

COMPARATIVE STUDY ON DESIGN OF RCSTRUCTURE USING MIVAN TECHNOLOGY

Submitted in partial fulfilment of the requirements for the
award of

Bachelor of Engineering Degree in Civil Engineering

By

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DEPARTMENT OF CIVIL ENGINEERING

SCHOOL OF BUILDING AND ENVIRONMENT

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

APRIL 2021



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DEPARTMENT OF CIVIL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of M.SHANMUGASUNDARAM (Reg.No. 37200701) and S.GOKULNATH (Reg. No.37200704) who carried out the project entitled "**COMPARATIVE STUDY ON DESIGN OF RC STRUCTURE USING MIVAN TECHNOLOGY**" Under our supervision from December 2020 to March 2021.

Internal Guide

(Mrs. R. NIRMALA., M.E.)

Head of the Department

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

We, M.Shanmugasundaram (37200701) and S.Gokulnath (37200704) hereby declare that the Project Report entitled “**COMPARATIVE STUDY ON DESIGN OF RC STRUCTURE USING MIVAN TECHNOLOGY**” done by us under the guidance of Mrs.Nirmala.R is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

1.

2.

SIGNATURE OF THE CANDIDATES

DATE:

PLACE:

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. Devyani Gangopadhyay, B.Arch., M.T.P., Ph.D.**, Dean, School of Building and Environment and **Dr. S. Packialakshmi, M.E., Ph.D.**, and **Dr. R. Padmapriya, M.E., Ph.D.**, Head of the Department, Dept. of Civil Engineering for providing us necessary support and details at the right time during the progressive reviews.

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ABSTRACT

Rapid urbanization has resulted in a geometric increase in the housing demand, which cannot be fulfilled using conventional materials and methods of construction. The traditional or conventional method of construction for mass housing & high rise buildings is comparatively, a slow process and has limited quality control, particularly when a large size project is involved. It is therefore obligatory to work out a method or a scheme where the speed and quality of construction are controlled automatically by a systematic approach.

Therefore MIVAN technology is identified to be suitable for Indian conditions for mass housing construction where quality and speed can be maintained at a reasonably high level. MIVAN technology is highly suited to load bearing wall construction whereas traditional formwork consisting of plywood and timber is not suitable to the high pressures of fresh concrete on the wall. The floor slabs and concrete wall diffuses monolithic that layout the structural system in constant pour and form work.

In this project, we are going to compare the structural analysis and design of RCC building using MIVAN technology over conventional framed structure. Structural modeling & analysis will be done using structural software. RC design follows IS code adopting Limit state method.

TABLE OF CONTENT

CHAPTER NO	TITLE	PAGE NO
1	INTRODUCTION	
	1.1 GENERAL	1
	1.2 BACKGROUND	2
	1.3 CONSTRUCTION OF ALUMINIUM FORMWORK STRUCTURE	3
	1.4 PROS OF ALUMINIUM FORMWORK OVER FRAMED STRUCTURE	6
	1.5 LIMITATION OF ALUMINIUM FORMWORK STRUCTURE	7
	1.6 VARIOUS CONSTRUCTION TECHNIQUES OF MIVAN STRUCTURE	7
	1.6.1 PINS AND WEDGES	7
	1.6.2 ELECTRICAL BOARDS AND PLUMBING LINES	8
	1.6.3 CONCRETING	9
	1.6.4 CURING	10
2	LITERATURE SURVEY AND METHODOLOGY	
	2.1 GENERAL	11
	2.2 REVIEW OF LITERATURE	11
	2.3 METHODOLOGY	16
3	PLANNING AND LOAD CALCULATION	
	3.1 GENERAL	17
	3.2 PLANNING	17

	3.3 LOAD CALCULATION	20
	3.4 LOAD CASES	21
	3.5 LOAD COMBINATION	22
4	STRUCTURAL MODELING AND ANALYSIS	
	4.1 GENERAL	23
	4.2 SOFTWARE USED	23
	4.2.1 AutoCAD	24
	4.2.2 STAAD	
	4.3 STRUCTURAL ANALYSIS OUTPUT FOR FRAMED STRUCTURE FORM STAAD	25
	4.4 STRUCTURAL ANALYSIS OUTPUT FOR ALUMINIUM FORMWORK FROM STAAD	31
	4.5 R.C.C ROOF SLAB DESIGN FOR FRAMED STRUCTURE	35
	4.5.1 R.C.C BEAM DESIGN FORM FRAMED STRUCTURE	46
	4.5.2 R.C.C COLUMN DESIGN FOR FRAMED STRUCTURE	51
	4.5.3 DESIGN OF FOUNDATION FOR FRAMED STRUUCUTRE	54
	4.5.4 R.C.C ROOF SLAB FOR MIVAN STRUCTURE	65
	4.5.5 R.C.C WALL DESIGN USING STAAD PRO	77

	4.5.6	R.C.C WALL FOOTING OF MIVAN STRUCTURE	81
	4.5.7	COMPARSION OF FRAMED & MIVAN STRUCTURE	90
5		CONCLUSION	
	5.1	GENERAL	91
	5.2	CONCLUSION	91
	5.3	REFERENCES	92

CHAPTER 1

INTRODUCTION

1.1GENERAL

Construction company from Europe as been aluminium formwork system called “Mivan”. manufacturing of such formwork systems started in malaysia in 1990 the Mivan Company Ltd. More than 30,000 sq m of consumed for formwork operation. By using Mivan number of building are constructed very economical and satisfactory for ICE.

Many countries such as Europe, Gulf Countries, Asia and all other parts of the world. This method is useful for constructing large number of houses within short time using room dimension walls as well as the slabs build in one continuous pour on concrete. The methods of hot air curing / curing compounds help with the removal if forms. This method helps to complete the construction of building on time and hence result into more accurate. well – maintained and good quality products at optimum money and in shortest time period. The concrete wall and floor slabs cast monolithic provides the structural system in a stable manner. Bigger room sized forms for walls and floors slabs are rise at site. These forms are made powerful and sturdy, manufactured with precision and easy to handle. large number of repetitions around the world. RMC batching plants checks with the strict quality control and convey it to site with help of transit mixers.

1.2 BACKGROUND

Construction is one of the significant sectors of Indian economy and is an integral part of the development. Today India's urban population is the second largest in the world and its future development leads to increased demand for housing to cope with this problem. India desperately needs to plan for acquisition of land and rapid creation of dwelling units. Construction is a complex process involving basically the areas of Architectural planning, Engineering & Construction. According to the Federation of Indian Chamber of Commerce and Industries (FICCI), keeping in view the existing housing crisis, the country shall need addition of more 2.5 million new dwelling units annually". In sight of retaining the huge task of giving moderate shelter to masses and cost effective technology been a larger significance. The current tensivity on Indian economy has been order for proper construction computing which could lead to speed in construction and economy. Hence 10 percentage is the overall cost of housing construction differentiate to the cost of traditional housing.

The speed of construction work want a higher attention for big scale projects. It is not required for the larger turnover of tools and funds and it helps reduces the cost of the house and its helpful for reaching the goals of the national objective to generate a huge stock of control within the time limit. Many countries such as Europe, Gulf Countries, Asia and all other parts of the world. This method is useful for constructing large number of houses within short time using room dimension walls as well as the slabs build in one continuous pour on concrete. The methods of hot air curing / curing compounds help with the removal if forms. This method helps to complete the construction of building on time and hence result into more accurate. well – maintained and good quality products at optimum money and in shortest time period. The concrete wall and floor slabs cast monolithic provides the structural system in a stable manner. Bigger room sized forms for walls and floors slabs are rise at site.

These forms are made powerful and sturdy, manufactured with precision and easy to handle. large number of repetitions around the world. RMC batching plants checks with the strict quality control and convey it to site with help of transit mixers.

Before concreting the frames of windows, doors , ducts, Staircase flights and jails are placed in their places. Pre- fabricated items are also integrated into the structure. This proves to be a added benefit as compared to other modern construction techniques.

Premium quality of Mivan Formwork panels ensure firmness of dimensions. In the removal of the formwork shape a premium quality concrete finish and the result will be more accurate tolerances and verticality. The high tolerance of the finish means hence plastering is required.

1.3 CONSTRUCTION OF ALUMINUM FORMWORK STRUCTURE



Fig.1.1 Aluminum formwork slab structure



Fig.1.2 Aluminum formwork wall structure

USES OF ALUMINUM FORMWORK STRUCTURE (MIVAN)

- The 3S construction includes Speed, Strength, Safety (3S – System of Construction).
- Column and beam are eliminated construction.
- Walls and slabs are created in one function.
- Especially planned, simple to handle light weight pre-engineered aluminum forms.
- Fix and assemble the position of shuttering.
- Merge concrete of the walls and slabs together

BENEFIT OF ALUMINIUM FORMWORK STRUCTURE (MIVAN)

- In distinction with most of the contemporary, formwork related to machine and tools does not turn upon heavy lifting tools and can be handle by unskilled labors.
- Construction is self-reliant and is specially suitable for huge magnitude construction of respective nature at one project site.
- By using this method best quality with exact dimensions for all the door and windows, meet at the right angle of wall to wall, wall to ceiling, etc., concrete surface finishes are good for painting directly without including plaster.
- Structure components are resistant and can be used various times without damaging the status of the surface.
- Construction of monolithic loads of slabs and bearing walls in concrete that gives essentially higher-level quality with less constructions joined contrast to the beam slabs construction and conventional column mixed with filter brick work or block work eventually covered by plaster.
- In sight of the four day cycle of shed the floor together with all slabs as against 14 to 20 in the conventional method, complete structure of RCC is available for successive finish trades much quicker, succeeding in a saves upto 10 to 15 days per floor in the overall working period.
- Wall are created by monolithic and floor slabs doesn't require any plasters finish. Hence the time taken by plastering and conventional method for construction of walls and is rescue.
- As totally finished structural frame is made accessible in one stretch for eventually – finishing things, steady progress can be arranged by ensuring, each dealing, raising the scope employing the labor force which help to complete the work on time.

- As the structure ,accepted a kind of “Assembly line production” phase – wise finishing in category of buildings can be design to reach the goals before time.

1.4 PROS OF ALUMINUM FORMWORK STRUCTURE (MIVAN) OVER FRAMED STRUCTURE

- Rise stability: The stability of a whole concrete structure is more than conventional brick bat masonry.
- Minimum quantity of joints thereby decreases the discharge and intensify the stability.
- Seismic resistance: The box type design gives more seismic resistance to the structure.
- Carpet place - shear walls are thin thus area get expanded.
- Even finishing of wall and slab- polished finish of aluminum feasibly view vividly on walls.
- Condition of building – Premium quality of concrete is used.
- Insignificant conservation – Power increase of concrete doesn't require any conservation.
- Quicker achievement– Matchless erection speed can occur due to light weight of forms.
- Physical labours - Few labour is required for carrying formworks.
- Untangled substructure design occurs to in line load distribution.

1.5 LIMITATIONS OF ALUMINIUM FORMWORK STRUCTURE (MIVAN)

- Tiny sizes finishing lines are seen on the concrete surfaces.
- Concealed services become tough because of small thickness of elements.
- It requires stable planning as well as uniform promotion to be cost effective.
- Corrections are not viable as all segments are cast in RCC.
- Huge amount of work is required to be more efficient that is at least 200 repeat of the forms should be viable at work.
- Box -type design shrinkage cracks which are seen.
- Due to of shear walls Heat of Hydration is high.

1.6 VARIOUS CONSTRUCTION TECHNIQUES OF MIVAN STRUCTURE

The extensive benefit as differentiate to other modern building ideas in Mivan structure is constitution of Formwork panels that ensures uniformity of dimensions of walls and slabs. The elimination of the formwork shape of a good standard concrete finish is process to exact liberality.

1.6.1 Pins and Wedges

Pins actually rearrange the fixed its top diameter of head is 12 mm and its tail is (6-8) mm with a rectangular hole of 2 mm thickness. Wedge is of thin iron sheet mainly take after the front image of frustum of cone. Its top proportion is 2 cm and base is of 1 cm. When the form is placed with wall ties with the holes, pin is placed and wedges are drilled using wooden hammer. Wall ties with grease and yellow cover finds its require after concreting. Once the concreting is completed and cured wall ties are removed by pulling them out. The cover which is placed on the central portion of the wall tie remains inside and the gap is filled with

cement mortar.



Fig.1.3 Pins and Wedges

1.6.2 Electrical boards and Plumbing lines

The RC walls in a construction behaves like column with no flexibility to drill and hence it becomes most needed step to place the electrical lines and sewer lines or plumbing.





Fig.1.5 Plumbing lines in wall

1.6.3 Concreting

The ordering of the form work that is wall ties, pins and wedges with electrical lines are set totally up to an accuracy of 1 mm, exactness is ready so that no concrete will discharge out of the form work. The dimension of mass should be 10mm or 12mm so it can move freely inside the wall. Robust sand or sea sand is used. Admixtures basically used for self-compacting nature. Gilinium and Reobuild are two admixtures which are used most productive in the RC walls construction. These admixtures are generally mixed up with design mix in a transit mixer. Once the mixing is done exactly for some duration of time, this mixture of concrete is pumped using pipes. After arranging the forms correctly, concrete pouring is done using the hydraulic drive. The self-compacting nature it as , it doesn't require any additional compaction, but still pin vibrators are basically used to place in the wall to vibrate the concrete. Proper compaction it is left for one day to set in its position.

1.6.4Curing

After day one of curing of the wall, form of removal is done as well. Once the form is finished successfully, the removal of an even finish of wall is contained, which doesn't need any plastering. The wall which is now completed with the form of removal is cleansed with regular water. Cleansing of walls takes 3 to 7 days. For better curing, decrease the heat of hydration with a white coating with lime powder.

CHAPTER 2

LITERATURE SURVEY AND METHODOLOGY

2.1 GENERAL

This is made and planned to do by reviewing some of the literature. The importance of reviewing the literature is to analysis the research works related to the study.

2.2 REVIEW OF LITERATURE

This literature review will be the implement by which research is viewed as a growing process. That makes it as a integral component of the scientific process.

Patil et al (2014), Mivan is an aluminum formwork system invented by one of the construction company from Europe. Mivan is an looming technology which has entitle and impulse the mass construction projects all over the world. In this project, we have talked about the pioneering and yet pragmatic approach of this technology with providing of speed, quality, financial incentives and construction aspects which is required for a successful housing project, with the help of a case study of a renowned company. This journal also includes comparison of aluminum formwork technology and conventional system. This differentiate reveals the reduced total cost. Other aspects include its, box type construction which proves much lead as far as earthquake resistant structure is considerable.

Shankar Bimal Banerjee et al (2015), The paper tries to give brief idea to the readers, about mivan technology, it is a precision-engineered formwork fabricated in Aluminum and the uses of mivan,

can save time and money for a multi crore project.

The most effective way of the construction of high, medium and low raise mass housing R/C structures. It is a precision-engineered formwork fabricated in Aluminum. Monolithic pouring Walls & beam and columns slabs are poured together. Speed - convince a disciplined & systemized way to construction, which establish a daily work cycle, the core of the productivity. The overall work cycle, that can reach 4/5 day per floor outputs to suit your project needs. It is flexible in design and can for many architectural or structural configurations, such as stairs, bay windows, curved features, etc.

Kalithasan et al (2016),The aluminium formwork construction method is 25 year older methods in Europe countries. But this method of construction is new type in India. This method is fastest construction compare another type. Our project is to compare than design, construction period and estimation. In Aluminium formwork all members are constructed using concrete, which consist of only walls and slab. Framed structure is beam, column, and slab. The wall is 250mm thick brickwork. This project selects same plan of structure and compare structural design, estimation and project duration in aluminium formwork and conventional method.

Mrunal et al (2018), Construction of mass housing is getting more importance, as the requirement of houses is rising day by day. Due to growing population in India, the new construction technique should be adopted for the faster construction procedure. Mivan technology or Box type of construction is fastest construction techniques for mass housing. In this technique beams and columns are replaced by reinforced concrete wall system. The differentiate between two of the structural systems i.e. Conventional structural system and Frameless R.C.C structural system is done. The E-TABS Software is used for modeling, analysis and design¹² of both structural systems from G+1 to G+5for all four zones. IS 1893 (2016) part- I is used for seismic

analysis. Lightweight Foam Concrete is used in Frameless R.C.C structural system.

Arvind Dewangan et al (2015), The technology has been used large-scale in other countries such as Europe, Gulf Countries, Asia etc.. MIVAN technology is suitable for constructing large – scale of houses within short time using room size forms to construct walls and slabs in one follow through pour on concrete. Early removal of forms can be pulled off by hot air curing/curing compounds. This provides fast construction, for example two flats per day. All the activities are planned in assembly line manner and hence final result will be more accurate, well – controlled and production at optimum cost and in possible time period. This paper reveals about importance of Mivan.

Tilak bhattarcharya et al (2007), The duty of housing due to the rising population of the country is becoming increasingly monumental. In other words of technical capabilities to face this challenge, the potential is immense; it only needs to be wisely exploited. Civil engineers not only build but also enhance the intensity of life. Their imagination and technical skill help to plan, design, construct and operate the facilities necessary to life. It is key for to gain and tackle the potent and versatile construction tools. Traditionally, construction firms all over the world have been slow to adopt the innovation and changes. Contractors are a conservative lot. It is required to analyze the depth of the problem and find effective solutions. MIVAN serves as a cost potent and affordable tool to solve the problems of the mega housing project all over the world. MIVAN aims to maximize the use of modern construction techniques and tools of entire project.

Ashok Mandal et al (2006), Application of modern scaffolding and formwork system has assumed an important position in modern civil engineering and construction work. Metallic scaffolding and shuttering materials are fast replacing age-old timber counterparts for obvious reasons. Although, such an equipment¹³ is widely used, it is surprising to

find that even professional engineers actually using these materials, are not very clear in perception of the various terms used in the trade. Now the situation has changed with respect to the use, application and importance of the scaffolding & formwork.

This change can be partly attributed to the following:

- The nature of construction as well as repairs / maintenance has become complicated and hence conventional timber scaffolding / formwork cannot cope up with the changing needs
- The source of conventional formwork/ scaffolding which is mainly timber, a natural resource, is fast dwindling and there is a growing awareness about environment protection measures.
- The safety of workers is a cause for concern for all industries. Hence, the increasing emphasis is on safer and dependable metallic / manmade formwork and scaffolding.

Sharmin reza Chowdhury et al (2012), Finite compound Modeling now a day is an essential approach in analyzing and replicate civil engineering problem. In this paper an attempt is made to apply the finite compound modeling in analyzing and survey the behavior of shear wall with opening under seismic load actions. In modern tall buildings, shear walls are commonly used as a vertical structural element for resisting the lateral loads that may be induced by the effect of wind and earthquakes. Shear walls are by and large located at the sides of buildings or arranged in the form of core that houses stairs and lifts.

Sinha et al, This literature details the design specifications and methods of reinforced concrete elements especially one way slabs, two way slabs, singly reinforced beams, doubly reinforced beams, short column, long column and footings, etc.,

Genc & Altun., Design procedure have been initiated rather of

traditional designing coping with multiplex design problems of modern times. Particularly in the area of architectural technology in words of describing building components, with the help of "design methods" is an important part in the design process.

Toklu et al, This journal deals with optimization is now gaining importance and enabling engineers to solve problems which were very difficult to solve by the accustomed methods. This means that optimization is enlarging its range of applicability from design part to analysis part.

2.3 METHODOLOGY

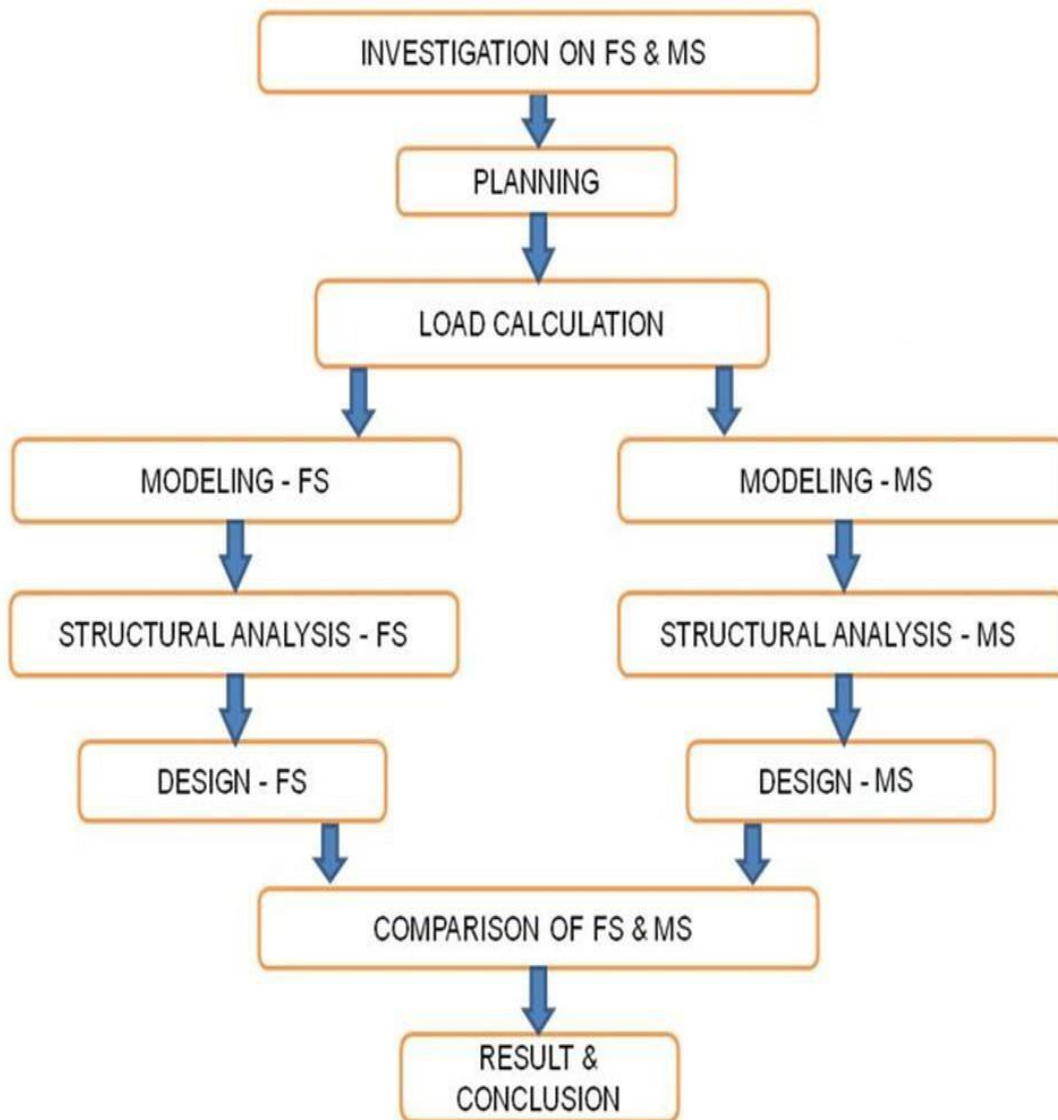


Fig.2.1 Methodology

CHAPTER 3

PLANNING & LOAD CALCULATION

3.1 GENERAL

This chapter gives the planning and load calculation of the building.

3.2 PLANNING

The planning of the construction building is drawn with the help of AutoCAD software.

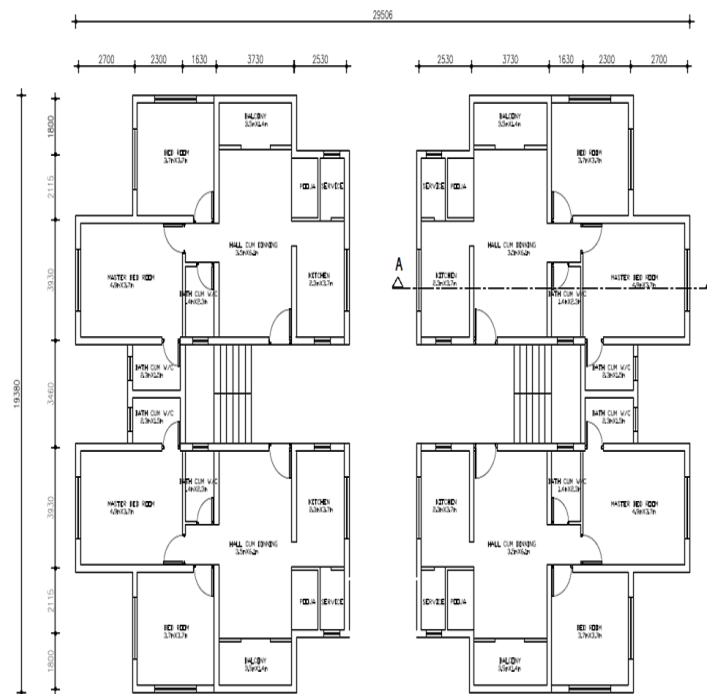


Fig.3.1 System of the building

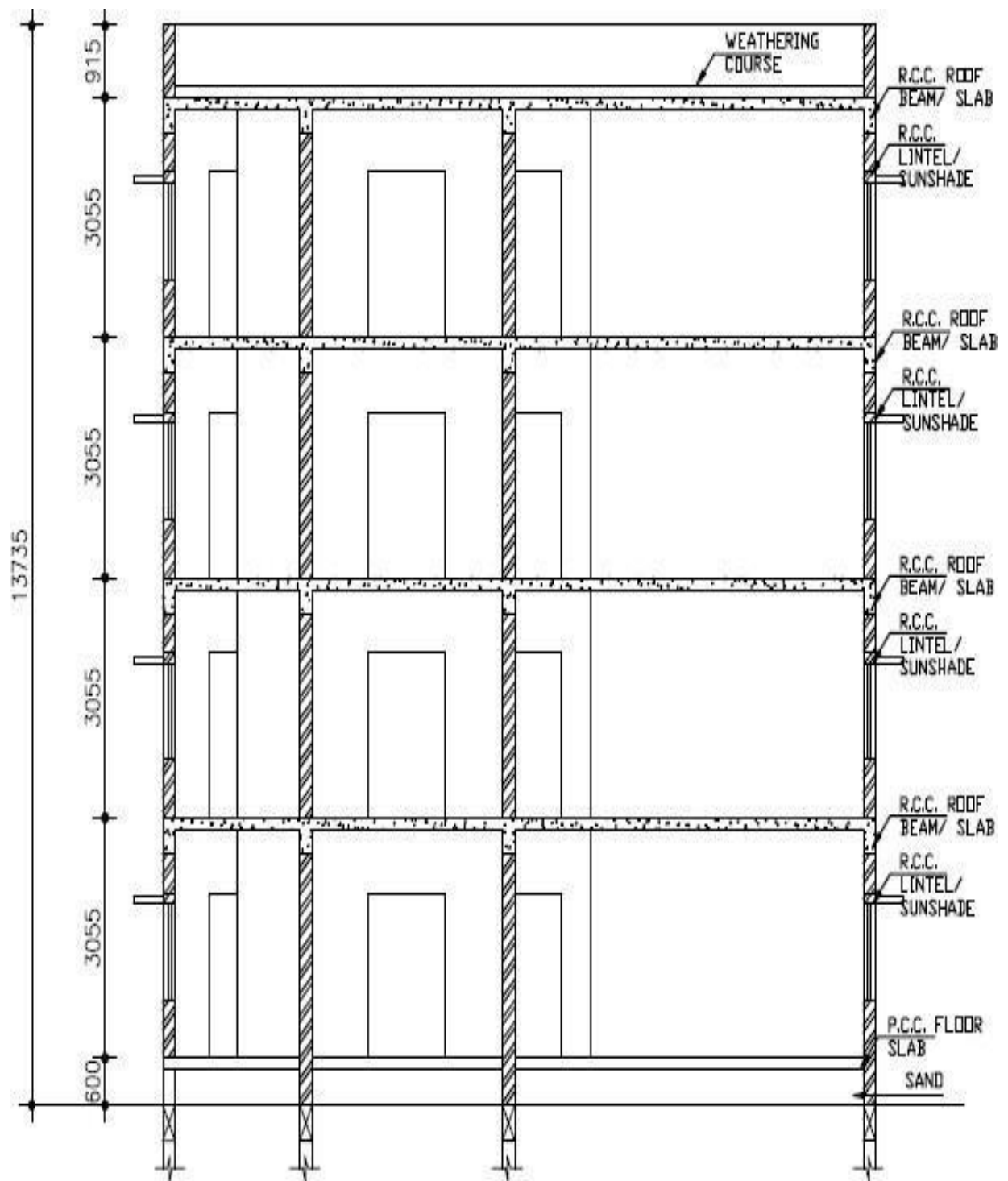


Fig.3.2 Sectional view of Framed structure

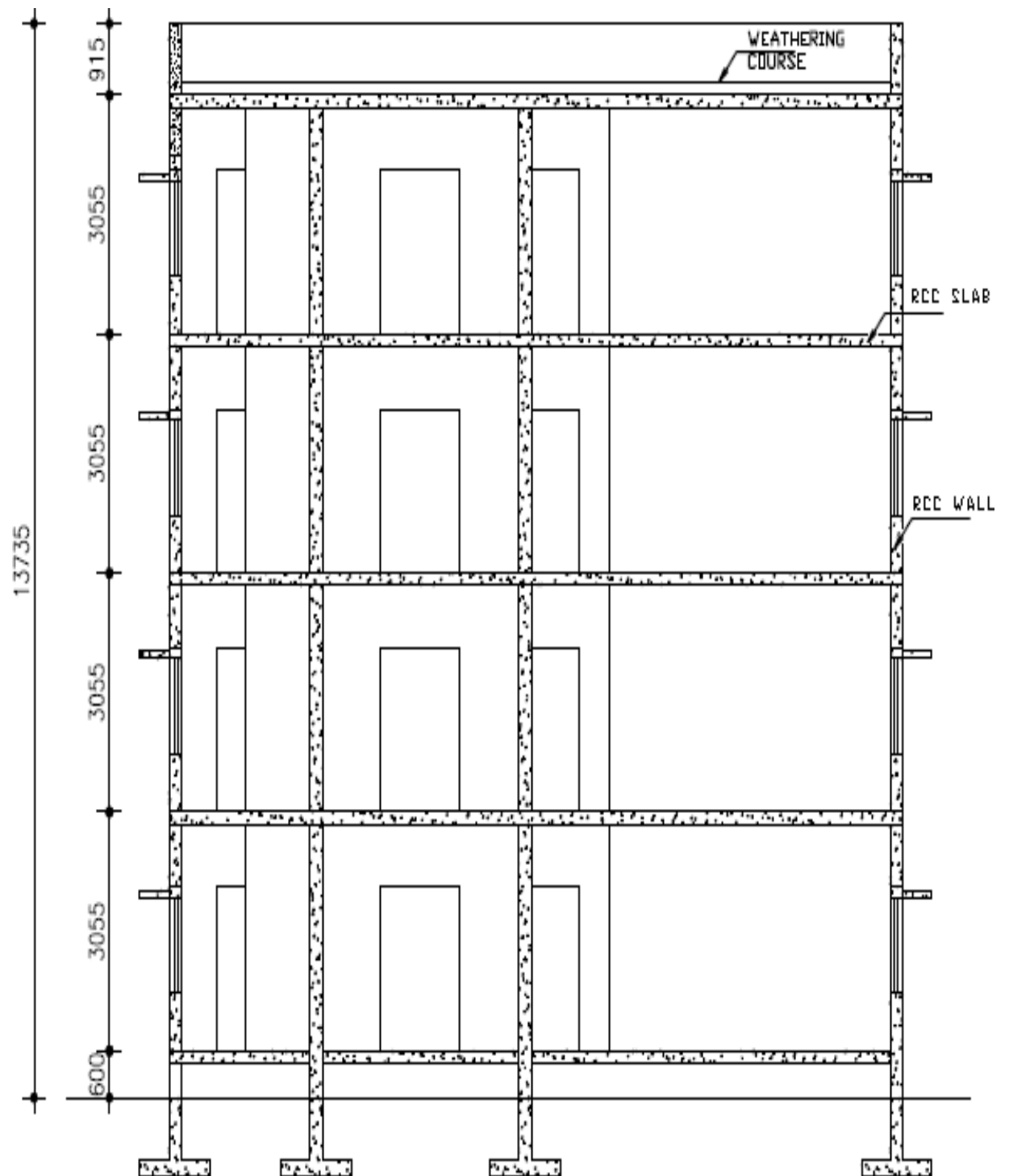


Fig.3.3 Sectional view of structure

3.3 LOAD CALCULATION:

MATERIAL:

Grade of reinforcement : Fe415
Grade of concrete : M25
Density of concrete : 2500Kg/m³

LOADING:

Dead load:

Partition wall and other external walls, floor finish etc., as per the provisions of IS: 875-1987(part I)

Superimposed load:

As per the provisions of IS: 875- 1987(part II)

Wind load:

As per the provisions of IS: 875-1987(part III)

CODES:

Concrete design : IS: 456-2000
Load calculation (DL, LL & WL) : IS: 875-1987
Design review : SP16
Detailing : SP34

PARTIAL SAFETY FACTORS:

Load factors:

For dead load = 1.50
For live load = 1.50

The above partial safety factors are taken from IS: 456-2000.

3.4 LOAD CASES:

Dead load:

At any floor level except ground floor (per m width)

Load from slab $= 0.15 \times 25 = 3.75 \text{ KN/m}^2$
(assuming 150 thickness)

Partition walls $= 0.23 \times 2.70 \times 20$
 $= 12.42 \text{ KN/m}$

Partitions (Terrace floor) $= 0.23 \times 0.90 \times 20$
 $= 4.14 \text{ KN/m}$

Floor finishes $= 1.00 \text{ KN/m}^2$

Floor finishes (Terrace floor) $= 2.00 \text{ KN/m}^2$

Live load:

Uniform distributed load (UDL) $= 3.00 \text{ KN/m}^2$

Wind load:

The wind load can be derived using by the Indian standards IS: 875(Part 3)-1987. The basic wind speed corresponding to Chennai region is taken from the code IS:875 (Part 3)-1987. The design wind speed is modified to induce the effect of risk factor (k_1), terrain coefficient (k_2) and local topography (k_3) to get the design wind speed V_z .

$$V_z = k_1 k_2 k_3 V_b$$

Wind pressure P_z at any height above mean ground level is $0.6 V_z^2$.
The coefficient 0.6 in the above formula depends on a number of factors

and mainly on the air temperatures.

$$P_z = 0.6V_z^2$$

3.5 LOAD COMBINATIONS:

- DL + LL
- DL + WL (+X)
- DL + WL (-X)
- DL + WL (+Z)
- DL + WL (-Z)
- DL + LL + WL (+X)
- DL + LL + WL (-X)
- DL + LL + WL (+Z)
- DL + LL + WL (-Z)

CHAPTER 4

STRUCTURAL MODELING AND ANALYSIS, DESIGN

4.1 GENERAL

This chapter discuss about the structural modeling and analysis the integrity of the building.

4.2 SOFTWARES USED

4.2.1 *AutoCAD*

In our projects all the drawing related works are done using AutoCAD software. It is a frequently used software system that allows the user to produce both 2- dimensional and 3-dimensional drawing and models. This offers a series of drawings to help you learn the 2D drawing techniques. Most of the 2D commands in new Releases have not changed since Release 2010. For those who are familiar with computers technology, learning AutoCAD will be easy, simply because you are aware of the typical response format and the structure of your system.

4.2.2 **STAAD**

STAAD is the structural software for model development, analysis, design, verification and visualization of all aspects of structural engineering. STAAD performs study and design of structure. The process and analysis are done simultaneously. The input format can be created through CAD based input generators. The order consist steps or big data to study and plan . STAAD Most general application will be the space structure can study both plate/shell elements and frame. Any type of structure such as plane, truss, floor structure and space structure can be analyzed by STAAD. Most of all implementation will be the space structure,

which is holographic, framed structure with loads that can be placed in any plane.

A structure command while integration for components may be given with the component tendency command. STAAD allows specifications for supports with different releases.

Loads on the figure can be mention as joint load, portion load etc., STAAD can also produce figure of the own weight and give out member loads in analysis. Joints loads forces and moments can be applied at any joint of structure. Positive force act in the positive coordinate directions. Portion loads may be uniformly give out load, focus loads and linearly differing loads. A floor is put through to a uniformly distributed load. Area load command can state the unit load per unit square area for division. The program will compute the tributary are for these members and gives proper member loads.

4.3 STRUCTURAL ANALYSIS OUTPUT FOR FRAMED STRUCTURE FORM STAAD

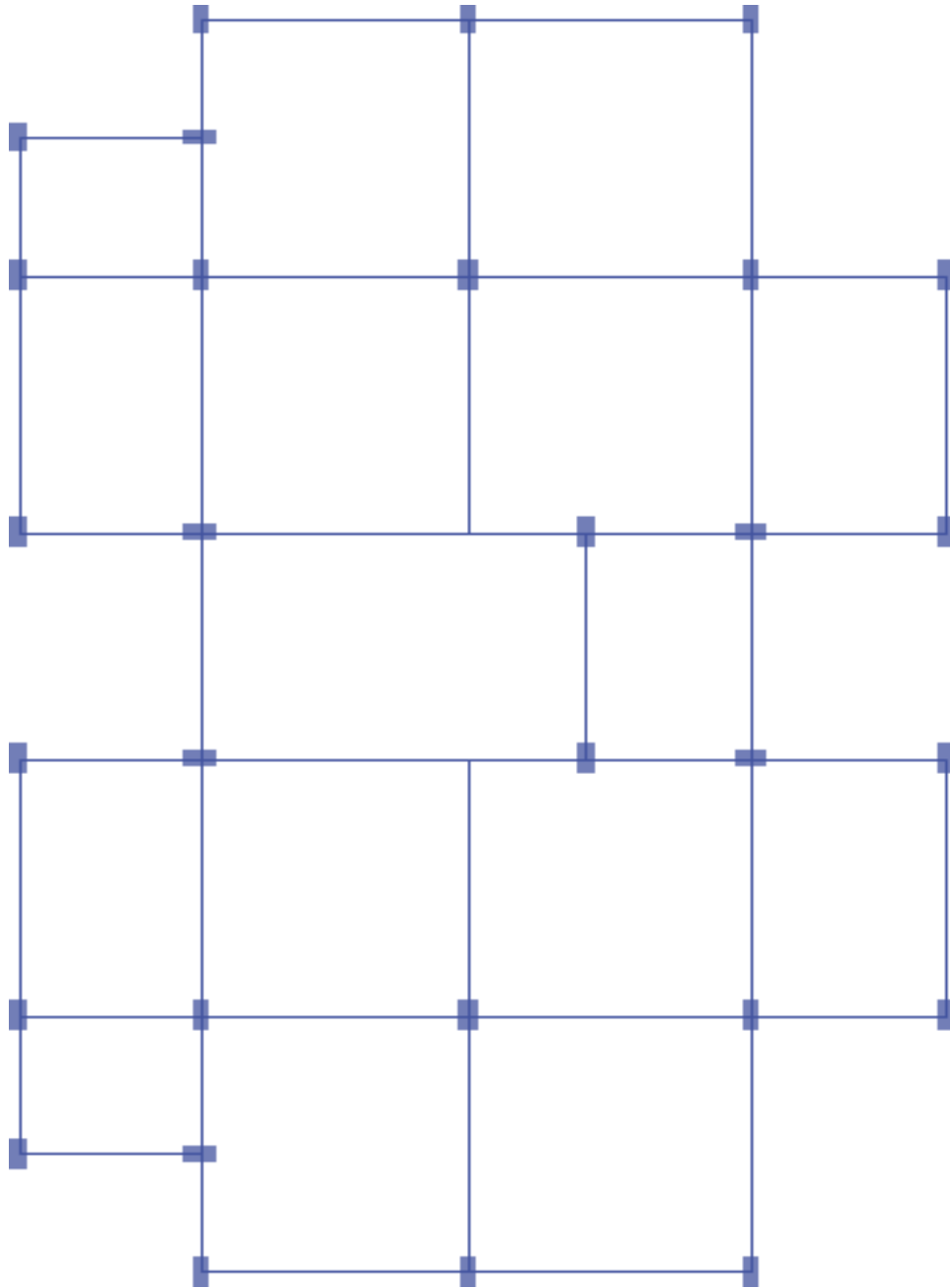


Fig.4.1 Plan view

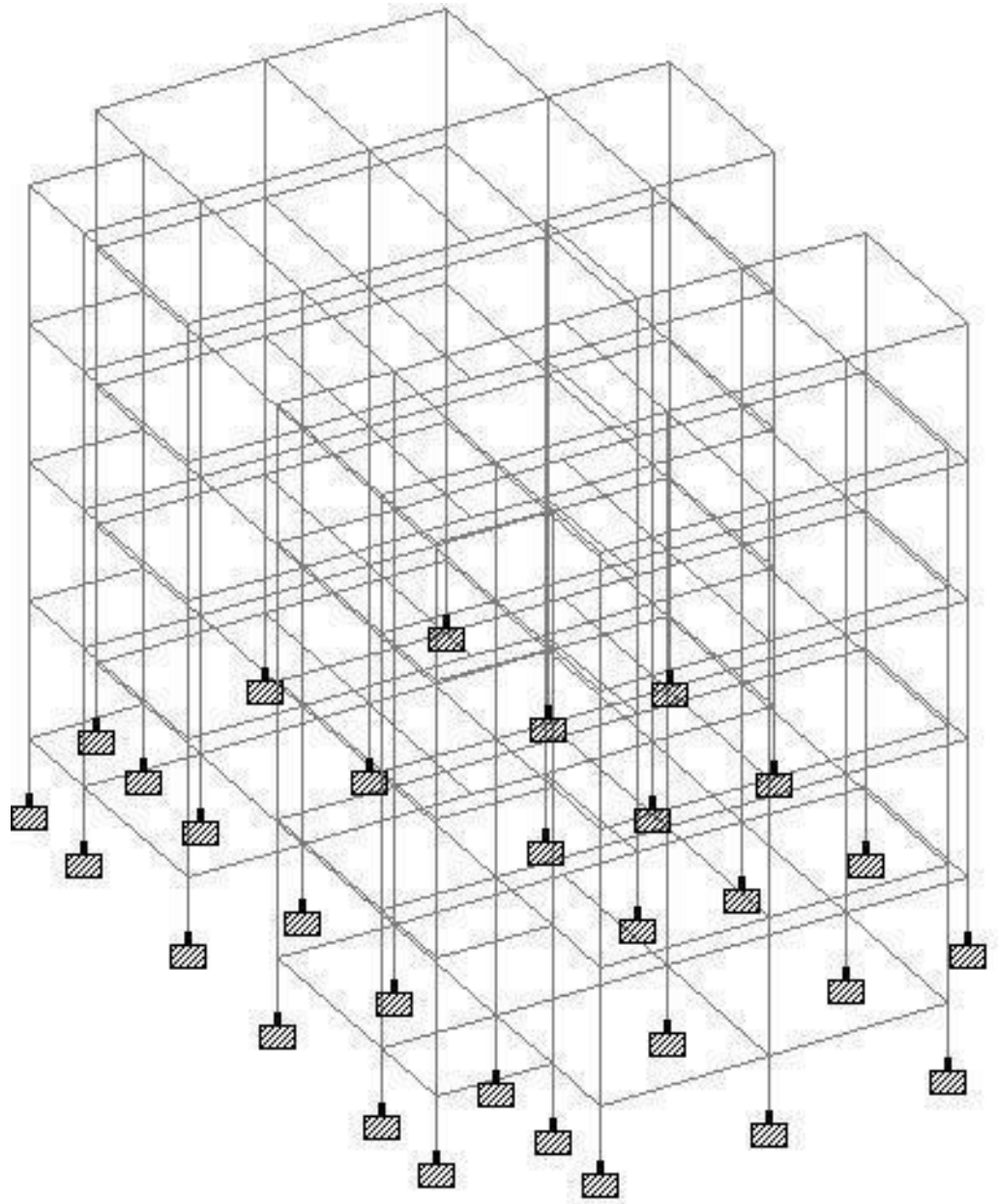


Fig.4.2 Isometric view

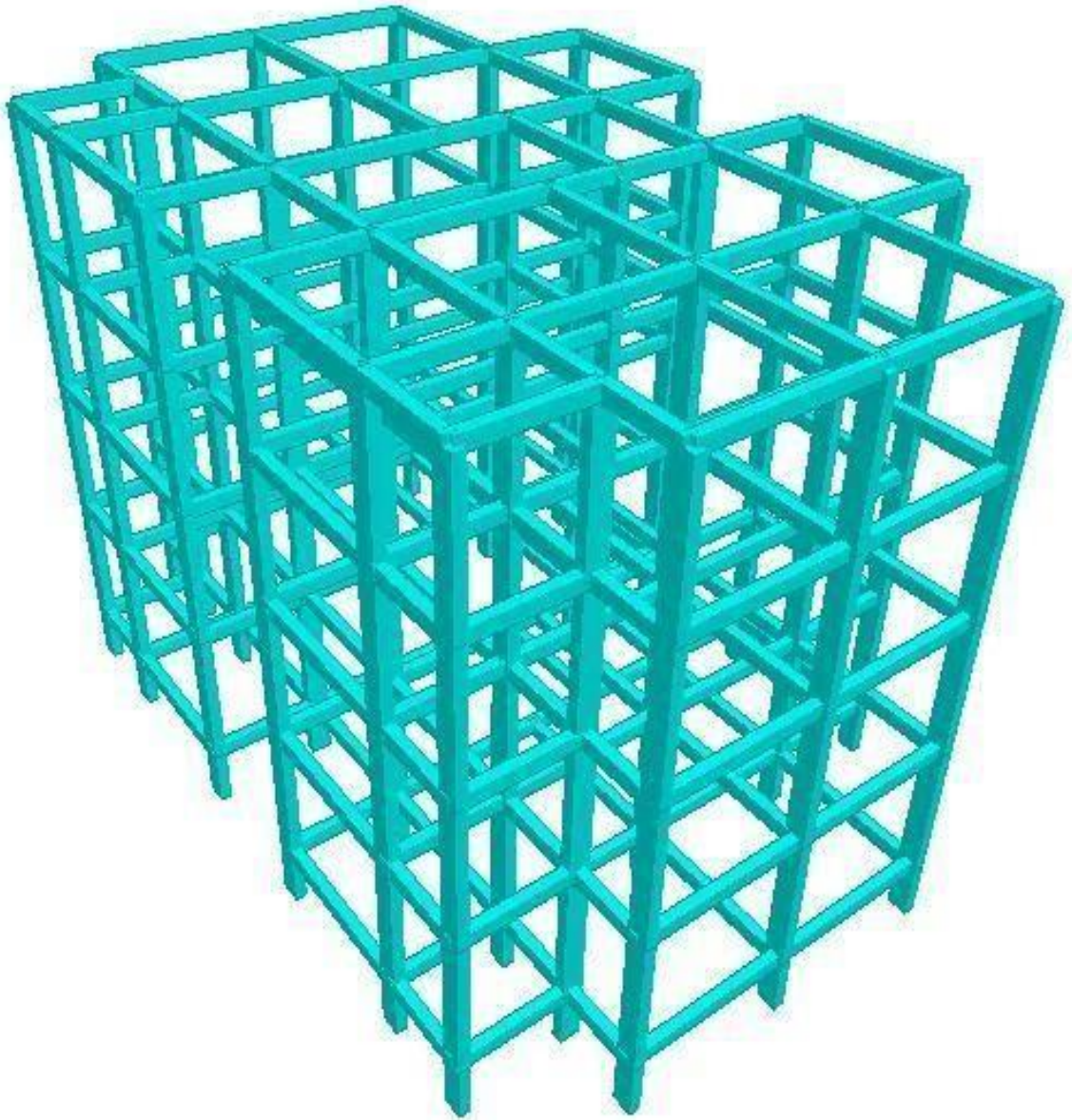


Fig.4.3 3D Rendered view

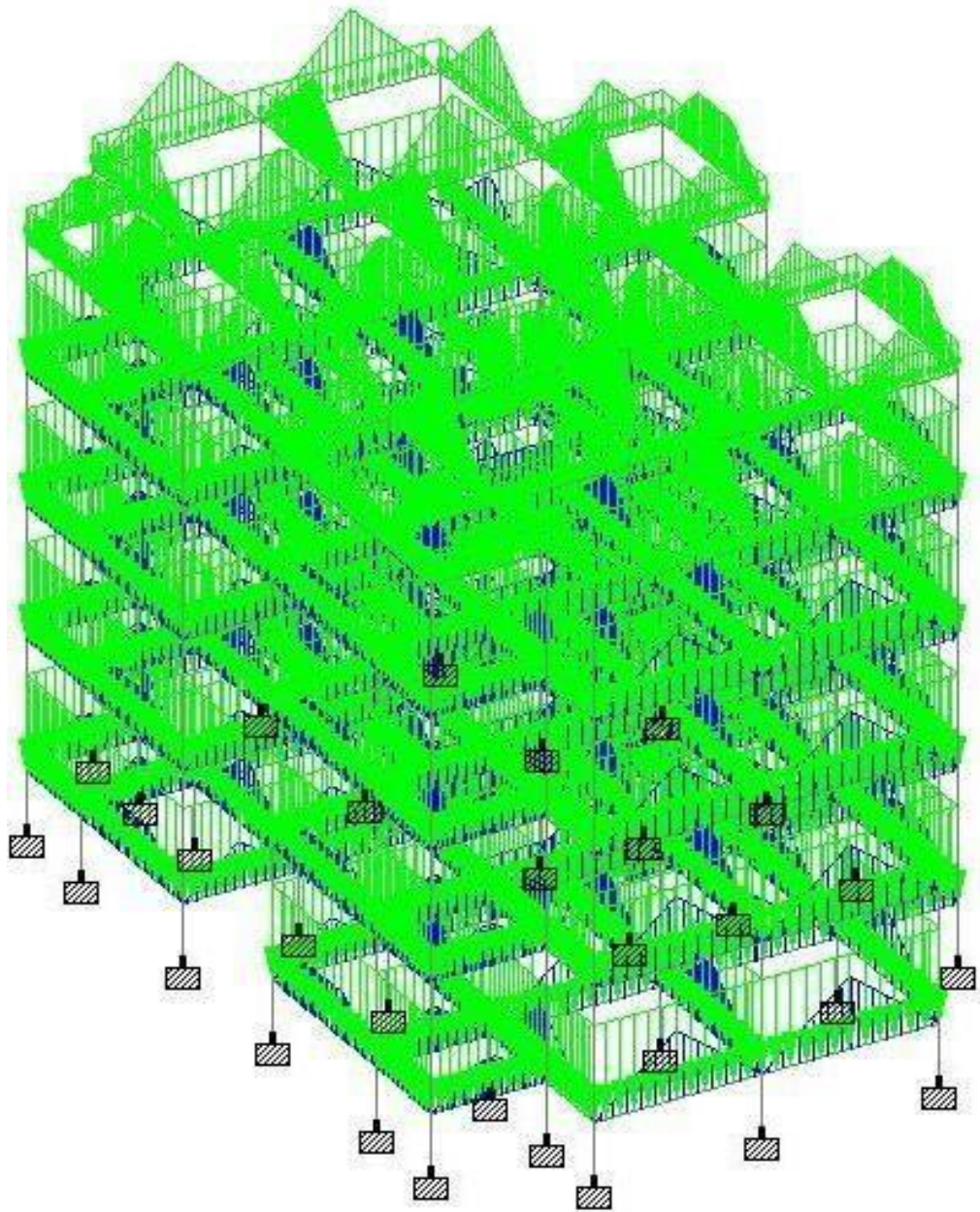


Fig.4.4 loading diagram

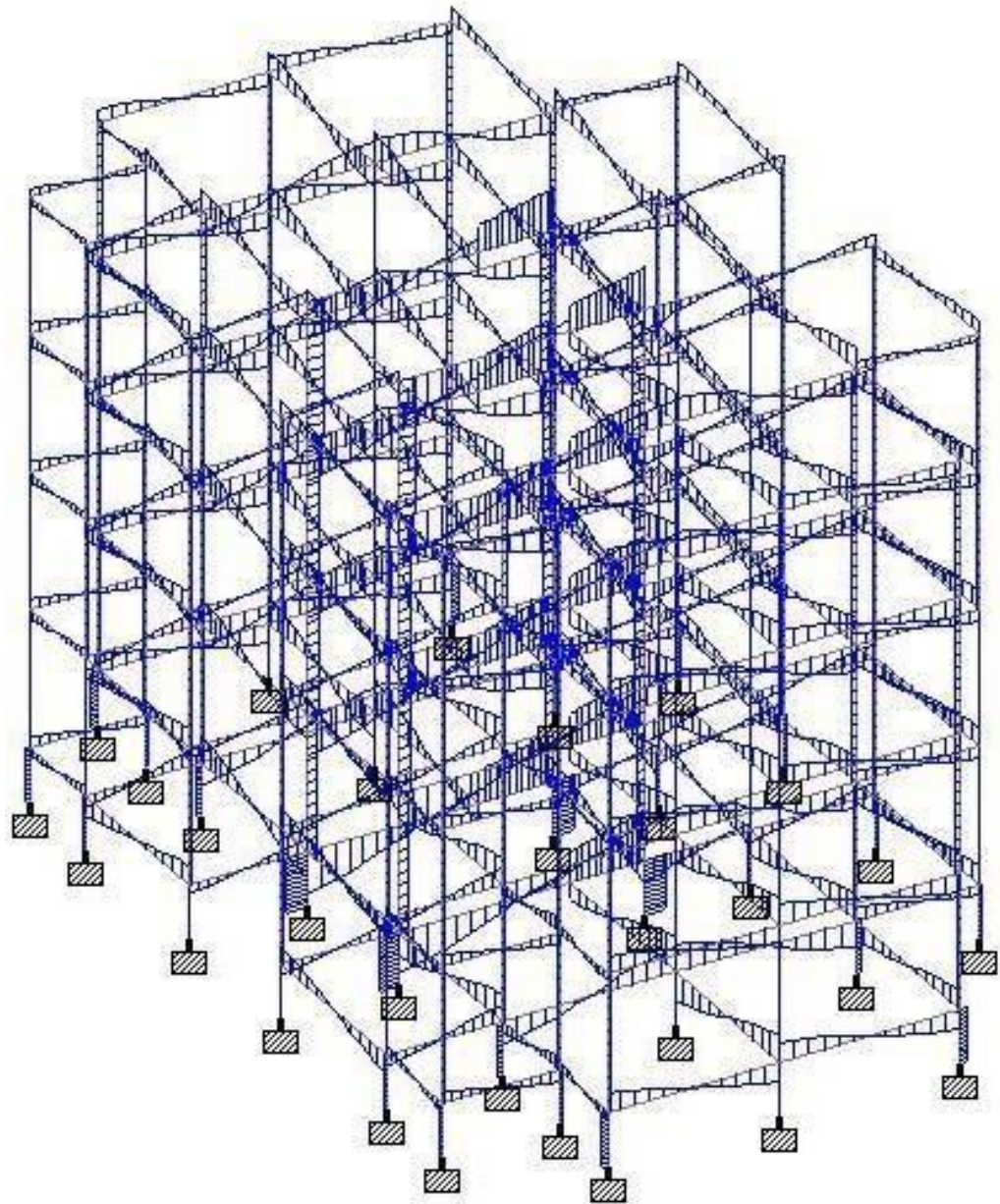


Fig.4.5 Shear force diagram

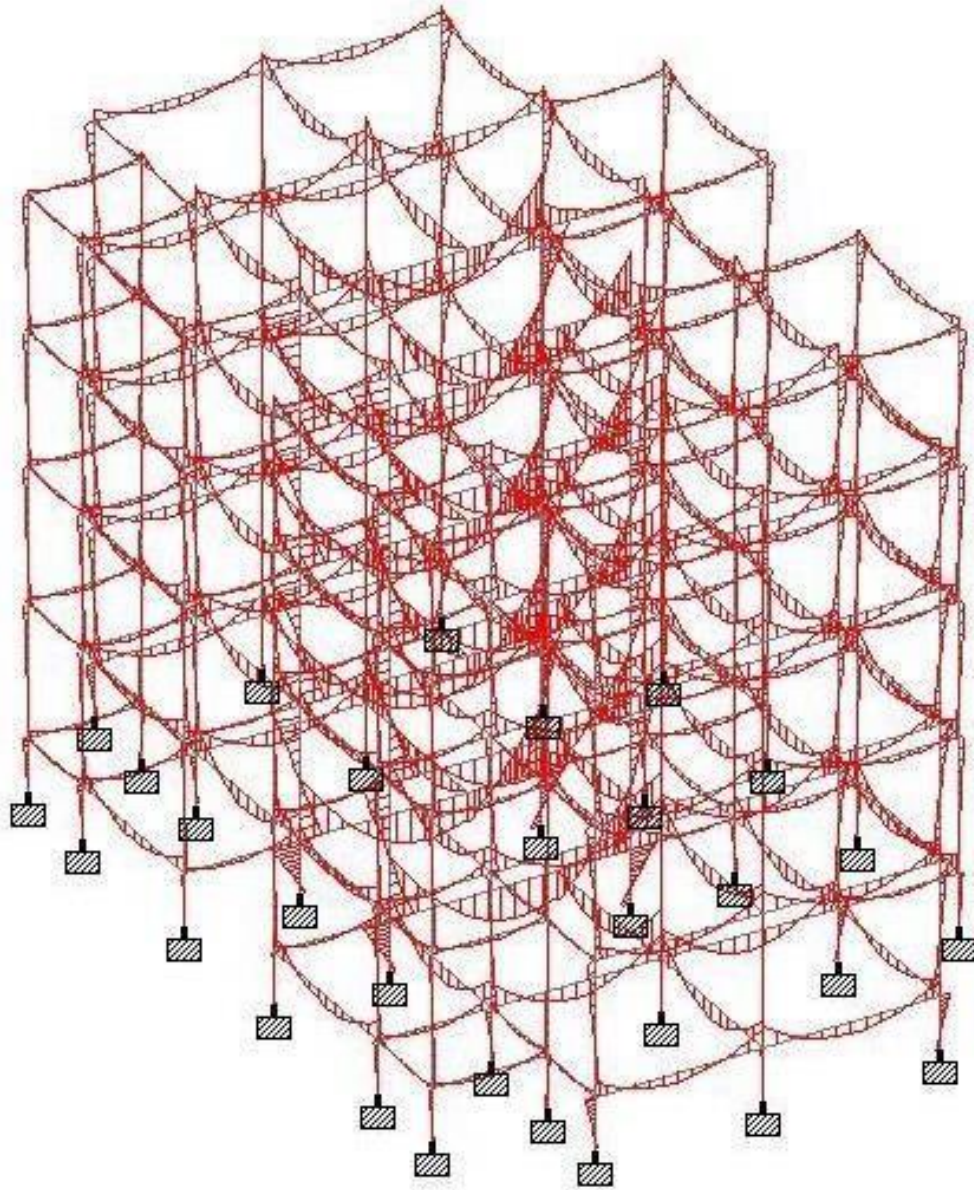


Fig.4.6 Bending moment diagram

4.4 STRUCTURAL ANALYSIS OUTPUT FOR ALUMINUM FORMWORK STRUCTURE (MIVAN) FROM STAAD

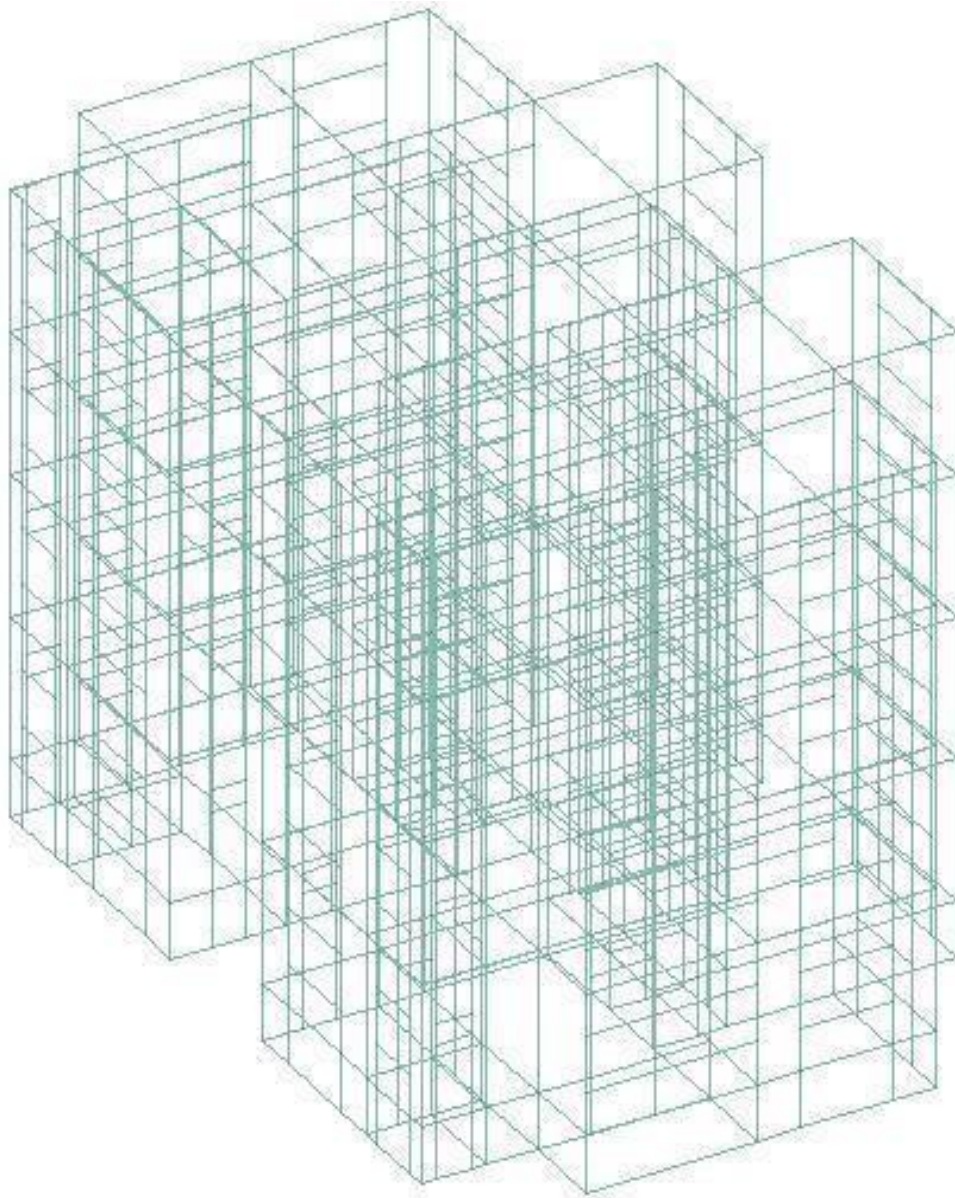


Fig.4.7 Isometric view



Fig.4.8 3D rendered view

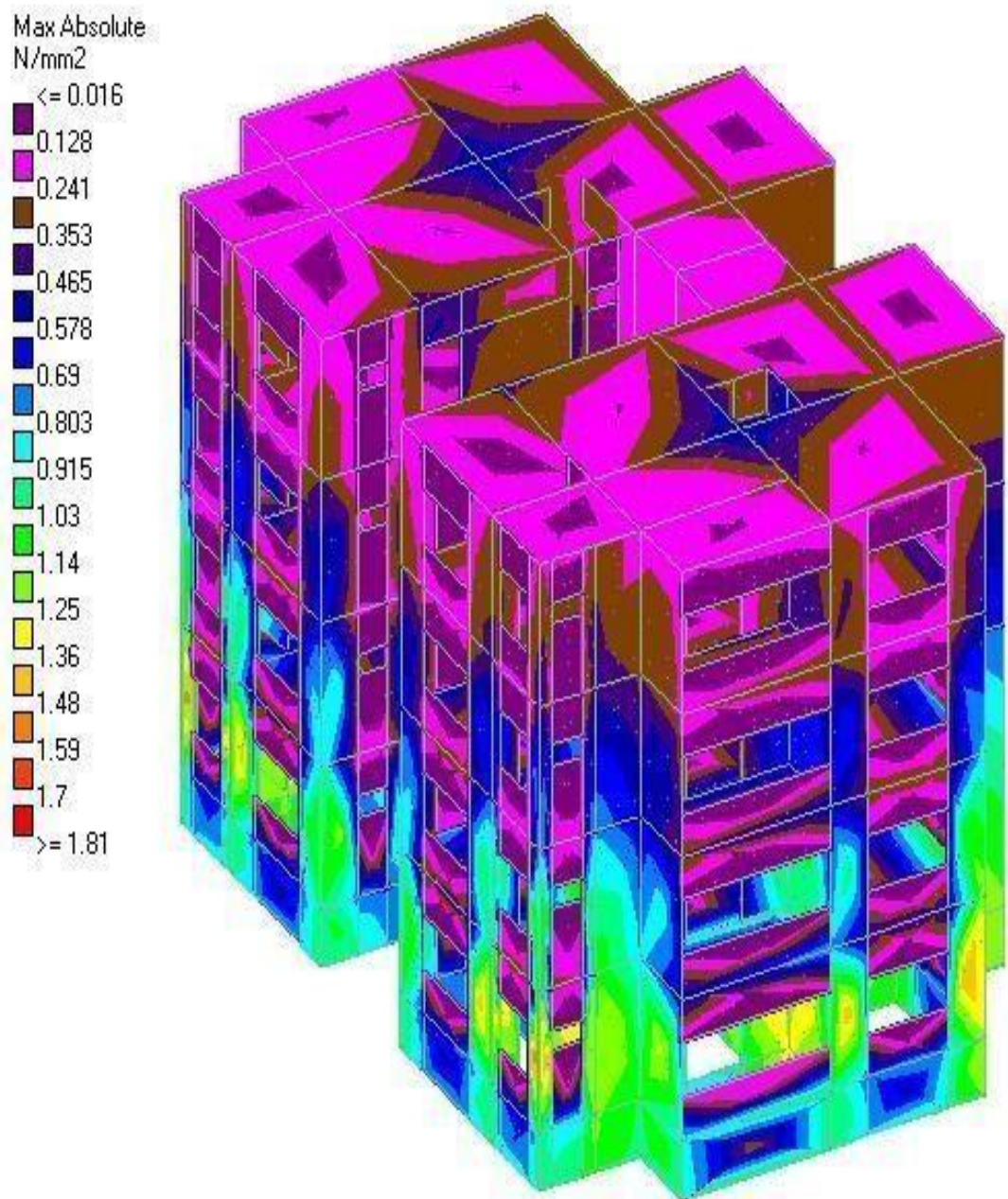


Fig.4.9 Plate stress diagrams (ABSOLUTE)

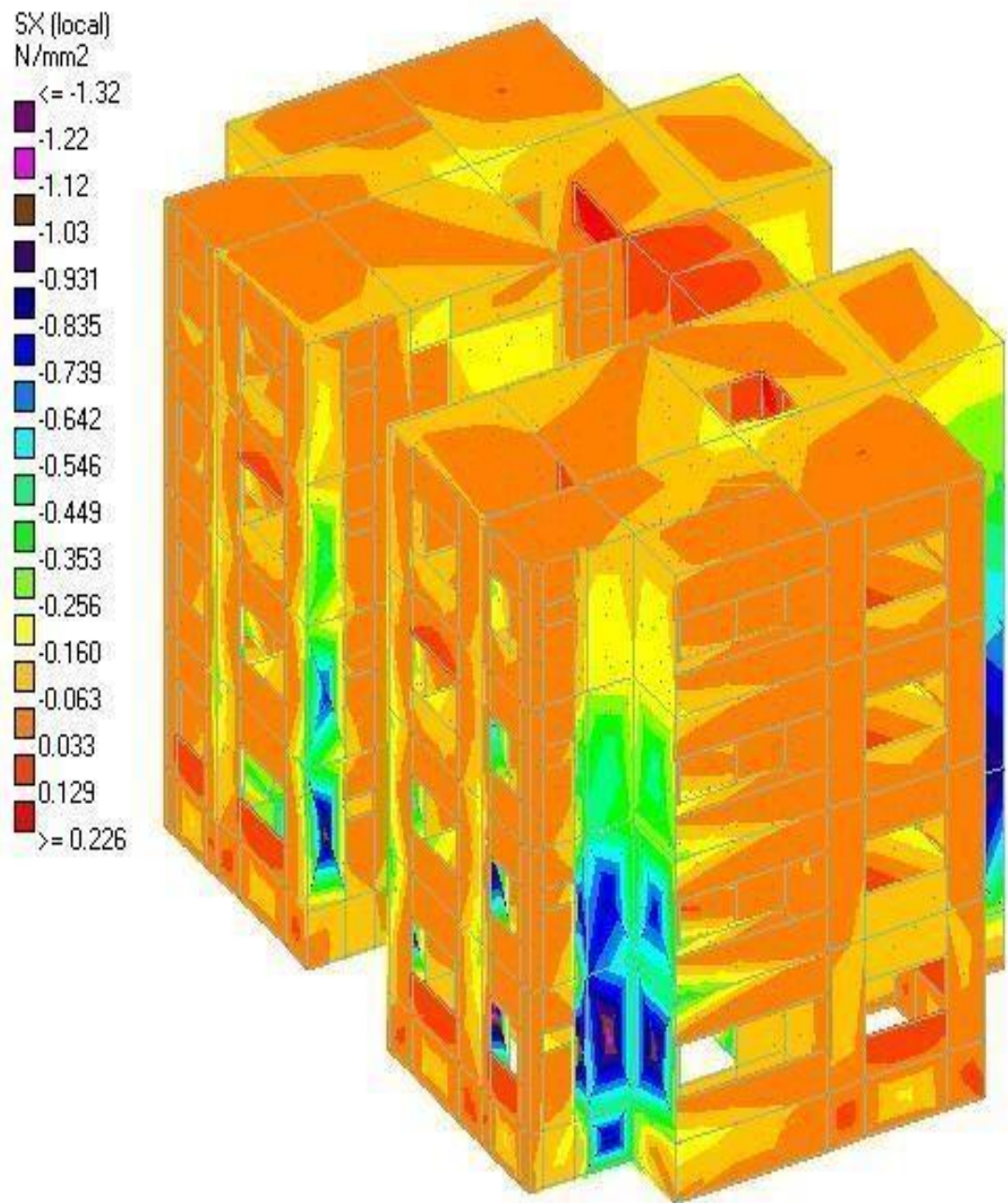


Fig.4.10 Plate stress diagrams (SX)

4.5 R.C.C ROOF SLAB DESIGN FOR FRAMED STRUCTURE

Size of room (Bed room) = 3.70 x 3.70m

Lx = 3.70m

Ly = 3.70m

Step 1

Aspect ratio: $L_y/L_x = 3.70/3.70 = 1.0$

The proportion is less than 2. The slab is to be plan as slab pass over in two directions.

Step 2

ESTIMATION OF THICKNESS OF SLAB:

$d = \text{Span} / (\text{Basic value})$

$d = 3700 / (0.8 \times 40)$

$= 119.08\text{mm}$

Take d = 130mm

D : 130 + 20 (cover)

D: 150mm

Step 3

EFFECTIVE SPAN

If the width of the support 230mm (or) clear span +effective depth of slab
whichever is less,

Effective span:

Clear span + ffective depth Centre to centre of support.

Whichever is less,

$$\text{C/C of support} = 3.70 + 0.23 = 3.93\text{m}$$

$$\text{Clear span + effective depth} = 3.70 + 0.13 = 3.83\text{m}$$

$$\text{Effective span of shorter span} = 3.83\text{m}$$

$$\text{Effective span of longer span} = 3.83\text{m}$$

Step 4

LOAD CALCULATION

$$\text{Imposed load} = 3 \text{ kN/m}^2$$

$$\text{Assume weight of floor finish} = 2 \text{ kN/m}^2$$

$$\text{Self weight of slab} = 0.15 \times 25 = 3.75\text{kN/m}^2$$

$$\text{Total load} = 8.75\text{kN/m}^2$$

$$\text{Design load } W_u = 1.50 \times 8.75 = 13.125\text{kN/m}^2$$

Step 5

CALCULATION OF BENDING MOMENT

Calculation of bending moment co-efficient for middle strips:-Consider 1m width of middle strips in both directions.

Shorter span:-

Positive moment co-efficient at mid span $\alpha_x = 0.035$

Negative moment co-efficient at mid span $\alpha_x = 0.047$

Longer span:-

Positive moment co-efficient at mid span $\alpha_y = 0.035$

Negative moment co-efficient at mid span $\alpha_y = 0.047$

Design bending moments

Shorter span

$$\begin{aligned}\text{Positive moment at mid span} &= \alpha_x w_u l_x^2 \\ &= 0.035 \times 13.125 \times 3.83^2 \\ &= 6.74 \text{ kNm}\end{aligned}$$

$$\begin{aligned}\text{Negative moment at support} &= \alpha_x w l^2 \\ &= 0.047 \times 13.125 \times 3.83^2 \\ &= 9.05 \text{ kNm}\end{aligned}$$

Longer span

$$\begin{aligned}\text{Positive moment at mid span} &= \alpha_x w_u l_x^2 = 0.035 \times 13.125 \times 3.83^2 \\ &= 6.74 \text{ kNm}\end{aligned}$$

$$\begin{aligned}\text{Negative moment at support} &= \alpha_x w_u l^2 = 0.047 \times 13.125 \times 3.83^2 \\ &= 9.05 \text{ kNm}\end{aligned}$$

Step 6

EFFECTIVE DEPTH OF THE SLAB

Effective depth of the slab

For balanced section of M25 grade concrete and fe415 grade steel

$$\text{Moment of resistance MR} = 0.138 f_{ck} b d^2$$

$$\text{Maximum bending moment} = 9.05 \times 10^6 \text{ Nmm}$$

$$\begin{aligned}\text{Effective depth } d &= \sqrt{(9.05 \times 10^6 / (0.138 \times 25 \times 1000))} \\ &= 51.22 \text{ mm} < 130 \text{ mm}\end{aligned}$$

Hence it is safe.

$$\text{Take effective depth} = 130 \text{ mm}$$

Step 7

Ast CALCULATION:

Reinforcement at middle strip: The tension reinforcement for the positive and negative values of the bending moments required area as follows:
10mm ϕ , steel bars shall be used.

Shorter span

At middle span (positive)

$$M_u = 0.87 f_y A_{st} d (1 - (f_y A_{st} / f_{ck} b d))$$

$$6.74 \times 10^6 = 0.87 \times 415 \times A_{st} \times 130 (1 - (415 \times A_{st} / 25 \times 1000 \times 130))$$

$$6.74 \times 10^6 = 46937 A_{st} - 5.99 A_{st}^2$$

$$A_{st} = 141.06 \text{ mm}^2$$

At support (Negative)

$$M_u = 0.87 f_y A_{st} d (1 - (f_y A_{st} / f_{ck} b d))$$

$$9.05 \times 10^6 = 0.87 \times 415 \times A_{st} \times 130 (1 - (415 \times A_{st} / 25 \times 1000 \times 130))$$

$$9.05 \times 10^6 = 46937 A_{st} - 5.99 A_{st}^2$$

$$A_{st} = 188.3 \text{ mm}^2$$

Longer span:

At middle span (positive)

$$M_u = 0.87 f_y A_{st} d (1 - (f_y A_{st} / f_{ck} b d))$$

$$6.74 \times 10^6 = 0.87 \times 415 \times A_{st} \times 130 (1 - (415 \times A_{st} / 25 \times 1000 \times 130))$$

$$6.74 \times 10^6 = 46937 A_{st} - 5.99 A_{st}^2$$

$$A_{st} = 141.06 \text{ mm}^2$$

At support (Negative)

$$M_u = 0.87 f_y A_{st} d (1 - (f_y A_{st} / f_{ck} b d))$$

$$9.05 \times 10^6 = 0.87 \times 415 \times A_{st} \times 130 (1 - (415 \times A_{st} / 25 \times 1000 \times 130))$$

$$9.05 \times 10^6 = 46937 A_{st} - 5.99 A_{st}^2$$

$$A_{st} = 188.3 \text{ mm}^2$$

Spacing of bars

Shorter span (Positive)

$$\begin{aligned} \text{Spacing (s)} &= (a_{st} / A_{st}) \times 1000 \\ &= (78.56 / 141.06) \times 1000 \\ &= 556.3 \text{ mm c/c} \Omega 550 \text{ mm c/c} \end{aligned}$$

Maximum spacing

$$(i) 3d = 3 \times 130 = 390\text{mm c/c}$$

(ii) 300mm c/c (adopt whichever is minimum)

Spacing: - use 10mm ϕ HYSD @ 300mm c/c

At support (Negative)

$$\begin{aligned}\text{Spacing (s)} &= (a_{st} / A_{st}) \times 1000 \\ &= (78.56 / 188.30) \times 1000 \\ &= 417.2\text{mm c/c} \Omega 410\text{mm c/c}\end{aligned}$$

Maximum spacing

$$(i) 3d = 3 \times 130 = 390\text{mm c/c}$$

(ii) 300mm c/c (adopt whichever is

minimum) Spacing: - use 10mm ϕ HYSD @

300 mm c/c

Longer span (positive)

$$\begin{aligned}\text{Spacing (s)} &= (a_{st} / A_{st}) \times 1000 \\ &= (78.56 / 141.06) \times 1000 \\ &= 556.3\text{mm c/c} \Omega 550\text{mm c/c}\end{aligned}$$

Maximum spacing

$$(i) 3d = 3 \times 130 = 390\text{mm c/c}$$

(ii) 300mm c/c (adopt whichever is minimum)

Spacing: - use 10mm ϕ HYSD @ 300mm c/c

At support (Negative)

$$\text{Spacing (s)} = (a_{st} / A_{st}) \times 1000$$

$$= (78.56 / 188.30) \times 1000$$

$$= 417.2\text{mm c/c} \Omega 410\text{mm c/c}$$

Maximum spacing

$$3d = 3 \times 130 = 390\text{mm c/c}$$

Spacing: - use 10mm ϕ HYSD @ 300 mm c/c

Step 8

CHECK FOR SHEAR STRESS

Considering the short span and unit width of slab

$$V_u = (0.5 \times w_u \times l_e)$$

$$= (0.5 \times 13.125 \times 3.83)$$

$$\begin{aligned}
 &= 25.13 \text{ kN} \\
 \tau_v &= (V_u / bd) \\
 &= (25.13 \times 10^3) / (1000 \times 130) \\
 &= 0.193 \text{ N/mm}^2 \\
 P_t &= (100 A_{st} / b d) \\
 &= (100 \times 188.3) / (1000 \times 130) \\
 &= 0.145 \\
 \tau_c &= 0.29 \text{ N/mm}^2
 \end{aligned}$$

$$\tau_c > \tau_v \text{ (i.e.) } 0.29 \text{ N/mm}^2 > 0.193 \text{ N/mm}^2$$

Hence the shear stresses are within safe permissible limits.

Step 9

CHECK FOR DEFLECTION

Width of slab in the short span direction, L x Area of steel provided,

$$\text{Middle of shorter span} = (78.56 \times 1000) / 300$$

$$= 261.87 \text{ mm}^2$$

$$\text{Percentage of steel} = (261.87 / (1000 \times 130)) 100$$

$$= 0.20 \%$$

Stress in tension steel (short span)

$$\begin{aligned}F_s &= 0.58 \times 415 \times (188.3/261.87) \\&= 173.07 \text{ N/mm}^2\end{aligned}$$

From figure no: 4 of IS 456: 2000

$$\text{Modification factor,} = 1.9$$

$$\text{Effective depth required} = 3.83 \times 10^3 / (1.90 \times 0.8 \times 40)$$

$$= 62.99\text{mm}$$

$$\text{Effective depth provided} = 62.99\text{mm} < 130\text{mm}$$

Hence the deflection within the permissible limit.

Step 10

TORSIONAL REINFORCEMENT

$$\begin{aligned}\text{Area of torsion steel} &= 0.75 A_{st} \\&= 0.75 \times 188.3 \\&= 141.22 \text{ mm}^2\end{aligned}$$

6mm ϕ , steel bars shall be used.

$$\begin{aligned}\text{Spacing(s) of torsion bars} &= (a_{st} / A_{st}) \times 1000 \\&= (28.27 / 141.22) \times 1000 \\&= 200 \text{ mm}\end{aligned}$$

$$\begin{aligned}\text{Size of mesh} &= l_x/5 = 3830/5 \\ &= 766\text{mm}\end{aligned}$$

Provide 6mm ϕ steel bars @ 200mm c/c in corners for a length of 766 mm mesh at top and bottom.

4.5.1 R.C.C BEAM DESIGN FOR FRAMED STRUCTURE

To get the positive moment and negative moment as well as maximum shear force are designed by STAAD analysis.

GIVEN DATA

Step 1

Width of Beam = 230 mm

Over all depth of Beam = 375 mm

Thickness of slab, D_f = 150 mm

Concrete grade = M25

Steel grade = Fe415

Step 2

Bending moment and shear force:

$$\text{Negative moment @ interior support} = 165.36 \text{ kNm}$$

$$\text{Positive moment @ centre of span} = 142.36 \text{ kNm}$$

$$\text{Maximum shear force at its support, } V_u = 73.20 \text{ kN}$$

Limiting moment of Resistance

$$M_{u\text{limit}} = 0.138 f_{ck} b d^2$$

$$= 0.138 \times 25 \times 230 \times 375^2$$

$$M_{u\text{limit}} = 111.60 \text{ kNm}$$

$$M_{u\text{limit}} < M_{u\text{max}}$$

Hence the section is designed for doubly reinforced.

$$M_{u2} = 142.36 - 111.60 = 30.76 \text{ kN.m}$$

Ast1 calculation

$$M_u = 0.87 f_y A_{st1} d (1 - (f_y A_{st1} / f_{ck} b d))$$

$$111.600 \times 10^6 = 0.87 \times 415 \times A_{st} \times 325 (1 - (415 \times A_{st} / 25 \times 230 \times 325))$$

$$111.600 \times 10^6 = 117341.25 A_{st} - 26.06 A_{st}^2$$

$$A_{st1} = 1364.67 \text{ mm}^2$$

Use 25mm dia bars

$$\begin{aligned}\text{No of bars required} &= A_{st} / a_{st} = 1364.67 / ((\pi/4) \times 25^2) \\ &= 2.78 \text{ Say } 3 \text{ nos}\end{aligned}$$

Main reinforcement (excess reinforcement Positive)

$$\begin{aligned}M_{u1} &= 0.87 f_y A_{st} (d-d') \\ 30.760 \times 10^6 &= 0.87 \times 415 \times A_{st} \times (325-50) \\ 30.760 \times 10^6 &= 99289 A_{st} \\ A_{st} &= 309.80 \text{ mm}^2 \\ \text{No of bars required} &= A_{st} / a_{st} \\ &= 309.80 / ((\pi/4) \times 25^2) \\ &= 0.60 \text{ Say } 1 \text{ nos}\end{aligned}$$

Provide 4 nos of bars #25 at the Bottom tension face at centre of span section.

Asc calculation

Main reinforcement (Negative)

$$\begin{aligned}M_u &= f_{sc} A_{sc} (d-d') \\ d'/d &= 50/325 = 0.154 \\ f_{sc} &= 353.40 \text{ N/mm}^2 \\ 165.36 \times 10^6 &= 353.40 \times A_{sc} \times (325-50) \\ A_{sc} &= 1701.5 \text{ mm}^2 \\ \text{No of bars required} &= A_{sc} / a_{sc} = 1701.5 / ((\pi/4) \times 25^2)\end{aligned}$$

$$= 3.47 \text{ Say } 4 \text{ nos Provide 4 Nos of bars}$$

#25 at the top face near support

Shear reinforcement

$$\text{Maximum shear force } V = 73.20 \text{ kN}$$

$$\tau_v = (V_u/bd) = (73.20 \times 10^3) / (230 \times 375)$$

$$= 0.85 \text{ N/mm}^2$$

$$P_t = (100 A_{st}/b d) = 100 \times ((1964) / (230 \times 375))$$

$$= 2.27\%$$

From table no: 19 in IS 456 - 2000

$$\tau_c = 0.64 \text{ N/mm}^2$$

$$\tau_v > \tau_c \text{ (i.e.) } 0.85 \text{ N/mm}^2 > 0.64 \text{ N/mm}^2$$

Hence shear reinforcement are required.

Excess shear force,

$$V_{us} = \tau_v - \tau_c \times bd$$

$$= (0.85 - 0.64) \times 230 \times 375$$

$$V_{us} = 17250 \text{ N}$$

Assume # 8mm, 2 legged vertical stirrups are used

$$A_{sv} = 2 \times (\pi / 4) \times 8^2 = 100.53 \text{ mm}^2$$

Spacing of stirrups (S_v)

$$S_v = 0.87 f_y A_{svd} / V_{us}$$

$$= 0.87 \times 415 \times 100.53 \times 375 / 17250$$

$$S_v = 245.05 \text{ mm c/c}$$

$$\text{i) } S_v \text{ min} = 0.87 \times f_y \times A_{sv} / (0.4 \times b)$$

$$S_v \text{ min} = 0.87 \times 415 \times 100.53 / ((0.85 - 0.64) \times 230)$$

$$= 182.04$$

$$= 180 \text{ mm}$$

$$\text{ii) } 0.75 \times 300 = 225 \text{ mm}$$

$$\text{iii) } 300 \text{ mm whichever is minimum}$$

Provide 8mm # @ 2 legged vertical stirrups at 180 mm c/c

Check for deflection

At centre of span

$$P_t = 100 A_{st} / (b \times d) = 1.03\%$$

$$F_s = 0.58 \times 415 = 240.7 \text{ N/mm}^2$$

$$M.F = 1.1$$

Neglecting bars in compression side

$$K_c = 1$$

$$\begin{aligned} L/d \text{ max} &= L/d \text{ basic} \times K_t \times K_f \\ &= 26 \times 1.1 \times 1.00 \times 1.00 \\ &= 28.6 \end{aligned}$$

$$L/d \text{ actual} = 3930 / 230 = 17.08$$

$$28.6 > 17.08$$

Hence deflection control is safe.

4.5.2 R.C.C COLUMN DESIGN FOR FRAMED STRUCTURE

To get the positive moment and negative moment as well as maximum axial force were designed by STAAD analysis.

GIVEN DATA

$$\text{Width of column} = 230 \text{ mm}$$

$$\text{Over all depth of column} = 550 \text{ mm}$$

$$\text{Concrete grade} = \text{M25}$$

$$\text{Steel grade} = \text{Fe415}$$

$$\text{Factored load } P_{uz} = 1880.43 \text{ kN}$$

Gross sectional area (A) & Area of steel (Asc)

Assume Pt = 2% of overall cross sectional area (A)

Design of Main reinforcement

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

$$1880.43 \times 10^3 = 0.4 \times 25 \times (0.98A) + 0.67 \times 415 \times (0.02A)$$

$$1880.43 \times 10^3 = 9.8A + 5.56A$$

$$1880.43 \times 10^3 = 15.36A$$

$$A = 122424 \text{ mm}^2$$

$$D = \sqrt{(A/230)} = 532 \text{ mm}$$

Provide minimum cross sectional dimension = 230mm x
550mm Provided area A = 126500 mm²

Area of steel (Asc)

$$A_{sc} = 0.02A = 0.02 \times 126500 = 2500 \text{ mm}^2$$

Use 20mm dia bars

$$\text{No of bars required} = A_{st} / a_{st} = 2500.00 / ((\pi/4) \times 20^2)$$

$$= 7.98$$

Say 8 nos

Provide 8 Nos of 20mm dia. Bars as main
reinforcement.

Design of lateral ties

$$\text{Dia} = 20/4 = 5\text{mm}$$

Dia 8mm which one is greater

I.e. dia = 8mm.

Pitch of lateral ties

$$P = \text{Least Lateral Dimension} = 230\text{mm} \quad P = 16 \times$$

$$20 = 320\text{mm}$$

$$P = 300\text{mm}$$

Whichever is less

Provide 8mm # 230mm c/c as lateral ties

Summary of design:

$$\text{Size of column} = 230\text{mm} \times 550\text{mm}$$

$$\text{Clear cover} = 40\text{mm}$$

Main reinforcement: 8 Nos of 20mm dia. Bars as main reinforcement

Lateral ties: 8mm ϕ HYSD bars @ 230mm c/c

4.5.3 DESIGN OF FOUNDATION FOR FRAMED STRUCTURE

The outer Column footings are designed as isolated footings. We obtain the axial load for the design of footing by STAAD analysis.

DESIGN OF ISOLATED FOOTING

DATA FOR DESIGN

$$\text{Axial load} = 1403.16\text{kN say } 1500\text{kN}$$

$$\text{Moment, } M_x = 2.37 \text{ kN}$$

$$\text{Moment, } M_z = 2.26 \text{ kN}$$

$$\text{Safe bearing capacity of soil} = 200\text{kN/m}^2$$

$$\text{Area required for foundation} = 1500 / 200$$

$$= 7.5\text{m}^2$$

$$\text{Area required} = L \times B$$

$$B \times B = 7.2\text{m}^2$$

$$B^2 = 7.2\text{m}^2$$

$$B = 2.74\text{m}$$

$$L = 2.74\text{m}$$

$$\text{Length required} = 2.74 \text{ m}$$

$$\text{Breadth required} = 2.74 \text{ m}$$

$$\text{Length provided} = 2.75 \text{ m}$$

$$\text{Breadth provided} = 2.75\text{m}$$

$$\text{Original area} = 2.75\text{m} \times 2.75\text{m}$$

$$= 7.56 \text{ m}^2$$

Column size:

$$\text{Length} = 0.45\text{m}$$

$$\text{Width} = 0.45\text{m}$$

Self weight of the footing:

$$\text{Unit weight of concrete} = 25.00\text{kN/m}^3$$

$$\text{Depth below Ground level} = 2.40\text{m}$$

$$\text{Depth of footing @ face of column} = 1.00\text{m}$$

$$\text{Depth of footing @ Edge of footing} = 0.30\text{m}$$

Volume of footing:

Volume of frusta of pyramids and concrete,

$$= h/3 ((A_1 + A_2 + (\text{sqrt } A_1 A_2)))$$

$$= (1.00 - 0.30) / 3 (0.45 \times 0.45) + (2.75 \times 2.75) + \sqrt{(0.45 \times 0.45 \times 2.75 \times 2.75)}$$

$$= 2.1\text{m}^3$$

$$\begin{aligned}
 \text{Volume of flat portion} &= 2.75 \times 2.75 \times 0.30 \\
 &= 2.27\text{m}^3 \\
 \text{Total volume of concrete} &= 4.37\text{m}^3 \\
 \text{Weight of footing} &= 4.37 \times 25 = 109.25\text{kN}
 \end{aligned}$$

Self weight of soil above footing

$$\text{Self weight of soil} = 18\text{kN/m}^3$$

$$\begin{aligned}
 \text{Volume of column portion (0.45x0.45x1.5)} & \\
 &= 0.30
 \end{aligned}$$

$$3 \text{ m}^3 \text{ Volume of soil portion } (2.75 \times 2.75 \times 2.40) - (4.37 + 0.303) = 13.477\text{m}^3$$

$$\text{Weight of soil portion} = 13.477 \times 18 = 242.59\text{kN}$$

$$\begin{aligned}
 \text{Total load} &= P_u + \text{self wt of footing} + \text{self wt of soil} \\
 &= 1800 + 109.25 + 242.59 \\
 p &= 2151.84 \text{ kN}
 \end{aligned}$$

Soil pressure with weight of footing and weight of soil above footing

$$Z_x = 2.75 \times (2.75)^2 / 6 = 3.47 \text{ m}^3$$

$$Z_z$$

$$\text{Soil Pressure} = 2.75 \times (2.75)^2 / 6 = 3.47 \text{ m}^3$$

$$= P / A \pm M_x / Z_x \pm M_z / Z_z$$

$$\begin{aligned}
 P_{\max} &= 2151.84 / (2.75 \times 2.75) + \\
 &\quad (68.34 / 3.47) + (68.34 / 3.47)
 \end{aligned}$$

$$= 323.93\text{kN/m}^2$$

$$\begin{aligned}
 P_{\min} &= 2151.84 / (2.75 \times 2.75) - \\
 &\quad (68.34 \times 3.47) - (68.34 / 3.47) \\
 &= 189.74 \text{ kN/m}^2
 \end{aligned}$$

Soil pressure without weight of footing and weight of soil above footing

$$\text{Soil Pressure} = P / A \pm M_x / Z_x \pm M_z / Z_z$$

$$\begin{aligned}
 P_{\max} &= 1800 / (7.56) + (68.34 / 3.47) + \\
 &\quad (68.34 / 3.47) \\
 &= 277.48 \text{ kN/m}^2
 \end{aligned}$$

$$\begin{aligned}
 P_{\min} &= 1800 / (7.56) - (68.34 / 3.47) \\
 &\quad - (68.34 / 3.47) \\
 &= 198.71 \text{ kN/m}^2
 \end{aligned}$$

$$\text{Net safe bearing capacity of soil} = 200 \text{ kN/m}^2$$

$$\text{Consider SBC can be increased by 50} = 1.50 \times 200 = 300 \text{ kN/m}^2$$

$$\text{Can be increased by Depth of soil} \times \text{density} = 2.40 \times 18 = 43.20 \text{ kN/m}^2$$

$$\text{Allowable safe Bearing capacity of the soil} = 300 + 43.20 = 343.20 \text{ kN/m}^2$$

P max is less than SBC, Hence it is safe.

Design of Isolated footing:

Soil pressured without weight of footing:-

$$P_{\max} = 277.48 \text{ kN/m}^2$$

$$P_{\min} = 198.71 \text{ kN/m}^2$$

Pressure along 'Z' direction

$$\text{Soil pressure along 'z'} = P / A \pm M_z / Z_z$$

$$P_{\max} = 1800 / (2.75 \times 2.75) + (68.34 / 3.47)$$

$$= 257.79 \text{ kN/m}^2$$

$$P_{\min} = 1800 / (2.75 \times 2.75) - (68.34 / 3.47)$$

$$= 218.40 \text{ kN/m}^2$$

Pressure along 'X' direction

$$\text{Soil pressure along 'x'} = P / A \pm M_x / Z_x$$

$$P_{\max} = 1800 / (2.75 \times 2.75) + (68.34 / 3.47)$$

$$= 257.79 \text{ kN/m}^2$$

$$\begin{aligned}
 P_{\min} &= 1800 / (2.75 \times 2.75) - (68.34 / 3.47) \\
 &= 218.40 \text{ kN/m}^2
 \end{aligned}$$

Upward soil pressure at A

$$\begin{aligned}
 &= 218.40 + (218.40 - 257.79) / \\
 &\quad 2.75 \times (2.75 - 1.15) \\
 &= 241.32 \text{ kN/m}^2
 \end{aligned}$$

$$\text{Over all depth of face of column} = 1000 \text{ mm}$$

$$\text{Clear cover} = 60 \text{ mm}$$

$$\text{Dia of bar assumed} = 12.00 \text{ mm}$$

$$\begin{aligned}
 \text{Effective depth} &= 1000 - 60 - (12/2) \\
 &= 964.00 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 M_{ux} &= P_{nu} (L-a / 2 \times B) \times (L-a / 4) \\
 &= 241.32((2.75-.0.45) / 2) \times 2.75) \times (2.75 - 0.45)/ 4 \\
 &= 438.82\text{kNm}
 \end{aligned}$$

$$\begin{aligned}
 M_{uy} &= P_{nu} (L) \times (B-b)^2 / 8 \\
 &= 241.32 \times 2.75 \times ((2.75-0.45)^2 / 8) \\
 &= 438.82\text{kNm}
 \end{aligned}$$

Maximum Bending moment at face of column = 438.82 kNm

Thickness of footing required against bending moments:-

$$\begin{aligned}
 M_{max} &= Q_u b d^2 \\
 438.82 \times 10^6 &= 0.138 \times 25 \times 2750 \times d^2
 \end{aligned}$$

$$d = 215.06\text{mm Say } 220\text{mm}$$

$$D = 220 + 60 = 280\text{mm}$$

$$\begin{aligned}
 \text{Upward soil pressure at B} &= 218.40 + (218.40 - 257.79) / 2.75 \\
 &\quad \times (2.75 - 1.15 - 0.45) \\
 &= 234.87\text{kN/m}^2
 \end{aligned}$$

$$\begin{aligned}
 M_{ux} = M_{uy} &= P_{nu} L \times ((B-b)^2 / 8) \\
 &= 234.87 \times 2.75 \times (2.75-0.45)^2 / 8 \\
 &= 427.10\text{kNm}
 \end{aligned}$$

$$\text{Maximum Bending moment @ face of column} = 427.10 \text{ kNm}$$

Thickness of footing required against bending moments

$$M_{\text{max}} = Q_u b d^2$$

$$427.10 \times 10^6 = 0.138 \times 25 \times 2750 \times d^2$$

$$d = \sqrt{(427.10 \times 10^6) / 0.138 \times 25 \times 2750}$$

$$= 212.17 \text{ mm say } 220 \text{ mm}$$

$$= 220 + 60$$

$$= 280 \text{ mm}$$

Check for Effective depth required against shear

The development length of shear is taken as distance of 'd' from the pedestal

$$V_{u \text{ max}} = P_u B ((L-a)/2) - d$$

$$= 241.32 \times 2.75 \times (2.75 - 0.45) / 2 - d$$

$$= 663.63(1.15 - d)$$

$$V_{u \text{ max}} = 763.17 - 663.63 d$$

The total shear stress induced at critical section is resisted by the shear stress, developed by concrete section,

$$\tau_{cu} = K_s \cdot \tau_c$$

$$K_s = 0.5 + \beta_c = 0.5 + (0.45/0.45)$$

$$= 1.50 > 1$$

$$K_s = 1$$

$$\tau_c = 0.25 \sqrt{f_{ck}}$$

$$= 1.25 \text{ N/mm}^2$$

$$\tau_{cu} = 1 \times 1.25$$

$$= 1.25 \text{ N/mm}$$

$$\tau_{cu} = 1 \times 1.25$$

$$= 1.25 \text{ N/mm}^2$$

$$\tau_{vu} = (V_{u\max}/bd)$$

$$\tau_{vu} = (763.17 - 663.63d)/2750 \times d$$

$$\tau_{vu} = \tau_{cu}$$

$$1.25 \times 10^3 = (763.17 - 663.63d)/2.75d$$

$$= 0.186 \text{ m}$$

$$d = 186 \text{ mm}$$

$$D = 250 \text{ mm}$$

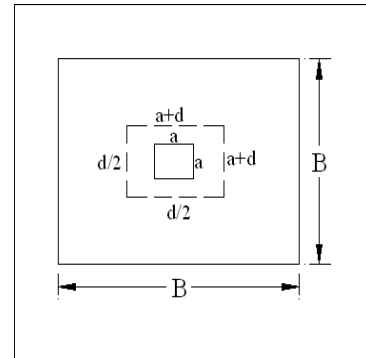
Check for Effective depth required against punching shear either two way shear. The condemnatory part of two way shear is lay hold on at a distance of $d/2$ around pedestal.

$$V_{u\max} = P_{nu} ((L \times B - (a+d)(b+d)))$$

$$= 241.32(2.75 \times 2.75 - (0.45+d)(0.45+d))$$

$$= 241.32(7.36 - d^2 - 0.9d)$$

$$1776.11 - 217.19d - 241.32 d^2$$



$$\tau_{vu} = (V_{u\max}) / (2(a+d) + 2(b+d))d$$

$$= \frac{1776.11 - 217.19d - 241.32 d^2}{(2(0.45+d) + 2(0.45+d)) \times d}$$

$$1.25 \times 10^3 (1.8d + 4d^2) = 1776.11 - 217.19d - 241.32 d^2$$

$$5241.32d^2 + 2467.19d - 1776.11 = 0$$

$$d = 392\text{mm say } 400\text{mm}$$

$$D = 450\text{mm}$$

$$\text{Provide maximum depth } D = 450\text{mm}$$

Reinforcement along x direction

$$M_u = 0.87 f_y A_{st}d(1 - (f_y A_{st} / f_{ck} bd))$$

$$438.82 \times 10^6 = 0.87 \times 415 \times A_{st} \times 400(1 - (415 \times A_{st} / 25 \times 2750 \times 400))$$

$$A_{st} = 3192.25 \text{ mm}^2$$

Provide 20mm dia bars.

$$\text{No of bar} = 3192.25 / ((\pi / 4) \times 20^2)$$

$$= 10.16 \text{ nos}$$

Say 11nos Provide 20mm dia bars 11nos in X-direction

Reinforcement along y direction

$$M_u = 0.87 f_y A_{st} d(1 - (f_y A_{st} / f_{ck} b d))$$

$$438.82 \times 10^6 = 0.87 \times 415 \times A_{st} \times 400(1 - (415 \times A_{st} / 25 \times 2750 \times 400))$$

$$A_{st} = 3192.25 \text{ mm}^2$$

Provide 20mm dia bars.

$$\text{No of bar} = 3192.25 / ((\pi / 4) \times 20^2)$$

$$= 10.16 \text{ nos Say 11nos}$$

Provide 20mm dia bars 11nos in Y-direction

4.5.4 R.C.C ROOF SLAB DESIGN FOR MIVAN STRUCTURE

Size of room (Bed room) = 3.70 x 3.70m

$L_x = 3.70\text{m}$, $L_y = 3.70\text{m}$

Step 1

Aspect ratio: $L_y/L_x = 3.70/3.70 = 1.0$

This proportion is less than 2. The slab is to be plan as slab spanning in two directions.

Step 2

ESTIMATION OF THICKNESS OF SLAB

$d = \text{Span} / (\text{Basic value})$

$d = 3700 / (0.8 \times 40)$

$= 119.08\text{mm}$

Take $d = 130\text{mm}$

$D = 130 + 20 (\text{cover}) = 150\text{mm}$

Step 3 EFFECTIVE SPAN

If the width of the support (RC wall) 200mm (or) clear span + effective depth of slab whichever is less.

Effective span:

Clear span + effective depth Center to centre of support.

Whichever is less,

$$\text{C/C of support} = 3.70 + 0.2 = 3.90\text{m}$$

$$\text{Clear span + effective depth} = 3.70 + 0.13 = 3.83\text{m}$$

$$\text{Effective span of shorter span} = 3.83\text{m}$$

Step 4

LOAD CALCULATION

$$\text{Imposed load} = 3 \text{ kN/m}^2$$

$$\text{Assume weight of floor finish} = 2 \text{ kN/m}^2$$

$$\text{Self weight of slab} = 0.15 \times 25 = 3.75 \text{ kN/m}^2$$

$$\text{Total load} = 8.75 \text{ kN/m}^2$$

$$\text{Design load } W_u = 1.50 \times 8.75 = 13.125 \text{ kN/m}^2$$

Step 5:

CALCULATION OF BENDING MOMENT:

Calculation of bending moment co- efficient for middle strips:-

Consider 1m width of middle strips in both directions.

Shorter span:

Positive moment co-efficient at mid span $\alpha_x = 0.035$

Negative moment co- efficient at mid span $\alpha_x = 0.047$

Longer span:

Positive moment co-efficient at mid span $\alpha_y = 0.035$

Negative moment co-efficient at mid span $\alpha_y = 0.047$

Design bending moments Shorter span

$$\begin{aligned}\text{Positive moment at mid span} &= \alpha_x w_u l_x^2 \\ &= 0.035 \times 13.125 \times 3.83^2 \\ &= 6.74 \text{ kNm}\end{aligned}$$

$$\begin{aligned}\text{Negative moment at support} &= \alpha_x w l^2 = 0.047 \times 13.125 \times 3.83^2 \\ &= 9.05 \text{ kNm}\end{aligned}$$

Longer span

$$\begin{aligned}\text{Positive moment at mid span} &= \alpha_x w_u l_x^2 = 0.035 \times 13.125 \times 3.83^2 \\ &= 6.74 \text{ kNm}\end{aligned}$$

$$\begin{aligned}\text{Negative moment at support} &= \alpha_x w l^2 = 0.047 \times 13.125 \times 3.83^2 \\ &= 9.05 \text{ kNm}\end{aligned}$$

Step 6

EFFECTIVE DEPTH OF THE SLAB

Effective depth of the slab

For balanced section of M25 grade concrete and fe415 grade steel

$$\text{Moment of resistance MR} = 0.138 f_{ck} b d^2$$

$$\text{Maximum bending moment} = 9.05 \times 10^6 \text{ Nmm}$$

$$\text{Effective depth } d = \sqrt{(9.05 \times 10^6 / (0.138 \times 25 \times 1000))}$$

$$= 51.22\text{mm} < 130\text{mm}$$

Hence it is safe.

Take effective depth = 130mm

Step 7

A_{st} CALCULATION

Reinforcement at middle strip

The tension reinforcement for the positive and negative values of the bending moments required area as follows: 10mm ϕ , steel bars shall be used.

Shorter span

At middle span (positive)

$$M_u = 0.87 f_y A_{st} d (1 - (f_y A_{st} / f_{ck} b d))$$

$$6.74 \times 10^6 = 0.87 \times 415 \times A_{st} \times 130 (1 - (415 \times A_{st} / 25 \times 1000 \times 130))$$

$$6.74 \times 10^6 = 46937 A_{st} - 5.99 A_{st}^2$$

$$A_{st} = 141.06 \text{ mm}^2 \text{ At support (Negative)}$$

$$M_u = 0.87 f_y A_{st} d (1 - (f_y A_{st} / f_{ck} b d))$$

$$9.05 \times 10^6 = 0.87 \times 415 \times A_{st} \times 130 (1 - (415 \times A_{st} / 25 \times 1000 \times 130))$$

$$9.05 \times 10^6 = 46937 A_{st} - 5.99 A_{st}^2$$

$$A_{st} = 188.3 \text{ mm}^2$$

Longer span

At middle span (positive)

$$M_u = 0.87 f_y A_{st} d (1 - (f_y A_{st} / f_{ck} b d))$$

$$6.74 \times 10^6 = 0.87 \times 415 \times A_{st} \times 130 (1 - (415 \times A_{st} / 25 \times 1000 \times 130))$$

$$6.74 \times 10^6 = 46937 A_{st} - 5.99 A_{st}^2$$

$$A_{st} = 141.06 \text{ mm}^2 \text{ At support (Negative)}$$

$$M_u = 0.87 f_y A_{st} d (1 - (f_y A_{st} / f_{ck} b d))$$

$$9.05 \times 10^6 = 0.87 \times 415 \times A_{st} \times 130 (1 - (415 \times A_{st} / 25 \times 1000 \times 130))$$

$$9.05 \times 10^6 = 46937 A_{st} - 5.99 A_{st}^2$$

$$A_{st} = 188.3 \text{ mm}^2$$

Spacing of bars

Shorter span (Positive)

$$\begin{aligned}\text{Spacing (s)} &= (a_{st} / A_{st}) \times 1000 \\ &= (78.56 / 141.06) \times 1000 \\ &= 556.3\text{mm c/c} \Omega 550\text{mm c/c}\end{aligned}$$

Spacing: - use 10mm ϕ HYSD @ 300mm c/c

At support (Negative)

$$\begin{aligned}\text{Spacing (s)} &= (a_{st} / A_{st}) \times 1000 \\ &= (78.56 / 188.30) \times 1000 \\ &= 417.2\text{mm c/c} \Omega 410\text{mm c/c}\end{aligned}$$

Maximum spacing

$$(i) 3d = 3 \times 130 = 390\text{mm c/c}$$

(ii) 300mm c/c (adopt whichever is minimum)

Spacing: - use 10mm ϕ HYSD @ 300 mm c/c

Longer span (positive)

$$\begin{aligned}\text{Spacing (s)} &= (a_{st} / A_{st}) \times 1000 \\ &= (78.56 / 141.06) \times 1000 \\ &= 556.3\text{mm c/c} \Omega 550\text{mm c/c}\end{aligned}$$

Spacing: - use 10mm ϕ HYSD @

300mm c/c At support (Negative)

$$\begin{aligned}\text{Spacing (s)} &= (a_{st} / A_{st}) \times 1000 \\ &= (78.56 / 188.30) \times 1000 \\ &= 417.2\text{mm c/c} \Omega 410\text{mm c/c}\end{aligned}$$

Maximum spacing

$$(i) 3d = 3 \times 130 = 390\text{mm c/c}$$

Spacing: - use 10mm ϕ HYSD @ 300 mm c/c

Step 8

CHECK FOR SHEAR STRESS

Considering the short span and unit width of slab

$$\begin{aligned}V_u &= (0.5 \times w_u \times l_e) \\&= (0.5 \times 13.125 \times 3.83) \\&= 25.13 \text{ kN} \\ \tau_v &= (V_u / bd) \\&= (25.13 \times 10^3) / (1000 \times 130) \\&= 0.193 \text{ N/mm}^2 \\ P_t &= (100 A_{st} / b d) \\&= (100 \times 188.3) / (1000 \times 130) \\&= 0.145\end{aligned}$$

IS 456 - 2000

$$\tau_c = 0.29 \text{ N/mm}^2$$

$$\tau_c > \tau_v \text{ (i.e.) } 0.29 \text{ N/mm}^2 > 0.193 \text{ N/mm}^2$$

Hence the shear stresses are within safe permissible limits.

Step 9

CHECK FOR DEFLECTION

Width of slab in the short span direction, L_x Area of steel provided,

$$\text{Middle of shorter span} = (78.56 \times 1000) / 300$$

$$= 261.87 \text{ mm}^2$$

$$\text{Percentage of steel} = (261.87 / (1000 \times 130)) 100$$

$$= 0.20 \%$$

Stress in tension steel (short span)

$$F_s = 0.58 \times 415 \times (188.3/261.87)$$

$$= 173.07 \text{ N/mm}^2$$

$$\text{Modification factor,} = 1.9$$

$$\text{Effective depth required} = 3.83 \times 10^3 / (1.90 \times 0.8$$

x40)

$$= 62.99 \text{ mm}$$

$$\text{Effective depth provided} = 62.99 \text{ mm} < 130 \text{ mm}$$

Hence the deflection within the permissible limit.

Step 10

TORSIONAL REINFORCEMENT

$$\begin{aligned}\text{Area of torsion steel} &= 0.75 A_{st} \\ &= 0.75 \times 188.3 \\ &= 141.22 \text{ mm}^2\end{aligned}$$

6mm ϕ , steel bars shall be used.

$$\begin{aligned}\text{Spacing(s) of torsion bars} &= (a_{st} / A_{st}) \times 1000 \\ &= (28.27 / 141.22) \times 1000 \\ &= 200 \text{ mm} \\ \text{Size of mesh} &= l_x/5 = 3830/5 \\ &= 766 \text{ mm}\end{aligned}$$

Provide 6mm ϕ steel bars @ 200mm c/c in corners for a length of 766 mm mesh at top and bottom.

4.5.5 RC WALL DESIGN USING STAAD PRO OF MIVAN STRUCTURE

GIVEN DATA

Width of wall	=	200 mm
Over all depth of wall	=	3000 mm
Thickness of slab, Df	=	150 mm
Concrete grade	=	M25
Steel grade	=	Fe415
Clear cover	=	25mm

SHEARWALL NO. : 1

DESIGN CODE : IS 456-2000

WIDTH : 4.27 M

FC : 25.00 MPA

HEIGHT : 3.00 M

FY : 415.00 MPA

THICKNESS : 200.00 MM

CONC. COVER : 25.000 MM

EDGE ELEMENTS :

MIN. REINFORCING RATIO :

WIDTH : 854.00 MM

HORIZONTAL : 0.00200

THICKNESS : 200.00 MM

VERTICAL : 0.00120

NOTE :

ALL HEIGHTS ARE IN LOCAL COORDINATE SYSTEM OF THE SURFACE.

NUMBER OF REINFORCING LAYERS IN EACH DIRECTION : 2

HORIZONTAL AND VERTICAL REINFORCING IS PER LAYER.

REINFORCING DISTRIBUTION BETWEEN LAYERS IS 50/50.

EDGE REINF. SHOWN IS PER EDGE.

FORMAT IS (NO. OF BARS ALONG THICKNESS + 2 X NO. OF BARS ALONG FACES)

REINFORCING SUMMARY (REBAR SPACING/AREA UNITS: MM/MM²)

LEVEL (M)	GOV. LOAD NO. FOR HOR./ VERT./ EDGE/ LINK	HORIZONTAL/ (RATIO)/ HOR. LINK	VERTICAL/ (RATIO)/ VER. LINK	EDGE/ (AREA/RATIO)
0.30	1/ 1/ 1/	8 DIA @ 251.00/ (0.00100) NOT REQUIRED	20 DIA @ 450.00/ (0.00798) NOT REQUIRED	(5+2X 2) - 8 DIA/ (452.565/ 0.00066)
0.60	1/ 1/ 1/	8 DIA @ 251.00/ (0.00100) NOT REQUIRED	20 DIA @ 450.00/ (0.00798) NOT REQUIRED	(5+2X 2) - 8 DIA/ (452.565/ 0.00066)
0.90	1/ 3/ 1/	8 DIA @ 251.00/ (0.00100) NOT REQUIRED	20 DIA @ 450.00/ (0.00798) NOT REQUIRED	(5+2X 2) - 8 DIA/ (452.565/ 0.00066)
1.20	1/ 1/ 1/	8 DIA @ 251.00/ (0.00100) NOT REQUIRED	20 DIA @ 450.00/ (0.00798) NOT REQUIRED	(5+2X 2) - 8 DIA/ (452.565/ 0.00066)
1.50	1/ 1/ 1/	8 DIA @ 251.00/ (0.00100) NOT REQUIRED	20 DIA @ 450.00/ (0.00798) NOT REQUIRED	(5+2X 2) - 8 DIA/ (452.565/ 0.00066)

LEVEL (M)	GOV. LOAD NO. FOR HOR. / VERT. / EDGE/ LINK	HORIZONTAL/ (RATIO) / HOR. LINK	VERTICAL/ (RATIO) / VER. LINK	EDGE/ (AREA/RATIO)
1.80	1/ 1/ 1/	8 DIA @ 251.00/ (0.00100) NOT REQUIRED	20 DIA @ 450.00/ (0.00798) NOT REQUIRED	(5+2X 2) - 8 DIA/ (452.565/ 0.00066)
2.10	1/ 1/ 1/	8 DIA @ 251.00/ (0.00100) NOT REQUIRED	20 DIA @ 450.00/ (0.00798) NOT REQUIRED	(5+2X 2) - 8 DIA/ (452.565/ 0.00066)
2.40	1/ 1/ 1/	8 DIA @ 251.00/ (0.00100) NOT REQUIRED	20 DIA @ 450.00/ (0.00798) NOT REQUIRED	(5+2X 2) - 8 DIA/ (452.565/ 0.00066)
2.70	1/ 1/ 1/	8 DIA @ 251.00/ (0.00100) NOT REQUIRED	20 DIA @ 450.00/ (0.00798) NOT REQUIRED	(5+2X 2) - 8 DIA/ (452.565/ 0.00066)
3.00	1/ 1/ 1/	8 DIA @ 251.00/ (0.00100) NOT REQUIRED	20 DIA @ 450.00/ (0.00798) NOT REQUIRED	(5+2X 2) - 8 DIA/ (452.565/ 0.00066)

4.5.6 R.C.C WALL FOOTING OF MIVAN STRUCTURE

Calculation of Footing Weight & Soil Weight

Dimension of Footing in X-dirn.(B x) = 3.00 m

Dimension of Footing in Y-dirn.(B y) = 1.20 m

Overall Thickness of Footing (D) = 0.50 m

Depth of Foundation from top of soil (Df) = 1.80 m

against Overturning (FOS ovt) = 2.00

Allowable Percentage of Contact area = 70.00

**Type of Wall – (Designed
as column)**

Size of
Column 1 = 0.50 m X 0.20m

Size of
Column 2 = 0.50 m X 0.20m

Size of
Column 3 = 0.50 m X 0.20m

Size of
Column 4 = 0.50 m X 0.20m

Distance of column1 centre from left edge of footing =0.75m Distance of column2 centre from left edge of footing =1.26m Distance of column3 centre from left edge of footing =1.77m Distance of column4 centre from left edge of footing = 2.28m

Total Weight of soil on footing (W_s) = 73.28KN

Total Weight of Foundation (W_f) = 44.04KN

Calculations of Loads for Stability Checking

Dead Load Case = 480.00 KN

Dead + Live Load Case = 480.00 KN

Dead Load Case = 7.20 KN

Dead + Live Load Case = 7.20 KN

Stability Calculation in Dead Load case

Wt. of soil, foundation & surcharge = 597.32 KN

FOS against overturning about Y-axis = 124.44

Overturning about X-axis does not occur

Contact Area = 3.60sq.m

Pressure on foundation = 169.92 KN/sq.m

Stability Calculation in Dead + Live Load case

Vertical load including self wt. of soil, foundation & surcharge 597.32KN

FOS against overturning about Y-axis = 124.44

Overturning about X-axis does not occur Contact Area =3.60 sq.m

Tension does not occur

Pressure on foundation = 169.92 KN/sqm

Minimum value of FOS against overturning about Y-axis is 124.44

Minimum Contact Area is 3.60 sqm and it occurs for Dead Load Case .

Maximum Bearing Pressure (PR max) = 0.17 N/sq.mm

Maximum Bearing Pressure is less than Allowable bearing capacity.

Hence OK.

Factored Load Calculation (For Shear and Moment Calculation)

Factored Vertical Load from Column in Combination No. 1 (Pu1)
=480000.00 N

Factored Vertical Load from Column in Combination No. 2 (Pu2)
=480000.00 N

Factored Vertical Load from Column in Combination No. 3 (Pu3)
= 480000.00 N

Factored Vertical Load from Column in Combination No. 4 (Pu4)
=480000.00 N

Factored Moment at Foundation bottom along X-direction in (Mux1)
=-7200000.00 Nmm

Factored Moment at Foundation bottom along X-direction in (Mux2)
=-7200000.00 Nmm

Factored Moment at Foundation bottom along X-direction in (Mux3)
=-7200000.00 Nmm

Factored Moment at Foundation bottom along X-direction in (Mux4)
=-7200000.00 Nmm

Design Pressure in Combination No.1 (PR design1)= 0.14 N/mm ²

Design Pressure in Combination No.2 (PR design2)= 0.14 N/mm ²

Design Pressure in Combination No.3 (PR design3)= 0.14 N/mm ²

Calculation of Shear and Moments

Design Pressure in Combination No.4 (PR design4) = 0.14 N/mm ²

Final Design Pressure (PR design) = 0.14 N/mm ²

Distance of critical Section for shear from Column Face = 426.00 mm

Shear force at the critical section

(Parallel to Y-axis) on left of column 2 = 120000.00 N/mm

Shear force at the critical section

(Parallel to Y-axis) on left of column 3 = 240000.00 N/mm

Calculation of Shear and Moments

Shear force at the critical section (Parallel to Y-axis) on right of column 1
= 120000.00N/mm

Shear force at the critical section (Parallel to Y-axis) on right of column 2
= 240000.00N/mm

Shear force at the critical section (Parallel to Y-axis) on right of column 3
= 360000.00N/mm

Shear force at the critical section (Parallel to X-axis) = 10.16 N/mm length

For upward bearing Pressure Moment at left of column 1 along X-
direction = 16222.22 Nmm

Moment at left of column 2 along X-direction = 40424.38 N mm/mm length

Moment at left of column 3 along X-direction = 47966.67 N mm/mm
length

Moment at right of column 1 along X-direction = 40111.11 Nmm/mm length

Moment at right of column 2 along X-direction = 47976.67 Nmm/mm length

Moment at right of column 3 along X-direction = 39529.16 Nmm/mm length

Moment along Y-direction for downward pressure =
17166.67N mm/mm length

Maximum design moment at bottom along X-direction =
47976.67N mm/mm length

Maximum design moment at bottom along Y-direction =
17166.67N mm/mm length

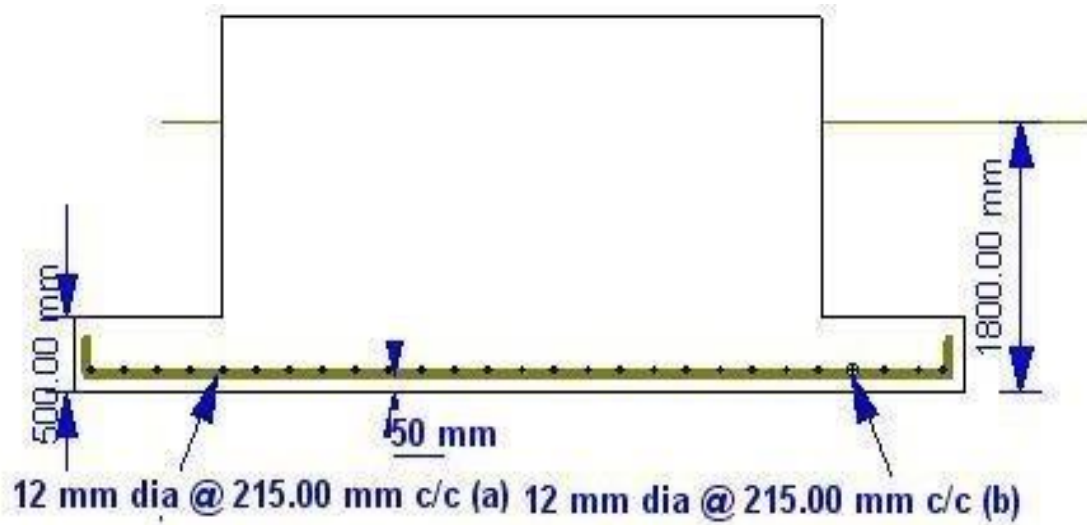
Maximum shear (X-direction) due to downward pressure =
87.14 N /mm length

Maximum shear (Y-direction) due to downward pressure =
10.16N/mm length

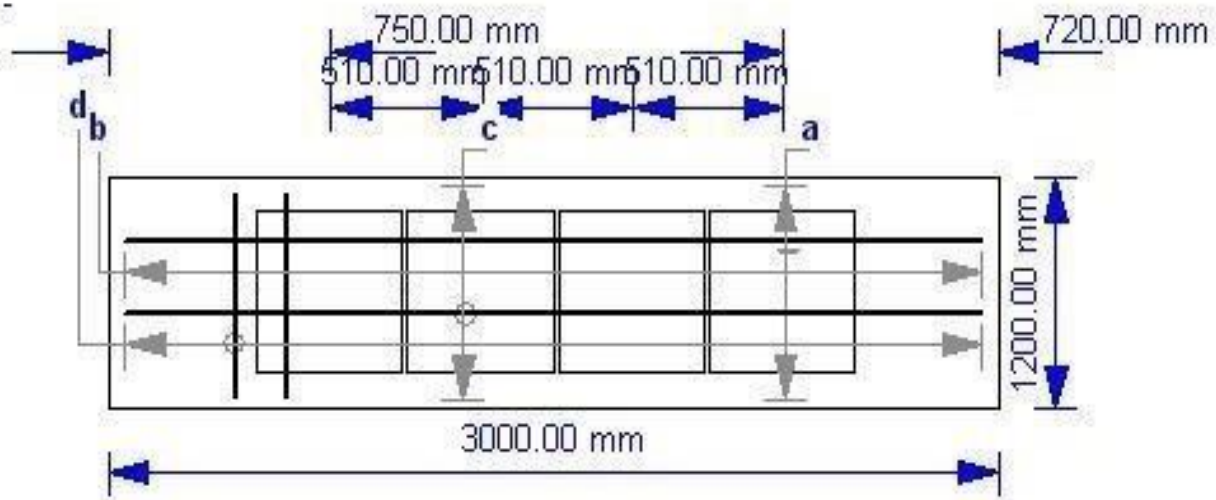
Reinforcement Area required in X-direction at bottom	= 0.53 mm ²
Reinforcement Area required in Y-direction at bottom	= 0.52 mm ²
Reinforcement Area required in X-direction at top	= 0.53 mm ²
Reinforcement Area required in Y-direction at top	= 0.52 mm ²
Spacing required in X-direction at bottom	= 212.27 mm
Spacing required in Y-direction at bottom	= 218.17 mm
Spacing required in X-direction at top	= 212.27 mm
Spacing required in Y-direction at top	= 218.17 mm
Spacing provided in X-direction at bottom	= 210.00 mm
Spacing provided in Y-direction at bottom	= 215.00 mm
Spacing provided in X-direction at top	= 210.00 mm
Spacing provided in Y-direction at top	= 215.00 mm

Fig5.8 reinforcement and spacing

Structural drawing for wall footing:



SECTION



PLAN

4.5.7 COMPARISON OF FRAMED & MIVAN STRUCTURE:

FRAMED STRUCTURE	MIVAN STRUCTURE
SLAB Overall depth = 150mm <i>Reinforcement:</i> 10mm dia. @ 300mm c/c in shorter span 10mm dia. @ 300mm c/c in longer span	SLAB Overall depth = 150mm <i>Reinforcement:</i> 10mm dia. @ 300mm c/c in shorter span 10mm dia. @ 300mm c/c in longer Span
BEAM Size = 230 x 375mm <i>Reinforcement:</i> Provide 4 nos of 25# bars @ Tension zone Provide 4 nos of 25# bars @ Compression zone Provide 8mm # @ 2 legged vertical stirrups at 180 mm c/c	WALL Thickness = 200mm Height = 3000mm Length = 4500mm <i>Reinforcement:</i> Provide 10mm dia. @ 200mm c/c in Horizontal direction Provide 20mm dia. @ 200mm c/c in Vertical direction
COLUMN Size = 230 x 550mm <i>Reinforcement:</i> Provide 8 nos of 20# bars Provide 8mm # @ 230 mm c/c lateral ties	
ISOLATED FOOTING Size = 2750 x 2750mm Depth of slab = 300mm <i>Reinforcement:</i> Provide 11 nos of 20# bars in X-direction Provide 11 nos of 20# bars in Y-direction	WALL FOOTING Width = 1200mm Depth of slab = 500mm <i>Reinforcement:</i> 12mm dia. @ 215mm c/c in X-direction 12mm dia. @ 215mm c/c in Y-direction

CHAPTER 5

CONCLUSION

5.1 GENERAL

This chapter describes about mivan technology using AutoCAD and STAAD software.

5.2 CONCLUSION

The duty of housing expected to arise resident of the country is getting huger. Namely to face this kind of dare, the boundary is limitless. It demand to be wise exploited. Construction management not only create but also intensify the standard of life. Their imagination and methodological ability help in groundwork of structural blueprint & construction set all the necessary resource for the building purpose. It is a key for gain knowledge and tackle any kind of situation and resourceful structural design.

In this project we have done the Structural study of both framed structure and MIVAN structure has been carried out using the STAAD Software. Based on the structural member arrived the structural design was carried out using limit state method.

The MIVAN structure has great resistance against seismic forces since all walls are made up of RCC which acts like shear walls.

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