ISSN 2277-2685
IJESR/April-June. 2026/ Vol-16/Issue-2/60-70
M. A. Malik *et. al.,* / International Journal of Engineering & Science Research
Full Length Research Article

Analysis & Design Of Multistoried Residential Building (C+G+5) Using Staad Pro

Mr. Syed Sabeel Pasha[1], M. A. Malik[2], Ramvath Narshima[3], Erra Kavitha[4], Md Ayaan[5]
[1]Associate Professor, Dept. Of Civil Engineering, Svits, Mahbubnagar, Telangana.
[2,3,4,5]Ug Students, Dept. Of Civil Engineering, Svits, Mahbubnagar, Telangana.
Accepted 04-04-2026

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.

Keywords: *Residential Building Design, Reinforced Concrete (RCC), AutoCAD 2008, STAAD Pro V8i, STAAD Foundation, Structural Analysis, Structural Design, Limit State Method.*

INTRODUCTION

The earthquake causes vibratory ground motions at the base of the structure, and the structure actively responds to these motions. For the structure responding to a moving base, there is an equivalent system. The base is fixed and the structure is acted upon by forces that cause the same distributions that occur in the moving – base system. In design system it is customary to assume the structure as a fixed base system acted upon by inertia forces. Seismic design involves two distinct steps:

Determining or estimating the structure forces that will act on the structure

Designing the structure to provide adequate strength, stiffness, and energy dissipation capabilities to with stand these forces.

Behavior of the Structure:

The building and other structure are composed of horizontal and vertical structural elements that resist lateral forces. The horizontal elements, diaphragms and horizontal bracings are used to distribute the lateral forces to vertical elements. The vertical elements that are used to transfer lateral forces to the ground are shear wall, braced frames and moment resisting frames. The structure must include complete lateral and vertical force resisting systems, capable of providing adequate energy dissipation capacity to withstand the design ground motions within the prescribed limits, deformations and strength demand.

Motivation:

Day to day variations in the designing of the structures we were motivated to deal with this project. As civil engineering is much concerned with different designs to meet the necessity of human life we took this project.

Problem definition:

As the land is con sized to meet the demands of all the growing population the adoption of multi storied had grown up to meet their demands. As it is cost effective. Many of Rc building constructed recent times have special feature of the ground is left open for the purpose of parking, i.e. columns in the ground story do not have any partition walls of either masonry or RC between them.

STEEL REINFORCEMENT

Steel bars are essentially used in the tension zone of flexural members of concrete to resist the tensile stresses as concrete is weak in tension and in compression members to increase the load carrying capacity.

Steel is used as reinforcement to take up the tensile stresses in RCC construction the following reasons,

- Its tensile strength is high
- It can develop good bond with concrete
- Its coefficient of expansion is nearly same as for concrete

- It is easily available

FUNCTIONS OF REINFORCEMENT IN RCC

The reinforcement in RCC serves the following different types of functions,

- To resist the bending tension in flexural members like slabs, beams and walls of water tanks etc.
- To increase the load carrying capacity of compression members like columns
- To resist diagonal tension due to shear.
- To resist the effects of secondary stresses like temperature etc.
- To reduce the shrinkage of concrete.
- To resist spiral cracking due to torsion
- To prevent the development of wide cracks in concrete due to tensile strain.

FUNCTIONS OF REINFORCEMENT IN RCC

The reinforcement in RCC serves the following different types of functions,

- To resist the bending tension in flexural members like slabs, beams and walls of water tanks etc.
- To increase the load carrying capacity of compression members like columns
- To resist diagonal tension due to shear.
- To resist the effects of secondary stresses like temperature etc.
- To reduce the shrinkage of concrete.
- To resist spiral cracking due to torsion
- To prevent the development of wide cracks in concrete due to tensile strain.

TYPES OF REINFORCEMENT

Reinforcing steel consists of bars usually circular in cross section. The following four types of steel reinforcement are generally used in reinforced concrete construction.

- Mild steel and medium tensile steel bars conforming to IS 432 (part I)
- High yield strength deformed steel bars (HYSD bars) conforming to IS 1566
- Steel wire fabric conforming to IS 1566
- Structural steel conforming to Grade A of IS 2062

All reinforcement shall be free from loose mill scale, loose rust, oil, mud, and any other substances which reduces bond between steel and concrete. The grades of steel normally used for reinforcement are Fe 250, Fe 415, and Fe 500. Fe refers to ferrous metal and the number following it refers to specified yield strength in N/mm2

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.

2.1CALCULATION 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

LITERATURE REVIEW:

- Method of analysis of statically indeterminate portal frame
- Method of flexibility coefficients
- Slope of displacement methods (iterative methods)
- Moment distribution method
- Kani's method (approximate method)
- Cantilever method
- Portal method
- Matrix method
- STAAD Pro.

This chapter reviews about some of the fundamental concepts of structural design and presents them in a manner relevant to the design of light-frame residential structures. The concepts form the basis for understanding the design procedures and overall design approach addressed in the remaining chapters of the guide. With this conceptual background, it is hoped that the designer will gain a greater appreciation for creative and efficient design of homes, particularly the many assumptions that must be made.

STRUCTURAL ANALYSIS:

The process of structural analysis is simple in concept but complex in detail. It involves the analysis of a proposed structure to show that its resistance or strength will meet or exceed a reasonable expectation. This expectation is usually expressed by a specified load or demand and an acceptable margin of safety that constitutes a performance goal for a structure. The performance goals of structural design are multifaceted. Foremost, a structure must perform its intended fnction safely voer its useful life.

The concept of useful life implies considerations of durability and establishes the basis for considering the cumulative exposure to time-varying risks (i.e. corrosive environments, occupant loads, snow loads, wind loads, and seismic loads). Given, however, that performance is inextricably linked to cost, owners, builders, and designers must consider economic limits to the primary goals of safety and durability.

In view of the above discussion, a structural designer may appear to hve little control over the fundamental goals of structural design, except to comply with or exceed the minimum limits established by law. While this is generally true, a designer can still do much to optimize a design through alternative means and methods that call for more efficient analysis techniques, creative design detailing, and the use of innovative construction materials and methods. In summary, the goals of structural design are generally defined by law and reflect the collective interpretation of general public welfare by those involved in the development and local adoption of building codes.

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

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

KANI'S METHOD:

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

The most significant feature of kani's method is that the process of iteration is self-corrective. Any error at any stage of iteration is corrected in subsequent steps consequently skipping a few steps of iterations either by over sight or by intention does not lead to error in final end moments.

Advantages:

It is used for side way of frames

Limitations:

The rotations of columns of any story should be function of a single rotation value of the same story. The beams of story should not undergo rotation when the column undergoes translation. That is the column should be parallel.

APPROXIMATE METHOD:

Approximate analysis of hyper static structure provides a simple means of obtaining a quick solution for preliminary design. It makes some simplifying assumptions regarding structural behavior so as to obtain a rapid solution to complex structures.

The usual process comprises reducing the given indeterminate configuration to a determine structural system by introducing adequate no. of hinges. It is possible to sketch the deflected profile of the structure for the given loading and hence by locate the point inflection since each point of inflection corresponds to the location of zero moment in the structure. The inflection points can be visualized as hinges for the purpose of analysis. The solution of structure is sundered simple once the inflection points are located. The loading cases are arising in multistoried frames namely horizontal and vertical loading. The analysis carried out separately for those two cases.

HORIZONTAL LOADS:

The behavior of a structure subjected to horizontal forces depends up on its height to width ratio among their factor. It is necessary to differentiate between low rise and high-rise frames in this case.
Low rise structures:
Height < width
It is characterized predominately by shear deformation
High rise structures:
Height > width
It is dominated by bending action.

MATRIX ANALYSIS OF FRAMES:

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

DESIGN OF MULTISTORIED RESIDENTIAL APARTMENTS:

General:

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

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

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

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

The objectives of the design are:

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

LIMIT STATE METHOD:

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

LIMIT STATE OF COLLAPSE:

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

This limit state corresponds to:
Flexural

- Compression
- Shear
- Torsion

LIMIT STATE OF SURVIVABILITY:

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

- Deflection
- Cracking
- Vibration

FOUNDATION DESIGN:

Foundations are structure elements that transfer loads from building or individual column to earth this load are to be properly transmitted foundations must be designed to prevent excessive settlement are rotation to minimize differential settlement and to provide adequate safety isolated footings for multi stored buildings. These may be square rectangular are

ISSN 2277-2685
IJESR/April-June. 2026/ Vol-16/Issue-2/60-70
M. A. Malik *et. al.,* / International Journal of Engineering & Science Research

circular in plan that the choice of type of foundation to be used in a given situation depends on a number of factors.

- Bearing capacity of soil
- Type of structure
- Type of oars
- Permissible differential settlements
- Economy

COLUMN DESIGN:

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

A column may be classify based on deferent criteria such as

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

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

BEAM DESIGN:

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

There are three types of reinforced concrete beams.

- Single reinforced beams
- Double reinforced concrete
- Flanged beams

DESIGN LOADS FOR RESIDENTIAL APARTMENTS:

Loads are a primary consideration in any building design because they define the nature and magnitude of hazards or external forces that a building must resist to provide reasonable performance (i.e. safety and serviceability) throughout the structure's useful life. The anticipated loads are influenced by a building's intended use (occupancy and function), configuration (size and shape), and location (climate and site conditions). Ultimately, the type and magnitude of design loads affect critical decisions such as material selection, construction details, and architectural configuration. Thus, to optimize the value (i.e. performance versus economy) of the finished product, it is essential to apply design loads realistically. While the buildings considered in this guide are primarily single-family detached and attached dwellings, the principles and concepts related to building loads also apply to other similar types of construction, such as low-rise apartment buildings. In general, the design loads recommended in this guide are based on:

- Dead Loads
- Live Loads
- Imposed Load

Dead Loads:

This is the permanent of stationary load like self-weight of structural elements. This includes

- self weight
- weight of finished
- Weight of partition walls etc.

Dead loads are based on the unit weight of elements, which are established taking into account materials specified for construction, given in IS 1911-1967

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

Live Loads:

These loads are not permanent or moving loads. The following loads includes in this type of loading:

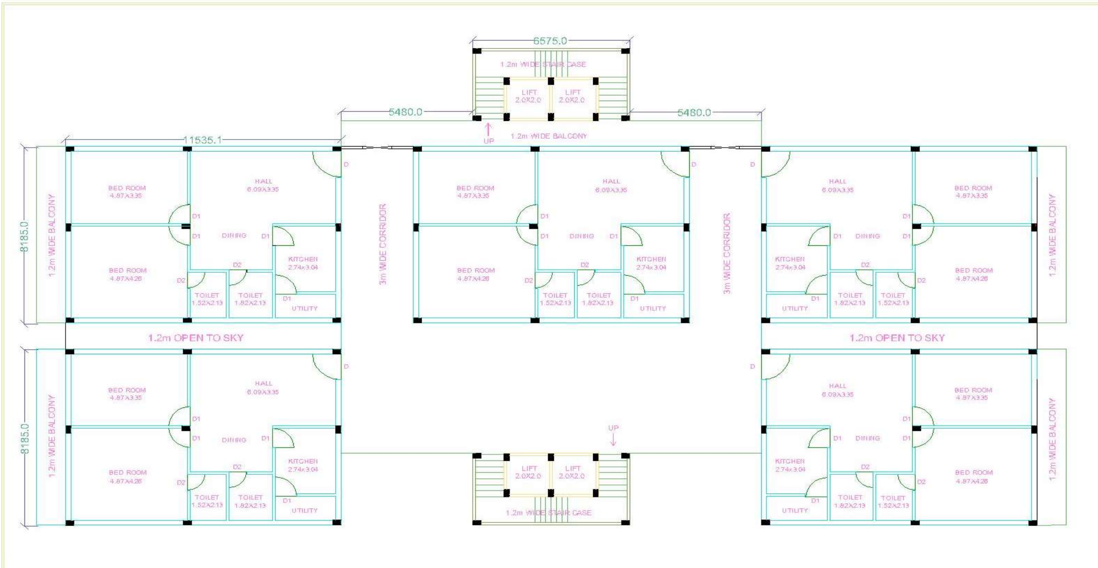
Imposed loads (fixed) weight of fixed seating in auditoriums, fixed machinery, partition walls. These loads through fixed in positions cannot be relied upon to act permanently throughout the life of the structure.

Imposed loads (not fixed) these loads change either in magnitude or position very often such as traffic loads, weight of furniture etc.

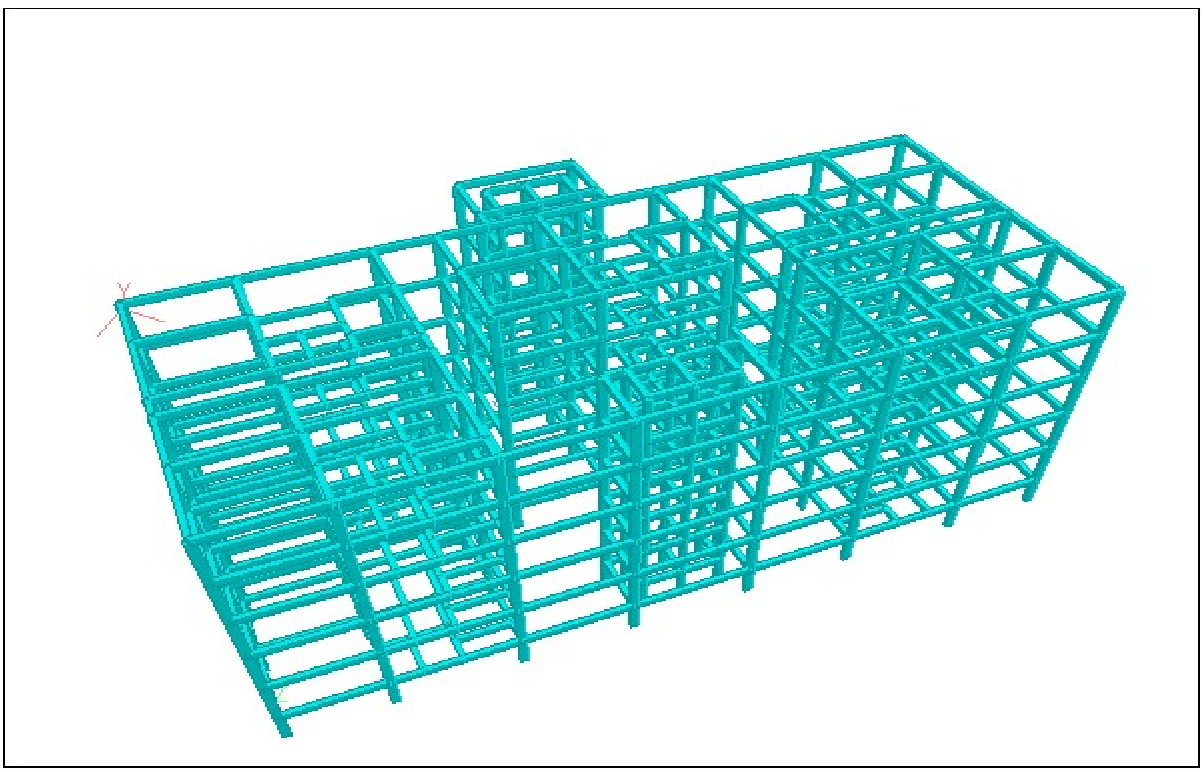
Live loads are produced by the use and occupancy of a building. Loads include those from human occupants, furnishings, no fixed equipment, storage and construction and maintenance activities. As required to adequately define the loading condition, loads are presented in terms of uniform area loads, concentrated loads, and uniform line loads.

PLAN OF THE STRUCTURE

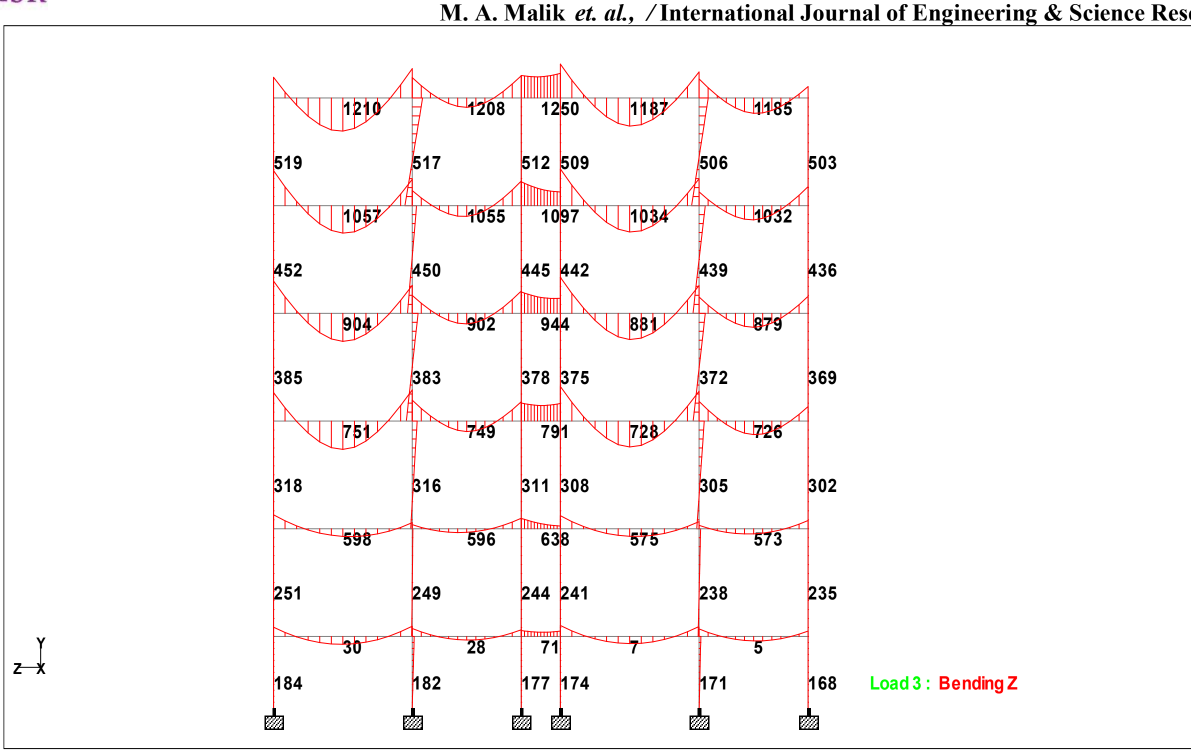
ISSN 2277-2685
IJESR/April-June. 2026/ Vol-16/Issue-2/60-70
M. A. Malik *et. al.*, / International Journal of Engineering & Science Research



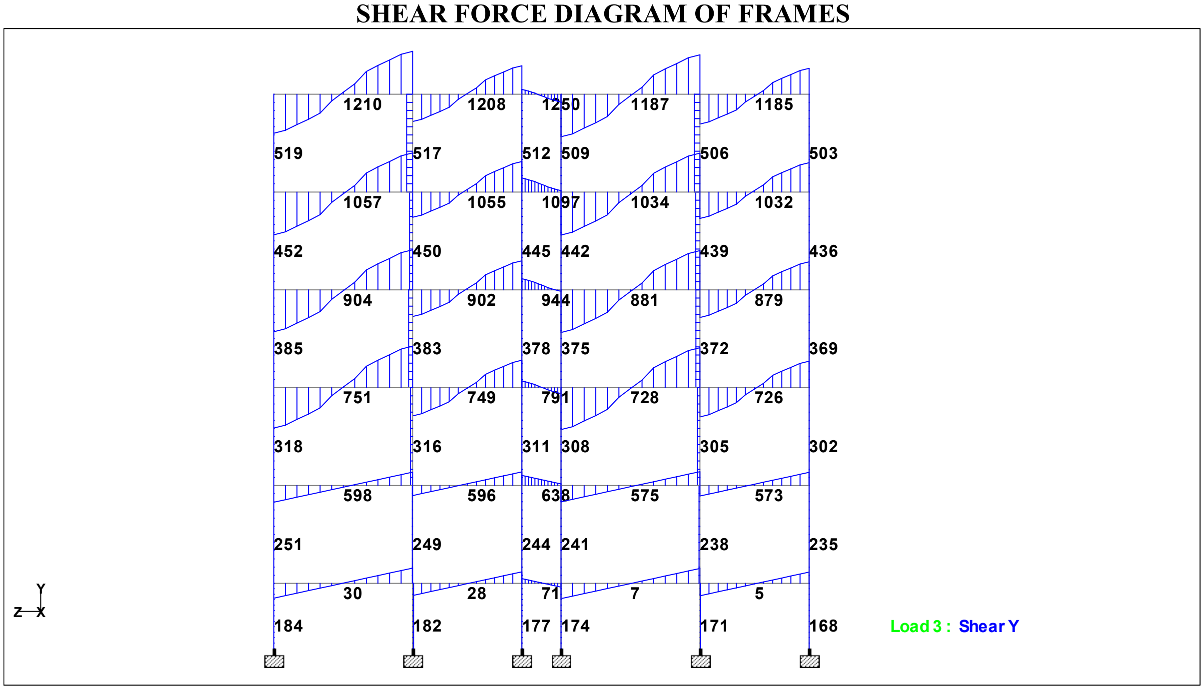
3D RENDERING



BENDING MOMENT DIAGRAM OF FRAMES

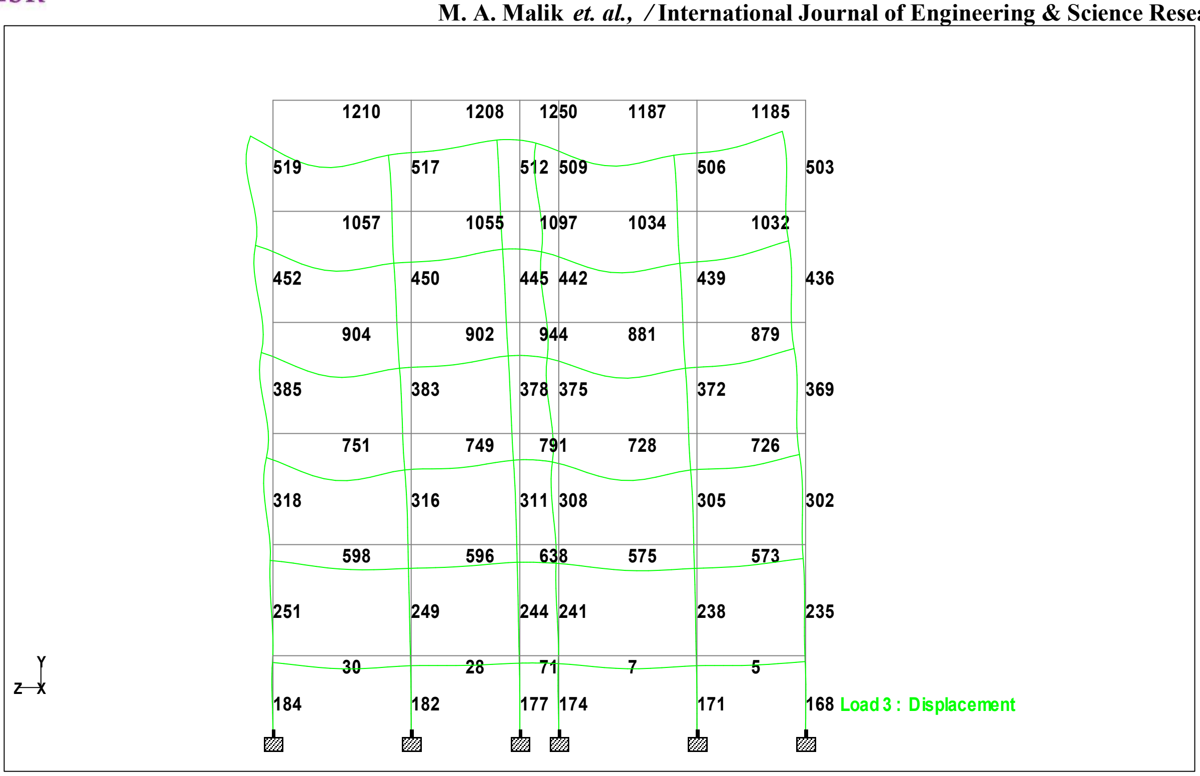


SHEAR FORCE DIAGRAM OF FRAMES

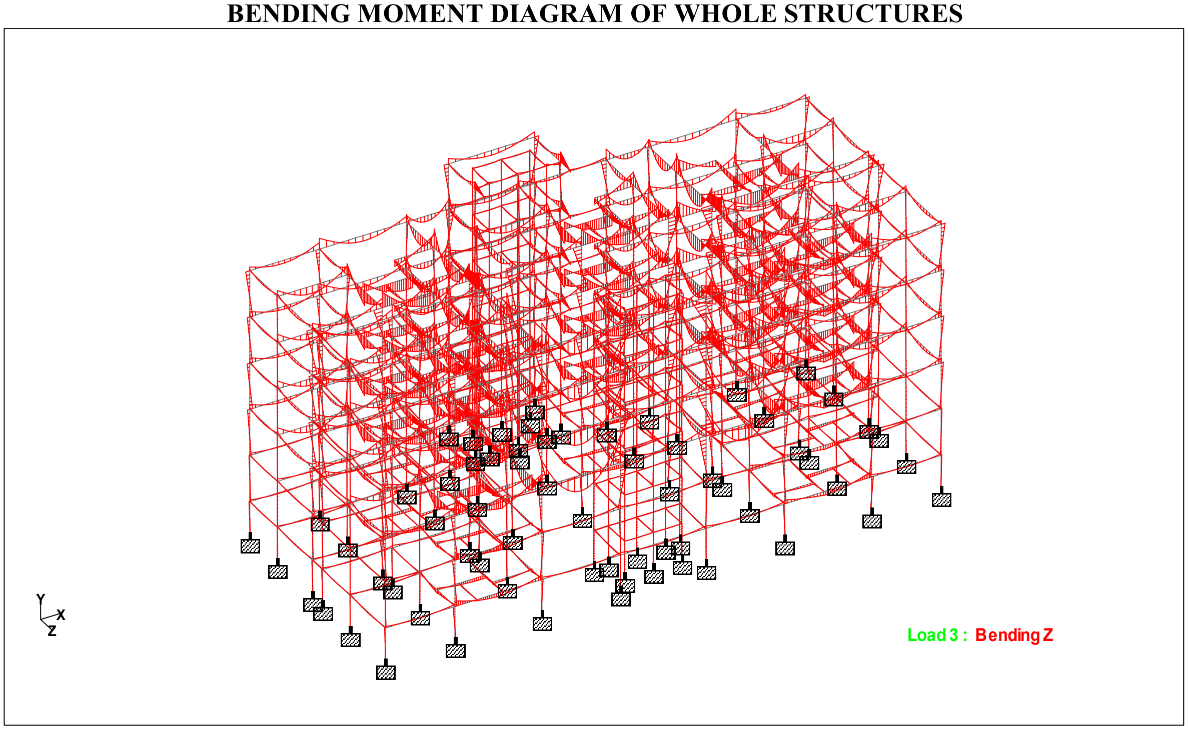


DEFLECTION DIAGRAM OF FRAMES

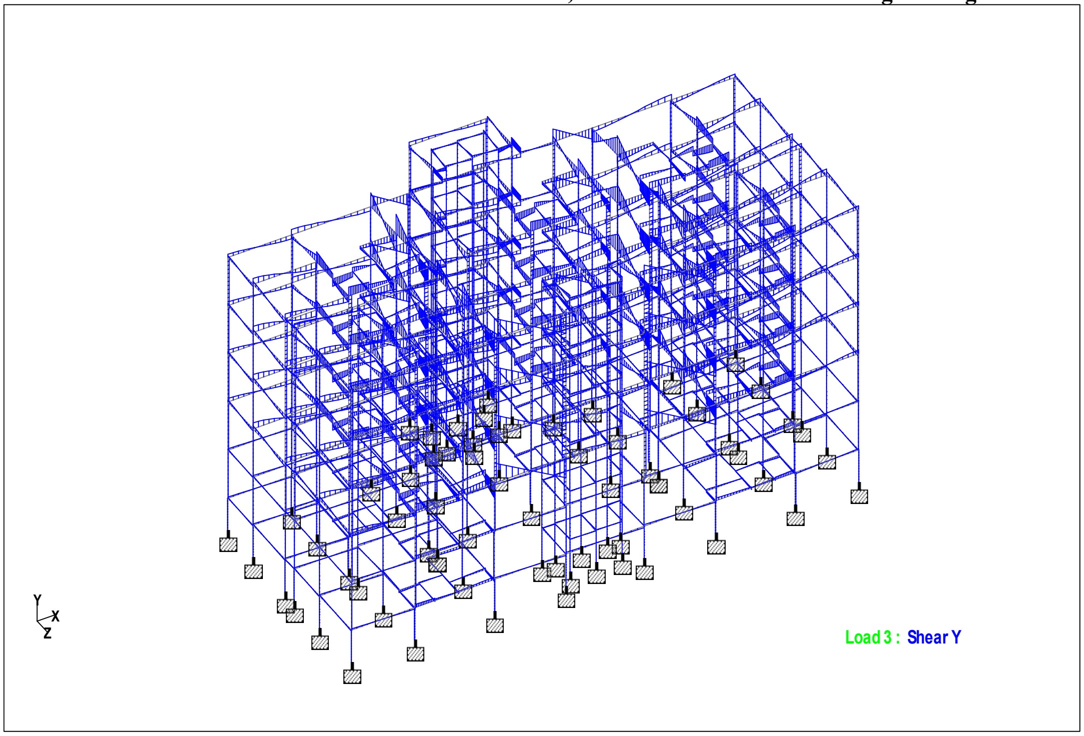
ISSN 2277-2685
IJESR/April-June. 2026/ Vol-16/Issue-2/60-70
M. A. Malik *et. al.,* / International Journal of Engineering & Science Research



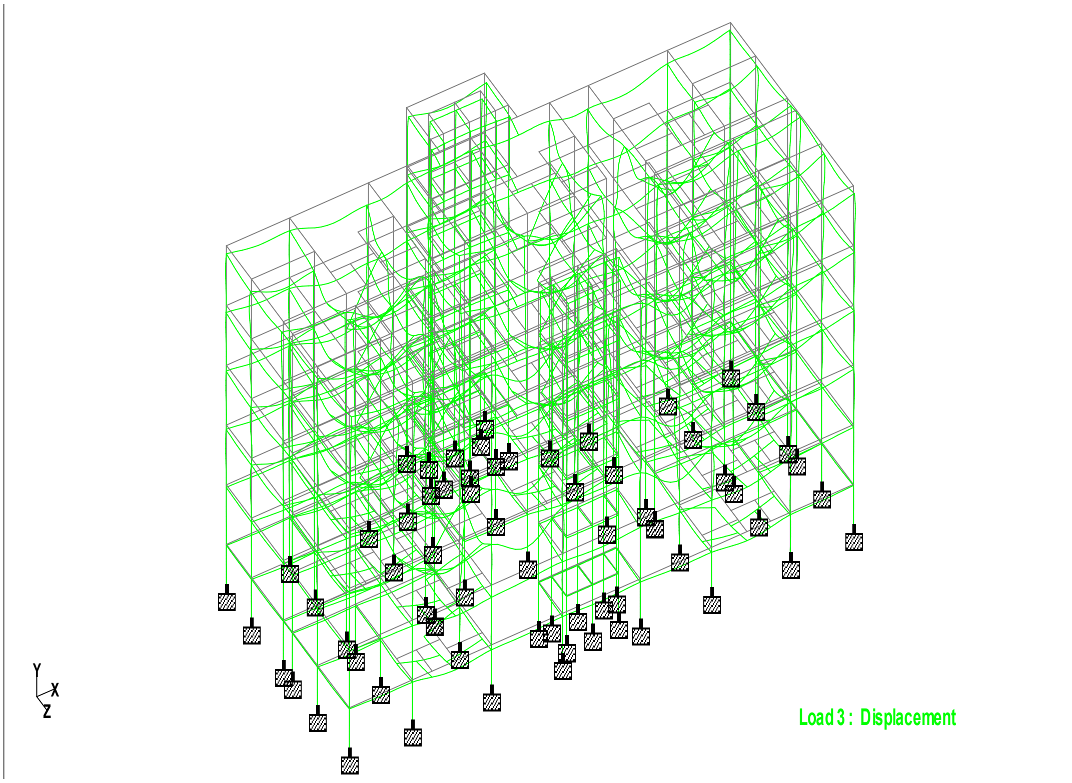
BENDING MOMENT DIAGRAM OF WHOLE STRUCTURES



SHEAR FORCE DIAGRAM OF WHOLE STRUCTURES



DEFLECTION DIAGRAM OF WHOLE STRUCTURES

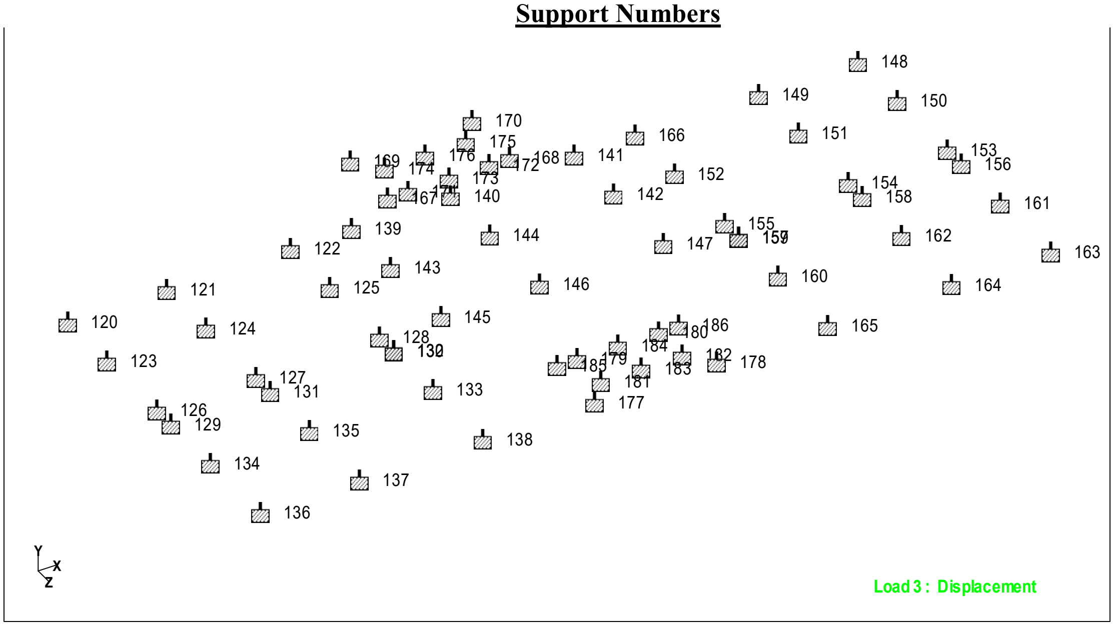


Unfactored Support Reactions Summary:

			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)

CONCLUSIONS:

The analysis and design of the multi-storeyed residential building (C+G+5) using STAAD Pro has been successfully completed in accordance with relevant Indian Standard codes. The project demonstrated the effective application of structural engineering principles in designing a safe, stable, and economical building structure.

The use of STAAD Pro significantly simplified complex calculations involving load distribution, bending moments, shear forces, and deflections. Various loads such as dead load, live load, wind load, and seismic load were carefully considered, and the structure was analysed under different load combinations to ensure safety and serviceability.

The design of structural components including beams, columns, slabs, and footings was carried out based on the results obtained from the software. All members were found to be safe under the applied loads, satisfying the strength and stability requirements as per IS codes.

The project also highlighted the importance of accurate modelling, proper load application, and interpretation of analysis results. The use of software tools not only improved efficiency but also minimized human errors compared to manual calculations.

In conclusion, the designed building is structurally sound, economical, and capable of withstanding the expected loads and environmental conditions. This project enhanced understanding of real-world structural design practices and the practical use of advanced engineering software in civil engineering.

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