Analysis and Design of a Three Storey Commercial Building

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Abstract - *The main intention of this project is to design a three-storey commercial building by taking considerations to Indian Standard codes. Design of this commercial building is completed with the assistance of Software known as Staad pro. Designing the structure manually consumes lot of time and it's very difficult to get an accurate result moreover there are chances for errors. Whereas by using this software a huge amount of time are often saved. As mentioned above the software named "STAAD pro" abridged as "Structural Analysis and Design Program" is user friendly and has unique features such as, it designs the structural components individually along with their Analysis and Results. The shear force diagram, bending moment diagram and torsion diagram at each level can be analyzed by this software. The method is as follows: plan of the structure including its specifications are collected from the construction site. After analyzing the structure and its criteria, the structural components of building namely slabs, beams, columns and footings are designed.*

*Key Words***:** Staad Pro, Analysis, Design

1. INTRODUCTION

1.1 General

The implementation of this project requires certain knowledge such as geotechnical investigation on the field, drafting and detailing in AutoCAD, experience in using computer/aided design software such as Staad pro for design and analysis, use of national building codes.

Objectives

a) To create the floor plan of a three-storey building.

b) To effectively use Staad Pro V8i software for the analysis of the structure.

c) To design the structural components.

d) Detailing of structural members

1.2 Scope

a) The detailed plan of the building will be obtained.

b) An idea about framed structures will be acquired.

c) The behaviour of each structural component can be analysed.

2. METHODOLOGY

a) **Literature reviews**: The journals related to the topic are referred and collected. It helps to understand the various aspects of the project and hence lead to the progress of the project.

b) **Site examination**: Site for the construction of this project was inspected and found that the soil is hard laterite and also the site is situated 6m from the main road.

c) **Structural Planning**: The plan of the building is generated in AutoCAD will be transferred to Staad Pro V8i.

d) **Analysis**: Staad Pro will analyze the plan and provide the number of beams and columns.

e) **Design**: Beam, column and slab will be designed with the help of Staad Pro and IS: 456:2000.

f) **Detailing**: All structural components of the building will be detailed with help of AutoCAD.

3. PLAN OF THE BUILDING

- This is a G+2 Storey building and area of each floor is 299.98m^2.
- Total area of the building is 899.94m^2.
- Height of ground floor is 4m.
- Second & third floors are 3.6m high.
- Height of parapet wall is 1.10m.
- Each floor consists of 12 shop rooms.
- The smallest shop room has a dimension of 420x300cm.
- Largest shop has the dimension of 420x620cm.
- Plot area is 1243.09m^2.
- Parking capacity of 50 vehicles is provided.
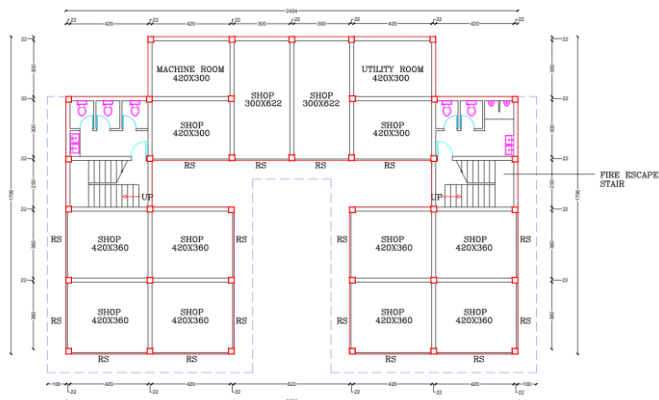- Drafting and detailing are done with AutoCAD.
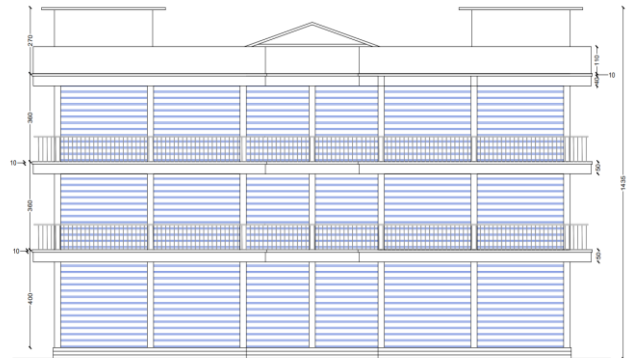
Fig -1: Plan of ground floor

Fig 2 -: Plan of first floor

Fig 3 -: Plan of second floor

Fig 4 -: Elevation

4. STAAD PRO MODEL AND ANALYSIS

Fig 5 -: Model of building

4.1 Types of loads

i.   **Wall load =** Wall thickness x Wall height x Brick density

ii. **D.L =** 3.75 kN/m^2

iii. **L.L =** 4 kN/m^2

iv. **Stair load =** 11 kN/m^2

v.   **Water tank load =** 100kN

vi. **Self-weight =** 1kN/m

4.2 Analysis
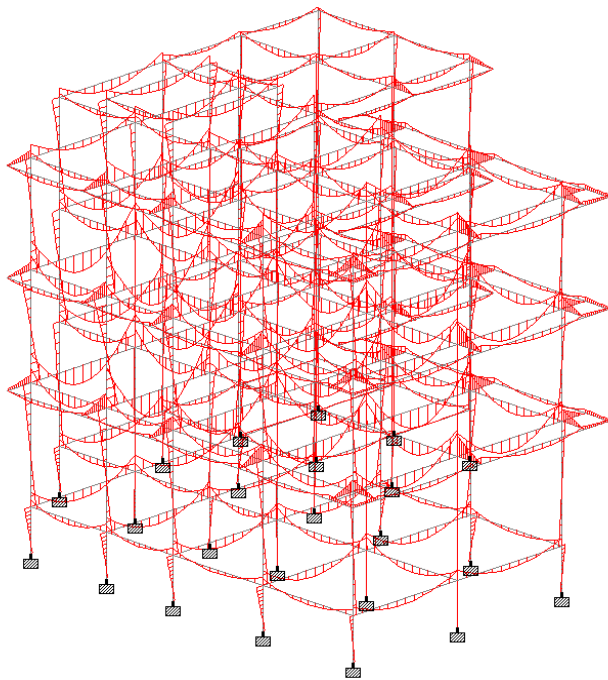
Fig 6- : Bending moment diagram
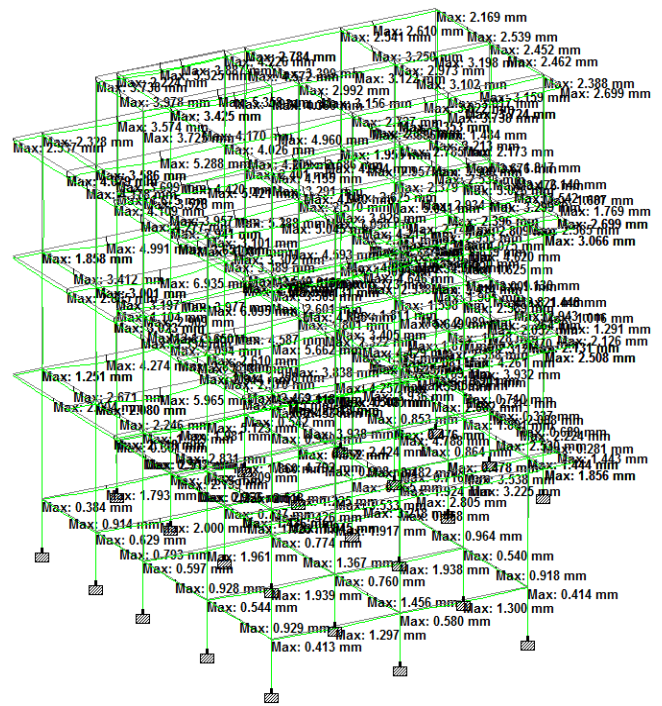
Fig 8- : Deflection diagram
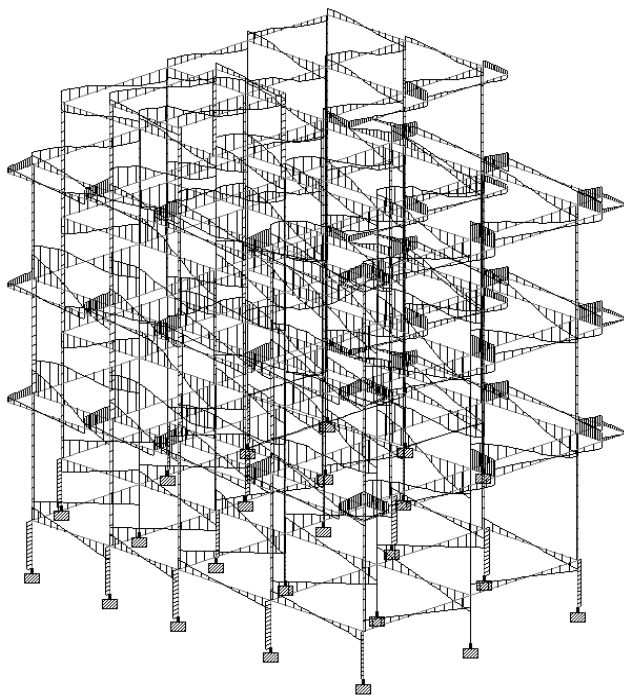
5. DESIGN

5.1 DESIGN OF COLUMN

Fig 7- : Shear force diagram

COLUMN SCHEDULE
(SCALE 1:100)

i. **Column C1A:**
   Dimension: 30cm x 30cm
   8 bars of 12mm dia
   8mm stirrups at 15cm c/c

Concrete grade: M25
Grade of steel: Fe415

ii. **Column C2A:**
Dimension: 40cm x 30cm
8 bars of 12mm dia
8mm stirrups at 15cm c/c
Concrete grade: M25
Grade of steel: Fe415

iii. **Column C2B:**
Dimension: 40cm x 30cm
4 bars of 16mm dia
4 bars of 12mm dia
8mm stirrups at 15cm c/c

Dimension: 40cm x 30cm
8 bars of 12mm dia
8mm stirrups at 15cm c/c

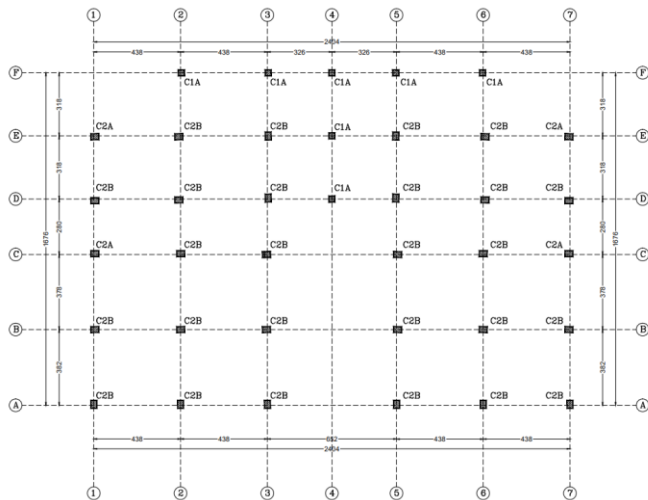Concrete grade: M25
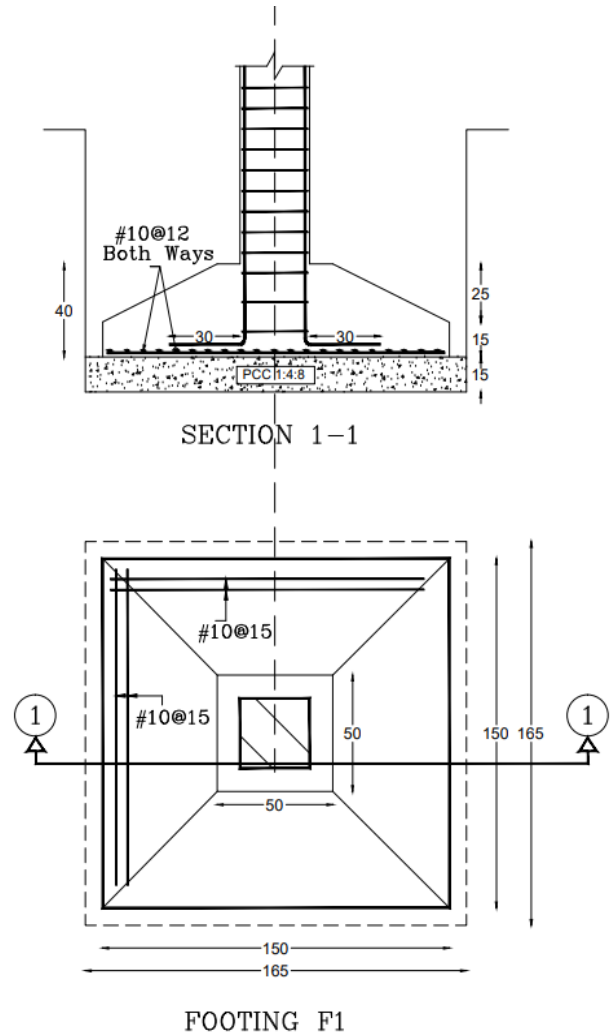Grade of steel: Fe415

- **Column layout**

Fig 9-: Column Layout

5.2 DESIGN OF FOOTINGS AND GRADE BEAM

SBC value is taken as 20t/m²

Footing F1:

SECTION 1−1

FOOTING F1

Footing F1
Dimension   = 150cm x 150cm
Size of column = 30cm x 30cm
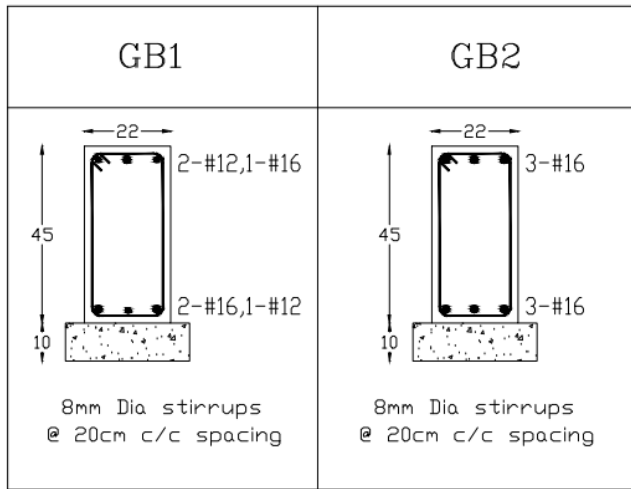Two way Reinforcement = 10mm dia @ 15cm c/c

Footing F2
Dimension = 200cm x 200cm
Size of column = 40cm x 30cm
Two way reinforcement = 10mm dia @15cm c/c

Footing F3
Dimension = 230cm x 230cm
Size of column = 40cm x 30cm
Two way reinforcement = 10mm dia @ 10cm c/c

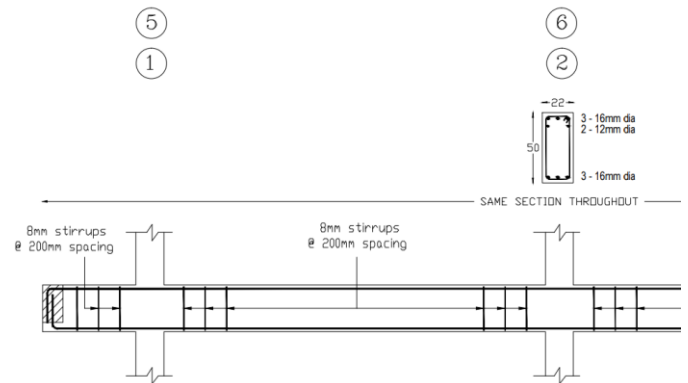## Design of grade beams

Grade Beam 1 (GB1)

Dimension: 45cm x 22cm
Reinforcement: 3 bars of 12mm dia
          3 bars of 16mm dia
           8mm dia stirrups @ 20cm c/c spacing

Grade Beam 2 (GB2)

Dimension: 45cm x 22cm
Reinforcement: 6 bars of 16mm dia
          8mm dia stirrups @20cm c/c spacing

Fig 10- : Footing and Grade beam Layout

5.3 DESIGN OF BEAMS

Fig 11-: Detailing of frame A

Dimension of beam used: 50cm x 22cm
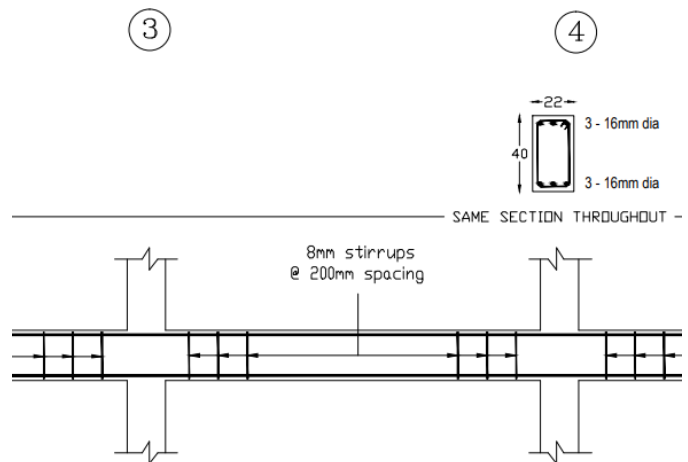
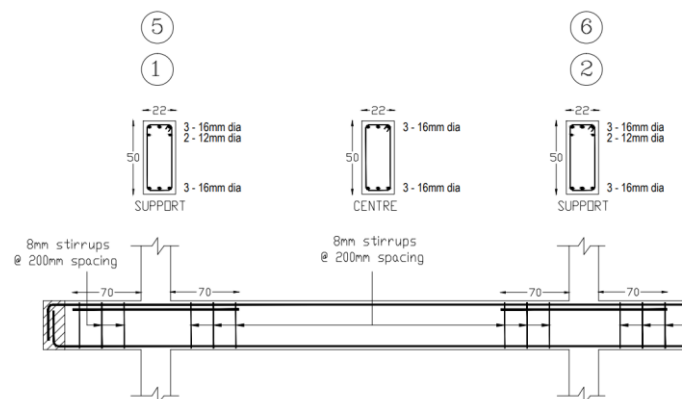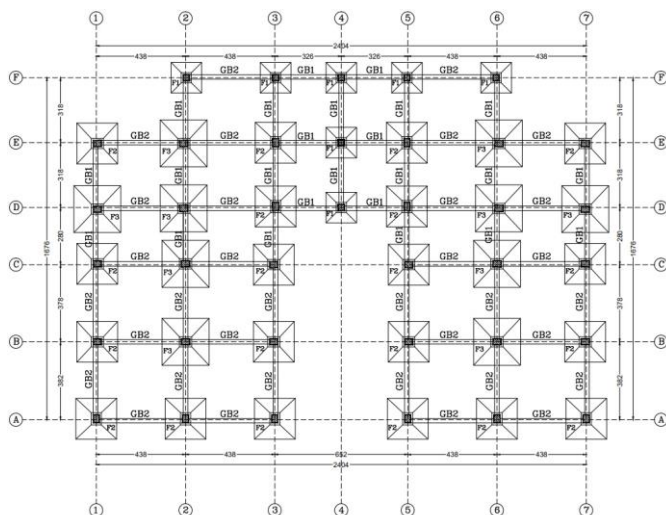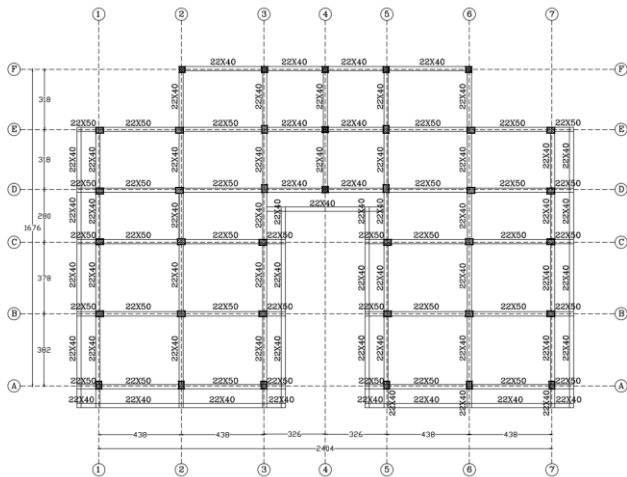**Fig -12-:** Detailing of frame F

Dimension of beam used: 40cm x 22cm

Fig 13-: Detailing of frame B and C

Dimension of beam used: 50cm x 22cm

Fig 14- : Framing plan
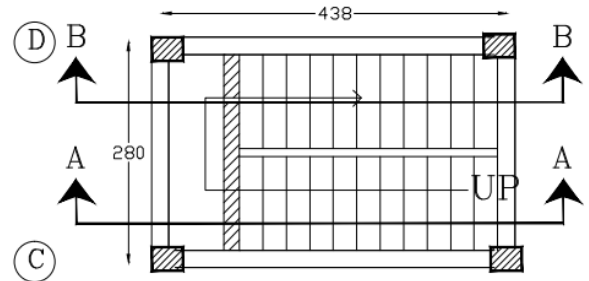
5.4 DESIGN OF SLAB

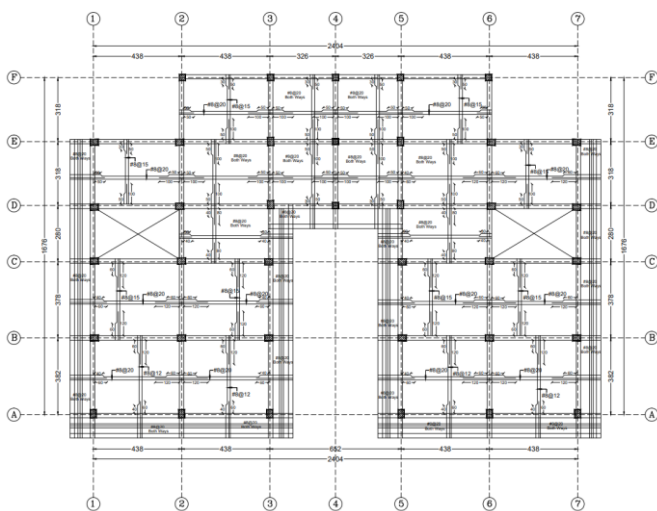Thickness of the slab is 12cm

Fig 15-: Reinforcement details of the slab

- Dimension: 318cm x 438cm.
  Reinforcement: Main bar 8mm @15cm c/c .
  Distributor bars 8mm @20cm c/c.
  Crank length on continuous face: 50cm.
  Extra bar length: 100cm.

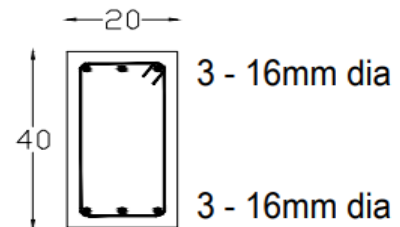 Crank length on discontinuous face: 30cm.
  Extra bar length: 50cm.

5.5 DESIGN OF STAIR CASE

Fig 16-: Key plan of stair case
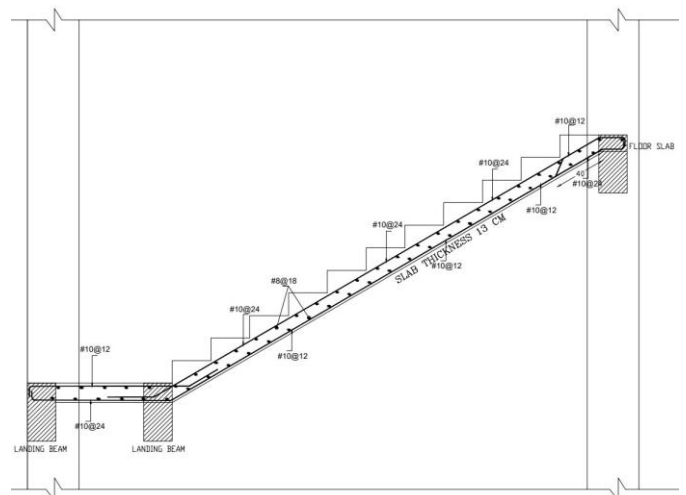

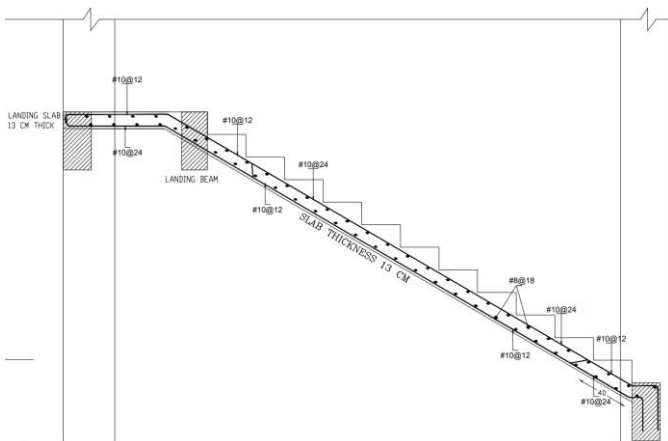**Fig 17**-: Landing Beam Section

Fig 18-: Section B-B

Fig 19-: Section A-A

6. CONCLUSION

This project deals with the analysis and design of a three storied commercial building with the assistance of Staad pro V8i software. Doing the Analysis and design of such type building manually is a tedious process. Also these kinds of structures have many complicated structural elements that make it even difficult. Manual analysis and design can also lead to human errors. So with the help of STAAD Pro V8i software the analysis of any complicated structure can be done without any errors. Under different loading conditions, the deflection of each structural member is analyzed in depth. It also gives an idea about the behaviour of each structural element. These structural members are designed with the help of both software and Indian Standard Codes.

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