ANALYSIS AND DESIGN OF RESIDENTIAL BUILDINGS (G+04) USING STAAD PRO

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ABSTRACT

Structural design is the primary aspect of civil engineering. The foremost basic in structural engineering is the design of simple basic components and members of a building viz. Slabs, Beams, Columns and Footings. In order to design them, it is important to first obtain the plan of the particular building. Thereby depending on the suitability, plan layout of beams and the position of columns are fled. Thereafter, the vertical loads are calculated namely the dead load and live load. Once the loads are obtained, the component takes the load first i.e. the slabs can be designed. Designing of slabs depends upon whether it is a one-way or two-way slab, the end conditions and the loading. From the slabs, the loads are transferred to the beam. The loads coming from the slabs onto the beam may be trapezoidal or triangular. Depending on this, the beam may be designed. In this project work G+4 building, G stands for ground floor, 4 indicates the four floors respectively. Hence G+4 indicate ground floor first floor second floor third floor fourth floor fifth floor headroom, the building consists of 2 flats at each floor level of 1,332 sqft. The total floor area of one floor is 2,664 sqft. The soil bearing capacity (SBC) is considered as 300kn/m2 or 30T/sqm, isolated foundation is used in this project work. The design of G+4 building manually includes design of slabs, beams, columns, footings, staircase The project is about analysis and design of G+4 building by STAAD Pro (V8i) software. The study evaluates critical load cases, including dead loads, live loads, seismic forces (using response spectrum analysis), and wind pressures, while assessing structural behaviour through axial forces, shear forces, bending moments, and torsional effects. Key performance parameters such as inter-story

drift ratios, lateral displacements, and natural vibration modes are analyzed to ensure compliance with safety and serviceability requirements. The design phase emphasizes moment redistribution, shear capacity verification, and ductility, resulting in optimized reinforcement detailing for beams, columns, and shear walls to enhance structural efficiency and resilience. Complicated and high rise structures need very time taking and cumbersome calculations using conventional manual method. STAAD Pro (V8i) provides us a fast, efficient, easy to use and accurate platform for analyzing and designing structures.

1. 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. Nowadays the house building is major work of the social progress of the county. Daily new techniques are being developed for the construction of houses economically, quickly and fulfilling the requirements of the community engineers and architects do the design work, planning and layout, etc., of the buildings. Draughtsman are responsible for doing the drawing works of building as for the direction of engineers and architects. The draughtsman must know his job and should be able to follow the instruction of the engineer and should be able to drawtherequired drawing of the building, site plans and layout plans etc., as for the requirements. 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 loadasper 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. 1.1 Early modern and the industrial age: With the emerging knowledge in scientific fields and the rise of new materials and technology, architecture engineering began to separate, and the architect began to concentrate on aesthetics and the humanist aspects, often at the expense of technical aspects of building design. Meanwhile, the industrial revolution laid open the door for mass production and consumption. Aesthetics became a criterion for the middle class as ornamental products, once within the province of expensive craftsmanship, became cheaper under machine production. Vernacular architecture became increasingly ornamental. House builders could use current architectural design in their work by combining features found in pattern books and architectural journals.

2. PLANNING & DESIGNING

2.1 Structural planning Structural planning is first stage in any structural design. It involves the determination of appropriate form of structure, material to be used, and the structural system, the layout of its components and the method of analysis. As the success of an engineering project is measured in terms of safety and economy, the emphasis today is being more on economy. Structural planning is the first step towards successful structural design. Structural Planning of Reinforced Concrete Framed Building Structural Planning of R.C framed building involves determination of:

- COLUMN POSITIONS
- BEAM LOCATIONS
- SPANNING OF SLABS •

LAYOUT AND PLANNING OF STAIRS •

TYPE OF FOOTING

2.2 Designing: - Designing of structures is an art and science of designing a safe, durable and elegant structure with economy. This not only requires imagination but also a good knowledge of science of designing besides aspects, like the relevant codes and local municipal Bye-laws with experience and judgment. The requirement of safety, serviceability, durability and economy are taken care of by the structural engineer where as the architect looks after the design structure of planning and the aesthetics. Stages in Structural Design The various stages involved in the design can be summarized as: i. Structural planning ii.

Estimation of Loads iii. Analysis of the structure iv. Design of the member v. Drawing of Preparation of schedules

3. PLAN AND ELEVATION

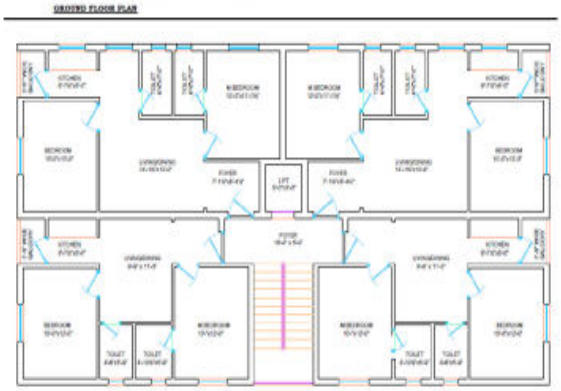
3.1 PLAN DRAWING Plans are a set of drawing or two-dimensional diagrams used to describe a place or object, or to communicate building or fabrication instructions. Usually plans are drawn or printed on paper, but they can take the form of a digital file. A plan is a view of a 3-dimensional object from the position of a horizontal plane through, above or below the object. In such views, the portion of the object in front of the plane is omitted to reveal what lies beyond. In the case of a floor plan, the roof and upper portion of the walls may be omitted. Elevations, top [roof] plans, and bottom plans are orthographic projections, but they are not sections as their viewing plane is outside of the object. A plan is a common method of depicting the internal arrangement of a 3 Dimensional object in two dimensions. It is often used in technical drawing and is traditionally cross-hatched. The style of crosshatching indicates the type of material the section passes through. **3.2 FLOOR PLAN** In architecture and building engineering, a floor plan otherwise known as a Scottish plan is a drawing to scale, showing a view from above, of the relationships between rooms, spaces and other physical features at one level of a structure. Dimensions are usually drawn between the walls to specify room sizes and wall lengths. Floor plans may also include details of fixtures like sinks, water heaters, construction methods, or symbols for electrical items. It is also called a plan which is a measured plane typically project at the floor height of 4 ft. [1.2 m], as opposed to an elevation which is a measured plane projected from the side of a building, along its height, or a section or cross section where a building, is cut along an axis to reveal the interior structure.

3.3 ELEVATION An elevation is a view of a 3-dimensional object from the position of a vertical plane beside an object. In other words, an elevation is a side-view as viewed from the front, back, left or right [and referred to as a front elevation, [left/right] side elevation, and a rear elevation]. It is the corollary to the concept of a “view” [which is always overhead and is therefore referred to as an overhead view]. An elevation is a common method of depicting the external configuration and detailing of a 3-dimensional object in two dimensions. Building facades are shown as elevations in architectural drawing and technical

drawings. Elevations are the most common orthographic projection for conveying the appearance of a building from the exterior. Perspectives are also common used for this purpose. A building elevation is typically labeled in relation to the compass direction it faces; the directions from which a person views it. E.g. the north elevation of a building is the side that most closely faces true north on the compass.

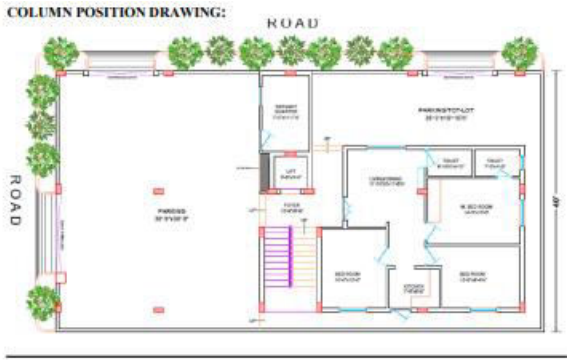
ARCHITECHTURAL PLAN

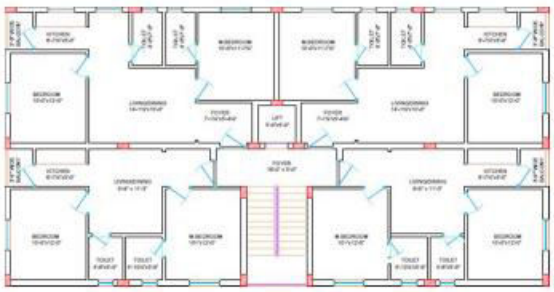
PROPOSED APARTMENT AT MAHANAGAR COLONY, SHAMSHABAD.



PROPOSED APARTMENT AT MAHANAGAR COLONY, SHAMSHABAD.
TYPICAL FLOOR PLAN

COLUMN POSITION DRAWING:



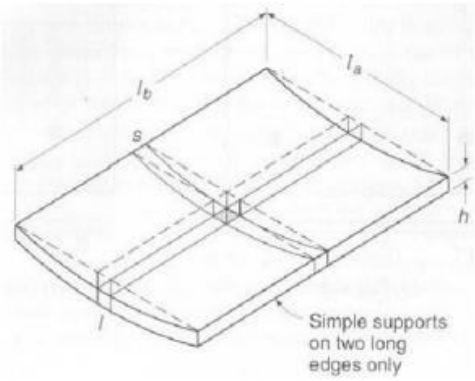


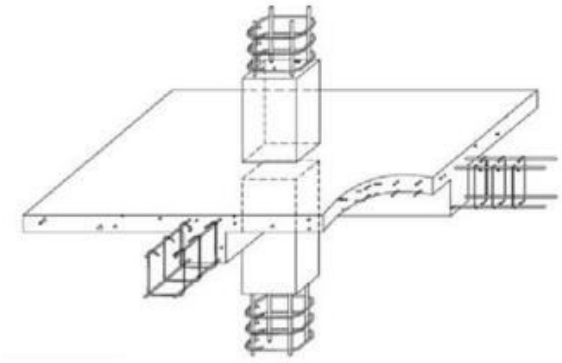
4. DESIGN OF SLABS

Slab is plain structural members forming floors and roofs of building whose thickness is quite small compared to their other dimensions. These carry load primarily by flexure and are in various shapes such as

square, rectangular, circular and triangular in buildings, tanks etc. inclined slabs may be used as ramps for multistoried as parking. A staircase is considered to be an inclined slab. Slab may be supported by beams or by walls and may be simply supported or continuous over one or more supports. When the ratio of the length to the width of a slab is more than 2, and then most of the load is carried by the shorter span and in such a case is known as one-way in case the ratio is less than 2 then it is called a Two-way slab, which is further classified as restrained and simply supported slabs. The various other types of the slabs are flat slabs, which rest directly on columns with beams and Grid Floors or Ribbed slabs. The thickness of the reinforced concrete slabs ranges from 75mm to 300mm slabs are designed just like beams keeping the breadth of slab as unity depending on the system of units. Thus the total slab is assumed to the consisting of strips of unit width compression reinforcement is used only in exceptional basis in a slab. Shear stress in a slab are very low and hence shear reinforcement is never provided and if necessary it is preferred to increase the depth of the slab to reduce the stress than providing the reinforcement. Temperature reinforcement is provided at right angles to the main longitudinal reinforcement in a slab. The design of the slab is purely is accordance with the code IS-456 2000 the designing process of the slabs the following assumption are made.M25 Concrete and Fe415 steel is used both for design and execution purpose.

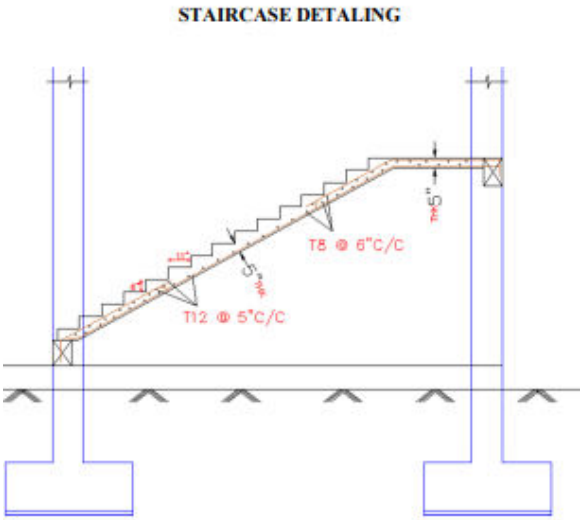
- The overall depth of the slab is restricted to 150mm with a clear cover of 20mm.
- The main reinforcement consists of Tor steel bars and temperature reinforcement consists of mild steel bars.
- The total depth of the section is obtained from the maximum bending moment of all moments on the span.





5. DESIGN OF STAIRCASE

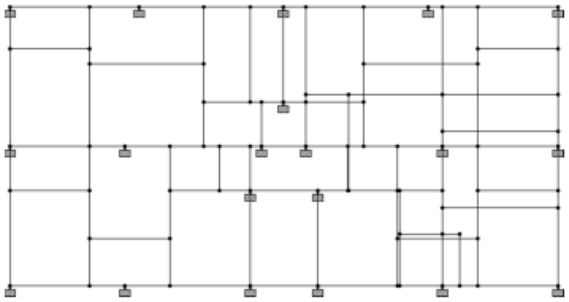
A stair is a series of steps arrange in such a manner as to connect different floors of a building. stairs are designed to provide an easy and quick access to the different floors. Stairs are provided in a building to afford a means of communication between various floors. they are called staircase. Since they have to perform the very important function, the slab over which the steps rests should be design properly to provide maximum comfort, easy and safety. The most important aspect in providing staircase is it location. The location of staircase should be such as to provide as easy to that in case of any casualty e.g. fire break earth quakes flooding etc. Occupants should be placed in the center or to the side of a building. The location depends up on the position of the room and the type of approach needed. In commercial buildings, it should be placed centrally so as to: 1.Provide easy access to all shops/offices 2.Maintain privacy. The inclined slab of a stair is known as height of stair while the straight portion other than the floor level is known as landing. While song on flight, one travels vertically, the landing is provided midway both to turn the position and lower to relax while going up. The vertical height of a stair is known as RISE and the available horizontal distance on a stair is known as TREAD. • Rise of step - 150 to 300 mm. • Tread of step -200 to 300mm. • Width of staircase - 1m in residential building to 2m or public building.



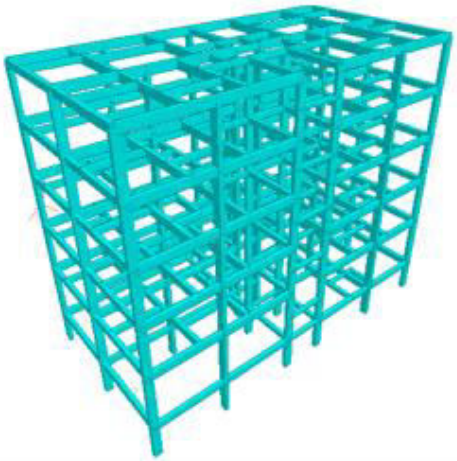
6.

6. LOADING

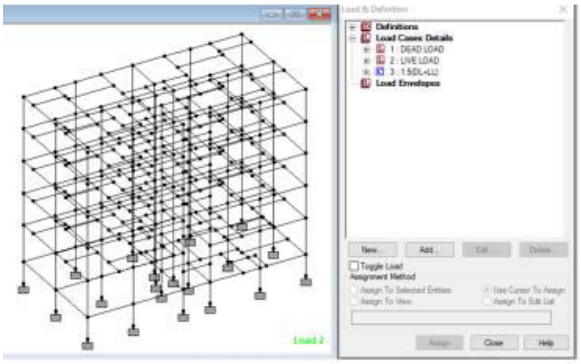
The concepts presented in this section provide an overview of building loads and their effect on the structural response of typical wood-framed homes. As shown in Table, building loads can be divided into types based on the orientation of the structural action or forces that they induce: vertical and horizontal (i.e., lateral) loads. Classifications of loads are described in the following sections. 6.2 BUILDING LOADS CATEGORIZED BY ORIENTATION: Types of loads on a hypothetical building are as follows: Gravity Loads: • Dead • Live Lateral Loads: • Wind • Seismic (earth quake)



Top view of structure.



STRUCTURE 3D RENDERING VIEW

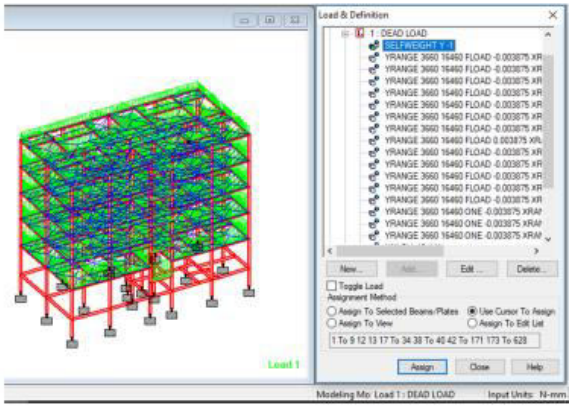


LOAD CASE DETAILS

7. BEAMS

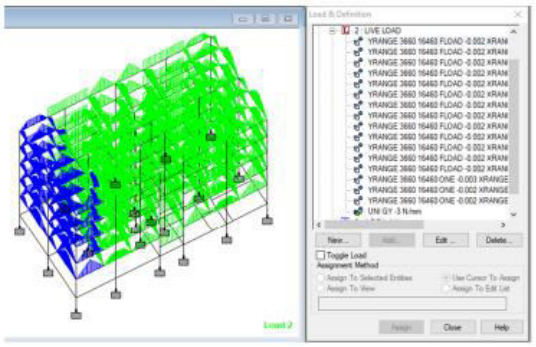
Beams transfer load from slabs to columns. beams are designed for bending. In general, we have two types of beam: single and double. Similar to columns geometry and perimeters of the beams are assigned.

Design beam command is assigned and analysis is carried out, now reinforcement details are taken. 7.1BEAMDESIGN: A reinforced concrete beam should be able to resist tensile, compressive and shear stress induced in it by loads on the beam. There are two types of reinforced concrete beams 1.) Singly reinforced beams 2.) Doubly reinforced concrete beam



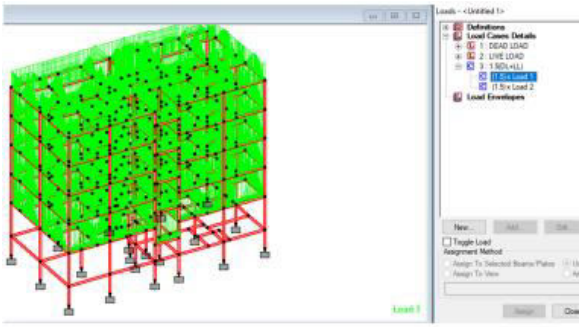
DEAD LOAD

SELF WEIGHT OF BEAM&COLUMN
2 WAY SLAB (FLOOR LOAD)
1 WAY SLAB (FLOOR LOAD)
CANTILEVER SLAB (MEMBER LOAD)
STAIR CASE (MEMBER LOAD)
WALL LOAD (MEMBER LOAD)



LIVE LOAD

2WAY SLAB(FLOOR LOAD)
1WAY SLAB (FLOOR LOAD)
CANTILEVER SLAB(MEMBER LOAD)
STAIR CASE(MEMBER LOAD)



Load Combinations

BEAMSBeams transfer load from slabs to columns. beams are designed for bending. In general, we have two types of beam: single and double. Similar to columns geometry and perimeters of the beams are assigned. Design beam command is assigned and analysis is carried out, now reinforcement details are taken.

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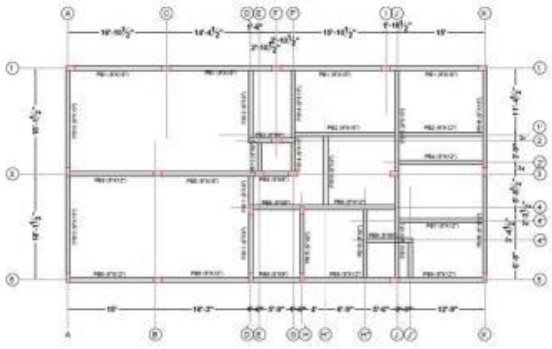
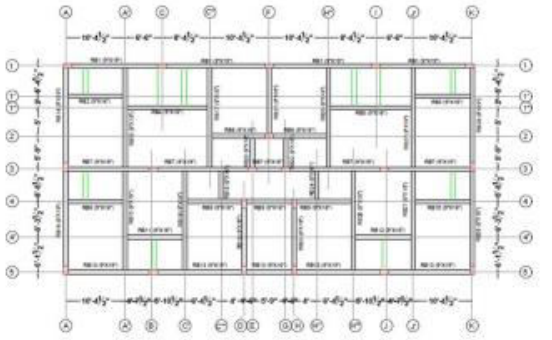


PLINTH BEAM LAYOUT



ROOF BEAM LAYOUT

8. CONCLUSION

Structural Aided Design is easy and also time effective whereas the manual calculations are tedious and time consuming. For structural Analysis and design of different structural items such as Footings, Columns, Beams, Slabs, Staircases etc. in this proposed Multistory Building Design project different load combinations was considered and the deflection shape of the building was studied. The bending moment and shear force were calculated and presented graphically. One critical beam case and column case was shown in detail. The slabs, footings and stair case were designed manually and the details of reinforcement were shown in auto-cad drawings. Through this project we understood about what is Architecture, how the building is planned, Structural analysis and design is done, consideration of different loads, codes etc. The various methods in analysis and design of structures, and in addition to this we understood the basics to be followed during analysis and designing a structure both manually and through STAAD Pro Software.

●We were able to successfully analyse and design the structural elements of multistorey building.

●STAAD PRO was found to be useful for analysis.

●This GROUP PROJECT enables us to go into the market with an excellent background regarding design of R.C.C

9. REFERENCES

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• Steel Design – IS:800-2007

• Concrete Design – IS:456-2000

• Dead load – IS:875 part 1-1987

• Live load – IS:875 part 2-1987