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Design and Analysis of G+7 Multi-Storey Residential Building using ETABS

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ABSTRACT

One area of study called structural analysis looks at how structures behave in order to forecast how various structural elements will react when loads are applied. Every structure will be susceptible to one or more categories of loads; the several types of loads that are typically taken into consideration are wind, living, and dead loads. IS:875-1987portionl,2,3, seismic force (IS:1893-2016)The programme known as ETABS (Extended Three-dimensional Analysis of Building System) includes all of the main analysis engines, including linear and non-linear, static, and dynamic.

In order to analyse and design buildings, computer software is also utilised to calculate forces, bending moments, stresses, strains, deformations, and deflections for complicated structural systems. G+7 building for wind, live and dead loads is used in this study. The G+7 R.C.C. framed building is modelled using the ETABS programme. The project has been designed in accordance with Indian norms 1S 1893:2016, IS 800-2007, and IS 456-2000.

Keywords: ETABS, Earthquake Loads, Live Loads, R.C.C. Frame Building.

1. INTRODUCTION

1.1 General

Presently due to overpopulation and significant expense of land, multi-story building is more fundamental for metropolitan city. Living in a densely populated area calls for a multi-story residential building. A multi-story building, which forces different floor over the ground level, which expect to expand the floor area of working in briefest developed region. Structure examination is a subject which includes planning, intending to developed an ideal structure. Essentially each undertaking is different with their plan rules, for example, approaching burden, soil properties, dynamic burden, developed region and so on. Here we gave the sub-titlesto hypothetically finish a private**.** To begin, we gathered the necessary information to measure the specifics of the soil, such as its moisture content, bearing capacity, types, and so on. We gave the ideal boundary in shaft, section, segment and balance with the thought of approaching burden to try not to shear and twist breakdown. As per limit state technique for breakdown in IS456:2000 we constructed G+7 developing which manage fortitude and dependability of design under greatest plan load flexure, pressure, shear and twist.

1.2 INTRODUCTION TO RESIDENTIAL BUILDING

A private structure is at least one family residences, housing or hotel, lodges, dorms, condos, pads, and confidential carports in which resting convenience is accommodated regular private purposes, regardless of kitchen or eating offices All structures expected for private occupation, whether super durable or brief, are delegated private structures. Single-family, portable, house, semi-segregated, line home, and apartment complex are the various kinds of residences.

1.3 ETABS SOFTWARE

ETABS stands for Extended Three-Dimensional Analysis of Building Systems. ETABS offers a user interface to perform Modelling,Analysis, Design and Reporting. ETABS provide sophisticated analysis and design for steel, concrete, and masonry structure.

1. In ETABS Beams and Columns are known as line objects. Slabs and Shear walls are known as Area objects.
2. It has built in template.
3. It has built in code books.

4. It will calculate loads automatically on beams and columns.
5. It is easy to give floor load for irregular panels.
6. It performs wind load and earthquake analysis also.
7. Auto calculation of beam reinforcements based on moments at column face, rather than at column center line and column reinforcement based on moments at beam soffit rather than at beam center line.
8. It designs shear wall.
9. It displays reinforcement areas or percentage on each beam and column.
10. Construction sequence analysis and Pushover analysis can be done by ETABS.

2. LITERATURE REVIEW

Material examinations investigate similarity with development materials, taking into account factors like solidness and cost-viability. The multidisciplinary writing envelops mathematical demonstrating, contextual analysis, code consistence, and ecological contemplations, by and large contribution significant experiences for future examination and pragmatic execution in development projects. A portion of the examination work led by before scientists on drifting segments has been depicted underneath.

1. **Design and Analysis of Residential Building by using ETABS**

Author: Dr. Valsson Varghese

Year: 2021

Journal details:

The contextual analysis in this paper principally stresses on primary way of behaving of multi-story fabricating for various arrangement setups like rectangular, C, L and I-shape.Modelling of 15-stories R.C.C. outlined building is finished on the ETABS programming for investigation ETABS issue, for examination and plan for building frameworks. The powerful graphical interface of ETABS is paired with unparalleled modeling, analytical, and design procedures that are integrated using a single database. STAAD andETABS both of the product are exceptional and particularly fit for taking care of various state of thestructures, static and dynamic loadings and different material properties.

2. **Analysis, Design and Estimation of G+4 Residential Building:**

Author: Prof. AradhanaChavan

Year: 2021

Journal details:

1.This project includes G +4 building with parking at ground floor and rest of the floors occupied with 2BHK flats. The response of a RCC high rise building under dead load, live load and seismic load is studied as per IS 875(Part 1):1987, IS 875(Part 2):1987and IS 1893: Part1: 2016 respectively. 2. Reinforcement details for each member i.e., beams and columns can be obtained directly after the process of analysis is carried out.

3.ANALYSIS& DESIGN

3.1 STATIC ANALYSIS METHOD

Static analysis in ETABS provides valuable insights into the behavior of a structure under constant loads. These results are crucial for understanding the internal forces and deformations the structure experiences.

Support Reactions: This data reveals the forces acting on the supports (foundations) of the structure due to the applied static loads. It helps ensure the foundation is designed to handle these forces and prevent failure.

Member Forces (Axial, Shear, Moment): These results detail the internal forces acting on individual beams, columns, and other structural elements. Engineers use this information to size members appropriately and ensure they can withstand the imposed loads without exceeding. **Stress Distribution**: Static analysis can also calculate the stress distribution within members. This helps identify areas where stresses might be concentrated, allowing for targeted reinforcement or member redesign if necessary their capacity.

Table 3.1 Building data

Building type	G+7 RCBuilding

Depthoffoundation	3m
Heightofeachstory	3 m
Totalheight of the building	24m
Sizeof beam	230 X 460 mm
Sizeof column	300 X 610 mm
Slab	150 mm
Externalwall thickness	230 mm
Internalwall thickness	150 mm
Heightofparapetwall	1.2 m

Fig 3.1 Plan of the Building

3.2 SEISMIC ANALYSIS

Dynamic analysis, particularly using the response spectrum method, delves deeper into how a structure reacts to dynamic loads, primarily earthquakes. This analysis provides critical information for seismic design:

Story Shears and Drifts: Dynamic analysis calculates the lateral forces and resulting displacements (drifts) experienced at each floor level of the structure. This information helps ensure the building can withstand the lateral forces and deformations imposed by an earthquake without collapse.

Story Displacement: This value represents the absolute lateral movement of a specific floor relative to a fixed reference point (usually the base of the structure). It reflects the overall deformation of the building due to the applied loads.

3.3 ANALYSIS OF MODEL

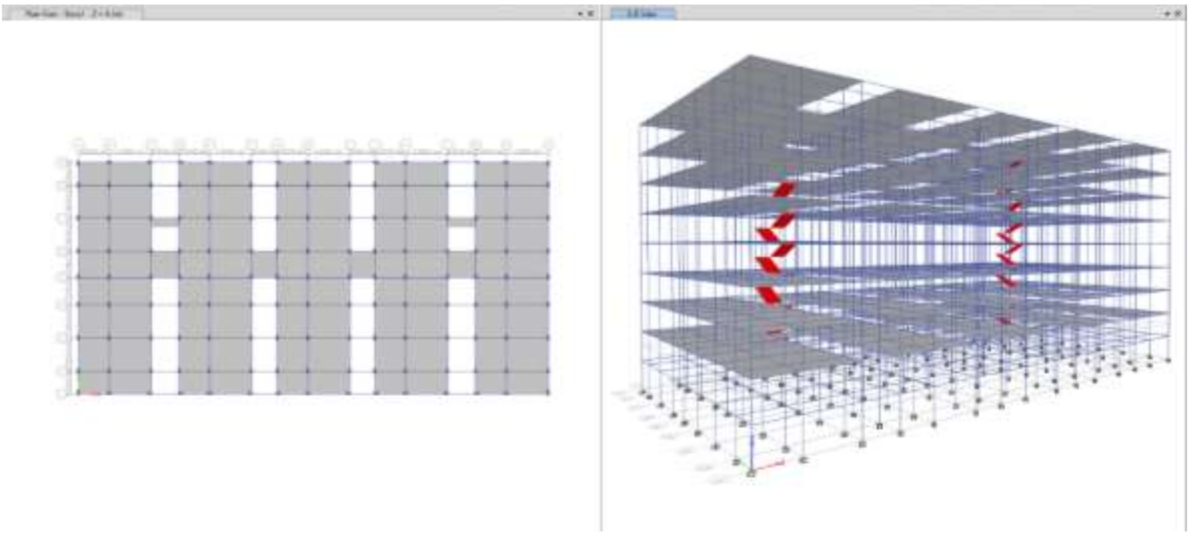


Fig 3.2 Analysis of the Model-1 structure

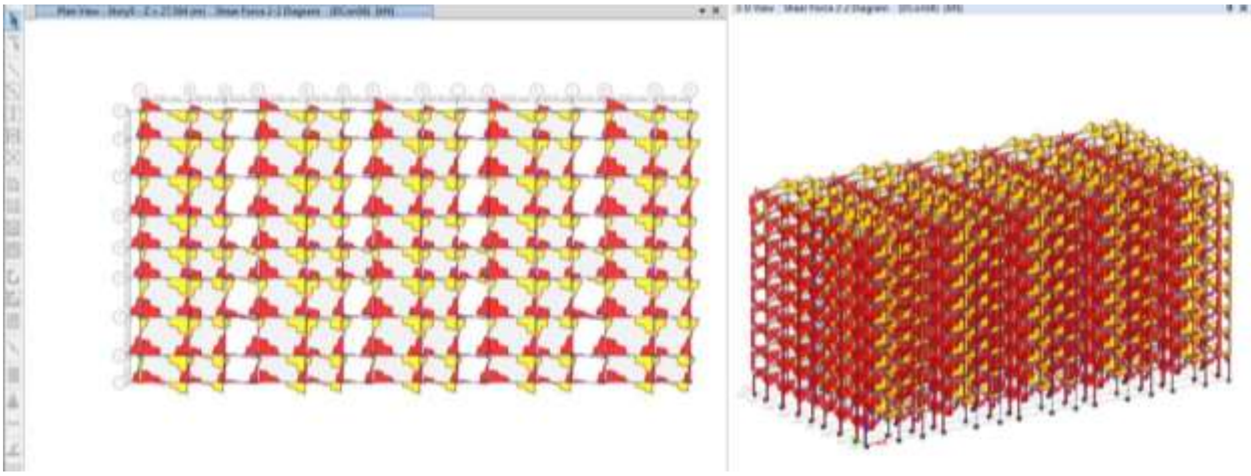


Fig 3.3 Member forces with respect to Load combination [1.5 (DL + LL + EQX)] - Shear Force

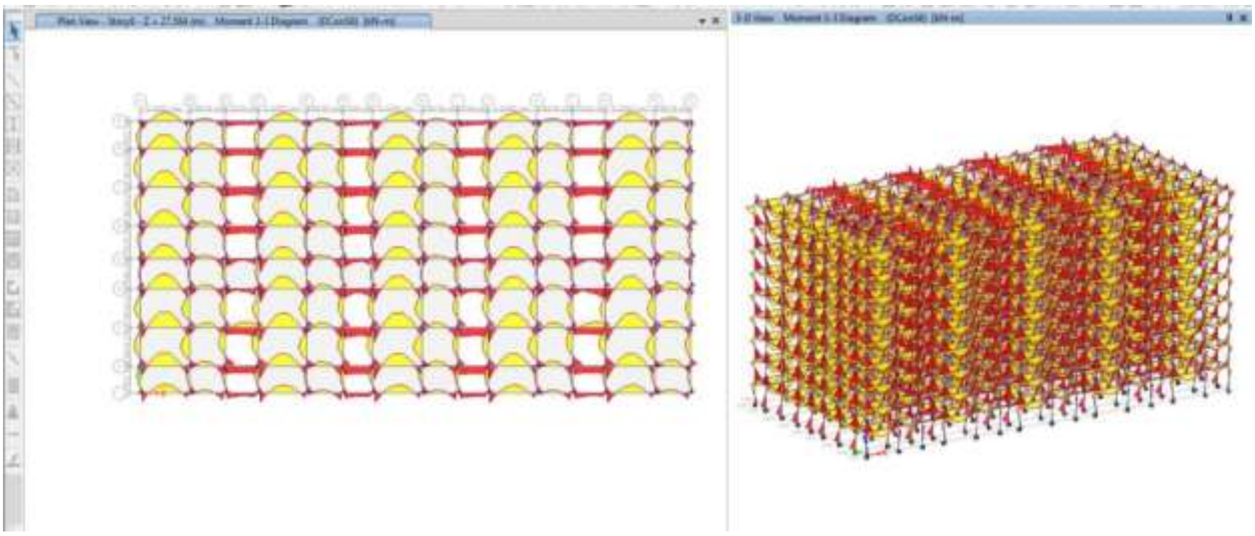


Fig 3.4 Member forces with respect to Load combination [1.5 (DL + LL + EQX)] - Bending Moment

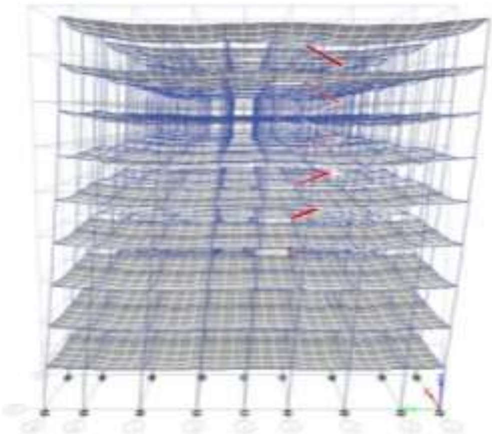


Fig 3.5 Deformed shape of the structure

3.4 DYNAMIC ANALYSIS

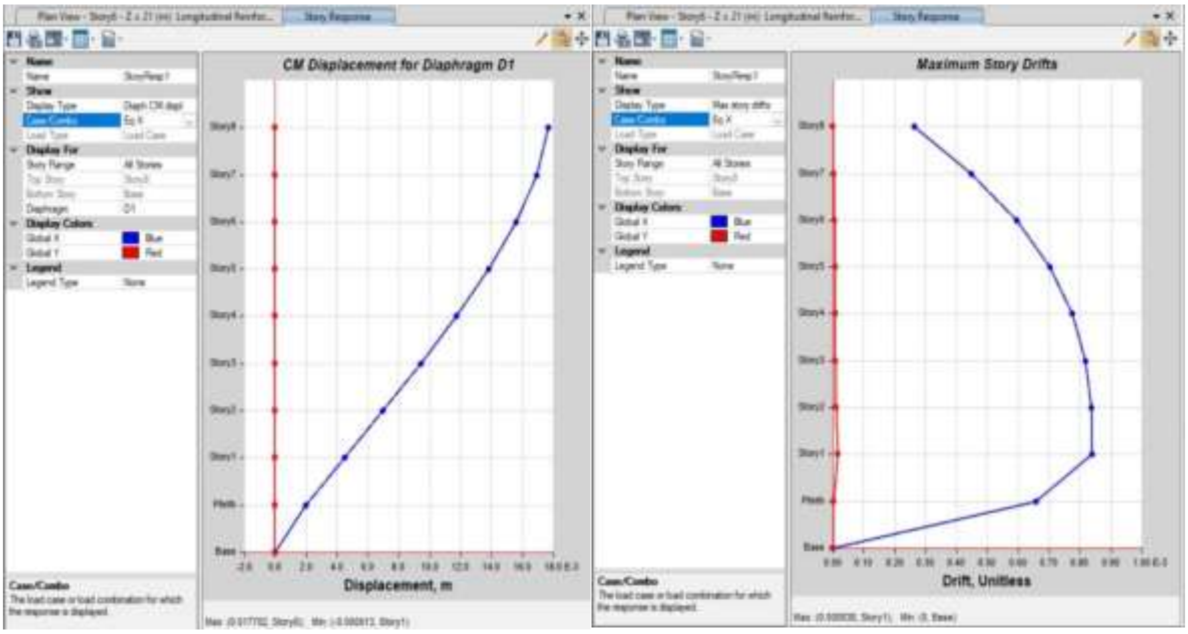


Fig 3.6 Story displacements & drift

The above figures are represented that maximum drift and maximum displacement of a structure. For top story got highest displacement when compared to the all stories and the story one got highest drift value.

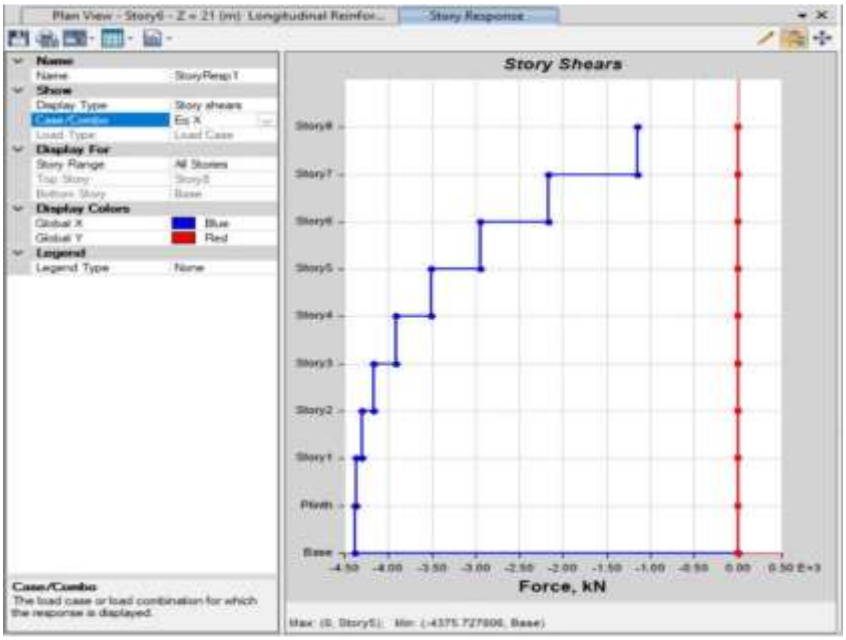


Fig 3.7 Story shear

The above picture represent the story shear of earthquake in x direction. The base value of shear is 4375KN.

3.4.1 Axial forces

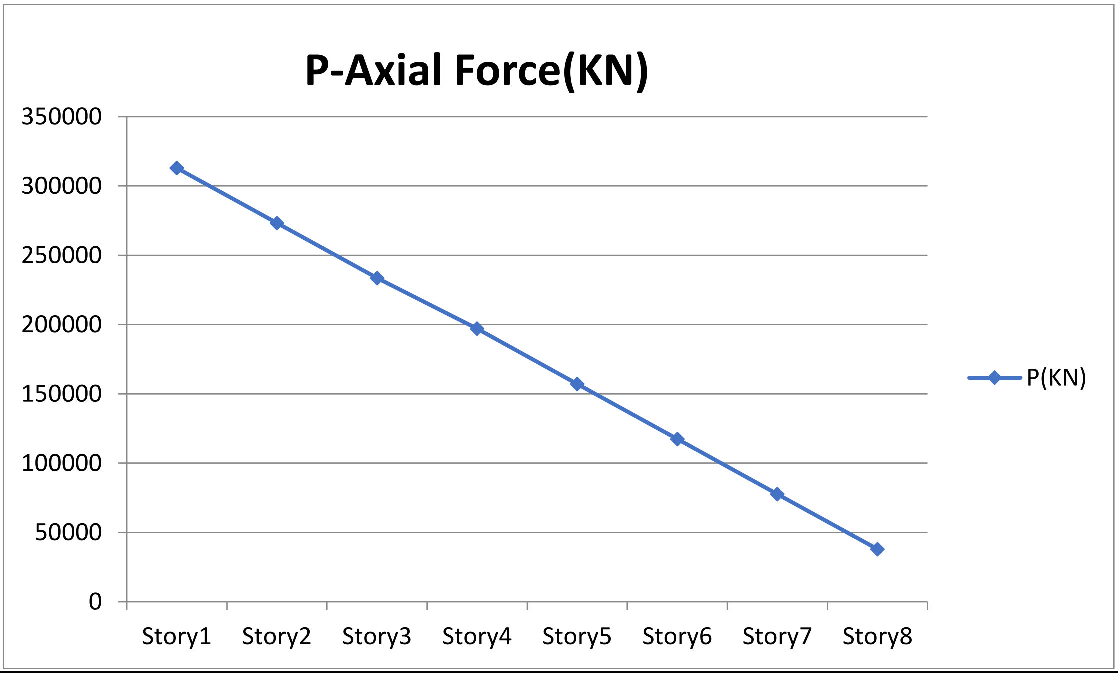


Table no:3.8 Maximum Axial forces arrived in all stories

While observing the axial forces of a building the values are constantly decreasing from the story 1 to story8 represented in above fig and also above forces are arrived at only bottom.

3.4.2 Shear Force

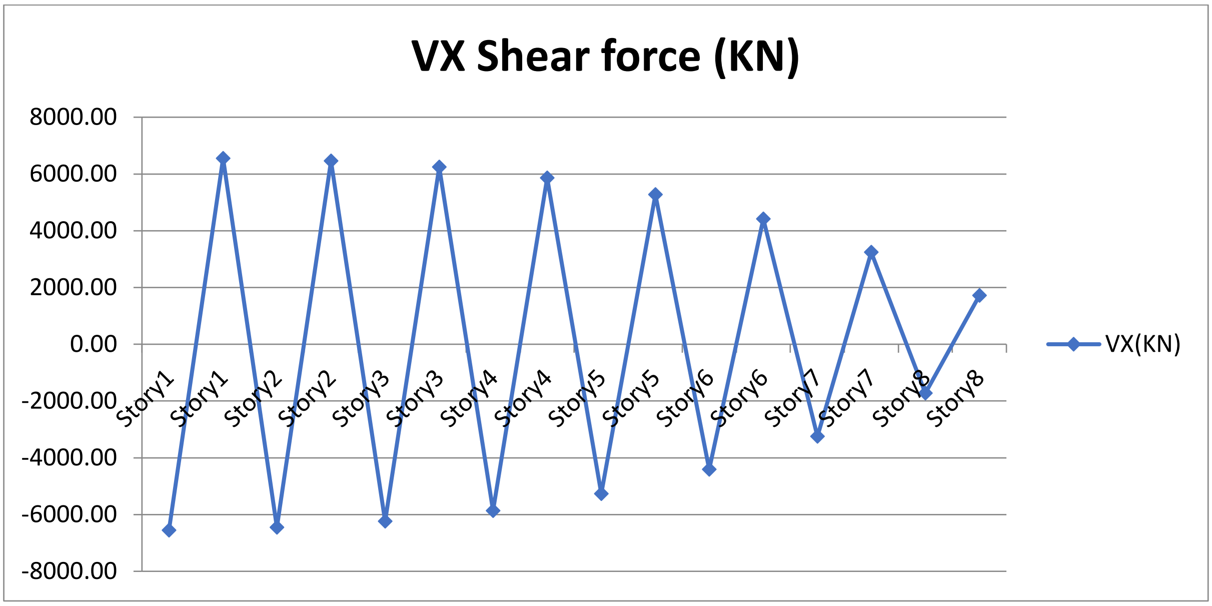


Fig no:3.9 Maximum shear forces in all stories

From the above representation the value of shear forces constantly decreases from the story 1 to story 7 and also the maximum value of shear forces occurs at the story 1.one value was clearly observed negative and the another one is positive and this may be same for all the stories.

3.4.3 Torsion moment

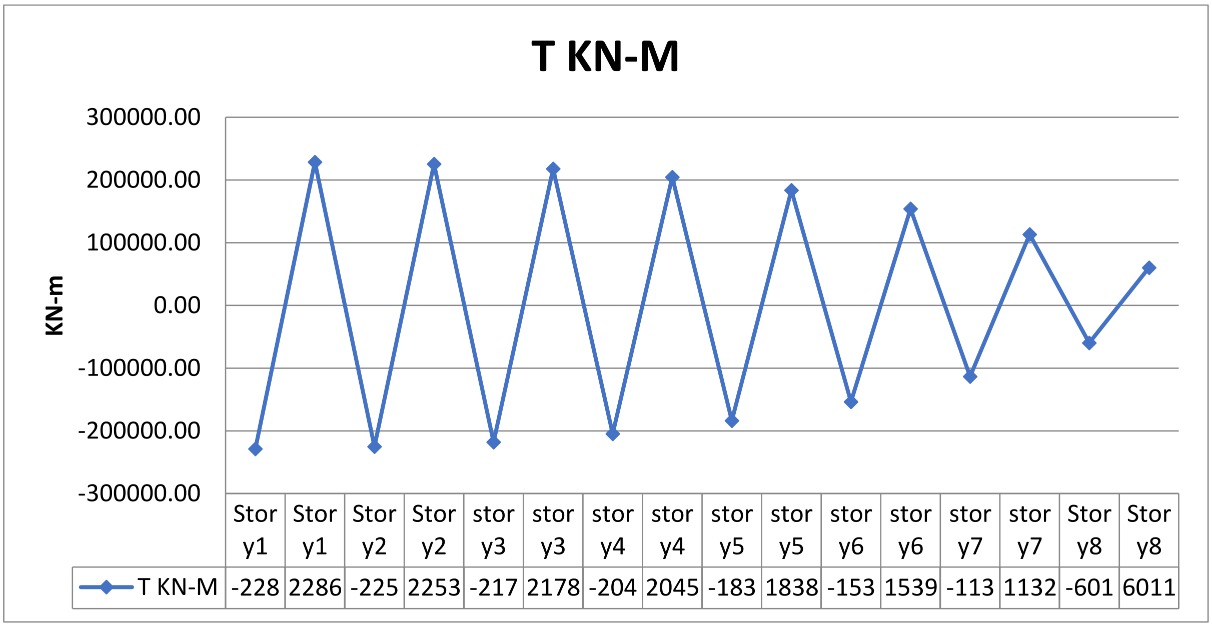


Fig no:3.10 Maximum Torsional moment for all stories

From the above representation the highest value of torsional moment occurs at the story 1 with the value of 228654KN-m and lowest value occurs at the story 8 with the value of 60113KN-m. While observing the figure due to earthquake load considering the twisting moment getting more value.

3.4.4 Bending Moment

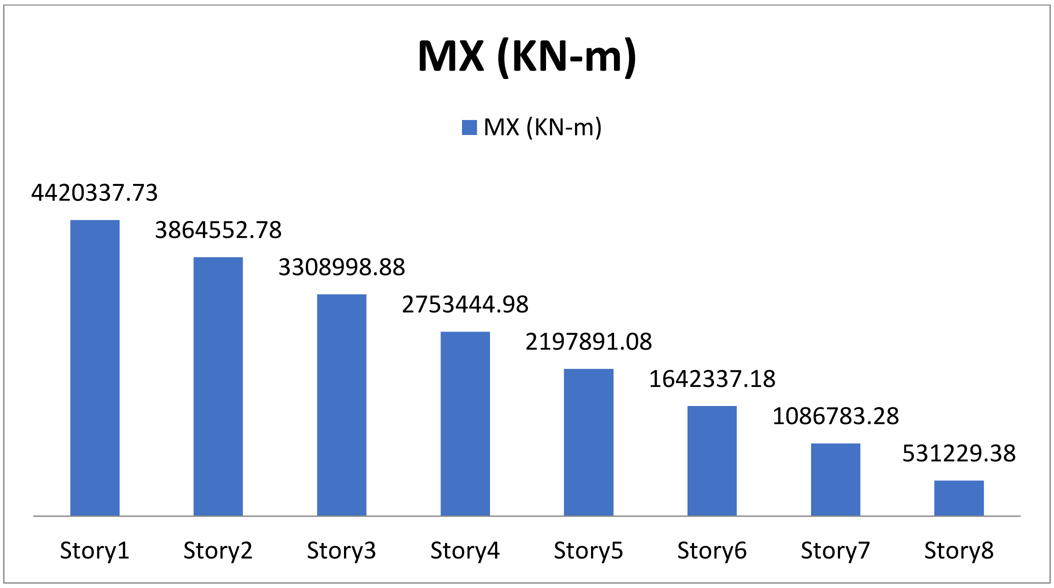


fig no:3.11 maximum bending moment in all stories

In all stories of building the bending moment is gradually decreasing from story 1 to story 4 so that this moment is automatically affect the design of the structure.

3.5Design

When it comes to design, the software called Etabs automatically design the column for the maximum axial force for which load case as well as for maximum bending moment designs the beam. The following figure indicates the all-structural elements in G+7 building successfully analyzed and pass the entire building without any errors.

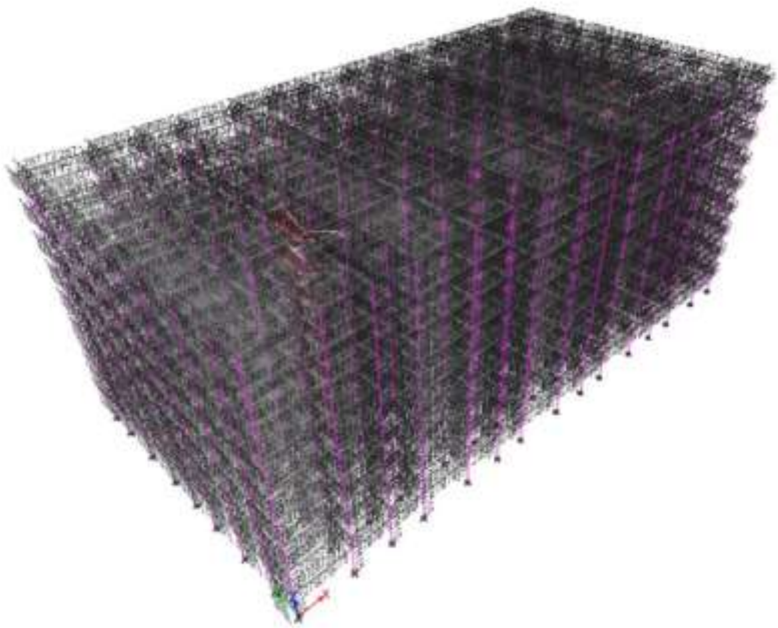


Fig 3.12 Design of entire structure gives positive without any errors

3.5.1Reinforcement details of beam

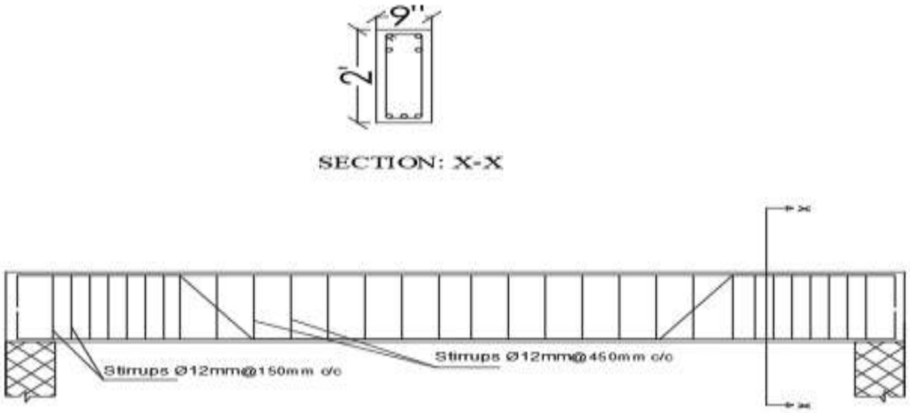
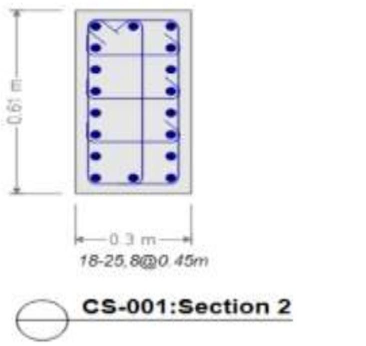


Fig 3.13 Beam sectional

S.No	Beam size’s	Beam Main bar	Beam Extra bar	Stirrups spacing
1	610mm X 230mm	4 No’s - 16mm dia	20 mm dia Top-2 No’s, 20 mm dia Bottom 1-No	12mm dia @ 450mmc/c 12mm dia @150mmc/c
2	460mm X 230mm	4 No’s - 16mm dia	20 mm dia Top-2 No’s, 20 mm dia Bottom 1-No	12mm dia @450mmc/c 12mm dia @150mmc/c

3.5.2 Reinforcement details of column



S.No	Beam size’s	Beam Main bar	Stirrups spacing
1	610mm X 300mm	18 No’s - 25mm dia	8mm dia @ 450mmc/c 8mm dia @150mmc/c
2	460mm X300mm	18 No’s - 16mm dia	8mm dia @450mmc/c 8mm dia @150mmc/c

3.5.3 Reinforcement details of slab

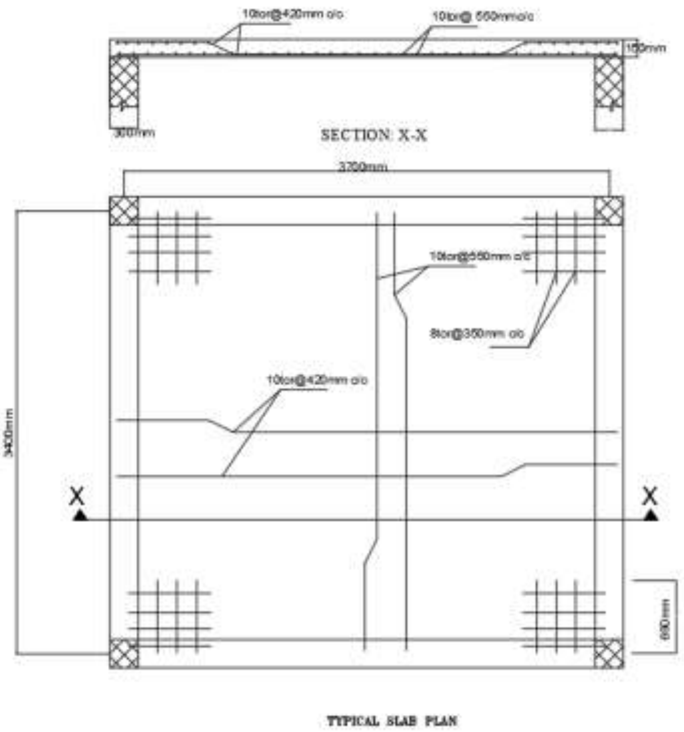


Fig 3.14 Slab sectional plan and details

3.5.4 Reinforcement details of Footing

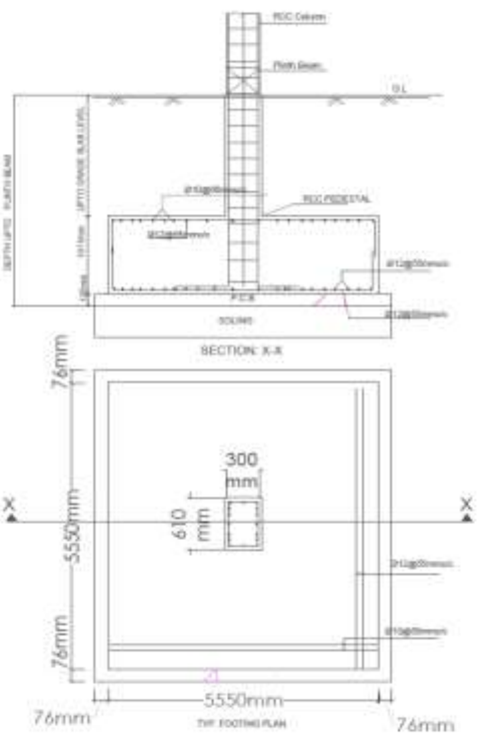


Fig 3.15 cross sectional details

4. CONCLUSION

- From the ETABS and STAAD foundation the analysis and design of G+7 Residential building was studied.
- The design was done using ETABS software and successfully verified manually according per IS 456-2000•..
- The critical beam was found out in ETABS and design manually.
- Theoretical column was found out in ETABS and design manually.
- Two-way Slab was designed manually.
- Isolated footing was designed in STAAD foundation software.
- Software-based analysis and design provide safer results than human calculations and design.

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