International Journal of Multidisciplinary Engineering in Current Research - IJMEC

Volume 9, Issue 6, June-2024, http://ijmec.com/, ISSN: 2456-4265

ANALYSIS AND DESIGN OF A COMMERCIAL CUM RESIDENTIAL BUILDING BY USING STAAD PRO

MD Rafi*[1], K Narender*[2], Tanveer Ahmed*[3], Kamaram Susmitha*[4], Mosali Chandu*[5], Mr. M Sathish Kumar*[6]

[*1, 2, 3, 4, 5] UG Students, Dept. of Civil Engineering, SVITS, Mahbubnagar, Telangana, India.

[*6] Assistant Professor, Dept. of Civil Engineering, SVITS, Mahbubnagar, Telangana, India.

Abstract: The project comprises the development of plans, elevations, and sectional view of a Residential Reinforced Concrete building of ground floor, using Auto-cad 2008. Structural loads (Gravitational loads only), Dead and Live loads are only considered for the design of structure, and the loads considered are as per IS: 875 – Part-I & II. The analysis and design of the building skeletal fame is performed by using STAAD Pro V8i package for factored (Limit state of strength) combination(s). The structural displacements in vertical and horizontal directions of the building are permitted to the limitations as per IS: 456 – 2000, for un-factored (Limit state of serviceability) combination(s). Structural elements like Slab(s) are designed manually and foundation design is done using STAAD foundation. The reinforcement details are furnished according to the codal provisions and presented in this report.

Introduction

Usually all multistoried buildings (structures) are of 3 types they are

1. Load bearing construction
2. Framed construction
3. Composite construction

But among the above 3 types, in the present stage all the multistoried structure are framed construction which are durable.

An engineering structure is an assembly of member of elements transferring the loads and providing a firm space to serve the desired function.

The structural design is a science and art of designing, with economy and elegance, a durable structure is that which can safely carry the forces and can serve the desired function satisfactorily during its expected service life span. The entire process of structural planning and designing requires not only imagination and conceptual thinking (which forms arts of designing) but of practical aspects, such as relevant design codes and bye-laws, backed up by ample experience, institution and judgment.

The process of design commences with planning of a structure, primarily to meet the functional equipment of the user or client. The functional requirements and the aspects of the aesthetics looked in to normally by an architect while the aspect of safety, serviceability, durability and economy of the structure for its intended use over the life span

Building In General:

A building can be defined as a structure broad by consisting of wall, floors, and roofs, erected to provide covered space for different uses such as residence, education, business, manufacturing, storage, hospitalization, entertainment, worship etc.

Normally all building are constructed according to drawings and specifications prepared by architects. Each city has prescribed building bye-laws to which building must confirm. The building bye-laws lay down norms like minimum front, side and rear setbacks, minimum height and area of habitable rooms, kitchen, bath, minimum area of windows, width of staircase etc., apart from respecting the bye-laws the building design should ensure optimum utilization of build up space (i.e. Area under circulation should be minimum) thermal comfort, proper ventilation, desirable illumination and acoustical characteristics and it should satisfy the functional requirements of people who live and work in the building.

Types of Buildings:

Depending upon the character of occupancy or the type of use, different type of buildings have been classified in following group as per national building code.

1. Residential Building.
2. Educational Building.
3. Institutional Buildings.
4. Assembly Buildings
5. Business Buildings.
6. Mercantile Building.
7. Industrial Buildings.
8. Storage Buildings.
9. Hazardous Buildings.

Components of a Building:

A building can be broadly divided into two parts viz.

(i) Sub-structure

(ii) Super Structure.

The portion of the building above the ground is termed as super structure. The portion of the building below the ground is termed as sub-structure. The components of a building can be broadly summarized as under.

1. Foundation
2. Plinth
3. Walls
4. Columns
5. Floors
6. Doors/Windows & Ventilators
7. Staircase 8. Roofs
9. Building Finishes
10. Building services.

The object of reinforced concrete design is to achieve a structure that will result in a safe and economical solution. For a given structural system, the design problem consists of the following steps:

Idealization of structure for analysis,

Estimation of loads,

Analysis of idealized structural model to determine axial thrust, shear, bending moments and deflections,

Limit state method:

In the limit state design method, non-deterministic parameters are determined based on observations taken over a period of time. The object of design based on the limit state concept is to achieve an acceptable probability that a structure will not become unserviceable in its life time for the use for which it is intended, that is, it will not reach a limit state. A structure with appropriate degrees of reliability should be able to withstand safely all loads that are liable to act on it throughout its life and it should also satisfy the serviceability requirements, such as limitations on deflections and cracking. It should also be able to maintain the required structural integrity during and after accidents such as fires, explosions and local failure. Due to its realistic approach, limit state method is used in design of structures.

The most important limit state which must be examined in design are as follows:

Limit state of Collapse

This state corresponds to the maximum load carrying capacity. Violation of collapse limit state implies failure in the sense that a clearly defined limit state of structural usefulness has been exceeded. However, it does not mean a complete collapse.

Thus, limit state may correspond to:

i. Flexure ii. Compression iii. Shear iv. Torsion

Limit state of serviceability

This state corresponds to development of excessive deformation and is used for checking members in which magnitude of deformations may limit the use of the structure or its components. This limit state may correspond to

i. Deflection ii. Cracking iii. Vibration

ABOUT STAAD PRO

STAAD Pro is a Structural Analysis and design computer program originally developed by Research Engineers International in Yorba Linda, CA. In late 2005, Research Engineer International was bought by Bentley Systems.

STAAD Pro allows structural engineers to analyse and design virtually any type of structure through its flexible modelling environment, advanced features and fluent data collaboration.

STAAD Pro is one of the leading structural analysis and design software which supports more than 100 steel, concrete and timber design codes and has the largest worldwide user base.

It can make use of various forms of analysis from the traditional 1st order static analysis, 2nd order p-delta analysis, geometric nonlinear analysis or a buckling analysis. It can also make use of various forms of dynamic analysis from modal extraction to time history and response spectrum analysis.

In recent years it has become part of integrated structural analysis and design solutions mainly using an exposed API called Open STAAD to access and drive the program using an VB macro system included in the application or other by including Open STAAD functionality in applications that themselves include suitable programmable macro systems. Additionally STAAD Pro is added direct links to applications such as RAM Connection and STAAD Foundation to provide engineers working with those applications which handle design post processing not handled by STAAD Pro itself. Another form of integration supported by STAAD Pro is the analysis schema of the CIM steel Integration Standard, version 2 commonly known as CIS/2 and used by a number modelling and analysis applications.

CALCULATION OF LOADS

Dead and live loads at plinth level (0.00)

Dead load of brick wall (230 mm thick)	=	0.23*3*20
		=12.0 KN/m
Dead load of brick wall (115 mm thick)	=	0.115*3.0*20
		=6.0kN/m

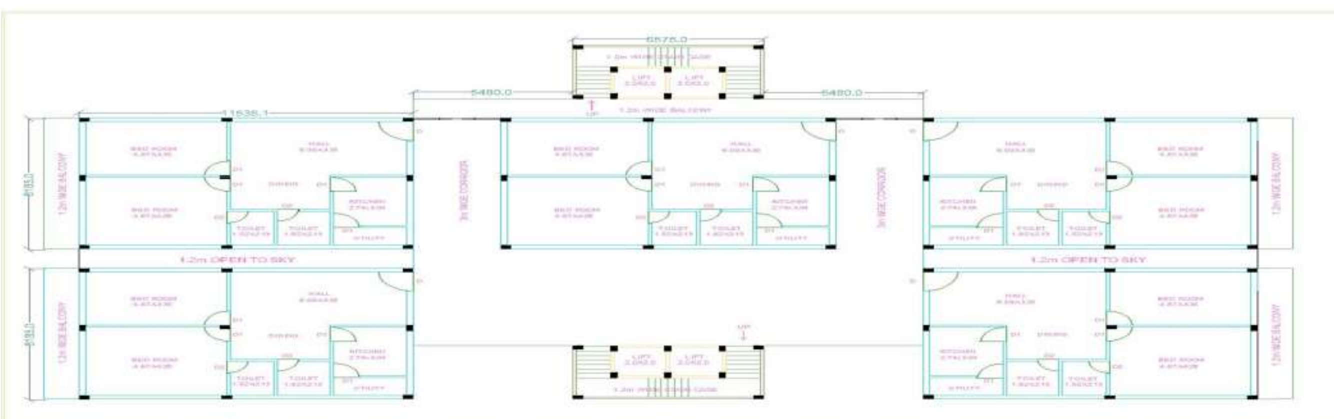
Dead and live loads at Floor level:

Dead load of slab (125 mm assuming)	=	0.125*25
	=	3.0 KN/m2
Floor finishes	=	1KN/m2
Total floor load	=	3.0 + 1.0
	=	4.0 kN/m2
Live load (On floor, accessible)	=	2.0 kN/m2

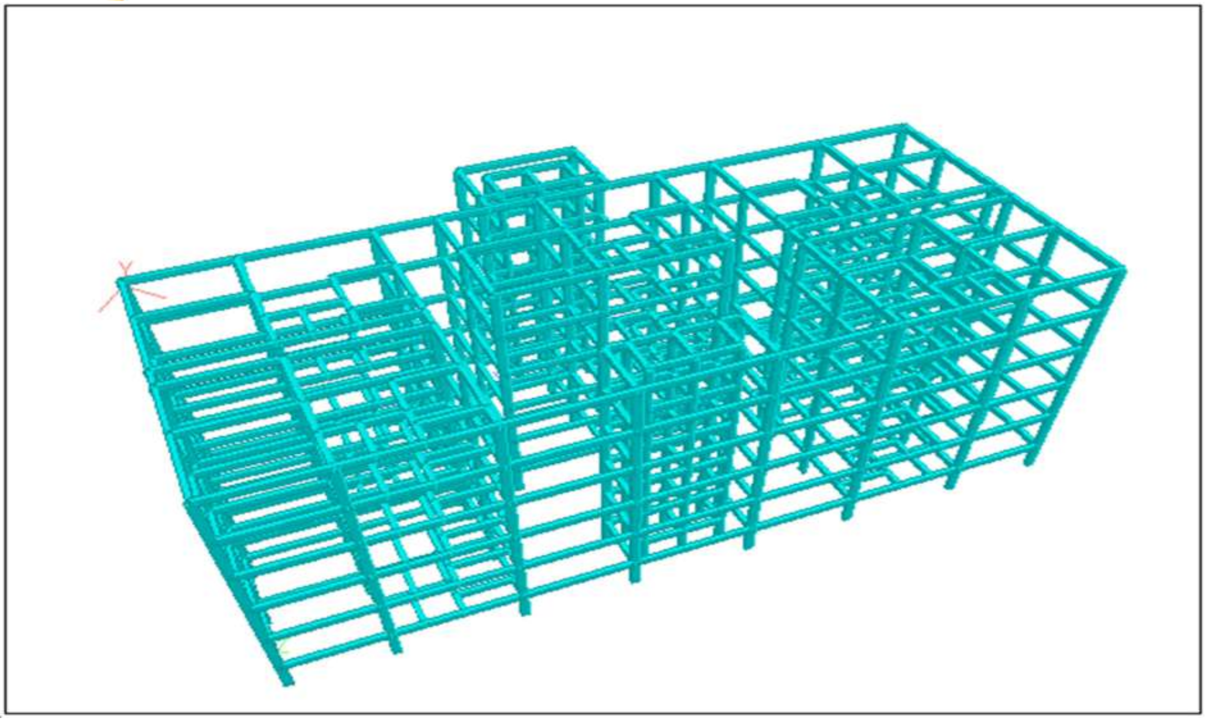
Dead and live loads at Roof level:

Dead load of brick wall (230 mm thick)	=	0.23*0.45*20
(Parapet wall)	=	2.07 N/m
Dead load of slab (125 mm assuming)	=	0.125*25
	=	3.0 kN/m2
Water proofing	=	3.0 kN/sq.m
Total floor load	=	3.125+3.0
		= 6.125 kN/ m2
Live load (On floor, accessible)	=	1.5 kN/ m2

PLAN OF THE STRUCTURE

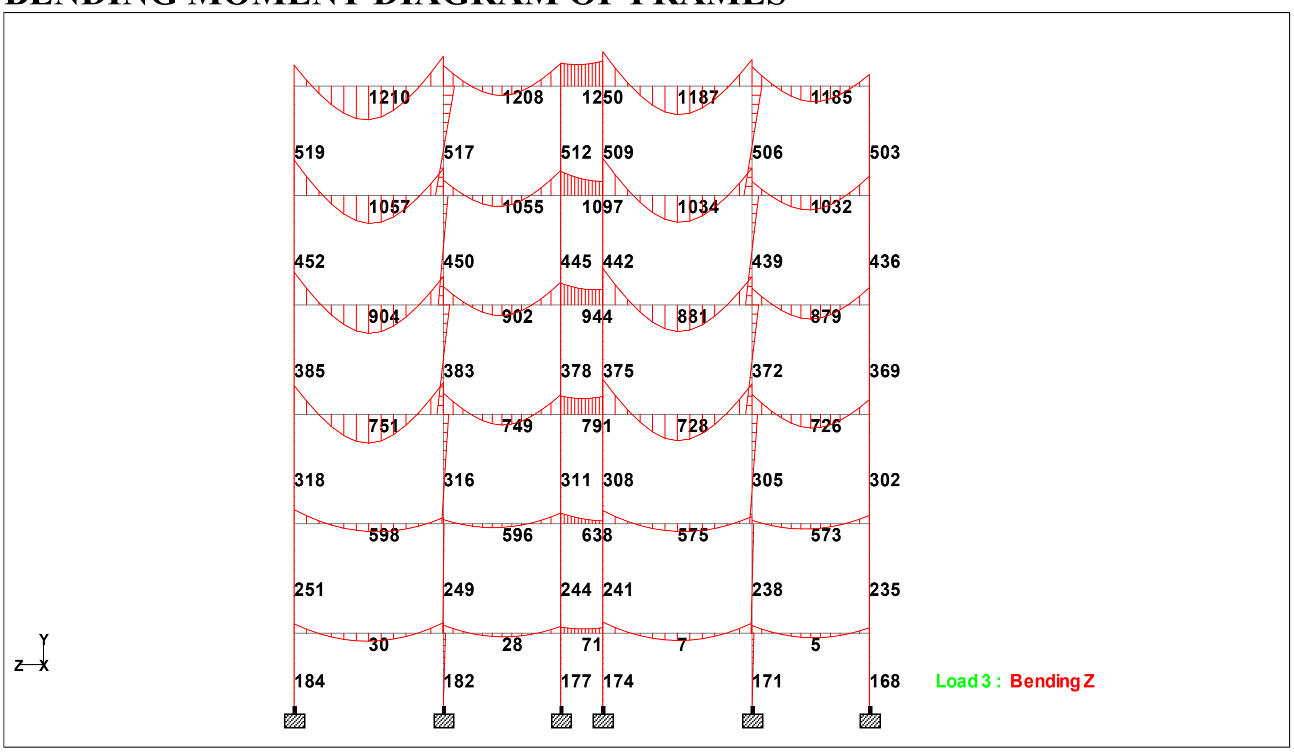


2.3 3D RENDERING

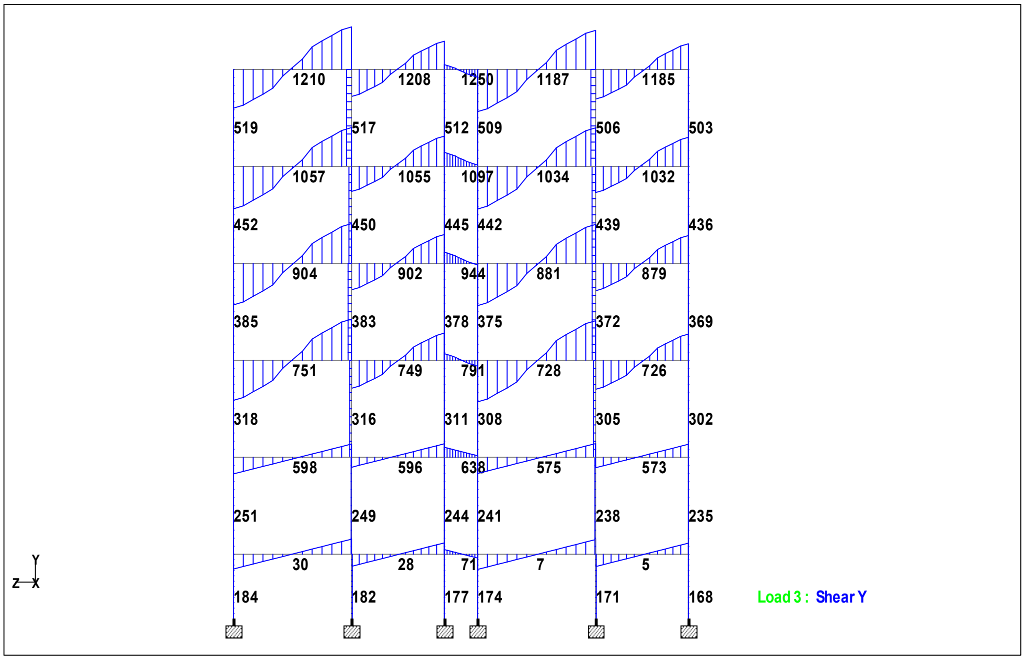


RESULTS

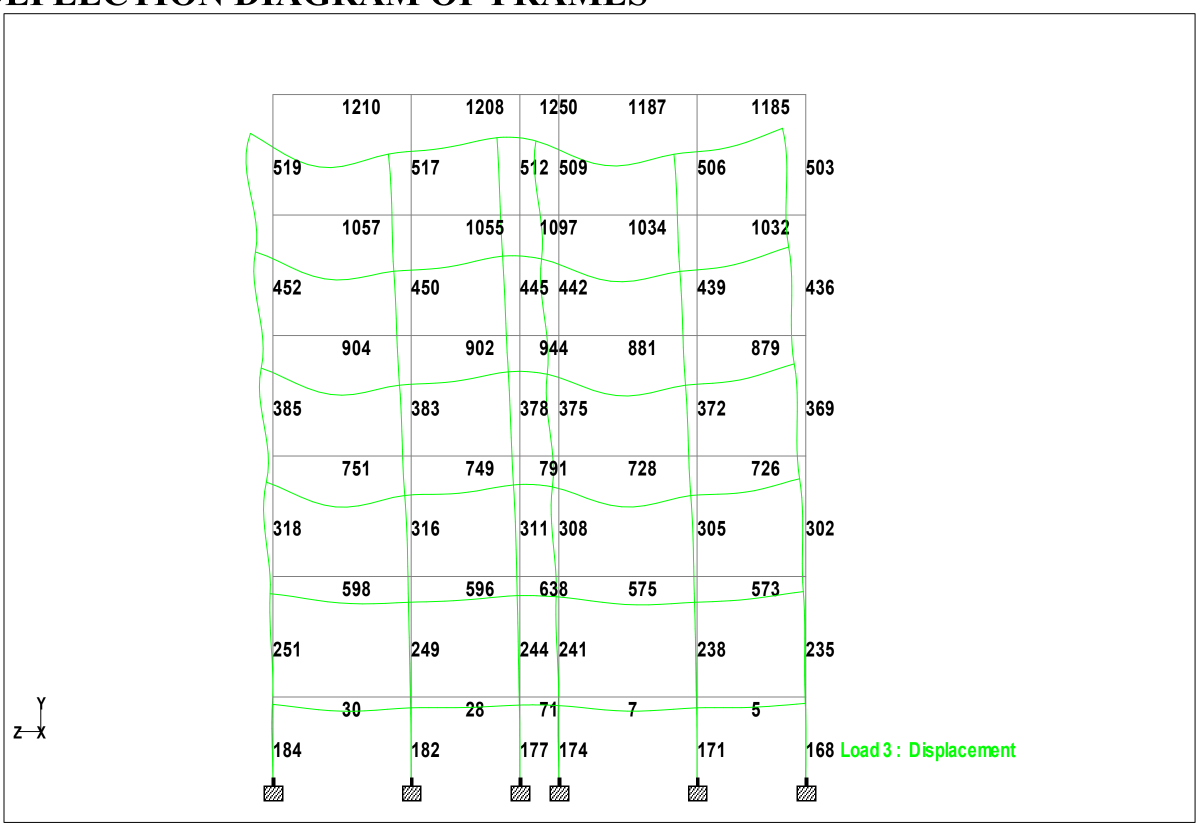
BENDING MOMENT DIAGRAM OF FRAMES



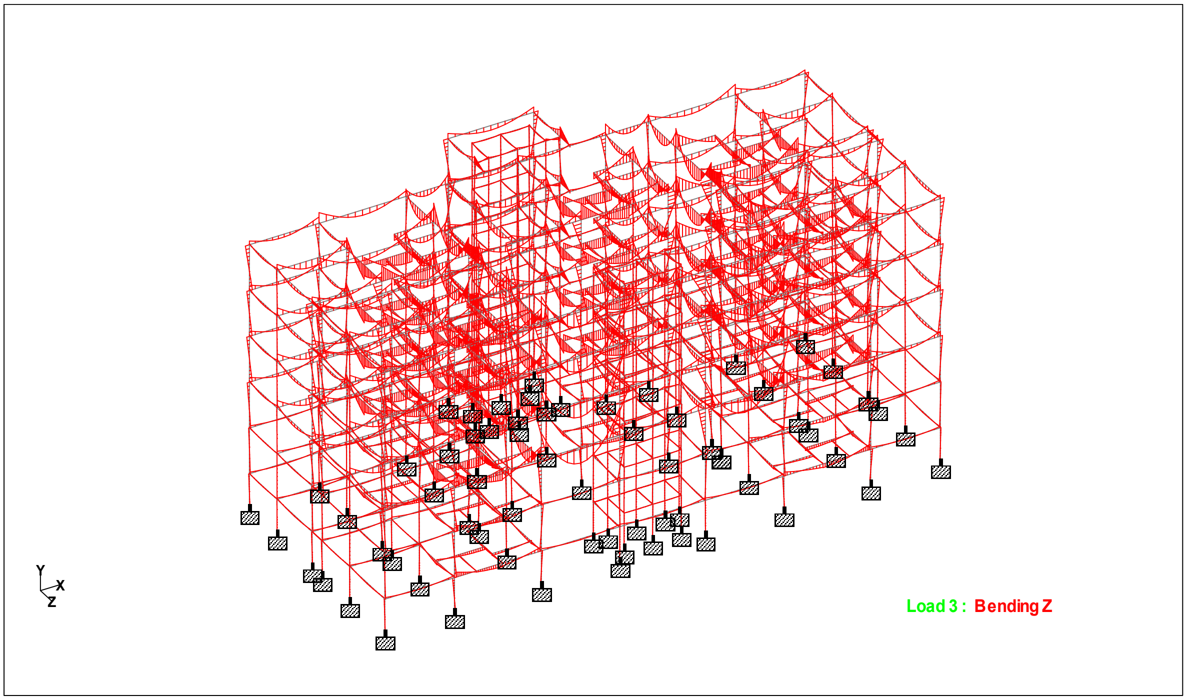
SHEAR FORCE DIAGRAM OF FRAMES



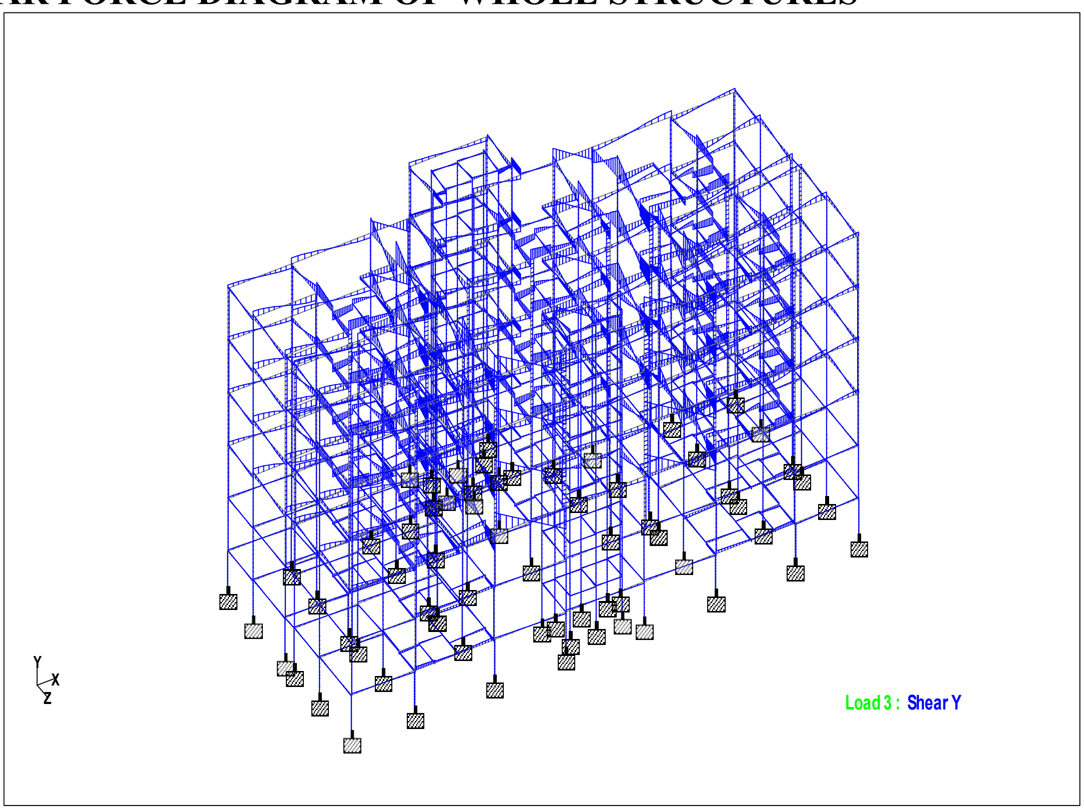
DEFLECTION DIAGRAM OF FRAMES



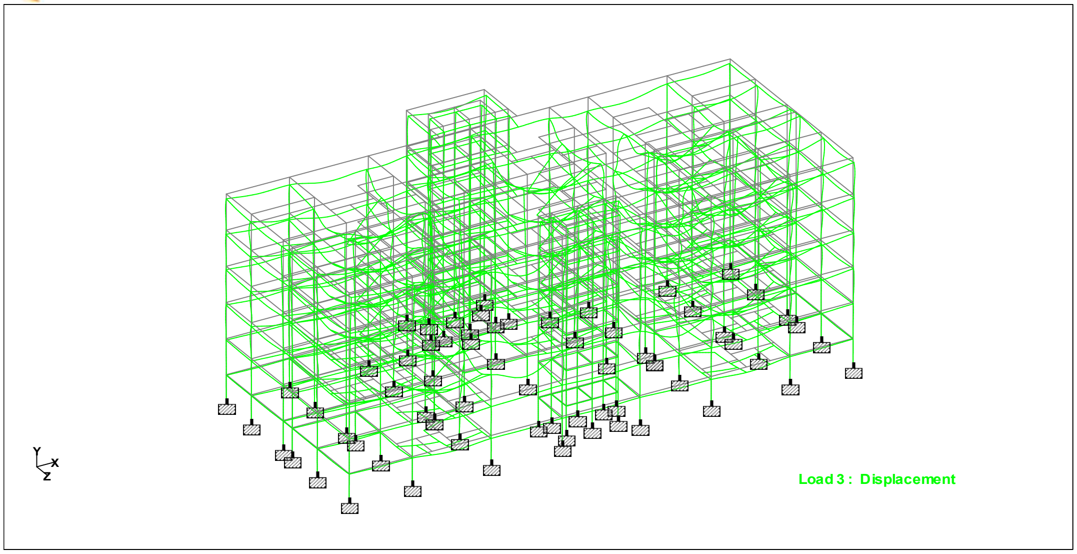
BENDING MOMENT DIAGRAM OF WHOLE STRUCTURES



SHEAR FORCE DIAGRAM OF WHOLE STRUCTURES



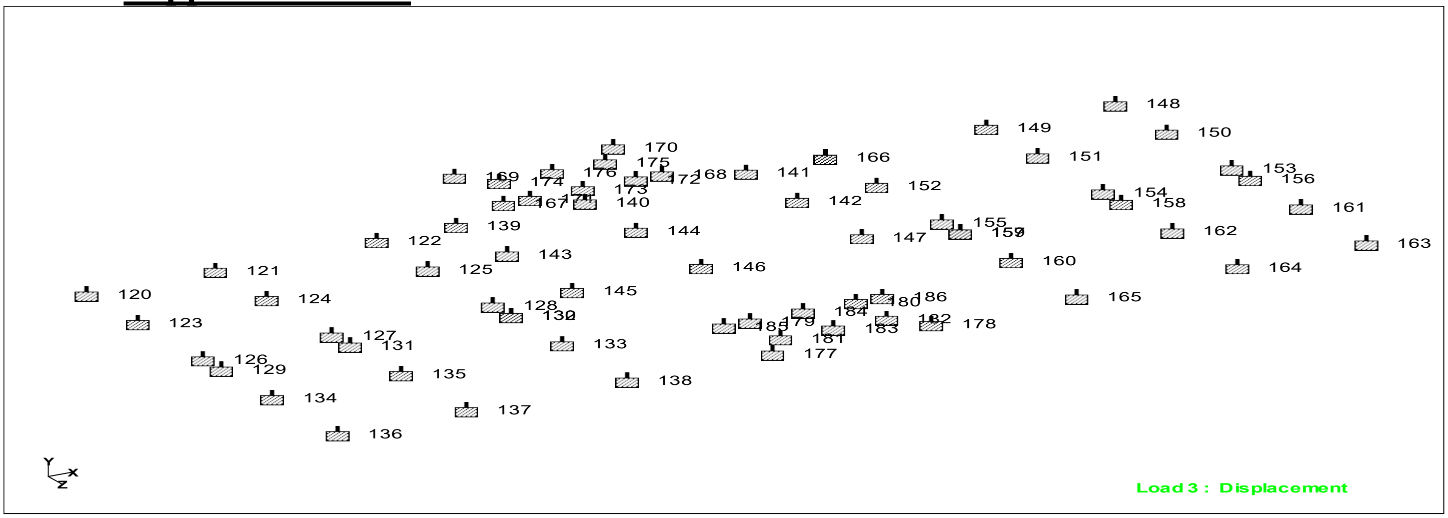
DEFLECTION DIAGRAM OF WHOLE STRUCTURES



Unfactored Support Reactions Summary:

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	155	11	34.986	995.972	-7.734	-5.394	-0.127	-36.493
Min Fx	154	15	-34.61	1065.896	-9.369	-5.954	-0.02	36.137
Max Fy	138	9	-17.23	2451.533	-10.071	-6.494	0.01	10.961
Min Fy	183	8	-0.002	-173.491	23.61	30.859	0.001	0.002
Max Fz	133	25	-9.68	1085.159	38.505	48.601	0.425	7.766
Min Fz	183	29	-0.013	467.017	-37.1	-47.734	0.008	0.014
Max Mx	179	25	0.608	441.686	37.001	51.833	1.784	-0.353
Min Mx	180	29	0.362	23.593	-36.191	-51.576	1.562	-0.205
Max My	185	25	1.105	382.275	22.795	26.683	2.51	-0.556
Min My	186	25	-1.362	383.626	22.681	26.546	-2.488	0.905
Max Mz	154	27	-29.595	613.422	-3.334	-2.004	-0.013	36.467
Min Mz	127	26	29.988	612.883	-3.273	-1.92	-0.007	-37.032

Support Numbers



DEFLECTION CHECK

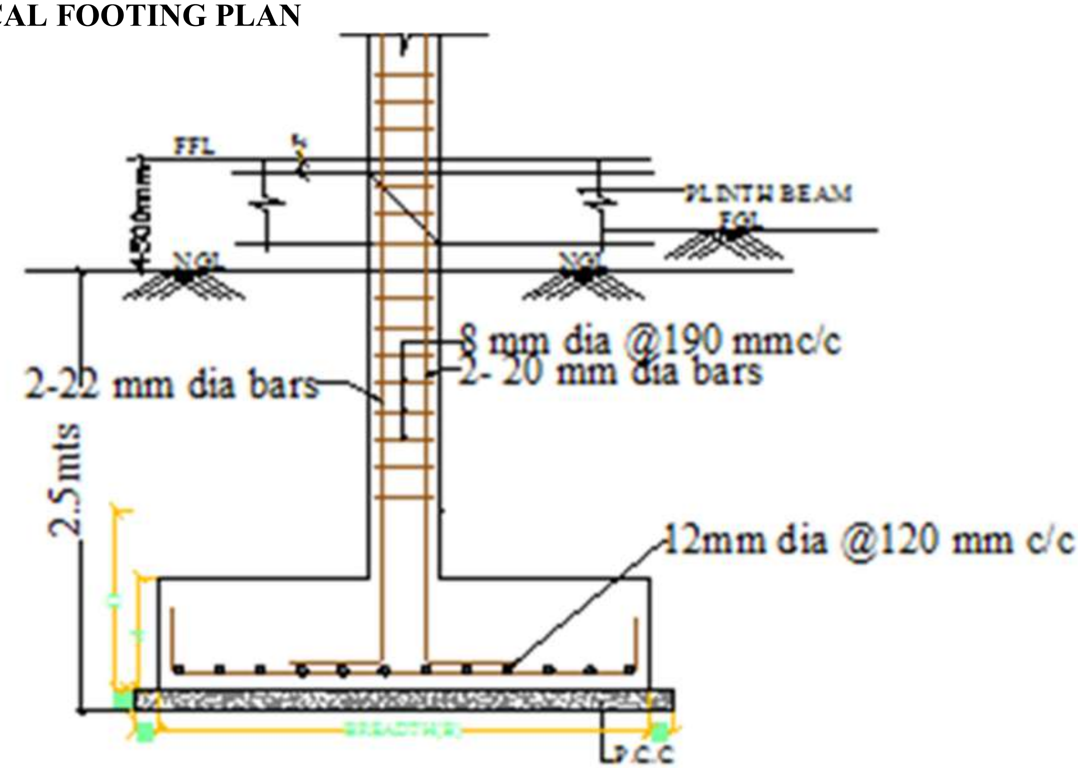
Deflection Summary of Whole Structure

			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	487	27	14.839	-6.861	0.465	16.355	0	0.001	-0.004
Min X	460	14	-16.366	-9.491	-0.386	18.923	0	-0.001	0.004
Max Y	529	5	3.139	0.929	0.173	3.279	0	0	0
Min Y	655	9	-4.234	-35.566	0.39	35.819	-0.002	0.001	0.009
Max Z	513	29	0.035	-4.807	29.022	29.418	0.001	0.001	-0.001
Min Z	512	25	0.037	-4.077	-26.271	26.586	0	0.001	0.001
Max rX	689	9	-1.637	-5.501	2.617	6.308	0.002	0	0
Min rX	649	9	-2.748	-13.989	0.391	14.262	-0.007	0	0.001
Max rY	501	13	-1.672	-7.569	-12.799	14.963	0.002	0.003	0
Min rY	457	13	-1.713	-7.629	-13.729	15.799	0.002	-0.002	0
Max rZ	671	9	-4.613	-32.458	2.397	32.872	-0.002	0	0.009
Min rZ	595	9	-1.413	-32.131	0.246	32.163	-0.002	0	-0.009
Max Rst	655	9	-4.234	-35.566	0.39	35.819	-0.002	0.001	0.009

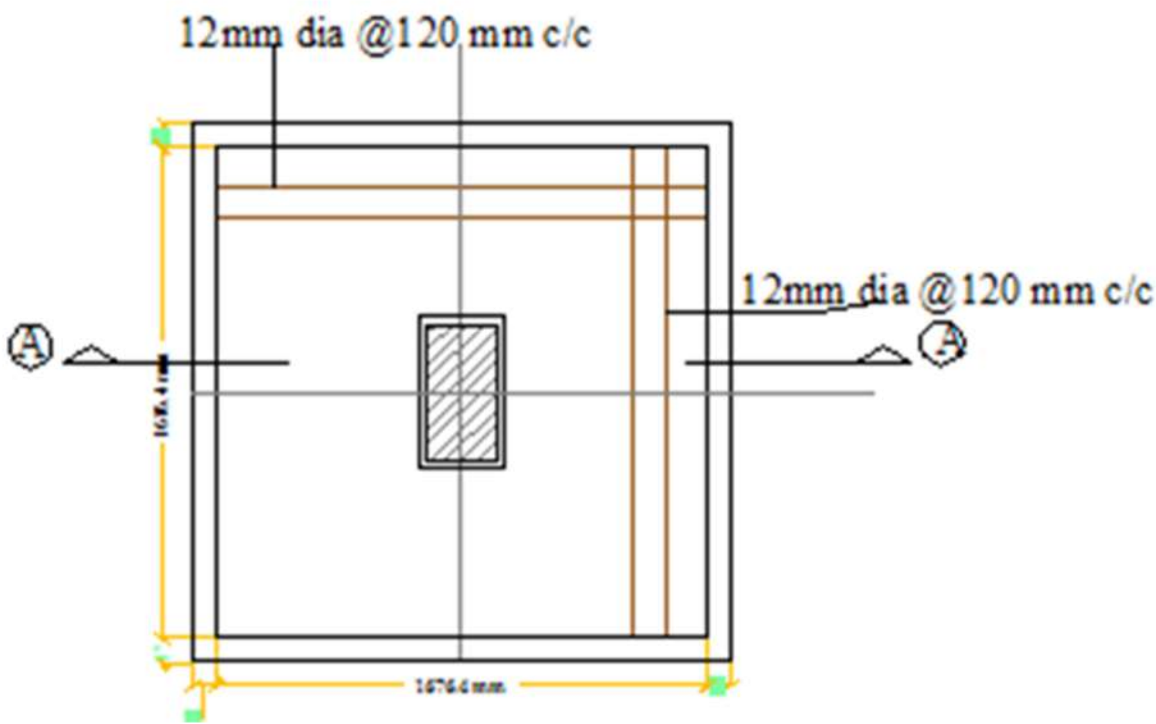
Lateral deflection developed in the structure = 4.927 mm
Permissible limit = H/500
= 20500/500 = 41 mm
= 4.927 < 41 mm (SAFE)
Vertical deflection developed in the structure = 0.068
Permissible limit (minimum of) = L/350 or 20 mm
= 26160/350 = 74.74 mm

$= 0.068 < 74.74$ (SAFE)

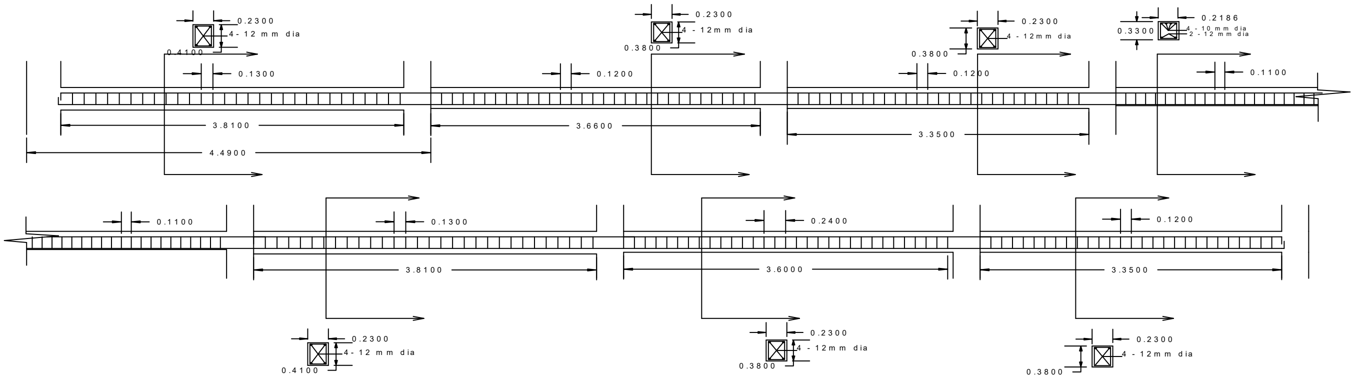
TYPICAL FOOTING PLAN



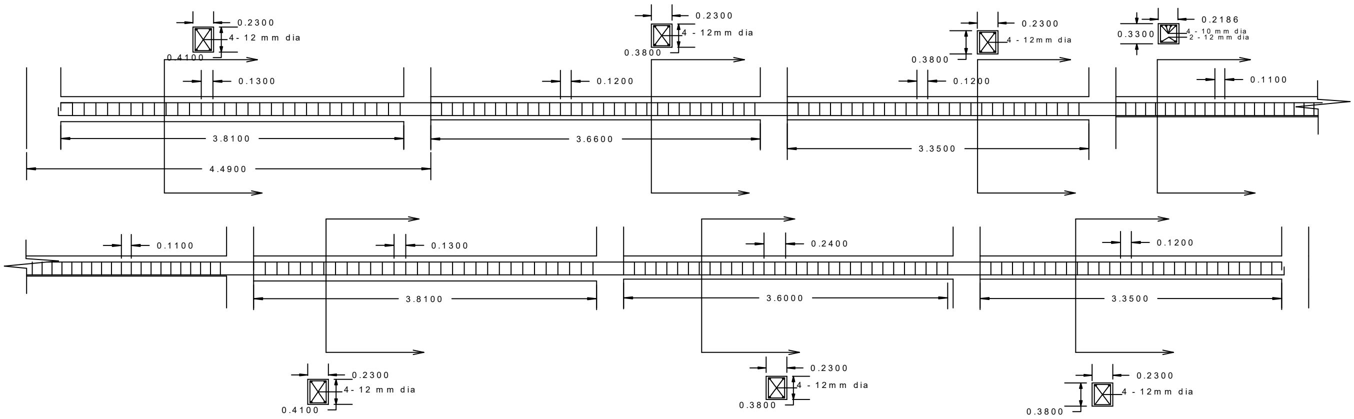
SECTION AT 'A-A'



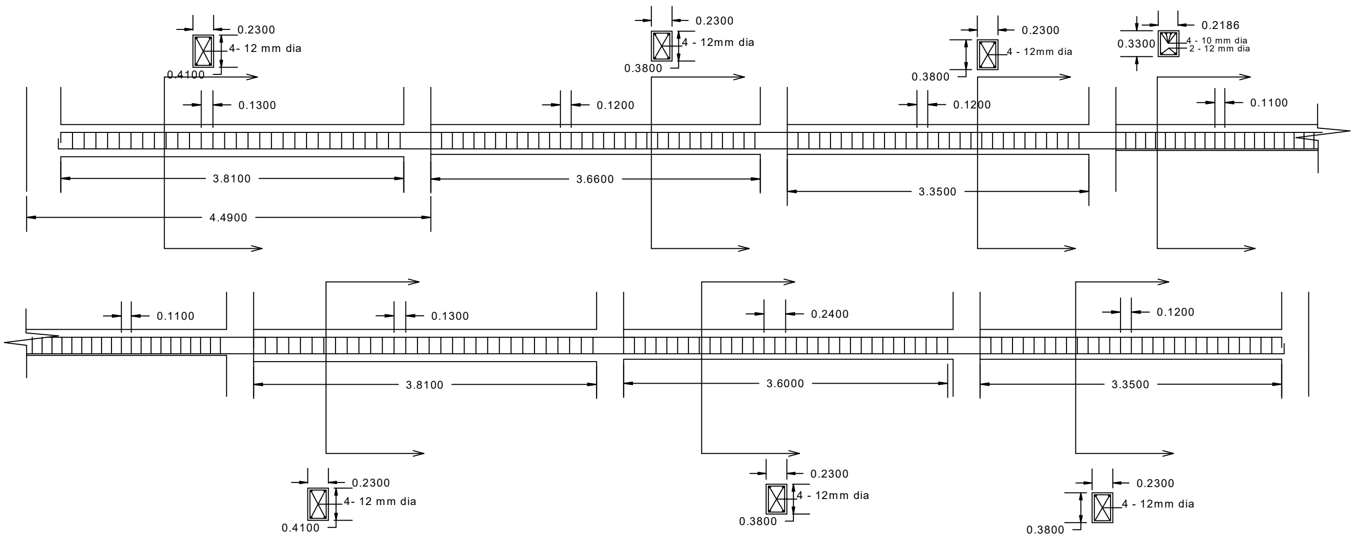
REINFORCEMENT DETAILING OF PLINTH BEAM



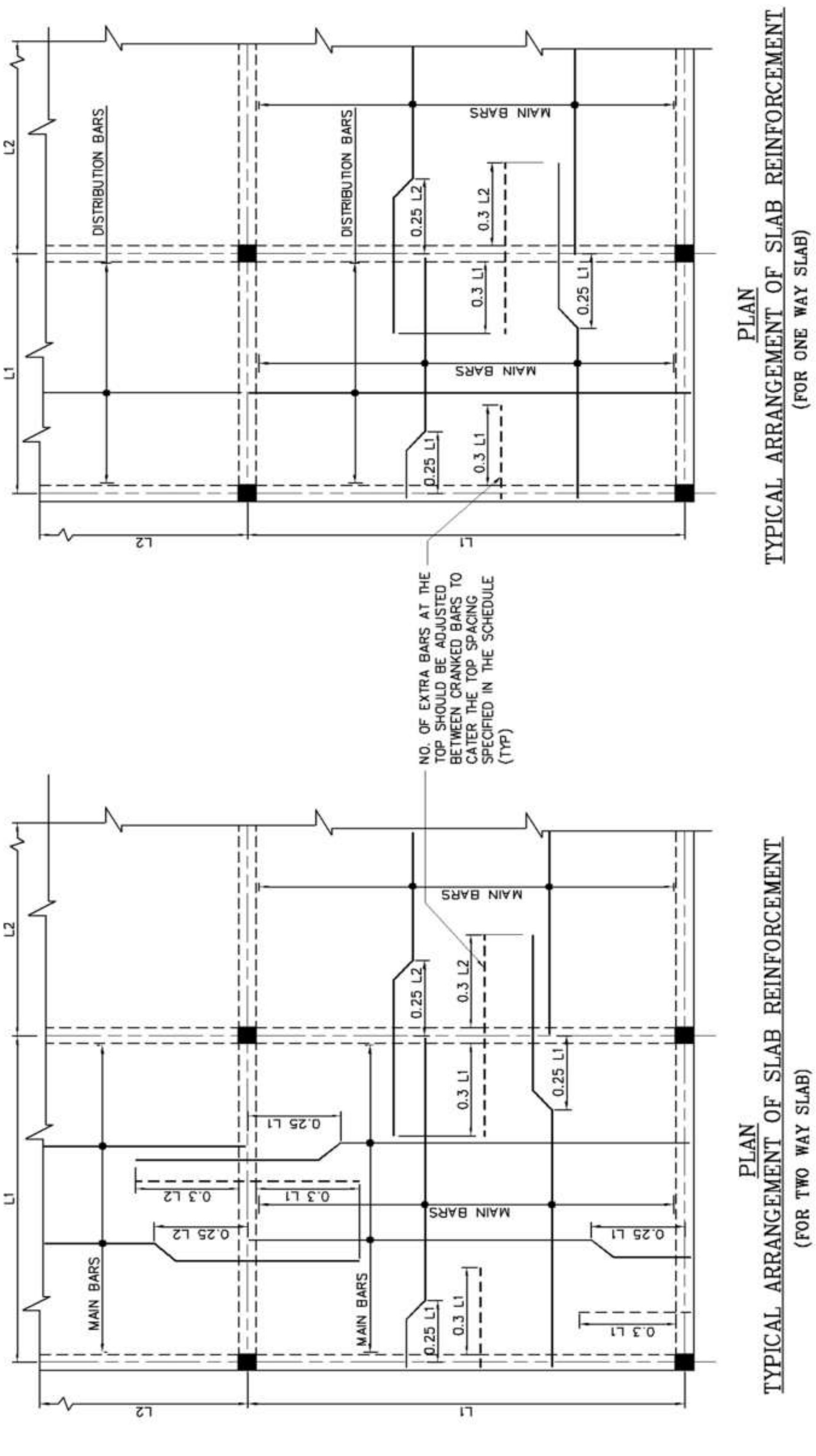
REINFORCEMENT DETAILING OF FLOOR BEAM

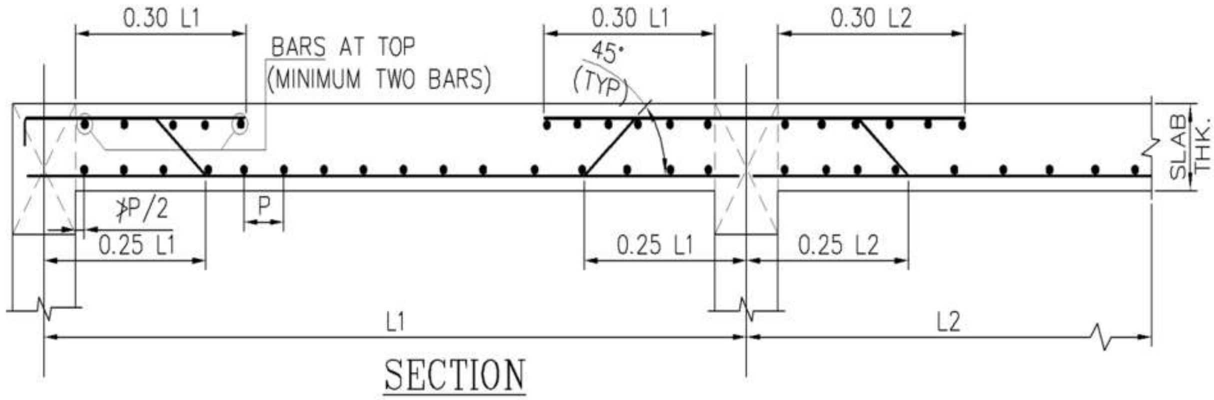


REINFORCEMENT DETAILING OF ROOF BEAM



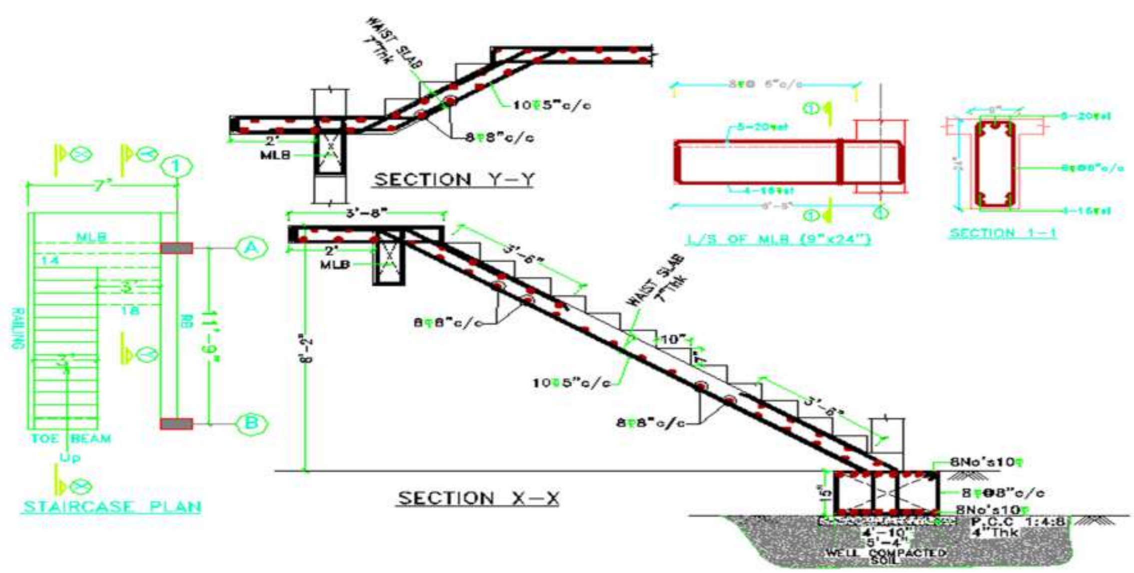
LAYOUTS OF SLABS





TYPICAL ARRANGEMENT OF SLAB REINFORCEMENT

REINFORCEMENT DETAILS OF STAIR CASE



CONCLUSIONS

1. The structural components of the building are safe in shear and flexure.
2. Amount of steel provided for the structure is economic.
3. There is no such large difference in analysis results of STAAD Pro and Kanis method.
4. Proposed sizes of the elements can be used in the structure.

FUTURE SCOPE OF STUDY

- By keeping the same analysis results of software, the design can be made more economical by designing members individually or in group.
- Meshing of the slab element can be done to get the accurate load distribution.

REFERENCES:-

1. **IS 456-2000** *Code Of Practice For Plain & Reinforced Concrete*
2. *Reinforced concrete* – **Ashok.K. Jain.**
3. *Limit state theory & Design of reinforced concurred* by **Dr. V.L Shah & Late**. **S.R.Karvy and shah**.
4. www.Bentley.com
5. www.staadpro.com