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 STRUCTUIRE

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

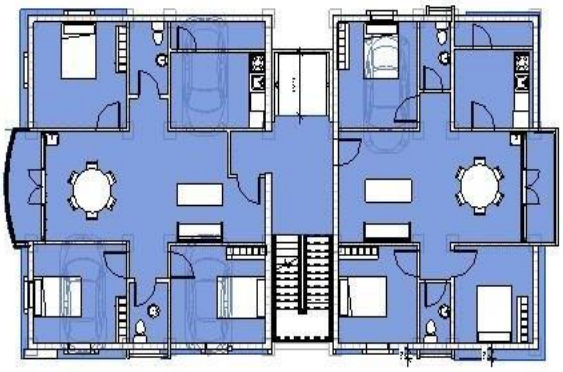


Fig.1 Architectural floor plan of residential building.

Fig.2 architectural roof plan of residential building

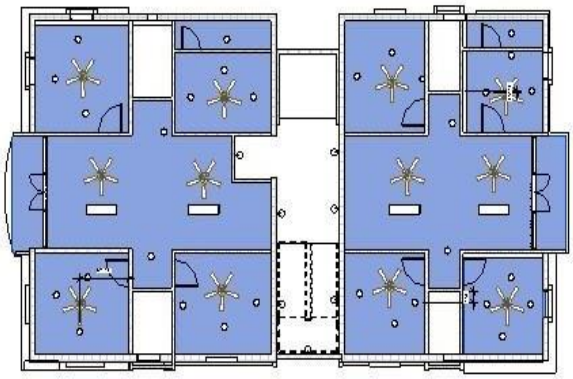
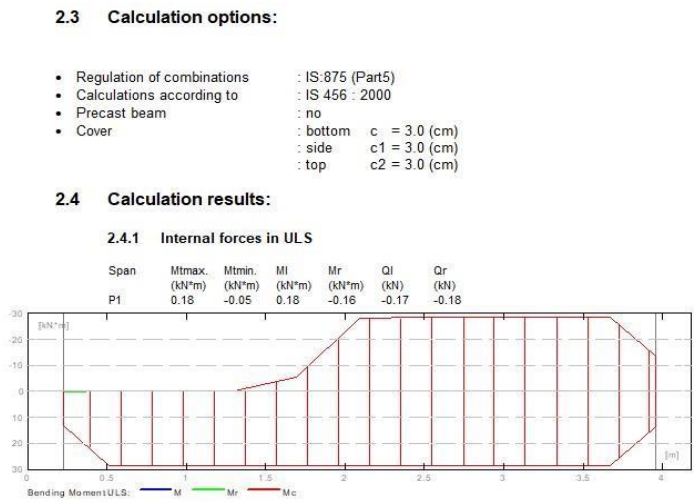


Fig. 3



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

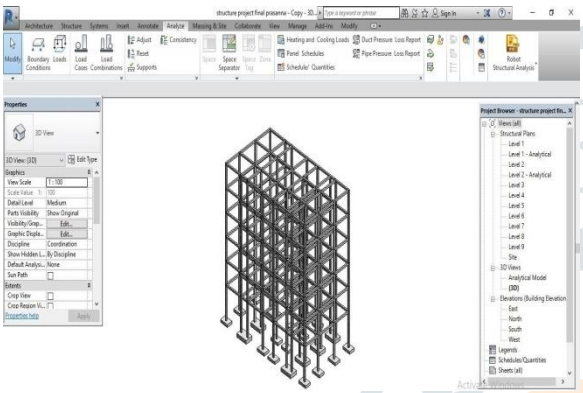


Fig.4

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

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_0 = 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

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	γ_f	N (kN)	Myu (kN*m)	Myl (kN*m)	Myi (kN*m)	Mzu (kN*m)	Mzl (kN*m)	Mzi (kN*m)
LL1	live load	1	1.50	36.39	-0.43	0.20	-0.17	0.38	-0.19	0.15

γ_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_0 (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_0/500+h/30) = 2.2 (cm) (25.4)
h = 30.5 (cm)
Mmin = N*emin = 1.21 (kN*m)
k = 1

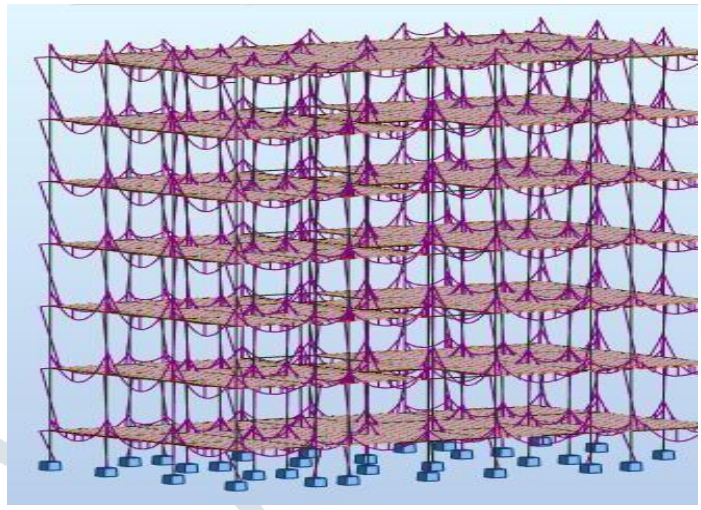
$$M_{ay} = k \cdot \frac{P_u h}{2000}\left(\frac{l_{ey}}{h}\right)^2 = 3.22 \text{ (kN*m)}$$

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

BOOK REFERENCES:

- **BUILDING PLANNING AND DRAWING – DR.N. Kumara Swamy, M.E., B.E. (civil engineering), Principal. Sixth edition: 2012, CHAROTAR PUBLICATIONS.**

CODAL REFERENCES:

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