Design and Analysis (G+5) of Residential Building

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Abstract: The building can be designed by using Autodesk Revit Software. Autodesk Revit is Building Information Modeling (BIM) software for landscape architects, landscape architects, structural engineers, MEP engineers and contractors. The software allows users to design a building and its components in 3D annotate the model with 2D drafting elements and access building information from the building model's database. The Residential building has two flats. Our structure has ground floor and five floors. Staircase can be placed in between two flats. By using of Robot Structure Analysis we can get similar functionality with Robot Structure analysis professional, which lets you test the effects of structural loads and verify code compliance using advanced BIM tools .The software which integrates with BIM workflows, is available only in architecture, engineering &construction collection.

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

1. INTRODUCTION

Now-a-days due to over population and high cost of land, multi-stored buildings is more essential for metropolitan city. Multi storied residential buildings is the perfect solution for living of high population area. A multi storied residential building which possess multiple floor above the ground level, which aim to increase the floor area of the building in shortest built up area. Structural analysis is a subject which involves designing, planning to build up a perfect building. Basically each project are different with their criteria such as incoming load, soil properties, dynamic load, built up area etc. Here we provided the details to complete residential apartment theoretically. We firstly collected some required data to measure the soil specific such as moisture content, bearing capacity of soil, types of soil etc.

REVIT ARCHITECTURE

Revit Architecture is designed to accommodate various ways of working, so that you can concentrate on your Building models rather than on adapting your methodology to the demands of the software .In this short tutorial, you learn how to use the features of Revit Architecture to design, change, and document a building. You learn how you can make design changes in any view of the building , and the parametric change In Revit Architecture coordinates those changes in all other views.

REVIT STRUCTURE

Revit Structure is Autodesk’s BIM software solution for structural engineering companies and structural engineers, that provides a feature rich tool set helping to drive efficient design processes in a BIM (Building Information Modeling) environment, or when working with other construction disciplines using Autodesk.

ROBOT STRUCTURAL ANALYSIS

Autodesk® Robot™ Structural Analysis Professional 2017 (referred to as Robot) is an integrated graphic program for modeling, analyzing and designing various types of structures. It lets you create structures, carry out calculations, and verify results. It also lets you create documentation for the designed and calculated structure.
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
3. Result

Beam Design:

1 Level:

- Name
- Reference level
- Fire rating
- Maximum cracking: 0.30 (mm)
- Environmenal class: moderate
- Concrete creep coefficient: $\psi = 2.00$

2 Beam: Beam465

2.1 Material properties:

- Concrete: M30
  - Unit weight: 2549.25 (kg/m³)
- Longitudinal reinforcement: Fe415
- Transversal reinforcement: Fe415
- Additional reinforcement: Fe415
  - $f_c = 36.00$ (MPa)
  - $f_y = 415.00$ (MPa)

2.2 Geometry:

<table>
<thead>
<tr>
<th>P1</th>
<th>Span</th>
<th>L supp.</th>
<th>L</th>
<th>R supp.</th>
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</thead>
<tbody>
<tr>
<td>0.23</td>
<td>3.72</td>
<td>0.23</td>
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<td></td>
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</tbody>
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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: $d = 3.0$ (cm)
  - Top: $c = 3.0$ (cm)

2.4 Calculation results:

2.4.1 Internal forces in ULS

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</thead>
<tbody>
<tr>
<td>P1</td>
<td>1.18</td>
<td>2.15</td>
<td>1.18</td>
<td>2.15</td>
<td>1.18</td>
<td>2.15</td>
<td>1.18</td>
<td>2.15</td>
</tr>
</tbody>
</table>

2.6 Reinforcement:

2.6.1 P1: Span from 0.23 to 3.95 (m)

Longitudinal reinforcement:

- Bottom:
  - Fe415: 12
- Assembling (top):
  - Fe415: 1.9

Transversal reinforcement:

- Main:
  - Spacing: 50
  - Fe415: 1.9

3 Material survey:

- Concrete volume: 0.29 (m³)
- Formwork: 3.64 (m²)
- Steel Fe415:
  - Total weight: 36.32 (kg)
  - Density: 212.25 (kg/m³)
  - Average diameter: 9.2 (mm)
  - Survey according to diameters:
    
    | Diameter (mm) | Length (m) | Weight (kg/m) | Number Total weight (kg) |
    |---------------|------------|---------------|--------------------------|
    | 8             | 0.39       | 0.78          | 0.31                     |
    | 8             | 1.97       | 0.76          | 3.53                     |
    | 12            | 2.51       | 2.23          | 3.60                     |
    | 12            | 4.12       | 3.66          | 10.98                    |

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 10
RC Column Design

1 | Level:
---|---
| Name | Floor
| Level | -269 (m)
| Elevator | 9 (b)
| Environment class | outdoor

2 | Column: Column1 | Number: 1

2.1 | Material properties:
---|---
| Concrete | M 30
| Unit weight | 2569.9 (Kg/m3)
| Longitudinal reinforcement | 40 (FT2)
| Transversal reinforcement | Fe500
| | | | | | |

2.2 | Geometry:
---|---
| | | |
| 2.2.1 | Rectangle: | 22.9 x 30.5 (cm)
| 2.2.2 | Beam length: | 6.18 (m)
| 2.2.3 | Flange thickness: | 0.09 (m)
| 2.2.4 | Beam height: | 3.36 (m)
| 2.2.5 | Cover: | 4.0 (cm)

2.3 | Calculation options:
---|---
| | |
| Calculations according to | IS 456 - 2000
| Present column | no
| Pre-design | no
| Slenderness taken into account | yes
| Calculation method | exact
| Tie | no tie slab
| Non-way structure |

2.4 | Loads:
---|---
| | |
| Case | N | H | Nmax | Vmax | Nmin | Vmin | Nmax | Vmax | Nmin | Vmin |
| | | | | | | | | | | |
| L1 | live load | 1 | 1.59 | 30.92 | -0.43 | 9.26 | -0.17 | 3.28 | -0.19 | 0.15 |

2.5 | Calculation results:
---|---
| |
| |
| 2.5.1 | ULS Analysis
Design combination: 1.5 (N1 + N2 + N3) Internal forces:

2.5.1.1 | Eccentricity:
---|---
| | |
| Eccentricity | ed | ey
| Static | ed | ey
| Stiff | ed | ey
| Total | ed | ey

2.5.1.2 | Detailed analysis-Direction Y:
---|---
| Stiffness analysis
Non-way structure:

2.5.1.2.1 | Slenderness analysis
Non-way structure

2.5.1.2.2 | Buckling analysis

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.

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

BOOK REFERENCES:


CODAL REFERENCES:

- IS: 1893 – 2002
- IS: 456 – 2000
- IS: 875 – 1987
- BS: 8004 - 2015