iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** VII **Month of publication:** July 2022

DOI: https://doi.org/10.22214/ijraset.2022.45462

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

Comparative Study of G+7 Storey Residential Building in Seismic Zone 5

Meet Patel[1], Nirmal Mehta[2], Arjun Butala[3]
[1]*Student of M.tech (Structural Engineering), Ganpat University, Ahmedabad, Gujarat, India*
[2, 3]*Assistant Professor, Ganpat University, Ahmedabad, Gujarat, India*

***Abstract**: The important objective of Structural engineers is to design and build a structure in such a way that damage to the structure and its structural component during the earthquake is minimize. This report aims towards the Seismic analysis of a multi- storey RCC building with symmetrical configuration. For the analysis purpose model of seven storey RCC with symmetrical floor plan is consider. Seismic Zone 5 is considering for this Research work. The analysis is carried by using Seismic Coefficient Method & Response Spectrum Analysis. Seismic Coefficient Method is a part of a Linear Static Method, where Response Spectrum Analysis is a part of a Linear Dynamic Method. E-TABS Software are used for the Analysis work. For this study, Two Models are prepared. (1) G+7 Residential Building with Columns & (2) G+7 Residential Building with Shear Walls. Various response parameters such as Story Displacement, Story Drift, Time Period and Story Stiffness can be determined. Above all factors are comprised between two models. The main parameters of the seismic analysis of structures are load carrying capacity, ductility, stiffness, damping and mass.*
Keywords: Seismic Co-Efficient Analysis, Response Spectrum Analysis, Story Drift, Story Displacement, Story Stiffness

I. INTRODUCTION

All over world, there is high demand for construction of buildings due to increasing urbanization and spiralling population, and earthquakes have the potential for causing the greatest damages to those tall structures. Reinforced concrete multi-storied buildings are very complex to model as structural systems for analysis. Usually, they are modelled as two-dimensional or three- dimensional frame systems using finite beam elements. Since earthquake forces are random in nature and unpredictable, the engineering tools need to be sharpened for analysing structures under the action of these forces. Earthquake loads are required to be carefully modelled so as to assess the real behaviour of structure with a clear understanding that damage is expected but it should be regulated. Analysing the structure for past earthquakes of different intensities and checking for multiple criteria at each level has become essential and pivotal these days.

The main parameters of the seismic analysis of structures are load carrying capacity, ductility, stiffness, damping and mass. The design can be divided into two main steps. First, a linear analysis is conducted with appropriate dimensioning of all structural elements, ensuring the functionality of the structure after minor earthquakes, and then the behaviour of structures during strong earthquakes has to be controlled using nonlinear methods. Dynamic analysis should be performed for symmetrical as well as unsymmetrical building.

The structural engineers perform for both regular as well as irregular buildings. The current version of the IS: 1893 - 2002 requires that practically all multi-storeyed buildings be analysed as three-dimensional systems. This is due to the fact that the buildings have generally irregularities in plan or elevation or in both. Further, seismic intensities have been upgraded in weaker zones as compared to the last version IS: 1893-1984. It has now indirectly become mandatory to analyse all multi-storeyed buildings in the country for seismic forces.

A. *Objectives of the Study*

1) To study & analyse the G+7 Building structure with two different Models, Model 1 - G+7 Building with Columns & Model 2 - G+7 Building with Shear Walls
2) Analyse the Structure in E-tabs software to carry out the story Displacement, Story Drift, Time Period and Story Stiffness of G+7 Building using Seismic Analysis Method in Earthquake Zone 5.
3) Comparison of two Models with using Seismic Coefficient Method & Response Spectrum Analysis Methods in E-tabs for Zone 5.

B. Seismic Methods of Analysis

For the determination of seismic responses there is necessary to carry out seismic analysis of structure. The analysis can be performed on the basis of external action, the behaviour of structure or structural materials, and the type of structural model selected. Based on the type of external action and behaviour of structure, the analysis can be further classified as following:

1) Linear Static Analysis,
2) Nonlinear Static Analysis,
3) Linear Dynamic Analysis; and
4) Nonlinear Dynamic Analysis.

Linear static analysis or equivalent static method can be used for regular structure with limited height. Linear dynamic analysis can be performed by response spectrum method. The significant difference between linear static and linear dynamic analysis is the level of the forces and their distribution along the height of structure. Nonlinear static analysis is an improvement over linear static or dynamic analysis in the sense that it allows inelastic behaviour of structure. A nonlinear dynamic analysis is the only method to describe the actual behaviour of a structure during an earthquake. The method is based on the direct numerical integration of the differential equations of motion by considering the elasto-plastic deformation of the structural element.

a) *Seismic Co-Efficient Analysis:* This approach defines a series of forces acting on a building to represent the effect of earthquake ground motion, typically defined by a seismic design response spectrum. It assumes that the building responds in its fundamental mode. For this to be true, the building must be low-rise and must not twist significantly when the ground moves. The response is read from a design response spectrum, given the natural frequency of the building (either calculated or defined by the building code). The applicability of this method is extended in many building codes by applying factors to account for higher buildings with some higher modes, and for low levels of twisting. To account for effects due to "yielding" of the structure, many codes apply modification factors that reduce the design forces (e.g. force reduction factors).
b) *Response Spectrum Function and Analysis:* The main purpose of a dynamic response analysis of a structure is to accurately estimate displacements and member forces in the real structure. A response spectrum function is simply a list of period versus spectral acceleration values. Modal responses are calculated using the ordinates of the appropriate response spectrum curve which correspond to the modal periods. Maximum modal contributions are combined in a statistical manner to obtain an approximate total structural response. There are computational advantages in using the response spectrum method of seismic analysis for prediction of displacements and member forces in structural systems. The method involves the calculation of only the maximum values of the displacement and member forces in each mode using smooth design spectra that are the average of several earthquake motions.

II. LITERATURE REVIEW

A. M. Jeevanathan, J.P. Annie Sweetlin

They provide the present day scenario witnesses a series of natural calamities like earthquakes, tsunamis, floods etc. Of these the most damaging and recurrent phenomena is the earthquake. The Effective design and the construction of Earthquake resistant structure have gained greater importance all over the world. In this paper the earthquake resistance of a G+20 multi- storey building is analysed using Equivalent static method with the help of E-TABS 9.7.4 software. The method includes seismic coefficient method as recommended by IS 1893:2002. The parameters studied were displacement, story drift and story shears. There is increase in displacement value from bottom floor to top floor. In this type of model wind displacement is within the limits and earthquake displacement are beyond the permissible limits of the building (h/500 = 135mm). Drift is within the limits for the building (0.004 times of the height of the storey) 0.004x3.2 = 12.8mm. Earthquake Base shear is greater than Wind Base shear. Complete guideline for the use of E-TABS 9.7.4 for seismic coefficient analysis is made available by this paper.

B. Mayuri D. Bhagwat et al., (2014)

Dynamic analysis of multi-storeyed practiced RCC building considering for Koyna and Bhuj earthquake is carried out by time history analysis and response spectrum analysis and seismic responses of such building are comparatively studied and modelled. Two time histories (i.e. Koyna and Bhuj) have been used to develop different acceptable criteria (base shear, storey displacement, storey drifts). Reinforced concrete buildings have been damaged on a very large scale in Bhuj earthquake of Jan 26th 2001, Even though these buildings are analysed and designed as per IS code.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

The damages are caused by inconsistence seismic response, irregularity in mass and plan, soft storey and floating columns etc. Hence it becomes necessary to evaluate actual seismic performance of building subjected to earthquake forces. Time History analysis gives more realistic seismic behaviour of the building. It gives more accurately seismic responses than response spectrum analysis because of it incorporates material nonlinearity and dynamic nature of earthquake.

III. METHODOLOGY & STRUCTURE MODELLING

The seismic analysis should be carried out for the buildings that have lack of resistance to earthquake forces. Seismic analysis will consider dynamic effects hence the exact analysis sometimes become complex. However, for simple regular structures equivalent linear static analysis is sufficient one. This type of analysis will be carried out for regular and low rise buildings and this method will give good results for this type of buildings. Dynamic analysis will be carried out for the building as specified by code IS 1893-2002 (part1). Dynamic analysis will be carried out either by Response spectrum method or site specific Time history method.

A. Methodology

In the present Study, Analysis of G+7 multi-story building in zone 5 for earth quake force is carried out. Two models were prepared for G+7 multi-story building in ETABS.

1) Model 1: - G+7 Building with Columns
2) Model 2: - G+7 Building with Shear Walls

Comparison of above two Model for different two methods are performed in this study. Two Methods are used for the Analysis work in E-tabs Software for Seismic Zone 5 are followings:

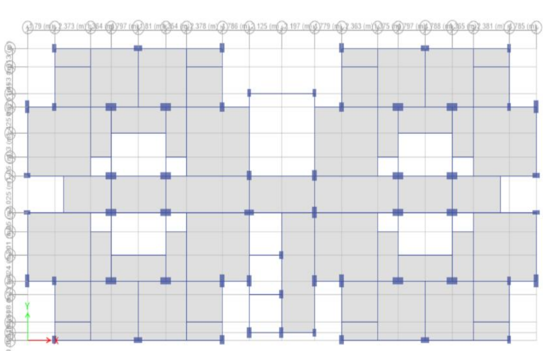
a) Seismic Co-Efficient Method &
b) Response Spectrum Analysis

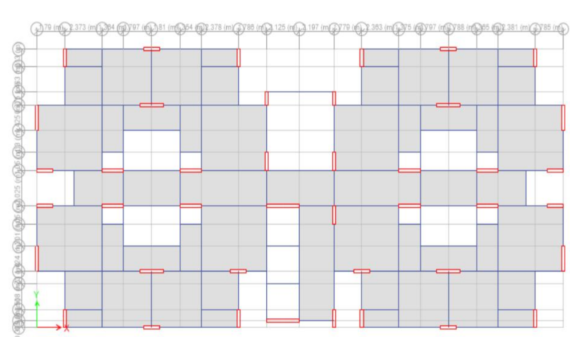
B. Statement of the Project

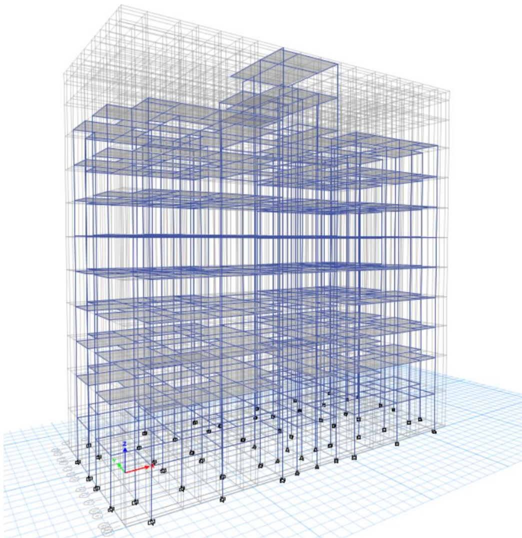
The design data shall be as follows:

1	Utility of buildings	:	Residential Building
2	No. of Storey	:	G + 7
3	Shape of the building	:	Rectangular (Symmetrical)
4	No. of Staircases	:	One
5	No. of Lifts	:	Three
6	Types of Walls	:	AAC Block Wall & RCC Wall
7	Geometric details		
	Ground Floor	:	3.60 m
	Floor-To-Floor Height	:	2.95 m
8	Material Details		
	Concrete Grade	:	M20, M25
	All steel grades	:	HYSD reinforcement of Fe 415, Fe 500
9	Type of construction	:	R.C.C Framed structure

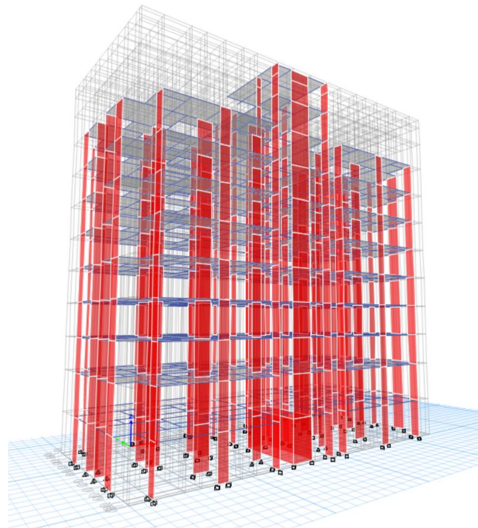
C. Structural Modelling by E-tabs







Model 1: - G + 7 Building Plan & Elevation (Columns)



Model 2: - G + 7 Building Plan & Elevation (Shear Walls)

D. Loads Applied on G+7 Building

Loading on tall buildings is different from low-rise buildings in many ways such as large accumulation of gravity loads on the floors from top to bottom, increased significance of wind loading and greater importance of dynamic effects. Thus, multi-storied structures need correct assessment of loads for safe and economical design. Except dead loads, the assessment of loads cannot be done accurately. Live loads can be anticipated approximately from a combination of experience and the previous field observations. Wind and earthquake loads are random in nature and it is difficult to predict them. They are estimated based on a probabilistic approach. The following discussion describes some of the most common kinds of loads on multi-storied structures.

1) Dead loads
2) Live loads
3) Gravity loads
4) Wind loads
5) Earthquake loads

- *Gravity (wall) Load Calculation (Masonry Work + Plaster Work)*

1	225 mm thick wall - GL (3.15 x 0.225 x 7.5 = 5.32 KN/M) + (3.60 x 0.04 x 24 = 3.45 KN/M)	=	8.77 KN/M
2	225 mm thick wall - Typical Floor (2.50 x 0.225 x 7.5 = 4.22 KN/M) + (2.95 x 0.04 x 24 = 2.83 KN/M)	=	7.05 KN/M
3	100 mm thick wall – GL (3.15 x 0.100 x 7.5 = 2.36 KN/M) + (3.60 x 0.04 x 24 = 3.45 KN/M)	=	5.81 KN/M
4	100 mm thick wall - Typical Floor (2.50 x 0.100 x 7.5 = 1.87 KN/M) + (2.95 x 0.04 x 24 = 2.83 KN/M)	=	4.7 KN/M
5	225 mm thick Parapet Wall (1.5 x 0.225 x 7.5 = 2.53 KN/M) + (1.5 x 0.04 x 24 = 1.44 KN/M)	=	3.97 KN/M
6	75 mm thick RCC Wall (1.15 x 0.075 x 25 = 2.15 KN/M) + (1.15 x 0.04 x 24 = 1.10 KN/M)	=	3.26 KN/M

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com

- *Slab Load Calculation*
  1. Live Load
     L.L. for all the rooms taken as 2 KN/M^2 on Typical stories.
     L.L. for the passage taken as 3 KN/M^2 on Typical stories.
     L.L. for the terrace taken as 1.5 KN/M^2.

  2. Floor Finish
     FF for all the rooms taken as 1 KN/M^2 on Typical stories.
     FF for the terrace taken as 3 KN/M^2.

  3. Super Dead Load
     SDL for all the Sunk Slabs taken as 2 KN/M^2 on Typical stories.
     SDL for the Stair Cabin Slab taken as 14 KN/M^2.

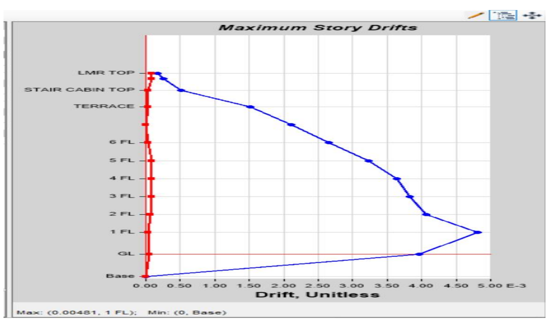
  4. Wind Load
     Wind Load calculation is done as per IS: 875 (PART 3) – 1987.

  5. Earthquake Load
     Earthquake Load calculation is done as per IS: 1893 (PART 1) – 2002.

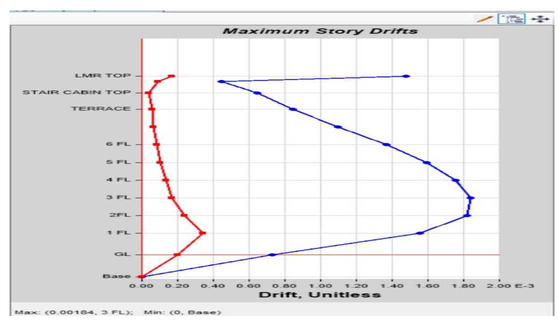
IV. ANALYSIS & RESULTS

A. *Seismic Co-Efficient Analysis*

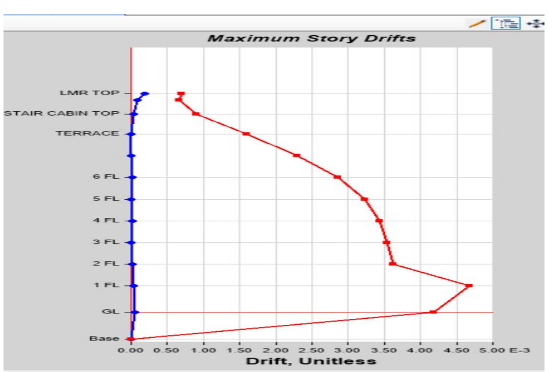
1) *Story Drift*



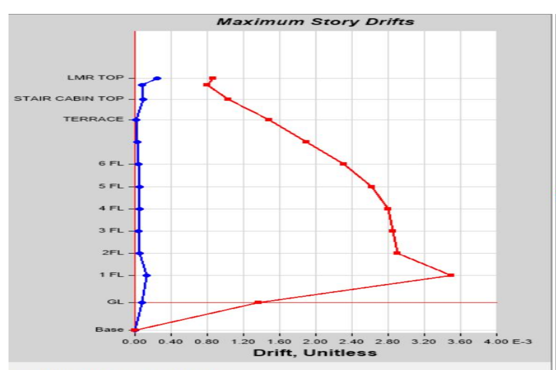
Story Drift by Load Case EQX in Model 1



Story Drift by Load Case EQX in Model 2

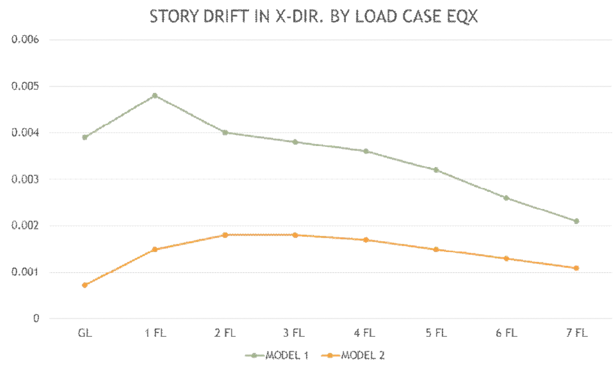


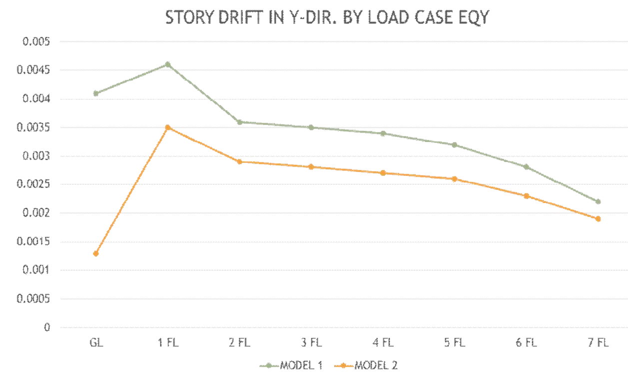
Story Drift by Load Case EQY in Model 1



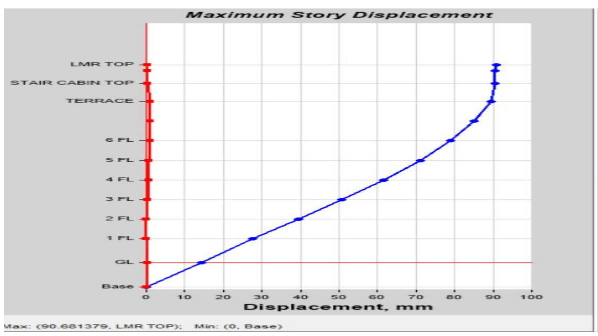
Story Drift by Load Case EQY in Model 2

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com



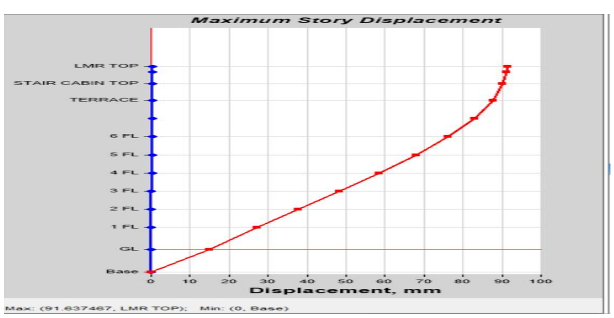


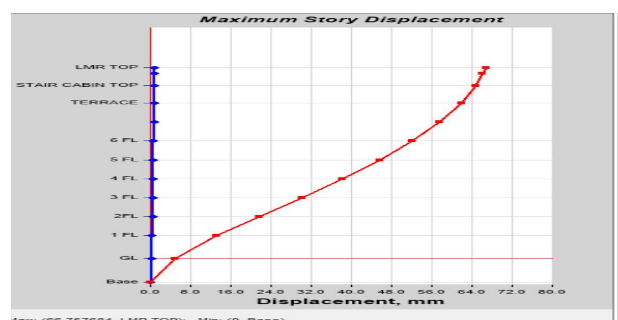
2) Story Displacement



Story Displacement by Load Case EQX in Model 1

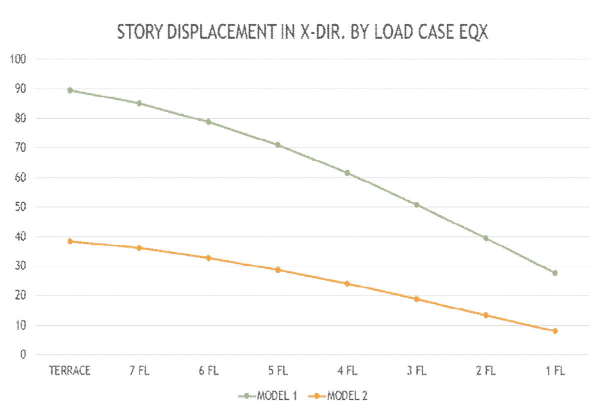
Story Displacement by Load Case EQX in Model 2

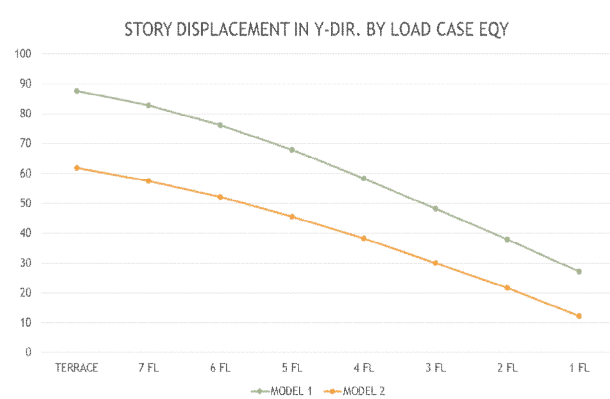




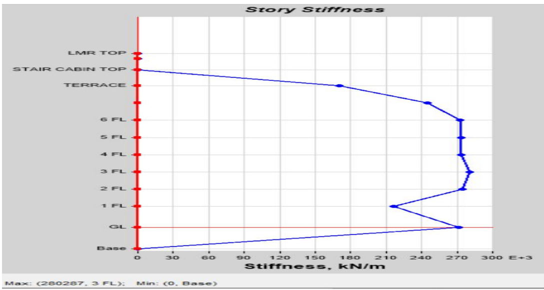
Story Displacement by Load Case EQY in Model 1

Story Displacement by Load Case EQY in Model 2

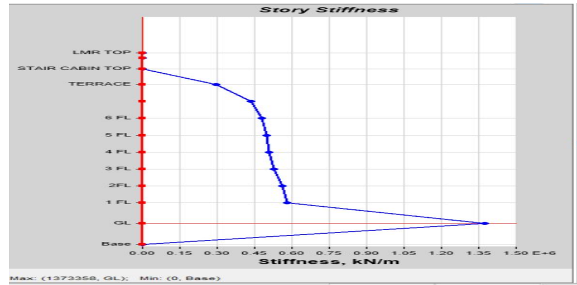




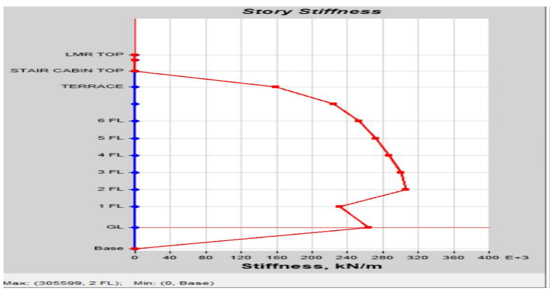
3) *Story Stiffness*



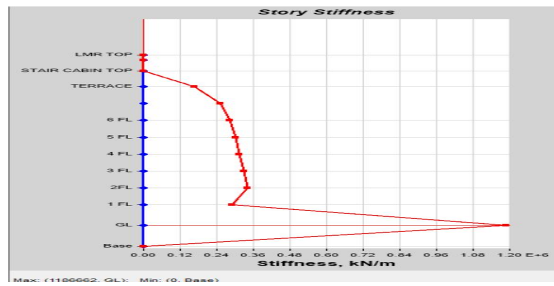
Story Stiffness by Load Case EQX in Model 1



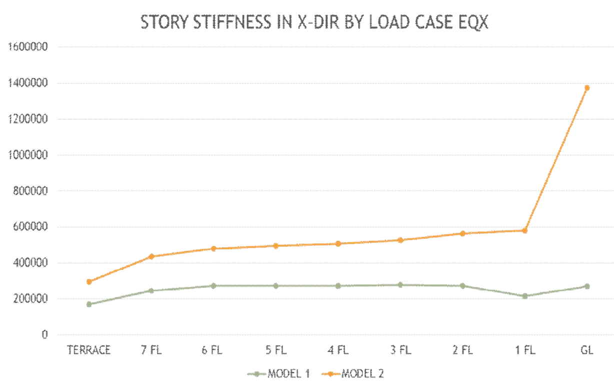
Story Stiffness by Load Case EQX in Model 2

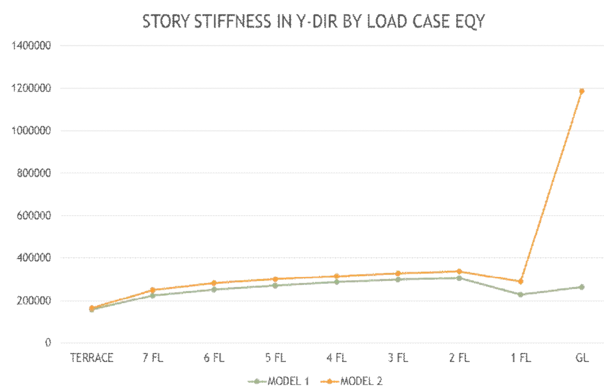


Story Stiffness by Load Case EQY in Model 1



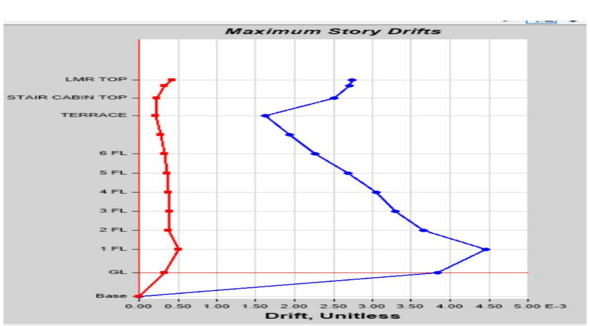
Story Stiffness by Load Case EQY in Model 2





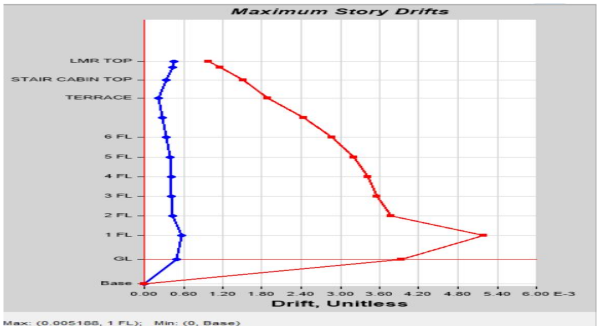
B. *Response Spectrum Analysis*

1) *Story Drift*

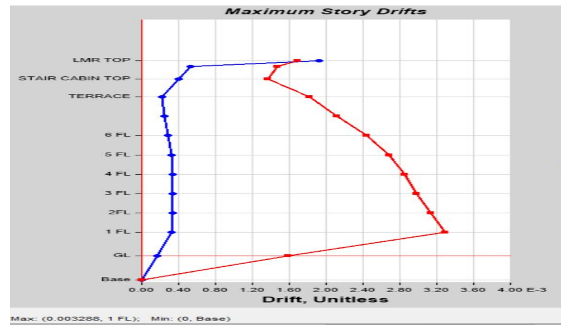


Story Drift by Load Case SPEC X in Model 1

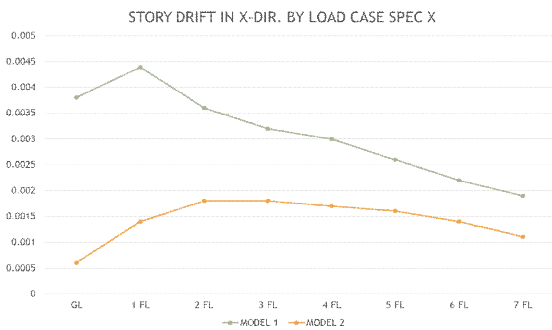
Story Drift by Load Case SPEC X in Model 2

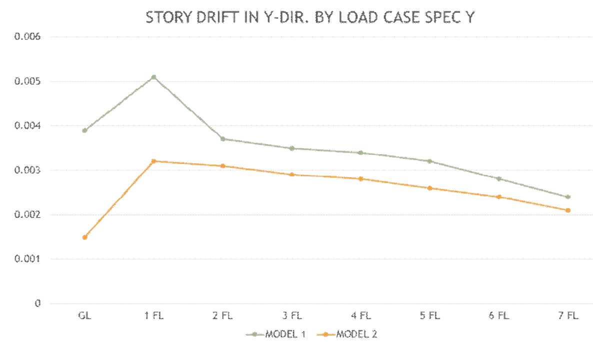


Story Drift by Load Case SPEC Y in Model 1

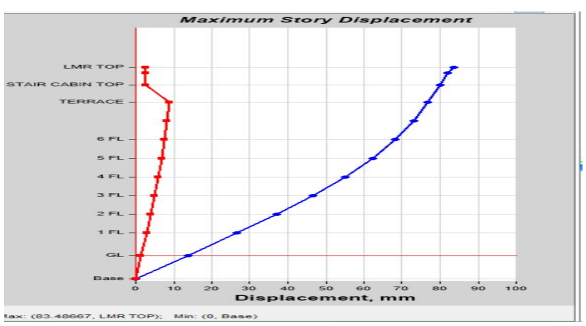


Story Drift by Load Case SPEC Y in Model 2

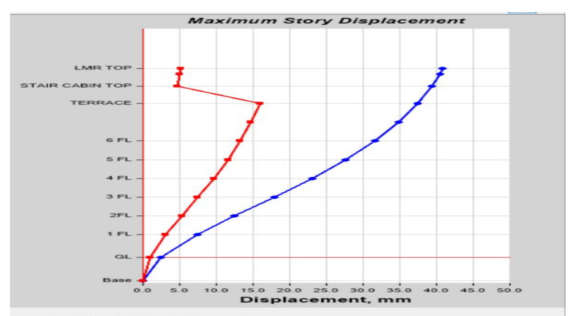




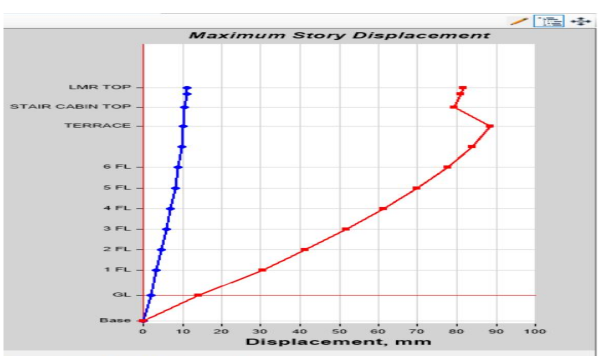
2) Story Displacement



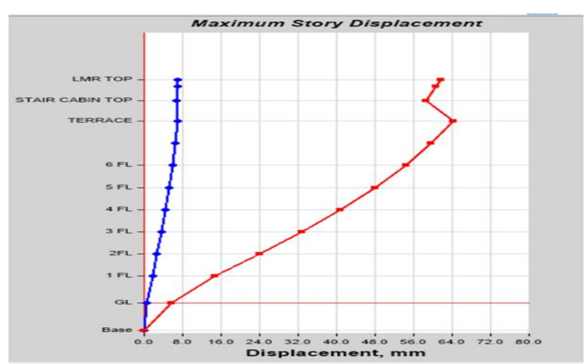
Story Displacement by Load Case SPEC X in Model 1



Story Displacement by Load Case SPEC X in Model 2

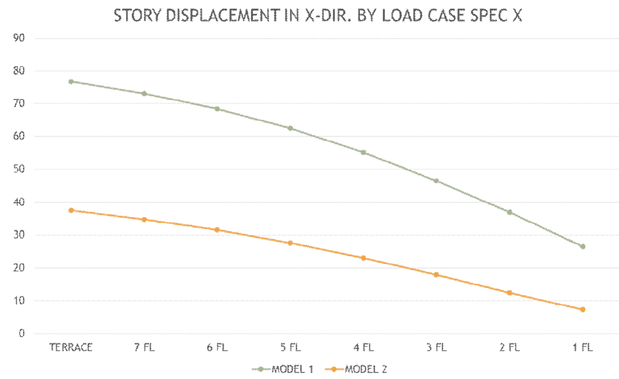


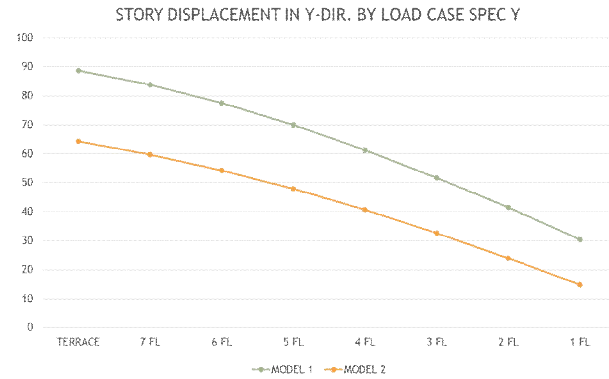
Story Displacement by Load Case SPEC Y in Model 1



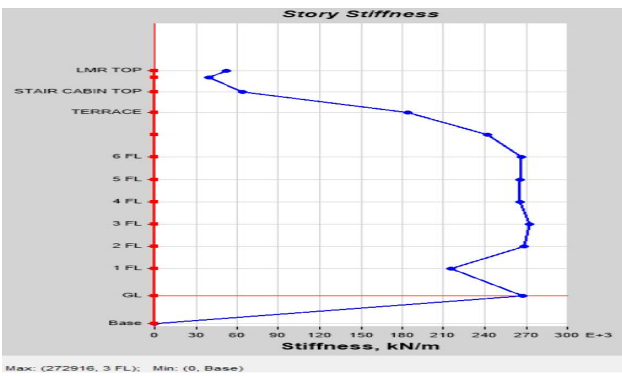
Story Displacement by Load Case SPEC Y in Model 2

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue VII July 2022- Available at www.ijraset.com



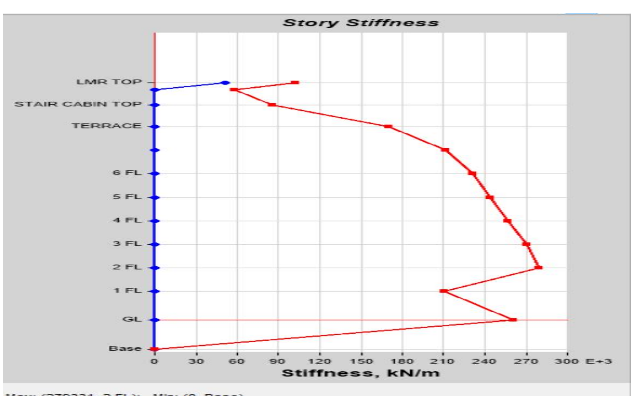


3) Story Stiffness

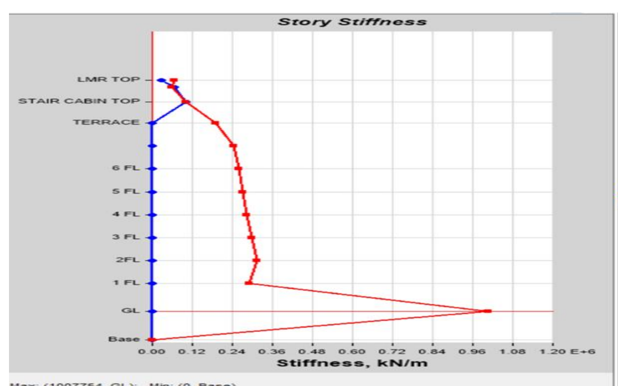


Story Stiffness by Load Case SPEC X in Model 1

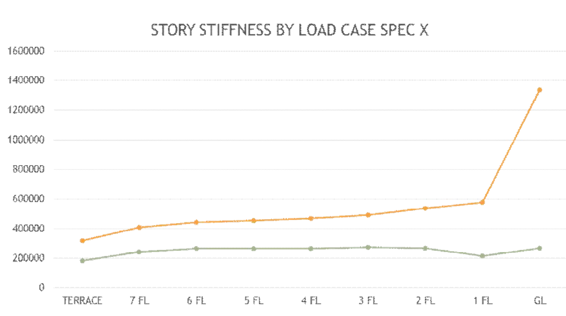
Story Stiffness by Load Case SPEC X in Model 2

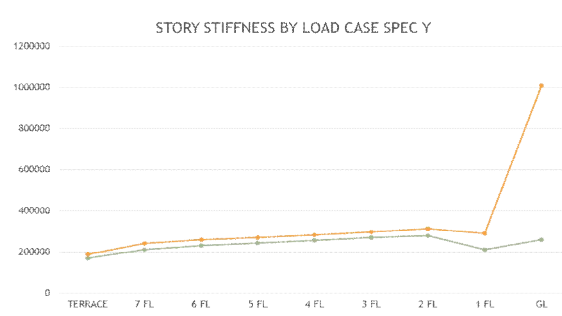


Story Stiffness by Load Case SPEC Y in Model 1



Story Stiffness by Load Case SPEC Y in Model 2





V. CONCLUSION

The behaviour of G+7 structure with columns and G+7 structure with Shear Walls studied in this Research Work. Analysis were done by Seismic Co-Efficient Method and Response Spectrum Analysis. The Analysis Were Obtain in the form of Numerical tables. The Figure clearly shows the story drift, Max. Story Displacement, Base Reaction, Time Period and Story Stiffness.

(Model 1 – G+7 Building with Columns & Model 2 – G+7 Building with Shear Walls)

1) In Seismic Co-Efficient Analysis, Story Drift is Observed less in Model 2 as compared to Model 1 in both X and Y direction. Acceleration for (Time Period) is observed same for both Models 1 & 2. Max. Story Displacement is also more in Model 1 as compared to Model 2 in load cases EQX & EQY. Story Drift is observed higher in Model 2 as compared to Model 1 in both load cases EQX & EQY.
2) In Dynamic Analysis, Story Drift in higher in Model 1 as compared to Model 2 in load cases EQX, EQY, SPEC X & SPEC Y. Story Displacement is also observed more in Model 1then model 2. Same as Seismic Co-Efficient Analysis, Story Stiffness value is higher in Model 2 As compared to Model 1.
3) Building Structure with more Nos. of Columns have greater Flexibility Then Buildings Structure with more Nos. of Shear Walls. From another Point of View, Building Structure with more Nos. of Shear Walls has Higher Stability Then Building Structure With more Nos. of Columns. Structure with both, Columns and Shear Walls are better Combination in terms of Economically, Stability and Flexibility.

REFERENCES

[1] IS 1893 (part 1): (2002), “Criteria for Earthquake Resistant Design of Structures Part 1 General Provisions and Buildings”, Bureau of Indian Standards.
[2] CSI Computers and Structures INC. “Introductory Tutorial for Etabs: Linear and Nonlinear Static and Dynamic Analysis and Design of Three-Dimensional Structures” 2011.
[3] B.C. Punmia, A.K. Jain, 2006, R.C.C Designs, Laxmi Publications New Delhi.
[4] IS-456 2000 plain and reinforced concrete code of practice.
[5] P. Agarwal, M. Shrinkhande, earthquake resistance design of structures, PHI learning Pvt.
[6] Theory of structures by Ramamrutham for literature review on kani’s method.
[7] Reinforced and slab concrete structures by A.K. Jain and B.C. Punmia for design of beams, columns.
[8] Etabs Version 17.0.1, Computers and Structures, Inc., Berkeley, California, International Code Council, Inc. (2000) International Building Code.
[9] B.K. Sanghani and P.G. Patel, “Behavior of Building Component in Various Zones”, International Journal of Advances in Engineering Sciences, Vol. 1, Issue 1 (Jan. 2011)
[10] Sinha.S.N. handbook of Reinforced concrete design, 1996, Tata McGraw-Hill Publishing Company limited, New Delhi 110008.