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Seismic Analysis of Multistoried RCC Buildings Due to Mass Irregularity By Time History Analysis

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Abstract— **From past earthquakes it is observed that if the structures are not properly analyzed and constructed with required quality, then it may lead great destruction and loss to human lives. It has been proved that many of structures are fully or partially damaged due to earthquake. This fact was never ignored while design of multistoried buildings by the structural engineers, researchers to ensure safety against earthquake forces while erection. So, there is need to determine seismic responses of such buildings. Seismic analysis of the structure is carried out for determination of seismic responses by time history analysis which is one of the important techniques for structural seismic analysis especially when the evaluated structural response is non- linear in nature. To perform such an analysis, a representative earthquake time history is required for the structure being evaluated.**

In this present work non-linear dynamic analysis of G+10 storied RCC building having mass irregularity considering different time histories is carried out. Here a G+10 stories building with mass irregularity has been modeled for seismic analysis and Bhuj earthquake time history and Koyna earthquake time history have been used. This paper highlights the effects on floor which has different loads (mass irregularity) in multistoried building with time history analysis by ETABS software.

Keywords—Time History Analysis, Seismic zone, Multistory building, Seismic responses, Seismic Analysis.

INTRODUCTION

Due to fast urbanization construction of a large number of multistoried buildings, many existing RC buildings located in seismic zones are deficient to withstand earthquakes. A large portion of India is susceptible to damaging levels of seismic hazards. Seismic safety of these building is of importance. Hence, it is necessary to take in to account the seismic load for the design of high-rise buildings. Seismic loads are required to be carefully modeled so as to assess the real behavior of structure with a clear understanding that damage is expected but it should be regulated

Multistoried buildings are designed as per Earthquake code IS: 1893-1984. But during Bhuj earthquake, in Ahmedabad two buildings which were designed as per IS:1893-1984 and were found to be seriously damaged due to mass irregularity as a swimming pool was located at the 10th floor. Here excess mass leads to increase in lateral inertia forces, reduced ductility of vertical load resisting elements and increased propensity towards collapse. Excess mass on higher floors produce more unfavorable effects than those at lower floors.

As per the Indian seismic code (IS: 1893-1984) The five seismic zones I, II, III, IV and V in correspond to areas that have potential for shaking intensity on the MMI scale of V or less, VI, VII, VIII and IX or more, respectively. Seismic zone map is revised with only four zones instead of five (IS: 1893-2002). Earthquake causes different shaking intensities at different locations and the damage induced in buildings at these locations is also different. Thus, there is necessary to construct a structure which is earthquake resistance at a particular level of intensity of shaking a structure. Analyzing the structure for various Indian seismic zones and checking for multiple criteria at each level has become an essential. This paper shows the effect of different seismic zone on the performance of G+10 residential multistoried RC building. The main parameters consider in this study to compare the seismic performance of base shear, storey shear and storey displacement with different methods of seismic analysis.

OBJECTIVES

1. To analyze a multistoried RC building (G +10 Storey) for earthquake intensity III, by using different methods such as IS method, response spectrum analysis and Time history analysis.
2. To compare seismic behavior of multistoried RC building for particular earthquake intensity in terms of responses.
3. To study the effects of different Seismic zones on performance of multi-storey building in terms of seismic responses such as base shear, storey displacement.
4. To know the relationship between different methods of seismic analysis and their seismic responses.

SEISMIC ANALYSIS

Based on the type of external action and behavior of structure, the analysis can be classified as,
(a) Linear Static Analysis,
(b) Nonlinear Static Analysis,
(c) Linear Dynamic Analysis and
(d) Nonlinear Dynamic Analysis.

Equivalent Static Analysis

This procedure does not require dynamic analysis, however, it account for the dynamics of building in exact manner. This is one of easier method which is based on IS 1893: 2002.In this method, the base shear design is calculated for the all floors of the building, and then coming load get distributed through the height of the building. Next the lateral forces at each floor are obtained and distributed to individuals' lateral load resisting elements.

Non-linear Static Analysis

It is also known as Pushover Analysis. It is practical method in which analysis is carried out under permanent vertical loads and gradually increasing lateral loads to calculate deformation and damage pattern of structure.

Non- linear static analysis is the method of seismic analysis in which behavior of the structure is characterized by capacity curve that represents the relation between the base shear force and the displacement of the roof.

Linear Dynamic Analysis

Response spectrum method is the linear dynamic analysis method. In that method the peak response of structure during an earthquake is obtained directly from the earthquake response, but this is quite accurate for structural design applications.

Nonlinear Dynamic Analysis

It is known as Time history analysis. It is an important technique for structural seismic analysis especially when the evaluated structural response is nonlinear. To perform such an analysis, a representative earthquake time history is required for a structure being evaluated. Time history analysis is a step-by-step analysis of the dynamic response of a structure to a specified loading that may vary with time. Time history analysis is used to determine the seismic response of a structure under dynamic loading of representative earthquake.

STRUCTURAL MODELING AND ANALYSIS

Problem Statement

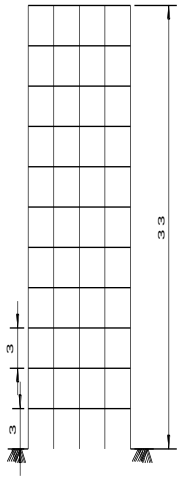
The (G+10) RCC multi storey building consider for analysis building to know the realistic behavior during earthquake with the general form of plan shown in figure1 .Building is modeled for Indian seismic zone III IS:1893-2002. Plan dimension in X and Y direction is 30 m and 20.0 m respectively.

The buildings has following dimensions,
Columns size 230mm x600mm,
All beam size 230mm x 450mm.
Floor slabs are taken as 125mm thick.
The height of all floors is 3m.
Soil type is hard.
Modal damping 5% is considered.
Material concrete grade is M30
Steel Fe500 is used.

Loadings Considered

For given structure, loading which applied includes live load, earthquake load and dead load are according to IS 875 part I, Part II and IS 1893:2002 respectively.

Live load on Staircase – 3 kN/m^2
Live load on floor slab - 2 kN/m^2
Live load on terrace floor - 4 kN/m^2
Floor finish load –
Staircase -1 kN/m^2
WC and Bath - 3 kN/m^2
Terrace floor slab - 1.5 kN/m^2
Floor slab - 1 kN/m^2



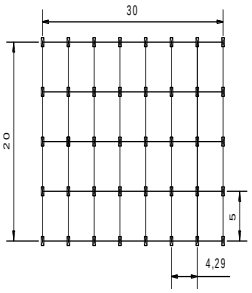


Fig.1 Elevation and Plan of Multistoried Building
(All dimensions are in meter).

Table 1 Different Time Histories Considered for Study

Sr. No	EQ	Date	Magnitude Richter Scale	P. G. A. g
1	Bhuj	Jan 26, 2001	6.9	0.110
2	Koyna	Dec 11, 1964	6.5	0.489

Table 2 Seismic Intensity Considered for Study

Sr. No.	Intensity MMI	PGA g
1	III	0.10-0.15

Results obtained from the above analysis are tabulated in Table: 3

Table 3 Variations in Base Shears (kN) Zone III

Sr. No.	Direction	Equivalent Static	Response Spectrum	Time History	
				Bhuj	*Koyna*
1	X	9469.78	9599.25	7115.61	7783.45
2	Y	11412.02	10078.93	6860.12	7133.57

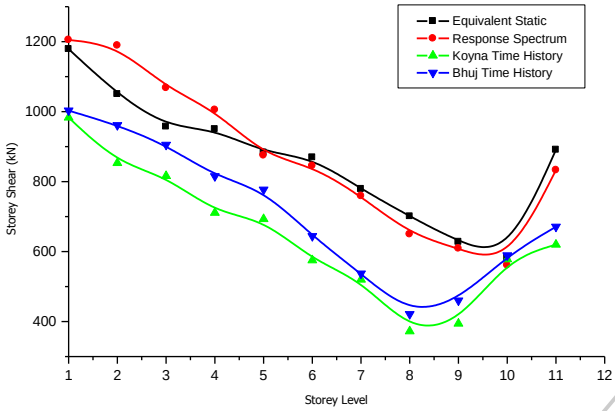


Fig. 2 Variations in Storey Shear (kN) for X direction

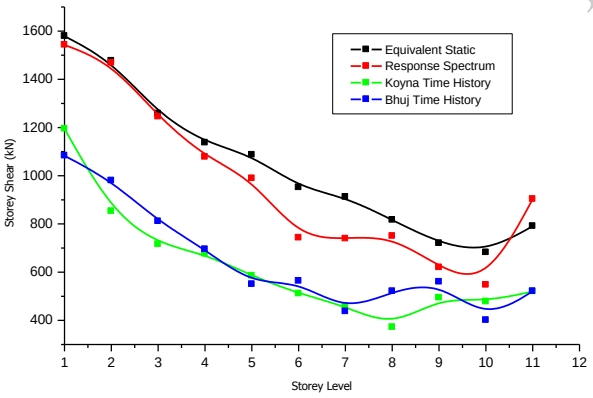


Fig. 3 Variations in Storey Shear (kN) for Y direction

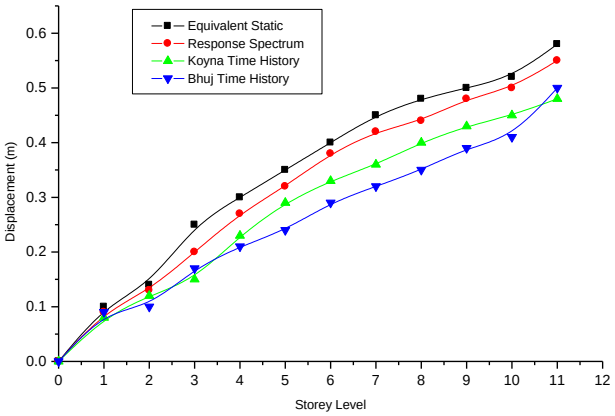


Fig. 4 Variations in Storey Displacement for X direction

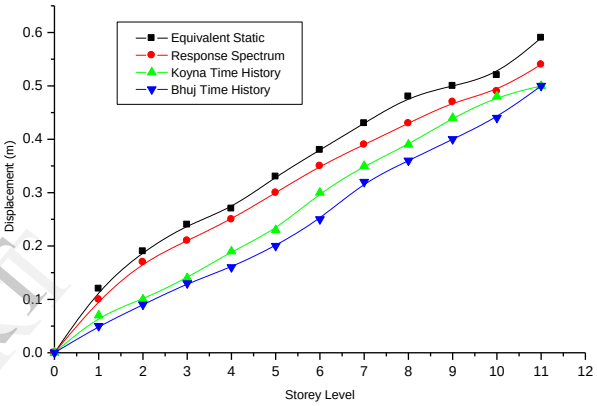


Fig. 5 Variations in Storey Displacement for Y directions

Above Graph shows variations in results in X direction and Y direction for Storey shear and Storey Displacement are shown in figure no. 2 to figure no.5.

RESULTS AND DISCUSSION

The parametric study of base shear of building with different stories for Indian seismic zone III is performed here. The results are shown by graphical representation.

1. For Irregular structure, to see the non-linear behaviour of structure Time history analysis should be performed.
2 .From graph of Storey Displacement it is observed that the displacement obtained by Equivalent static analysis are higher than Dynamic analysis such as Response Spectrum and Time History Analysis.
3. Equivalent static analysis is not sufficient when buildings are irregular buildings and it is essential to provide Dynamic analysis due to non-linear distribution of force.
4. The results from Equivalent static analysis, the displacement values are higher than Response Spectrum and Time History analysis.
5. The Storey Shear graph shows that non- linear variations with different methods in X direction and Y direction due to irregular loading on building.

6. It is seen that the values of Base Shears obtained from Equivalent static analysis, response spectrum analysis and Time history analysis varies in the range of 9469.78 kN to 7789.45 kN and 11412.02 kN to 7133.57 kN when earthquake is in X direction and Y direction respectively.
7. Equivalent static analysis and response spectrum analysis values of base shear comes nearly same, but by time history analysis especially for Bhuj decreases by 33% in X direction and by 65 % in Y direction, the main reason for this change being due to variable mass at different floors and Equivalent static analysis and response spectrum methods fail to catch the same.
8. As Time History is realistic method, used for seismic analysis, it provides a better check to the safety of structures analyzed and designed as compared to Equivalent static analysis and Response spectrum methods.

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