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SEISMIC ANALYSIS OF STRUCTURE WITH STRUCTURAL IRREGULARITIES

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Abstract: Behavior of a multi-story building during strong earthquake motion depends on structural configuration. Irregular configuration either in plan or in elevation is recognized as one of the major causes of failure during earthquakes. The paper presents a study on the seismic response of the RC structure under strong earthquake motions. FEM based software ETABS V 19 was used to evaluate seismic performance of the structure. The objective of this study is to understand the importance of irregularities, behavior of different irregularity of reinforced concrete structure to seismic forces, its failure pattern during earthquake, to suggest safe performance level for various types of irregularities.

Keywords: Irregularity, Horizontal Irregularity, Vertical Irregularity, Mass Irregularity,Seismic performance.

I. INTRODUCTION

Irregular structures make up a majority of the fashionable urban infrastructure. Today's field of study would like and innovative prospect for the structure of recentgeneration infrastructural development has created an inevitability towards the de sign of irregular configurations. Several structures in the current condition have irregular designs in both plan and elevation, making them vulnerable to disastrous earthquakes in the future. In suchcases, It is vital to evaluate the ability of buildings to withstand disaster, especiallyearthquakes. Injury to the structure during an earthquake begins with the weakestsupport. This structural weakness is caused by the structure's discontinuities in mass, stiffness, and shape. Different structural irregularities have an effect on thebuilding's ground-breaking reactions to a number of ways. Buildings with a uniformconfiguration and irregular structures sustain significantly less damage than onewith equally distributed stiffness and mass throughout the structural might be constructed with uneven mass, stiffness, and strength distribution at the peak. The structural engineer's duty becomes more difficult when such buildings square measure positioned in an extremely high unstable zone. The structural engineer therefore has to have a plan and elevation.

The structural process is designed, chosen, and configured with input from the group of individuals involved in the building facilities construction, including the owner, architect, structural engineer, contractor, and local authorities. As a result, structures detailed understanding of the inconsistent behavior of irregular structures.
Inductile time-history analysis has the ability to be an useful tool for studying structurally unstable responses. A collection of precisely collected ground motion records will provide an accurate study of the expected unsteady structural performance. Dynamic inductile analysis still raises certain questions, especially about its complexity and relevance for practical design applications, despite the factthat computational tools' accuracy and power have greatly improved.

The selection of a set of samples time - history is also significant since the calculated inductile dynamic behavior is extremely sensitive to the characteristicsof the input motions. The amount of analysis studies will rise significantly as a result.Structures usually possess combination of irregularities and through one irregularitymight not lead to correct prediction of unstable response.
In terms of building size and form, the organization of structural and non-structuralelements within the structure, the distribution of mass inside the structure, and otherfactors, current earthquake codes accurately describe structural configuration as either regular or irregular.
Depending on the required time function, time-history analysis helps either linear or nonlinear assessment of dynamic system response under loads. Without a question, the most accurate and realistic analysis method accessible is nonlinear dynamic analysis.
The term also refers by "nonlinear time history analysis" or "nonlinear response history."

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1.1 Types of Irregularities:

1.1.1 Vertical irregularity is caused by the unequal pattern of weight, stiffness, or strength along a building structure's elevation.

1.1.2 Horizontal irregularity: Horizontal irregularity is caused by the existence of discontinuities in the plan floor and looks to be more vulnerable to significant deformation and damage when subjected to strong ground vibrations than those with regular plan floors. Because of its specific stiffness and orientation depends on the direction of horizontal stresses, each wing will exhibit different dynamic behavior under earthquake forces.

1.1.3 Mass irregularity: Mass irregularity is determined to arise once the earthquake weight of any level exceed 150 percent of the seismic weight of the floors below.

1.1.4 Stiffness irregularity (Soft story): During severe ground motions, soft levelsor extreme soft stories of multi-story buildings cause chaos and destruction (and even collapse). The presence of such a soft or exceptionally soft story is identifiedby lateral stiffness irregularity provisions in seismic design regulations.

II. LITERATURE REVIEW

Following papers highlight about the Effects, Study on performance enhancement,and Evaluation of structure under seismic analysis with structural irregularities.

1. Nimmy Mariam Abraham, Siva Naveen E, and Anitha Kumari S D "Analysisof Irregular Structures Under Earthquake Loads," Procedia Structural Integrity 15 (2019), 806–819 (2nd International Conference on StructuralIntegrity and Exhibition 2018). : It is studied how multi-story frames with individualirregularities and combination with irregularities behave structurally.

The results demonstrate that irregularity significantly affects structural response. As a result of earthquake loads, all the irregularity instances evaluated demonstrated significantly greater response than the normal structure.

In contrast to reentrant corners and vertical geometric imperfections, stiffness andvertical geometric irregularities combination produced the highest movement response. According to the results of this study, The presence of irregularity does not alwaystrigger a stronger reaction. A few combinations of irregularities affect structural reactions.

2. Salvatore MARINO, Serena CATTARI, Sergio LAGOMARSINO "Use Of Nonlinear Static Procedures For Irregular Urm Buildings In Literature And Codes", 18–21 June 2018: Thessaloniki hosted the 16th European Conference on Earthquake Engineering: The study looked into nonlinear static procedures (NSPs) recommended in literature and codes, as well as how they applied to irregular unreinforced masonry (URM) structures.

A comparison of codes and several literature proposals was carried out; specifically, the following were investigated: the performance (PL) analysis, the required intensity measure, and the loading pattern distribution to be employed (IM).
The results indicate that current NSPs have more problems, and improvements arepredicted to overcome the shortcomings observed. As a reference response, non -linear time (dynamic) analysis were also used. The current analysis aimed to identify the most critical issues with the current procedures and recommend improvements

The procedure outlined in ASCE/SEI 41-13 might be seen in action (2014) gave extremely conservative code result throughout many circumstances, however this was mostly related to an overly conservative analysis of the performance levels projected inside.

3. Santoshkumar B. Naik1,Mohd. Zameeruddin Mohd. Saleemuddin2,Keshav "Seismic Performance Evaluation of Reinforced Concrete Frames with Irregular Elevations using Nonlinear Static PushoverAnalysis", Volume 2, Issue 7, [July-2015] Journal of Modern Trends in Engineering and Research International (JMTER). ICRTET'2015 Special Issue: The current work's aim is to evaluate how moderate reinforced concrete structureswith variable heights respond to seismic pressures.

Deformation-controlled Analyses concerning nonlinear static (pushover) systems were carried out for lateral masses obtained. Results obtained from pushover analysis shows that, because the share of irregularity will increases the structure moves in to inflexible zone with the formation of collapse mechanism.

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Because of the proportion of irregularity in height grows, the bottom shear reduces,lowering the structure's lateral load carrying capabilities. As a result, structural engineers must take extra precautions while designing an asymmetrical structure.

Although deformation is increased due to the construction of a collapse mechanism,there seems to be a significant decrease in structural results in terms of reactions such as lateral displacement, story drift, and story. According to the research, ductile or non-ductile behaviors, weight, rigidity, strength regularity, and unsteady performance are all substantially correlated.

4. Sangita S. Meshram, Neha P. Modakwar, and Dinesh W. Gawatre “SeismicAnalysis of Structures with Irregularities”, International Conference on Advances in Engineering & Technology – 2014 (ICAET-2014) e-ISSN: 2278- pp 63-66, ISSN: 2320-334X, 1684: They chose a non-realistic design with 5mX5mcross and L - shaped frames. The structure is planned as a commercial complex with fifteen and five-story R.C. buildings.

They consider that the location is in Seismic Zone II with medium soil conditions. The researchers investigated the structural performance of re-entrant corner sites.They sought to understand the various irregularities and torsional responsescaused by plan layout and vertical irregularity. They came to the conclusion that itscorner columns for re-entrant needed to be strengthened.

The study found that torsional reaction is the same in all zones, suggesting that re-entrant corner columns must be reinforced at lower floor levels or above two story levels. When the diaphragms at a certain levels are eliminated, the amount of torque produced greatly increases; therefore, in re-entrant corner buildings, it is higher to prevent diaphragm irregularity.

5: M. Pirizadeh, H. Shakib “Probabilistic seismic performance evaluation of non-geometric vertically irregular steel buildings”, Journal of ConstructionalSteel Research 82 (2013) 88–98: Different non-geometric vertically irregular structures' earthquake performance compared to that of a standard case study. under different level of performance in this paper using a probabilistic technique.

Using a probability - based performance-based earthquake resistant methodology,the effects on non-geometric vertical irregularity on the seismic behaviors of steel moment resistance structural systems were examined in terms of limit-state capacities and the structural plasticity issue.

The non-uniform distribution of lateral resistivity characteristics across the structure's peak effects the structure's seismic performance, particularly over the CP to GI limit-states, even though it establishes the structure's main specifications.These variables also affect the structure's ability to resist seismic intensity and/or plasticity, depending on type of vertically irregularities and where it is located abovethe building's peak.

Investigation of vertical irregularities raise the structure's possibilities of up to 30%greater performance than the GI performance level. It has been noted that the MAFs of exceeding the performance standards are inflated nearly equally irrespective of whether soft and/or weak stories are placed at the lowest or mid height of the structure.

6. : Kien Le-Trung, Kihak Lee, and Do-Hyung Lee , "Seismic Behavior And Evaluation Of Steel Smf Buildings With Vertical Irregularities" (The 14th World Conference on Earthquake Engineering), October 12-17, 2008, Beijing,China: This research compares the unstable characteristics for vertical uneven compared to their standard products, steel special moment frame (SMF) structures.The study's requirement that all structures be in Los Angeles exposed them to 20 earthquake forces with a seismic risks level of 2 percent during a 50-year period. In terms of a height-wise distributions of story drifts, maximum story drift criteria, global collapse story drift capabilities, and confidence levels, the impact of variousirregular types and levels on the ground motions behaviors of the buildings were investigated and mentioned. The seismic performance for irregular buildings was hindered to strength of the structure.

A 20% reduction in the story's stability can result in a considerable reduction in thebuilding's level of confidence. It implies that IBC 2000 provision of an 80 percent strength irregularity limitation is appropriate.

The maximum drift occurred frequently inside the story considerably bigger for thestructures being evaluated in this study than the drift at other floors. As a result, it’sdetermined as the vertical irregularity located near to the base story had a greater impact than those located in other parts of the buildings. As a result, the Dependingupon that vertical orientation of irregularities, various limit values may be employedfor differentiate between regular and irregular buildings.

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III. OBJECTIVES OF THE STUDY

To use E-tabs to model the C V Raman Block, NMAM Institute of Technology NITTE, taking into account structural irregularities.

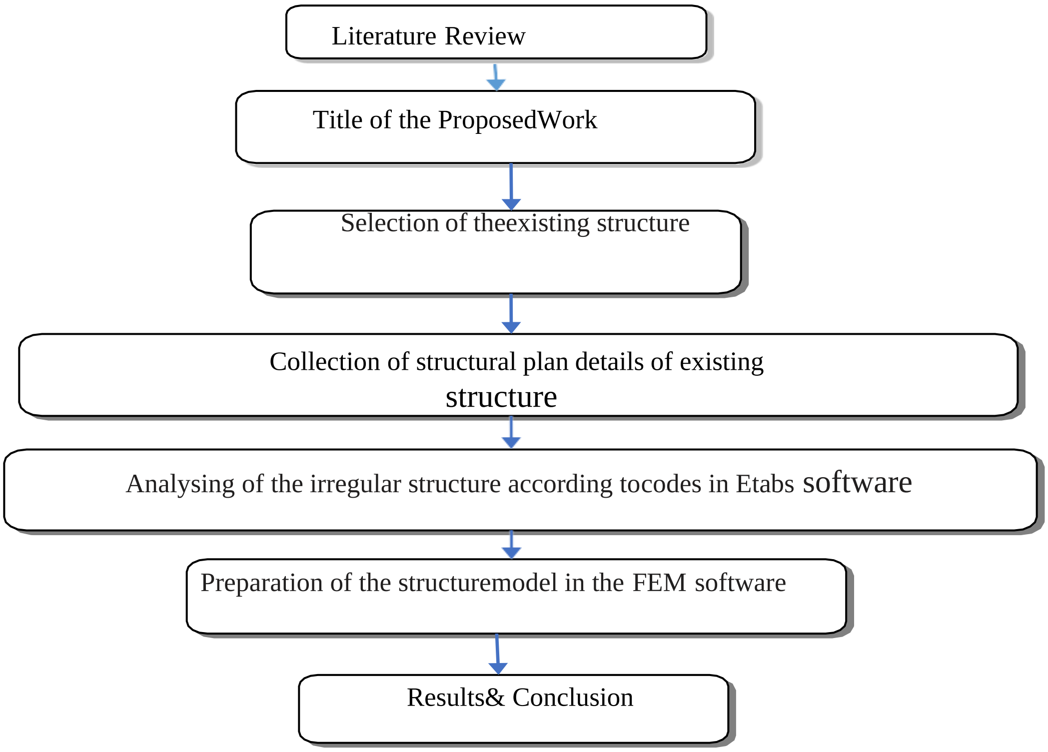
To evaluate the seismic performance of the structure under different irregularities

To evaluate the effects of structure location in accordance with seismic code standards.

To evaluate the structure's response to earthquake ground motions.

Figure out the best building configuration based on this study.

IV. METHODOLOGY



V. WORK CARRIED OUT

Literature study was carried out.

Learning E-tabs software for structural modelling.

Plan of CV Raman Block is collected from Resident Engineer, Construction & maintenance Dept. NMAM Institute of Technology, NITTE.
The asymmetrical structure might be created via uneven mass distribution, stiffness at the top, and building strength. The arrangement irregularities are among the essential causes of injuryduring the occurrence of ground motions. Plan irregularity can arise as aconsequence like an uneven mass, stiffness, and strength distributions along the plan.
This study used a G+6 story building design. The Finite element analysisprogrammed is being used to construct a 3D model as well as analyze it.For analysis, an irregular shape design of the project is chosen.
The peak of the structure is taken into account as 4.3 meters. As frame elements, all beams and columns are represented. Shell components serve as a description for the slabs.

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5.1 INTRODUCTION TO ETABS SOFTWARE

ETABS is an effective programmer, designed by the company computers and structures Inc. That considerably improve structural components and technical skills of an engineer. A portion of its power comes from a variety of choices and possibilities. The other factor is how easy it is to operate. the fundamental strategyutilizing software that quite simple.

Using the line and place object tool, the user inserts grid lines, specifies materials and structural attributes, and then positions structural objects in relation to the gridlines. All of the loads which the structure is subjected could be specified and allocated to the relevant structural components. Dynamic analysis features such asmass supply, total number of mode forms, and their directions are described.

5.2 VERIFICATION PROBLEMS

Since this present study uses ETABS as a software system tool for concluding static analysis results for frame structure.

Why is verification and validation important?
Verification and validation action as early as that each element of software testing progress as a result of they: Make sure that the tip product meets the design conditions. Decreases the possibilities of defects and fabrication failure. Ensures that fabrication meets the character standards and expectations of all stakeholdersconcerned.

5.2.1 Portal frame structure

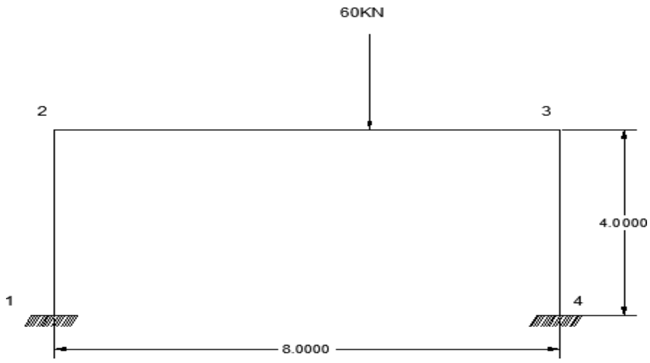

Fig 5.1.1: Portal Frame

Table 5.1.1: Bending moments and shear force in one story symmetrical framefrom different approaches.

SL.NO.	DESCRIPTION	NODE NUMBERS	RESULT FROMETABS
1.	MOMENTS (kN/m)	1	50.2569
		2	98.1442
		3	50.2569
2.	SHEAR (kN)	1	14.7814
		2	33.6084
		3	53.6081
		4	14.7814

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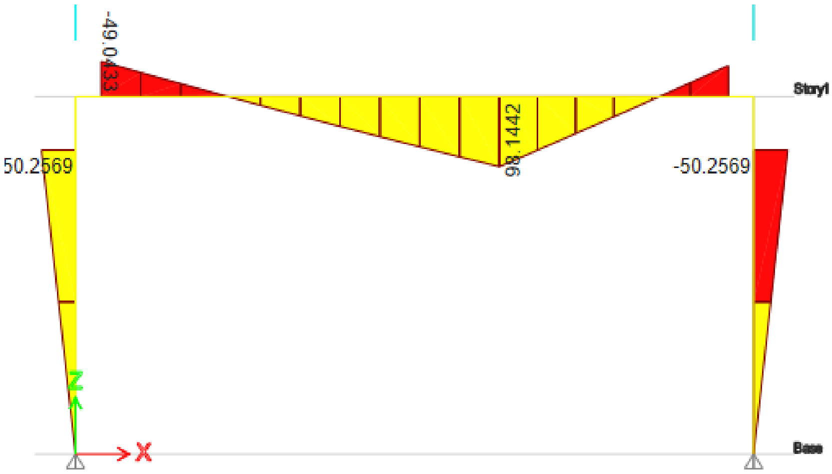

Fig 5.1.2: Bending moment diagram analyzed by E-tabs

Fig 5.1.3: shear force diagram analyzed by E-tabs

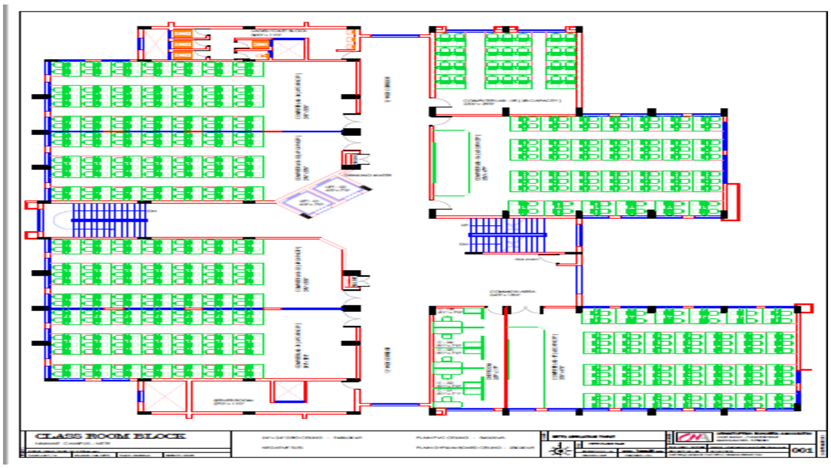

Fig 5.1.4: Plan of CV Raman block, NMAMIT, NITTE

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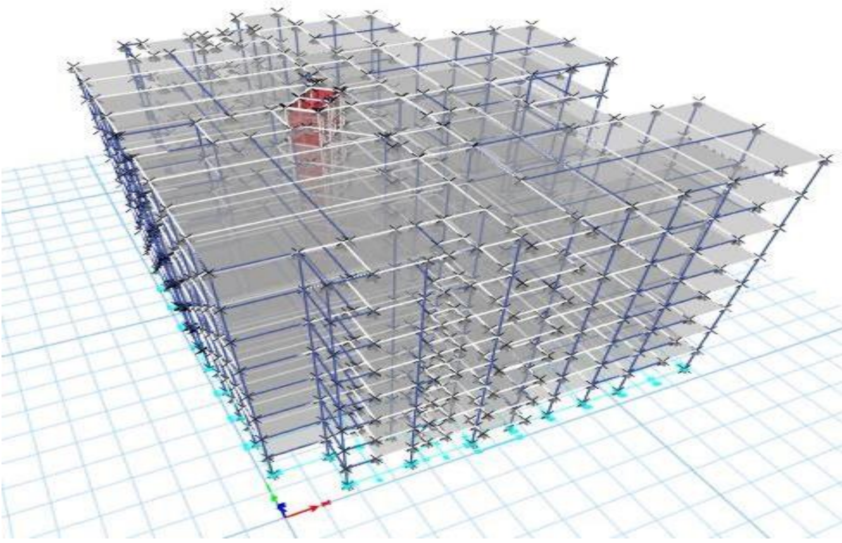

Fig 5.1.5: CV Raman block 3D modelled in E-tabs

5.3 TIME HISTORY ANALYSIS INTRODUCTION

Time-history analysis allows for linear or non - linear analysis of dynamic structuralresponses under loading, with the time function varying as desired. Without a doubt,nonlinear dynamic analysis is the most realistic and correct analysis methodology available.
It's conjointly referred as "Nonlinear time history analysis", "nonlinear response history".
Earthquake loading is considered as a natural or artificial ground motion on a structural model which includes components with inelastic (inelastic and nonlinearare frequently used interchangeably in earthquake application areas) force- deformation interactions and a minimal amount of a first-order estimate of geometric nonlinearities (P-Delta effects).
The earthquakes movement propagation throughout the structure gives entire response histories for any amount of interest (e.g. displacements, stress resultants), resulting in a plethora of information. While different levels of full actions are possible as a result of modelling choices, differing ground motion records can provide demands that vary dramatically

Table 5.3.1: Maximum displacement values at x and y direction

Sr.No	Story level	Maximum displacement at x direction (mm)	Maximum displacement at y direction (mm)
1	Story 6	21.67	49.44
2	Story 5	24.36	48.067
3	Story 4	24.203	42.909
4	Story 3	20.914	34.498
5	Story 2	14.566	23.023
6	Story 1	5.908	8.733
7	base	0	0

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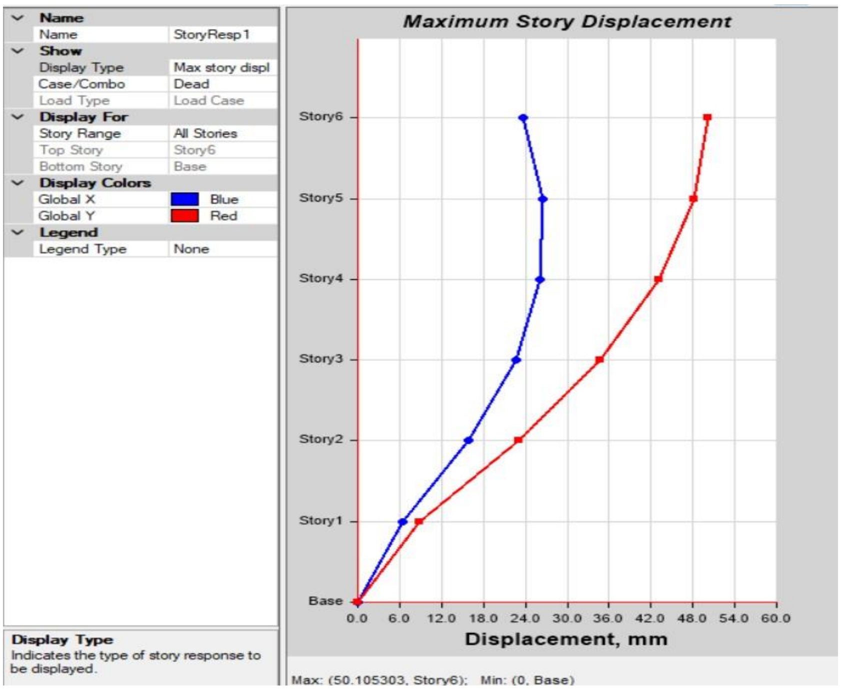

Fig 5.3.1: Maximum story displacement graph

Table 5.3.2: Maximum story drift at x and y direction

Si.No	Story level	Max story drift at xdirection	Max story drift at y direction
1	Story6	3.291	2.762
2	Story 5	5.158	4.439
3	Story4	3.531	8.411
4	Story 3	6.71	11.64
5	Story 2	9.402	14.288
6	Story 1	6.42	8.713

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Fig 5.3.2: Maximum story drift plot

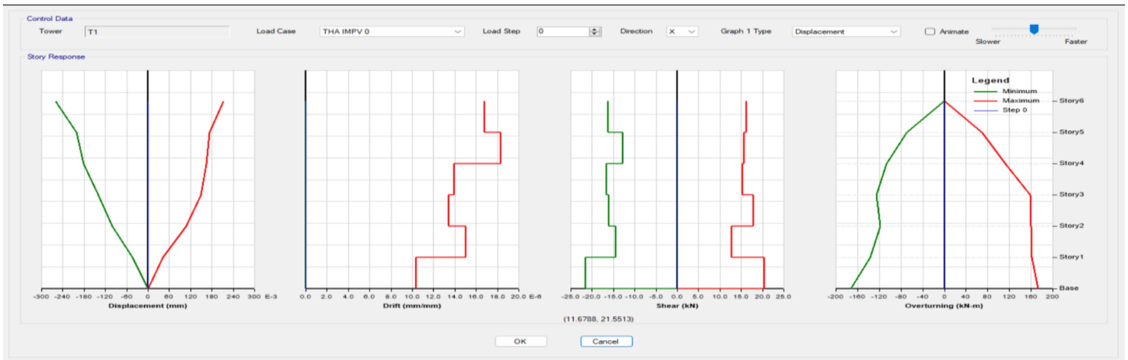

Fig 5.3.4: Combined story response plot for time history analysis in x direction forELCENTERINO

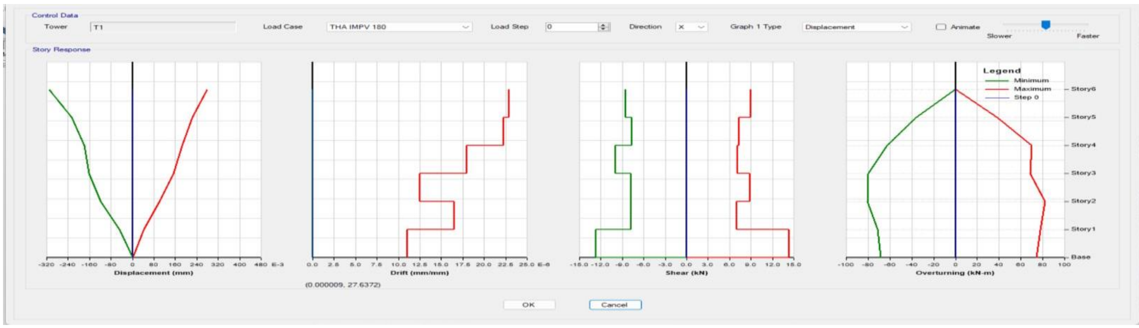

Fig 5.3.5: Combined story response plot for time history analysis in y direction forELCENTERINO

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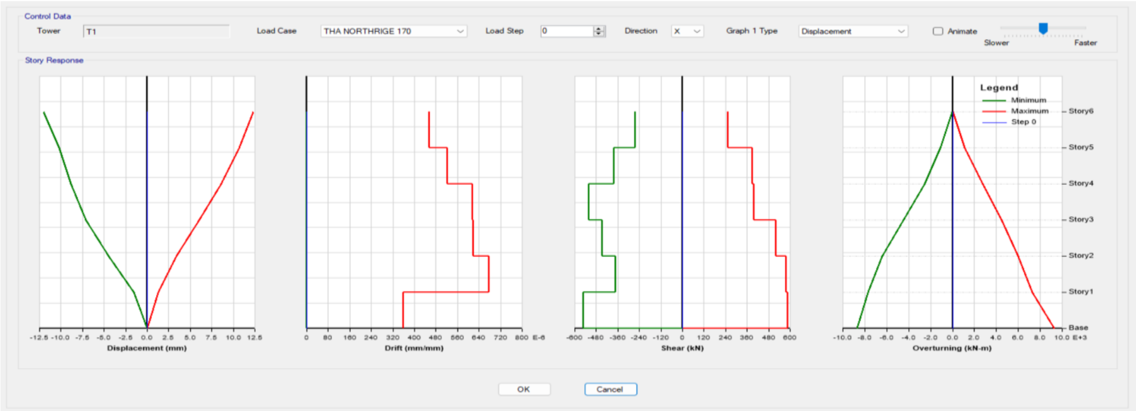

Fig 5.3.6: Combined story response plot for time history analysis in y direction forNORTHRIDGE

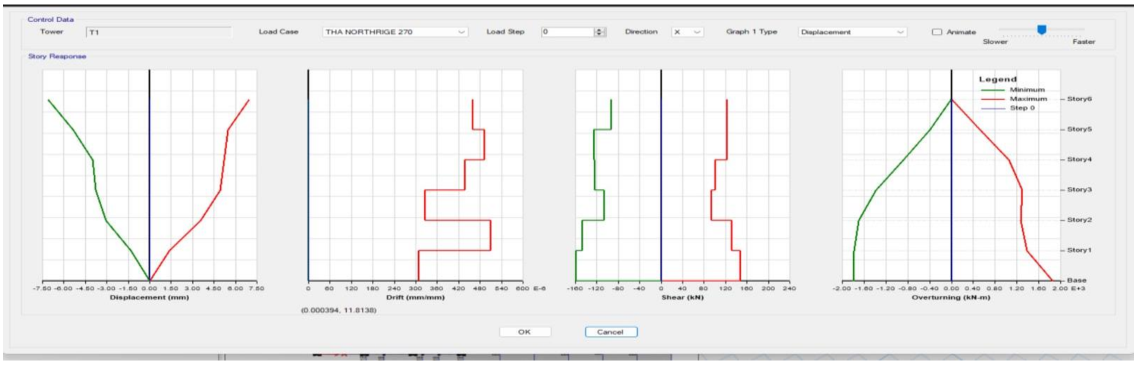

Fig 5.3.7: Combined story response plot for time history analysis in y direction forNORTHRIDGE

VI. RESULT AND CONCLUSION

- Results are obtained from the Time history analysis and pushover analysisare represented by below graphs as shown in the following figures.

- The graphs shows that the variation for the maximum story displacement graphs with maximum displacement values.

- The graphs also represent a time history study of a real-time earthquake.

- The response curves then are plotted on a graph for time history analysis.

- The structural systems analysis is performed using the ETABS V19software.

- The seismic response of buildings is investigated in various seismic zones,and the results compared depending on building performance.

- The structure is constructed with static load situations in consideration, butseismic forces also are taken into account during evaluation.

- At the dead load case, the maximum displacement arises at 50mm in theglobal y direction and 22mm in the global x direction, according to the maximum story displacement graph.

- The maximum story drift plot demonstrates that the maximum displacement occurred between consecutive stories at story 2 at x direction9.87mm and y direction 14.28mm.

- The acceleration v/s time for the real-time seismic data can be representedby the linear static graphs that's been obtained for ELCENTRINO and NORTHRIDGE in both the x and y directions.

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- FOR THE ACCELERATION V/S TIME FOR REAL-TIME EARTHQUAKE DATA, STORY DRIFT ANDJOINT DRIFT PLOTS ARE ALSO OBTAINED.

- RESPONSE SPECTRUM CURVE FOR TIME HISTORY ANALYSIS IN THE X AND Y DIRECTIONS FOR THE ACCELERATION DURATIONS FOR ELCENTRINO AT 0.05 SEC ANDNORTHRIDGE AT 0.01 SEC.

REFERENCES

[1] S Siva Naveen E, Nimmy Mariam Abraham, Anitha Kumari S D "Analysis of Irregular Structures under Earthquake Loads", (2nd International Conferenceon Structural Integrity and Exhibition 2018), Procedia Structural Integrity 41 (2019) 806–819.

[2] Salvatore MARINO, Serena CATTARI, Sergio LAGOMARSINO "Use Of Nonlinear Static Procedures For Irregular Urm Buildings In Literature And Codes", (16th European Conference on Earthquake Engineering Thessaloniki), 18 – 21 June 2018.

[3] Santoshkumar B. Naik1,Mohd. Zameeruddin Mohd. Saleemuddin2,Keshav "Seismic Performance Evaluation of Reinforced Concrete Frames with Irregular Elevations using Nonlinear Static PushoverAnalysis", International Journal of Modern Trends in Engineering and Research (IJMTER) Volume 2, Issue 7, [July-2015] Special Issue of ICRTET'2015.

[4] Neha P. Modakwar, Sangita S. Meshram, Dinesh W. Gawatre "Seismic Analysis of Structures with Irregularities", International Conference on Advances in Engineering & Technology – 2014 (ICAET-2014) e-ISSN: 2278-1684, p-ISSN: 2320-334X PP 63-66.

[5] M. Pirizadeh, H. Shakib "Probabilistic seismic performance evaluation of non-geometric vertically irregular steel buildings", Journal of Constructional SteelResearch 82 (2013) 88–98.

[6] Kien Le-Trung, Kihak Lee and Do-Hyung Lee "Seismic Behavior And Evaluation Of Steel Smf Buildings with Vertical Irregularities" (The 14th WorldConference on Earthquake Engineering) October12-17, 2008, Beijing, China.

[7] L.T.Guevara, J. L.Alonso E. For-toul "Floor-plan shape influence on the response to earthquakes", Earthquake Engineering, Tenth World Conference© 1992 Balkema. Rotterdam. ISBN 9054100605

[8] Guevara, LT. 1989. Architectural Considerations in the Design of Earthquake-Resistant Buildings: Influence of Floor-Plan Shape on the Response of Medium-Rise Housing to Earthquake. PhD Dissertation. CED, University of California, Berkeley.

[9] C.M. Ravi Kumar, K.S. Babu Narayan, M.H. Prashanth, H.B Manjunatha and D. Venkat Reddy, "Seismic Performance Evaluation of RC Buildings with Vertical Irregularity", Indian Society of Earthquake Technology, 2012, PaperNo. E012.