PLANNING, ANALYSIS, DESIGNING AND ESTIMATIONOF RESIDENTIAL BUILDING

Mr. M RAMA MANIKANTHA [1]| Dr. D VENKATESWARLU [2]| Mr. SAURAV KUMAR [3]| Mr. K ALEKHYA [4]| Mr. P N S S LAKSHMAN [5]| Mr. K RAVI KANTH [6]

[1]Assistant Professor, Civil Engineering, GIET (A), Rajahmundry, A.P, India
[2]Professor & HOD, Civil Engineering, GIET (A), Rajahmundry, A.P, India
[3,4,5,6] B. Tech Students, Civil Engineering, GIET (A), Rajahmundry, A.P, India

ABSTRACT

The project focuses on designing and estimating a residential building with two flats using Indian Standard codes. Planning involved the use of AutoCAD and Revit software for creating floor plans, elevations, and interior/exterior designs. Structural analysis was conducted manually and with STAAD Pro V8i Software. Designing structural components adhered to Indian Standard Codes using the Limit State Method. Estimation includes finding the quantities of materials required for the development of the structure and requirements of labor etc. In Estimation only the quantities of different materials are calculated manually. This project highlights the importance of providing adequate shelter, a fundamental need for habitation, while emphasizing the significance of using appropriate standards and technologies to achieve a successful outcome.

Keywords: Residential Buildings, AutoCAD 2023, Revit 2021, STAAD Pro V8i, IS 875 (Part-1), IS 875 (Part2) and IS 875 (Part-3) – 1987.

I. INTRODUCTION

Introduction In a rapidly urbanizing world, the provision of adequate shelter stands as a fundamental necessity for human habitation. In India, where population density and urban migration rates continue to surge, the demand for housing solutions that are not only efficient but also adhere to stringent standards is more pressing than ever. The project at hand addresses this critical need by focusing on the planning, design, estimation, and construction management of a residential building comprising two flats, utilizing Indian Standard codes and contemporary technologies.

The Endeavour begins with meticulous planning, employing industry- standard software such as AutoCAD and Revit Architecture to craft comprehensive floor plans, elevations, and interior/exterior designs. Central to the project's success is the structural analysis phase, where both manual calculations and STAAD Pro V8i, are leveraged. By subjecting the proposed structure to rigorous scrutiny, engineers ascertain its structural integrity and resilience against various loads and environmental factors. Adherence to Indian Standard Codes, particularly through the Limit State Method, guarantees that the design withstands the test of time and complies with the nation's regulatory framework.

Estimation includes finding the quantities of materials required for the development of the structure and requirements of labor etc. In Estimation only the quantities of different materials are calculated manually.

In conclusion, the project exemplifies a holistic approach to residential building development in India, where innovation, adherence to standards, and efficient management converge to address the burgeoning demand for shelter. As the nation marches towards a more sustainable and equitable future, endeavours such as this pave the way for resilient communities and vibrant urban landscapes.

II. LITERATURE REVIEW

[1] S. HARISH AND L. RAMAPRASAD REDDY (2023) - This paper was discussed briefly entire structure from top to bottom required parameters of foundations, different types of columns different shapes of beams. The design of storage building is taken as different methods limit state and working stress method based upon on the experimental results. Planning and designing are also used in various software like Auto Cad. In this case learned about particular thing is design in right track for calculation.

[2] R.D. DESHPANDE (2022-23) - This project makes an attempt to view the construction working of varied elements in the multi-storied building. Designing and scheming and evaluation of multi-storied building has been done for G+2 building. According to material properties the loads are calculated is taken from code IS 875 part-II and piles are schemed based on protected bearing capacity of soil.

[3] PRAVIN KUMAR JAGTAP, CHAITANYA PATEL, LISHA RAORANE 2022: In this present

study we have planned and schedule G+20 residential building and allocate the needed resources and after that we got the estimated cost of the construction. To reduce the complexity of construction project various tools like Primavera p6, M.S project are effective project software tools used for proper planning, scheduling and detailed cost 5 estimation of various activities, resources involved in the project.

[4] PRANAV SAI GAJAPATHI RAJU DANTHULURI (2021)– This project contains Details Estimate For G+2 Storied Building presentation, they have done the designing using STAAD Pro and estimated from sub structure to super structure, they also estimated interior designing and wooden work required in the completion of the project, they solely followed national building codes for the construction on the building so that it does not violate any governments norms.

[5] SUYOG R JADHAV (2017- 2021) – As Manual design and analysis of structural elements of buildings is time consuming, it can be reduced by using software such as sturds. They have used Civil engineering software to reduce human labor work, AutoCAD plans can be easily imported to. Detailed report of analysis and design of all the structural elements can be obtained. The advantage of is that the detailing of the structural elements can also be obtained as an AutoCAD file report.

[6] ATIKA PATHAN, NIDHI SONAVANE AND PRADUMAN SINGH (2021) -In this project on "Design of a 6-storeyed building". A Residential building design was performed as Auto cad and Staad-pro software. The building comprises structures for the superstructure and concrete for substructure. This design was safe and can be implemented. Also, a market survey was undertaken for the market rates of various materials and activities on different construction sites.

[7] HANDAYANI, DELLY NOFIANI (2021): The project scheduling system that can accommodate projects that have large-scale activities by proposing scheduling and risk analysis using primavera p6 and primavera risk analysis. The method demonstrates practical value for project managers in identifying the shortest project duration and estimation the most optimal time duration for carrying out activities.

[8] MOHAMMAD WAFFY FAZIL (2021) – In this research they have focused to avoid cost overrun in the project. Their aim is to provide a basis to improve cost estimation performance in construction. Their primary objectives were to synthesize the factors that are affecting cost estimation performance in construction

projects and propose future directions regarding cost estimation performance based on the identified factors.

[9] ALISHA SK (2020) – The aim of this project was to provide the residential building as economical as possible and also to reduce the seismic effects on it, because shelter is one of the basic requirements for anyone, they have followed various rules and regulation on construction of residential building authorized by the government, they have the structure is analyzed both manually and in STAAD Pro as per (IS: 456- 2000) with a different load condition on it.

[10] PANKAJ D. VARSANI, PROF. AMIT N. BHAVSAR (2020): Planning of such projects requires huge amount of paper work time, which can b reduced with the help of project planning software. Providing good planning, proper organization, sufficient flow of resources to a project cannot automatically achieve the desired result.

[11] SACHIN NALAWADE, OMKAR GHODE, PIYUSH VAIDYA (2019): Most of the construction project suffers from cost and time overruns due to multiple factors. Earn value management is a project performance evaluation technique and which has been adapted for construction management.

[12] SHAH HARSH, PROF MAMATA RAJGOR DR. JAYESH KUMAR PITRODA (2018): The main objective of this study is to plan, schedule and track an industrial project with the help of Primavera P6 software and study the results generated. Also to recommended measures to the organization for enhancing their project planning skills for similar projects in future.

[13] MANORANJAN ROY – (2018) – This project contains Details Estimate For G+2 Storied Building presentation, they have done the designing using STAAD Pro and estimated from sub structure to super structure, they also estimated interior designing and wooden work required in the completion of the project, they solely followed national building codes for the construction of the building so that it does not violate any governments norms.

[14] MVK. SATISH (2017)- He examined and designed a G+3 hospital building and its facility arrangement reaction to seismic load were studied using STAAD Pro and after were investigated through a 3Dnon linear reaction history examination and corrected with non-linear static working methodology (NSP), this study recommends utilization of modular NSP rather than first mode NSP as it gives better result while comparing building structures.

[15] SAFWAN AHMAD (2017)- Designed a G+2 hospital building using STAAD Pro by applying suitable loads and sectional details to component within the main aim of this factor was to study the extent of credibility of using STAAD Pro for analysis Dr. Ashokkumar et.al (2017) designed a G+3 hospital building using substitute frame method in STAAD Pro the efficiency of analyzing using software over manual method was analyzed and a comparative analysis was carried out.

[16] UDAY KUMAR (2017) – As Manual design and analysis of structural elements of buildings is time consuming, it can be reduced by using software such as STRUDS. They have used Civil engineering software to reduce human labor work, AutoCAD.

III. METHODOLOGY

First, we visited the site where we have to build the residential building after that we measured the dimensions of the field then we started planning according to the dimensions of the plot. A drawing was made for the plan of the plot with the help of software Like AutoCAD and Revit.
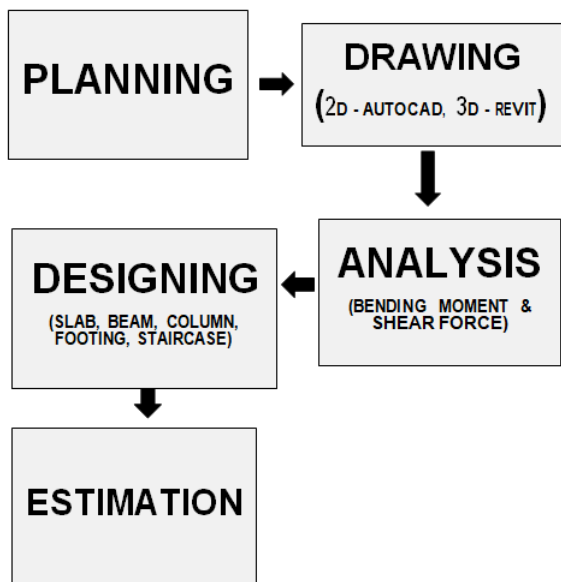

Figure 1 Flowchart methodology

After that we started our analysis on the basis of the plan made and it can be done manually or through software but we are doing it with the help of Staad Pro V8i. After this Designing will be started. Bending moment, shear force, slabs, beams and others factors will be taken into account while designing the residential building. At last estimation of the building will be done by taking all the material used while Construction of the residential building and it will also

include the labor charge on it. we used AutoCAD for creating 2D, and Staad pro for analysis of the residential building. Revit was also used to create the 3D view of the residential building.

IV.PLAN

Building plans are a graphical representation of what a building will look after construction. They are used by builders and contractors to construct buildings of all kinds. Building plans are also useful when it comes to estimating how much a project will cost, and preparing project budgets.

Study area:

1. Project location: Rajanagaram, (East Godavari Dist.) near GSL Medical College & General Hospital.
2. Type of building: G+2 Residential Building.
3. Total area: 300 sq. m.
4. Type of soil: Red soil.
5. Safe Bearing Capacity of soil (SBC): 200 KN/m^2

Building Bye Laws and Regulations:

1. Line of building frontage and minimum plot sizes.
2. Open spaces around residential building.
3. Minimum standard dimensions of building elements.
4. Provisions for lighting and ventilation.
5. Provisions for drainage and sanitation.
6. Requirements for off-street parking spaces.
7. Requirements of landscaping.
8. Size of structural elements.

Details of the Project:

1. Type of Building: G+2 residential building.
2. Number of storey's: 3 storeys'.
3. Type of foundation: Isolated foundation.
4. Height of Building: 9.5m from G.L
5. Total gross area of building: 300 sq m
6. Column size: 230mm × 400 mm
7. Beam size: 230 × 300 mm
8. External wall thickness: 230 mm
9. Internal wall thickness:115 mm

Material properties as per is: 456-2000

1. Grade of steel = Mild steel or higher grade as required and applicable.
2. Grade of concrete = M25
3. Density of R.C.C = 25 KN/m³
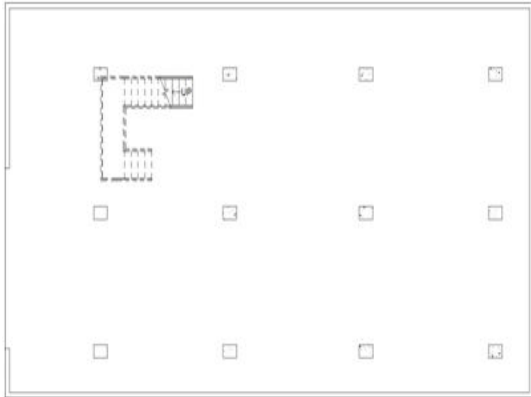
V. PLAN VIEW OF G+2 RESIDENTIAL BUILDING

Figure 2 Plan of ground floor

Figure 3 Plan of first floor

Figure 4 plan of second floor

Figure 5 Front elevation of the building (All dimensions are in mm)

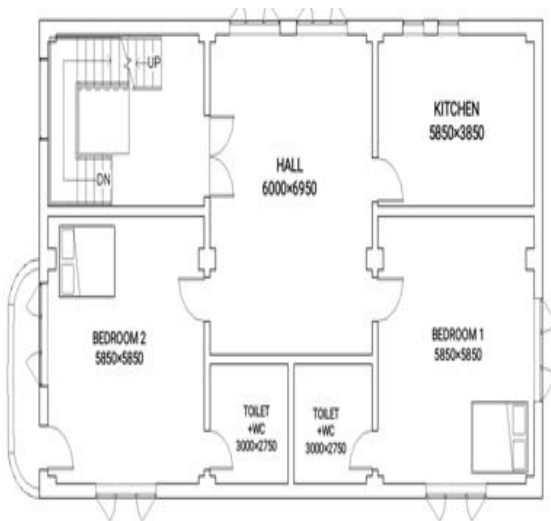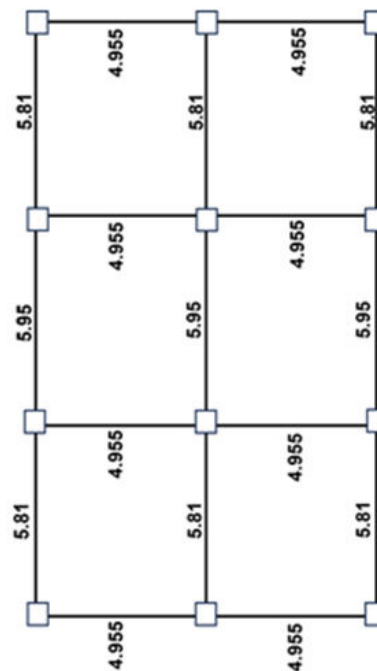**Figure 6 overall 3d rendered view**

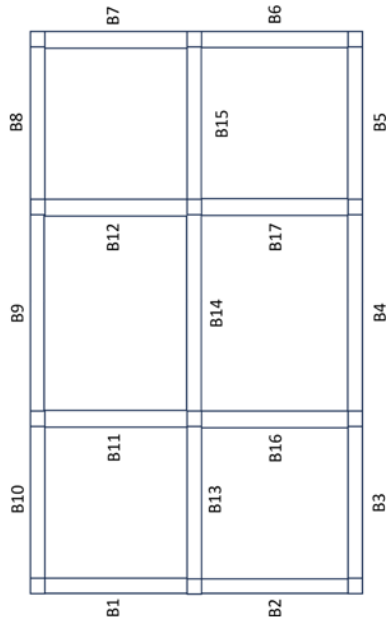**Figure 7 Beams length on each Floor of Building**

Figure 8 Beams Numbering

VI. GRAVITY LOAD ANALYSIS

Load Analysis is the process of determining forces in each element in a structure. Gravity load include" dead", or permanent load, which is the weight of the structure, including walls, floors, finishes and mechanical systems and" live", or temporary load, which is the weight of structure's contents and occupants.

Load Calculations on Beams:
For Slab 1, Slab 2, Slab 5 & Slab 6:
B2, B4 are shorter beams = 4.955m
B1, B3 are longer beams = 5.81m
- Thickness of slab = 0.15m
- Density of concrete = 25 kN/m^3
- Dead load = 3.75 kN/m^2
  (IS 875-1978 Part - 1)
- Live Load = 2 kN/m^2
  (IS 875-1978 Part - 2)
- Floor load = 1 kN/m^2
  (IS 875-1978 Part - 3)
- Total load = W = 6.75 kN/m^2

Load distribution on shorter span = [6.75 X 4.955/3] = 11.14875 kN/m^2
Load distribution on longer span = [6.75 X 4.955/6] [3-(4.955/5.81)^2] = 12.6686 kN/m^2

For Slab 3 & Slab 4
B2, B4 are shorter beams = 4.955m
B1, B3 are longer beams = 5.95m
- Thickness of slab = 0.15m
- Density of concrete = 25 kN/m^3

- Dead load = 3.75 kN/m^2
  (IS 875-1978 Part - 1)
- Live Load = 2 kN/m^2
  (IS 875-1978 Part - 2)
- Floor load = 1 kN/m^2
  (IS 875-1978 Part - 3)
- Total load = W = 6.75 kN/m^2

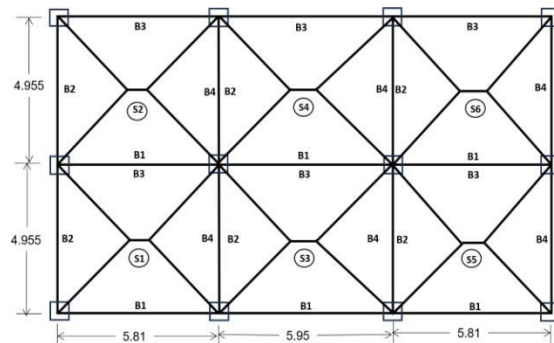Load distribution on shorter span = [6.75 X 4.955/3]
= 11.14875 kN/m^2

Figure 9 load distribution on beams
(BEAMS – B1, B2, B3, B4, SLABS – S1, S2, S3, S4, S5 & S6)

VII. DESIGN METHODOLOGY
A reinforced concrete structure should be so designed that it fulfills its intended purpose during its life time with:
a. Adequate safety, in terms of strength and stability.
b. Adequate serviceability in terms of stiffness and durability.
c. Reasonable economy.

The following are used for the design of reinforced concrete structures/ elements:

a. Working Stress Method (WSM)
b. Limit State Method (LSM) In this project,

We are used limit state method of design. So, let us discuss the concept of limit state method.

Design of Footings:
- Size of Column = 230 X 400 mm Axial Load (P)= 600 KN
- Self-weight of footing = 10%
- Safe bearing capacity of soil= 200 kN/m^2
  M25= fck = 25 kN/mm^2
- Fe 415= fy= 415 kN/m^2

Design of Column:
- Dimension:0.23m × 0.4m
- Axial Load (P):600 kN

- Factored Load (Pu):1.5 × 600= 900 kN
- M25 Fck:25 N/mm2
- Fe 415 Fy:415 N/mm2

Design of Slab:
- Lx = 10 m, Ly = 18 m
- Live load = 3 kN/m^2
- Floor finish = 2 kN/m^2
- fck = 25 MPa
- fy = 415MPa

Design of Beam:
- Support width = 230mm
- Effective span = 9.6 m = 9600 mm
- Live load = 20 kN/m
- M25 = fck = 25 N/mm^2
- Fe 415 = fy = 415 N/mm^2

Design for Staircase:

- Type of Staircase = dog legged staircase.
- Rise = 150 mm Tread = 300 mm
- Width of landing = 300 mm
- Fck = 20 N/mm2
- Fy = 415 N/ mm^2

VIII. ANALYSIS OF BUILDING IN STAAD Pro V8i

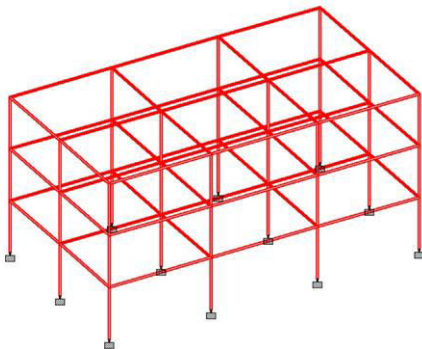| 1.	Type of Building	Residential Building
2.	No. of Stories	G+2
3.	Floor Height Ground Floor Remaining Floor	3.5 m 3.0 m
4.	Material	Concrete M20 & Reinforcement of Steel Fe415
5.	Size of Beam	230m X 300m
6.	Size of Column	230m X 400m
7.	Size of Wall	300m

Table 1 Building Data for Analysis

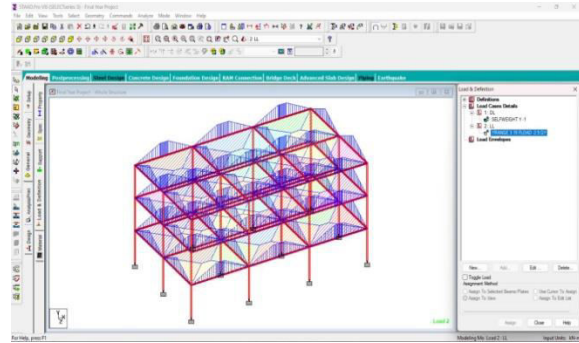**Figure 10 Three-dimensional rendered view of the building from STAAD Pro V8i**

Figure 11 Live loads Distributed to the nearing supports in Building Components
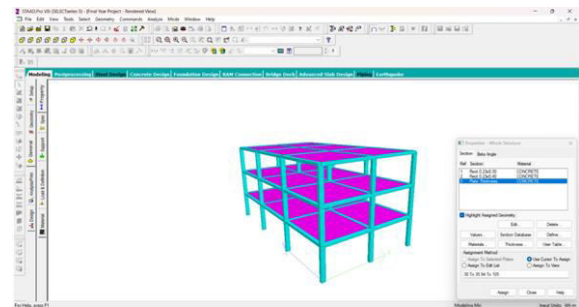

Figure 12 Rendered View of Beams, Columns, Slabs of Residential Building with Plate mesh

IX. ESTIMATION

Before the start of any work for its execution, the owner of the builder should have a thorough knowledge of the volume of work. The minutest details can help him understand if the work can be completed within the stipulated time frame and budget. It also enables him to understand the probable cost that may be incurred to complete the proposed work. Therefore, it is necessary to list the probable costs or develop an estimate for the proposed work from its plans and specifications. An estimate is prepared by calculating the quantities from the drawings for various items and multiplying them with the unit cost of the item concerned. To prepare an estimate one requires

- Drawing: - The drawing is the basis from which quantities of various items for a work are calculated. The drawings consist of the plan, the elevations, and the sections through important points.
- Specifications: - General Specification: - The general specification forms the general idea for the project. In this, the nature and class of work and the names of materials that should be used are described. - Detailed Specification: - Detailed specification describes every item of work in the estimate. This specification of work serves as a

guide to execute the work to the owner's satisfaction.

- Rates: Rates for different items of works are vital factors to determine the estimated cost.
- Standing circulars for taxes and insurance etc. are required to fix up rates of that item which are not in the schedule of rates.

X. CONCLUSION

Based on the work carried out, the following conclusions were made:

1. In this project, PLANNING, ANALYSIS, DESIGNING AND ESTIMATION OF RESIDENTIAL BUILDING is carried out.

2. We all the members of our team have learned to plan a building (with referring to National Building Code of India-2016). This project has made us to learn Drawing and Drafting the building plans using AUTOCAD software.

3. The gravity load analysis performed manually as per IS code, through which the bending moments are obtained.

4. Using STAAD Pro software, the analysis has done as per IS codes. The design is safe in all aspects.

5. Finally, manually and software results are compared and observed that they are approximately equal.

6. The design of slab, beam, and column are design in limit state method, which is safe at control of deflection and in all aspects.

7. Finally, the structure is designed to withstand safely all loads liable to act throughout its life time; it shall also satisfy the serviceability requirements.

8. Manual estimation of G+2 residential building was studied. The quantities of all the work were tabulated floor wise.

9. From the above works we got a clear display of quantities of G+2 residential building.

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