ANALYSIS OF SEISMIC DEMAND IN DIFFERENT STRUCTURAL MEMBER

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ABSTRACT

In this paper, a global limit state function for load-carrying capacity of structural system is firstly set up, in which the margin of safety is the difference between the limit base shear of structural system and the total horizontal seismic action. To probabilistically assess the global seismic capacity of structure, a new point estimation method (PEM) for analyzing statistical moments of complex random function is put forward, and then it is combined with deterministic finite element analysis to produce the so-called "random pushover analysis (RPA)". On the basis of the above new methodologies, a semi analytical approach which integrates the improved point estimation method, pushover analysis and first order reliability method (FORM) is developed to analyze the nonlinear seismic reliability of structure as a global system. By applying the proposed approach in R.C. frame structure, the changing rules of the global seismic reliability of the structure with the coefficient of variation of the total seismic action and correlation coefficient of storey-level seismic forces are derived. In this paper we will discuss Analysis of seismic demand in different structural member.

Keywords: *Analysis, Seismic, structural member, Estimation method, semi analytical, random pushover analysis, R.C. frame, Seismic Design, RCC buildings, structural engineering*

INTRODUCTION

The seismic method of analysis is used to determine the varied responses of buildings during earthquakes and to implement structural retrofitting. It is a critical tool for earthquake-prone locations such as Japan, North-East India, Nepal, the Philippines, and many more. This technique of analysis is especially useful for the design of RCC construction elements such as beams, columns, and slabs. The seismic forces are dynamic in character, and their load carrying ability, ductility, wetness, stiffness, and mass are all assessed. [1]

Seismic analysis is a subset of structural analysis that calculates a building's (or nonbuilding's) response to earthquakes. In earthquake-prone areas, it is part of the structural design, earthquake engineering, or structural assessment and retrofit process (see structural engineering).

During an earthquake (or even a violent wind storm), a building may 'wave' back and forth. The 'fundamental mode' is the lowest frequency of building response. Most buildings, on the other hand, have greater modes of reaction that are only engaged during earthquakes. Although the image only depicts the second phase, there are higher 'shimmy' (abnormal vibration) modes. Nonetheless, in most circumstances, the first and second modes do the most damage. [2]

SEISMIC DESIGN METHODOLOGY

To forecast pipeline behaviour in response to differential ground movements, several seismic analytic methodologies for pipeline design were developed. There are two basic structural response models to consider:

1. A static model of buried pipelines prone to fault crossing owing to soil failure.
2. Dynamic Analysis Model for Unburied Pipelines Subjected to Ground Wave Load. [3]

In recent decades, where the occurrence frequency of seismic events is relatively high, evaluating the seismic safety of existing masonry buildings has become one of the most significant factors to be contextualised. Characterising historical buildings is a difficult process because numerous elements influence their overall seismic reaction. Poor seismic performance of such structures, in particular, is a major source of tragedies. In truth, some masonry buildings were constructed with no regard for seismic activity. This deficiency increases worldwide vulnerability and, as a result, the seismic danger of entire urbanised sectors, such as historical centres. Seismic vulnerability is defined as the proclivity of buildings to sustain particular damage during a certain seismic event. Current code risk evaluation methods are frequently based on a number of conditions, such as strong linkages between structural components, the presence of rigid floors, and so on, which are difficult to detect in historic urban centres.

Existing masonry structures in historic districts are frequently clustered in aggregates, allowing them to interact with one another in the event of a seismic event. [4]

REVIEW OF LITERATURE

T. Balendra (1994) investigates the seismic analysis of asymmetric multistory buildings, including foundation interaction and P-A effects on three-dimensional asymmetric multistory buildings with flexible foundations. The P effect is also included in the calculation approach, where the additional tilt and torsion moments on each level caused by the pA effect are replaced by fictitious lateral forces and moments. The system as a whole has 3N + 5 degrees of freedom displacement. The required basic equations were developed with the three motions of each floor and the five movements of the total building in mind. Given that only the superstructure allows for classical normal mode, the decisive equations for foundation displacement on the floor are first separated using the mode superposition approach. By numerical stepwise time history analysis, structural deformation combined with the dynamic soil structure-interaction-forced displacement relationship in the system-wide deterministic equations leads to five integro-differential equations of basal displacement. [5]

Anil K. Chopra (1995) creates a simplified methodology for analysing and designing unsymmetrically planned structures. This model is built on one super element per building floor and may reflect the floor's elastic and inelastic qualities. This is accomplished by adapting the projectile's stiffness matrix and load-bearing area to that of the element; this area refers to the projectile's thrust and moment. Several numerical investigations have proved that the super element model's precision is adequate for most design objectives. For most practical structures, the peak response error is estimated to be less than 20%. One of the primary advantages of this reduced model is that it takes at least an order of magnitude less time than standard inelastic 3D models to design, analyse, and understand the structural model and its reaction. [6]

David Thambiratnam (2001) attempts to simplify the seismic analysis of asymmetric buildings. This approach is utilised for torsional coupling and bending rotation at the beam column junction and can be used with a home computer to get rapid and reasonably accurate results comparable to FEA. They manually create this technique based on assumptions:

- Floors are rigid diaphragms with three degrees of freedom (two lateral and one rotating).
- The kinetic energy of vertical members is either neglected or aggregated into the floor masses.
- Vertical members have three or five degrees of inclination at each end.
- The principal axes of whole vertical members are presumed to be horizontal x-y axes.
- The lateral stiffness of any floor is determined by the stiffness of the vertical elements just below and above the floor level.
- Rotation at the vertical members' ends is proportional to their second moment of area. [7]

Jitendra Chouhan (2014) compared the seismic behaviour of horizontally uneven RC frame buildings to that of standard RC frame buildings. Four multi-story buildings are studied for this purpose, with and without bracing walls. Building 1 has a standard plan, building 2 has an L-shaped plan, building 3 has a T-shaped plan, and Building 3 has a C-shaped plan. The feedback parameters were kept in order to investigate the behaviour. are the stage's lateral displacement and drift? All structures are believed to be in Zones II, III, IV, or V. To perform STAAD analysis. Professional software is used. [8]

OBJECTIVES

- To use finite element modelling to model towering buildings.
- To assess the seismic performance of a typical tall building as a result of earthquake excitations.
- Using time history analysis, investigate the seismic behaviour of tall building structures using horizontal dampers.

RESEARCH METHODOLOGY

This study's overall design was exploratory. The seismic reliability evaluations of multi-story structures were carried out using four distinct approaches: the conventional technique, the story-wise approach, the block diagram approach, and the performance areas approach. All of these strategies necessitate the provision of a set of statistical data derived from the seismic reaction of structures in various seismic hazard categories. To accomplish this, the considered structure must first be subjected to a series of accelerograms (scaled to the necessary intensity).

The highest responses in the structure under each ground motion record are evaluated in the standard reliability analysis approach, regardless of their positions. Following that, the reliability of avoiding encountering different damage levels is estimated independently for each structural and non-structural component. Although this method is effective, it does not account for the influence of damage location. Furthermore, it is not possible to estimate overall reliability for the complete structural system while taking into account the effects of both structural and non-structural components. [9]

RESULT AND DISCUSSION

Types of Seismic Analysis

This method is divided into five categories. These are- [10-11]

1. Equivalent Static Analysis:

An array of forces is employed in this analysis to simulate the effect of earthquake ground motion. It is based on the notion that the building is responsive in its basic state. This is applicable to low-rise buildings and structures that do not rotate considerably about their axes. Further research has been conducted to expand its application to high-rise buildings and to reduce the level of spin about its axis.

2. Response Spectrum of Analysis:

An array of forces is employed in this analysis to simulate the effect of earthquake ground motion. It is based on the notion that the building is responsive in its basic state. This is applicable to low-rise buildings and structures that do not rotate considerably about their axes. Further research has been conducted to expand its application to high-rise buildings and to reduce the level of spin about its axis.

3. Linear Dynamic Analysis:

When structures are too irregular or too tall, response spectrum analysis is no longer appropriate, and more complex analysis, such as non-linear static or dynamic analysis, is generally necessary.

This analysis can be done using the mode superposition approach, the response spectrum method, or the elastic history time method. This approach produces greater vibration modes and an accurate distribution of forces in the elastic range. The force distribution over the height of the structure and the level of force distinguish Linear Static Analysis from Dynamic Static Analysis. Aside from that, the structure's response to ground motion is estimated in the time domain, preserving all phase information. [12-13]

4. Non-Linear Static Analysis:

It is an improvement over linear static or dynamic analysis since it allows for the structure's inelastic behaviour. But one factor remains constant: it assumes a set of static incremental lateral loads across the structure's height. This is sometimes referred to as "pushover" analysis. To display a capacity curve, a force pattern is applied to a structural model with non-linear features, and the total force is plotted with relation to displacement. This is then paired with a demand curve (usually in the form of an Acceleration-Displacement Response Spectrum (ADRS)) to reduce the problem to an SDOF System. Furthermore, this approach is easier and provides information on strength, deformation, ductility, and demand distribution. Along with advantages it has some limitation like it neglects the variation in loading patterns and also the effect of resonance and higher modes influence on buildings.

5. Non-Linear Dynamic Analysis:

This analysis is based on the direct numerical integration of the motion differential equations while accounting for the structure element's elastoplastic deformation. Its advantages include delivering results with little uncertainty as well as temporal domain analysis. This technique also takes into account amplification owing to resonance, changes in displacements at different levels of buildings, and an increase in motion duration. [14]

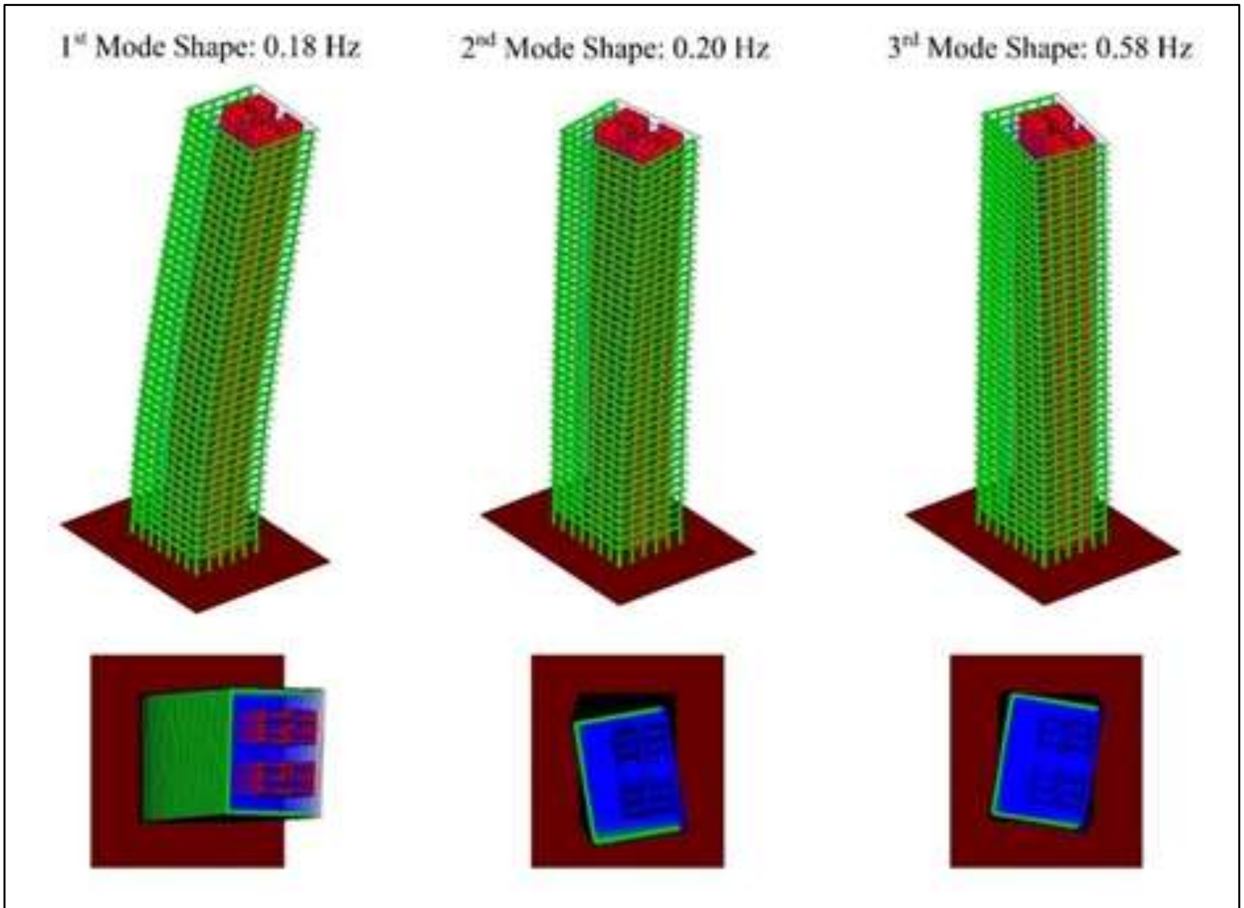

Figure 1: Structural Analysis of a High rise building

A summary of the hierarchy in the computation of the reliability for structures with a configuration as depicted in Fig. 1, is as follows:

- The reliability curves of the structural and non-structural components of each story are determined under the considered hazard level.
- The reliability curves of the structural and non-structural components are combined to obtain the reliability curve of each story and for each damage state, as shown in Figure 2. [15]

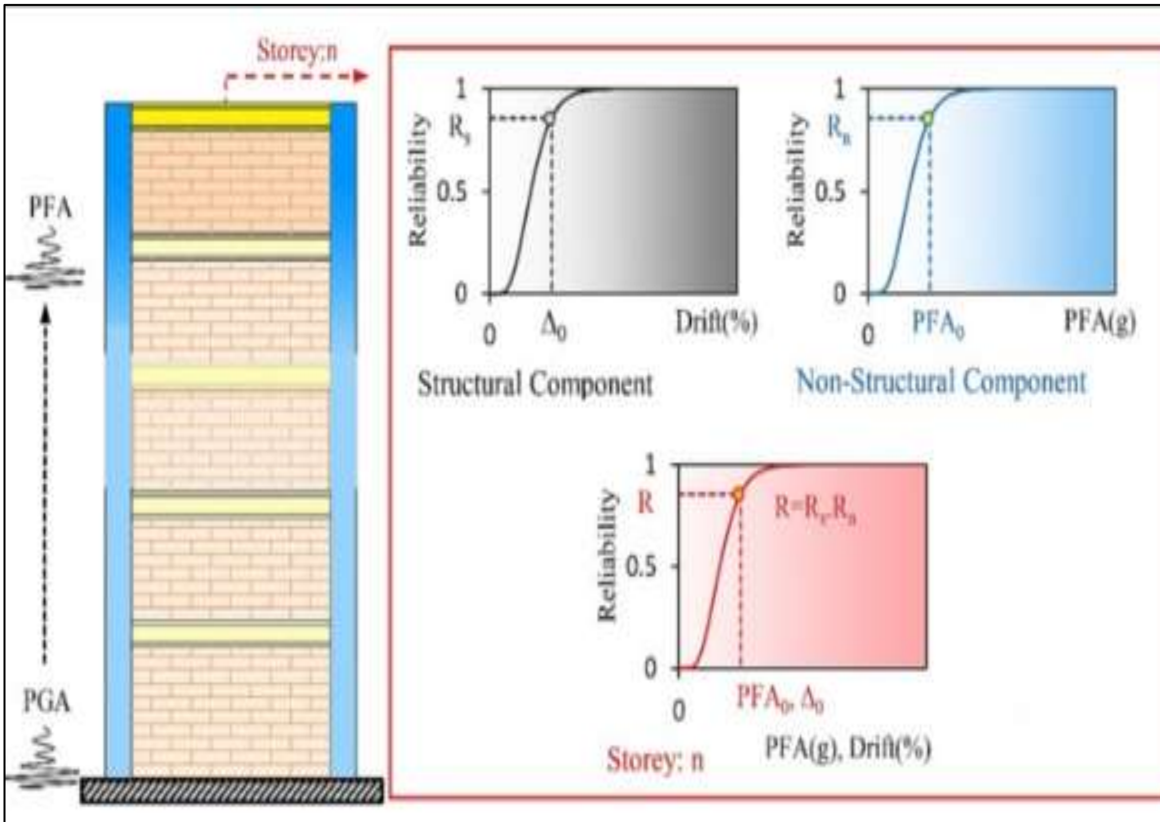

Figure 2: Schematic of the definition of the reliability curve for a single story.

CONCLUSION

There are other techniques to determining the influence of earthquakes on structures, however these evaluations have limits as well. Attempts have been made to alter this analysis so that it can be used to both high-rise and low-rise buildings at the same time. For the time being, specific analysis is being performed based on suitability.

For small structures, dynamic analysis can be performed manually; however, for complicated structures, finite element analysis can be utilised to derive mode shapes and frequencies. Various seismic analysis methodologies, such as Linear Static Analysis, Nonlinear Static Analysis, Linear Dynamic Analysis, and Nonlinear Dynamic Analysis, can be used depending on the precision of the data required and the importance of the building to be examined. Response spectrum analysis or equivalent static analysis can be used with minimum effort for smaller buildings. If we want an exact and precise outcome from the analysis, we should use non-linear dynamic analysis.

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