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Design of G+2 Residential Building

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A B S T R A C T

The project explained the design and modelling of the G+2 residential building by using Autodesk Revit architecture (with BIM new technology) as it gives a clear vision via design, construction and documentation. With the advancement of technology, the use of software to solve numerous problems in every technical discipline that formerly took a long time has become quite common. As a result, the use of software technology in the field of civil engineering to analyse, design and predict the behaviour of civil engineering structures before their life span has increased dramatically over the last decade.

The project describes the analysis and design of residential buildings. The area of the building is to be conducted 63.25sq.m. (G+2) will be constructed frame structure. The analysis of the frame to compute the force and moment will be carried out with Stadd Pro software. The analysis of structure was done by using stadd pro software analysing as well as IS-456:2000 code of practice for plain and reinforced cement concrete.

The structural members like slabs, beams, and columns, are designed with the limit state method using the national building code and ISn456:2000 grade concrete and grade of steel are to be used. The project aims to develop independent and creative thinking through fundamental theoretical knowledge we obtained during the study practical application field.[1], [2],

Keywords: Components, Levels, R.C.C Elements, Plan, Section and 3D Model.

1. Introduction

Building with 3D model and 2D environment with the help of Revit software. 3D representations of the models are to assist in sequencing, visualisation, and planning of critical construction activities however this practice greatly diminished since the adoption of Revit software. The engineering information provided to the construction plays a vital role in the construction process. The poor information leads to inefficient design communication and hence results in construction rework which comes up with cost. Residential Building a model helps you to understand detailed information or visualise of structure, including labour (a proper vision of a structure is developed before construction using Revit software. Nowadays due to overpopulation and the high cost of land, multi-stored buildings are more essential for metropolitan cities. Multi-storied residential buildings are the perfect solution for living in high-population areas. A multi-storied residential building which possesses multiple floors above the ground level, which aims to increase the floor area of the building in the shortest built-up area. So, to satisfy these needs and make the process easy a new software called Revit Architecture. By the use of BIM (Building Information Modelling), we can make the clients clearer about the physical and functional characteristics of the place. As BIM involves the generation and management of digital representation. [3]–[10]

2. Literature Review

1. ***M.Mallikarjun,Dr.p.v. Surya Prakash (2016)*:** Carried out a study on the analysis and design of a multi-storied residential building of ung-2+G+10 by using the most economical column method and the dead load and live load and live load was applied on the various structural components like slabs, beams, and found that as the study is carried using most economical column method this was achieved by reducing the size of columns at top floors as the load was more at the bottom floor.
2. ***P.P. Chandurkar et al (2013)*:** Had presented a study of a G+9 building having three meters in height for each storey. The World Building design was carried out according to the IS code for seismic resistant design and the building was considered fixed at base.
3. ***Geethu et al.(2016):*** Made a comparative study on the analysis and design of the multi-storied building by STADD PRO software. They provided the details of both residential and commercial building design.

4. ***Chandrashekar (2015)*****:** Analyzed and designed the multi-storied building by using STADD PRO software. A G+5 storey building under lateral loading effects of wind and earthquake was considered for the chances of occurrence of the spread of fire and the importance of fireproof material up to the highest possible standards of performance as well as reliability.

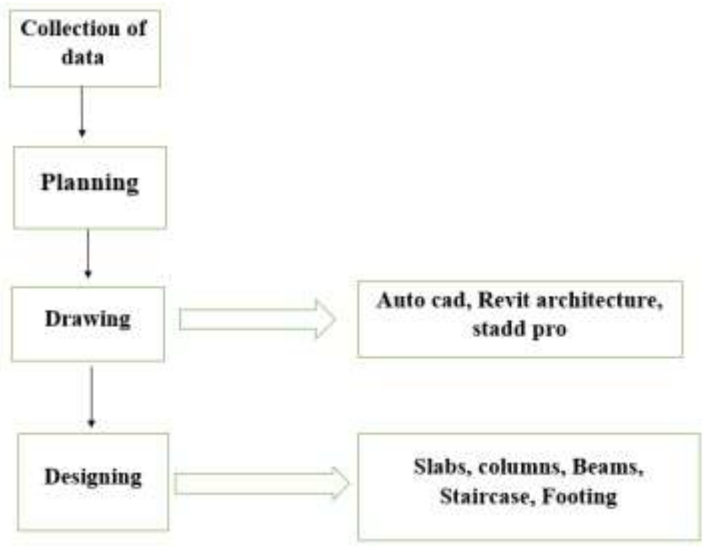
5. ***J.Vinoth Kumar(2009)***: The study concentrated on the deployment of the model to support model to support planning, and scheduling tracking of the job site operation in India.

6. ***Saeed Reza Mohandse (2015-2012):*** Due to the numerous steps of the construction industry and its complicated and extensive structure, errors and reworks often might happen in this section. As such, BIM (Building Information Modelling) is regarded as a beneficial tool for minimizing waste and improving the efficiency of building construction. This paper reviews and summarizes a substantial design.

7. ***A.Sachin G. Mahesh (2020):*** Predictability of building operations greatly improved. The includes utilization of beam for visualization, 3d coordinates, planning and scheduling.

8. ***Mehmet. F.rgunsal (2020):*** The project studied six BIM utilization activities: visualization,3D coordination, cost estimation, prefabrication, construction planning and monitoring.

3. Research Methodology



In this project the following software is used for planning, modelling, analysis and designing of residential buildings:-

1) AUTOCAD:- used for Drafting and Architecture.

2) REVIT ARCHITECTURE:- use for 3D modelling

3) STADD PRO:- Use for Analysis and Designing.

- Modelling is an activity or process in which we think about and make models to describe how objects like buildings, houses, or any other construction work in real and how they look in real estate.
- A model is generally considered a physical representation of an object and maintains an accurate relationship between all of its aspects.
- Autodesk Revit and Autocad are building information modelling software for Architects, Engineers, and Designers. It allows users to design a building and all its components in 3D and finally annotate the model with 2D drafting elements and access building information from the building model database. [11]–[16],

4. Plan Details

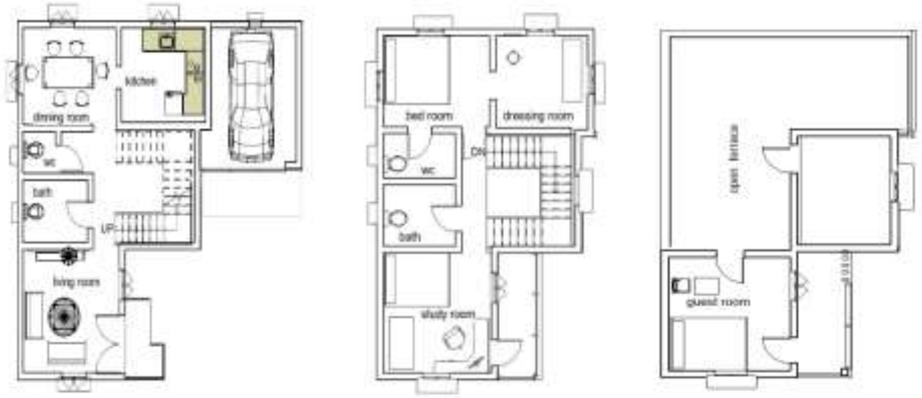


Fig. 1 (a) **Fig. 1 (b)** **Fig. 1 (c)**

Fig. 1: (a) shows GF, (b) shows FF, (c) shows SF

4.2 Dimensions

GROUND FLOOR	**FIRST FLOOR**
1) living room - 3.54 x 3.63m	1) study room - 3.54 × 3.63 m
2) kitchen - 3.50 × 3.18m	2) bedroom - 3.50 × 3.18 m
3) dining room - 3.18 × 2.94 m	3) Dressing room – 3.18 x 2.94m
4) bath - 2.20 × 1.2 m	4) WC – 2.30 X 1.64m
5) WC- 1.20 × 1.20 m	5) Bath – 2.30 x 1.60m
6) car parking - 4.06 × 3.24 m	

SECOND FLOOR

1) Open terrace – 6.66 x 6.80m
2) Guest room- 3.77 x 3.83m

4.3 Data Collection

Design of one-way slab

Clear span = 7×3m

L.L = 1.5KN/m2

Using M20andFe415

Ly / Lx = 7/ 3 =2.33 > 2

Effective depth(d)

d= (l/26)× M.F

(IS 456: 2000pageno: 38MF = 1.3)

d = (3000/ 26)×1.3 = 90mm

Taking ′ d′ = 120mm

D=125+20+ 10 / 2 =150mm

(assumediaofbaris10mm)

Effective span length (Le)

Le=3000+125=3.125m

Load calculation

T.L=0.15×25+1+1.5=6.25KN/m2

F.L=6.25×1.5=9.375KN/m2

Factored bending moment (Mu)

Mu= (9.325×3.1252)/16 =5.722KNm

(for continuous slab atthemidofinterioris1)

Check for depth

(dreg)2= Mu/ 0.138×fckbd

(dreg)=46mm<provided

Hence, it is safe

Main steel (Ast)

Ast = Mu/ 0.87×fy(d−0.42u)

Ast = 5.722×102/ 0.87×415×(125.42×0.48×d) =180mm2

Spacing= 3.141×52/ 180×1000=280mmc/c

Distribution bars

Ast min=180mm2@280mmc/c.

Design of two-way slab

Ly / lx= 7/4.75=1.5<2

Effective depth(d)= lx/26∗1.5=125mm

Overall depth(D)=125±20±10/ 2 =150mm

Effective span(eff)=4.75±0.125=4.875m

5.2.1 Loads

D.L=0.15×25=3.75KN/m2

L.L=2KN/m2

F.F=1KN/m2

Wu=10.125KN/m2

Mx=24.54KN−m

My=11.55KN−m

5.2.2 Check for depth

d2= 24.54/ 0.138×20×1000

dreq=95<provided

Hence, it is safe

Main steel

Astx= Mx / 0.87×415×(d+0.42×0.48d)

Astx=604mm2@120mmc/c(using10mmbars)

Asty = 11.54 × 103 / 0.87 × 415 ×(d−0.42×0.48d)

Asty = 294mm2@270mmc/c(using10mmbarsLy / lx= 7/4.75=1.5<2

Design of column

Data

Axial load= 400KN

Length=3.3m

Column size

200x300mm M20andFe415grades

Effective length

leff =0.6×l (both sides fixed)

leff = 0.6 ×3.3 = 2.145m

Factored load

pu = 1.5×400 = 600KN

Main steel

pu = 0.4fck ×Ac

+0.67fy ×Asc

Assume Asc = 1% of gross area, then we get

Asc = 678.58mm2, (using12mmdiabar)

Lateral ties

using 8mm dia bar

Spacing 200mm, (least lateral dimension)

Design of beam

Data

Clear span=4.75m

Depth of flanges Df = 150mm

bw = 200mm

Imposed load = 112KN/m

UseM20andFe415steelgrades

deff = span\15 = 4750\ 15 =320mm6)

D=320+20+25=360mm

Effective span

leff = 4.75 + 0.2 = 4.95m

Loads

F.L=1.5×112 = 168KN/m

Bending moment

Mu = wl2 8 = 0.125× 168× 4.952 8

Shear force

Vu = wl 2 = 0.5× 168× 4.952

Breath of flanges

bf = (l6 +bw +6Df)

bf = (4.95=514.55KN −m=415.8KN 6 +0.2+6×0.15) =1925mm

Moment capacity

0.36fck × bf × Df (d −0.416Df)

1925 ×150×0.36×20× (320−0.416×150) = 535.55KN −m > required

Tension reinforcement

(Ast) = mu /0.87fy

D (1 − 0.42× 0.48d) = 545mm2

Providing Ast = 3no′ sof14mm at bottom, 2no′ s of 10mm at top

total = 618mm2

Shear reinforcement

τc = 0.28N/mm2

τv = vu/ bwd

(5.1) τv = 6.49N/mm2 > 0.28N/m2

Sv = (0.87fyd) τv

Sv = 220mmdiaofbar = 8mm For nominal beam = bw = 200mm, D = 300mmadequate

Design of staircase

Data

Height of story= 3 m

Size of stair hall= 3.24x2.67 m

Support width=200mm

L.L=2 KN/m2

UsingM20andFe415grades

Rise = 150mm, Tread = 300mm

No. of rises = 1650

150 =11

No. of treads = 11 −1 = 10

Effective length

leff = 3000 +1500+ 200 2 =4600mm

Effective depth

Waist slab d= 4600 25 =180mm

Depth

(D)=180+15+ 102 = 200mm

A dop t D = 150mm

Load calculation

Self-weight of waist slab =180 (√ 1502 +3002 300) =4.19KN/m2

Self-weight of step per meter length

150/2 ×24=1.8KN/m2

F.F = 0.75KN/m2

L.L = 2KN/m2 F.L = 1.5×8.74 = 13.11KN/m2

Bending moment

Mu = wl2 / 8 = 34.67KN/m

Check for effective depth

d2 = 34.67× 103 0.138×20×200

= 112 < provided

5.5.9 Main steel

Ast =0.87×415(180 − 0.42 × 0.48 × 180) = 711mm2

π 4 ×102

711 ×1000=100mmc/c,(Using10mmdiabars)

Distribution bars Ast min = 180mm2@250mmc/c, (Using8mmbar

Design of footing

Data

Considering SBC of soil= 200KN/m2

column size = 200x300mm

Using M20 and Fe415 grades

Load

P=400KN

p+10% ×p, (for self-weight of footing)

400+ 10/100 ×400 = 440KN

F.L = 1.5×440 = 660KN

Area of footing

P/SBC = 440/200 = 2.2m2

Providing square footing on each side = 1.5m

Bending moment

M=Area × stress × (0.65/2) M= (1.5×200) × (0.65/2) =97.5KNm

Depth of footing

d2 = 97.5×106 /0.138 × 20 ×200 = 420mm

Overall depth D = 420 + 60 = 480mm, (cover = 60mm)

Main steel

Ast = 0.5× 415/20

Ast = 623mm2

∫ (1 − (1 −4.7×97.5×106/ 20 ×1500×4202)1500×420)

Ast min = 0.0012 ×1500×480 = 864mm2

Check for shear

Shear force = 293.33× [15002 − (200 + 420)2] = 529.05KN

Shear force = τv = 529.05/ 200 ×420 = 0.0062N/mm2

Permissible stress

τ c = o.25 × √20 = 1.11N/mm2

Hence it is safe

Spacing

π 4 ×102 /864 =100mmc/c, (Using10mmbars@12no, s)

Permissible stress

τ c = 0.25 × √20 = 1.11

Hence, It is safe.

5. Results & Conclusion

Fig 2 Structural design of plan

fig. 3 Rendering view of the plan

In this report, the design of the multistorey building for residential purposes is presented. We have completed the planning and designing of a multistorey (G+2) structure. ,

Designing software like Stadd reduces a lot of time in design work. Details of every member can be obtained using Stadd Pro. Accuracy is improved by using software

The layout should be efficient and practical, with well-defined living spaces and adequate natural lighting and ventilation.

G+2 residential buildings should provide a comfortable and inviting living environment for their occupants while also contributing positively to the surrounding community.

A clear efficiency and modelling of a residential building with efficient structural and architectural plans. 3D realistic view enables us to indicate the family and the components placed within the building.

The Proposed residential building has been analyzed and designed. All the results of analysis and design are found to be safe.

Future scope :

The future scope of a G+2 residential building largely depends on factors like sustainability, smart technology integration, and community needs.

Emphasizing energy efficiency, incorporating renewable energy sources, and designing flexible living spaces could enhance its appeal and longevity. Additionally, integrating smart home features for convenience and security could make it more attractive to future residents. [5], [41]–[46], [6]–[10]

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