



DESIGN AND ANALYSIS OF G+3 RESIDENTIAL BUILDING USING MANUAL AND STAAD Pro

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Abstract : In order to compete in the ever-growing competent market it is very important for a structural engineer to save time. As a sequel to this an attempt is made to analyse and design a multi- storeyed building by using a software package STAAD PRO (V8i) for analysing a multi storied building one has to consider all the possible loadings and see that the structure is safe against all possible loading conditions. The present project deals with the analysis of a multi storied residential building of G+3. Gravity load and lateral load are applied and the design for beams, columns, footing is obtained. STAAD PRO (V8i) with its new features surpassed its predecessors, and computers with its data sharing capabilities with other major software like AutoCAD, Sketch up. We conclude that STAAD PRO (V8i) is a very powerful tool which can save much time and is very accurate in analysis & design. Thus it is concluded that STAAD PRO (V8i) package is suitable for the design of a multi-storied building.

IndexTerms – autocad, staad pro, structural design, multi-story buildings, residential buildings .

INTRODUCTION

1.1 INTRODUCTION:

The search of man for new methods for constructing his shelter and the invention of Cement, led him to the use of multi-storey buildings in the form of framed structures. The RCC roofs made it easier to build on top of one another. More and more people began opting for multi- storey flats as the land value showed a sharp increase, to exponential increase in the population density, multi-storied buildings are becoming a necessity these days. Recently, there have been considerable increase in the number of tall buildings both residential and commercial. Modern trend is towards taller and taller structures.

The advancement in science and technology had made it possible to build high rise structures in areas even susceptible to cyclones. Thus, the effect of lateral loads like wind loads and forces can produce critical stress in the structure, set up undesirable vibrations and in addition cause lateral sway of structure, which can reach a stage of discomfort to occupants.

Under normal working conditions, the deformation and cracking must not be excessive for the structure to remain serviceable durable and aesthetically pleasing during the expected design life. Further more, the structure should be economical with regard to both construction and maintenance cost. As a part of study, modelling, analysis, designing and detailing of a multi storied reinforced concrete building was done..

1.2 OBJECTIVES:

The objectives aim to cover the critical aspects of structural design and analysis, emphasizing the practical application of STAAD software in modern engineering projects

1. To Understand Structural Behavior: Analyze the structural integrity and behavior of a G+3 (Ground plus three floors) building under various loads using STAAD software to ensure safety and stability.
2. To Optimize Design for Efficiency: Utilize STAAD's advanced computational capabilities to design an economical and efficient structural system that maximizes space utilization while minimizing material waste.
3. To Ensure Compliance with Standards: Ensure the design adheres to relevant building codes and standards, providing a comprehensive guide to compliance through the use of STAAD's integrated design check features.
4. To Demonstrate Advanced Analysis Techniques: Showcase the application of advanced analysis techniques in STAAD,

such as dynamic analysis for seismic loads and wind load simulation, to design buildings that can withstand environmental stresses.

1.3 USED SOFTWARES APPLICATIONS

Applications

STAAD's robust analytical capabilities allow for precise structural calculations and optimization, while AutoCAD's drafting tools enable the creation of detailed architectural plans and elevations. Together, they facilitate a comprehensive approach to building design, from conceptualization to construction, ensuring accuracy, efficiency, and compliance with industry standards. This integration is pivotal for architects and engineers aiming to produce resilient, sustainable, and cost-effective multi-storey structures in a modern urban landscape.

Theory of design

STAAD provides the analytical engine to simulate the building's response to various loads, ensuring structural integrity and compliance with design codes. AutoCAD complements this by offering a platform for detailed architectural drafting, enabling the visualization of the building's aesthetic and functional aspects. Together, they form a cohesive design methodology that allows for the creation of safe, efficient, and visually appealing multi-storey structures, tailored to meet the demands of modern urban development.

II LITERATURE REVIEW

Arjun Sahu and Team's Contribution (2018) : Arjun Sahu, along with his colleagues, delved into the design and analysis of a multi-storey G+3 residential building utilizing STAAD. Pro and AutoCAD.

B Harish and Colleagues' Insights (2019) : B Harish and his team addressed the emerging importance of wind engineering in the structural integrity of G+3 residential buildings.

Borugadda Raju et al., (2015) has been designed and analysed G+30 multi-storey building adopting STAAD PRO (V8i) in limit state methodology. STAAD PRO (V8i) contains an easy interface that permits the users to produce the model and the load values and dimensions are inputted.

Anoop. A, (2016): has explained that the scope of the project is to provide a multi storied building of G+ 5 floors. Revit 2011 and Auto CAD 2014 software is used for developing 3-D models. The structure analysis and design are done using STAAD.Pro. The results are checked for selected members using limit state method of design as per IS 456-2000.

III METHODOLOGY

The methodology for the design and analysis of a G+3 building using STAAD and AutoCAD is a systematic approach that integrates both software tools. Initially, the project begins with data collection and requirements analysis. Using AutoCAD, preliminary designs and architectural layouts are created, providing a visual blueprint for the structure. Subsequently, these designs are imported into STAAD for structural analysis, where load calculations and stress tests are conducted to ensure the building's resilience. The iterative process between AutoCAD and STAAD allows for refinement of the design, ensuring all architectural and structural elements are optimized for safety, functionality, and aesthetic appeal. This methodology emphasizes a collaborative and iterative design process, leveraging the strengths of both STAAD's analytical power and AutoCAD's precision in drafting.

IV SOFTWARES

4.1 SOFTWARES

AutoCAD is a premier drafting software that architects and engineers use for creating precise 2D and 3D designs. STAAD Pro is an advanced structural analysis and design software that engineers utilize to ensure buildings and structures are safe and resilient.

AUTOCAD

AutoCAD, developed by Autodesk and first released in December 1982, stands as a pioneering computer-aided design (CAD) software that revolutionized the way professionals across various industries create, modify, and optimize their design workflows. It is a powerful tool that enables architects, engineers, drafters, and designers to produce precise 2D and 3D drawings and models. The software's robust features allow for the creation of complex and detailed designs with accuracy and efficiency. AutoCAD's user-friendly interface, coupled with its extensive library of tools and capabilities, makes it an essential software for anyone involved in the design process.

STAAD PRO

STAAD Pro, an acronym for Structural Analysis And Design Program, is a comprehensive software application developed by Bentley Systems for structural analysis and design. Originally created by Research Engineers International in 1997, STAAD PRO (V8i) has become one of the most widely used tools for civil and structural engineers worldwide. The software is renowned for its ability to analyse and design structures of all types, from simple residential buildings to complex infrastructure projects like bridges, towers, and industrial facilities. STAAD PRO (V8i) supports a vast array of international steel, concrete, timber, and aluminium design codes, making it a versatile choice for global engineering practices.

SCOPE OF WORK

1. In this emerging world, the requirements of houses are more. To overcome that requirement, the houses are built by proper utilization of area.
2. By constructing the residential house, the consumption of area is less, it leads to enhance the opportunities for both agriculture and residential purpose.

3. The design plans and specifications contain no errors and meet the appropriate code as well as owner requirements
4. The aim of design is to achieve the acceptable probabilities that the structure will not become unit for the use for which it is intended. With an appropriate degree of safety, they should sustain all the loads and deformation of all the constructions it should have adequate durability and adequate resistance to the effects of misuse.
5. Limit state method is the probabilistic approach where structures is tested at design strength of material, where as a method of design in which structures or members are proportioned for prescribed working loads at stresses which are well below their ultimate values.

DESIGN AND ANALYSIS OF G+3 BUILDING USING SOFTWARES

DETAILS OF THE STRUCTURE

- This project consists of plan of one at in one floor and each at having two bedrooms, living, kitchen, three toilets. The structural and materials details of the structure are mentioned.

Length of the building	= 13.19 m
Breadth of the building	= 8.67 m
Thickness of outer wall	= 0.23 m
Thickness of inner wall	= 0.15 m
Window W	: 1.50 m x 1.35 m
Window W1	: 1.00 m x 1.00 m
Door D	: 1.00 m x 2.10
Door D1	: 0.75 m x 2.10 m
Ventilator	: 0.90 m x 0.45 m

PLAN OF THE BUILDING

A plan is a drawing showing in a view from the above, of the relationships between rooms, spaces and other physical features at one level of structure which is represented by a plane on which it is drawn. Below figure is the plan which has been considered for this project

DESIGN & ANALYSIS OF G+3 BUILDING USING STAAD

ANALYSIS OF THE STRUCTURE BY USING STAAD PRO(V8i)

INPUT PARAMETERS OF G+3 RESIDENTIAL BUILDING FOR STAAD PRO

Number of stories	= 3 (G+3)
Height of ground floor	= 3.5 m
Height of each storey	= 3 m
Height of plinth from the foundation	= 3.5 m
Height of parapet wall	= 1 m
Total height of building	= 13.19 m
Thickness of plate	= 0.15 m
Dimensions of beam	= 0.25 m x 0.35 m
Dimensions of Column	= 0.4 m x 0.4 m

Parapet Wall = 0.2 x 1 m

Type of structure - R.C.C frame structure

Type of walls - Brick wall

Concrete Grade : M₂₅

Steel Grade : Fe415

CODES:

IS-456:2000 : Design for RCC structure

IS-456:2000 : Design code for columns(sp chart-16)

IS-875(part-1) : For dead loads

IS-875(part-2) : For live loads

IS-875(part-3) : For wind loads

LOAD AND LOAD COMBINATIONS

LOADS AND LOAD COMBINATIONS

DEAD LOAD

Dead load is defined as the loads that are relatively constant over time, including the weight of the structure itself, and immovable fixtures such as beams, columns etc.. dead loads are also known as permanent or static loads. The code which is used to calculate the dead load is IS875: part 1 -1987

LIVE LOAD

Live load is the load includes any temporary or transient force that act on a structuralelement. Typically it includes people, furniture etc.. and almost everything else that can be moved throughout a building. The code which is used to calculate the live load is IS 875: (part 2) - 1987This code covers imposed loads to be assumed in the design of buildings. The imposed loads which should be taken minimum load consideration for the purpose of structural safety of building.

WIND LOAD

Wind load is used to refer to any pressure or force that the wind exerts on a building or structure .The code which is used to calculate wind load is IS 875: (part 3).This code standard specifies wind forces and their effect (static and dynamic) that should be taken into account when designing buildings, structure and components there off.

Live load : 3 kN/m² at each floor

Dead load : 38.87 kN/m² (self weight of slab,beam,column)

Floor finish : 1 kN/m²

Parapet wall : 4.4 kN/m²

Wind load : As per ASCE(American Society Of Civil Engineering)-7-2002
Building classification category : ii
Basic wind speed = 10 mph (miles per hour)
Exposure category: b

LOAD COMBINATIONS

A combination of load occurs when different types of loads act simultaneously or together in a structure. To avoid failures in a structure, a load factor is used in the case of combination of loads acting on a building.

The following are the different load combinations as per IS 456:2000

1. WX
2. Wx
3. WZ

4. Wz
5. DL
6. LL
7. 1.5(DL+LL)
8. 1.2(DL+LL+E X)
9. 1.2(DL+LL-E X)
10. 1.2(DL+LL+E Z)
11. 1.2(DL+LL-E Z)
12. 1.5(DL+E X)
13. 1.5(DL-E X)
14. 1.5(DL+E Z)
15. 1.5(DL-E Z)

These load combination are automatically taken by STAAD PRO (V8I) by selecting IS456:2000 code.

VDESIGN USING STAAD PRO SOFTWARE

1 STEPS INVOLVED IN STAAD PRO

STEP – 1

- Enter basic input data ; define grid and storey data
- Set units of length in meters, force in kilonewtons
- Define grid data in structured wizard
- Define storey and number of bays
- Merge into STAAD PRO (V8I) model

STEP – 2

- Define section properties
- Define beams
- .Define columns
- .Define slabs
- .Assign to required sections

STEP – 3

- Create supports
- Create fixed support
- Assign the supports to base of the structure

STEP – 4

- Defining loads and definitions
- Define load combinations
- Define wind definitions
- Add define loads

STEP – 5

- Define materials
- Add concrete
- Assign to structure

STEP - 6

- Analysing the structure
- Run analysis
- Check zero errors

STEP – 7

- Go to post processing mode
- Design beams and columns
- Define beams and columns as per ISCODE
- Give parameters to beams and columns
- Assign to selected beams and columns
- Go to post processing mode
- Check the results
- Check displacement results
- Check moments and forces

2.DESIGN OF STRUCTURE USING STAAD PRO

DESIGN OF BEAM:

In most of the reinforced concrete structures, beams and slabs are always cast monolithically. Form works are erected for beams and slabs together and concrete is poured in one operation from bottom of the beam to the top of the slab. Stirrups and bent up bars are also extended into the slab. Stirrups and bent up bars are also extended into the slab.

DESIGN OF COLUMN

A vertical member whose effective length is greater than 3 times its least lateral dimension carrying compressive loads is called as Column. Column transfers the loads from the beams or slabs to the footings and foundations.

3.ANALYSIS & DESIGN OF STRUCTURE BY

MANUAL METHOD:

This frame analysis of loads on beam is done manually by calculating loads on each frame. Now we have to calculate bending moment and shear force diagrams for each frame. For analysis of frames manually we use iterative method. The following iterative methods are moment distribution method, kani's method. In this project kani's method is used for finding out the moments.

All beams are fixed supports.

All columns are fixed .There is no load acting on them.

1. CALCULATION FIXED END MOMENTS :

$$M_{AB} = -WL^2/12 = 0 \times 3.5^2/12 = 0 \text{ KNm}$$

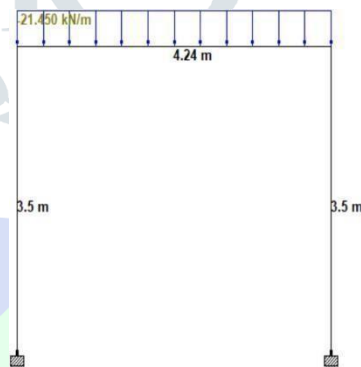
$$M_{BA} = WL^2/12 = 0 \times 3.5^2/12 = 0 \text{ KNm}$$

$$M_{BC} = -WL^2/12 = -21.45 \times 4.24^2/12 \\ = -32.13 \text{ KNm}$$

$$M_{CB} = WL^2/12 = 21.45 \times 4.24^2/12 \\ = 32.13 \text{ KNm}$$

$$M_{CD} = -WL^2/12 = 0 \times 3.5^2/12 = 0 \text{ KNm}$$

$$M_{DC} = WL^2/12 = 0 \times 3.5^2/12 = 0 \text{ KNm}$$



2.CALCULATION OF ROTATION FACTOR :

Table 1 : CALCULATION OF ROTATION FACTOR

JOINTS	MEMBERS	$K = I/L$	ΣK	DISTRIBUTION FACTOR($K/\Sigma K$)	ROTATION FACTOR ($0.5 \times D.F$)
B	BA	0.28		0.54	-0.27
	BC	0.23	0.51	0.46	-0.23
C	CB	0.23		0.46	-0.23
	CD	0.28	0.51	0.54	-0.27

3. ITERATION PROCEDURE:

MOMENT=ROTATIONFACTOR*(ΣMa_{JOINTS} +ROTATION CONTRIBUTION FROM FARENDS)

1ST ITERATION:

$$M_{BA} = 0.27(-32.13+0+0) = 8.67 \text{ kN/m}$$

$$M_{BC} = -0.23(-32.13+0+0) = 7.38 \text{ kN/m}$$

$$M_{CB} = -0.23(32.13+7.38) = -9.08 \text{ kN/m}$$

$$M_{CD} = -0.27(32.13+7.38) = -10.16 \text{ kN/m}$$

2ND ITERATION:

$$\begin{aligned}
 M_{BA} &= -0.27(-32.13-9.08+0) = 11.12 \text{ kN/m} \\
 M_{BC} &= -0.23(-37.13-9.08+0) = 9.47 \text{ kN/m} \\
 M_{CB} &= -0.23(32.13+9.47+0) = -9.56 \text{ kN/m} \\
 M_{CD} &= -0.27(32.13+9.47+0) = -11.23 \text{ kN/m}
 \end{aligned}$$

3RD ITERATION:

$$\begin{aligned}
 M_{BA} &= -0.27(-32.13-9.56+0) = 11.25 \text{ kN/m} \\
 M_{BC} &= -0.23(-32.13-9.56+0) = 9.58 \text{ kN/m} \\
 M_{CB} &= -0.23(32.13+9.58+0) = -9.59 \text{ kN/m} \\
 M_{CD} &= -0.27(32.13+9.58+0) = -11.26 \text{ kN/m}
 \end{aligned}$$

4TH ITERATION:

$$\begin{aligned}
 M_{BA} &= -0.27(-32.13-9.59+0) = 11.27 \text{ kN/m} \\
 M_{BC} &= -0.23(-32.13-9.59+0) = 9.59 \text{ kN/m} \\
 M_{CB} &= -0.23(32.13+9.59+0) = -9.59 \text{ kN/m} \\
 M_{CD} &= -0.27(32.13+9.59+0) = -11.26 \text{ kN/m}
 \end{aligned}$$

5TH ITERATION:

$$\begin{aligned}
 M_{BA} &= -0.27(-32.13-9.59+0) = 11.24 \text{ kN/m} \\
 M_{BC} &= -0.23(-32.13-9.59+0) = 9.59 \text{ kN/m} \\
 M_{CB} &= -0.23(32.13+9.59+0) = 9.59 \text{ kN/m} \\
 M_{CD} &= -0.27(32.13+9.59+0) = 11.26 \text{ kN/m}
 \end{aligned}$$

4. CALCULATION OF ROTATION CONTRIBUTION :

This frame analysis of loads on beam is done manually by calculating loads on each frame. Now we have to calculate bending moment and shear force diagrams for each frame. For analysis of frames manually we use iterative method. The following iterative methods are moment distribution method, kani's method. In this project kani's method is used for finding out the moments.

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All columns are fixed .There is no load acting on them.

CALCULATION FIXED END MOMENTS :

$$M_{AB} = -WL^2/12 = 0*3.5^2/12 = 0 \text{ kNm}$$

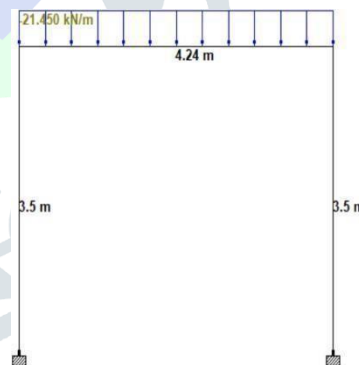
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 M_{BC} &= -WL^2/12 = -21.45*4.24^2/12 \\
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 M_{CB} &= WL^2/12 = 21.45*4.24^2/12 \\
 &= 32.13 \text{ kNm}
 \end{aligned}$$

$$M_{CD} = -WL^2/12 = 0*3.5^2/12 = 0 \text{ kNm}$$

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2.CALCULATION OF ROTATION FACTOR :

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JOINTS	MEMBERS	K= I/L	ΣK	DISTRIBUTION FACTOR(K/ ΣK)	ROTATION FACTOR (0.5*D.F)
B	BA	0.28	0.51	0.54	-0.27
	BC	0.23		0.46	-0.23
C	CB	0.23	0.51	0.46	-0.23
	CD	0.28		0.54	-0.27

ITERATION PROCEDURE:

MOMENT=ROTATIONFACTOR*($\Sigma M_{aJOINTS}$ +ROTATION CONTRIBUTION FROM FARENDS)

1ST ITERATION:

$$M_{BA} = 0.27(-32.13+0+0) = 8.67 \text{ kN/m}$$

$$M_{BC} = -0.23(-32.13 + 0 + 0) = 7.38 \text{ kN/m}$$

$$M_{CB} = -0.23(32.13 + 7.38) = -9.08 \text{ kN/m}$$

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2ND ITERATION:

$$M_{BA} = -0.27(-32.13 - 9.08 + 0) = 11.12 \text{ kN/m}$$

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3RD ITERATION:

$$M_{BA} = -0.27(-32.13 - 9.56 + 0) = 11.25 \text{ kN/m}$$

$$M_{BC} = -0.23(-32.13 - 9.56 + 0) = 9.58 \text{ kN/m}$$

$$M_{CB} = -0.23(32.13 + 9.58 + 0) = -9.59 \text{ kN/m}$$

$$M_{CD} = -0.27(32.13 + 9.58 + 0) = -11.26 \text{ kN/m}$$

4TH ITERATION:

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5TH ITERATION:

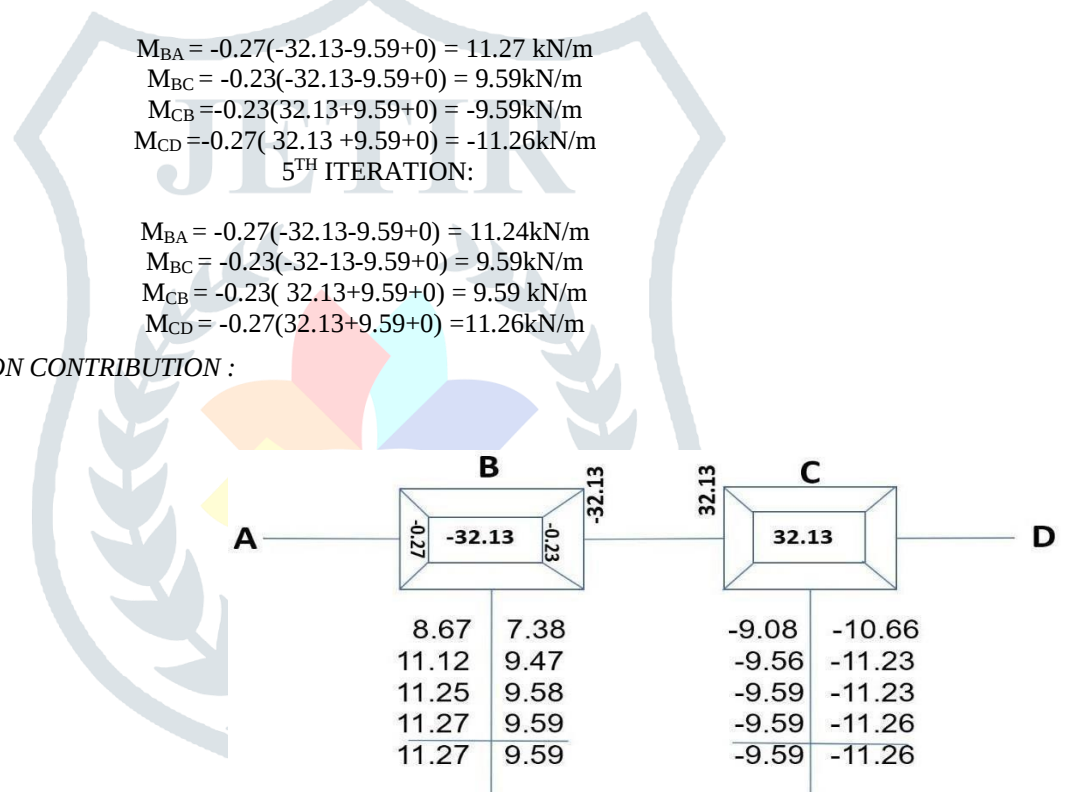
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CALCULATION OF ROTATION CONTRIBUTION :



5.FINAL END MOMENTS:

$$M_{AB} = M_{FAB} + 2M_{AB} + M_{BA} = 0 + 2(0) + 11.27 = 11.27 \text{ kN-m}$$

$$M_{BA} = M_{FBA} + 2M_{BA} + M_{AB} = 0 + 2(11.27) + 0 = 22.54 \text{ kN-m}$$

$$M_{BC} = M_{FBC} + 2M_{BC} + M_{CB} = -32.13 + 2(9.59) - 9.5 = -22.54 \text{ kN-m}$$

$$M_{CB} = M_{FCB} + 2M_{CB} + M_{BC} = 32.13 + 2(-9.59) + 9.59 = 22.54 \text{ kN-m}$$

$$M_{CD} = M_{FCD} + 2M_{CD} + M_{DC} = 0 + 2(-11.26) = -22.52 \text{ kN-m} \quad M_{DC} = M_{FDC} + 2M_{DC} + M_{CD} = 0 + 2(0) - 11.26 = -11.26 \text{ kN-m}$$

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DESIGN OF SLAB BY LIMIT STATE METHOD

DATA :

$$L_x = 3.73 \text{ m (shorter span)}$$

$$L_y = 4.84 \text{ m (longer span)}$$

$$L_y/L_x = 4.84/3.73 = 1.29 < 2 \text{ (Aspect ratio)}$$

SO, DESIGN AS TWO WAY SLAB

MATERIAL:

$$F_{ck} = 25\text{N/mm}^2 \quad F_y = 415\text{N/mm}^2$$

3.LOADS:

$$\text{Live Load} = 3\text{kN/m}^2$$

$$\text{Floor Finish} = 1\text{kN/m}^2$$

4.EFFECTIVE DEPTH:

$$\text{Span/Depth} = 26(\text{slenderness ratio})$$

$$(\text{From clause 23.2.1 of IS code 456:2000, page 37}) \text{ depth}_{\text{eff}} = L_x/26$$

$$d_{\text{eff}} = 3730/26$$

$$d_{\text{eff}} = 150\text{mm}$$

$$(\text{effective span} = d_{\text{eff}}/2 + \text{span} + d_{\text{eff}}/2) \quad \text{effective span in } L_x = 3730 + 150 = 3880\text{mm} \quad \text{effective span in } L_y = 4840 + 150 = 4990\text{mm}$$

5.CALCULATION OF LOADS:

$$\text{Self weight of slab} = 0.15 \times \text{unit weight of concrete}$$

$$= 0.15 \times 25\text{kN/mm}^3$$

$$= 3.75\text{kN/m}$$

$$\text{Total load} = \text{live load} + \text{self weight} + \text{floor finish}$$

$$= 3 + 3.75 + 1$$

$$= 7.75\text{kN/m}$$

$$\text{Total factored load} = 7.75 \times 1.5 = 11.6\text{kN/m}$$

DESIGN OF MOMENTS :(from ANNEX D-1.1/90)

$$M_x = \alpha_x \times W L_x^2$$

$$M_y = \alpha_y \times W L_y^2$$

$$\alpha_x = \text{shorter span co-efficient (FROM TABLE-26/91)} \quad \alpha_y = \text{longer span co-efficient}$$

$$L_y/L_x = 4.84/3.73 = 1.29$$

$$\alpha_x = 0.098,$$

$$\alpha_y = 0.055 (\text{From IS 456:2000 (TABLE-27/91)})$$

$$\text{For shorter span, } M_{ux} = \alpha_x \times W_u L_x^2 = 0.098 \times 11.6 \times 3.88^2$$

$$= 16.24\text{kN/m}$$

$$\text{For longer span, } M_{uy} = \alpha_y \times W_u L_y^2 = 0.055 \times 11.6 \times 3.88^2 = 9.6\text{kN/m}$$

DESIGN OF SHEAR

$$\text{Shear force} = V_u = W_u \times L_x/2$$

$$= 11.6 \times 3.88/2$$

$$= 22.50\text{ kN}$$

$$\text{From IS 456:2000 (T-26/97)}$$

$$\text{Bending moment co-efficient for rectangular panels}$$

$$\text{Negative moments at continuous edge}$$

$$-ve M_x = 0.047 \times 11.6 \times 3.88^2 = 8.20\text{kN/m}$$

$$-ve M_y = 0.024 \times 11.6 \times 4.99^2 = 6.93\text{kN/m} \quad \text{Positive moments at mid span}$$

$$+ve M_x = 0.036 \times 11.6 \times 3.88^2 = 6.28\text{kN/m}$$

$$+ve M_y = 0.032 \times 11.6 \times 4.99^2 = 9.24\text{kN/m}$$

LIMITING MR: (FROM ANNEX G-1.1 C/96)

$$M_{u\text{lim}} = 0.36 \times X_u(\text{max})/d (1 - 0.42 \times X_u(\text{max})/d) b d^2 F_{ck}$$

$$(X_{u(\text{max})}/d \text{ for } f_{e415} \text{ is } 0.48) (\text{FROM PAGE NO.70})$$

$$= 0.36 \times 0.48 \times (1 - 0.42 \times 0.48) \times 1000 \times 150^2 \times 25$$

$$= 77.6\text{kN/m}$$

$$M_{u(\text{lim})} = 77.6\text{kN/m} > M_u = 8.2\text{kN/m}$$

Hence ,Slab has to be designed as under reinforced section

8. CHECK FOR DEPTH:

$$M_U = 0.138 \times F_{ck} \times b d^2 \text{ (for Fe}_{415}\text{)}$$

$$8.2 \times 10^6 = 0.138 \times 25 \times 1000 \times d^2 d_{\text{required}} = 48.75 \text{ mm}$$

$$\text{Therefore, } d_{\text{req}} = 48.75 \text{ mm} < d_{\text{provided}} = 150 \text{ mm}$$

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9. DESIGN FOR REINFORCEMENT:

Along X-direction:

$$M_u = 0.87 F_y \times A_{st} \times d (1 - A_{st} \times F_y / F_{ck} \times b \times d) \text{ (FROM ANNEX G-1.1 b/96)}$$

$$8.2 \times 10^6 = 0.87 \times 415 \times A_{st} \times 150 (A_{st} \times 415 / 25 \times 1000 \times 150)$$

$$\text{Therefore, } A_{st} = 154 \text{ mm}^2$$

$$\text{minimum percentage of steel} = 0.12\% b d$$

$$= 0.12 / 100 \times 1000 \times 150 \quad a_{st} = 180 \text{ mm}^2$$

$$\text{using 10mm diameter bars, } A_{st} = 78.58 \text{ mm}^2 \quad \text{spacing} = A_{st} / a_{st} \times 1000$$

$$= 78.58 / 180 \times 1000$$

$$= 436 \text{ mm}$$

Therefore, provide 10mm diameter bars @ 430mm along x-direction

Along Y-direction:

$$13.57 \times 10^6 = 0.87 \times 415 \times A_{st} \times 150 (1 - A_{st} \times 415 / 25 \times 1000 \times 150)$$

$$A_{st} = 257.9 \text{ mm}^2$$

$$\text{min percentage of steel} = 0.12\% \times b \times d$$

$$= 0.12 / 100 \times 1000 \times 150$$

$$\text{Therefore, spacing} = A_{st} / a_{st} \times 1000$$

$$= 257.9 / 180 \times 1000$$

$$= 436 \text{ mm}$$

Therefore, provide 10mm diameter bars @ 430mm along y-direction

VI REINFORCEMENT DETAILS

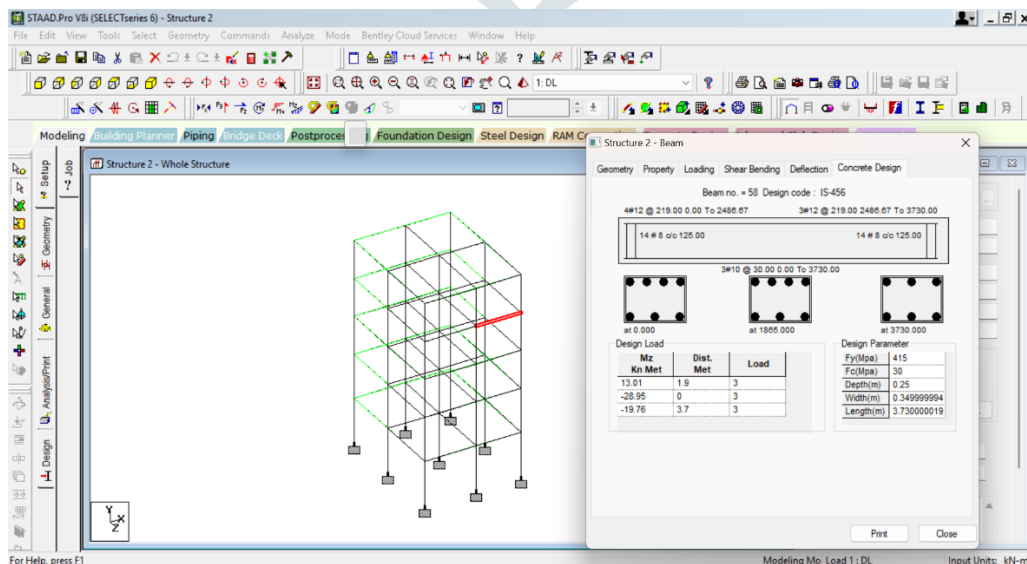


Figure 1 : DESIGN OF REINFORCED BEAM

- The above figure shows that the reinforced details of concrete beam generated by the Staad software

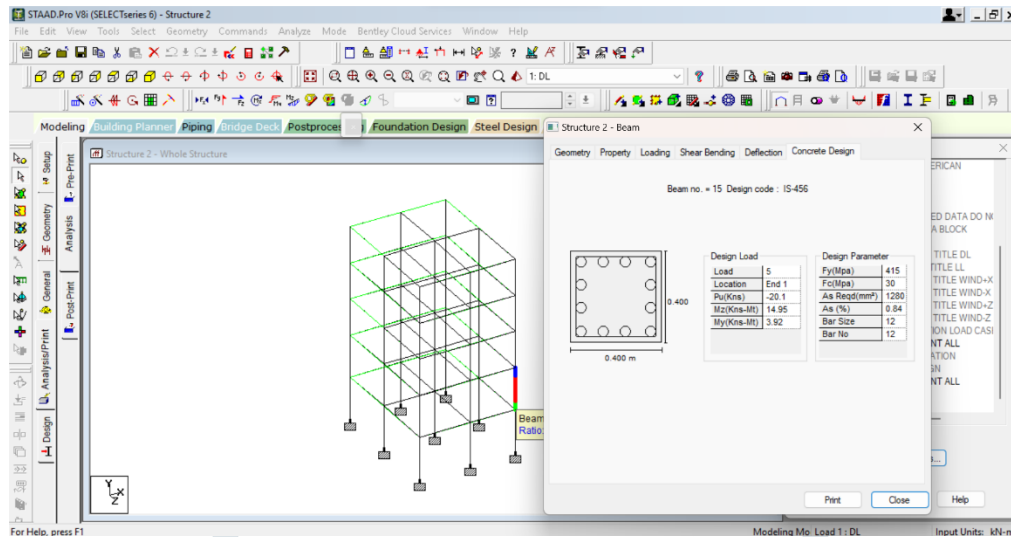


Figure 2 : DESIGN OF REINFORCED COLUMN

- The above figure shows that the reinforced details of concrete beam generated by the Staad software

VII CONCLUSION & REFERENCE

CONCLUSION :

In conclusion, the project successfully harnessed the versatility of AutoCAD for detailed 2D and 3D modeling of the building plan, and the precision of STAAD Pro for structural analysis, adopting practical dimensions and reinforcement details for slabs, beams, and columns. The comparative analysis with manual calculations validated the reliability of the software, with only minor discrepancies observed. The design adhered to the limit state method, ensuring safety against deflection and overall structural integrity. Ultimately, the project culminated in the virtual execution of a well-designed, robust G+3 building, demonstrating the efficacy of integrating advanced software tools in modern structural engineering.

REFERENCE

1. Advanced R.C.C Design, (Author) S.S Bhavikatti and published by new age international New Delhi, (2nd Edition 2008).
2. Building construction,(Authors) Dr.B.CPunmiaDr.Ashok Kumar Jain and Pub-lished by Laxmi Publications,(2nd Edition 2005).
- 3.Theory of structures,(Author) S.Ramamrutham and Authored by R.Narayan(9th Edition 2014).
4. IS 456:2000(Reinforced concrete for general building construction).
5. IS 875, Part-1,1987 (Dead loads for buildings and structures).
6. IS 875, part-2,1987 (imposed loads for building and structures).
7. SP:16 (design aids for IS 456).
8. IS 1893:2016 Design of structures part-1: general provisions and buildings