

# **PLANNING AND DESIGN OF RESIDENTIAL BUILDING**

**A REPORT**

Submitted In partial fulfilment of the requirements  
for the Degree  
**“Bachelor in Technology”**  
in  
**“ Civil Engineering”**

**BY**

**UJJAL PATRA ( 2021298029)**

**BISWA RANJAN PARIDA ( 1901298050)**

**BAHADUR TUDU (2021298008)**

**ANKITA ACHARYA (2021298004)**

Under the guidance of

**Asst.Prof . Shibani Hota**



**DEPARTMENT OF CIVIL ENGINEERING  
GANDHI INSTITUTE FOR TECHNOLOGY, AUTONOMOUS,  
BHUBANESWAR -752054**

**2022-23**

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**2022-23**



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## CERTIFICATE

This is to certify that the thesis entitled “**Planning and Design Of Residential Building**” submitted by (“**Ujjal patra ( 2021298029)**  
**Biswaranjan parida ( 1901298050)** **Bahadur Tudu (2021298008)**  
**Ankita acharya (2021298004)** in partial fulfilment of the requirements for the award of Bachelor of Technology Degree in Civil Engineering at Gandhi Institute For Technology, Bhubaneswar is an authentic work carried out by him under my supervision and guidance.. To the best of my knowledge, the matter embodied in this Project Report has not been submitted to any other University/Institute for the award of any Degree or Diploma.

S. Hata

S. Jaisankar  
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**Project Coordinator**  
**Dept. of Civil Engineering**

**External**



## DECLARATION

We declare that this project report titled " **Planning and Design of residential building** "submitted in partial fulfilment of the Degree of **B.Tech** in Civil Engineering is a record of original work carried out by us under the supervision of **Asst.Prof . Shibani Hota**, and has not forward the basis for the award of any other degree or Diploma, in this or any other institutions or University. In keeping with the ethical practice in reporting scientific information, due acknowledgements have been made wherever the findings of others have been cited.

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## ACKNOWLEDGEMENT

I extend my deep sense of gratitude and indebtedness to my guide

**Asst.Prof.Shibani Hota** , Professor Department Of Civil Engineering, Gandhi Institute for Technology Autonomous, Bhubaneswar for his kind attitude, invaluable guidance, valuable suggestion, keen interest, immense help, inspiration and encouragement which helped me carrying out my project work. I am extremely grateful to **Prof. Surajit Pattnaik**, Head of the Department of Civil Engineering and **Prof. Abhijit Mangaraj**, faculty advisor and members of Civil Engineering Department, Gandhi Institute for Technology, Bhubaneswar, for providing all kind of possible help throughout the two semesters for the completion of this project work.

Lastly, I thank all those who are involved directly or indirectly in completion of the present project work.

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## **ABSTRACT**

This project describes analysing and design of residential building. Using pile footing the structure should be designe. The proposed residential building is to be constructed at (location). The area of the proposed building 1500 sq ft (G+2) will be constructed framed structure. The analysis of frames to compute the force and moment will be carried out with staad pro software. AutoCAD software will be used for planning of the building. Staad pro software will be used for analysis of building as well as IS 456:2000 code of practice for plain and reinforced cement concrete. The structural members are like slabs, beams; columns are designed with limit state method using national building code and IS 456:2000 grade concrete and grade of steel are to be used. The project is to develop independent and creative thinking fundamental theoretical knowledge we obtained during the course of the study practical application of field.

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## LIST OF SYMBOLS

The following symbols carrying the meanings noted against them are used in this volume

|                    |   |
|--------------------|---|
| $A$                | = Area  |
| $A_{st}$           | = Area of the steel reinforcement                             |
| $A_{sc}$           | = area of compression steel                                   |
| BM                 | = Bending Moment  |
| $B$                | = Breadth of the beam, slab                                   |
| $D$                | = Overall depth of beam or slab                               |
| $b$                | = Breadth of column   |
| $d$                | = Effective depth of beam or slab                             |
| $f_y$              | = Characteristic strength of steel                            |
| $f_{ck}$           | = Characteristic compressive strength of concrete             |
| $l$                | = Length of the beam  |
| $l_x$              | = Length of shorter span of slab                              |
| $l_y$              | = Length of longer span of slab                               |
| $l_{ex}$           | = Effective length of the slab along shorter span             |
| $l_{ey}$           | = Effective length of the slab along longer span              |
| $M_x, M_y$         | = Moments on the strip of unit width spanning $l_y$ and $l_x$ |
| $M_{ux}, M_{uy}$   | = Moments about x and y axes due to design loads              |
| $M_{ux1}, M_{uy1}$ | = Maximum uniaxial moment capacity for an axial load of $P_u$ |
| MOR                | = Moment of resistance  |
| $P_u$              | = Axial load on compression member                            |
| $S_v$              | = Spacing of stirrups   |
| $V$                | = Shear force   |
| $V_s$              | = Design shear force  |
| $W$                | = Total load  |
| $a_x$              | = Bending moment co-efficient along shorter span              |
| $a_y$              | = Bending moment co-efficient along longer span               |
| $t_v$              | = Permissible shear stress in concrete                        |

# CHAPTER – 1

## INTRODUCTION

### 1. GENERAL

The basics need of human existences are food, clothing's & shelter. From times immemorial man has been making efforts in improving their standard of living. The point of his efforts has been to provide economic and efficient shelter. The possession of shelter besides being a basic, used, gives a feeling of security, responsibility and shown the social status of man.

Every human being has an inherent liking for a peaceful environment needed for his pleasant living, this object is achieved by having a place of living situated at the safe and convenient location, such a place for comfortable and pleasant living requires considered and kept in view.

- A peaceful environment.
- Safety from all natural source & climate conditions
- General facilities for community of his residential area.

The engineer has to keep in mind the municipal conditions, building bye laws. Environment, financial capacity, water supply, sewage arrangement, provision of future, aeration, ventilation etc., in suggestion a particular type of plan to any client.

In this project, it is proposed to design a residential house for the purpose of living. The size of proposed plot size is 30m x 25m. the height of each floor is 3m from floor level to the bottom of roof slab. The main outer walls & cross walls are 230mm thick brick masonry in cement mortar.

## **2. DEMAND OF HOUSES**

The house is the first unit of the society and it is the primary unit of human habitation. The house is built to grant the protection against wind, weathers and to give insurance against physical insecurity of all kinds.

The special features of the demand for housing consist of in its unique nature and depend on the following factors.

- Availability of cheap finance.
- Availability of skilled labors.
- Availability of transport facility.
- Cost of labors & material of construction.
- Predictions of future demand.
- Rate of population growth and urbanization.
- Supply of developed plots at reasonable prices.
- Taxation policy on real estates.
- Town planning & environmental conditions.

### **3. RESIDENTIAL UNITS**

A residential unit is a detached house, semi detached house, row house units, mobile home, floating or apartment it can be any part that is occupied by an individual as a place of residential of lodging.

- Is leased as a place of residence or lodging.
- Is vacant but was last occupied or supplied as a place of residence or lodging for individual

### **4. BUILDING PLANNING AND DESIGN**

Boring and samples taken at the site will provide information regarding location and extent of rocks, bearing capacity of the subsurface strata at various points and level of the water table. A survey may indicate terrain and other conditions that will strongly influence the design decision. Limitations imposed by difficult terrain, in addition to those imposed by local laws or ordinances may limit such items as drive ways and parking entrances. The process of designing a Soft Storied Residential Building involves:

- Program development
- Site analysis
- Building planning
- Building design

Program development is for the most part, evaluation of the information over

which the architect has relatively less control but shapes up the project in basic way. It involves the evaluation of physical data, which must be recognized, identified and weighed by the architect in making design decision dealing with site views, allocation and development.

Physical characteristics of a site may impose limitation on a building program. Therefore, an early analysis of site data and conditions should be undertaken by the architect in order to ascertain and evaluate such limitations. Boring and samples taken at the site will provide information regarding location and extent of rocks, bearing capacity of the subsurface strata at various points and level of water table. A survey may indicate terrain and other conditions that will strongly influence the design decisions.

## **DESIGN PHILOSOPHIES**

The object of reinforced concrete design is to design a structure using concrete

- and steel such that it results in safe and economical solution. For a given structural system, the design problem consists of the following steps:

Idealization of structure of analysis

- Estimation of loads
- Analysis of idealized structural model to determine the axial thrust, shearing force, bending moment and deflections.
- Design of structural elements.
- Detailed structural drawings and schedule of reinforcing bars.

There are three philosophies for the design of reinforced concrete and pre-

stressed concrete as well as steel structures, namely:

- Working stress method
- Ultimate load method
- Limit state method

The working stress method was the principal method prevalent in use from the early last century. The ultimate load philosophy, on the other hand came in use because of its more rational approach. Recently, there has been a transition to the limit state method because of its more rational approach than ultimate load method. Which has overcome the most serious drawbacks of the last method.

## **OBJECTIVE OF THE PROJECT**

A structural engineer working in any construction project must be in familiar with planning, analysis & design of framed structures. Hence we the students made an attempt to choose a problem, involving analysis and design of multi-storied framed structures as our project work.

Work done are,

- Planning & analysis of a single storied (G+2) residential building.
- Detailed design by limit state method.
- Preparation of structural drawings for slabs, beams, columns, footings.

## **8. REGULATION AND BYE LAWS**

- Line of building frontage and minimum plot sizes.
- Open spaces around residential building.
- Minimum standard dimensions of building elements.
- Provisions for lighting and ventilation.
- Provisions for safety from explosion.
- Provisions for means of access.
- Provisions for drainage and sanitation.
- Provisions for safety of works against hazards.
- Requirements for landscaping.
- Requirements for off-street parking.
- Special requirement for low income housing.
- Size of structural elements.

## **9. LOCATION**

The main aim of the project is planning analysis and design of multi-storey residential building (G+2) Bhubaneswar .

The project is to achieve an acceptable probability that structure will perform satisfactorily during the intended life. With an appropriate degree of safety, they should sustain all the loads and deformation of normal construction and use and have adequate durability.

The plot area of the site is 1500 sq ft , the plinth area of the building is.

## **CHAPTER – 2**

### **LITERATURE REVIEW**

**Prof. Natish Sayyed Prof. Mrunali Dongre**  
**April 2021**

As author project is based on the planning of residential building he have studied about the basic requirements of planning for his residential building. In the process of implementing this project, he learned how to apply the theoretical aspects of evaluation in actual projects

**Mrs. Shilpa Valsakumar 2022**

From literature review, it is found that Mono column buildings has unique structure they have good aesthetic view. Mono column structure can withstand all loads including earthquake loads and wind loads.

**Prof. Aradhana Chavan 06, June-2021**

This project includes G +4 building with parking at ground floor and rest of the floors occupied with 2BHK flats. over all project helped us to understand the Building Process and use of different software for easy and timely completion of work.

## **G.B. Ramesh kumar 2018**

The dimension of structural members are specified and the load such as dead load live load and floor load and earth quake load are applied . The building will be utilized for presentations, as a craftsmanship display or show room, and so on so that there are no dividers inside the building.

## **Dunnala Lakshmi Anuja2 V.S.Nagasai 2019**

Frame analysis was done bySTAAD.pro. Slab and beams were designed as per IS code 456-2000.The properties such as shear, deflection, development, torsions arewith the IS code provisions.

## CHAPTER – 3

### LABORATORY TEST

#### PLASTIC LIMIT

The value of the plastic limit is used to classify the fine-grained soils and evaluating the activities of clayey soil. It indicates the toughness index of soil.

The plastic limit is the water content at which a soil-water paste changes from a semisolid to a plastic consistency as it is rolled into a 3.175-mm (1/8-inch) diameter thread in a standard test

|                               |      |      |
|-------------------------------|------|------|
| Watchglass no                 | 3    | 4    |
| Wt. of watch glass + wet soil | 27   | 27.3 |
| Wt. of watch glass + dry soil | 24.7 | 25.5 |
| Wt. of water                  | 2.3  | 1.8  |
| Wt. of container (gm)         | 19   | 18.7 |
| Wt. of dry soil (gm)          | 20   | 20   |
| Moisture content %            | 50   | 50   |

Table : 1 plastic limit test values

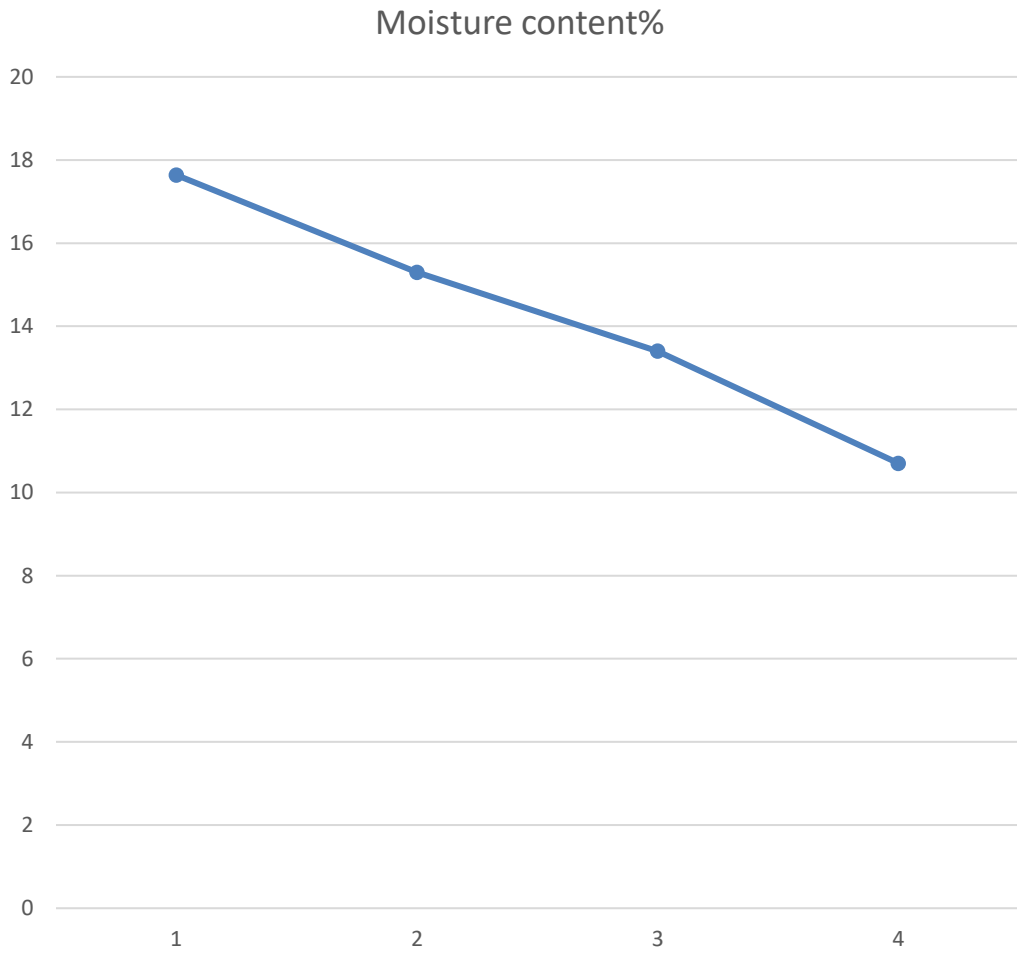
## LIQUID LIMIT

- Liquid limit is the water content where the soil starts to behave as a liquid. Liquid limit is measured by placing a clay sample in a standard cup and making a separation (groove) using a spatula. The cup is dropped till the separation vanishes. The water content of the soil is obtained from this sample.
- A high liquid limit normally indicates a high compressibility and a high shrinkage/swelling potential. A high-plasticity index  $I_p$  generally results in a low shear strength. A low  $I_p$  means that a soil used as foundation will change significantly in consistency even with a small change in water content.

| DESCRIPTION                    | TRAIL 1 | TRAIL 2 | TRAIL 3 | TRAIL 4 |
|--------------------------------|---------|---------|---------|---------|
| No of observation              | 1       | 2       | 3       | 4       |
| No of blows                    | 20      | 25      | 30      | 38      |
| Moisturation number            | 5       | 1       | 2       | 3       |
| Wt. of wet soil + moisturation | 37      | 33      | 30      | 27      |
| Wt. of dry soil + moisturation | 34      | 31      | 28      | 26      |
| Wt. of moisture fur            | 20      | 20      | 18      | 19      |
| Wt. of dry soil                | 120     | 120     | 120     | 120     |
| Wt. of water                   | 3       | 2       | 2       | 1       |
| Moisture content%              | 17.64   | 15.3    | 13.4    | 10.7    |

Table : 2 Liquid limit test values

# LIQUID LIMIT GRAPH



## MAXIMUM DRY DENSITY

The determination of maximum dry density and optimum moisture content of the soil is a measure of compaction level of soils. This can be measured by mainly two methods Standard Proctor Compaction Test and Modified Proctor Compaction Test. Both the tests help to determine the optimum moisture content that is required for soil to attain maximum compaction i.e maximum dry density for performing construction.

| TEST NO                       | 1      | 2      | 3      | 4      |
|-------------------------------|--------|--------|--------|--------|
| Weight of empty mould         | 4.544  | 4.544  | 4.544  | 4.544  |
| Internal dia of mould         | 10     | 10     | 10     | 10     |
| Height of mould               | 12.5   | 12.5   | 12.5   | 12.5   |
| Volume of mould               | 981.57 | 961.57 | 981.57 | 981.57 |
| Wt. of mould + compacted soil | 6.671  | 6.712  | 6.759  | 6.642  |
| Wt. of compacted soil         | 2.427  | 2.168  | 2.215  | 2.098  |
| Wet density                   | 2.47   | 2.2    | 2.24   | 2.13   |
| Container no                  | 36     | 8      | 32     | 41     |
| Wt. of container              | 12     | 11     | 13     | 12     |
| Wt. of container + wet soil   | 50     | 50     | 50     | 50     |
| Wt. of container + dry soil   | 48.29  | 43.3   | 45.6   | 43.4   |
| Wt. of dry soil               | 36.29  | 32.3   | 32.6   | 31.4   |
| Wt. of water                  | 1.71   | 6.7    | 4.4    | 6.6    |
| Water content W%              | 4      | 20     | 13     | 21     |
| Dry density                   | 2.37   | 1.83   | 1.98   | 1.76   |

Table : 3 Standard Proctor Compaction test values

# CHAPTER – 4

## METHODOLOGY

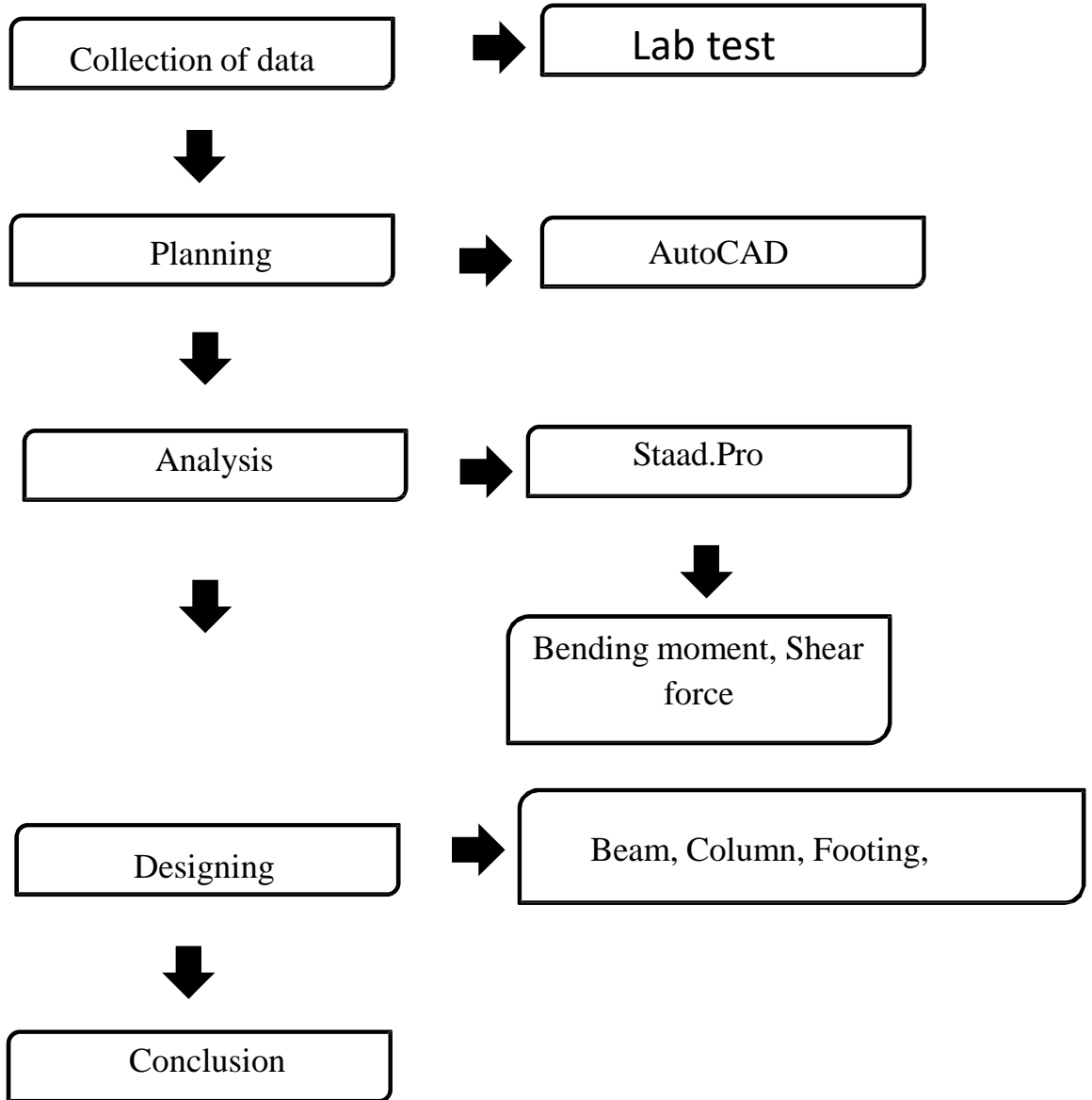


Fig.1 METHODOLOGY

## SITE VIEW



Fig.2 SITE VIEW

## **CHAPTER – 5**

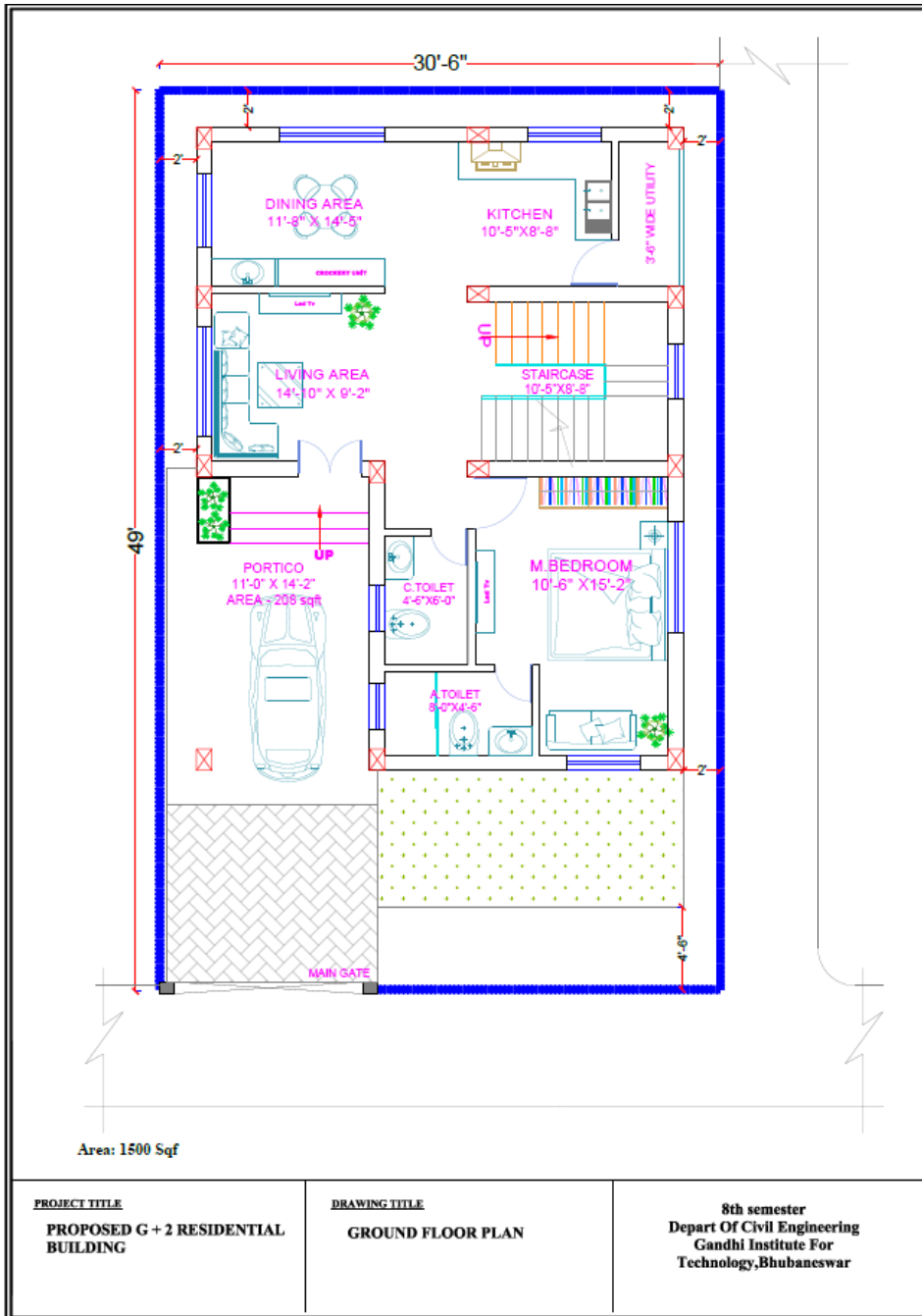
### **PLANNING**

First of all the plan for the building should be drafted. According to the needs and the usage of the building the loads are calculated and the slabs are then design for the loads based on its edge conditions specified. The size of the beam, area of steel reinforcement and the spacing of stirrups are calculated.

The columns are designed according to the loads transmitted from the floors, from the design the size of the column, area of steel reinforcement and the spacing of lateral ties required are determined.

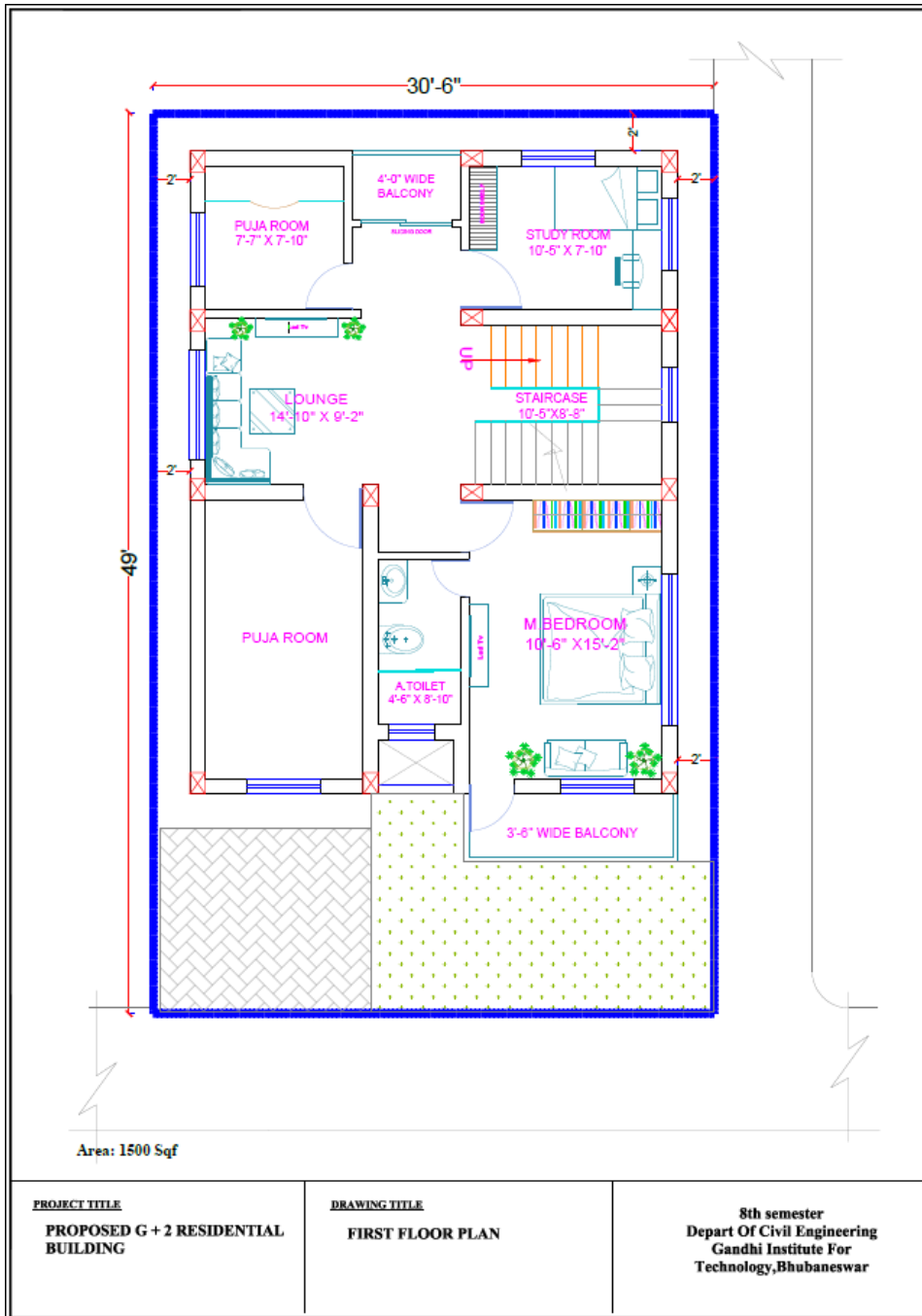
According to the bearing capacity of the soil and the load from the super- structure the type of foundation suitable is chosen and it is designed. The reinforcement details of the various structural elements should be drafted.

# GROUND FLOOR PLAN



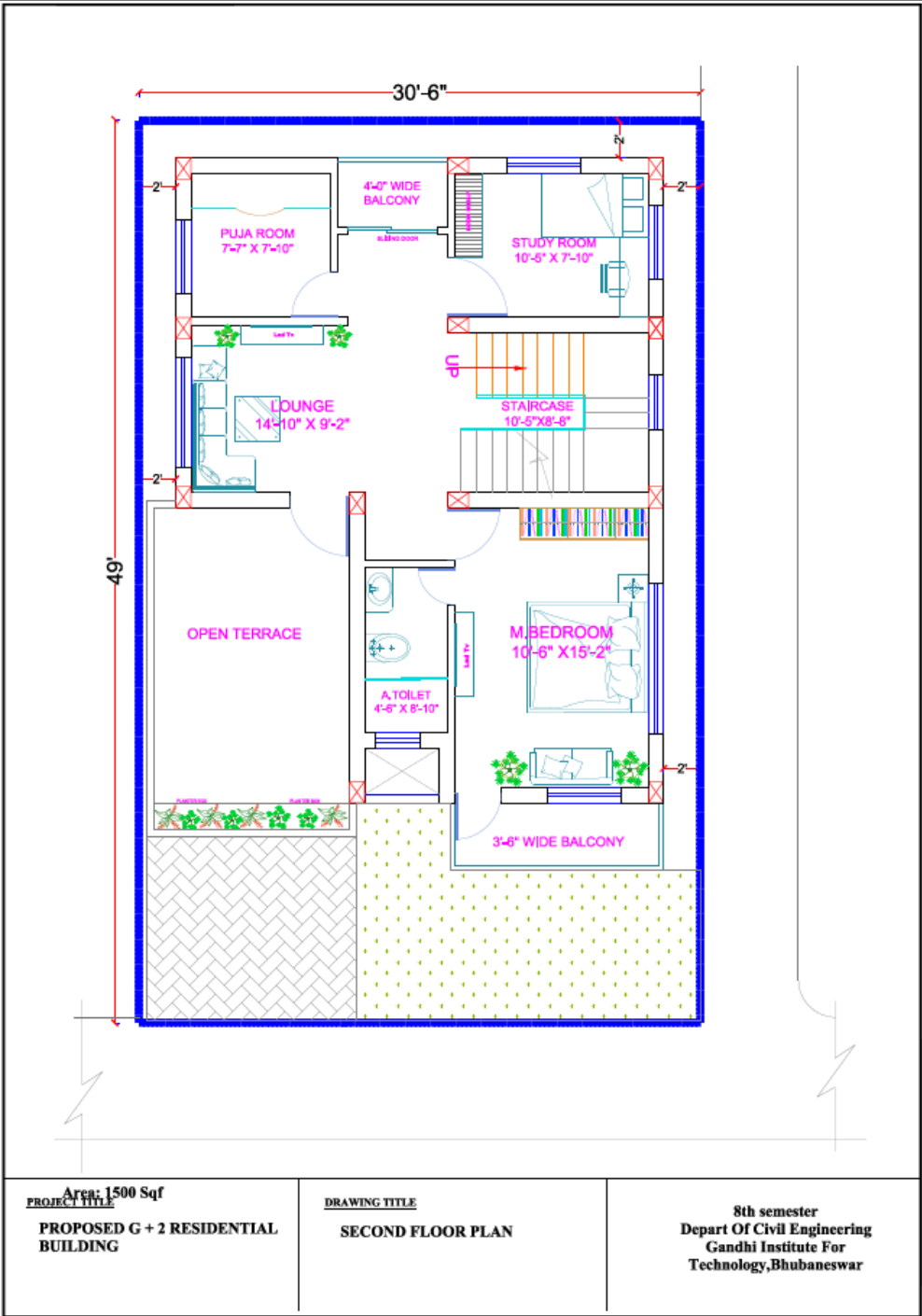
**Fig.3 GROUND FLOOR PLAN**

# FIRST PLAN



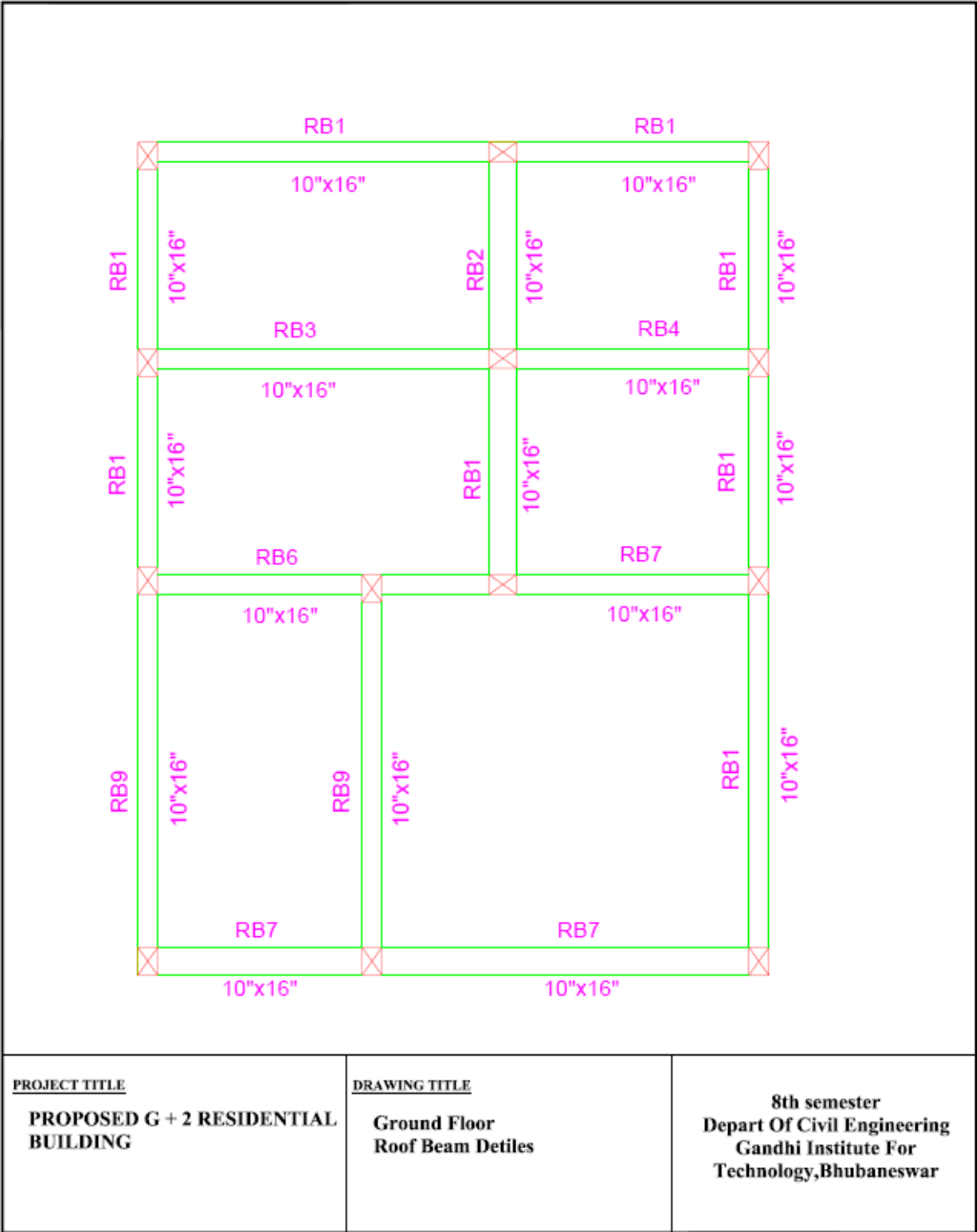
**Fig 4 FIRST FLOOR PLAN**

# SECOND FLOOR PLAN



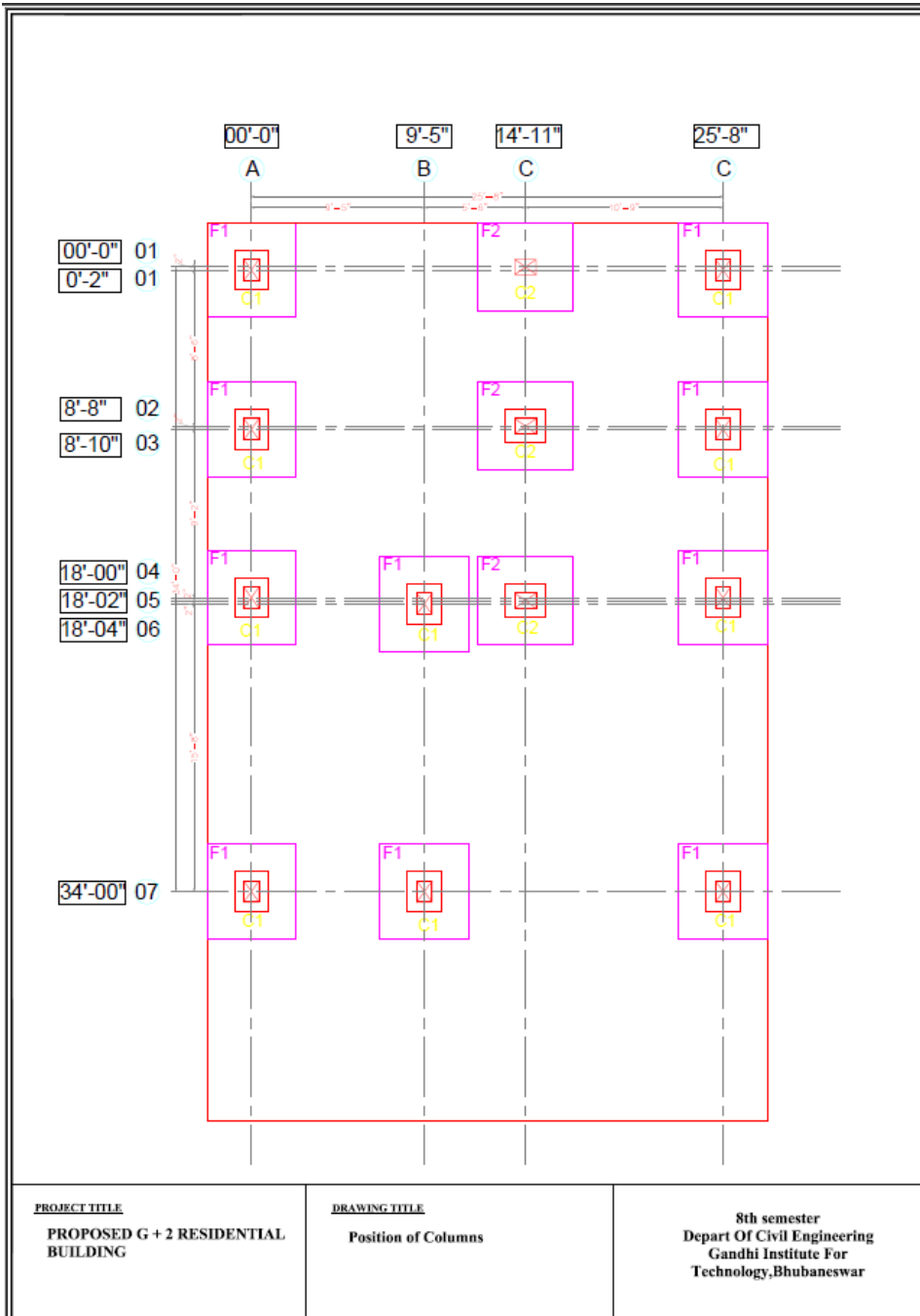
**Fig.5 SECOND FLOOR PLAN**

# BEAM PLACEMENT



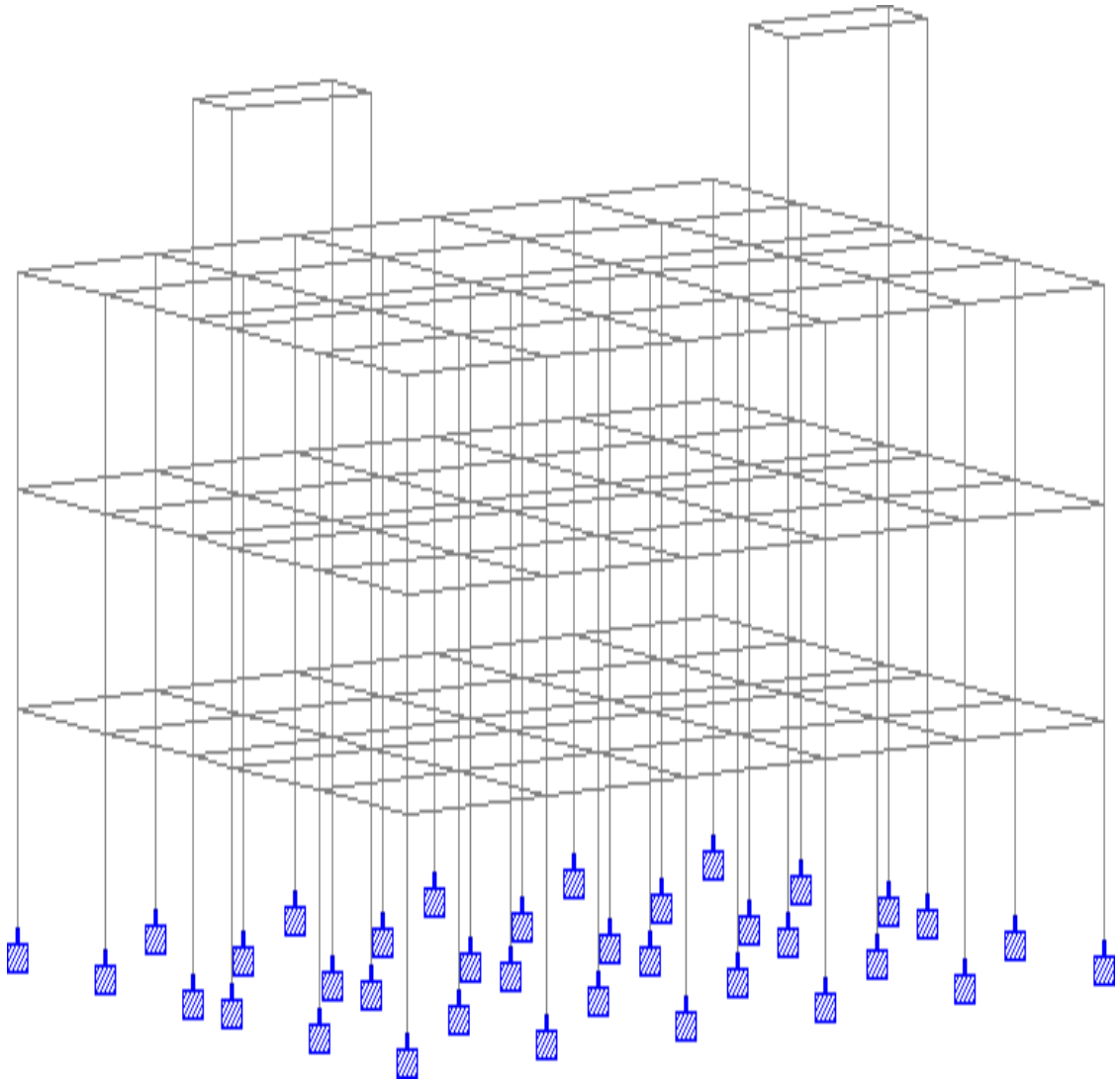
**Fig.6 BEAM PLACEMENT**

# Position of column



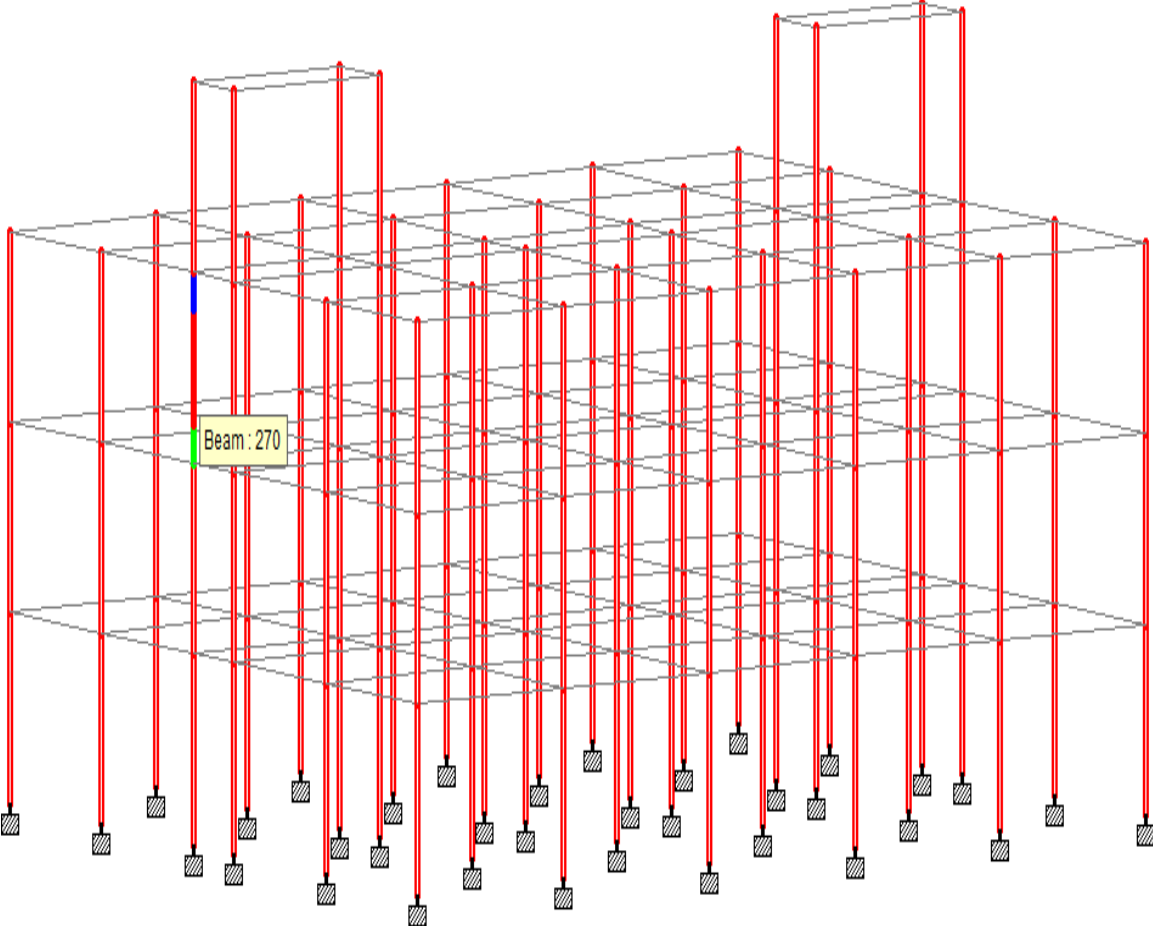
**Fig.7 COLUMN PLACEMENT**

# SUPPORT LAYOUT



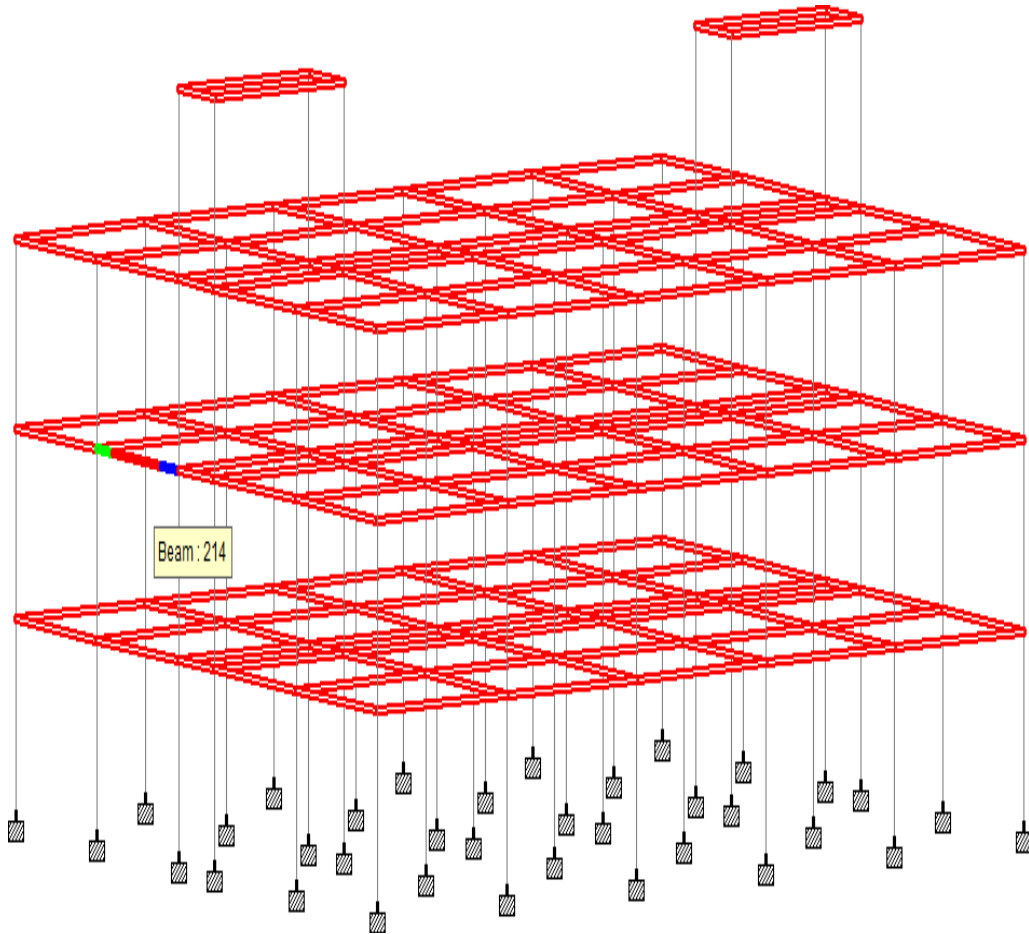
**Fig.8 SUPPORT LAYOUT**

# COLUMN LAYOUT



**Fig.9 COLUMN LAYOUT**

# BEAM LAYOUT



**Fig.10 BEAM LAYOUT**

## **2. DESIGN OF BEAM**

### **1. GENERAL**

A beam is a horizontal structural element that is capable of withstanding load primarily by resisting bending. The load from the slab is transferred to beam. The bending force induced into the material of the beam as a result of the external loads, own weight, span and external reactions to these loads is called as bending moment. Therefore, beam is a structural member which is subjected to bending moments and shear force due to transverse load. The beam transfers its load to the column.

Considering a beam, bending moment and shearing stresses are greater than those of slabs. Therefore, the depth of the beam is governed by the bending moment criteria while deflection criteria normally get satisfied.

A beam simply supported at its ends carrying a uniformly distributed loads bends with a concavity upwards. It is subjected to maximum sagging or positive bending moment at its mid-span and zero at its supports. Sometimes the beam will be subjected to maximum negative or hogging moment.

The point where the curvature changes from sagging to hogging is called as point of contra flexure. While designing a beam, according to the bending moment we design as a flanged section or rectangular section or a Tee-beam or an L-beam.

### **TYPES OF BEAMS**

Based on support conditions Simply supported beams Based on shape

Tee beam

L beam

Rectangular beam

Cantilever beam

Fixed beam

## DESIGN OF BEAM:

### DESIGN OF RECTANGULAR BEAM

#### DATA:

|                |          |              |                        |
|----------------|----------|--------------|------------------------|
| Effective span | = 4.5 m  | $f_{ck}$     | = 20N/mm <sup>2</sup>  |
| Width of beam  | = 230mm  | $f_y$        | = 415N/mm <sup>2</sup> |
| Overall depth  | = 500 mm | Service load | = 4 KN/m               |
| $d'$           | = 50mm   |              |                        |

#### LOADS:

Load on floor

$$\begin{aligned} \text{Self weight of the slab} &= 25 \times .2 \\ &= 5 \text{ KN/m}^2 \end{aligned}$$

$$\text{Live load} = 4 \text{ KN/m}^2$$

$$\text{Floor finish} = 1 \text{ KN/m}^2$$

$$\text{Total load on slab} = 10 \text{ KN/m}^2$$

#### Inner frame (beam):

Floor area

$$\begin{aligned} \text{For transverse direction beam} &= 0.5 * b * h \\ &= 0.5 \times 4.5 \times 4.5/2 \\ &= 5.0625 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \text{For longitudinal direction beam} &= [(a+b) \times h] / 2 \\ &= [(5 + 0.93) \times 2.25] / 2 \\ &= 6.671 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \text{Floor load / m run} &= 10 \times 6.67/5 \\ &= 13.34 \text{ KN/m} \end{aligned}$$

$$\text{Considering wall of thickness} = 230 \text{ mm}$$

$$\begin{aligned} \text{Wall load / m} &= 20 \times 0.23 \times 3 \\ &= 14 \text{ KN/m} \end{aligned}$$

$$\begin{aligned} \text{Self weight of beam} &= 0.5 \times 25 \times 0.23 \\ &= 2.875 \text{ KN/m} \end{aligned}$$

$$\text{Total load on beam} = (13.34 \times 2) + 2.875 + 14$$

$$\text{Total working load} = 43.55 \text{ KN/m}$$

$$\begin{aligned} \text{Design of ultimate load } W_u &= 1.5 \times 43.55 \\ &= 65.33 \text{ KN/m} \end{aligned}$$

### ULTIMATE MOMENTS AND SHEAR FORCES:

$$\begin{aligned} \text{Bending moment } M_u &= W_u \cdot L^2 / 8 \\ &= 65.33 \times 5^2 / 8 \\ &= 204.167 \text{ KNm} \end{aligned}$$

$$\begin{aligned} \text{Shear force } V_u &= W_u \cdot L / 2 \\ &= 65.33 \times 5 / 2 \\ &= 163.33 \text{ KN} \end{aligned}$$

### MAIN REINFORCEMENT:

$$\begin{aligned} M_{u,\text{lim}} &= 0.138 f_{ck} b d^2 \\ &= 0.138 \times 20 \times 230 \times 450^2 = 210.22 \text{ KNm} \end{aligned}$$

Since  $M_u < M_{u,\text{lim}}$ , design is a singly reinforced section.

$$\begin{aligned} M_u &= 0.87 \cdot f_y \cdot A_{st} \cdot d \left[ 1 - \frac{A_{st} \cdot f_y}{b \cdot d \cdot f_{ck}} \right] \\ 204.167 \times 10^6 &= 0.87 \times 415 \times 450 \times A_{st} \left( 1 - \frac{A_{st} \cdot 415}{230 \times 20 \times 450} \right) \\ A_{st} &= 2500 \text{ mm}^2 \end{aligned}$$

Provide 20 mm dia of bars.

$$\begin{aligned} \text{No of bars} &= 2500 / (\pi \times 20^2 / 4) \\ &= 8 \text{ bars} \end{aligned}$$

### SHEAR REINFORCEMENT:

$$\begin{aligned} r_v &= V_u / b d \\ &= 163.33 \times 10^3 / (230 \times 450) \\ &= 1.57 \text{ N/mm}^2 \end{aligned}$$

$$\begin{aligned} \% \text{ of steel} &= 100 A_{st} / b d \\ &= (100 \times 2500) / (230 \times 450) \\ &= 0.68\% \end{aligned}$$

$$k = 1$$

$$r_c = 0.598 \text{ N/mm}^2$$

Hence the shear stress are with safe permissible limits.

Refer table -19

$$r_c = 0.598 \text{ N/mm}^2$$

$$\begin{aligned} V_{us} &= [V_u - [r_c * b * d]] \\ &= [163.33 \times 10^3 - (0.598 \times 230 \times 450)] \\ &= 102.205 \text{ KN} \end{aligned}$$

### SPACING:

Using 8 mm dia 2 legged stirrups

$$\begin{aligned} 1.S_v &= [0.87 \times 415 \times 2 \times 50 \times 475 / 54.96102.205 \times 10^3] \\ &= 80 \text{ mm} \\ 2.0.75d &= 0.75 \times 450 = 337.5 \text{ mm} \\ 3. &= 300 \text{ mm} \end{aligned}$$

Providing 8 mm dia 2 legged stirrups @ 80mm c/c

### REINFORCEMENT DETAILS:

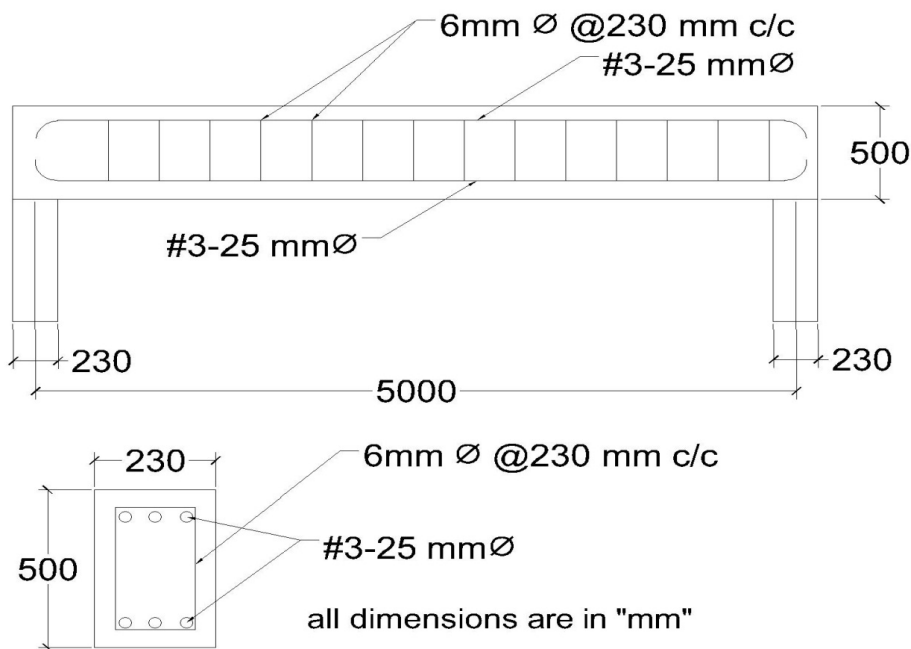


Fig 11 REINFORCEMENT DETAIL OF BEAM

### **3. DESIGN OF COLUMN**

#### **1. GENERAL**

A column is generally a compression member supporting beams and slabs in a structural system and having an effective length exceeding three times the least lateral dimension. A column may be considered to be short when its effective length does not exceed 12 times the least lateral dimension. If the ratio of effective length to least lateral dimension exceeds 12 times the column is considered as long or slender for design purposes.

#### **2. EFFECTIVE LENGTH**

For normal design purpose assuming idealized conditions, the effective length is assessed on the basis of IS 456-2000.

#### **3. LOADS ON COLUMNS**

Columns in a building frame are subjected to the following loads:

- Live loads on the floor supported by column
- Dead load of the floor and beams supported by the column
- Self weight of the column



#### **4. MINIMUM ECCENTRICITY**

All columns shall be designed for minimum eccentricity equal to the unsupported length of column/500 plus lateral dimension/30, subjected to a minimum  $\phi 20$ mm. This minimum eccentricity is incorporated in the design equation recommended in IS 456-2000.

#### **5. TYPES OF COLUMN**

Based on slenderness ratio,

- Short column
- Long column

Based on loading,

- Axial loaded column
- Axial load with uniaxial loading
- Axial load with biaxial loading
- Eccentrically loaded column

### 3.3.6 DESIGN OF AXIAL

#### COLUMN DATA:

|       |                            |
|-------|----------------------------|
| $P_u$ | = 1050KN                   |
| $f_c$ | = 20<br>N/mm <sup>2</sup>  |
| $k$   | = 415                      |
| $f_y$ | = 415<br>N/mm <sup>2</sup> |
| $L$   | = 3m                       |
| $B$   | = 230 mm                   |
| $D$   | = 230mm                    |

#### LOAD ON COLUMN:

$$\begin{aligned} \text{Dead load of slab} &= 10 \times 5 \times 4.5 \\ &= 225 \text{ KN} \end{aligned}$$

$$\begin{aligned} \text{Dead load of beam} &= (25 \times 0.23 \times 0.5 \times 5) + (25 \times 0.23 \times 0.5 \times 4.5) \\ &= 27.3125 \text{ KN} \end{aligned}$$

$$\begin{aligned} \text{Wall load} &= 14 \times 0.23 \times 3 (5+4.5) \\ &= 91.77 \text{ KN} \end{aligned}$$

$$\text{Total load} = 344.08 \text{ KN}$$

$$\begin{aligned} \text{Factored load} &= 1.5 \times 344.08 \\ &= 516.12 \text{ KN} \end{aligned}$$

$$\text{No of stories} = 2$$

$$P_u = 2 \times 516.12$$

$$= 1032.24 \text{ KN} \sim 1050 \text{ KN}$$

### SLENDERNESS RATIO:

$$L_e = 1000$$

$$\frac{L_e}{D} = \frac{1000}{230} = 4.32 < 12$$

Hence it is short column.

### MINIMUM ECCENTRICITY:

$$e_{min} = \frac{1}{500} D + \frac{30}{500} = \frac{1}{500} \times 230 + \frac{30}{500} = 0.46 + 0.06 = 0.52 < 12.5$$

Also,  $0.05 D_x = 0.05 \times 230 = 12.5$   
 $> e_{min}$

Consider cover = 25 mm

### AREA OF COLUMN ( $A_g$ ) :

$$A_g = (A_c + A_{sc})$$

$$230 \times 230 = (A_c + A_{sc})$$

$$A_c = 52900 - A_{sc}$$

$$P_u = 0.4 f_{ck} * A_c + 0.67 f_y * A_{sc}$$

$$\frac{1050 \times 10^3}{10^3} = 0.4 * 20 * (52900 - A_g) + 0.67 * 415 * A_g$$

$$A_{sc} = 2321.05 \text{ mm}^2$$

Assume 25 mm dia bar

$$\text{No of bars} = \frac{2321.05}{\pi * 25^2 / 4}$$

$$\pi * 25^2 / 4$$

~ 6 nos Provide #6 of 25 mm dia bars.

## REINFORCEMENT OF LATERAL BAR:

Dia of lateral bar  $\leq \frac{1}{4}$  of main bar

$$\leq 25/4$$

$$= 6.54\text{mm}$$

$\sim$  6mm bar

## SPACING

48 x dia of ties = 48 x 6 = 288 mm Pitch of

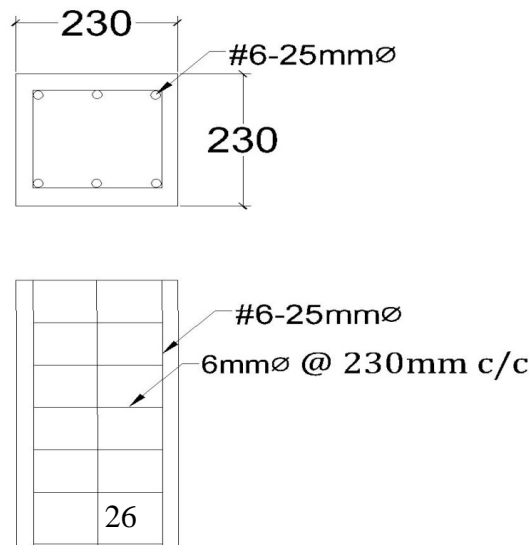
lateral bar = 16d = 16\*25 = 400 mm 300 mm

Least lateral dimension = 230 mm

Provide 6mm dia ties @ 230 mm c/c.

**Hence it is safe.**

## REINFORCEMENT DETAILS:



all dimensions are in "mm"

Fig.12 REINFORCEMENT DETAIL OF COLUMN

## **5. DESIGN OF FOOTING**

### **1. GENERAL**

Footing is the bottom most important component of the structure. The footing generally lies well below the ground level. The footing provided for the column is called column footing. The main function of the footing is to transfer the load from the column to the ground so that the intensity of pressure on the soil does not exceed the safe bearing capacity of the soil.

Reinforced concrete footings are designed to resist the design factored moments & shear forces due to the imposed loads. The area of the footing should be such that the bearing pressure developed at the base of footings does not exceed the safe bearing capacity of the soil.

In plain concrete footings, the thickness at the edge should be at least 150 mm for footings on solids and not less than 300 mm above the tops of piles for footings on piles

### **TYPES OF FOUNDATION**

The types of foundation are

- Shallow foundation
- Deep foundation

### **TYPES OF FOOTINGS**

- **TYPES OF FOOTINGS**

The types of footings are

Isolated footing

Strap footing

Mat footing

Spread footing

Combined footing

### 3.5.4 DESIGN OF ISOLATED FOOTING DATA:

|                           |                         |
|---------------------------|-------------------------|
| Axial service load, $P_u$ | = 1500KN                |
| Dimension of column       | = 230 x230              |
| S.B.C of the soil         | = 400 KN/m <sup>2</sup> |
| $f_y$                     | = 415 N/mm <sup>2</sup> |
| $f_{ck}$                  | = 30 N/mm <sup>2</sup>  |

#### DIMENSION OF FOOTING:

|                     |  |
|---------------------|--|
| $P_u$               | = 1500KN   |
| Weight of footing   | = 10% of $P_u$<br>= 0.1 x1500 = 150KN                    |
| Total load, $W_u$   | = $P_u + P_u$<br>= 1500 +150<br>= 1650KN                 |
| Area of the footing | = total load / S.B.C<br>=1650 / 420 = 2.75m <sup>2</sup> |
| Size of the footing | =1.75 m x1.75 m  |

#### PRESSURE DISTRIBUTION AT BASE:

|                       |   |
|-----------------------|---|
| Soil pressure at base | = 1650 / (1.75 x1.75)<br>= 538.77 KN/m <sup>2</sup> < (1.5 x 400) KN/m <sup>2</sup> |
|-----------------------|---|

Hence it is safe within the permissible limits.

## **FACTORED BENDING MOMENT:**

$$M = P(L - a^2)/8L = 1650(1.75 - 0.23)^2 / (8 \times 1.75) = 272.29 \text{ KNm}$$

Since it is a square slab moment and reinforcements will be same in both directions.

## THICKNESS OF FOOTING SLAB:

$$\begin{aligned} M_u &= 0.138 * b * d^2 * f_{ck} \\ 272.29 \times 10^6 \text{ d} &= 0.138 \times 30 \times 1000 \times d^2 \\ &= 275 \text{ mm} \end{aligned}$$

Depth (d) based on shear consideration will be double than that due to moment consideration.

$$\begin{aligned} \text{Effective depth } d &= 2x \\ &275\text{mm} \\ \text{Overall depth } d &= 550\text{mm} \\ D = d + d' &= 600\text{mm} \\ &= 550 + 50 \end{aligned}$$

## REINFORCEMENTS :

$$\begin{aligned} M_u &= 0.87 \cdot f_y \cdot A_{st} \cdot d \left[ 1 - \frac{(A_{st} \cdot f_y)}{(b \cdot d \cdot f_{ck})} \right] \\ 272.29 \times 10^6 &= (0.87 \times 415 \times 550 \times A_{st}) \left[ 1 - \frac{(A_{st} \times 415 / 1000 \times 30 \times 550)}{(b \cdot d \cdot f_{ck})} \right] \\ A_{st} &= 1422.06 \text{ mm}^2 \\ A_{st} &= 0.12\% \text{ b D} \\ \text{min} &= 0.12 \times 1000 \times 600 / 100 \\ &= 720\text{mm}^2 \end{aligned}$$

Adopt 20 mm dia bars

$$\begin{aligned} &= (\pi/4) \times 20^2 \times 1000 / 1422.06 \\ &= 220 \text{ mm} \end{aligned}$$

Provide 20 mm dia bars @ 220 mm

c/c

# REINFORCEMENT

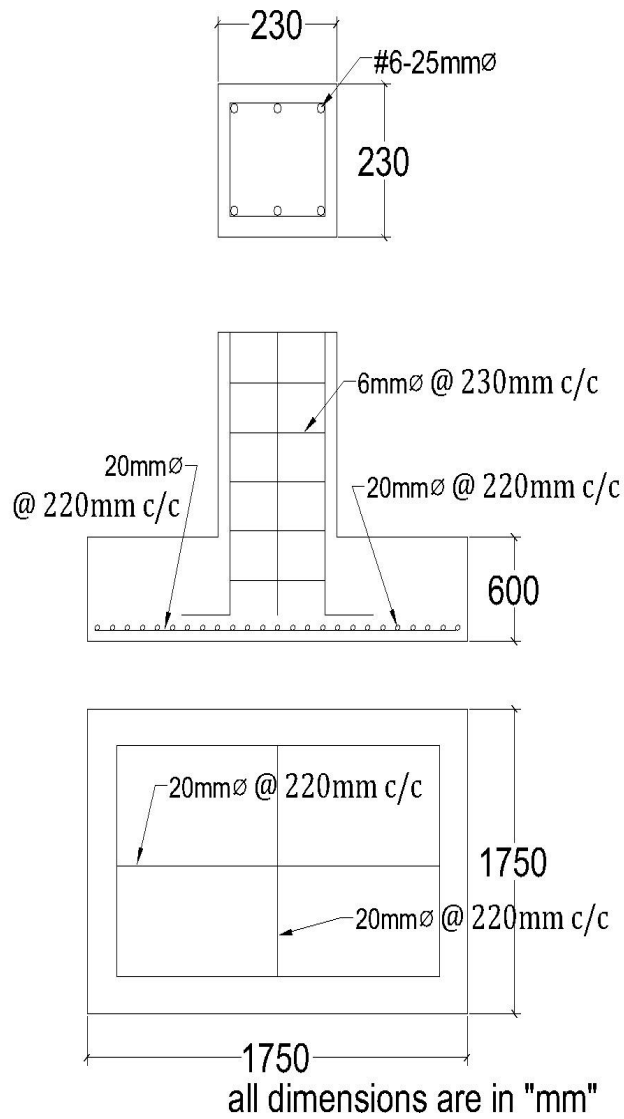


Fig.13 REINFORCEMENT DETAIL OF FOOTING

# CHAPTER - 6

## ANALYSIS

### 1. GENERAL

In the case of multi-storied frames, the degree of indeterminacy is very high and hence solution by consistent deformation, slope deflection, moment distribution or column analogy methods is almost ruled out. Kani's method, however, may be employed, but it needs more computational efforts. For quicker solution, design engineers use the following approximate methods of analysis.

### 2. TYPES OF ANALYSIS

Vertical loads are taken from the appropriate code (IS 875)

Any one of the following methods for loads:

- Portal method
- Cantilever method
- Factor method
- STAAD Pro Analysis

Structural design is the primary aspect of civil engineering. The very basis of construction of any building, residential house or dams, bridges, culverts, canals, etc, is designing. Structural engineering has existed since humans first started to construct their own structures. The foremost basic in structural engineering is the design of simple basic components and members of a building viz., Slabs, Beams, Columns and Footings. In order to design them, it is important to first obtain the plan of the particular building that is, positioning of the particular rooms. Such that they serve their respective purpose and also suiting to the requirement and comfort of the inhabitants. Thereby depending on the suitability; plan layout of beams and the position of columns are fixed.

### 3. LOAD COMBINATIONS

For our structure the following loads are considered

#### 1. DEAD LOAD

Dead loads of this structure is calculated as per **IS 875 Part-1**

Self weight of frames is calculated by software itself.

Floor finishes =  $1 \text{ KN/m}^2$

Wall load = wall thickness x wall height x unit weight of brick

$$= 14 \text{ KN/m}$$

Self weight of the slab = Thickness of slab x Unit weight of concrete

$$= 0.2 \times 25$$

$$= 5 \text{ KN/m}^2$$

#### 2. LIVE LOAD

Live loadings of this structure is calculated as per **IS 875 Part-2**

Live load on floors =  $4 \text{ KN/m}^2$

Live load on roof =  $4 \text{ KN/m}^2$

#### 4.3.3 LOAD COMBINATION

As per **IS 875 Part-5** & **IS 456-2000**, the following load combinations are taken for software analysis.

$$1.5(\text{DEAD LOAD} + \text{LIVE LOAD})$$

## **4.4 STAAD PRO ANALYSIS**

STADD is structural engineering software for 3D model generation, analysis and Multi-material design. Capabilities for static, dynamic, or pushover analysis of bridges, containment structures, embedded structures (tunnels and culverts), pipe racks, steel, concrete, aluminum or timber buildings, transmission towers, stadiums or any other simple or complex structure.

STADD.Pro is the premier finite element analysis and design tool for any type of project including towers, culverts, plants, bridges, stadiums and marine structures. With an array of advanced analysis capabilities including linear static, response spectra, time history, cable, pushover and non-linear analyses, STADD.Pro provides your engineering team with a callable solution that will meet the demands of your project every time. In addition, no matter what material or what country you are designing your structure, STADD.Pro can easily accommodate your design and loading requirements. Delivering high-performance buildings, small and large, on schedule, on budget and error free is the challenge facing practitioners today. Integrating design, analysis, fabrication and construction, in multiple disciplines through all phases of work, with changes happening every day, is critical for success.

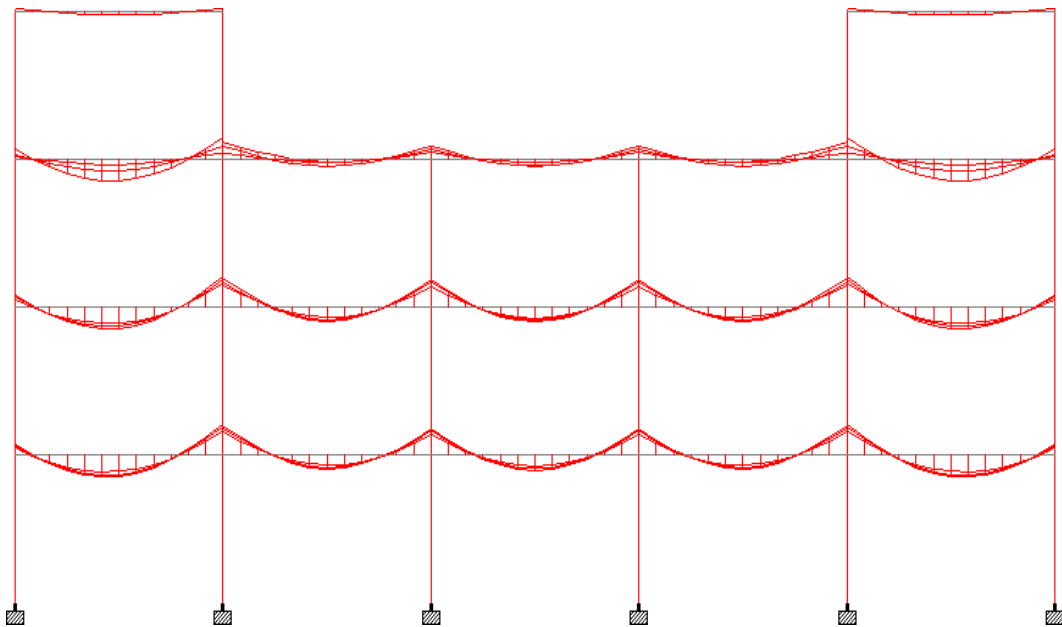


Fig.14 SHEAR FORCE DIAGRAM

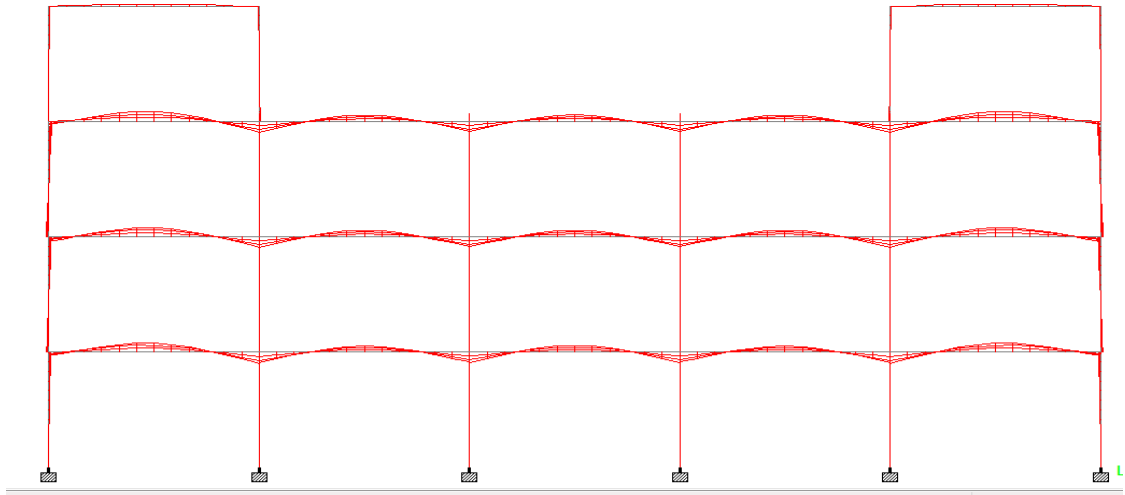


Fig.15 BENDING MOMENT DIAGRAM

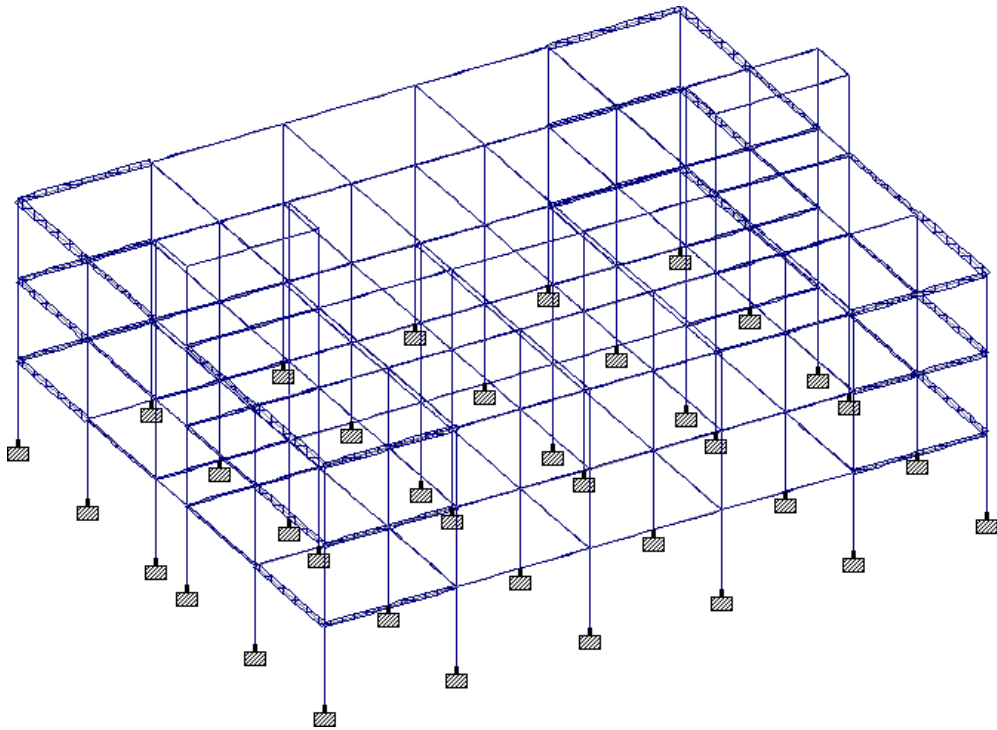


Fig.16 TORSION DIAGRAM

# AXIAL FORCE DIAGRAM

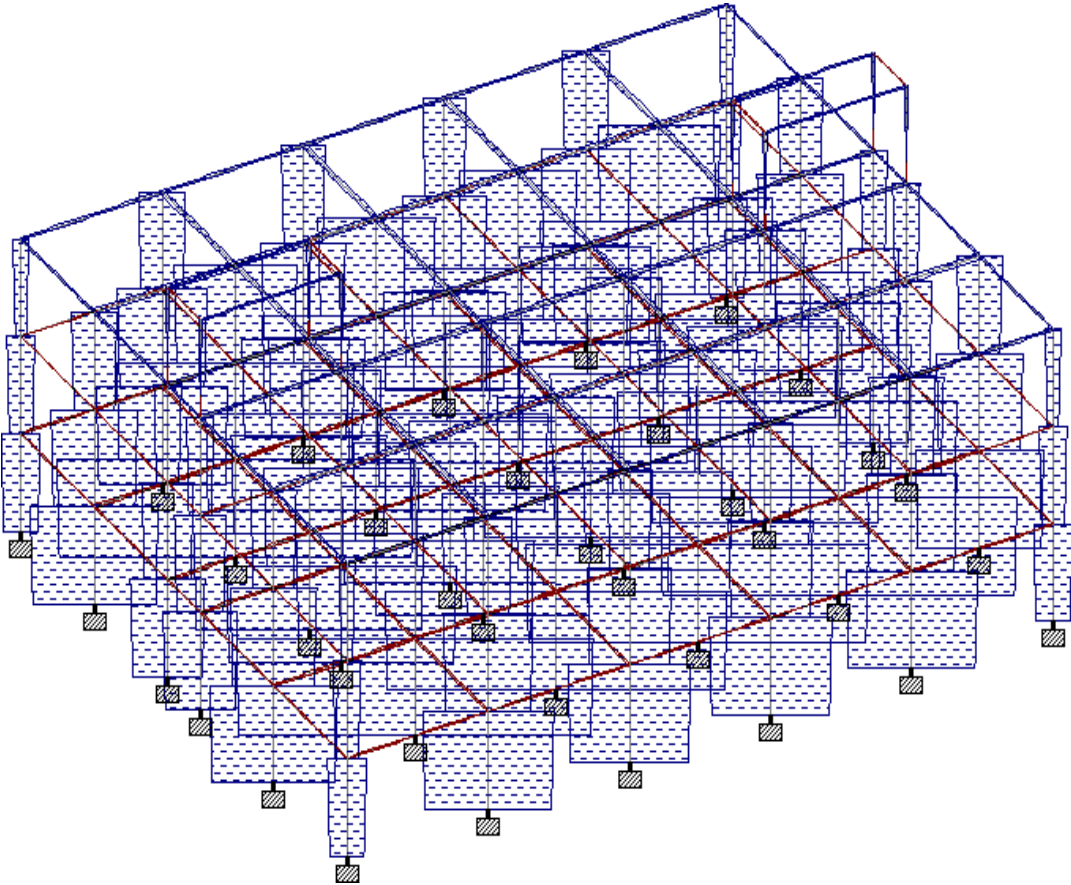


Fig 17 AXIAL FORCE DIAGRAM

## **CHAPTER – 7**

### **CONCLUSION**

The project has given opportunity to understand the basic principles of design. Analysis and Design of residential building is carried out to have maximum utility and safety. The framed structures is performed using STADD pro software. As the result of analysis dead loads and live loads were found. The Structural components such as slabs for floors and roofs, beams at different floors and columns have been designed as per IS 456-2000.

During the course of the project, we have gained knowledge on designing of slabs, beams, columns, footings and staircases. The building is designed as per IS 456-2000. We have used the application of AUTOCAD and STADD PRO during course of this project to obtain elevation, section and reinforcement details.

## **CHAPTER - 8**

### **REFERENCES**

- **“Design of Reinforced Concrete Structures”** ,by Dr. Krishna Raju, CBS publishers & Distributors, New Delhi.
- **“Design of reinforced concrete Structure”**, Ramamrutham.S, Dhanpat Raj Publishing Company, New Delhi, 2010.
- **IS 456:2000** - Code for practice for plain and reinforced concrete.
- **IS 875:1987** – code of practice for load calculation.
- **“Design of a Residential Building”**, by V.Manasa.