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Analysis and Design of a Residential Building By Using STAAD Pro

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ABSTRACT :- Structural design is an investigation method of the rigidity, strength and stability of the building. The essential aim in structural analysis and design is to construct a structure capable of overcoming all applied loads without failure during it's intended life. The process of structural design involves various stages such as computation of loads, member design, detailing and many more. The conventional method of structural design and analysis leads to lot of complications and tedious calculations which are time consuming. Nowadays to complete a design and analysis in efficient manner, fast software's are used. Computer aided design of residential building by using STAAD PRO which includes-

- Generating structural framing plan
- Getting model
- Analysis of structure
- Design of structure

1. INTRODUCTION :-

STAAD PRO has a state of art user interface, tools for visualization, well built analysis and design software with advance finite element and capable of dynamic analysis. From generation of model, analysis and design to visualization tools and verification of results. STAAD PRO is a common choice for steel, concrete, aluminium and cold-formed steel design of multistorey buildings, factories, tunnels, bridges and much more.

To perform a complete analysis, a structural engineer must find out information such as loads on structure, geometry, support conditions and materials properties. The results of such analysis typically include support reactions, stresses and displacements. This information is then analysed with respect to the criteria that indicate the conditions of failure. The objective of design is the attainment of an acceptable possibility that structures constructed will perform satisfactorily during their design life. With an appropriate degree of safety, they should bear all loads and deformations caused due to normal construction and use and have sufficient durability and resistance to the effects of seismic and wind. Structure along with structural elements shall be designed by limit state design method. Account should be taken of accept theories, experiment and experience and the requirement to design for durability. Design, including design for durability, construction and service life should be considered as a whole. The achievement of design objectives needs concurrence with clearly defined standards for materials, construction, workmanship and also maintenance and use of structure in service. The design of the structure depends upon the minimum

requirements as suggested by the Indian standard codes. The minimum requirements concerned to the structural safety of structures are satisfied by way of laying down minimum design loads which have to be assumed for dead loads, live loads, and others external loads, the structure would be required to bear.

1.1 Steps in structural design :

The steps involved in designing a structure are : structural planning, loads computation, analysis method, design of member and detailing, etc.

1.2 About STAAD Pro :

It is a globally used software for design and analysis of structure by structural engineers. STAAD Pro has a GUI-Graphical User Interface due to which we can generate the model of the structure, which is then analyzed by STAAD engine. When analysis and design is completed, GUI can be used to view the results graphically.

1.3 Outcomes of literature review :

Bedabrata Bhattacharjee & A.S.V. Nagender in their paper "Computer aided analysis and design of multi-storeyed buildings" states that the design involves calculation of loads manually and analyzing entire structure by STAAD Pro. The design methods used in STAAD Pro analysis is limit state design method with referrence to the IS Code of Practice. STAAD. Pro has a easy to use user interface, visualization tools, powerful analysis and design engines with advanced finite element and capable of dynamic analysis. At initial stage they started with the analysis of simple 2-D frames and manually checked the accuracy of the software with the results. The results proved to be very accurate. They analyzed and designed a G+7 storey building[2- D Frame] initially for various load combinations. Mr. K. Prabin kumar, R. Sanjaynath in their paper "A study on design of multi-storey residential building - a review" concluded that at first, the planning of the structure is done using AutoCAD. Calculations of loads were done manually and then the structure was analyzed using STAAD Pro. STAAD Pro is straightforward to use so as that the frame are going to be drawn, load values and dimensions are given. The method used in STAAD Pro analysis is limit state method. STAAD Pro is able to calculate the reinforcement required for any concrete section. Different structural action is considered on members such as torsion, flexure, axial, etc. Shear reinforcement is sufficient to withstand each shear forces and torsional moments. Beams are designed for flexure, shear and torsion. Columns are delineated for axial forces at the ends. The building is planned as per IS: 456-2000. Arjun Sahu, Anurag Verma , Ankit Singh, Aryan Pal , Mohd. Shariq in their paper ."Design & analysis of multistorey (g+3) residential building using STAAD Pro & AutoCAD" stated that Planning, analysis and design of G+3 multi-storey residential building is done using STAAD Pro and AutoCAD. It's a G+3 storied building with parking in the ground floor and the remaining floors are occupied with apartments. All the structural elements were designed manually and detailed using AutoCAD. The analysis and design were done based on standard provisions using STAAD Pro for static and dynamic loads. The dimensions of structural members are specified and the loads such as live load, dead load, earthquake load and floor load are applied. Deflection and shear tests are checked for columns, slabs and beams.

3. OBJECTIVES :

Computer aided analysis and design of residential building by using STAAD PRO Includes -

1. Generation of structural framing plan
2. Creation of model of structure in STAAD PRO
3. Application of various load combinations on the member

4. Analysis of the structure
5. Design of the structure

4. METHODOLOGY :

- **Step 1:** To model the residential building using the STAAD Pro software and analyse the same structure using STAAD Pro.
- **Step 2:** To analyse the residential building and structural elements like beams, stairs, columns, slabs.
- **Step 3:** To design the residential building using STAD Pro - To design the structural elements like beams, stairs, columns, slabs using software.

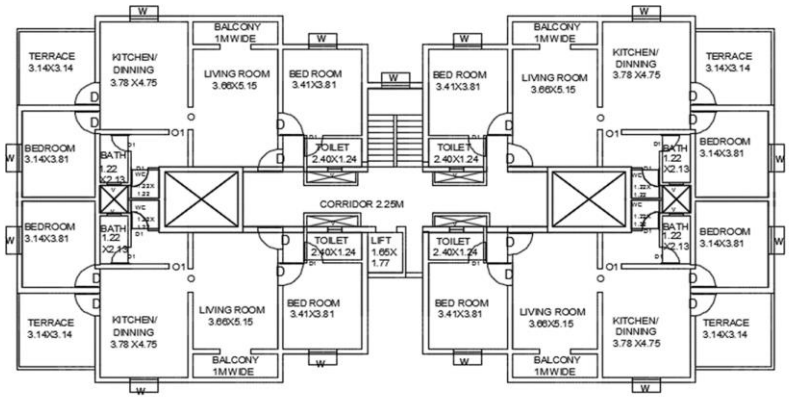


Fig 1. Plan of building

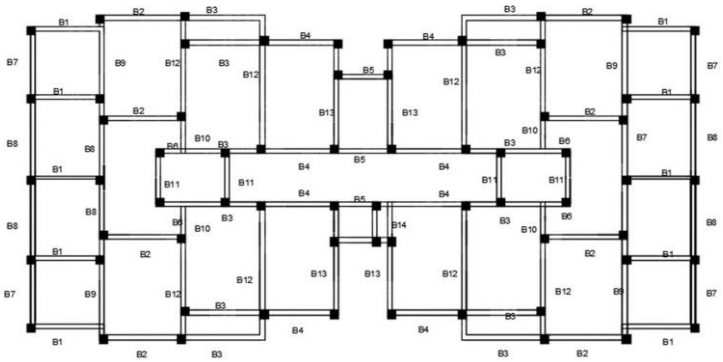


Fig 2. Column position

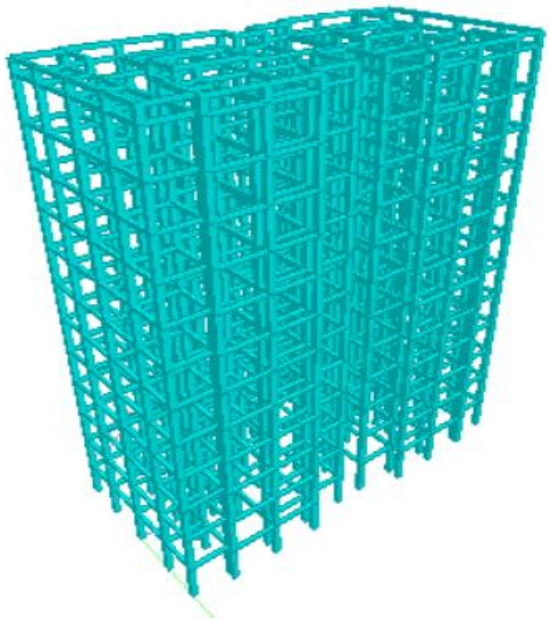
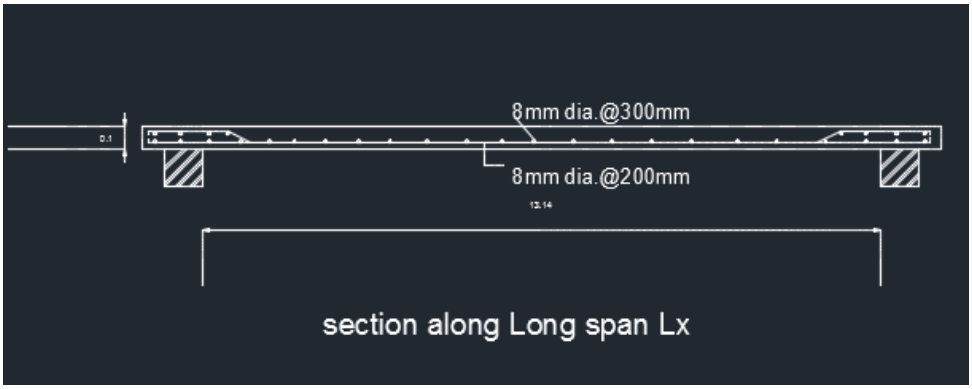


Fig 3. 3D rendering

5. DESIGN OF RCC ELEMENTS :

5.1 Design of one way slab :

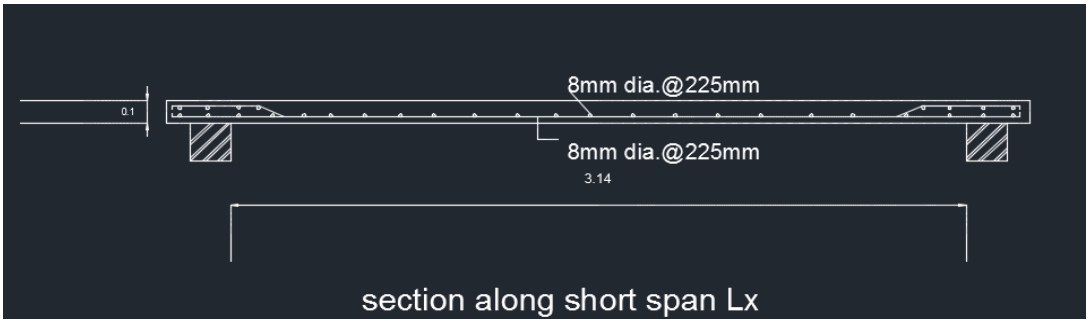
- Ly = 13.14 m
- Lx = 2.25m
- Density = 25 KN/ m3
- Depth of slab = 130 mm
- Diameter of bar = 10 mm dia. bar @ 200 mm spacing (main steel)
- Distribution steel = 8 mm dia. Bar @ 300 mm spacing

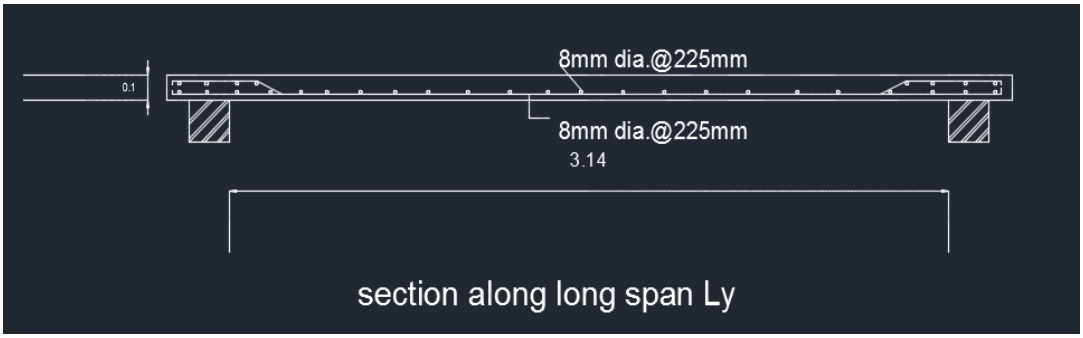


5.2 Design of two way slab :

- Ly = 3.14 m
- Lx = 3.14 m

- Density = 25 KN/ m3
- Depth of slab = 100 mm
- Diameter of bar = 8 mm dia. bar @ 225 mm spacing



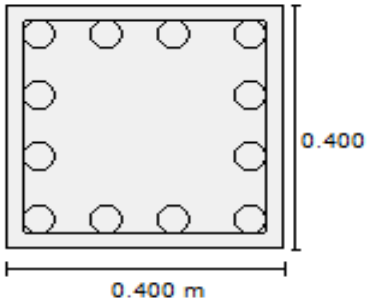


5.3 Design of beams :

- b = 230 mm
- D = 400 mm
- Cover = 25 mm
- f_{ck} = 25 N/mm^2
- f_y = 415 N/mm^2
- M_u = 82.52 KN-m

5.4 Design of columns :

- b = 400 mm
- D = 400 mm
- Cover = 40 mm
- f_{ck} = 25 N/mm^2
- f_y = 415 N/mm^2
- P_u = 134.8 KN
- M_z = 20.7 KN-m
- M_y = 0.06 KN-m

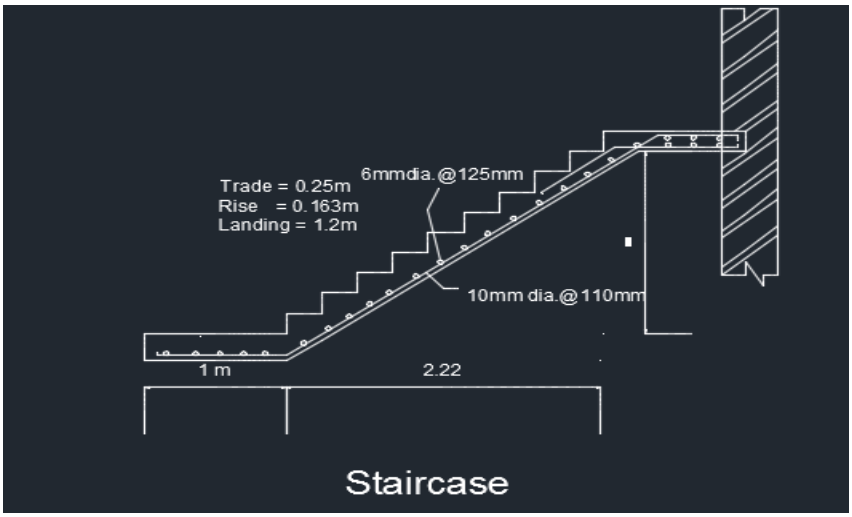


5.5 Design of footings :

- b = 400 mm
- D = 400 mm
- Safe bearing capacity = 200 KN/m2
- Provided dimensions of combined footing = 3.5m * 8m(on node no 101 &102 having c/c distance 2.4m)
- Depth of footing = 600 mm
- Reinforcement of combined footing =longitudinal direction 12 mm dia. @ 120mm & transverse direction 24mm dia. @ 80mm c/c
- Provided dimensions of isolated footing = 1.8m * 1.8m
- Depth of isolated footing = 800 mm
- Reinforcement for individual footing = 16 mm dia. @ 300 mm c/c

5.6 Design of stair case :

- Vertical distance between floors = 3.1 m
- Width of staircase = 1 m
- Rise of step = 150 mm
- Tread of step = 270 mm
- Depth of slab = 150 mm
- Diameter of bar = 10 mm @ 125 mm spacing c/c (MAIN STEEL)
- Diameter of bar = 8 mm @ 220 mm spacing c/c (DISTRIBUTION STEEL)



6. CONCLUSIONS :

1. The structural elements of building are safe in flexure and shear.
2. Quantity of steel provided for building is economical and adequate.
3. Proposed sizes of structural emlements can be used in building as it is.
4. The design of beam, slab, column, footing and stair case are safe in deflection, bending, shear and other aspects.
5. On comparison of the manual design and geometrical model using STAAD Pro, the area of steel required for beam, column, footing, slab, staircase are comparatively similar to that of the requirement.

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