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SEISMIC ANALYSIS OF AN EXISTING BUILDING

Junaid Afzal Shah[1], Dr. Pooja Sharma[2], Dr. Rajesh Goyal[3], Er. Mudasir Hussain Dar[4]
[1,4]M.Tech Scholar(Structural Engg.), Desh Bhagat University Punjab
[2]HOD Deptt. Of CivilEngg. Desh Bhagat University Punjab, [3]Astt. Professor and Supervisor of thesis

Abstract: In this thesis a G+6 storey building is evaluated and analysed for its seismic resistance. Indian Standard IS-1893:2002 (Part-1) has been followed for the analysis procedure. Building has been modelled in commercial software ETABS. The principle objective of this project is to analyse a multi-storeyed building using ETABS. The innovative and revolutionary new ETABS is the ultimate integrated software package for the structural analysis and design of buildings. The primary parameters of the seismic investigation of structures are load carrying capacity, ductility, stiffness, damping and mass. The different parameters like time period, story drift, forces and so on are figured.

The story drift was found to be within permissible limits as per IS 1893:2002.The base shear and Storey forces showed a change of -37%.50% and more than 100% increase for zone II, IV and V respectively. The maximum Storey Drift for zone II, IV & V was found to be 0.01211, 0.09985 & 0.10253.The frame was found to be adequately designed for seismic loads in zone II and III. However, needs a little variation in design for zone IV and V.

I. INTRODUCTION

In this modern world the growing population has made it mandatory to develop more integrated tools for construction of tall buildings but these buildings become susceptible to damage and collapse due to earthquakes. For this purpose framed structures are proven to be best in the field. These structures show good performance for dynamic loading as well as gravity loading. The analysis of existing buildings has become a necessity as the buildings should be resistant towards the earthquake loads in addition to the gravity loads. It is seen that for past earthquakes many buildings have undergone damages despite of being properly designed. Thus it becomes need of the hour to evaluate and analyse the buildings for earthquake loads. There are many methods available for analysis of a building.

On application of external forces be it load due to self weight of the building, wind load, snow load, etc or any other loads like earthquake loads, blasting loads, etc a structure needs to be analysed to get an idea of its performance. These analysis include dynamic as well as static examination and the contrast between them. The main diference between these two examinations depends on the frequency of the excitation caused by them. In the event that a load is applied sufficiently slowly, the inertial forces can be disregarded and the examination can be rearranged as static analysis. Structural dynamics is the kind of structural analysis which covers the conduct of structures subjected to dynamic stacking. Structures in general are subjected to various dynamic and static loads and thus needs to be evalvated correspondingly. Dynamic analysis includes determination of dynamic relocation, time history, and modular examination of a building.

The recent earthquakes resulted in serious damage of structures which emphasises on the requirement of seismic analysis of such structures. In India about 60% of area is susceptible to serious damage due to large shocks. The earthquakes can neither be stopped nor predicted, which makes the structures more liable to damage, however, the intensity and other parameters can be assumed to a great precision. The structures can be designed accordingly for safety of inhabitants and can help in decreasing the degree of damage and harm. For analysis of structures proper methods should be adopted to make sure these effects are counteracted to a great extent. Response spectrum method and static pushover analysis has been seen to be given most appropriate results. The structures to be analysed must be checked for the degree of damages that is expected from the predicted earthquakes in its lifetime, for this concern linear elastic methods are not satisfactory.

“The criteria of level adopted by codes for fixing the level of design seismic loading are generally as follows:

- Structures should be able to resist minor earthquakes (<DBE), without damage.
- Structures should be able to resist moderate earthquakes (DBE) without significant structural damage but with some non-structural damage.
- Structures should be able to resist major earthquakes (MCE) without collapse.

"Design Basis Earthquake (DBE)” is defined as the maximum earthquake that reasonable can be expected to experience at the site once during lifetime of the structure. The earthquake corresponding to the ultimate safety requirements are often called as “Maximum Considered Earthquake (MCE) ".generally,” The (DBE) is half of (MCE)”.

The uneven horizontal and vertical movement of ground below the structure due to the haphazard nature of an earthquake results in vibration of the superstructure and also results in inertial forces on them. Hence, these structures should be designed for stability, strength and serviceability under certain levels of seismic forces.The effect of earthquake on a structure depends mostly on its mass, material used, damping ratio, ductility, and other factors. For decreasing the ease of collapse these factors should be managed as far as possible.

The structure undergoes a dynamic movement when it experiences the earthquake tremors. These movements are caused due to the forces generated due to the increasing speed of these tremors. The loads generated on a structure due to these tremors, called seismic loads, are evaluated on the outer wall of the structure horizontally. Thus, it means that apart from gravity loads the structure will undergo definite lateral loads expected from these shocks.while designing the structure for safety and serviceability these forces should be considered in order to make sure the structure will oppose and resist such forces. The ductility plays an important role in resisting the seismic loads and thus a structure should have an adequate ductility. Strengthened structure having adequate ductility has following benifits:

- It helps in overcoming stack inversions, differential settlements of foundation.
- It gives a fair and adequate warning to inhabitants in order to vacate the building soon before it fails. The warning is in the form of disfiguring of a member. This helps in reducing the death toll which is always the main concern of a builder.
- When the joints are properly ductile it allows them to resist forces and gives steel supports adequate time for yielding.

The above benefits help us decide to use SMRF in areas of zone IV and V rather than OMRF. “Where, Ordinary Moment Resisting Frame (OMRF) is a minute opposing casing not meeting uncommon enumerating necessities for flexible conduct and Special Moment Resisting Frame (SMRF) is a minute opposing casing extraordinarily point by point to give bendable conduct and consent to the prerequisites given in IS 4326 or IS 13920 or SP6.”

II. SEISMIC METHODS OF ANALYSIS

For the safety and serviceability of a structute it is important to analyse it for seismicity and to determne its seismic reactions.such an analysis can be done based on various activities of the structure and material used. There are a number of methods available for seismic analysis namely:

Equivalent static methodLinear static analysis or equivalent static method can be utilized for general structure with restricted tallness. Linear dynamic analysis can be performed by reaction range strategy. The critical distinction between direct static and linear dynamicanalysis is the level of the powers and their conveyance along the stature of structure. Nonlinear static analysis is a change over linear static or dynamic investigation as in it permits inelastic conduct of structure. A nonlinear dynamic analysis is the main technique to portray the genuine conduct of a structure amid a tremor. The technique depends on the direct numerical combination of the differential conditions of movement by considering the elasto-plastic deformation of the basic component.

Equivalent Static Analysis

This method is the most simple and approximate method and is used for general structures with limits height. It involves less computation and takes approximate values for different parameters as per the details provided in the code available.This procedure involves determination of base shear and then distributing the same along the height of building at each storey level.

Linear Dynamic Analysis

This method has two procedures Response spectrum method and elastic time history method. It takes into consideration actual condition of a structure during an earthquake and gives more accurate results. These procedures cover over the linear static method. The most important difference between the two is the point of application of force acting on the structure and its distribution.

III. DEFINITIONS AS PER IS 1893:2002.

“Storey: when the multi story building or the residential building is constructed in that when the floor to floor gap will be there that is the story.

Storey Shear : We will calculated all the lateral loads at each floor of the building

Story Drift: is defined as the difference in lateral deflection between two adjacent stories. During an earthquake, large lateral forces can be imposed on structures; Lateral deflection and drift have three primary effects on a structure; the movement can affect the structural elements (such as beams and columns); the movements can affect non-structural elements (such as the windows and cladding); and the movements can affect adjacent structures. Without proper consideration during the design process, large deflections and drifts can have adverse effects on structural elements, non-structural elements, and adjacent structures

Effect of drift on the structure: As far as seismic plan, parallel avoidance and float can influence both the auxiliary components that are a piece of the horizontal power opposing framework and basic components that are not some portion of the sidelong power opposing framework. As far as the sidelong power opposing framework, when the parallel powers are set on the structure, the structure reacts and moves because of those powers. Thus, there is a connection between the sidelong power opposing framework and its development under horizontal loads; this relationship can be investigated by hand or by PC. Utilizing the consequences of this investigation, appraisals of other plan criteria, for example, turns of joints in unusual propped casings and revolutions of joints in extraordinary minute opposing edges can be gotten. Additionally, the sidelong examination can likewise be utilized and ought to be utilized to evaluate the impact of horizontal developments on auxiliary components that are not some portion of the parallel power opposing framework, for example, pillars and segments that are not unequivocally considered as being a piece of the horizontal power opposing framework. Configuration arrangements for minute edge and unconventional supported casing structures have necessities to guarantee the capacity of the structure to maintain inelastic pivots coming about because of disfigurement and float. Without legitimate thought of the normal development of the structure, the sidelong power opposing framework may encounter untimely disappointment and a comparing loss of quality. What's more, if the parallel redirections of any structure turn out to be too expensive, P-Δ impacts can cause shakiness of the structure and possibly result in fall.

Centre of Mass: The centre of mass is the unique point at the centre of a distribution of mass in space that has the property that the weighted position vectors relative to this point sum to zero. In analogy to statistics, the centre of mass is the mean location of a distribution of mass in space.

Centre of Rigidity: Centre of rigidity is the stiffness centroid within a floor-diaphragm plan. When the centre of rigidity is subjected to lateral loading, the floor diaphragm will experience only translational displacement. Other levels are free to translate and rotate since behaviour is coupled both in plan and along height. As a function of structural properties, center of rigidity is independent of loading. Certain building codes require center of rigidity for multi-storeybuilding design-eccentricity requirements. For a given floor diaphragm, center of rigidity is calculated through the following process:

Case 1 applies a global-X unit load to an arbitrary point, perhaps the center of mass, such that the diaphragm rotates Rzx.

Case 2 applies a global-Y unit load at the same point, causing rotation Rzy.

Case 3 applies a unit moment about global-Z, causing rotation Rzz. These three load cases are shown in Figure 1 Center of rigidity (X,Y) is then computed as X = -Rzy / Rzz and Y = Rzx / Rzz."

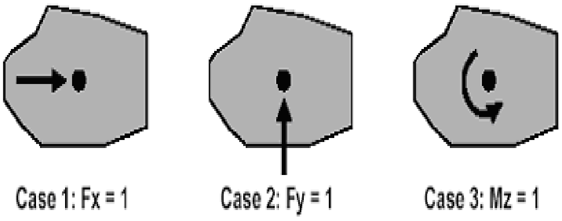

Figure 1.1: Load cases for centre of rigidity

IV. METHODOLOGY

Brief description about software's used

ETABS(Extended 3-DAnalysis of Building System)

For the analysis and design of civil engineering structures a new inventive and progressive software ETABS has been developed. It helps in creating a 3D model which can give the response of a real structure, using 40 years of hard work and innovation. This software is most effective in providing 3D modelling and representation instruments, quick linear and non linear analysis results, precise and accurate design models for a variety of materials, as well as insightful plots, reports, and schematic illustrations. These things help the user to effectively and accurately comprehend the analysis and design report.

Starting with the modelling of the structure, ETABS helps in designing each part of the structure with ease and accuracy. In ETABS the modelling is much easier as it allows for the generation of floors and elevation framing in simpler steps. The drawings from other software can be directly converted into a model base in ETABS, then the model can be overlaid.

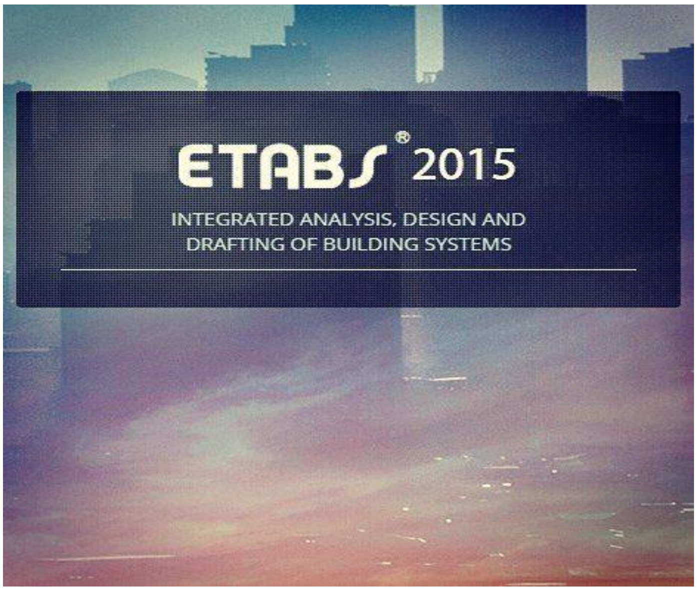

Fig : ETABS logo

AutoCad(Autodesk Computer Aided Drafting)

AutoCAD is a computer program utilized for 2-Dimensional and 3-Dimensional designing and drafting. AutoCAD is produced and promoted via Autodesk Inc. also, was one of the main CAD programs that could be executed on PCs.

AutoCAD was at first got from a program called Interact, which was composed in an exclusive language. The primary arrival of the product utilized just primitive elements, for example, polygons, circles, lines, circular segments and content to build complex items. Afterward, it came to help custom objects through a C++ application programming interface. The modern variant of the product incorporates a full arrangement of instruments for solid demonstration and 3-D. AutoCAD additionally underpins various application program interfaces for automation and customization.

DWG (drawing) is the local record organize for AutoCAD and a fundamental standard for

CAD information interoperability. The product has likewise offered help for Design Web Format (DWF), an organization created via Autodesk for distributing CAD information

BUILDING TYPE	Reinforced concrete frame
USAGE	Residential Apartment
LOCATION	Alappuzha District, Kerela
STORIES	G+6
PLAN	21.40m×17.89m

Evaluation of the building

The building into consideration is a residential apartment building situated in Manner town of Alappuzha District in Kerela. This building is ten storey with irregular plan and a height of 2.25 m. It is a framed building with a simple lift core wall.

Comparison With Other Zones

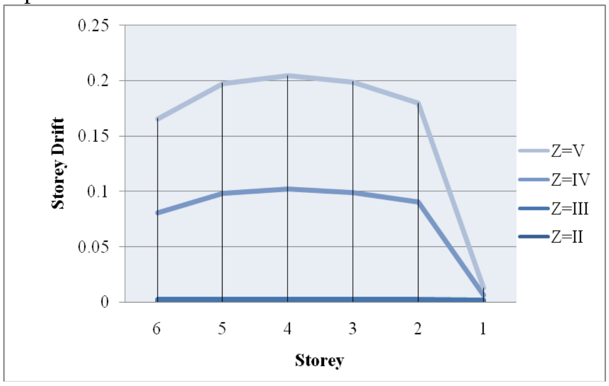

Figure: Comparison of Storey drift at each storey level

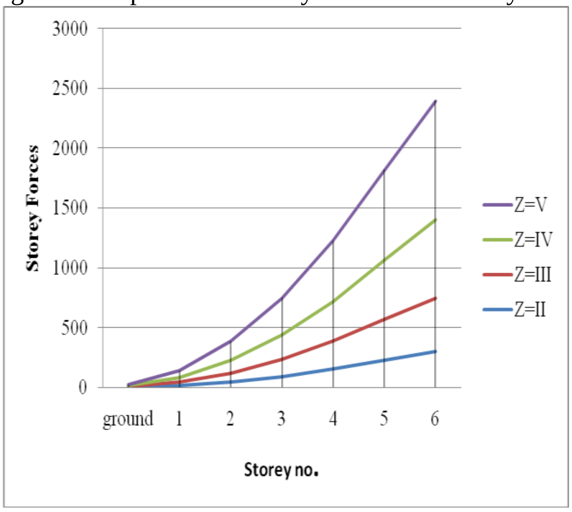

Figure: Comparison of Storey forces at each storey level

Zone	Period used	W(kN)	Vb(kN)
II	1.068	36371.2914	771.92
III	1.068	36371.2914	1235.072
IV	1.068	36371.2914	1852.608
V	1.068	36371.2914	2777.9299

Table: Base shear comparison table

V. CONCLUSION

The maximum storey drift was found to be 0.001229 at 4th storey which is less then permissible drift of 0.0116 (0.004h) specified by IS 1893-2002. The building under consideration is safe under seismic loads for Zone III. The results show considerable increase with zone change. The storey drift was found to have high values above permissible limits (0.004h) in case of zone IV & V. The base shear and Storey forces showed a change of -37%.50% and more than 100% increase for zone II, IV and V respectively.The maximum Storey Drift for zone II , IV & V was found to be 0.01211, 0.09985 & 0.10253.The frame was found to be adequately designed for seismic loads in zone II and III. However, needs a little variation in design for zone IV and V.The frame was found to be adequately designed for seismic loads of zone III. However, in case of zone IV & V it needs to be re-designed adequately.

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