

ANALYSIS AND DESIGN OF G+4 RESIDENTIAL BUILDING BY USING ETABS

A MINI PROJECT REPORT SUBMITTED IN PARTIAL
FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

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(Approved by AICTE, Accredited by N.B.A, NewDelhi, NAAC-A+ Grade)

2019 - 2023

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CERTIFICATE

This is to certify that the mini Project Report entitled "ANALYSIS AND DESIGN OF G+4 RESIDENTIAL BUILDING BY USING ETABS" that is being submitted by

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in partial fulfillment of the requirement for the award of B.Tech in Civil Engineering to the **RAJEEV GANDHI MEMORIAL COLLEGE OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS)**, Nandyal (Affiliated to J.N.T. University, Anantapur) is a bonafide record of confide work carried out by them under our guidance and supervision. The results embodied in this mini Project report have not been submitted to any other university or institute for the award of any Degree.

Signature of the Project Guide

Dr.J.JOEL SHELTON PhD

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Professor and HOD

Examiner:

Date:

Dedicated to my beloved parents, and teachers who have worked hard throughout my education.

ACKNOWLEDGEMENTS

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ABSTRACT

Structural Analysis is a branch which involves in the determination of behavior of structures in order to predict the responses of different structural components due to the effect of loads. Each and every structure will be subjected to either one or the groups of loads, the various kinds of loads normally considered are dead load, live load, wind load IS:875-1987 part1,2,3, earthquake load (IS:1893-2016).. ETABS(Extended Three dimensional Analysis of Building System) is a software which is incorporated with all the major analysis engines that are static ,dynamic, Linear and non-linear, etc.

This computer software's are also being used for the calculation of forces, bending moment , stress, strain deformation or deflection for a complex structural systems this software is used to analyze and design the buildings. In this study G+4 building for Dead load, Live load, wind load. Modeling of G+4 R.C.C framed building is done on the ETABS software. The project is designed as per Indian codes IS 875 part1,2,3;IS 456:2000.

Keywords: ETABS,WIND LOADS,LIVE LOADS,R.C.C FRAME BUILDING.

Contents

Acknowledgements	iii
Abstract	iv
1 INTRODUCTION	1
1.1 General	1
1.2 INTRODUCTION TO RESIDENTIAL BUILDING	2
1.3 ETABS SOFTWARE	2
1.4 ADVANTAGES OF ETABS	2
1.5 DISADVANTAGES OF ETABS	4
2 LITERATURE REVIEW	5
2.1 Background studies	5
2.2 Objectives of the study	7
3 METHODOLOGY	8
3.1 Flow chart for Methodology	8
3.2 Software used	8
4 Plan of the Building	10
4.1 Column Orientation of the Building	11
4.2 Plan of the Building	12
4.3 Dimensions of the Building	13
4.4 Procedure for Modelling	13
4.5 Modelling of G+4 Residential building	15
5 Detailing of Loads	16
5.1 Calculation of loads	16
5.2 Application of Parapet wall load	17

5.3	Combination of Loads	18
6	Analysis of G+4 Residential Building	19
7	DESIGN OF CONCRETE FRAMES	23
7.1	Beam Design	23
7.2	Rectangular column Design	24
7.3	Square column Design	25
7.4	Slab Design	26
7.5	ISOLATED Footing Design	27
8	CONCLUSION	29
	REFERENCES	30

List of Figures

3.1	Flow chart for Methodology	8
4.1	Column Orientation of the Building	11
4.2	Plan of the Building	12
4.3	Model of G+4 residential building in ETABS	15
5.1	Assaigning of Parapet wall load in ETABS	17
6.1	Displacements	19
6.2	Shear Force Diagram	20
6.3	Shear Results For Beam	20
6.4	Bending Moment Diagram	21
6.5	Bending Moment Results For Beams	21
6.6	Axial Force Diagram	22
6.7	Axial Results For Frames	22
7.1	cross section of beam at story 1	23
7.2	Longitudinal section of beam at story 1	23
7.3	cross section of Rectangular column at story 1	24
7.4	cross section of square column at story 1	25
7.5	Plan of the Slab	26
7.6	Elevation of the footing	27
7.7	Plan of the footing	27

Chapter 1

INTRODUCTION

1.1 General

Now a days due to overpopulation and high cost of land, multi-storied building is more essential for metropolitan city. Multi-storied Residential building is the perfect solution for living of high populated area. A multi-storied building, which posses multiple floor above the ground level, which aim to increase the floor area of building in shortest built up area. Structure analysis is a subject which involves designing, planning to built up a perfect building. Basically each project are different with their design criteria such as incoming load, soil properties, dynamic load, built up area etc. Here we provided the details to complete a residential apartment theoretically. We firstly collected some required data to measure the soil specific such as moisture content, bearing capacity of soil, types of soil etc. We provided the perfect parameter in beam, slab, column and footing with the consideration of incoming load to avoid shear and bending collapse. In accordance with limit state method of collapse in IS456:2000 we built G+4 building which deal with strength and stability of structure under maximum design load flexure, compression , shear and torsion .

1.2 INTRODUCTION TO RESIDENTIAL BUILDING

A residential building is one or more family dwellings, lodging or boarding houses, hostels, dormitories, apartment houses, flats, and private garages in which sleeping accommodation is provided for conventional residential purposes, with or without kitchen or dining facilities. All buildings intended for private occupation, whether permanent or temporary, are classified as residential buildings. Single-family, mobile, cottage, semi-detached, row home, and apartment building are the different types of dwellings.

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) Assam on 15th August, 1950 with an intensity of 8.6. 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 centre line and column reinforcements based on moments at beam soffit, rather than at beam centre line.
- 8) It design shear walls.
- 9) It design shear walls.
- 10) It displays reinforcement areas or percentage on each beam and column
- 11) Construction sequence analysis and Pushover analysis can be done by ETABS.

1.4 ADVANTAGES OF ETABS

ETABS is a 3D modeling software for any kind of structural analysis and design. Using this program you can perform both steel structure and RC Structure. Here are some important

advantages of ETABS software for 3D modeling.

- ETABS allows user for Graphic input and modification for the sake of easy and quick model creation for any type of structure.
- Creation of 3D model with the utilization of plan views and elevations, 3D model of any kind of complex structure can be created easily.
- With the help of similar storey concept creation of 3D model is very easy and quicker. If the storey's are similar then the model generation time can be reduced multiple time through similar storey concept.
- Editing of model is very easy. Moving any object from one position to other, combining two or more objects using merge command, making the similar object using Mirror command and make copy of any object in the same level of different story level.
- Drawing of object with most accuracy using snap command consisting of end, perpendicular and middle or some other options.
- Creation of object is very quick for any type of object like beam, column, slab, wall etc. with one click of mouse.
- Easy navigation through multiple viewing of windows. This feature allows you to create or edit your model very easily with real time view.
- Create your model and editing has been easy through 3D view with different type of zoom option as well as panning command for moving the whole model easily without any rotation.

- Different view option of the 3D model including plan view, any side elevation view, and also customization view created by the modeler.

1.5 DISADVANTAGES OF ETABS

- While using ETABS, one cannot edit input file directly.
- You cannot print and read input file as easily as STAAD software as no manual is available in this software.
- In large models, some loads may be missed out. In fact, they are hard to check.
- The method of Analysis is slower and consumed more disk space sometimes.
item Shear design results used to be in terms of ASV/SV.

Chapter 2

LITERATURE REVIEW

2.1 Background studies

1. Analysis And Design Of G+5 Residential Building By Using E-tabs:

Author: N.Lingeshwaran

Year: 2017

Journal details:

The structure is design based on the E-TABS, and the theory of LIMIT STATE METHOD which provide adequate strength, serviceability, and durability besides economy. The displacement, shear force, bending moment variation has been shown. If any beam fails, the dimensions of beam and column should be changed and reinforcement detailing can be produced.

2. Design and Analysis of a Residential building using ETABS integrated with Green Building concept:

Author: : : Ujjwal Bhardwaj

year: 2018

Journal details:

By implementing green concepts in residential buildings we have attempt to use renewable resources more sensibly in order to create an eco-friendly environment which will excel the living experience for residents, and minimize the ecological footprints of the building. This paper presents stories RCC framed building analyzed and designed under the lateral loading effect of earthquake using (Extended Three Dimensional Analysis of Building system). All the major analysis process i.e. static, dynamic, Linear and non-linear, etc., as well as designing of the building is included in the ETABS software. Because of the facilities provided in this

software at the modelling stage, the buildings can be modelled as per the arrangement of the members of the project in Practical, and this software considers the beams, columns as Line members; slabs, Ramps/staircases, walls are as area members. This paper mainly deals with the structural analysis and designing of a residential building using ETABS software and those results are further verified by manual calculation and design as per IS 456: 2000 and in the pre-building phase the green design concepts are implemented in the architectural design of a building to reduce the carbon footprints of the building.

3. Design and Analysis of Residential Multistory Building (G+5) by using ETABS

Author: Mr. Kundan Kulbhusan

Year: 2019

Journal details:

Analysis of dead loads, live loads, wind loads (axial load) , and seismic load and by dead load and live loads induced shear force and bending moment are analysis with diagram of gravity load , axial load , lateral load ,and longitudinal reinforcement

4. Design and Analysis of Residential Building by using ETABS

Author: Dr. Valsson Varghese

Year: 2021

Journal details:

The case study in this paper mainly emphasizes on structural behavior of multi-storey building for different plan configurations like rectangular, C, L and I-shape. Modelling of 15-storeys R.C.C. framed building is done on the ETABS software for analysis ETABS issue, for analysis and design for building systems. ETABS features are contain powerful graphical interface coupled with unmatched modeling, analytical, and design procedures, all integrated using a common database. STAAD and ETABS both of the software are well equipped and very much capable of handling different shape of the structures, static and dynamic loadings and different material properties.

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

Author: Prof. Aradhana Chavan

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.

2.2 Objectives of the study

- 1) To perform analysis and design of the structure without any type of failures.
- 2) To understand the basic principles of structures by using Indian Standard Codes
- 3) To understand the parameters of the design for beams, columns, slabs and other structural components.
- 4) To prepare the 3D model of the structure by using the E-TABS Software for detailed analysis and design

Chapter 3

METHODOLOGY

3.1 Flow chart for Methodology

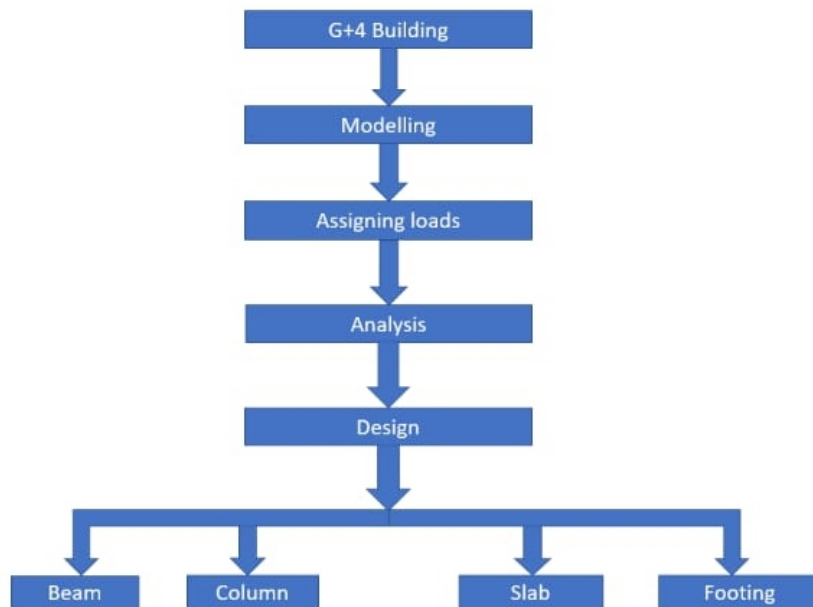


Figure 3.1: Flow chart for Methodology

3.2 Software used

The following softwares are used for the design of G+4 Residential building in this project.

1. AUTOCAD Software.
2. ETABS Software.
3. STAAD Foundation.

1. AUTOCAD

AUTOCAD is a commercial computer-aided design (CAD) and drafting software application. Developed and marketed by AutoCAD was first released in December 1982 as a desktop app running on microcomputers with internal graphics controllers. The main use of AUTOCAD software is to draw or drafting the plan, elevation and sections of structures in 2D or 3D view. For the present project AUTOCAD is used for representing the plan of considered Residential Building.

2. ETABS

ETABS stands for Extended Three-Dimensional Analysis of Building System. ETABS is an engineering software product that caters to multi-story building analysis and design. Modelling tools and templates, code-based load prescriptions, analysis methods and solution techniques, all coordinate with the grid-like geometry unique to this class of structure.

3. STAAD Foundation

STAAD foundation stands for Structural Analysis and Design foundation and used for Structural Analysis and Design Software from Bentley. It is the most powerful software that can design almost any kind of civil engineering structure such as steel, concrete, timber, aluminum, and cold-formed steel designs. The newly released or complete package of analysis from Bentley is STAAD Pro V8i.

Chapter 4

Plan of the Building

The material used for construction is reinforced concrete with M-30 grade concrete and Fe-500 grade of steel.

- Number of stories = 5
- Storey height = 3m
- Number of bays along x-direction = 5
- Number of bays along y-direction = 5
- Size of square column = 450 x 450mm
- Size of Rectangular column = 350 x 450mm
- Size of Beam = 400 x 500mm
- Slab thickness = 150mm

4.1 Column Orientation of the Building

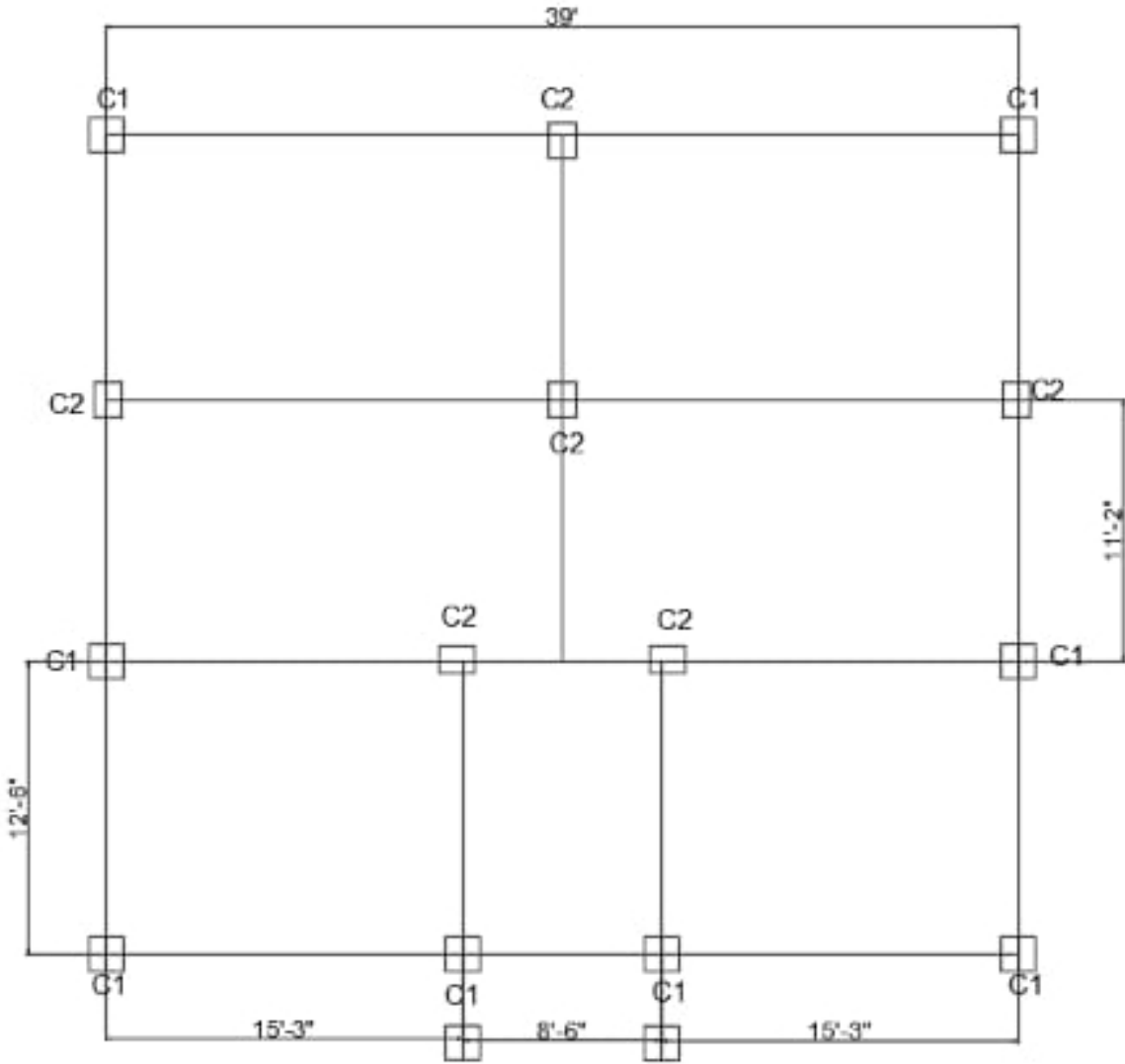


Figure 4.1: Column Orientation of the Building

4.2 Plan of the Building

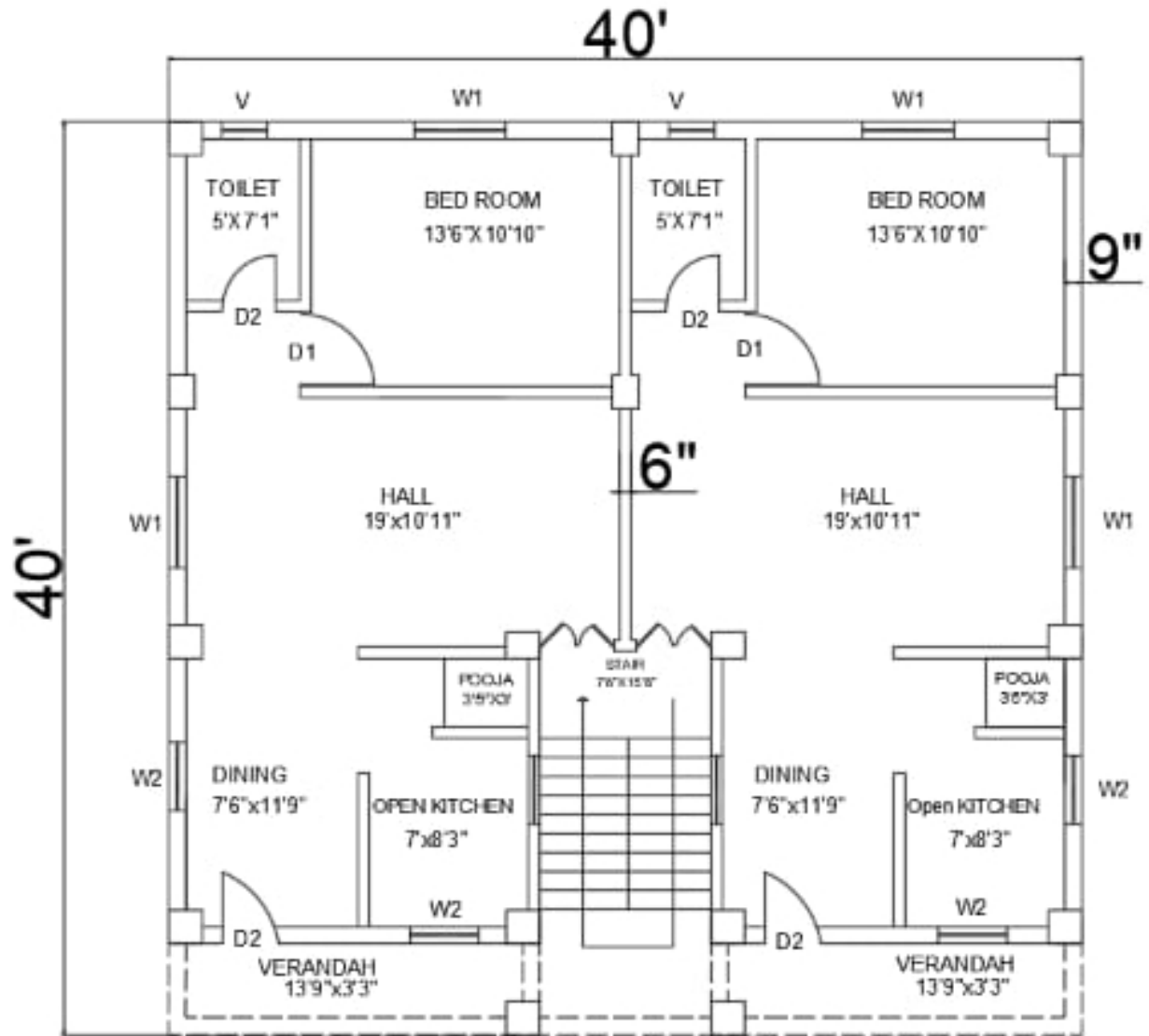


Figure 4.2: Plan of the Building

Note: All Dimensions are in Feet and inches plan is same for all Storeys.

4.3 Dimensions of the Building

- Bedroom = 13'6" x 10'10"
- Master Bedroom = 7'0" x 8'3"
- Kitchen = 4.5m x 4.5m
- Hall = 19'0" x 10'11"
- Toilet = 5'0" x 7'1"
- Pooja = 3'5" x 3'0"
- Door (D1) = 1.2m x 2.1m
- Door (D2) = 0.9m x 2.1m

4.4 Procedure for Modelling

- New model – change units to KN-M - number of stories = 5- number of bays in X direction = 5- number of bays in Y direction = 4- storey height = 3m - Give each bay width in X-direction - bay width in Y direction - restraints -OK.
- Define materials- add new materials-material type (concrete) material name (concrete)- tick the switch to advanced property display option- material property options displays- material name (concrete) -material type(concrete) -modify/show material properties - material property data-material property - ok.
- Define-section properties-frame sections-add new properties-frame section - property type(concrete)-select rectangular section name (beam)-depth=0.5- width=0.4-material(concrete)concrete reinforcement-select beam-ok. Add new property-frame section -property type (concrete)-select rectangular- section name (column)-material (square column)450 x 450 concrete reinforcement -select column-ok-select rectangular-section name (column)-material(rectangular column) 350 x450 concrete reinforcement-select column-ok.
- Define-section properties-area sections-add new section-section name (slab) - material name(concrete)-thickness-membrane= 0.15-ok.

- Select all the support grid points-assign-joint-restraints-fixed-ok.
- Select-select-select lines parallel to -coordinate axes or planes-Z-axis-ok-assign-frame-frame sections-columns-ok.
- Select-select-select lines parallel to-coordinates axes or planes-X-axis and Y-axis-ok-assign frame -frame sections -beam-ok.
- Select quick draw floor-properties of object -slab-select all elements and assign.
- Set display options- tick extrude view-ok.
- Define- load patterns-load pattern (dead)-name type (dead)-multiplier (1)-load patternsload pattern (live)-name type (live)-add load pattern (wind load) -select-properties-frame sections-select beams and columns-ok- assign-frame loadsgravity-load pattern name (dead)-Global Z=1-OK.
- Select-select properties-area sections-slab-ok-assign-area loads -Self weight-load pattern name (dead)-Global Z=1-ok.
- Select-properties-frame sections-beam ok-assign-frame loads-distributed-load pattern name (live)-uniform load 2-ok.
- Define-load combinations-add new combo-load combination (comb1)-load case name (dead and live)-load case type (linear static)-scale factor (1.5)-add-ok.
- Analyze-set analysis options-ok-Analyze-run analysis-run now.
- Go to design-concrete frame design-start design/check-view all members are passed.

4.5 Modelling of G+4 Residential building

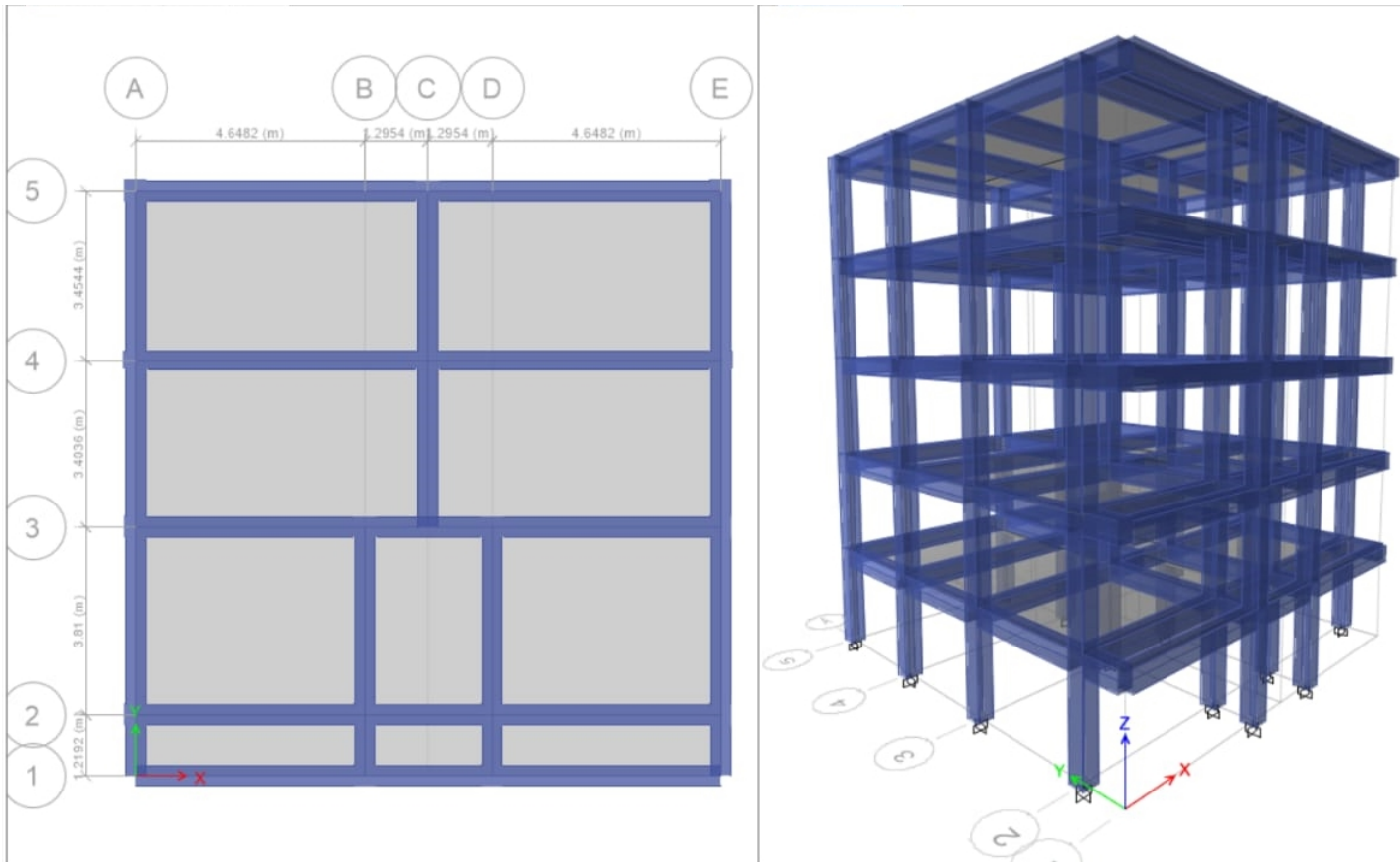


Figure 4.3: Model of G+4 residential building in ETABS

Chapter 5

Detailing of Loads

In ETABS all the load considerations are first defined and then assigned. The loads in ETABS are defined as using static load cases command in define menu.

- Assigning of Dead loads. After defining all the loads are assigned for external walls , internal walls , parapet walls as per IS 875 1987 PART 1
- Assigning of Live loads. Live loads are assigned for the entire structure including floor finishing as per IS 875 1987 PART 2
- Assigning of wind loads wind loads are defined and assigned as per IS 875 1987 PART 3 by giving wind speed and wind angle in X ,Y directions as 0 , 90 respectively

5.1 Calculation of loads

- Dead Load
- Self Weight = ETABS Defaultly taken
- External wall = 13.8 KN/M
- Internal wall = 9.0 KN/M
- Parapet wall = 3.0 KN/M
- Floor finish = 2 KN/M²
- Live load = 2 KN/M²
- Wind Load X+ direction = wind ward coefficient = 0.8 , leeward coefficient = 0.5
- Wind load in Y- direction = wind ward coefficient = 0.8 , leeward coefficient = 0.5

5.2 Application of Parapet wall load

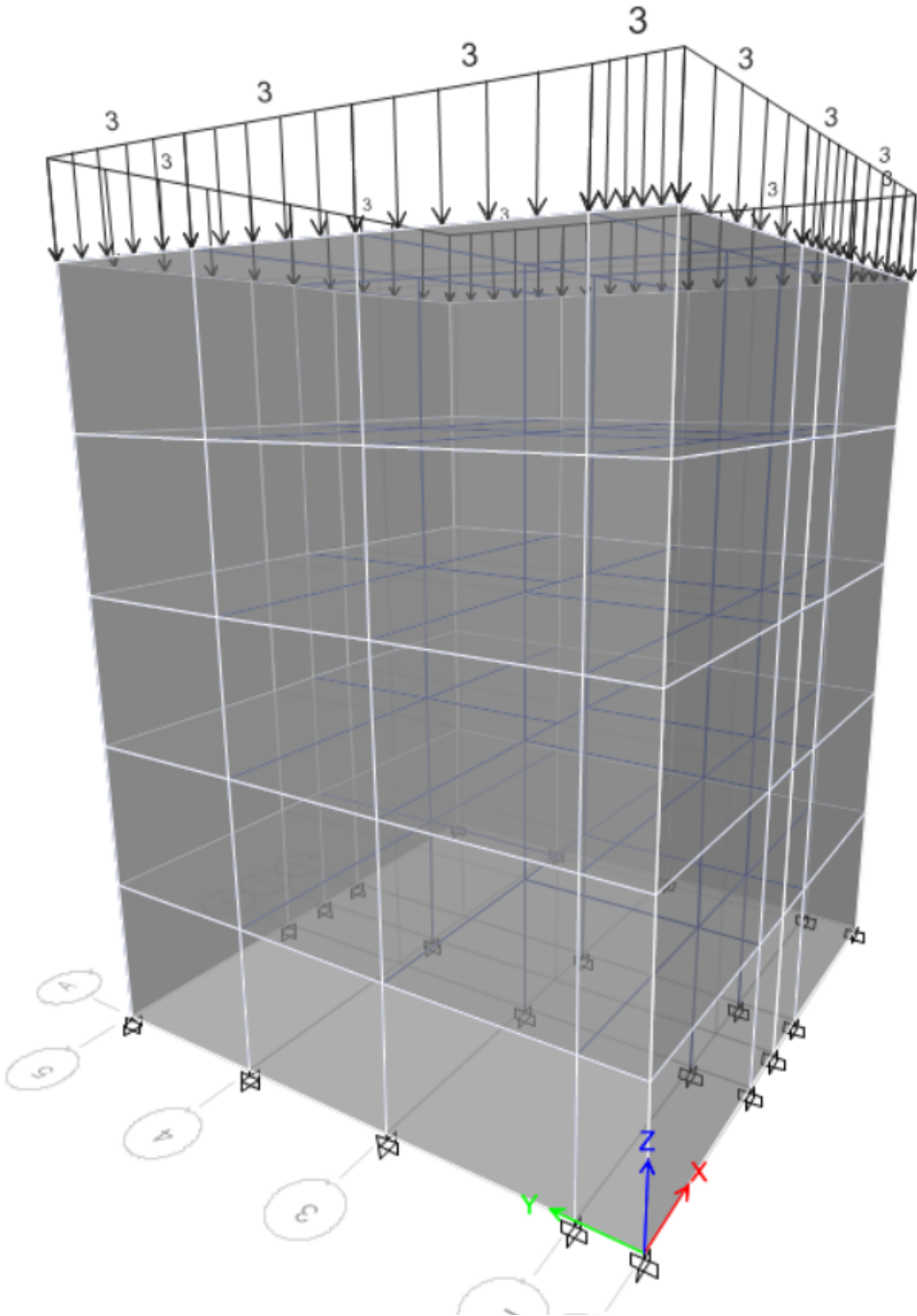


Figure 5.1: Assaigning of Parapet wall load in ETABS

5.3 Combination of Loads

- Dead load + Live load - 1.5
- Dead load + Live load - 1.2
- Dead load + Live load -1.2 + wind load x+ - (-1.2)
- Dead load + Live load -1.2 + wind load y- - (+1.2)
- Dead load + Live load + wind load x+ -1.5
- Dead load + Live load -0.9 + wind load x+ - 1.5
- Dead load +Live load -0.9 + wind load y- - 1.5

Chapter 6

Analysis of G+4 Residential Building

After the completion of all the above steps we have performed the analysis. Shear, Bending moment and axial force diagrams are analytical tools used in conjunction with structural analysis and also it is useful for performing structural design by determining the values of shear force and bending moment at a given structural element of a beam, and axial force is used for column design.

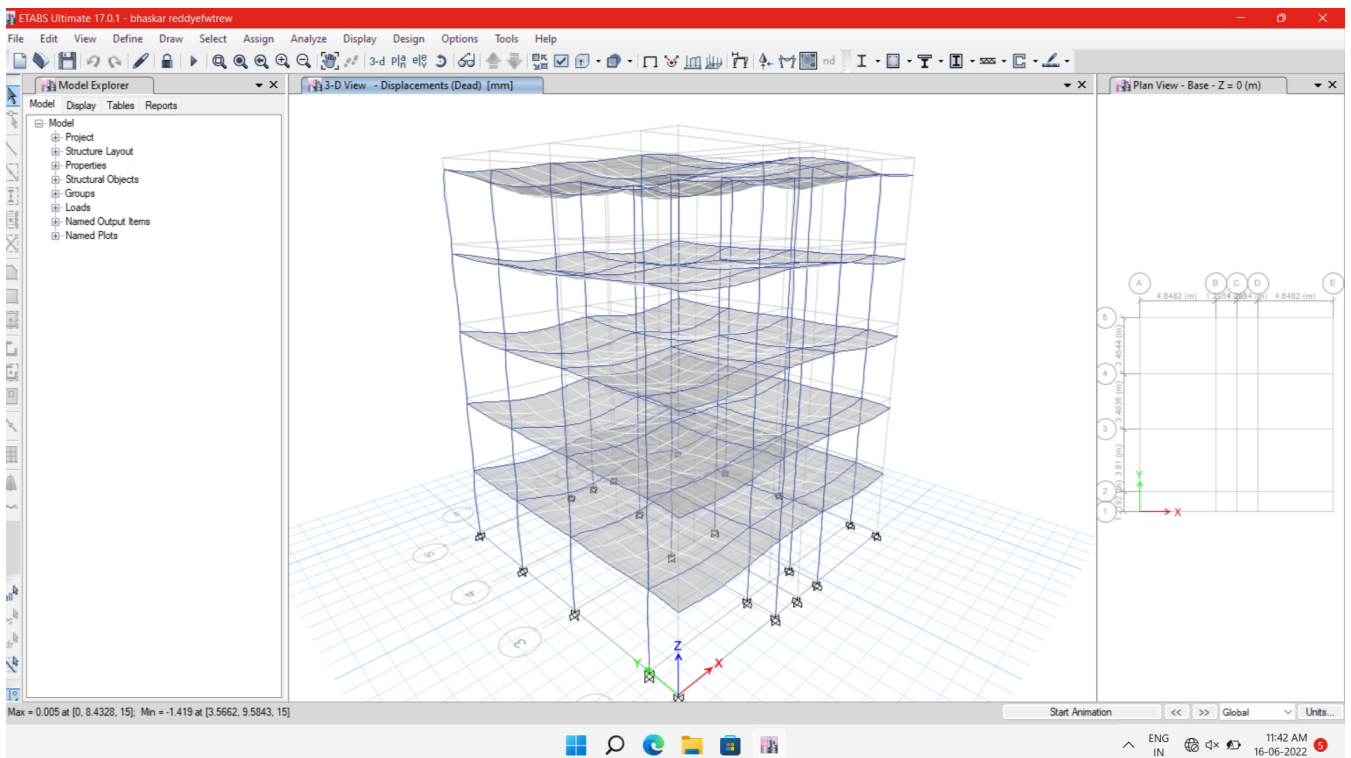


Figure 6.1: Displacements

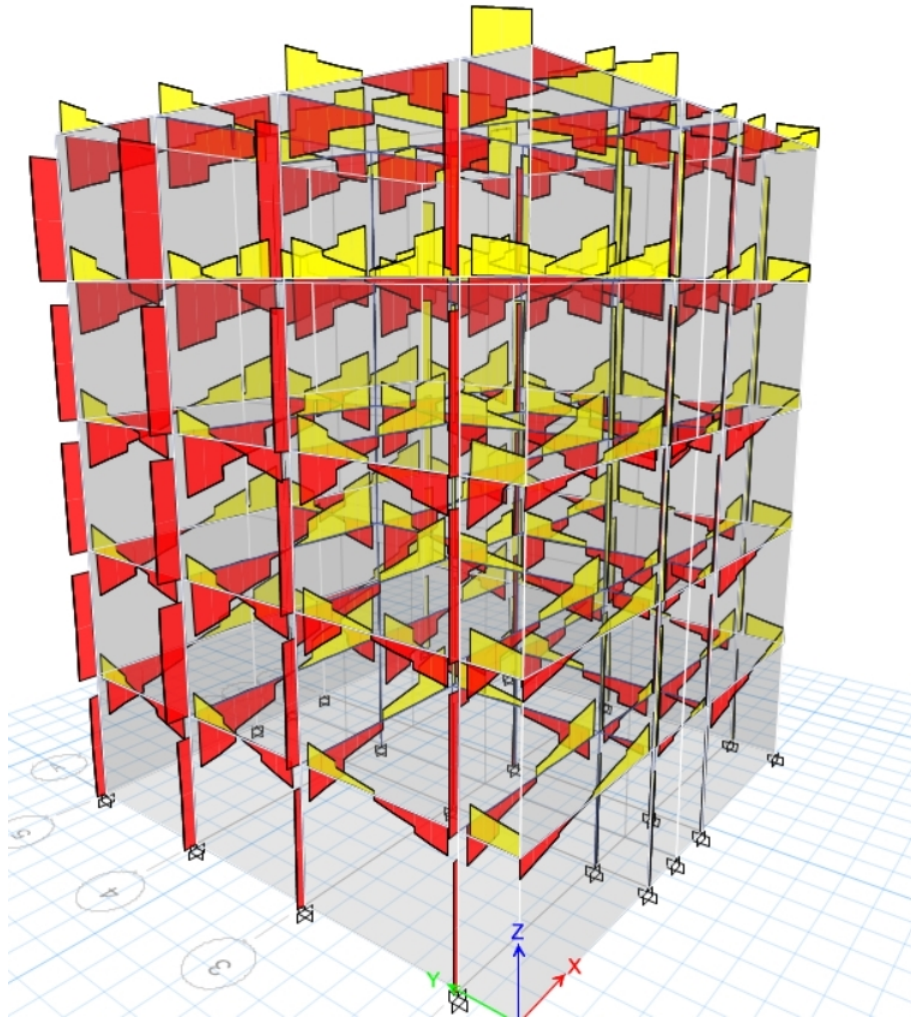


Figure 6.2: Shear Force Diagram

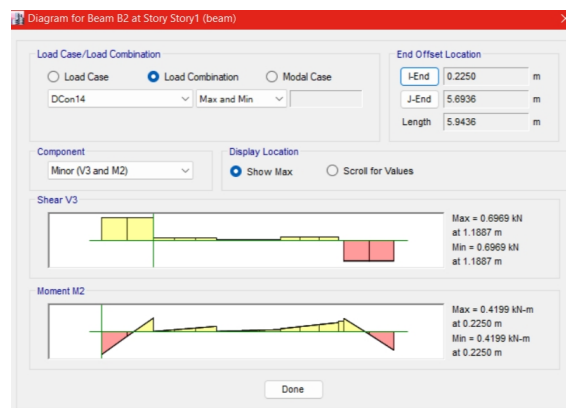


Figure 6.3: Shear Results for Beam

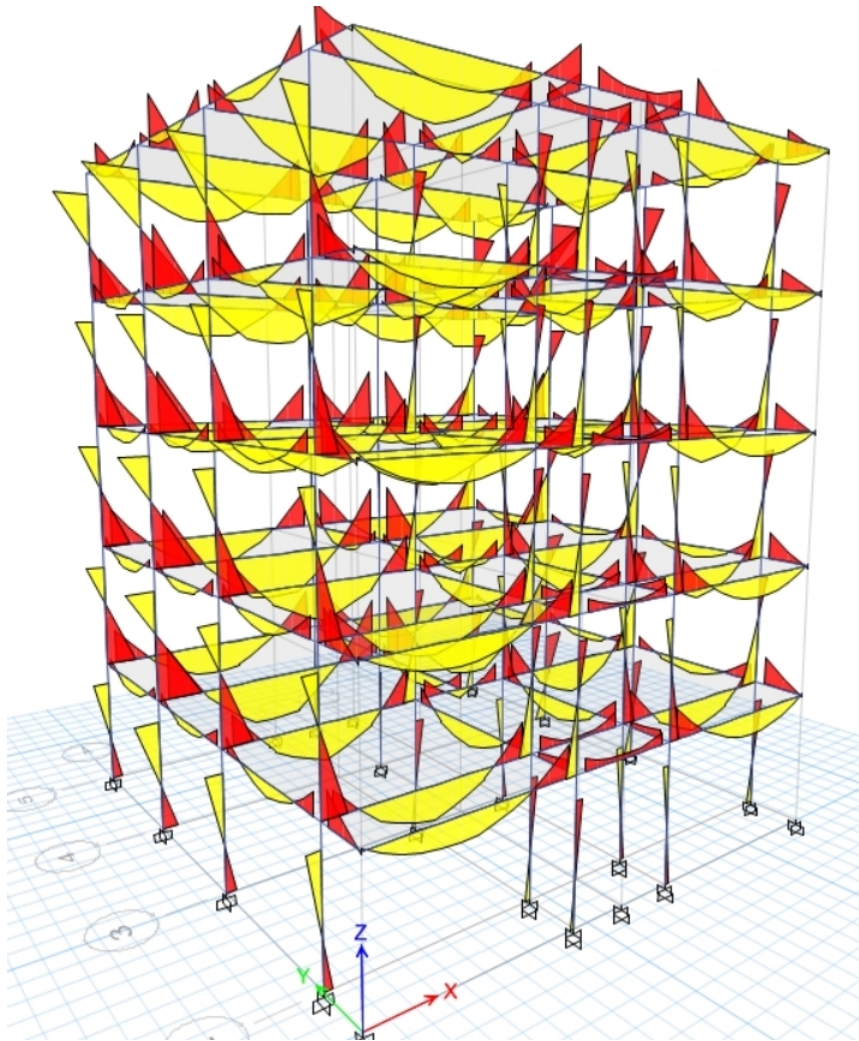


Figure 6.4: Bending Moment Diagram

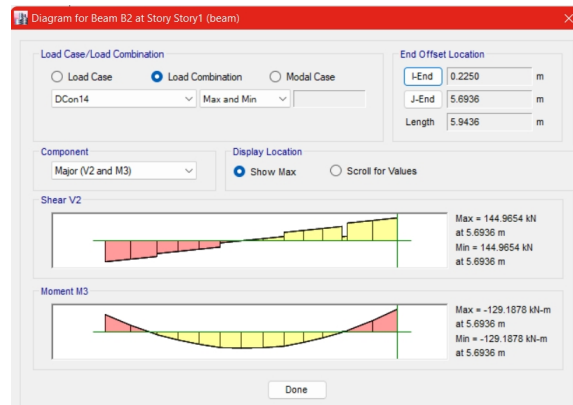


Figure 6.5: Bending Moment Results For Beams

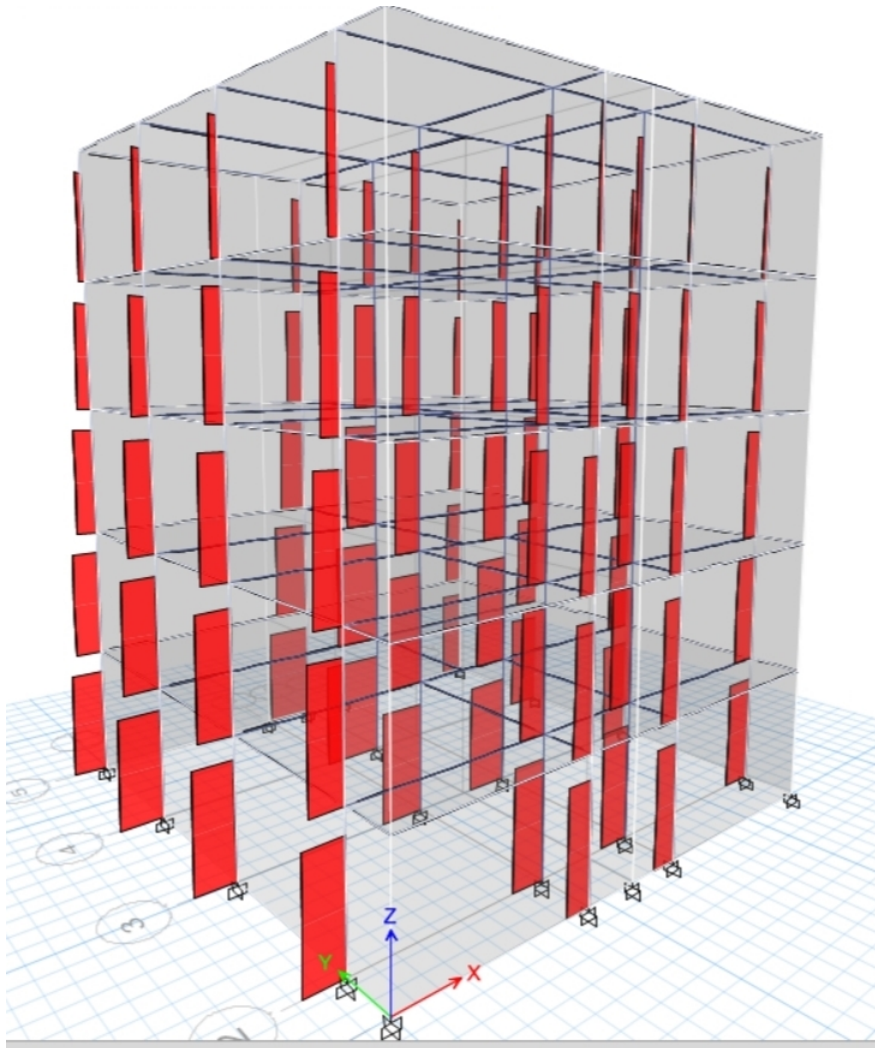


Figure 6.6: Axial Force Diagram

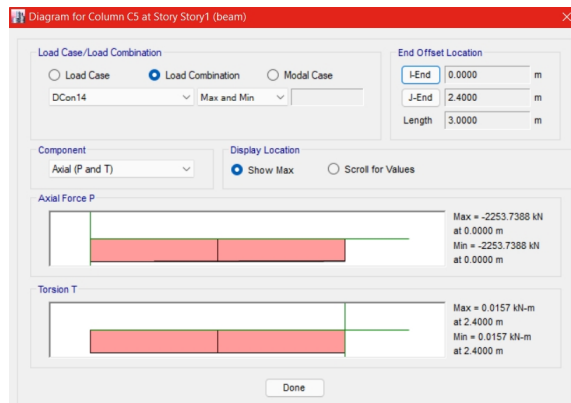


Figure 6.7: Axial Results For Frames

Chapter 7

DESIGN OF CONCRETE FRAMES

7.1 Beam Design

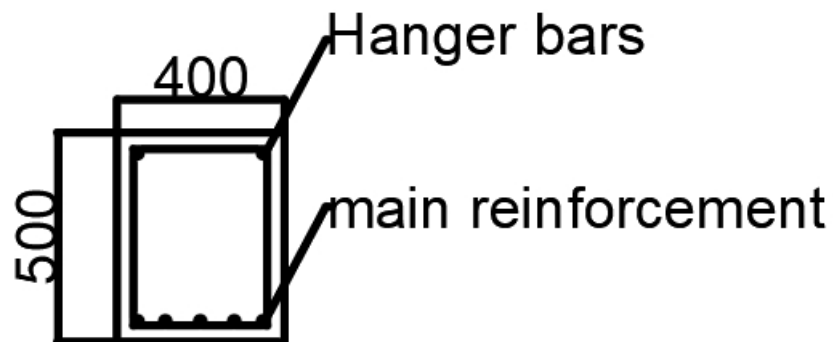


Figure 7.1: cross section of beam at story 1

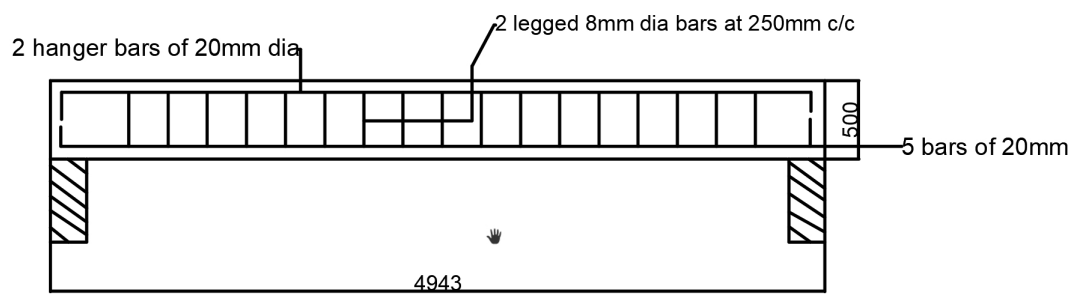


Figure 7.2: Longitudinal section of beam at story 1

DETAILING OF BEAM DESIGN	
Width of the beam	400mm
Depth of the beam	500mm
Area of Steel provided	1570.79mm ²
Bottom reinforcement	5 bars of 20mm dia
Stirrups	8mm dia bars at 250mm c/c

7.2 Rectangular column Design

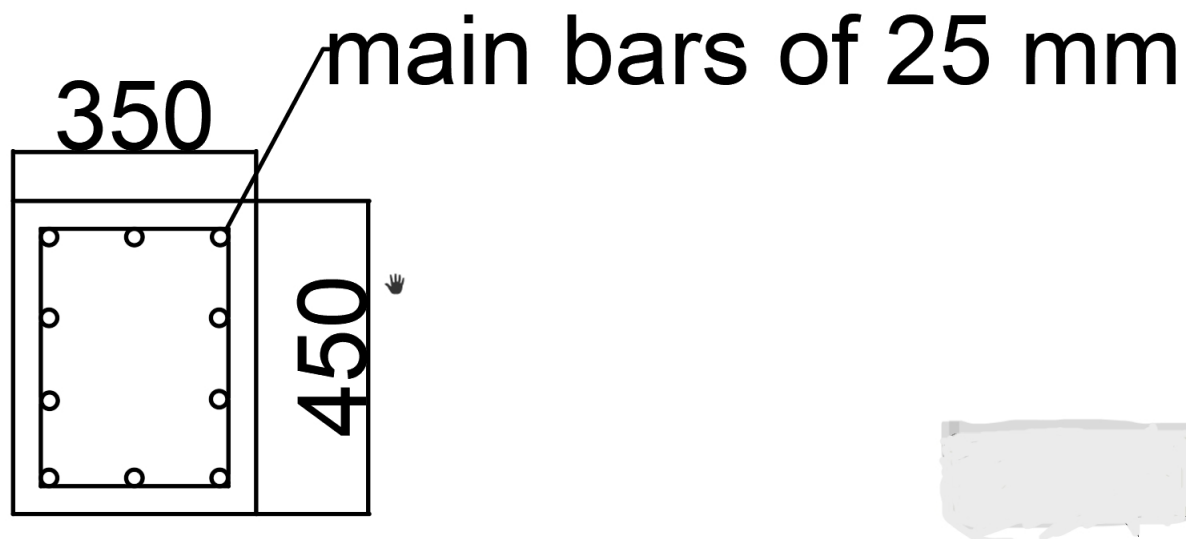


Figure 7.3: cross section of Rectangular column at story 1

DETAILING OF RECTANGULAR COLUMN DESIGN	
Width of the beam	350mm
Depth of the beam	450mm
Area of Steel provided	4623.09mm ²
No of bars	10 bars of 25mm dia
Lateral ties	8mm dia bars at 300mm c/c

7.3 Square column Design

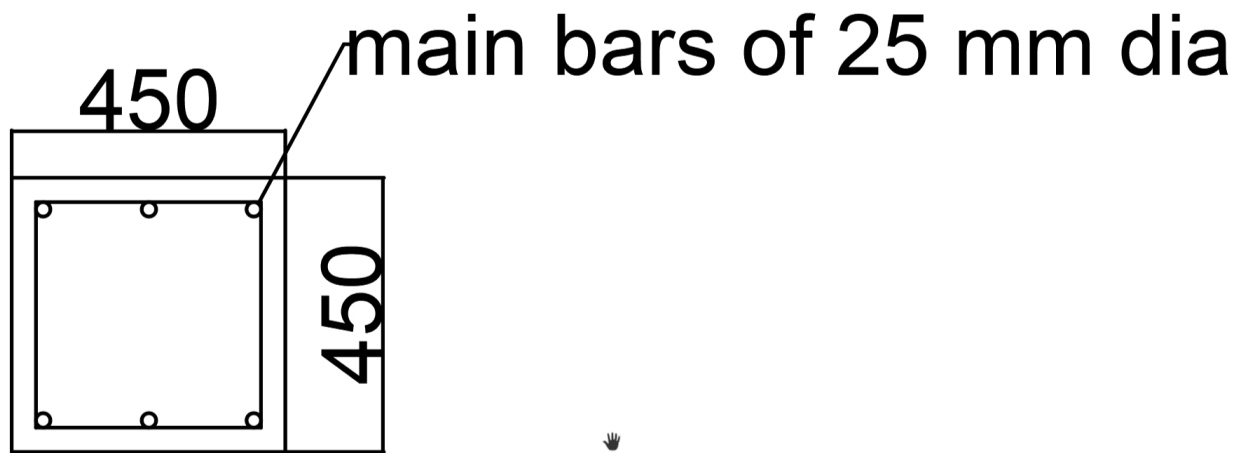


Figure 7.4: cross section of square column at story 1

DETAILING of SQUARE COLUMN DESIGN	
Width of the beam	450mm
Depth of the beam	450mm
Area of Steel provided	2069.6MM ²
No of bars	6 bars of 25m <u>dia</u>
Lateral ties	8mm <u>dia</u> bars at 300mm c/c

7.4 Slab Design

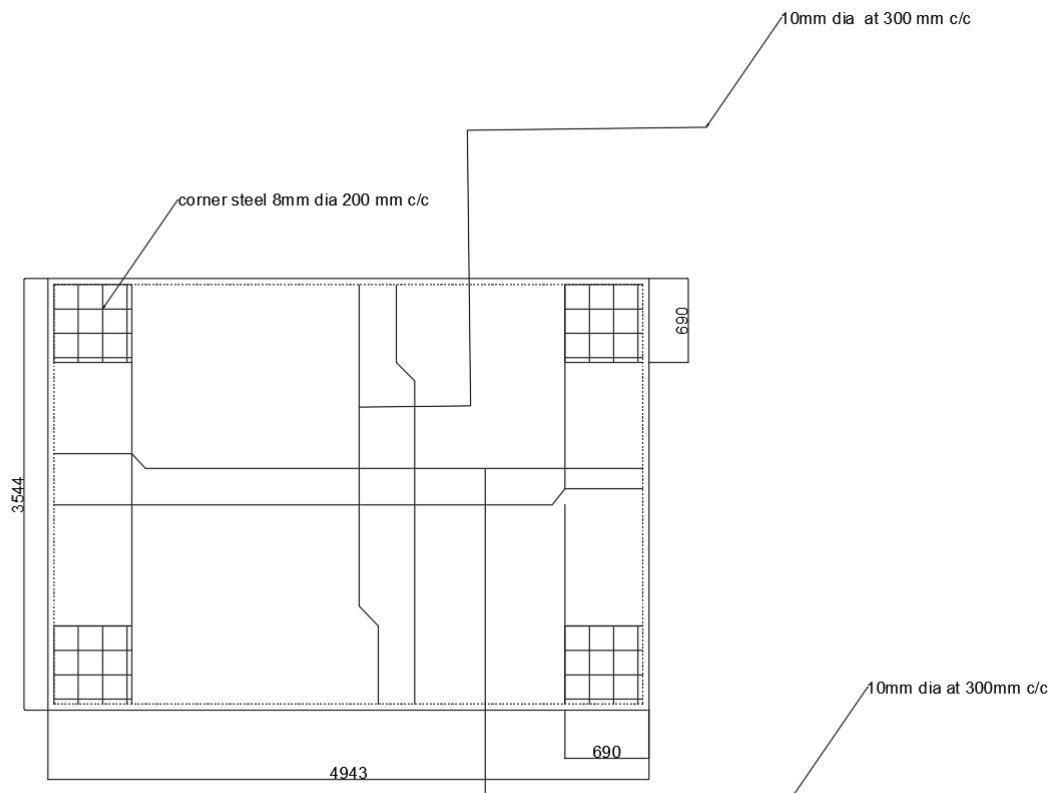


Figure 7.5: Plan of the Slab

DETAILING OF SLAB DESIGN	
Lenth of shorter span	3.45m
Length of longer span	4.94m
Area of Steel provided along shorter direction	180.25mm ²
Area of steel provided along longer direction	210.375mm ²
Spacing along shorter span	10mm dia at 300mm c/c
Spacing of longer span	10mm dia at 300mm c/c
Torsional reinforcement distance	690mm
Torsional reinforcement spacing	8mm dia at 200mm c/c

7.5 ISOLATED Footing Design

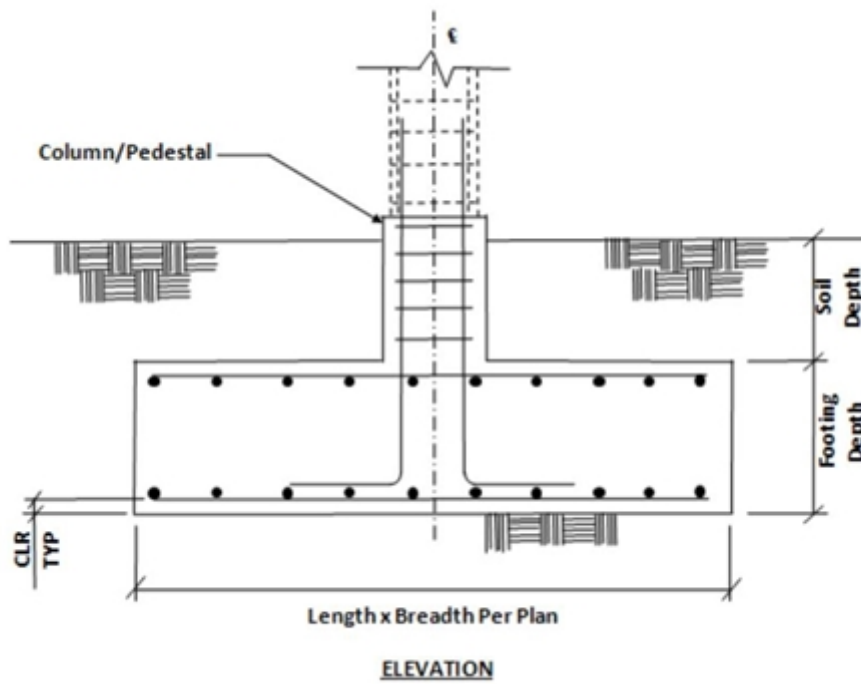


Figure 7.6: Elevation of the footing

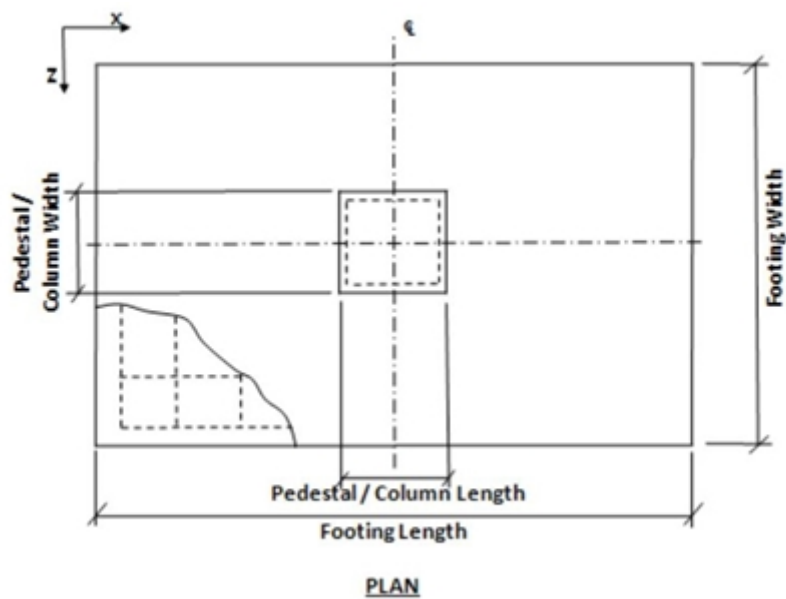


Figure 7.7: Plan of the footing

DETAILING OF FOOTING DESIGN	
Column size	350mm x 450mm
Lenth of the footing	5.45m
Width of the footing	5.45m
Depth of the footing	0.711m
Area of steel for bottom reinforcement(Mx)	9481.380mm ²
Area of steel for bottom reinforcement(Mz)	9126.334mm ²
Area of steel for top reinforcement(Mx)	4649.940mm ²
Area of steel for top reinforcement(Mz)	5180.433mm ²
Bottom reinforcement(Mx)	12mm dia bars atm65mm c/c
Bottom reinforcement(Mz)	12mm dia bars at 60mm c/c
Top reinforcement(Mx)	8mm dia bars at 50mm c/c
Top reinforcement(Mz)	8mm dia bars at 55mm c/c

Chapter 8

CONCLUSION

- * From the ETABS and STAAD foundation the analysis and design of G+4 Residential building was studied.
- * The critical beam was found out in ETABS and design manually.
- * The critical column was found out in ETABS and design manually.
- * Two way Slab was designed manually.
- * Isolated footing was designed in STAAD foundation software.

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