

Design And Analysis Of Residential Building In STAAD Pro

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ABSTRACT

Building construction is the engineering deals with the construction of building such as residential houses. In a simple building can be define as an enclose space by walls with roof, food, cloth and the basic needs of human beings. In the early ancient times humans lived in caves, over trees or under trees, to protect themselves from wild animals, rain, sun, etc. as the times passed as humans being started living in huts made of timber branches. The shelters of those old have been developed nowadays into beautiful houses. Rich people live in sophisticated condition houses. In order to compete in the ever-growing competent market, it is very important for a structural engineer to save time. as a sequel to this an attempt is made to analyze and design a Multi-storeyed building by using a software package staad pro. For analysing a multi storied building one has to consider all the possible loadings and see that the structure is safe against all possible loading conditions. There are several methods for analysis of different frames like kani's method, cantilever method, portal method, Matrix method. The present project deals with the analysis of a multi storeyed residential building of G + 8storey building. The dead load & live loads are applied and the design for beams, columns, footing is obtained STAAD Pro along with in addition we are giving seismic loadings i.e. designing the building withstand the loads were applied in the software and analysis was done.

Keywords : STAAD. Pro, Residential Buildings, Auto CADD,

INTRODUCTION

Building construction is the engineering deals with the construction of building such as residential houses. In a simple building can be define as an enclose space by walls with roof, food, cloth and the basic needs of human beings. In the early ancient times humans lived in caves, over trees or under trees, to protect themselves from wild animals, rain, sun, etc. as the times passed as humans being started living in huts made of timber branches. The shelters of those old have been developed nowadays into beautiful houses. Rich people live in sophisticated condition houses. Buildings are the important indicator of social progress of the county. Every human has desire to own comfortable homes on an average generally one spends his two-third life times in the houses. The security civic sense of the responsibility. These are the few reasons which are responsible that the person do utmost effort and spend hard earned saving in owning houses.

The design is made using software on structural analysis design (STAAD.pro). The building subjected to both the vertical loads as well as horizontal loads. The vertical load consists of dead load of structural components such as beams, columns, slabs etc and live loads. The horizontal load consists of the wind forces thus building is designed for dead load, live load and wind load as **per IS 875**. The building is designed as two-dimensional vertical frame and analyzed for the maximum and minimum bending moments and shear forces by trial and error methods as per **IS456-2000**. The help is taken by software available in institute and the computations of loads, moments and shear forces and obtained from this software.

STATEMENT OF PROJECT:

Salient features:

Utility of building :Residential complex

No of stories :G+8

Shape of the building :7 APARTMENTS

No of staircases :7

No. of flats: 40

Type of construction : R.C.C framed structure

Types of walls : Brick wall

Geometric details:

Ground floor: 3m

Floor to floor height: 3m.

Height of plinth : 0.6m

Materials:

Concrete grade:M40

All steel grades: Fe415 grade

Bearing capacity of soil: 300KN/M2

Method of flexibility coefficients:

The method of analysis is comprises reducing the hyper static structure to a determinate structure

form by:

Removing the redundant support (or) introducing adequate cuts (or) hinges.

Limitations:

It is not applicable for degree of redundancy>3

Slope displacement equations:

It is advantageous when kinematic indeterminacy <static indeterminacy. This procedure was first formulated by axle bender in 1914 based on the applications of compatibility and equilibrium conditions. The method derives its name from the fact that support slopes and displacements are explicitly computed. Set up simultaneous equations is formed the solution of these parameters and the joint moment in each element or computed from these values.

Kani's method:

This method over comes some of the disadvantages of hardy cross method. Kani's approach is similar to H.C.M to that extent it also involves repeated distribution of moments at successive joints in frames and continues beams. However, there is a major difference in distribution process of two methods. H.C.M distributes only the total joint moment at any stage of iteration. The most significant feature of kani's method is that process of iteration is

self-corrective. Any error at any stage of iterations corrected in subsequent steps consequently skipping a few steps error at any stage of iteration is corrected in subsequent consequently skipping a few steps of iterations either by over sight of by intention does not lead to error in final end moments.

Advantages:

It is used for side way of frames.

Approximate method:

Approximate analysis of hyper static structure provides a simple means of obtaining a quick Solution for preliminary design. It makes Some simplifying assumptions regarding Structural behavior so to obtain a rapid solution to complex structures. The usual process comprises reducing the given indeterminate configuration to a determine structural system by introducing adequate no of hinges. it is possible to sketch the deflected profile of the structure for the given loading and hence by locate the print inflection. Since each point of inflection corresponds to the location of zero moment in the structures. The inflection points can be visualized as hinges for the purpose of analysis. The solution of structures is sundered simple once the inflection points are located. The loading cases are arising in multistoried frames namely horizontal and vertical loading. The analysis carried out separately for these two cases.

Horizontal cases:

The behavior of a structure subjected to horizontal forces depends upon its heights to width ratio among their factor. It is necessary ti differentiate between low rise and high rise frames in this case.

Low rise structures:

Height < width

It is characterized predominately by shear deformation.

High rise buildings

Height > width

It is dominated by bending action

Matrix analysis of frames:

The individual elements of frames are oriented in different directions unlike those of continues beams so their analysis is more complex, never the less the rudimentary flexibility and stiffness methods are applied to frames stiffness method is more useful because its adaptability to computer programming stiffness method is used when degree of redundancy is greater than degree of freedom. However, stiffness method is used degree of freedom is greater than degree of redundancy especially for computers.

DESIGN OF MULTI STORIED RESIDENTIAL BUILDING:

A structure can be defined as a body which can resist the applied loads without appreciable deformations.

Civil engineering structures are created to serve some specific functions like human habitation ,transportation, bridges ,storage etc. in a safe and economical way. A structure is an assemblage of individual elements like pinned elements (truss elements),beam element ,column, shear wall slab cable or arch. Structural engineering is concerned with the planning, designing and thee construction of structures. Structure analysis involves the determination of the forces and displacements of the structures or components of a structure. Design process involves the selection and detailing of the components that make up the structural system.

The main object of reinforced concrete design is to achieve a structure that will result in a safe economical solution.

- The objective of the design is
- Foundation design
- Column design
- Beam design
- Slab design

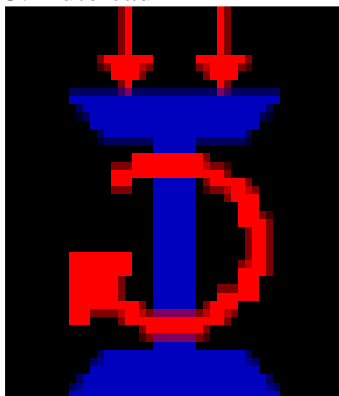
These all are designed under limit state method

SOFTWARE'S

This project is mostly based on software and it is essential to know the details about these software's.

List of software's used

1. Staad pro(v8i)
2. Staad foundations 5(v8i)
3. Auto cad



STAAD pro



Auto Cad

Foundations

STAAD:

Staad is powerful design software licensed by Bentley .Staad stands for structural analysis and Design any object which is stable under a given loading can be considered as structure. So first find the outline of the structure, where as analysis is the estimation of what are the type of loads that acts on the beam and calculation of shear force and bending moment comes under analysis stage. Design phase is designing the type of materials and its dimensions to resist the load. This we do after the analysis.

To calculate S.F.D and B.M.D of a complex loading beam it takes about an hour. So when it comes into the building with several members it will take a week. Staad pro is a very powerful tool which does this job in just an hour's STAAD is a best alternative for high rise buildings. Now a days most of the high rise buildings are designed by STAAD which makes a compulsion for a civil engineer to know about this software. These software can be used to carry rcc ,steel, bridge , truss etc according to various country codes.

Alternatives for STAAD:

struts, robot, sap, adds pro which gives details very clearly regarding reinforcement and manual calculations. But these software's are restricted to some designs only where as STAAD can deal with several types of structure.

2.2 STAAD Editor:

STAAD has very great advantage to other software's i.e., STAAD editor. STAAD editor is the Programming For the structure we created and loads we taken all details are presented in programming format in STAAD editor. This program can be used to analyze another structures also by just making some modifications, but this require some programming skills. So load cases created for a structure can be used for another structure using STAAD editor.

STAAD foundation:

STAAD foundation is a powerful tool used to calculate different types of foundations. It is also licensed by Bentley software's. All Bentley software's cost about 10 lakhs and so all engineers can't use it due to heavy cost. Analysis and design carried in STAAD and post processing in STAAD gives the load atvarious supports. These supports are to be imported into these software to calculate the footing details i.e., regarding the geometry and reinforcement details.

This software can deal different types of foundations

SHALLOW (D<B)

- Isolated (Spread) Footing
- Combined (strip) Footing
- Mat (raft) Foundation

DEEP (D>B)

1. Pile Cap
2. Driller Pier

1. Isolated footing is spread footing which is common type of footing.
2. Combined Footing or Strap footing is generally laid when two columns are very near to each other.
3. Mat foundation is generally laid at places where soil has less soil bearing capacity.
4. pile foundation is laid at places with very loose soils and where deep excavations are required.

So depending on the soil at type we has to decide the type of foundation required.

Also lot of input data is required regarding safety factors, soil, materials used should be given in respective units.

After input data is give software design the details for each and every footing and gives the details regarding

1. Geometry of footing
2. Reinforcement

3. Column layout

4. Graphs

5. Manual calculations

These details will be given in detail for each and every column.

Another advantage of foundations is even after the design; properties of the members can be updated if required.

The following properties can be updated

- Column Position
- Column Shape
- Column Size
- Load Cases
- Support List

It is very easy deal with this software and we don't have any best alternative to this.

AutoCAD:

AutoCAD is powerful software licensed by auto desk. The word auto came from auto desk company and cad stands for computer aided design. AutoCAD is used for drawing different lay outs, details, plans, elevations, sections and different sections can be shown in auto cad.

It is very useful software for civil, mechanical and also electrical engineer. The importance of this software makes every engineer a compulsion to learn this software's. We used AutoCAD for drawing the plan, elevation of a residential building. We also used AutoCAD to show the reinforcement details and design details of a stair case. AutoCAD is a very easy software to learn and much user friendly for anyone to handle and can be learn quickly. Learning of certain commands is required to draw in AutoCAD

PLAN AND LOADINGS

PLAN:

The auto cad plotting no.1 represents the plan of a g+8 building. The plan clearly shows that it is

a combination of four apartments. We can observe there is a combination between each and every apartments.

In each block the entire floor consists of a double-bed room house which occupies entire floor of ablock. It represents a rich locality with huge areas for each house. It is a g+8 proposed building.

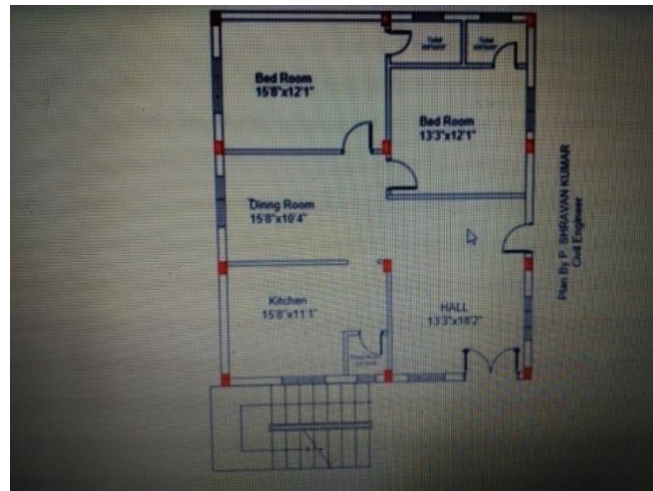
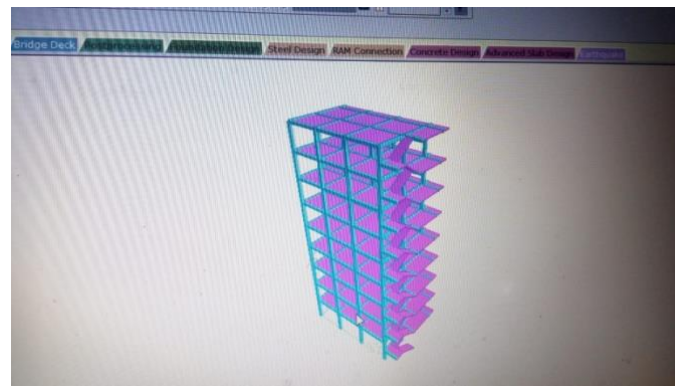
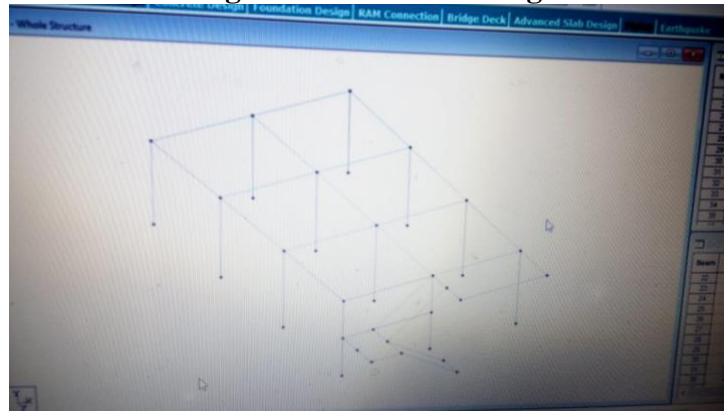


Fig.: 3.1. Plan of building



3.2. LOAD CONDITIONS AND STRUCTURAL SYSTEM RESPONSE:

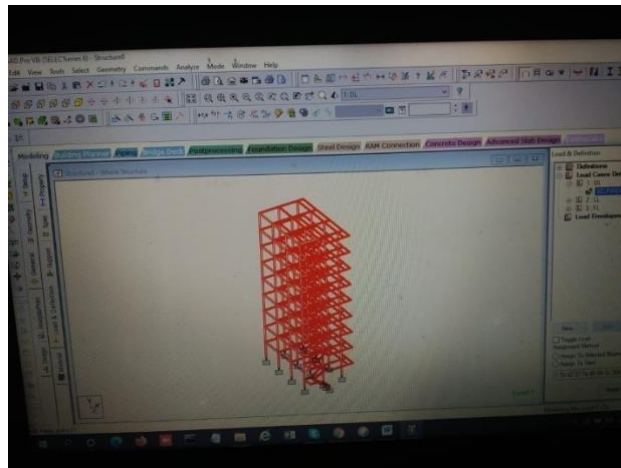
The concepts presented in this section provide an overview of building loads and their effect on the structural response of typical wood-framed homes. As shown in Table, building loads can be divided into types based on the orientation of the structural action or forces that they induce: vertical and horizontal (i.e., lateral) loads. Classification of loads are described in the following sections.

Design loads for residential buildings :

Dead Loads:

Dead loads consist of the permanent construction material loads compressing the roof, floor, wall, and foundation systems, including claddings, finishes and fixed equipment. Dead load is

the total load of all of the components of the components of the building that generally do not change over time, such as the steel columns, concrete floors, bricks, roofing material etc. In STAAD pro assignment of dead load is automatically done by giving the property of the member. In load case we have option called self weight which automatically calculates weights using the properties of material i.e., density and after assignment of dead load the skeletal structure looks red in color as shown in the figure.



Example for calculation of dead load

Dead load calculation:

Weight=Volume x Density

Self weight floor finish= $0.12 \times 25 + 1 = 3 \text{ kn/m}^2$

The above example shows a sample calculation of dead load.

• **Live Loads:**

Live loads are produced by the use and occupancy of a building. Loads include those from human occupants, furnishings, no fixed equipment, storage, and construction and maintenance activities. As required to adequately define the loading condition, loads are presented in terms of uniform area loads, concentrated loads, and uniform line loads. The uniform and concentrated live loads should not be applied simultaneously in a structural evaluation. Concentrated loads should be applied to a small area or surface consistent with the application and should be located or directed to give the maximum load effect possible in endues conditions. For example. The stair load of 300 pounds should be applied to the center of the stair tread between supports.

In STAAD we assign live load in terms of U.D.L .we has to create a load case for live load and select all the beams to carry such load. After the assignment of the live load the structure appears as shown below.

For our structure live load is taken as **25 N/mm** for design.

Live loads are calculated as per **IS 875 part 2**

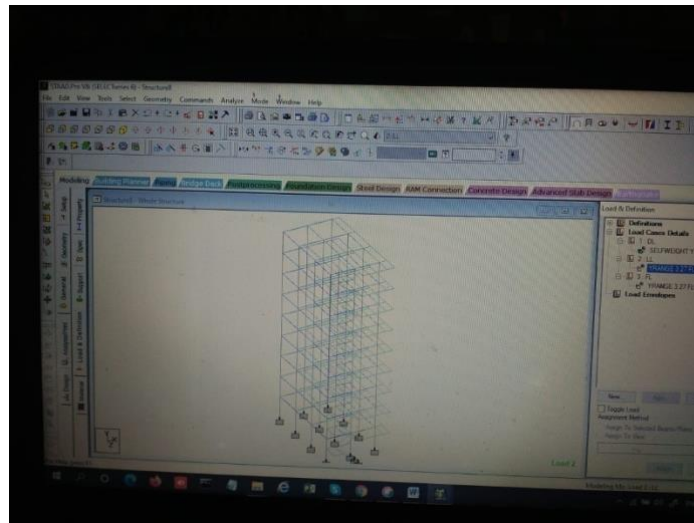
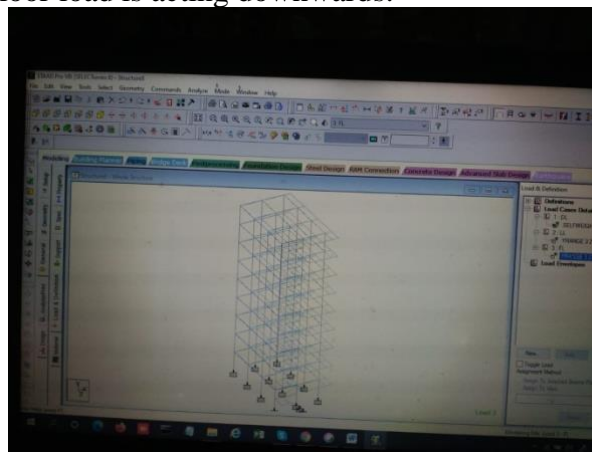


Diagram of live load

- **Floor load:**

Floor load is calculated based on the load on the slabs. Assignment of floor load is done by creating a load case for floor load. After the assignment of floor load our structure looks as shown in the below figure.

The intensity of the floor load taken is: **0.0035 N/mm²**
-ve sign indicates that floor load is acting downwards.



SFD and BMD:

The Shear Force Diagram (SFD) and Bending Moment Diagram(BMD) of a beam shows the variation of shear force and bending moment along the length of the beam.

These diagrams are extremely useful while designing the beams for various applications.

a shear force F , which is defined as the algebraic sum of all vertical forces either to the left or to the right hand side of a section.

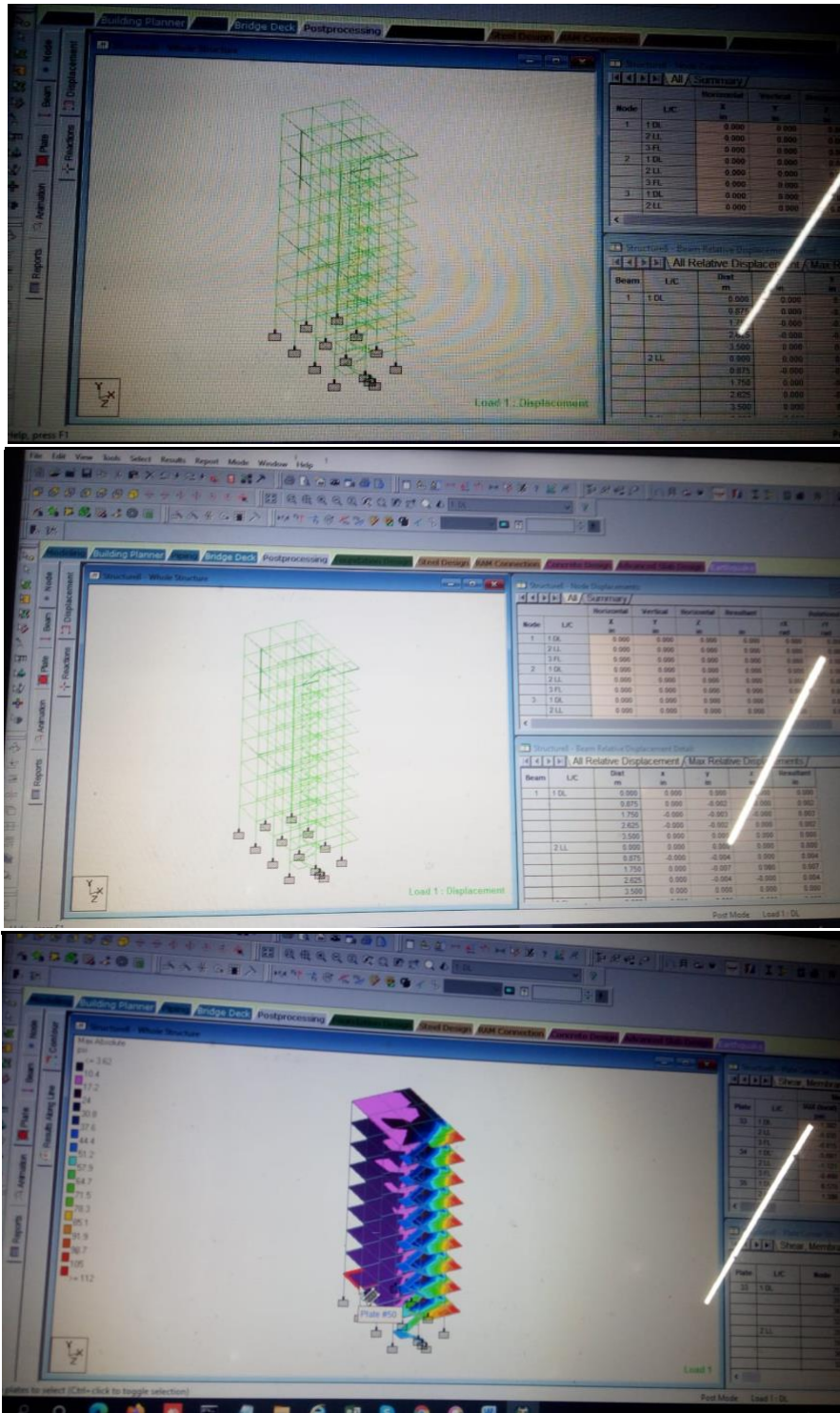
a bending moment M , which is defined as the algebraic sum of the moments of all vertical forces either to the left or to the right of a section

SFD(Shear force diagram)

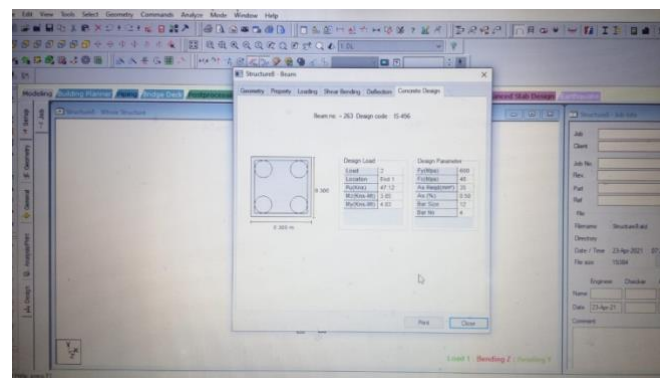
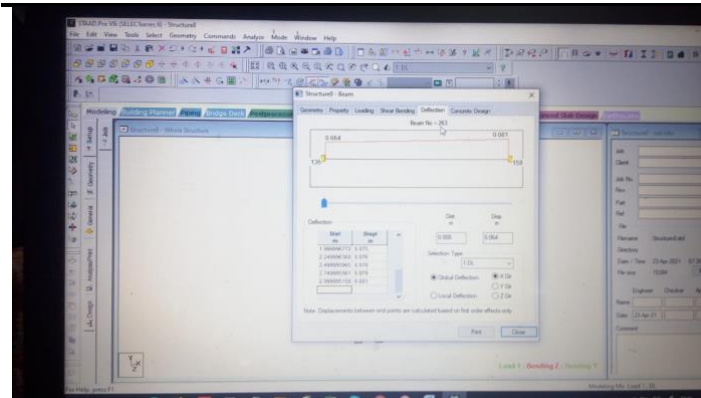
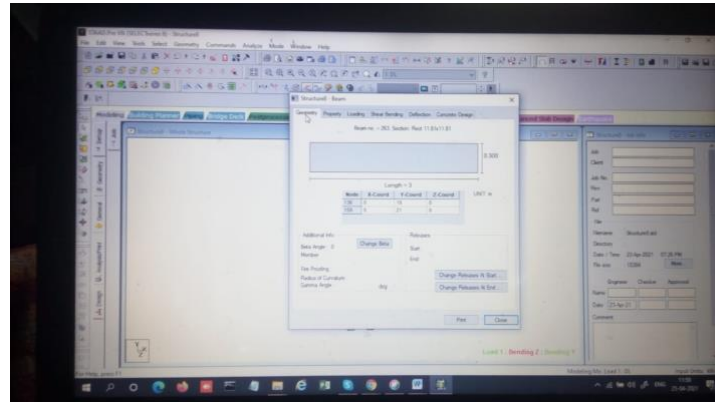
A shear force diagram is the graphical representation of the variation of shear force along the length of the beam and is abbreviated as S.F.D.

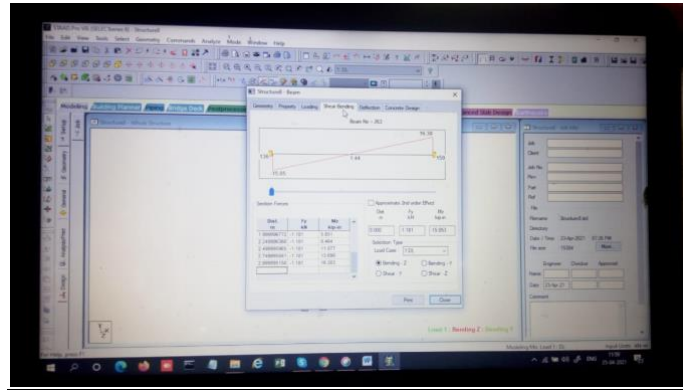
BMD(Bending moment diagram)

A bending moment diagram is the graphical representation of the variation of the bending moment along the length of the beam and is abbreviated as B.M.D.



RESULT





VT = -10.44 Mx = 0.01 LD= 2
Provide 2 Legged 61 @ 110 mm c/c

BEAM NO. 11 DESIGN RESULTS

M40 Fe600 (Main) Fe600 (Sec.)
LENGTH: 3500.0 mm DISE: 230.0 mm X 300.0 mm COVER: 25.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	875.0 mm	1750.0 mm	2625.0 mm	3500.0 mm
TOP REINF. (Sq. mm)	87.98	0.00	0.00	0.00	87.98
BOTTOM REINF. (Sq. mm)	0.00	87.98	87.98	87.98	0.00

STAD SPACE PAGE 11 End of Page -- PAGE NO. 11

SUMMARY OF PROVIDED REINF. AREA

COLUMN NO. 15 DESIGN RESULTS

M40 Fe600 (Main) Fe600 (Sec.)
LENGTH: 3000.0 mm CROSS SECTION: 300.0 mm X 300.0 mm COVER: 40.0 mm
** QUINCE LOAD CASE: 1 END JOINT: 15 BRIST COLUMN

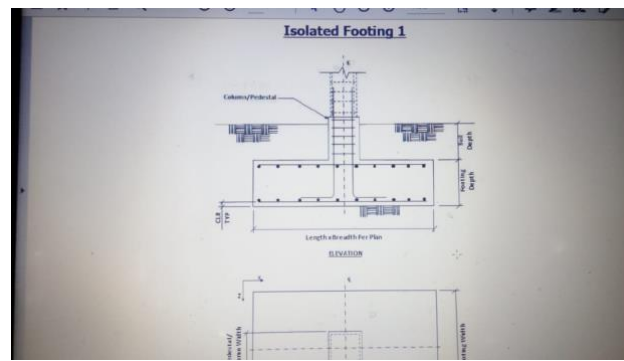
REQD. STEEL AREA : 236.07 Sq.mm.
REQD. CONCRETE AREA: 23058.41 Sq.mm.
MAIN REINFORCEMENT : Provide 4 - 12 dia. (9.50%, 452.39 Sq.mm.)
(Equally distributed)
TIE REINFORCEMENT : Provide 8 mm dia. rectangular ties @ 150 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNO-MET)
Pux : 1721.98 Muex : 61.15 Muyl : 61.15

INTERACTION RATIO: 0.25 (see per cl. 39.4, 28434(2000))

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNO-MET)
WORST LOAD CASE: 1
END JOINT: 15 Pux : 1815.43 Muex : 74.14 Muyl : 74.14 (81.02)

STAD SPACE PAGE 124 End of Page -- PAGE NO. 124



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ENGINEERDATE23-Apr-21

ENDJOBINFORMATION

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ISOTROPICCONCRETE

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POISSON0.17

DENSITY23.6158

ALPHA5e-006

DAMP0.05

TYPECONCRETE

STRENGTHFCU27578.9

ENDDEFINEMATERIAL

MEMBERPROPERTY

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74TO75858699TO101104TO106109TO111114TO116126127140 -

141TO142145TO147150TO152155TO157167168181TO183186 -

187TO188191TO193196TO198208209222TO224227TO229232 -

233TO234237TO239249250263TO265268TO270273TO275278 -

279TO280290291304TO306309TO311314TO316319TO321331 -

332345TO347350TO352355TO357360TO362372 -

373PRISYD0.3ZD0.3

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144148149153154158TO166169TO180184185189190194195 -

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CONSTANTS

MATERIALCONCRETEALL

SUPPORTS

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SELFWEIGHTY-1LISTALL

LOAD2LOADTYPELiveTITLLELL

FLOORLOAD

YRANGE327FLOAD-3.5GY

LOAD3LOADTYPERoofLiveTITLLEFL

FLOORLOAD

YRANGE327FLOAD-1.5GY

PERFORMANALYSIS

STARTCONCRETEDESIGN

CODEINDIAN

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FYSEC600000ALL

FYMAIN600000ALL

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373

DESIGNELEMENT33TO3646TO55385TO398400TO413415TO428430 -

431TO443445TO458460TO473475TO488490TO503

ENDCONCRETEDESIGN

PERFORMANALYSIS

FINISH

CONCLUSIONS

1. Planning, analysis and design of G+8 multi-storey residential building was done.
2. It's a G+8 storied building and the rest of the floors are occupied with Flats.
3. All the structural components were designed manually and detailed using AutoCAD.
4. The analysis and design were done according to standard specifications using STAAD.Pro for static and dynamic loads.
5. The dimensions of structural members are specified and the loads such as dead load, live load and wind load are applied.
6. Deflection and shear tests are checked for beams, columns and slabs. The tests proved to be safe.
7. Both theoretical and practical work has been done.
8. Hence, I conclude that we can gain more knowledge in practical work when compared to theoretical work.

REFERENCES:

1. Dr. S.R. Karve & Dr. V.L. Shah - "**Illustrated design of Reinforced concrete Buildings**"
2. 3.Reinforced concrete Structures by A.K. Jain and B.C. Punmia for design of beams, columns and Slab.
3. Fundamentals of Reinforced concrete structure by N. C. Sinha.
4. Reinforced Concrete Vol 1 DR.H.J.SHAH
5. IS 456-2000 code book for design of beams, columns and slabs
6. SP-16 for design of columns.