# DESIGN AND ANALYSIS OF G+4 STOREY RESIDENTIAL BUILDING BY USING AUTOCAD AND STAADPRO

*A Major project report submitted to*

*Jawaharlal Nehru Technological University*

*In partial fulfilment of the requirement for the award of the degree of*

**BACHELOR OF TECHNOLOGY**

**IN**

**CIVIL ENGINEERING**


**Submitted by**

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**SCHOOL OF ENGINEERING & TECHNOLOGY**

**IBRAHIMPATNAM RR District-501506 (TELANGANA)**


**AY 2020 – 2021**

# EVALUATION SHEET

This is to verify that this is my own personal work which I have prepared after doing research from the available lecture

Signature of Student

Signature of Supervisor
Signature of HOD

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# DECLARATION

I hereby declare that the major project work entitled **"DESIGN AND ANALYSIS OF G+4 STOREY RESIDENTIAL BLOCK OF 2BHK FLATS USING AUTOCAD AND STAAD.PRO"**carried in the IV year of B.Tech (Civil Engineering) as per the requirement of institution / university for further fulfilment of award of the degree of Bachelor of Technology during the academic year 2020 – 2021 in the Department of Civil Engineering, Guru Nanak Intuitions Technical Campus affiliated to Jawaharlal NehruTechnological University Hyderabad, Under the supervision of **Ms.G.LPOORNIMA,** Assistant Professor (GNITC). I am very much thankful for hercontribution in solving the technical queries and document preparation.

I further declare that the work reported in this project has not been submitted and will not be submitted, either in a part or in full, or the award of any other Degree or Diploma in this Institute or any other Institute or University.

All the source of knowledge used has been duly acknowledged.

**B. SAHSHANK ASIS**

**(17WJ1A0127)**

# CERTIFICATE

This is to certify that the Major project **"DESIGN AND ANALYSIS OF G+4 STOREY RESIDENTIAL BLOCK OF 2BHK FLATS USING AUTOCAD AND STAAD.PRO"** is submitted by B. SHASHANK ASIS(**17WJ1A0127**). In the partial fulfilment for the award of the Degree of Bachelor of Technology in Civil Engineering to the Jawaharlal Nehru Technological University is a record of Bonafide work carried out by them under my 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 or Diploma.

**Ms.G.LPOORNIMA**
Asst.Professor/Department of Civil Engineering,
GNITC

**Dr.P.JAGADEESAN**
External Examiner Prof. & Head of the Department

# ACKNOWLEDGEMENT

This is an acknowledgement of the intensive drive and technical competence of many individual who have contributed to the success of our project.

I would like to express our sincere thanks to **Dr. H. S. SAINI**, Managing Director, and **Dr. M. RAMALINGA REDDY**, Director, **Dr. RISHI SAYAL**, Associate Director, Guru Nanak Institutions Technical Campus, School of Engineering and Technology, for providing us with all the necessary facilities and support.

I place on record our sincere thanks to **Dr.P.JAGADEESAN,** Professor and Head of Civil Engineering Department for his whole hearted co-operation, provided excellent Lab facility, continuous monitoring, constant encouragement and unfailing inspiration.

I also thank to our guide**Ms.G.LPOORNIMA,** Asst.Professor of Civil Engineering Department. I am extremely grateful and in depth for her sincere support and encouragement extended for us.

I take this opportunity to record my sincere thanks to **Dr.S.S.S.MUNTAZ VALI**, Professor & Project Coordinator in Department of Civil Engineering GNITC for giving timely suggestions during the progress of the project work.

The satisfaction and euphoria that accompany the successful completion of task would be great but incomplete with the mention of the people made it possible with their constant guidance and encouragement crowns all the effort with the success. In this context, I would like to thank all the staff members teaching and non-teaching, who have extended their timely help and eased my task.

Finally I would like to thank our parents who have always encouraged me to do the best.

# ABSTRACT

In order to compete in the ever growing competent market it is very important for a structural engineer to save time in the works related to the design of structures. As a sequel to this an attempt is made to analyse and design a multi-storeyed building by using a software package known as **"Staad.pro"**. Staad.pro with its new features surpassed its predecessors and competitors with its data sharing capabilities with other major software like Auto Cad and MS Excel.

The present project deals with the analysis of a multi-storeyed residential building of G+4. The dead loads, live loads and wind loads are applied.The design has been done according to the Limit state method and confirming to Indian Standards code IS 456-2000 for various structural and non-structural components.Further reinforcement detailing for various structural elements being made as per SP-16. The structural elements like slab, beam, column, footing and staircase has being designed and detailing was incorporated by designing these structural elements. Thus it is

concluded that Staad.pro package is suitable for the design of a multi-storeyed building.

**Keywords**: *Staad.pro, dead load, live load, wind load, limit state method, Indian standards, reinforcement, structural elements.*

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# 1. INTRODUCTION

## 1.1 General

Any construction project to begin with starts with the Layout of the building or structure followed by Design and Analysis of the structure which is succeeded by cost estimation and planning for the project. This project involves the layout, analysis and design of a G+4 residential building.

For completing the project very popular Civil Engineering software's such as AutoCAD, STAAD.ProV8i.

## 1.2 Objectives of the Project

The objectives of the project are mentioned below:

1. Draft the Layout of the proposed building using AutoCAD.
2. Analyse and Design the building on STAAD.ProV8i.

## 1.3 Role of AutoCAD

AutoCAD is a commercial software application for 2D and 3D computer aided design and drafting for various fields in engineering like civil, mechanical, electrical, automation, architecture etc. It was first launched in 1982 by Autodesk, Inc.

AutoCAD Architecture allows designers to draw 3D objects such as walls, doors and windows, with more intelligent data associated with them rather than simple objects. The data can be programmed to represent products sold in the building industry, or it can be extracted into a file for pricing material estimation etc.

In this project AutoCAD has been used extensively for drafting and modelling for the structure. Also the various detailing for the foundation has also been completed using AutoCAD. Use of AutoCAD has drastically reduced the drafting time when done manually thus saving time which can be used in other productive work.

## 1.4 Role of STAAD.Pro

Staad.ProV8i has a very user friendly interface and very useful for designing complex structures and analysing them. STAAD.ProV8i is a design and structural analysis program developed by Research Engineers International, CA. It was acquired by Bentley Systems in 2005. It is one of the most widely used design and structural analysis software's for concrete, steel and timber design codes.

STAAD .Pro allows designers and structural engineers to design and analyse virtually any type of structure through its very flexible modelling environment, fluent data collection and advanced features.

STAAD.Prosupports over 70 international codes including IS456:2000, IS800:2007 and over 20 U.S codes in more than 7 languages.

STAAD .Pro is able to integrate with other Bentley Products such as STAAD foundation, ProSteel and OpenSTAAD. It is also able to integrate with other third party applications thus giving a good flexibility to designers working on various software's.

Using STAAD.Pro one can check all the structural parameters in a design such as bending moment analysis, shear force analysis, buckling in a column, loads, deflection thereby helping the structural engineer in designing the structure better.

STAAD.ProV8i also has the DESIGN feature which enables engineers to calculate the various design data including the reinforcement in case of concrete design. This feature also corrects the designers in case of any mistake and rectifies it. It is also useful in cost estimation as it also gives the various quantities of steel, reinforcement and concrete take off thereby reducing the load of cost estimation from the engineer.

# 2. LITERATURE REVIEW

## 2.1 Case Studies

### 2.1.1 Bedabrata Bhattacharjee & A.S.V. Nagender 2007(NIT Rourkela):

They used STAAD.Pro for the analysis and design of a G+21 multi storeyed building. The dead loads acting on the slab were calculated manually while live load, seismic load and wind load have been entered by following respective IS Codes. The design was done using limit state of design according to IS 456:2000. They showed how efficiently and easily such a high rised building can be designed within a very short span of time.

### 2.1.2 Ashis Debashis Behera 2012:

This report studied the comparison between two 30 storeyed building having the same layout and dimensions but with two different load combinations.

DL+LL+Seismic Load

DL+LL+Wind Load

The analysis and design for both the models were done using STAAD.Pro. The results showed that the building with seismic load combination required more reinforcement than the building with the wind load combination.

### 2.1.3 B. Suresh & P.M.B Raj Kiran Nanduri 2012:

This research paper focuses on the comparison between earthquake resistant analysis and design vs. the non-earthquake resistant analysis and design using STAAD.Pro. This paper shows that the concrete and reinforcement requirement for both structures is similar and that there is no higher cost involved in building a structure with seismic loading.

### 2.1.4 Azidah Ziden, Fatariah Zakaria & Ahmad Nizam Othman (University Sains Malaysia, Penang, Malaysia) 2012:

This study shows how AutoCAD can be an effective tool in increasing the performance of students of various levels. It helps in proper visualisation of the project to be undertaken and thus help students in learning engineering design n

better. The study also shows how AutoCAD increases the efficiency of the student/designer.

### 2.1.5 Krishna Kumar Kumbhakar, Ashan Rabbani (National Institute of Technology,Patna)2008:

In the field of structural engineering, structural analysis and design of high rise buildings are redominant in finding out significant threats to improve the integrityand stability of the structure. Multi storeyed structures are designed, they are meant to fullfill the basic aspects, requirements and serviceability. They applied the dead load and live load on the structure hence obtained the size of beam, columns and footing of structure. They come to the conclusion that STAAD . Pro is very powerful designing and analysis software in less time with accuracy

### 2.1.6 Dhanavath Seva, Bhukya Chandra Sekhar, Faria Aseem (Indian Institute of Madras) 2017:

For analysing multi storeyed building one has to consider all the possible loadings and see that the structure is safe against all possible loadings. The main scope of the project is to apply class room knowledge in the real world by designing a multi storeyed residential building.

# 3.METHODOLOGY

## 3.1 Study of IS875:1987:

IS875 deals with the various load cases that act upon a structure and ways to calculate them. There are various parts of the code that deal with the various load types such as dead load, live load, wind load, snow load and various special loads and load combinations. As the building is not a high rise building, load such as snow are not considered in the design process.

The Code gives the unit weights of various materials as well as the values of imposed loads that act in various types of structures and parts of these structures.

## 3.2 Preparation of Building Layout using AutoCAD:

The layout for the proposed building was prepared, discussed and approved by an architect. The layout was then prepared using AutoCAD. The various layouts were prepared and then later discussed with the architect for error correction.

## 3.3 Analysis and Design using STAAD.Pro:

Once the layout of the building was approved by the architect the layout was transferred from AutoCAD to STAAD.Pro using a DXF file format. Once the layout was transferred, multiple storeys were created using the Translational Repeat Tool in STAAD.Pro. After this member properties were assigned. Next the load cases were generated and applied to the structure. Once the loads were applied the structure was analysed and corrections were made to the structure for the various errors that were generated while the structure was being analysed.

After the analysis, we started designing the structure by entering the DESIGN tab in STAAD.Pro. All the design parameters were entered and load cases selected. This completes the design of the beam, columns and slabs.

For designing the foundation STAAD foundation program is opened and the structure along with the load cases is transferred.

# 3 .LAYOUT OF G+4 BUILDING USING AUTOCAD

## 4.1 General:

AutoCAD or Computer Aided Design is a very helpful tool in drafting and designing any structure. AutoCAD uses a Graphical User Interface for the purpose of drafting and designing any structure. The software has various inbuilt tools for complex drafting. Also AutoCAD can be used for 2D, 3D and for perspective design.

With the help of AutoCAD all the drafting for the project has been done.

## 4.2 Details of the Project:

The plot size for the project was 50’X60’. Accordingly the building has been laid in the centre of the plot leaving ample space on all the sides for landscaping and pathways for cars and for visitors parking.

### 4.3 Layout Using AutoCAD:

The layout has been mostly completed using the Line command. The unit for the layout is inches with accuracy of "0.000". Below is a screen shot of the line diagram showing the beam and column layout.

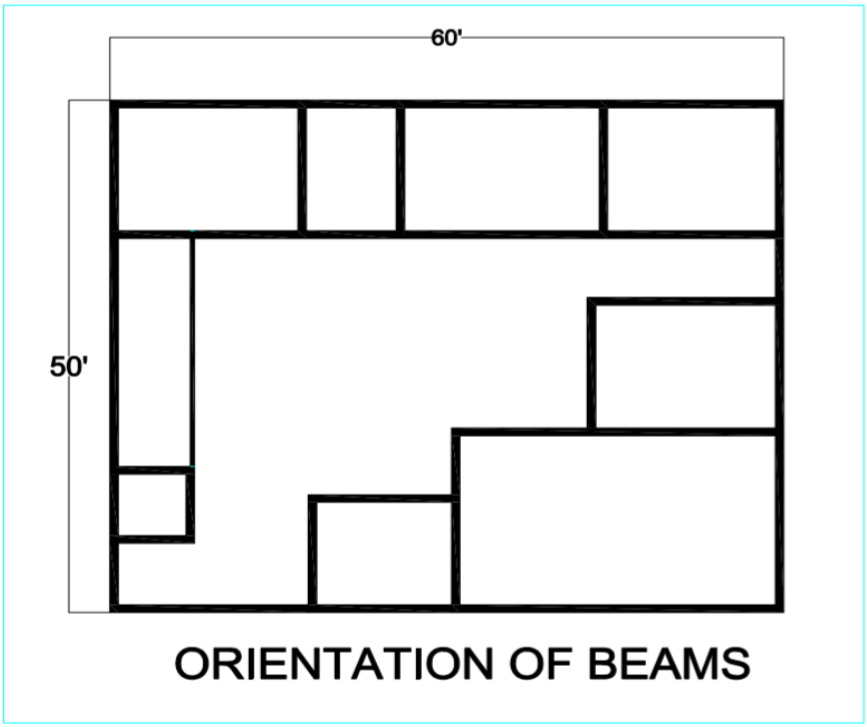



Fig 4.1 Orientation of beams

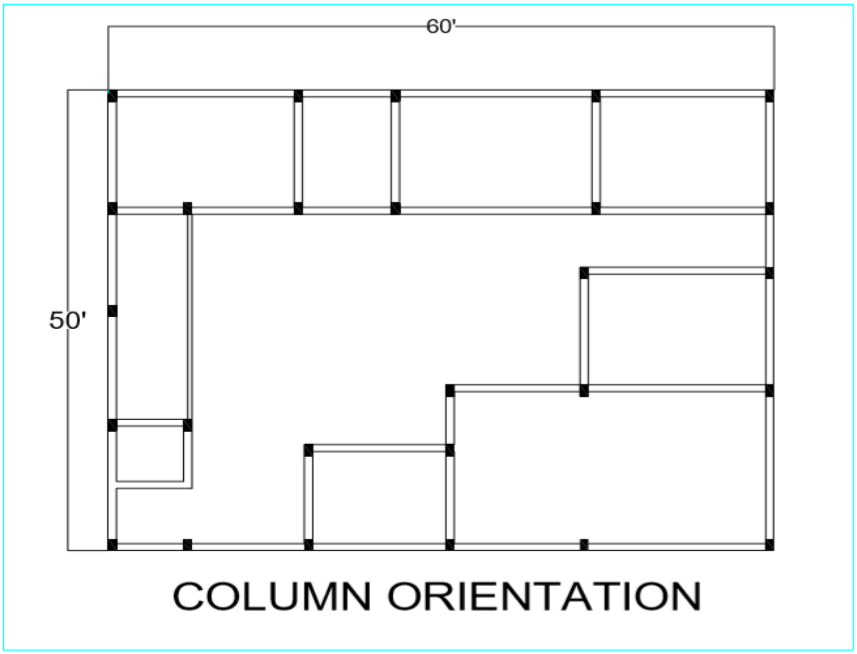


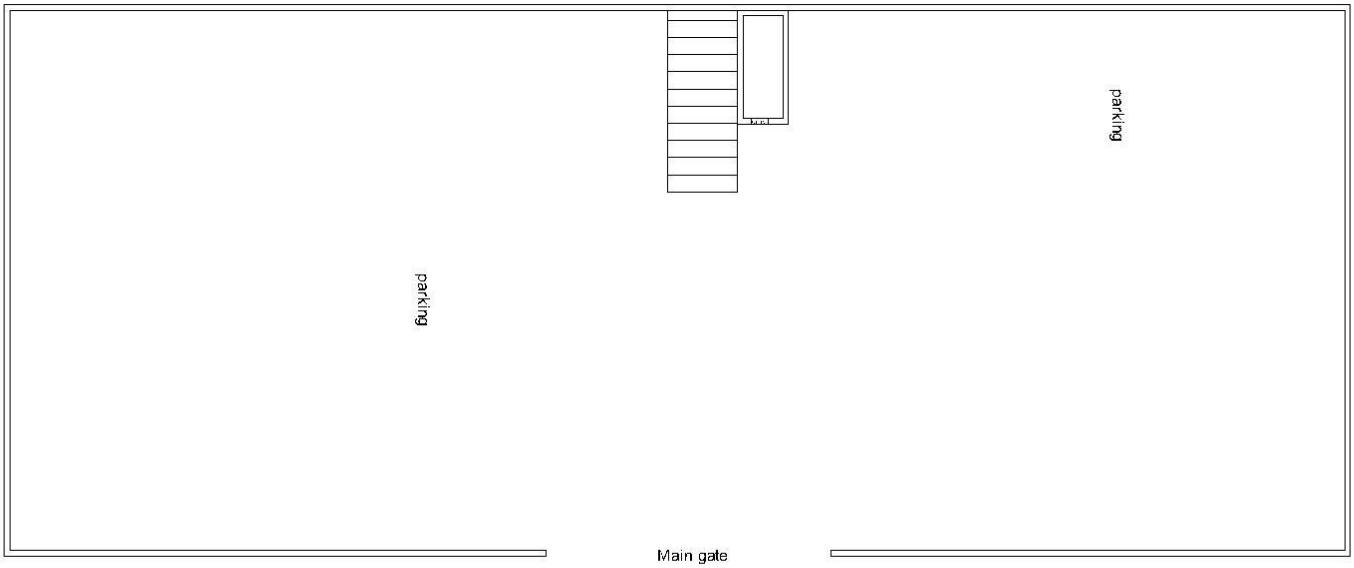

Fig 4.2 Orientation of columns

In the above picture the black rectangular boxes signify the columns. The beams have a cross section of 0.450x 0.300 m. The columns have a cross section of 0.450x0.450 m. Slabs have a uniform thickness of 230mm while the staircase slab has a thickness of 200mm. The floor to floor to height is kept at 3 m.

All the work has been done in layers in AutoCAD, for easy editing and viewing. Layers make it easy to manipulate each individual layer making it visible and invisible for clarity as well as locking the layer to prevent editing in them. The various layers that have been used are

1. Walls
2. Beams
3. Columns
4. Slabs
5. Window
6. Door
7. Text

The plan for the proposed project has in each floor having a 2BHK layout. Each apartment has two master bedrooms with attached bath and toilet. The ground floor of the building will be used as parking.


parking
parking
Main gate

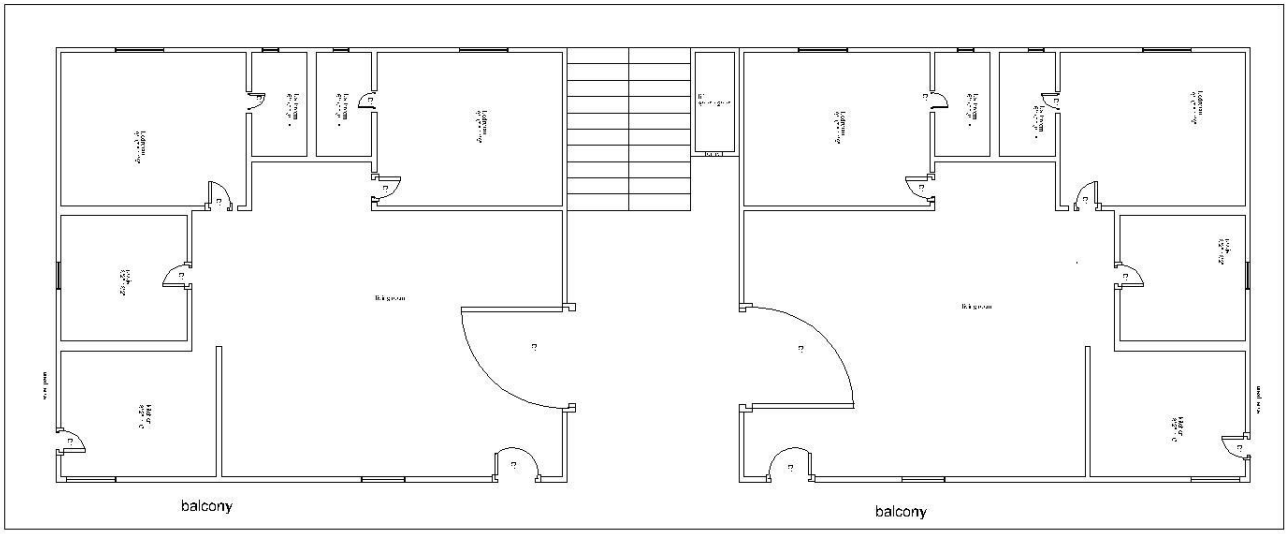



Fig 4.3 Plan of all floors

The staircase has width of 2m, with riser of 157mm and a thread of 300mm. The landing is of size 4mx1m. All the walls have a thickness of 9” leaving a room of 1” for plaster and paint.

# 5.ANANLYSIS OF G+4 BUILDING USING STAAD.PRO

## 5.1 General:

The layout from AutoCAD is transferred to STAAD.Pro using a DXF file. The elevation is then created by using Translational Repeat tool.

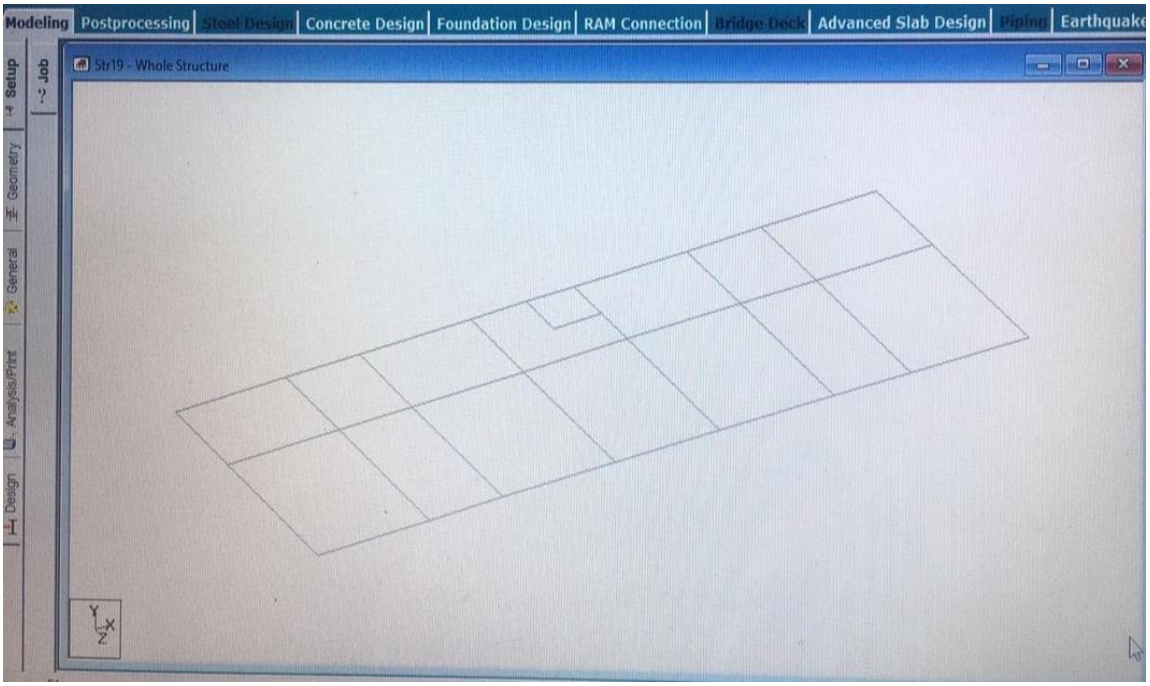



Fig 5.1 Plan of G+4 structure in STAAD.Pro

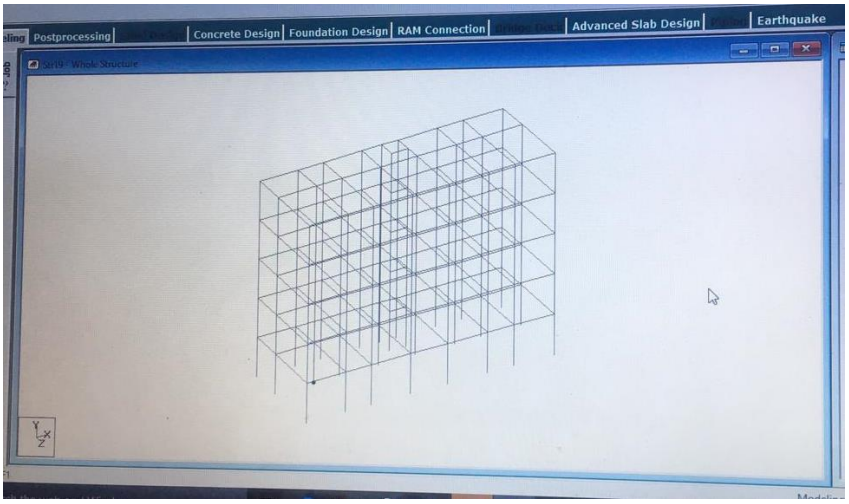



Fig 5.2 Isometric view

The total width of the building is 31’8” while the length is 77’4”. The figure also shows the X,Y,Z direction. Here Y direction is taken as the vertical component. The X,Y,Z coordinate system is also the same as coordinate system used in AutoCAD.

## 5.2 Generation of Member and Member Property:

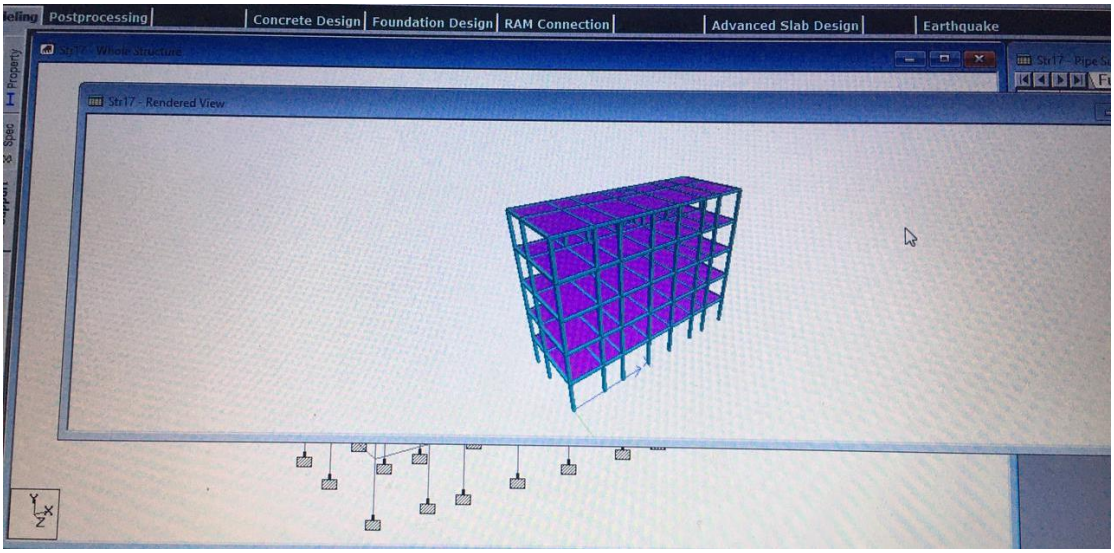



Fig 5.3 Generation of member and member property

STAAD.Pro can be used to create various different geometry for the members, these include: 1. Circle
2. Rectangle
3. TEE
4. Trapezoidal
5. General
6. Tapered I (Steel Section)
7. Tapered Tube (Steel Section)
8. Assign Profile

By using the Property Defining window we can generate the member property in STAAD.Pro. The member section is selected and the dimensions are specified. The beams have a cross-section of 0.45 m x 0.3 m and the columns have a cross section of 0.45m x 0.45m.

## 5.3 Creation of Supports:

All the columns have been assigned fixed support using the STAAD.Pro Support creator and have been assigned accordingly. Fixed Supports have restricted movements in all directions as well there is restricted moment. This means FX, FY, FZ, MX, MZ, MY all will have some values.

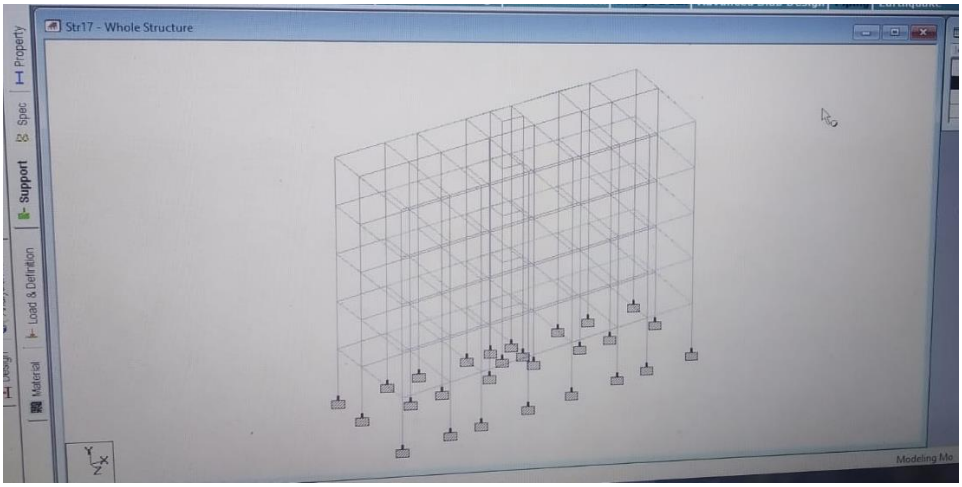



Fig 5.4 Support generation for the structure

STAAD.Pro can be used to create a number of different supports for various cases which include:

1. Fixed
2. Pinned
3. Fixed But
4. Enforced
5. Enforced But
6. Multilinear Spring
7. Foundation
8. Inclined
9. Tension/Compression Springs

## 5.4 Materials:

The material for the structure is selected as concrete with their property and constants as per IS Codes.

## 5.5 Loading:

The loading that have been considered on the structure are as follows

1. Self-Weight
2. Dead Load
3. Live Load
4. Seismic Load
5. Wind Load
6. Load Combinations

### 5.5.1 Self-Weight:

It is the weight of the entire structure generated by STAAD.Pro itself with the Self Weight Command.

### 5.5.2 Dead Load from Slab:

Dead load from the slab can be generated by STAAD.Pro itself by specifying the Slab thickness and the load on the floor. This was found out to be 3KN/m.

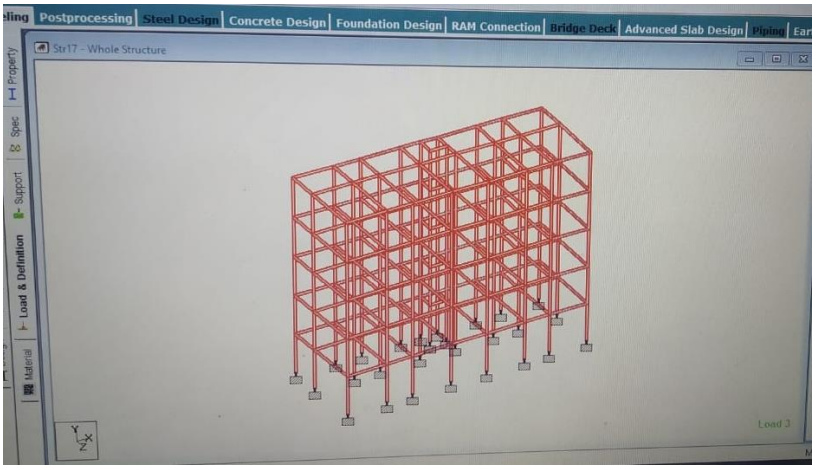



Fig 5.5 Dead load action on the structure

### 5.5.3 Live Load:

The live load acting on each floor was considered to be 2KN/SqM. The live loads are generated in the same way as dead load.

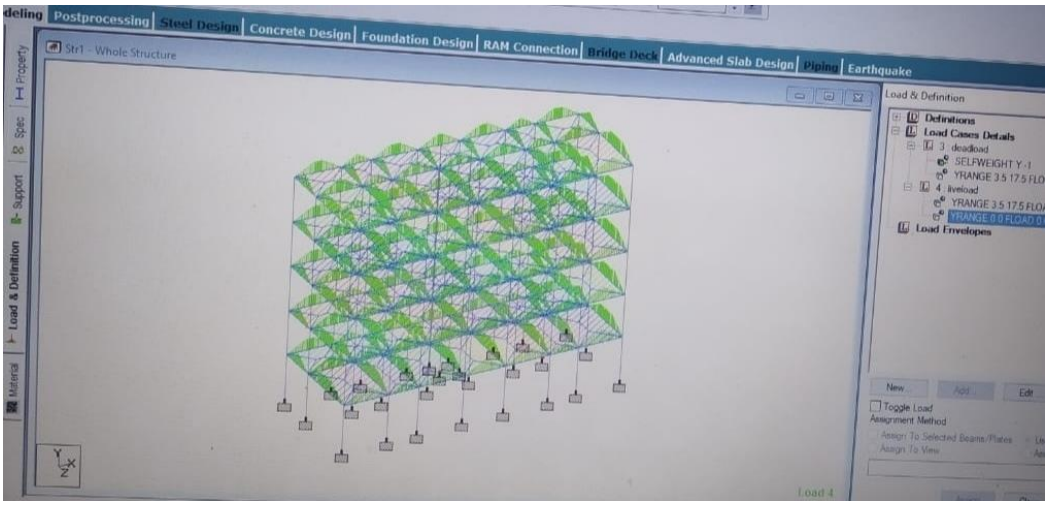



Fig 5.6 Live load acting on the structure

### 5.5.4 Wind Loads:

The wind loads were derived from IS 875:1987(part 3) and these loads were generated by STAAD.Pro Wind Load generator in accordance with IS 1987.

The Wind Load generator generates load in X and Z direction only. Y Direction only contains gravity loads.

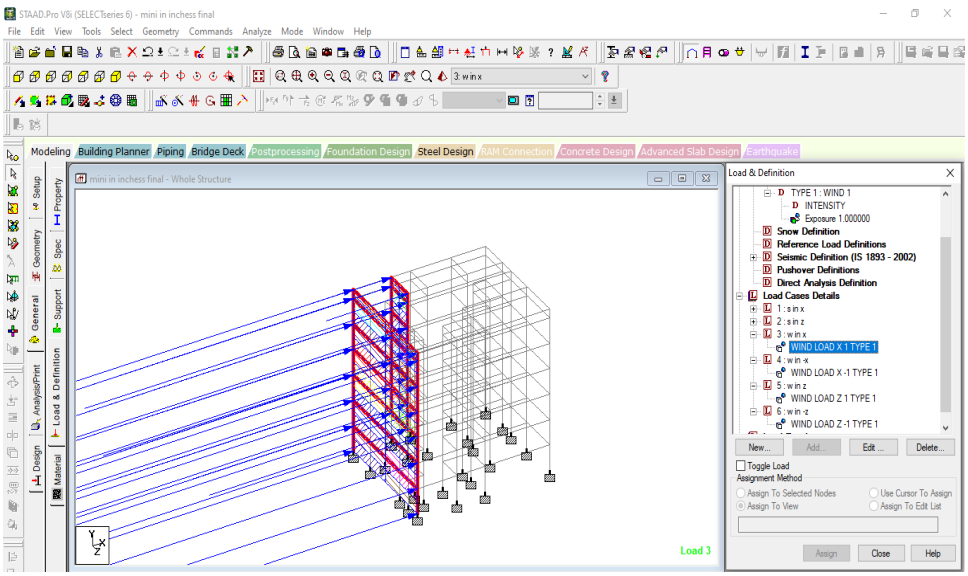



Fig 5.7Wind action in x direction

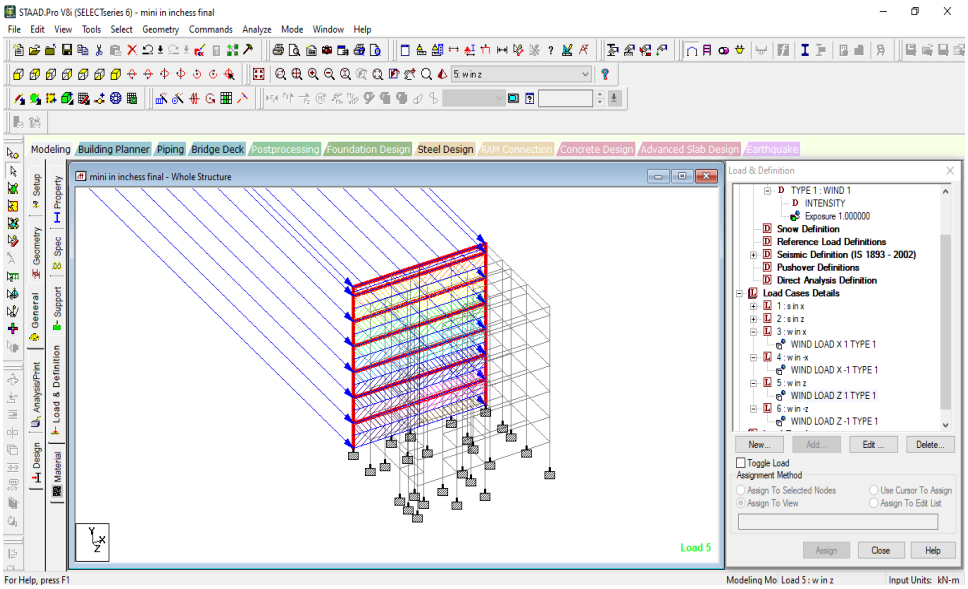



Fig 5.8 Wind action in z direction

### 5.5.5 Load Combinations:

The structure has to be analysed for load combinations considering all the previous loads in proper ratio. These combinations are generated by the inbuilt auto-load generator for various load combinations as per IS 875:1987(part 5).

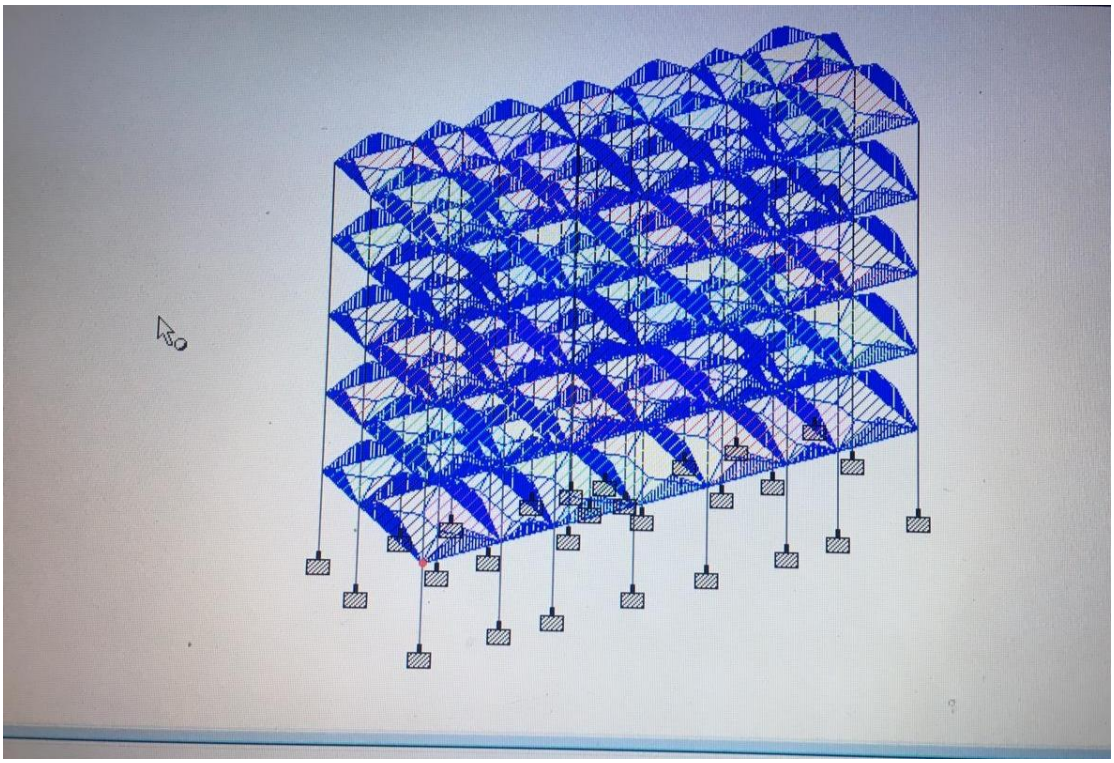


Fig 5.9 Load combinations acting on the structure

## 5.6 Analysis of the Structure:

The STAAD.Pro Engine analyses the structure based on the loads and member property defined. This engine has the capacity to analyse each and every member of the structure and let the designer know if any changes are required in the structure for a safe and efficient design.

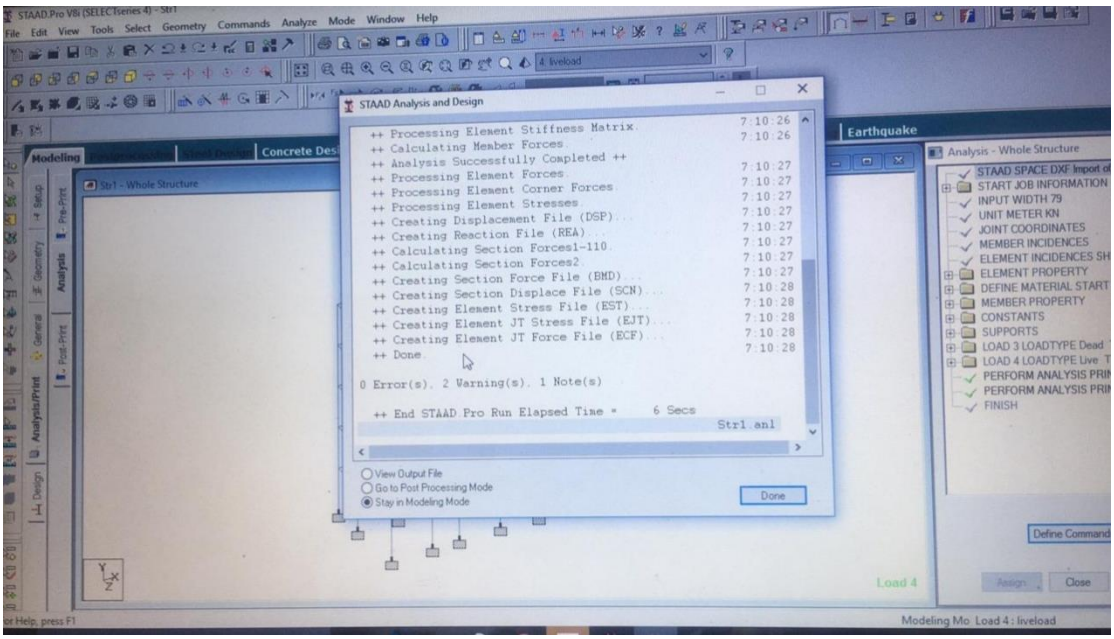



Fig 5.13 GUI showing the analysing window

# 6.DESIGN OF G+4 STRUCTURE USING STAAD.PRO

## 6.1 General:

After the STAAD.Pro has completed analysing the whole structure, we can now proceed to the design part of the structure. STAAD.Pro can design a structure for various types of materials like Steel, Concrete, Aluminium and Timber. We will choose RCC or Reinforced Cement Concrete for designing our structure. After Completion of the analysis we go back to the modelling mode and click on the Design Tab where we select concrete as the material. Once that is done we select the Design Code which is to be followed. We select IS 456.

Once that is done we select the various members to be designed such as columns, beams, slabs etc. After that we specify the design parameters according to our wish, otherwise STAAD will carry out the design as per the specified Design Code.

Once all the parameter and data are entered into the STAAD engine, we run the analysis again so as to get the design values.

After the completion of the analysis we get the design values for the various members in the form of a written data. To get the entire schedule of a member we have to just click the member and we will get the schedule for that particular member.

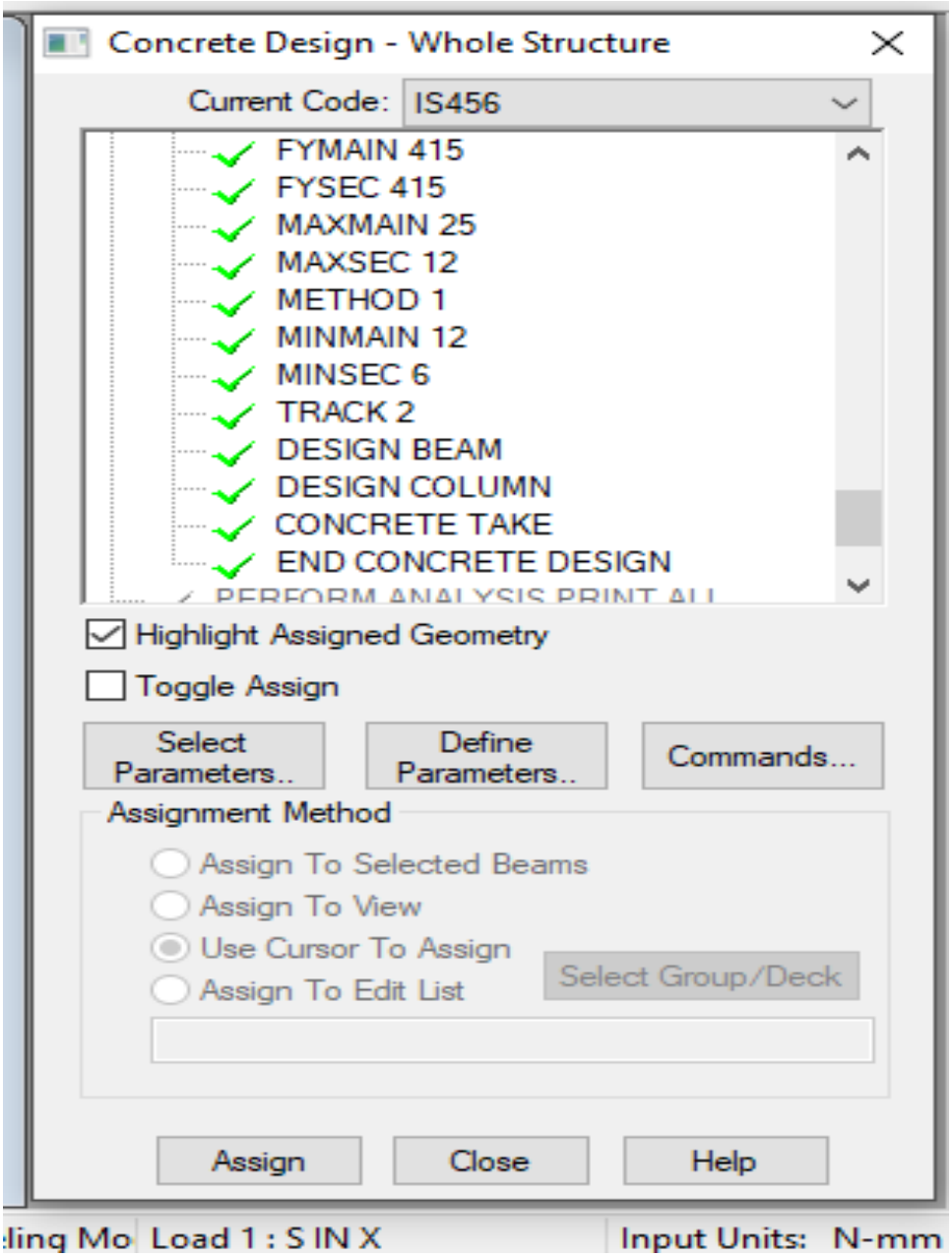



Fig 6.1 Assigning design parameters to the whole structure

Various Design parameters can be entered as per the users command. These include the cover, reinforcement grade, maximum and minimum bar size, design for torsion, eccentricity etc.If not entered the values will be taken as default by the STAAD engineer as per the Codal Provisions.

# 6. RESULTS AND DISCUSSION

## 7.1 Analysis & Design Results:

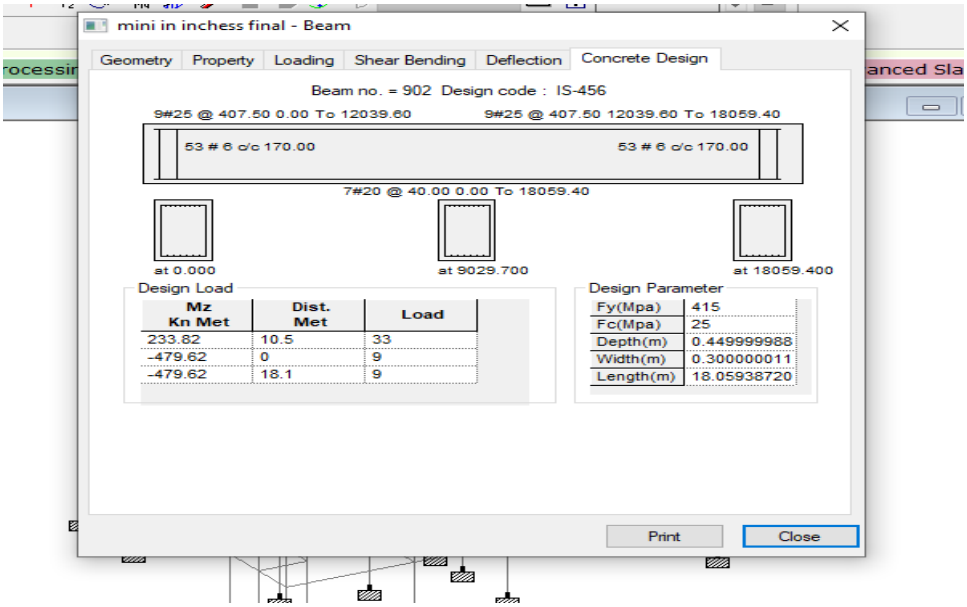



Fig 7.1 Beam Schedule

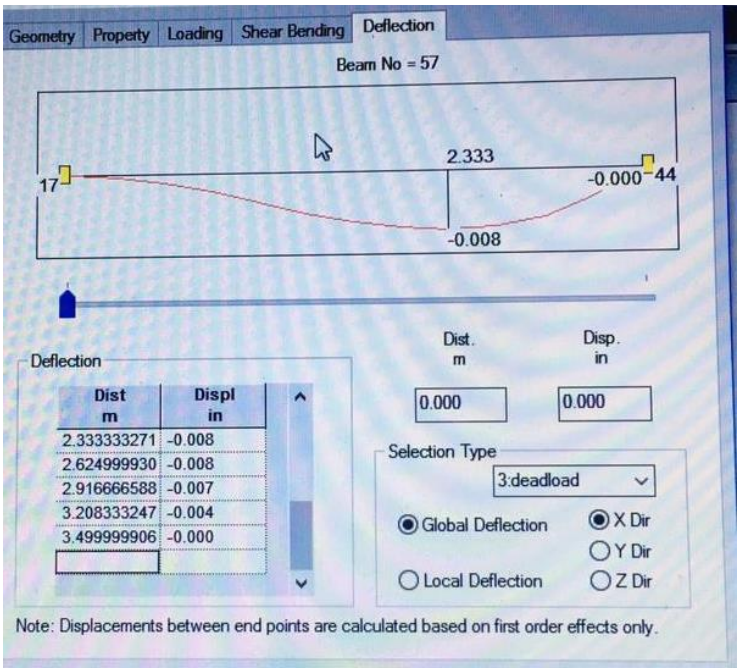



Fig 7.2 Column Schedule

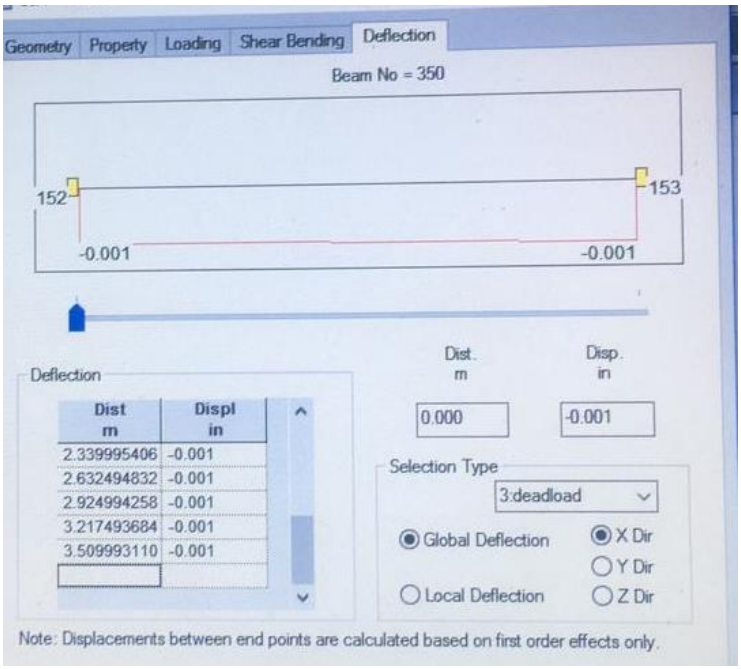



Fig 7.3 Beam Deflection

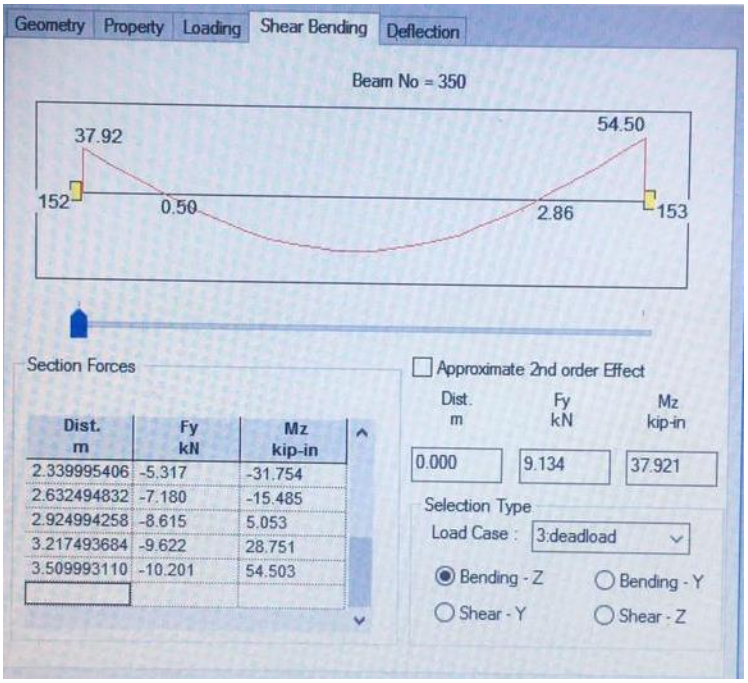



Fig 7.4 Shear bending

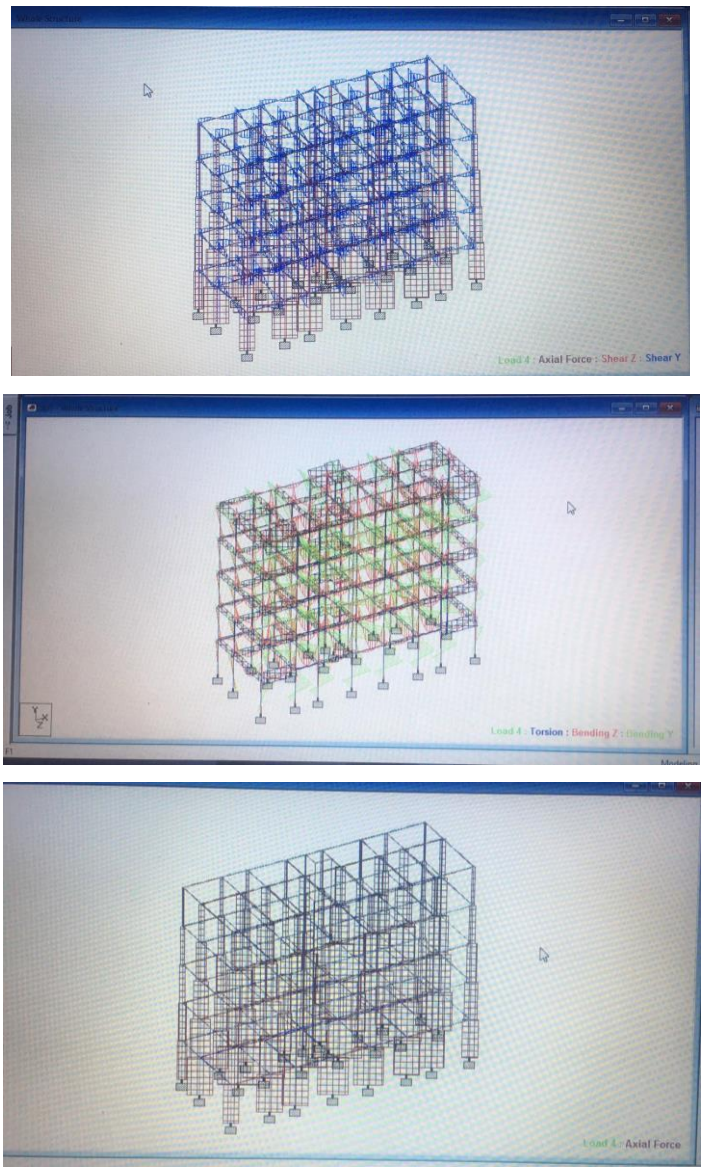



Fig 7.5 Design results

## 7.2 Foundation Design

The foundation for the structure has been designed using STAAD Foundation. The structure and load cases can be transferred to STAAD Foundation using in-built program. The Foundation is designed as per IS specifications an in accordance to the soil conditions where the structure is to be built.

To design the foundation firstly the structure is to be transferred to STAAD foundation along with the selected load cases. After that the type of the foundation has to selected, whether it is an isolated, combined or mat foundation. Finally the job is to be created and the foundation analysed and designed.

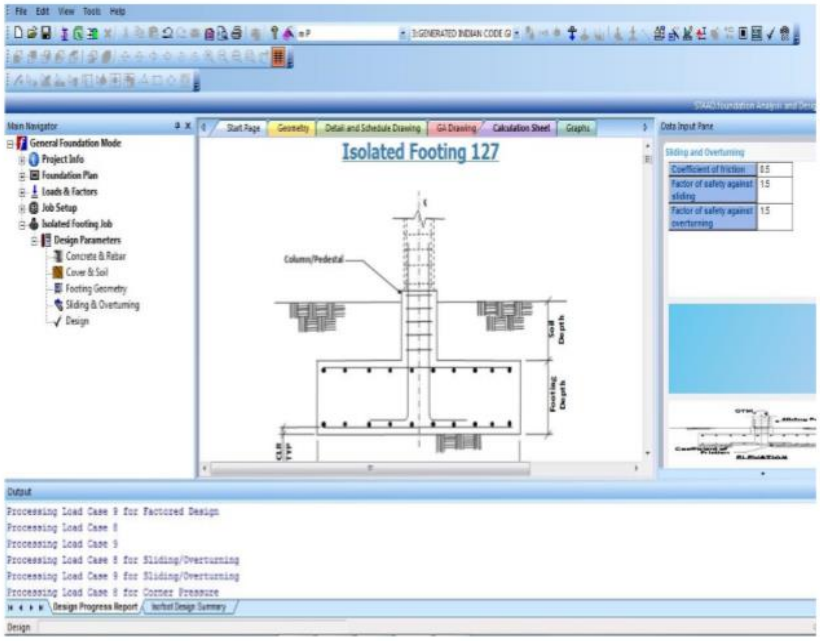



Fig 7.6 Design window of STAAD Foundation

The Foundation Design Details for Footing no 127 are as follows:

1. Cover: 50mm
2. Length: 3.75 m
3. Width: 3.75m
4. Thickness of Slab: 300mm
5. Reinforcement Top (X): 6mm @75mm
6. Reinforcement Top (Y): 6mm @75mm
7. Reinforcement Bottom (X): 6mm @75mm
8. Reinforcement Bottom (Y): 6mm @75mm

# 7. CONCLUSION

## 8.1 Conclusion:

This project includes the layout of G+4 residential building using AutoCAD, Analysis and Design using STAAD.Pro.

The layout of the proposed G+4 residential building is based on a plot of size 60'x 50' located at Hyderabad. Previously the plot was being used as a commercial complex, but according to the new plan it will be used as a multi-storeyed residential building. The ground floor of the building will be used as parking. Each apartment is of 2BHK configuration. All the drafting was done using AutoCAD. Also these drawings made on AutoCAD also served as a base for transfer of the structure for analysis and design into STAAD.Pro.

The analysis and design of the entire structure has been completed using STAAD.Pro. The results include the various forces acting on various members as well various schedules for various members. Also using the software we got the concrete take-off as well as the weight of the various reinforcement bars thus easing the load of cost estimation.

The foundation has been designed as an isolated footing using soil condition as medium. The foundation design values were calculated using STAAD Foundation.

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