Structural Analysis of a Multistory building with Hollow core Slab using Etabs

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Abstract: *Earthquake is the most disastrous and unpredictable natural phenomenon which causes huge destruction to human lives as well as infrastructure. Seismic forces generated during earthquake leads to severe damage to structural failure. In the present study a G+8 storied multistoried building was analyzed through the response spectrum analysis using ETABS software. A hollow core slab is a precast prestreeed concrete member with continuous voids provided to reduce weight and cost. The effect of seismic force on buildings with hollowcore slab arrangements have been analyzed in ETABS. We have adopted limit sate method of analysis. The design is in confirmation with IS456-2000.*

Keywords: IS456-2000, Hollow core slab, analyzed design, ETABS.

INTRODUCTION

The term building in Civil Engineering is used to mean a structure having various components like foundation, walls, columns, floors, roofs, doors, windows, ventilators, stairs lifts, various types of surface finishes etc. Structural analysis and design is used to produce a structure capable of resisting all applied loads without failure during its intended life. Structural engineers are facing the challenges of striving for most efficient and economical design with accuracy in solution while ensuring that the final design of a building and the building must be serviceable for its intended function over its design life time. The purpose of standers is to ensure and enhance the safety , keeping careful balance between economy and safety.

RESPONSE SPECTRUM METHOD

This method is derived from time history analysis. A designer is not often bothered about the structure's response at every instance of time, maximum response is enough information to design adequately strong structure. In this method graph between maximum spectral acceleration and various time period of structure is prepared for some ground acceleration and structures response at every instance of time is not calculated. Response spectrum method, it is the linear dynamic analysis method6. This method involves the calculation of only the maximum values of displacements and member forces in each mode of vibration. This method uses smooth design spectra that are the average of several earthquake motions. Different earthquake will have different response spectra but for ease of structural engineer IS 1893:2002 has given a general purpose response spectra which is derived by considering few big earthquake from past.

TIME HISTORY METHOD

This method calculates response of structure subjected to earthquake excitation at every instant of time (hence the name Time History). Various seismic data are necessary to carry out the seismic analysis i.e. acceleration, velocity, displacement data etc., which can be easily procured from seismograph data's analysis for any particular earthquake. It is an important technique for

structural seismic analysis especially when the evaluated structural response is nonlinear.

HOLLOWCORE SLAB

A HCS (hollow core slab) is a precast, or a prestressed concrete component having holes that spread during the span of the slab, on condition that decrease weight, thus cost and such a lateral of advantage, can work in electrical or mechanical manages. Mainly operated as surface or else roof deck systems, HCS also have usage as members, partition sections, and bridge deck elements. The span of the HCS reaches equal (18m) without supports. Elements pre-stressed HCS purpose designed for various applications needing floor or roof systems. This method can be preferably used in residential, commercial or car garages projects. Precast, prestressed HCS offer major structural member success through the operation of HSC, but all together demanding little material consumption.

The HCS are efficient. Slabs are made using dry casting or extrusion molding systems where the concrete is required very low through a machine. The concrete is compressed around the cores formed with role or pipes. The slab with continuous holes is being as heating/cooling ducts and as channels for electrical wiring. Hollow core slabs minimize the transmission of sound and vibrations between building floors and eliminate floor squeals.

The precast HCS has longitudinal voids extending the full slab length which makes the slab lighter than a considerable solid slab of equal depth or strength. The lower weight is very important issue because it reduced the costs of transportation and construction costs

Fig 1. Hollow-core concrete slab.

OBJECTIVE OF THE WORK
- To analyze the multi-story building using hollow core slab
- To prepare a model using ETAB and analysis by response spectrum method.

- To develop the mode shape and estimate the base shear value of this building
- To study the performance of hollow core slab.

LITERATURE REVIEW

- ❖ S.N Mokhatar,N.Ishak, A.M.A Budiea, A.F Kamarudin, J.Hadipramana, Z.M Jaini and M.S Md.Noh : Journal of applied geoscience and build environment, Vol 2 No.1(2020) "Analysis of seismic response: A Case study on multistory building" this paper was establish modal analysis and seismic analysis by using the response spectrum method on Eurocode 8 code of practice to answer the issue . Case study in Malaysisa. The base shear values was analysed by using commercial software and validate with manual calculating. The analysis indicated when a number of mode shape increase the natural frequency also gained and natural period was decreased.

- ❖ **Mohmmed Rizwan Sultan** *: IJIRAE ISSE :2349-2163 issue8, volume 2(August 2015)* **"Dynamic Analysis of Multi-storey Building for Different Shapes".** The most important objective of this study is to grasp the behavior of the structure in high seismic zone and also to evaluate storey overturning moment, story drift, displacement, design lateral forces. 15 story building and four different shapes (c- shape H shape, L shape) compared .conjointly the story overturning moment varies inversely with height of the story. The lower base shape is getting in C shape building and higher base shear is getting in rectangular shape building. C shape building is more vulnerable compare to all other different shapes.

- ❖ **Jebin James** : *IRJET volume :03 issue:10 oct-2016*, **"Seisimic Analysis of RC frame with Masonary Infill Walls Using ETABS ".** Rc framed building are generally designed without considering the structural action of masonry infill walls present. The non-linear static pushover analysis is performend for RC frame with various arrangement. Infill wall can be modulated in several forms such as equivalent diagonal struct approach and finite

method.arrangement of infill wall also at less the displacement and base shear the ton of building displacement gets reduces.

- ❖ **Mustaq** : *IJMETMR ISSN NO:2348-4845*, **"Optimized Design of a G+20 storied Building Using ETABS".** When the building increase in height the stiffness of the structure becomes more important. The structural response due to lateral loads with load combination is extracted effect of lateral load on moments ,axial forces, shear forces, base shear,maximum storey drift and tensile force on structural system study.

- ❖ **B.Anjaneyulu, K.Jaya Prakash**: *IJSEAT, vol.4, Issue 2, ISSN 2321-6905 FEB-2016*, **"Analysis and Design of flat slab by using Etabs Software".** "Flat Slab" is better understood as the slab without beams resting directly on supports. To support heavy loads the thickness of slab near the support with the column is increased and these are called drops, or columns are generally provided with enlarged heads called column heads or capita. The Finite element analysis & Equivalent frame analysis is carried out by using software ETABS, The analysis & design is performed by Equivalent Frame Method with staggered column & without staggered column as prescribed in the different codes like IS 456-2000, ACI 318-08 are compared. Flat plate/slab construction is a developing technology in india flat slabs has many advantages over conventional slabs and hence it can be a very good option for modern constructions demanding structural stability andstate of art aesthetic aspects and prospects.

- ❖ **Pardeshi Sameer,Prof.N.G.Gore**: *IRJET vlume :03 Issue:01 jan-2016*, " **Study of seismic analysis and design of multi storey symmetrical and asymmetrical building**". In this study, 3D analytical model of G+15 storied buildings have been generated for symmetric and asymmetric building models and analyzed using structural analysis tool ETABS software. In this study, 3D analytical model of G+15 storied buildings have been generated for symmetric and asymmetric building models and analyzed using structural analysis tool

ETABS software**.** As a result of comparison between time history method and response spectrum method it has been observed that the values obtained by response spectrum analysis of base shear and top storey displacement are higher than time history analysis.

- ❖ **Prakriti chandrakar,Dr.P.S.Bokare**: *IJSR ISSN(online):2319-7064 (2015),* **"Earthquake Analysis of G+10 Building usingResponse Spectrum Method and Time History Method - A Comparison"**. Time history analysis is significant technique for structural seismic analysis particularly when evaluated structural response is nonlinear. In present work an attempt has been made to study the dynamicbehavior of G+10 multistoried building frame for two distinct plan geometries one bisymmetric regular rectangular frame and anotherframe with T shaped plan using IS1893-2002 recommended response spectrum method and time history analysis. Analysis has been carried out using ETABS software. Based on result it is found that the base shear obtain from RSM is slightly higher compared to THM, and also storey deflection is more in response spectrum method than time history method. A similar pattern arises in base shear, Response spectrum gives on average about 15% to 20% higher base shear value as compared to time history.

- ❖ **Bilal Shaikh, Mohammed Sawood, Farasha, Sarfraj Ahmed, Haneef:** *IRJET volume:06 issue 05/may 2019*, " **Planning, Analyzing and design of high rise building using etabs".** Design a multi-storeyed building (B+G+15(3 dimentional frame))using ETABS. The design method used in ETABS analysis are limit state design conforming to Indian standard code of practice. All design against seismic loads must consider the dynamic nature of the load. To design detail and to provide the adequate membersize, reinforcement and connection details so that to enable the structure to withstand safely against the calculated loads.

- ❖ **Suresh Mahantappa Hungund** : *IJRD volume : 4, Issue:6, june 2019* , **"Comparative study on seismic**

performance of CFST buildings and RCC buildings with and without bracings using ETABS software". Determine the response of G+25 CFST building under static and dynamic analysis. Compare the performance in terms of time period, story displacement drift and storey shear. We can compare the performance of concrete filled stell tube with concrete encased steel section columns.

❖ **Sopna Nair,Dr. G Hemalatha,Dr. P Muthupriya**: *IJCIET, Volume 8, Issue 8, August 2017.*" **RESPONSE SPECTRUM ANALYSIS AND DESIGN OF CASE STUDY BUILDING".** The objective of the proposed study is the reliability assessment of the case study building to earthquake loadings through the development of fragility curves. Primary task is to identify a case study structure for which fragility curves are not developed yet and which could effectively represent the structural viability of present and future buildings. It is proposed to develop fragility curves for a building with flat-slabs and shear wall system which effectively represents recent high rise buildings particularly in GCC countries. dynamic analysis using Response Spectrum method is adopted. Modal analysis is performed to compute modal responses and they are combined using SRSS method to get the maximum responses. For design of vertical elements (columns and shear walls), forces from response spectrum method are considered. For the design of foundation worst load combinations of earthquake forces as well as uplift water pressures are considered.

❖ **B.Anusha,B.Raghavendra,K.Shashi preetham,M.SaiKrishna,P.Gurusw amy Goud**: *IJEAST Vol.4, ISSN 2455-2143, Issue 12, pages 211-214, April 2020.* **"ANALYSIS AND DESIGN OF HOSTEL BUILDING(G+4) USING ETABS".** This building modal has been analyzed by ETABS software with a capacity of 120 students. It consists of around 60 rooms which is allotted as per standards. They analyzed and designed the beam, column, slabs and staircase. The result are downloaded from the software and compared with manual calculations which are designed as per

IS:456-2000. The structure is safe under the loads.

❖ **Sayyed feroz sikandar, shaikh zameeroddin.S, Prof.Agrawal.A.S**: *IJESC Volume 9 Isue No.6, June 2019*, **"ANALYSIS AND DESIGN OF MULTISTORY BUILDING USING ETABS 2017".** An apartment building is analysed and designed, located in Latur, Maharashtra with (G+10) storeys having a car parking facility provided at basement floor. Design of slab, staircase and an isolated footing are done manually. The design methods used in ETABS are limit state design confirming to IS code of practice.

❖ **M.Firoj and S.K.Singh** : *16SEE,IIT Roorkee,India,Paper no 300, December 20-22,2018*. **"RESPONSE SPECTRUM ANALYSIS FOR IRREGULAR MULTI-STOREY STRUCTURE IN SEISMIC ZONE V".** In the present study, a G+10 storied building was analyzed through the response spectrum analysis using three different computer software i.e. ETABS, STAD PRO and SAP200. the displacement of joints, axial forces, time period and mass participating factors were studied. The design response spectrum curve suggested by the IS:1893 Part-1 for seismic design is utilized to perform the dynamic analysis. The joint displacement in x-direction is found more as compared due to the factthat the earthquake motion was applied in X-direction.

❖ **CH.Rajkumsr, Dr.D. Venkateswarlu** : *IJPRES Volume VIII / Issue 5/ Jun 2017*. **"ANALYSIS AND DESIGN OF MULTISTORT BUILDING WITH GRID SLAB USING ETABS".** Grid floor system consisting of beams space at regular intervels in perpendicular directions, monolithic with slab. In the present problem G+building is consider and analysis and design is done for both gravity and lateral loads. And this is with the flat slab. In the top stories location the story shear is maximum for spectrum loads.

❖ **Ragy Jose, Restina Mathew, Sandra Devan, Sankeerthana Venu, Mohith Y S**:. *IRJET volume:04 Issue:06/ june -2017.* **"ANALYSIS AND DESIGN OF COMMERCIAL BUILDING USING ETABS".** A G+3 storey building is considered for this study.

Analysis is carried out by static method and design is done as perIS456:2000 guidelines. Also an attempt has been made to design the structural elements manually.drawing and detailing are done using Auto CAD as per SP34.structural analysis and design is used to produce a structure capable of resisting all applied load without failure during its intended life.

❖ **Zameer.K,Vinay.H.P,VirupakshiGouda.M,Vaishnavi.M**: *IRJET Volume:05 Issue:05/May-2018*. **"ANALYSIS,DESIGN AND ESTIMATION OF MULTISTORIED RESIDENTIAL BUILDING USING ETABS SOFTWARE".** The present work deals with the analysis and design of a multistoried building of (G+3) by using most economical beam to column method. The main aim of the project is a multi-storey building and to ensure that the structure is safe and economical against gravity loading condition and to fulfil the function for which the structure have been built for. In this project, we have adopted limit state method of analysis. The design is confirmation with IS456-2000.

❖ **CH.Lokesh Nishanth,Y.Sai Swaroop,Durga chitanya kumar jagarapu,Pavan kumar jogi**: *article in materials today: proceeding July 2020/33(2020)700-704*. **"ANALYSSIS AND DESIGN OF COMMERCIAL BUILDING WITH DIFFERENT SLAB ARRANGEMENTS USING ETABS".** The principle purpose of this work is to analysis and design a commercial building with different slab arrangements,i.e, conventional slab, flat slab with drop panels, grid/waffle slab, and building with load bearing wall. The effect of seismic and wind forces on buildings with different slab arrangements have been analyzed by utilizing ETABS software. Analysis and design are done as per IS456-2000 code book. Load combination are taken as IS:875-part5(2015) code book. The result shows that building with grid slab is stable and economical, contrasting to all other slab arrangements using in the building analysis against wind and seismic loads.

❖ **Elsa Mintu Zachariah, Karthika R,Kaziya james,Renji kunchacko,Asisha Mary Mammen:** *IRJET Volume:06 Issue:05/ May 2019*. **"ANALYSIS OF A MULTISTORIED COMMERCIAL CUM RESIDENTIAL BUILDING USING ETABS"**. the analysis and design of a multi-storied commercial cum residential building(B+G+3) using the software ETABS (Extended Three Dimensional Analysis Of Building Systems). This softwareenables to check the stability of structure under gravity loading, shear forces and seismic loads. The proposed site is in Pathanamthitta with a plot area of 25 cents. In this project, limit state method is adopted for analysis. In this work, an attempt is made according to Building Bye Laws and design of building is done as per IS: 456-2000, SP-16 and SP-34 specifications

❖ **P.Chaitanya Kishore, R.Sumathi**: *IJRAT special issue "ICADMMES 2018" E-ISSN: 2321-9637*, **"DESIGN AND ANALYSIS OF MULTISTORY BUILDING ON SLOPING GROUND AND FLAT GROUND BY USING ETABS".** The fundamental goal of the present work is to contemplate the conduct of the structures on slanting ground and level ground. In this work an endeavor has been made to examine the conduct of the sporadic Multi story working with two diverse inclining edges 1400, 1200 and the examination was made with the level ground by considering it on various quake zones like zone III, IV and V. The correlation is made for level ground fabricating and inclined ground building. The models are readied utilizing ETABS auxiliary investigation programming. Investigation is finished by utilizing Response range examination. The consequences of the examination i.e., relocation, minutes, story shear and story floats are classified and contemplated

❖ **Agus bambang siswanto, Mukhamad Afif Salim**: *Article in international journal of civil engineering and technology-april 2018 volume9, Issue 4*, **"BASIC CRITERIA DESIGN OF EARTHQUAKE RESISTANT BUILDINGS STRUCTURE"**. In

order for earthquake loads on structures that counts is not too large and the direction is quite predictable, as well as the distribution of earthquake loads can be done in a simple way, the provisions that need to be considered in the structural design of buildings in earthquake prone areas are: the layout of the structure, capacity planning with the concept of strong column - weak beam, as well as a good detailing of structural elements. By fulfilling the above requirements, it can be expected to design structures in earthquake prone areas can be done in a simple, safe, and secure way economical.

METHODOLOGY:

- Literature survey
- Modelling of plan
- Importing to ETABS
- Defining and assigning members
- Assigning loads &load combination
- Response spectrum analysis & design
- Time history analysis
- Checking model for errors
- Analysis &design of structure
- Result & conclusion

- **LITERATURE REVIEW**: Literature reviews of various authors are collected and their results were studied.

- **MODELLING OF PLAN**: The plan drawn in AUTOCAD

- **IMPORTING TO ETABS** : AUTOCAD plan imported to ETABS

- **DEFINING AND ASSIGNING MEMBERS**: The material specifications are assigned and beams and columns are placed.

- **ASSIGNING LOADS $ LOAD COMBINATION**: After assigned beams and columns various loads are assigned as per ISCODE specifications.

- **RESPONSE SPECTRUM ANALYSIS AND DESIGN** :In this method graph between maximum spectral acceleration and various time period of structure is prepared for some ground acceleration and structures response at every instance of time is not calculated. This method involves the calculation of only the maximum values of displacements and member forces in each mode of vibration.

- **TIME HISTORY ANALYSIS** :This method calculate response of structure subjected to earthquake excitation at every instant of time. Various seismic data are necessary to carry out the seismic analysis i.e acceleration, velocity, displacement data .etc. .

- **CONCLUSION AND RESULT** : conclusion taken from the graph .

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