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ANALYSIS AND DESIGN OF MULTI STOREY BUILDING SUBJECTED TO SEISMIC LOAD USING E-TABS

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Abstract The present work deals with the analysis, design and estimation of multi storey building subjected to seismic condition. In addition to the dead load and live load, the seismic loads are applied and the design for beams, columns and footings is carried out. The E-Tabs software has been adopted as with its new features surpassed its predecessors with its data sharing for analysis and design.

In the present scenario, a structure of **G+2** situated in **Gangavati (Koppal District)** is considered for Analysis which consists of a Ground floor, First floor and Second floor. The Analysis is carried out for **seismic zone2**. The building model are analyzed and compared for the seismic zone as per **IS 1893-2002** for static load analysis and response spectrum analysis.

The main aim of the project is to complete the analysis, design and estimation of a multi-storey building while ensuring to satisfy the economic and safety aspects under the seismic conditions while fulfilling the purpose for which the structure has been built.

Manual analysis is carried out by using kani's method to verify the results obtained through E tabs software. The results of Analysis are used to verify the fitness of structure for intended use. E tabs software are also being used for the calculation of forces, bending moment, stress, strain and deformation or deflection for a complex structural system.

The comparison of results is carried out for **Storey Displacement, Storey Shear, and Base Shear**. The results are obtained and represented in the forms of graphs and tables for the seismic zone.

Key Words: SEISMIC ANALYSIS, STOREY DISPLACEMENT, STOREY SHEAR, STOREY DRIFT.

1. INTRODUCTION

The starting point of the structures is most likely started with basic types of development being utilized for protection against sun, wind and rain.

As the well-known saying goes "NECESSITY IS THE MOTHER OF INVENTION", the need safe house developed among all to assemble necessary and available materials for the construction and various methods also took birth.

In spite of the fact that the development is spreading in horizontal way, because of the quick increment in population, there is an urge for development to increment vertical way likewise bringing about, high rise structures like sky scrapers and other multi storied structures.

Basically Buildings nowadays are of two types of building systems,

a) Load bearing masonry buildings
b) Framed buildings

Load bearing masonry buildings: - The design of load bearing masonry wall are carried out as per **IS 1905-1980** (Indian standards code of practice for structural safety of buildings: Masonry wall (second revision). . This kind of framework is appropriate for structures with limit of four stories, and little structure houses whose ranges of pillars are less and the chunks are cast of RCC and the dividers are of burden bearing block stone work.

Framed buildings: - The types of buildings in which the reinforced concrete frames are provided for beams and columns to carry as well as to transfer the loads to be coming over it are the framed buildings. The brick work for the walls is considered to be non load bearing wall. The brick work used in this type of building structures is for filler type only. In the framed buildings the slabs are of thickness depending upon the loads coming over it and are generally maintained 150 to 200 mm. The provision

of slender walls in this type of structure is made possible. For multi storied buildings where the number of stories is high or the loads expected on the structure is more this framed type of system is adopted and suitable.

1.1 Seismic Zones:

The geological survey of India (G.S.I.) first published the seismic zoning map of India in the year 1935. After a number of modifications and alterations, this map was initially based on the amount of damage suffered by different regions of India because of earthquakes.

The color is coded in different shades of red, this map shows the four distinct seismic zones of the nation, which are prominently shown in the map:

I. Zone 2: least active seismic zone
II. Zone 3: moderate seismic zone
III. Zone 4: high seismic zone
IV. Zone 5: highest seismic zone

Fig-1 : Seismic zone representation on Indian Map

The map with seismic zoning data helps in studying the amount of damage to be expected for design consideration before designing any structure in that respective zone. By this way any designer or engineer can assure the safety of that structure in that respective zone.

1.2 Seismic Loads:

Buildings with ground plus Two floor and above or building with a height of 15m and above should be designed and constructed by adopting the norms prescribed in the national building code and in the "criteria for earthquake resistant design of structures" bearing IS 1893-2002 published by the bureau of Indian standards making the buildings resistant to earthquake.

2. MODEL DESCRIPTION

- G+2 MULTISOREY BUILDING
- SEISMIC ZONE 2
- Plot area = 2699.66 Sqm.
- Ground floor area = 890.70 Sqm
- First floor area = 884.04 Sqm
- Second floor area = 884.04 Sqm
- Total built up area = 2658.78 Sqm

3. PROBLEM IDENTIFICATION

I. From the past records of earthquake, there is an urge in the demand of earthquake resisting building which can be fulfilled by analysis and design of buildings subjected to earthquake.

II. Nowadays the construction of tall building is widely seen almost everywhere, thus the effects of lateral loads like wind and seismic loads are increasing and every designer is facing a problem to achieve adequate safety, strength and stiffness.

4. OBJECTIVES

1) To compare the storey drift, storey shear and storey displacement for multi storey building using E tabs.
2) To study the behavior of multi storey building in various seismic zone 2.
3) Analysis of multi-storey building subjected to all possible loading conditions including seismic load and to see that structure is safe against those loading conditions.
4) To analysis different frames by using kani's method.
5) Analyze Design and Estimation of the building.

5. MATERIALS, METHODOLOGY AND MODELS

The design of the structural elements of the building should conform and satisfy the following Indian code for reinforced concrete design, published by the bureau of Indian standards, New Delhi.

All the countries have formulated and fixed various national building codes which represent certain guidelines for the design and construction of any structures in those respective countries. These codes are established and evolved by expert structural engineers who study, analyze and decide over the years of experience, and these codes are revised periodically to suit the current trends. IS 456:2000 – plain and reinforced concrete is the code of practice.

5.1 Methods of Analysis:

Analysis is carried out in Manual method by Kani's method and also by using software i.e. ETABS and are compared and seen that there is an error of 5 to 10%.

The following are the analysis methods used from E Tabs software.

- Linear Static
- Linear Dynamic
- Non-linear Static

5.1.1 Linear Static:

The linear static analysis method is adopted for the building analysis in a seismic zone and is based on the assumption that the building is responding in its fundamental mode. The analysis method represents the behavior of the building during the

earthquake ground motion; typically it's defined by a seismic design response spectrum analysis where a series of forces are acting on the building.

In the state where the behavior of the building is in its fundamental mode, the building should not twist and it should be a low rise structure.

Many building codes have extended the applicability of this method to make sure it holds good for the high rise structures with low levels of twisting.

To analyze the effects of a structure due to "yielding", the modification factors also known as reduction factors are used as an aid for many building codes that reduce the design forces.

5.1.2 Linear Dynamic:

In IS:1893,2002 (Part 1) two methods, one Seismic factor and other Response Spectrum method is described to carry out the analysis for Earthquake forces. One Table (in Clause 4.2.1) is also provided to decide upon the method to be used, depending upon structure elevation and seismic zone. At the lowermost of this table, it is evidently mentioned that structures with irregular shape and/or irregular dissemination of mass and stiffness in x and/or y plane, shall be analyzed as per Response Spectrum approach. For all practical reasons, no structure is uniform in all the respects (i.e. mass/stiffness, shape distribution in x and y plane). This means that for no structures, the Seismic Co-efficient method shall be helpful. Response Spectrum approaches, being time elapsing and tiresome process, mostly, computer applications are possible.

5.1.3 Non-linear Static:

In a nonlinear static analysis technique the building model integrates directly the nonlinear force deformation features of individual components and elements due to inelastic physical response. Several methods (ATC40, FEMA273) existing and all have in common that the nonlinear force–deformation features of the building is characterized by a Pushover curve, PO curve of base shear vs. top translation, obtained by subjecting the building model to monotonically augmenting lateral forces or augmenting translations, distributed over the peak of the building in correspondence to the first mode of vibration until the building disintegrates. The maximum translation likely to be experienced during a given earthquake is determined using either highly damped or in elastic response spectra.

6. DIFFERENT TYPES OF LOADS AND THEIR COMBINATIONS

Loads and properties of materials constitute the basic parameters affecting the design of a R.C. Structure. The various types of loads acting on the structure which need consideration in building design are as follows:

The loads that are considered for the structural design are as below,

I. Dead load (IS 875:1987 PART-1)
II. Imposed/Live load (IS 875:1987 PART-2)
III. Wind load (IS 875:1987 PART-3)
IV. Seismic load (IS 1893(PART-1): 2002)
V. Combination of loads (IS 875:1987 PART-5)

Hence the design is done for this load combination number 5 i.e. **1.5(DL+LL).**

7. STRUCTURAL ANALYSES

The architectural plans and elevation of the commercial complex are enclosed in annexure. Suitable sizes for beams and columns are assumed initially and the three dimensional structural frame corresponding to the commercial complex is taken. The bottom ends of the columns are assumed to be fixed for the purpose of analysis .tie beams are provided for the basement level to make the columns short and also to take the wall loads if any. The loads considered in the analysis are 1) dead loads 2)

live loads and 3) earthquake loads. All these loads have been calculated as per IS 875. The live load assumed for floors and roof slabs are 3KN/m^2. The dead loads due to self weight, floor finishes and partitions are also calculated.

7.1 E Tabs Results Figures

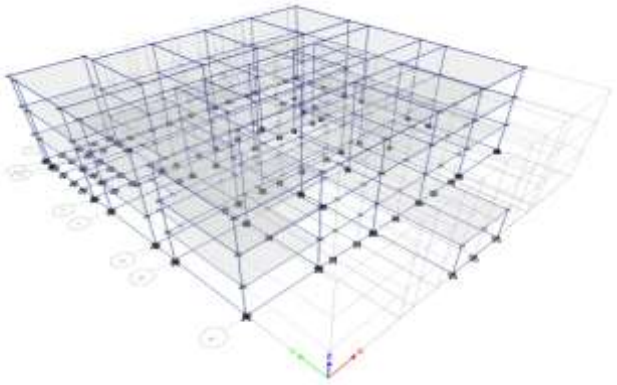


Fig-2 : 3D View Of Building

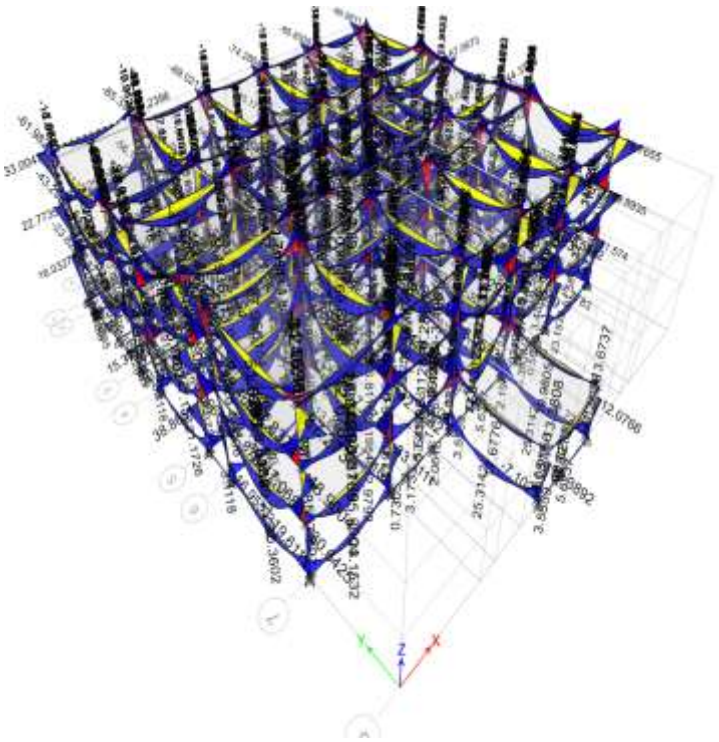
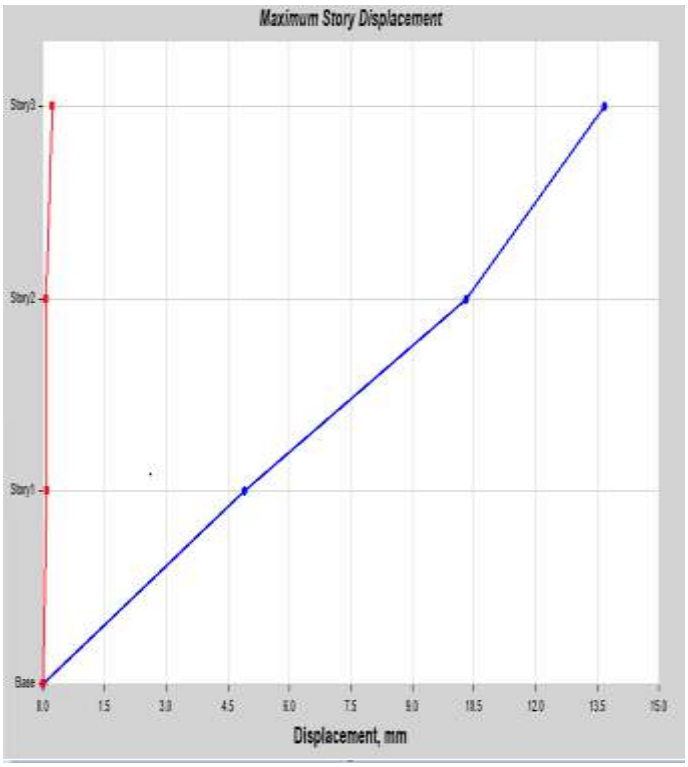


Fig-3 : 3D View of BENDING MOMENT DIAGRAM

Fig-4 : Maximum and Minimum Bending Moment And Shear By E-TABS

Chart-1: Maximum Storey Displacement in EQ-X



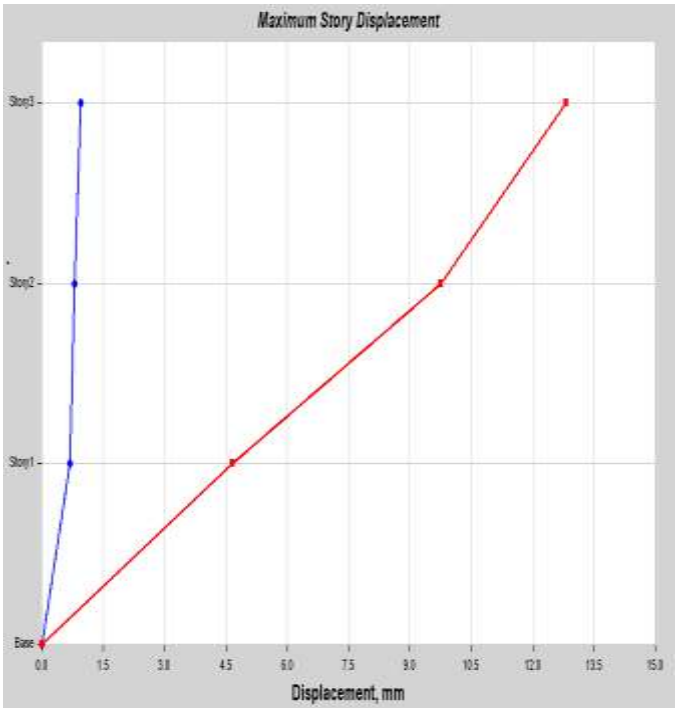


Chart-2 : Maximum Storey Displacement in EQ-Y

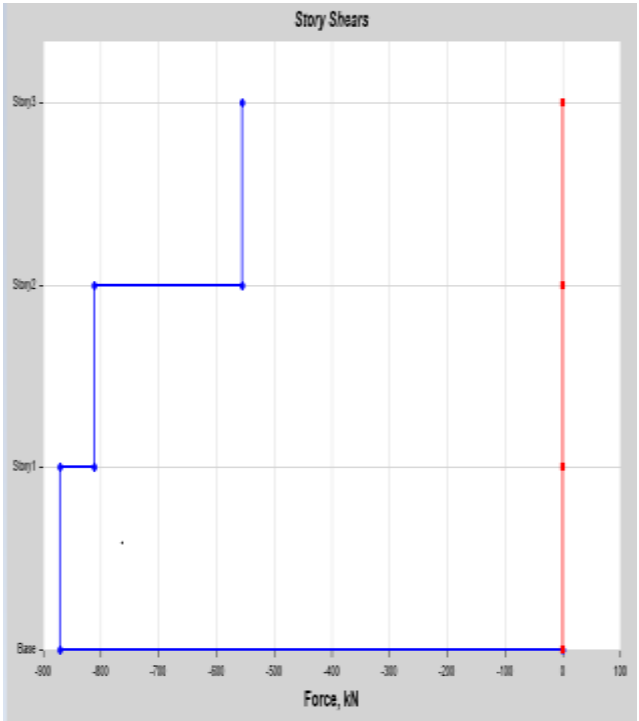


Chart-3 : Storey shear in EQ-X

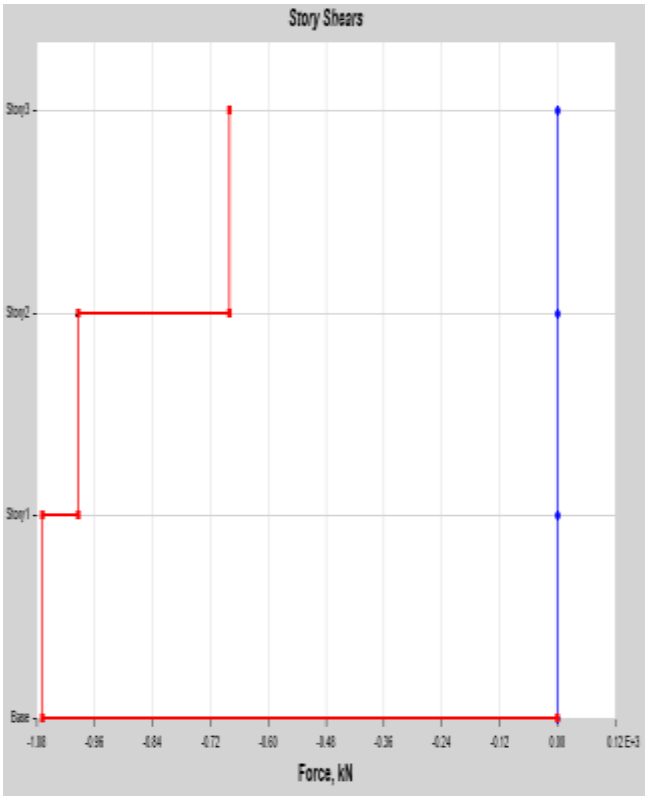


Chart-4: Storey shear in EQ-Y

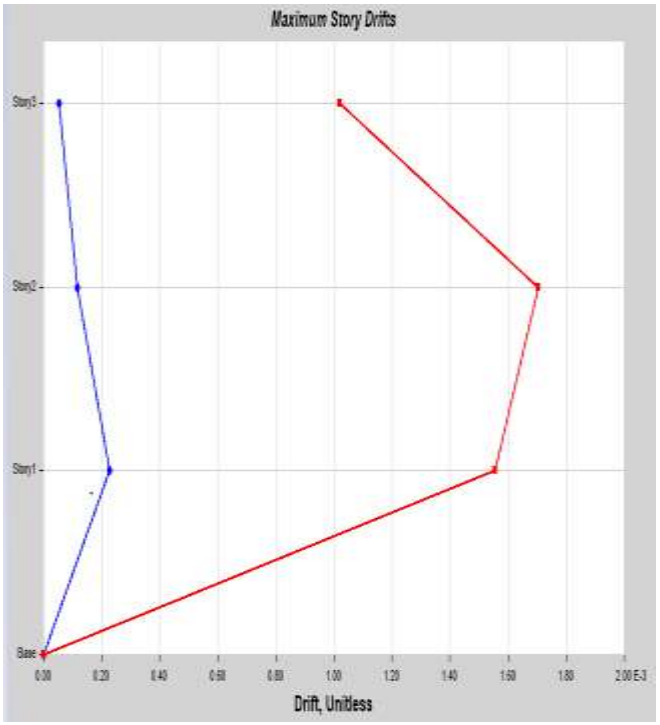


Chart-5: Storey Drift in EQ-Y

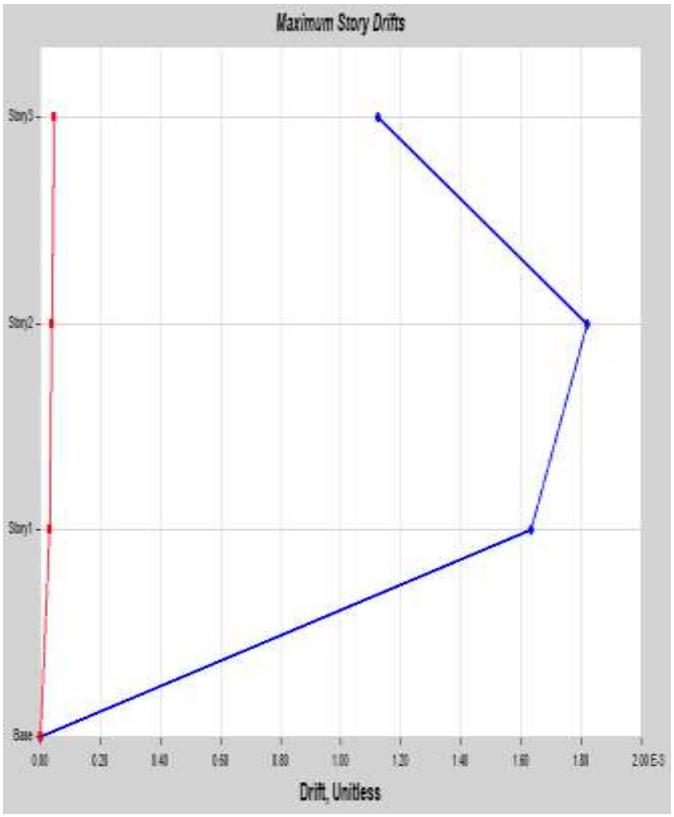


Chart-6: Storey Drift in EQ-X

8. RESULT AND DISCUSSION

8.1 Maximum Storey Displacement:

The maximum storey displacement is increasing with the increase in height of the building. "The Y-Axis of the graph represents the storey height and the X-Axis represents the displacement in mm". The maximum displacement in the models is represented as follows i.e.

Table: 01 Storey Displacement (mm)

SL NO.	STOREY	STOREY DISPLACEMENT(mm)	
		MODEL IN EQ-Y	MODEL IN EQ-X
1	BASE	0	0
2	STOREY 1	4.6	4.6
3	STOREY 2	9.5	10.2
4	STOREY 3	12.5	13.7

8.2 Maximum Storey Drift:

The maximum storey drift represents a spring action where the drift value increases and then decreases. "The Y-Axis of the graph represents the storey height and the X-Axis represents the amount of drift of storey from its initial position"; Storey drift value is Unit less.

Table: 02 Storey Drift

SL NO.	STOREY	STOREY DRIFT	
		MODEL IN EQ-Y	MODEL IN EQ-X
1	BASE	0	0
2	STOREY 1	1.58	1.62
3	STOREY 2	1.70	1.82
4	STOREY 3	1.10	1.17

8.3 Storey Shear:

The Storey Shear is the plane at which the storey is expected to cut or shear or break, "The Y-Axis of the graph represents the storey height and the X-Axis represents the amount of force in KN". Storey shear is expressed as FORCE and its unit is KN.

Table: 03 Storey Shear

SL NO.	STOREY	STOREY SHEAR (kN)	
		MODEL IN EQ-Y	MODEL IN EQ-X
1	BASE	-1.08	-880
2	STOREY 1	-0.99	-820
3	STOREY 2	-0.68	-550
4	STOREY 3	-0.68	-550

8.4 Discussion

1. It is observed that the STOREY DISPLACEMENT in the MODEL increases with the increase in height of the building. The maximum and minimum displacements are found to be in EQ-X direction.
2. It is observed that the STOREY DRIFT in the MODEL is HIGH at STOREY2 and reduces as the height of the building increases.
3. It is observed that the STOREY SHEAR in the model in EQ-X and EQ-Y are obtained in negative values.

9. SCOPE FOR FUTURE WORK

The study of buildings in seismic zone condition can be extended for future study in a wide variety of conditions amongst which few are as follows:

I. The quantity of reinforcement required for the structure with seismic load can be checked to know the quantity of steel and cost of structure.
II. Light weight building materials can be incorporated in the structural elements where ever it is required to reduce the total weight of the structure and hence can reduce the cost of project.
III. As we know in very quickly change in global world there is an unfavourable construction in then affects society cannot be neglected in recent days. we have seen the major natural disaster such as earthquakes.
IV. The above project can further Planned using the project management tools like Microsoft project and can be managed and monitored during execution to achieve fast and efficient execution.

V. When the buildings are located in highly terrain areas.
VI. Types of loads and loading combinations.
VII. Depending upon the height of the building and number of floors. .
VIII. Depending upon seismic zones where the building is expected to stand.
IX. Types of materials used as alternative for construction (Steel or Composite Sections).
X. Comparison with various manuals methods for analysis.
XI. Comparison with various software's for analysis such as CYPE, STAADPRO, and SAP etc.

10. CONCLUSION

In the present scenario of analyzing of the multistory building, the parameters are considered based upon the gravity condition for the live load, dead load and dynamic loads, and the seismic parameters such as storey displacement, storey drift and base shear in both X and Y direction.

Analysis is carried out in Manual method by Kani's method and also by using software i.e. ETABS and are compared and seen that there is an error of 5 to 10%.

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