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Analysis And Design Of A C+G+5 Storey Commercial Building

M Nithin[*1], Abdul Kaleem[*2], Md Umar[*3], Md Fazalullah[*4], Mr. Syed Sabeel Pasha[*5]

[*1,2,3,4] B.Tech Student, [*5] HOD & Associate Professor, Dept. of Civil Engineering.
Sree Visvesvaraya Institute of Technology and Science, Mahbubnagar, Telangana, India.

Abstract : In this Commercial building we are doing C+G+5 office building. It consists of 5 floors. A five stored office building having a regular layout and which can be divided in to a number of similar vertical plane frames has been considered in this project to illustrate the analysis and design of a rigid jointed plane Structural planning, Estimation of load, Analysis of structure, Member design, Drawing, Preparation of schedules.

Structural planning: Involves determination of Form of the structure, Material of the structure, Structural system, Layout of components, Method of analysis, Philosophy of structural design. In Estimation of loads we are taking dead loads, live loads & wind load according to code IS: 875 To Analysis the structure we are using STAAD for Member design: Slabs, Beams, Columns, Footings. Designing process is doing by the Limit state method & Analysis is by using STAAD. Condition of a structure just before failure is called Limit state method. The structure should have same load carrying capacity, serviceability throughout the life time.

1. INTRODUCTION

The project comprises the development of plans, elevations, and sectional view of a Commercial 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.

Engineering term applied to the profession in which a knowledge of the mathematical and natural sciences, gained by the experiment and practically is applied to the effective use of the materials, and forces of nature. The term engineer properly denotes a person who has received professional training in pure and applied sciences, but is often loosely used to desire the operator of an engineer, marine locomotive engineer or a stationary engineer. In modern terminology, these later occupations are known as crafts or trades, Civil Engineering is perhaps the broadest of engineering fields, for it deals with the creation, improvement, and protection of the communal environment, providing facilities for living. Industry and transportation, include large buildings, roads, bridges, canals rail road lines, airports, water supply systems, dams, irrigation, harbors, docks, aqueducts tunnels and other engineered constructions.

The Civil Engineering must have a thorough knowledge of all types of surveying of the properties and mechanics of construction materials, mechanics of structures and soils and of hydraulics and fluid mechanics.

Before the middle of the 18th century, large-scale construction works usually placed in the hands of military engineers. Military engineering involved such work as preparation of topographical maps, their location, design and construction of road and bridges and the buildings of forts and docks. In 18th century, however, the term Civil Engineering came in to use to describe engineering work that was performed by civilians for non-military purpose.

Concrete, artificial engineering material made from a mixture of Portland cement, water, fine and coarse aggregates and a small amount of air. It is the most widely used construction material in the world. Concrete is the only major building material that can be delivered to the job site in a plastic state. This unique quality makes concrete desirable as a building material because it can be molded to virtually any form or a shape. Concrete provided wide latitude in surface textures and colors and can be used to construct a wide variety of structures such as highways and streets, bridges, dams, large buildings, airport runways, irrigation structure, break waters, piers and docks, side walks, soils and farm building homes and even barges and ship. Other desirable qualities of concrete as a building material are its strength, economy and durability. Depending on the mixture of materials used, concrete will support, in compression, 700 or more kg/sq cm, (10,000 or more 1b/sq cm). The tensile strength of concrete is much lower, but by using properly designed steel reinforcing. Structural members can be made that are as strong as in tension as in compression. The durability of concrete is evidenced by the fact that concrete columns built by the Egyptians more than 3600 years ago are still standing.

Concrete used in most construction works in reinforcement is with steel. When concrete structural members must resist extreme tensile stresses, steel supplied the necessary strength. Steel is embedded with twisted bars or in concrete in the form of a mesh or roughened. A bond forms between both compounds. This assembly of concrete and steel is called as REINFORCED CEMENT CONCRETE.

Reinforced concrete has a remarkable capacity to adapt to the assumptions of the designer. This has been pointed out to number of engineers. Lugi Nervy, the renowned Italians architect engineer has stated it eloquently as follows:

Mainly because of plastic flow, a concrete structure tries with admirable ductility to adapt itself to our calculations, which don’t always represent the most logical and spontaneous answer to the request of the forces at play and even tries to correct our deficiencies and errors sections and regions too highly stressed yield and channel some of their loads to other sections or regions, which accept this additional task with commendable spirit of collaboration with the limits of their own strength.

II. NEED FOR THE STUDY

Multi Storied Buildings have become a part of the day-to-day development. So, the construction of the Multi Storied Buildings gained importance, their method of constructions also gained importance.

A multi-story building is a building that has multiple floors above ground in the building. Multi-story buildings aim to increase the area of the building without increasing the area of the land the building is built on, hence saving land and, in most cases, money (depending on material used and land prices in the area). Buildings serve several needs of society – primarily as shelter from weather and as general living space, to provide privacy, to store belongings and to comfortably live and work. A building as a shelter represents a physical division of the human habitat (a place of comfort and safety) and the outside (a place that at times may be harsh and harmful).

III. OBJECTIVE OF THE STUDY

This project describes a method of analysis and design of a multi storied residential quarters. The scope behind presenting this project is to learn the concept of construction, and to design an elegant, safe and durable structure with economy. The most prominent convenient method of designing and analyzing Multi Storied Building is STAAD.pro.

STAAD.Pro is one of the first software applications in the world made for the purpose of helping the structural engineers to automate their work, to eliminate the tedious and lengthy procedures of the manual methods. STAAD.Pro is a general-purpose structural analysis and design program with applications primarily in the building industry - commercial buildings, bridges and highway structures, industrial structures, chemical plant structures, dams, retaining walls, turbine foundations, culverts and other embedded structures, etc.

The interfaces with AutoCAD to provide design drawings are some of the highlighting features of this project. The Main advantage of displaying the drawing in auto cad is the user has more flexibility to modify the detailing drawing Auto CAD as per his decision. The total design and analysis is done by STAAD-Pro 2006 version.

IV. 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.

V. LITERATURE REVIEWS:

Method of analysis of statically indeterminate portal frame.

- Method of Flexibility Coefficients.
- Slope Displacement Methods (Iterative Methods)

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- Moment Distribution Method.
- Kani's Method (Approximate Method).
- Cantilever Method.
- Portal Method.
- Matrix Method.
- STAAD.Pro.
- ETABS

Force methods:

Originally developed by James Clerk Maxwell in 1864, later developed by Otto Mohr and Heinrich Muller-Breslau, the force method was one of the first methods available for analysis of statically indeterminate structures. As compatibility is the basis for this method, it is sometimes also called as compatibility method or the method of consistent displacements. In this method, equations are formed that satisfy the compatibility and force-displacement requirements for the given structure in order to determine the redundant forces. Once these forces are determined, the remaining reactive forces on the given structure are found out by satisfying the equilibrium requirements.

Displacement methods:

The displacement method works the opposite way. In these methods, we first write load displacement relations for the members of the structure and then satisfy the equilibrium requirements for the same. In here, the unknowns in the equations are displacements. Unknown displacements are written in terms of the loads (i.e. forces) by using the load displacement relations and then these equations are solved to determine the displacements. As the displacements are determined, the loads are found out from the compatibility and load- displacement equations. Some classical techniques used to apply the displacement method are discussed.

Slope deflection method:

This method was first devised by Heinrich Manderla and Otto Mohr to study the secondary stresses in trusses and was further developed by G.A.Maney extend its application to analyze indeterminate beams and framed structures. The basic assumption of this method is to consider the deformations caused only by bending moments. It's assumed that the effects of shear force or axial force deformations are negligible in indeterminate beams or frames.

The fundamental slope-deflection equation expresses the moment at the end of a member as the superposition of the end moments caused due to the external loads on the member, while the ends being assumed as restrained, and the end moments caused by the displacements and actual end rotations. A structure comprises of several members; slope deflection equations are applied to each of the member. Using appropriate equations of equilibrium for the joints along with the slope-deflection equations of each member we can obtain a set of simultaneous equations with unknowns as the displacements. Once we get the values of these unknowns i.e. the displacements, we can easily determine the end moments using the slope-deflection equations.

Moment distribution method:

This method of analyzing beams and multi-storied frames using moment distribution was introduced by Prof. Hardy Cross in 1930, and is also sometimes referred to as Hardy Cross method. It is an iterative method in which one goes on carrying on the cycle to reach to a desired degree of accuracy. To start off with this method, initially all the joints are temporarily restrained against

Rotation and fixed end moments for all the members are written down. Each joint is then released one by one in succession and the unbalanced moment is distributed to the ends of the members, meeting at the same joint, in the ratio of their distribution factors. These distributed moments are then carried over to the far ends of the joints. Again, the joint is temporarily restrained before moving on to the next joint. Same set of operations are performed at each joint till all the joints are completed and the results obtained are up to desired accuracy. The method does not involve solving a number of simultaneous equations, which may get quite complicated while applying large structures, and is therefore preferred over the slope-deflection method.

Kani's method:

This method was first developed by "Prof. Gasper Kani" of Germany in the year "1947". The method is named after him. This is an indirect extension of slope deflection method. This is an efficient method due to simplicity of moment distribution. The method offers an iterative scheme for applying slope deflection method of structural analysis. Whereas the moment distribution method reduces the number of linear simultaneous equations and such equations needed are equal to the number of translator displacements, the number of equations needed is zero in case of the Kani's method. This method may be considered as a further simplification of moment distribution method wherein the problems involving sway were attempted in a tabular form thrice (for double story frames) and two shear coefficients had to be determined which when inserted in end moments gave us the final end moments. All this effort can be cut short very considerably by using this method.

→ Frame analysis is carried out by solving the slope−deflection equations by successive approximations. Useful in case of side sway as well.

→ Operation is simple, as it is carried out in a specific direction. If some error is committed, it will be eliminated in subsequent cycles if the restraining moments and distribution factors have been determined correctly

VI. CALCULATION OF LOADS

Dead and live loads at Floor level:

Dead load of slab (125 mm assuming) = 0.125*25

= 3.0 KN/m^2

Floor finishes = 1KN/m^2

Total floor load = 3.0 + 1.0

= 4.0 kN/m^2

Live load (On floor, accessible) = 2.0 kN/m^2

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/m^2

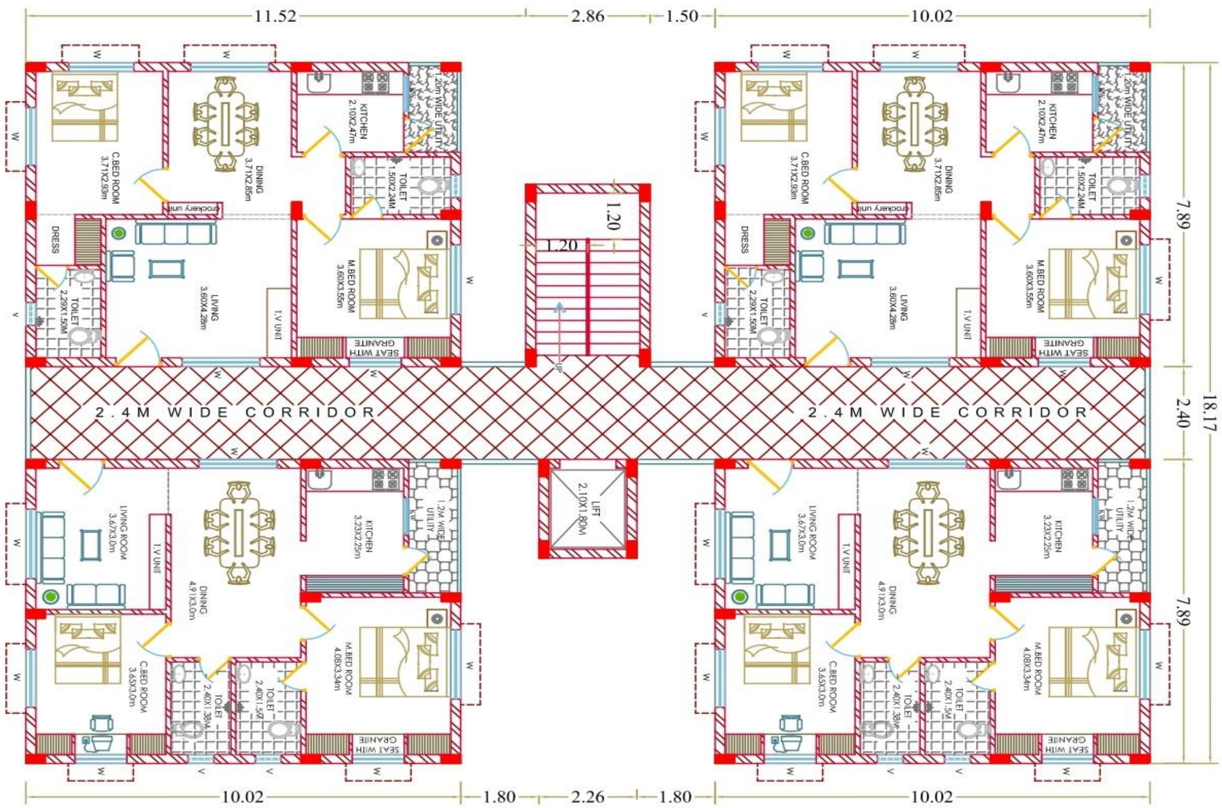
Water proofing = 3.0 kN/sq.m

Total floor load = 3.125+3.0

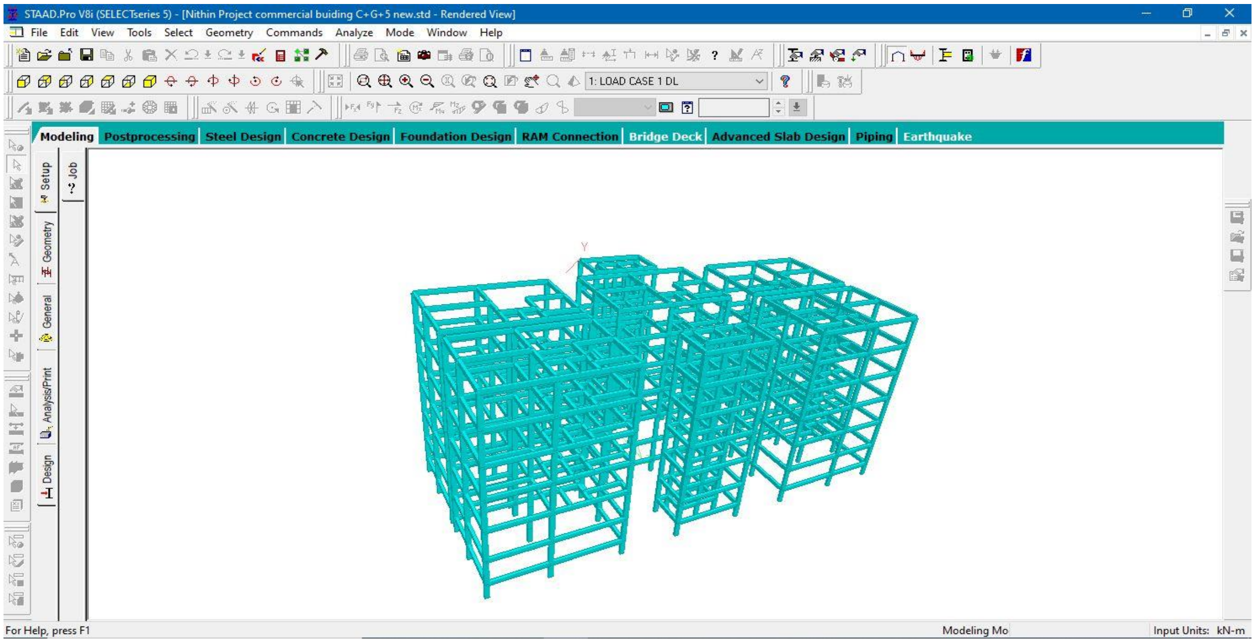
= 6.125 kN/ m^2

Live load (On floor, accessible) = 1.5 kN/ m^2

PLAN OF THE STRUCTURE



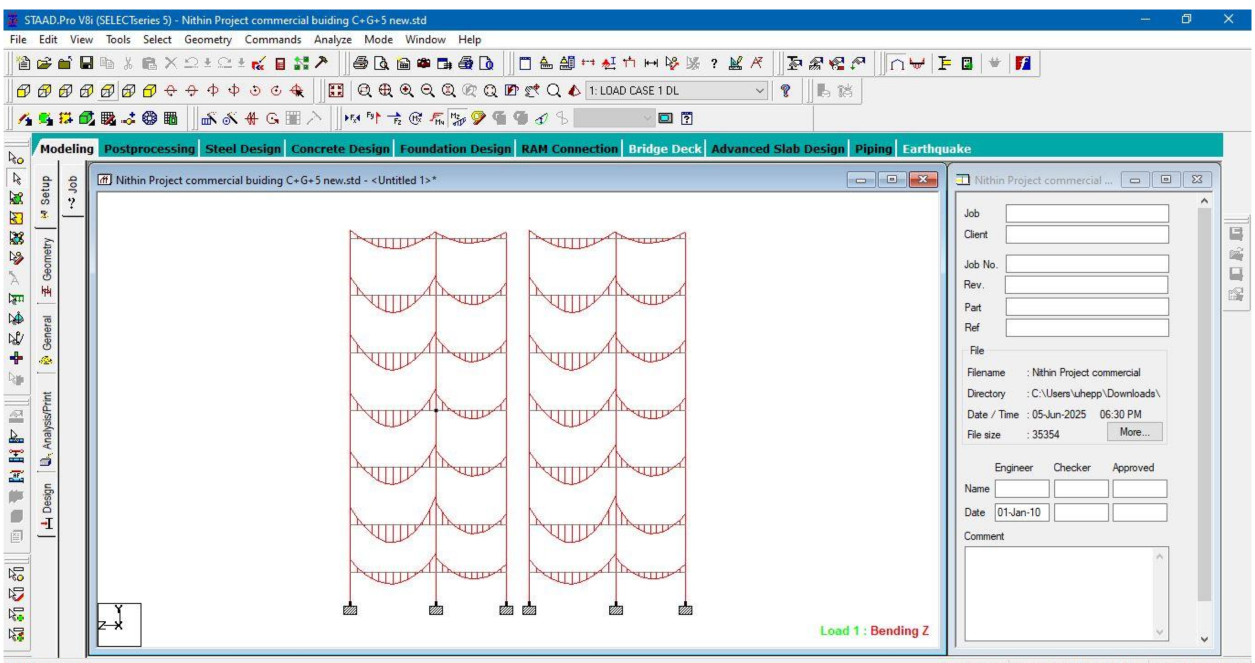
3D RENDERING



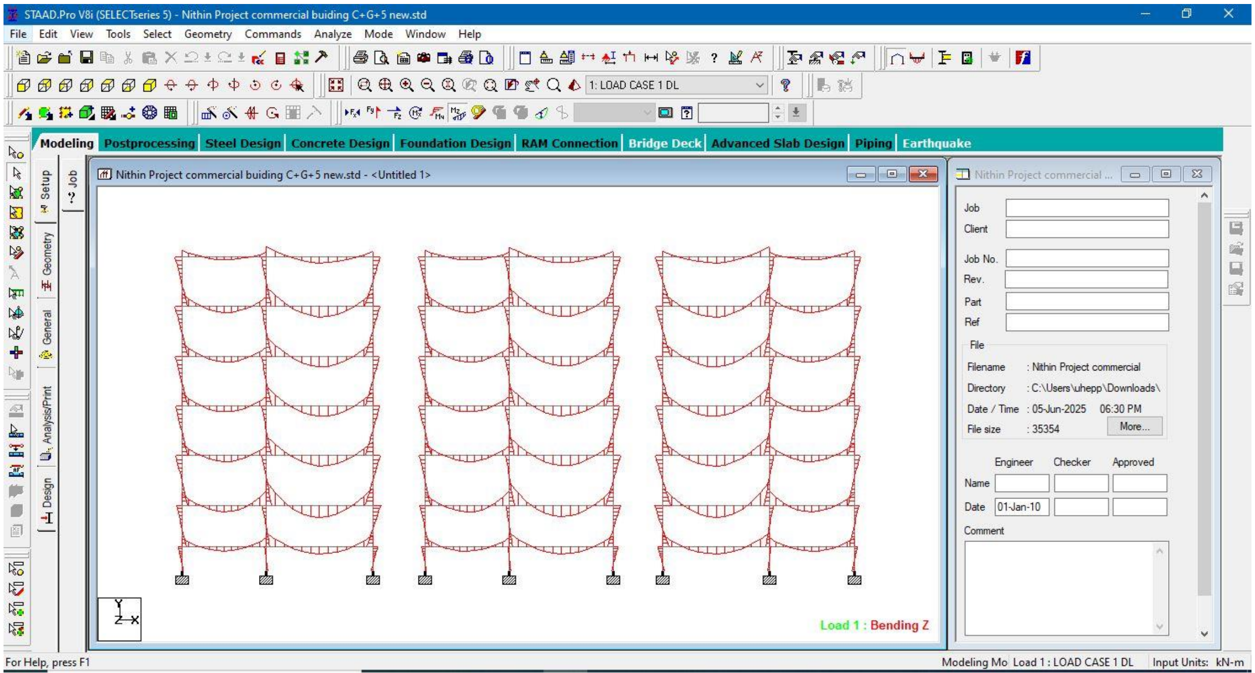
VII. STRUCTURAL DIGRAMS

BENDING MOMENT DIAGRAM OF FRAMES

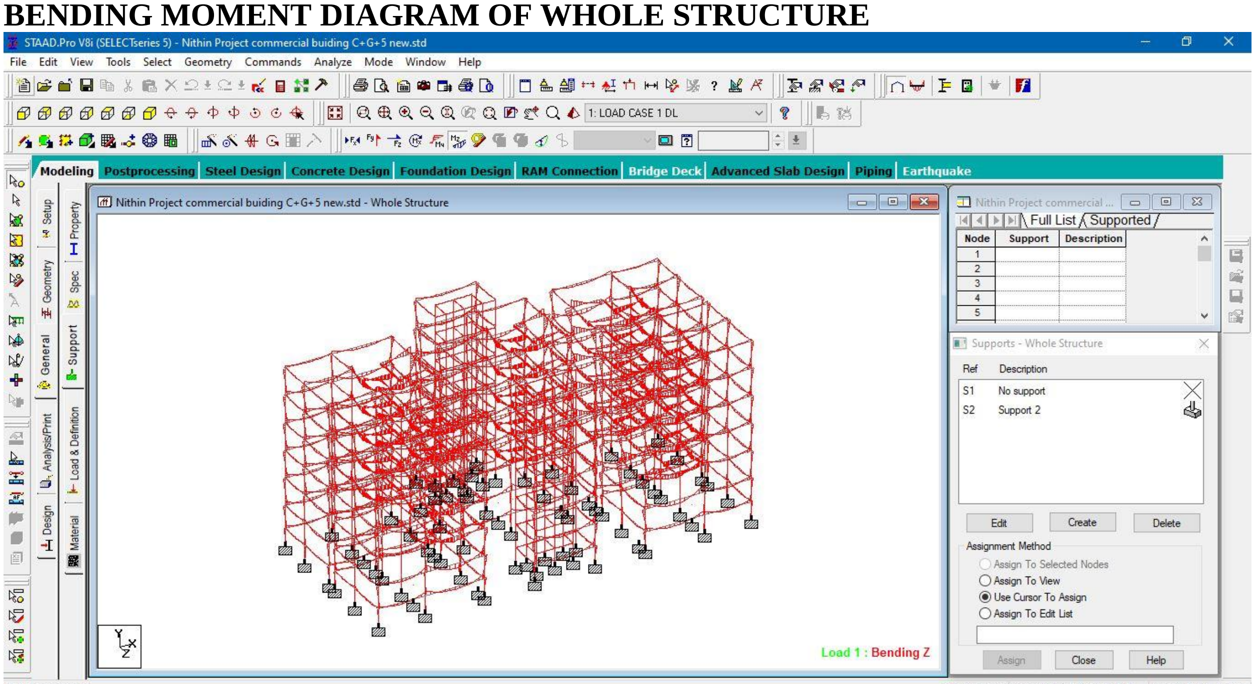
FRAME 1



FRAME 2

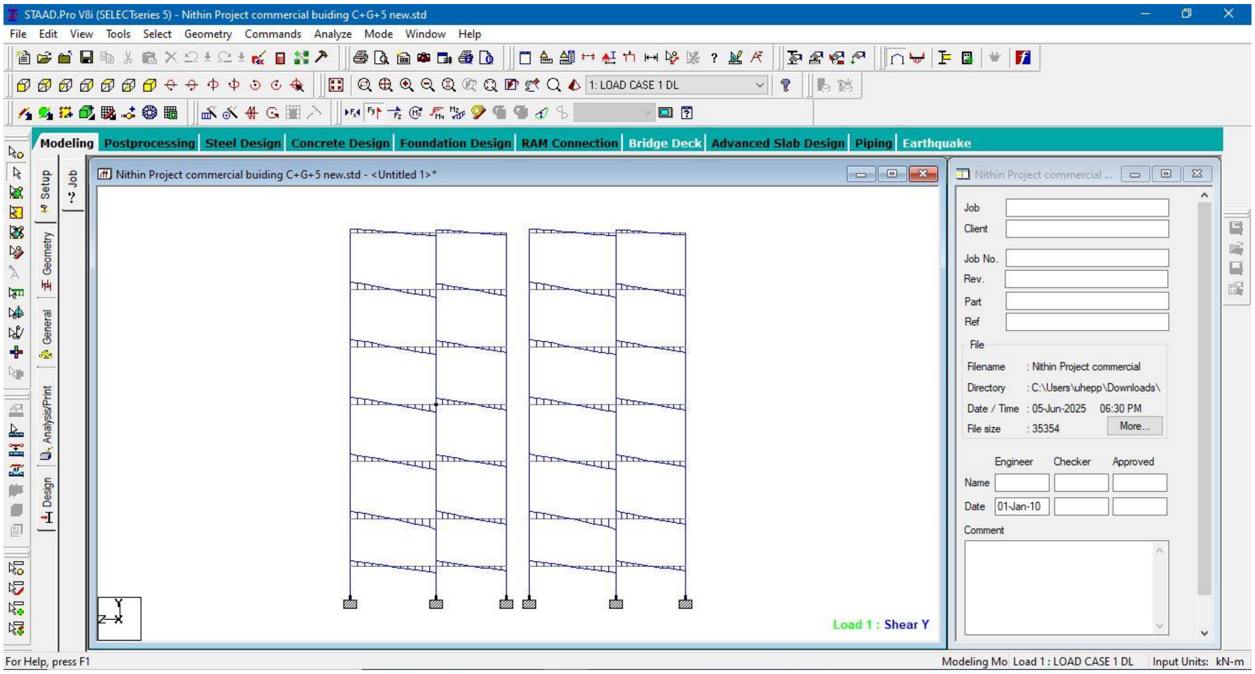


BENDING MOMENT DIAGRAM OF WHOLE STRUCTURE

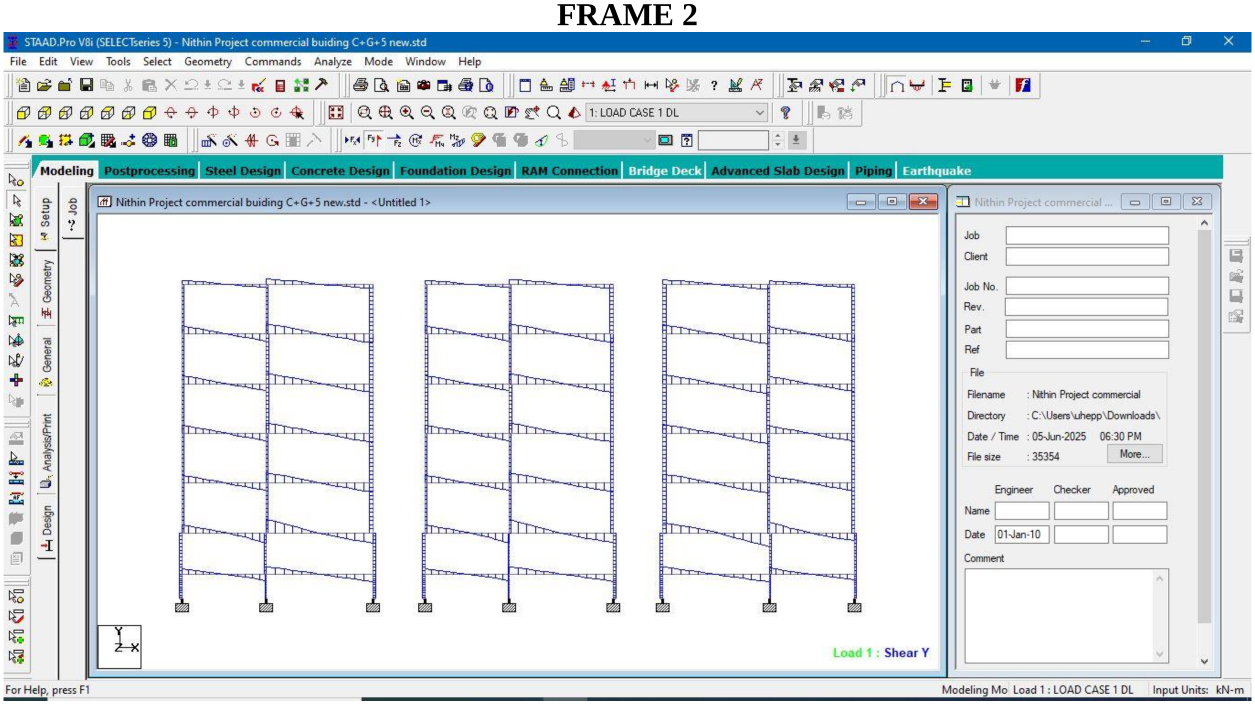


SHEAR FORCE DIAGRAM OF FRAMES:-

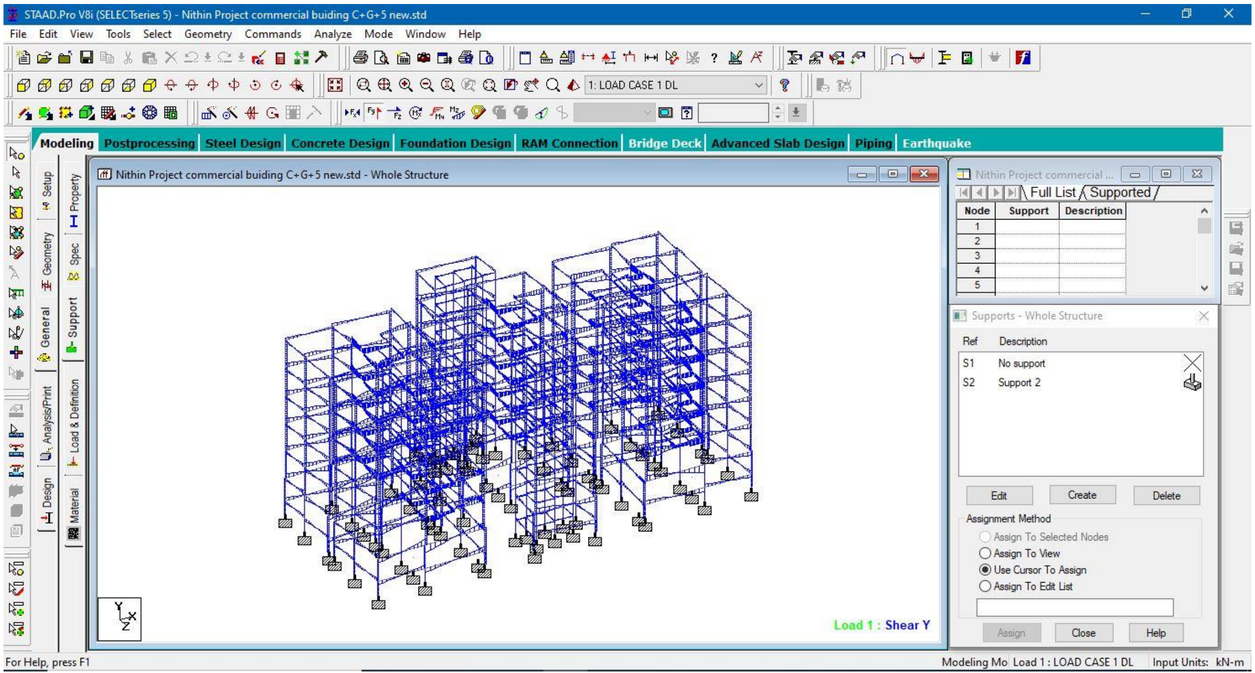
FRAME 1



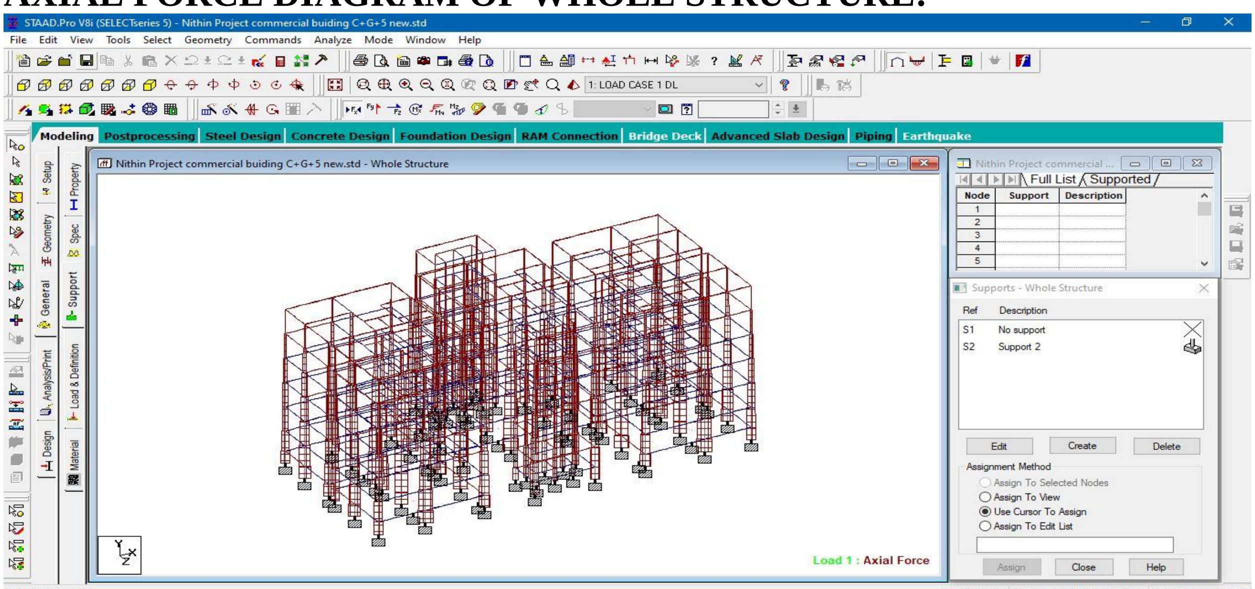
FRAME 2



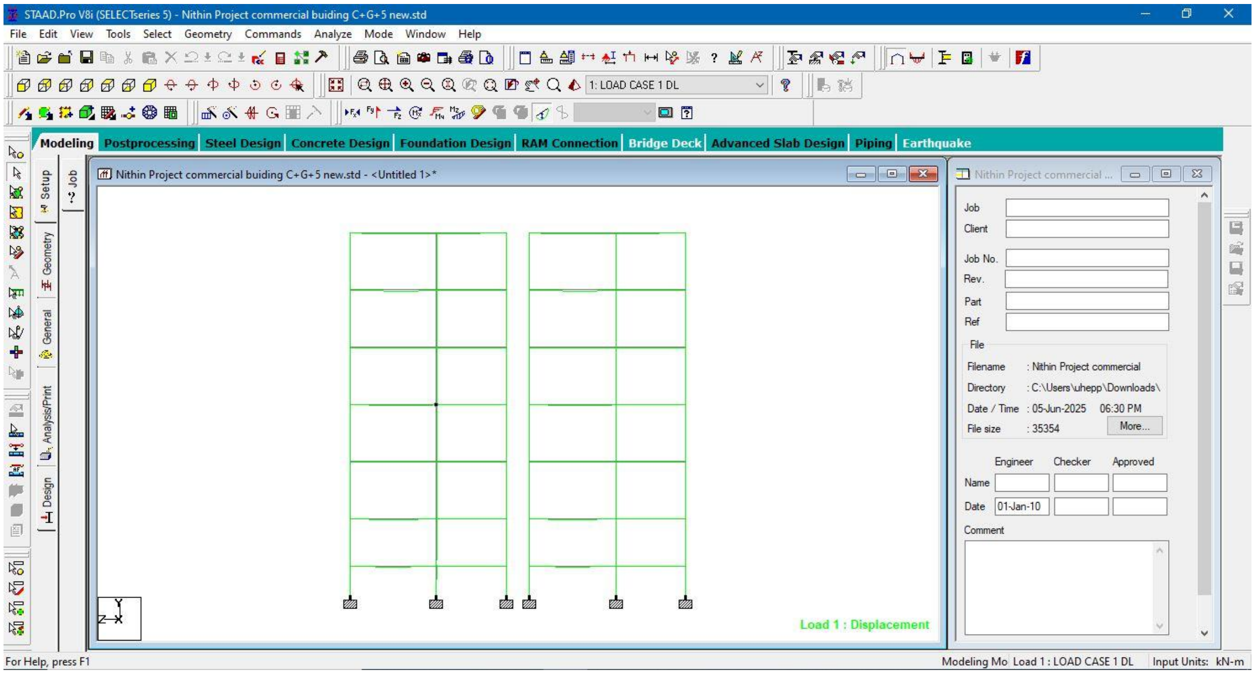
SHEAR FORCE DIGRAM OF WHOLE STRUCTURE:



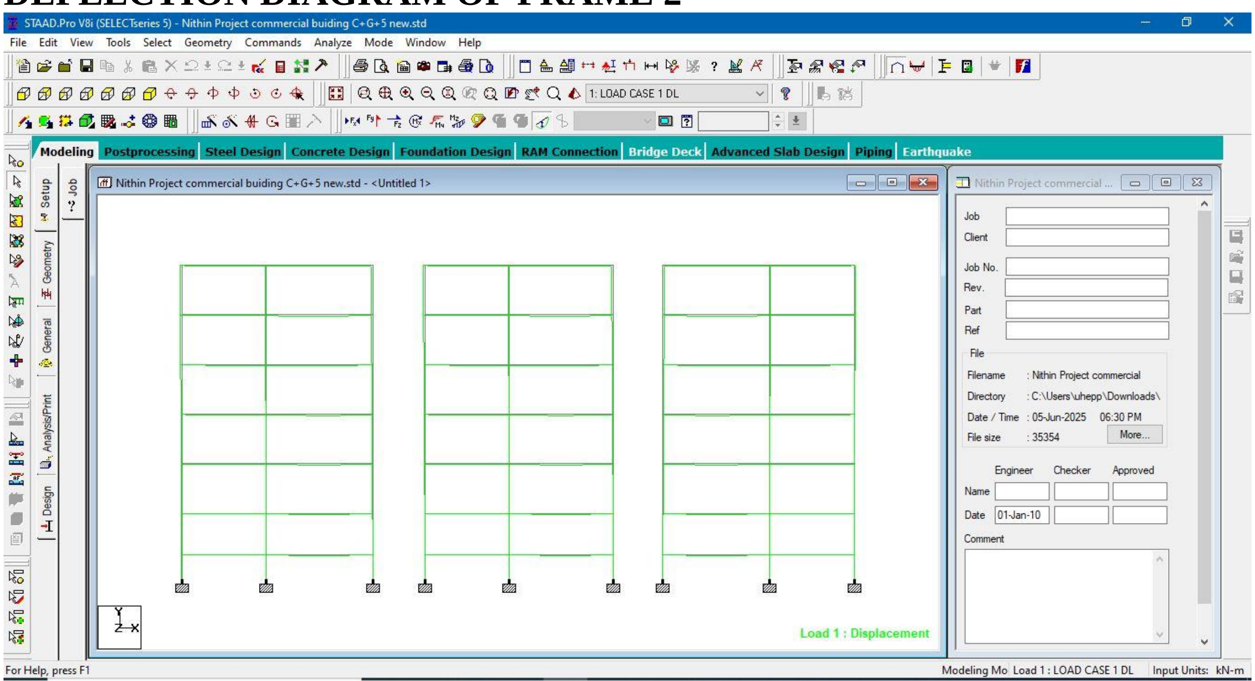
AXIAL FORCE DIAGRAM OF WHOLE STRUCTURE: -



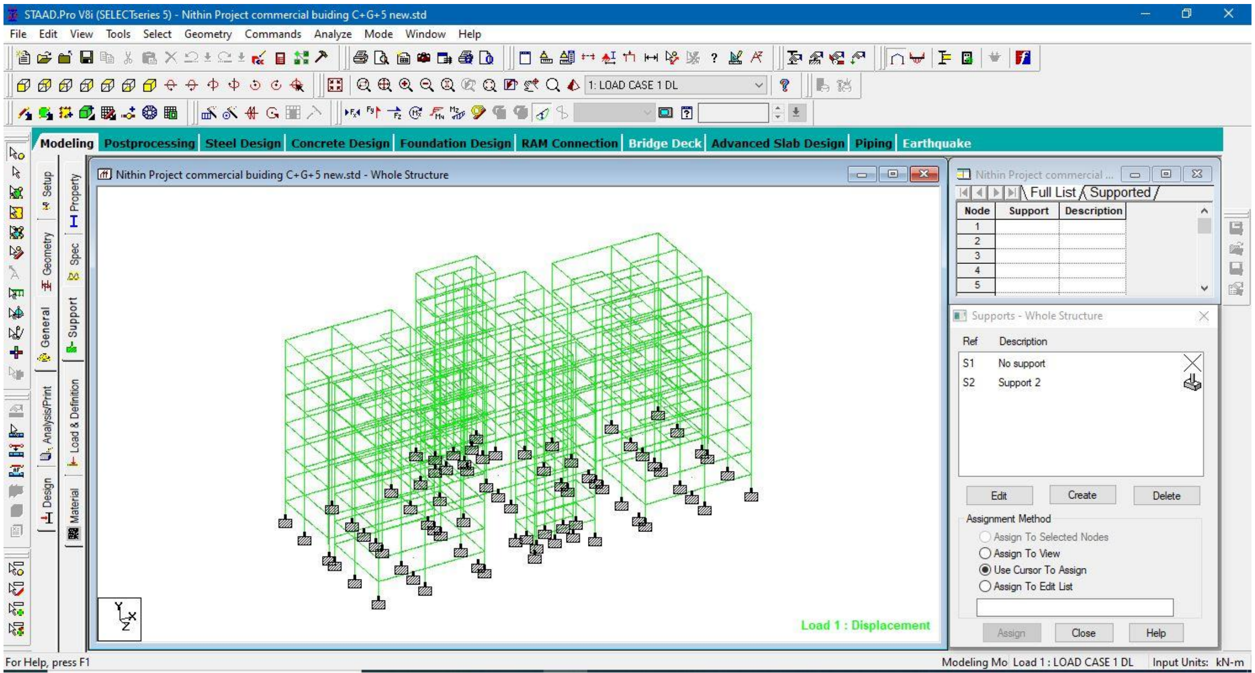
DEFLECTION DIAGRAM OF FRAME 1



DEFLECTION DIAGRAM OF FRAME 2



DEFLECTION DIAGRAM OF WHOLE STRUCTURE



VIII. CONCLUSIONS

1. Short term deflection of all horizontal members is within 20mm.
2. The structural components of the building are safe in shear and flexure.
3. Amount of steel provided for the structure is economic.
4. There is no such large difference in analysis results of STAAD Pro and Kanis method.
5. Proposed sizes of the elements can be used in the structure.

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