# Residential Building Analysis and Design (G+5)

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**Abstract: The structure may be planned using Autodesk Revit. Autodesk Revit is Building Information Modeling (BIM) software used by structural engineers, MEP engineers, contractors, and landscape architects. Users are able to create a 3D model of a building and all of its components, annotate that model using 2D sketching tools, and then access data stored in the database of that model. There are two apartments in the building in question. Our building has a basement and five storeys. A stairwell may be installed in the middle of two apartments. Robot Structure Analysis provides comparable capabilities to Robot Structure analysis professional by allowing you to simulate the impacts of structural loads and check for code compliance using cutting-edge BIM software.The program, which is compatible with BIM processes, is exclusive to the AEC software library.**

**Key words: Revit software, BIM tools, Robot Structural analysis.**

## 1. INTRODUCTION

Due to rising land prices and population, multi-story structures have become more important in today's megacities. When it comes to housing a large population, multi-story structures are the way to go. A residential structure with more than one story above ground, designed to maximize living space while minimizing footprint. Structural analysis is the study of designing and planning the construction of a sound structure. The parameters for each project are distinct, depending on factors like the incoming load, soil characteristics, dynamic load, built up area, and so on. In this article, we supplied the information necessary to potentially finish a house or apartment. We began by gathering the necessary information to determine the soil's characteristics, such as its moisture level, its bearing ability, its kind, and so on.

## REVIT ARCHITECTURE

So that you may focus on your Building models rather of adjusting your workflow to meet the needs of the program, Revit Architecture is designed to be flexible with how you operate.This quick guide will teach you the ropes of using Revit Architecture for building design, alterations, and documentation. Changes to the building's design may be made from any angle thanks to parametric modeling, which you will learn about. All of the other views in Revit are updated simultaneously with the architecture.

## REVIT STRUCTUIRE

To facilitate efficient design processes in a Building Information Modeling (BIM) environment or when collaborating with other Autodesk-based construction disciplines, Revit Structure is Autodesk's BIM software solution for structural engineering firms and structural engineers.

## ROBOT STRUCTURAL ANALYSIS

Robot, short for Autodesk® RobotTM Structural Analysis Professional 2017, is a graphical application that may be used to model, analyze, and design many different kinds of buildings. You can use it to build things, do math, and double-check your work. In addition to designing and calculating a structure, it also allows you to produce documentation for it

## 2. METHODOLOGY

a. MODELLING

i. (G+5) Residential building
ii. Creating a Project
iii. Adding Walls
iv. Adding a Curtain Wall
v. Adding Doors
vi. Adding windows
vii. Adding Components
viii. Adding Floors
ix. Adding Stairs
x. Adding Ceiling
xi. Adding a Roof
xii. Creating Toposurface
xiii. Adding Site Components
xiv. Creating a Sheet
xv. Adding Model Text
xvi. Adding Material Takeoff Scheduling
xvii. Add Painting
xviii. Camera View
xix. Rendering
xx. Walkthrough

### Revit Structure:

i. Creating a Project
ii. Adding Grids
iii. Adding Columns
iv. Adding Beams
v. Adding Footing

### Structural Analysis:

a. Creating a Project
b. Converting Revit Model into Robot
c. Adding Fixed support
d. Adding Loads
e. Wind Load Analysis
f. Seismic load Analysis
g. R.C.C Design
h. RC Beam Design
i. RC Column Design

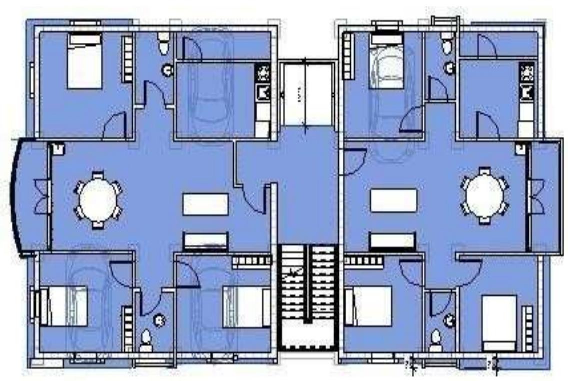

**Fig.1 Architectural floor plan of residential building.**

**Fig.2 architectural roof plan of residential building**

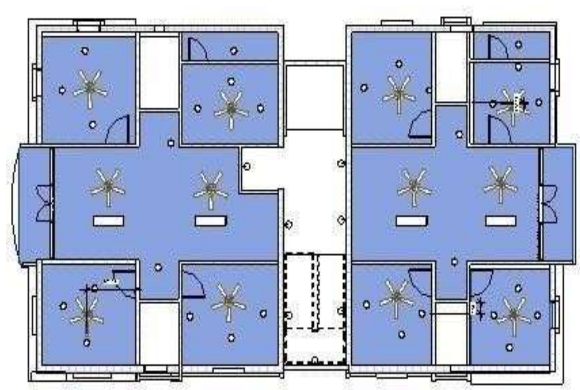

Fig. 3

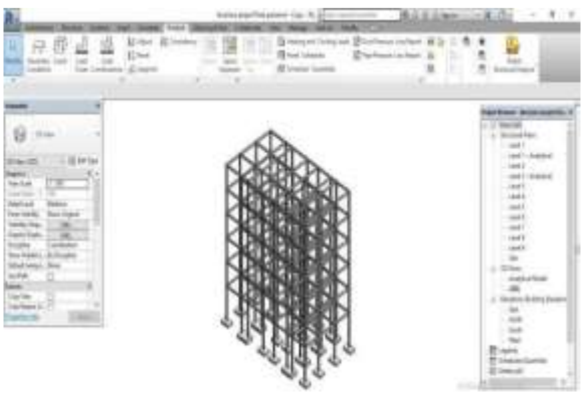

Fig.4

## 3. Result

**Beam Design:**

**1 Level:**

- Name :
- Reference level : ---
- Fire rating : 0 (h)
- Maximum cracking : 0.30 (mm)
- Environment class : moderate
- Concrete creep coefficient : $\varphi_p$ = 2.00

**2 Beam: Beam465** **Number: 1**

**2.1 Material properties:**

- Concrete : M 30 $f_{cu}$ = 30.00 (MPa)
  Unit weight : 2549.29 (kG/m3)
- Longitudinal reinforcement : Fe415 $f_y$ = 415.00 (MPa)
- Transversal reinforcement : Fe415 $f_y$ = 415.00 (MPa)
- Additional reinforcement : Fe415 $f_y$ = 415.00 (MPa)

**2.2 Geometry:**

| 2.2.1 Span | Position | L.supp. (m) | L (m) | R.supp. (m) |
|---|---|---|---|---|
| **P1** | **Span** | **0.23** | **3.72** | **0.23** |

Span length: $L_o$ = 3.95 (m)
Section from 0.00 to 3.72 (m)
22.9 x 30.5 (cm)
without left slab
without right slab

Fig.5

**2.3 Calculation options:**

- Regulation of combinations : IS 875 (Part5)
- Calculations according to : IS 456 : 2000
- Precast beam : no
- Cover : bottom c = 3.0 (cm)
  : side c1 = 3.0 (cm)
  : top c2 = 3.0 (cm)

**2.4 Calculation results:**

**2.4.1 Internal forces in ULS**

| Span | Mtmax. (kN*m) | Mtmin. (kN*m) | Ml (kN*m) | Mr (kN*m) | Ql (kN) | Qr (kN) |
|---|---|---|---|---|---|---|
| P1 | 0.18 | -0.05 | 0.18 | -0.16 | -0.17 | -0.18 |

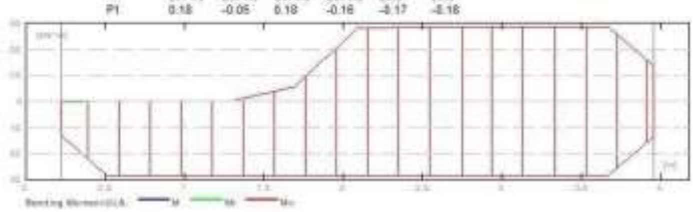

Fig.6

**2.6 Reinforcement:**

**2.6.1 P1 : Span from 0.23 to 3.95 (m)**

**Longitudinal reinforcement:**

- bottom
  3 Fe415 12 l = 4.12 from 0.03 to 4.15
- assembling (top)
  3 Fe415 8 l = 1.97 from 0.03 to 2.00
- support (Fe415)
  3 Fe415 12 l = 2.51 from 1.64 to 4.15

**Transversal reinforcement:**

- main
  stirrups 50 Fe415 8 l = 0.78
  e = 1*0.06 + 24*0.15 (m)

**3 Material survey:**

- Concrete volume = 0.29 (m3)
- Formwork = 3.54 (m2)
- Steel Fe415
  - Total weight = 35.32 (kG)
  - Density = 121.25 (kG/m3)
  - Average diameter = 9.2 (mm)
  - Survey according to diameters:

| Diameter (mm) | Length (m) | Weight (kG) | Number (No.) | Total weight (kG) |
|---|---|---|---|---|
| 8 | 0.78 | 0.31 | 50 | 15.33 |
| 8 | 1.97 | 0.78 | 3 | 2.33 |
| 12 | 2.51 | 2.23 | 3 | 6.68 |
| 12 | 4.12 | 3.66 | 3 | 10.98 |

Fig.10

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## RC Column Design

**1 Level:**

- Name :
- Reference level : -2.00 (m)
- Fire rating : 0 (h)
- Environment class : mild

**2 Column: Column1** **Number: 1**

**2.1 Material properties:**

- Concrete : M 30 $f_{cu}$ = 30.00 (MPa)
  Unit weight : 2549.29 (kG/m3)
- Longitudinal reinforcement : Fe415 $f_y$ = 415.00 (MPa)
- Transversal reinforcement : Fe500 $f_y$ = 500.00 (MPa)

**2.2 Geometry:**

2.2.1 Rectangular 22.9 x 30.5 (cm)
2.2.2 Height: L = 6.15 (m)
2.2.3 Slab thickness = 0.00 (m)
2.2.4 Beam height = 0.30 (m)
2.2.5 Cover = 4.0 (cm)

**2.3 Calculation options:**

- Calculations according to : IS 456 : 2000
- Precast column : no
- Pre-design : no
- Slenderness taken into account : yes
- Calculation method : exact
- Ties : to slab
- Non-sway structure

**2.4 Loads:**

| Case | Nature | Group | $\gamma_f$ | N (kN) | Myu (kN*m) | Myl (kN*m) | Myl (kN*m) | Mzu (kN*m) | Mzl (kN*m) | Mzl (kN*m) |
|---|---|---|---|---|---|---|---|---|---|---|
| LL1 | live load | 1 | 1.00 | 36.38 | -0.43 | 0.28 | -0.17 | 0.30 | -0.19 | 0.15 |

$\gamma_f$ - load factor

**2.5 Calculation results:**

**2.5.1 ULS Analysis**

**Design combination: 1.50LL1 (C)**
Internal forces:
NSd = 54.58 (kN) MSdy = -0.26 (kN*m) MSdz = 0.23 (kN*m)
Design forces:
Cross-section in the middle of the column
NSd = 54.58 (kN) NSd*etotz = -3.48 (kN*m) NSd*etoty= 1.09 (kN*m)

**2.5.1.1 Eccentricity:**

| Eccentricity: | | ez (My/N) | ey (Mz/N) |
|---|---|---|---|
| Static | ee: | -0.5 (cm) | 0.4 (cm) |
| II order | eadd: | 5.9 (cm) | 0.0 (cm) |
| Minimal | emin: | 2.2 (cm) | 2.0 (cm) |
| Total | etot: | -6.4 (cm) | 2.0 (cm) |

**2.5.1.2 Detailed analysis-Direction Y:**

**2.5.1.2.1 Slenderness analysis**

Non-sway structure

| $l_o$ (m) | β | $l_e$ (m) |
|---|---|---|
| 6.00 | 1.00 | 6.00 |

ley/h = 19.69 > 12.00
lez/b = 26.25 > 12.00
Slender column

**2.5.1.2.2 Buckling analysis**

M2 = 0.30 (kN*m) M1 = -0.64 (kN*m) Mi = -0.26 (kN*m)
Case: Cross-section in the middle of the column, Slenderness taken into account

Mi = max (0,4M1 + 0,6M2 ; 0,4*M2) = -0.26 (kN*m) (39.7.1)
emin = max (20mm ; $l_o$/500+h/30) = 2.2 (cm) (25.4)
h = 30.5 (cm)
Mmin = N*emin = 1.21 (kN*m)
k = 1

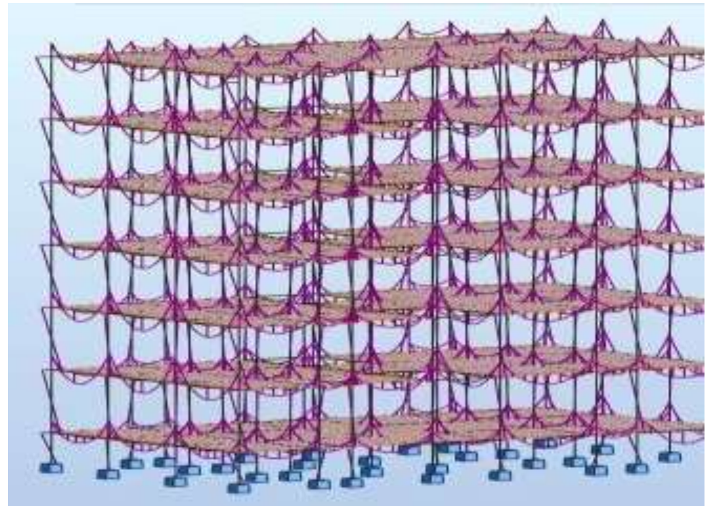
$$M_{ay} = k \cdot \frac{P_u h}{2000}\left(\frac{l_{ey}}{h}\right)^2 = 3.22 \text{ (kN*m)}$$

Md = max (Mmin;Mi+May) = -3.48 (kN*m)

## RESULT

- Designing using Software's like robot structural analysis and revit reduces lot of time in design work.
- Details of each and every member can be obtained using robot structural analysis.
- Accuracy is improved by using software.

## Bending Moment Diagram



## CONCLUSION

- We made a sincere effort to present the structural design and modelling of a school building. For the completion of our project we used REVIT SOFTWARE, ROBOT STRUCTURAL ANALYSIS.
- We planned our building according to the BUILDING BYE LAWS and PRINCIPLES OF PLANNING.
- It is a 5 storey residential building.

## 4. REFERENCE

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