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TIME HISTORY ANALYSIS OF VERTICAL IRREGULAR BUILDINGS USING ETABS

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ABSTRACT

It is critical to test and perform seismic building analysis as lots of damage and structural losses causes due to earthquake in past. It is compulsorily desired to analyse response of building structure for possible losses. Seismic response for real time history is required to perform to design building under seismic consideration. The research includes analysis of four different building models which are vertically irregular. The method selected is vertical irregular problem analysis with respect to time history analysis. Four building models are considered with time history reference data to perform and conduct research work. Software used to perform analysis is ETABS. All analysis are compared for outcomes such as deflection, base reaction and stress.

The data collection is then arranged mainly in the tabular format for deflection, base shear and stress. The complete building analysis and data outcomes are arranged together. Time history based analysis is tested for vertical irregular buildings and cases. Result and discussion is described with the help of graphs and the graphs were critically analysed and studied to conclude the outcome and summary of analysis from each graph.

KEYWORDS: Multistory Buildings, Vertical Irregularity, Seismic Analysis, Time History Analysis, Displacement, Base Shear, Stress.

I. INTRODUCTION

Researchers studied for earthquakes since long time and still they earthquakes are unpredicted. It is impossible to predict time and place of earthquake. To design and construct the structure which can withstand against earthquake is research interest since last many years, also researchers required to measure the frequency and intensity of earthquake for future structural design. Safety, strength and performance are the parameters which are to be considered while designing structure in seismic zones specially. However codes and guidelines are prepared by engineering societies in world which can be used to design buildings.

Factors responsible to failure of structure under seismic are:

(i) Wrong and weak structure configuration and irregularities in planning phase.
(ii) Lesser strength and ductility considerations in design phase.
(iii) Unplanned and non-scientific construction activities and sequences.

II. PROBLEM FORMULATION AND OBJECTIVES

In this research G+19 multi-storey building of plan dimensions 30m x 25m, beam size 325x425 mm, column sizesfor Story 1-7 =625mmx625mm, Story 8-14 = 525mmx525mm, Story 15-19 = 425mmx425mm is modelled with different vertical irregularities i.e. Setback and mass irregularity and analyzed with various time history data (Holliste and Yermo).

The setback irregularities considered in the modeling are as follows:

- Model A consist of 6x5 bay up to top floor.
- Model B consist of 6x5 bay up to 10 floor. 2x2 bay up to top floor (corner position).
- Model C consist of 6x5 bay up to 10 floor. 2x2 bay up to top floor (center position).
- Model D consist of 6x5 bay up to 10 floor. 2x2 bay up to top floor (edge position).

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The following figure obtained from earthquakes in time zones, the same is considered for all cases and references to test building considered in problem statement with seismic loading in different time zones.

Holliste Earthquake and Yermo Earthquake

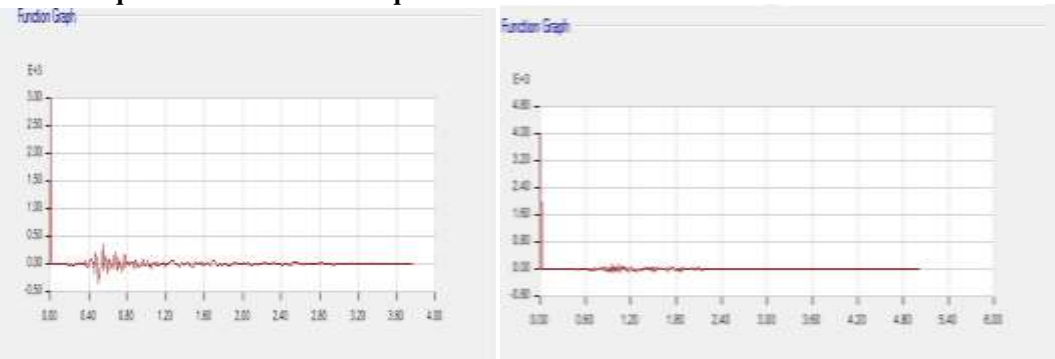

Figure 1: Time History Graph Holliste and Yermo Earthquake

Following are the four models considered, modelled and analysed with seismic loading under different time zones. The models are considered with variation and difference in term of vertical irregularity.

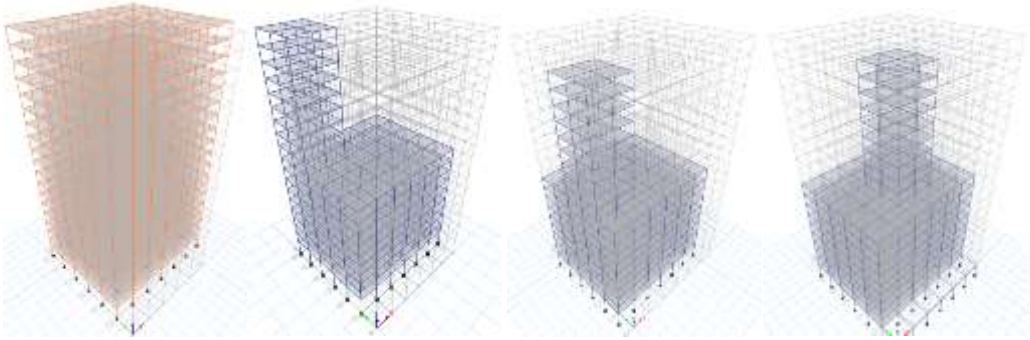

Figure 2: Model A, B, C and D

III. METHODOLOGY

Building response is planned to test with ETABS software defining all dimensional parameters and material properties. Analysis is to be performed for vertical irregularities in different time history.

In short description:

- Initially taking a model of plan dimension30mx25m G+19 storey building in ETABS.
- Modelling of model is done with different types of vertical irregularities.
- The model is considered to be taken in zone V.
- Time History Analysis is done on the models in ETABS.
- Results are tabulated and then compared with time history and vertical irregularities.

TIME HISTORY ANALYSIS

Analysis of Models for Holliste Time History Data (With Load Combinations)

Table 1: Displacement Analysis Table

Sr. No.	Model Name	Maximum Displacement (mm)
1	A	198.80
2	B	315.30
3	C	302.00
4	D	292.80

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Table 2: Base Reaction Analysis Table

Sr. No.	Model Name	Base Reaction (KN)
1	A	3097
2	B	2692
3	C	2513
4	D	2536

Table 3: Stress Analysis Table

Sr. No.	Model Name	Stress (E^{-3}) KN/mm^2
1	A	182.00
2	B	252.00
3	C	252.00
4	D	252.00

Time History Analysis for Holliste vs Yermo

Figure: Time History Analysis Table (Holliste vs Yermo)

	Holliste			Yermo		
Model	**Base Reaction (KN)**	**Displacement (mm)**	**Stress (N/mm^2)**	**Base Reaction (KN)**	**Displacement (mm)**	**Stress (N/mm^2)**
A	2978.89	147.36	964.89	3931.94	201.71	1109.76
B	2421.99	143.08	904.83	3098.93	206.05	1027.64
C	2510.35	138.83	809.54	3284.83	221.43	927.57
D	2566.12	158.28	986.87	3391.78	224.56	893.15

IV. RESULTS AND DISCUSSION

Result Comparison Graphs of Models for Holliste Time History Data

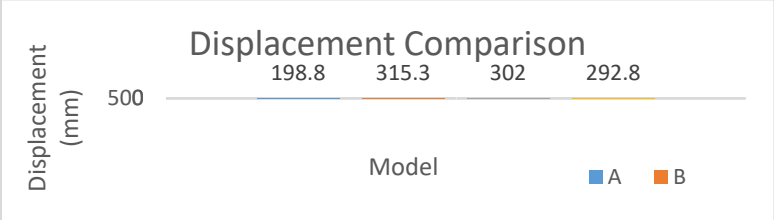

Figure 3: Model Displacement Comparison

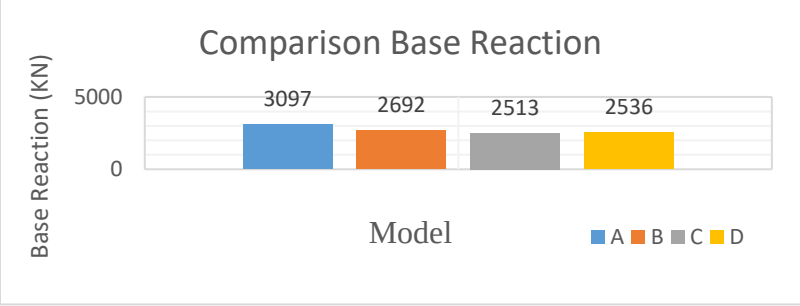

Figure 4: Base Reaction Comparison

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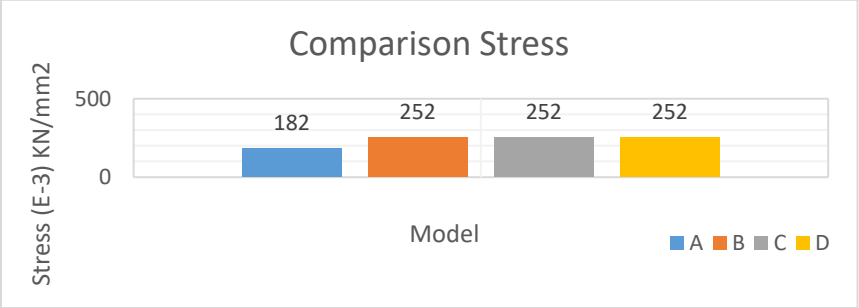

Figure 5: Stress Comparison

Displacement in Model B is found maximum while Model C and D possess near value with each other while Model A displaced lowest amongst all cases.
Base reaction in case A is maximum and is minimum in case C. But it is found that there is nominal difference in result values for case C and D.
Stress obtained in case B, C and D are similar and may say maximum or greater than case A which is lesser than all other cases.

Result Comparison Graphs for Holliste vs Yermo Time History

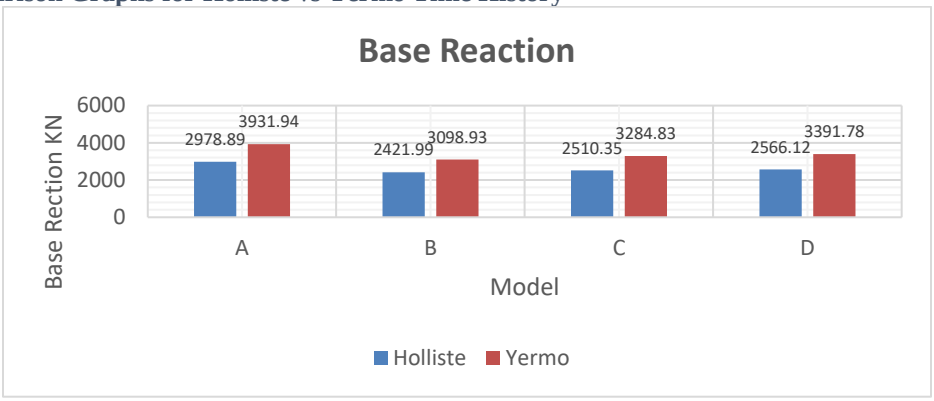

Figure 6 : Base Reaction Comparison (Model Wise)

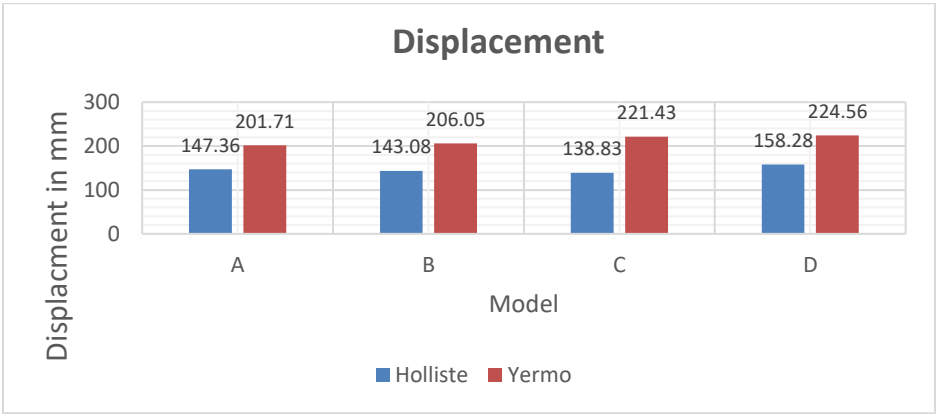

Figure 7 : Displacement Comparison (Model Wise)

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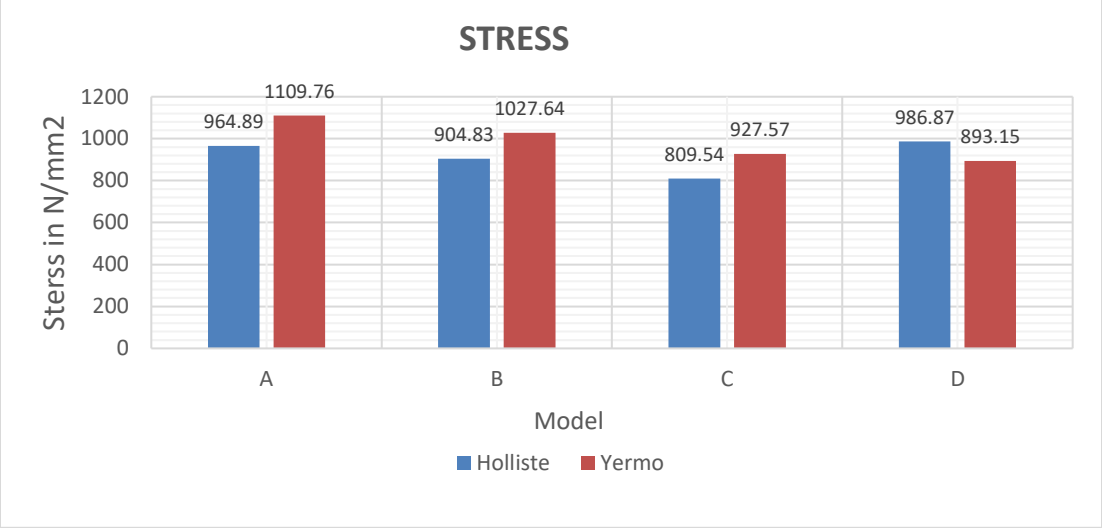

Figure 8: Stress Comparison (Model Wise)

Comparing both time histories base reactions in both time histories is found maximum in case A and minimum in case B, whereas displacement in both time histories is found maximum in case D but minimum in case C for Holliste time history and minimum in case A for Yermo time history. Stresses in holliste time history is maximum in case D and minimum in case c. In Yermo time history stresses in case A is maximum and case D is minimum.

V. CONCLUSION AND FUTURE SCOPE

It is concluded that four models are considered and modelled in ETABS and two time histories are considered to analyse the models. It is recommended that ETABS can be successfully considered and employed to analyse such cases and buildings considering various time histories. Present research considered Holliste time history and Yermo history one by one for all four building cases considered.

1. It is found that results obtained from Yermo time history are higher than Holliste time history for all values of displacement, base reaction and stresses.
2. In Yermo time history data acceleration is noticed at higher side than Holliste time history and results are also noticed higher for Yermo time history. It can be further concluded that ETABS is providing true results with respect to acceleration difference.
3. It is recommended as conclusion that irregular buildings are safer than regular building under seismic conditions and should be preferred over regular buildings.
4. The column size is designed lighter with the height of building therefore it is concluded that designing lighter column saves cost of building and helps to achieve optimized design of building.

VI. FUTURE SCOPE

The Scope of the study can be extended are below

1 Comparative study by providing shear wall at different location.
2 Comparative study by providing bracings and base isolation.
3 Nonlinear time history analysis can be performed on the structure.
4 Parametric studies of these structures can be done considering the effect of brick infill.
5 Present study can be carried to further level by applying nonlinear method of structural analysis.
6 Also the statures can be analysed by adopting multiple stiffness systems like shear wall with bracings.
7 Time history analysis also can be perfumed by the above structures with different method of structural analysis.
8 The analysis can be carried out for vertical irregularity by adopting soil structure interaction.
9 The pushover analysis in vertical irregularity structures by use of different types of isolators.
10 Different types of dampers can be adopted for analysis of structures.
11 Comparison can be made between the performances of different base isolators using floating column structures.

12 Pushover analysis for floating column and base isolated structures can also be performed.

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