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Earthquake Analysis of RCC structure by using Pushover Analysis

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Abstract

In this paper we are going to discuss analysis on the RCC structure. i.e., PUSHOVER analysis is a nonlinear static procedure using simplified nonlinear technique to estimate seismic structural deformations. In this technique a computer model of the building is subjected to a lateral load. To conduct performance-based design modelling of reinforced structure with provision material is essential. In this report we had studied to investigate the structural performance during earthquake considering Pushover analysis.

We have analyzed and designed building in seismic zone III. The lateral forces were obtained as per, IS 456:2000 and applied to the building. Non-linear static method of analysis is used. For modelling of RCC structures, Etabs software is used and also results are compared. It is found that designed structure is found to be economical.

Keywords: Pushover analysis & design, Seismic load, stability, Story drift, story displacement.

1. INTRODUCTION

The movement of lithosphere plates, causing the vibrations on the surface of earth these vibrations on the surface of earth are known as earthquake. In that, the place in the crust where the movement starts are called as focus. And the place on the surface above the focus is called as Epicenter. Vibrations travels outward from the epicenter as wave. Seismic waves are the energy that travels through the earth and record on seismograph or seismometer. Now-a-days information about the earth interior has been obtained from the study of the propagation of the seismic waves through the earth.

In this project work, behavior of regular high-rise G+10,G+15,G+20,G+25 story building in seismic zone III. Structures are analyzed in the Etabs software. The results are obtained for Base shear, story displacement and story drift. The seismic analysis is done according to IS 1893:2016 IS 875(Part I) by using nonlinear static analysis method. We have taken seismic zone III for study. The lateral damage of structure during the earthquake occurs. For that, we studied and compared the results to avoid the failures.

1.1 General

Now-a-days, failure of the structure when earthquake occurs is very common. But to avoid this structure should build very carefully and in proper manner with latest techniques. So, for that analysis of the RCC structure is necessary. In this project we analyzed the four structures, their drift and displacement, so we can develop new techniques. Main focus in this study to prevent the collapse of the structure. And understanding the weak parts of the structure. We studied pushover analysis by using Etabs. Pushover analysis is the best and accurate method. And through pushover method the comparison has been done between Base shear, Story Drift and also Story displacement.

1.2 Objectives

1)To study the seismic behavior of multistorey regular structures when subjected to earthquake force in earthquake zone III.

2)To perform non-linear static analysis on multistorey building i.e., performing non-linear static analysis by using Pushover method.

3)The behavior of four models is checked for Base Shear, Story Drift and Story displacement at each and every story are carried out for seismic forces.

4)To check & design of the seismic response of multi-storied building using ETABs.

5)Analysis of G+10, G+15, G+20, G+25 by using pushover method in ETABs software

1.3 Types of Earthquakes

1)Tectonic Earthquake- The most common earthquake

2)Volcanic Earthquake-A special class of tectonic earthquake is sometime recognized as volcanic earthquake. However, these are confined to area volcanoes.

3)Collapse Earthquake-In the area of mining activity sometimes the roofs of underground mines collapse causing minor tremors.

4)Explosion Earthquake-Ground shaking may also occur due to the explosion of chemical or nuclear devices, such tremors are called as explosion earthquakes.

5)reservoir induced earthquake- The earthquakes that occur in the area of large reservoirs are referred to as reservoir induced earthquake.

1.4 Push-over Analysis

Pushover analysis is a non-linear static procedure using simplified nonlinear technique to estimate seismic structural deformations. It is an incremental static analysis. Analysis involves applying of horizontal loads intensity of the lateral load is slowly increased & the sequence of cracks, yielding, plastic hinge formation & failure of various structural components is recorded in it. The advantages of using pushover analysis are the simplicity efficiency in modelling and low computational time. It is to estimate the seismic capacity of exist or non-exist structures & look several recent guidelines for retrofit seismic design. Useful for performance-based design for new and old building rely on ductility. In pushover analysis magnitude of lateral load increased monotonically be maintain a predefined distribution pattern along the height of the building structure. Structure is displaced till the target displacement or structure collapse. Relation between base shear and displacement is plotted for pushover analysis.

1.6 Earthquakes affect building

Ground shaking is the primary cause of earthquake damage to man-made structures. Many factors to influence the strength of earthquake shaking at a site including the earthquake's magnitude, the site's proximity to the fault, the local geology, and the soil type.

More than 250 structures throughout the United States have been outfitted with seismic sensors by the USGS National Strong Motion Project (NSMP) to improve the overall understanding of earthquakes and their effects on the built environment.

The instrumentation and monitoring of structures by NSMP is only one part of USGS effort to protect people's lives and property from earthquake hazards in all of the Nation's seismically active regions.

1.5. Structure Description

The building used for analysis is a non- existing structure which is G+10, G+15, G+20 and G+25 storied RCC structure with the floor-to-floor height of 3m. The building is assumed to be located at seismic zone III. The structure is designed as a frame model with fixed for the ground story column. The building details are given below:

No. of bays along X- axis: 8

No. of bays along Y- axis: 6

Spacing along X and Y- axis :8m

Size of Column: 600mm*800mm

Size of Beam: 450mm*550mm

Thickness of slab: 150mm

Grade of steel: Fe500

Grade of Concrete: M30

Design Details of building are given below:

Live load: 3kN/m^2

Dead load: 2kN/m^2

Earthquake load: As per IS 1893 (Part I):2016

2. Literature

1) Ali Kadhim Sallal (2018) "Design and analysis ten storied building using ETABS software-2016" Volume 4; Issue 2; May 2018; Page No. 21-27... The main purpose of this software is to design and analysis multi-Storied building in a systematic process. This paper presents a building where designed and analyzed under effect of earthquake and wind pressure by using ETABS software. In this case, (18m x 18m) and eight stories structure are modeled using ETABS software. Ten story is taken as (3m) height and making the total height of the structure (31m)

2) Pushkar Rathod, Rahul Chandrashekar "seismic analysis of multistoried building for different plans using ETABS 2015" Volume: 04 Issue: 10 | Oct -2017..... Pushkar Rathod and Rahul Chandrashekar (2017): With the help of seismic analysis, the structure can be designed and constructed to withstand the high lateral movement of earth's crust during an earthquake. Any type of basic or a highly advanced structure which maybe under static or dynamic conditions can be evaluated by using ETABS. ETABS is a coordinated and productive tool for analysis and designs, which range from a simple 2D frames to modern high-rises which makes it one of the best structural software for building systems.

3) Aniket A. Kale (2020): International Journal of Engineering Research & Technology (IJERT)ISSN: 2278-0181http://www.ijert.orgPublished by: Vol. 9 Issue 03, March-2020 Carried out the wind & seismic analysis 15, 30 & 45 storied buildings of four different shapes of same area by using advance software CSI ETABS. Response

spectrum method was used to find the dynamic effects. The comparison has been done by considering the parameters such as story displacement, story drift, base shear, overturning moments, acceleration & time period. It has been concluded that for maximum earthquake structure of 15-storey is most stable structure &for maximum wind effect triangular structure of 15-storey is most stable. For 45-storey circular & rectangular shape building is most stable for maximum earthquake & wind effect respectively. Wind effect is critical for 45 story building & on the other hand seismic is critical at 15 story & 30 story building. Wind effect is more critical than earthquake.

*Following are the major findings from above paper: -

a. Analysis was done by using Etabs software and successfully verified manually as per IS 456-2000.

b. Etabs is the perfect useful software for this project which reduce the time for analysis and design.

4) DR. K. CHANDRASEKHAR REDDY1 & G. LALITH KUMAR2

International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES) Impact Factor: 5.22, e-ISSN: 2455-2585 Volume 5, Issue 03, March-2019.In this study, 3D analytical model of G+30 storied buildings have been generated for symmetric and asymmetric building models and analyzed using structural analysis tool ETABS software. Mass and stiffness are two basic parameters to evaluate the dynamic response of a structural system. This paper is concerned with the effects of various vertical irregularities on the seismic response of a structure.

5) Dharanya A, Gayathri S and Deepika M, "Comparison Study of Shear Wall and Bracings under Seismic Loading in Multi- Story Residential Building", International Journal of

Chem Tech Research, 2017, Vol.10(8), pp. 417-424..... Dharanya et. al. (2017) provided the improvement of reinforced concrete frame structure against lateral loading by providing shear wall and cross bracing. In this study, a G+4 storey residential RC building with soft storey has to be analyzed with cross bracings and shear wall. This analysis was made as per IS 1893:2002 codal provision by using ETABS software. The cross bracings such as X bracing are to be provided at the outer periphery of the column and the shear walls are provided at the corners of the buildings. The building model are analyzed by equivalent stiffness method using ETABS software. The main parameters compared are lateral displacement, base shear, storey drift, axial force, shear force and time period.

2.1. Review

In the above papers we studied that the most structural failures occurred due to inadequate stiffness, Irregularities of structure. To record the results of story drift and story displacement mostly pushover analysis is used as it is more accurate than other methods. With the help of seismic analysis, the structure can be designed and constructed to withstand the high lateral movement of earth's crust during an earthquake. Any type of basic or a highly advanced structure which maybe under static or dynamic conditions can be evaluated by using ETABS.

3D analytical model of storied buildings has been generated for symmetric and asymmetric building models and analyzed using structural analysis tool ETABS software. Etabs is the perfect useful software for this project which reduce the time for analysis and design.

3. Methodology

- This Project is Primarily Software-based, and it is essential to understand the specifics of these software
- To studied about earthquake, i.e., seismic zones, waves.
- To Studied pushover analysis, Nonlinear static analysis.
- Make G+10, G+15 structure and detailed study on it.
- Comparison & analysis structure, Study on weakness, premature failure.
- Established in real-world, and provide safety structure.

3.1. Indian Standard Codes

I)The estimate of earth quake loads and the IS 1893-2016(Part-1) Criteria of Earthquake Resistant Buildings Part.

II)IS 875 (Part-1)

III)IS 456:2000

4. CONCLUSIONS

From above we will have following conclusions:

1)Pushover analysis is an ideal method to explore the non-linear behavior of structure.

2)A high-rise building of G+10, G+15 subjected to seismic, wind and live loads were analyzed using Etabs software.

3)Behavior of the high-rise building was shown clearly using the graphs and lateral displacements.

4)Better accuracy of the analysis can be obtained by using this Etabs software.

5)further work we are going to do in Phase-II

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