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Design and Analysis of G+3 Residential Building Using STAAD Pro

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ABSTRACT: The design of the G+3 multi-storied building starts with the planning of the residential building both for individual house and total layout of the building. The building has an overall area of 270 sq.m with four houses in each floor. Each house an area of 121 sq.m. Ground floor is used for parking with a capacity of 15 cars. Total building is designed in AutoCAD and analyzed by STAAD Pro. REVIT Architecture software is used for 3D diagrams and renderings. After being analyzed by STAAD Pro the results are verified by manual design using code books IS 456-2000 and SP-16. STAAD Pro is the new advancement in structural engineering. This software is used for analysis and design of concrete, steel, timber and aluminum. The model is been created and analyzed under various load condition such as dead load, live load, and some combination. As a result of analysis, shear force, bending moment and support reaction are evaluated. Based on analyzed result, the structure is designed manually and cross referenced with the software results.

KEYWORDS: Ast - Area of Steel Ast, (Min) - Minimum Area of Steel ,Ast (Pro) - Area of Steel Provided ,Asc - Area of Concrete ,D - Effective Depth , - Overall Depth ,H - Height Ratio ,L - Length ,B – Breadth, M - Bending Moment, Pa - Active Earth Pressure, Mu (supp) - Ultimate Moment at Supports , Mu (mid) - Ultimate Moment at Centre, Vu - Ultimate Shear Stress ,Mu - Ultimate Moment of Resistance,Wu - Factored Load or Design Load,Fck - Compressive Strength of Concrete ,fy - Yielding Strength of Steel.

I. INTRODUCTION

Designing and analyzing of G+3 multi storied residential building using analyzingsoftware STAAD Pro. Structural analysis is the backbone of civil engineering. During recentyears, there has been a growing emphasis on using computer aided software's and tools toanalyze the structures. These developments are most welcome, as they relieve the engineer ofthe often-lengthy calculations and procedures required to be followed while large orcomplicated structures are analyzed using classical methods. But not all the time such detailedanalysis is necessary to be performed. Now-a-days, high rise buildings and multistory buildingsare common in metropolitan cities. These multistoried buildings have large number of Jointswhich are free to move and it is very difficult and time consuming when it analyzed manually.Hence the computer method for analysis is used using the modern analyzing software STAADPro.

- 1.To analyze the multi-storey residential building consists of 3 floors using STAAD Pro.
2. To obtain the results of Maximum shear force and Maximum bending Moment for beams, Maximum axial force for columns.
3. To design the critical structural members of beam, column, slab, footing and staircase using IS 456-2000 & SP-16.

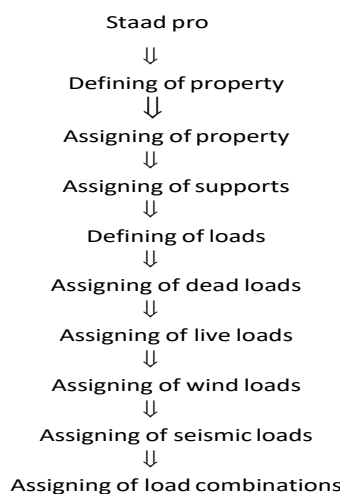
II. LITERATURE REVIEW

• Sreeshna K.S (2016) this paper deals with structural analysis and design of B+G+3 storied apartment building. The work was completed in three stages. The first stage was modelling and analysis of building and the second stage was to design the structural elements and the final was to detail the structural elements. In this project STAAD.Pro software is used for analyzing the building. The IS:875 (part 1) and (part 2) were referred for dead load and live load. Design of



structural elements like beam, column, slab, staircase, shear wall, retaining wall, pile foundation is done according to IS codes. •Aman et al., (2016) has discussed that the point of the structural engineer is to model a guarded structure. Then the structure is subjected to various types of loading. Mostly the loads put in on the building are considered as static. Finite part analysis that exhibit the result of dynamic load like wind result, earthquake result, etc. The work is conducted using STAAD.Pro software • Madhurivassaval et al., (2016) he says that the most common problem country facing is the growing population. Because of the less availability of land, multi-storey building can be constructed to serve many people in limited area. Efficient modelling is performed using STAAD.Pro and AutoCAD. Manual International Journal of Pure and Applied Mathematics Special Issue 2798 calculations for more than four floor buildings are tedious and time consuming. STAAD.Pro provides us a quick, efficient and correct platform for analysing and coming up with structures. • SK Salem (2017) has explained that the objective of the project is to detect and scan a multistorey building. Load calculations are done manually and STAAD.Pro software is used or analyzing the structure. STAAD.Pro is the recommended software. STAAD.Pro is user friendly software which allows the users to make the mount and the load values to be given and dimensions. Then the work is continued for 2-D and 3-D frames with different loading conditions. • Devi Krishna Chaitanya (2017) has said that in order to compete in the ever-growing competent market it is very important for a structural engineer to save lots of time. For this an attempt is made to model and survey a construction using software. For analysing the structure all possible loads are considered to see whether the structure is safe against loading. There are many strategies for analysis of various frames like kani's methodology, cantilever methodology, portal methodology and Matrix methodology. The dead load &live loads are Design And Analysis of G+3 Residential Building Using STAAD.Proapplied. Then, the design for beams, columns, footing are done. STAAD. Pro is a very powerful toll which can save time. • Mahesh This study was focused on the analysis of the structure in the effect of wind load on the sloping ground by the software Staad.Pro. The design of wind was based on the Indian standard code IS 875 part- III. The study stated that as the height increases the Bending moment, shear force and joint displacement all show an approx. directly proportional relationship with the height. Hence it was concluded that the zone IV was the most critical one as the values of bending moment, shear force and joint displacement was highest in the IV zone and was least in the Zone I. • Anoop A project to design a G+3 floor structure at Kalakoda, 4km from Paravoor. The planning of the building was done using the software Revit 2011 with the help of AutoCAD 2014, and the structural analysis was done in Staad.Pro. Vi The project considered the load cases on basis of the indian standard codes 151893:2002 for seismic load, IS 875 Part 3 for wind loads, IS 875 Part 1 for dead loads and Part 2 for live loads. The combinations of these loads were generated on the basis of IS 875 Part 5. And the design was done on the basis of IS 456:2000. After analysis, it was concluded that the graphical.

III. METHODOLOGY





IV. ANALYSIS AND DESIGN

2D ANALYSIS:

The 2D analysis methods are:

1. Slope deflection method.
2. Moment distribution method.
3. Matrix stiffness method.
4. Conjugate beam method.
5. Matrix flexibility method.

3D ANALYSIS:

The members or pin - jointed space carry only axial forces provided the loads are applied at the joints and the members are straight. The nature of the stress in the members of a pin – jointed frame is the same whether it is a plane frame or a space frame. A large number of pin – jointed frames commonly encountered in practice, such as radio and transmission tower are 3D space frames.

The 3D analysis methods are:

1. Force method.
2. Displacement method.

SOFTWARE PACKAGE:

STAAD Pro V8i (SS6 Version) is the most popular structural engineering software product for 3D model generation, analysis and multi – material design. It has an intuitive, user friendly, visualization tools, powerful analysis and design facilities and seamless integration to several other modeling and design products. For static or dynamic analysis of bridges, containment structures, embedded structures (tunnels and culverts), pipe racks, steel, concrete, aluminum or timber buildings, transmission towers, stadiums or many other simple or complex structure, STAAD Pro has been the choice of design professionals around the world for their specific analysis need.

ANALYSIS OF THE STRUCTURE

GENERAL

The frames were identified from the building and the corresponding loads were calculated using IS 875 (part-1), (part-2). The analysis of frames for the vertical forces was carried by STAAD Pro Software.

ANALYSIS OF THE FRAMES:

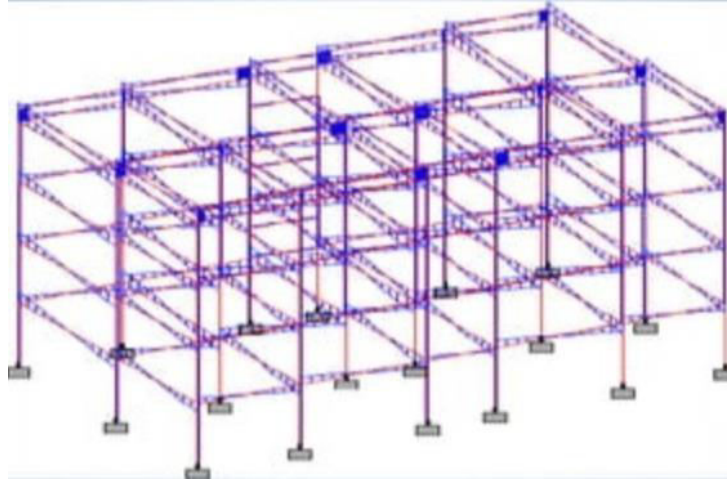


Fig No: 1

2-DIMENSIONAL VIEW OF THE STRUCTURE:

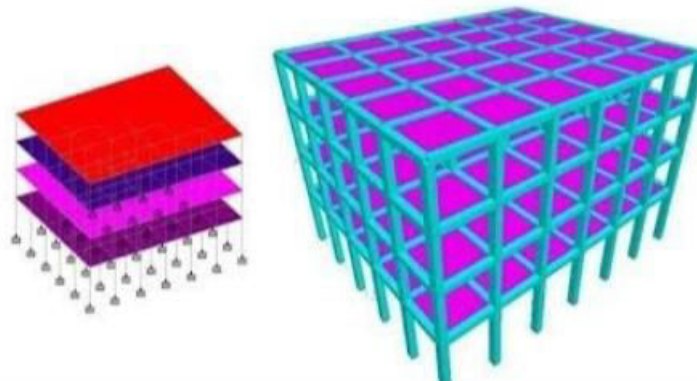


Fig No: 2

DESIGN OF TWO-WAY SLAB

DATA:

Effective Shorter Span (L_x) = 4.26 m Effective Longer Span (L_y) = 5.02 m
Width of Support = 0.3m
 F_{ck} = 25 N/mm²
 F_y = 415 N/mm²

STEP 1: TYPE OF SLAB

L_y/L_x = 5.02/4.26
= 1.18 < 2

Since L_y/L_x ratio is lesser than 2
The slab should be designed as two-way slab

STEP 2: DEPTH OF SLAB

Clear cover = 25 mm
Adopt effective depth = 125mm
Over all depth (D) = 150mm



STEP 3: LOADS

Self-weight of slab	=	3.125 KN/m ²
Live load	=	2 KN/m ²
Floor finish	=	1 KN/m
Total load	=	6.125 KN/m ²

FACTORED LOAD

$$W_u = (1.5 \times 6.125)$$

$$= 9.1875 \text{ KN/m}^2$$

STEP 4: MAXIMUM BENDING MOMENT

From IS 456, Table 26

Short span coefficient

$$\alpha_x (-ve) = 0.0418 \quad \alpha_x (+ve) = 0.0312$$

Long span coefficient

$$\alpha_y (-ve) = 0.032 \quad \alpha_y (+ve) = 0.024 \quad M_{ux} (+ve) = \alpha_x W_l^2$$

$$= (0.0418 \times 9.1875 \times 4.262)$$

$$= 6.96 \text{ KN-m}$$

$$M_{ux} (-ve) = \alpha_x W_l^2$$

$$= (0.0312 \times 9.1875 \times 4.262)$$

$$= 5.20 \text{ KN-m}$$

$$M_{uy} (+ve) = \alpha_y W_l^2$$

$$= (0.024 \times 9.1875 \times 4.262)$$

$$= 4 \text{ KN-m}$$

$$M_{uy} (-ve) = \alpha_y W_l^2$$

$$= (0.032 \times 9.1875 \times 4.26)$$

$$= 5.33 \text{ KN-m}$$

STEP 5: CHECK FOR DEPTH

From IS 456, Pg.no:96

$$M_u, \text{ lim} = 0.36 x_{u, \text{ max}} (1 - 0.42 x_{u, \text{ max}}) b d^2 f$$

$$c k = 0.36 \times 0.48 (1 - (0.42 \times 0.48)) \times 1000 \times 125^2 \times 25$$

$$M_u, \text{ lim} = 53.89 \times 10^6 \text{ KN-m}$$

$$M_u, \text{ actual} < M_u,$$

V. CONCLUSIONS

1. Building plan was developed in AUTOCAD with required dimensions.
2. The structural model was developed in STAAD.PRO and STAAD. etc for execute of analysis and design.
3. The analysis and design was carried out manually.
4. The area of steel reinforcement required for beam design showed 9% less in STAAD.Pro analysis when compared to man.
5. The area of steel reinforcement required for column design showed 11% less STAAD. Pro when compared to manual design.
6. Pile cap design and analysis was done in Staad.etc.
7. The area of steel reinforcement required for slab design showed 2% less iSTAAD.etc
8. when compared to manual design.
9. Beam design showed optimum results in STAAD.Pro. Hence economic design and area of steel required was chosen from STAAD.pro.
10. Column design showed optimum results in STAAD.Pro. Hence econo design and area of steel required was chosen from STAAD.pro.
11. Slab design showed optimum results in STAAD.etc. Hence econor (design and area of steel required was chosen from STAAD.etc.



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Code Books:

1. IS 456-2000 code book for design of beams, columns and slabs.
2. SP-16 for ddesign of columns.



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