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**BUILDING USING STAAD PRO**

**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.

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.

There are several methods for analysis of different frames like kani’s method, cantilever method, portal method, Matrix method.

The present project deals with the analysis of a multi storeyed residential building of G+6 consisting of 5 apartments in each floor. The dead load &live loads are applied and the design for beams, columns, footing is obtained

STAAD Pro with its new features surpassed its predecessors, and compotators with its data sharing capabilities with other major software like AutoCAD, and MS Excel.

We conclude that staad pro is a very powerful tool which can save much time and is very accurate in Designs.

Thus it is concluded that staad pro package is suitable for the design of a multi-storeyed building.

**Assumptions and Notations used:**

The notations adopted throughout the work is same IS-456-2000.

**Assumptions in Design:**

1.Using partial safety factor for loads in accordance with clause 36.4 of IS-456-2000 as ϒt=1.5

2.Partial safety factor for material in accordance with clause 36.4.2 is IS-456-2000 is taken as 1.5 for concrete and 1.15 for steel.

3.Using partial safety factors in accordance with clause 36.4 of IS-456-2000 combination of load.

D.L+L.L. 1.5

D.L+L.L+W.L 1.2

**Density of materials used:**

**MATERIAL: DENSITY**

1. Plain concrete 24.0KN/m3
2. Reinforced 25.0KN/m3
3. Flooring material(c.m) 20.0KN/m3
4. Brick masonry 19.0KN/m3
5. Fly ash 5.0KN/m3

**4.LIVE LOADS:** In accordance with IS. 875-86

1. Live load on slabs = 20.0KN/m2
2. Live load on passage = 4.0KN/m2

iii)Live load on stairs = 4.0KN/m2

**DESIGN CONSTANTS:**

Using M30 and Fe 415 grade of concrete and steel for beams, slabs, footings, columns. Therefore:-

fck = Characteristic strength for M30-30N/mm2

fy = Characteristic strength of steel-415N/mm2

**Assumptions Regarding Design:**

1. Slab is assumed to be continuous over interior support and partially fixed on edges, due to monolithic construction and due to construction of walls over it.
2. Beams are assumed to be continuous over interior support and they frame in to the column at ends.

**Assumptions on design:-**

1. M20grade is used in designing unless specified.
2. Tor steel Fe 415 is used for the main reinforcement.
3. Tor steel Fe 415 and steel is used for the distribution reinforcement.
4. Mild steel Fe 230 is used for shear reinforcement.

**Symbols:**

The following symbols has been used in our project and its meaning is clearly mentioned respective to it:

|  |  |  |
| --- | --- | --- |
| A |  | -Area |
| Ast |  | - Area of steel |
| b |  | - Breadth of beam or shorter dimension of rectangular column |
| D |  | -Overall depth of beam or slab |
| DL |  | -Dead load |
| d1 |  | -effective depth of slab or beam |
| D |  | - overall depth of beam or slab |
| Mu,max |  | -moment of resistance factor |
| Fck |  | -characters tic compressive strength |
| Fy |  | -characteristic strength of of steel |
| Ld |  | -development length |
| LL |  | -live load |
| Lx |  | -length of shorter side of slab |
| Ly |  | - length of longer side of slab |
| B.M. |  | -bending moment |
| Mu | -factored bending moment | |
| Md | -design moment | |
| Mf | -modification factor | |
| Mx | -mid span bending moment along short span | |

My - mid span bending moment along longer span M’x -support bending moment along short span M’y - support bending moment along longer span pt -percentage of steel W -total design load

Wd -factored load

Tc max -maximum shear stress in concrete with shear

Tv -shear stress in concrete Tv -nominal shear stress ɸ -diameter of bar

Pu -factored axial load

Mu,lim -limiting moment of resistance of a section with out compression

reinforcement

Mux,Muy -moment about X and Y axis due to design loads

Mux1,Muy1 maximum uniaxial moment capacity for an axial load of pu,bending

moment x and Y axis respectively

Ac - area of concrete&

Asc -area of longitudinal reinforcement for column

# CHAPTER 1 INTRODUCTION

Building construction is the engineering deals with the construction of building such as residential houses. In a simple building can be define as an enclose space by walls with roof, food, cloth and the basic needs of human beings. In the early ancient times humans lived in caves, over trees or under trees, to protect themselves from wild animals, rain, sun, etc. as the times passed as humans being started living in huts made of timber branches. The shelters of those old have been developed nowadays into beautiful houses. Rich people live in sophisticated condition houses.

Buildings are the important indicator of social progress of the county. Every human has desire to own comfortable homes on an average generally one spends his two-third life times in the houses. The security civic sense of the responsibility. These are the few reasons which are responsible that the person do utmost effort and spend hard earned saving in owning houses.

Nowadays the house building is major work of the social progress of the county. Daily new techniques are being developed for the construction of houses economically, quickly and fulfilling the requirements of the community engineers and architects do the design work, planning and layout, etc., of the buildings. Draughtsman are responsible for doing the drawing works of building as for the direction of engineers and architects. The draughtsman must know his job and should be able to follow the instruction of the engineer and should be able to draw the required drawing of the building, site plans and layout plans etc., as for the requirements.

A building frame consists of number of bays and storey. A multi-storey, multi-paneled frame is a complicated statically intermediate structure. A design of R.C building of G+6 storey frame work is taken up. The building in plan (40\*28) consists of columns built monolithically forming a network. The size of building is 40x28m. The number of columns are 85. it is residential complex.

The design is made using software on structural analysis design (staad-pro). The building subjected to both the vertical loads as well as horizontal loads. The vertical load consists of dead load of structural components such as beams, columns, slabs etc. and live loads. The horizontal load consists of the wind forces thus building is designed for dead load, live load and wind load as **per IS 875**. The building is designed as two dimensional vertical frame and analyzed for the maximum and minimum bending moments and shear forces by trial and error methods as per **IS** **456-2000**. The help is taken by software available in institute and the computations of loads, moments and shear forces and obtained from this software.

**1.1 Early modern and the industrial age**:

With the emerging knowledge in scientific fields and the rise of new materials and technology, architecture engineering began to separate, and the architect began to concentrate on aesthetics and the humanist aspects, often at the expense of technical aspects of building design.

Meanwhile, the industrial revolution laid open the door for mass production and consumption. Aesthetics became a criterion for the middle class as ornamental products, once within the province of expensive craftsmanship, became cheaper under machine production.

Vernacular architecture became increasingly ornamental. House builders could use current architectural design in their work by combining features found in pattern books and architectural journals.

**1.1.1 Modern architecture:**

The Bauhaus Dessau architecture department from 1925 by Walter Gropius.

The dissatisfaction with such a general situation at the turn of the 20th century gave rise to many new lines of thought that served as precursors to modern architecture. Notable among these is detachers’ derkbund, formed in 1907 to produce better quality machine made objects. The rise of the profession of industrial design is usually placed here. Following this lead, the Bauhaus school, founded in Weimar, Germany in 1919, redefined the architectural bounds prior set throughout history viewing the creation of a building as the ultimate synthesis—the apex—of art, craft and technology.

When modern architecture was first practiced, it was an avant-garde moment with moral, philosophical, and aesthetic underpinning. Immediately after world war I, pioneering modernist architects sought to develop a completely new style appropriate for a new post-war social and economic order, focused on meeting the needs of the middle and working classes. They rejected the architectural practice of the academic refinement of historical styles which served the rapidly declining aristocratic order.

**1.2 Statement of project**

Salient features:

Utility of building : residential complex

No of stories : G+6

Shape of the building : 5 APARTMENTS

No of staircases : 5

No. of flats: 30

No of lifts : 4

Type of construction : R.C.C framed structure

Types of walls : brick wall Geometric details:

Ground floor : 3m

Floor to floor height : 3m.

Height of plinth : 0.6m Depth of foundation: 500mm Materials:

Concrete grade : M30 All steel grades: Fe415 grade

Bearing capacity of soil: 300KN/M2

**1.3 Literature review**:

Method of analysis of statistically indeterminate portal frames:

1. Method of flexibility coefficients.
2. Slope displacements methods(iterative methods)
3. Moment distribution method
4. Kane’s method
5. cantilever method
6. Portal method
7. Matrix method
8. STAAD Pro

**1.3.1 Method of flexibility coefficients**:

The method of analysis is comprises reducing the hyper static structure to a determinate structure form by:

Removing the redundant support (or) introducing adequate cuts (or) hinges.

**Limitations:**

It is not applicable for degree of redundancy>3

**1.3.2 Slope displacement equations:**

It is advantageous when kinematic indeterminacy <static indeterminacy. This procedure was first formulated by axle bender in 1914 based on the applications of compatibility and equilibrium conditions.

The method derives its name from the fact that support slopes and displacements are explicitly comported. Set up simultaneous equations is formed the solution of these parameters and the joint moment in each element or computed from these values.

**Limitations:**

A solution of simultaneous equations makes methods tedious for manual computations. this method is not recommended for frames larger than too bays and two storey’s. .

**Iterative methods:**

These methods involves distributing the known fixed and moments of the structural member to adjacent members at the joints in order satisfy the conditions of compatibility.

**Limitations of hardy cross method:**

It presents some difficulties when applied to rigid frame especially when the frame is susceptible to side sway. The method cannot be applied to structures with intermediate hinges.

**1.3.3 Kani’s method:**

This method over comes some of the disadvantages of hardy cross method. Kani’s approach is similar to H.C.M to that extent it also involves repeated distribution of moments at successive joints in frames and continues beams. However there is a major difference in distribution process of two methods. H.C.M distributes only the total joint moment at any stage of iteration.

The most significant feature of kani’s method is that process of iteration is self corrective.

Any error at any stage of iterations corrected in subsequent steps consequently skipping a few steps error at any stage of iteration is corrected in subsequent consequently skipping a few steps of iterations either by over sight of by intention does not lead to error in final end moments.

**Advantages:**

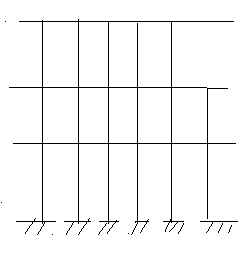
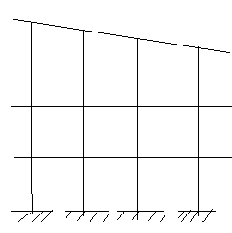
It is used for side way of frames.

**Limitations:**

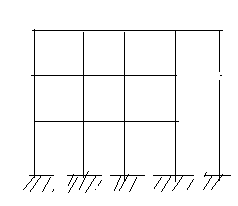
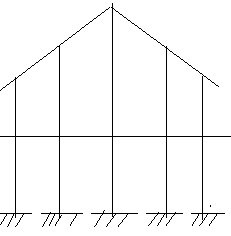
The rotational of columns of any storey should be function a single rotation value of same storey.

The beams of storey should not undergo rotation when the column undergoes translation. That is the column should be parallel.

Frames with intermediate hinges cannot be analysis.

**Applicable**



**Not applicable**

**1.3.4 Approximate method:**

Approximate analysis of hyper static structure provides a simple means of obtaining a quick

Solution for preliminary design. It makes Some simplifying assumptions regarding Structural behaviour so to obtain a rapid solution to complex structures.

The usual process comprises reducing the given indeterminate configuration to a determine structural system by introducing adequate no of hinges. it is possible to sketch the deflected profile of the structure for the given loading and hence by locate the print inflection

Since each point of inflection corresponds to the location of zero moment in the structures. The inflection points can be visualized as hinges for the purpose of analysis. The solution of structures is sundered simple once the inflection points are located. The loading cases are arising in multi-storeyed frames namely horizontal and vertical loading. The analysis carried out separately for these two cases.

**Horizontal cases:**

The behaviour of a structure subjected to horizontal forces depends upon its heights to width ratio among their factor. It is necessary to differentiate between low rise and high rise frames in this case.

Low rise structures:

Height < width

It is characterized predominately by shear deformation.

High rise buildings

Height > width

It is dominated by bending action **Matrix analysis of frames:**

The individual elements of frames are oriented in different directions unlike those of continues beams so their analysis is more complex .never the less the rudimentary flexibility and stiffness methods are applied to frames stiffness method is more useful because its adaptability to computer programming stiffness method is used when degree of redundancy is greater than degree of freedom. However stiffness method is used degree of freedom is greater than degree of redundancy especially for computers.

**1.4 Design of multi storied residential building:**

**General:**

A structure can be defined as a body which can resist the applied loads without appreciable deformations.

Civil engineering structures are created to serve some specific functions like human habitation ,transportation, bridges ,storage etc. in a safe and economical way. A structure is an assemblage of individual elements like pinned elements (truss elements),beam element ,column, shear wall slab cable or arch. Structural engineering is concerned with the planning, designing and thee construction of structures.

Structure analysis involves the determination of the forces and displacements of the structures or components of a structure. Design process involves the selection and detailing of the components that make up the structural system.

The main object of reinforced concrete design is to achieve a structure that will result in a safe economical solution.

The objective of the design is

1. Foundation design
2. Column design
3. Beam design
4. Slab design

These all are designed under limit state method

**1.4.1 Limit state method:**

The object of design based on the limit state concept is to achieve an acceptability that a structure will not become unserviceable in its life time for the use for which it is intended. I.e. it will not reach a limit state. In this limit state method all relevant states must be considered in design to ensure a degree of safety and serviceability.

**Limit state:**

The acceptable limit for the safety and serviceability requirements before failure occurs is called a limit state.

**Limit state of collapse**:

This is corresponds to the maximum load carrying capacity.

Violation of collapse limit state implies failures in the source that a clearly defined limit state of structural usefulness has been exceeded. However it does not mean complete collapse.

This limit state corresponds to :

1. Flexural
2. Compression
3. Shear
4. Torsion

**Limit state of survivability:**

this state corresponds to development of excessive deformation and is used for checking member in which magnitude of deformations may limit the rise of the structure of its components.

1. Deflection
2. Cracking
3. Vibration

# CHAPTER 2 SOFTWARES

This project is mostly based on software and it is essential to know the details about these software’s.

List of software’s used

1. Staad pro(v8i)
2. Staad foundations 5(v8i)

3

. Auto cad



**Staad pro Staad Auto Cad Foundations**

**STAAD**

Staad is powerful design software licensed by Bentley .Staad stands for structural analysis and design

Any object which is stable under a given loading can be considered as structure. So first find the outline of the structure, where as analysis is the estimation of what are the type of loads that acts on the beam and calculation of shear force and bending moment comes under analysis stage. Design phase is designing the type of materials and its dimensions to resist the load. this we do after the analysis.

To calculate s.f.d and b.m.d of a complex loading beam it takes about an hour. So when it comes into the building with several members it will take a week. Staad pro is a very powerful tool which does this job in just an hour’s staad is a best alternative for high rise buildings.

Now a days most of the high rise buildings are designed by staad which makes a compulsion for a civil engineer to know about this software.

These software can be used to carry rcc ,steel, bridge , truss etc. according to various country codes.

**2.1 Alternatives for staad:**

struts, robot, sap, adds pro which gives details very clearly regarding reinforcement and

manual calculations. But these software’s are restricted to some designs only where as staad can deal with several types of structure.

**2.2 Staad Editor:**

Staad has very great advantage to other software’s i.e., staad editor. staad editor is the programming

For the structure we created and loads we taken all details are presented in programming format in staad editor. This program can be used to analyze another structures also by just making some modifications, but this require some programming skills. So load cases created for a structure can be used for another structure using staad editor.

**Limitations of Staad pro:**

1.Huge output data

2.Even analysis of a small beam creates large output.

3.Unable to show plinth beams.

**2.3 Staad foundation:**

Staad foundation is a powerful tool used to calculate different types of foundations. It is also licensed by Bentley software’s. All Bentley software’s cost about 10 lakhs and so all engineers can’t use it due to heavy cost.

Analysis and design carried in Staad and post processing in staad gives the load at various supports. These supports are to be imported into these software to calculate the footing details i.e., regarding the geometry and reinforcement details.

This software can deal different types of foundations

SHALLOW (D<B)

* 1.Isolated (Spread) Footing
* 2.Combined (Strip) Footing
* 3.Mat (Raft) Foundation

DEEP (D>B)

* 1.Pile Cap
* 2. Driller Pier

1. Isolated footing is spread footing which is common type of footing.
2. Combined Footing or Strap footing is generally laid when two columns are very near to each other.
3. Mat foundation is generally laid at places where soil has less soil bearing capacity.
4. pile foundation is laid at places with very loose soils and where deep excavations are required.

So depending on the soil at type we has to decide the type of foundation required.

Also lot of input data is required regarding safety factors, soil, materials used should be given in respective units.

After input data is give software design the details for each and every footing and gives the details regarding

1. Geometry of footing
2. Reinforcement
3. Column layout
4. Graphs
5. Manual calculations

These details will be given in detail for each and every column.

Another advantage of foundations is even after the design; properties of the members can be updated if required.

The following properties can be updated

* + Column Position
  + Column Shape
  + Column Size  Load Cases
  + Support List

It is very easy deal with this software and we don’t have any best alternative to this.

**AutoCAD:**

AutoCAD is powerful software licensed by auto desk. The word auto came from auto desk company and cad stands for computer aided design. AutoCAD is used for drawing different layouts, details, plans, elevations, sections and different sections can be shown in auto cad.

It is very useful software for civil, mechanical and also electrical engineer.

The importance of this software makes every engineer a compulsion to learn this software’s.

We used AutoCAD for drawing the plan, elevation of a residential building. We also used AutoCAD to show the reinforcement details and design details of a stair case.

AutoCAD is a very easy software to learn and much user friendly for anyone to handle and can be learn quickly

Learning of certain commands is required to draw in AutoCAD.

# CHAPTER 3 PLAN AND ELEVATION

**PLAN**

The auto cad plotting no.1 represents the plan of a g+6 building. The plan clearly shows that it is a combination of five apartments. We can observe there is a combination between each and every apartments. .

In each block the entire floor consists of a three bed room house which occupies entire floor of a block. It represents a rich locality with huge areas for each house.

It is a g+6 proposed building, So for 5 blocks we have 5\*6=30 flats.

The plan shows the details of dimensions of each and every room and the type of room and orientation of the different rooms like bed room, bathroom, kitchen, hall etc.. All the five apartments have similar room arrangement.

The entire plan area is about 1100 sq.m. There is some space left around the building for parking of cars. The plan gives details of arrangement of various furniture like sofa etc.

The plan also gives the details of location of stair cases in different blocks. we have 2 stair cases for each block and designing of stair case is shown in AutoCAD plot no.3

In the middle we have a small construction which consists of four lifts and those who want to fly through lift can use this facility and we know for a building with more than g+4 floors should compulsory have lift and the charges for the facilities is collected by all the members. At that junction we have a club for our enjoyment and charges are collected by all the building occupants every month.

So these represent the plan of our building and detailed explanation of remaining parts like elevations and designing is carried in the next sections.

**Elevation:**

AutoCAD plot no.2 represents the proposed elevation of building. It shows the elevation of a g+6 building representing the front view which gives the overview of a building block.

The figure represents the site picture of our structure which are taken at the site .the building is actually under constructions and all the analysis and design work is completed before the beginning of the project.

Each floor consists of height 3m which is taken as per GHMC rules for residential buildings.

The building is not designed for increasing the number of floors in future.so the number of floors is fixed for future also for this building due to unavailability of the permissions of respective authorities.

Also special materials like fly ash and self compacted concrete were also used in order to reduce the dead load and increase life of the structure and also improve economy. But these materials were not considered while designing in staad to reduce the complexity and necessary corrections are made for considering the economy and safety of the structure as it is a very huge building with 30 apartments.

The construction is going to complete in the month of June 2012 and ready for the occupancy.

This is regarding the plan and details of the site and next section deals with the design part of the building under various loads for which the building is designed.



Figure 3.2a Elevation of the building

## **Center line plan**

The above figure represents the center line diagram of our building in staad pro. Each support represents the location of different columns in the structure. This structure is used in generating the entire structure using a tool called transitional repeat and link steps. After using the tool the structure that is created can be analyzed in staad pro under various loading cases.

Below figure represents the skeletal structure of the building which is used to carry out the analysis of our building.

All the loadings are acted on this skeletal structure to carry out the analysis of our building.

This is not the actual structure but just represents the outline of the building in staad pro.

A mesh is automatically created for the analysis of these building.

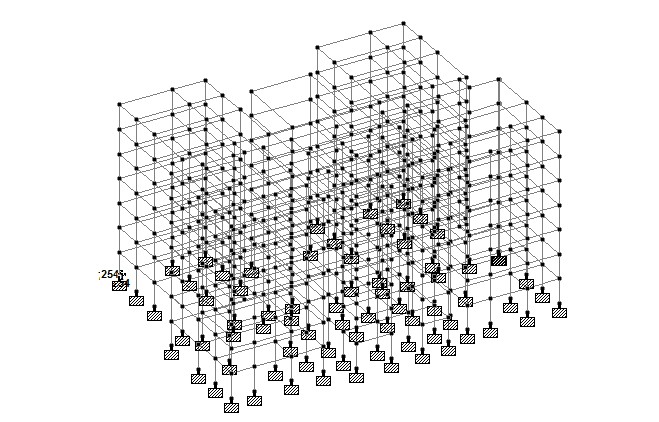


Figure 3.2b Skeletalstructure of the building

# CHAPTER 4 LOADINGS

**4.1 Load Conditions and Structural System Response :**

The concepts presented in this section provide an overview of building loads and their effect on the structural response of typical wood-framed homes. As shown in Table, building loads can be divided into types based on the orientation of the structural action or forces that they induce: vertical and horizontal (i.e., lateral) loads. Classification of loads are described in the following sections.

**4.2 Building Loads Categorized by Orientation:**

Types of loads on an hypothetical building are as follows.

* Vertical Loads
* Dead (gravity)
* Live (gravity)
* Snow(gravity)
* Wind(uplift on roof)
* Seismic and wind (overturning)  Seismic( vertical ground motion)

**4.2.1 Horizontal (Lateral) Loads:**

Direction of loads is horizontal w.r.t to the building.

* Wind
* Seismic(horizontal ground motion)
* Flood(static and dynamic hydraulic forces
* Soil(active lateral pressure)

**4.2.2 Vertical Loads :**

Gravity loads act in the same direction as gravity (i.e., downward or vertically) and include dead, live, and snow loads. They are generally static in nature and usually considered a uniformly distributed or concentrated load. Thus, determining a gravity load on a beam or column is a relatively simple exercise that uses the concept of tributary areas to assign loads to structural elements, including the dead load (i.e., weight of the construction) and any applied loads(i.e., live load). For example, the tributary gravity load on a floor joist would include the uniform floor load(dead and live) applied to the area of floor supported by the individual joist. The structural designer then selects a standard beam or column model to analyze bearing connection forces (i.e., reactions) internal stresses (i.e., bending stresses, shear stresses, and axial stresses) and stability of the structural member or system a for beam equations.

The selection of an appropriate analytic model is, however no trivial matter, especially if the structural system departs significantly from traditional engineering assumptions are particularly relevant to the structural systems that comprise many parts of a house, but to varying degrees. Wind uplift forces are generated by negative (suction) pressures acting in an outward direction from the surface of the roof in response to the aerodynamics of wind flowing over and around the building.

As with gravity loads, the influence of wind up lift pressures on a structure or assembly(i.e., roof) are analyzed by using the concept of tributary areas and uniformly distributed loads. The major difference is that wind pressures act perpendicular to the building surface (not in the direction of gravity) and that pressures vary according to the size of the tributary area and its location on the building, particularly proximity to changes in geometry (e.g., eaves, corners, and ridges).Even though the wind loads are dynamic and highly variable, the design approach is based on a maximum static load (i.e., pressure) equivalent. Vertical forces are also created by overturning reactions due to wind and seismic lateral loads acting on the overall building and its lateral force resisting systems, Earthquakes also produce vertical ground motions or accelerations which increase the effect of gravity loads. However, Vertical earthquake loads are usually considered to be implicitly addressed in the gravity load analysis of a light-frame building.

**4.2.3 Lateral Loads:**

The primary loads that produce lateral forces on buildings are attributable to forces associated with wind, seismic ground motion, floods, and soil. Wind and seismic lateral loads apply to the entire building. Lateral forces from wind are generated by positive wind pressures on the windward face of the building and by negative pressures on the leeward face of the building, creating a combined push and-pull effect. Seismic lateral forces are generated by a structure’s dynamic inertial response to cyclic ground movement.

The magnitude of the seismic shear (i.e., lateral)load depends on the magnitude of the ground motion, the buildings mass, and the dynamic structural response characteristics(i.e., dampening, ductility ,natural period of vibration ,etc.).for houses and other similar low rise structures, a simplified seismic load analysis employs equivalent static forces based on fundamental Newtonian mechanics(F=ma) with somewhat subjective(i.e., experience-based) adjustments to account for inelastic, ductile response characteristics of various building systems. Flood loads are generally minimized by elevating the structure on a properly designed foundation or avoided by not building in a flood plain.

Lateral loads from moving flood waters and static hydraulic pressure are substantial. Soil lateral loads apply specifically to foundation wall design, mainly as an “out-of-plane” bending load on the wall. Lateral loads also produce an overturning moment that must be offset by the dead load and connections of the building. Therefore, overturning forces on connections designed to restrain components from rotating or the building from overturning must be considered.

Since wind is capable of the generating simultaneous roof uplift and lateral loads, the uplift component of the wind load exacerbates the overturning tension forces due to the lateral component of the wind load. Conversely the dead load may be sufficient to offset the overturning and uplift forces as is the case in lower design wind conditions and in many seismic design conditions.

**4.3 Structural systems :**

As far back as 1948,it was determined that “conventions in general use for wood, steel and concrete structures are not very helpful for designing houses because few are applicable”(NBS,1948).More specifically, the NBS document encourages the use of more advanced methods of structural analysis for homes. Unfortunately. the study in question and all subsequent studies addressing the topic of system performance in housing have not led to the development or application of any significant improvement in the codified design practice as applied to housing systems.

This lack of application is partly due to conservative nature of the engineering process and partly due to difficulty of translating the results of narrowly focused structural systems studies to general design applications. Since this document is narrowly scoped to address residential construction, relevant system

Based studies and design information for housing are discussed, referenced, and applied as appropriate. If a structural member is part of system, as it typically the case in light frame residential construction, its response is altered by the strength and stiffness characteristics of the system as a whole.

In general, system performance includes two basic concepts known as load sharing and composite action. Load sharing is found in repetitive member systems(i.e., wood framing) and reflects the ability of the load on one member to be shared by another or, in the case of a uniform load, the ability of some of the load on a weaker member to be carried by adjacent members. Composite action is found in assemblies of components that, when connected to one another, from a “composite member” with greater capacity and stiffness than the sum of the component parts.

However, the amount of composite action in a system depends on the manner in which the various elements are connected. The aim is to achieve a higher effective section modulus than the component members are taken separately. For example, when floor sheathing is nailed and glued to floor joists, the floor system realizes a greater degree of composite action than a floor with sheathing that is merely nailed; the adhesive between components helps prevents shear slippage, particularly if a rigid adhesive is used. Slippage due to shear stresses transferred between the component parts necessitates consideration of partial composite action, which depends on the stiffness of an assembly’s connections. Therefore, consideration of the floor system of fully composite T-beams may lead to an un conservative solution.

Whereas the typical approach of only considering the floor joist member without composite system effect will lead to a conservative design. This guide addresses the strengthenhancing effect of sharing and partial composite action when information is available for practical design guidance. Establishment of repetitive member increase factors (also called system factors) for general design use is a difficult task because the amount of system effect can vary substantially depending on system assembly and materials.

Therefore, system factors for general design use are necessarily conservative to cover broad conditions. Those that more accurately depict system effects also require a more exact description of and compliance with specific assembly details and material specifications. It should be recognized however that system effects do no t only affect the strength and stiffness of light-frame assemblies(including walls, floors and roofs).They also alter the classical understanding of how loads are transferred among the various assemblies of a complex woodframed home. For example, floor joists are sometimes doubled under non load-bearing partition walls “because of the added dead load and resulting stresses” determined in accordance with accepted engineering practice.

Such practice is based on a conservative assumption regarding a load path and the structural response. That is, the partition wall does create an additional load, but the partition wall is relatively rigid and actually acts as a deep beam, particularly when the top and bottom are attached to the ceiling and floor framing, respectively. As the floor is loaded and deflects, the interior wall helps resist the load. Of course, the magnitude of effect depends on the wall configuration (i.e., amount of openings) and other factor. The above example of composite action due to the interaction of separate structural systems or subassemblies points to the improved structural response of the floor system such that it is able to carry more dead and live than if the partition wall were absent .on whole-house assembly test has demonstrated this effect (Hurst,1965).Hence ,a double joist should not be required under a typical non load-bearing partition; In fact, a single joist may not even be required directly below the partition, assuming that the floor sheeting is adequately specified to support the partition between the joists. While this condition cannot yet be duplicated in a standard analytic form conductive to simple engineering analysis, A designer should be aware of the concept when making design assumption regarding light frame residential constructions.

At this point, the readership should consider that the response of a structural system, Not just its individual elements, determines the manner in which a structure distributes and resists horizontal and vertical loads. For wood framed systems, the departure from calculations based are classical engineering mechanics (i.e., single members with standard tributary areas and assumed elastic behaviour)and simplistic assumptions regarding load path can be substantial

**4.4 Design loads for residential buildings :**

**General**

Loads are a primary consideration in any building design because they define the nature and magnitude of hazards are external forces that a building must resist to provide a reasonable performance(i.e., safety and serviceability )through out the structure’s useful life. The anticipated loads are influenced by a building’s intended use (occupancy and function),configuration(size and shape)and location(climate and site conditions).Ultimately, the type and magnitude of design loads affect critical decisions such as material collection, construction details and architectural configuration.

Thus, to optimize the value (i.e., performance versus economy) of the finished product, it is essential to apply design loads realistically. While the buildings considered in this guide are primarily single-family detached and and attached dwellings, the principles and concepts related to building loads also apply to other similar types of construction, such as low-rise apartment buildings. In general, the the design loads recommended in this guide are based on applicable provisions of the ASCE 7 standard-Minimum Design ;loads for buildings and other structures (ASCE,1999).the ASCE 7 standard represents an acceptable practice for building loads in the United states and is recognized in virtually all U.S. building codes. For this reason, the reader is encouraged to become familiar with the provisions, commentary, and technical references contained in the ASCE 7 standard. In general structural design of housing has not been treated as a unique engineering discipline or subjected to a special effort to develop better, more efficient design practices. Therefore, this part of the guide focuses on those aspects aspects of ASCE 7 and other technical resources that are particularly relevant to the determination of design loads for residential structures.

The guide provides supplemental design assistance to address aspects of residential construction where current practice is either silent or in need of improvement. Residential buildings methods for determining design loads are complete yet tailored to typical residential conditions. as with any design function, the designer must ultimately understand and approve the loads for a given project as well as the overall design methodology, including all its inherent strengths and weakness.

Since building codes tend to vary in their treatment of design loads the designer should, as a matter of due diligence, identify variances from both local accepted practice and the applicable code relative to design loads as presented in this guide, even though the variances may be considered technically sound. Complete design of a home typically requires the evaluation of several different types of materials. Some material specifications use the allowable stress design (ASD) approach while others use load and resistance factor design (LRFD).

**4.4.1 Dead Loads:**

Dead loads consist of the permanent construction material loads compressing the roof, floor, wall, and foundation systems, including claddings, finishes and fixed equipment. Dead load is the total load of all of the components of the components of the building that generally do not change over time, such as the steel columns, concrete floors, bricks, roofing material etc.

In staad pro assignment of dead load is automatically done by giving the property of the member.

In load case we have option called self weight which automatically calculates weights using the properties of material i.e., density and after assignment of dead load the skeletal structure looks red in color as shown in the figure.

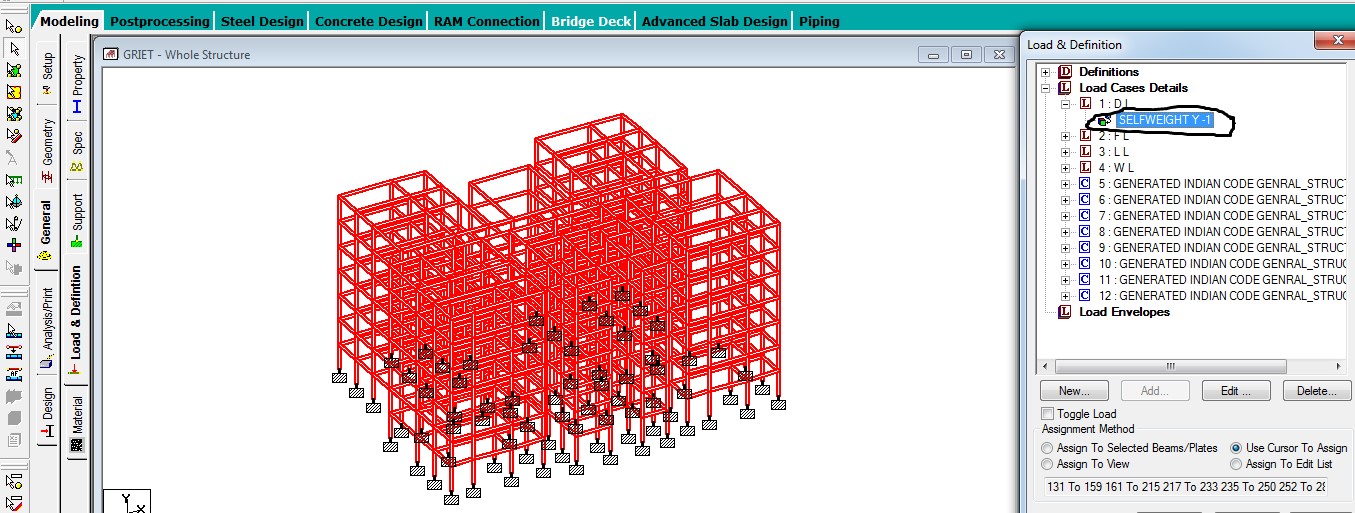


Fig 4.4.1a Example for calculation of dead load;

Dead load calculation

Weight=Volume x Density

Self weight floor finish=0.12\*25+1=3kn/m^2

The above example shows a sample calculation of dead load.

Dead load is calculated as per **IS 875 part 1**

**4.4.2 Live Loads:**

Live loads are produced by the use and occupancy of a building. Loads include those from human occupants, furnishings, no fixed equipment, storage, and construction and maintenance activities. As required to adequately define the loading condition, loads are presented in terms of uniform area loads, concentrated loads, and uniform line loads. The uniform and concentrated live loads should not be applied simultaneously n a structural evaluation. Concentrated loads should be applied to a small area or surface consistent with the application and should b e located or directed to give the maximum load effect possible in enduse conditions. For example. The stair load of 300 pounds should be applied to the center of the stair tread between supports.

In staad we assign live load in terms of U.D.L .we has to create a load case for live load and select all the beams to carry such load. After the assignment of the live load the structure appears as shown below.

For our structure live load is taken as **25 N/mm** for design.

Live loads are calculated as per **IS 875 part 2**

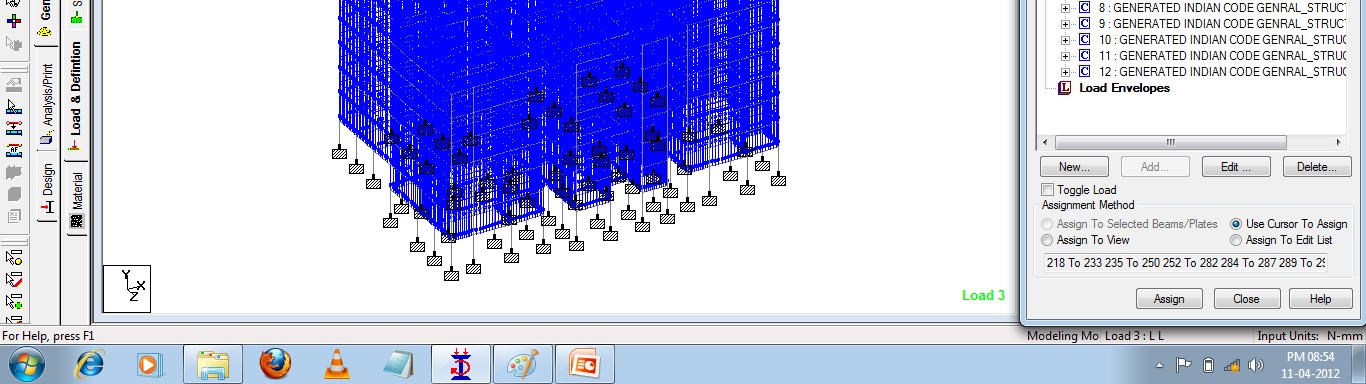
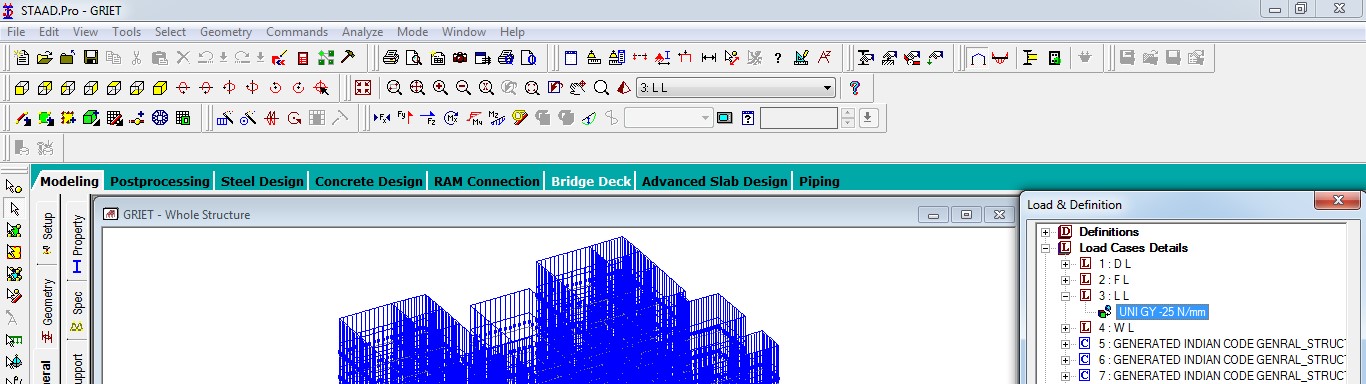


Fig 4.4.2a diagram of live load

**4.4.3 Wind loads:**

In the list of loads we can see wind load is present both in vertical and horizontal loads.

This is because wind load causes uplift of the roof by creating a negative(suction) pressure on the top of the roof

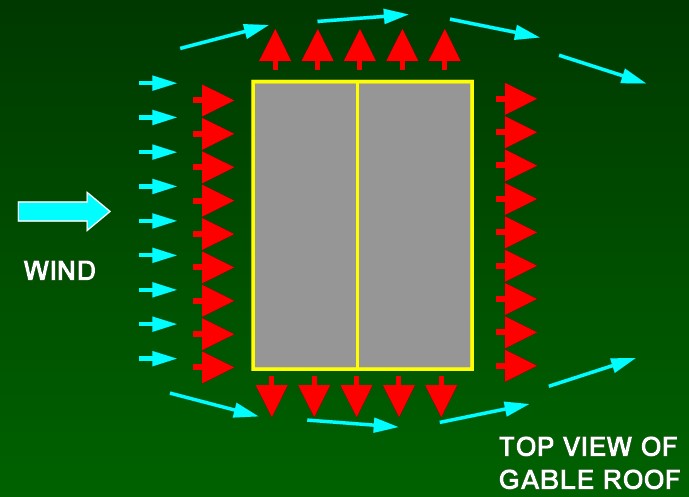
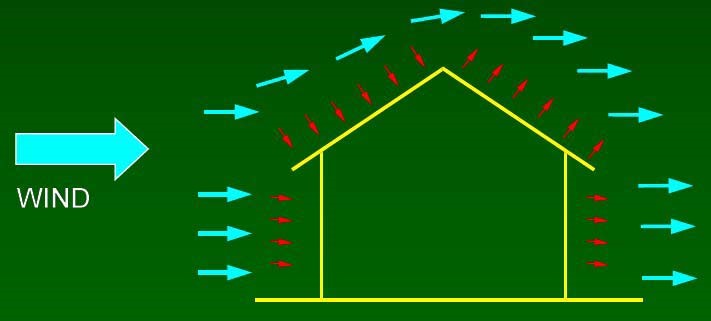


Fig 4.4.3a a diagram of wind load

wind produces non static loads on a structure at highly variable magnitudes. the variation in pressures at different locations on a building is complex to the point that pressures may become too analytically intensive for precise consideration in design. Therefore, wind load specifications attempt to amplify the design problem by considering basic static pressure zones on a building representative of peak loads that are likely to be experienced. The peak pressures in one zone for a given wind direction may not, However, occur simultaneously in other zones. For some pressure zones, The peak pressure depends on an arrow range of wind direction. Therefore, the wind directionality effect must also be factored into determining risk consistent wind loads on buildings.

In fact, most modern wind load specifications take account of wind load directionality and other effects in determining nominal design loads in some simplified form(sbcci,1999; ASCe,1999).this section further simplifies wind load design specifications to provide an easy yet effective approach for designing designing typical residential buildings. Because they vary substantially over the surface of a building. wind load star considered at two different scales. on large scale, the load produced on the overall building are on major structural systems that sustain wind loads from from more than one surface of building, are considered the main wind force resisting systems (MWFRS).the MWFRS of a home includes the shear walls, Diaphragms that create the lateral force resisting systems(LFRS).As well as the structural systems such as trusses that experience loads from two surfaces are regimes of the building.

The wind loads applied to the MWFRS account for the large affects of time varying wind pressures on the surface are surfaces of the building. On a Smaller scale, pressures are somewhat greater on localized surface area of the building, particularly near abrupt changes in building geometry (i.e., eaves, ridges, and corners). These higher wind pressures occur on smaller areas, particularly affecting the loads borne by components and cladding (e.g., sheathing, windows, doors, purling, studs).

The components and cladding (C&C) transfer localized time-varying loads to the MWFRS, at which point the loads average out both spatially and temporally since, at a given time, some components may beat near peak loads while others are at substantially less than peak.

The next section presents a simplified method for determining both MWFRS and C&C wind loads. Since the loads in the section 3.6.2 are determined for specific applications, the calculation of MWFRS and C&C wind loads is implication the values provided. Design example 3.2 in section 3.10 demonstrate the calculation of wind loads by applying the simplified method of the following section 3.6.2to several design conditions associated with wind loads and the load combinations.

Century, modernism morphed into the international style, an aesthetic epitomized in many ways by the Twin Towers of New York’s world trade center.

Many architects resisted modernism, finding it devoid of the decorative richness of ornamented styles. Yet as the of the movement lost influence in the late 1970s, postmodernism developed as a reaction against the austerity of Modernism. Robert ventures’ contention that a “decorated shed” (an ordinary building which is functionally designed inside and embellished on the outside) was better than a “Duck” (a building in which the whole form and its function are tied together) gives an idea of this approach.

Assignment of wind speed is quite different compared to remaining loads.

We have to define a load case prior to assignment.

After designing wind load can be assigned in two ways

1. collecting the standard values of load intensities for a particular heights and assigning of the loads for respective height.
2. calculation of wind load as per **IS 875 part 3.**

We designed our structure using second method which involves the calculation of wind load using wind speed.

In Hyderabad we have a wind speed of 45 kmph for 10 m height and this value is used in calculation.

After the assignment of wind load the structure looks as shown in figure

**4.4.3.1 Basic wind speed:**

Gives basic wind speed of India, as applicable to 1m height above means ground level for different zones of the country. Basic wind speed is based on peak just velocity averaged over a short time interval of about 3 seconds and corresponds to mean heights above ground level in an open terrain.

The wind speed for some important cities/towns is given table below.

**4.4.3.2 Design wind speed:**

The basic wind speed (Vb) for any site shall be obtained the following effects to get design wind velocity at any height (Vz) for the chosen structure.

1. Risk level
2. Terrain roughness, height and size of the structure and
3. Local topography

It can be mathematically expressed as follows:

Vs.=Vb\* K1\* K2\* K3

Where

Vz= design wind speed at any height Z in m/s

K1= probability factor (risk coefficient)

K2=terrain height and structure size factor and

K3=topography factor

**Table 4.4.3.3**

**Basic wind speed at 10 m for hight for some important cities/town**:

|  |  |  |  |
| --- | --- | --- | --- |
| **CITIES SPEED** | **BASIC WIND**  **(m/s)** | **CITIES SPEED** | **BASIC WIND**  **(m/s)** |
| Cuttack | 50 | Pune | 39 |
| Agra | 47 | Jhansi | 47 |
| Durbhanga | 55 | Raipur | 39 |
| Ahmadabad | 39 | Jodhpur | 47 |
| Darjeeling | 47 | Rajkot | 39 |
| Ajmer | 47 | Kanpur | 47 |
| Dehra dun | 47 | Ranchi | 39 |
| Alomar | 47 | Kohima | 44 |
| Delhi | 47 | Roorkee | 39 |
| Amritsar | 47 | Kurnool | 39 |
| Alanson | 47 | Rourkela | 39 |

|  |  |  |  |
| --- | --- | --- | --- |
| Gangtok | 47 | Lakshadweep | 39 |
| Auragabad | 39 | Simla | 39 |
|  |  |  |  |
| Gauhati | 50 | Srinagar | 39 |
| Bahraich | 47 | Ludhina | 47 |
| Gaya | 39 | Surat | 44 |
| Bangalore | 33 | Madras | 50 |
| Gorakhpur | 47 | Tiruchchirappalli | 47 |
| Varanasi | 47 | Madurai | 39 |
| Hyderabad | 44 | Trivandrum | 39 |
| Bareilly | 47 | Mandi | 39 |
| Impale | 47 | Udaipur | 47 |
| Bhatinda | 47 | Mangalore | 39 |
| Jabalpur | 47 | Vododara | 44 |
| Bhalali | 39 | Moradabad | 47 |
| Jaipur | 47 | Varanasi | 33 |
| Bhopal | 39 | Mysore | 50 |
| Jamshedpur | 47 | Vijayawada | 50 |
| Bhuvaneshwar | 50 | Nagpur | 44 |

|  |  |  |  |
| --- | --- | --- | --- |
| Bhuj | 50 | Vishakhapatnam | 50 |
| Bikaner | 47 | Naimital | 47 |
| Bikaro | 47 | Nasik | 39 |
| Bokaro | 47 | Nellore | 50 |
| Bombay | 44 | Panjim | 39 |
| Calcutta | 50 | Patiala | 47 |
|  |  |  |  |
| Calicut | 47 | Patna | 47 |
| Chandigarh | 47 | Pondicherry | 50 |
| Coimbatore | 39 | Por blair | 44 |

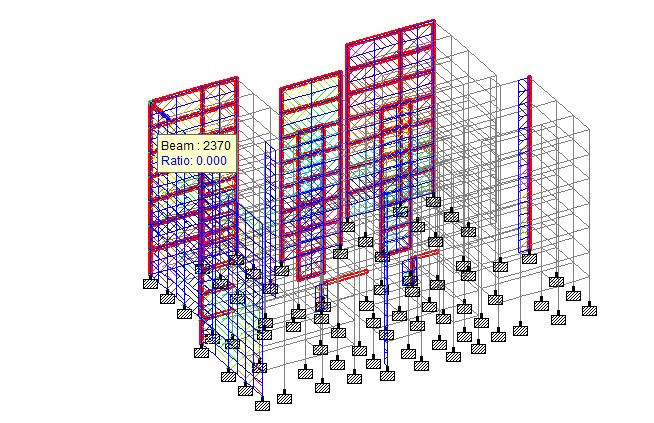


figure 4.4.3.3b Wind Load

**4.4.4 Floor load**:

Floor load is calculated based on the load on the slabs. Assignment of floor load is done by creating a load case for floor load. After the assignment of floor load our structure looks as shown in the below figure.

The intensity of the floor load taken is: **0.0035 N/mm2** -ve sign indicates that floor load is acting downwards.

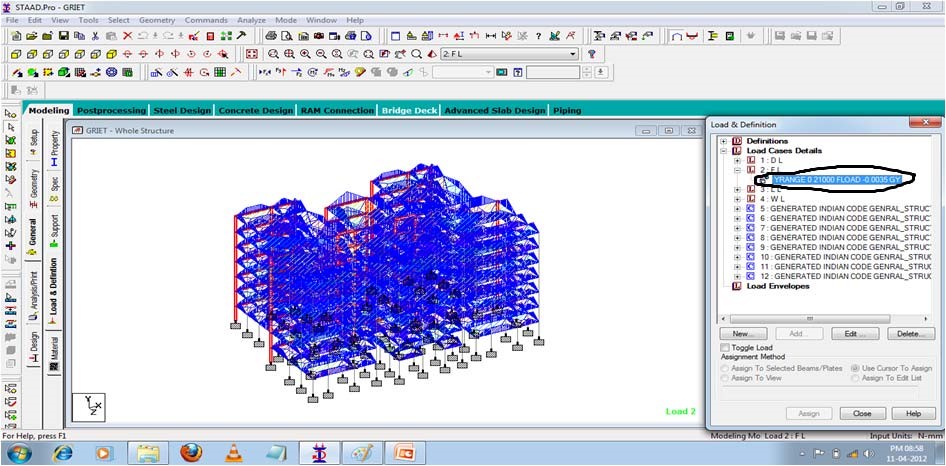


Fig 4.4.4.a  **Diagram of floor load**

**4.4.5 Load combinations:**

All the load cases are tested by taking load factors and analysing the building in different load combination as per **IS456** and analyzed the building for all the load combinations and results are taken and maximum load combination is selected for the design

Load factors as per **IS456-2000**

|  |  |  |
| --- | --- | --- |
| **Live load** | **dead load** | **wind load** |
| 1.5 | 1.5 | 0 |
| 1.2 | 1.2 | 1.2 |
| 0.9 | 0.9 | 0.9 |

When the building is designed for both wind and seismic loads maximum of both is taken. Because wind and seismic do not come at same time as per code.

Structure is analyzed by taking all the above combinations.

## CHAPTER 5 BEAMS

Beams transfer load from slabs to columns .beams are designed for bending.

In general we have two types of beam: single and double. Similar to columns geometry and perimeters of the beams are assigned. Design beam command is assigned and analysis is carried out, now reinforcement details are taken.

**5.1 Beam design:**

a reinforced concrete beam should be able to resist tensile, compressive and shear stress induced in it by loads on the beam.

There are three types of reinforeced concrete beams

1. single reinforced beams
2. double reinforced concrete
3. flanged beams

**5.1.1 Singly reinforced beams:**

In singly reinforced simply supported beams steel bars are placed near the bottom of the beam where they are more effective in resisting in the tensile bending stress. I cantilever beams reinforcing bars placed near the top of the beam, for the same reason as in the case of simply supported beam.

**5.1.2 Doubly reinforced concrete beams:**

It is reinforced under compression tension regions. The necessity of steel of compression region arises due to two reasons. When depth of beam is restricted. The strength availability singly reinforced beam is in adequate. At a support of continuous beam where bending moment changes sign such as situation may also arise in design of a beam circular in plan.

Figure shows the bottom and top reinforcement details at three different sections.

These calculations are interpreted manually.

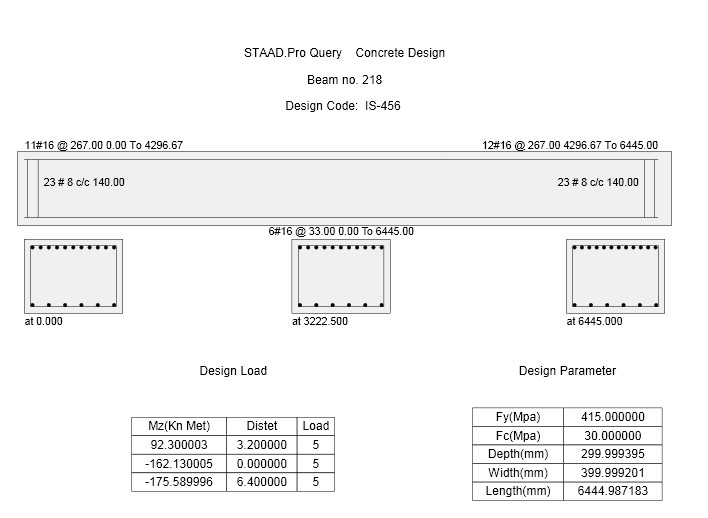


Fig 5.2a A diagram of the reinforcement details of beam

The following figure shows the deflection of a column.

**Deflection:**

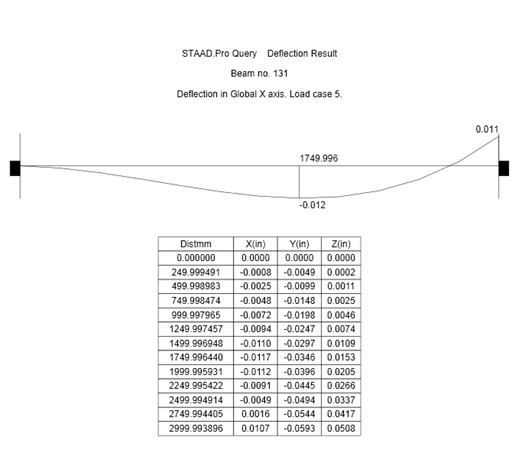


Fig 5.2b A diagram of the deflection of a column.

Due to huge output data, output of a sample beam is shown below.

Beam design

====================================================================== ======

B E A M N O. 218 D E S I G N R E S U L T S

M30 Fe415 (Main) Fe415

(Sec.)

LENGTH: 6445.0 mm SIZE: 400.0 mm X 300.0 mm COVER:

25.0 mm

DESIGN LOAD SUMMARY (KN MET)

-------------------------------------------------------------------

---------

SECTION |FLEXURE (Maxm. Sagging/Hogging moments)| SHEAR

(in mm) | P MZ MX Load Case | VY MX

Load Case

-------------------------------------------------------------------

---------

0.0 | 0.00 23.66 -1.39 4 | 154.56 0.78 5

| 0.00 -162.13 0.78 5 |

537.1 | 0.00 22.68 -1.98 9 | 131.59 0.78 5

| 0.00 -91.95 2.30 7 |

1074.2 | 0.00 22.24 -1.98 9 | 106.30 0.78 5

| 0.00 -36.08 2.30 7 |

1611.2 | 0.00 37.65 -1.05 6 | 80.61 0.78 5

| 0.00 -15.45 2.21 10 |

2148.3 | 0.00 64.93 0.78 5 | 51.11 2.30 7

| 0.00 -6.69 2.21 10 |

2685.4 | 0.00 86.02 0.78 5 | 29.06 2.30 7

| 0.00 0.00 0.00 1 |

3222.5 | 0.00 92.30 0.78 5 | 10.62 2.21 10

| 0.00 0.00 0.00 1 |

3759.6 | 0.00 83.77 0.78 5 | -32.40 -1.05 6

| 0.00 -3.53 -1.39 4 |

4296.7 | 0.00 60.45 0.78 5 | -57.22 0.78 5

| 0.00 -7.41 -1.39 4 |

4833.8 | 0.00 31.42 2.30 7 | -84.78 0.78 5

| 0.00 -15.12 -1.98 9 |

5370.8 | 0.00 20.20 2.21 10 | -110.48 0.78 5

| 0.00 -42.41 -1.05 6 |

5907.9 | 0.00 20.40 2.21 10 | -135.77 0.78 5

| 0.00 -100.07 -1.05 6 |

6445.0 | 0.00 19.37 2.21 10 | -158.73 0.78 5

| 0.00 -175.59 0.78 5 |

-------------------------------------------------------------------

---------

SUMMARY OF REINF. AREA (Sq.mm)

---------------------------------------------------------------------------

SECTION | TOP | BOTTOM | STIRRUPS

(in mm) | Reqd./Provided reinf. | Reqd./Provided reinf. | (2 legged)

-------------------------------------------------------------------

---------

0.0 | 2102.75/2211.68(11-16í )| 625.79/ 804.25( 4-16í )| 8í

@ 140 mm

537.1 | 1151.51/1206.37( 6-16í )| 265.73/ 603.19( 3-16í )| 8í

@ 140 mm

1074.2 | 422.27/ 603.19( 3-16í )| 260.79/ 603.19( 3-16í )| 8í

@ 140 mm

1611.2 | 218.75/ 603.19( 3-16í )| 425.58/ 603.19( 3-16í )| 8í

@ 140 mm

2148.3 | 218.75/ 603.19( 3-16í )| 756.82/ 804.25( 4-16í )| 8í

@ 140 mm

2685.4 | 0.00/ 402.12( 2-16í )| 1042.62/1206.37( 6-16í )| 8í

@ 140 mm

3222.5 | 0.00/ 402.12( 2-16í )| 1133.58/1206.37( 6-16í )| 8í

@ 140 mm

3759.6 | 218.75/ 603.19( 3-16í )| 1010.85/1206.37( 6-16í )| 8í

@ 140 mm

4296.7 | 218.75/ 603.19( 3-16í )| 699.37/ 804.25( 4-16í )| 8í

@ 140 mm

4833.8 | 218.75/ 603.19( 3-16í )| 368.27/ 603.19( 3-16í )| 8í

@ 140 mm

5370.8 | 481.59/ 603.19( 3-16í )| 240.74/ 603.19( 3-16í )| 8í

@ 140 mm

5907.9 | 1254.86/1407.43( 7-16í )| 242.95/ 603.19( 3-16í )| 8í @ 140 mm

6445.0 | 2284.09/2412.74(12-16í )| 826.67/1005.31( 5-16í )| 8í @ 140 mm

-------------------------------------------------------------------

SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF

THE SUPPORT

SHEAR DESIGN RESULTS AT 490.0 mm AWAY FROM START SUPPORT

VY = 133.60 MX = 0.78 LD= 5

Provide 2 Legged 8í @ 140 mm c/c

SHEAR DESIGN RESULTS AT 490.0 mm AWAY FROM END SUPPORT

VY = -137.98 MX = 0.78 LD= 5 Provide 2 Legged 8í @ 140 mm c/c

shear

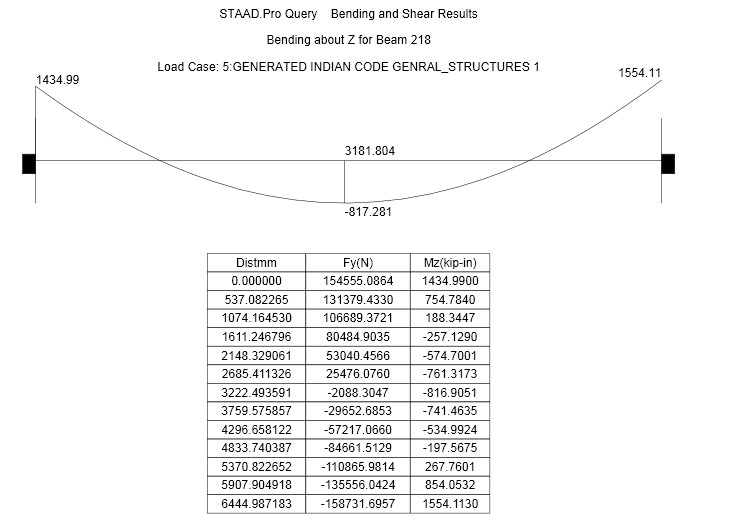


Fig 5.2c A diagram of the shear force of a column.

**5.3 Check for the design of a beam (no. 230):**

**Given data**:

Cross section of beam : b x d = 300mm x400 mm Vertical shear force = vu =145.93 KN τc = 0.29 N/mm2 (from table 19 of IS 456 200)

**Minimum Shear Reinforcement:**

When τv  is less than τc , given in Table 19, minimum shear reinforcement shall -be provided

**Design of Shear Reinforcement**:

When τv exceeds τc, given in Table 19, **shear** **reinforcement shall be** provided in any of the following forms:

1. Vertical stirrups,
2. Bent-up bars along with stirrups, and
3. Inclined stirrups, τv = vu/(b x d) (As per clause 40.1 of IS 456-2000)

=145.93 x 103/(400x300)

=1.216 N/mm2

τv ≥ τc

design reinforcement Vus = Vu- τcxbxd (As per clause 40.4 of IS 456-2000)

= 145.93 x103 -0.29x400x300

= 111100 N

Shear reinforcement shall be provided to carry a shear equal to ***Vu -*** τc ***bd The*** strength of shear reinforcement ***Vus,*** shall be calculated as below:

**For vertical stirrups:**

**Vus = 0.87 fyAsvd/Sv** (As per clause 40.4 of IS 456-2000)

Asv = total cross-sectional area of stirrup legs or bent-up bars within a distance Sv.

Sv = spacing of the stirrups or bent-up bars along the length of the member, τv = nominal shear stress

τc = design shear strength of the concrete,

**b** = breadth of the member which for flanged beams, shall be taken as the breadth of the web ***bw,***

fy = characteristic strength of the stirrup or bent-up reinforcement which shall notbe taken greater than 415 N/mm2, **α** = angle between the inclined stirrup or bent- up bar and the axis of the member, not less than

45”, and **d** = effective depth.

111130 N= 0.87x415x2xπx82x400/Sv

Sv = 140 mm

Sv should not be more than the following

1. 0.75xd = 0.75 x 400 = 300 mm
2. 300 mm
3. Minimum shear reinforcement spacing = Svmin

**Minimum shear reinforcement:**

Minimum shear reinforcement in the form of stirrups shall be provided such that:

Asv/bSv ≥ 0.4/ 0.87fy (As per clause 26.5.1.6 of IS 456-2000)

Asv = total cross-sectional area of stirrup legs effective in shear,

Sv = stirrup spacing along the length of the member, b = breadth of the beam or breadth of the web of flanged beam, and

fy = characteristic strength of the stirrup reinforcement in N/mm\* which shall not be taken greater than 415 N/mn2

Sv=2x(π/4)x82x0.87x415/(0.4x300)

=302 mm.

Provided 2 legged 8mm @ 140 mm stirrups.

Hence matched with staad output.

## CHAPTER 6 COLUMNS

A column or strut is a compression member, which is used primary to support axial compressive loads and with a height of at least three it is least lateral dimension.

A reinforced concrete column is said to be subjected to axially loaded when line of the resultant thrust of loads supported by column is coincident with the line of C.G 0f the column I the longitudinal direction.

Depending upon the architectural requirements and loads to be supported,R.C columns may be cast in various shapes i.e square ,rectangle, and hexagonal ,octagonal,circular.Columns of L shaped or T shaped are also sometimes used in multi-storeyed buildings.

The longitudinal bars in columns help to bear the load in the combination with the concrete.The longitudinal bars are held in position by transverse reinforcement, or lateral binders.

The binders prevent displacement of longitudinal bars during concreting operation and also check the tendency of their buckling towards under loads.

**6.1 Positioning of columns**:

Some of the guiding principles which help the positioning of the columns are as follows:-

1. Columns should be preferably located at or near the corners of the building and at the intersection of the wall, but for the columns on the property line as the following requirements some area beyond the column, the column can be shifted inside along a cross wall to provide the required area for the footing with in the property line.

alternatively a combined or a strap footing may be provided.

1. The spacing between the column is governed by the lamination on spans of supported beams, as the spanning of the column decides the the span of the beam. As the span of the of the beam increases, the depth of the beam, and hence the self weight of the beam and the total.

**Effective length**:

The effective length of the column is defined as the length between the points of contraflexure of the buckled column. The code has given certain values of the effective length for normal usage assuming idealized and conditions shown in appendix D of IS 456(table 24)

A column may be classified based as follows based on the type of loading:

1. Axially loaded column
2. A column subjected to axial load and uneasily bending 3) A column subjected to axial load and biaxial bending.

**6.2 Axially loaded columns:**

All compression members are to be designed for a minimum eccentricity of load into principal directions. In practice, a truly axially loaded column is rare ,if not nonexistent.

Therefore, every column should be designed for a minimum eccentricity .clause 22.4 of IS code

E min=(L/500)+(D/300) ,subjected to a minimum of 200 mm.

Where L is the unsupported length of the column (see 24.1.3 of the code for definition unsupported length) and D is the lateral dimension of the column in the direction under the consideration.

**6.2.1 Axial load and uniaxial ben**ding:

A member subjected to axial force and bending shall be designed on the basis of

1. The maximum compressive strength in concrete in axial compression is taken as 0.002
2. The maximum compressive strength at the highly compressed extreme fiber in concrete subjected to highly compression and when there is no tension on the section shall be

0.0035-0.75 times the strain at least compressed extreme fiber.

Design charts for combined axial compression and bending are in the form of intersection diagram in which curves for Pu/fck bD verses Mu/fck bD2  are plotted for different values of p/fck where p is reinforcement percentage.

**6.2.2 Axial load and biaxial bending:**

The resistance of a member subjected to axial force and biaxial bending shall be obtained on the basis of assumptions given in 38.1 and 38.2 with neutral axis so chosen as to satisfy the equilibrium of load and moment about two weeks.

Alternatively such members may be designed by the following equation:

(Mux/ Muy)αn +(Muy/ Muy1)αn<=1.0

Mux&Muy=moment about x and Y axis due to design loads

Mux1&Muy1=maximum uniaxial moment capacity for an axial load of Pu bending about x and y axis respectively.

αn is related to Pu/puz puz=0.45\*fck\*Ac+0.75\*fy\*Asc

For values of pu/Puz=0.2 to 0.8, the values of αn vary linearly from 1.0 to 2.0 for values less than

0.2, αn is values greater than 0.8 , αn  is 2.0

The main duty of column is to transfer the load to the soil safely.columns are designed for compression and moment. The cross section of the column generally increase from one floor to another floor due to the addition of both live and dead load from the top floors. Also the amount if load depends on number of beams the columns is connected to. As beam transfer half of the load to each column it is connected.

**6.3 Column design:**

A column may be defined as an element used primary to support axial compressive loads and with a height of a least three times its lateral dimension. The strength of column depends upon the strength of materials, shape and size of cross section, length and degree of proportional and dedicational restrains at its ends.

A column may be classify based on deferent criteria such as

1. shape of the section
2. slenderness ratio(A=L+D)
3. type of loading, land
4. pattern of lateral reinforcement.

The ratio of effective column length to least lateral dimension is released to as slenderness ratio.

In our structure we have 3 types of columns.

* Column with beams on two sides
* Columns with beams on three sides
* Columns with beams on four sides

So we require three types of column sections. So create three types of column sections and assign to the respective columns depending on the connection. But in these structure we adopted same cross section throughout the structure with a rectangular cross section .In foundations we generally do not have circular columns if circular column is given it makes a circle by creating many lines to increase accuracy.

The column design is done by selecting the column and from geometry page assigns the dimensions of the columns. Now analyze the column for loads to see the reactions and total loads on the column by seeing the loads design column by giving appropriate parameters like

1. Minimum reinforcement, max, bar sizes, maximum and minimum spicing.
2. Select the appropriate design code and input design column command to all the column.
3. Now run analysis and select any column to collect the reinforcement details

The following figure shows the reinforcement details of a beam in staad.

The figure represents details regarding

1. Transverse reinforcement
2. Longitudinal reinforcement

The type of bars to be used, amount of steel and loading on the column is represented in the below figure.

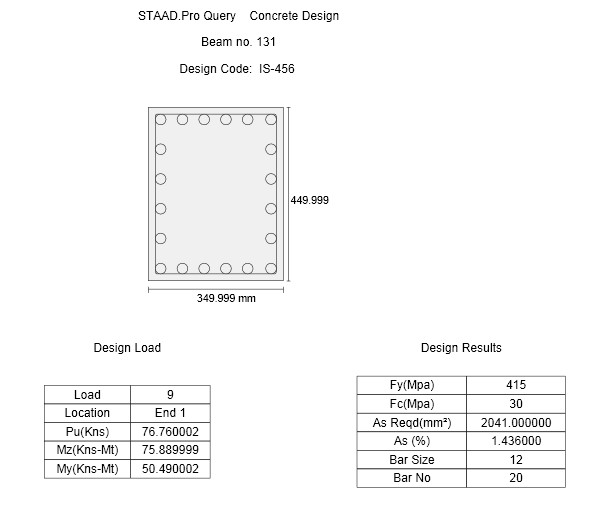


Fig 6.3a reinforcement details of a column

**Output:**

Due to very huge and detailed explanation of staad output for each and every coloumn we have shown a column design results below showing the amount of load,moments,amount of steel required,section adopted etc.

The main problem with staad is it takes all coloumns also as beams initially before design and continue the same.so here output of column 1 which os actually 131st beam as most of beams are used in drawing the plan.

**Out put for coloumn 1(beam 131):**

C O L U M N N O. 131 D E S I G N R E S U L T S

M30 Fe415 (Main) Fe415

(Sec.)

LENGTH: 3000.0 mm CROSS SECTION: 350.0 mm X 450.0 mm COVER:

40.0 mm

\*\* GUIDING LOAD CASE: 9 END JOINT: 1 SHORT COLUMN

DESIGN FORCES (KNS-MET)

-----------------------

DESIGN AXIAL FORCE (Pu) : 76.8

About Z About Y

INITIAL MOMENTS : 75.89 50.49

MOMENTS DUE TO MINIMUM ECC. : 1.61 1.54

SLENDERNESS RATIOS : - -

MOMENTS DUE TO SLENDERNESS EFFECT : - -

MOMENT REDUCTION FACTORS : - -

ADDITION MOMENTS (Maz and May) : - -

TOTAL DESIGN MOMENTS : 75.89 50.49

REQD. STEEL AREA : 2041.15 Sq.mm.

REQD. CONCRETE AREA: 155458.86 Sq.mm.

MAIN REINFORCEMENT : Provide 20 - 12 dia. (1.44%, 2261.95 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. rectangular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)

----------------------------------------------------------

Puz : 2734.00 Muz1 : 144.59 Muy1 : 107.38

INTERACTION RATIO: 1.00 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)

----------------------------------------------------------

WORST LOAD CASE: 9

END JOINT: 1 Puz : 2799.74 Muz : 157.05 Muy : 116.44 IR: 0.92

The following figure shows the deflection of same column.

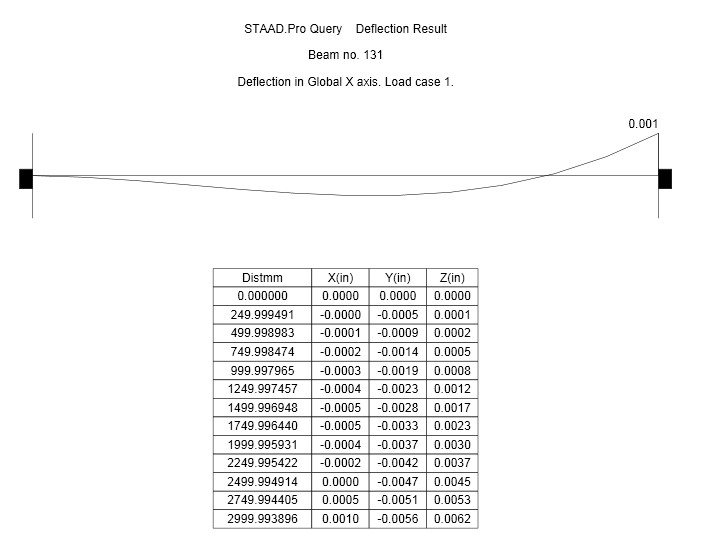


Fig 6.3 b deflection of column

**Check for Column design :**

Short axially loaded columns: Given data

fck =30 N/mm2

fy =415N/mm2 puz=2734 N b=350 d=450

Design of reinforcement Area:

(As per clause 39.6 of IS 456 2000)

Puz=0.45fckAc+0.75fyAsc

2734=0.45\*30\*(350\*450-Asc) +0.75\*415\*Asc

On solving the above equation we get

Asc=2041.15 Sq.mm.((Matched with Output)

Design of Main(Longitudinal) reinforcement:

(As per clause 26.5.3.1 of IS 456-2000 )

1. The cross sectional area of longitudinal reinforcement shall not be less 0.8% , not more than 6% of the gross cross sectional area of the column.
2. The bars shall not be less than 12 mm in diameter.
3. Spacing of longitudinal bars measured along the periphery of the column shall not exceed 300 mm.

Provided main reinforcement: 20 - 12 dia

(1.44%, 2261.95 Sq.mm.)

Check for Transverse reinforcement :

(As per clause 26.5.3.2 of IS 456-2000)

**A) Pitch:**

Shall not be more than the least of the following

1) Least lateral dimension of the compression member (350mm). 2) 16 x diameter of longitudinal reinforcement bar

= 16x 12 = 192 mm

3) 300 mm

**B)** Diameter:

* + 1. Shall not be less than one fourth of the diameter of main reinforcement.
    2. Not less than 6 mm.

**PROVIDED TIE REINFORCEMENT**: Provide 8 mm dia. rectangular ties @ 190 mm c/c

CHAPTER 7

SLABS

**7.1 Slab design**:

Slab is plate elements forming floor and roofs of buildings carrying distributed loads primarily by flexure.

**One way slab**:

One way slab are those in which the length is more than twice the breadth it can be simply supported beam or continuous beam.

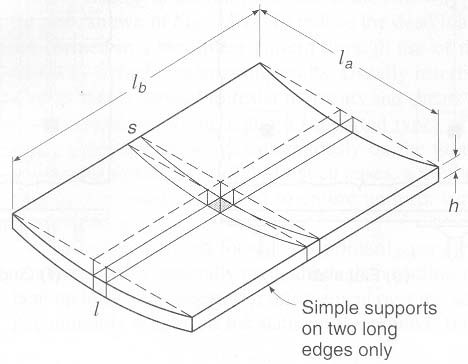
**Two way slab**:

When slabs are supported to four sides two ways spanning action occurs.Such as slab are simply supported on any or continuous or all sides the deflections and bending moments are considerably reduces as compared to those in one way slab.

**Checks:**

There is no need to check serviceability conditions, because design satisfying the span for depth ratio.

1. Simply supported slab
2. Continuous beam



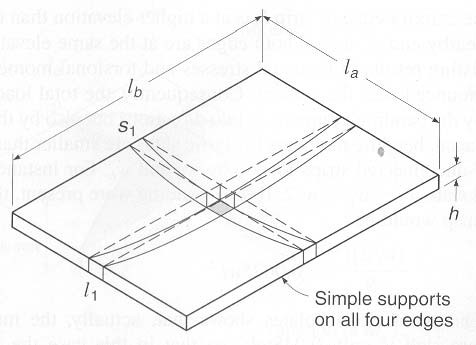
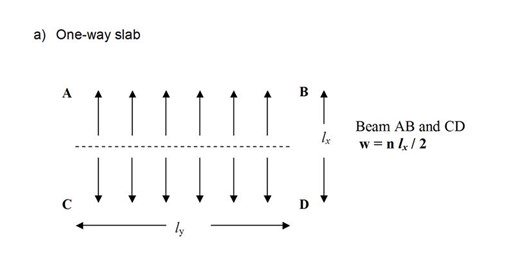


Fig 7.1. a Diagrams of slab deflection in one way and two way slabs

Following figures shows the load distributions in two slabs.



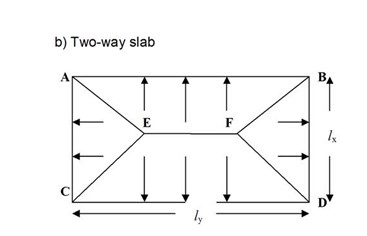


Fig 7.1.b A Diagram of load distribution of one way and two way slabs

Slabs are designed for deflection. Slabs are designed based on yield theory

This diagram shows the distribution of loads in two slabs.

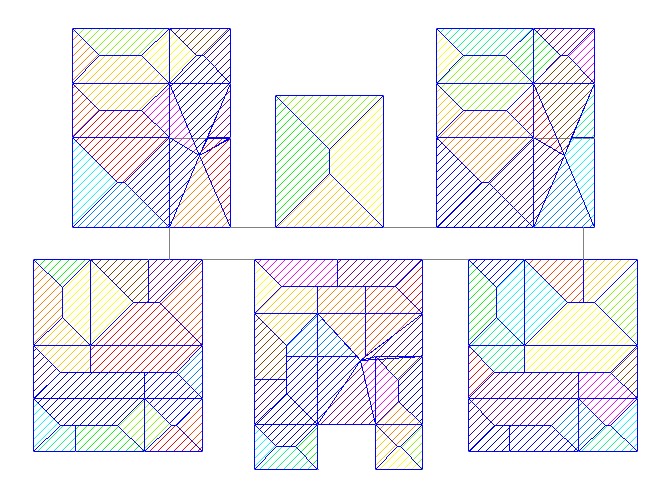


Figure 7.1.c Distribution of loads in two slabs.

order to design a slab we has to create a plate by selecting a plate cursor. Now select the

members to form slab and use form slab button. Now give the thickness of plate as 0.12 m. Now similar to the above designs give the parameters based on code and assign design slab command and select the plates and assign commands to it. After analysis is carried out go to advanced slab design page and collect the reinforcement details of the slab.

Slabs are also designed as per **IS456-2000**

The following figure shows the monolithic connection between beam, column and slab

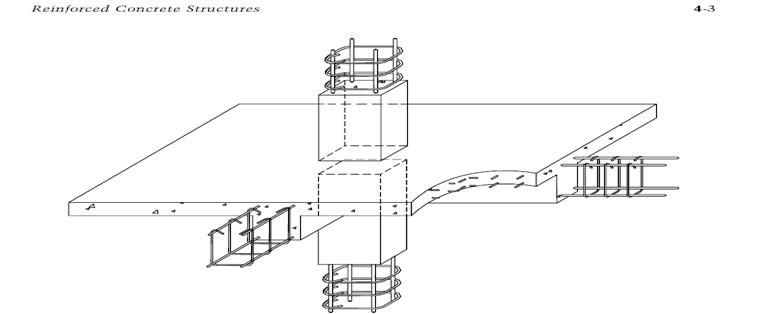


Figure 7.1.d monolithic connection between beam, column and slab

**Design of slabs :**

Size: 3.88m x 3.53m

End conditions for slab:

Adjacent long and short sides are continuous and other edges discontinuous.

Assuming the thickness of slab as 120 mm.

**Calculation of loads:**

**Live load:**

For residential building live load is usually taken as 2 kN/sq.m. (in accordance with 875 part II)

**Dead load :**

Self-weight of slab = 1x1x0.12x25 = 3.0 KN/m2

Weight of flooring (75mm thick) = 1x1x0.005x20 = 1.0 KN/m2

|  |  |
| --- | --- |
| Accidental loads | = 1.0 KN/m2 = 1.0 KN/m2 |
| **Live load**: | **5.0** KN/m2 |
| Live load is taken | = 2.0 KN/m2 |
| Total load | = 2 + 5.0 KN/m2 |
| Factored load | = 1.5x7.0 KN/m2 |
| Design load | = 10.5 KN/m2 |

**Calculation of moments:**

**(**As per Table 12 of IS 456-2000)

**Bending moment coefficients for slab:**

Dead load and super imposed load

Near the middle

|  |  |  |  |
| --- | --- | --- | --- |
| End of span  At support next to |  |  | +1/12 |
| End support |  |  | -1/10 |
| Positive bending moment at mid span |  | = | wl2/12 |
| Mu |  | = | 10.5x(3.88)2/12 |
|  |  | = | 13.17KNm |
| Negative bending moment at support | = -10.5x(3.88)2/10 | | | |
|  | = 15.8KNm | | | |
| Design bending moment    **Calculation of effective depth:**    Adopting M30 concrete and Fe 415 steel  As per IS 456-2000(Annexure G) | = 15.8KNm | | | |
| Mu,limit | =0.36xXumax/d(1-0.42Xumax/d)bd2fck | | | |
|  | =0.36x0.46(1-0.42x0.48)bd2x30 | | | |
| Xumax/d | =0.48 | | | |
| Mulimit | =4.13bd2 | | | |
| Assuming b | =1000mm | | | |
| Mu | =Mulimit | | | |
| d | =√15.8x106/(4.13x1000) | | | |
| Adopting 8-mm dia bars as reinforcement | =61.852mm | | | |
| Effective cover | = 15+10/2 =20mm | | | |
| Over all depth | = D =61.852+20=81.852 | | | |
| Therefore providing overall depth D | = 120mm | | | |
| Effective depth d | = 120-20=100mm | | | |

**Calculation of steel:** (MAIN REINFORCEMENT)

Form IS 456-2000(Annexure G)

Mu =0.87xfyxAstxd (1-fyxAst/bdfck)

15.8 =0.87x415x100xAst (1-415xAst/(1000x100x30)

Ast =437.6mm2

Providing minimum steel of =0.12%xbxD=144mm2

Spacing of 10mm dia bars = (astx1000)/Ast

= (∏x102x1000)/(4x437.6)

=179.47mm c/c

As per IS 456 2000, clause 26.3.3b,the spacing of Reinforcement should be not more than least of following

1. 3xeffective depth =3x100 =300mm
2. 300mm

Provide 10 mm Ф bars @ 175 mm.

Distribution reinforcement:

As per IS 456-2000(clause: 26.5.2.1)

Providing 0.12% of gross area as distribution reinforcement

Area of steel = (0.12x120x1000)/100 =144mm2

Adopting 6mm Ф bars as distribution reinforcement

Spacing = (astx1000)/Ast

= (∏/4x62x1000)/144

=196.35mm c/c

Provide 6mm Ф bars @ 180mm c/c

**Check for development length:**

As per IS 456-2000(clause 26.2.1)

The development length Ld is given by

|  |  |
| --- | --- |
| Ld | = Фσst/4 **ᵗ**bd |
|  | = (10x0.87x415)/(4x1.2x1.6) |
|  | = 470.11 mm (req.) |
| Ld(available) | = MI/V+L0 |
| M1 | = 0.87xfyxAstxd(1-fyxAst/bdfck) |
|  | = 0.87x415x437x100(1-437x415/(1000x100x30) |
|  | = 14.82x106N-mm |

Shear force at the section due to design loads

|  |  |
| --- | --- |
| V | = W1/2 = 10.5x3.88/2 |
|  | = 20.37 |
| M1/V+L0 | = 14.82/20.37 +L0 |
|  | = 0.727m + L0 |
|  | =727mm +L0 |

Ld(available)>Ld(req’d) safe

CHAPTER 8

## FOOTINGS

Foundations are structural elements that transfer loads from the building or individual column to the earth .If these loads are to be properly transmitted, foundations must be designed to prevent excessive settlement or rotation, to minimize differential settlement and to provide adequate safety against sliding and overturning.

**GENERAL:**

1. Footing shall be designed to sustain the applied loads, moments and forces and the induced reactions and to assure that any settlements which may occur will be as nearly uniform as possible and the safe bearing capacity of soil is not exceeded.
2. Thickness at the edge of the footing: in reinforced and plain concrete footing at the edge shall be not less than 150 mm for footing on the soil nor less than 300mm above the tops of the pile for footing on piles.

**BEARING CAPACITY OF SOIL:**

The size foundation depends on permissible bearing capacity of soil. The total load per unit area under the footing must be less than the permissible bearing capacity of soil to the excessive settlements.

**8.1 Foundation design:**

Foundations are structure elements that transfer loads from building or individual column to earth this loads are to be properly transmitted foundations must be designed to prevent excessive settlement are rotation to minimize differential settlements and to provide adequate safety isolated footings for multi storey buildings. These may be square rectangle are circular in plan that the choice of type of foundation to be used in a given situation depends on a number of factors.

1. Bearing capacity of soil
2. Type of structure
3. Type of loads
4. Permissible differential settlements
5. economy

A footing is the bottom most part of the structure and last member to transfer the load. In order to design footings we used staad foundation software.

These are the types of foundations the software can deal.

Shallow (D<B)

* 1.Isolated (Spread) Footing
* 2.Combined (Strip) Footing
* 3.Mat (Raft) Foundation

Deep (D>B)

* 1.Pile Cap
* 2. Driller Pier

The advantage of this software is even after the analysis of staad we can update the following properities if required.

The following Parameters can be updated:

* Column Position
* Column Shape
* Column Size  Load Cases
* Support List

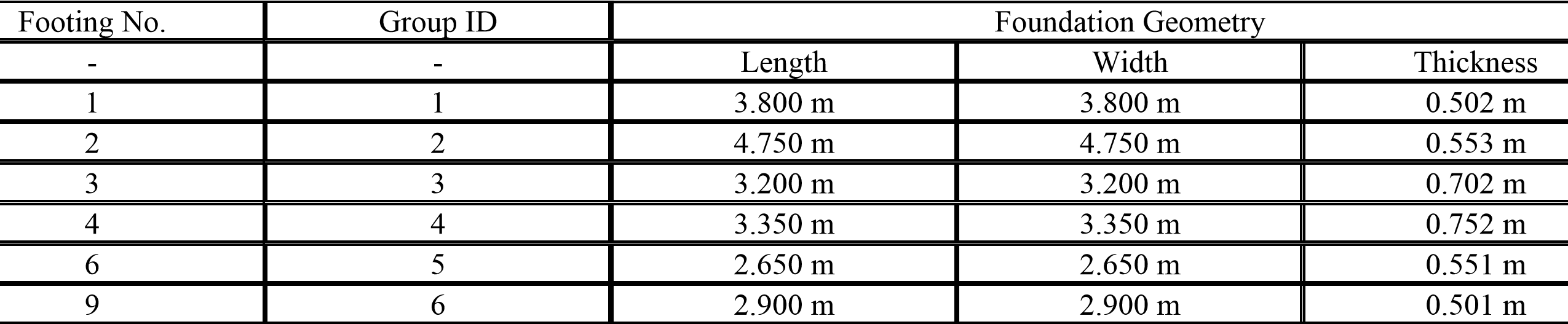
After the analysis of structure at first we has to import the reactions of the columns from staad pro using import button.

After we import the loads the placement of columns is indicated in the figure.



Fig 8.1a placement of columns

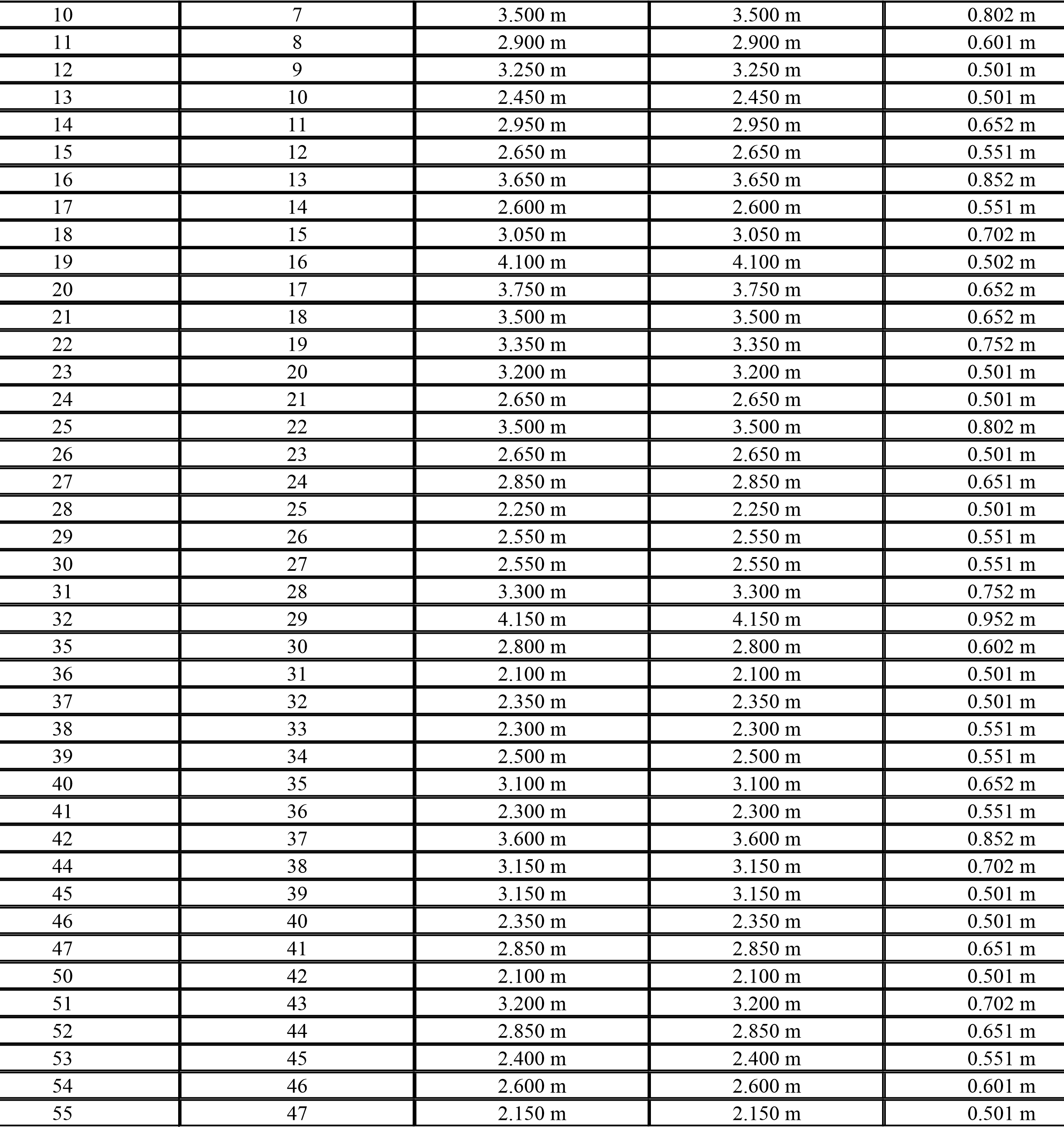
After importing the reactions in the staad foundation the following input data is required regarding materials, Soil type, Type of foundation, safety factors.

* Type of foundation: ISOLATED.
* Unit weight of concrete:25kn/m^3
* Minimum bar spacing:50mm
* Maximum bar spacing:500mm
* Strength of concrete:30 N/mm^2
* Yield strength of steel:415 n/mm^2
* Minimum bar size:6mm
* Maximum bar size:40mm
* Bottom clear cover:50mm
* Unit weight of soil:22 kn/m^3
* Soil bearing capacity:300 kn/m^3
* Minimumlength:1000mm
* Minimum width:1000mm
* Minimum thichness:500mm
* Maximum length:12000mm
* Maximum width:12000mm
* Maximum thickness:1500mm
* Plan dimension:50mm
* Aspect ratio:1
* Safety against friction,overturning,sliding:0.5,1.5,1.5

After this input various properties of the structure and click on design.

After the analysis detailed calculation of each and every footing is given with plan and elevation of footing including the manual calculation.

The following tables show the dimensions and reinforcement details of all the footings.





|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | #10 @ 65 mm c/c | #10 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 2 | #12 @ 70 mm c/c | #12 @ 70 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 3 | #10 @ 70 mm c/c | #10 @ 70 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 4 | #10 @ 60 mm c/c | #10 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 6 | #8 @ 65 mm c/c | #8 @ 50 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 9 | #8 @ 60 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 10 | #10 @ 65 mm c/c | #10 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 11 | #8 @ 50 mm c/c | #8 @ 50 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 12 | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 13 | #8 @ 65 mm c/c | #8 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 14 | #10 @ 75 mm c/c | #10 @ 70 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 15 | #8 @ 65 mm c/c | #8 @ 50 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 16 | #10 @ 65 mm c/c | #10 @ 50 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 17 | #8 @ 65 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 18 | #8 @ 50 mm c/c | #10 @ 70 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 19 | #10 @ 70 mm c/c | #10 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 20 | #10 @ 60 mm c/c | #10 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 21 | #10 @ 65 mm c/c | #10 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 22 | #10 @ 60 mm c/c | #10 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 23 | #8 @ 55 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 24 | #8 @ 55 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 25 | #10 @ 65 mm c/c | #10 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 26 | #8 @ 55 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 27 | #8 @ 50 mm c/c | #8 @ 50 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 28 | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 29 | #8 @ 55 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 30 | #8 @ 55 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 31 | #10 @ 65 mm c/c | #10 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 32 | #10 @ 50 mm c/c | #10 @ 50 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 35 | #10 @ 75 mm c/c | #10 @ 75 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 36 | #8 @ 75 mm c/c | #8 @ 70 mm c/c | #8 @ 75 mm c/c | #8 @ 75 mm c/c |
| 37 | #8 @ 55 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 38 | #8 @ 70 mm c/c | #8 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 39 | #8 @ 55 mm c/c | #8 @ 50 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 40 | #10 @ 70 mm c/c | #10 @ 70 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 41 | #8 @ 70 mm c/c | #8 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 42 | #10 @ 65 mm c/c | #10 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 44 | #10 @ 65 mm c/c | #10 @ 70 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 45 | #8 @ 70 mm c/c | #8 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 46 | #8 @ 60 mm c/c | #8 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 47 | #8 @ 50 mm c/c | #8 @ 50 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 50 | #8 @ 75 mm c/c | #8 @ 70 mm c/c | #8 @ 75 mm c/c | #8 @ 75 mm c/c |
| 51 | #10 @ 65 mm c/c | #10 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 52 | #8 @ 50 mm c/c | #8 @ 50 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 53 | #8 @ 65 mm c/c | #8 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 54 | #8 @ 55 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 55 | #8 @ 75 mm c/c | #8 @ 70 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 58 | #8 @ 55 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 59 | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 61 | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 62 | #10 @ 75 mm c/c | #10 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 63 | #10 @ 70 mm c/c | #10 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 64 | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 65 | #10 @ 75 mm c/c | #10 @ 75 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 66 | #8 @ 80 mm c/c | #8 @ 75 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 67 | #8 @ 65 mm c/c | #8 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 68 | #8 @ 55 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 69 | #8 @ 55 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 70 | #8 @ 50 mm c/c | #8 @ 50 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 71 | #10 @ 75 mm c/c | #10 @ 75 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 72 | #8 @ 50 mm c/c | #8 @ 50 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 73 | #8 @ 55 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 74 | #8 @ 55 mm c/c | #8 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 77 | #8 @ 60 mm c/c | #8 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 78 | #8 @ 70 mm c/c | #8 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 79 | #8 @ 55 mm c/c | #8 @ 50 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 80 | #8 @ 65 mm c/c | #8 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 81 | #8 @ 65 mm c/c | #8 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 82 | #8 @ 50 mm c/c | #10 @ 75 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 83 | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 84 | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 85 | #8 @ 55 mm c/c | #10 @ 70 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 86 | #10 @ 55 mm c/c | #10 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 87 | #10 @ 65 mm c/c | #10 @ 70 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 88 | #8 @ 80 mm c/c | #8 @ 75 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 89 | #10 @ 75 mm c/c | #10 @ 75 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 90 | #8 @ 60 mm c/c | #8 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 91 | #10 @ 65 mm c/c | #10 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 92 | #10 @ 60 mm c/c | #10 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 93 | #8 @ 60 mm c/c | #8 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 94 | #8 @ 70 mm c/c | #8 @ 65 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 95 | #10 @ 60 mm c/c | #10 @ 55 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 96 | #10 @ 65 mm c/c | #10 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 97 | #10 @ 65 mm c/c | #10 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |
| 99 | #10 @ 65 mm c/c | #10 @ 60 mm c/c | #8 @ 80 mm c/c | #8 @ 80 mm c/c |

After the design is complete the calculations is obtained for each and every column and a sample column calculations is shown below.

### Isolated Footing 1

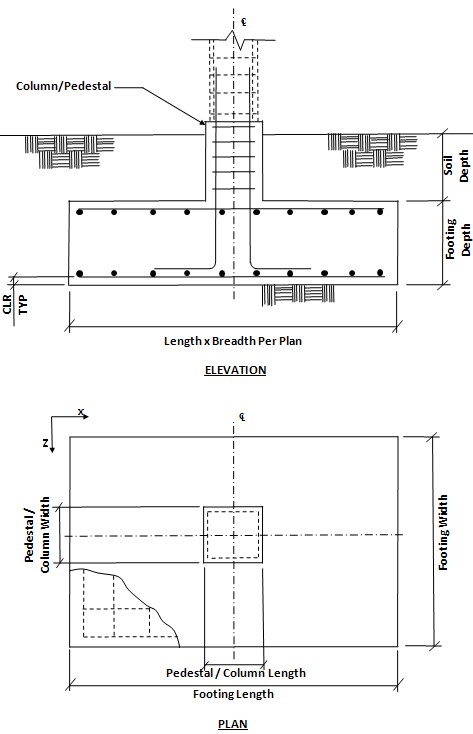


Fig 8.1.a Elevation and Plan of Isolated Footing

#### Footing Geometry

Footing Thickness (Ft) : 500.00 mm

Footing Length – X (Fl) : 1000.00 mm

Footing Width – Z (Fw) : 1000.00 mm

#### Column Dimensions

|  |  |
| --- | --- |
| **Column Shape :** | Rectangular |
| **Column Length – X**  **(Pl) :** | 0.45 m |
| **Column**  **Width – Z (Pw) :** | 0.35 m |

#### Pedestal

Pedestal Length – X : N/A

Pedestal Width – Z : N/A

**Design Parameters**

**Concrete and Rebar Properties**

Unit Weight of Concrete : 25.000 kN/m3

Strength of Concrete : 30.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2

Minimum Bar Size : # 6

Maximum Bar Size : # 40

Minimum Bar Spacing : 50.00 mm

Maximum Bar Spacing : 500.00 mm Footing Clear Cover (F, CL) : 50.00 mm

**Soil Properties :**

Soil Type : Un Drained

Unit Weight : 22.00 kN/m3

Soil Bearing Capacity : 300.00 kN/m2

Soil Surcharge : 0.00 kN/m2

Depth of Soil above Footing : 0.00 mm

Untrained Shear Strength : 0.00 N/mm2

**Sliding and Overturning :**

Coefficient of Friction : 0.50

Factor of Safety Against Sliding : 1.50

Factor of Safety Against Overturning : 1.50

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Applied Loads – Allowable Stress Level | | | | |  |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) |  | Moment X (kNm) | Moment Z (kNm) |
| 1 | 168.123 | -1.837 | 0.275 |  | 1.491 | 1.441 |
| 2 | 140.638 | -3.797 | -0.289 |  | 0.593 | 3.370 |
| 3 | 842.201 | -16.764 | -1.784 |  | 2.831 | 14.560 |
| 4 | -116.948 | 20.364 | 19.053 |  | 32.167 | -52.030 |
| 5 | 1726.443 | -33.597 | -2.696 |  | 7.373 | 29.057 |
| 6 | 1240.817 | -2.441 | 20.708 |  | 44.499 | -39.191 |
| 7 | 1521.493 | -51.314 | -25.020 |  | -32.702 | 85.682 |
| 8 | 1381.155 | -26.878 | -2.156 |  | 5.898 | 23.245 |
| 9 | 76.762 | 27.790 | 28.993 |  | 50.487 | -75.884 |
| 10 | 427.606 | -33.301 | -28.168 |  | -46.014 | 80.207 |
| 11 | 252.184 | -2.755 | 0.413 |  | 2.237 | 2.162 |
| 12 | 151.310 | -1.653 | 0.248 |  | 1.342 | 1.297 |
|  |  | Applied Loads – Strength Level | | |  |  |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) |  | Moment X (kNm) | Moment Z (kNm) |

1. 168.123 -1.837 0.275 1.491 1.441
2. 140.638 -3.797 -0.289 0.593 3.370
3. 842.201 -16.764 -1.784 2.831 14.560
4. -116.948 20.364 19.053 32.167 -52.030
5. 1726.443 -33.597 -2.696 7.373 29.057
6. 1240.817 -2.441 20.708 44.499 -39.191
7. 1521.493 -51.314 -25.020 -32.702 85.682
8. 1381.155 -26.878 -2.156 5.898 23.245
9. 76.762 27.790 28.993 50.487 -75.884
10. 427.606 -33.301 -28.168 -46.014 80.207
11. 252.184 -2.755 0.413 2.237 2.162 12 151.310 -1.653 0.248 1.342 1.297

Design Calculations :

#### Footing Size

Initial Length (Lo) = 1.00 m

Initial Width (Wo) = 1.00 m

Uplift force due to buoyancy = -0.00 kN Effect due to adhesion = 0.00 kN

Min. footing area required from bearing pressure, Amin = P / qmax = 5.796 m 2

Footing area from initial length and 2

Lo x Wo = 1.00 m

width, Ao =

### Final Footing Size

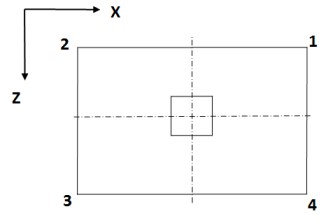
Length (L2) = 3.80 M Governing Load Case : # 4

Width (W2) = 3.80 M Governing Load Case : # 4

Depth (D2) = 0.50 m Governing Load Case : # 4

Area (A2) = 14.44 m2

### Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m^2)** | **Pressure at corner 2 (q2)**  **(kN/m^2)** | **Pressure at corner 3 (q3)**  **(kN/m^2)** | **Pressure at corner 4 (q4)**  **(kN/m^2)** | **Area of footing in**  **uplift (Au)**  **(m2)** |
| 5 | **136.4151** | 126.3869 | 127.7045 | 137.7327 | 0.00 |
| 5 | 136.4151 | **126.3869** | 127.7045 | 137.7327 | 0.00 |
| 5 | 136.4151 | 126.3869 | **127.7045** | 137.7327 | 0.00 |
| 5 | 136.4151 | 126.3869 | 127.7045 | **137.7327** | 0.00 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

#### Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**    **(kN/m^2)** | **Pressure at corner 2 (q2)**    **(kN/m^2)** | **Pressure at corner 3 (q3)**    **(kN/m^2)** | **Pressure at corner 4 (q4)**    **(kN/m^2)** |
| 5 | **136.4151** | 126.3869 | 127.7045 | 137.7327 |
| 5 | 136.4151 | **126.3869** | 127.7045 | 137.7327 |
| 5 | 136.4151 | 126.3869 | **127.7045** | 137.7327 |
| 5 | 136.4151 | 126.3869 | 127.7045 | **137.7327** |

Adjust footing size if necessary.

#### Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 14.44 sq.m

Area not in contact with soil = 0.00 sq.m % of total area not in contact = 0.00%

**Check For Stability Against Overturning And Sliding**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X-**  **Direction** | **Along Z-**  **Direction** | **About X-**  **Direction** | **About Z-**  **Direction** |
| 1 | 94.894 | 633.851 | 406.729 | 280.722 |
| 2 | 42.284 | 556.554 | 1358.999 | 115.812 |
| 3 | 30.503 | 286.709 | 1001.994 | 84.696 |
| 4 | 1.560 | 1.668 | 2.896 | 1.941 |
| 5 | 28.379 | 353.724 | 601.339 | 79.013 |
| 6 | 291.089 | 34.319 | 49.231 | 71.120 |
| 7 | 16.584 | 34.012 | 71.523 | 29.044 |
| 8 | 29.051 | 362.094 | 615.569 | 80.883 |
| 9 | 4.629 | 4.437 | 7.522 | 5.444 |
| 10 | 9.130 | 10.794 | 19.225 | 11.929 |
| 11 | 78.517 | 524.459 | 336.534 | 232.274 |
| 12 | 100.353 | 670.316 | 430.128 | 296.871 |

#### Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction

Critical Load Case for Sliding along X-Direction : 4

Governing Disturbing Force : 20.364 kN

Governing Restoring Force : 31.776 kN

Minimum Sliding Ratio for the Critical Load Case : 1.560

Critical Load Case for Overturning about X-Direction : 4

Governing Overturning Moment : 41.693 kNm

Governing Resisting Moment : 120.746 kNm

Minimum Overturning Ratio for the Critical Load Case 2.896 :

**Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction**

Critical Load Case for Sliding along Z-Direction : 4

Governing Disturbing Force : 19.053 kN

Governing Restoring Force : 31.776 kN

Minimum Sliding Ratio for the Critical Load Case : 1.668

Critical Load Case for Overturning about Z-Direction : 4

Governing Overturning Moment : -62.212 kNm

Governing Resisting Moment : 120.746 kNm Minimum Overturning Ratio for the Critical Load Case : 1.941

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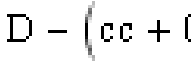
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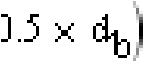
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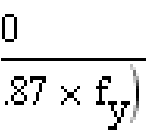
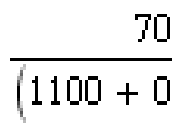
78.540753

k

Nm

As Per IS 456 2000 ANNEX G G-1.1C

= 0.479107



Limiting Factor1 (Kumax) =

Limiting Factor2 (Rumax) =

= 4133.149375 kN/m^2

= 3138.136379 kNm Limit Moment Of Resistance (M



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=

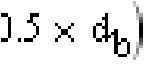
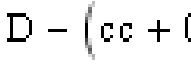


Mu <= Mumax hence, safe

#### Check Trial Depth against moment (w.r.t. Z Axis)

**Critical Load Case = #5**

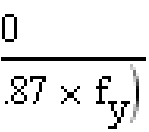
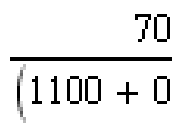
Effective Depth = = 0.45 m



Governing moment (Mu) = 656.192207 kNm

As Per IS 456 2000 ANNEX G G-1.1C

= 0.479107



Limiting Factor1 (Kumax) =

Limiting Factor2 (Rumax) =

= 4133.149375 kN/m^2

= 3138.136379 kNm

Limit Moment Of Resistance (M



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Mu <= Mumax hence, safe

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Shear Force(S) = 582.75 kN

Shear Stress(Tv) = 343.078914 kN/m^2

Percentage Of Steel(Pt) = 0.2566

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(Tc) = 1005.98 kN/m^2

Tv< Tc hence, **safe**

#### Check Trial Depth for one way shear (Along Z Axis)

**Critical Load Case = #5**

Shear Force(S) = 573.75 kN

Shear Stress(Tv) = 337.778591 kN/m^2

Percentage Of Steel(Pt) = 0.2479

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(Tc) = 1005.98 kN/m^2

Tv< Tc hence, safe

#### Check Trial Depth for two way shear

**Critical Load Case = #5**

Shear Force(S) = 1640.97 kN

Shear Stress(Tv) = 1083.55 kN/m^2

As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.00



Shear Strength(Tc)= = 1369.3064 kN/m^2



Ks x Tc = 1369.3064 kN/m^2

Tv<= Ks x Tc hence, safe

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Bar Size

Bar diameter corresponding to max bar size (db) = 25.000 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 1.47 m



Allowable Length(ldb) = = 1.63 m

ldb >ld hence, **safe**

Along Z Axis

Bar diameter corresponding to max bar size(db) = 25.000 mm

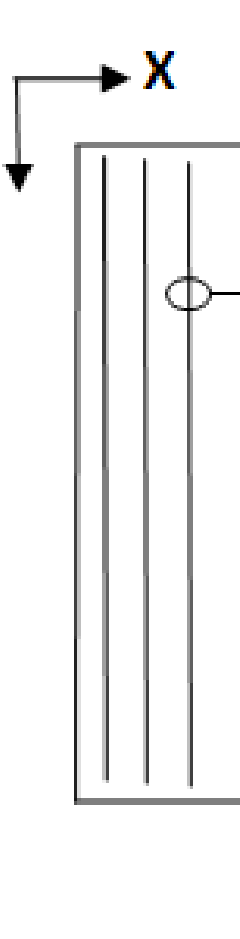
As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 1.47 m



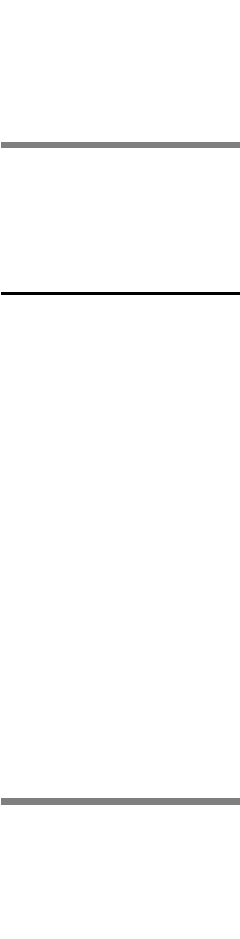
Allowable Length(ldb) = = 1.68 m

ldb >ld hence, safe



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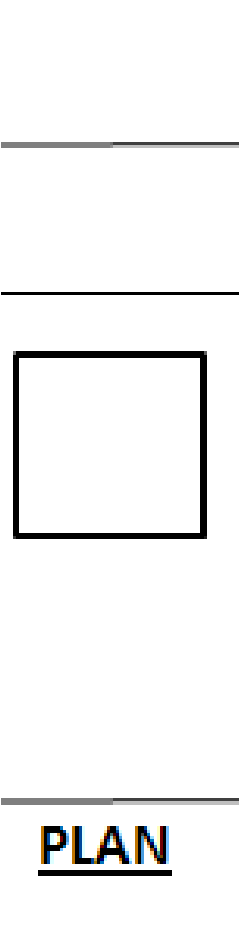


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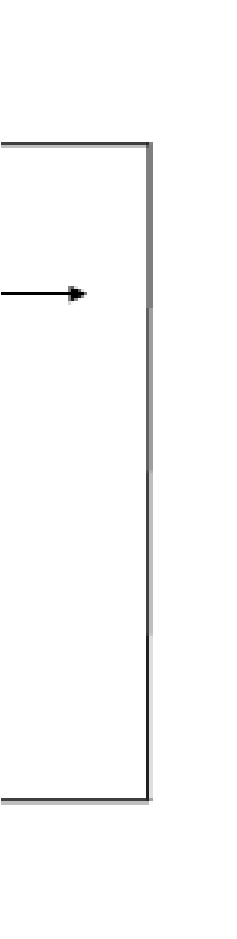


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For moment w.r.t. X Axis (Mx)

As Per IS 456 2000 Clause 26.5.2.1

**Critical Load Case = #5**

Minimum Area of Steel (Astmin) = 2289.12 mm2

Calculated Area of Steel (Ast) = 4359.21 mm2

Provided Area of Steel (Ast,Provided) = 4359.205 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Dia = 10.000

Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 67.091 mm

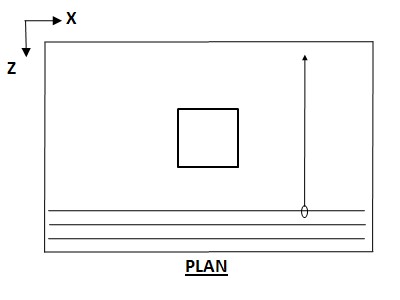
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

**Based on spacing reinforcement increment; provided reinforcement is**

**#10 @ 65.000 mm o.c.**

#### Along X Axis



For moment w.r.t. Z Axis (Mz)

As Per IS 456 2000 Clause 26.5.2.1

**Critical Load Case = #5**

Minimum Area of Steel (Astmin) = 2289.12 mm2

Calculated Area of Steel (Ast) = 4210.337 mm2

Provided Area of Steel (Ast,Provided) = 4210.337 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Dia = 10.000

Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 69.62 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

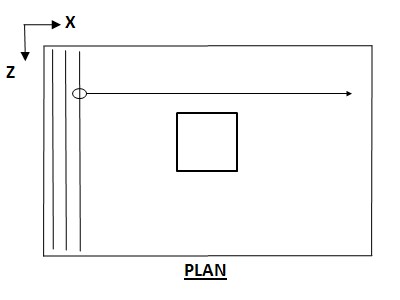
The reinforcement is accepted.

**Based on spacing reinforcement increment; provided reinforcement is**

**#10 @ 65.000 mm o.c.**

Top Reinforcement Design

#### Along Z Axis



Minimum Area of Steel (Astmin) = 2289.120 mm2

Calculated Area of Steel (Ast) = 2284.560 mm2

Provided Area of Steel (Ast,Provided) = 2289.120 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 0.000 kNm

Selected Bar Dia = 8.000

Minimum spacing allowed (Smin) = 50.000 mm

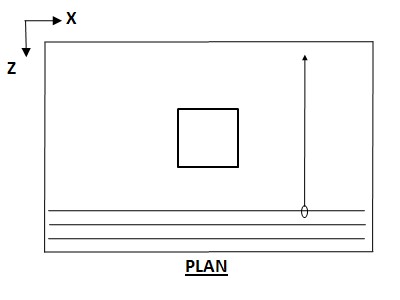
Selected spacing (S) = 82.044 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size... The reinforcement is accepted.

**Based on spacing reinforcement increment; provided reinforcement is**

**#8 @ 80.000 mm o.c.**

Along X Axis



Minimum Area of Steel (Astmin) = 2289.120 mm2

Calculated Area of Steel (Ast) = 2284.560 mm2

Provided Area of Steel (Ast,Provided) = 2289.120 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 0.000 kNm

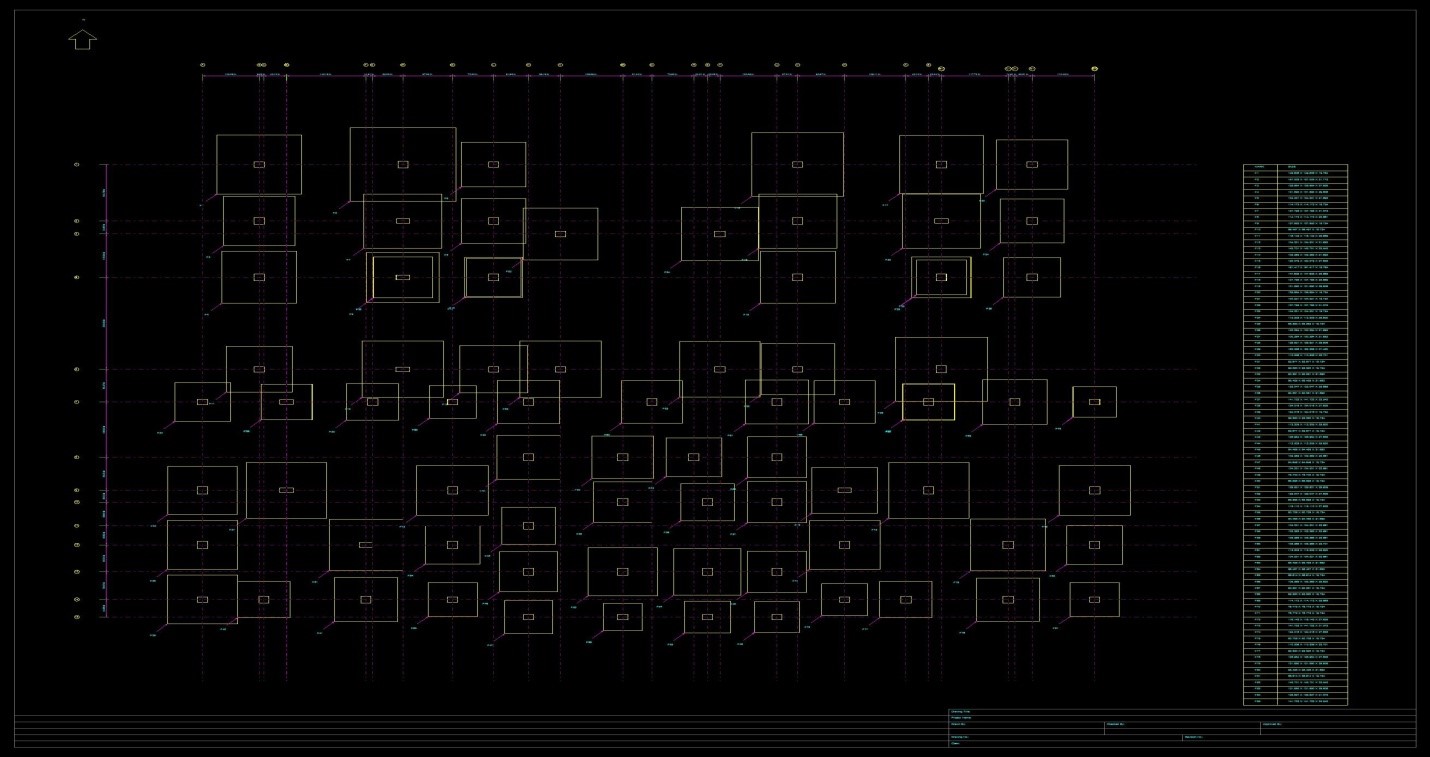
Selected Bar Dia = 8.000

Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 82.044 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size... The reinforcement is accepted. **Based on spacing reinforcement increment; provided reinforcement is**

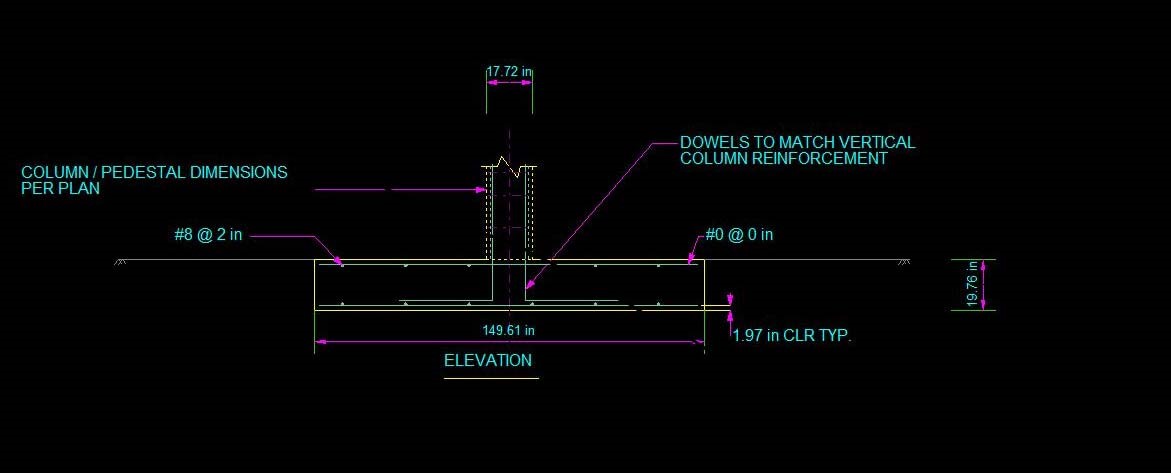
**#8 @ 80.000 mm o.c.**



The figure shows layout of foundations for each and every column.

Here we can observe that some of the footings coincide as they are very near, in such situations combined(strap or cantilever) is laid.

Reinforcement details of column is shown below



##### Fig 8.2.1 elevation of reinforcements

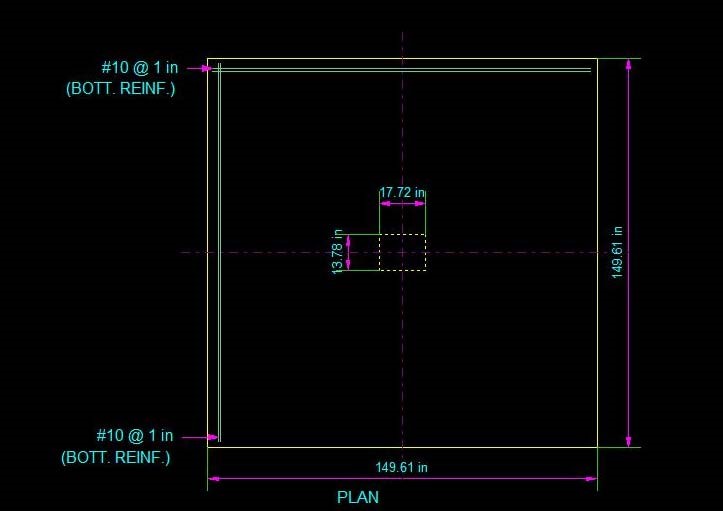


Fig 8.2.b plan of reinforcement

**Staad Editor**:

STAAD SPACE

START JOB INFORMATION

ENGINEER DATE 14-Apr-08

END JOB INFORMATION

INPUT WIDTH 79

UNIT METER KN

JOINT COORDINATES

1 0 0 0; 2 6.445 0 0; 3 0 0 3.65; 4 0 0 7.29; 6 6.445 0 7.29; 9 10.51 0 0;

10 6.445 0 3.65; 11 10.51 0 3.65; 12 6.445 0 7.3; 13 10.51 0 7.3;

14 0 0 13.235; 15 6.44 0 7.29; 16 6.44 0 13.235; 17 10.51 0 7.29;

18 10.51 0 13.235; 19 24.153 0 0; 20 30.598 0 0; 21 24.153 0 3.65;

22 24.153 0 7.29; 23 34.663 0 0; 24 30.593 0 7.29; 25 30.598 0 3.65;

26 30.598 0 7.29; 27 34.663 0 3.65; 28 30.598 0 7.3; 29 34.663 0 7.3;

30 34.663 0 7.29; 31 24.153 0 13.235; 32 30.593 0 13.235; 35 12.083 0 15.35;

36 8.668 0 15.35; 37 5.088 0 15.35; 38 1.223 0 15.35; 39 -2.542 0 15.35;

40 -2.542 0 21.06; 41 1.228 0 15.35; 42 1.228 0 21.06; 44 -2.542 0 24.59;

45 -2.542 0 28.12; 46 0.204 0 28.12; 47 4.788 0 28.12; 50 8.673 0 15.35;

51 8.673 0 21.06; 52 12.083 0 18.92; 53 12.083 0 23.35; 54 12.083 0 26.325;

55 12.083 0 29.255; 58 23.213 0 26.325; 59 23.213 0 29.255; 61 16.307 0 29.255;

62 4.788 0 24.59; 63 16.303 0 26.325; 64 16.303 0 29.255; 65 20.103 0 26.325;

66 20.103 0 29.255; 67 20.103 0 21.825; 68 23.213 0 21.825; 69 16.303 0 21.825;

70 16.303 0 18.92; 71 17.613 0 15.35; 72 23.213 0 15.35; 73 23.213 0 18.92;

74 19.488 0 18.92; 77 8.668 0 24.59; 78 8.668 0 28.12; 79 26.258 0 15.35;

80 30.023 0 15.35; 81 30.028 0 15.35; 82 33.888 0 15.35; 83 37.468 0 15.35;

84 37.473 0 15.35; 85 26.258 0 21.06; 86 30.028 0 21.06; 87 26.258 0 24.59;

88 26.258 0 28.12; 89 33.588 0 28.12; 90 29.004 0 28.12; 91 37.473 0 21.06;

92 33.588 0 24.59; 93 37.468 0 24.59; 94 37.468 0 28.12; 95 13.51 0 13.235;

96 13.51 0 4.49; 97 20.663 0 4.49; 99 20.663 0 13.235; 100 0 3 0;

101 6.445 3 0; 102 0 3 3.65; 103 0 3 7.29; 104 6.445 3 7.29; 105 10.51 3 0;

106 6.445 3 3.65; 107 10.51 3 3.65; 108 6.445 3 7.3; 109 10.51 3 7.3;

110 0 3 13.235; 111 6.44 3 7.29; 112 6.44 3 13.235; 113 10.51 3 7.29;

114 10.51 3 13.235; 115 24.153 3 0; 116 30.598 3 0; 117 24.153 3 3.65;

118 24.153 3 7.29; 119 34.663 3 0; 120 30.593 3 7.29; 121 30.598 3 3.65;

122 30.598 3 7.29; 123 34.663 3 3.65; 124 30.598 3 7.3; 125 34.663 3 7.3;

126 34.663 3 7.29; 127 24.153 3 13.235; 128 30.593 3 13.235;

129 34.663 3 13.235; 130 12.083 3 15.35; 131 8.668 3 15.35; 132 5.088 3 15.35;

133 1.223 3 15.35; 134 -2.542 3 15.35; 135 -2.542 3 21.06; 136 1.228 3 15.35;

137 1.228 3 21.06; 138 -2.542 3 24.59; 139 -2.542 3 28.12; 140 0.204 3 28.12;

141 4.788 3 28.12; 142 8.673 3 15.35; 143 8.673 3 21.06; 144 12.083 3 18.92;

145 12.083 3 23.35; 146 12.083 3 26.325; 147 12.083 3 29.255;

148 23.213 3 26.325; 149 23.213 3 29.255; 150 16.307 3 29.255;

151 4.788 3 24.59; 152 16.303 3 26.325; 153 16.303 3 29.255;

154 20.103 3 26.325; 155 20.103 3 29.255; 156 20.103 3 21.825;

157 23.213 3 21.825; 158 16.303 3 21.825; 159 16.303 3 18.92;

160 17.613 3 15.35; 161 23.213 3 15.35; 162 23.213 3 18.92; 163 19.488 3 18.92;

164 8.668 3 24.59; 165 8.668 3 28.12; 166 26.258 3 15.35; 167 30.023 3 15.35;

168 30.028 3 15.35; 169 33.888 3 15.35; 170 37.468 3 15.35; 171 37.473 3 15.35;

172 26.258 3 21.06; 173 30.028 3 21.06; 174 26.258 3 24.59; 175 26.258 3 28.12;

176 33.588 3 28.12; 177 29.004 3 28.12; 178 37.473 3 21.06; 179 33.588 3 24.59; 180 37.468 3 24.59; 181 37.468 3 28.12; 182 13.51 3 13.235; 183 13.51 3 4.49;

184 20.663 3 4.49; 186 20.663 3 13.235; 189 33.888 3 13.25; 190 6.44 3 15.335;

191 0 6 0; 192 6.445 6 0; 193 0 6 3.65; 194 0 6 7.29; 195 6.445 6 7.29;

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208 24.153 6 3.65; 209 24.153 6 7.29; 210 34.663 6 0; 211 30.593 6 7.29;

212 30.598 6 3.65; 213 30.598 6 7.29; 214 34.663 6 3.65; 215 30.598 6 7.3;

216 34.663 6 7.3; 217 34.663 6 7.29; 218 24.153 6 13.235; 219 30.593 6 13.235;

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236 12.083 6 23.35; 237 12.083 6 26.325; 238 12.083 6 29.255;

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248 23.213 6 21.825; 249 16.303 6 21.825; 250 16.303 6 18.92;

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259 30.028 6 15.35; 260 33.888 6 15.35; 261 37.468 6 15.35; 262 37.473 6 15.35;

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271 37.468 6 24.59; 272 37.468 6 28.12; 273 13.51 6 13.235; 274 13.51 6 4.49;

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414 12.083 12 29.255; 415 23.213 12 26.325; 416 23.213 12 29.255;

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669 -2.542 21 24.59; 670 -2.542 21 28.12; 671 0.204 21 28.12;

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681 16.307 21 29.255; 682 4.788 21 24.59; 683 16.303 21 26.325;

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711 37.468 21 24.59; 712 37.468 21 28.12; 713 13.51 21 13.235;

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POISSON 0.17

DENSITY 23.5616

ALPHA 1e-005

DAMP 0.05

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CONSTANTS

MATERIAL CONCRETE ALL

SUPPORTS

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EXP 1.5 JOINT 1 TO 4 6 9 TO 32 35 TO 42 44 TO 47 50 TO 55 58 59 61 TO 74 77 -

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LOAD 2 LOADTYPE Live TITLE F L

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LOAD 3 LOADTYPE Live TITLE L L

MEMBER LOAD

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1864 TO 1878 1967 TO 2043 2045 TO 2063 2065 TO 2079 2168 TO 2244 - 2246 TO 2264 2266 TO 2280 2369 TO 2445 2447 TO 2465 2467 TO 2480 -

2481 UNI GY -25

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WIND LOAD Z 1.5 TYPE 1 YR 0 21

LOAD COMB 5 Generated Indian Code Genral\_Structures 1

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LOAD COMB 6 Generated Indian Code Genral\_Structures 2

1 1.2 2 1.2 3 1.2 4 1.2

LOAD COMB 7 Generated Indian Code Genral\_Structures 3

1 1.2 2 1.2 3 1.2 4 -1.2

LOAD COMB 8 Generated Indian Code Genral\_Structures 4

1 1.2 2 1.2 3 1.2

LOAD COMB 9 Generated Indian Code Genral\_Structures 5

1 1.5 4 1.5

LOAD COMB 10 Generated Indian Code Genral\_Structures 6

1 1.5 4 -1.5

LOAD COMB 11 Generated Indian Code Genral\_Structures 7

1 1.5

LOAD COMB 12 Generated Indian Code Genral\_Structures 8

1 0.9

PERFORM ANALYSIS PRINT ALL

START CONCRETE DESIGN

CODE INDIAN

UNIT MMS NEWTON

CLEAR 25 MEMB 218 TO 233 235 TO 250 252 TO 282 284 TO 287 289 TO 294 - 297 TO 300 302 TO 320 322 TO 328 1263 TO 1265 1269 1271 TO 1275 1364 TO 1440 -

1442 TO 1460 1462 TO 1476 1565 TO 1641 1643 TO 1661 1663 TO 1677 -

1766 TO 1842 1844 TO 1862 1864 TO 1878 1967 TO 2043 2045 TO 2063 - 2065 TO 2079 2168 TO 2244 2246 TO 2264 2266 TO 2280 2369 TO 2445 -

2447 TO 2465 2467 TO 2481

CLEAR 40 MEMB 131 TO 159 161 TO 215 217 1276 TO 1363 1477 TO 1564 -

1678 TO 1765 1879 TO 1966 2080 TO 2167 2281 TO 2368

FC 30 ALL

FYMAIN 415 ALL

FYSEC 415 ALL

MAXMAIN 16 ALL

MAXSEC 10 ALL

MINMAIN 12 ALL

MINSEC 8 ALL

TRACK 2 ALL

DESIGN BEAM 218 TO 233 235 TO 250 252 TO 282 284 TO 287 289 TO 294 - 297 TO 328 1263 TO 1265 1269 1271 TO 1275 1364 TO 1476 1565 TO 1677 1766 -

1767 TO 1878 1967 TO 2079 2168 TO 2280 2369 TO 2481

DESIGN COLUMN 131 TO 159 161 TO 215 217 1276 TO 1363 1477 TO 1564 -

1678 TO 1765 1879 TO 1966 2080 TO 2167 2281 TO 2368

CONCRETE TAKE

END CONCRETE DESIGN

FINISH

**Estimation:**

Total volume of concrete = 661.74 CU.METER

|  |  |
| --- | --- |
| BAR DIA  (in mm) | WEIGHT  (in Staad) |
| -  8 | 142796.00 |
| 10 | 340.00 |
| 12 | 289856.00 |
| 16 | 172675.47 |
| TOTAL= 605667.50 | |

**Bending Moment:**

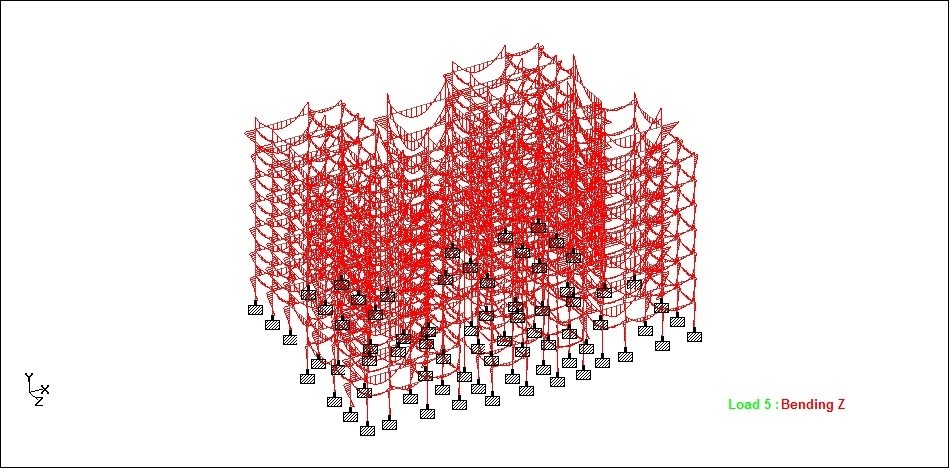


Fig 9.2 a showing bending moments of all the beams

**Shear:**

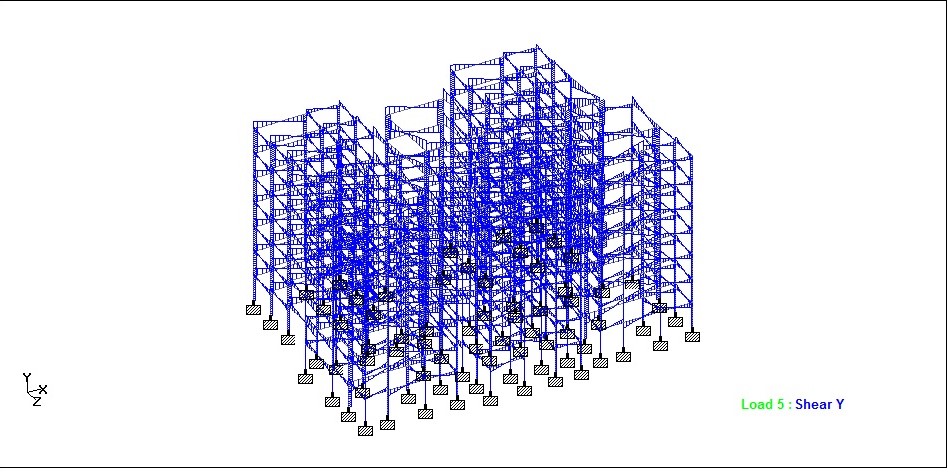


Fig 9.2 b Showing Shear Force of all the beams

**Conclusions:**

1. Designing using Software’s like Staad reduces lot of time in design work.

2. Details of each and every member can be obtained using staad pro.

3. All the List of failed beams can be obtained and also Better Section is given by the software.

4. Accuracy is improved by using software.

**References:**

1. Theory of Structures by ramamrutham for literature review on kani,s method

2. Theory of structures by B.C.punmia for literature on moment distribution method.

3. Reinforced concrete Structures by a.k. Jain and B.C. punmia for design of beams, columns and slab.

**Code Books**

1. IS 456-2000 code book for design of beams, columns and slabs

2.SP-16 for design of columns.