A Project Report

On

DESIGN AND PLANNING OF A G+4 RESIDENTIAL BUILDING

Submitted to

TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY, UDAIPUR (RAJ.)

[Approved by AICTE and Affiliated to RTU]

In partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

In

CIVIL ENGINEERING

By

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Under the guidance of

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DECLARATION

I, **OM PRAKASH PRAJAPAT**, the students of **B-Tech (CIVIL)**, hereby declare that the final year project titled **"DESIGN AND PLANNING OF A G+4 RESIDENTIAL BUILDING"**, which is submitted to the **DEPARTMENT OF CIVIL ENGINEERING, TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY UDAIPUR** in partial fulfilment of requirement for the award of the degree of **(B-Tech CIVIL)** in **2021**, has not been previously formed the basis for the award of any degree, diploma or other similar title or recognition.

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CERTIFICATE

This is to certify that the project report entitled **"DESIGN AND PLANNING OF A G+4 RESIDENTIAL BUILDING"** is a Bonafede work carried out by **"OM PRAKASH PRAJAPAT"**, who carried out the project work under my supervision.

To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Dr. Pankaj Kumar Porwal

(Principal & HOD Civil Engineering Dept.)

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to Dr. Rakesh Yadav Sir (HOD Civil Engineering Department) for her invaluable guidance. Her continuous encouragement and support have always been an inspiration and a source of energy for us. We thank her for all of her valuable time, effort and help. We would also like thank Prof Dr. Pankaj Porwal Sir (Principal Techno NJR) for their constant guidance and support to help us complete this project. We would also like Er. Bharat Suthar Sir & Bhupendra Purohit Sir for their valuable time and suggestions in completing this project. Also, our sincere thanks to all the people who were directly or indirectly associated with the project in any other way.

OM PRAKASH PRAJAPAT

ABSTARCT

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 and planning for the said project. This project involves the layout, design, analysis and planning of a G+4 residential building located in Rajnagar, Rajasmand.

The layout of the proposed G+4 residential building is based on a plot of size 150' x 90 '. 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 while the remaining 4 floors will be divided into 8 apartments each having an area of 246sq m. Each apartment is of 3BHK 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.

The cost estimate for the project has been calculated using Centre Line Method in Microsoft Excel. For the Abstract cost CPWD Schedule of rates has been followed and a total cost of Rs 9517974 has been calculated.

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Chapter 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 said project. This project involves the layout, design, analysis, planning and cost estimation of a G+4 residential building located in Rajnagar Rajasmand.

For completing the project very popular Civil Engineering software's such as AutoCAD, STAAD Pro V8i and Microsoft Excel for Cost Estimation have been used.

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. Analyses and Design the building on STAAD Pro V8i
3. Calculate the approximate cost of the building.

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 datacan 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.

Also, one of the important features of AutoCAD is the import and export feature which allowsusers to move their plans drawn using AutoCAD to other design software's such as STAAD Pro and ETABS with the help of DXF file format which has in turn reduced load on the designer. Also, structural designs made on STAAD and ETABS are also

exportable to AutoCAD for minute detailing required.

1.4 Role of STAAD Pro

STAAD Pro V8i has a very user-friendly interface and very useful for designing complex structures and analyzing them. STAAD Pro V8i 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 analyses virtually any type of structure through its very flexible modelling environment, fluent data collection and advanced features.

STAAD pro is able to integrate with other Bentley Products such as STAAD.foundation and 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 pro V8i also has the DESIGN feature which enables engineers to calculate the various design data including the reinforcement in case of concrete design. This features also corrects the designers in case of any mistake and rectify 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.

1.5 Role of Microsoft Excel in Cost Estimation

Excel is a typical spreadsheet which is nowadays widely used in cost estimation and also sometimes for planning purposes. Excel has various inbuilt calculation tools which can be used for complex calculation. Apart from that one can also input one's own formula for special calculations. The user interface is very friendly and easy to use. There are around Rows: 1,048,576 Columns: 16,384, which makes it easier for the user to enter a large amount of data into a single spreadsheet. Also, there are features like the auto correct which make changes to the entire document if there is an error in inputting an entry. This makes the job the less redundant and easier for the Estimator.

The key objective of cost estimation is to arrive at an accurate cost and schedules so as to avoid schedule slips and cost overruns. Cost estimation goes beyond preparing approx. costs and helps in preparing schedules, manage human resource, support assessment and decision making. The wide range of topics in cost estimation represents the crossing of various fields such as project management, business management and engineering. Cost estimation recognizes and pays attention to the relationship between cost and physical dimension of what is being built.

In a construction project there are several types of estimators such as building estimator, electrical estimator, quantity surveyor etc. The work of an estimator is very important because they help in planning, managing the project cost, investment appraisal, risk analysis etc. Estimators also help in budgeting, planning and monitoring a project.

Chapter 2

Literature Review

2.1 AutoCAD

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 datacan be programmed to represent products sold in the building industry, or it can be extracted into a file for pricing material estimation etc.

AutoCAD uses a Graphical User Interface for the purpose of drafting and designingany structure. The software has various inbuilt tools for complex drafting. Also, AutoCAD can be used for 2D and 3D design and also for perspective design. Below is a screenshot of the GUI of AutoCAD.

With the help of AutoCAD all the drafting for the project has been done. It has made the life of a drafter quite easy than the conventional drafter using paper and pencil. It has made possible to make easy changes in the drawing as and when required. Also, various commands such as COPY, OFFSET, ROTATE, MOVE have made the tedious process of redundant work quite easy and faster.

Also, one of the important features of AutoCAD is the import and export feature which allowsusers to move their plans drawn using AutoCAD to other design software's such as STAAD Pro and ETABS with the help of DXF file format which has in turn reduced load on the designer. Also, structural designs made on STAAD and ETABS are also exportable to AutoCAD for minute detailing required.

2.2 STAAD Pro

STAAD pro allows designers and structural engineers to design and analyses virtually anytype of structure through its very flexible modelling environment, fluent data collection and advanced features.
STAAD pro supports over 70 international codes including IS456:2000 IS800:2007 and over 20 U.S codes in more than 7 languages.

The GUI or Graphical User Interface or user communicates with the STAAD Pro analysis engine through the standard input file. That input file, a text file consists of a series of commands which are sequentially executed. These commands contain either instructions or data pertaining to analysis and/or design. The STAAD Pro input file may be created through the text editor or the GUI facility. Generally, any text editor can be utilized to edit/create the STD input file. The GUI Modelling facility creates the input

file through an interactive graphics-oriented procedure.

STAAD allows users to create various types of structures and also analyses these structures which are listed below

- A SPACE structure, is a 3D-frame structure in which loads may be applied in any plane, it is the most general type.
- A PLANE structure is bound by any two axes with loads acting on the same plane.
- A TRUSS structure is a structure having various truss members with axial loading butno bending.
- A FLOOR structure is a 2D or 3D structure with no horizontal movement of the structure. Columns are also to be modelled with the floor in a FLOOR structure as long as the structure has no horizontal loading. In case there is a horizontal load, it should be analyzed as a SPACE structure.

2.3 Microsoft Excel

Excel is a typical spreadsheet which is nowadays widely used in cost estimation and also sometimes for planning purposes. Excel has various inbuilt calculation tools which can be used for complex calculation. Apart from that one can also input one's own formula for special calculations. The user interface is very friendly and easy to use. Also, there are features like the auto correct which make changes to the entire document if there is an error in inputting an entry. This makes the job the less redundant and easier for the Estimator.

2.4 Case Studies

2.5.1 Bedabrata Bhattacharjee & A.S.V. Nagender 2007(NIT Rourkela): They used STAAD pro for the analysis and design of a G+21 multi storied 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-rise building can be designed within a very short span of time.

2.5.2Ashis Debashis Behera 2012: This report studied the comparison between two 30 storied buildings having the same layout and dimensions but with two different load combinations.

(DL + LL + Siesmic Load)
(DL + LL + Wind Load)

2.5.3 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.

2.5.4 B. Suresh & P.M.B Raj Kiran Nanduri 2012: This research paper focusses 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.

2.5.5 Azidah Ziden, Fatariah Zakaria & Ahmad Nizam Othman (University 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 visualization of the project to be undertaken and thus help students in learning Engineering Design better. The study also shows how AutoCAD increases the efficiency of the student/designer.

Chapter 3

Methodology

3.1 Study of IS 875 1987

IS 875 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 situated in Delhi and is not a high-rise building, loads such as wind and snow werenot 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 fromAutoCAD to STAAD Pro using a DXF file format. Once the layout was transferred, multiple stories 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 analyzed and corrections were made to the structure for the various errors that were generated while the structure was being analyzed.

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. Once this is done the soil conditions and the type of foundation is entered. After this the program analyses and designs the foundation.

3.4 Cost Estimation using Microsoft Excel

The total steel and concrete requirement are calculated by STAAD Pro reducing a lot of calculation. Remaining calculation left to be done is the calculation of walls, cement plaster, doors and windows, earthwork and foundation. The calculations are based on the centerline method which is quite easy to do.

Chapter 4

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 designingany 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 28x46 mts or 90'x150'. Accordingly, the building has been laid in the center of the plot leaving ample space on all the sides for landscaping and pathways for cars and for visitors parking.

Table 1 General Layout Details

Area of Plot	90'x150'
FAR	2.25(allowed)
Plot details	Front – service road followed a green belt from the main road Left & right side – private residential buildings Rear – service lane
Number of Floors	G+4
Number of Units	8 Ground Floor to be used as Car Parking
Type Apartment	3BHK
Area of Each Apartment	246 sq m

Salient Features of The Project: -

- Vaastu compliant design.
- Effective stepped planning for use of terraces at different levels.
- Separate entrances for all units.
- Combined lobby for all floors.

4.3 Layout Using AutoCAD

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

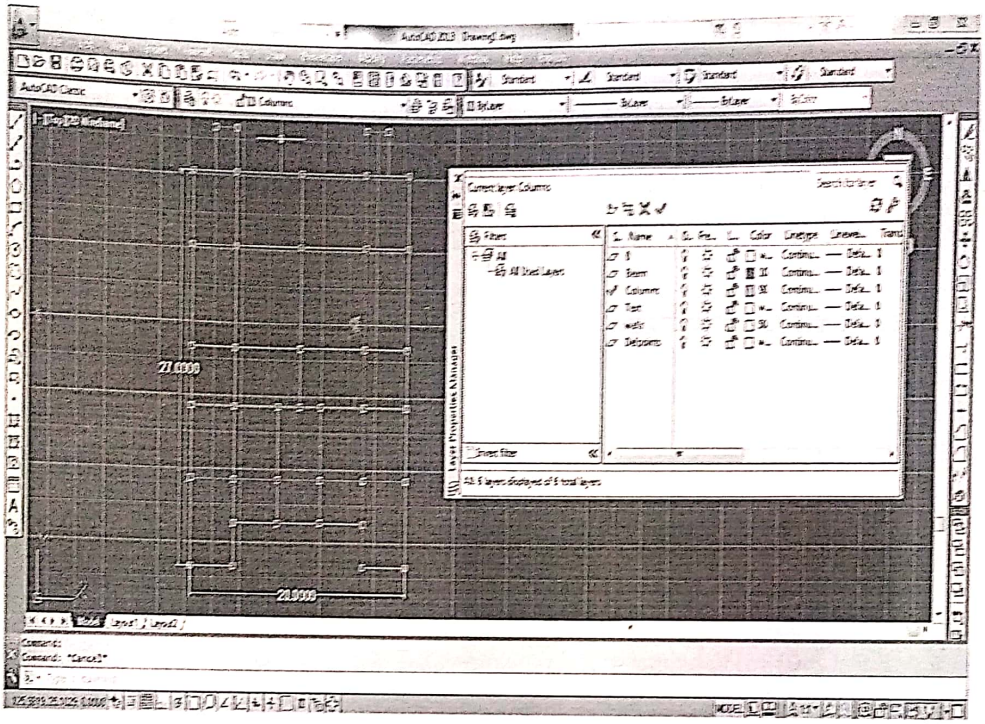

Fig 1. Beam and Column Layout using Layers

In the above picture the red lines signify the beam center line while the green rectangular boxes signify the Columns. The beams have a cross section of 0.3 X 0.4 m. The columnshave a cross section of 0.4 X 0.4 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 3.15 m.

All the work has been done in layers in AutoCAD, for easy editing and viewing. Layers makeit easy to manipulate each individual layer making it visible and invisible for clarity as wellas 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 2 apartments in each floor having a 3BHK layout along with a study and a family lounge. Each apartment has two master bedrooms with attachedbath n toilet. The third bedroom shares a common bath and toilet with the rest of theapartment. There are a total of 8 apartments divided in 4 floors. The ground floor of the building will be used as parking.

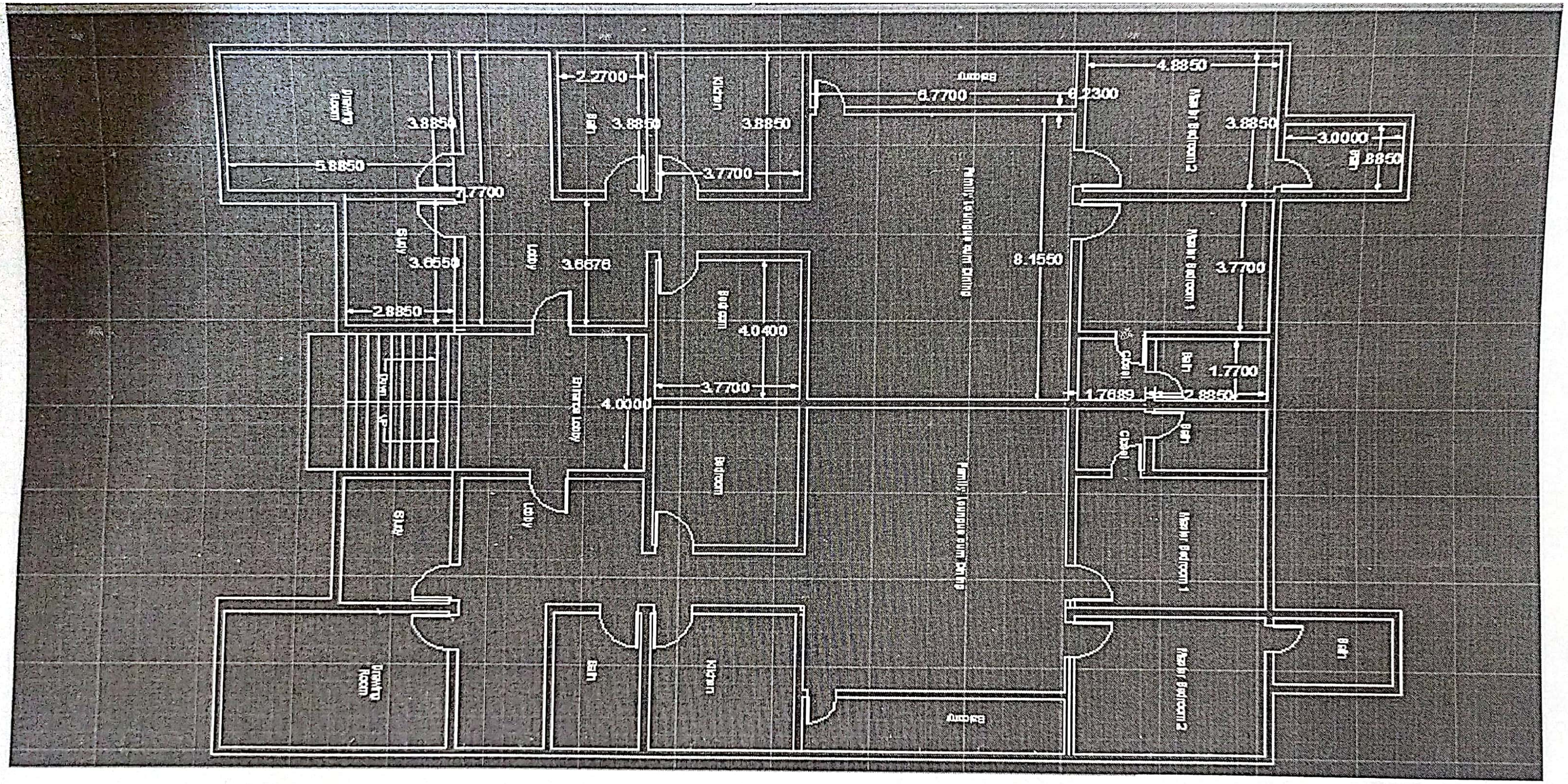

Fig 2. Plan Layout of 1st ,2nd 3rd & 4th
Floor

The staircase has width of 2m, with rises of 157mm and a tread 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. There are two sizes of doors a) 1x2.1m & b) 0.75x2.1m. The smaller size door has been used in bathrooms and closets. There is also a provision for balcony with a width of 1.5m along the family cum dining longue.

Chapter 5

Analysis 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.

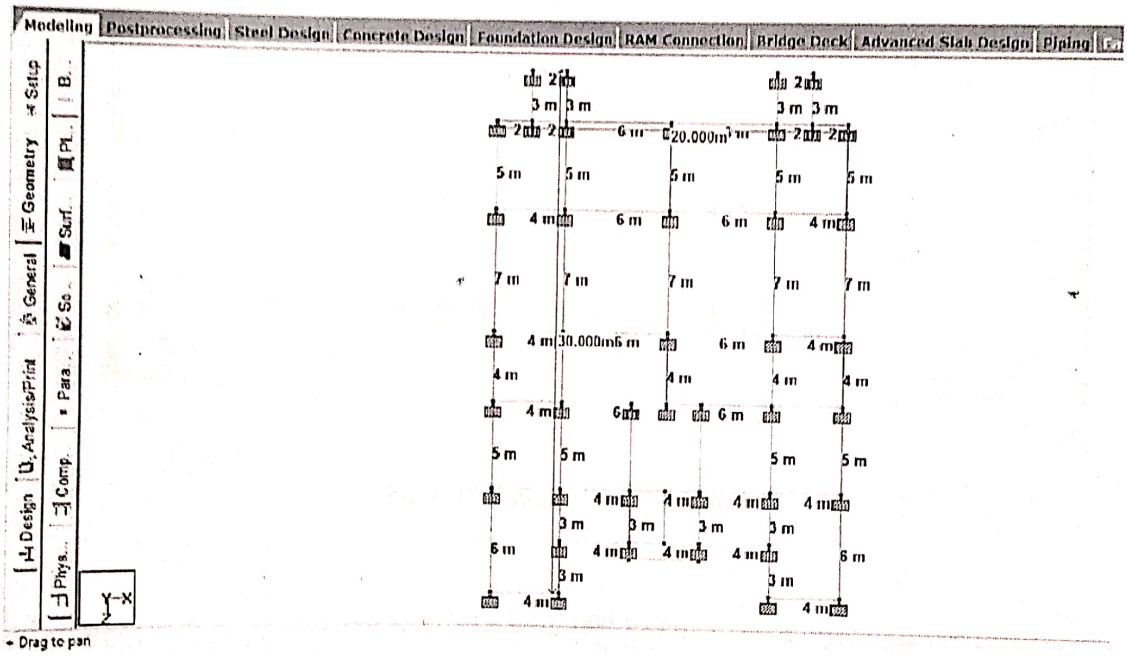

Fig 3. Plan of the G+4 Structure

The above figure shows the beam and column layout that has been transferred from AutoCAD. The total width of the building is 20.0 m while the lengths around 30.0 m. The figure also shows the X, Y, Z direction. Here Y direction s taken as the vertical component. The X, Y, Z coordinate system is also the same as coordinate system used in AutoCAD. Fig 2. Plan Layout of 1st ,2nd 3rd & 4th Floor

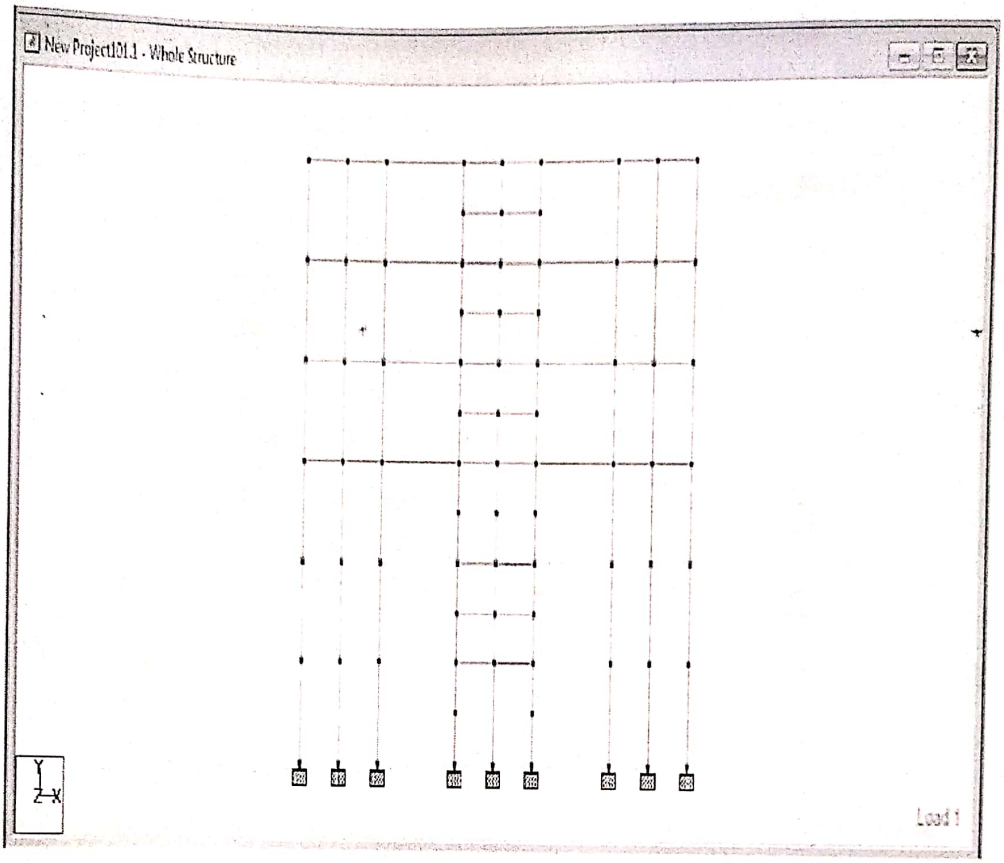

Fig 4. Elevation of the Structure

Table 2 Structural Details

Length of Building	30.0m
Width of Building	20.0m
Height	3.15(Below G) + G+4 @3.15m=18.9m
Live Load on the Floor	3.0 KN/m2
Grade of Concrete	M30
Steel	Fe 415
Column Size	0.5m x 0.5m
Beam Size	0.3m x 0.4m
Slab Thickness	230mm
Total No Columns	252
Total No Beams	581
No of Footing	42

5.2 Generation of Member and Member Property

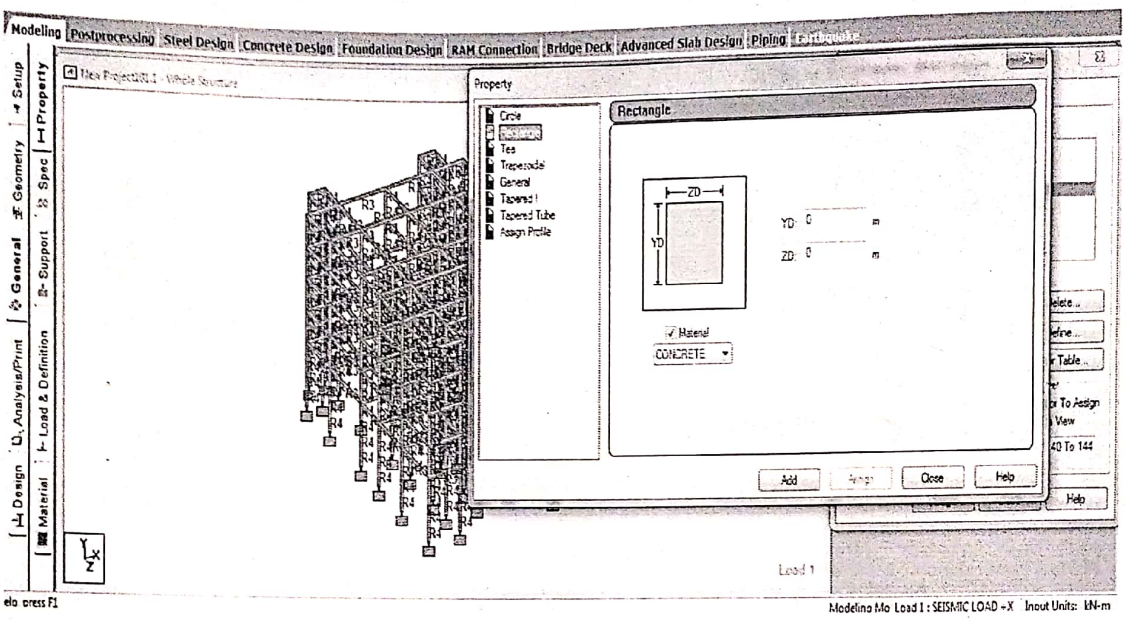

Fig 5. Generation of Member and Member Property

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 0.3 m x 0.4 m and the columns have a cross section of 0.4m x 0.4m.

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.

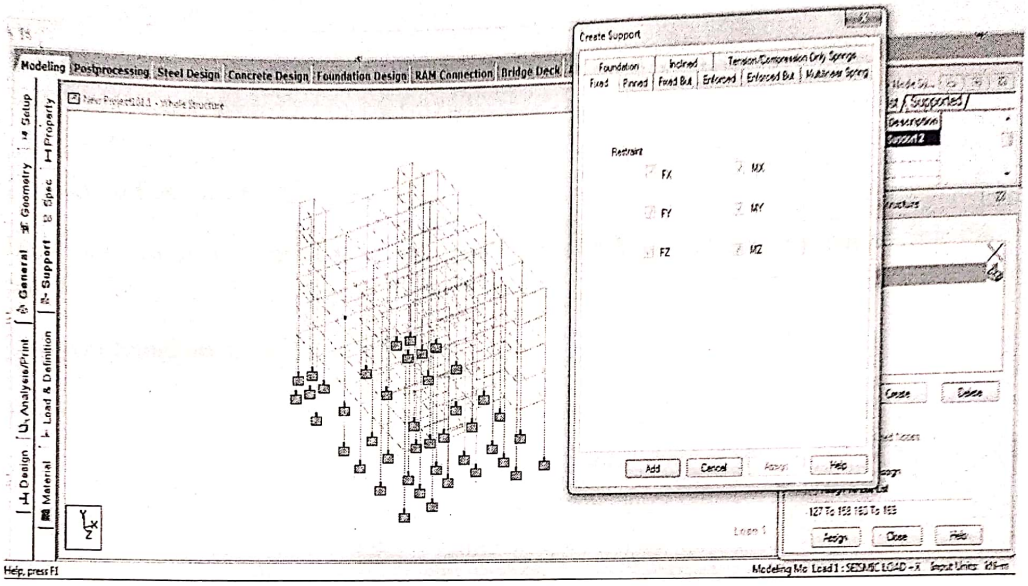

Fig 6. Support Generation for the Structure.

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

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 materials for the structure is selected as concrete with their property and constants as perIS Codes.

5.5 Loading

The loading that has been considered on the structure are as follows:

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

5.5.1 Self-Weight

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

5.5.2 Dead Load from Slab

Dead load from the slab can be generated by STAAD Pro itself by specifying the SlabThickness and the load on the floor per Sqm.

This was found out to be 5.75KN/sq m

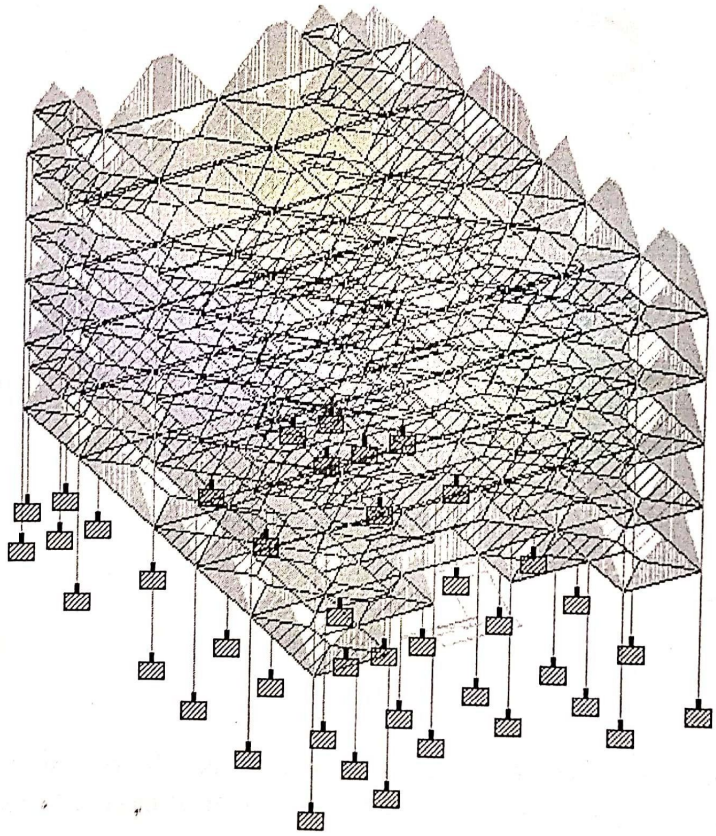

Fig 7. Dead Load from Slab Action
of the Structure

5.5.3 Live Load

The live load acting on each floor was considered to be 3KN/ sqm. The live load aregenerated in the same way as dead load

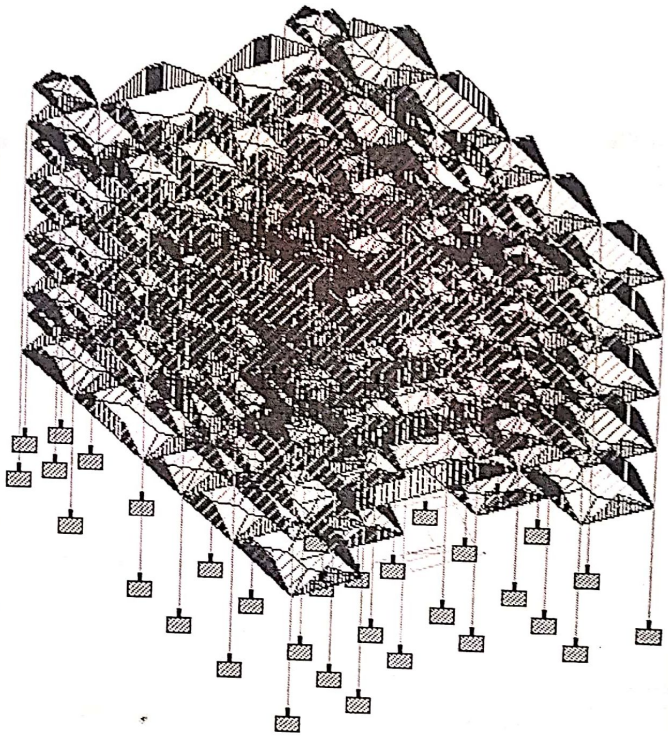

Fig 8. Live Load acting on the structure.

5.5.4 Seismic Loads

The seismic loads were derived from IS 1893 2002 and these loads were generated bySTAAD Pro Seismic Load generator in accordance with IS1893.

The Seismic Load generator generates load in X and Z direction only. Y Direction onlycontains gravity loads.
STAAD follows the following procedure to generate the seismic loads

- User inputs the seismic zone co-efficient and desired "1893(Part 1)-2002 specs"through the load generator command
- Program calculates the structure period (T).
- Program calculates Sa/g utilizing T.
- STAAD calculates V from the above equation. W is obtained from the

weight dataprovided by the user through the DEFINE 1893 LOAD command.

- The total lateral seismic load (base shear) is then distributed by the program amongdifferent levels of the structure per the IS: 1893(Part 1)-2002 procedures.

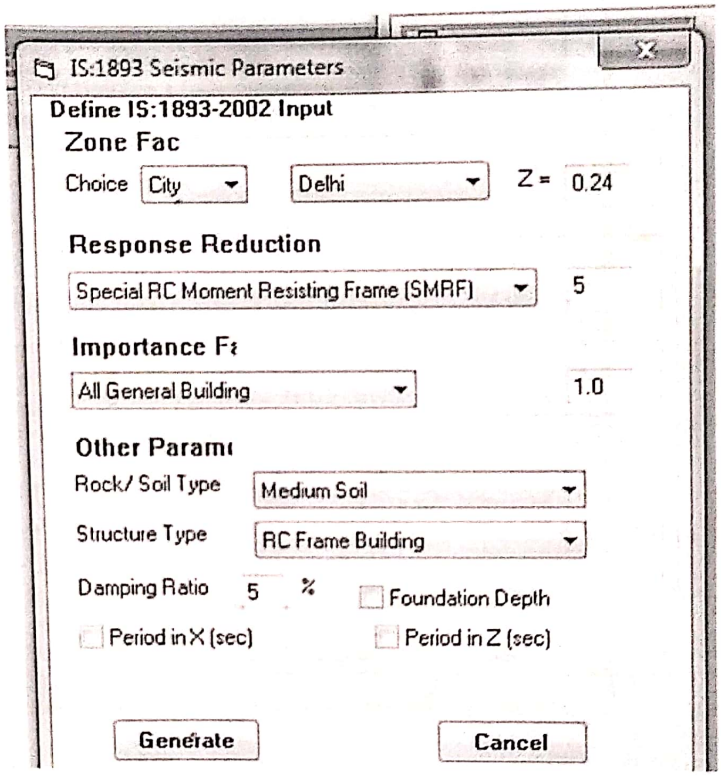

Fig 9 (a). Input of Seismic Parameters

Zone Factor 0.24 for Rajasmand.

The frame selected is Special RC Moment Resisting Frame (SMRF) and RF is taken as 5.

Importance Factor for All General Building is 1.0
Rock Soil Type is "

Rock Soil type is "Medium

Soil" Structure Type is "RC

Frame Building"

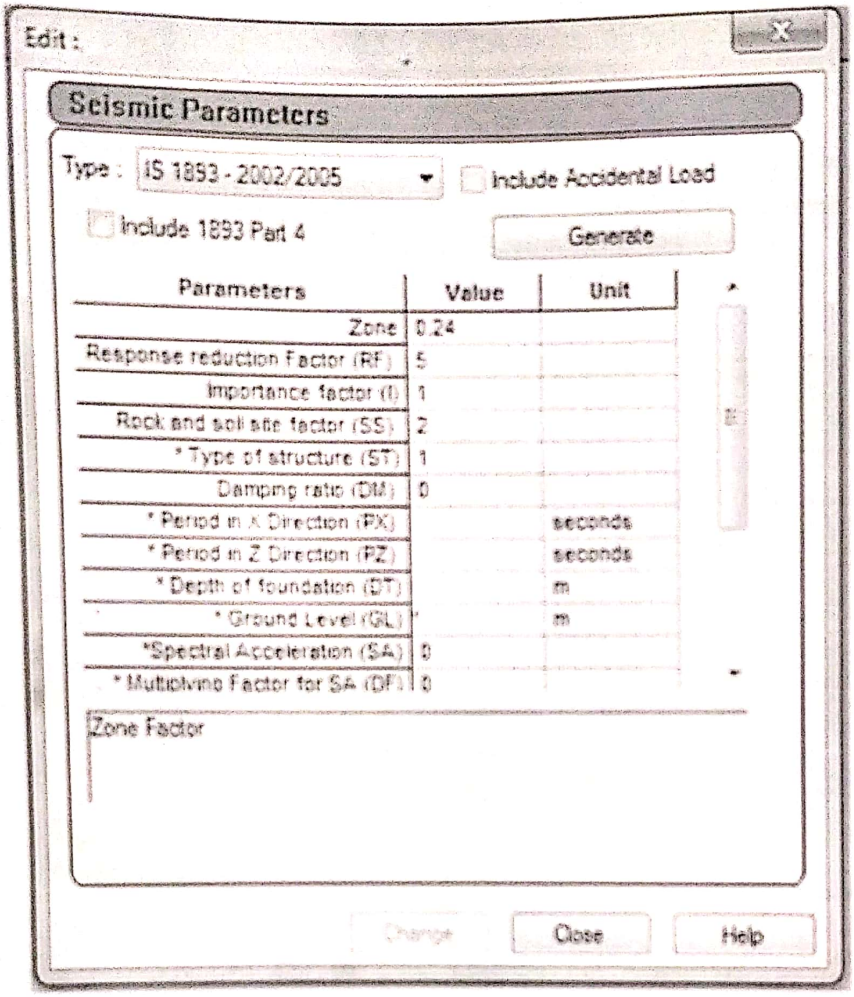

Fig 9 (b). Generation of Seismic Parameters

The Figure Mentions the Seismic Code as IS 1893:2002.

The zone factor is 0.24 for Rajasmand

The response reduction factor (RF) is taken as 5. The importance Factor for the building is taken as 1.

Rock and soil site factor (SS) is taken as 2 for medium SoilType of structure is taken as 1

Damping Ratio is taken as 0 for accurate results. By default, the value is 5

5.5.5 Load Combinations

The structure has to be analyzed 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 Codes

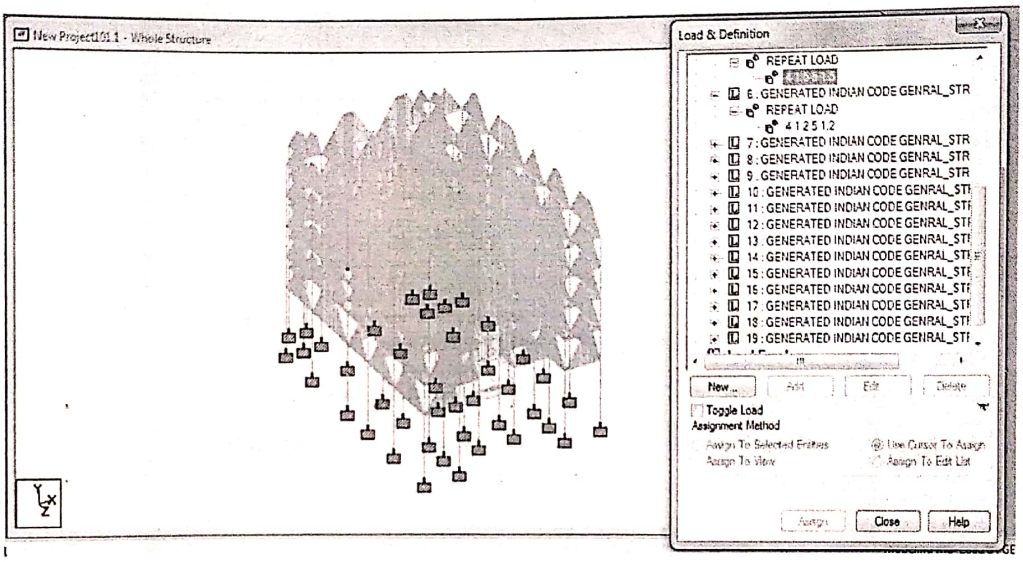

Fig 10. Load Combinations Acting on Structure

5.5.6 The Various Load Combinations used are as follows:

1. 1.5 DL 1.5 LL
2. 1.2 DL 1.2 LL
3. 1.2 DL 1.2 LL 1.2 EQ(X)
4. 1.2 DL 1.2 LL 1.2 EQ(Z)
5. 1.2 DL 1.2 LL -1.2 EQ(X)
6. 1.2 DL 1.2 LL -1.2 EQ(Z)
7. 1.5 DL
8. 1.5 DL 1.5 EQ(X)
9. 1.5 DL 1.5 EQ(Z)
10. 1.5 DL -1.5 EQ(X)
11. 1.5 DL -1.5EQ(Z)
12. 0.9 DL 1.5 EQ(X)
13. 0.9 DL 1.5 EQ(Z)
14. 0.9 DL -1.5 EQ(X)
15. 0.9 DL -1.5 EQ(Z)

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 analyses 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.

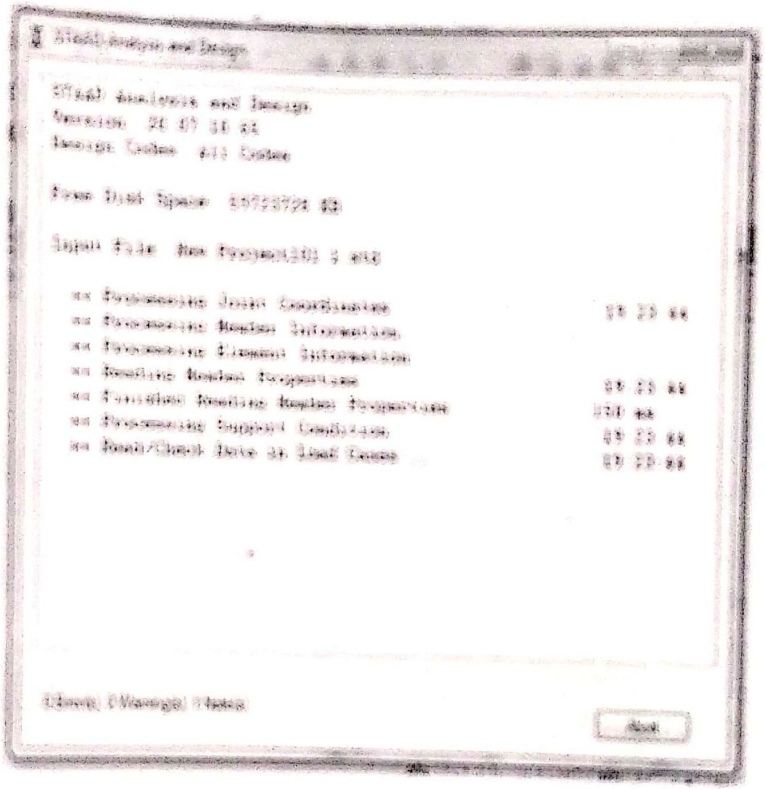

Fig 11 GUI showing the analysing and design window

Chapter 6

Design of G+4 structure using STAAD Pro

6.1 General

After the STAAD Pro has completed analyzing 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, Aluminum & Timber. We will choose RCC or Reinforces 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.

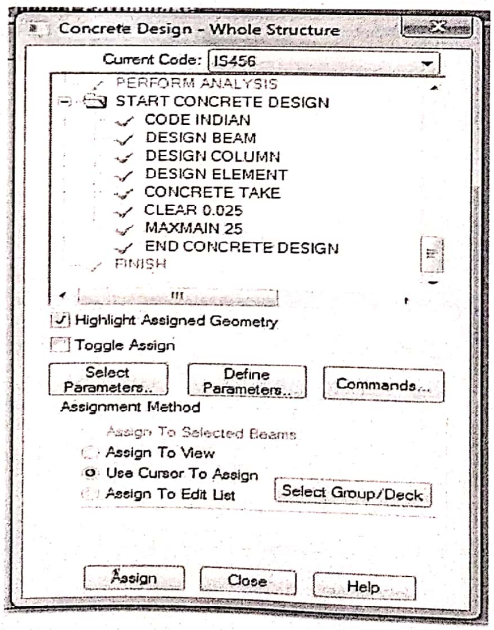

Fig 12. Assigning Design Parameters to the whole structure

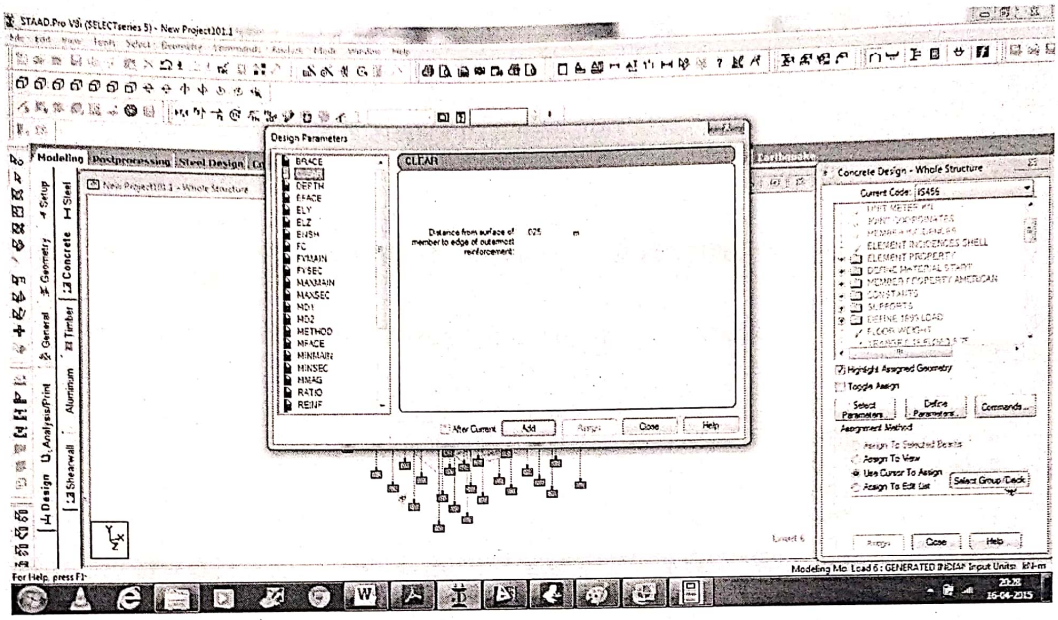

Fig 13. Input of Design Parameters into STAAD Pro

Various Design parameters can be entered as per the user's 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 engine as per the Codal Provisions.

Chapter 7

Results

7.1 Analysis & Design Results

SUPPORT REACTIONS -UNIT KN METE STRUCTURE TYPE = SPACE

JOINT	LOAD	FORCE-X	FORCE-Y	FORCE-Z	MOM-X	MOM-Y	MOM Z
127	3	0.18	128.13	0.89	2.03	0.03	-0.33
	6	0.14	102.50	0.71	1.62	0.02	-0.26
	7	0.14	102.50	0.71	1.62	0.02	-0.26
	8	0.14	102.50	0.71	1.62	0.02	-0.26
	9	0.14	102.50	0.71	1.62	0.02	-0.26
	10	0.14	102.50	0.71	1.62	0.02	-0.26
	11	0.12	84.20	0.59	1.33	0.02	-0.22
	12	0.12	84.20	0.59	1.33	0.02	-0.22
	13	0.12	84.20	0.59	1.33	0.02	-0.22
	14	0.12	84.20	0.59	1.33	0.02	-0.22
	15	0.12	84.20	0.59	1.33	0.02	-0.22
128	3	-0.18	145.18	0.89	1.97	0.02	0.45
	6	-0.15	116.14	0.71	1.58	0.02	0.36
	7	-0.15	116.14	0.71	1.58	0.02	0.36
	8	-0.15	116.14	0.71	1.58	0.02	0.36
	9	-0.15	116.14	0.71	1.58	0.02	0.36
	10	-0.15	116.14	0.71	1.58	0.02	0.36
	11	-0.12	95.40	0.59	1.29	0.02	0.29
	12	-0.12	95.40	0.59	1.29	0.02	0.29
	13	-0.12	95.40	0.59	1.29	0.02	0.29
	14	-0.12	95.40	0.59	1.29	0.02	0.29
	15	-0.12	95.40	0.59	1.29	0.02	0.29
129	3	2.48	694.08	2.93	6.31	0.01	-5.34
	6	1.98	555.26	2.34	5.05	0.01	-4.27
	7	1.98	555.26	2.34	5.05	0.01	-4.27
	8	1.98	555.26	2.34	5.05	0.01	-4.27
	9	1.98	555.26	2.34	5.05	0.01	-4.27
	10	1.98	555.26	2.34	5.05	0.01	-4.27
	11	1.63	456.11	1.92	4.15	0.01	-3.51
	12	1.63	456.11	1.92	4.15	0.01	-3.51
	13	1.63	456.11	1.92	4.15	0.01	-3.51
	14	1.63	456.11	1.92	4.15	0.01	-3.51
	15	1.63	456.11	1.92	4.15	0.01	-3.51

BEAM NO. 158 DESIGN RESULTS

M30 Fe415 (Main) Fe415 (Sec.)

LENGTH: 5000.0 mm SIZE: 400.0 mm X 300.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	1250.0 mm	2500.0 mm	3750.0 mm	5000.0 mm
TOP REINF.	0.00 (Sq. mm)	221.20 (Sq. mm)	264.04 (Sq. mm)	221.20 (Sq. mm)	0.00 (Sq. mm)
BOTTOM REINF.	436.25 (Sq. mm)	0.00 (Sq. mm)	0.00 (Sq. mm)	0.00 (Sq. mm)	493.75 (Sq. mm)

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SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	1250.0 mm	2500.0 mm	3750.0 mm	5000.0 mm
TOP REINF.	3-10i 1 layer(s)	3-10i 1 layer(s)	4-10i 1 layer(s)	3-10i 1 layer(s)	3-10i 1 layer(s)
BOTTOM REINF.	6-10i 1 layer(s)	3-10i 1 layer(s)	3-10i 1 layer(s)	3-10i 1 layer(s)	7-10i 1 layer(s)
SHEAR REINF.	2 legged 8i @ 150 mm c/c	2 legged 8i @ 150 mm c/c	2 legged 8i @ 150 mm c/c	2 legged 8i @ 150 mm c/c	2legged 8i @150 mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THESUPPORT

SHEAR DESIGN RESULTS AT START SUPPORTVY = 3 470.0 mm AWAY FROM -40.50 MX = -1.41 LD=

Provide 2 Legged 8i @ 150 mm c/c

SHEAR DESIGN RESULTS AT END SUPPORTVY = 3 470.0 mm AWAY FROM 38.53 MX = -1.41 LD=

Provide 2 Legged 8i @ 150 mm c/c

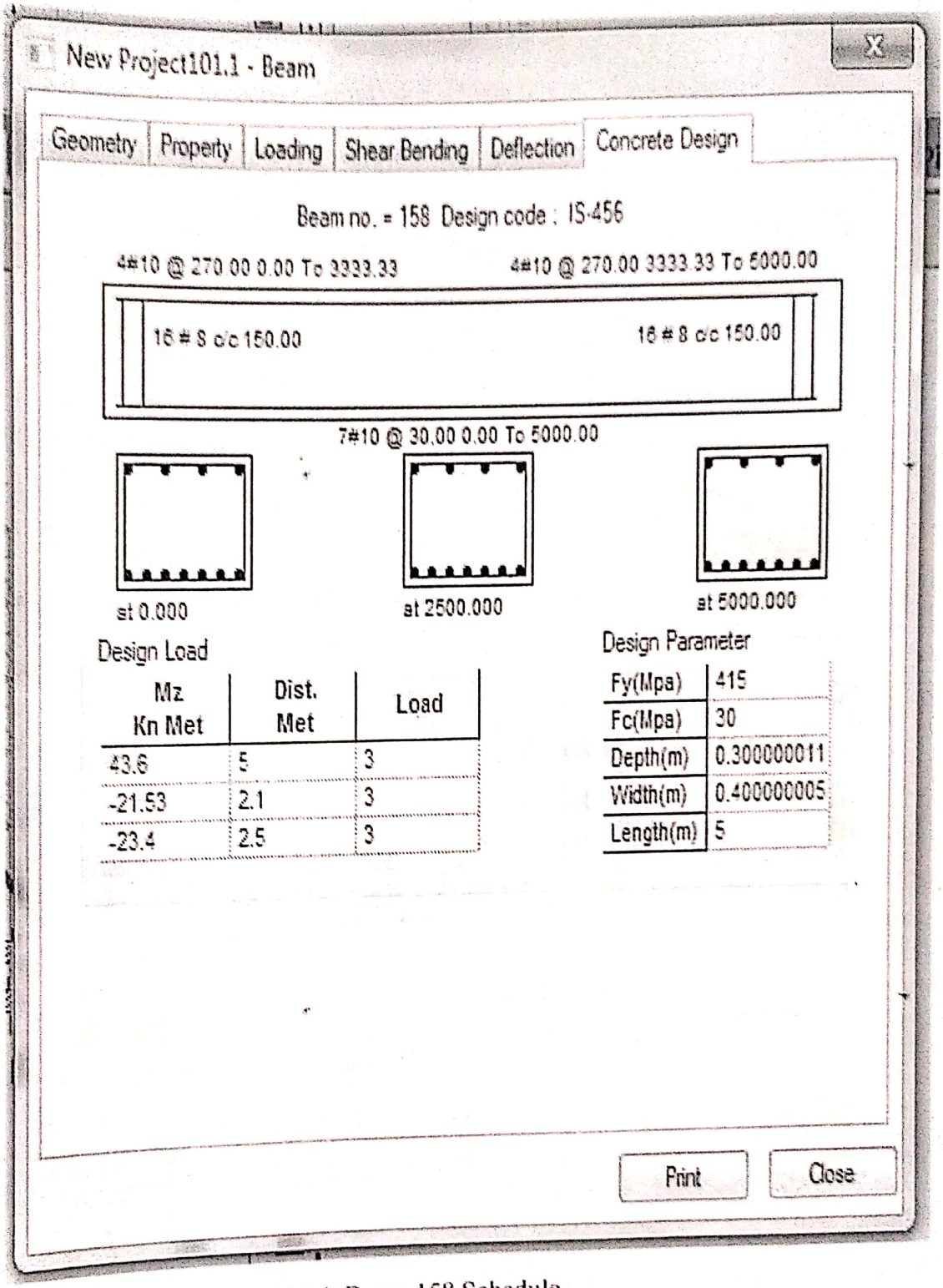

Fig 14. Beam 158 Schedule

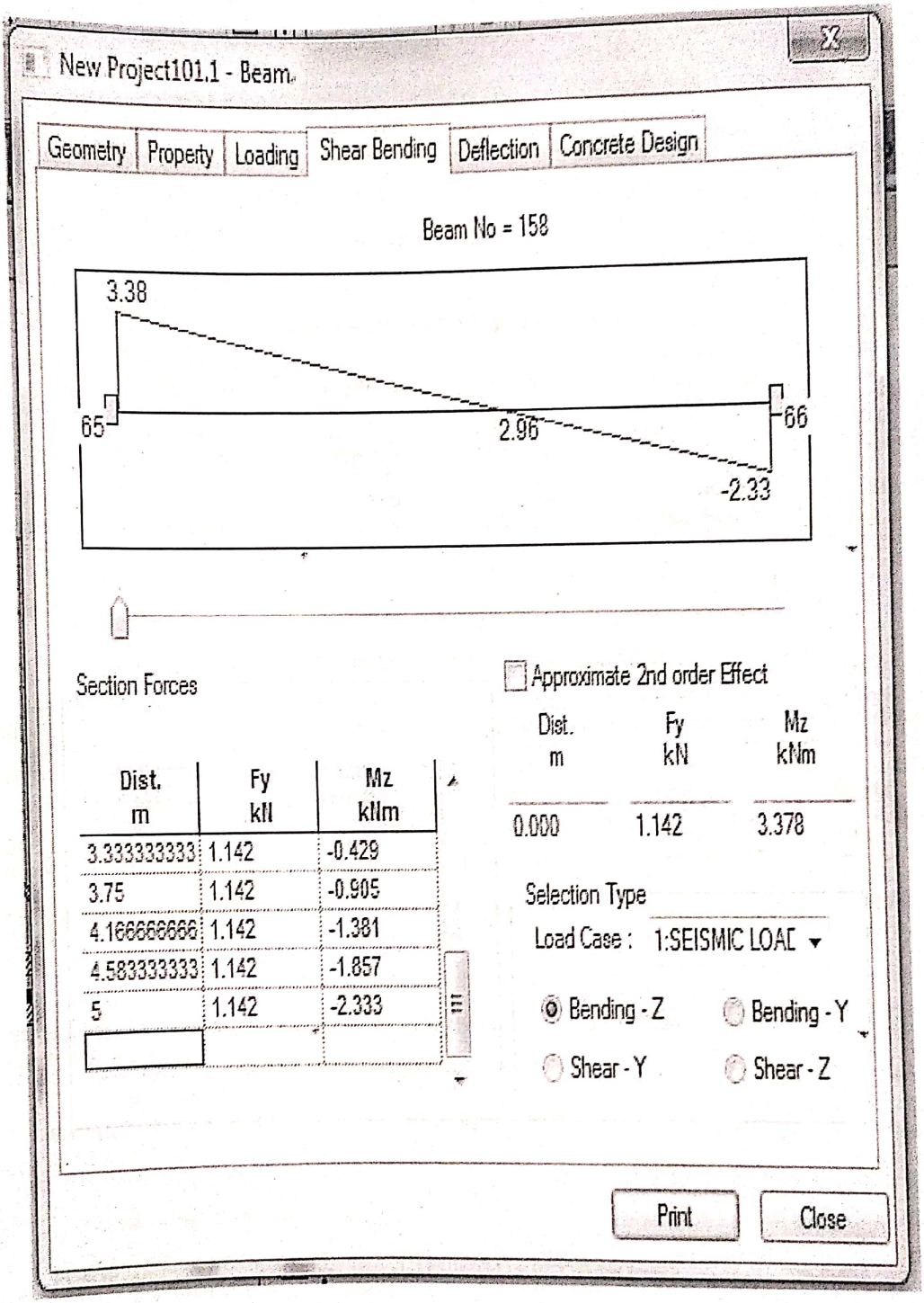

Fig 15. Beam 158 Shear Bending

BEAM NO. 729 DESIGN RESULTS

M30 Fe415 (Main) Fe415

(Sec.) LENGTH: 4000.0 mm SIZE: 400.0 mm X 300.0 mm

COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	1000.0 mm	2000.0 mm	3000.0 mm	4000.0
TOP REINF.	0.00 (Sq. mm)	221.20 (Sq. mm)	221.20 (Sq. mm)	221.20 (Sq. mm)	0.00 (Sq.mm)
BOTTOM REINF.	221.51 (Sq. mm)	0.00 (Sq. mm)	0.00 (Sq. mm)	0.00 (Sq. mm)	240.32 (Sq.mm)

SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	1000.0 mm	2000.0 mm	3000.0 mm	4000.0
TOP REINF.	2-12í 1 layer(s)	3-12í 1 layer(s)	3-12í 1 layer(s)	3-12í 1 layer(s)	2-12í 1 layer(s)
BOTTOM REINF.	3-10í 1 layer(s)	3-10í 1 layer(s)	3-10í 1 layer(s)	3-10í 1 layer(s)	4-10í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 150 mm c/c	2 legged 8í @ 150 mm c/c	2 legged 8í @ 150 mm c/c	2 legged 8í @ 150 mm c/c	2 legged 8í @ 150mm c/c

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THESUPPORT

SHEAR DESIGN RESULTS AT START SUPPORT 470.0 mm AWAY FROM
VY = 3 -23.86 MX = -0.88 LD=

Provide 2 Legged 8í @ 150 mm c/c

SHEAR DESIGN RESULTS AT END SUPPORT 470.0 mm AWAY FROM
VY = 3 26.11 MX = -0.88 LD=

Provide 2 Legged 8í @ 150 mm c/c

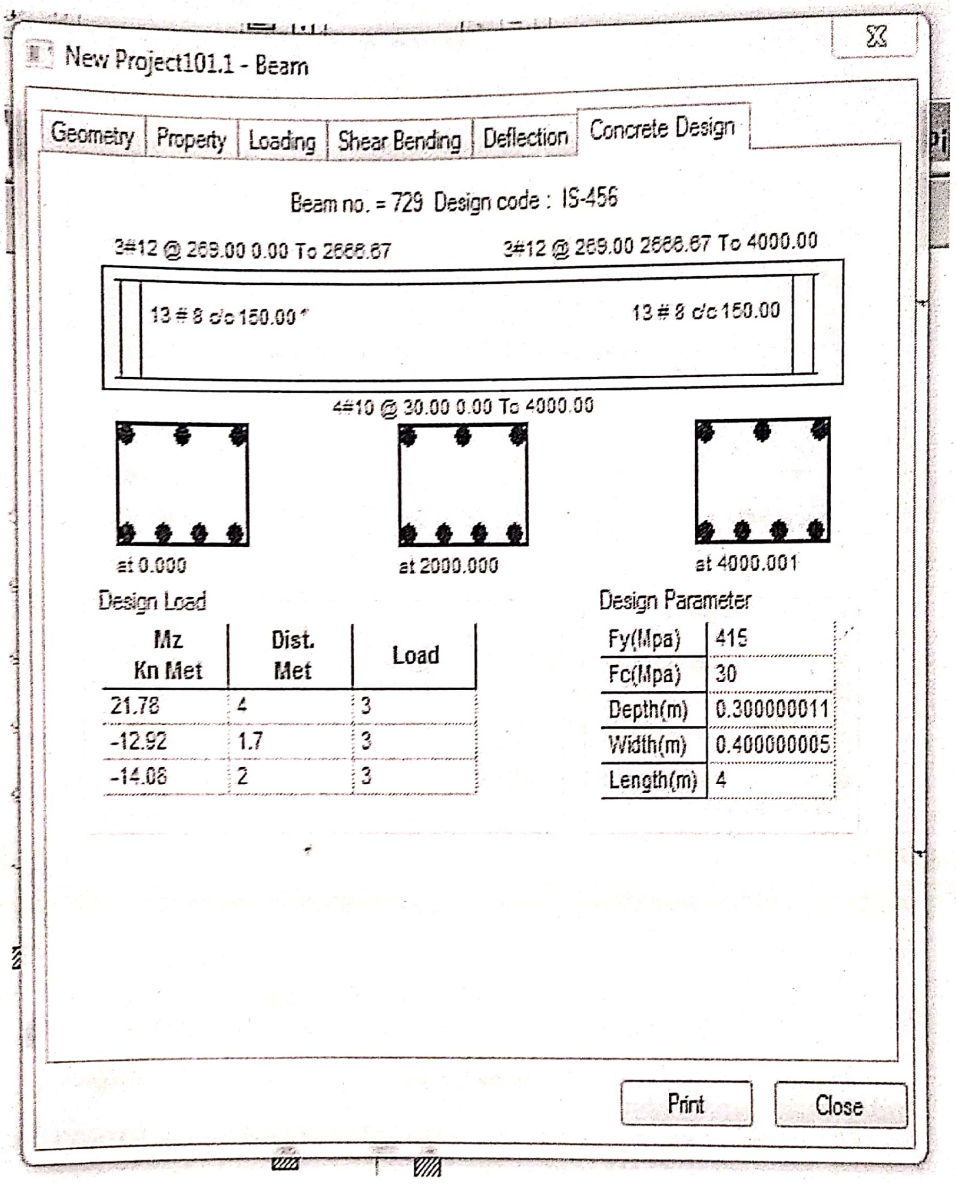

Fig 16. Beam 729 Schedule

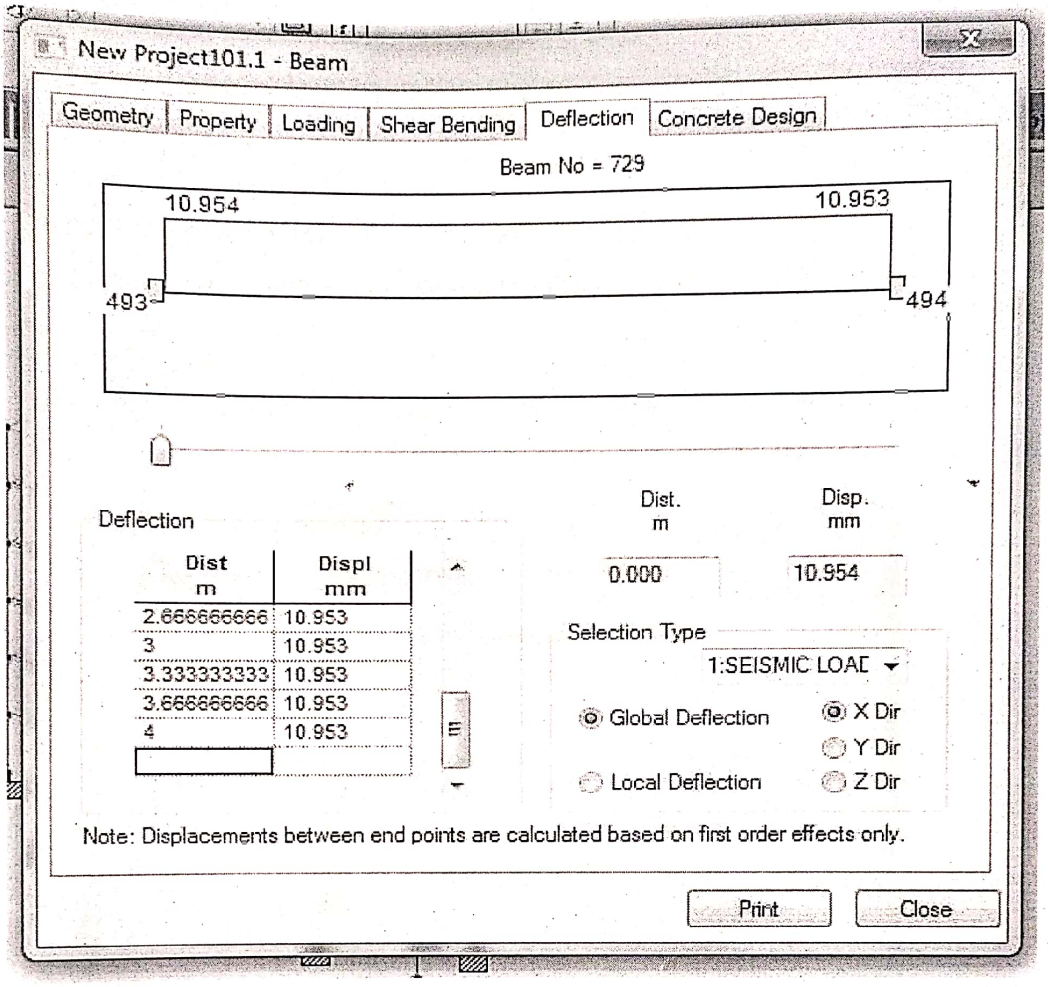

Fig 17. Beam 729 Deflection

COLUMN NO. 790 DESIGN RESULTS

M30 Fe415 (Main) Fe415

(Sec.) LENGTH: 3150.0 mm CROSS SECTION: 400.0 mm X 400.0 mm COVER: 40.0 mm

** GUIDING LOAD CASE: 3 END JOINT: 114 TENSION COLUMN

REQD. STEEL AREA : 1536.00 Sq.mm. REQD. CONCRETE AREA: 158464.00 Sq.mm.

MAIN REINFORCEMENT : Provide 8 - 16 dia. (1.01%, 1608.50 Sq.mm.)
(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. rectangular ties @ 255 mm c/cSECTION

CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)

Puz : 2617.34 Muz1 : 43.90 Muy1 : 43.90

INTERACTION RATIO: 0.92 (as per Cl. 39.6, IS456:2000) SECTION

CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)

WORST LOAD CASE: 3

END JOINT: 114 Puz : 580.75 Muz : 0.00 Muy : 0.00 IR: 0.52

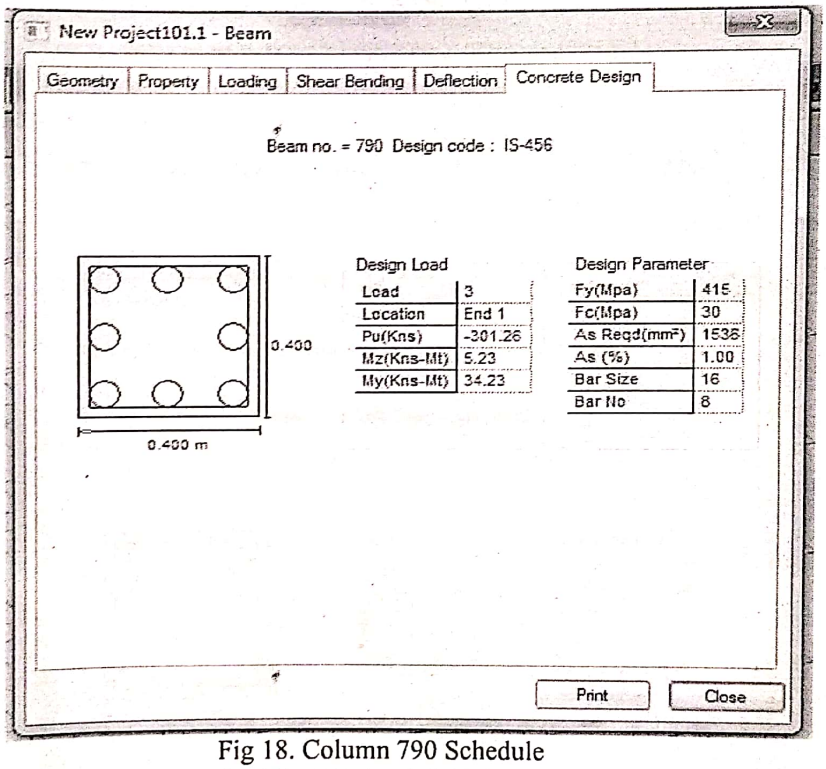

Fig 18. Column 790 Schedule

COLUMN NO. 1088 DESIGN RESULTS

M30 Fe415 (Main) Fe415

(Sec.) LENGTH: 3150.0 mm CROSS SECTION: 400.0 mm X 400.0 mm COVER: 40.0 mm

** GUIDING LOAD CASE: 3 END JOINT: 542 TENSION COLUMN

REQD. STEEL AREA :
1280.00
Sq.mm.REQD. CONCRETE AREA:
158720.00
Sq.mm.

MAIN REINFORCEMENT : Provide 12 - 12 dia. (0.85%, 1357.17 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. rectangular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)

Puz : 2541.12 Muz1 : 53.41 Muy1 : 53.41

INTERACTION RATIO: 0.67 (as per Cl. 39.6, IS456:2000) SECTION

CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)

WORST CASE: 3
LOAD
END JOINT: 542 Puz : 490.01 Muz : 0.00 Muy : 0.00 IR: 0.31

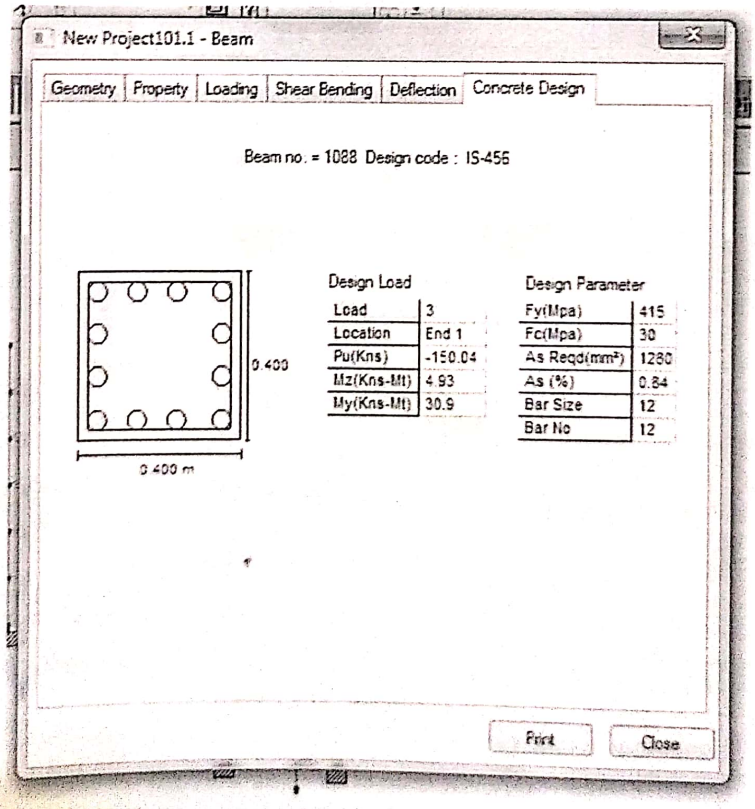

Fig 19. Column 1088 Schedule

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 isan isolated, combined or mat foundation. Finally, the job is to be created and the foundation analyzed and designed.

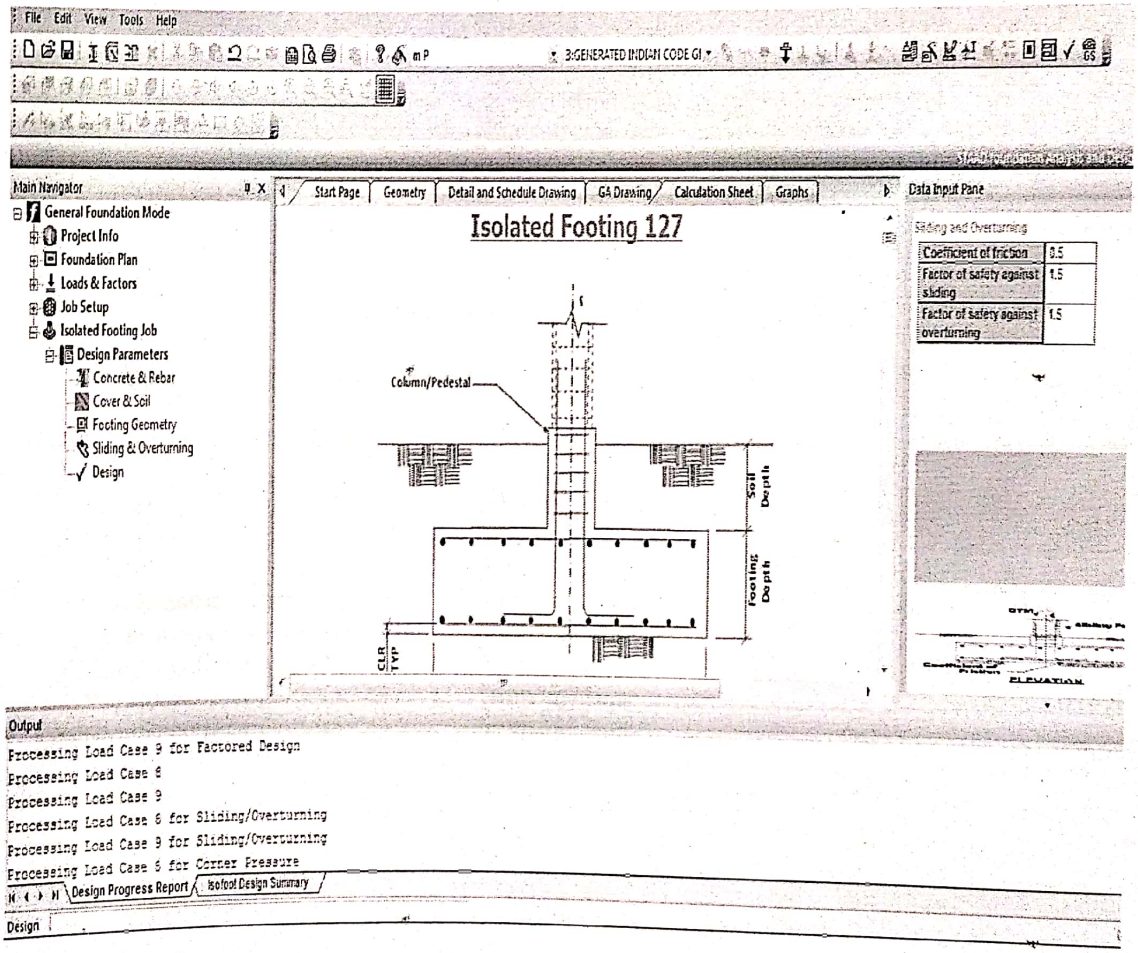

Fig 20. Design Window of STAAD Foundation

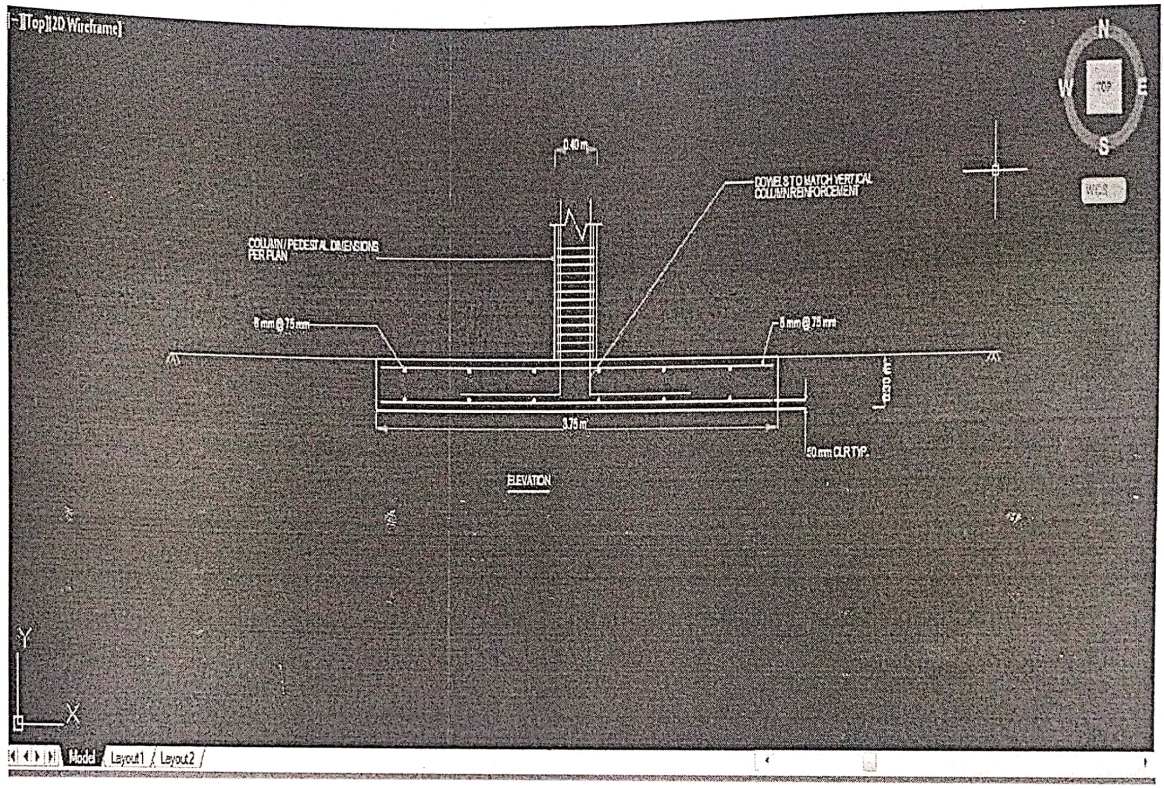

Fig 21. Elevation of

Foundation 127The 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

7.3 Cost Estimate of G+4 Residential Building

The cost estimate includes the quantities of the various materials that have been used and alsoan abstract cost for the construction of the building. The cost estimate has been prepared using Microsoft Excel. Centre line method has been followed for the calculation of thevarious quantities.

The first part of the Cost estimate contains the quantity survey for various materials and it has been done individually for each of the 4 floors and also for the earthwork and the ground floor.

The quantity estimate for concrete and rebar has been taken from the STAAD Pro Results. STAAD Pro gave the total amount of concrete take off for the superstructure along with the rebar requirement of various diameters. The weight of rebar was in form of Newton(N) which was converted to tons.

The second part of the cost estimate includes the Abstract Cost of the building floor wise. The rates used in the abstract have been taken from the CPWD Schedule of Rates for Rajasthan.

Below is the Complete Cost Estimate including the quantity estimate and abstract cost of the proposed G+4 Residential building in Rajnagar Rajasmand.

Chapter 8

Conclusion

8.1 Conclusion

This project includes the layout of G+4 residential building using AutoCAD, Analysis and Design using STAAD Pro, Planning concludes with the cost estimatefor the entire project.

The layout of the proposed G+4 residential building is based on a plot of size 150' x 90 ' located at Rajnagar Rajasmand. 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 while the remaing 4 floors will be divided into 8 apartments each having an area of 246sq m. Each apartment is of 3BHK configuration. All the drafting was done using AutoCAD. Also these drawings made on AutoCAD also servedas 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.

The cost estimate for the project has been calculated using Centre Line Method in Microsoft Excel. For the Abstract cost CPWD Schedule of rates has been followed and a total cost ofRs 11082364 has been calculated.

References

1. IS 875 1987 (Part 1, 2 & 3)

2. STAAD Pro User Manual

3. CPWD Schedule of Rates for Delhi

4. http://en.wikipedia.org/wiki/AutoCAD

5. http://en.wikipedia.org/wiki/Primavera_%28software%29

6. http://en.wikipedia.org/wiki/STAAD

7.International Journal of Advanced Engineering Technology E-ISSN 0976-3945IJAET/Vol.III/ Issue IV/Oct.-Dec., 2012/104-106
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9. http://dx.doi.org/10.3991/ijet.v7i2.1906
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