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ANALYSIS AND DESIGN OF MULTI-STOREY BUILDING BY USING STAAD PRO

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Abstract-The primary goal of a structural engineer is to build structures for safe computing technology; but, structural engineers can take on far larger and more sophisticated structures that are subjected to a variety of loading conditions. Previously, the loads operating on the structure were thought to be static, although no structure load is static, with the exception of self-weight (dead load).In the subject of civil engineering, a wide variety of application software is now available. All of these programmes are built on a foundation of superior technology. Finite element analysis that takes into account the effects of dynamic loads such as wind, earthquakes, and other natural disasters. The purpose of this paper is to investigate the efficacy of several civil engineering application software. An ongoing project has been chosen for this purpose.

I. INTRODUCTION

There is growing responsiveness of multi-storey reinforced concrete structures, to accommodate growing population. Generally, such structures have prismatic sections which are common in developing countries, which resist applied loads without any appreciable deformation of one part relative to another.

There is a need to accomplish some function, one of them is to receive loads (usually known as service loads) at certain points & transmit them safely to other points, that prompts the designer to give life to a structure further, more over it is the need for a safe, serviceable, feasible and aesthetically pleasing fulfilment of a structure.

Many structures are built of reinforced concrete: bridges, viaducts, buildings, retaining walls, tunnels, tanks, conduits, and others. To analyze and design of a multi-storey building we must analyze and design the elements that combined it, such slabs, beams, columns and footing. It is also very durable and fire resistant with good control and correct construction Procedures are followed.

1. Reinforced Concrete:

Reinforced concrete is simply concrete in which steel bars with desirable magnitude are introduced in the casting stage; the resulting composite material can resist the tensile stresses developed by the external loads.

2. Structural Elements:

Each building structure consists of the following elements: -

2.1 Slabs: Horizontal plate elements carrying the loads.

2.2 Beams: Horizontal members carrying the load from slabs.

2.3 Columns: Vertical members carrying mainly axial loads (interior columns) but sometimes they carry axial loads and moments in the case of exterior beams.

2.4 Walls: Vertical plate elements resisting vertical, lateral or in-plane loads.

2.5 Bases and foundations: Directly supported by the soil, they help to distribute the loads, transferred by the elements above, and on a larger area thus reducing the stresses applied to the soil.

3. Design Philosophy:

The main objective of reinforced concrete structural design is to comply with the following essential requirements.

- Structures designed should satisfy the criteria of the desirable ultimate strength in flexural, shear, compression, tension and torsion development under a given loading conditions and their combinations.
- The structure designed should satisfy the criterion for serviceability, which limits the deflections and keeps the cracks width with acceptable limits.
- The structure should also have adequate durability, impermeability, resistance to acids, corrosion, frost, fire etc.
- The building should have adequate stability against overturning, sliding, buckling and vibration under the action of loads. A satisfactory structural design should ensure the three basic criteria of strength, serviceability and stability. A good designer should also consider economy and aesthetics.

4. Design Bases:

The single most important characteristic of any structural member is its actual strength, which must be large enough to resist, with some margin to spare, all foreseeable loads that may act on it during the life of the structure, without failure or other distress.

It is logical, to proportion members, to select concrete dimensions and reinforcement, so that member strengths are adequate to resist forces resulting from certain hypothetical overload stages, significantly above loads expected actually to occur in service.

5. Multi-Storey Buildings:

The tallness of a building is relative and cannot be defined in absolute terms either in relation to height or the number of stories. But, from a structural engineer's point of view the tall building or multi- storied building can be defined as one that, by virtue of its height, is affected by lateral forces due to wind or earthquake or both to an extent that they play an important role in the structural design.

6. Concrete Frame Structures:

Concrete frame structures are a very common - or perhaps the most common- type of modern building. As the name suggests, this type of building consists of a frame or skeleton of concrete. Horizontal members of this frame are called beams, and vertical members are called columns.

7. Reinforced Concrete (RC):

Is a composite material in which concrete's relatively low tensile strength and ductility are counteracted by the inclusion of reinforcement having higher tensile strength and/or ductility?

The reinforcement is usually, though not necessarily, steel reinforcing bars (rebar) and is usually embedded passively in the concrete before the concrete sets.

8. Beam and Column Construction:

This is often called as "skeleton construction". The floor slabs, partitions, exterior walls etc. are all supported by a framework of steel beams and columns. This type of skeleton structure can be erected easily leading to very tall buildings. In such a beam and column construction, the frame usually consists of columns with beams and girders framed into them from both directions at each floor level.

II. RESEARCH REVIEW

A review of the analysis and design of a multi-storey building with STAAD Pro is carried out. Planning is done by using AutoCAD and load calculations were done manually and then the structure was analyses using STAAD Pro. The dead load, imposed load and wind load with load combination are calculated and applied to the structure.

Overall, the concepts and procedures of designing the essential components of a multi-storey building are described. STAAD Pro software also gives a detailed value of shear force, bending moment and torsion of each element of the structure which is within IS code limits.

Various research papers have been published on building planning and analysis is on tall buildings by using the STAAD Pro. The research papers have been gathered and are as follows. The study of seismic and wind load response of G+40 storey RCC high rise building. The structure is inspected against the base shear and roof displacement and they are in

permissible limits. An RCC high rise building G+30 stories combined seismic load and wind loads.

In the top beam of the structure requires more reinforcement required for static analysis as compare to dynamic analysis. Deflection and shear bending are less in static analysis compare to dynamic analysis. In column area of steel is always less for static load compared to dynamic load. The study of bending moment and shear force of the structure.

1. Auto CAD:

Auto Cad is a designing and drafting software which is used for developing 2-dimensional and 3- dimensional structures, developed and sold by Autodesk, Inc. It is a vector graphics drawing program.

It uses primitive entities comparable to lines, polylines, circles, arcs and text as the foundation for the complex. Auto CAD's native file format, DWG, and to a lesser extent, its interchange file format, DXF has become the drawing and detailing works were done by creating use of Auto CAD 2014.

2. STAAD.PRO:

STAAD.Pro is user-friendly software which is used for analysing and designing of structure by the structural engineers. STAAD Pro provides a lot of precise and correct results than manual techniques. It's the foremost computer code for 3D model generation and multi-material design.

The software is fully compatible with all windows operating system but is optimized for windows XP. STAAD.Pro software is used for static or dynamic analysis for structures such as bridges, low rise or high-rise buildings, stadiums, steel structures, etc.

3. Dead Loads:

All permanent constructions of the structure form the dead loads. The dead load comprises of the weights of walls, partitions floor finishes, false ceilings, false floors and the other permanent constructions in the buildings.

The dead load loads may be calculated from the dimensions of various members and their unit weights. the unit weights of plain concrete and reinforced concrete made with sandand gravel or crushed natural stone aggregate may be taken as 24 kN/m" and 25 kN/m" respectively.

4. Imposed Loads:

Imposed load is produced by the intended use or occupancy of a building including the weight of movable partitions, distributed and concentrated

loads, load due to impact and vibration and dust loads. Imposed loads do not include loads due to wind, seismic activity, snow, and loads imposed due to temperature changes to which the structure will be subjected to, creep and shrinkage of the structure, the differential settlements to which the structure may undergo.

5. Wind Load:

Wind is air in motion relative to the surface of the earth. The primary cause of wind is traced to earth's rotation and differences in terrestrial radiation. The radiation effects are primarily responsible for convection either upwards or downwards. The wind generally blows horizontal to the ground at high wind speeds.

III. METHODOLOGY

1. Modelling:

(C+G+5) Residential and Commercial building.

2. Loads:

1.5(Live Load +Dead Load).

3. Analysis:

- Analysis of RCC framed structure.
- Shear Force and Bending Moment calculations.

4. Design:

Design of Slab, Beam, Column, Footing and Staircase.

5. Geometric Parameters:

- Beam = 230 * 300mm.
- Column = 230 * 300mm.
- Slab = 150mm.

IV. ANALYSIS AND DESIGN OF MULTI- STOREYED

We have chosen STAAD Pro because of its following advantages: easy to use interface, conformation with the Indian Standard Codes, versatile nature of solving any type of problem, Accuracy of the solution. STAAD.Pro features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities.

From model generation, analysis and design to visualization and result verification, STAAD.Pro is the

professional's choice for steel, concrete, timber, aluminium and cold-formed steel design of low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles and much more. The results were to satisfaction and were accurate. In the initial phase of our project we have done calculations regarding loadings on buildings and also considered seismic and wind loads.

Structural analysis comprises the set of physical laws and mathematics required to study and predicts the behaviour of structures. Structural analysis can be viewed more abstractly as a method to drive the engineering design process or prove the soundness of a design without a dependence on directly testing it.

1. The modeling analysis is done in the STAAD PRO:

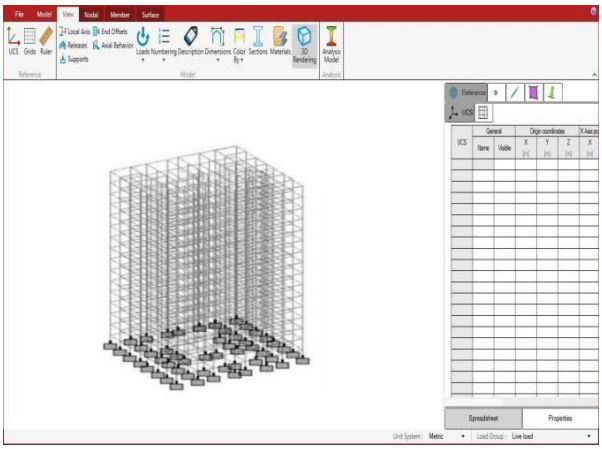

Fig 1. 3D View of Model.

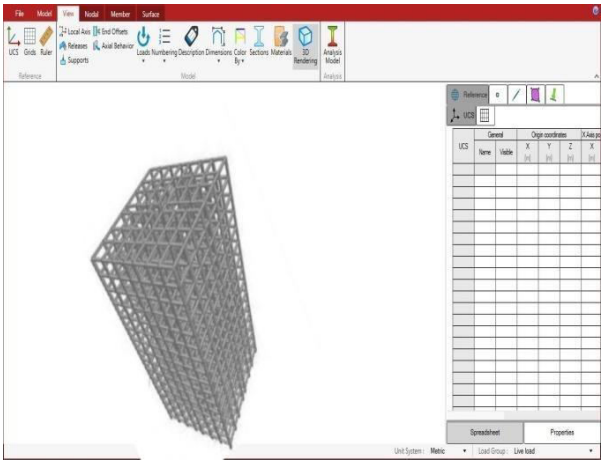

Fig 2. 3D Rendering.

2. Design of RCC elements:

The RCC are slab, beam, column, footing and stair case etc…

2.1 Design of slab: Slabs are most widely used structural elements forming floor and roofof building. Slab support mainly transverse load and transfer them to supports by bending actions more or one direction. On the basis of spanning direction: It is two type one-way slabs and two-way slab.

- **One-way slab:** When the slab is supported on two opposite side parallel edges, it spans only in the directions perpendicular to the supporting edges. It bends in one directions and main steel is provided in the directions of the span. Such a slab is known as one-way slab.
- **Two-way slab:** When the is supported on four edges and the load distribution is also on four edges of the panel. The reinforcement is provided on both the sides. Such slab is known as two-way slab.

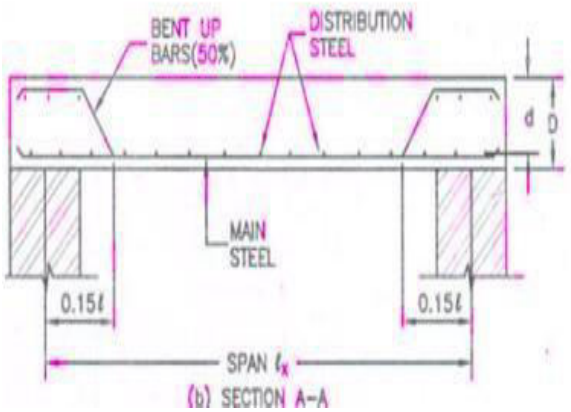

Fig 3. One way slab reinforcement.

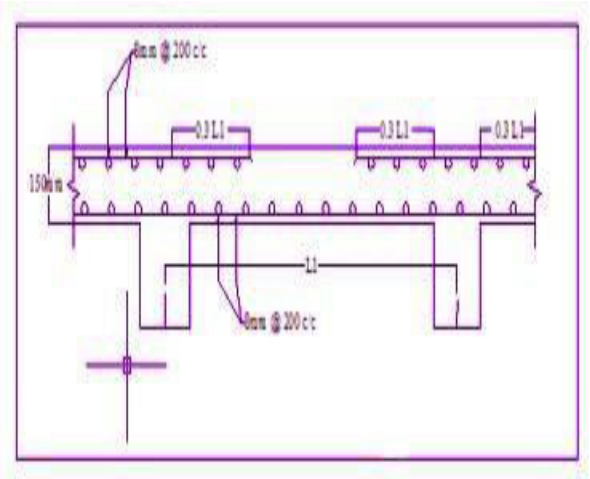

Fig 4. Two-way slab reinforcement.

2.2 Design of beam: There are three types of reinforced concrete beams

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- **Single Reinforced Beams:**In singly reinforced simply supported beams steel bars are placed near the bottom of the beam where they are effective in resisting in the tensile bending stress.
- **Double Reinforced Beams:**It is reinforced under compression tension regions. The necessities of steel of compression region arise due to two reasons. When depth of beam is restricted. The strength availability singly reinforced beam is in adequate.

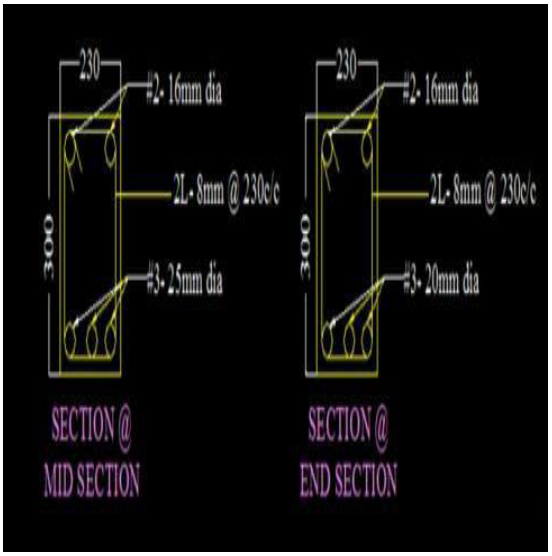

Fig 5. Beam reinforcement.

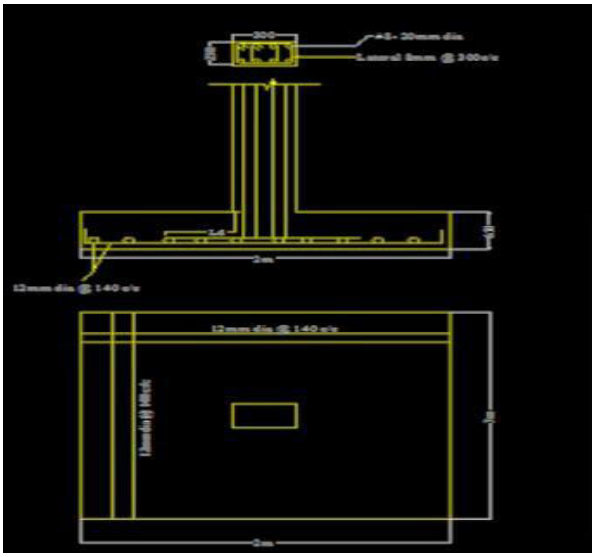

Fig 6. Column and footing reinforcement.

2.3 Column:

A column may be defined as an element used primary to support axial compressive loads and with a height of a least three times its lateral dimension.

The strength of column depends upon the strength of materials, shape and size of cross section, length and degree of proportional and dedicational restrains at its ends.

2.4 Footing:

Foundations are structural elements that transfer loads from the building or individual column to the earth.

If these loads are to be properly transmitted, foundations must be designed to prevent excessive settlement or rotation, to minimize differential settlement and to provide adequate safety against sliding and overturning.

2.5 Design of Stair Case:

The purpose of a stair case to provide access to pedestrian in a building. The geometrical forms of staircase may be quite different depending on the individual circumstances involved. The shape and structural arrangement of a staircase would generally depend on two main factors.

- Type of construction of structure around the stair case that is load bearing brick structure or reinforced concrete framed structure.
- Availability of space: Type of staircase provided for the proposed building is Bifurcated staircase, which consists of two flights. The first flight starts from plinth level to lintel level and second flight starts from lintel level to roof level.

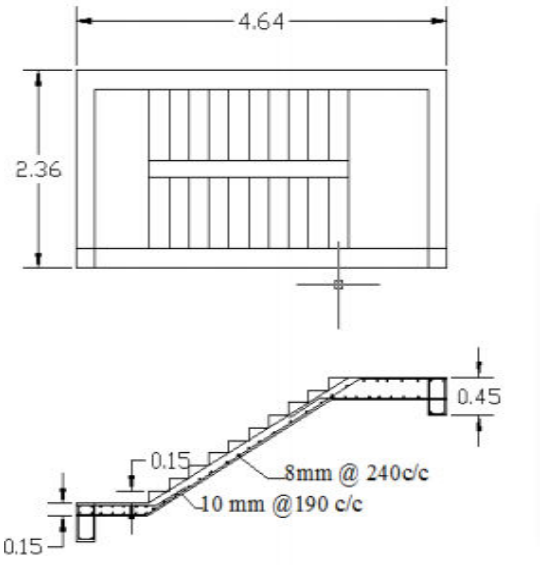

Fig 7. Stair case reinforcement.

V. CONCLUSION

Planning, analysis and design of multi storey residential building was done. It's a building with parking in the basement and the rest of the floors are occupied with apartments. All the structural components were designed manuallyand detailed.

The analysis and design were done according to standard specific Posts using STAAD.Pro for stalk and dynamic loads. The dimensions of structural member are specified sod the loads such es dead load. live loan floor load and eadliquake load are spurned. I...on andeleven tests are clanked for beams. Columns mg slabs. The nets proved to be safe. Tleorettral work has been done. Hence, conclude that we can gain more knowledge in practical work that compared to theoretical work.

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