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Analysis of School Building using E-TABS Software

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Abstract: ***The structural analysis software plays an important role to carry out the seismic and wind force calculation for the infrastructure. Constructional design has become so much competitive in this world that using computers become mandatory. The behaviour of a building during earthquakes depends critically on its overall shape, size and geometry, in addition to how the earthquake forces are carried to the ground. In this project a school building has been selected having G+7 floors. A detailed study of this building for gravity loads and earthquake loads are analysed and results of moment carrying are observed. In this project E-TABS has been presented for the computation of moments and shear force. We have also presenting the manual calculation of moments and shear force using KANI'S method for the validation of software.***
Keywords: E-tabs, school building, G+7 building, earthquake, wind force.

I. INTRODUCTION

According to studies made on the seismology about 90% earthquake happens due to tectonics. At present people are facing problems like land scarcity which is leading to increase in cost of land. The population explosion and advent of industrial revolution led to the exodus of people from villages to urban areas i.e. construction of multi-storied buildings has become inevitable both for residential and commercial purposes. If these high rise structures are not properly designed for the lateral forces, it may lead to the complete failure of the structure. Hence, the earthquake resistance structures are designed based on factors like natural frequency of the structure, damping factor, type of foundation and ductility of the structure. The structures designed for ductility should be subjected for less lateral loads as it has better moment distribution resistance. This aspect is taken care of by Response Reduction Factor, (R) for different type of structure. To ensure safety against seismic forces of multi-storied building hence, there is need to study of seismic analysis to design earthquake resistance structures. As the increase in number of high buildings there will be increase in number of structure due to wind force. Hence along with the seismic design of high rise structures it is necessary to design for wind resistance structures. Although the wind force is less affecting factor considered to seismic force, these forces causes storey drift and displacement of the structures. This will lead to the failure of the structure hence the structures should be designed for wind force especially those buildings near the coastal regions, hilly areas and high rise buildings.

A. Study Area

Earthquake engineering is a large area of study. The analysis and design of superstructure is our major interest. The analysis and design of superstructure includes earthquake prone regions with base fixed. It also includes the failure mechanism of geometric irregular superstructure.

II. LITERATURE REVIEW

A. "Structural Analysis of multi-storeyed building using E-tabs" by Abhay Guleria VOL.3, 5th May 2014.

The analysis of the multi-storey building reflected that the storey overturning moment varies inversely with the storey height. Storey drift displacement increased with storey height up to 6th storey reaching to maximum value and then started decreasing. From dynamic analysis, mode shapes are generated and it can be concluded that asymmetrically plans under go more deformation than symmetrical plans.

B. "Analysis of multi-storey apartment using ETABS" by Sayyed A.Ahad Vol.6, 5 may 2017.

An apartment is analysed and designed located in Latur, Maharashtra with G+10 storeys having a car parking provided at basement floor. The modelling and analysis of the structure is done by using E-TABS and designing was done. Design of slab, stair case and an isolated footing are done manually. The design method involves load calculations manually and analysing the whole structure by E-TABS.

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C. *"Study of seismic and wind effects on multi-storey building" by Ummar Farooq Pasha Vol.7, 2019.*

Comparison between ordinary existing building with gravity loads only and that of seismic resistant structures to understand the behaviour of each structure during earthquake using E-TABS. Suggest a proper design for existing buildings wherever there is a low performance during an earthquake. Introduce the principle of good earthquake resistant building practices.

D. *"Seismic evaluation of multi-storey building using E-TABS" by Mahesh Kumar C L, Shewtha K G, Sunil S K, Raghavendra H J Vol. 04 issue 08, Aug 2017.*

In this paper they considered G+10 floors.

The various loads applied on building such as dead load, live load and earthquake load. Then analyzing the behavior of structure subjected to combination of loads using the E-TABS software. For the irregularity building considering the equivalent static method for different zone and soil type. The tall building is affected by the lateral force due to wind earthquake action.

E. *"The seismic analysis of multi-storeyed building with shear walls of different shapes" by Donthireddy Raja Shekar Reddy, Joshi Sreenivasa Prasad. Vol. 8 Issue 07 July 2019.*

This work deals with the study on improvement on shape of the shear wall in symmetrical high rise building with different shear wall. They have considered G+14 multi-storeyed building is analysed for storey drift, storey displacement and base shear using E-TABS software. The analysis of this building for seismic loading with the Zone II, III, IV. The analysis of this building is done by using dynamic method.

III. E-TABS SOFTWARE

ETABS is an engineering software product that caters to multi-story building analysis and design. Modeling tools and templates, code-based load prescriptions, analysis methods and solution techniques, all coordinate with the grid-like geometry unique to this class of structure. Basic or advanced systems under static or dynamic conditions may be evaluated using ETABS. For a sophisticated assessment of seismic performance, modal and direct-integration time-history analyses may couple with P-Delta and Large Displacement effects. The structural analysis software plays an important role to carry out the seismic calculation for the infrastructures. ETABS is a coordinated and productive tool for designs which range from simple 2D frames to elaborate modern high-rises. ETABS provides an unequal suite of tools for structural engineers designing buildings, whether they are working on the one story industrial structures or the tallest commercial high-risers.

A. Creation of grid points and generation of structure.
B. Defining and assigning of property.
C. Assigning of supports.
D. Defining of loads.
E. Initial setup of standard codes
F. Assigning of dead loads.
G. Assigning of live loads.
H. Assigning of seismic loads.
I. Assigning of wind load.
J. Assigning of load combinations.
K. Analysis.

IV. VALIDATION OF E-TABS

Since the present study uses the E-TABS as a software tool for carrying out the analysis, the method of analysis in the E-TABS is verified at the beginning by comparing the E-TABS results with classical method for portal frame. Analyze the frame shown in fig.4.1 by Kani's method.

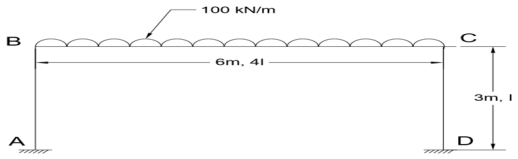

Fig. 4.1: Frame

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In this section the verification problems are carried out to check the accuracy of modelling done in E-TABS.
It is found that,

A. All the results from E-TABS matches with the classical approach.
B. E-TABS is a very convenient software to perform dynamic analysis.
C. E-TABS gives BMD and SFD at face of a column which is essential for economical design.
D. It is possible to obtain the value of BMD at any given point of intersect in the structural element.

V. ANALYSIS AND RESULT

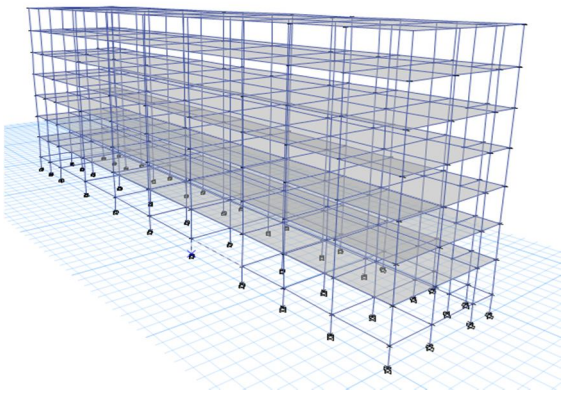

Fig.5.1: Model of RC G+7 frame storied building using e-tabs (3D view)

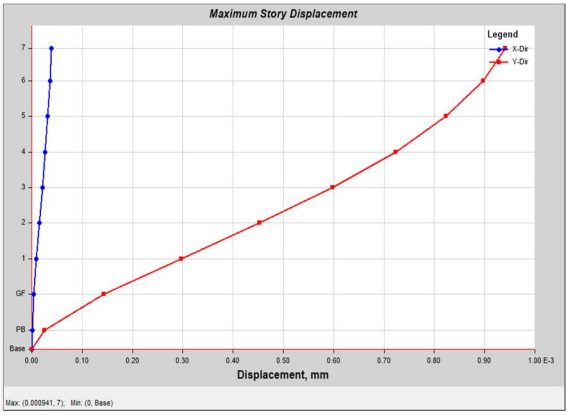

Fig.5.2: Maximum storey displacement

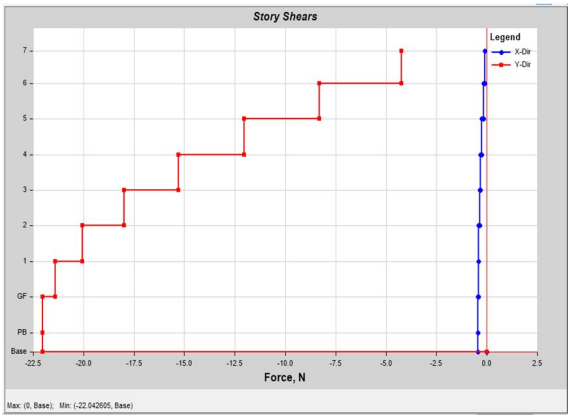

Fig.5.3: Storey shear

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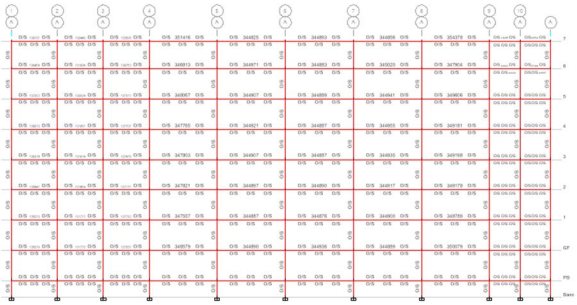

Fig.5.4: Behavior of building before changes in design

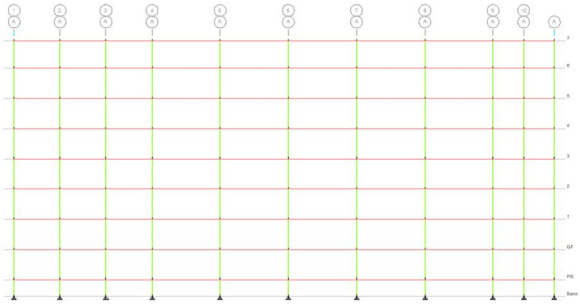

Fig.5.5: Behavior of building after changes in design

VI. CONCLUSION

From the results obtained shown in above pictures we can observe that the building has only been designed for the gravity loads. The structure will suddenly fail when there will be earthquake or slowly due wind force due to deflecting action of columns and beams. It is also observed that the building fails due to the over reinforcement of concrete elements. Hence the design of beams, columns and slabs have been changed so that the building should be safe against lateral loads and also should be economical. These changes in dimensions made the structure safe and sound. The beams and columns are made of same dimensions and also the slab thickness have been reduced. The new suggested dimensions are listed below:

		Ground Floor to 7th Floor
Beam (mm)	Exterior	300x300
	Interior	300x300
Column (mm)	C1	300x600
	C2	300x600
	C3	300x600
	C4	300x1000
	C5	300x1000
	C6	300
	Exterior Circular	300
Slab (mm)		200

Table.5.1: Dimension details

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		Ground Floor to 7th Floor
Beam (mm)	B	150x300
Column (mm)	C	150x300
	Exterior Circular	300
Slab (mm)		150

Table.6.1: Revised dimension details

The dimension details (Table.5.1) are provided for 6 floors building to withstand all the forces i.e., gravity and lateral loads. With the increase in height of a building the structure will fail. When the construction is under process, the dimensions of constructed elements cannot be changed. In that cases techniques called retrofitting can be done. One of the method can be used for retrofitting is usage of chemical anchors. Next for the components to be constructed can be built according to the changed or revised dimensions (Table.5.2).

A. From this Paper the Following Points have Been Concluded

1) Decisions made at the planning stage on designing of a building can be changed when the requirements are changed during the construction process.

2) The provided design data is suitable up to 6 floors. When the height of building increases the design should be changed and checked accordingly.

3) Comparing a detailed Analysis of school building for gravity, earthquake and wind force, Results shows that the building can withstand the forces with slight changes in cross sectional area of the structural members.

4) It also shows that the building can designed with a rectangular or circular column having same dimensions throughout the building.

5) At the construction stage, the changed design can be implemented for remaining part of construction. As for constructed parts the strength can be increased by retrofitting.

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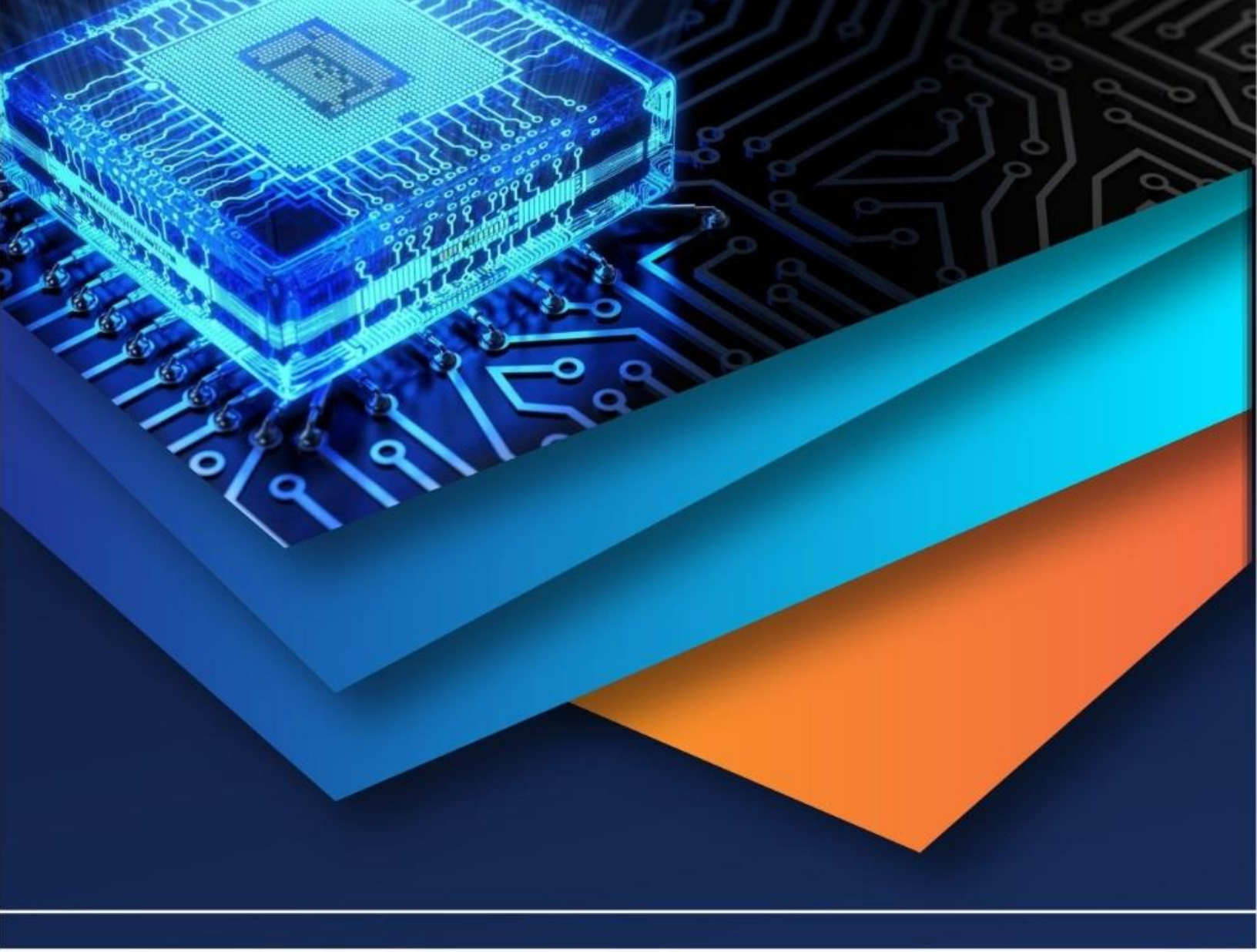

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