PLANNING, ANALYSIS AND DESIGN OF BLOOD BANK BUILDING

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report **"PLANNING, ANALYSIS AND DESIGN OF BLOOD BANK BUILDING**" is the bonafide work of **"R.MANIKANDAN (422714103045), S.MUTHUKUMARAN (422714103052) AND J.MUTHUNARAYANAN (422714103054)"** who carried out the project work under my supervision.

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ABSTRACT

The project work describes about the planning, analyzing and designing of Blood Bank Building. The plinth area of building is 540m^2 out of total site area of 900 m^2. The blood bank building is located on Thiruvandarkoil, Pondicherry. This building lies on the medium type soil having the safe bearing capacity as 220 KN/m^2. The blood bank building will have 20 numbers of beds. For our project, we have referred IS code books and technical books for designing .The project has the salient features like good foundation and very good sanitary arrangement.

The drawing using **AUTO CAD** software was also prepared during this study. Hence the detailed design for all the structural elements & drawings involved in this study are presented.

In the project, the building is designed as a framed structure. The structural elements such as beams and columns are analyzed by using **STAADpro** software.

The design of the structure is done by referring IS456-2000 and the structural elements slabs, beams, columns and footings are designed as manual design by using Limit state method. For design M20 grade concrete and high yield strength deformed bars of grade Fe 415 has been used.

LIST OF SYMBOLS

f_y	:	Characteristic strength of steel
f_{ck}	:	Characteristic strength of concrete
X_c	:	Depth of neutral axis
E_s	:	Modulus of elasticity
L_x	:	Effective span of shorter span
L_y	:	Effective span of longer span
D	:	Over all Depth
D	:	Effective Depth
C.C	:	Clear cover
d_x	:	Effective depth in shorter span
d_y	:	Effective depth in longer span
D_f	:	Depth of foundation
B_v	:	Basic value
M_f	:	Modification factor
c/c	:	Center to center distance of support
W.S.	:	Thickness of wall
D.L	:	Dead load
L.L	:	Live load
W	:	Total load
W_u	:	Design load
V_u	:	Design shear stress
τ_v	:	Nominal shear stress
τ_c	:	Permissible shear stress
Z	:	Lever arm
BM	:	Bending moment
MR	:	Moment of resistance
SBC	:	Safe bearing capacity of soil
S_v	:	Spacing of vertical stirrups
A_{sv}	:	Shear reinforcement
A_{st}	:	Area of steel in tension

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CHAPTER 1

INTRODUCTION

1.1. GENERAL

A blood bank is a centre where blood gathered as a result of blood donation is stored and preserved for later use in blood transfusion. The term "blood bank" typically refers to a division of a hospital where the storage of blood product occurs and where proper testing is performed (to reduce the risk of transfusion related adverse events). However, it sometimes refers to a collection center, and indeed some hospitals also perform collection.

Now a day, stand alone blood banks also occur and can be a Govt. holding body or a private body.

It also called as blood donation centre or collection centre.

Fig. 1.1 San Diego blood bank

It also usually houses the administration of the BTS or is closely associated with it. The blood centre may accommodate a static blood collection facility while also coordinating mobile and demountable collection facilities. Additional national or regional specialist laboratory services and research activities may be provided from the facility.

Here they separate the human blood into four categories, are WBC, RBC, Platelets and Plasma.

1.2. GROWTH AND CHANGE

Blood centres are not static over time. They change and grow. Change is driven by a number of factors including the introduction of new technologies, equipment and processes, new clinical practices in the use of blood and the improved education and training of staff.

Blood centres grow to absorb change and to provide increased capacity required to service population

When the centre is located on a large parcel of land, growth may occur simply by expanding the centre, when the site is small and the centre is multi-storeyed, growth is more difficult.

1.3. RISK MANAGEMENT

The blood centre is responsible for the processing, testing and storage of blood in the national or provincial BTS.

1.4. BLOOD STORAGE

Blood and blood products are normally stored in one of two ways, in refrigerator and freezer cabinets or in walk-in cool rooms and freeze rooms. Choosing one of these two methods for the primary storage of blood and blood products is central to the operation of the blood centre and should only be made after a detailed review of local circumstances.

1.5. TYPES OF BLOOD TRANSFUSED

Whole blood or blood with RBC is transfused to patients with anaemia/iron deficiency. It also helps to improve the oxygen saturation in blood. It can be stored at 1.0°C-6.0°C for 35-45 days. Platelet transfusion is transfused to those who suffer from low platelet count. This can be stored at room temperature for 5-7 days. Plasma transfusion is indicated to patients with liver failure, severe infections or serious burns. Fresh frozen plasma can be stored at a very low temperature of -25°C for up to 12 months.

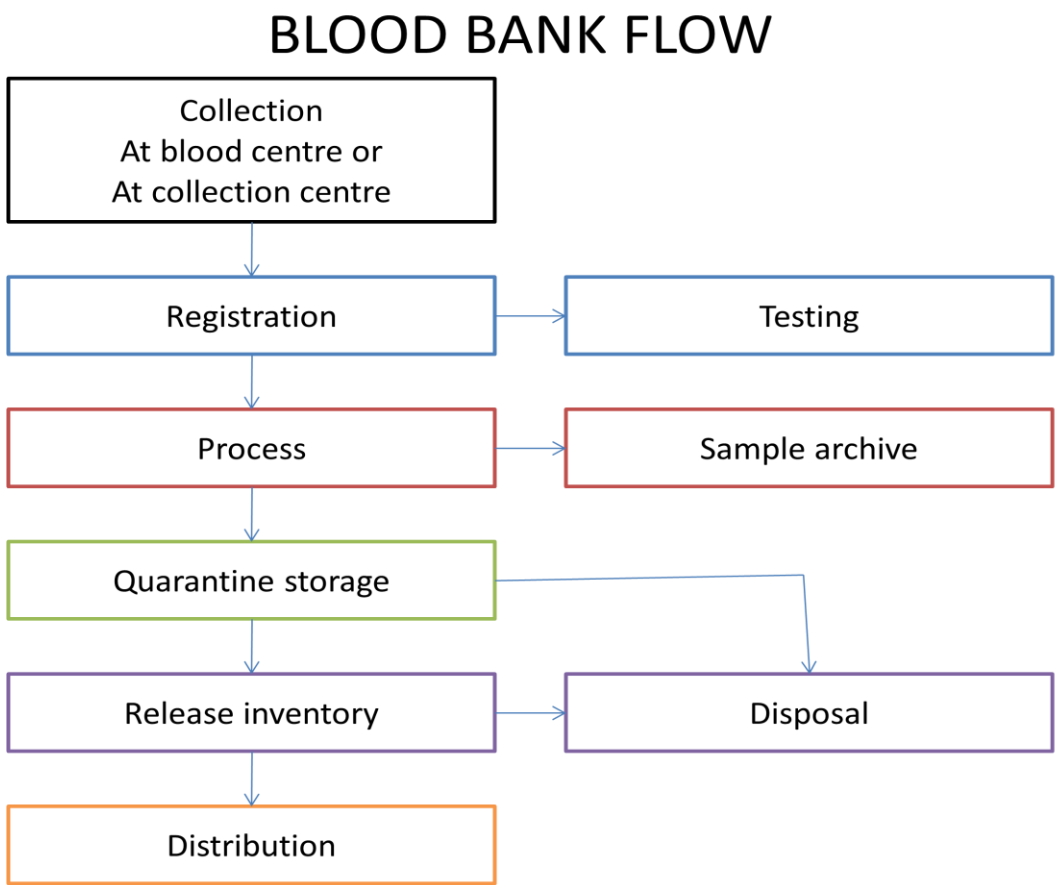


Chart 1.1 Blood bank flow

1.6. PROJECT AT A GLANCE

Type of construction	:	Framed structure
Type of foundation	:	Isolated square footing
Superstructure	:	Brick work in cement mortar 1:5
Roofing	:	Reinforced cement concrete 1:1.5:3
Land area	:	$900m^2$

Plinth area	:	$540m^2$
Grade of concrete	:	M_{20}
Grade of steel	:	Fe_{415}

1.7. SYNOPSIS

The project of the "DESIGN OF BLOOD BANK" presents functional planning, analyzing and designing.

The "BLOOD BANK" will be constructing at Thiruvandarkoil in Pondicherry. Hence the new building is proposed to construct in that area.

The proposed building consist of

- Office room
- Staff room
- Meeting room
- Laundry
- Training room
- Passage
- Store & Delivery room
- Donor treatment
- Donation area
- Toilet
- Waiting hall
- Reception
- Hemoglobin screening

1.8. OBJECTIVES

- To draw the plan, elevation and section for the building with the help of Auto CADD 2010 software.
- To analysis the slab, beam, column and footing of the structure by using the STAAD.pro V8i software.
- To Design the structural components by using limit state method, as per IS Code of IS 456-2000.

CHAPTER 2

LITERATURE REVIEW

Shaik nishrath et.al., they done a project work on blood bank building with shear walls. Considering in this project “Reinforced concrete framed buildings are adequate for resisting both the vertical and the horizontal loads acting on shear walls of a building”. They gave rigidity of shear wall, torsion rigidity and shear center of a building in a detailed description.

D.Gangasekhar et.al., they prepared a project report on blood bank building and estimation. In this report “The building is planned in accordance with the national building code of India”. They finalized the blood bank building with proper ventilation and proper size doors and windows. In this building, ceiling height is provided as 3.2m, for assembly buildings are mentioned national building code (NBC).

Cowper et.al., they described about the framework for analyzing the primary healthcare-seeking patterns of consumers for primary care providers in rural northern California. In this project they analysis the building as blood bank centre analysis.

M.N.Harsitha et.al., they prepared a project report of blood bank building with two wheeler and four wheeler parking. In this report they mentioned about the preservation of blood. This blood bank building has proper cooler room and also cooler room is constructed with thermo concrete. In this project, the ceiling height is provided as 3.5m.

CHAPTER 3
METHODOLOGY

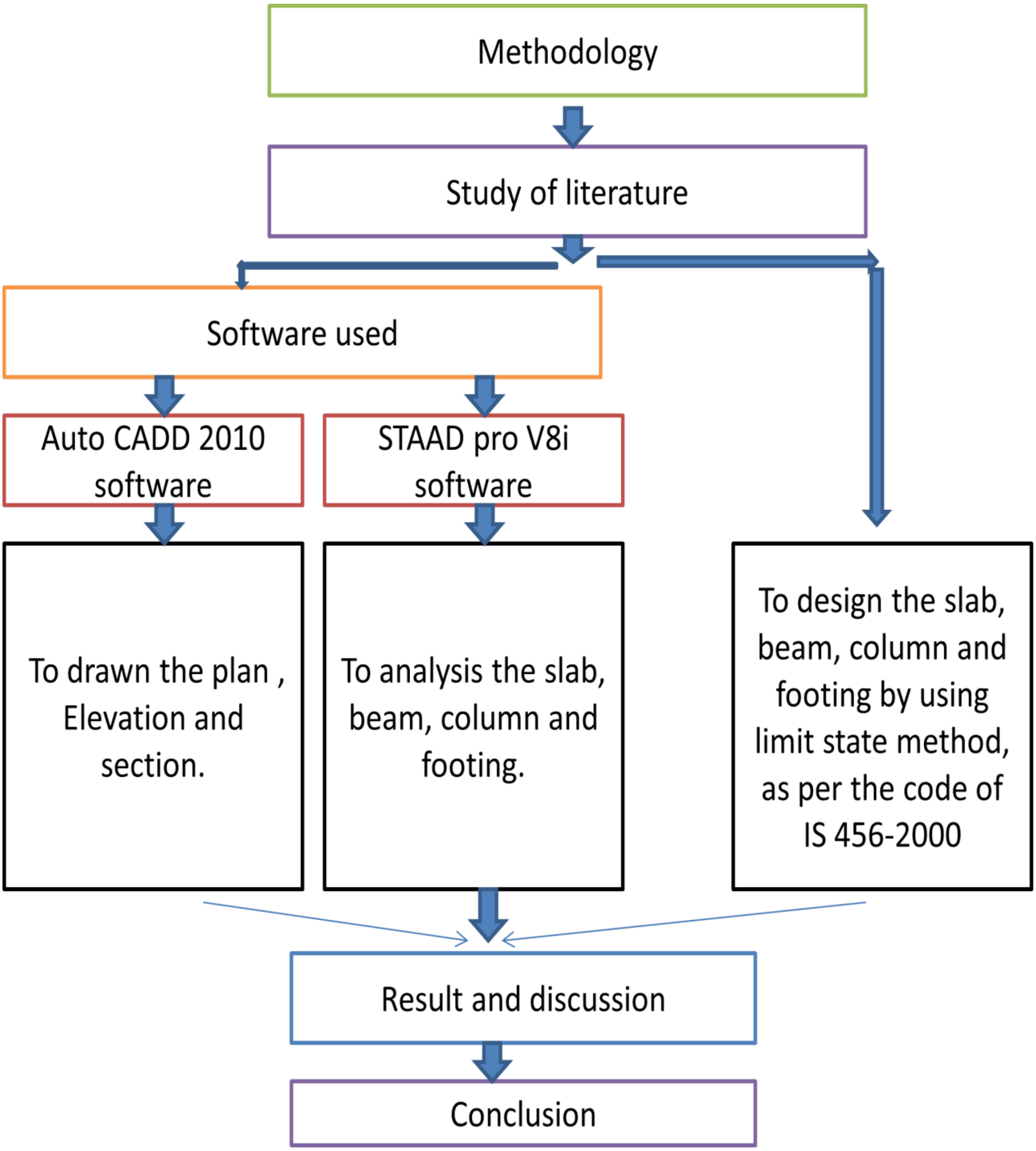


Chart 3.1 Methodology

3.1 GENERAL

The successful design of structures goes back to ancient times. For many centuries, structures were designed using common sense, trial and error, and rules of proportion acquired through experience.

Industrialization and mass-production of iron and steel in the nineteenth century led to rapid changes in construction sector. This is turning provided an impetus to replace the traditional trial-and-error approach for designing structures. It became inevitable in this busy world that usage of the software is a must to save time and to get more accuracy. In this work carried out, we use STAAD.Pro software for the analysis and the design work the various structural components of the building such as slab, beam, column, footing etc.

3.2 METHODOLOGY ADOPTED

All structure has two basic requirements in common. Safety from collapse and satisfactory performance or the structure for its intended use. The limit state design is a philosophy of design where one designs a structure so that it will not reach any of the specified limit states during the expected life of the structure.

Many types of limit states or failure condition can be specified. The two major limit states which are usually considered are the following.

1. The ultimate strength limit state, or the limit state of collapse, which deals with the strength and stability of the structure under the maximum overload it is expected to carry. This implies that no part or whole of the structure should fall apart under any combination of expected overload.
2. The serviceability limit state which deals with conditions such as deflection, cracking of the structure under service loads, durability, over all stability excessive vibration, fire resistance, fatigue etc.

3.3 PARTIAL SAFETY FACTORS FOR LOADS AND MATERIAL STRENGTH γ_m

Having obtained the characteristic loads and characteristic strengths, the design load and design strength are obtained by the concept of partial a\safety factors. Partial safety factors are applied both to loads on the structure and to strength and to strength of materials. These factors are explained below.

3.3.1 PARTIAL SAFETY FACTOR FOR LOAD (γ_f)

The loads to be used for ultimate design is also termed as factored load in IS code the symbol DL is used for Dead Load, LL is used for Live Load, WL for Wind Load and EL for Earthquake Loads. The obtained by multiplying the characteristic load by the partial safety factor is called factored load is given by Factored Load = (characteristic load) x (partial safety factor for load). It is extremely important that in limit state design load is different from that used in elastic design. It is factored loads, and not the characteristic loads which are used for calculation of reactions, bending moment and shear forces.

It may be noted that by adopting a partial safety factor of 1.5, for both dead and live loads, the value of moment, shear force etc. to be used is limit state design by IS code is 1.5 times the moment, shear etc. that would have been for elastic design. The partial safety factors for the different load combinations in table below.

Load combination	**Ultimate limit state**
Dead and Imposed load	1.5DL+1.5IL
Dead and earthquake load	0.9DL+1.5EL
Case 1 : Dead load contributes to stability Case 2 : Dead load assists to overturning	1.5DL+1.5EL
Dead, Imposed and earthquake load	1.2(DL+LL+WL)

3.3.2 PARTIAL SAFETY FACTORS FOR MATERIALS STRENGTH (γ_f)

The grade strength of concrete is the characteristic strength of concrete and guaranteed yield strength of steel. The partial safety factors for concrete and steel is given in table below.

Design strength = Characteristic strength/partial safety for strength.

Material	Ultimate limit
Concrete	1.5
Steel	1.5

3.4 ADVANTAGES OF LIMIT STATES DESIGN

1. Limit states design by providing consistent safety and serviceability, ensures and economical use of materials and a wide range of applications.
2. Limit states design provides both a basic calculation tool for designing and evaluating civil engineering structures and a means for unifying structural codes and standards.

DRAWINGS

CHAPTER 4

INTRODUCTION OF STAAD.PRO

STAAD .Pro is one of the most widely used structural design and analysis software programs in the field of civil engineering and architecture. It is an efficient and highly reliable structural information processing system capable of supplying an engineer with accurate and complete technical data for design and analysis.

STAAD.Pro integers graphical modeling, static, dynamic, and nonlinear analysis, infinite element analysis structural frame design and structural data base management into powerful menu-driven information processing system. STAAD .Pro is used on regular basis by thousands o0f engineers in over 30 countries.

The development of STAAD .Pro (Structural Analysis and Design Professionals) was initiated in 1980 by research and development group, REI (Research Engineers Internationals USA)

STAAD .Pro is used for analysis and design of wide variety of structure types including

- Process plant and industrial structure of all kinds.
- Commercial and Residential low and high rise building structures.
- Large towers structures including power transmission and communication structures.
- Bridge structures including cable stayed, suspension, arch, dams, culverts, bridges, and pre-stressed concrete.
- Civil works structure such as reservoir and floor control dams, culverts, bridges, transportation facilities, and others.
- Radar dishes and their supporting structures.
- Manufacturing and machinery and manufactured component parts.

- Construction and agricultural equipment such as crane booms, loaders earth movers, tillers, and others.
- Transportation equipment such as component part such as automobiles and truck frames and bodies, rail road cars, and connectors, air craft wings and fuselages, ship structures and others

4.1 STAAD EDITOR

Input data is given to the system coded in prescribed syntax.

4.2 GRAPHICAL MODEL CREATION

ADD BEAM is a graphical user Interface within STAAD .Pro that is designed for the generation, display, and changing of structural model data. Some of the major features of ADD BEAM are model creation, naming, editing and checking.

4.3 MEMBERS AND FINITE ELEMENT TYPES

STAAD .Pro contains a large library of member and infinite elements types containing of 7 member types (constant or variable cross section), over 100 conventional, isoperimetric, and hybrid formulation finite element types and many special transition elements including,

- Plane truss/frame/grids and space truss/frame members.
- Curved plane and space frame member’s element including internal pressure effects
- Plate bending elements to mode 1 thin to moderately thick plates (3, 4 and 8 node triangles and quadrilaterals)
- 3-d solids (6, 8 nodes triangular prisms and straight and curved edge bricks)
- Thin shell elements (3 and 4 node triangles and quadrilaterals with 5 or 6 degrees of freedom per code)
- Axis symmetric elements (4, 8 node quadrilaterals) for modeling solids of revolution.
- Large library of special transition elements for plane stress plane strain.

- Axis symmetric stress (4, 8 nodes quadrilaterals) and 3-d solids (8 node bricks) problems.
- Special finite element for modeling shear walls and floors slabs where a rotational degree of freedom is provided a about an axis normal to the element in order to allow coupling of members rational degrees of freedom with the element (Example: Beam bending may now be coupled with a shear wall)
- Multi level super element (i.e. Sub structure defined from user specified collections of members, finite elements and other super elements) may be defined for large and complex linear static analysis problems.

4.4 VARIABLE DEGREE-OF-FREEDOM STRUCTURAL MODELS

Structure may be composed of any combination of member and or finite element types whether they have same or different types and number of displacement degree-of –freedom per code. Only the minimum number of relevant displacement degree-of-freedom is automatically used by STAAD .Pro in the analysis of a structure resulting in significant analysis cost reductions.

4.5 MEMBERS AND FINITE ELEMENT PROPERTY SPECIFICATIONS

4.5.1 MEMBER ELEMENT PROPERTIES

Prismatic and variable section member property input including cross-sectional area, shear areas, torsion constant, bending moment of inertia, section moduli, cross-section dimensions, location of shear center and others.

Pre-stored tabular specification of member properties including channel, tree, single and double angle, pipe, tube, round and rectangular solid bar and other shapes. Further users may specify member properties by giving a flexibility or stiffness matrix.

4.5.2 FINITE ELEMENT PROPERTIES

- Element rigidity matrix input for orthographic or anisotropic material properties.

- Element type and thickness for isotropic elements.
- Order of numerical integration for certain element for better control of accuracy and efficiency.

4.6 BASIC STRUCTURAL ANALYSIS

Structural engineering is a result dependent process. Following the review and revolution of previously obtained results, the engineer decide on appropriate additions, changes, and deletions to the structure currently under design modifications to design are also driven by the demands of the client, the fabricator, the contractor and other such influencing factors.

4.6.1 STATIC ANALYSIS

Equilibrium equation for static analysis is

$$[k]\{U\} = \{f\}$$

Where,

k is the stiffness matrix,

u is the displacement and

f is the force.

For each currently ACTIVE dependent loading condition the loading combination is formed during the STIFFNESS ANALYSIS according to the load combination factors.

4.6.2 DYNAMIC ANALYSIS

Equilibrium equation for the dynamic analysis

$$Mx+cx+kx = f\ (t)$$

STAAD .Pro performs linear dynamic analysis of frame and finite element structures. Some of the types of dynamic analysis performed are:

- Eigen value analysis for the computation of natural frequencies and mode shapes.
- Response spectrum analysis for the earth loading.
- Steady state analysis for the harmonic loads.

- Maximum response harmonic analysis to compute peak steady state response.
- Analysis, static or dynamic, can acquire a highly complicated nature.
- The process has been highly simplified by the usage of processing tools such as STAAD .Pro.

ANALYSIS REPORT

STAAD.Pro Report

Job Information

Structure Type	SPACE FRAME

Number of Nodes	120	Highest Node	120
Number of Elements	214	Highest Beam	281
Number of Plates	56	Highest Plate	337

Number of Basic Load Cases	3
Number of Combination Load Cases	4

Type	L/C	Name
Primary	1	SEISMIC
Primary	2	DEAD
Primary	3	LIVE
Combination	4	1.5(DL+IL)
Combination	5	1.2(DL+IL+EL)
Combination	6	1.5(DL+EL)
Combination	7	0.9DL+1.5EL

Table 4.1: Materials

Mat	Name	E (kN/mm^2)	N	Density (kg/m^3)	A (/°C)
1	STEEL	205.000	0.300	7.83E 3	12E -6
2	STAINLESSSTEEL	197.930	0.300	7.83E 3	18E -6
3	ALUMINUM	68.948	0.330	2.71E 3	23E -6
4	CONCRETE	21.718	0.170	2.4E 3	10E -6

Table 4.2: Primary Load Cases

Number	Name	Type
1	SEISMIC	Seismic
2	DEAD	Dead
3	LIVE	Live

Table 4.3: Combination Load Cases

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
4	1.5(DL+IL)	2	DEAD	1.50

		3	LIVE	1.50
5	1.2(DL+IL+EL)	2	DEAD	1.20
		3	LIVE	1.20
		1	SEISMIC	1.20
6	1.5(DL+EL)	2	DEAD	1.50
		1	SEISMIC	1.50
7	0.9DL+1.5EL	2	DEAD	0.90
		1	SEISMIC	1.50

Table 4.4: Reaction Summary

			Horizontal	**Vertical**	**Horizontal**	**Moment**		
	Node	**L/C**	**FX** (kN)	**FY** (kN)	**FZ** (kN)	**MX** (kNm)	**MY** (kNm)	**MZ** (kNm)
Max FX	25	4:1.5(DL+IL)	**13.266**	396.490	2.862	1.427	0.002	-6.207
Min FX	26	6:1.5(DL+EL)	**-65.857**	737.905	-0.996	-2.400	-0.703	55.696
Max FY	10	6:1.5(DL+EL)	-60.422	**738.659**	-8.846	-6.233	-0.697	51.086
Min FY	25	1:SEISMIC	-26.473	**-55.529**	-4.675	-4.114	-0.468	28.883
Max FZ	8	6:1.5(DL+EL)	-38.618	305.328	**32.684**	17.900	-0.621	39.819
Min FZ	34	6:1.5(DL+EL)	-56.448	430.193	**-31.384**	-16.685	-0.691	52.370
Max MX	8	6:1.5(DL+EL)	-38.618	305.328	32.684	**17.900**	-0.621	39.819
Min MX	34	6:1.5(DL+EL)	-56.448	430.193	-31.384	**-16.685**	-0.691	52.370
Max MY	33	4:1.5(DL+IL)	11.571	226.012	-21.440	-9.933	**0.018**	-5.415
Min MY	40	6:1.5(DL+EL)	-42.882	305.621	-27.418	-9.756	**-0.792**	46.003
Max MZ	26	6:1.5(DL+EL)	-65.857	737.905	-0.996	-2.400	-0.703	**55.696**
Min MZ	25	4:1.5(DL+IL)	13.266	396.490	2.862	1.427	0.002	**-6.207**

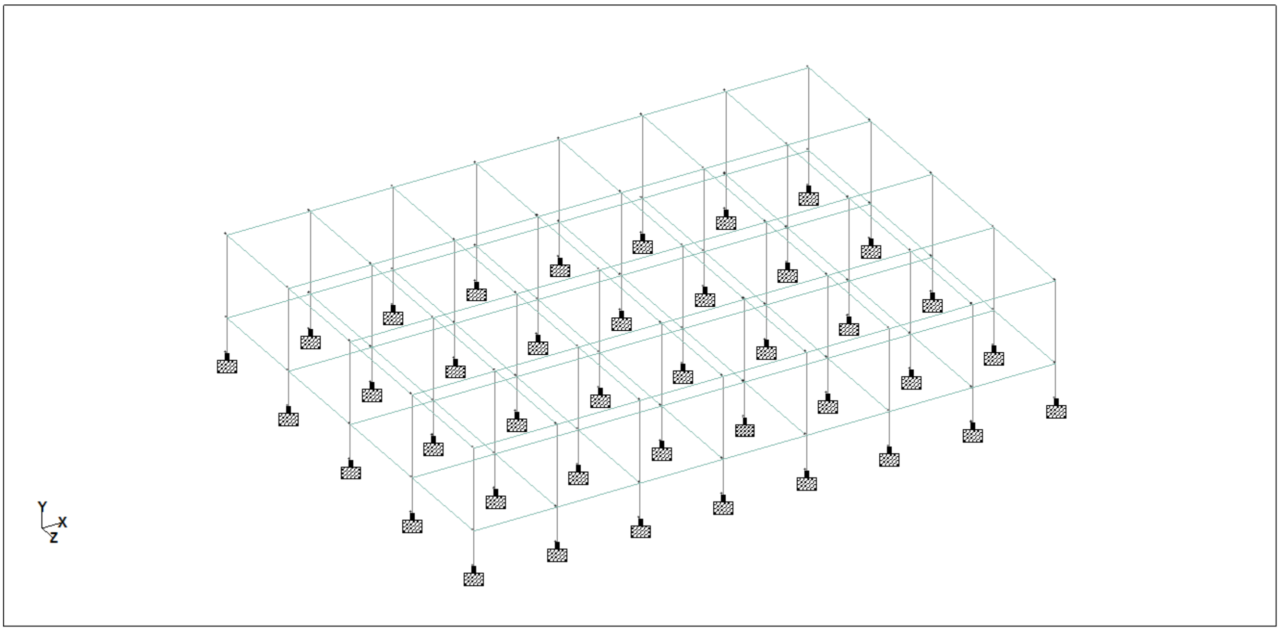


Fig. 4.1 Whole structure

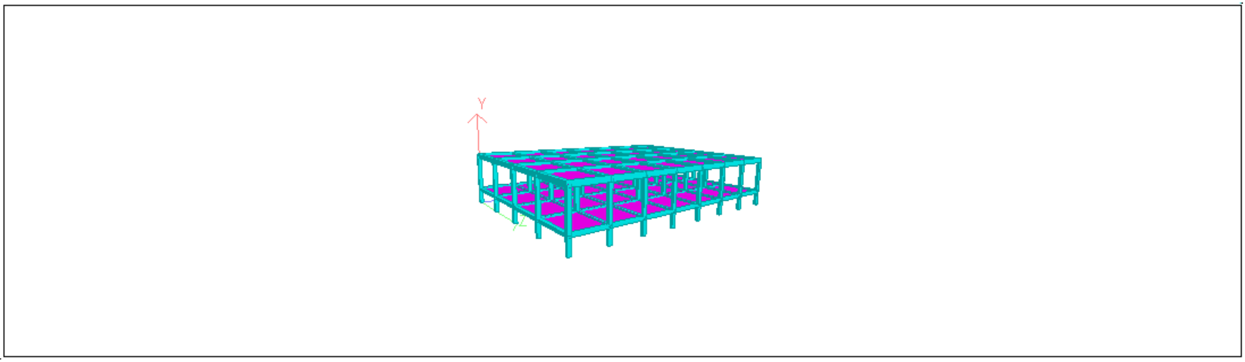


Fig. 4.2 3D Rendered View

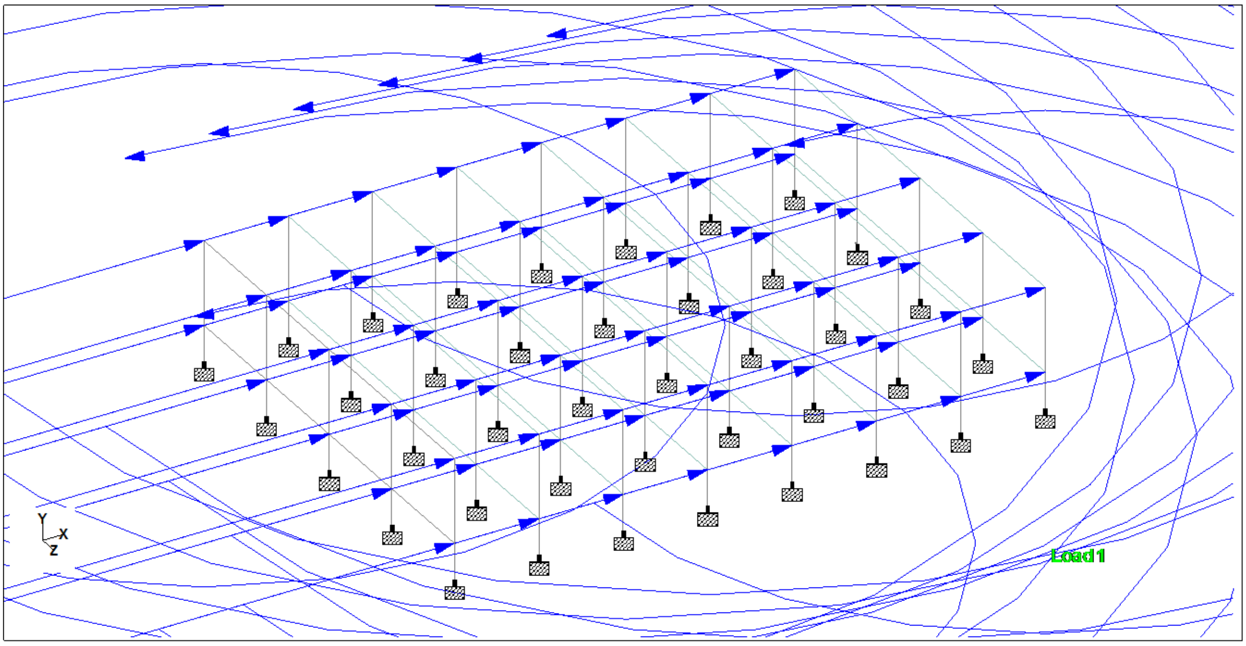


Fig. 4.3 Seismic load

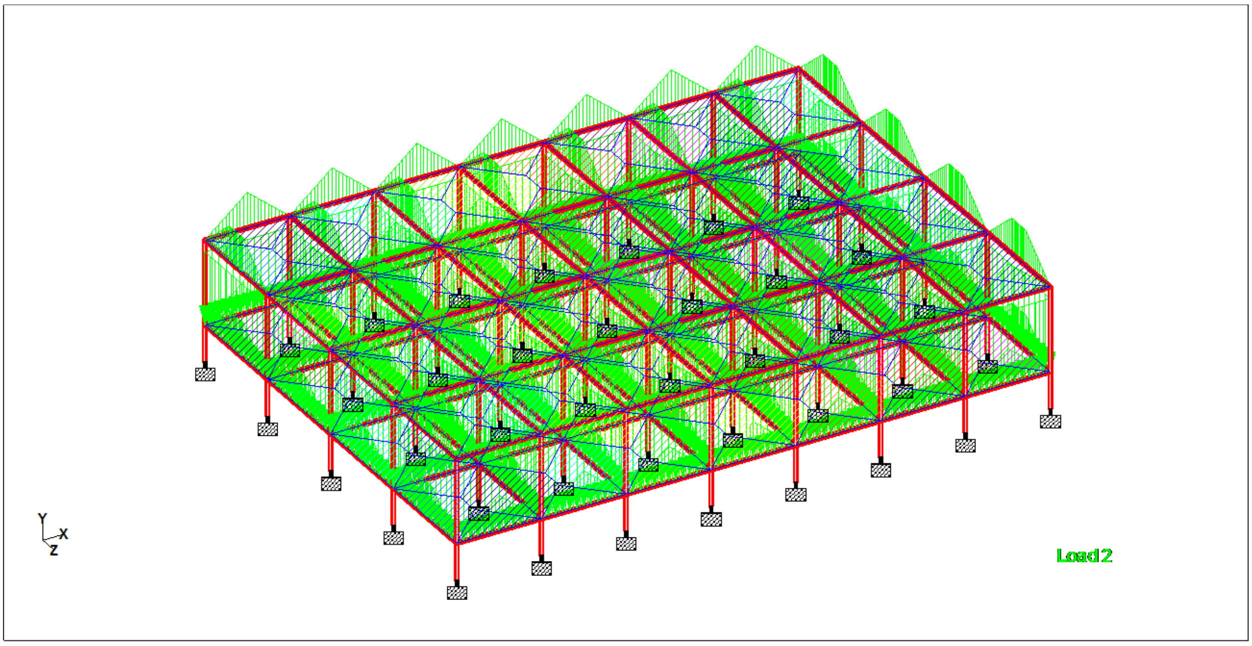


Fig. 4.4 Dead load

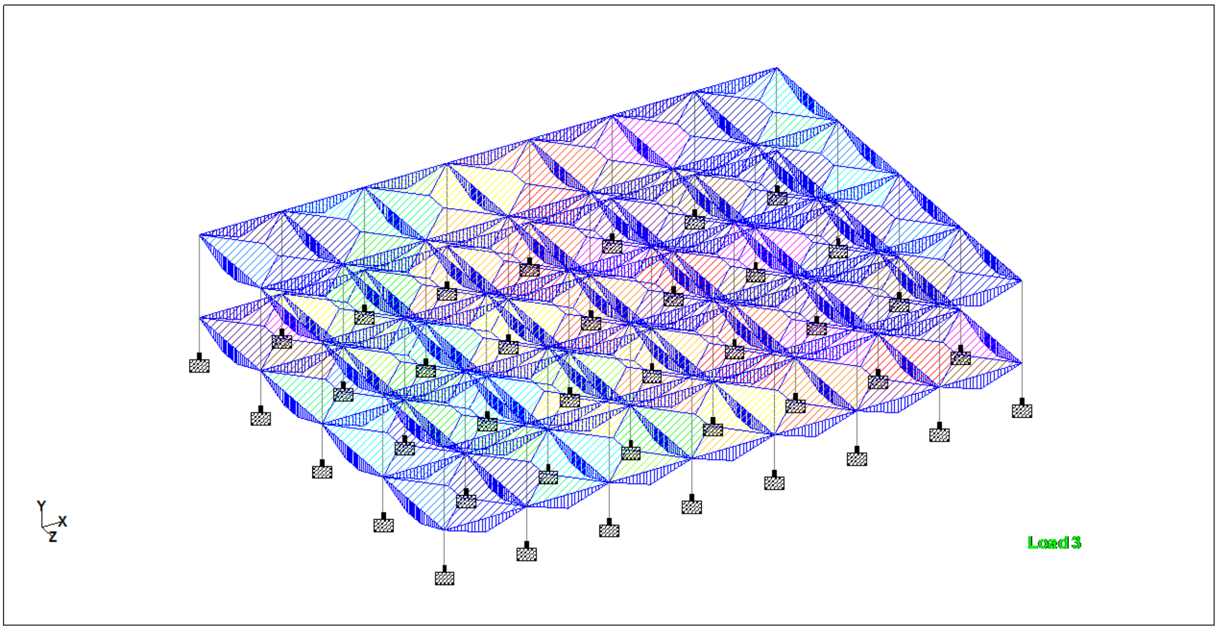


Fig. 4.5 Live load

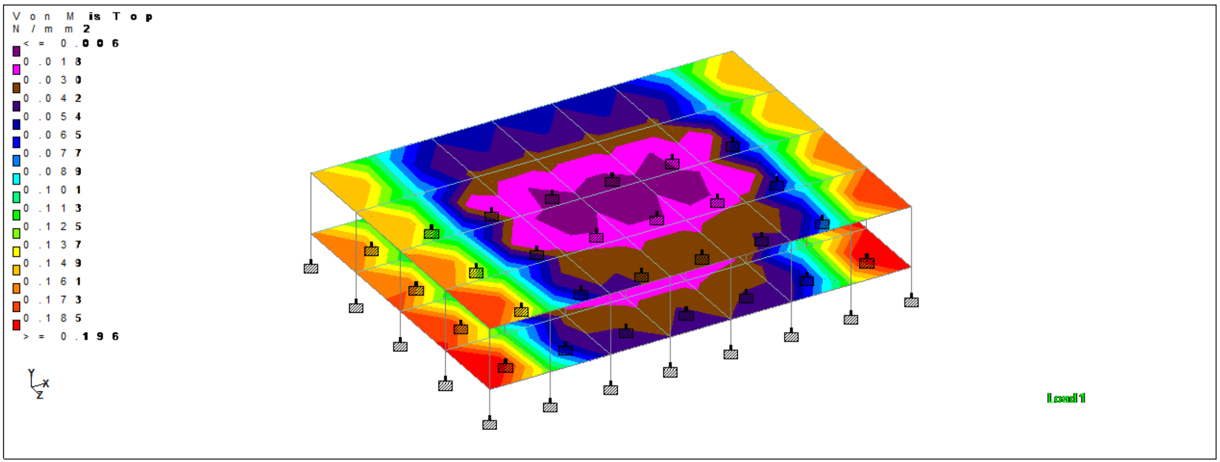


Fig. 4.6 Stress diagram due to seismic load

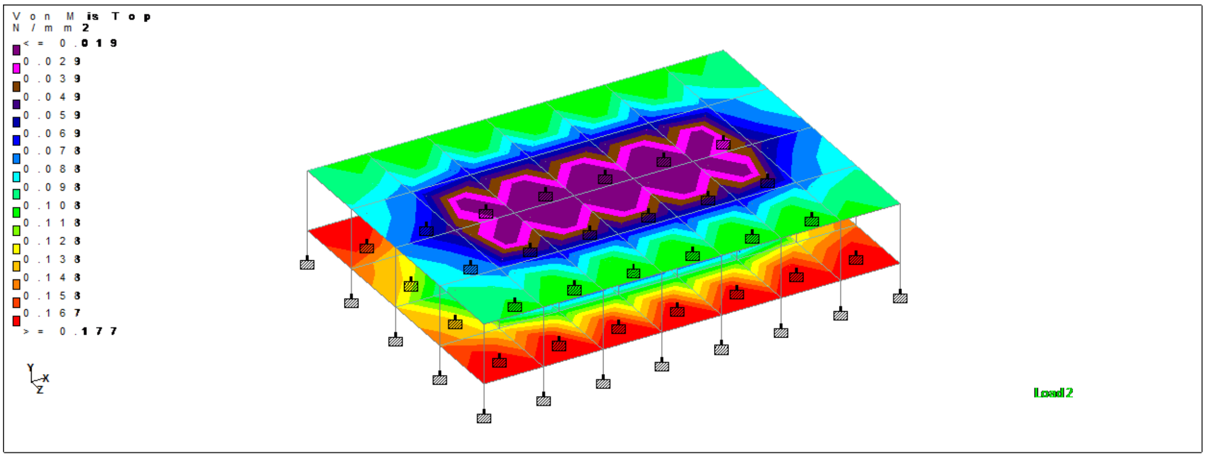


Fig. 4.7 Stress diagram due to Dead load

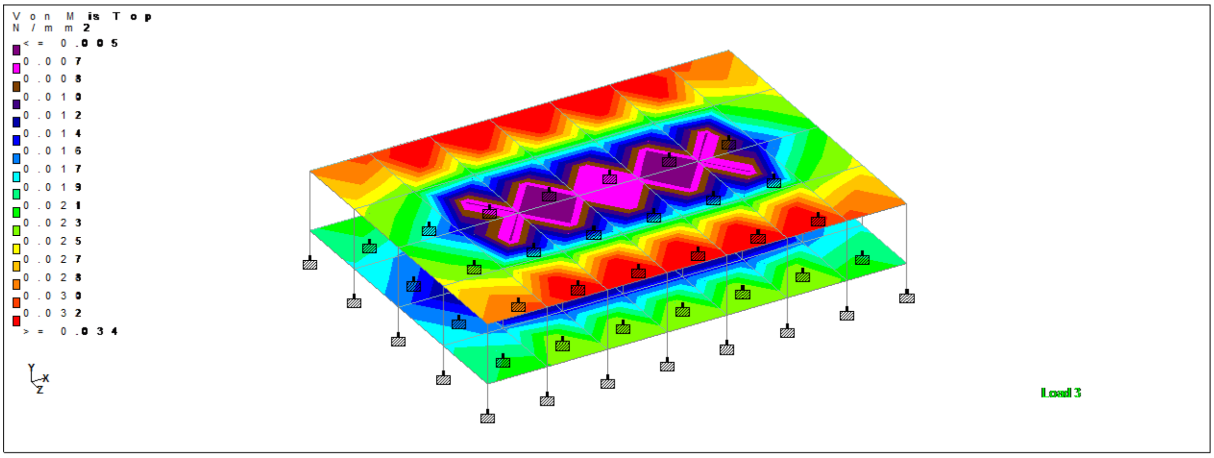


Fig. 4.8 Stress diagram due to Live load

Table 4.5: Column Input Data

Member	Type	Length (m)	Eff. Length Factors		Braced		Cover (cm)	Link Size
			Major	Minor	Major	Minor		
M1	Column	1.500	1.00	1.00	No	No	4.0	8
M42	Column	3.500	1.00	1.00	No	No	4.0	8

Table 4.6: Column Main Reinforcement

Member	L/C	Axial (kN)	Major (kNm)	Minor (kNm)	Design Axis	As Req. (mm^2)	Total Bars	As Prov. (mm^2)
M1	L1	177.962	28.091	17.500	Biaxl maj	804	4T16	804
M42	C6	164.325	74.493	13.026	Biaxl maj	3217	16T16	3217

Table 4.7: Member 1 - Scheduled Bars

Bar Mark	Type and Size	No. Of Bars	Bar Length (mm)	Shape Code	A (mm)	B (mm)	C (mm)
01	T16	4	1500	00			
02	T8	6	1000	51	220	220	

Table 4.8: Member 42 - Scheduled Bars

Bar Mark	Type and size	No. Of Bars	Bar Length (mm)	Shape Code	A (mm)	B (mm)	C (mm)
01	T16	16	3500	00			
02	T8	14	1000	51	220	220	
03	T8	28	475	13	125	220	50

Table 4.9: Beam Spans

Member	Span	Type	Length (m)	Cover Top (cm)	Cover Btm (cm)	Cover Side (cm)	Link Size
M91	1	Beam	3.500	2.5	2.5	2.5	8
	2	Beam	3.500	2.5	2.5	2.5	8
	3	Beam	3.500	2.5	2.5	2.5	8
	4	Beam	3.500	2.5	2.5	2.5	8
	5	Beam	3.500	2.5	2.5	2.5	8
	6	Beam	3.500	2.5	2.5	2.5	8
	7	Beam	3.500	2.5	2.5	2.5	8

Table 4.10: Member 91 - Main Steel Summary

Distance (m)	Span	Moment (kNm)	As Req. (mm^2)	As' Req. (mm^2)	Bottom	Top Layers		
					Bars	Area	Bars	Area
0.000	1(s)	22.218	255	0		679		679
		-18.151	209	0				
0.150	1	16.661	188	0		339		339
		-16.754	189	0				
0.500	1	4.839	160	0		339		339
		-13.494	160	0				
1.000	1	0.971	160	0		339		339
		-8.836	160	0				
1.500	1	2.026	160	0		679		679
		-14.027	160	0				
2.000	1	1.959	160	0		339		339
		-13.473	160	0				
2.500	1	5.136	160	0		339		339
		-5.855	160	0				
3.000	1	9.794	160	0		339		339
		-1.138	160	0				
3.350	1	20.206	230	0		339		339
		-2.728	160	0				
3.500	1(e)	26.095	303	0		679		679
		-3.432	160	0				
3.500	2(s)	25.851	299	0		679		679
		-11.886	160	0				
3.650	2	20.103	225	0		339		339
		-10.842	160	0				
4.000	2	7.838	160	0		339		339
		-8.405	160	0				
4.500	2	0.680	160	0		339		339
		-5.152	160	0				
5.000	2	1.812	160	0		339		339
		-12.297	160	0				
5.250	2	1.987	160	0		339		339
		-13.372	160	0				
5.500	2	2.038	160	0		339		339
		-12.377	160	0				
6.000	2	5.519	160	0		339		339
		-5.393	160	0				
6.500	2	9.001	160	0		339		339
		-1.122	160	0				
6.850	2	19.589	219	0		339		339

		-2.658	160	0				
7.000	2(e)	25.288	286	0		679		679
		-3.339	160	0				
7.000	3(s)	25.331	287	0		679		679
		-12.869	160	0				
7.150	3	19.613	219	0		339		339
		-11.770	160	0				
7.500	3	7.415	160	0		339		339
		-9.204	160	0				
8.000	3	0.715	160	0		339		339
		-5.539	160	0				
8.500	3	1.837	160	0		339		339
		-12.527	160	0				
8.750	3	2.007	160	0		679		679
		-13.554	160	0				
9.000	3	1.836	160	0		339		339
		-12.511	160	0				
9.500	3	5.457	160	0		339		339
		-5.431	160	0				
10.000	3	9.122	160	0		339		339
		-1.129	160	0				
10.350	3	19.715	220	0		339		339
		-2.673	160	0				
10.500	3(e)	25.443	288	0		679		679
		-3.357	160	0				
10.500	4(s)	25.443	288	0		679		679
		-12.725	160	0				
10.650	4	19.701	220	0		339		339
		-11.635	160	0				
11.000	4	7.492	160	0		339		339
		-9.090	160	0				
11.500	4	0.711	160	0		339		339
		-5.454	160	0				
12.000	4	1.834	160	0		339		339
		-12.482	160	0				
12.250	4	2.004	160	0		679		679
		-13.517	160	0				
12.500	4	1.834	160	0		339		339
		-12.482	160	0				
13.000	4	5.454	160	0		339		339
		-5.418	160	0				
13.500	4	9.090	160	0		339		339
		-1.129	160	0				
13.850	4	19.701	220	0		339		339
		-2.672	160	0				
14.000	4(e)	25.424	288	0		679		679
		-3.355	160	0				
14.000	5(s)	25.443	288	0		679		679
		-12.787	160	0				
14.150	5	19.715	220	0		339		339
		-11.687	160	0				
14.500	5	7.495	160	0		339		339
		-9.122	160	0				
15.000	5	0.711	160	0		339		339
		-5.457	160	0				
15.500	5	1.836	160	0		339		339
		-12.511	160	0				
15.750	5	2.007	160	0		679		679
		-13.554	160	0				
16.000	5	1.874	160	0		339		339
		-12.527	160	0				
16.500	5	5.539	160	0		339		339
		-5.479	160	0				
17.000	5	9.204	160	0		339		339

		-1.123	160	0				
17.350	5	19.613	219	0		339		339
		-2.666	160	0				
17.500	5(e)	25.331	287	0		679		679
		-3.349	160	0				
17.500	6(s)	25.288	286	0		679		679
		-12.482	160	0				
17.650	6	19.589	219	0		339		339
		-11.437	160	0				
18.000	6	7.436	160	0		339		339
		-9.001	160	0				
18.500	6	0.708	160	0		339		339
		-5.519	160	0				
19.000	6	1.821	160	0		339		339
		-12.377	160	0				
19.250	6	1.987	160	0		679		679
		-13.372	160	0				
19.500	6	1.812	160	0		339		339
		-12.297	160	0				
20.000	6	4.924	160	0		339		339
		-5.152	160	0				
20.500	6	8.405	160	0		339		339
		-1.169	160	0				
20.850	6	20.103	225	0		339		339
		-2.719	160	0				
21.000	6(e)	25.851	293	0		679		679
		-3.405	160	0				
21.000	7(s)	26.095	297	0		679		679
		-14.451	160	0				
21.150	7	20.206	227	0		339		339
		-13.054	160	0				
21.500	7	7.609	160	0		339		339
		-9.794	160	0				
22.000	7	0.769	160	0		339		339
		-5.855	160	0				
22.500	7	1.959	160	0		339		339
		-13.473	160	0				
22.750	7	2.163	160	0		339		339
		-14.785	164	0				
23.000	7	4.179	160	0		339		339
		-14.027	160	0				
23.500	7	8.836	160	0		339		339
		-7.516	160	0				
24.000	7	13.494	160	0		339		339
		-0.802	160	0				
24.350	7	16.754	187	0		339		339
		-2.297	160	0				
24.500	7(e)	22.218	251	0		679		679
		-2.961	160	0				

Summary: the member is **safe**

Table 4.11: Member 91 - Main Reinforcing Bars

Bar	Size	Design Length Start (m)	Design Length End (m)	Anchorage (cm)
1	12	0.001	24.499	56.4
2	12	0.001	24.499	56.4
3	12	0.001	24.499	56.4
4	12	0.001	24.499	56.4
5	12	0.001	24.499	4
6	12	0.001	24.499	56.4

Table 4.12: Member 91 - Shear Zones Summary

Range (m)	Asv Provided (mm^2)	Legs	Spacing (cm)
0.001 - 3.499	101	2	12.5
3.499 - 6.999	101	2	12.5
6.999 - 10.499	101	2	12.5
10.499 - 13.999	101	2	12.5
13.999 - 17.499	101	2	12.5
17.499 - 20.999	101	2	12.5
20.999 - 24.499	101	2	12.5

Summary: the member is **safe**

Table 4.13: Span / Effective Depth

Member	Span	Length (m)	Type	Basic Limit	Modified Limit	Span Depth
M91	1	3.500	Beam	26.0	50.9	13.4
	2	3.500	Beam	26.0	50.9	13.4
	3	3.500	Beam	26.0	50.9	13.4
	4	3.500	Beam	26.0	50.9	13.4
	5	3.500	Beam	26.0	50.9	13.4
	6	3.500	Beam	26.0	50.9	13.4
	7	3.500	Beam	26.0	50.9	13.4

STRUCTURAL DESIGN

DESIGN OF ROOF SLAB (TWO WAY SLAB)

As per IS 456-2000

GENRAL

Slabs are primary members (element) of a structure which support the imposed loads directly on them and transfer the same safety to the supporting elements such a beams, walls, columns, etc., Therefore a slab should be safe and stable against the applied loads and should have the required strength and stiffness to satisfy the serviceability requirements.

LOADS ON SLABS

Generally, in the design of horizontal slabs, two typ0es of loads are considered:

IMPOSED LOADS

Imposed load is the load induced by the indented use or occupancy of the building including the weight of movable partitions, loads due to impact vibrations and snow loads. The imposed loads for roof slabs are given in the Table 2 of IS: 875(part 2) 1987.

DEAD LOADS

The dead load in a slab comprises the weight of immovable partitions. Floor finish, weathering course and preliminary its self weight. The dead loads are to be determined based on the unit weights of material and components as given in Table1 and 2.

BASIC RULES FOR THE DESIGN OF SLABS

The two main factors to be considered while designing a slab are,

1. Strength of slab against flexure, shear, twist etc.
2. Stiffness against deflection.

Normally, a slab is primarily designed for flexural and checked for shear, stiffness etc. The thickness of the slab should be sufficient to satisfy the strength and stiffness criteria as specified in clauses 18 to 24 IS:456-2000. Steel reinforcement is to be provided in slabs in accordance with the requirements is found is more than that required for strength requirements.

TWO-WAY SLAB-CODAL REQUIRMENTS

A slab is called a “Two way” when the load on it distributed to all its four supports. In two slab tension (main) reinforcement is provided in the short well as in the long direction.

EFFECTIVE SPAN

Effective span of a simply supported slab is the lesser of,

I. c/c distance of supports and

II. clear span + depth/2,

In two way slabs, the main reinforcement in shorter direction is placed at the bottom slab with the necessary cover to reinforcement and that in the longer direction is placed just over the reinforced in shorter direction. Therefore the effective depth for a long span reinforcement will be less than that of the short span reinforcement. But, for the calculation of effective span in the long and short directions, the effective depth of main reinforcement of shorter span is used. However while calculating the area of tension steel required for the two directions, the corresponding effective depth values are used. The other code specification (regarding effective span) specified for one way slabs are applicable to two way slabs also.

THICKNESS OF SLAB REQUIRED

FOR STRENGTH

In a two way slab, generally, the bending moment will be maximum in the shorter span direction. The thickness of the slab is then determined considering the maximum bending moment in the slab. Reinforcement is provided at the different sections taking into account the corresponding bending moments.

FOR STIFFNESS

For the control of deflection. The thicknesses of slab satisfy the requirement specified in clause 23.2of IS: 456-2000 as in the case of one way slabs. For two way slabs of shorter spans up to 3.5m, and imposed load less than or equal to $3kN/m^2$, the thickness of slab should satisfy the conditions specified in clause 24.1 of IS:456-2000.

BENDING MOMENTS IN TWO WAY SLABS

The maximum bending moments, per unit width, in a two way slab are determined as,

$M_x = \alpha_x W_u l_x^2$

$M_y = \alpha_y W_u l_x^2$

Where α_x and α_y are co-efficient given in Table 26 and 27 of IS: 456-2000.

W_u = total design load per unit area and

l_x = length of the slab in shorter direction.

DATA:

Size $= 4.5mX3.5m$

L_y $= 4500mm$

L_x $= 3500mm$

Width of support (w.s) = 300mm

Live load (L.L) $= 3KN/m^2$

Weathering coarse (w.c) $= 0.8KN/m^2$

Grade of concrete (f_{ck}) $= 20N/mm^2$

Grade of steel (f_y) $= 415N/mm^2$

Side ratio:

$Ly/Lx = 4.5/3.5$

$1.28<2$

Therefore, it is two way slab.

Trial section:

$$d_x = \frac{lx}{Bc\,Mf}$$

$$= \frac{3500}{(32X0.9)}$$

$$d_x = 121.52mm$$

$$d_x = 120mm$$

$$d_y = d_x - ø$$

$$= 120 - 10$$

$$d_y = 110mm$$

$$d' = c.c + \frac{ø}{2} \; [\, ø = 10mm]$$

$$= 15+\frac{10}{2}$$

$$d' = 20mm$$

D = dx+d'

= 120+20

D = 140mm

Adopt:

D = 140mm

d_x = 120mm

d_y = 110mm

d' = 20mm

ø = 10mm

b = 1000mm

Effective length

w.s > $\frac{l}{12}$

300 > $\frac{3500}{12}$

300 > 291.67

Shorter span:

1) $L_x + \frac{dx}{2} = 3500 + \frac{120}{2} = 3560$mm
2) $L_x + \frac{w.s}{2} = 3500 + \frac{300}{2} = 3650$mm

L_{eff} = 3560mm (or) 3.56m

Design load:(W_u)

Live load (L.L) = 3KN/m^2

Weathering course= 0.8KN/m^2

Dead load (D.L) = DXbXLX25

= 0.14X1X1X25

D.L = 3.50KN/m^2

Total load (w) = L.L + w.c + D.L

= 3 + 0.8 + 3.5

W = 7.3 KN/m^2

Consider 1m breath w = 7.3 KN/m

W_u = $wx\gamma_f$

= 7.3 x 1.5

W_u = 10.95 KN/m

Design moment (Mu):

M_{ux-ve} = $W_u \alpha_{x-ve} l_x^2$

= $10.95x0.047x3.56^2$

M_{ux-ve} = 6.52 KNm (or) $6.52x10^6$ Nmm

M_{ux+ve} = $W_u \alpha_{x+ve} l_x^2$

= $10.95x0.036x3.56^2$

M_{ux+ve} = 5 KNm (or) $5x10^6$ Nmm

M_{uy-ve} = $W_u \alpha_{y-ve} l_x^2$

= $10.95x0.032x3.56^2$

M_{uy-ve} = 4.44 KNm (or) $4.44x10^6$ Nmm

M_{uy+ve} = $W_u \alpha_{y+ve} l_x^2$

= $10.95x0.024x3.56^2$

M_{uy+ve} = 3.33 KNm (or) $3.33x10^6$ Nmm

M_{umax} = 6.52 KNm (or) $6.52x10^6$ Nmm

Effective depth:

d_{reqd} = $\sqrt{\frac{\text{Mumax}}{\text{Qu.b}}}$

= $\sqrt{\frac{6520000}{2.672X1000}}$

d_{reqd} = 49.40mm

Check:

$d_{reqd} < d_{ass}$

49.40 < 100mm

Hence it is safe

Middle strip:

Ast_x:

$M_{ux} = 0.87f_yAstd(1-\frac{Astfy}{bdfck})$

$6.52x10^6 = 0.87x500xAstx120(1-\frac{AstX500}{1000X120X20})$

$Ast = 128.34mm^2$

Min Ast:

$Ast_{min} = 0.12\%bD$

$= \frac{0.12}{100}x1000x140$

$= 168mm^2$

Spacing:

$S = \frac{ast}{Ast}x1000$

$= \frac{78.54}{168}x1000$

S = 467mm = 400mm

Min spacing:

3d or 300mm

3x120 or 300mm

360 or 300mm

S_x = 300mm

Adopt:

S_x = 300mm

Ast$_y$:

$M_{uy} = 0.87f_yAstd(1-\frac{Astfy}{bdfck})$

$6.52x10^6 = 0.87x500xAstx120(1-\frac{AstX500}{1000X120X20})$

Ast = 128.34mm^2

Min Ast:

Ast_{min} = 0.12%bD

$= \frac{0.12}{100}x1000x140$

= 168mm^2

Spacing:

$S = \frac{ast}{Ast}x1000$

$= \frac{78.54}{168}x1000$

S = 467mm = 400mm

Min spacing:

3d or 300mm

3x120 or 300mm

360 or 300mm

S_y = 300mm

Adopt:

S_y = 300mm

Provide:

Middle stirrup $Ast(\frac{3}{4}l_x\&l_y)$

Ast_x = 10mm@ 300mm c/c

Ast_y = 10mm@ 300mm c/c

Edge stirrup:

Ast = Ast_{min}

Ast = 168mm

S $= \frac{ast}{Ast} x1000$

$= \frac{50.26}{168} x1000$

S = 300mm = 300mm

Min spacing:

5d or 450mm

5x120 or 450mm

600 or 450mm

Adopt:

S = 300mm

Provide:

Edge stirrup Ast($\frac{1}{8}l_x \& l_y$)

8mm ø @ 300mm c/c

Check for deflection:

$d_{reqd} = \frac{leff}{Bc\,Mf}$ base value B_v = 40x0.8 = 32

f.s $= 0.58xf_y x \frac{Ast\ reqd}{Ast\ pro}$

Ast pro $= \frac{ast}{s} x1000$

$= \frac{78.54}{300} x1000$

Ast pro = 261.8mm

$$f.s = 0.58x500x\frac{168}{261.8}$$

$$f.s = 186N/mm^2$$

%Ast provide:

$$= \frac{\text{Ast pro}}{bd}x100$$

$$= \frac{261}{1000X120}x100$$

$$\%\text{Ast provide} = 0.21$$

$$\%\text{therefore Mf} = 2$$

$$d_{reqd} = \frac{3560}{32X2}$$

$$d_{reqd} = 55.625mm$$

Check:

$$d_{reqd} < 120mm$$

$$55.63 < 120mm$$

Hence it is safe against to deflection

Check for shear:

Design shear:(V_u)

$$V_u = Wux0.6xl_{xeff}$$

$$= 10.95x0.6x3.56$$

$$V_u = 23.38KN$$

Nominal shear stress:(τ_v)

$$\tau_v = \frac{Vv}{bd}$$

$$= \frac{23.38X1000}{1000X120}$$

$$\tau_v = 0.194N/mm^2$$

Permissible shear stress:(τ_c)

%Astprov. Concrete grade

$\%Astprov \quad = \frac{\text{Ast pro}}{\text{bd}} x100$

%Ast provide= 0.21%

$K \quad = 1.3$

$0.15 = 0.28$

$0.20 = ?$

$0.25 = 0.36$

$\tau_c \quad = 0.28+[(\frac{0.36-0.28}{0.25-0.15})x(0.21-0.15)$

$\tau_c \quad = 0.33$

$K\ \tau_c \quad = 0.429 N/mm^2$

Maximum shear stress:(τ_{cmax})

$\frac{1}{2}\ \tau_{cmax} = \frac{1}{2} x2.8$

$\tau_{cmax} \quad = 1.4 N/mm^2$

Check:

$\tau_v < K.\ \tau_c < \frac{1}{2}\ \tau_{cmax}$

$0.194<0.429<1.4$

It is safe against shear

Adopt:

Size of slab = 4.5m x 3.5m

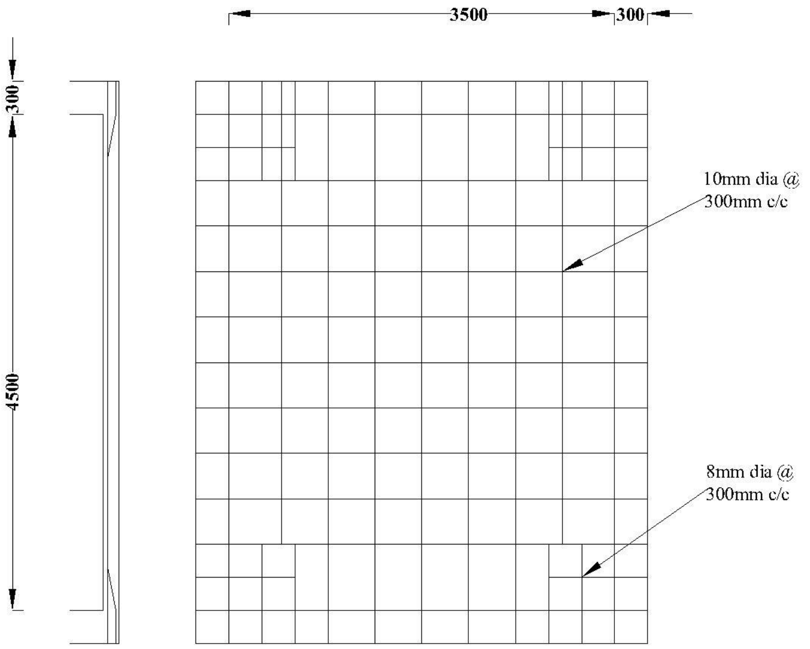
Middle strip Ast.

Ast_x = 10mm dia bars @ 300mm c/c

Ast_y = 10mm dia bars @ 300mm c/c

Edge strip Ast.

8mm dia bars @ 300mm c/c.



Reinforcement detial of slab (Top view)

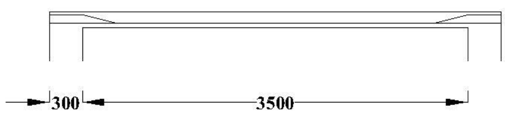


Fig.5.1 Reinforcement detial of slab (Cross sectional view)

DESIGN OF BEAM

As per IS 456-2000

GENERAL

A beam has to be generally designed for the actions such as bending moments. Shear forces and twisting moments developed the laterals loads. The bending moment in a beam is maximum only at certain section/sections and of different values at other sections. The size of a beam is designed considering the maximum bending moment in it and is uniform throughout its length. But the reinforcement or by cracking according to the requirements. Methods of analysis can be broadly classified as follows.

1. Classical methods:
   a. slope deflection method
   b. Strain energy method
2. Relaxation/Iterative methods:
   a. Moment distribution method
   b. Kani's method
3. Matrix methods:
   a. stiffness method
   b. Flexibility method
4. Computer methods:
   a. Matrix method
   b. Finite element method

DESIGN OF BEAM (LONGER SPAN)

DATA:

Clear span = 4500mm.

Width of beam = 300mm.

Beam spacing = 3800mm

Live load = 3 KN/m^2.

Grade of concrete (f_{ck}) = $20N/mm^2$

Grade of steel (f_y) = $415N/mm^2$

Effective depth:

Over all depth D $= \frac{l}{12}$ to $\frac{l}{15}$

$= \frac{4500}{12}$ to $\frac{4500}{15}$

= 375 to 300

D = 450mm

Adopt:

Beam size = 300mmx450mm.

Effective cover d' $= c.c + \frac{ø}{2}$

$= 25 + \frac{20}{2}$

= 35mm

Effective depth d = D – d'

= 450 - 35

d = 415mm

Effective span = clear span + effective depth.

= 4.5 + 0.415

L = 4.915m.

Design moments and shear force:

M_u = 26.35KNm (from STAADpro)

V_u = 32.08KN (from STAADpro)

Tension reinforcement:

$M_{ulimit} = 0.138fckbd^2$

$=0.138x20x300x415^2$

= 142.602KNm.

$Mu < Mu_{limit}$.

Hence the section is under reinforcement section.

$M_u \quad = 0.87\ fy\ Ast\ d\ (1-\frac{Astfy}{bdfck})$

$26.35x10^6 \quad = 0.87x415xAstx415(1-\frac{AstX415}{300X415X20})$

$Ast \quad = 181.33mm^2$

provide 12mm dia bars.

no of bars $= \frac{Ast}{ast}$

$= \frac{181.33}{(\pi x122)/4}$

= 2nos.

Provide 2no's 0f 12mm dia bars in tension zone

2no's of 10mm dia hanging bars.

$Ast_{provided} \quad = 383.274mm^2$

Check for shear stress:

$V_u \quad = 32.08$ KN.

$\tau_v \quad = \frac{Vu}{bd}$

$= \frac{32080}{300x415}$

$= 0.25N/mm^2$

$pt \quad = \frac{100xAst}{bd}$

$= \frac{100X383.274}{300X415}$

= 0.307%

From IS 456:2000 $\tau_c \quad = 0.42N/mm^2$.

$\tau_{v<}\tau_c$

Hence it is safe under shear.

Minimum shear reinforcement:

$$\frac{Asv}{bsv} \geq \frac{0.4}{0.87Xfy}$$

$$S_v = \frac{0.87XfyXAsvXd}{Vu}$$

A_{sv} = 8mm ø

A_{sv} = 50.2mm^2

S_v = 182mm = 180mm

Maximum spacing:

S_{max} = 0.75d or 300

= 0.75x415 or 300

= 310 or 300

Adopt:

S = 180mm

Provide:

2 legged 8mm ø stirrup @ 180mm c/c.

Adopt:

Size of beam = 300mm x 450mm

Provide

2no's 0f 12mm dia bars in tension zone

2no's of 10mm dia hanging bars

2 legged 8mm ø stirrup @ 180mm c/c.

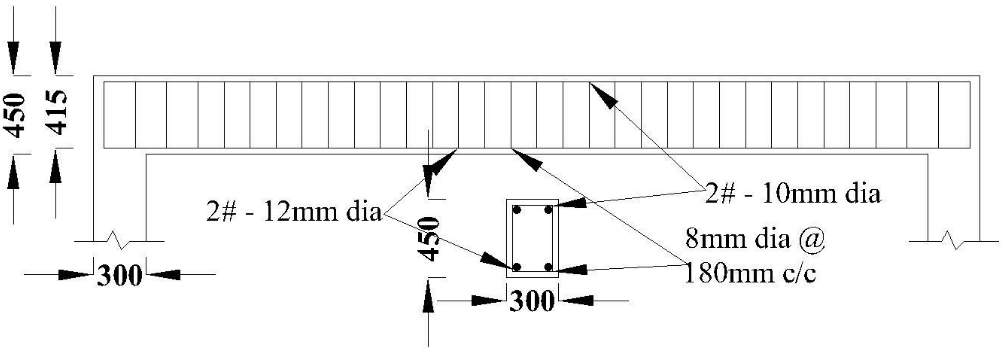


Fig.5.2 Reinforcement detial of beam (longer span)

DESIGN OF BEAM (SHORTER SPAN)

DATA:

Clear span = 3500mm.

Width of beam = 300mm.

Beam spacing = 4800mm

Live load = 3 KN/m^2.

Grade of concrete (f_{ck}) = $20N/mm^2$

Grade of steel (f_y) = $415N/mm^2$

Effective depth:

Over all depth D $= \frac{l}{12}$ to $\frac{l}{15}$

$= \frac{3500}{12}$ to $\frac{3500}{15}$

= 292 to 233

D = 450mm

Adopt:

Beam size = 300mmx450mm.

Effective cover d' $= c.c + \frac{ø}{2}$

$= 25 + \frac{20}{2}$

= 35mm

Effective depth d = D – d'

= 450 – 35

d = 415mm

Effective span = clear span + effective depth.

= 3.5 + 0.415

$L \quad = 3.915m.$

Design moments and shear force:

$M_u \quad = 28.57KNm$ (from STAADpro)

$V_u \quad = 21.81KN$ (from STAADpro)

Tension reinforcement:

$M_{ulimit} = 0.138fckbd^2$

$=0.138x20x300x415^2$

$= 142.602KNm$

$Mu < Mu_{limit}$.

Hence the section is under reinforcement section.

$M_u \quad = 0.87 \text{ fy Ast d } (1-\frac{Astfy}{bdfck})$

$28.57x10^6 \quad = 0.87x415xAstx415(1-\frac{AstX415}{300X415X20})$

$Ast \quad = 197.153mm^2$

provide 12mm dia bars.

no of bars $\quad = \frac{Ast}{ast}$

$=\frac{197.153}{(\pi x122)/4}$

$= 1.74nos.$

Provide 2no’s 0f 12mm dia bars in tension zone

2no’s of 10mm dia hanging bars.

$Ast_{provided} \quad = 383.274mm^2$

Check for shear stress:

$V_u \quad = 21.81KN$

$\tau_v \quad = \frac{Vu}{bd}$

$= \frac{21810}{300X415}$

$= 0.17N/mm^2$

pt $= \frac{100xAst}{bd}$

$= \frac{100X383.274}{300X415}$

$= 0.30\%$

From IS 456:2000 τ_c $= 0.37N/mm^2$.

$\tau_v < \tau_c$

Hence it is safe under shear.

Minimum shear reinforcement:

$\frac{Asv}{bsv} \geq \frac{0.4}{0.87Xfy}$

$S_v = \frac{0.87XfyXAsvXd}{Vu}$

A_{sv} = 8mm ø

$A_{sv} = 50.2mm^2$

S_v = 182mm = 180mm

Maximum spacing:

S_{max} = 0.75d or 300

= 0.75x415 or 300

= 310 or 300

Adopt:

S = 180mm

Provide:

2 legged 8mm ø stirrup @ 180mm c/c.

Adopt:

Size of beam = 300mm x 450mm

Provide

2no's 0f 12mm dia bars in tension zone

2no's of 10mm dia hanging bars

2 legged 8mm ø stirrup @ 180mm c/c.

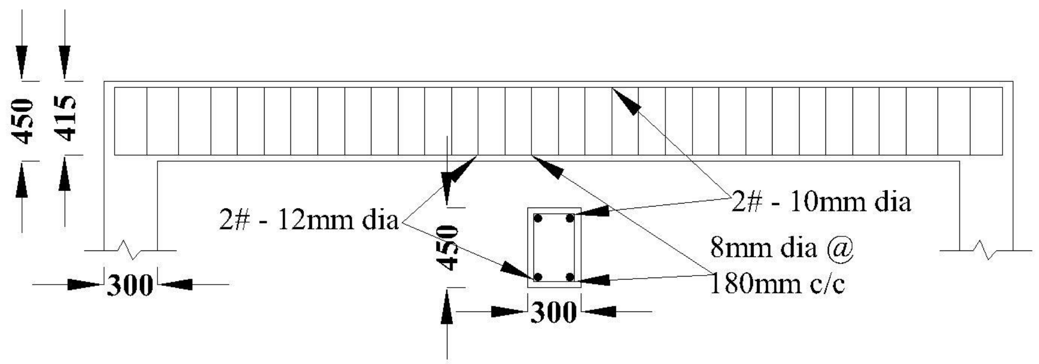


Fig.5.3 Reinforcement detial of beam (shorter span)

DESIGN OF LINTEL

DATA:

Window opening	= 1.5m (1500mm)
Depth of brick work over lintel	= 4000-450-2100-150
	= 1300mm
Thickness of wall	= 0.3m or 300mm
Lintel breath	= 0.3m or 300mm
Weight of masonry	= 19KN/m^3
f_y	= 415N/mm^2
f_{ck}	= 20N/mm^2
Span of sun shade	= 0.45m or 450mm
Assume the size of the lintel	= 300x150mm
Effective depth available (d)	= 150-20-8/2 = 126mm
Effective span in lesser of	
a) c/c of bearing	= 1500+300
	= 1800mm
b) clear opening + effective depth	=1500+126
	=1626mm
Effective span (l_{eff})	= 1.626m
Weight of the triangle Portion of masonry (W_1)	$=\frac{1}{2}$x1.626x1.408x0.3x19
	= 6.52KN
Imposed load on sunshade	= 1.626x0.45x0.75
	= 0.55KN
Self weight of lintel	= 0.15x0.3x1.626x25

	= 1.83KN
Total weight	= 1.65+0.55+1.83
	= 4.03KN
Maximum bending moment at mid span	$= ((W_1 x l^2)/6) + ((W_2 x l^2)/8)$
	$= ((6.52x1.626^2)/6) + ((4.03x1.626^2)/8)$
	= 2.59KNm
Design moment M_u	= MxFOS
	= 2.59x1.5
	$= 3.885KNm$ or $3.885x10^6 Nmm$

Main Ast:

M_u $= 0.87$ fy Ast d $(1-\frac{Astfy}{bdfck})$

$3.885x10^6$ $= 0.87x415xAstx126(1-\frac{AstX415}{300X126X20})$

Ast $= 74.56mm^2$

Minimum Ast:

Ast_{min} $= \frac{0.85}{fy}xbd$

$= \frac{0.85}{500}x300x126$

$= 64.26mm^2$

Ast_{reqd} $= 74.56mm^2$

Provide:

2 Nos of 10mm ø @ top and bottom

Also provide 2 legged 6mm ø stirrups @ 230mm c/c.

Adopt:

Size of beam = 300mm x 150mm

Provide

2 no's of 10mm ø @ top and bottom

Also provide 2 legged 6mm ø stirrups @ 230mm c/c.

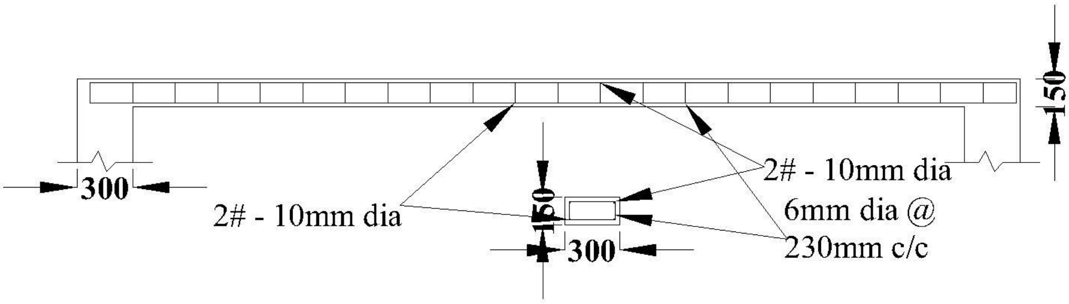


Fig.5.4 Reinforcement detial of lintel beam

DESIGN OF SUN SHADE

DATA:

Size	= 600mm
W.C	= $0.5KN/m^2$
Live load	= $0.75KN/m^2$
f_y	= $415N/mm^2$
f_{ck}	= $20N/mm^2$
Width of support	= 300mm
Reinforcement steel	
Main Ast	= 8mm ø
Min Ast	= 6mm ø

Side ratio:

Effective depth d_x $= \frac{lx}{Bc\ Mf}$

$= \frac{600}{7X0.90}$

d_x = 95.24mm = 90mm

d_x = 90mm

Effective cover d' $= c.c + \frac{ø}{2}$ [ø=10mm]

$= 15 + \frac{10}{2}$

d' = 20mm

Overall depth D $= d_x + d'$

= 90+20

D = 110mm

Effective length:

1) $L_x + \frac{dx}{2} = 600 + \frac{90}{2} = 645mm$
2) $L_x + \frac{w.s}{2} = 600 + \frac{300}{2} = 750mm$

Whichever is less

L_{eff} = 645mm (or) 0.645m

Design load:(Wu)

Live load (L.L)		$= 0.75KN/m^2$
Weathering course		$= 0.5KN/m^2$
Dead load (D.L)		= DXbXLX25
		= 0.11X1X1X25
	D.L	$= 2.75KN/m^2$
Total load (w)		= L.L + w.c + D.L
		= 0.75 + 0.5 + 2.75
	W	$= 4KN/m^2$
Consider 1m breath	w	= 4KN/m
	W_u	$= w x \gamma_f$
		= 4 x 1.5
	W_u	= 6KN/m

Design moment:(Mu)

M_u $= (Wu \times l_{eff}^2)/2$

$= (6x0.645^2)/2$

M_u = 1.25KNm

Effective depth:

$d_{reqd} = \sqrt{\frac{Mumax}{Qu.b}}$

$= \sqrt{\frac{1.250000}{2.672X1000}}$

d_{reqd} = 21.63mm

Check:

$d_{reqd} < d_{ass}$

21.63 < 100mm

Hence it is safe

Ast:

$M_u = 0.87 f_y Astd(1-\frac{Astfy}{bdfck})$

$1.25x10^6 = 0.87x415xAstx90(1-\frac{AstX415}{1000X90X20})$

Ast = 32.22mm^2

Min Ast:

Ast_{min} = 0.12%bD

$= \frac{0.12}{100}x1000x110$

= 132mm^2

Adopt:

Ast_{req} = 132mm^2

Spacing:

$S = \frac{ast}{Ast}x1000$

$= \frac{78.54}{132}x1000$

S = 595mm = 550mm

Min spacing:

3d or 300mm

3x90 or 300mm

270 or 300mm

S_x = 270mm

Provide:

10mm ø 270mm c/c (main R/f)

Distribution Ast:

Ast = Ast_{min}

Ast = 132mm

S = $\frac{ast}{Ast}$x1000

= $\frac{28.27}{132}$x1000

S = 214mm = 200mm

Min spacing:

5d or 450mm

5x90 or 450mm

450 or 450mm

Provide:

6mm ø @ 200mm c/c (distributors Ast)

Check for deflection:

d_{reqd} = $\frac{leff}{Bc\ Mf}$ base value B_v = 7

f.s = 0.58xf_yx$\frac{Ast\ reqd}{Ast\ pro}$

Ast pro = $\frac{ast}{s}$x1000

= $\frac{78.54}{270}$x1000

Ast pro = 290.89mm

f.s = 0.58x415x$\frac{132}{290.89}$

f.s = 131.60N/mm^2

%Ast provide:

$$= \frac{\text{Ast pro}}{\text{bd}} x100$$

$$= \frac{290.89}{1000X90} x100$$

%Ast provide =0.32%

%therefore Mf =2

d_{reqd} $= \frac{645}{7X2}$

d_{reqd} = 46.07mm

Check:

d_{reqd} < 90mm

46.07 < 90mm

Hence it is safe against to deflection

Check for shear:

Design shear:(Vu)

V_u = $Wlx0.6xl_{xeff}$+ $Wclx0.6xl_{xeff}$

= 0.6x0.75x0.645+0.6x2.75x0.645

V_u = 1.354KN

Nominal shear stress:(τ_v)

τ_v $= \frac{Vv}{bd}$

$= \frac{1.35X1000}{1000X90}$

τ_v = 0.015N/mm^2

Permissible shear stress:(τ_c)

%Astprov. Concrete grade

%Astprov $= \frac{\text{Ast pro}}{\text{bd}} x100$

%Ast provide = 0.32%

K = 1.3

0.25 = 0.36

0.32 = ?

0.50 = 0.48

τ_c = $0.36+[(\frac{0.48-0.36}{0.50-0.25})x(0.32-0.25)$

τ_c = 0.39

K τ_c = 0.50N/mm^2

Maximum shear stress:(τ_{cmax})

$\frac{1}{2}\tau_{cmax}$ = $\frac{1}{2}$x2.8

τ_{cmax} = 1.4N/mm^2

Check:

$\tau_c < K.\ \tau_c < \frac{1}{2}\tau_{cmax}$

0.015<0.50<1.4

It is safe against shear.

Adopt:

Size of sunshade= 450mm

Provide

Main Ast = 10mm dia bars @ 270mm c/c

Distributors Ast = 6mm dia bars @ 200mm c/c.

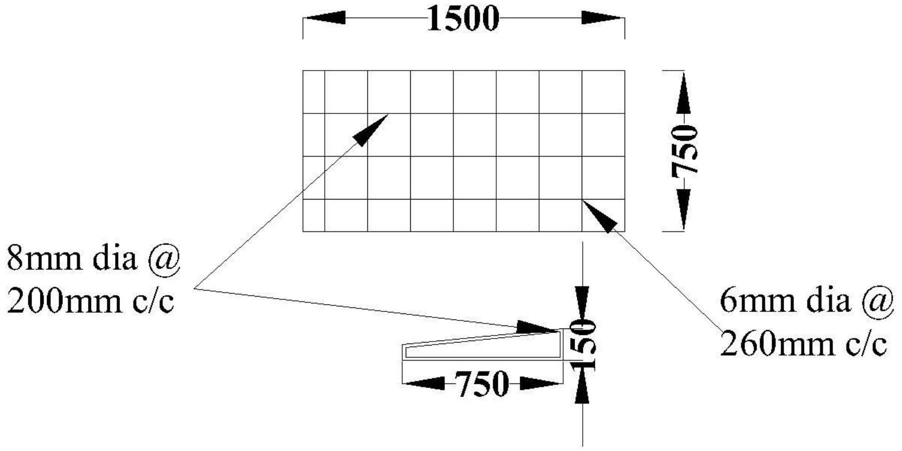


Fig.5.5Reinforcement detial of sunshade

DESIGN OF SHORT COLUMN

GENERAL

A column is a structural member provided to carry a compression load and whose effective length exceeds three times its lateral dimension. In building, columns are provided to support the roofing flooring system effectively and to transmit the loads safely to the foundation.

A column forms a very important component of structure columns support beams which in turns support walls and columns. The failure of column takes place due to the collapse of the structure.

A column is defined as a compression member; the effective length of which exceed three times the least lateral dimensions may be made of plain concrete.

Columns can be cat to any shape such as square, circular, hexagonal, octagonal, etc. Longitudinal or main reinforcement are provided to resist compression along with concrete.

The cross sectional area of reinforcement should not be less than 0.8% and not more than 6% of the cross sectional area of the column. The purpose of providing minimum reinforcement is to prevent the buckling of column due to accidental eccentricity of the load on it. Generally a cover of 40mm is provided. The main reinforcement is provided with transverse reinforcements in the form of lateral ties to prevent the dialoging of main reinforcement, buckling, etc.

DATA:

Grade of concrete (f_{ck}) $= 20N/mm^2$

Grade of steel (f_y) $= 415N/mm^2$

Design load:

Design load $P_u = 164.33kN$ (from STAADpro)

For future expansion assume 3 floor's

$P_u = 164.33x3$

$= 492.99KN$

Gross area:

$A_g = a^2$

Longitudinal reinforcement (A_{sc}):

$$A_{sc} = 2\%\ A_g$$

Area of column:

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

$$= A_g - 2\%A_g$$

$$= A_g - 0.02A_g$$

$$A_c = 0.98A_g$$

Using strength equation:

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

$$0.492 \times 10^6 = (0.4 \times 20 \times 0.98A_g) + (0.67 \times 500 \times 0.02A_g)$$

$$0.492 \times 10^6 = 14.54A_g$$

$$A_g = 33837.689 mm^2$$

Area of column:

$$A_g = a^2$$

$$a^2 = 33837.689$$

$$a = \sqrt{33837.689}$$

$$= 183mm = 300mm$$

$$A_{sc} = 2\%A_g$$

$$= 0.02 x a^2$$

$$= 0.02 x 300^2$$

$$A_{sc} = 1800mm^2$$

provide 25mm dia bars

$$\text{no of bars} = \frac{Ast}{ast}$$

$$= \frac{1800}{(\pi x252)/4}$$

$= 3.669$nos.

Provide 4 no's of 25mm dia bars.

Longitudinal ties:

$$Ø \quad = \frac{1}{4}x25$$

$$= 6.25mm = 8mm$$

Pitch:

1) Least dimension 300mm
2) 16xø = 16x25 =400mm
3) 48x8 = 384mm
4) 300mm

Provide:

8mm dia ties @ 300mm c/c.

Adopt:

Size of column = 300mm x 300mm

Provide

4no's 0f 25mm dia bars

Also provide 8mm dia ties @ 300mm c/c.

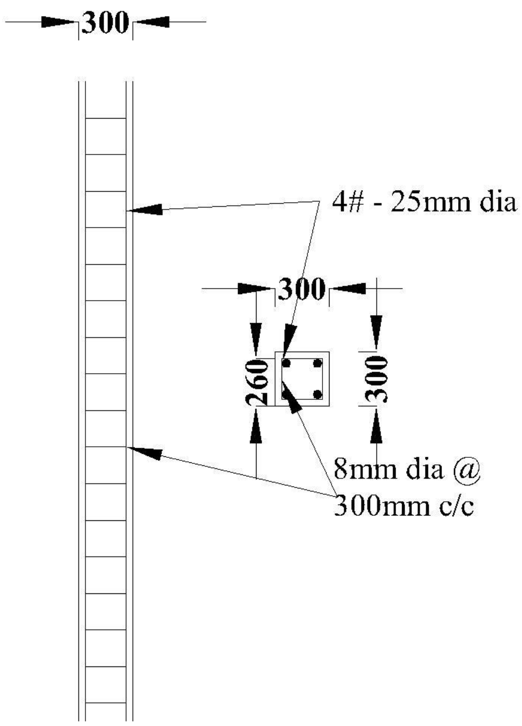


Fig.5.6 Reinforcement detial of column

DESIGN OF PLINTH BEAM (LONGER SPAN)

As per IS 456-2000

DATA:

Clear span = 4500mm.

Width of beam = 300mm.

Grade of concrete (f_{ck}) = 20N/mm^2

Grade of steel (f_y) = 415N/mm^2

Effective depth:

Over all depth D $= \frac{l}{12}$ to $\frac{l}{15}$

$= \frac{4500}{12}$ to $\frac{4500}{15}$

= 375 to 300

D = 300mm

Adopt:

Beam size = 300mmx300mm.

Effective cover d' $= \text{c.c} + \frac{ø}{2}$

$= 25 + \frac{20}{2}$

= 35mm

Effective depth d = D – d'

= 300 - 35

d = 265mm

Effective span = clear span + support width

= 4.5 + 0.3

$L \quad = 4.8m.$

Design moments and shear force:

$M_u \quad = 38.71KNm$ (from STAADpro)

$V_u \quad = 46.61KN$ (from STAADpro)

Tension reinforcement:

$M_{ulimit} = 0.138 fckbd^2$

$= 0.138x20x300x265^2$

$= 58.146KNm.$

$M_u < M_{ulimit}.$

Hence the section is under reinforcement section.

$M_u \quad = 0.87\ fy\ Ast\ d\ (1-\frac{Astfy}{bdfck})$

$38.71x10^6 \quad = 0.87x415xAstx265(1-\frac{AstX415}{300X265X20})$

$Ast \quad = 459.753mm^2$

provide 20mm dia bars.

no of bars $\quad = \frac{Ast}{ast}$

$= \frac{459.753}{(\pi x202)/4}$

$= 1.46nos.$

Provide 2no's 0f 20mm dia bars in tension zone

2 no's of 10mm dia hanging bars

$Ast_{provided} \quad = 785.398mm^2$

Check for shear stress:

$V_u \quad = 46.61KN.$

$\tau_v \quad = \frac{Vu}{bd}$

$$= \frac{46610}{300X265}$$

$= 0.586N/mm^2$

pt $= \frac{100xAst}{bd}$

$$= \frac{100X785.398}{300X265}$$

$= 0.98\%$

From IS 456:2000

τ_c $= 0.65N/mm^2$

$\tau_v < \tau_c$

Hence it is safe under shear.

Minimum shear reinforcement:

$$\frac{Asv}{bsv} \geq \frac{0.4}{0.87Xfy}$$

$$S_v = \frac{0.87XfyXAsvXd}{Vu}$$

A_{sv} = 8mm ø

A_{sv} $= 50.2mm^2$

S_v = 182mm = 180mm

Maximum spacing:

S_{max} = 0.75d or 300

= 0.75x265 or 300

= 198.75 or 300

Adopt:

S = 180mm

Provide:

2 legged 8mm ø stirrup @ 180mm c/c.

Adopt:

Size of beam = 300mm x 300mm

Provide

2no’s 0f 20mm dia bars in tension zone

2no’s of 10mm dia hanging bars

2 legged 8mm ø stirrup @ 180mm c/c.

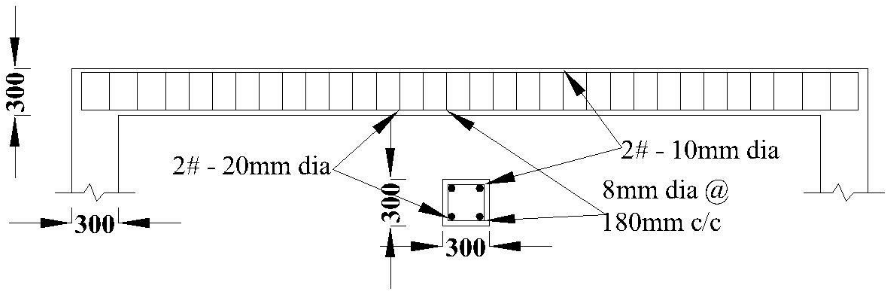


Fig.5.7 Reinforcement detial of plinth beam (longer span)

DESIGN OF PLINTH BEAM (SHORTER SPAN)

As per IS 456-2000

DATA:

Clear span = 3500mm.

Width of beam = 300mm.

Grade of concrete (f_{ck}) = 20N/mm^2

Grade of steel (f_y) = 415N/mm^2

Effective depth:

Over all depth D $= \frac{l}{12}$ to $\frac{l}{15}$

$= \frac{3500}{12}$ to $\frac{3500}{15}$

= 292 to 233

D = 300mm

Adopt:

Beam size = 300mmx300mm.

Effective cover d' $= c.c + \frac{\phi}{2}$

$= 25 + \frac{20}{2}$

= 35mm

Effective depth d = D – d'

= 300 - 35

d = 265mm

Effective span = clear span + support width.

= 3.5 + 0.3

$L \quad = 3.8m.$

Ultimate moments and shear force:

$M_u \quad = 26.24KNm$ (from STAADpro)

$V_u \quad = 42.46KN$ (from STAADpro)

Tension reinforcement:

$M_{ulimit} = 0.138fckbd^2$

$=0.138x20x300x265^2$

$= 58.146KNm.$

$M_u < M_{ulimit}.$

Hence the section is under reinforcement section.

$M_u \quad = 0.87 \text{ fy Ast d } (1-\frac{Astfy}{bdfck})$

$26.24x10^6 \quad = 0.87x415xAstx265(1-\frac{AstX415}{300X265X20})$

$Ast \quad = 297.325mm^2$

provide 16mm dia bars.

no of bars $\quad = \frac{Ast}{ast}$

$=\frac{297.325}{(\pi x162)/4}$

$= 1.478nos.$

Provide 2no’s 0f 16mm dia bars in tension zone

2 no’s of 10mm dia hanging bars

$Ast_{provided} \quad = 559.203mm^2$

Check for shear stress:

$V_u \quad = 42.46KN.$

$\tau_v \quad = \frac{Vu}{bd}$

$$= \frac{42460}{300X265}$$

$= 0.53N/mm^2$

$$pt = \frac{100xAst}{bd}$$

$$= \frac{100X559.203}{300X265}$$

$= 0.703\%$

From IS 456:2000

$\tau_c = 0.54N/mm^2$

$\tau_{v} < \tau_c$

Hence it is safe under shear.

Minimum shear reinforcement:

$$\frac{Asv}{bsv} \geq \frac{0.4}{0.87Xfy}$$

$$S_v = \frac{0.87XfyXAsvXd}{Vu}$$

A_{sv} = 8mm ø

$A_{sv} = 50.2mm^2$

S_v = 182mm = 180mm

Maximum spacing:

S_{max} = 0.75d or 300

= 0.75x265 or 300

= 198.75 or 300

Adopt:

S = 180mm

Provide:

2 legged 8mm ø stirrup @ 180mm c/c.

Adopt:

Size of beam = 300mm x 300mm

Provide

2no’s 0f 16mm dia bars in tension zone

2no’s of 10mm dia hanging bars

2 legged 8mm ø stirrup @ 180mm c/c.

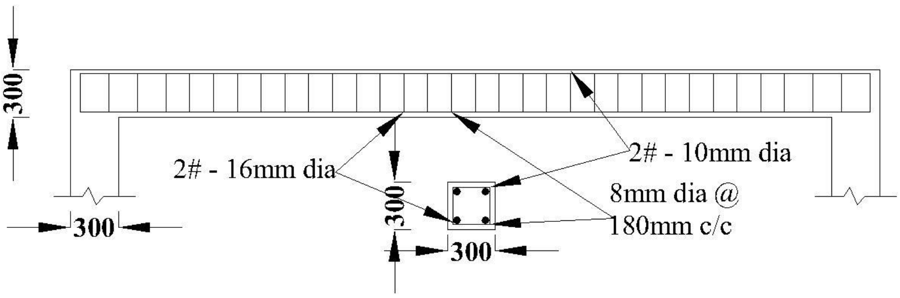


Fig.5.8 Reinforcement detial of plinth beam (shorter span)

DESIGN OF COLUMN FOOTING

GENERAL

Foundation is the bottom most but the most important component of a structure, which lies below the ground level. Even though it does not provide any aesthetic appearance to the elevation of a building, it has to be well planned and carefully designed to ensure the safety and stability of the structure. The foundation provided for a R.C. column is called a 'column base' or a' column footing'.

BASIC REQUIREMENTS OF ACOLUMN BASE

The main purpose of providing a base to a column is to transfer the load carried by the column to the soil on a larger area safety of the soil. As per clause 34.1 of IS 456-2000 a column base should satisfy the following requirements.

1. It should be strong enough structurally to sustain the applied loads, moments and induced reactions.
2. To avoid failure of foundation, the area of the base should be large enough to ensure that the pressure on the soil under the base not exceed its safe bearing capacity.
3. When the columns of a structure carry different magnitude loads, the size and shapes of their base should be planned such that the pressure distribution on the soil under all columns is almost uniform to avoid uneven settlement of the structure, which will otherwise cause the failure of other components.

DATA:

Column load	= 492.99KN
Assume self weight of footing as 10%	= 49.299KN
Total load on the soil	= 542.289KN
Safe bearing capacity of soil	= 220KN/m^2
Area of footing required	$= \frac{542.289}{220} = 2.464$m^2
Side of the square footing	$= \sqrt[2]{2.464}$
	= 1.57m = 2m
Provide a square footing	= 2x2m

Net upward pressure factored load = 542.289x2

= 1084.578KN

Net upward design pressure of the base $= \frac{1084.578}{2X2}$

$= 271.144 KN/m^2$

Bending Moment:

Projection of footing from the face of column $= \frac{2-0.3}{2}$

= 0.85

Bending moment of section:

Mx $= 271.144x2x0.85x\frac{0.85}{2}$

Mx $= 195.90x10^6$ Nmm

Effective depth required:-

$d_{req} = \sqrt{\frac{Mu}{QuXb}}$

$= \sqrt{\frac{195900000}{2.672X2000}}$

d_{req} = 191.462mm

d = 300-75

= 225

d = 225mm

Tension R/F

Mu $= 0.87\ fy\ Ast\ d\ (1-\frac{Astfy}{bdfck})$

$195.90x10^6 = 0.87x415xAstx225(1-\frac{AstX415}{2000X225X20})$

Ast $= 2763.56 mm^2$

Provide 25mm dia bars @ 175mmc/c.

Percentage steel:-

$=\frac{\text{Ast pro}}{\text{bd}}$x100

$=\frac{2763.56}{2000\text{X}225}$x100

P = 0.614%

Check for transverse shear

Permissible shear stress = 0.52N/mm^2

V_y = 271.144x2 (0.85-0.425)

V_y = 230.472KN

Total depth of footing at the middle of section = 200+($\frac{725-200}{1000}$)x225

= 318.125mm

Effective depth of centre = 318.125-75

= 243.125mm

Effective depth of centre = 200-75

=125mm

Breadth of section at top = 300+2x425

= 1150mm

Effective resistance the transverse shear = 2000x75+($\frac{1150+2000}{2}$)x446

= 852591.75mm^2

Nominal shear stress $=\frac{31556}{852591.75}$

= 0.037Nmm^2 < 0.52Nmm^2

Check for punching shear

Length = 4(300+2x225)

= 3000mm

Over all depth of section $= 200+(\frac{725-200}{1000})x675$

$= 554.38mm$

Eff depth $= 554.38-75$

$= 479.38mm$

Punching shear V $= 271.144(2.0-0.225)^2$

$= 854.27KN$

Nominal shear τ_z $= \frac{854270}{3000x479.38} = 0.594$

Permissible shear stress τ_{cz} $= 0.25\sqrt{f_{ck}}$

$= 1.118N/mm^2$

Check:

$\tau_z < \tau_{cz}$

0.708<1.11

Size of footing 2mx2m

Thickness of base of column = 725mm

Thickness of free edge = 200

Depth of foundation from ground level

P $= \frac{1+sinø}{1-sinø}$

$= \frac{1+\sin 35^o}{1-\sin 35^o}$

$= 3.69$

$= \frac{P}{ɣ}(\frac{1+sinø}{1-sinø})^2$

$= \frac{0.37}{2}(\frac{1+\sin 35^o}{1-\sin 35^o})^2$

$= 1.48$

$P_{passive}$ = 1.5m

Adopt:

Size of column = 300mm x 300mm

Size of footing = 2m x 2m

Provide

25mm dia bars @ 175mmc/c

Depth of foundation = 1.5m.

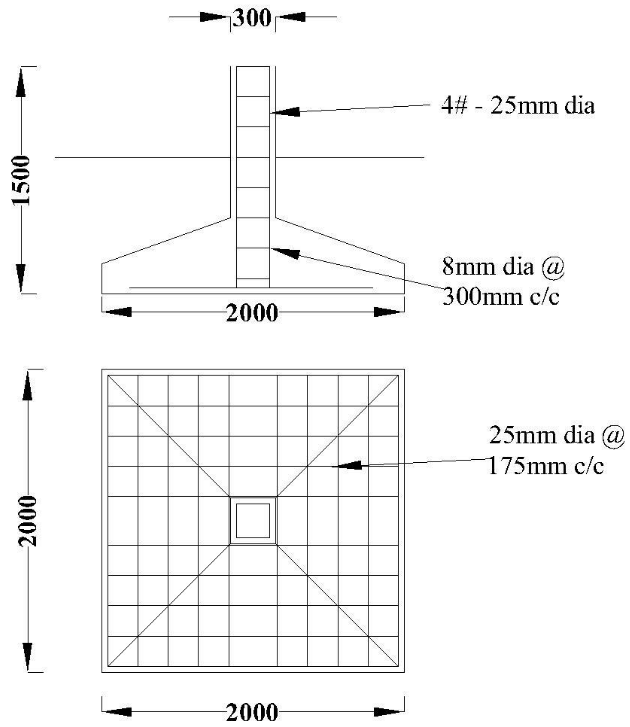


Fig.5.9 Reinforcement detial of column footing

DESIGN OF SEPTIC TANK

DATA:

No of people	= 50
Sewage/capita/day	= 120 litres
De-sludging period	= 1 years

Design:

Quantity of sewage produced per day = 6000 litres/day

Assuming detention period to be 24 hours, we have

The quantity of sewage produced during the detention period, i.e.,

Capacity of the tank $= 6000 \times \frac{24}{24}$

Now assuming the rate of sludge deposit as 30 litres/capita/year and with the given 1 year period of cleaning, we have

The quantity of sludge deposited = 30x50x1

= 1500 litres

Total required capacity of the tank = 6000+1500

= 7500 litres

$= 7.5\ m^3$

Assuming the depth of the tank as 1.5 m,

The cross-sectional area of the tank $= \frac{7.5}{1.5} = 5\ m^2$

Using square tank, we have

$B^2 = 5$

$B = \sqrt{5} = 2.33$ m

= 2.5 m

The dimensions of the tank will be 2.5m x 2.5m x (1.5+0.3)m as overall depth with 0.3m free board. Hence, use a tank of size 2.5m x 2.5m x 1.8m.

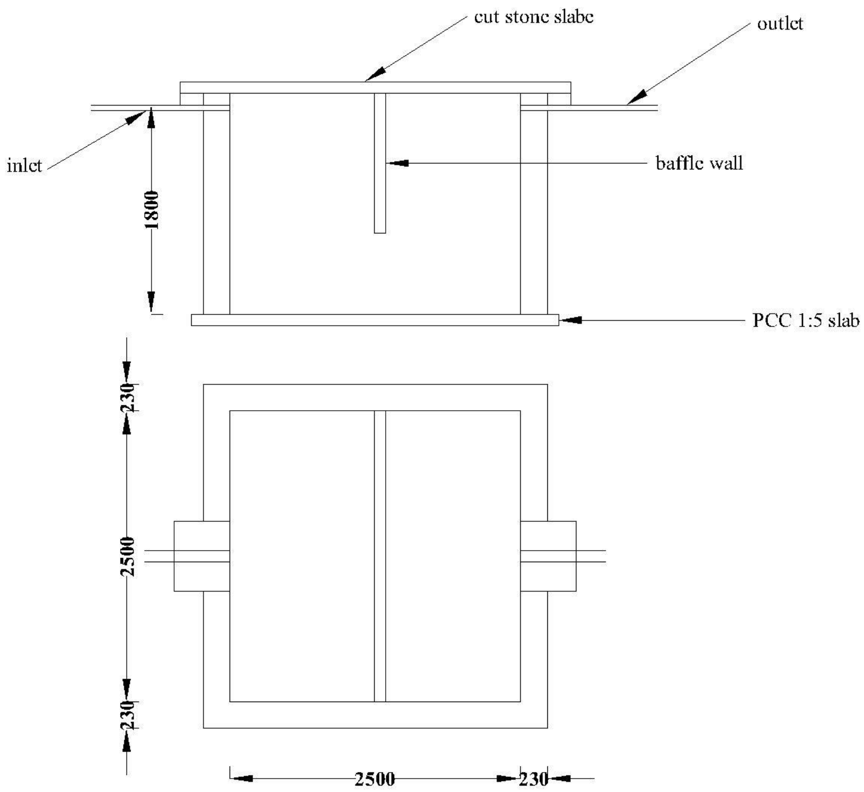


Fig.5.10 Detialed diagram of septic tank

CHAPTER VI
CONCLUSION

In this project planning, analysis and design of blood bank building.We had learnt to plan a building with referring to National Building code of India-2005.

It is used to learn drawing and drafting the building plans using Auto CAD software. In this blood bank building project, we learnt to create the models by giving nodes and property to the structural elements using analysis and also we learnt to the structure with corresponding loads as given IS 875 part 1&2 using analysis. This project is very useful to learn the design by referring IS 456:2000 for each slab and beam. SP:16 codes alone are used for easier design of slab, yet we learned to design the columns and beams by using STAADpro software.

The important thing that we done the project by referring a lot of books for designing and we are very much satisfied with exposing to field of design.

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