelastic Seismic Analysis of Six Storey RCC Building

Varun Kumar Sikka<sup>1</sup>, Parveen Singh<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of Civil Engineering, Rattan Institute of Technology and Management, Haryana, India

<sup>2</sup>Research Scholar, Department of Civil Engineering, Rattan Institute of Technology and Management, Haryana, India

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## ABSTRACT

The aim of this master thesis is to determine the nonlinear response of reinforced concrete frame using SAP 2000 that has been carried out with the intention to investigate the relative factors in the nonlinear analysis of RCC frames. This includes the variation in the load-displacement graph. In order to find out the various structural performance levels of the building asymmetrical model of G+5 storey building with sap 2000 has been developed. Along with such model, a seismic evaluation followed by information about various strengthening techniques for beam and columns are also examined. The study includes the pushover analysis of G+5 building using sap2000. For structural design and assessment of reinforced concrete members, the nonlinear analysis has become an important tool. The method can be used to study the behavior of reinforced concrete structure including force redistribution this analysis of the nonlinear response of RC structures has to be carried out in a routine way. It helps in the investigation of the behavior of the structure under different loading conditions such as load-deflection behavior and the crack pattern.

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## INTRODUCTION

Earthquake being natural disasters have the potential for causing the greatest damages to the structures and its members. Engineering techniques ought to be changed so as to investigate and study the structures beneath the action earthquake loading as earthquake forces are additional calamitous and unpredictable in nature. The performance-based seismic design process explicitly hazards it is likely to experience. Also, however the building behaves considering uncertainties inherent within the quantification of potential hazards and the uncertainties in assessment of the particular building response. The long-term risk and benefit implications usually cannot be assessed using a traditional design approach. The Performance-based design begins with the selection of design criteria considering one or more performance objectives. Each performance goal considers the suitable risk of incurring specific levels of injury and the consequential losses that occur as results of this damage, at a specified level of seismic hazard.

## NEED OF PERFORMANCE-BASED SEISMIC DESIGN

Performance-based design is each economical and effective to avoid future earthquake losses. Further, the technology won't to carry out performance-based seismic design is transferable, and may be adapted for to be used in a performance-based design for the other extreme hazard including fire, wind, flood, snow, blast, and terrorist attack.

Performance-based Seismic Design is the Seismic design methodology of the future. In addition to meeting the basic safety of the objective of preventing loss of life, Performance-based Seismic Design can offer a cost-effective means to: Reduce earthquake financial loss due to structural and non-structural damage.

Performance-based engineering is that the style, analysis, and construction of built facilities that meet-as economically as possible-the unsure future demands of owner-users and nature.

The main objective of this study is as follows:

To design a six-storied RC framed building using Sap 2000 v15.1.0 and analyzing the same using pushover analysis procedure, using SAP2000 v15.1.0 for ascertaining the seismic load-carrying capacity of that structure.

Characterization of the ground shaking hazard.  
Determination of performance point of a building.  
Determination of the probable damage to the structure at various levels of response.  
Determination of the potential for casualty, capital and occupancy losses as a function of structural and non-structural damage.

## LITERATURE REVIEW

### Introduction

To provide a close review of the literature associated with modeling of structures in its entirety would be tough to deal with during this chapter. A quick review of previous studies on the appliance of the pushover analysis of structures is given in this section. This literature review focuses on recent contributions associated with pushover analysis of structures and past efforts most closely associated with the requirements of this work.

**Habibullah, et, et, et al., (1998)** investigated the performance-based mostly style has brought the nonlinear static pushover analysis procedure to the forefront. The ATC-40 and FEMA-273 documents have developed modeling procedures, acceptance criteria, and analysis procedures for pushover analysis. These documents outline force-deformation criteria for hinges utilized in pushover analysis. This text presents the steps utilized inactivity a pushover analysis of an easy three-dimensional building. SAP2000, a progressive, all-purpose, three-dimensional structural analysis program is employed a tool for activity the pushover. The SAP2000 static pushover analysis capabilities that are absolutely integrated into the program enable fast and simple implementation of the pushover procedures prescribed within the ATC-40 and FEMA-273 documents for each 2 and three-dimension buildings.

**Raju, et al (2011)** investigated the capability of the existing building as per this code of apply is a crucial task in the performance-based analysis. For earthquake resistant style, analysis of the seismic performance of buildings, it's essential to work out if an appropriate answer in terms of capability and performance is achieved. The nonlinear static analysis (Pushover analysis) may be a promising tool.

**Tande et al., (2013)** disburshed the careful discussions on non-linear static analysis ways, numerous structural performance levels of the building. Seismal analysis followed by info regarding structural performance levels of the building. Seismal analysis followed by info regarding numerous strengthening techniques for beam and column. The study includes the Pushover analysis of G+6 story building exploitation SAP 2000 with the default and user-defined hinges.

## PUSHOVER ANALYSIS AND METHODOLOGY

### Introduction

In this study, springless static analysis of a structure employing such (constant or variable) force pattern from zero loads to a prescribed final displacement. Use of it dates back to Sixties to Nineteen Seventies to research the stability of steel frames. Several pc programs were developed since then with several options and limitations. it's a static-nonlinear associate technique wherever a structure is subjected to gravity loading and a monotonic displacement controlled lateral load pattern that unendingly will increase through elastic and springless behavior till a final condition is reached.

### Strategies Of Study Pushover Analysis

A static procedure that uses a simplified nonlinear technique to estimate unstable structural deformations. Structures plan themselves throughout the earthquake. As individual elements of a structure yield or fail, the dynamic forces on the building area unit shifted to different computed.

One in every of the foremost underlining requirements of this revision was the wave and earthquake disasters moving country, resulting in the differentiation within the earthquake zones accustomed planning the 2002 SNI code.

The fresh introduced code includes a predominant influence on the amplification of the designed earthquake load. As a consequence, the building designed supported the 2002 SNI code needs re-evaluation and strengthening. One technique for strengthening concrete structural parts is by mistreatment Fiber strengthened Polymer (FRP) elements.

The structure expertise light-weight damages. There's no permanent drift. The building retains original strength and stiffness considerably. Minor cracking of facades, partitions, and ceilings likewise as structural parts. Elevators will be restarted. Fireplace protection operable.

The building house and systems area unit anticipated being fairly usable. However, instrumentation and contents area units typically secure however might not operate thanks to mechanical failure or lack of utilities.

Concrete frame expertise minor hairline cracking, restricted yielding a number of locations, and no buckling. Steel moment frames expertise minor native yielding at few locations. No buckling, fracture, and evident distortion of members. Lastly, braces of Braced steel frame structure minor yielding or distortion.

### Nonfunctional performance

Not thought-about (N-E) it may be fascinating to try to this once rehabilitation should be performed while not interruption of building operation. In some cases, it's doable to Performa all or most of the structural rehabilitation from outside occupied building areas, whereas intensive disruption of traditional operation could also be needed to perform nonfunctional rehabilitation. Conjointly Since several of the foremost severe hazards to life safety occur as results of structural vulnerabilities, some municipalities might need to adopt rehabilitation ordinances that need structural rehabilitation solely.

### MODELLING ON SAP 2000

#### GENERAL

The SAP name has been similar with progressive analytical strategies since its introduction over thirty years past. SAP 2000 follows within the same tradition that includes an awfully refined, intuitive versatile computer program battery-powered by an unmatched analysis engine and style tools for engineers performing on transportation, industrial, construction, sports and different facilities.

Complex Models will be generated and meshed with powerful inbuilt templates. Integrated design code features can automatically generate wind, wave, bridge, and seismic load with comprehensive automatic steel concrete design code check per The US, Canadian and international design standards.

## RESULTS AND DISCUSSIONS

### General

This chapter represents the results of research of RCC frame. Analysis of RCC frame beneath the static hundreds has performed victimization SAP2000 computer software.

### Analysis Results Of R.C.C Frame

It is discovered with an increase in the reinforcement of beams solely, there's a nominal proportion modification within the base force variable from zero.07% to - 8.46%. That the structure will carry. The combination of modification of reinforcement in beams and columns show an even increase in base force capability. A table conjointly obtains which supplies the coordinates every of every } live of the pushover curve and summarizes the quantity of hinges in each state (for instance, between IO, LS, CP or between D and E).

This information is shown in Table. 5.1.

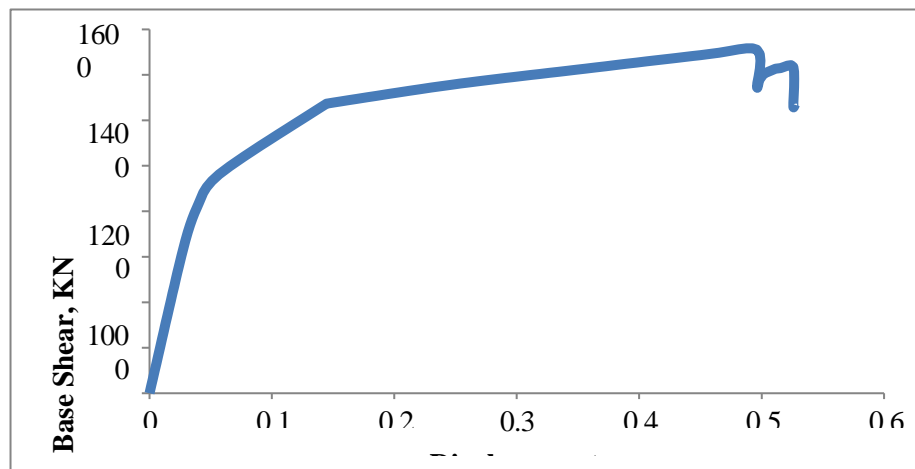


Fig. 5.1 Pushover curve of a building

## CONCLUSION

The structure is designed for its inelastic properties. This leads to the optimum utilization of the sections.

For the model studied, non-linear time history analysis result shows that PBPD frame has 1.61%,

40.93%,18.82%,55.98%,41.51%,12.87%,51.89% and 25.94% increased

Acceleration 54.27%,64.24%,63.60%,69.66%,37.52%,23.16%, 51.10% and 80.63%

Increased displacement for selected ground motion as compared to higher hysteretic energy dissipation in Elastic design.

The increased hysteretic energy dissipation of the frame indicates that the structure utilizes its capability lying within the dead zone.

For the model studied, Non-linear Static (Pushover) analysis shows excellent behavior of the PBPD frame beneath static pushover hundreds as compared to the elastic frame. No sudden plastic hinges.

- No sudden plastic hinges were discovered within the columns of the PBPD frame as compared to the elastic style frame. The hinges are fashioned in beams solely that convert the full structure into a mechanism and avoid the entire collapse.
- Static pushover hundreds because of massive displacement within the PBPD frames as compared to the elastic style frame; the structure didn't lose stability.
- It will be therefore all over that the PBPD technique is superior to the elastic style in terms of the optimum capacity utilization. Pushover analysis is an approximation technique and supported static loading. It's going to not accurately represent dynamic phenomena.
- The performance level of structure is indicated by the intersection of demand and capability curves and also the hinges developed within the beams and also the columns.
- Pushover analysis will determine weak parts by predicting failure mechanisms and account for the distribution of forces throughout progressive yielding. It's going to facilitate engineers to create action for rehabilitation work. The result show the building that was designed just for gravity load is found inadequate for Haql region. However, the building still will be thought-about for Makkah, Jeddad and Gizan. .

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