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Analysis and Design of a Building By Using STAAD

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Abstract – An Computer aided design of a Building involves analysis of building frames by using STAAD and manual design of the frame elements. Conventional method of analysis involves lot of complications and tedious calculations such analysis is a time consuming task. Analysis can be made quickly by using software's. STAAD and STAAD PRO is the leading design software in the market. Many design companies use this software for their project design purposes. Hence this project mainly deals with the analysis of the building by using STAAD . These analysis results will also be compared by manual calculations of a sample beam and column of the same structure and these elements are design manually as per IS 456-2000.
Index Terms - STAAD , Design of RCC elements, Analysis, multi-storey building, slab, beam, column, footing and stair case etc.

1. INTRODUCTION

Structural design is an art and science of designing, with economy and elegance, a safe, serviceable, and a durable structure. The entire process of structural planning and design requires not only imagination and conceptual thinking (which form art of designing) but also sound knowledge of science of structural engineering besides knowledge of practical aspects, such as relevant design codes and bye-laws, backed up by ample experience, institution and judgment.

The process of design commences with planning of a structure, primarily to meet the functional requirements of the user or the client. The requirements proposed by the client may not be well defined. They may be vague and may also be impracticable because is not aware of the various implications involved in the process of planning and design and about the limitations and the intricacies of structural science. The functional requirements and the aspect of aesthetics are look into normally by an architect while the aspect of safety, serviceability, durability and economy of the structure for its intended use over life span of the structure are attended by the structural designers (many times, a structural engineer is require to act in capacities of both the architect and the structural designer

1.1. Stages in Structural Designs: The process of structural design involves the following stages. The process of structural design involves the following stages: Structural planning, Computation of loads, Method of analysis, Member design and Detailing, drawing and preparation of schedules.

1.2 About STAAD : It is widely used software for structural analysis and design from research engineers international it consists of following. It is a graphical user interface, it is used to generate the model, which can then be analyzed using STAAD engine. After analysis and design is completed, and the view results graphically. The STAAD analysis and design engine: It is a general purpose calculation engine for structural analysis and integrated steel, concrete, timber and aluminum design. The documentation for STAAD consists of a set of manual as described.

1.3 Getting started:

This manual contains information on the contents of the STAAD package computer system requirements installation process, copy protection issues and description on how to run the programs in the package. Tutorials that provide detailed and step-
by-step explanation on using the program are also provided.

1.4 Graphical environment: The manual contains a detailed description of STAAD . The topics covered include mode generation, structural analysis and design, result verification and report generation.

1.5 Technical Reference: This manually deals with the theory behind engg calculations made by STAAD engine. It also includes an explanation of commands available is a STAAD command file.

1.6 Release report: This manually deals with the latest enhancement of program which is being supplied to the users as ready reference. It includes all related technical understanding and graphical changes from the last version

2. Modeling:

- Graphical mesh generation facilities available for generating elements from complex shapes with holes.
- Import of DXF files, for 3D surface entities.
- Degree of freedom at nodes can be released selectively.

2.1 Property and loading

- Constant thickness as well as linearly varying thickness between nodes.
- New IBC 2003 code for automatic distribution of seismic load.
- New loading for sample application of complex loading patterns.
- New floor load generator which automatically updates the pressure distribution if floor changes also allows for elimination of floor members and creation of floor groups.
- Automatically reduces the live loads dubbed as live load or roof load (live) as per UBC/IBC.
- Wind load on open lattice structure.

2.2 Analysis capabilities:

Static, P-Delta, Non-linear Analysis.

- Liner, P-Delta analysis.
- Non-linear with automatic load stiffness connection.
- Multiple analyses in same run.
- True curvilinear beams (not piecewise linear).
- Plate elements contain extra drilling degree of freedom.
- Tapered tabular cross section such as Hexagonal octagonal, etc (excellent for poles).
- Unidirectional support (compression only/tension only) for generation of soil springs.
- Master/slave capabilities.
- I beam warping end restraint added an option for torsional stiffness.
- Bulking analysis.

2.3 Concrete design:

- One way slab design to design irregular shaped slabs full reinforcement contour and reinforcement layout plans are created.
- Rectangular concrete shear wall design (with deep beam design) and automatically mesh all existing wall and provide horizontal, vertical and edge reinforcement, based on axial moments.
- Automatic calculation of cracked moment of inertia for concrete design.

3. OBJECTIVES

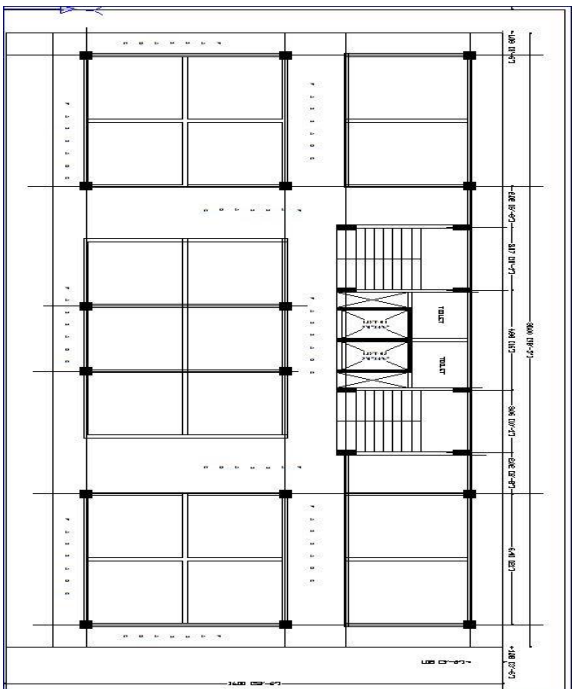
Computer aided design of commercial cum residential building by using STAAD PR which includes.

- Generating structural framing plan
- Creating model in STAAD
- Application of loads on the member
- Analysis of the structure
- Design the structure.

4. DESIGN PROCEDURE

A Three floor commercial cum residential building is considered whose architectural plan and structural framing plans were prepared as shown in followings figures. The entire analysis of building has been done in one stage keeping the IS code provision in view wherever necessary. The whole building has been split into its structural components viz., slab, beams, columns and footings. These components are designed for M20 grade concrete and Fe415 grade steel.

At first the slab have been classified into two types based on edge conditions, spans, dimensions, Lx and Ly ratios and typical analysis suggested. The loads of these slabs (dead load + live load) are transferred on the beam both in X and Y direction. A preliminary design of typical beam had been carried out based on the loads carrying over through slab, their own dead weight (section assumed) all the wall loads coming as such. The column section has been proportioned to take the loads. The maximum positive and shear have been evaluated for beam and column



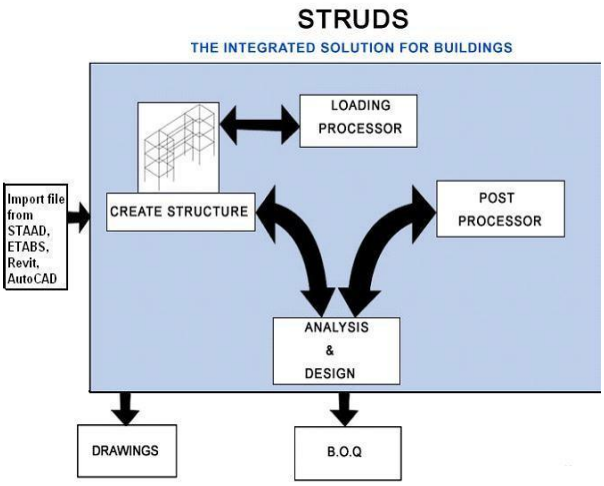


Fig-1: STRUDS-Flow diagram

Table -1: Model specification for analysis and design

Type of structure	**RCC Framed structure**
No. of floors	Ground Floor + 3 floors
Location	Buldana
Type of Soil	Soft Murum
Types of Footing	Raft Footing
Allowable bearing pressure	452.48kN/m2
Story height	3 m
Plinth level	1.0 m
Outer periphery walls	230 mm thick
Inner periphery walls	115mm thick
Partition walls	115mm thick
Slab thickness	130 mm
Concrete & Steel	M20 Grade, Fe415

Fig 1. 3D rendering

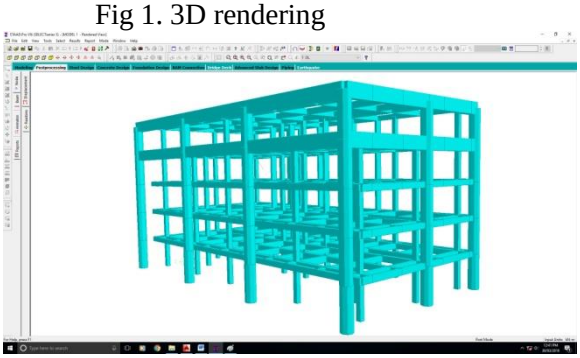


Fig 2. Axial force diagram

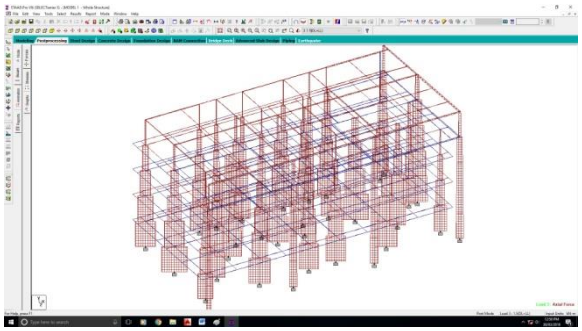
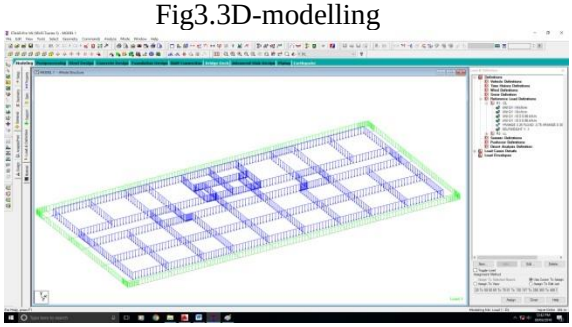


Fig3.3D-modelling



5.1 Design of slab

5.1 Design of One way slab

span S= 3.195 m

slab thickness t = 0.3m greater than 'min. eff depth reqd'. Hence ok Grade of concrete fck = 20N/mm2 Grade of reinforcement fy = 415N/mm2

Type of panel One way adjacent sides continuous

6.0 DESIGN OF COLUMN A column may be defined as an element used primarily to support axial compressive loads coming from the beam. All columns are subjected to axial force and some moments. The column is design as uniaxial column. From the STAAD output values, considering the column which is subjected to maximum axial load & moment.

Load KN	**Moment KN.m**
2880	3254.01

P_u = 2880KN

M_u = 3254.01 KNm

f_{ck} = 20N/mm2

f_y = 415N/mm2

L = 3 m From IS 456-2000

7.0 Design of beams

7.1 There are three types of reinforced concrete beams:

(A) Singly reinforced beams
(B) Doubly reinforced beams ,and
(C)Singly or doubly reinforced flanged beams.

7.2 Design end section as rectangular Beam

b = 350mm
D = 750mm
f_{ck} = 20 N/mm2
f_y = 415 N/mm2
M_u = 473 KNm

8.0 DESIGN OF FOOTINGS

Consider the column member which is subjected to maximum axial load & moment.

8.1 RAFT FOOTING

A raft footing or mat is a combined footing that covers the entire area beneath a structure and support all the wall and column. When the allowable soil pressure is low , or the building load are heavy, the use of spread footing would cover more than one – half of the area and it may prove more economical to use mat or raft foundation.

A design for a highly axially loaded column

1.No of column = 6
2.Column size = 450 × 450 mm
3.C1 Column carries a load of 1512 KN
4.C2 column carries a load of 2190 KN
5.C3 column carries a load of 2880 KN
6.Soil bearing capacity 300 KN/m^2

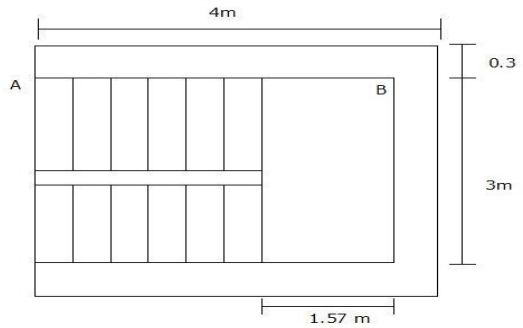
9.0 DESIGN OF STAIR CASE

Stairs Provide access for the various floors of the building the stair consists of series of steps with landings at appropriate intervals the stretch between the two landings is called flight. The rise may vary from 150mm to 200mm The tread is in between 250 mm to 300mm As per IS : 456, the slope or pitch of the stairs should be in between 250 to 400

9.1 Depending up on the Geometry/shape

(A)Single Flight stair case
(B)Quarter Turn Stair case
(C) Doglegged Stair case
(D) Open well stair case
(E)Geometrical stair case
(F)Spiral stair case

9.2 DESIGN FACTORS:



1. Size of stairs 4×3 m
2. Vertical distance between floor 3m
3. Allow a live load of 2000 N/m^2
4. M20
5. Fe 415

9.3 Design of First Flight:

Size of Room = 4x3M
Width of the flight = 1.75m
Assuming rise = 150mm
Tread = 250mm
Number of rise = 1500/150 = 10 Nos. Number of tread = 10-1 = 9 Nos.

Providing landing width = 1570mm

Effective span = (9x250) +1500 = 3750mm

10.0 CONCLUSION

1. Manual design and analysis of structural elements of buildings is time consuming, it can be reduced by using software such as STRUDS.

2. AutoCAD plans can be easily imported toSTRUDS.

3. Detailed report of analysis and design of all the structural elements can be obtained.

4. The advantage of STRUDS is that the detailing of the structural elements can also be obtained as an AutoCAD file report.

5. The design values of the structural elements as obtained from STRUDS are slightly on higher side compared to the manual design calculation.

11.0.FUTURE SCOPE OF STUDY

- By keeping the same analysis results of software, the design can be made more economical by designing members individually or in group.
- Meshing of the slab element can be done to get the accurate load distribution.

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