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Analysis and Design Of G+6 Multi-Storied Building Using Staad Pro

Pranav Kumar[1], Sanjeev Jangde [2], Vagesh Kumar [3]

[1] M.Tech Scholar, ISBM University Gariyaband, Chhattisgarh, India
[2] Assistant Professor, ISBM University Gariyaband, Chhattisgarh, India
[3] Assistant Professor, ISBM University Gariyaband, Chhattisgarh, India

A B S T R A C T

In this present project report there is analysis and design of G+6 commercial cum residential building which is a upcoming project of Essarjee Constructions Pvt. Ltd. Bhopal in this we have manually calculated the different loads that are coming on the beams then by assigning the self load of beams and columns we have analyses it in the STAAD Pro and the designing of beams and columns are also done in STAAD Pro where as slabs and staircases are designed manually as per IS 456:2000. Some of the beams and columns are also checked manually then the detailing has been done into tabular form and Auto CAD drawings.To perform an accurate analysis a structural engineer must determine such information as structural loads, geometry, support conditions, and materials properties. The results of such an analysis typically include support reactions, stresses and displacements. This information is then compared to criteria that indicate the conditions of failure. Advanced structural analysis may examine dynamic response, stability and non-linear behavior

Keywords: Structure Analysis, STAAD Pro, G+6 multi-storied, Frame Structure

1. Introduction

Structures can have many different forms and purposes, and they have been modified throughout history for a variety of reasons, including the availability of building materials, the climate, land costs, ground conditions, intended uses, and aesthetic considerations. A multi-stored building is one that has more than one storey above ground. By raising the building's floor space without expanding the land it is constructed on, multi-story buildings typically save money and land (depending on the materials used and local land values). In addition to creativity and abstract thought, the design of a multi-story structure necessitates a solid understanding of structural engineering science and current design rules and legislation. These practical knowledge and skills must be supported by a wealth of experience, intuition, and judgement. Standards are meant to guarantee and improve safety while carefully balancing economy and safety.

The process for analysing and designing a particular building will vary depending on its kind, complexity, number of stories, etc. Prior to finalising the structural system and bringing the sizes of the structural parts to the attention of the concerned architect, the architectural drawings of the structure are examined. The processes in the structural design process will vary depending on the kind of building, how complex it is, and how much time is available..

Often, the work is required to start soon, so the steps in design are to be arranged in such a way the foundation drawings can be taken up in hand within a reasonable period of time. Further, before starting the structural design, the following information of data are required:

(i) A set of architectural drawings;

(ii) Soil Investigation report (SIR) of soil data in lieu thereof;

(iii) Location of the place or city in order to decide on wind and seismic loadings;

(iv) Data for lifts, water tank capacities on top, special roof features or loadings, etc.

This project report covers the analysis and design of the G+6 commercial/residential building, which is a future project of Essarjee Constructions Pvt. Ltd. in Bhopal. First, we manually calculated the various loads that will be placed on the beams. Next, we used STAAD Pro to analyse the self-load of the beams and columns, and we also designed the beams and columns using STAAD Pro. In contrast, slabs and staircases were designed manually in accordance with IS 456:2000. A few of the beams and columns are moreover manually examined after which the detailing is completed in AutoCAD drawings and tabular form.A structural engineer needs to ascertain details like structural loads, geometry, support conditions, and material properties in order to conduct an appropriate analysis. Such a study usually yields displacements, stresses, and support reactions. After that, this data is contrasted with standards that denote the circumstances of failure. Stability, non-linear behaviour, and dynamic responsiveness may all be examined in advanced structural analysis.

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2. LITERATURE REVIEW

- V.Varalakshmi (2014 : The design and analysis of multistoried G+5 building at Kukatpally, Hyderabad, India. The Study includes design and analysis of columns, beams, footings and slabs by using well known civil engineering software named as STAAD.PRO. Test on safe bearing capacity of soil was obtained.
- P.Jayachandran (2006): The design and analysis of multistoried G+4 building at Salem, tamilnadu, India. The study includes design and analysis of footings, columns, beams and slabs by using two software's named as STAAD.PRO and RCC Design Suit.
- L.G.Kalurkar (2014): The design and analysis of multistoried G+5 building using composite structure at earthquake zone-3. A three dimensional modeling and analysis of the structure are carried out with the help of SAP 2000 software. Equivalent Static Method of Analysis and Response spectrum analysis method are used for the analysis of both Composite and RCC structures. The results are compared and found that composite structure more economical.
- Swati D.Ambadkar, Vipul S. Bawner, analyzed G +11 building by using STAAD PRO. Analysis is done for various variations such as 1) Terrain with few or no obstructions having heights below 1.5 m. 2) Terrain with obstructions having heights between 1.5 to 10 m. 3) Terrain with numerous closely spaced obstructions having the size of building structures up to 10 m in height.4) Terrain with numerous large high closely spaced obstructions. According to Internal Pressure Coefficients (Cpi) provided for that various variations.

3. Statement of project

Utility of building **: commercial cum residential building**

No of stories **: G+6**

Shape of the building **: rectangular**

No of staircases **: 4**

No. of flats **: 32**

No of shops **: 120**

Type of construction **: R.C.C framed structure**

Types of walls **: brick wall**

3.2 Geometric details

First floor height **: 2.5m.**

Floor height for commercial building **: 3.5m**

Floor height for residential building **: 3m**

Height of plinth level **: 0.6m**

Depth of foundation **: 2.4 m**

Area of each residential flats **: 73.4 sq m**

Materials

Concrete grade **: M20**

All steel grades **: Fe415 grade**

Type of steel bars **: HYSD**

Bearing capacity of soil **: 131 kN/m2**

Poisson's ratio **: 0.17**

Young's modulus of concrete **: 5000**

Density

Plain concrete **: 24.0kN /m3**

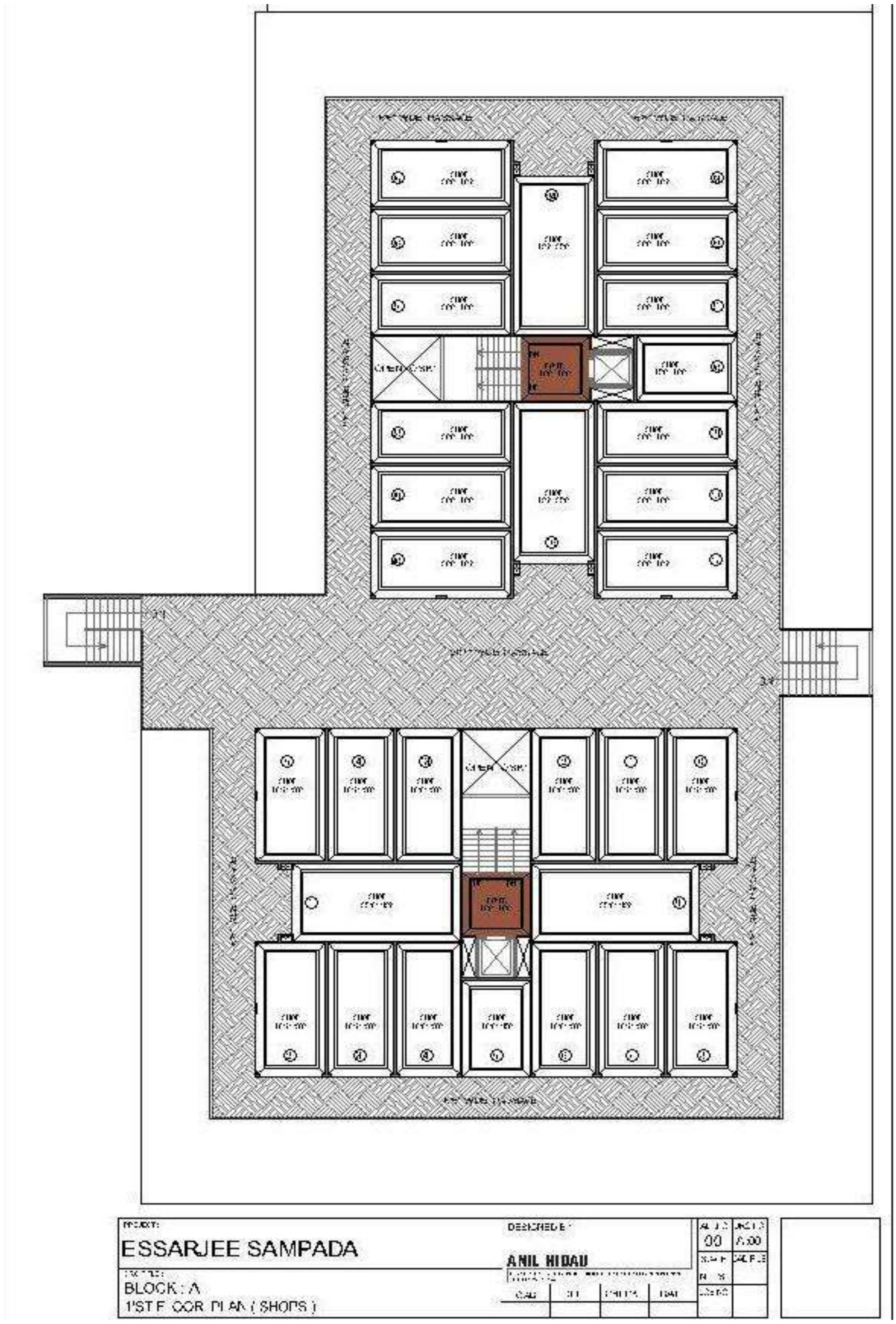
Reinforced concrete **: 25.0kN /m3**

Flooring material **: 20.0kN/m3**

Brick masonry **:19.0kN/m3**

1. **Plans**

Plan of residential apartment



Plan of commercial building

4. OBJECTIVES

This project aims for relearning of concept of structural design with the help of computer aids. Briefly we have gone through following points through out of the project work.

Carrying out a complete analysis and design of the main structural elements of a multi-storey building including beams, columns, slabs, staircase, foundation

Detailing as per the result

Structure designed should satisfy limit state of stability.

It should satisfy the limit state of serviceability.

It should satisfy the criteria of ultimate strength.

Getting familiar with structural soft wares (STAAD Pro, AutoCAD, MS-Excel)

Getting real life experience with engineering practices

5. METHODOLOGY

1. Literature review on previous researches.
2. Statement of the project
3. Objectives of the project
4. Modeling
    a. Creation of nodal points
    b. Representation of beams and columns
    c. Assigning supports and properties
    d. 3D rendering view
    e. Assigning of dead loads as per IS 875 Part 1
    f. Assigning of live loads as per live load as per IS 875 Part 2
    g. Adding of load combination
    h. Analysis of the structure
    i. Concrete designing as per IS 456:2000

6. CODES

- **IS 456-2000 Plain and Reinforced Concrete - Code of Practice**

It is an Indian Standard code of practice for general structural use of plain and reinforced concrete.The latest revision of this standard was done in year 2000, reaffirmed 2005. This code uses the limit state design approach as well working stress design approach. It is written for use in India. It gives extensive information on the various aspects of concrete.

- **SP:16-1980 Design Aids for Reinforced Concrete to IS:456-1978**

The structural practice handbook SP:16-1980 Design Aids for Reinforced Concrete to IS:456-1978 has tables and charts that helps structural engineers to rapidly design simple sections. Even though the design aid is based on the 1978 code, it continues to be used without revision as there have been no major changes to Section 5, on which the design aid is based.

- **IS 875 : Part 1 : 1987 Code of practice for design loads (other than earthquake)vfor buildings and structures**

It deals with the dead loads, Unit weights of building material and stored materials

- **IS 875 : Part 2 : 1987 Code of practice for design loads (other than earthquake) for buildings and structures.**

It deals with the various types of imposed load that can come on different types of buildings

Loads Calculation

Dead Loads:

Dead loads consist of the permanent construction material loads compressing the beam, column, roof, floor, wall, and foundation, including claddings, finishes and fixed equipment. Dead load is the total load of all of the components of the components of the building that generally do not change over time.

As per IS: 875 (Part 1) - 1987

Dead Load of slab

Dead Load for 110mm thick slab

(i) Dead load= 25 X 0.11 X 1 X 1 = 2.75 kN/m^2

(ii) Floor finish load= 25 X 0.04 X 1 X 1 = 1 kN/m^2

(iii) Ceiling load= 20 X 0.01 X 1 X 1 = .2 kN/m^2

Total Dead load= 3.95 kN/m^2

Dead Load for 100mm thick slab

(iv) Dead load= 25 X 0.1 X 1 X 1 = 2.5 kN/m^2

(v) Floor finish load= 25 X 0.04 X 1 X 1 = 1 kN/m^2

(vi) Ceiling load= 20 X 0.01 X 1 X 1 = .2 kN/m^2

Total Dead load=3.7 kN/m^2

Dead Load of Wall

Dead load of 200mm thick wall = 20×.20×2.7=10.8kN/m

Dead load of 100mm thick wall = 20×0.10×2.7=5.4kN/m

Dead load of 100mm thick parapet wall = 20×0.10×1.050=2.1kN/m

Dead Load of Staircase:

Weight of waist slab in plan:

$=D\sqrt{1+\frac{R^2}{T^2}}\times 25$

$= 0.225\sqrt{1+\frac{0.15^2}{0.25^2}}\times 25$

=0.225×1.17×25

= 6.58 kN/m

Weight of step :

= 25RT/(2T)

= 25×0.15×0.25/(2×0.25)

=1.875 kN/m

For landing :

=0.225 ×1×25

=5.625 kN/m

Total dead load = 5+5.625

= 10.625 kN/m

Live load

Live loads are produced by the use and occupancy of a building. Loads include those from human occupants, furnishings, no fixed equipment, storage, and construction and maintenance activities. As required to adequately define the loading condition, loads are presented in terms of uniform area loads, concentrated loads, and uniform line loads. The uniform and concentrated live loads should not be applied simultaneously n a structural evaluation. Concentrated loads should be applied to a small area or surface consistent with the application and should b e located or directed to give the maximum load effect possible in endues conditions.

As per IS: 875 (Part 2) - 1987

1. Mercantile building

   (i) Shops = 4.0 kN/m^2

   (ii) Corridors passages staircases balconies = 4.0 kN/m^2

2. Residential building

   (i) Rooms & kitchen = 2.0 kN/m^2

   (ii) Toilets & bathrooms = 2.0 kN/m^2

   (iii) Balconies = 3.0 kN/m^2

   (iv) Staircase = 3.0 kN/m^2

Load combinations

All the load cases are tested by taking load factors and analyzing the building in different load combination as per **IS: 456-2000** and analyzed the building for all the load combinations and results are taken and maximum load combination is selected for the design.

As per IS: 456-2000load combination factor is 1.5(DL + LL)

7. Conclusions

- Last but not the least, though Staad is being progressively used in various types engineering structures viz., high-rises, bridges, foundations, pilings and even piping..As a result the engineers are now mostly entirely depending on the software for the analysis and design.We are losing our understanding on the behavior of the structure and are merely working with numerical results thereby compromising with proper engineering sense.So it must be clearly understood that even the most sophisticated analysis/design packages should require a skilled structural engineer to drive it.
- Also STAAD has certain inherent drawbacks. It is concluded that in spite of its numerous advantages Staad Pro is silent on certain aspects like Soil- Structure Interaction and High Strength Concrete. Staad Pro does not throw light on concrete grade beyond M40 and also steel grade beyond Fe500 in its RC Designer part whereas other softwares like SAP, E Tabs etc. have provision to change/modify the material properties in this issue.
- In future Staad needs to update itself in modifying the material properties part and also in assigning member properties by highlighting more on the local aspects like developing more pop-ups in individual local floor levels. Like the recently introduced software Tekla, it should have provisions in investigating any local aspects by simply windowing on the structure itself.
- In this study, performance of institutional building frames are studied considering various combination and seismic parameters. Results of this parametric study are as follows 1. In beam forces, maximum bending moment and maximum shear force are calculated and it is observe that second floor is critical and ground floor is efficient because of direct contact with soil and foundation. 2. In column force, maximum axial force is calculated and it is observed that maximum load is in base columns because it resist complete load of institutional building and as seen in top floor axial force is reduced up to 4 times of base 3. In joint displacement, maximum displacement is seen in top floor in both direction (X and Z direction) but Z direction is more critical than X direction. 4. In section displacement, maximum displacement is seen in first floor section in both direction (X and Z direction)

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