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Dynamic Analysis of RCC Buildings with Shear Wall

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ABSTRACT: As the world move towards the implementation of Performance Based Engineering philosophies in seismic design of Civil Engineering structures, new seismic design provisions require Structural Engineers to perform both linear and nonlinear analyses for the design of structures. While Linear Equivalent Static Analysis is performed for regular buildings up to 90m height in zone I and II, Dynamic Analysis should be performed for regular and irregular buildings in zone IV and V. Dynamic Analysis can take the form of a full nonlinear dynamic Time History Analysis or of a linear Response Spectrum Analysis. In present work, two multi storey buildings, one of six and other of eleven storey have been modeled using software package SAP 2000 12 for earthquake zone V in India. Six different types of shear walls with its variation in shape are considered for studying their effectiveness in resisting lateral forces. The paper also deals with the effect of the variation of the building height on the structural response of the shear wall. Dynamic responses under prominent earthquake, El-Centro have been investigated. This paper highlights the accuracy and exactness of Time History analysis in comparison with the most commonly adopted Response Spectrum Analysis and Equivalent Static Analysis.

KEY WORDS: Time History Analysis, Response Spectrum Analysis, Shear Wall.

INTRODUCTION

Structural design of buildings for seismic loading is primarily concerned with structural safety during major earthquakes, but serviceability and the potential for economic loss are also of concern. Seismic loading requires an understanding of the structural behavior under large inelastic deformations. Behavior under this loading is fundamentally different from wind or gravity loading, requiring much more detailed analysis to assure acceptable seismic performance beyond the elastic range. Some structural damage can be expected when the building experiences design ground motions because almost all building codes allow inelastic energy dissipation in structural systems.

OBJECTIVES

The main objectives of present study include:

1. The effect of type of shear walls on structural response under seismic loading.
2. Dynamic analysis of framed structures using Time History Method, Response Spectrum Method and Equivalent Static Method.
3. Dynamic responses under El-Centro earthquake have been investigated.

METHODS OF SEISMIC ANALYSIS OF STRUCTURES

Various methods of differing complexity have been developed for the seismic analysis of structures. They can be classified as follows.

1. Linear and Nonlinear Static Analysis
2. Linear and Nonlinear Dynamic Analysis.

Methods of Static Analysis

The method of static analysis used here is Equivalent Static Method.

Equivalent Static Analysis

All design against earthquake effects must consider the dynamic nature of the load. However, for simple regular structures, analysis by equivalent linear static methods is often sufficient. This is permitted in most codes of practice for regular, low- to medium-rise buildings and begins with an estimate of peak earthquake load calculated as a function of the parameters given in the code. Equivalent static analysis can therefore work well for low to medium-rise buildings without significant coupled lateral–torsional modes, in which only the first mode in each direction is of significance. Tall buildings (over, say, 75 m), where second and higher modes can be important, or buildings with torsional effects, are much less suitable for the method, andrequire more complex methods to be used in these circumstances.

Methods of Dynamic Analysis

The methods of dynamic analysis used here are Time History Method and Response Spectrum Method.

Time History Method

Time-history analysis is a step-by-step analysis of the dynamical response of a structure to a specified loading that may vary with time. The analysis may be linear or non linear. Time history analysis is used to determine the dynamic response of a structure to arbitrary loading.

Response Spectrum Method

The word spectrum in seismic engineering conveys the idea that the response of buildings having a broad range of periods is summarized in a single graph. For a given earthquake motion and a percentage of critical damping, a typical response spectrum gives a plot of earthquake-related responses such as acceleration, velocity, and deflection for a complete range, or spectrum, of building periods. Thus, a response spectrum may be visualized as a graphical representation of the dynamic response of a series of progressively longer cantilever pendulums with increasing natural periods subjected to a common lateral seismic motion of the base.

STRUCTURAL MODELING AND ANALYSIS

General

The finite element analysis software SAP2000 Nonlinear is utilized to create 3D model and run all analyses. The software is able to predict the geometric nonlinear behavior of space frames under static or dynamic loadings, taking into account both geometric nonlinearity and material inelasticity. The software accepts static loads (either forces or displacements) as well as dynamic (accelerations) actions and has the ability to perform eigen values, nonlinear static pushover and nonlinear dynamic analyses.

Details of the Models

The models which have been adopted for study are symmetric seven storey (G+6) and eleven storey (G+10) buildings. The buildings are consisting of square columns with dimension 500mm x 500mm, all beams with dimension 450mm x 250mm. The floor slabs are taken as 125mm thick. The foundation height is 1.5m and the height of the all four stories is 3m. The modulus of elasticity and shear modulus of concrete have been taken as $E = 2.48\times10^{7}$ kN/m^{2} and $G = 1.03 \times 107$ kN/m^{2}.

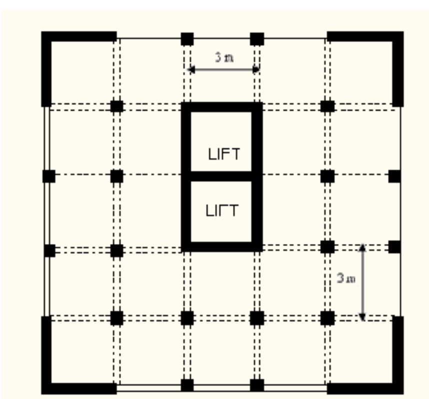

Fig. 1 Plan of the seven and eleven storey building

Shear Wall Sections

Six types of shear walls show in Fig. 2 were used in the building models. Analysis were carried out placing these shear walls in the same locations. The thickness of the shear walls are 400 mm.

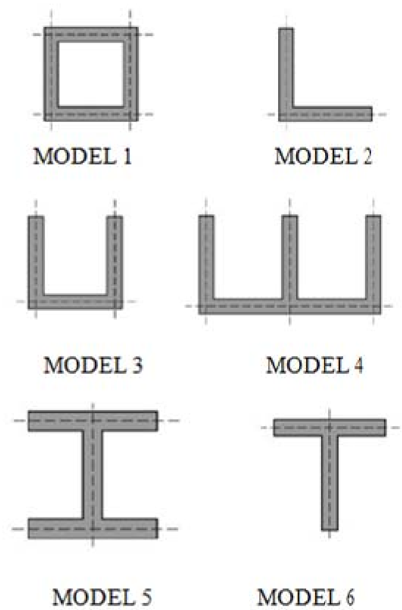

Fig. 2 Types of Shear Wall Sections

RESULTS AND DISCUSSIONS

Comparison between Equivalent Static Method and Response Spectrum Method

Equivalent static method is a linear static method for the seismic analysis whereas response spectrum method is a linear dynamic method. Fig. 3 illustrates the comparison of storey drift using equivalent static method and response spectrum method for seven storey building with U shaped shear frame (model 3) .The percentage variation between the two methods of analysis for the above case is 2.69%. A detail of percentage variation in storey drift of different models of shear walls is illustrated in Table 1.

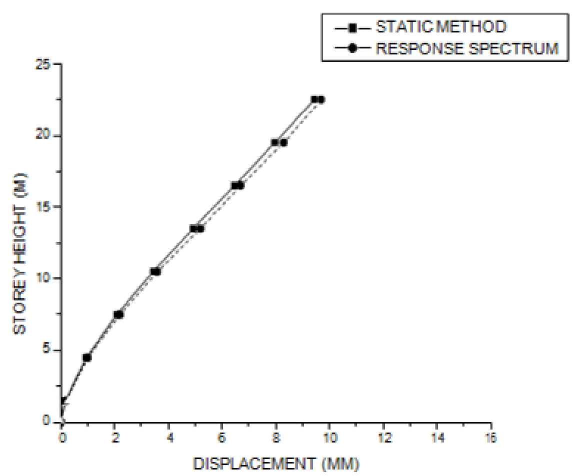

Fig. 3 The comparison of storey drift using equivalent static method and response spectrum method for seven storey building with U shaped shear frame (model 3).

The percentage variation of two methods for model 2 and model 6 is 6.05 and 4.91 respectively which is considerably higher when compared to the rest four models.

Table 1 Percentage Variation in Storey Drift between Equivalent Static and Response Spectrum Method for Different Types of Shear Walls

MODEL TYPE	% Variation
MODEL 1	1.80
MODEL 2	6.05
MODEL 3	2.69
MODEL 4	0.84
MODEL 5	0.78
MODEL 6	4.91

Fig. 4 illustrates the comparison of storey drift using equivalent static method and response spectrum method for seven storey building with U shaped shear frame (model 3). The percentage variation between the two methods of analysis for the above case is 24.47%. A detail of percentage variation in storey drift of different models of shear walls is illustrated in Table 2.

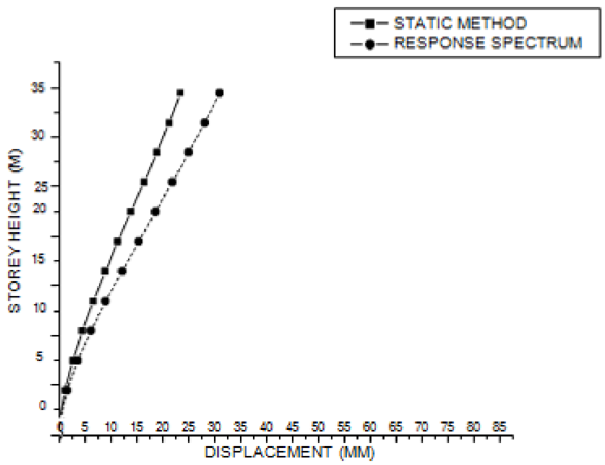

Fig. 4 The comparison of storey drift using equivalent static method and response spectrum method for eleven storey building with U shaped shear frame (model 3).

Table 2 Percentage Variation in Storey Drift between Equivalent Static and Response Spectrum Method for Different Types of Shear Walls

MODEL TYPE	% Variation
MODEL 1	28.49
MODEL 2	26.95
MODEL 3	24.47
MODEL 4	26.01
MODEL 5	25.67
MODEL 6	23.76

Comparison between Response Spectrum Method and Time History Method

The Time History procedure is used if it is important to represent inelastic response characteristics or to incorporate time dependent effects when computing the structure's dynamic response. A comparison between response spectrum method and time history analysis is carried out for storey drift for seven storey and eleven storey building with and without infill walls for various types of shear walls. Fig. 5 illustrates the comparison of storey drift using response spectrum method and time history method for seven storey building with U shaped shear frame (model 3) .The percentage variation between the two methods of analysis for the above case is 30.21%. A detail of percentage variation in storey drift of different models of shear walls is illustrated in Table 3.

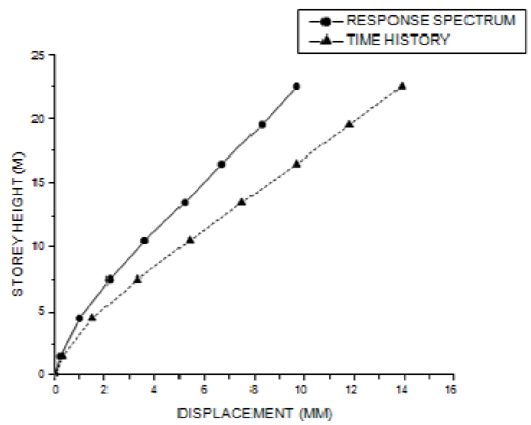

Fig. 5 The comparison of storey drift using response spectrum method and time history method for seven storey building with U shaped shear frame (model 3).

The percentage variation of two methods for model 2 and model 6 is 30.21 and 38.70 respectively which is considerably higher when compared to the rest four models.

Table 3 Percentage Variation in Storey Drift between Response Spectrum and Time History Method for Different Types of Shear Walls

MODEL TYPE	% Variation
MODEL 1	31.88
MODEL 2	42.55
MODEL 3	30.21
MODEL 4	29.05
MODEL 5	29.65
MODEL 6	38.70

Fig. 6 illustrates the comparison of storey drift using response spectrum method and time history method for seven storey building with U shaped shear frame (model 3). The percentage variation between the two methods of analysis for the above case is 61.39%. A detail of percentage variation in storey drift of different models of shear walls is illustrated in Table 4.

Table 4 Percentage Variation in Storey Drift between Equivalent Static and Response Spectrum Method for Different Types of Shear Walls

MODEL TYPE	% Variation
MODEL 1	52.88
MODEL 2	61.20
MODEL 3	61.39
MODEL 4	57.52
MODEL 5	54.27
MODEL 6	59.38

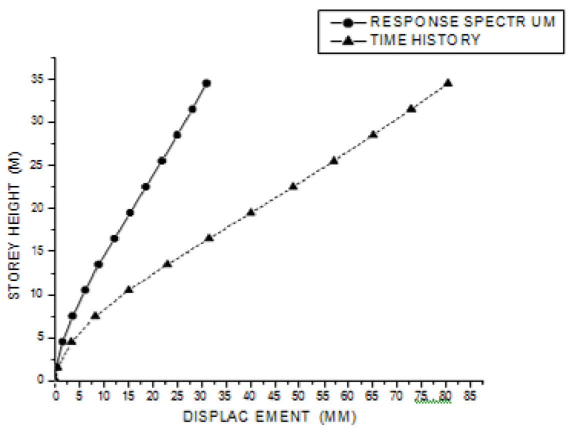

Fig. 6 The comparison of storey drift using response spectrum method and time history method for eleven storey building with U shaped shear frame (model 3).

CONCLUSIONS

From the above studies it can be concluded that Equivalent Static Method can be used effectively for symmetric buildings up to 25 m height. For higher and unsymmetrical buildings Response Spectrum Method should be used. For important structures Time History Analysis should be performed as it predicts the structural response more accurately in comparison with other two methods since it incorporates p - Δ effects and material non linearity which is true in real structures. From the above studies it is evident that square shaped shear wall (MODEL 1) is the most effective and L shaped (MODEL 6) is the least effective.

REFERENCES

[1] Chopra A. K, *Dynamics of structures theory and applications to earthquake engineering*, Prentice-Hall, Englewood Cliffs, N.J. 1995.

[2] IS: 1893 (Part 1) 2002- Indian standard- "*Criteria for earthquake resistant design of structures"*, Bureau of Indian Standards, New Delhi.

[3] IS: 4326-2005: 1993- Indian standard-"*Indian Standard Code of Practice for Earthquake Resistant Design and Construction of Building Second Revision",* Bureau of Indian Standards, New Delhi.

[4] Paulay T and Priestley M. J. N, *Seismic Design of Reinforced Concrete and Masonry Buildings*, Willy Interscience, Canada, 1992.

[5] Bungale S. T, *Wind and Earthquake Resistant Buildings Structural Analysis and Design,* Monticello, New York 12701, U.S.A, 2005.