ANALYSIS AND DESIGN OF SINGLE COLUMN BUILDING USING STAAD PRO

A

PROJECT REPORT

Submitted in partial fulfilment of the requirements for the award of the degree

Of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision

Of

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To

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HIMACHAL PRADESH, INDIA

MAY – 2021

STUDENT'S DECLARATION

I hereby declare that the work presented in the Project report entitled **"ANALYSIS AND DESIGN OF SINGLE COLUMN BUILDING USING STAAD PRO"** submitted for partial fulfilment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is an authentic record of my work carried out under the supervision of **Mr. CHANDRA PAL GAUTAM**. This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

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MAY, 2021

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **““ANALYSIS AND DESIGN OF SINGLE COLUMN BUILDING USING STAAD PRO”** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat** is an authentic record of work carried out by **Akshay Pathania (171659), Hardik Nagpal (171620)** during a period from August, 2020 to May,2021 under the supervision of **Mr. Chandra Pal Gautam** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

Date: MAY 2021

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Date: MAY 2021

ABSTRACT

The main purpose of this project is to study and construct a multi-story structure (G+3) on a single column using STAAD PRO and compare it with multiple column building. The design involves dead load, live load and floor load and analyzing the whole structure by STAAD PRO. STAAD PRO has a cutting-edge user interface, visualization tools, and advanced analysis and design engines. From model generation, analysis and design to results in post processing, STAAD PRO is the best in the market.

It has an easy-to-use user interface that allows users to draw any structure and enter load values and dimensions. STAAD PRO also gives the option of selecting the material of structure and analyzing it from over 80 codes recognized all over the world. A rough plan was drawn and then selected for STAAD PRO. We have used only dead load, live load and floor load on single column building and compared the results for the general column building. The study and design of a [G+ 3] RCC frame under various load combinations was our final project.

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LIST OF ACRONYMS AND ABBREVIATIONS

a	Coefficient of thermal expansion
E	Modulus of Elasticity
F x	Shear force in X direction
F y	Shear force in Y direction
F z	Shear force in Z direction
G	Shear modulus
nu	Poisson’s ratio
DL	Dead Load
LL	Live Load
WL	Wind Load
EL	Earthquake Load
M x	Moment in X direction
M y	Moment in Y direction
M z	Moment in Z direction

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

A commercial building is one that is primarily used for business purposes. Office buildings, warehouses, and retail (convenience stores, "big box" stores, shopping malls, and so on) are all examples of different types.

A commercial building in a city often combines residential and commercial uses. Local governments frequently enforce strict commercial zoning regulations and have the authority to designate any zoned area as such. A commercial area or an area zoned at least partially for commerce is required for a business to be located.

These modern reinforced concrete structures may appear to be extremely complicated in design. The majority of these structures, on the other hand, are made up of a variety of basic structural elements such as beams, columns, slabs, walls, and foundations.

As a result, the designer must become acquainted with the design of these fundamental reinforced concrete elements. After that, the joints and connections are meticulously developed. Reinforced concrete structures were first designed using a purely empirical approach at the turn of the century.

The so-called rigorous elastic theory followed, in which stress levels in concrete and steel were reduced and stress-deformations were believed to be linear. The limit state form, while being a semi-empirical technique, has been found to be the best for designing reinforced concrete structures.

The main aim of the project is to use Staad Pro to analyse and design an RCC structure. Beams, Columns, Staircase, and Slab are the major structural components of this building, with beams and columns designed using Staad software and slab and staircase designs done manually using I.S Codes.

Various loads, such as dead load, live load, and earthquake load, are acting on this structure. I.S Codes can be used to calculate these loads. The acting of these loads is caused by a variety of factors.

1.2 OBJECTIVES

- To study the effects of various loads like (dead load, live load, wind load, seismic load) on a single column building(G+3) and compare it with a normal column building on STAAD PRO.

1.3 SCOPE

The key aim of this project is to apply what we've learned in class to create a real-world RCC framework. These structures necessitate large, open spaces that are not obstructed by columns. The large floor area provides enough flexibility and space for future expansion. Change in the production layout that does not necessitate significant structural changes. The construction of a two-story business building with a large seminar hall for training participants was the subject of this Major Qualifying Project.

The project team's goal is to create a structural system that is both cost-effective and safe, as well as adaptable to the intended use. Based on the building's anticipated business use, the project team creates an architectural layout and floor plan. After that, the group created a structural framing system to model. Beams, girders, columns, connections, and foundation elements will all be designed, as will all major structural members. Both steel and concrete construction are investigated in frame designs. Both materials were then compared and analysed, with one of the materials being used to create a final, cost-effective structural frame.

The team compared a variety of structural strategies and materials to see how they affected the structure's economics, performance, and constructability.

1.4 BACKGROUND

The research base that contributed to the development of this Major Qualifying Project is discussed in this section of the background. The information gathered about the various elements of the building, as well as the structural design and analysis, is presented in the sections below.

1.5 ABOUT OUR PROJECT

Due to rapid urbanization and globalization there is a continuous rise of high rise buildings which are not only safe but also provide better ground utilization and look pleasant to the eyes as well.

Our project also deals with the analysis and design of a multi storey building (G+3) on a single column and analyzing it on STAAD PRO and comparing it on various parameters with a general column building.

PARAMETER	**VALUE**
SINGLE COLUMN	2.6m*2.6m
COLUMNS	0.61m*0.61m
BEAMS	0.61m*0.61m
PLATES THICKNESS	0.1 m
COMPRESSIVE STRENGTH	40000 Kn/m^2

YIELD STRENGTH FOR MAIN REINFORCEMENT	500000 Kn/ m^2
MAXIMUM SEC. REINFORCEMENT	12 mm
MAXIMUM MAIN REINFORCEMENT	20 mm
LOCATION OF BUILDING	District Kangra Himachal Pradesh

Table 1.1 Input Parameters

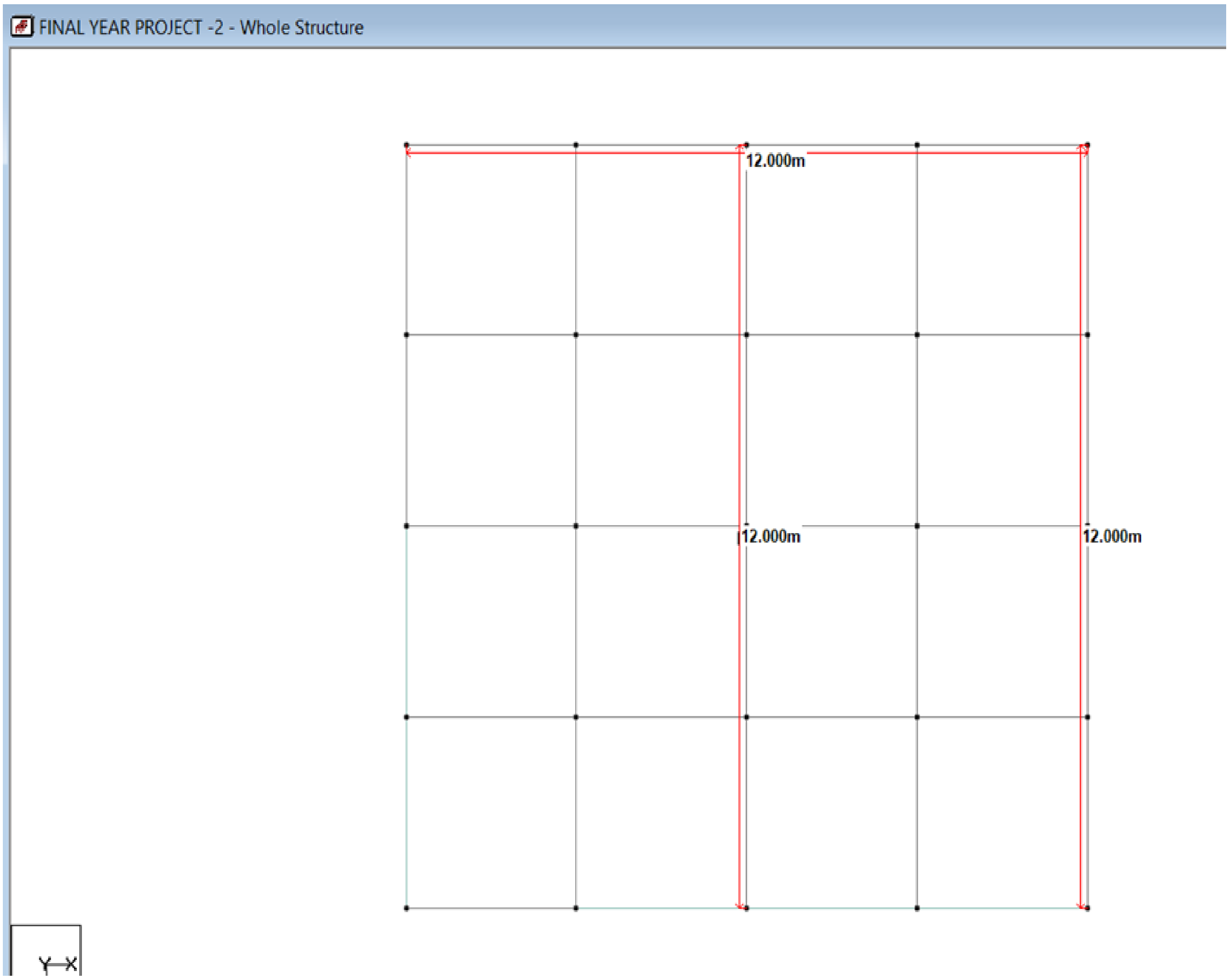


Figure 1.1 Base Plan of Structure

CHAPTER 2

LITERATURE REVIEW

2.1 Journals

1. Babu and Venkatesh (2016) reported that a single column supports the entire structure, while the other members serve as cantilevers. On STAAD PRO, the structure was evaluated for different loading conditions.

2. Arora et al. (2017) studied that earthquake Resistant Design and reported that present paper deals with the advantages and the future trends in earthquake resistant design of the structures.

3. Saleem and Kumar (2017) reported that STAAD Pro is a convenient software that allows users to create mounts and load values for specific dimensions. They also analysed the differences between manual and software design, which led to an improvement in design quality and accuracy.

4. Nagaraju1 et al. (2018) reported that the Limit state method was used to build the column, beam, rectangular footing, and staircase, which is secure than working stress method. They also concluded that structural members such as columns and beams have been engineered for ductility, so lateral forces at member joints will be minimal and torsion will be avoided.

5. Trivedi and Pahwa (2018) done Wind Analysis and Design of G+11 Storied Building Using STAAD-Pro. They concluded that Wind loads can be measured in a specific region using a zone factor.

6. Falak Vats (2019) concluded that high-rise structures STAAD Pro can be used to calculate loads and their combinations, analyse the structure, and construct the structure based on the analysis.

7. Irfan and Vimala (2019) in their paper collapse mechanism of 5,12,15 storey buildings are analyzed. Base shear, displacement increases with increase in SCWB. In low rise buildings hinge formations involved only beams whereas high rise involved beams and columns.

8. Kunal et al. (2019) In paper comprises of seismic analysis and design of G+7 RCC building. Various loads and load combinations were applied and analyzed using STAAD PRO. It is a very adaptable software having ability for determine seismic analysis.

9. Savadi and Hosur (2019) showed that cost of the Composite is least as compared to RCC and steel. Bending Moment and shear force is also least in composite due to decreased dead load. Composite structure is best solution for the multi storied structure.

10. Sahu et al. (2020) studied the STAAD Pro, with its latest features, outperformed its predecessors and competitors, and that its data sharing capabilities with other major applications, such as AutoCAD, set it apart from the competition. and it was also accurate in designs.

2.2 **Design Codes**

2.2.1 IS 456:2000

Indian Standard plain and reinforced concrete code of practice. The main code for the design of all reinforced concrete (RC) structures, IS 456:2000, has added new dimensions to the current situation, and its importance in building earthquake-resistant structures must be considered in full. IS 456:2000 suggests that earthquake resistant structures be detailed using IS 13920: 1993 and IS 4326: 1993.

2.2.2 IS 1893 (Part I):2002

Indian Standard Criteria for Earthquake Resistant Design of Structures.

This norm includes requirements that are wide in scope and apply to all types of structures. It also has clauses that are only applicable to houses. Apart from seismic zoning map and seismic coefficients of important cities, map showing epicenters, map showing epicenters, and dynamic analysis, it includes general principles and design parameters, variations, design scope, key attributes of buildings, and dynamic analysis.

2.2.3 IS 875 (Part 1):1987

Code of practice for design loads (other than earthquake) for buildings and structures – Dead loads

IS 875 (Part 1) deals with the different live loads that must be taken into account when designing buildings. The weights of walls, partitions, floor finishes, false ceilings, false floors, and other permanent constructions in buildings make up the dead load. The dead load loads can be measured using the dimensions and unit weights of different members. Simple concrete and reinforced concrete have different unit weights.

2.2.4 IS 875 (Part 2):1987

Code of practice for design loads (other than earthquake) for buildings and structures - Imposed loads.

IS 875 (Part 2) deals with the different live loads that must be taken into account when designing buildings. The weight of movable partitions, dispersed and concentrated loads, load due to impact and vibration, and dust loads are all examples of imposed loads caused by the intended use or occupation of a building. Wind, seismic activity, snow, and temperature-related loads are not included in the enforced loads.

2.2.4 IS 875 (Part 3):1987

Code of practice for design loads (other than earthquake) for buildings and structures - Wind Loads

Wind loads must be considered when designing buildings, structures, and materials, according to IS 875 (Part 3). This specification specifies the wind forces and their effects (static and dynamic) that should be considered when constructing building structures, as well as the force exerted by the horizontal aspect of the wind. Wind loads are determined by the speed of the wind.

CHAPTER 3
STAAD. PRO

3.1 Introduction to Staad. Pro

STAAD Pro. V8i is the most commonly used structural engineering programme for model generation, analysis, and multi-material design. It has a graphical user interface that is intuitive and easy to use, as well as visualisation tools, efficient analysis and design features, and seamless integration with a range of other modelling and design software products.

STAAD Pro was chosen because of the benefits it provides:

- Easy-to-use interface
- Compliance with Indian Standard Codes
- Adaptability in solving a wide range of problems
- Accuracy of the solution

It is made up of the various components:

STAAD.Pro GUI is used to create the perfect which is then analysed with the STAAD engine. The GUI can also be used to view the results graphically after the analysis and design have been completed.

The STAAD analysis and design engine is comprised of the following components: It's a structural analysis and integrated aluminium, concrete, timber and steel construction calculation engine.

To starting, we solved some sample problems with STAAD Pro and double-checked the accuracy of the results using manual calculations. The outcomes were fulfilment and exact. During the initial stages of our project, we calculated building loadings as well as seismic and wind loads.

In order to do an effective analysis, a structural engineer must first assess structural stresses, geometry, support conditions, and material properties. Support reactions, stresses, and displacements are common outcomes of this type of investigation. After that, the data is compared to criteria that indicate failure conditions. Dynamic response, stability, and non-linear behaviour are all things that advanced structural analysis can look into. The goal of design is to achieve a reasonable probability that the structures being designed will perform satisfactorily for the duration of their intended lives. With the appropriate level of education.

They should be able to withstand all normal construction and use loads and deformations, as well as have sufficient durability and resistance to seismic and wind effects. In most cases, the Limit State Method should be used to design the structure and structural elements. Accepted theories, experimentation, and experience should all be considered, as well as the need to design for long-term use.

The entire design process, including durability design, construction, and use in service, should be taken into account. The accomplishment of design goals necessitates adherence to precisely established criteria for materials, manufacturing, workmanship, as well as maintenance and usage of the structure in operation.

The design of the building is regulated by the Indian Standard Codes' minimum standards. Minimum construction loads for dead loads, forced loads, and other external loads that the structure must withstand are established to address the minimum standards for structural protection in buildings.

It is hoped that strict adherence to the loading standards recommended in this code will ensure not only the structural safety of the buildings being designed, but also the structural safety of the buildings themselves.

3.2 TOOLS IN STAAD PRO

3.2.1 MOVE TOOL

This tool is used to move a particular member or a whole structure in STAAD PRO.

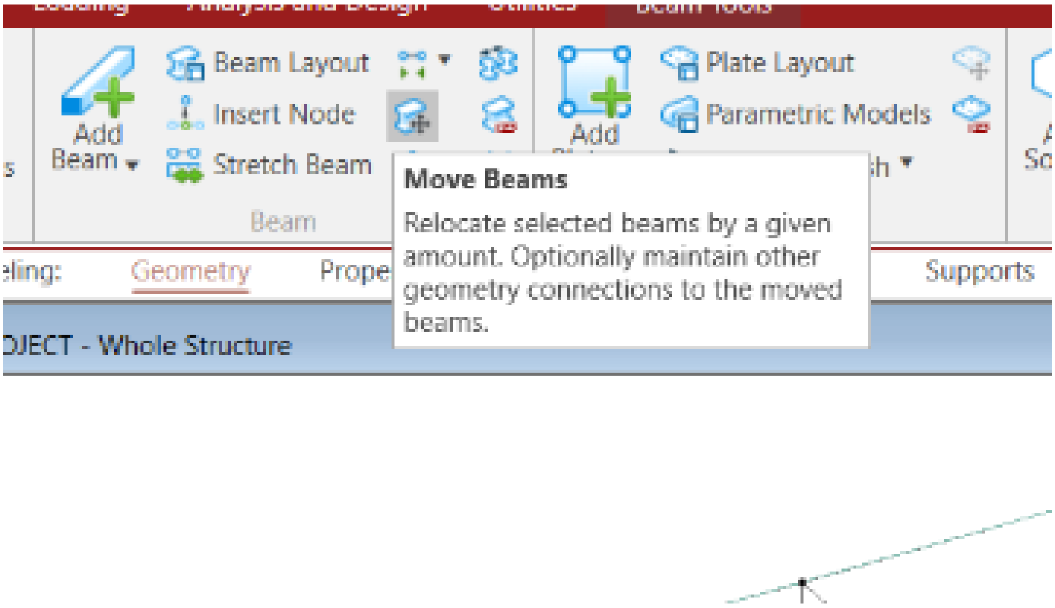


Figure 3.1 Move command

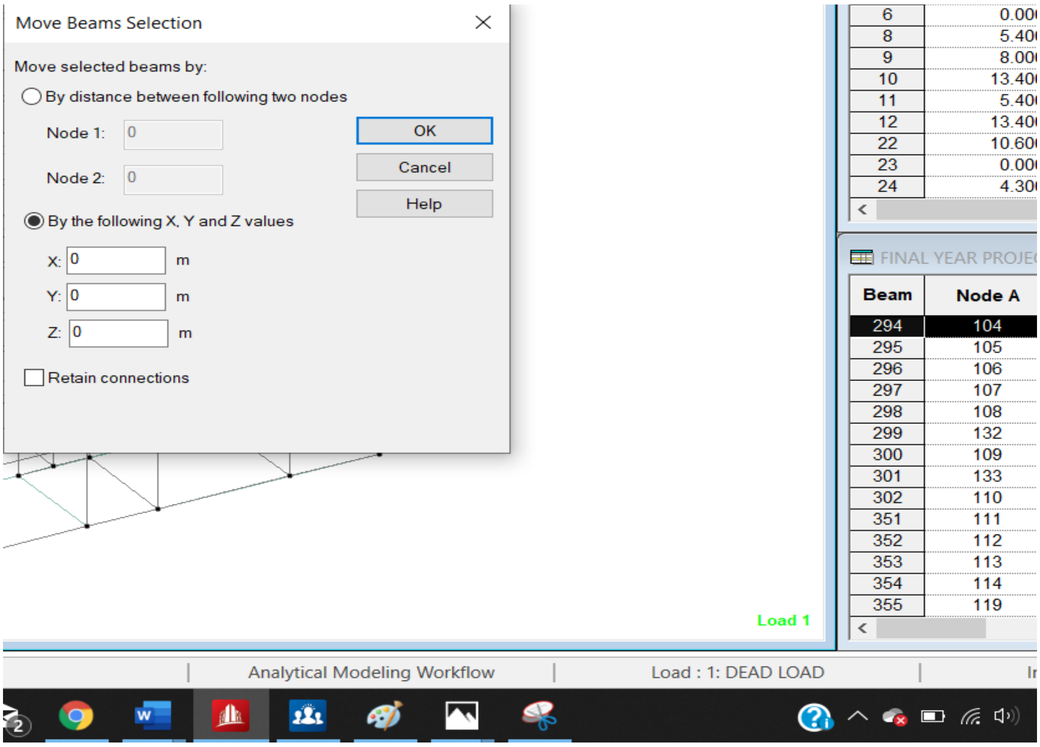


Figure 3.2 Move command in staad pro

3.2.2 TYPES OF CURSORS IN STAAD PRO

There are generally 4 types of cursors in STAAD PRO which are following:

- NODE CURSOR used for selecting the nodes.
- BEAM CURSOR used for selecting the beams
- PLATE CURSOR used for selecting the plates.
- SOLID CURSOR used for selecting any other solid material

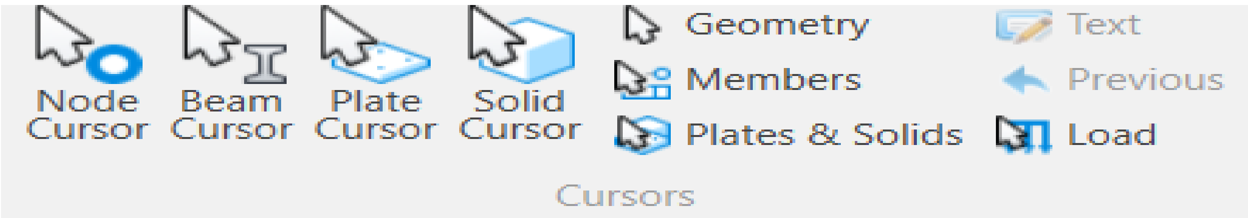


Figure 3.3 Types of cursors

3.2.3 SELECTING THE MEMBERS

STAAD PRO gives us the option of selecting the members like nodes, beams, plates, solids in a particular direction. The image below showcases it.

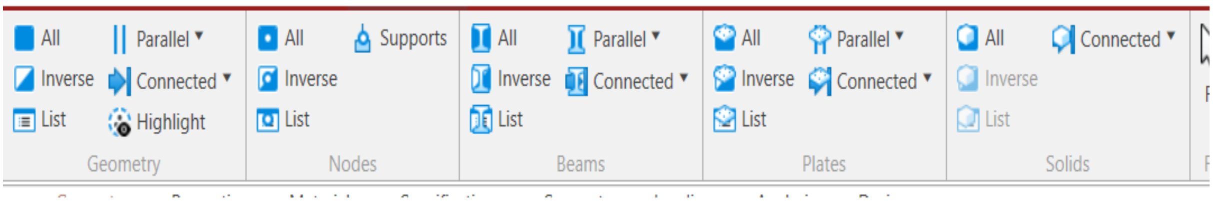


Figure 3.4 Ways to select the members

3.2.4 MIRROR COMMAND

STAAD PRO allows the user to mirror the structure in any direction as they want. Whether along the x axis , y axis , z axis respectively.

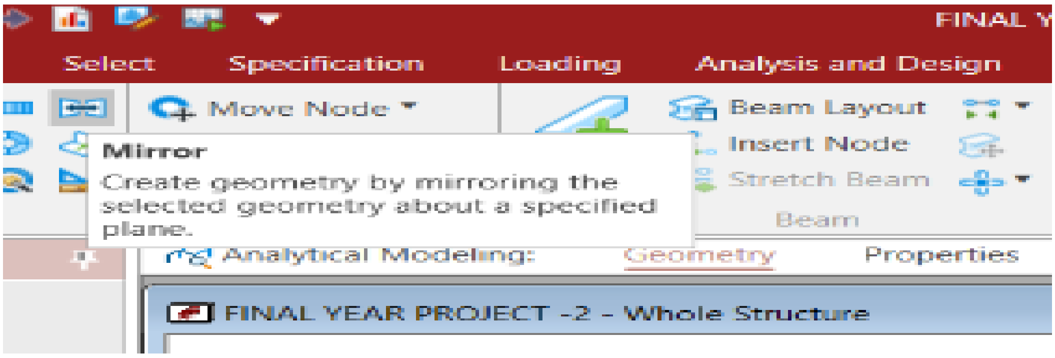


Figure 3.5 Mirror command

3.2.5 TRANSLATIONAL REPEAT

As the name suggests this command is used to repeat the structure in any direction. This command is preferred for high rise buildings.

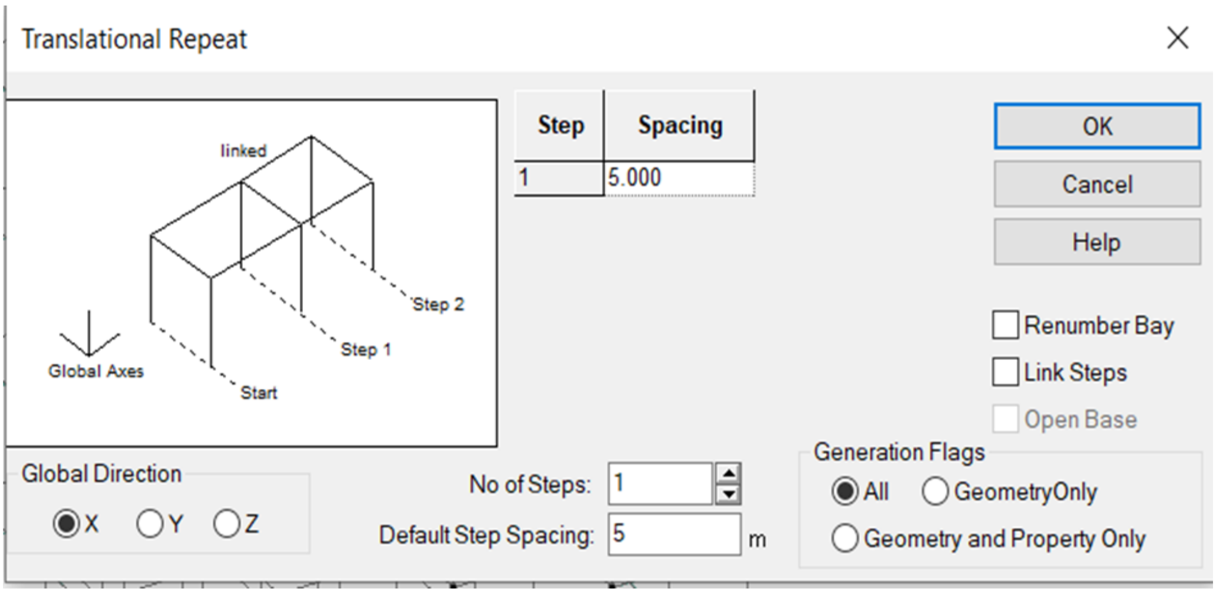


Figure 3.6 Translational repeat

3.2.6 CIRCULAR REPEAT

This command is used to prepare circular or dome structures.

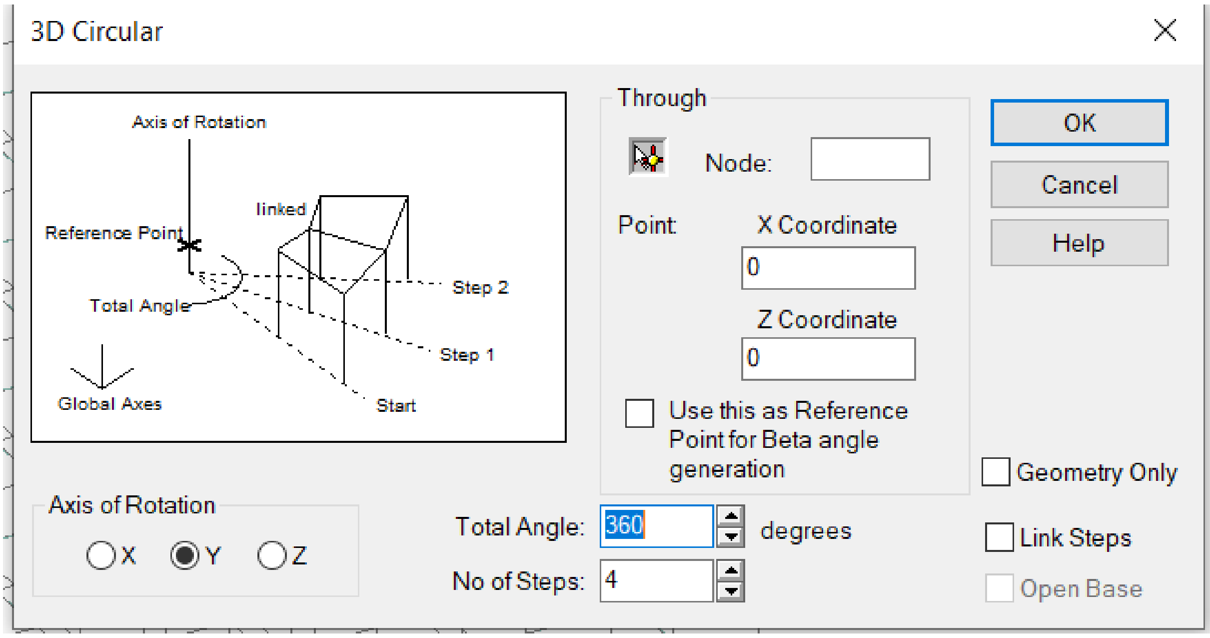


Figure 3.7 Circular repeat command

3.2.7 POST PROCESSING MODE

This mode is used after analysis shows zero errors and zero warnings. This mode displays all the results of the structure. From shear force to bending moment to displacement to plate stress this mode covers all the results for each member.

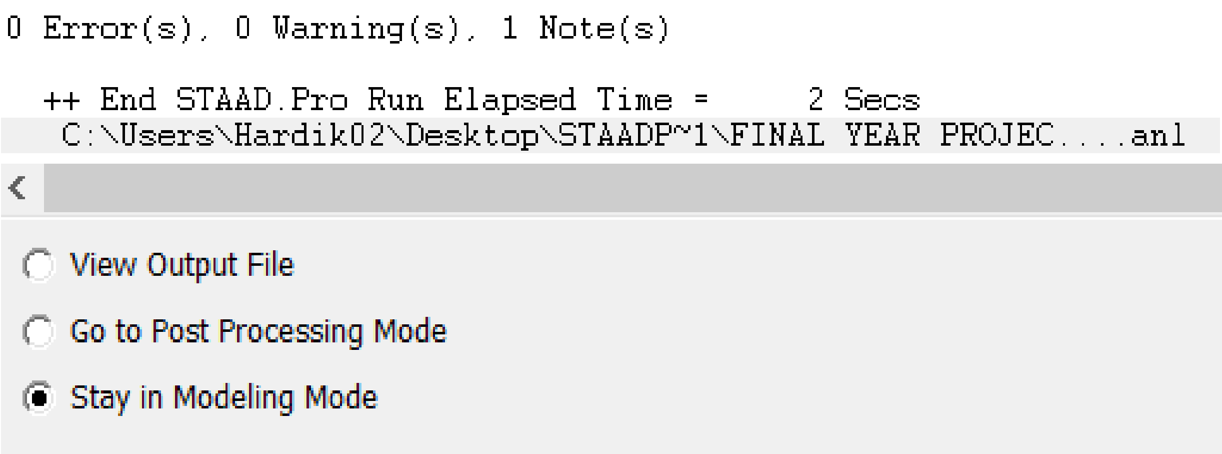


Figure 3.8 Analysis window showing post processing mode

3.2.8 STAAD PRO CONNECT EDITOR

This option is used as a coding in STAAD PRO and is a very effective tool to correct the errors. However it needs to be used very carefully and only after the user is well versed with the interface and the use of software.

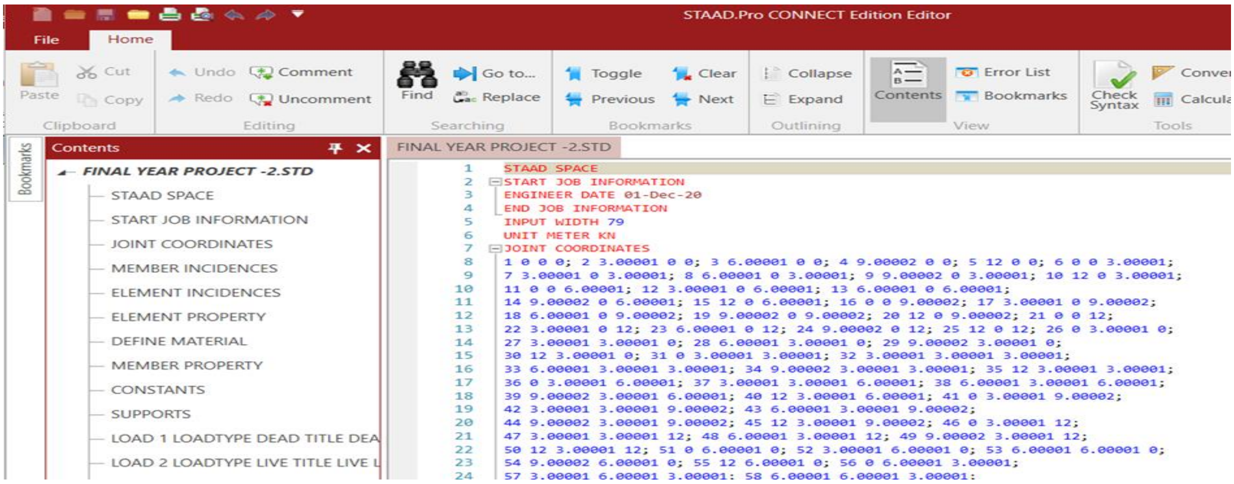


Figure 3.9 Staad pro connect editor window

3.2.9 VARIOUS TYPES OF STAAD SOFTWARE

There are many types of staad software available which are included in the connect edition like staad foundation, rcdc connect edition , staad building planner , ssdn connection client etc.

Figure 3.10 Types of staad softwar

CHAPTER - 4

WORKING WITH STAAD. *PRO*

The STD input file is how the Graphical User Interface interacts with the STAAD.pro research engine. The input file is a text that includes a sequence of commands that must be run in the correct order. The commands are either recommendations or orders.

The STAAD input file can also be created using a text editor or the GUI Modelling facility. In general, any text editor can be used to edit/create the STD input file. The GUI Modelling facility creates the input file using an integrated menu-driven graphics-oriented interface.

4.1 Types of Structures

An assemblage of elements can be described as a structure. Structures made up of frame, plate/shell, and solid elements can be analysed and designed using STAAD.Pro. STAAD can analyse almost any type of structure. Software designed for professionals. a structure in space,

A three-dimensional framed structure with loads applied in any plane is the most general structure. A plane structure is bound by a global X-Y coordinate scheme when loads are in the same plane. Truss members can only withstand axial member forces and cannot bend in a TRUSS system.

A floor arrangement is a two-dimensional or three-dimensional structure that has no horizontal (global X or Z) movement [all FX, FZ, and MY joints are restrained]. The floor framing (in the global X-Z plane) of a building is a good example of a floor structure.

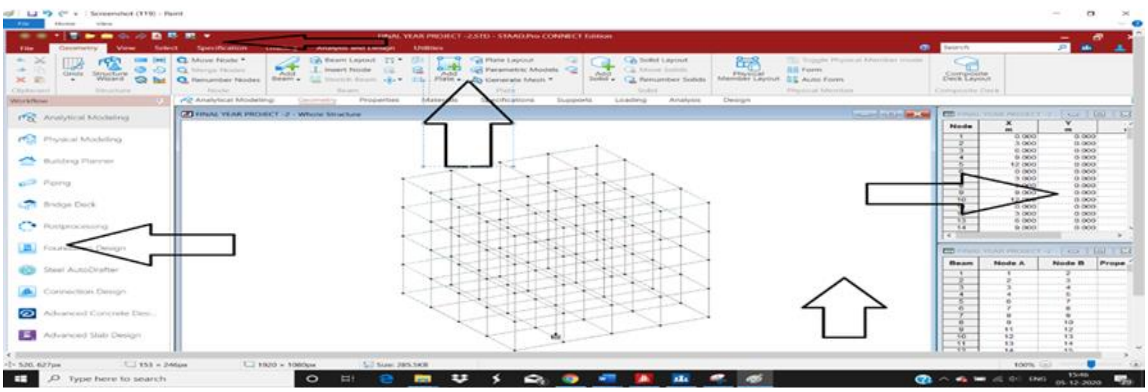


Figure 4.1 Generation of structure through gui

4.2 Supports

It can be pinned, fixed, or fixed with different releases. A pinned support has no restraints against rotational movement but does have limits against all translational movement. To put it another way, a pinned support will elicit responses but will not be able to withstand any moments. The restraints on a fixed support are in place to prevent movement in all directions. It's also possible to specify translational and rotational springs. To reflect the springs, the spring constants are used. The translational spring constant is the force needed to displace a support joint one length unit in the defined global direction. On the other hand, a rotational spring constant is known as the force needed to rotate the support joint one degree around the given global direction.

4.3 Loads

Joint loads, member loads, temperature loads, and fixed end member loads are all types of loads that can be specified in a structure. STAAD is an acronym for "Standardized Transportation Authority.

In addition, Pro can calculate the structure's self-weight and practise it in analysis as uniformly distributed member loads.

4.3.1 Joint loads

Any free joint of a structure can be subjected to joint loads, which include both forces and moments.

The structure's global coordinate system is affected by these loads. The positive coordinate directions are acted upon by positive forces. A single joint can have any number of loads applied to it, and the loads will be additive on that joint.

4.3.2 Members load

There are three different kinds of member loads that can be assigned to the members of a system. These types of loads include uniformly spaced loads, clustered loads, and linearly varying loads (including trapezoidal). The full or partial length of a member is affected by uniform loads.

Concentrated loads have an effect at any intermediate, pre-determined location. Loads that vary linearly act across the entire length of a member. Trapezoidal linearly differing loads work over the whole length of a member or a part of it, and are transformed into a uniform load and multiple clustered loads.

In any independent loading condition, any number of loads can be specified to act on a member. The member coordinate system or the global coordinate system can be used to specify the member loads. Member loads that are uniformly distributed in the global coordinate system can be specified to act along the entire or projected length of the member.

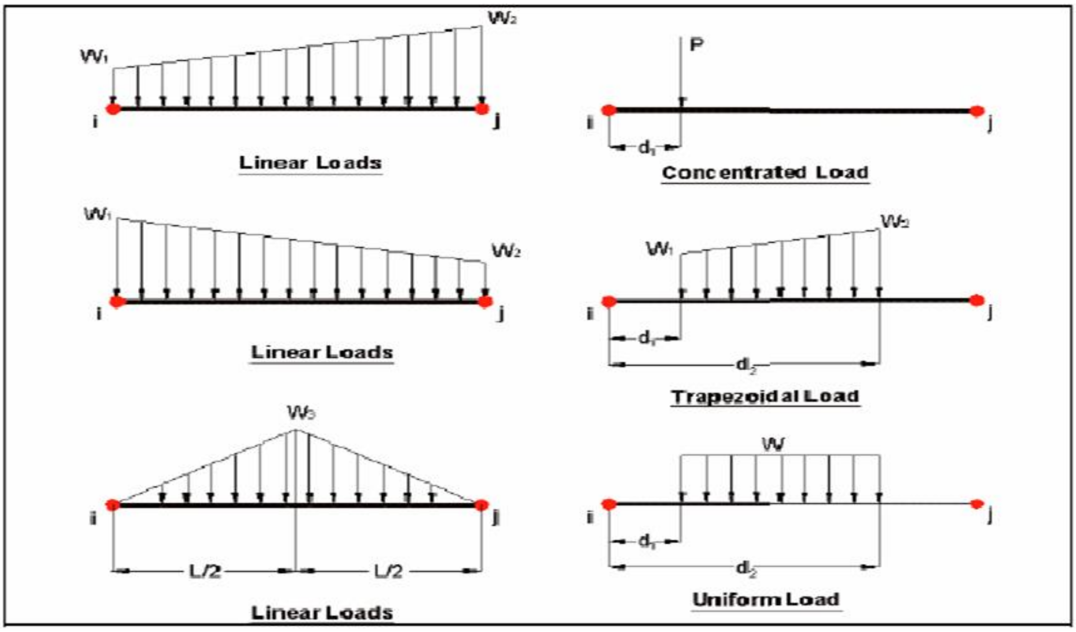


Figure 4.2 Member load configuration

4.3.3 Floor load

A uniformly distributed load is often applied to a floor (bounded by the X-Z plane).

4.3.4 Generator of Seismic Loads:

The equivalent lateral load analysis procedure is followed by the STAAD seismic load generator. The lateral loads are assumed to be applied in the X and Z directions, with the gravity loads being applied in the Y direction. As a result, the Y axis will be perpendicular to the floors and will point upward in a building model (all Y joint coordinates positive). The user must supply seismic zone coefficients, importance factors, and soil characteristic parameters in order to generate loads in accordance with the codes. Rather than using the approximation. The programme calculates the period using the Raleigh quotient technique, using code-based formulas to estimate the building period in a specific direction. Following that, the seismic coefficient C is calculated using this period. Following the calculation of the base shear using the appropriate equation, it is distributed among the various levels and roofs in accordance with the specifications. Lateral loads are applied to the structure as a result of the distributed base shears. These loads can then be used for analysis and design as standard load cases.

4.3.5 Generator for Wind Loads:

From user-specified wind intensities and exposure factors, the STAAD Wind Load generator can calculate wind loads on joints of a structure. For different height zones of the structure, different wind intensities can be specified. Exposure factors can be used to simulate openings in a structure. The exposure factor of each structure joint is defined as the fraction of the impact area on which the wind load works. Built-in algorithms measure the exposed area based on the areas bounded by members (plates and solids are ignored), calculate wind loads based on the speed and exposure data, and distribute the loads as lateral joint loads.

4.4 Design Parameters

A range of parameters are included in the code that are needed for IS 13920 architecture. It agrees all of the parameters required to complete a specification in accordance with IS: 456. It also has a few additional parameters that are only available when the design follows IS: 13920. The default parameter values were selected to be numbers that are often found in standard design specifications.

4.5 Design of Beams

Flexure, shear, and torsion resistance are also built into beams. If required, the influence of the axial force may be considered. To determine the critical load cases at different parts of the beams, all active beam loadings are pre-scanned for all of these forces. To be constructed according to IS: 13920, the width of the member must not be less than 200mm.

4.6 Design of Columns

IS 456:2000 specifies the design of columns for axial forces and biaxial moments. Shear forces are also taken into account when designing columns. All major requirements for choosing longitudinal and transverse reinforcement as defined by is 456 have been taken into account in the staad column design

Advantages of following clauses, however, have been met in order to incorporate IS 13920 provisions:

1. Concrete should have a minimum grade of M20.

2. Only steel reinforcements of grade Fe415 or less are permitted.

3. The column member must have a minimum dimension of 200 mm. The shortest dimension of a column with an unsupported length greater than 4m must not be less than 300 mm.

4. The shortest cross-sectional dimension to the perpendicular dimension ratio should preferably be greater than 0.

5. Hoops must be spaced no more than half the column's shortest lateral dimension, unless special confining reinforcement is provided.

6. Through each joint face to mid-span, and on either side of any segment where flexural yielding can occur, special confining reinforcement shall be given. The length lo must be greater than a) the wider lateral dimension of the member at the segment where yielding occurs, b) 1/6 of the transparent span of the member, and c) 450 mm.

7. Hoops used as special confining reinforcement must have a spacing of no more than 14 of the minimum member size, but no less than 75 mm or more than 100 mm.

4.7 General Observations

This portion contains general statements about how the Indian standard code of practice (is: 800-1984) for structural steel design is implemented in staad.pro. The principles of allowable stress design guide the design philosophy and procedural logistics for member selection and code checking. Overstressing failure and failure due to stability considerations are two major failure modes. The sections that flow describe the key aspects of the calculated allowable stresses and the stability criteria. Members are proportioned to withstand design loads without exceeding permissible stresses, and the least-costly segment is selected based on the least weight requirements. The code testing portion of the software looks at specifications for reliability and strength, as well as vital loading conditions and governing code parameters.

4.8 Allowable Stresses

Staad.pro uses allowable stress method of design as defined by is: 800 for member design and code checking. It's a method for proportioning structural members under service conditions based on design loads and forces, allowable stresses, and design limitations for the appropriate material. This manual would not be able to cover every aspect of is: 800. However, the main types of the allowable stresses specified by is: 800 and implemented in staad.pro will be discussed in this section.

4.9 Various Analyses

Multiple analyses in a single run may be required for structural analysis and design. Staad.pro helps the user to modify input such as member resources, help requirements, and so on in an input file to enable numerous analyses in the same run. The findings of different analyses can be integrated for design purposes. In systems with bracing, it might be possible to render those members inactive for one load case and then allow them for another. This method of study necessitates the use of staining.

4.10 Stability Requirements:

All members' slenderness ratios are calculated and compared to the appropriate maximum values. The maximum slenderness ratios for different types of members are summarised in is: 800. A proper maximum slenderness ratio for each member can be provided in the staad implementation of is: 800.

4.11 Deflection Test

This feature enables the user to use deflection as a criterion in code checking and member selection. Three parameters can be used to control the deflection check. Other strength and stability-related criteria are used in addition to deflection. The local deflection is calculated using the most recent analysis results.

4.12 Code Checking

The main aim is to determine if the specified section will satisfy the specifications of the specification code. the codes are verified using the is: 800 (1984) standards. forces and moments at various parts of the participants are used in the code checking equations. to designate sections, use the beam parameter or the segment order.

Chapter-5

ANALYSIS OF G+3 RCC FRAMED

5.1 COLUMN

A column is a structural structure that supports axial compressive loads and has a height of at least three times its lateral dimension. The material thickness, cross section form and scale, and length and degree of proportional and dedicational limitations at the ends of a column decide its strength.

CENTRAL COLUMN DIMENSIONS OF 2.6m*2.6m

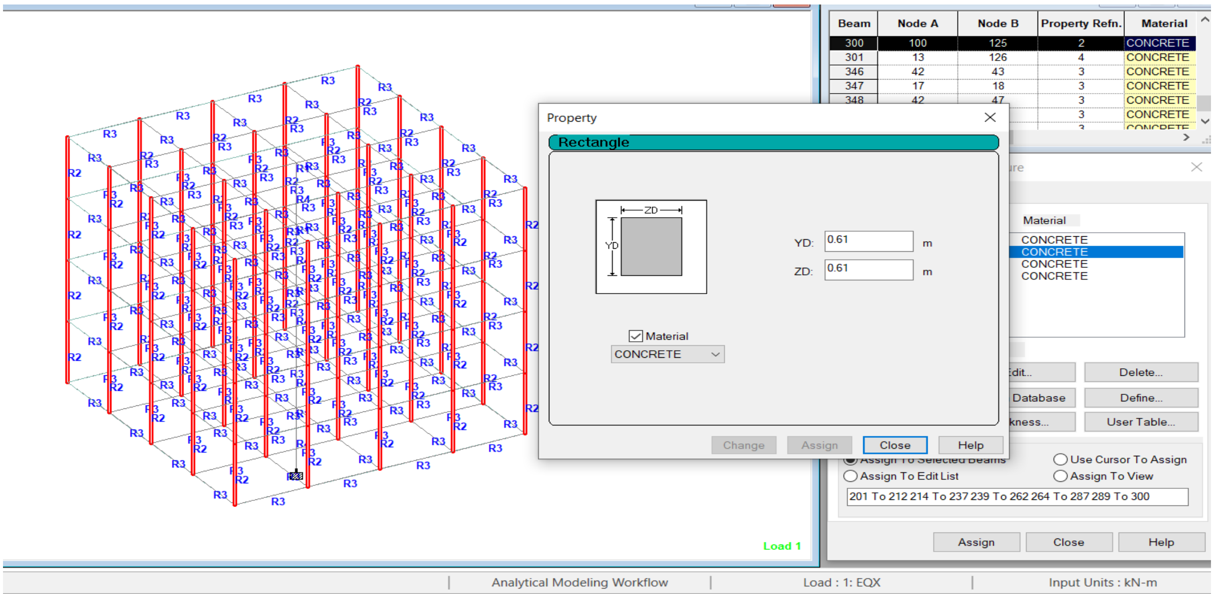


Figure 5.1 Column dimensions

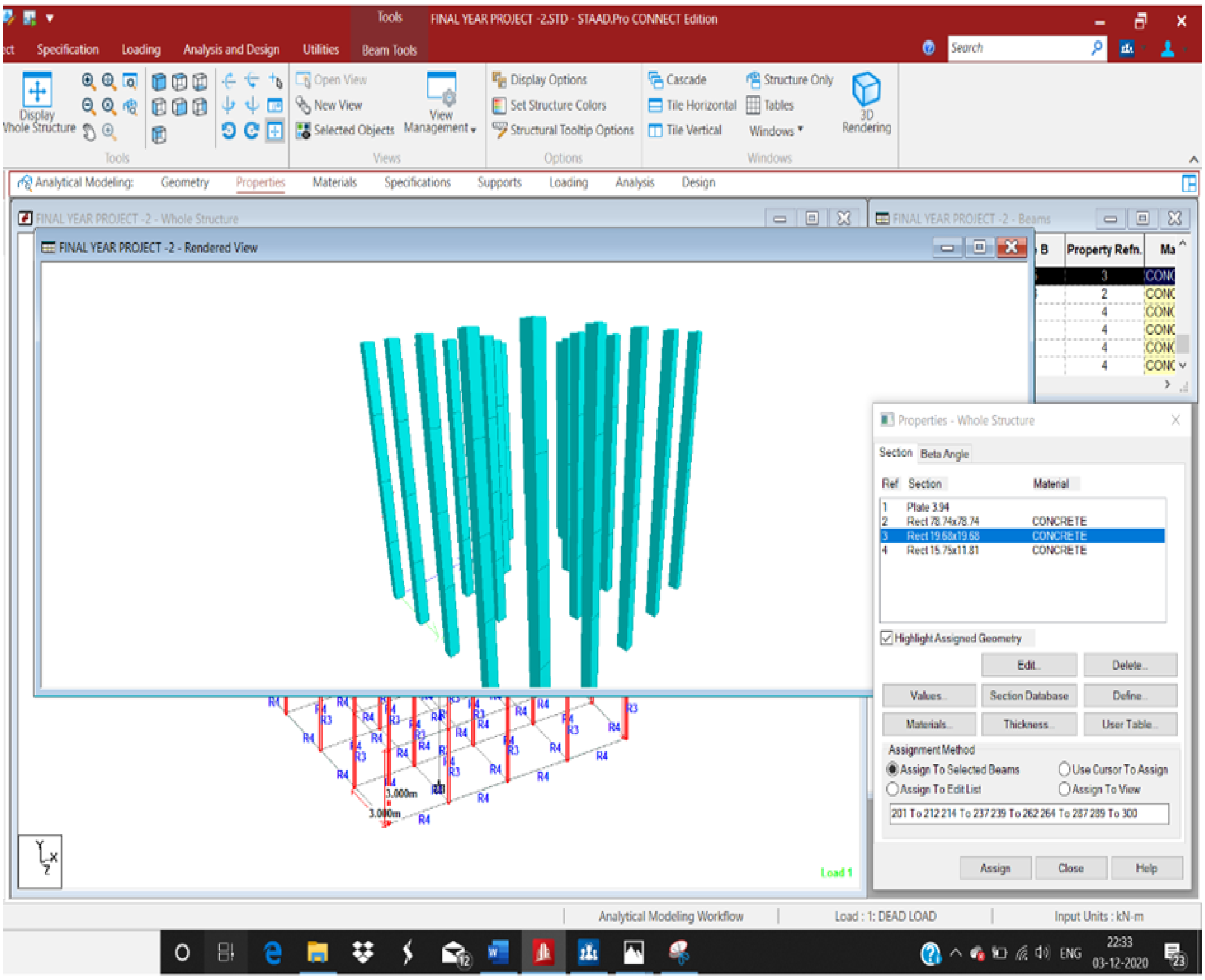


Figure 5.2 Columns 3d rendered view

5.2 BEAMS

Beams are used to transfer weight from slabs to columns. bending is built into the design of beams. The beams are generally: single and double. the perimeters and geometry of the beams are assigned in the same way that they are for columns.

The design beam command has been assigned, and the analysis has been completed; now the reinforcement details are being collected. Loads should be able to cause tensile, compressive, and shear stress in a reinforced concrete beam.

Loads on a reinforced concrete beam should be able to cause shear, tensile and compressive in the beam.

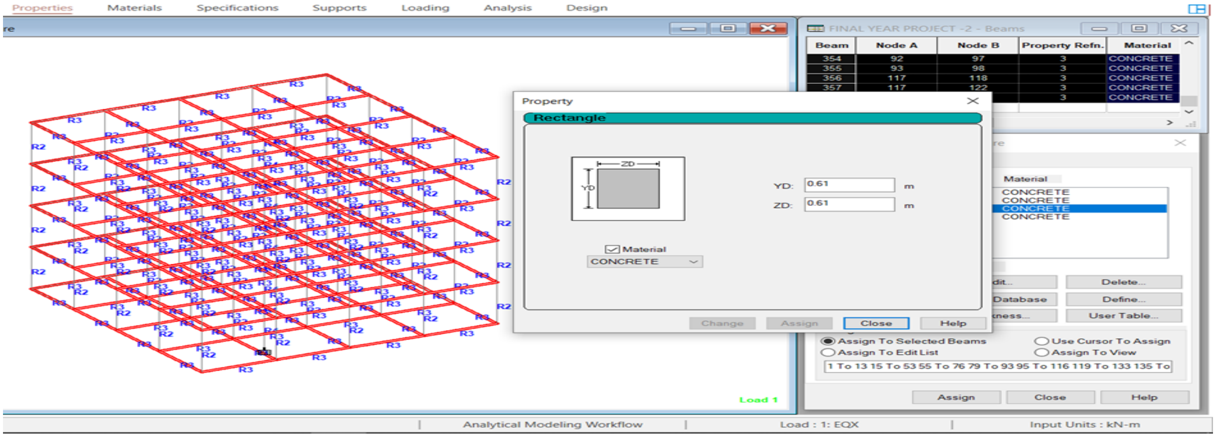


Figure 5.3 beam dimensions

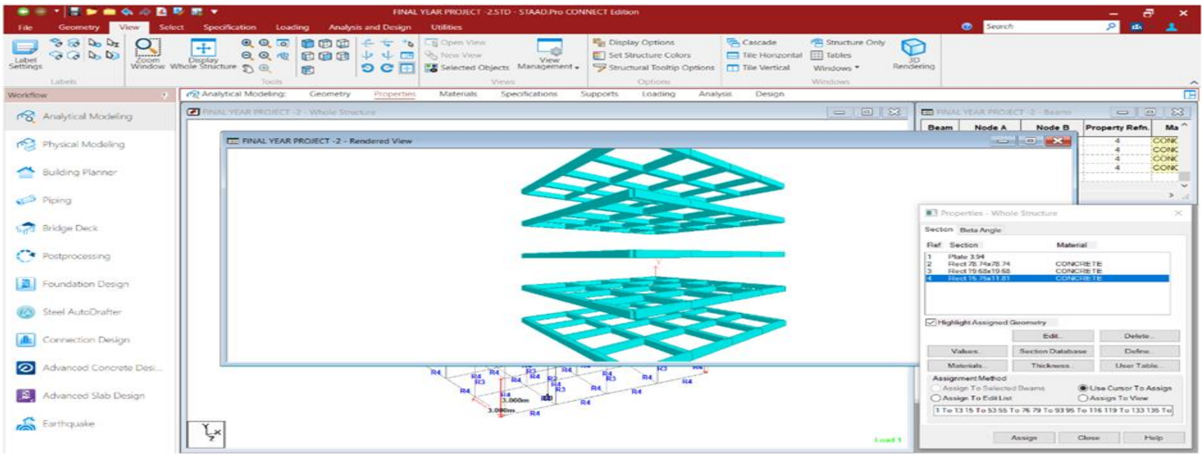


Figure 5.4 3d rendered view of beams

5.3 SLABS

Slabs are plate elements with a much smaller depth than the other two dimensions.

They usually carry a load that is evenly distributed throughout the building's floors and roof. It's called Restricted Slab. Which is only supported by the column. IS 456:2000 was used to design the reinforced concrete slab.

The building uses 140 mm thick slabs that are designed as two-way slabs. For slab design, M30 concrete grade is used.

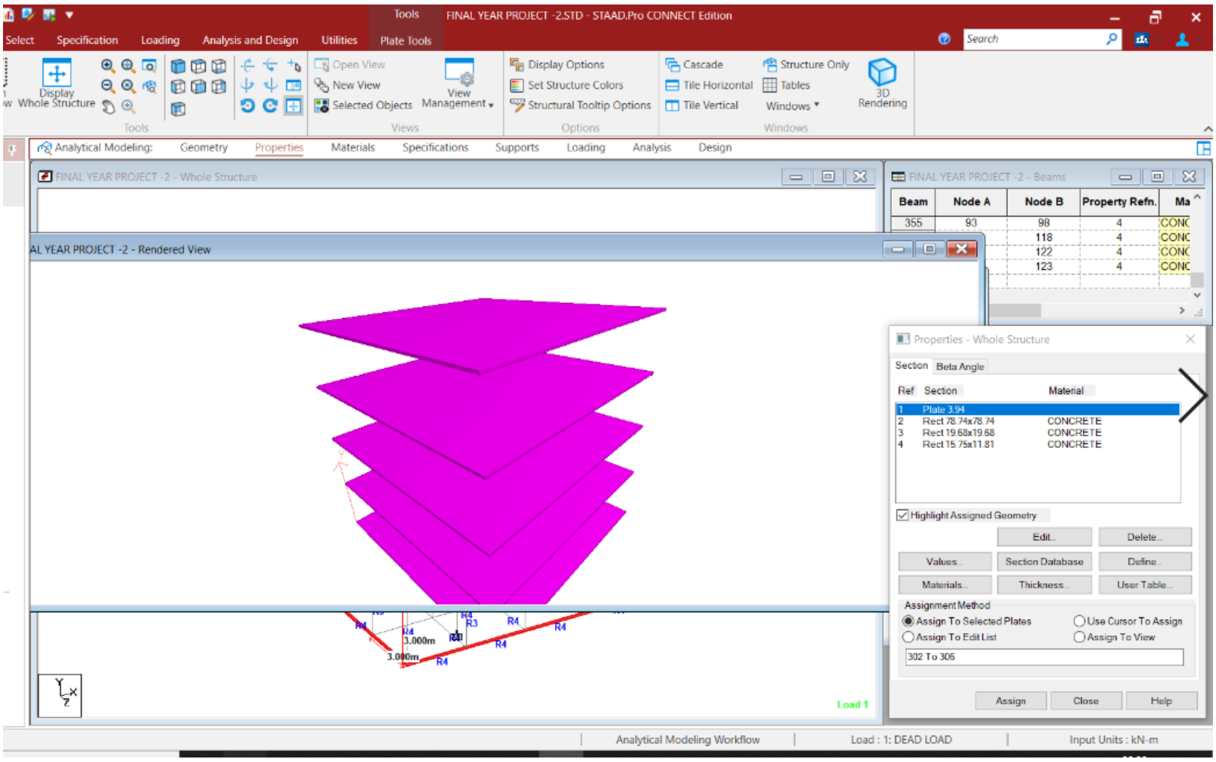


Figure 5.5 Slabs 3d rendered view

CHAPTER-6

LOADING OF STRUCTURE

6.1 TYPES OF LOADS

6.1.1 Self-weight:

STAAD can be used to calculate the structure's self-weight. Use the self-weight command in the load case column to help yourself out. Dead load from walls: STAAD can also generate dead load from walls. By indicating the thickness of the walls, you can be more professional. The weight of the wall was taken into account when calculating the load per m. The weight of the inner walls would be twice that of the outer walls when measuring the weight of the walls with a stair case or elevator.

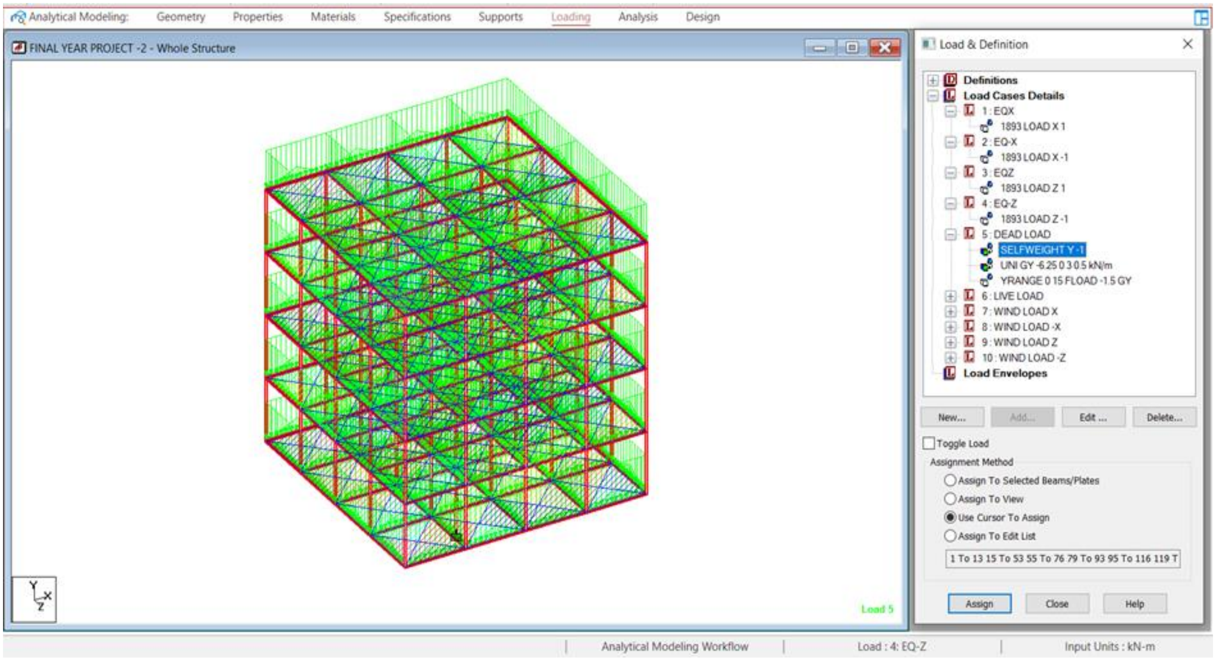


Figure 6.1 Self-weight in -y direction

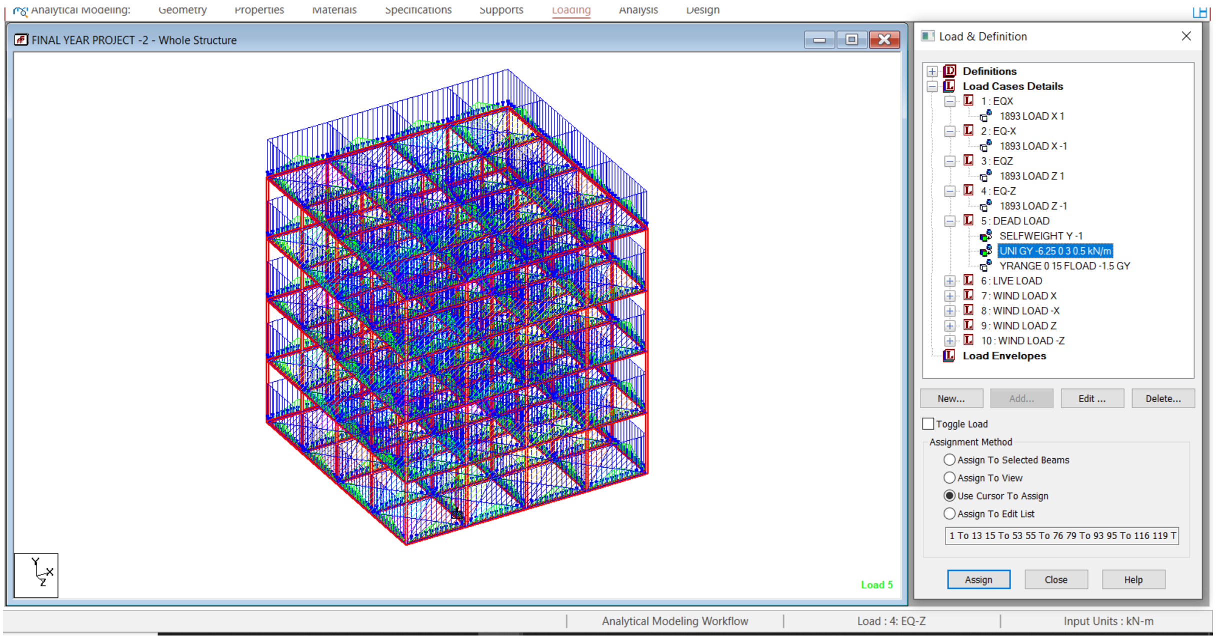


Figure 6.2 Wall load of -6.25 kn/m on structure.

6.1.2 FLOOR FINISH

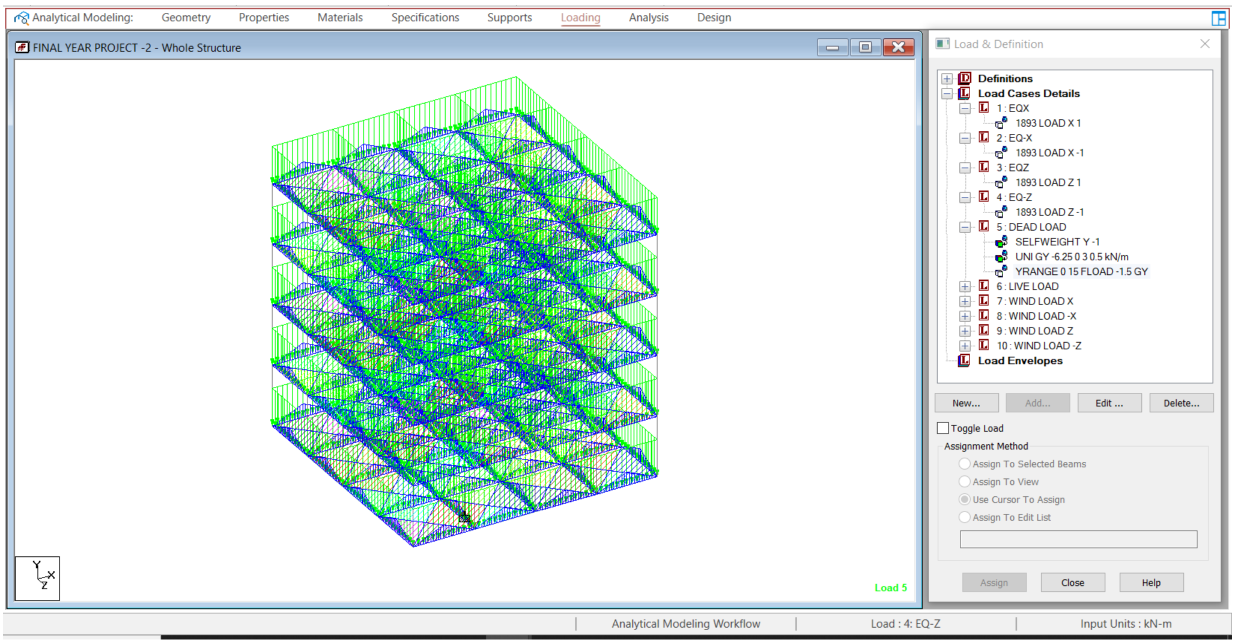


Figure 6.3 Floor finish of -1.5 k n/m^2

6.1.3 LIVE LOAD

Each floor was given a live load of 2.0 kN/m2, while the terrace level was given a live load of 1.0 kN/m2. The live loads in each floor were produced in the same way as the dead loads in the previous case. This can be done by using the participant load button in the load case column.

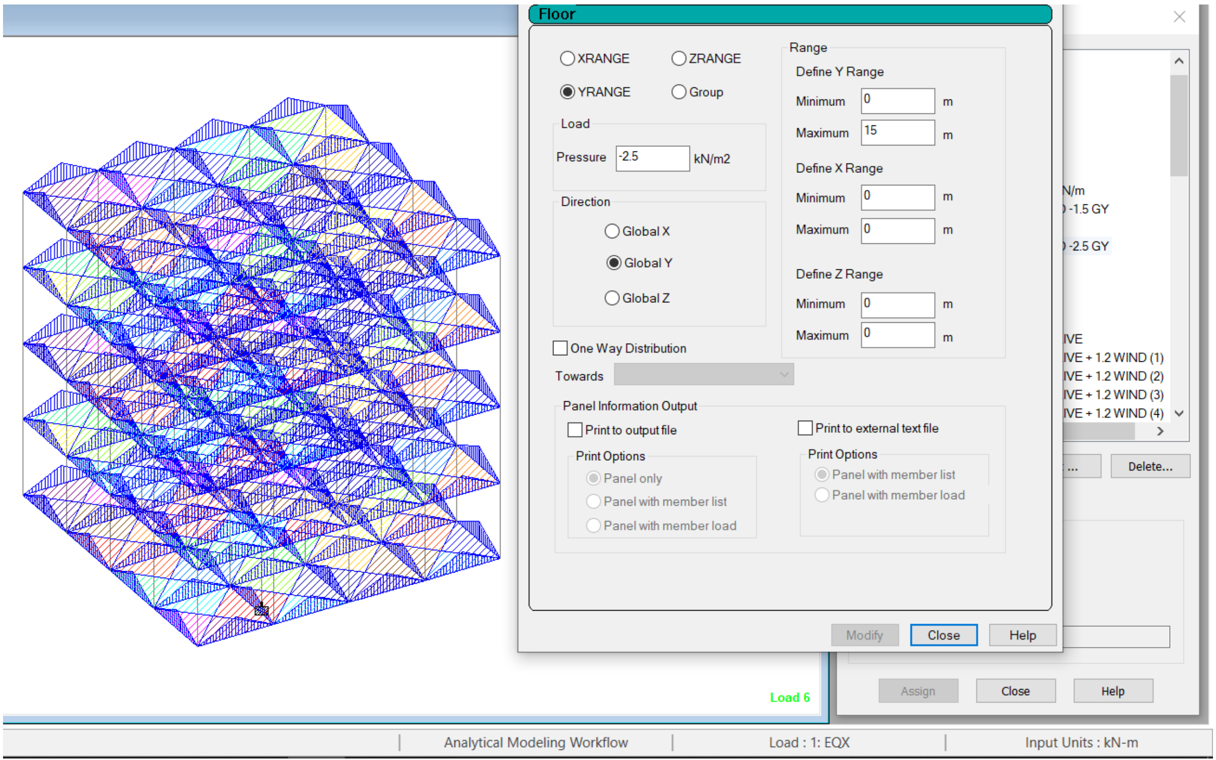


Figure 6.4 Live load of -2.5 k n/m^2 on structure

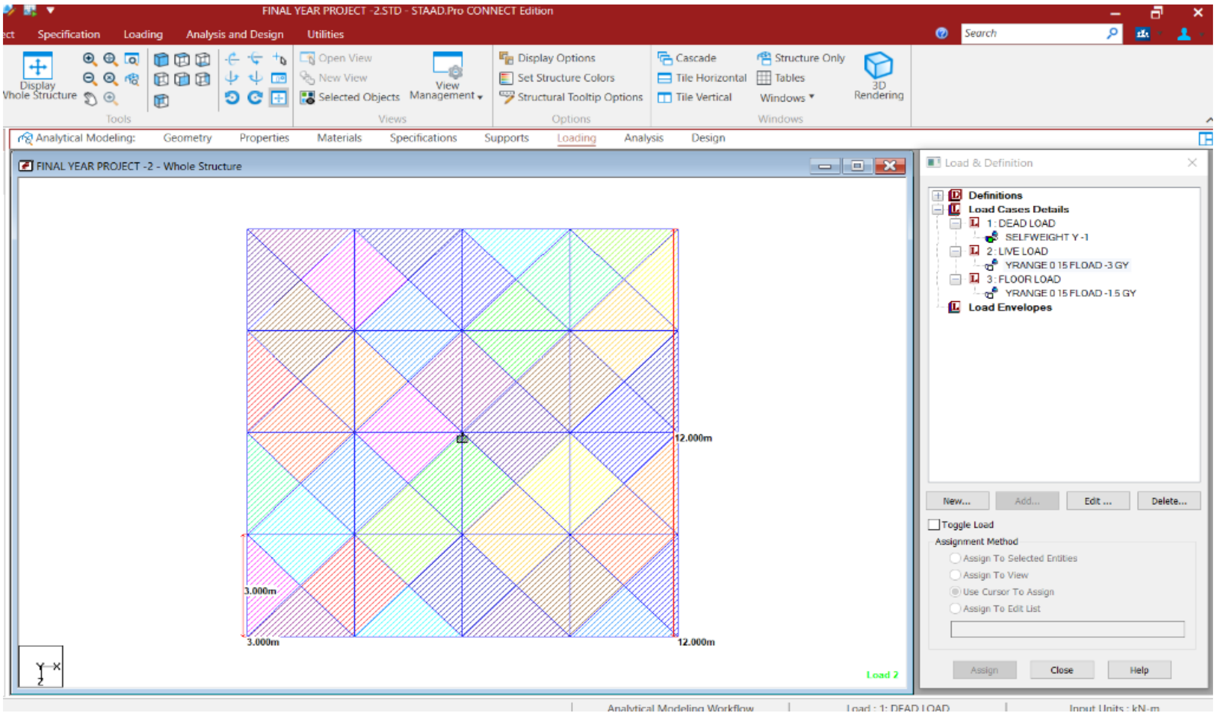


Figure 6.5 Top view of live load

6.1.4 WIND LOAD

The wind load values were formed by the code in accordance with IS 875. The group wind load given the concept of wind load in the describe load command section. Wind intensities were manually measured and entered into the programme at various heights. Based on those values, it calculates the wind load at various floors.

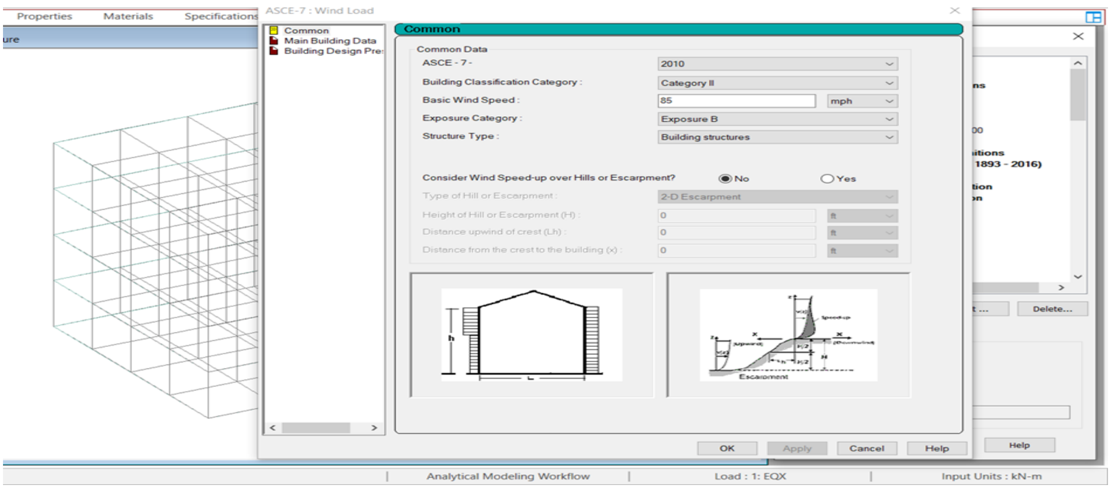


Figure 6.6 Input parameters for wind load

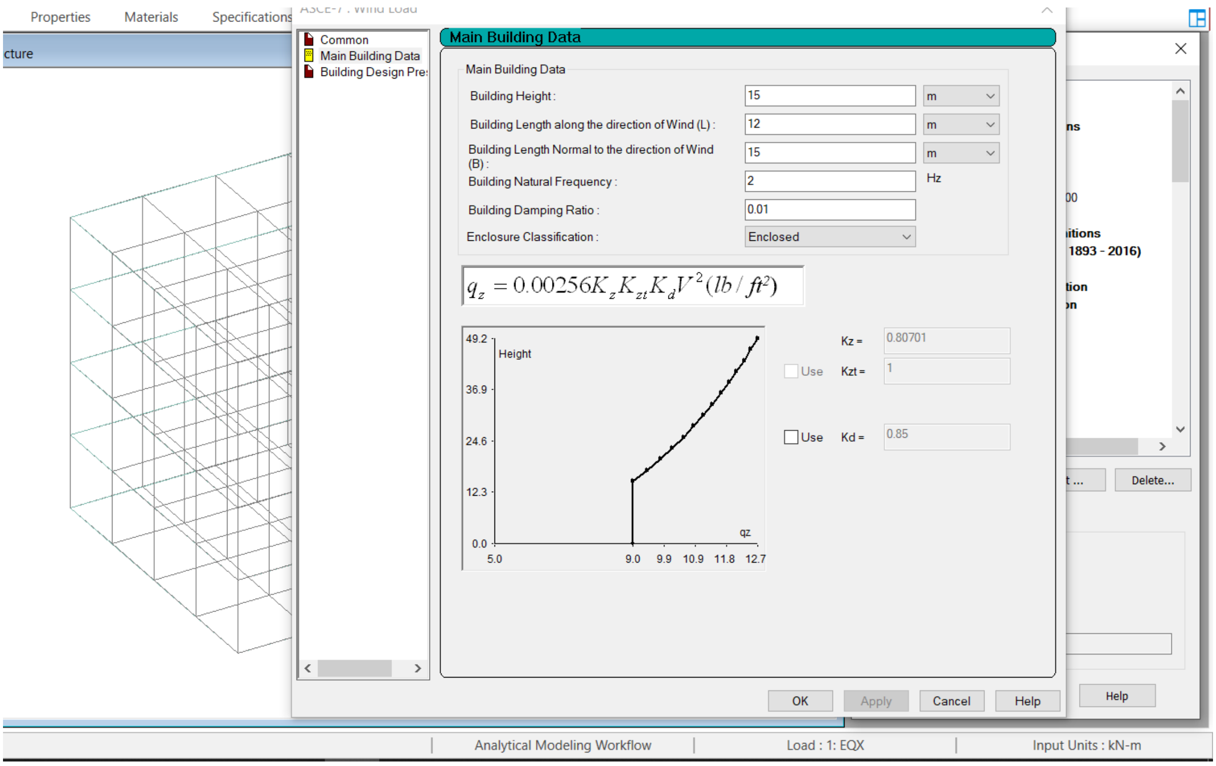


Figure 6.7 Main building data for wind load

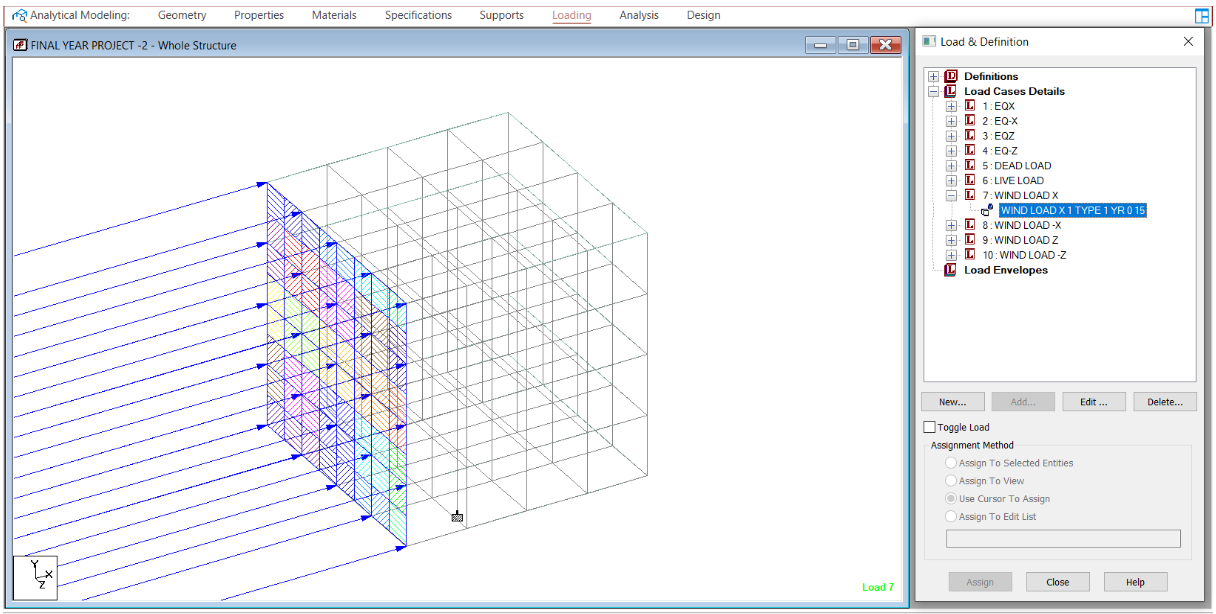


Figure 6.8 Wind load in +x direction

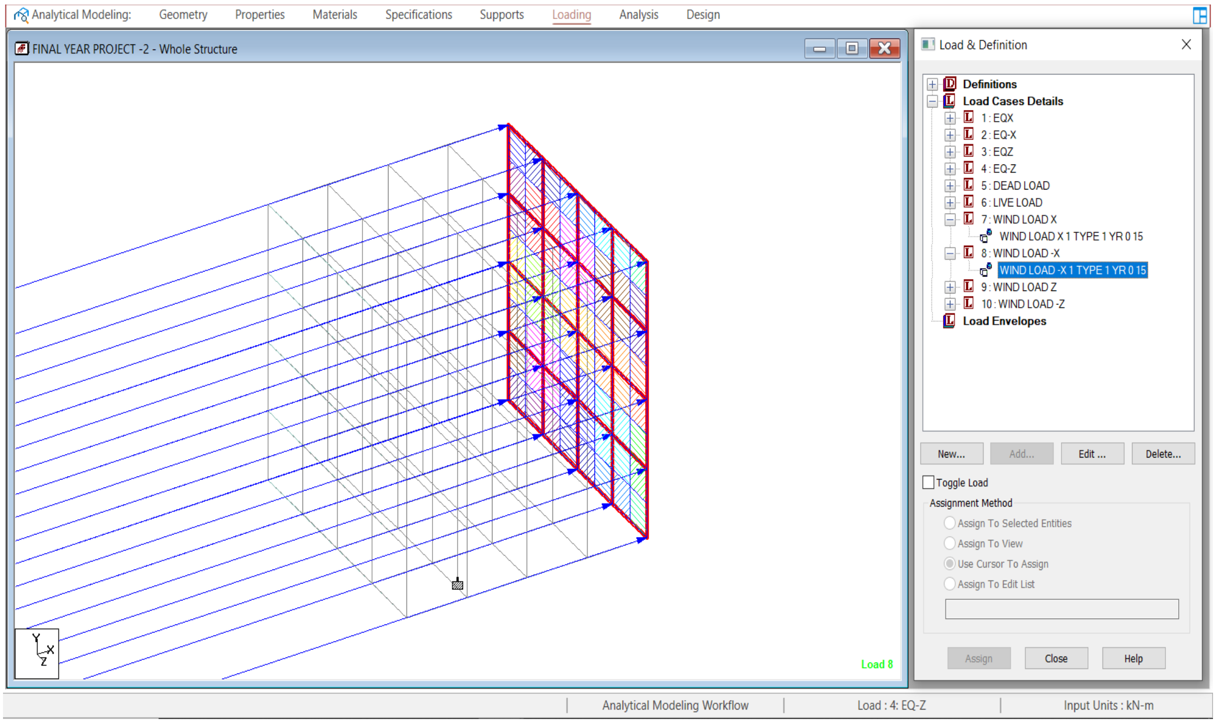


Figure 6.9 Wind load in -x direction

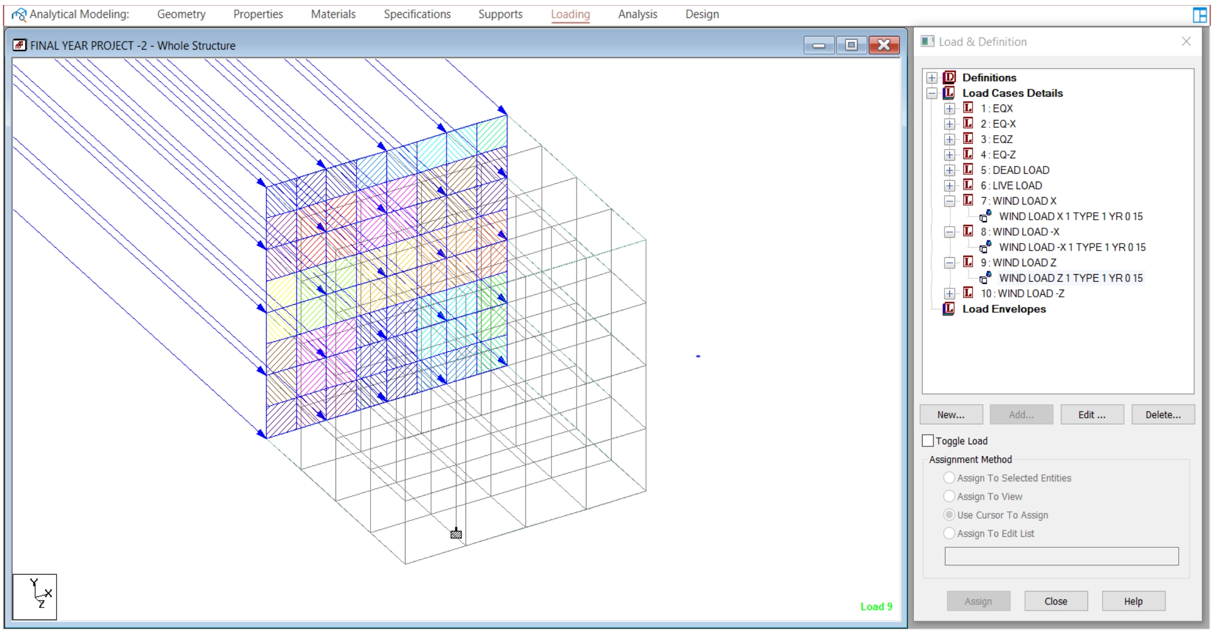


Figure 6.10 Wind load in +z direction

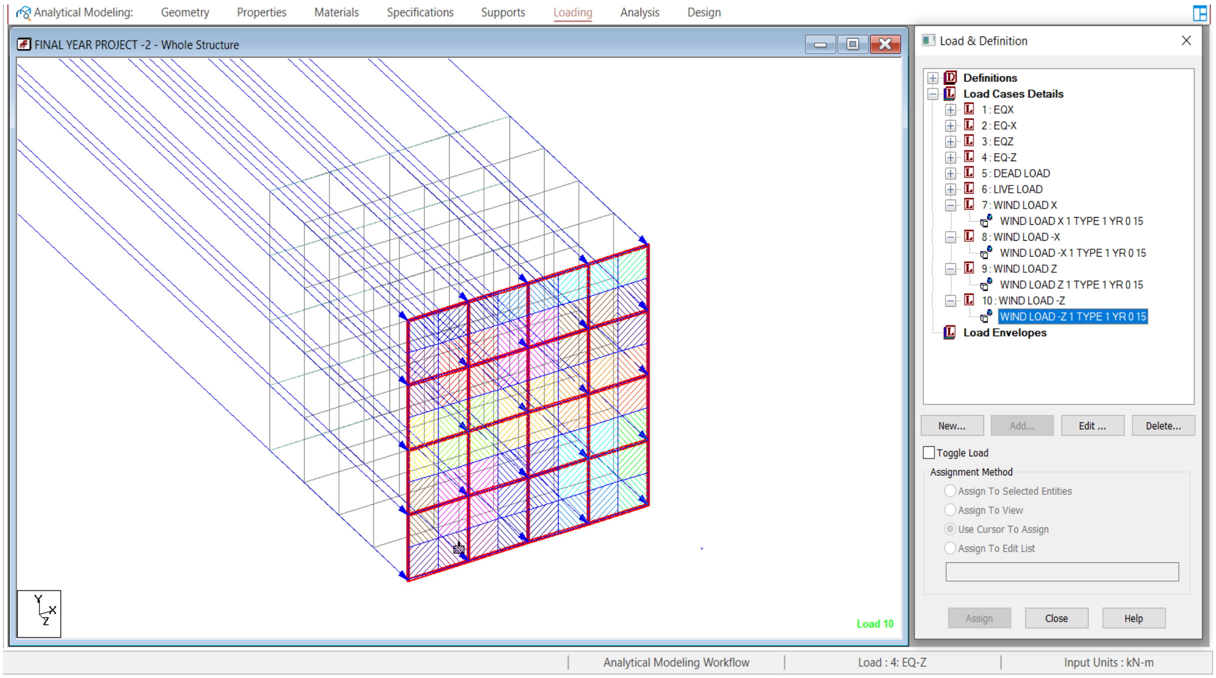


Figure 6.11 Wind load in -z direction

6.1.5 SEISMIC LOAD

IS 1893-2002 was used to determine the seismic load values, In accordance with the IS code, STAAD. Pro has a seismic load generator.

SEISMIC PARAMETERS

- Z= Zone factor which depends upon the location of building. It is given in IS 1893 Table no. 3 Seismic Zone factor on page no. 10.
- The next parameter is Response Reduction parameter denoted by R. It tells about the type of building. It is given on Table 9 Clause 7.2.6
- Third parameter is Importance factor which tells about the use of building. It is denoted by I and is given on Table 8 Clause 7.2.3
- Fourth parameter is Design Acceleration Coefficient denoted by (Sa/g) which denotes the type of soil and is given on Clause 6.4
- The last parameter is time period denoted by Ta and is given on Clause 7.6.2.

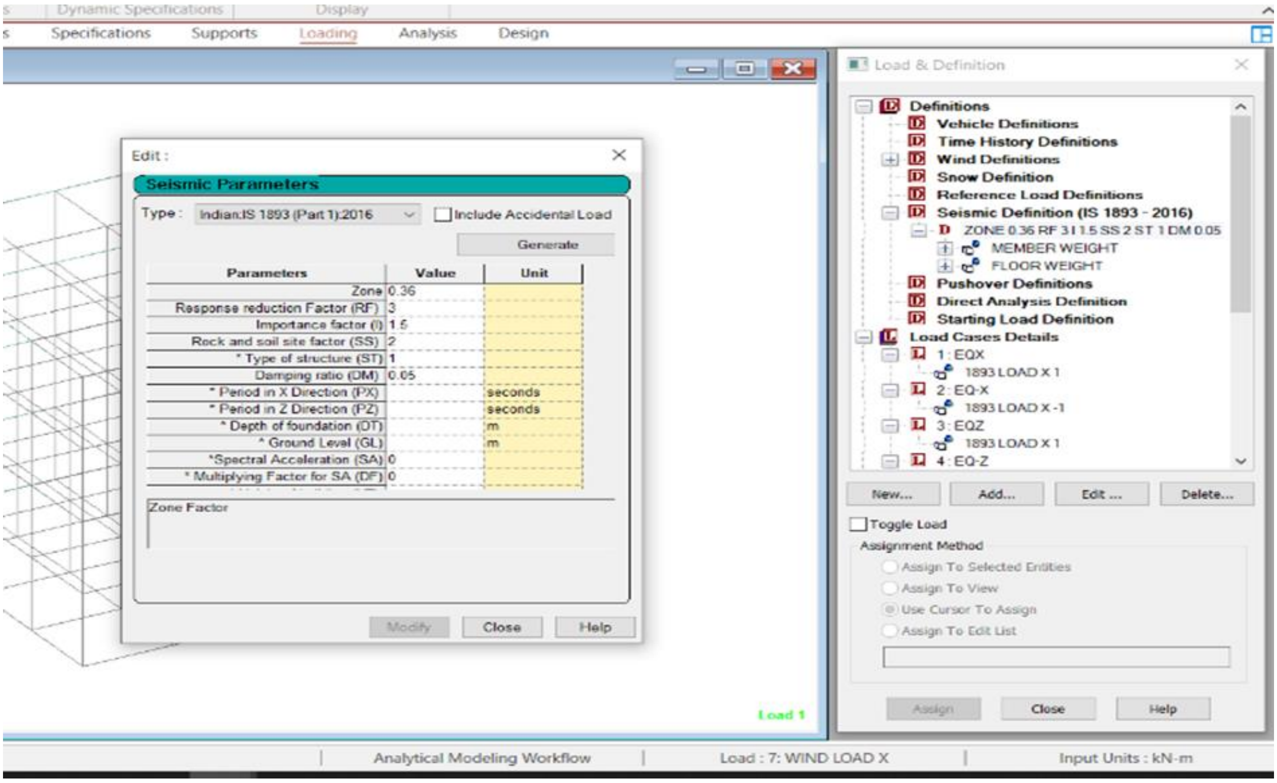


Figure 6.12 Seismic parameters for structure

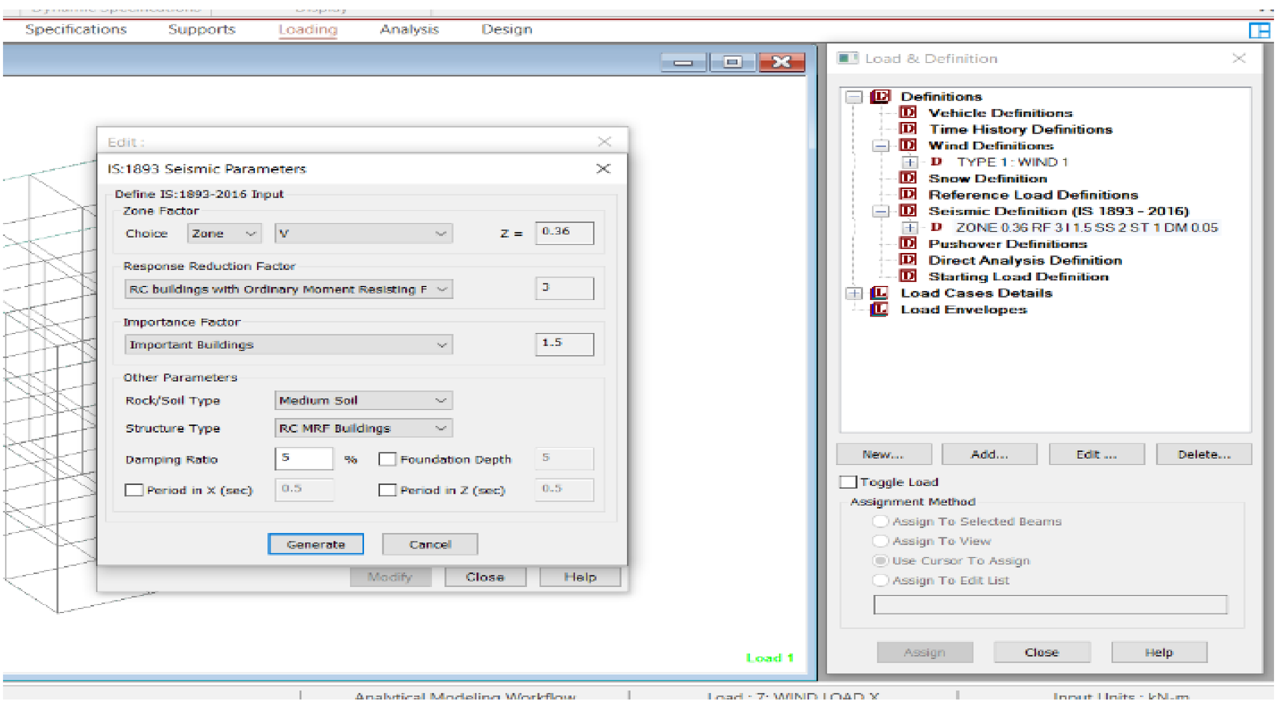


Figure 6.13 Seismic parameters for structure

6.1.6 LOAD COMBINATIONS

The structure has been evaluated for auto load case, which takes into account all previous loads in a proper ratio and generates a load combination code in accordance with Indian code for general structures in the load combination category.

Rules for Combining:

Each load category can be set with one of three rules for each Code/Category: -

a. All cases should be combined.

b. Each case has a different combination.

c. All combinations are possible.

It will be loaded with a mix of earthquake, wind, self-weight, dead load, and live loads.

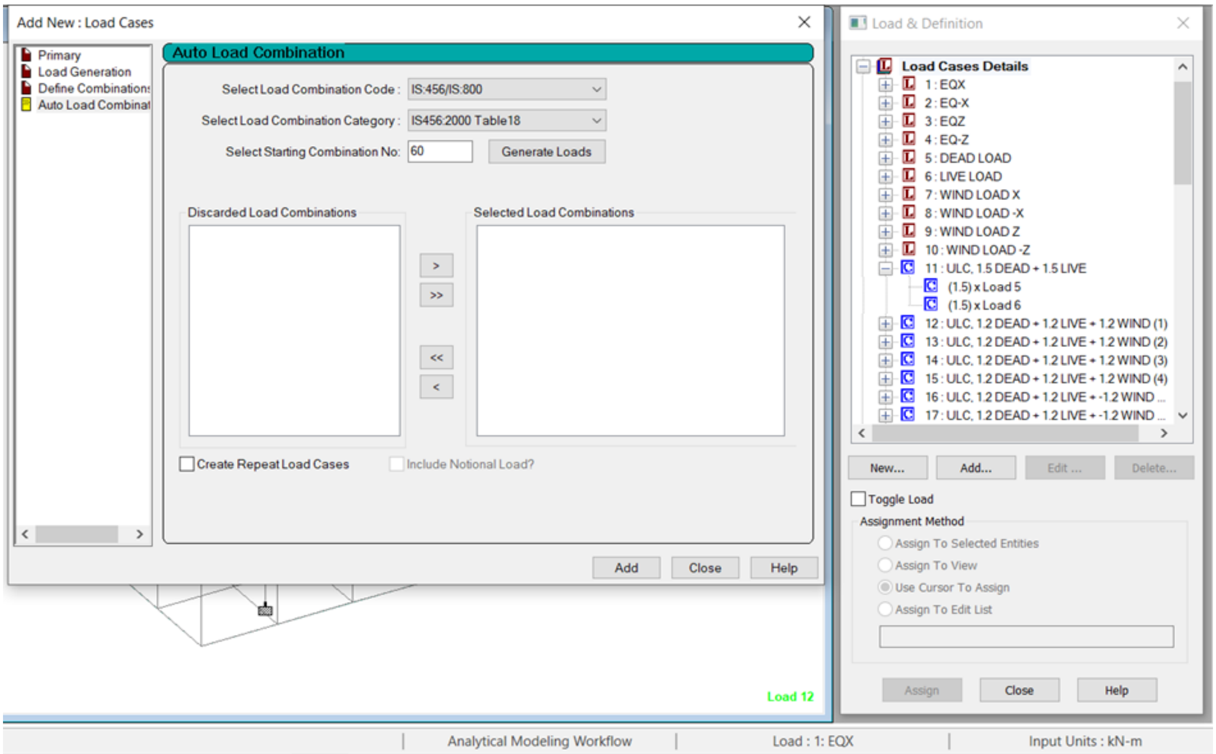


Figure 6.14 Auto generating load combinations as per is 456.

CHAPTER 7

ANALYSIS OF STRUCTURE

7.1 CONCRETE DESIGN

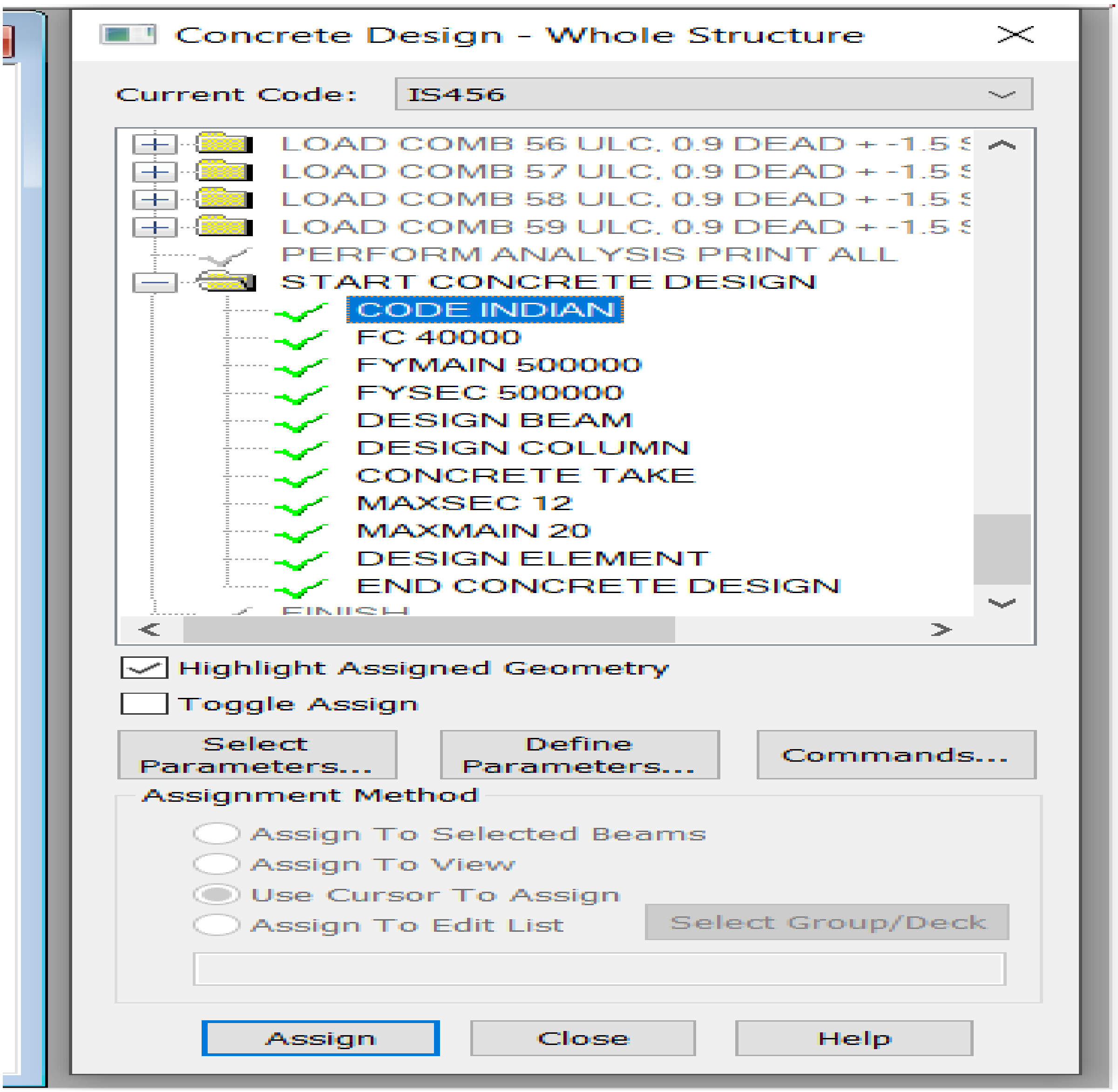


Figure 7.1 Parameters for concrete design

TABLE 7.1 CONCRETE DESIGN PARAMETERS

CODE	**IS 456**
COMPRESSIVE STRENGTH OF CONCRETE	40000 kN/m^2
YIELD STRENGTH FOR MAIN REINFORCEMENT	500000 KN/m^2
YIELD STRENGTH FOR SHEAR REINFORCEMENT	500000KN/m^2
MAXIMUM SECONDARY REINFORCEMENT	12 mm
MAXIMUM MAIN REINFORCEMENT	20 mm
CLEAR COVER	30 mm

7.2 RUN ANALYSIS COMMAND

Analysis is performed by clicking on the top Run Analysis Command on the top. The following picture shows that there are zero errors and zero warning for the given structure.The analysis window gives three options as to Go to Output file or Go to post processing mode or to modelling mode.

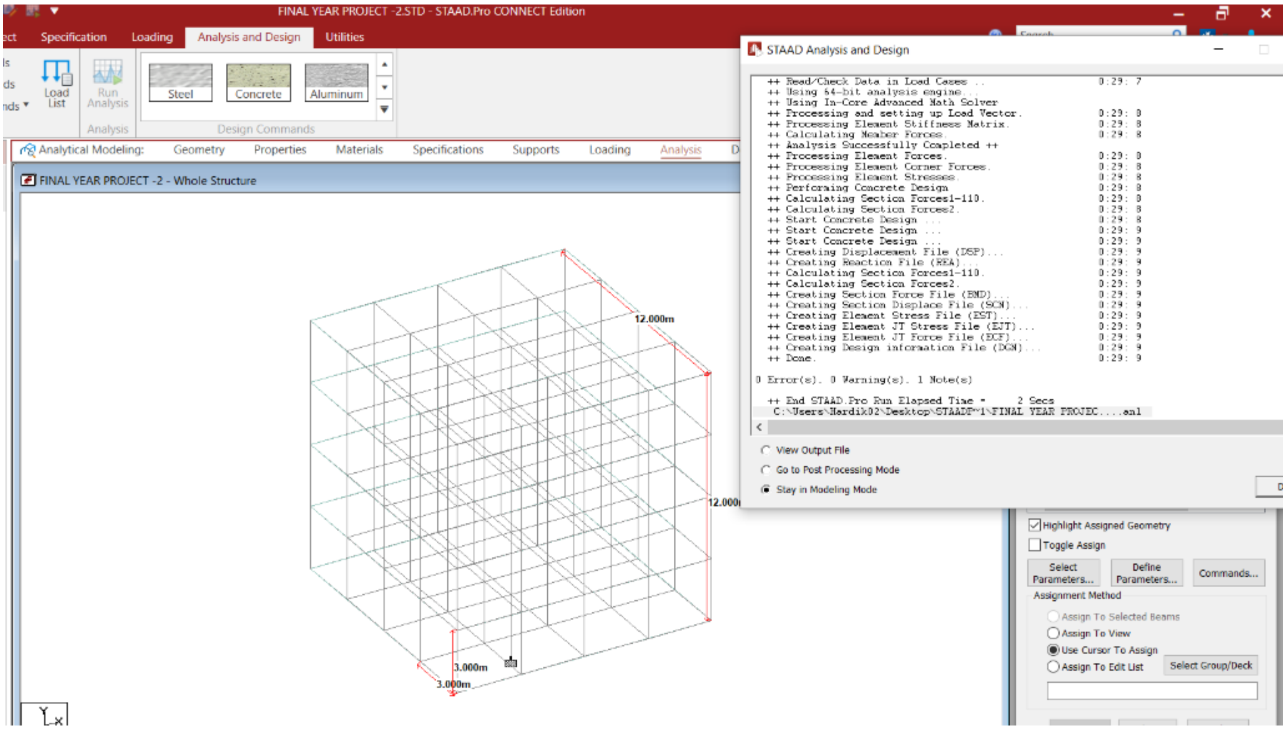


Figure 7.2 Analysis window showing zero errors and warnings.

7.3 POST PROCESSING MODE

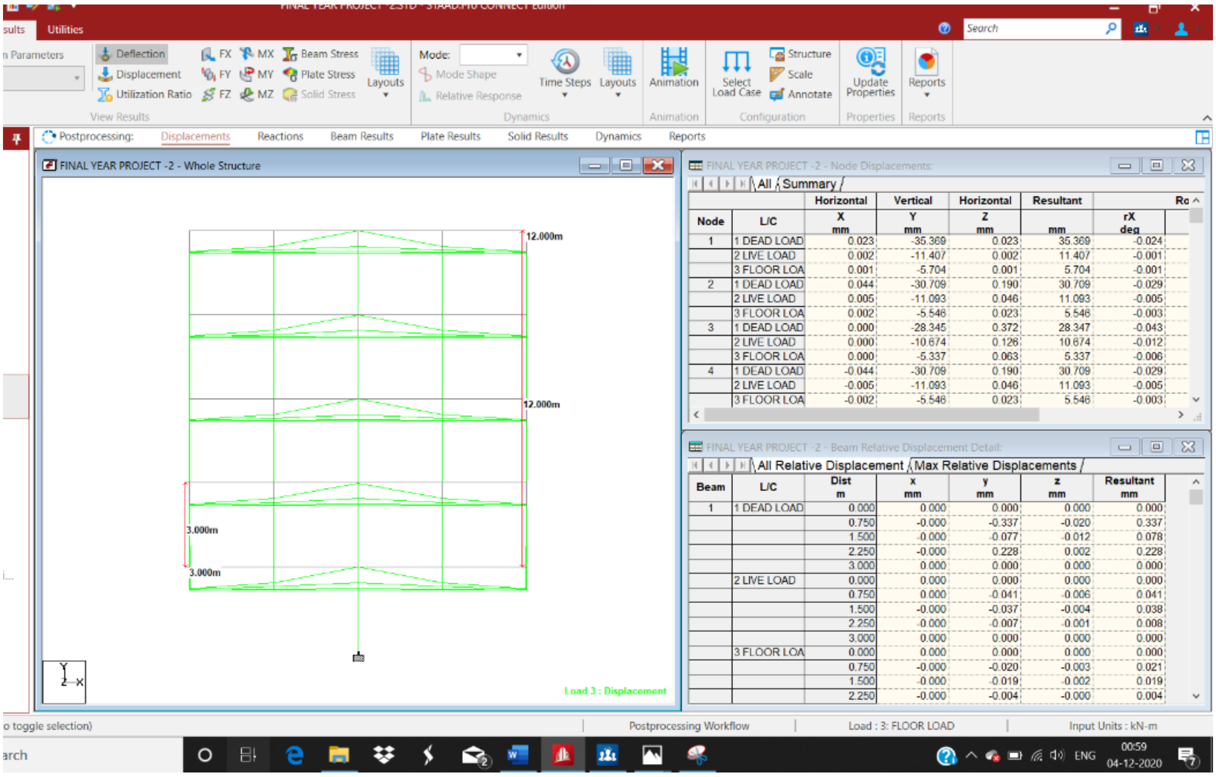


Figure 7.3 Deflection of structure

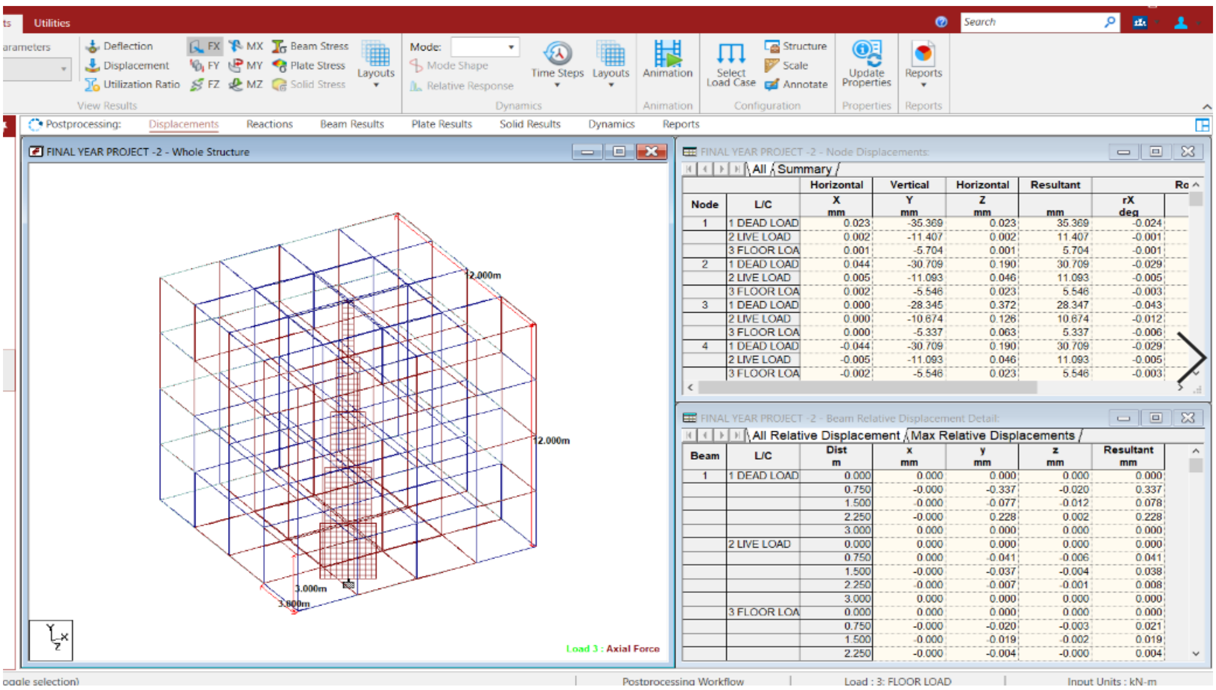


Figure 7.4 Shear force in x direction

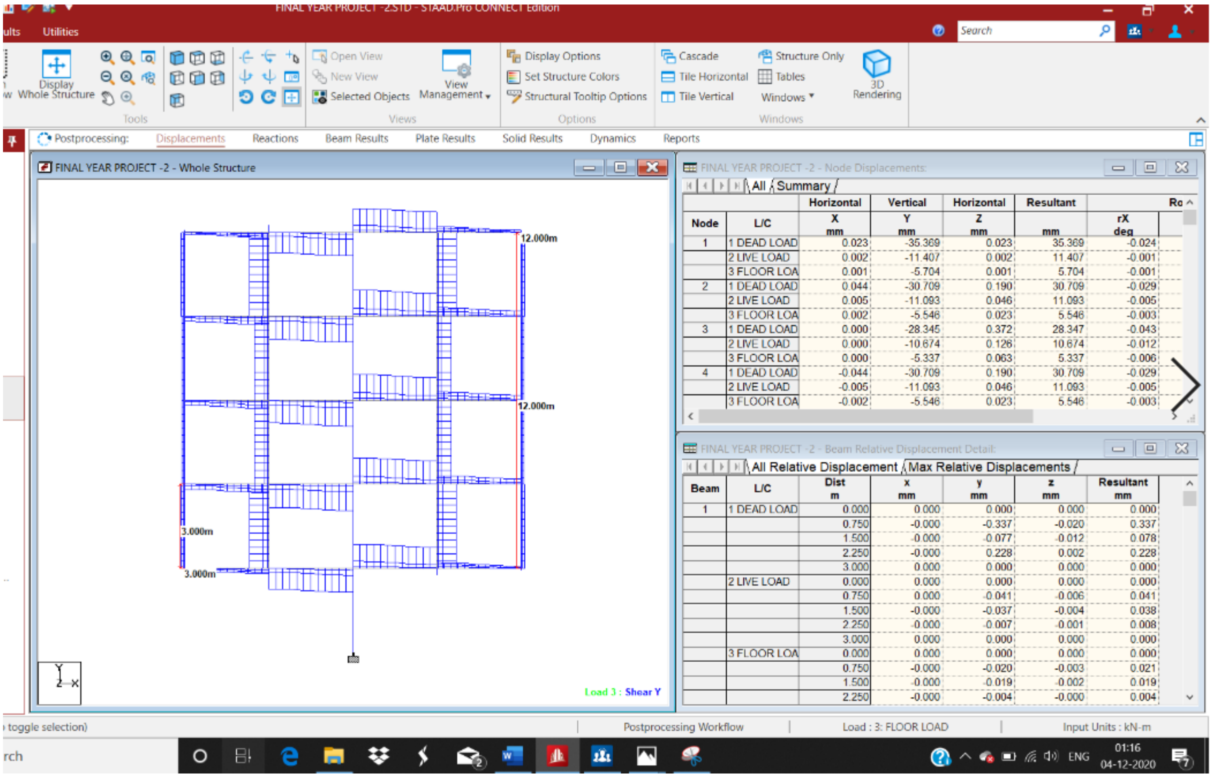


Figure 7.5 Shear force in y direction

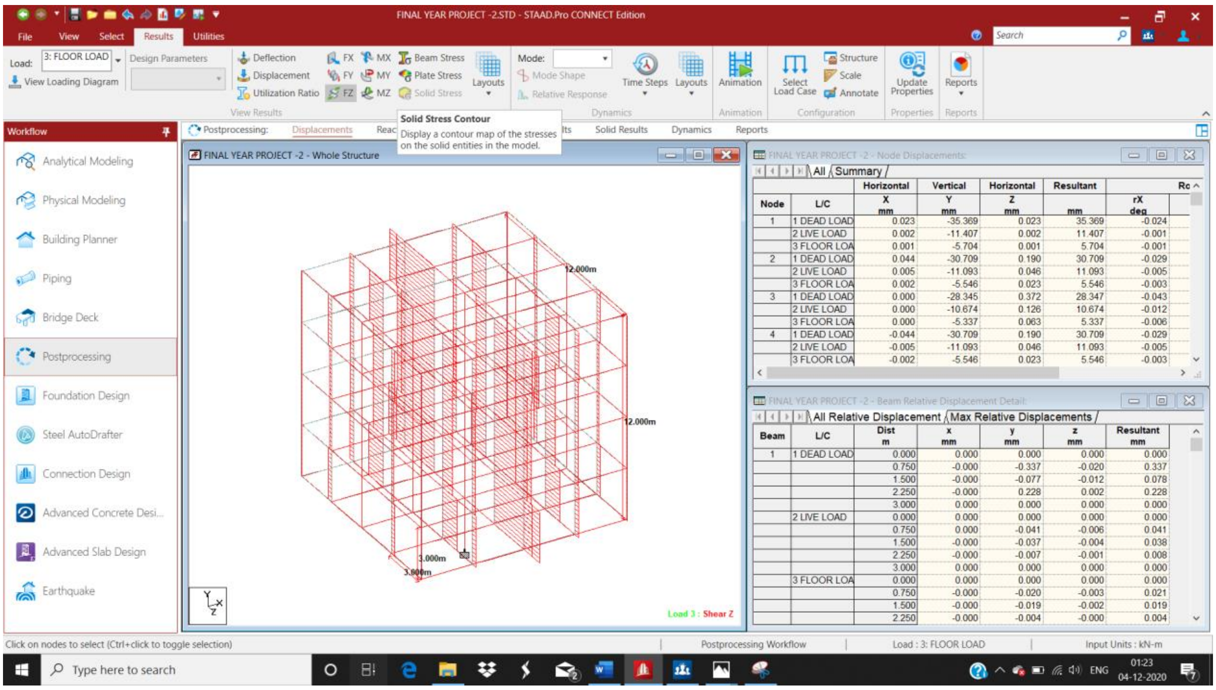


Figure 7.6 Shear force in z direction

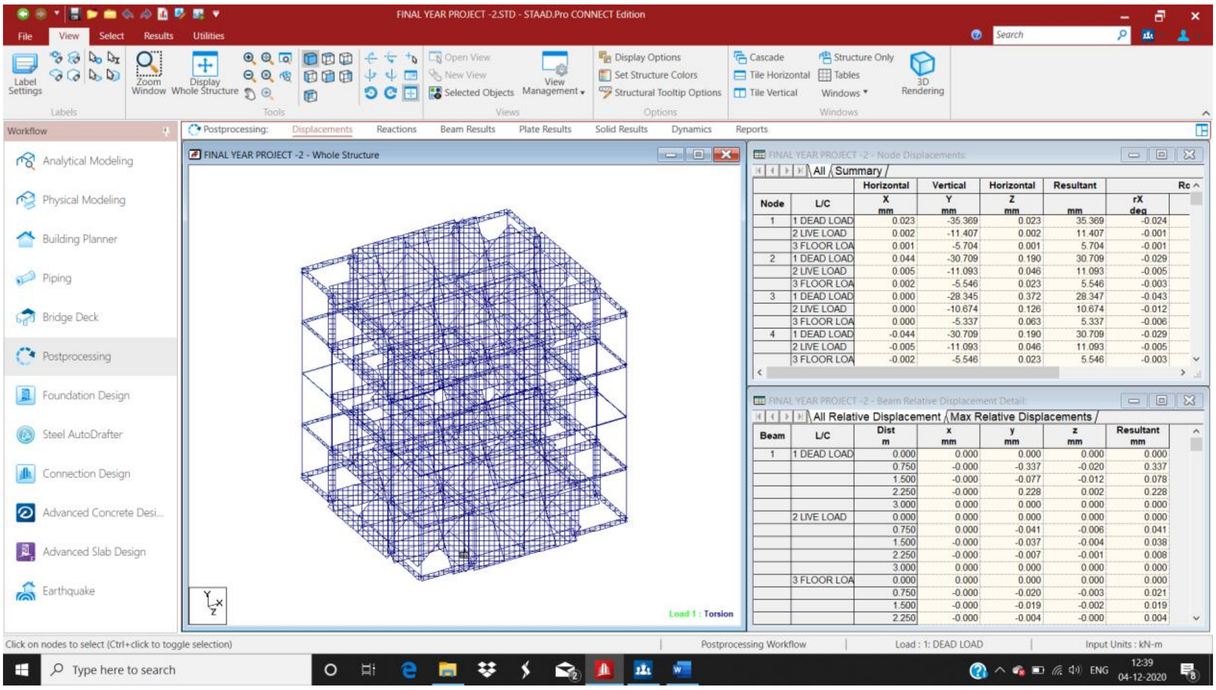


Figure 7.7 Moment in x direction

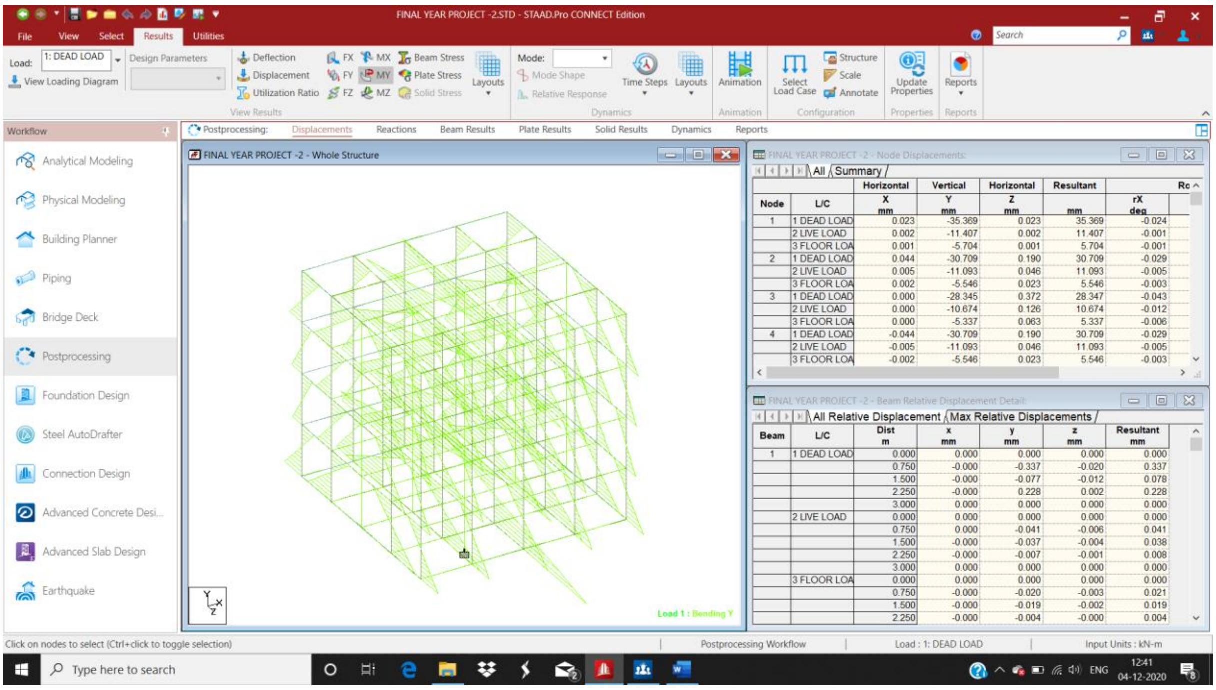


Figure 7.8 Moment in y direction

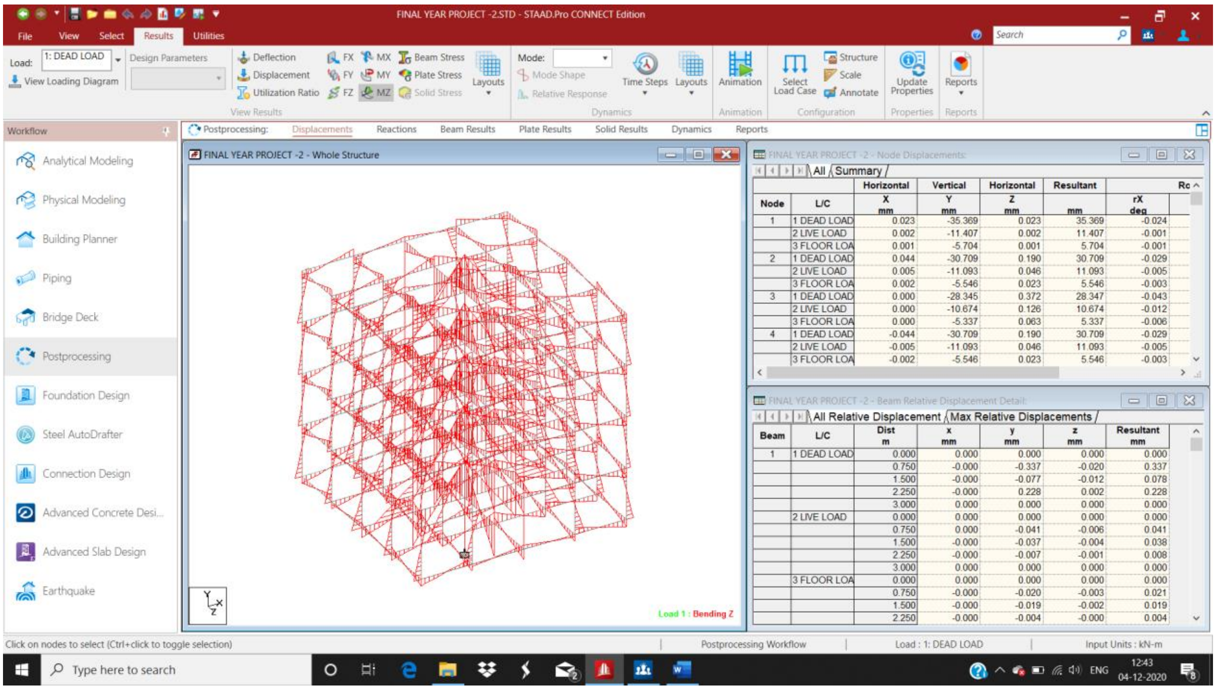


Figure 7.9 Moment in z direction

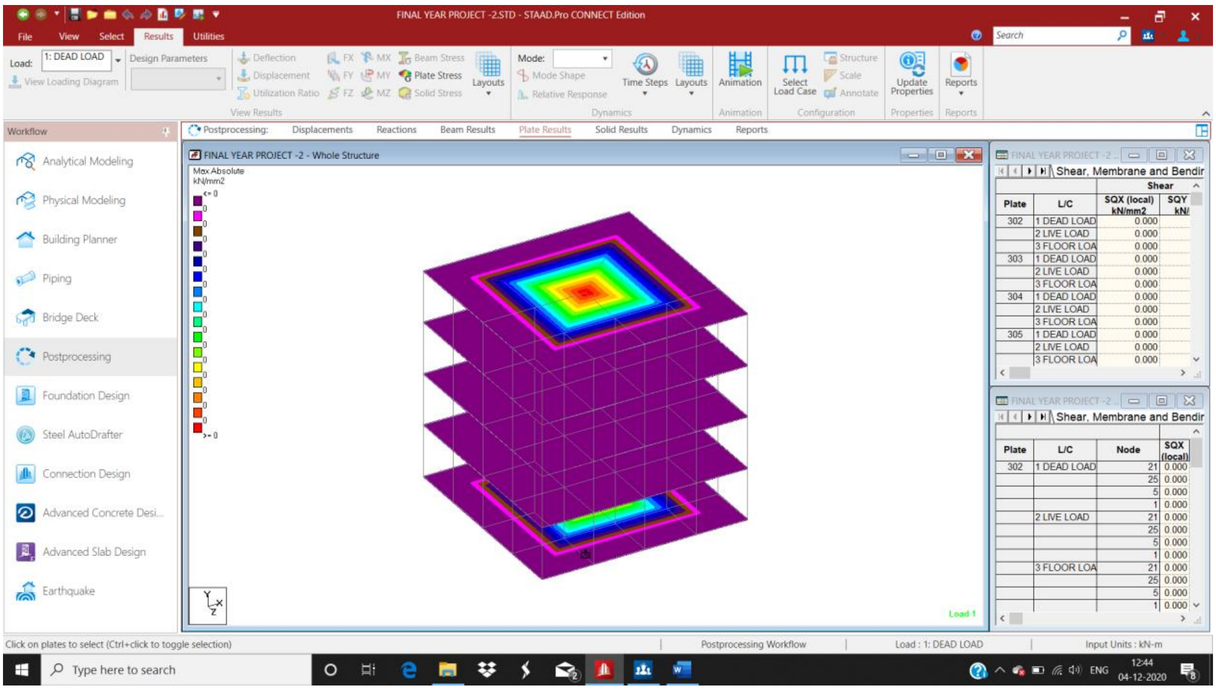


Figure 7.10 Plate stress

CHAPTER 8

FOUNDATION DESIGN ON STAAD FOUNDATION

8.1 STEPS INVOLVED IN FOUNDATION DESIGN

1. The first step in foundation design is to select the important load cases from STAAD model which are to be included in STAAD FOUNDATION.

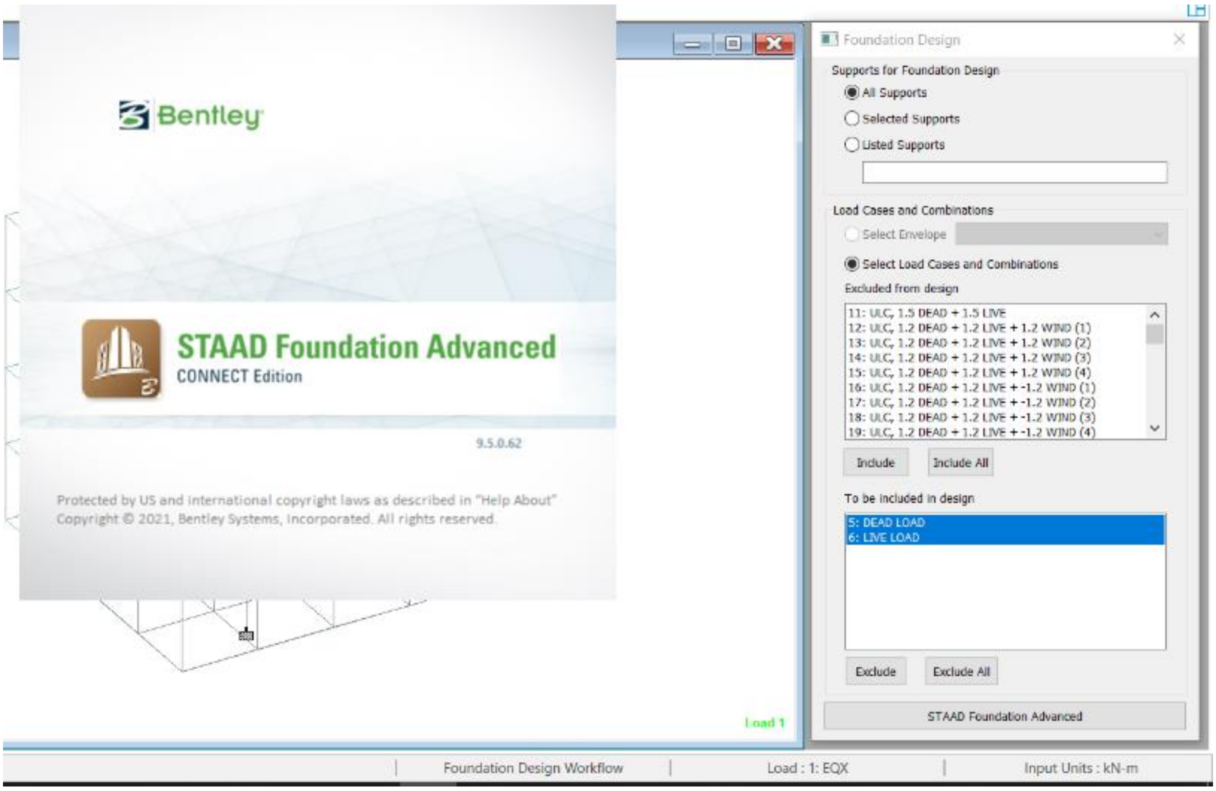


Figure 8.1 Selecting major loads for STAAD FOUNDATION ADVANCED.

2. The second step is to generate load combination according to the desired recommended codes

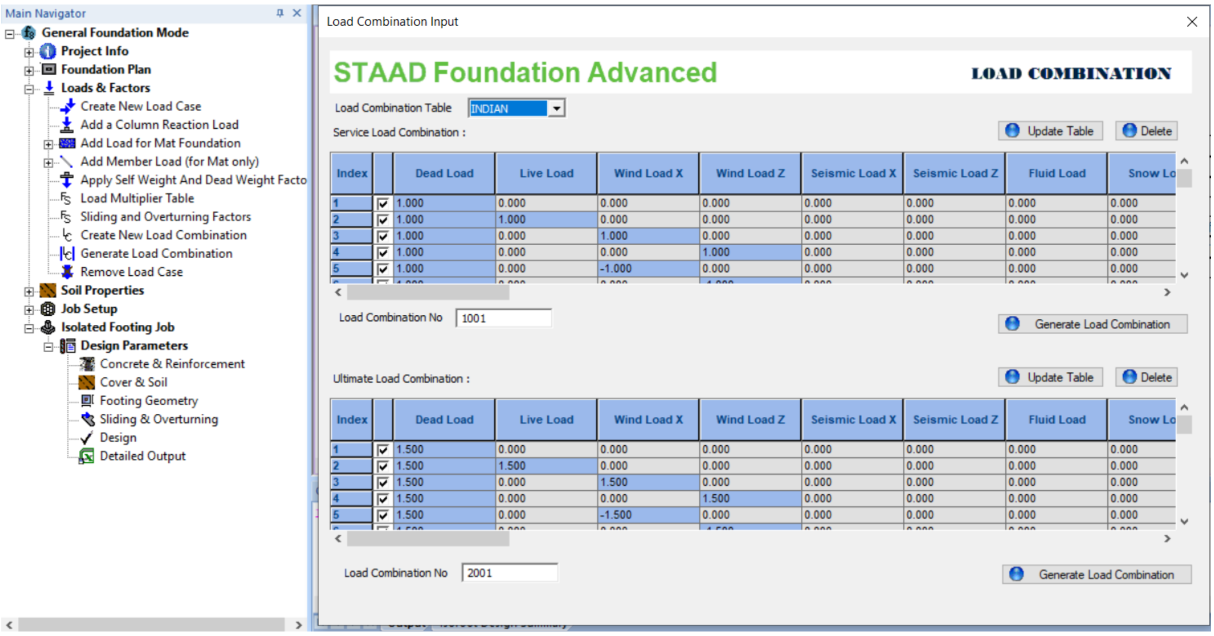


Figure 8.2 Load combination generation table

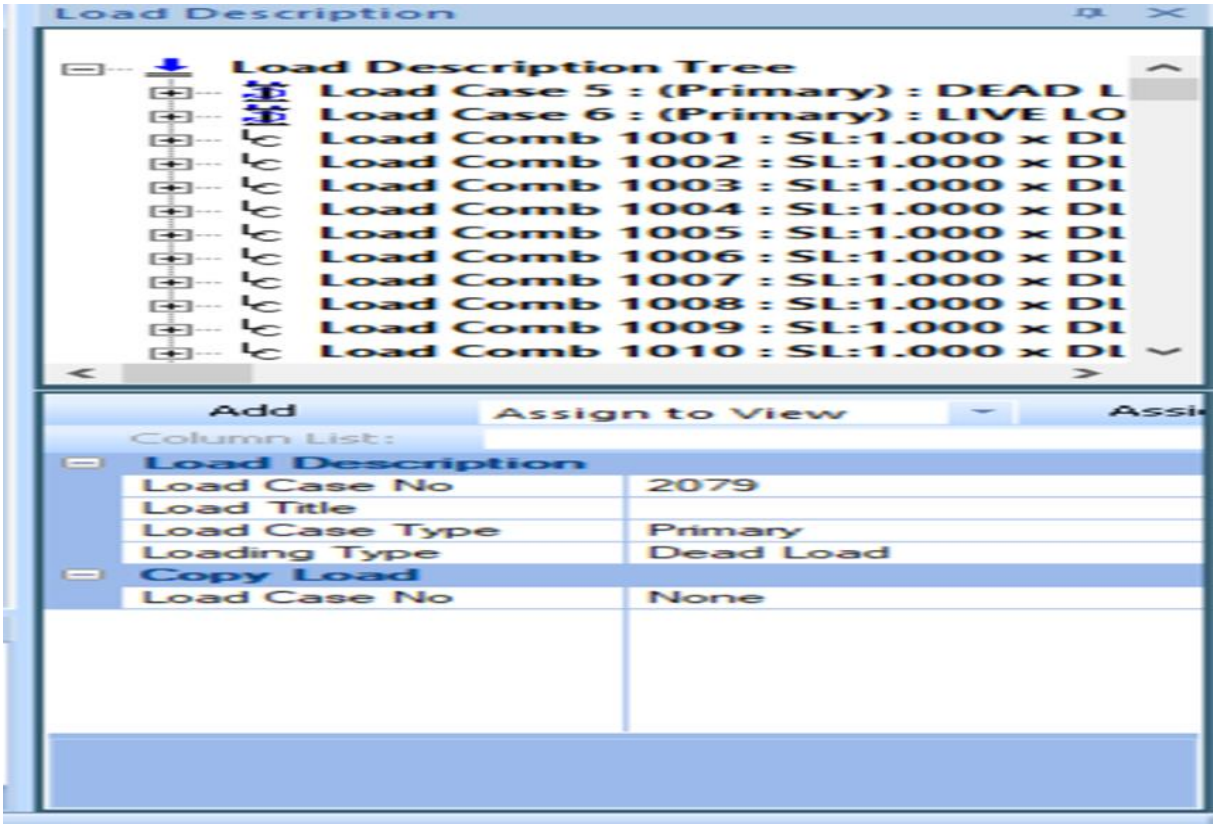


Figure 8.3 Various loads and their combinations descriptions

3. The third step is to create a job profile describing about the name and the type of footing.

- JOB NAME - single footing 11 May. 21
- JOB TYPE - Isolated
- DESIGN CODE – Indian
- DEFAULT UNIT TYPE- SI

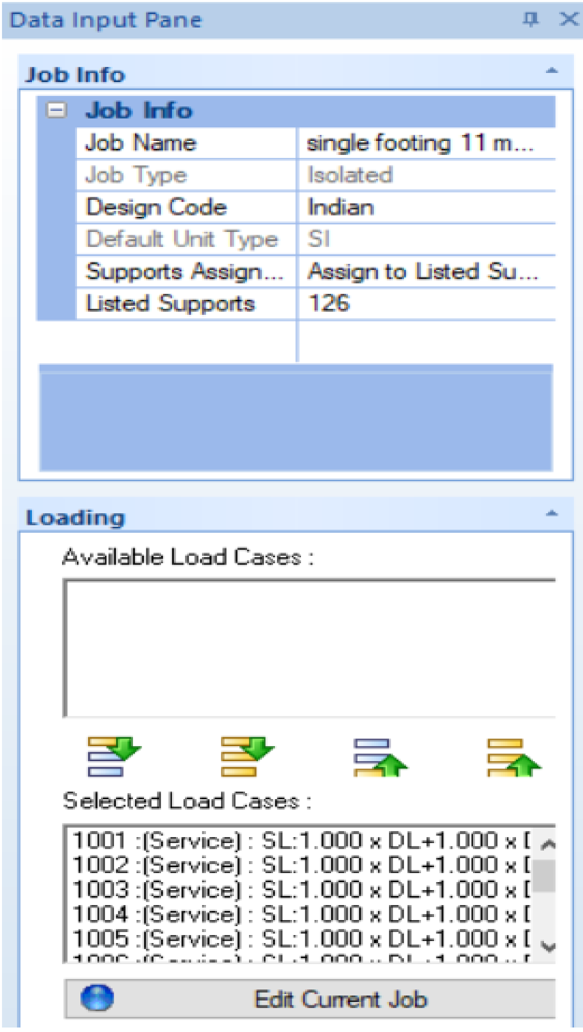
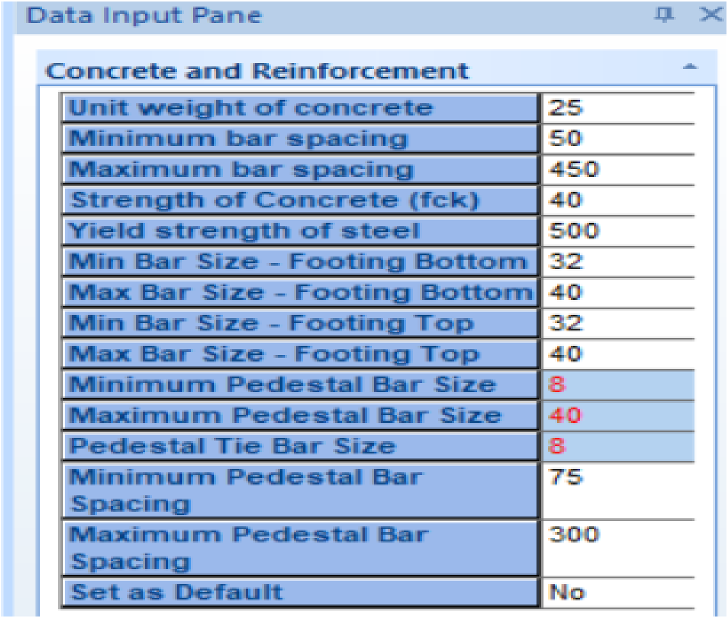


Figure 8.4 Creating job profile and selecting load cases

4. The next step is to input parameters of footing which includes Concrete and reinforcement parameters,Cover and soil parameters,footing geometry parameters, sliding and overturning.



Data Input Pane

Concrete and Reinforcement

Unit weight of concrete	25
Minimum bar spacing	50
Maximum bar spacing	450
Strength of Concrete (fck)	40
Yield strength of steel	500
Min Bar Size - Footing Bottom	32
Max Bar Size - Footing Bottom	40
Min Bar Size - Footing Top	32
Max Bar Size - Footing Top	40
Minimum Pedestal Bar Size	8
Maximum Pedestal Bar Size	40
Pedestal Tie Bar Size	8
Minimum Pedestal Bar Spacing	75
Maximum Pedestal Bar Spacing	300
Set as Default	No

Figure 8.5 Concrete and reinforcement parameters

Data Input Pane

Cover and Soil

Pedestal Clear Cover	50	m
Bottom clear cover	50	m
Unit weight of Soil	22	kN
Base Value of Soil bearing capacity	400	kF
Multiplier on Soil Bearing Capacity For Ultimate Loads	1.7	
Depth of Soil above footing	500	m
Type of Depth	Fixed Top	
Surcharge Pressure	0	kN
Depth of Water Table	2000	m
Phi value of soil Ø (in Degree)	0	
Min % of Contact Area for Service Loads	0	
Minimum % of Contact Area For Ultimate Loads	0	
Set as Default	No	

Figure 8.6 Cover and soil input parameters

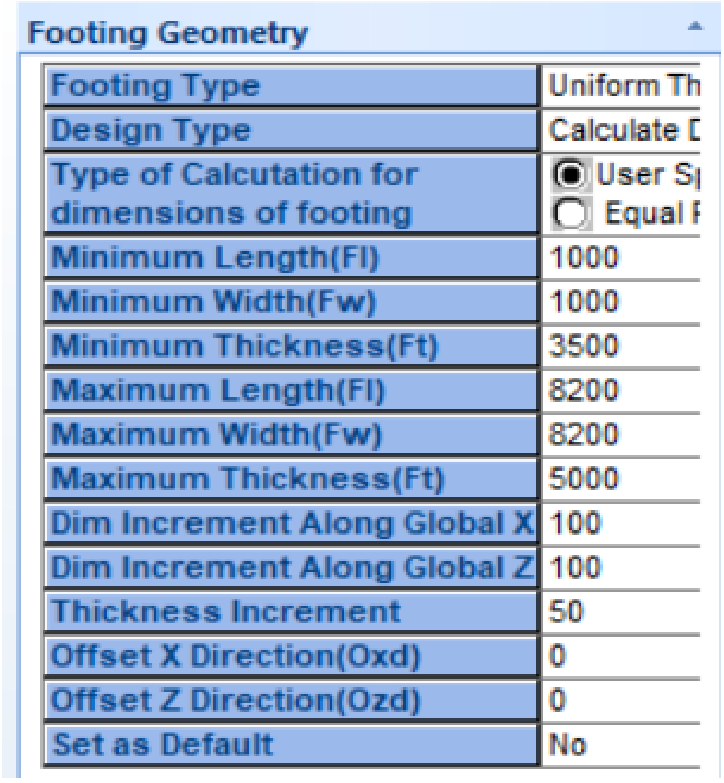


Figure 8.7 Footing geometry parameters

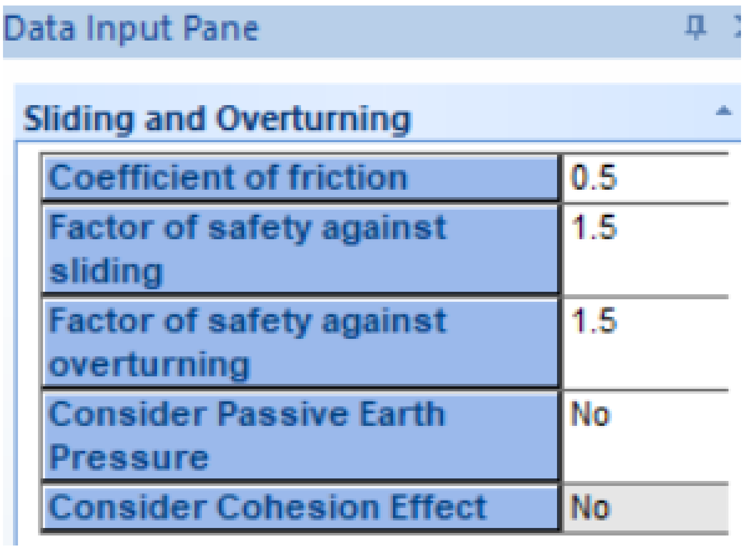


Figure 8.8 Sliding and overturning parameters

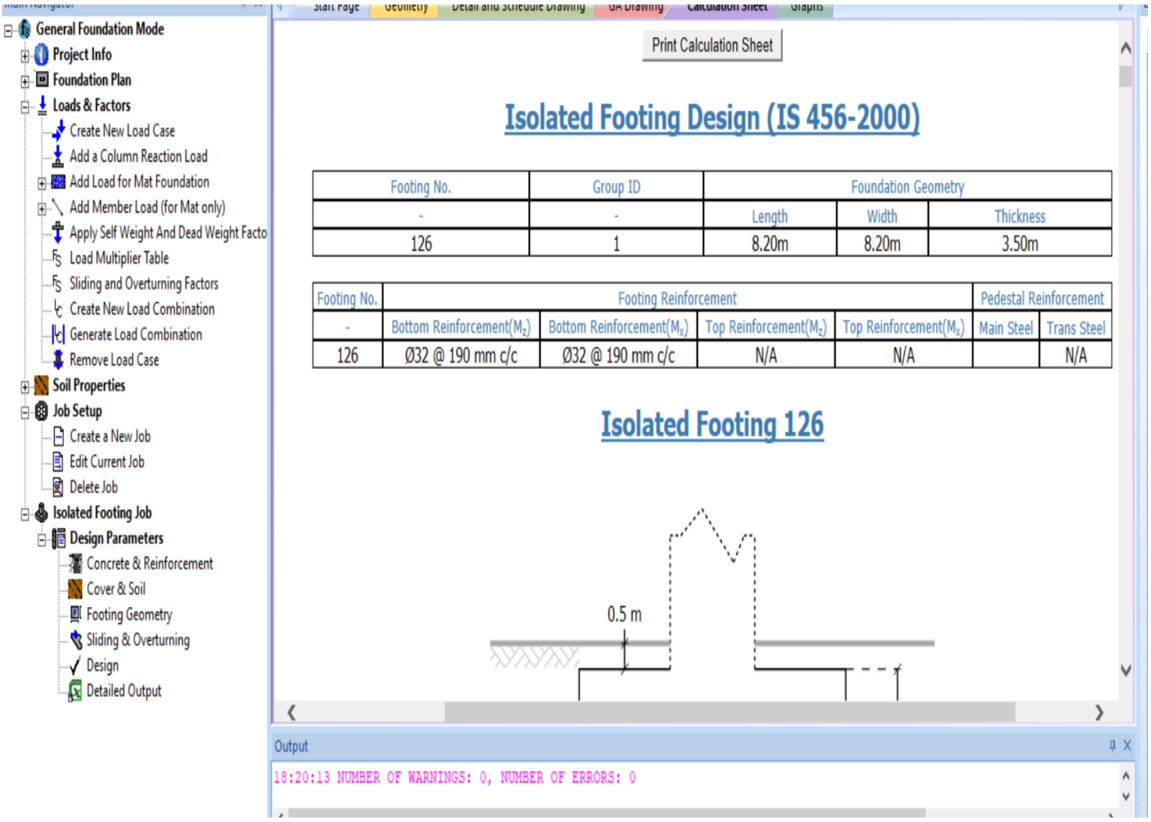


Figure 8.9 Analysis window showing zero errors with the dimensions of footing

Isolated Footing 126

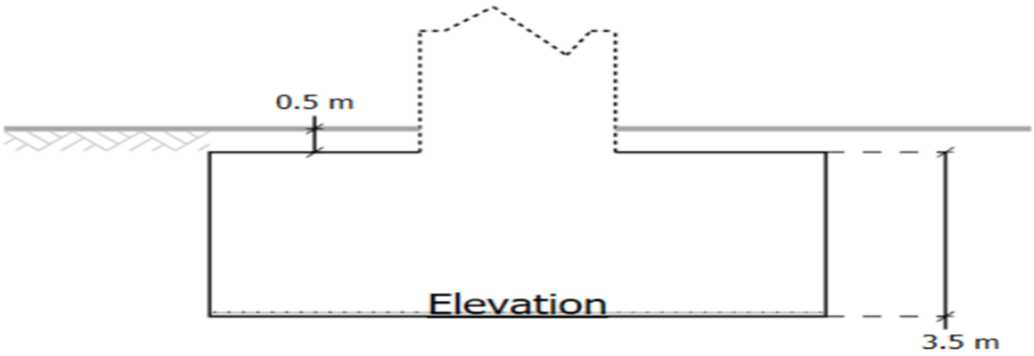


Figure 8.10 Elevation of isolated footing

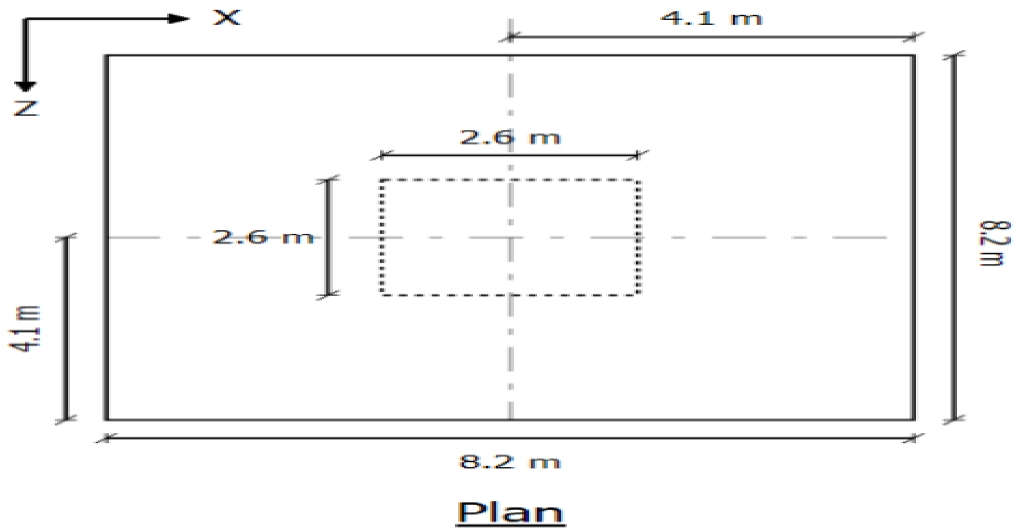


Figure 8.11 Plan of isolated footing

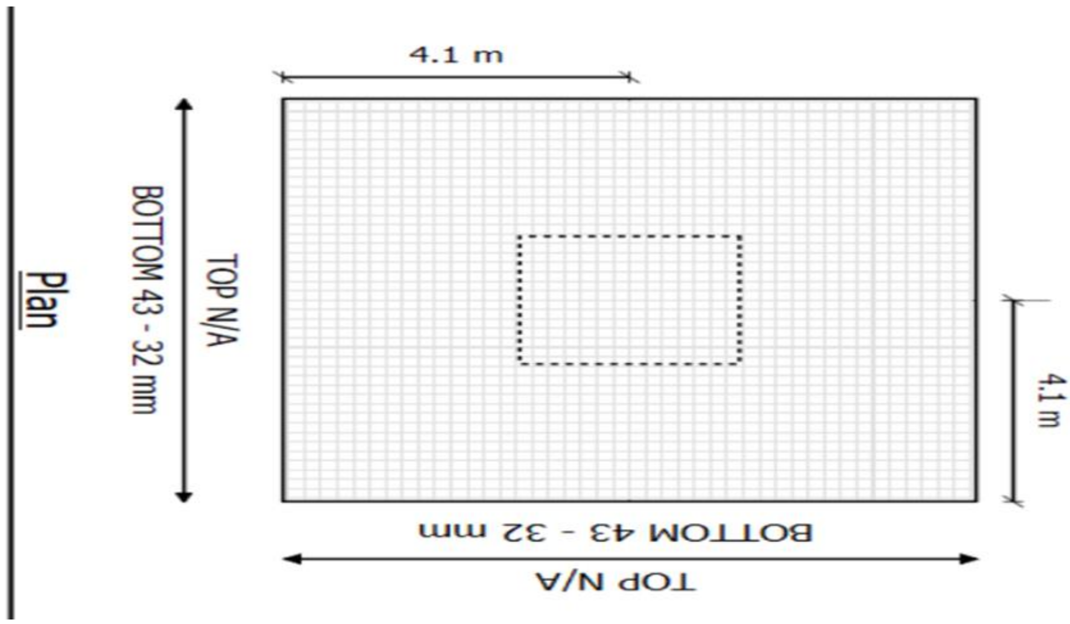


Figure 8.12 Reinforcement summary of foundation

CHAPTER 9

COMPARISON OF SINGLE COLUMN STRUCTURE WITH MULTIPLE COLUMNS STRUCTURE OF SAME DIMENSIONS

The comparisons of both structures have been made for a particular LOAD CASE that is 1.5(DL+LL) so that all major loads are included for simplicity.However STAAD PRO gives us flexibility to select any load for results and analysis.

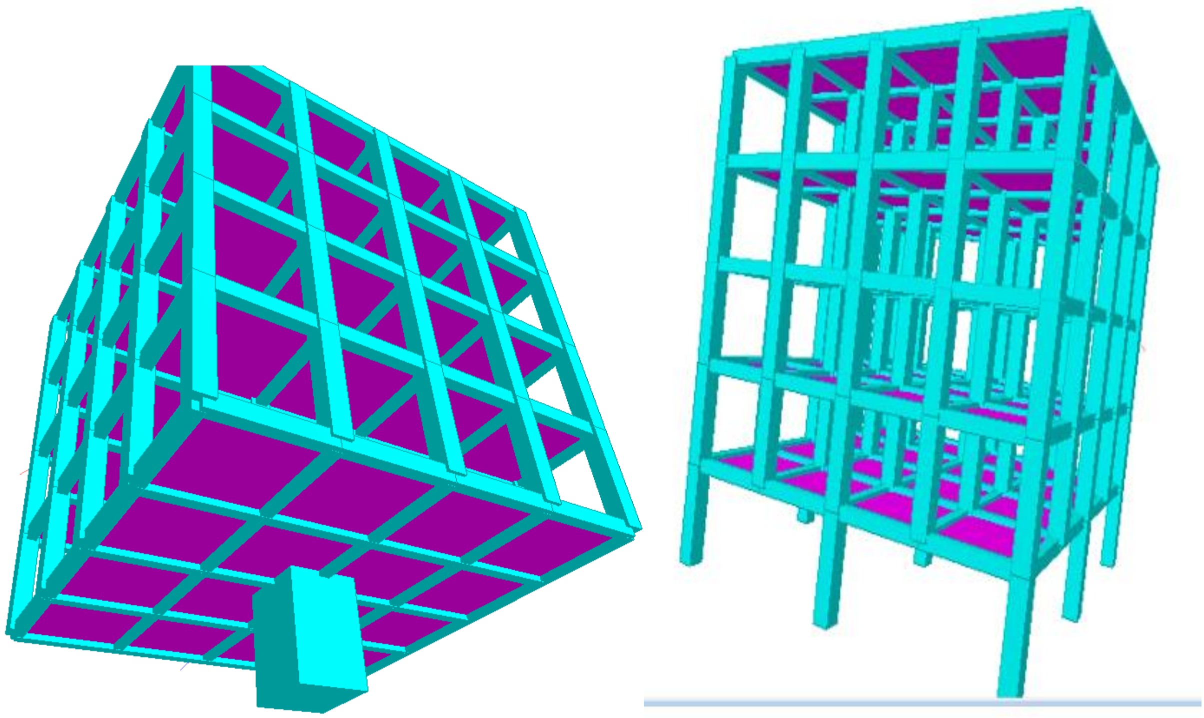


Figure 9.1 Single column building and multiple columns building used for comparison in project.

9.1 COMPARISON OF DEFLECTION OF SINGLE COLUMN WITH GENERAL COLUMN

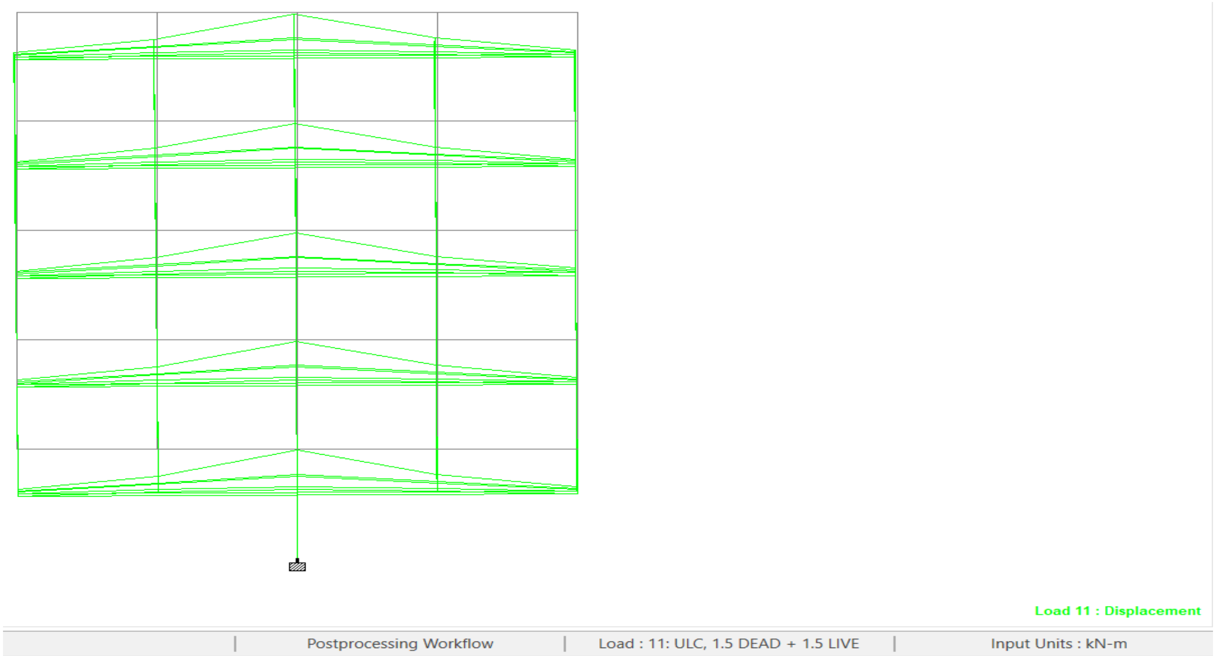


Figure 9.2 Deflection of single column building

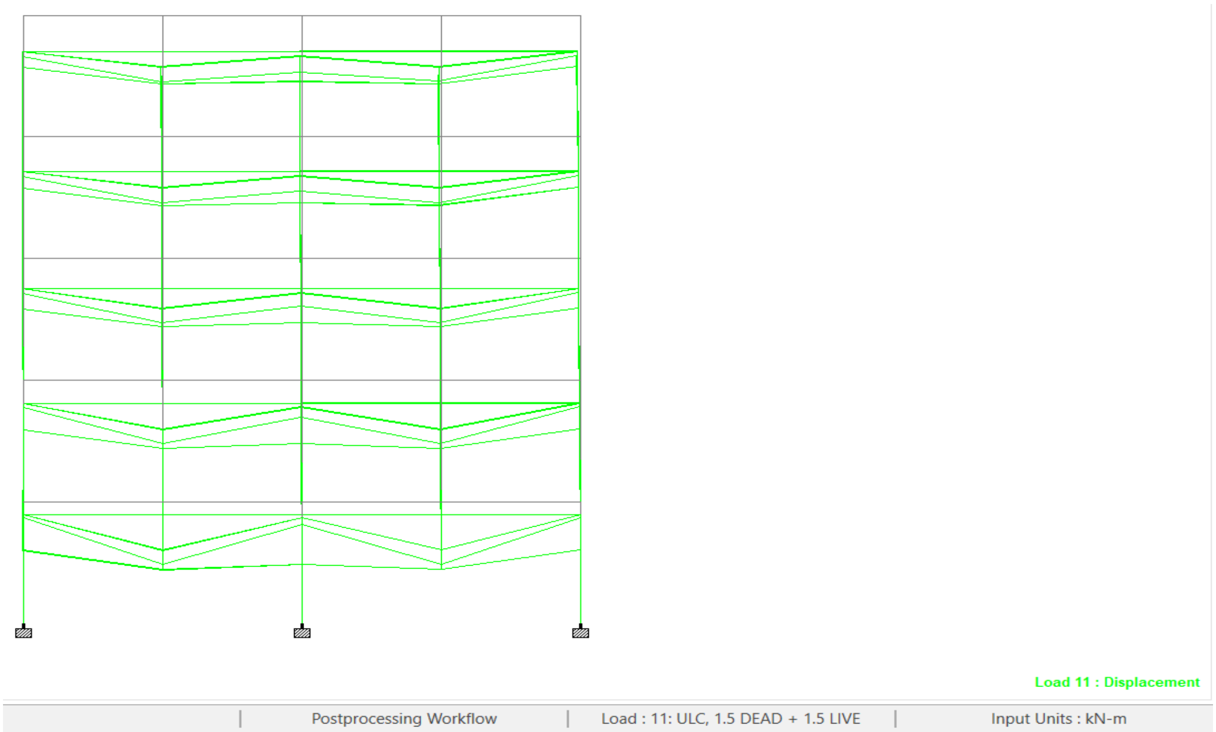


Figure 9.3 Deflection of multiple column building.

9.2 COMPARISON OF SHEAR FORCE IN X DIRECTION FOR BOTH STRUCTURES

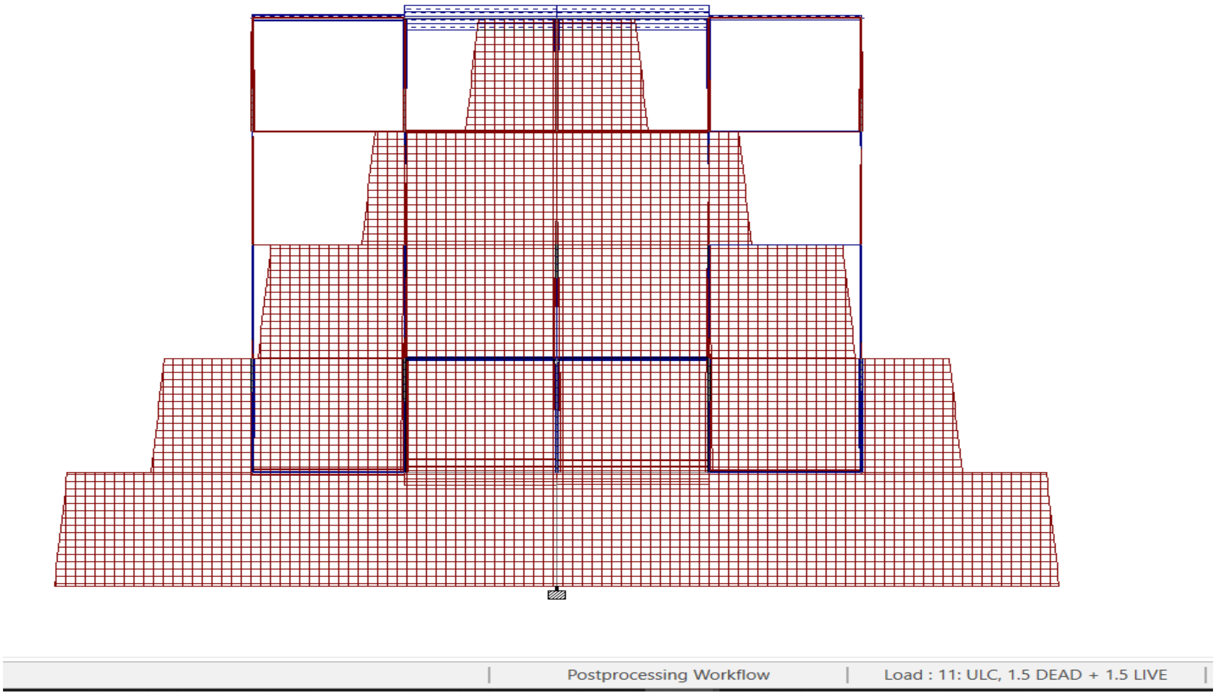


Figure 9.4 Shear force diagram of Fx of single column building(FRONT VIEW)

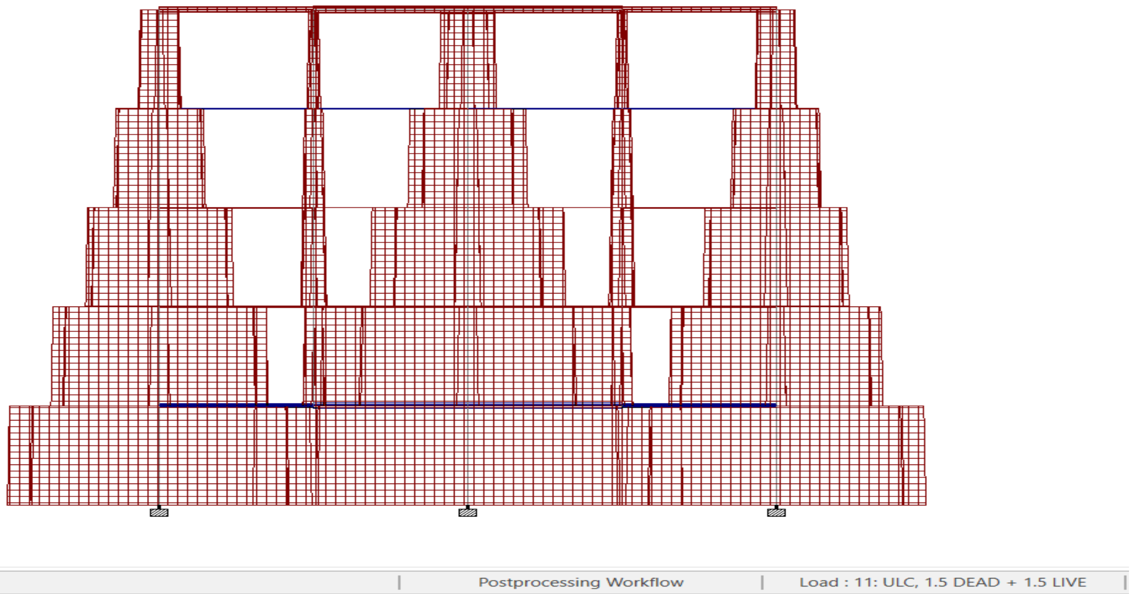


Figure 9.5 Shear force diagram of Fx of multiple column building(FRONT VIEW)

9.3 COMPARISON OF SHEAR FORCE IN Y DIRECTION Fy OF BOTH STRUCTURES

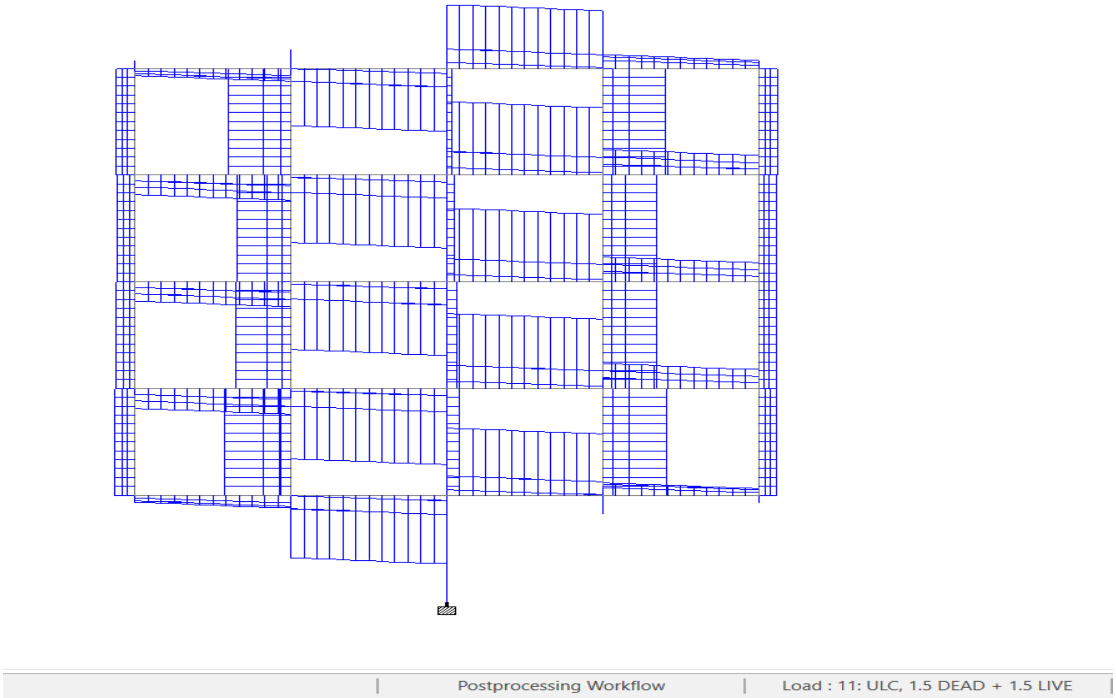


Figure 9.6 Front view of Fy of single column building

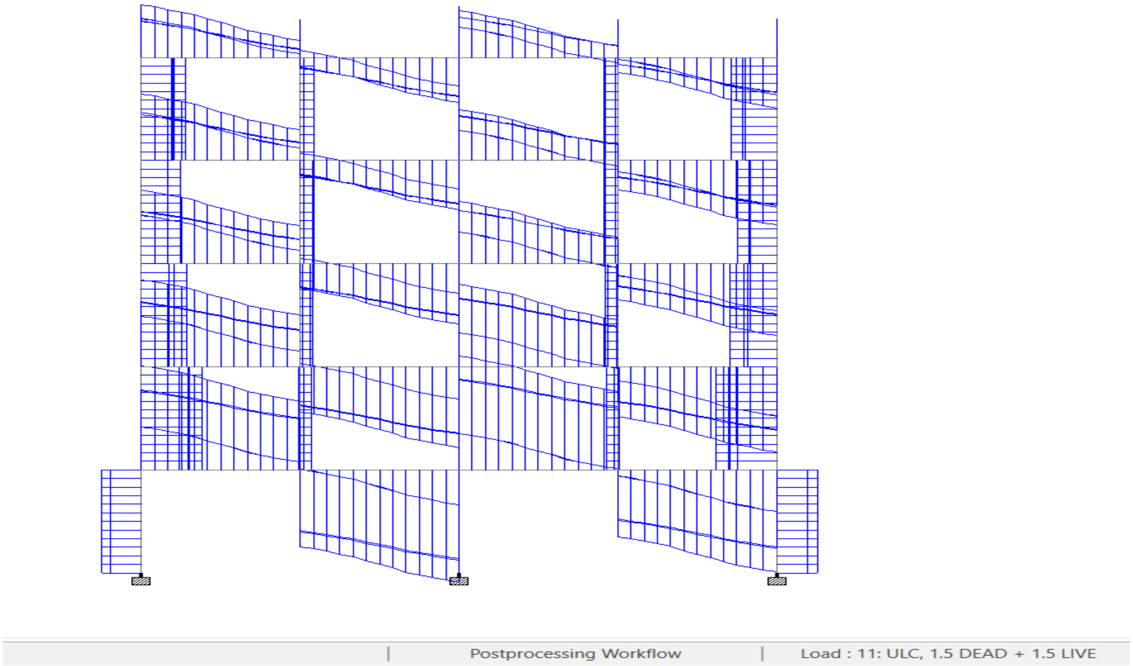


Figure 9.7 Front view of Fy of multiple columns building

`9.4 COMPARISON OF Fz FOR BOTH STRUCTURES

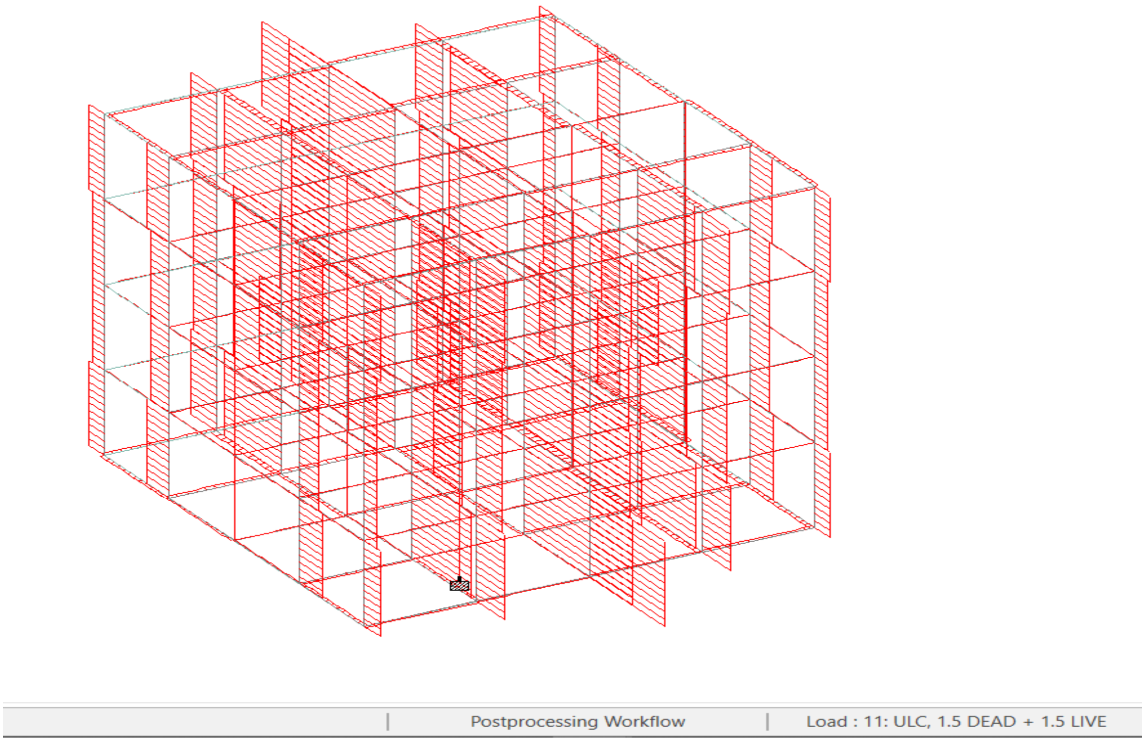


Figure 9.8 Shear force in Z direction for single column building (3D view)

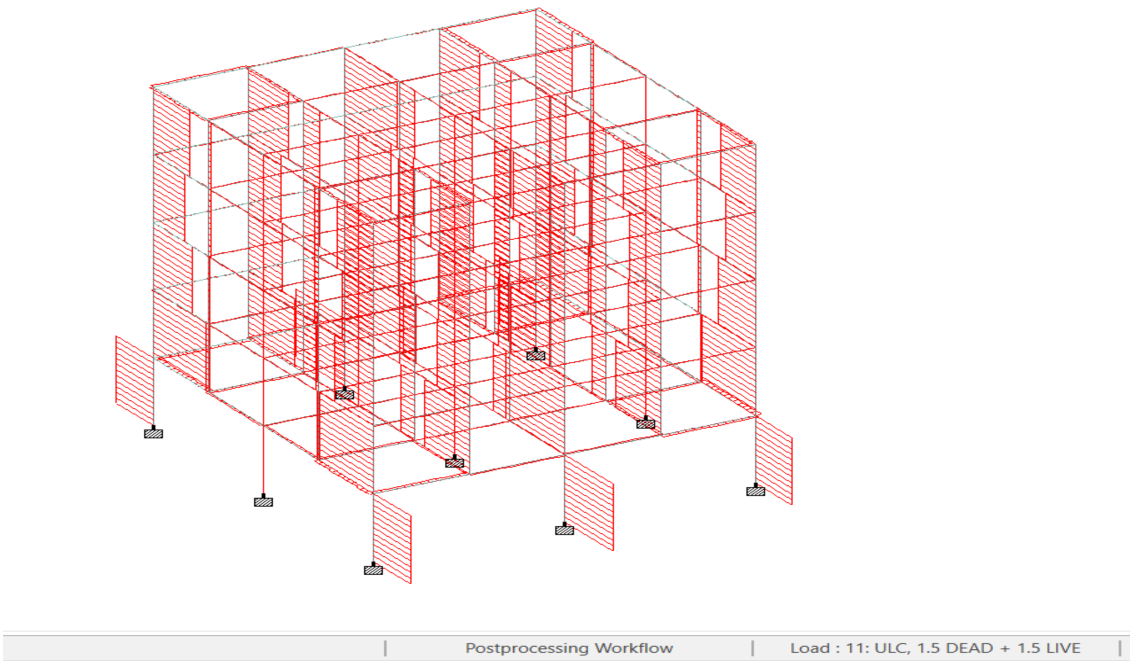


Figure 9.9 Shear force in Z direction for multiple columns building (3D view)

9.5 COMPARISON OF Mx FOR BOTH STRUCTURES

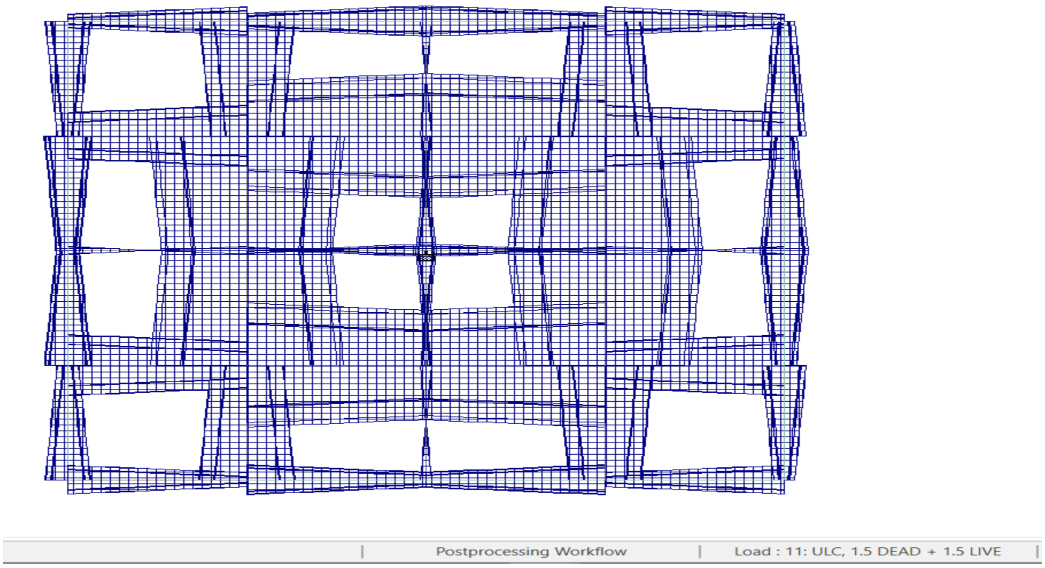


Figure 9.10 Moment in x direction for single column building(TOP VIEW)

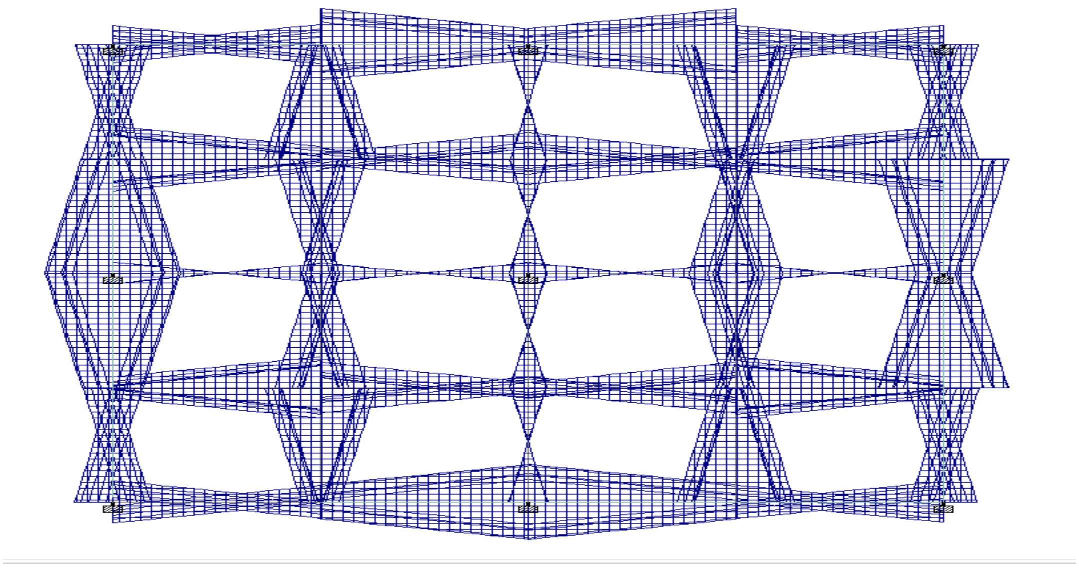


Figure 9.11 Moment in X direction for multiple columns building(TOP VIEW)

9.6 COMPARISON OF MOMENT IN Y DIRECTION FOR BOTH STRUCTURES

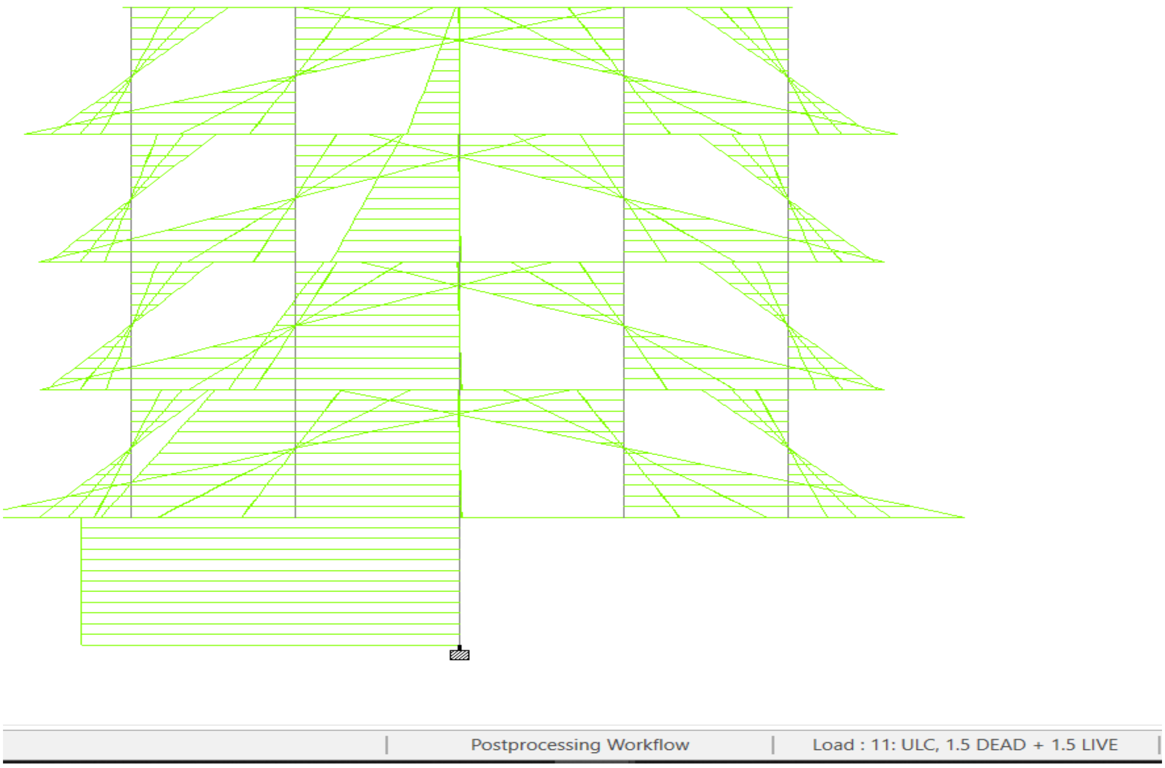


Figure 9. 12 Moment in Y direction for single column structure(VIEW FROM -X)

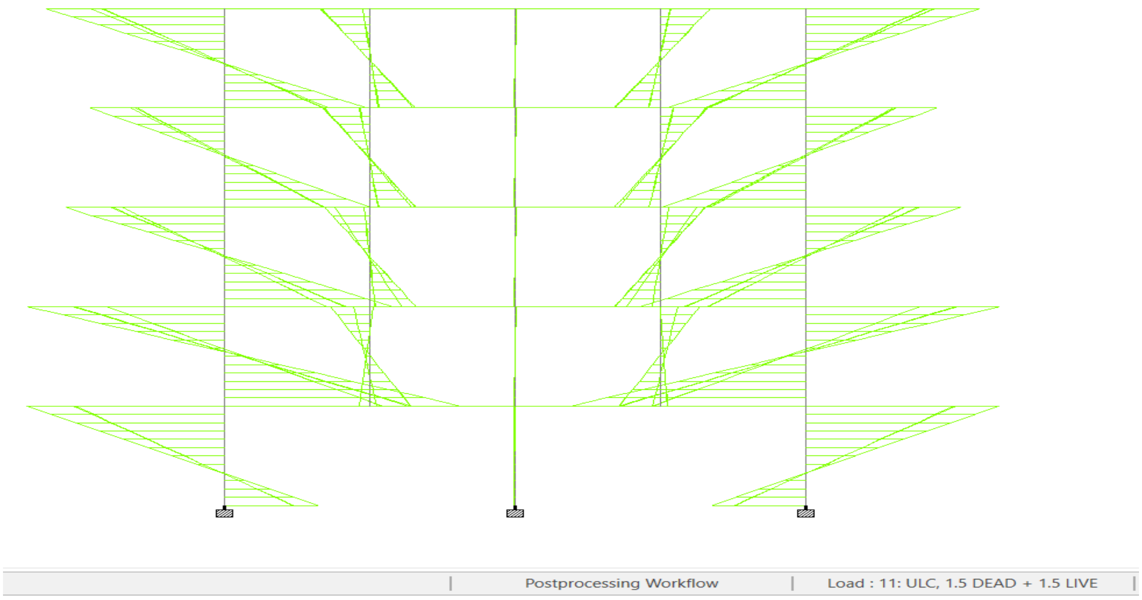


Figure 9.13 Moment in Y direction for multiple columns structure (VIEW FROM -X)

9.7 COMPARISON OF Mz FOR BOTH STRUCTURES

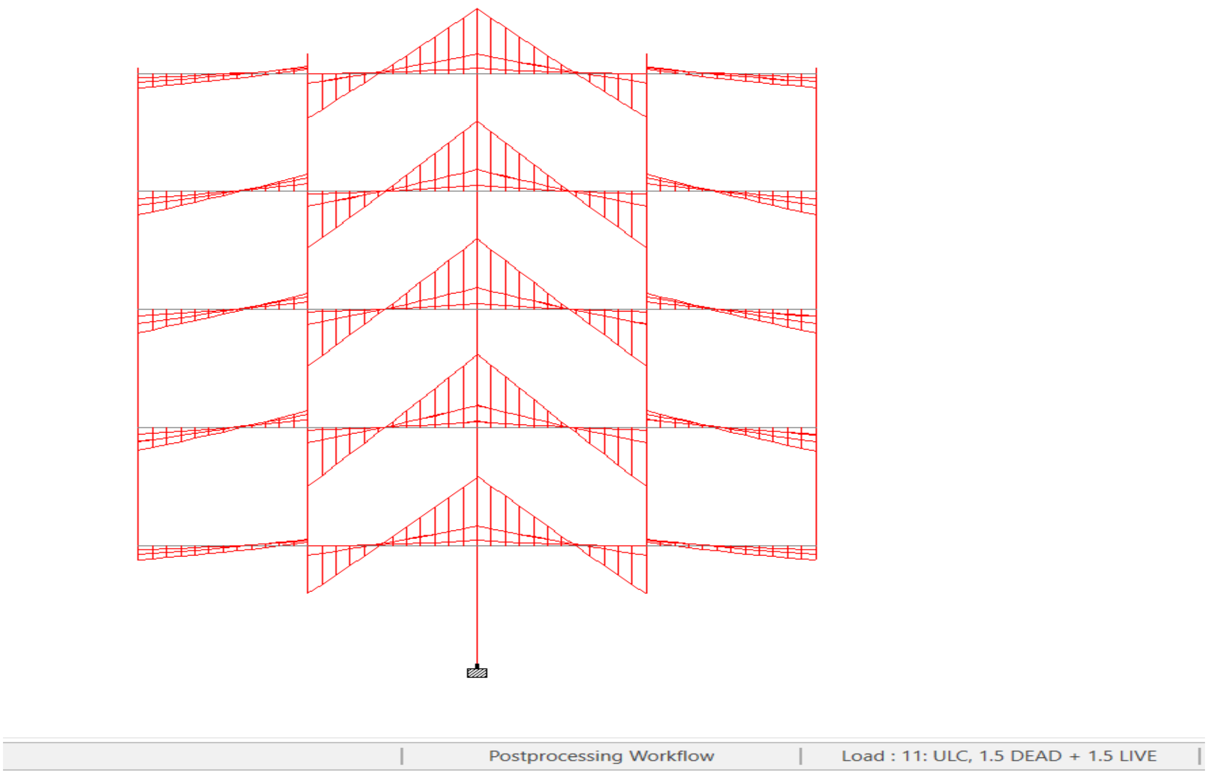


Figure 9.14 Moment in Z direction for single column structure (FRONT VIEW)

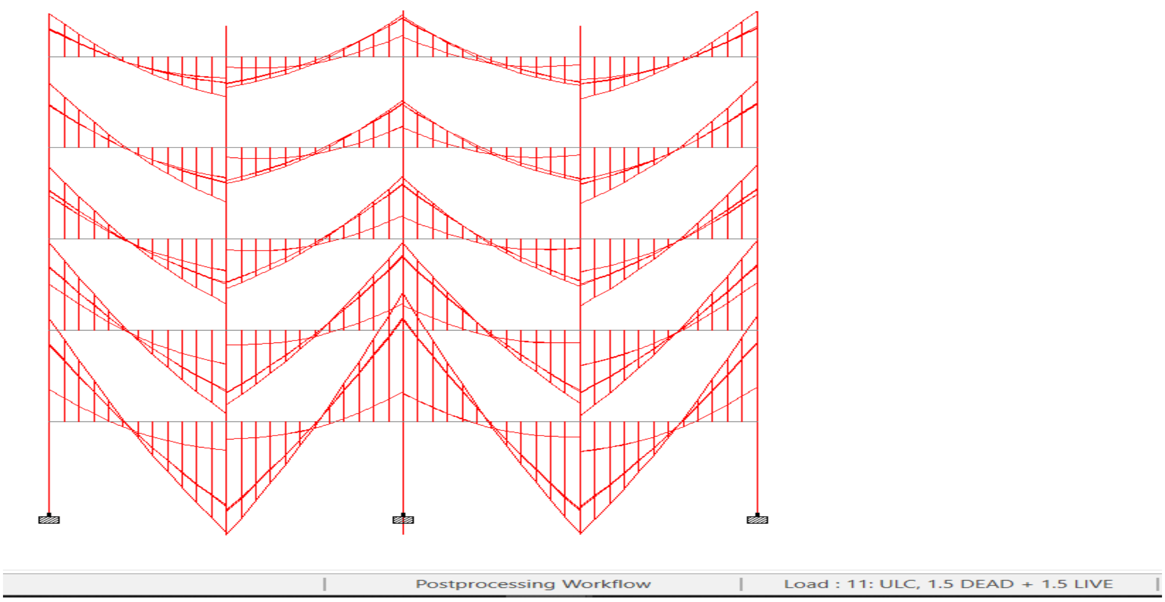


Figure 9.15 Moment in Z direction for multiple columns structure (FRONT VIEW)

CHAPTER 10

OBSERVATIONS

Table 10.1 Comparison Of Both Structures

DESCRIPTION	**LOCATION FOR BOTH STRUCTURES**	**LOAD CASE FOR MAXIMUM LOAD FOR BOTH**	**SINGLE COLUMN BUILDING**	**MULTIPLE COLUMNS BUILDING**	**PERCENTAGE DIFFERENCE IN VALUES**
DISPLACEMENT IN X(cm)	NODE 115, NODE 111	LOAD CASE NO. 53,52	0.355	2.620	86%
DISPLACEMENT IN Y(cm)	NODE 111,NODE 66	2 EQ-X, 1EQX	0.118	0.123	4%
DISPLACEMENT IN Z(cm)	NODE 123, NODE 103	LOAD CASE NO. 39 ,38	0.596	2.642	77%
MAX SHEAR FORCE IN X DIRECTION	NODE 126, NODE 126	LOAD CASE NO. 36,53	623.705	618.956	0.8%
MAX SHEAR FORCE IN Y DIRECTION	NODE 126,NODE 130	LOAD CASE NO. 11,38	27751.2951	3689.537	87%
MAX SHEAR FORCE IN Z DIRECTION	NODE 126,NODE 126	LOAD CASE NO. 38,39	623.705	619.255	0.8%
MAX MOMENT IN X DIRECTION	NODE 126,NODE 126	LOAD CASE NO. 54,55	5149.170	1053.934	80%
MAX MOMENT IN Z DIRECTION	NODE 126,NODE 126	LOAD CASE NO. 53,52	5149.015	1053.934	80%

Table 10.2 Volume Of Concrete And Weight Of Bars For Single Column Structure

DESCRIPTION	DL+LL	DL+LL+WL+EL	DL+LL+WL+EL+LOAD COMBINATIONS
WEIGHT OF STRUCTURE(Kn)	136612	210836	366831
VOLUME OF CONCRETE (m^3)	199.3	260.3	425.5

Table 10.3 Weight Of Structure And Volume Of Concrete For Multiple Columns Structure

DESCRIPTION	DL +LL	DL+LL+WL+EL	DL+LL+WL+EL+LOAD COMBINATIONS
WEIGHT OF STRUCTURE(Kn)	108592	108592	252913
VOLUME OF CONCRETE (m^3)	153.6	153.6	333.7

CHAPTER 11

RESULTS

			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X cm	Y cm	Z cm	cm	rX rad	rY rad	rZ rad
Max X	115	53 ULC, 0.9 D	0.355	-1.456	0.090	1.501	0.000	-0.000	-0.001
Min X	111	36 ULC, 1.5 D	-0.596	-2.476	0.150	2.551	0.000	0.000	0.001
Max Y	111	2 EQ-X	0.278	0.118	0.000	0.302	0.000	0.000	-0.000
Min Y	121	11 ULC, 1.5 D	-0.154	-3.001	0.154	3.009	0.001	-0.000	0.001
Max Z	123	39 ULC, 1.5 D	-0.150	-2.476	0.596	2.551	0.001	-0.000	0.000
Min Z	103	54 ULC, 0.9 D	-0.090	-1.456	-0.355	1.501	-0.001	0.000	0.000
Max rX	18	11 ULC, 1.5 D	0.006	-1.696	-0.029	1.696	0.003	0.000	0.000
Min rX	8	11 ULC, 1.5 D	0.006	-1.616	0.040	1.616	-0.003	-0.000	0.000
Max rY	102	38 ULC, 1.5 D	-0.155	-2.471	-0.258	2.489	-0.001	0.000	0.001
Min rY	120	37 ULC, 1.5 D	0.258	-2.471	0.155	2.489	0.001	-0.000	-0.001
Max rZ	12	11 ULC, 1.5 D	0.029	-1.696	-0.006	1.696	0.000	-0.000	0.003
Min rZ	14	11 ULC, 1.5 D	-0.040	-1.616	-0.006	1.616	0.000	0.000	-0.003
Max Rst	121	11 ULC, 1.5 D	-0.154	-3.001	0.154	3.009	0.001	-0.000	0.001

Figure 11. 1 Maximum and minimum values at nodes

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
Max Fx	126	36 ULC, 1.5 D	623.705	25051.294	0.000	-1406.118	0.017	-7399.218
Min Fx	126	37 ULC, 1.5 D	-623.705	25051.294	0.000	-1406.118	-0.017	4586.464
Max Fy	126	11 ULC, 1.5 D	0.000	27751.295	0.000	-1406.091	-0.000	-1406.404
Min Fy	126	3 EQZ	-0.000	-0.000	415.803	3995.227	-0.011	-0.000
Max Fz	126	38 ULC, 1.5 D	0.000	25051.294	623.705	4586.723	-0.017	-1406.377
Min Fz	126	39 ULC, 1.5 D	0.000	25051.294	-623.705	-7398.959	0.017	-1406.377
Max Mx	126	54 ULC, 0.9 D	0.000	15030.777	623.705	5149.170	-0.017	-843.826
Min Mx	126	39 ULC, 1.5 D	0.000	25051.294	-623.705	-7398.959	0.017	-1406.377
Max My	126	36 ULC, 1.5 D	623.705	25051.294	0.000	-1406.118	0.017	-7399.218
Min My	126	37 ULC, 1.5 D	-623.705	25051.294	0.000	-1406.118	-0.017	4586.464
Max Mz	126	53 ULC, 0.9 D	-623.705	15030.777	0.000	-843.671	-0.017	5149.015
Min Mz	126	36 ULC, 1.5 D	623.705	25051.294	0.000	-1406.118	0.017	-7399.218

Figure 11.2 Results of reactions at nodes

Postprocessing: Displacements Reactions Beam Results Plate Results Solid Results Dynamics Reports

All | Summary | Envelope

	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
Max Fx	301	11 ULC, 1.5 D	126	**27751.295**	-0.000	-0.000	-0.000	1406.091	1406.404
Min Fx	170	37 ULC, 1.5 D	112	**-942.559**	-889.958	5.209	-6.056	-6.999	-1135.928
Max Fy	73	11 ULC, 1.5 D	38	-134.787	**1300.814**	0.052	-9.622	-0.251	2083.915
Min Fy	50	11 ULC, 1.5 D	38	-134.790	**-1300.820**	-0.052	9.622	-0.251	2083.920
Max Fz	218	11 ULC, 1.5 D	18	201.279	4.907	**778.746**	1.027	-1265.704	7.615
Min Fz	213	39 ULC, 1.5 D	13	20215.934	-142.073	**-798.834**	0.013	5381.035	-1334.471
Max Mx	29	11 ULC, 1.5 D	14	465.670	-327.537	-31.433	**119.662**	-48.743	560.746
Min Mx	7	11 ULC, 1.5 D	8	465.673	327.539	31.432	**-119.662**	-48.742	560.750
Max My	301	39 ULC, 1.5 D	126	25051.294	-0.000	623.705	0.017	**7398.959**	1406.377
Min My	301	54 ULC, 0.9 D	126	15030.777	-0.000	-623.705	-0.017	**-5149.170**	843.826
Max Mz	301	36 ULC, 1.5 D	126	25051.294	-623.705	-0.000	0.017	1406.118	**7399.218**
Min Mz	213	36 ULC, 1.5 D	13	20215.934	-798.861	-142.046	0.013	1334.224	**-5381.282**

Figure 11.3 Results of moments in beams and columns

Postprocessing: Displacements Reactions Beam Results Plate Results Solid Results Dynamics Reports

Shear, Membrane and Bending | Summary

			Principal		Von Mis		Tresca	
	Plate	L/C	Top psi	Bottom psi	Top psi	Bottom psi	Top psi	Bottom psi
Max Prin	306	11 ULC, 1.5 D	**39.522**	14.945	39.522	14.945	39.522	14.945
Min Prin	302	11 ULC, 1.5 D	**-14.971**	-39.512	14.971	39.512	14.971	39.512
Max Prin	306	11 ULC, 1.5 D	39.522	**14.945**	39.522	14.945	39.522	14.945
Min Prin	302	11 ULC, 1.5 D	-14.971	**-39.512**	14.971	39.512	14.971	39.512
Max Von	306	11 ULC, 1.5 D	39.522	14.945	**39.522**	14.945	39.522	14.945
Min Von	302	1 EQX	-0.000	-0.000	**0.000**	0.000	0.000	0.000
Max Von	302	11 ULC, 1.5 D	-14.971	-39.512	14.971	**39.512**	14.971	39.512
Min Von	302	1 EQX	-0.000	-0.000	0.000	**0.000**	0.000	0.000
Max Tre	306	11 ULC, 1.5 D	39.522	14.945	39.522	14.945	**39.522**	14.945
Min Tres	302	1 EQX	-0.000	-0.000	0.000	0.000	**0.000**	0.000
Max Tre	302	11 ULC, 1.5 D	-14.971	-39.512	14.971	39.512	14.971	**39.512**
Min Tres	302	1 EQX	-0.000	-0.000	0.000	0.000	0.000	**0.000**

Figure 11.4 Results of plates

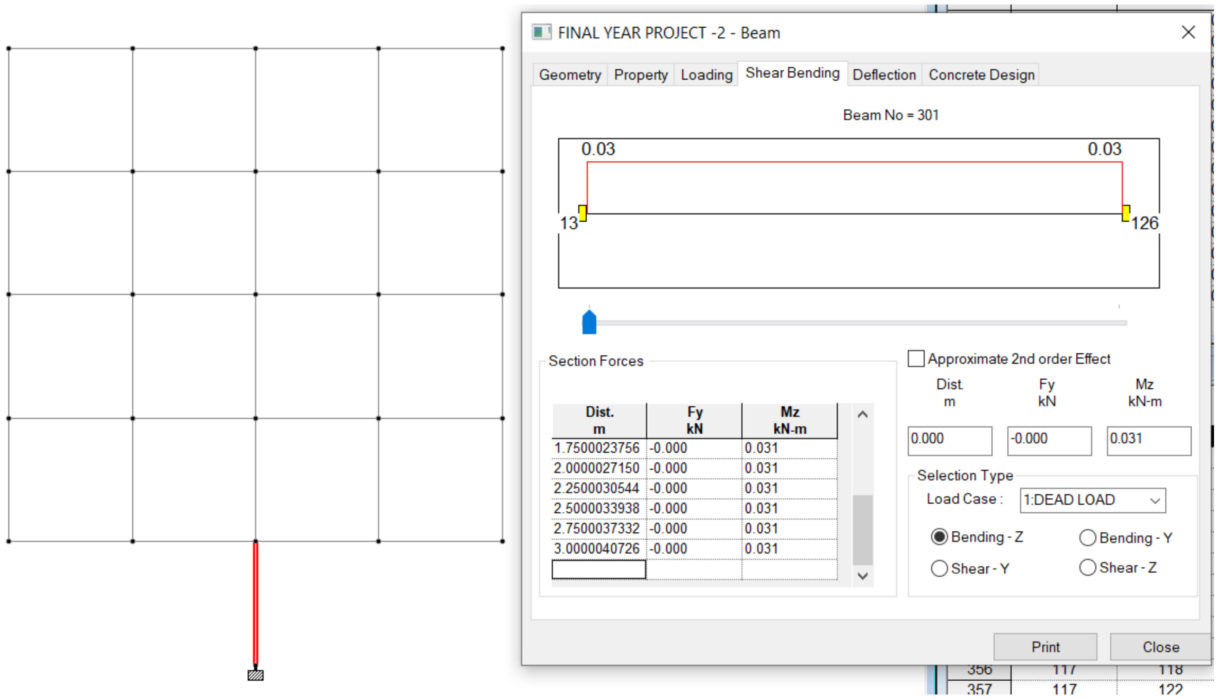


Figure 11.5 Shear bending of beam 301

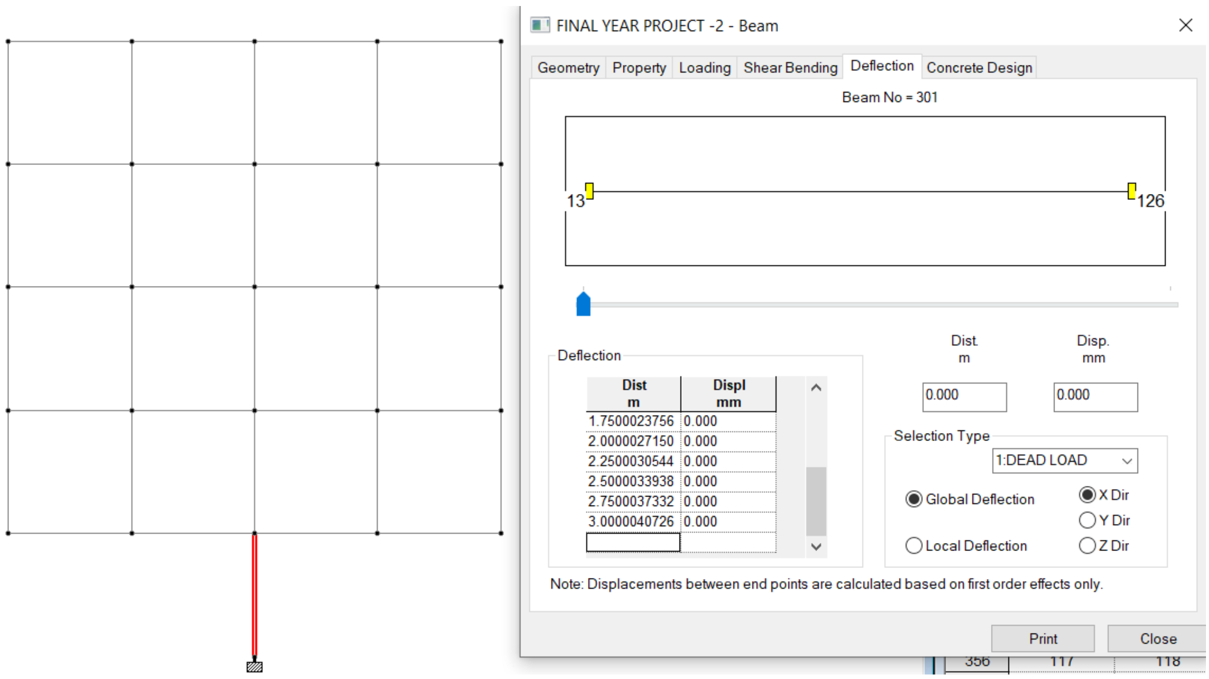


Figure 11.6 Deflection of beam 301

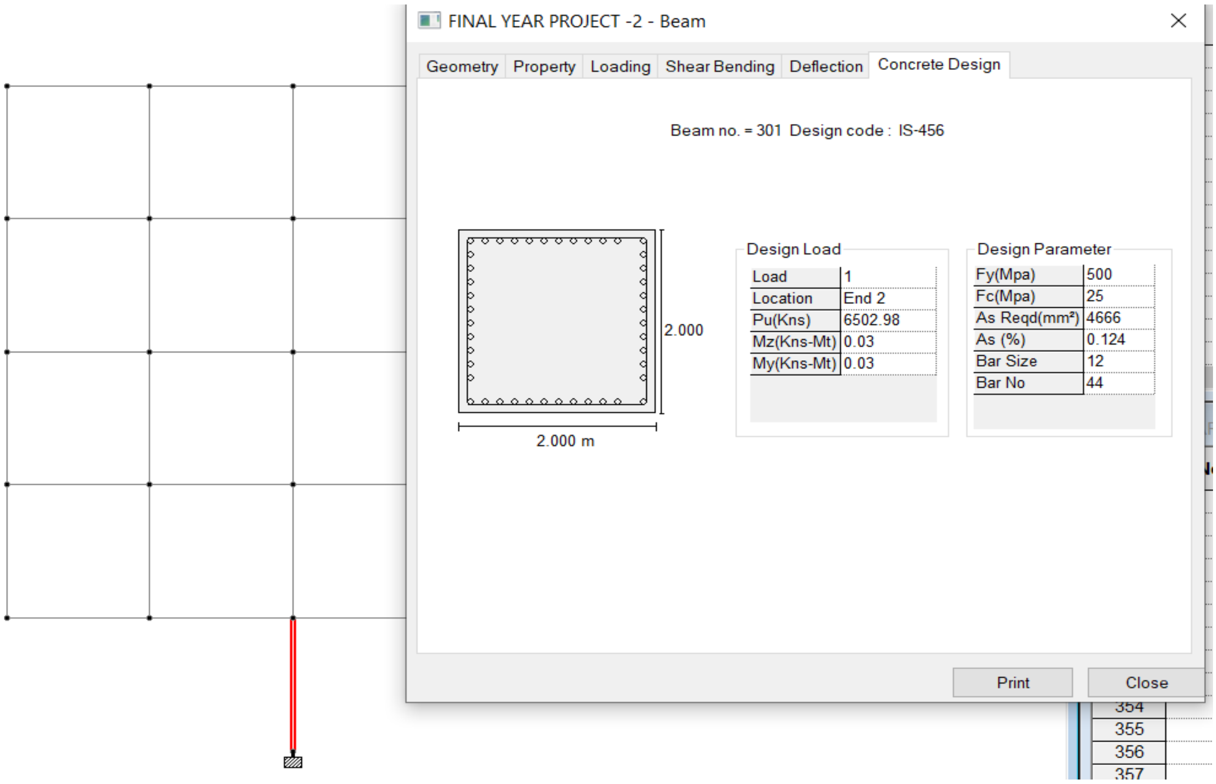
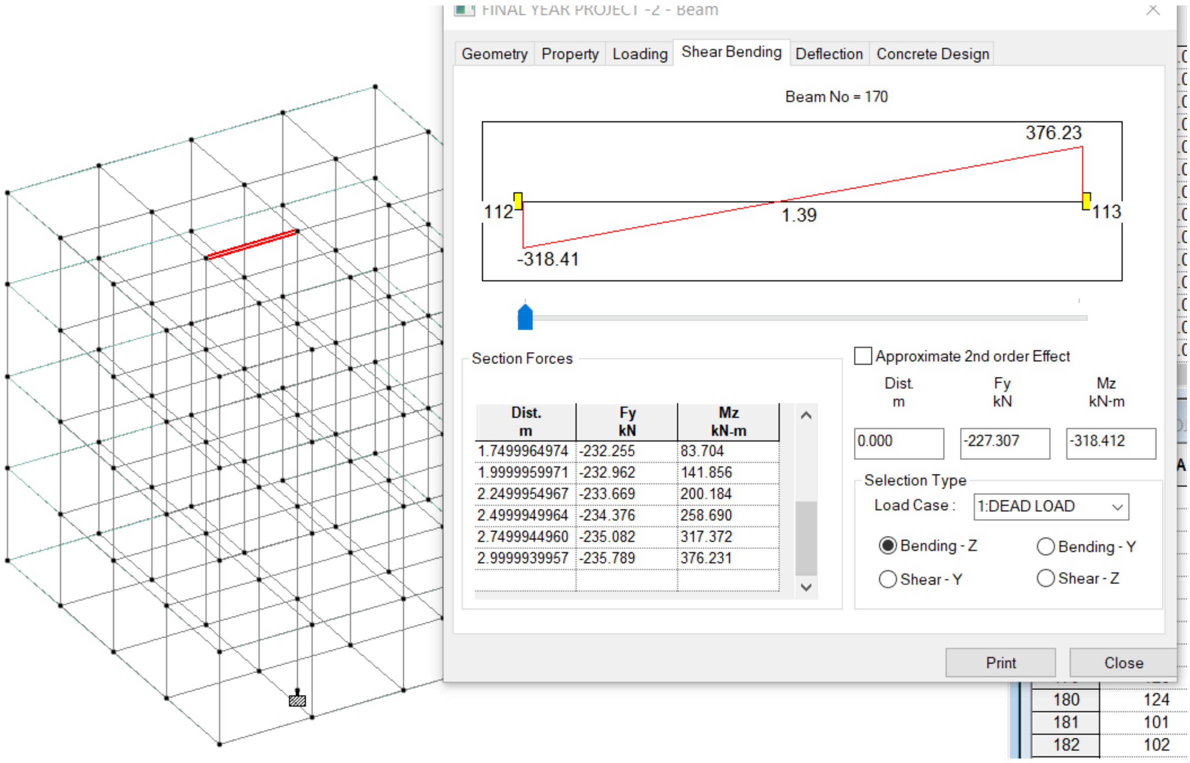


Figure 11.7 Concrete design of beam 301



Dist. m	Fy kN	Mz kN-m
1.7499964974	-232.255	83.704
1.9999959971	-232.962	141.856
2.2499954967	-233.669	200.184
2.4999949964	-234.376	258.690
2.7499944960	-235.082	317.372
2.9999939957	-235.789	376.231

Figure 11.8 Shear bending of beam 170

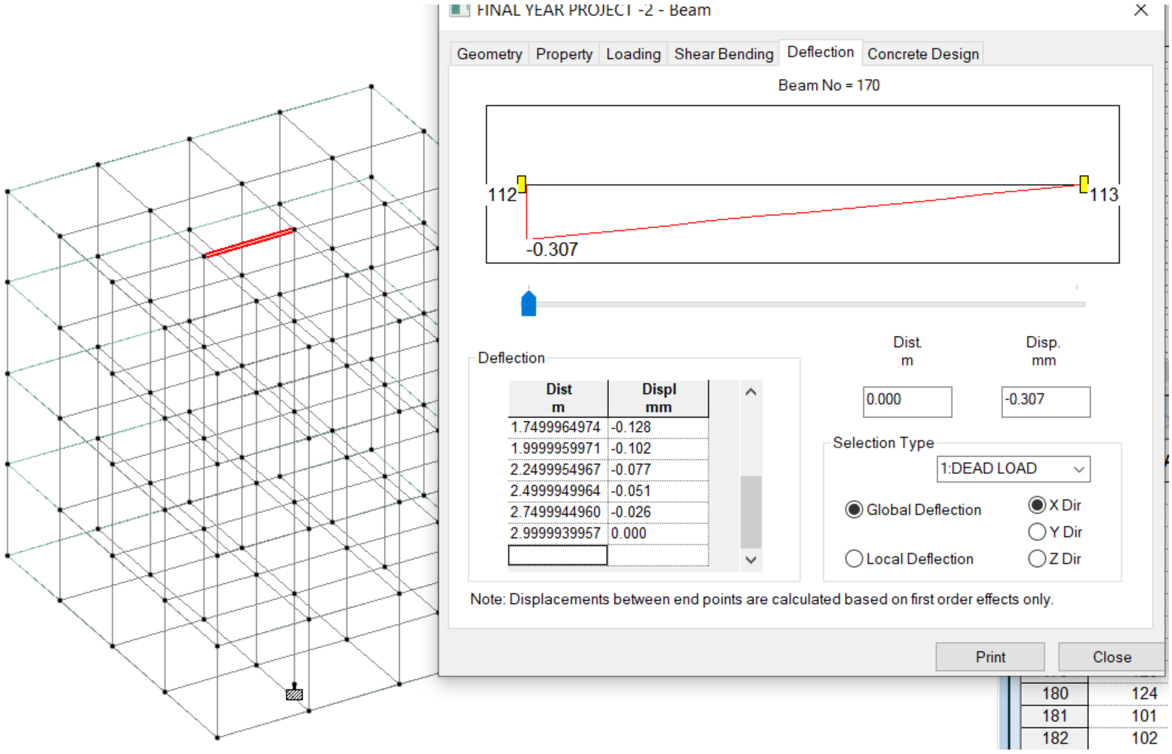


Figure 11.9 Deflection of beam 170

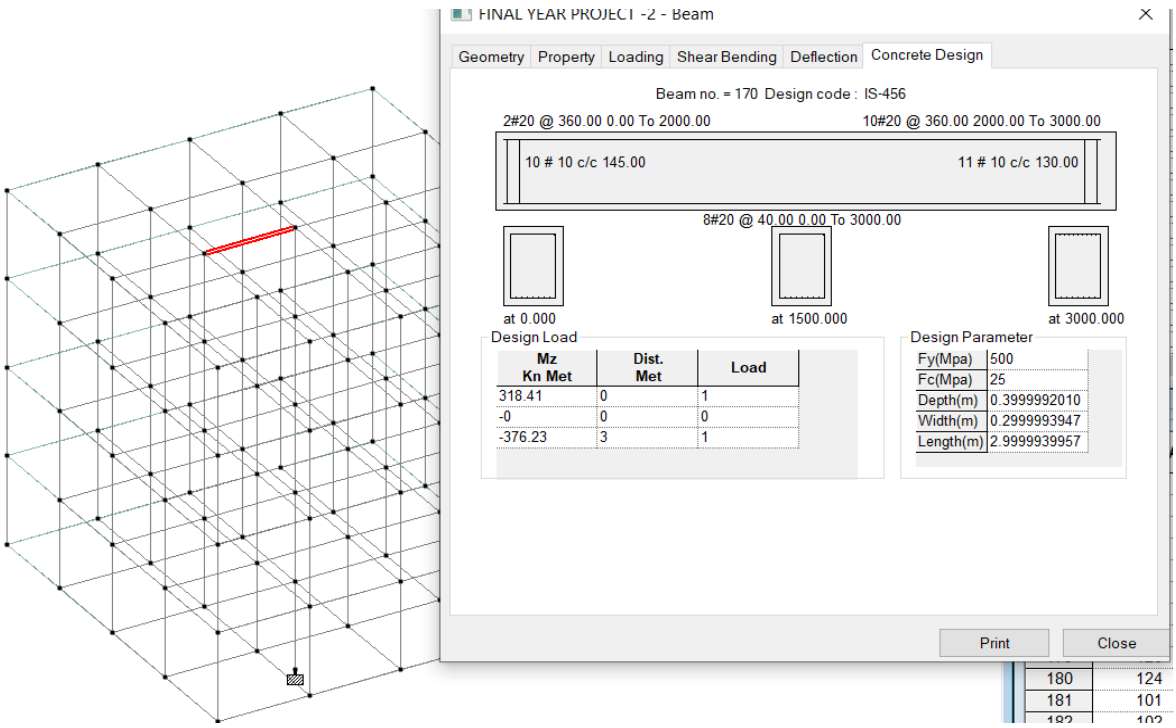
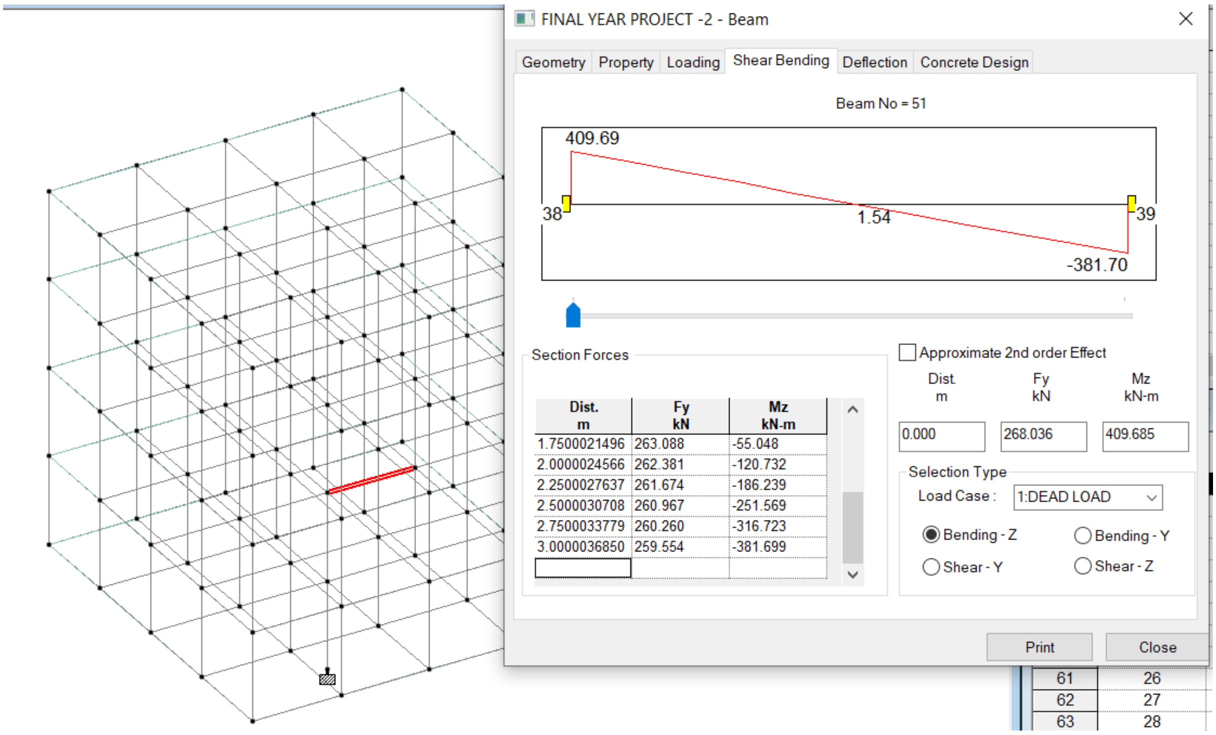
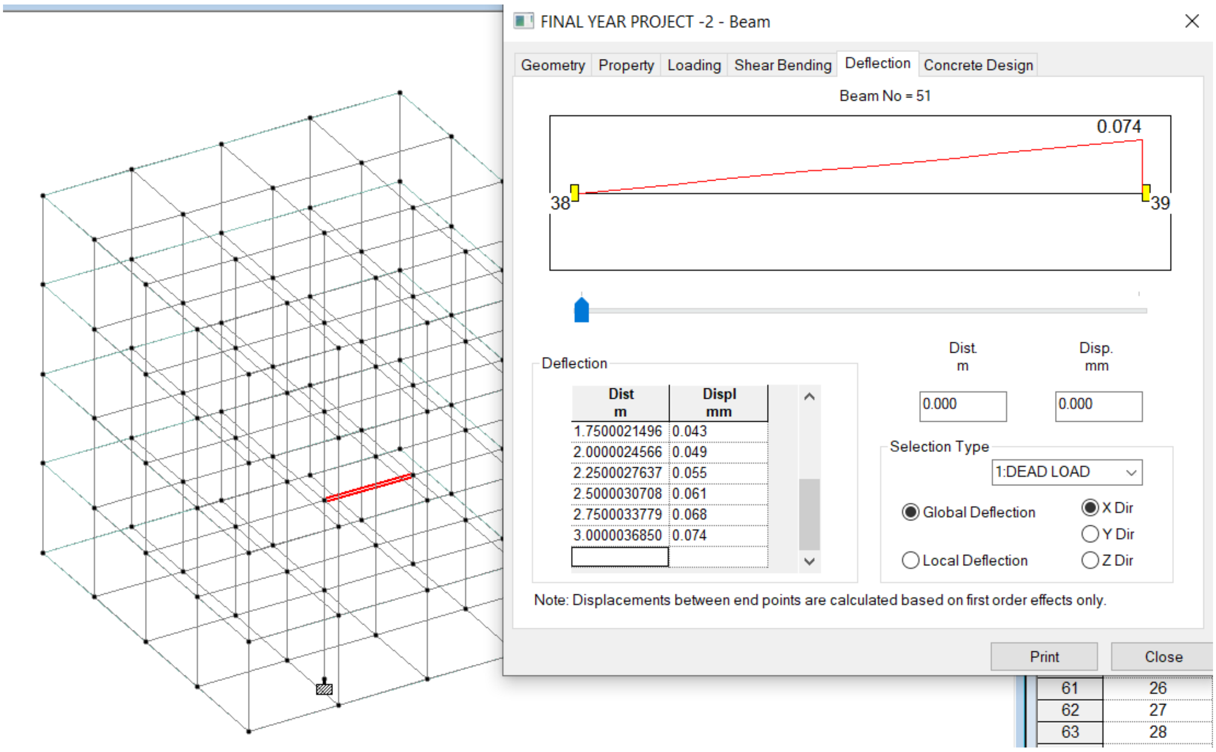


Figure 11.10 Concrete design of beam 170



Dist. m	Fy kN	Mz kN-m
1.7500021496	263.088	-55.048
2.0000024566	262.381	-120.732
2.2500027637	261.674	-186.239
2.5000030708	260.967	-251.569
2.7500033779	260.260	-316.723
3.0000036850	259.554	-381.699

Figure 11.11 Shear bending of beam 51



Dist m	Displ mm
1.7500021496	0.043
2.0000024566	0.049
2.2500027637	0.055
2.5000030708	0.061
2.7500033779	0.068
3.0000036850	0.074

Figure 11.12 Deflection of beam 51

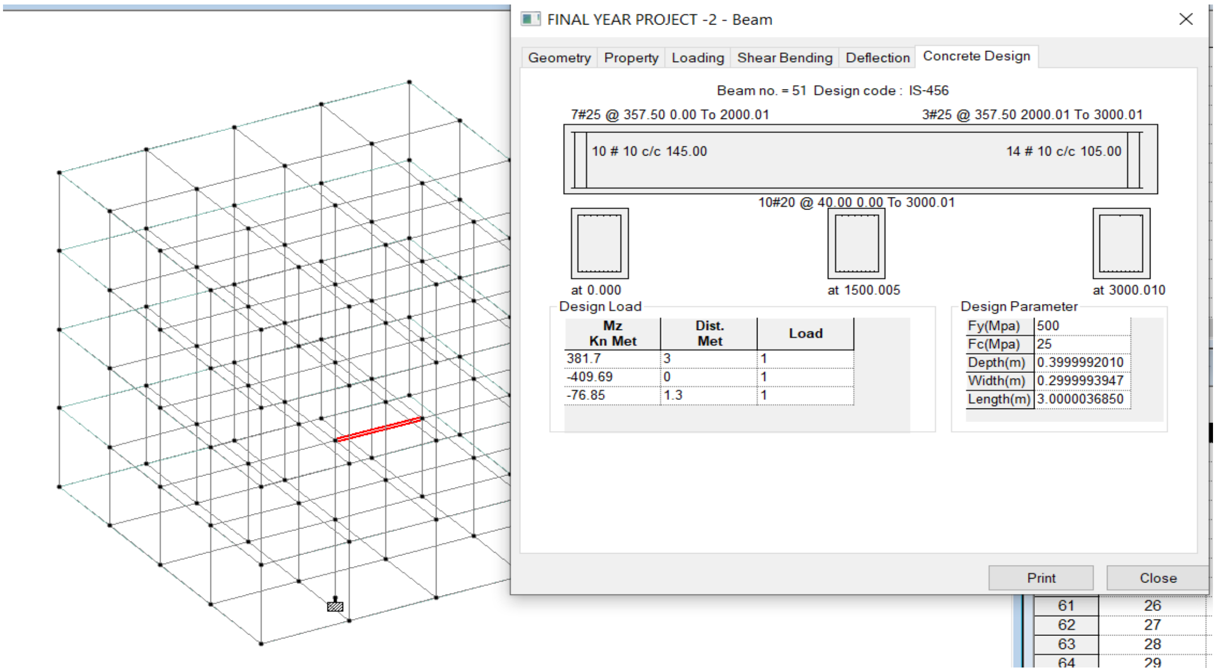


Figure 11.13 Concrete design of beam 51

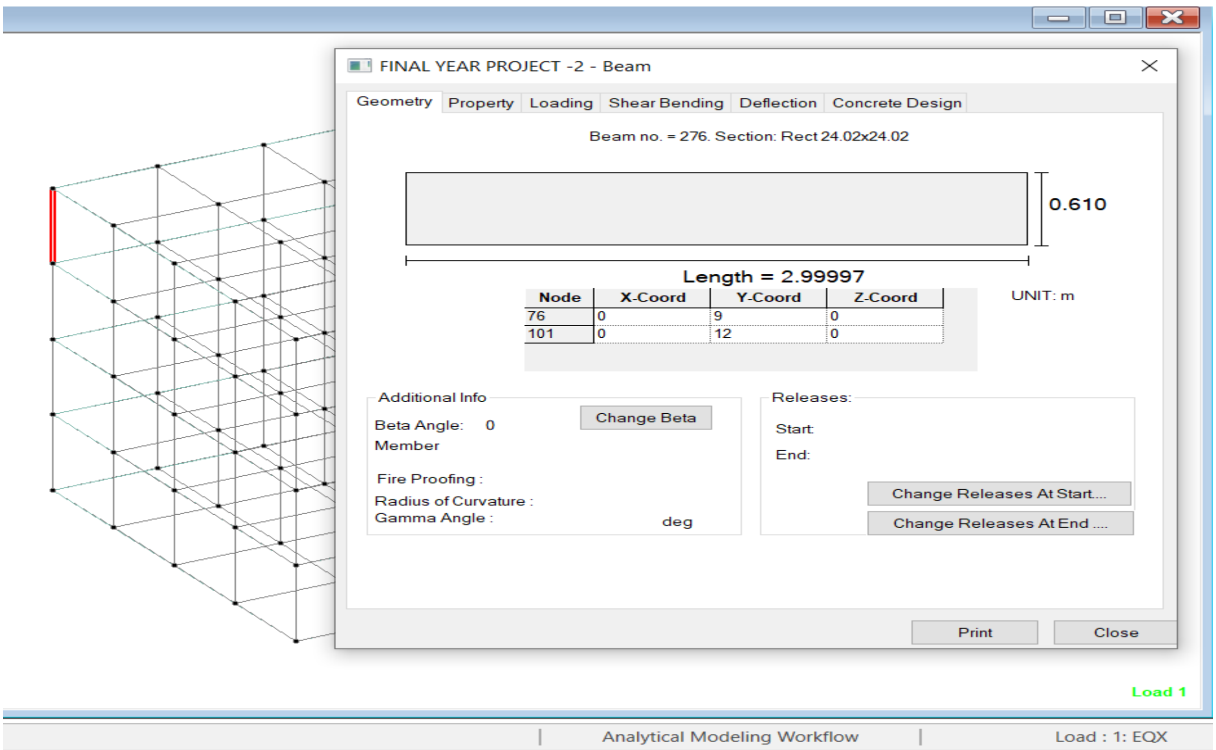


Figure 11.14 Beam 276 geometry

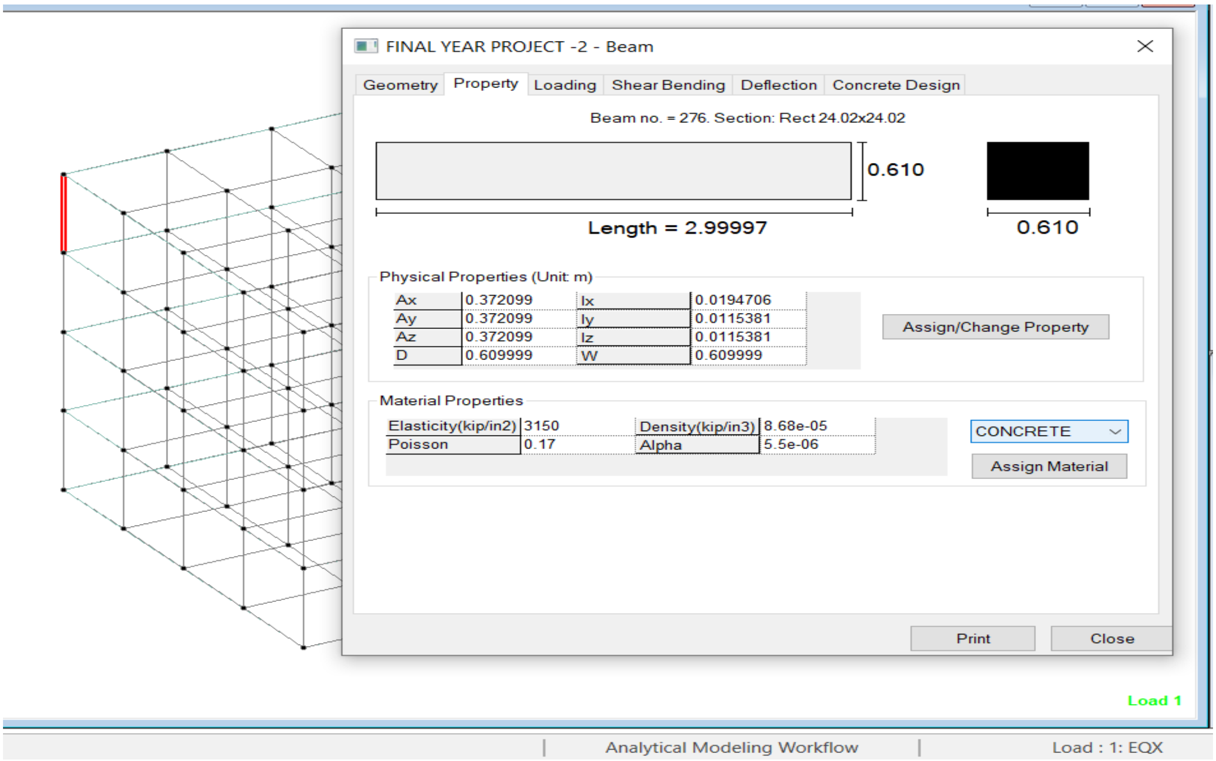


Figure 11.15 Beam 276 property

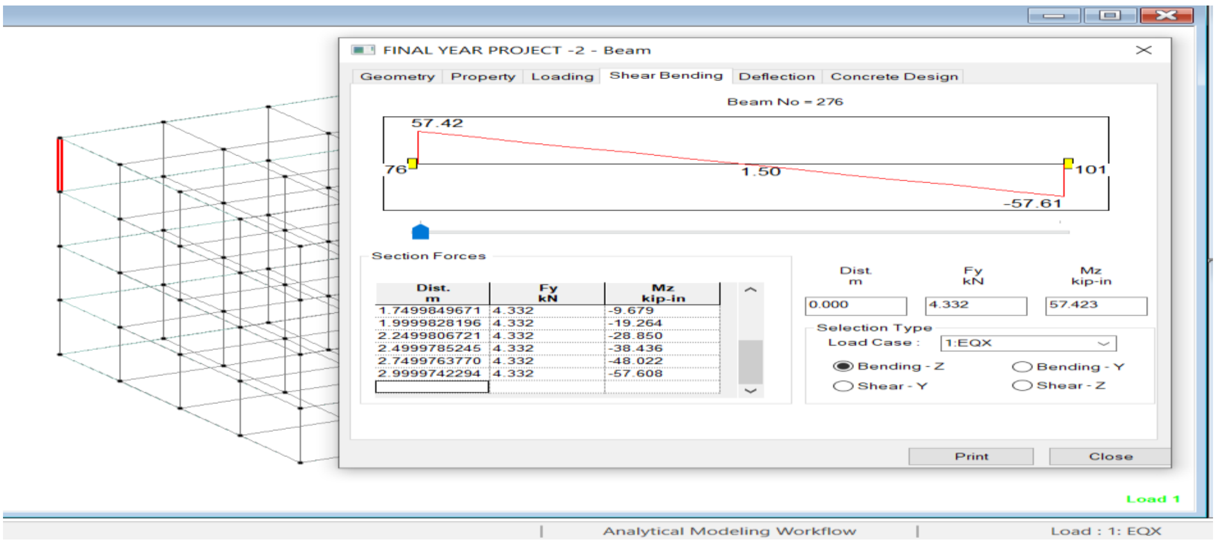


Figure 11.16 Beam 276 shear bending

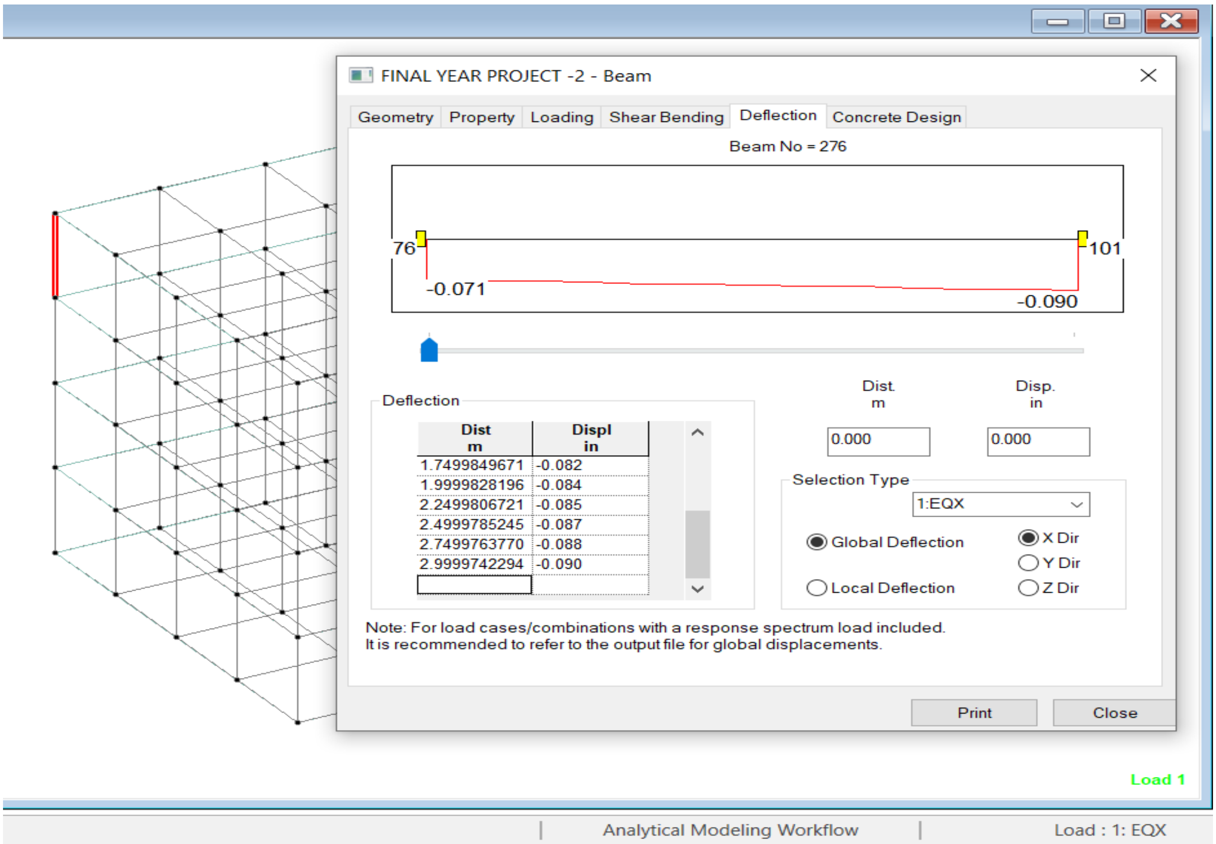


Figure 11.17 Deflection of beam 276

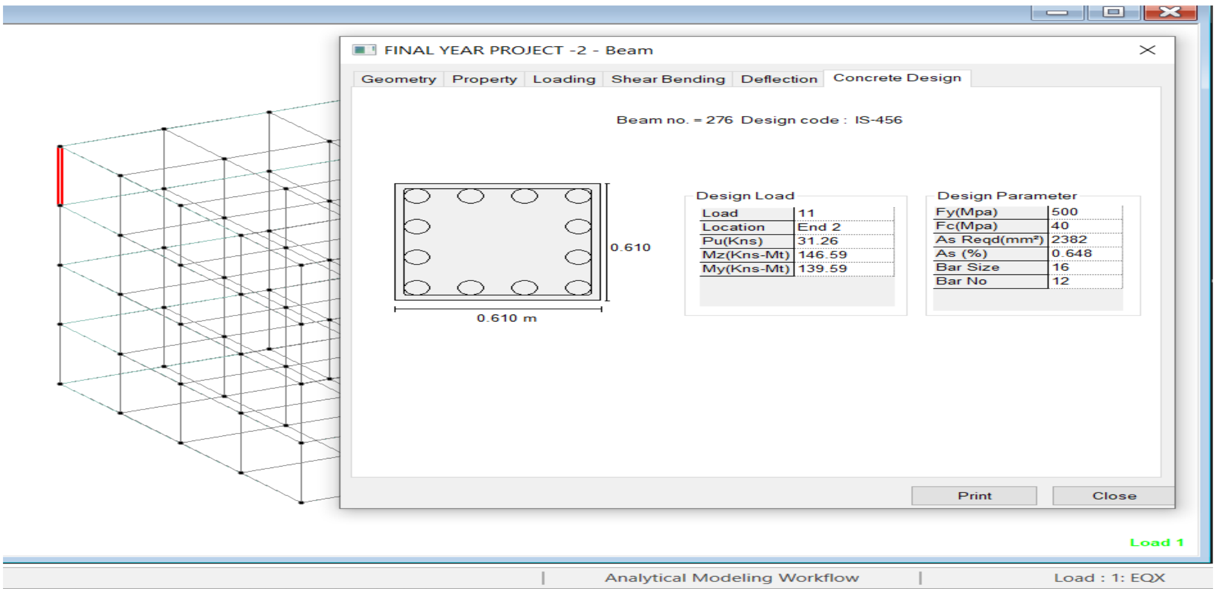


Figure 11.18 Concrete design of beam 276

Chapter-12

CONCLUSION

1. Single column building has been designed successfully to withstand dead load, live load , floor finish , wind load, earthquake load and all possible load combinations as per IS 456:2000.

2. On comparing the MAX DISPLACEMENTS IN X,Y, Z respectively ,the maximum values are found to be 70-80% more for multiple columns building as compared to single column building.

3. The Shear force values of Fx,Fy,Fz are found to be more in single column building as compared to multiple columns building.

4. The Moment values of Mx,Mz are found to be more in single column building as compared to multiple columns building.

5. For comparing the cost the values of Volume of concrete required and weight of structure have been used.

6. The volume of concrete and weight of structure for both structures increases as the load increases.

7. In terms of volume of concrete the single column structure is found to be (425.5-333.7)/425.5*100=21.5% more expensive than multiple column structure.

8. In terms of weight of structure the single column structure is found to be (366831-252913)/366831*100=31.05% more expensive than multiple columns structure.

9. Detailing of each member can be obtained in STAAD PRO.

10. Single column building gives better architectural view and ground space utilization.

Chapter-13

FUTURE SCOPE

There is a need to accommodate the influx of people into urban areas as the population of cities grows. However, because of the rapid rise in land prices and the scarcity of land, multi-story buildings are becoming increasingly popular. When compared to a structure supported by multiple columns, a single column provides a better architectural view. They save ground space by requiring less space for foundation and allowing for more parking. Mono column structure is unique. RCC or steel can be used to construct single column structures. In comparison to structures supported by multiple columns, this structure on a single column provides a large amount of usable floor space. They save ground space by requiring less space for foundation and allowing for more parking. When the maximum amount of space is used, the serviceability is maximised.

Chapter-13

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