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ANALYSIS AND DESIGN OF RESIDENTIAL (G+4) BUILDING USING SOFTWARES

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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 Revit and staad pro.The Revit software used for the 3D modeling of the building

Key Words: Design, Analysis, Residential Building, Auto Cad, Autodesk Revit, Staad Pro

1. INTRODUCTION

A Building is a structure with a roof and walls standing more or less permanently in one place, such as a House or Factory. Buildings constructed in a variety of sizes, shapes and functions from building materials available. Buildings serve several societal needs primarily as shelter from weather, security, living space, privacy, to store belongings, and to comfortably live and work. There are several types of buildings based on their purpose of use

Residential Buildings

These building include any building in which sleeping accommodation provide for normal residential purposes, with or without cooking and dining facilities. It includes single or multi-family dwellings, apartment houses, lodgings or rooming houses, restaurants, hostels, dormitories and residential hostels.

Educational Buildings

These include any Building used for school, college or day-care purpose involving assembly for instruction, education, education or recreation and which in not covered by assembly buildings.

Institutional Buildings

These buildings are used for different purposes, such as medical or other treatment or care of persons suffering from physical or mental illness, diseases or infirmity, care of infants, con-valescents or aged persons and for penal detention in which the liberty of the inmates is restricted. Institutional buildings ordinarily provide sleeping accommodation.

Assembly Buildings

These are the buildings where groups of people meet or gather for amusement, recreation, social, religious, assembly halls, city halls, marriage halls, exhibition halls, museums, places of work ship, etc.

Business Buildings

These buildings are used for transaction of business, for keeping of accounts and records and for similar purposes, offices, banks, professional establishments, courts houses, libraries. The principal function of these buildings is transaction of public business and keeping of books and records.

Industrial Buildings

These are buildings where products or materials of all kinds and properties are fabrication, assembled, manufactured or processed, as assembly plant, laboratories, dry cleaning plants, power plants, pumping stations, smoke houses, laundries etc.

Store Buildings

These buildings are used primarily for the storage or sheltering of goods, wares or merchandise vehicles and animals, as ware houses, cold storage, garages, trucks. In this Project a Residential building is designed. Residential Buildings

are can be constructed based on the size of the site and Economy of the people such as High class, Middle class and Low-class people. In this project a Residential Building facilitated with all required rooms such as living room, Kitchen etc. with required plot size is designed.2

2. LITERATURE REVIEW

Ramesh(2001) , " Design And Analysis (G+5) Of Residential Building ".They Modeled The Structure Through The Rivet Software And Designed In The Robot Structural Analysis. They Presented The Results And Calculations On The Columns,Finally They Concluded The Structure Was Planned According To Building Bye Laws And Principles Of Planning.

Aman(20007), ," Analysis And Design Of Multi Storey Building By Using STAAD Pro ".They Modeled The C+G+5 Residential / Commercial Building In Staad Pro. They Focused On The Structural Members I.E.., Slabs (One- Way And Two-Way Slab); Beams (Single And Double), Columns; Footings; Staircases. They Concluded Short Term Deflection Of All Horizontal Members Is With In 20mm. The Structural Components Of The Buildings Are Safe In Shear And Flexure.

Deshmukh(2012), , " Analysis And Design Of G+19 Storied Building Using Staad Pro ".They Designed The G+19 Storied Building(High Rise Building) Analysed Through The Staad Pro. They Showed The Results Of Shear Force And Bending Moment, Deflections And Presented The Deflection Graphs On Between Height Of Each Storey. In There Paper They Consider The Loads Of Seismic Loads, Dead Load, For Structure. Finally They Concluded Staad Pro Has Capability To Calculate Reinforcement Needed For Any Cocrete Section,To Find Lateral Deflection Due To Earth Quake Load.

Kunalwalker(2013), ,"Design And Analysis Of Residential Building Using Staad Pro". They Did The Structural Design Involves Various Stages Such As Computation Ofloads, member design, detailing and many more. They focussed on the softwares like AutoCAD for Planning, Staad Pro for Designing. Finally, They concluded the structural elements of buildings with proposed dimensions and compared by the manual design and geometrical model using Staad Pro.

Siva Naga Kanya(2013),. " Design and Analysisof RCC Framed Structure (G+5) by using Staad Pro ". Objective of there project is to Design and Analysis on the wind and seismic forces on G+5 Multistorey Building. They presented the manual calculations for the structural members and the anlysis was done in Staad Pro Software. Finally, they compared the area of steel reinforcement values to the software analysis on the structural component

Nagasai et al. (2014), "Planning, Analysis and Design of Residential Building (G+5) By using STAAD Pro." This paper deals with Frame analysis, which was done by STAAD.pro. Slab and beams were designed as per IS code 456-2000. The properties such as shear, deflection, development, torsions are defined by the IS code provisions.

Falak Vats (2016), "Review paper on design and analysis of multi-storey building by the use of Stadd.Pro," He concluded that Stadd.Pro provides a much faster approach to structural analysis and design with a chances of minimum errors. There has been several research conducted comparing the results from Stadd.Pro to the manually calculated results, which all support the use of Stadd.Pro over manual the one. Stadd.Pro is a much better way to analyse complicated load combinations and is quite versatile.

Sowrav Saha, et al. (2017), "Design and Analysis of Multistorey (G+14) Residential Building Using Staad.Pro & Autocad" The aim of their project was to bring an idea to plan, through analysis and design of a multi-storeyed, earthquake resistant residential building. They were unsuccessful in fully completing the project in a successful and efficient manner by considering all the relevant features given.

Amar Hugar et al. (2018), has been discussed that the Computer Aided Design of Residential Building involves scrutiny of building using STAAD.Pro and a physical design of the structure. Traditional method of study show tedious calculations, and such tests are time consuming task. Analysis is made quickly by using software. This project completely deals with scrutiny of the building using the software STAAD.Pro. Finally, the results are compared with physical calculations. The elements are created as per IS:456-2000.

Bandipati Anup et al. (2019), this paper deals with evaluating and planing a multi-storeyed building [G + 2 (3-dimensional frame)] adopting STAAD Pro. The technique used in STAAD.Pro is limit state technique. Initially they have created 2-D frames and cross checked with manual calculations. They tested and created a G + 2 storey building [2-D Frame] instantly for all feasible load combinations. The work has been finished with some more multi-storyed 2-Dimensional and 3- Dimensional frames beneath various load combinations.

Bute, et al. (2021), – "Design a detailed 3D model of a building With the comparison of manual and Software estimates on Autodesk revit", they concluded for the uses of scheduling and cost estimating in Autodesk Revit

respectively, and provided a case study to show how Autodesk Revit can work for Architects, Engineers and contractors. As well as comparing Autodesk Revit Estimate with Manual Estimate.

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Jinendra Ralekar,DhanashreeWalke,"Design and Analysis of Residential Building Using Staad Pro". They did the Structural Design involves various stages such as computation ofloads, member design, detailing and many more. They focussed on the softwares like AutoCAD for Planning, Staad Pro for Designing. Finally, They concluded the structural elements of buildings with proposed dimensions and compared by the manual design and geometrical model using Staad Pro.

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Planing through AutoCAD

Introduction: Auto CAD 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, 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. Use of AutoCAD has drastically reduced the drafting time when done manually thus saving time which can be used in other productive work.

Planning Dimensions

1. Total Floor Size= 77'2" x 52'
2. Each floor having 4 flats.
3. Flat size= 42'6" x 52' Each flat contains the dimensions
4. Hall =19'1.5"x 12'10.5"
5. Guest room = 14'6"x10'10.5"
6. Kitchen = 9'6"x13'3"
7. Balcony = 4'0"
8. Master Bed Room=14'6"x11'9"
9. Bath Room = 6'4" x 11'0"

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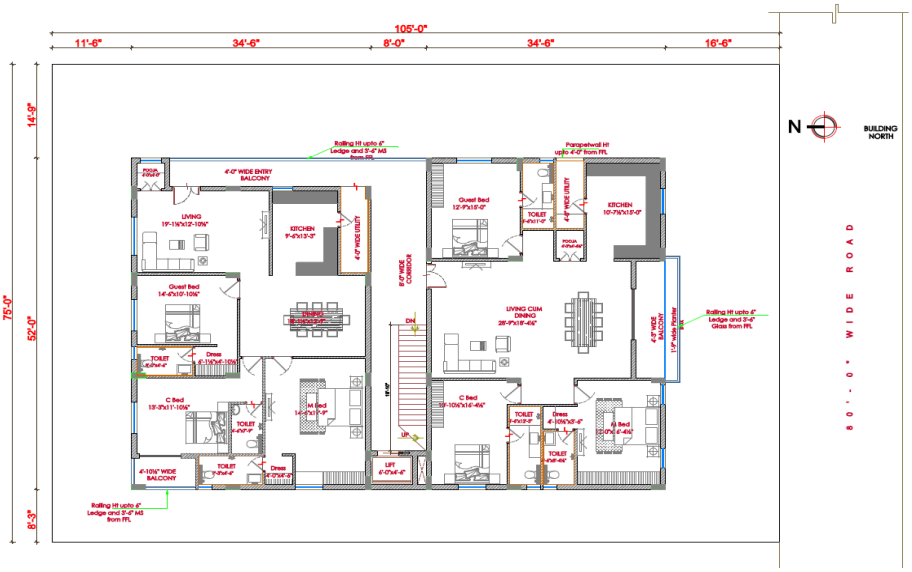
AutoCAD Planing



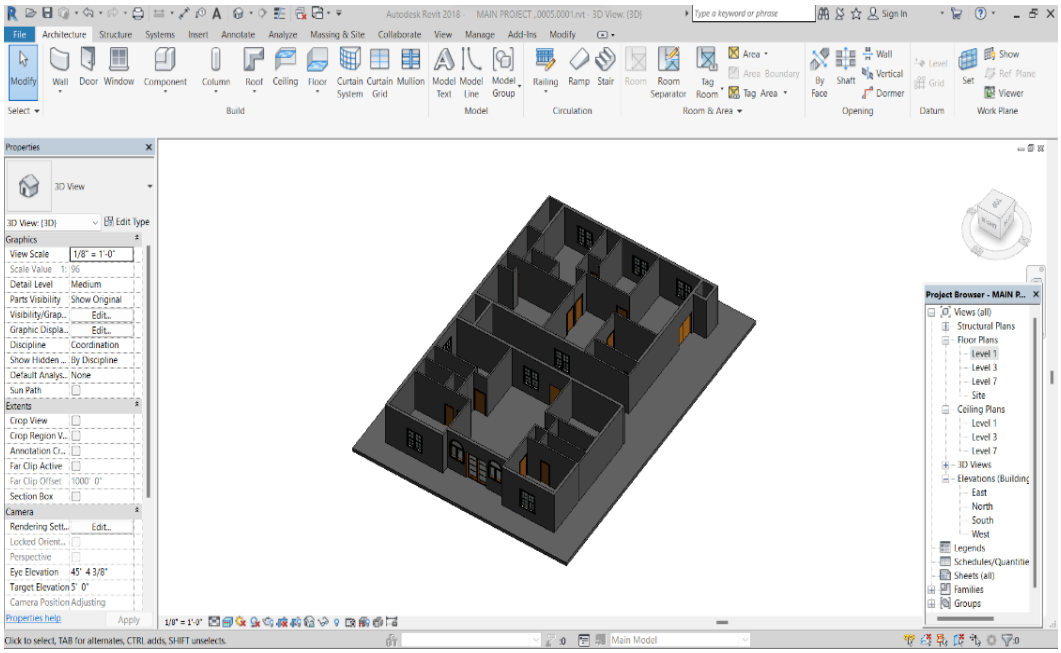
Modelling through AutoDesk REVIT

Introduction

Autodesk Revit is considered as one of the famous software of 3D BIM modelling. It provides a complete environment for 3D modelling in architecture design, MEP, structure design, and construction. Autodesk Revit is a building information modelling software for architects, landscape architects, structural engineers, mechanical, electrical and plumbing (MEP) engineers, designers and contractors. The original software was developed by Charles River Software, founded in 1997, renamed Revit Technology Corporation in 2000, and acquired by Autodesk in 2002. The software allows users to design a building and structure and its components in 3D , annotate the model with 2D drafting elements, and access building information from the building model's database. Revit is 4D building information modelling capable with tools to plan and track various stages in the building's lifecycle, from concept to construction and later maintenance and/or demolition.

Revit Structure:

- Creating a Project
- Adding Grids
- Adding Columns
- Adding Beams
- Adding Footing



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Walls

Standard size of a wall-residential building outer walls will be 9inches (230mm). For interior partition walls will be 4.5inches (120mm).

Doors

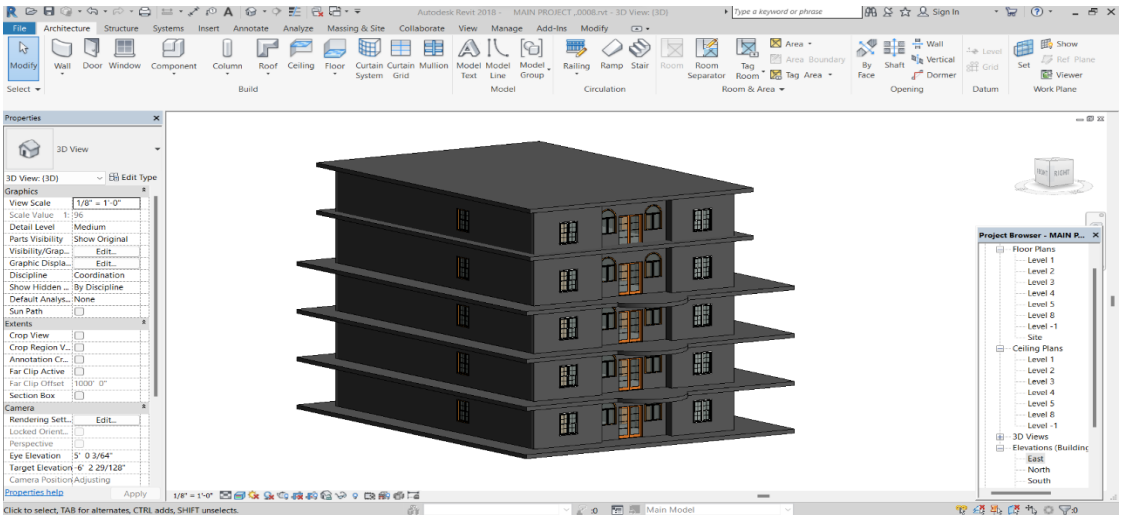
Main entrance door of a residential building should be 1000 mm x 2100 mm in size. Other doors should have a minimum width of 900 mm and a height of 2000 mm. Doors for the garage are 2500 mm x 2300 mm and for W.C. and bathrooms are 600 mm to 750 mm x 1800 mm with the single – leaf shutter.

Windows

The main purpose of windows is to give a proper amount of air circulation and ventilation to the closed enclosure. Also, the size of the window depends upon the room and also the location of the room according to the wind direction follow in the plot region.

Staircase

Staircase is used in building for moving from ground floor to upper floor. Staircase have many component like riser, tread, flight, landing etc.



Analysis and Design of through STAAD PRO

Introduction

Staad Pro stands for Structural Analysis and Designing Program STAAD or (STAAD. Pro) is a structural analysis and design software application originally developed by Research Engineers International in 1997. In late 2005, Research Engineers International was bought by Bentley Systems. STAAD. Pro is one of the most widely used structural analysis and design software products worldwide. It can apply more than 90 international steel, concrete, timber

and aluminium design codes. STAAD can be used for analysis and design of all types of structural projects from plants, buildings, and bridges to towers, tunnels, metro stations, water/wastewater treatment plants and more.

Design of Loads

Live load

In IS 875 -1987 part-II, for Residential building live load value is 2 KN/m2 so, we considered

live load value as 2 KN/m2.

Floor finish=1 KN/m2.

Wind load

As per IS 875 -1987 part -III , we calculated the wind load values for several heights

Dead loads:

Unit weight of the concrete : 25 KN/m3

Unit weight of the brick : 20 KN/m3

Self-weight of the critical beam : 2.013 KN/m

Self-weight of the column : 4.5 KN/m

Self-weight of the slab : 3.125 KN/m

Floor finish : 1 KN/m2

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DESIGN CRITERIA:

Concrete grade : M30 N/mm2

Steel grade : Fe 415 N/mm2 for beam & slab

Fe 500 N/mm2 for column

Wind effect is not considered

Earthquake effect is considered

Member sizes:

Beam : 230X300 mm & 300X350 mm

Column : 300X600 mm & 600X300 mm

Slab thickness : 125mm

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

Analysis and design of Building

STEP 1: Creation of nodal points. Based on the column positioning of plan we entered the node points into Staad file.

STEP 2: Representation of beams and coloumns.by using add beam command we had drawn the beams and columns between the corresponding node points.

STEP 3: 3 D view of structure. Here we have used the transitional repeat command in y direction to get the 3 D view of structure.

STEP 4: supports and property assigning .after the creation of structure the supports at the base of structure are specified as fixed. Also the materials were specified and cross section of beam and columns members was assigned.

STEP 5: assigning of dead loads.

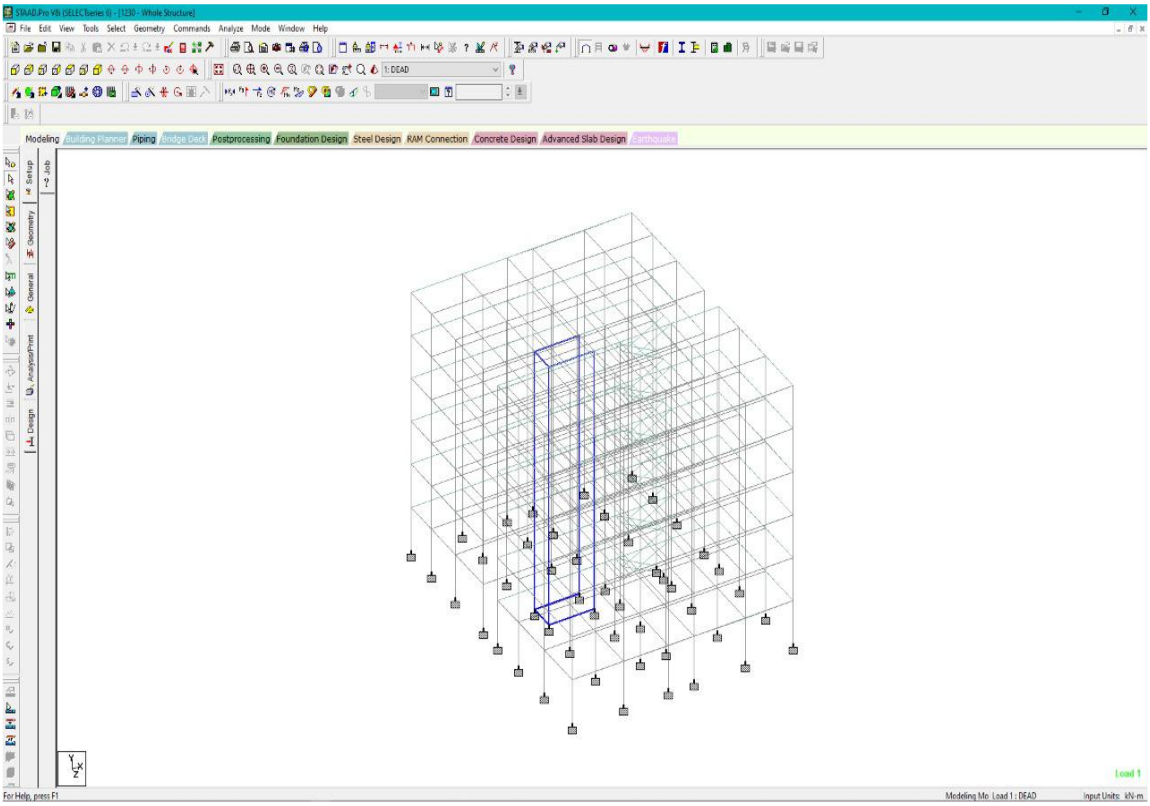
STEP 6: assigning of live loads.

STEP 7: assigning of wind loads.

STEP 8: adding of load combinations.

STEP 9: ANALYSIS after completion of all the above steps we have performed the analysis and checked for errors.

STEP 10: DESIGN finally concrete design is performed with suitable design commands for different structural components. After the assigning commands again we perform analysis for any errors.



Structure

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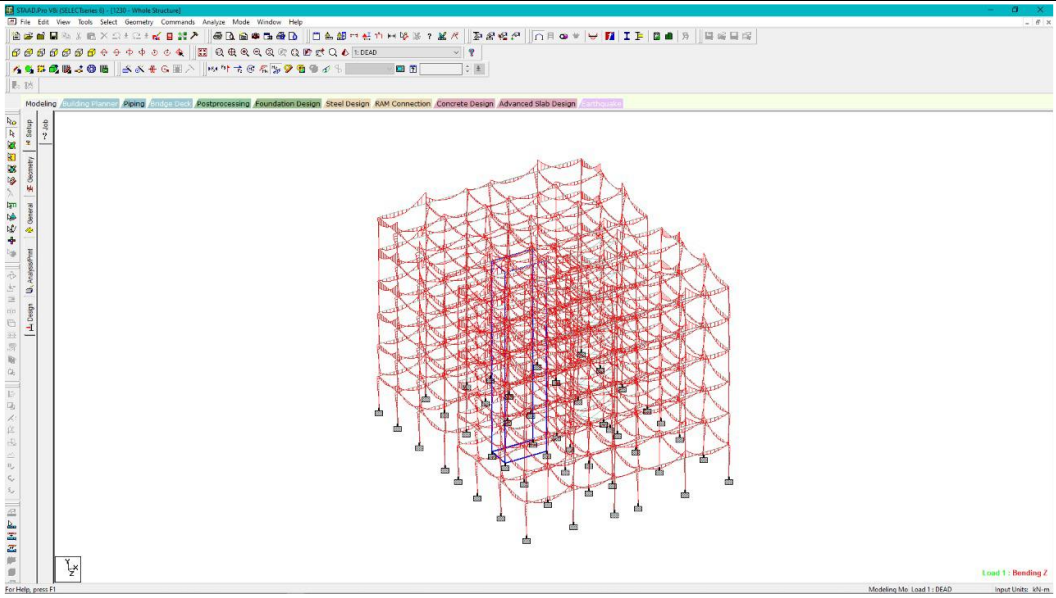
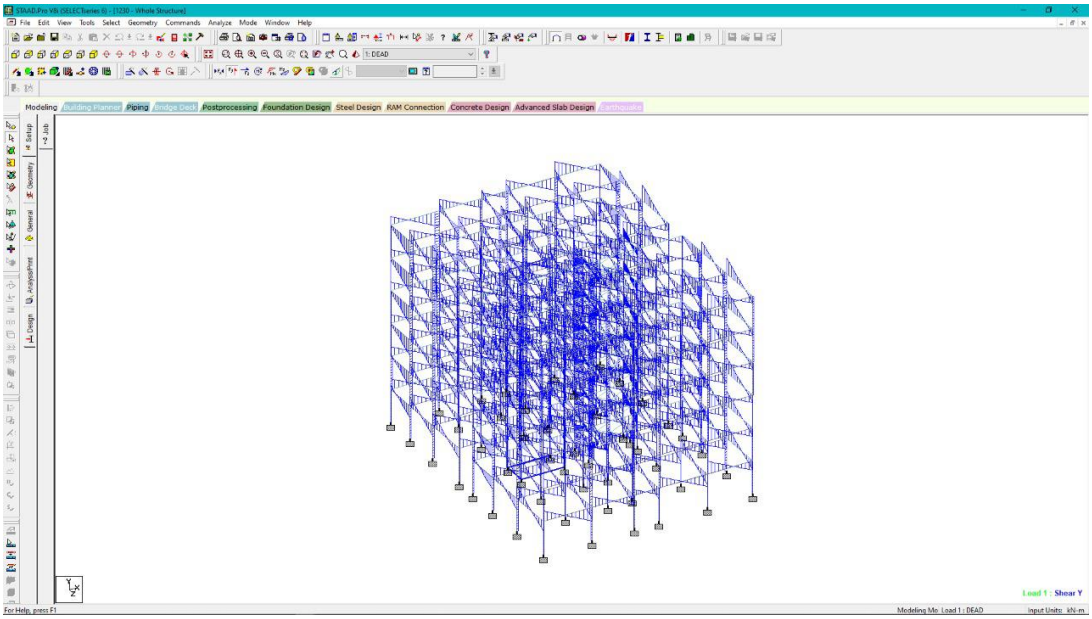
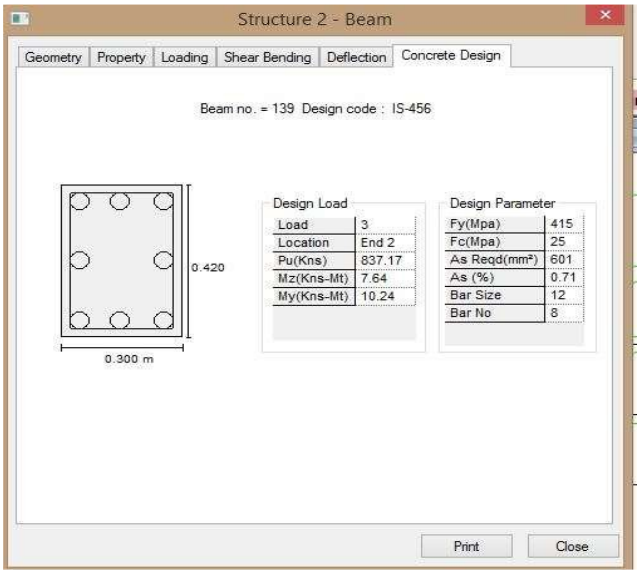
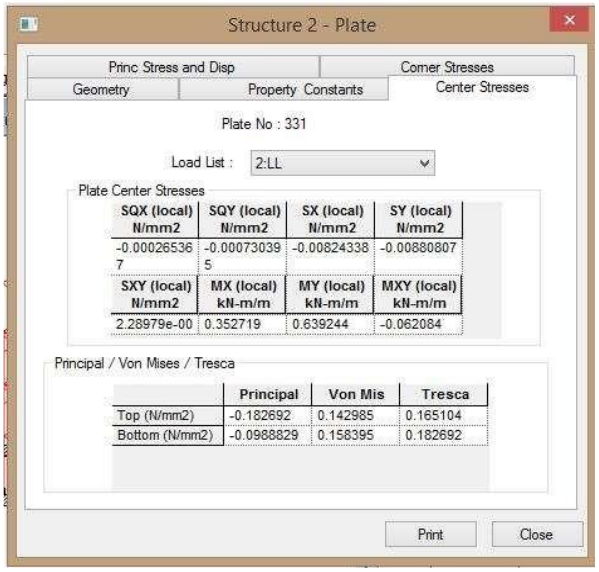


Bending moment Diagram



Shear Force Diagram





Concrete design of column Design details of slab

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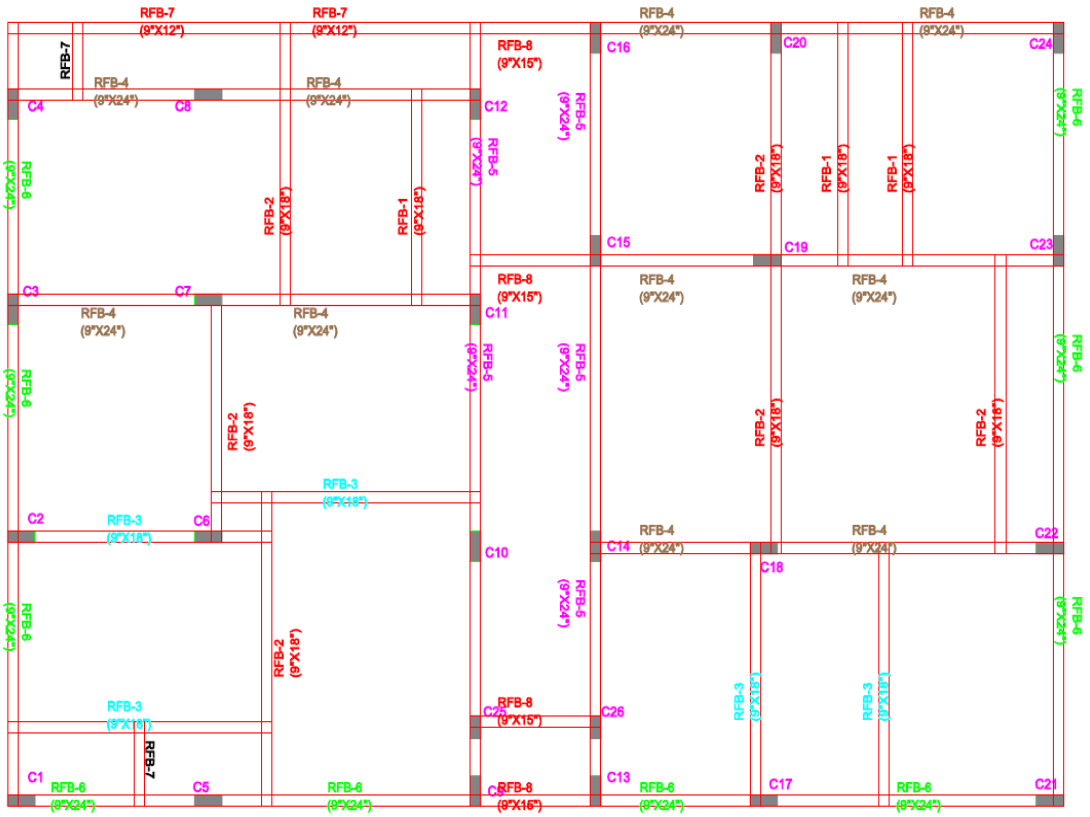
COLUMN REINFORCEMENT DETAILS

S.NO	MARK	SIZE a	SIZE b	COL- SEC.	MAIN BARS (STILT,GF,FF)	MAIN BARS (SF,TF)	TIES
1	C 2 C 3 C 5 C6 C 7 C 8 C 10 C 11 C 14 C 15 C 17 C 18 C 19 C 20 C 22 C 23	9"	24"	24" x 9"	8 - Y 20 300 MM	4 - Y 16 + 4 - Y 20 300 MM	Y8 - 7" C/C
2	C 1 C 4 C 9 C 12 C 13 C 16 C 21 C 24	9"	24"	24" x 9"	4 - Y 16 + 4 - Y 20 300 MM	8 - Y 16 300 MM	Y8 - 6" C/C
3	C 25 C 26	9"	18"	18" x 9"	6 - Y 16 300 MM	6 - Y 16 300 MM	Y8 - 8" C/C

COLUMN REINF. DETAILS



ROOF BEAM LAYOUT

N

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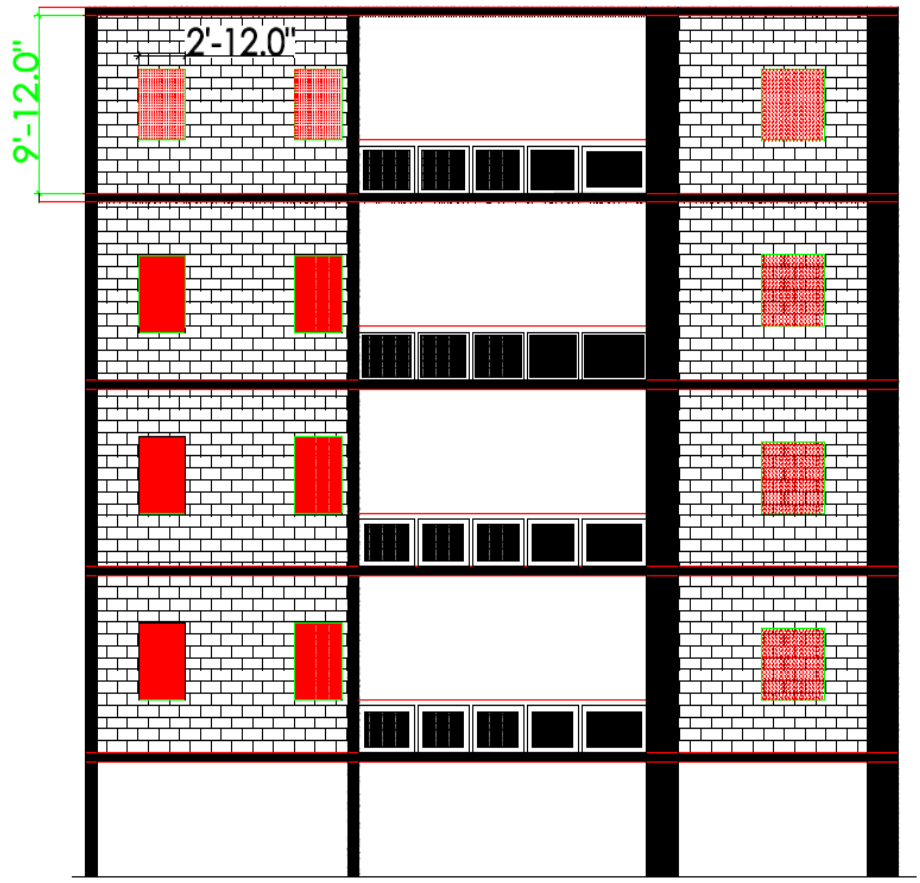

Design for Flexure:

Maximum sagging (creating tensile stress at the bottom face of the beam) and hogging (creating tensile stress at the top face) moments are calculated for all active load cases at each of the above mentioned sections. Each of these sections are designed to resist both of these critical sagging and hogging moments. Where everthe rectangular section is inadequate as singly reinforced section, doubly reinforced section istried.

Design for Shear:

Shear reinforcement is calculated to resist both shear forces and torsionalmoments. Shear capacity calculation at different sections without the shear reinforcement is based on the actual tensile reinforcement provided by STAAD program. Two-legged stirrups are provided to take care of the balance shear forces acting on these sections.

Beam Design Output:

The default design output of the beam contains flexural and shear reinforcement provided along the length of the beam.

Column Design:

Columns are designed for axial forces and biaxial moments at the ends. All active load cases are tested to calculate reinforcement. The loading which yield maximum reinforcement is called the critical load. Column design is done for square section. Square columns are designed with reinforcement distributed on each side equally for the sections under biaxial moments and with reinforcement distributed equally in two faces for sections under uni-axial moment. All major criteria for selecting longitudinal and transverse reinforcement as stipulated by IS: 456 have been taken care of in the column design ofSTAAD.

3. CONCLUSIONS

We concluded the Modelling, Analysis and design of G+4 residential building with Revit and staad pro. All aspects of design was while analysing and designing of the structure was done using staad pro. Staad pro has to calculate the reinforcement needed for the any concrete section.

The program contains a number of parameters which are designed as per IS 456 (2000). Beams are designed for shear force bending moment and deflection. Shear variation and moment

variation of the particular beam observed clearly on the building, deflection of a beam observed clearly.

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