WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Analysis and Design of Multi Storey (G+5) Commercial Building by Using Staad Pro

B. SRAVAN KUMAR M. SREEDHAR[1], K. SOMESHAWARI[2], S. MOULA HUSSAIN[3], J. SUJITH KUMAR[4], M. JANARDHAN REDDY[5], O. GOKUL NANDAN[6]

[1]Assistant professor Department of civil Engineering, Anantha Lakshmi Institute of Technology & Sciences, itukulapalli, anantapur, AP, India.
[2]UG Scholar Department of civil Engineering, Anantha Lakshmi Institute of Technology & Sciences, itukulapalli, ananthapur, AP, India.
[3]UG Scholar Department of civil Engineering, Anantha Lakshmi Institute of Technology & Sciences, itukulapalli, ananthapur, AP, India
[4]UG Scholar Department of civil Engineering, Anantha Lakshmi Institute of Technology & Sciences, itukulapalli, ananthapur, AP, India
[5]UG Scholar Department of civil Engineering, Anantha Lakshmi Institute of Technology & Sciences, itukulapalli, ananthapur, AP, India
[6]UG Scholar Department of Civil Engineering, Anantha Lakshmi Institute of Technology & Sciences, itukulapalli, ananthapur, AP, India
Anantha Lakshmi Institute of Technology & Sciences (Approved by AICTE, NEW DELHI & Affiliated to JNTUA, Ananthapuramu, Accredited by NACC) Itikalapalli(v), Near S.K. University Anantapur 515721

ABSTRACT :

The analysis and design of a multi-storey (G+5) commercial building using STAAD.Pro is essential to ensure structural safety, cost-effectiveness, and material efficiency. This project focuses on the structural design of a commercial building in accordance with standard building codes and regulations, aiming to optimize both performance and resource utilization. Structural analysis is conducted using STAAD.Pro, a powerful tool capable of evaluating forces, moments, and deflections under various loading conditions, including dead loads, live loads, wind loads, and seismic loads. The design encompasses key structural components such as beams, columns, slabs, and footings, with consideration for strength, serviceability, and durability. The project adheres to relevant Indian Standards, including IS 456:2000, IS 1893:2002, and IS 875 (Parts 1, 2, 3, and 4). The outcomes of this project aim to provide valuable insights into efficient structural design practices and demonstrate the practical application of STAAD.Pro in real-world engineering scenarios.

Keywords: Structural Analysis, STAAD.Pro, AutoCAD, IS Standards, Commercial Building Design

INTRODUCTION

The basics needs of human existences are food, clothing's & shelter. From times immemorial man has been making efforts in improving their standard of living. The point of his efforts has been to provide an economic and efficient shelter. The possession of shelter besides being a basic, used, gives a feeling of security, responsibility and shown the social status of man.

Every human being has an inherent liking for a peaceful environment needed for his pleasant living, this object is achieved by having a place of living situated at the safe and convenient location, such a place for comfortable and pleasant living requires considered and kept in view.

- A Peaceful environment.
- Safety from all natural source & climate conditions
- General facilities for community of his residential area.

The engineer has to keep in mind the municipal conditions, building bye laws, environment, financial capacity, water supply, sewage arrangement, provision of future, aeration, ventilation etc., in suggestion a particular type of plan to any client.

TYPES OF COMMERCIAL BUILDING

1. Office Buildings

- **High-Rise Office Towers:** Typically found in city centers; designed for corporate offices.
- **Mid-Rise/Low-Rise Office Buildings:** Common in suburban areas or smaller cities.
- **Co-working Spaces:** Modern office spaces for freelancers, startups, and small companies.

2. Retail Buildings

- **Shopping Malls:** Multi-storey complexes with shops, food courts, cinemas, etc.
- **Department Stores:** Large, often standalone buildings with several levels of merchandise.
- **Mixed-Use Retail Centers:** Combines retail on lower floors with office or residential on upper floors.

3. Hotels

- **Business Hotels:** Cater to business travelers; usually include conference rooms.
- **Luxury Hotels:** High-end, multi-storey with amenities like spas, restaurants, and suites.
- **Extended-Stay Hotels:** For longer stays; includes kitchenettes and residential-style features.

4. Mixed-Use Developments

- **Vertical Mixed-Use:** Combines retail, office, hotel, and residential in one high-rise.
- **Podium-Type Developments:** Retail on lower levels, office/hotel/residential on top.

5. Medical Buildings

- **Hospitals:** Multi-storey, with specialized zones (ER, surgery, inpatient, etc.).
- **Medical Office Buildings (MOBs):** Outpatient services like clinics, diagnostics, etc.

6. Educational/Institutional Buildings

- **University Campuses:** Multi-storey academic and administrative buildings.
- **Training/Research Facilities:** Often associated with labs, tech parks, or corporate R&D.

7. Warehousing & Showrooms

- **Multi-Level Warehouses:** Especially in urban or space-constrained areas.
- **Car Showrooms/Tech Showrooms:** With parking, display floors, and service areas.

1.2 Future Scope: Analysis and Design of (G+5) Multi-Storey Commercial Building

1. **Enhanced Seismic and Wind Load Analysis** – Incorporating more advanced methods for dynamic analysis to improve structural resilience.
2. **Use of Building Information Modeling (BIM)** – Integrating BIM for better coordination between architectural, structural, and MEP systems.
3. **Sustainable and Green Design** – Applying green building standards (e.g., IGBC, LEED) for eco-friendly construction and operation.
4. **Smart Building Technologies** – Implementing IoT-based systems for real-time monitoring, energy management, and security.
5. **High-Performance Construction Materials** – Utilizing innovative materials like fiber- reinforced concrete and self-healing materials for durability.
6. **Modular and Prefabricated Construction** – Accelerating project timelines through off-site fabrication and modular assembly.
7. **AI-Assisted Structural Health Monitoring** – Employing AI and machine learning to predict and prevent structural issues.
8. **Lifecycle Cost and Performance Optimization** – Focusing on cost-effective designs that minimize maintenance and operational expenses.
9. **Adaptability in Design** – Creating flexible spaces that can be reconfigured for different commercial uses over time.
10. **Compliance with Evolving Standards** – Ensuring future-readiness by aligning with updates in IS codes and urban development policies.

AVANTAGES OF COMMERCIAL BUILDING

1. High Income Potential

- Commercial properties (like office spaces, shops, malls) generally generate **higher rental income** than residential ones.
- Long-term leases with stable tenants (banks, offices, stores) provide steady cash flow.

2. Longer Lease Terms

- Commercial tenants often sign leases of **3–10 years** or more, reducing vacancy risk.

- Residential leases are typically 11 months to 1 year.

3. Professional Tenants

- Tenants are usually businesses, not individuals.
- Fewer complaints and more structured communication.

4. Higher Property Value Growth

- If located in a busy business district or upcoming area, commercial properties can appreciate faster due to **increased demand** for retail/office space.

5. Triple Net Lease Potential

- In many commercial leases, **tenants cover expenses** like property tax, maintenance, and insurance (called triple net lease).
- Reduces the burden on the property owner.

6. Better Maintenance by Tenants

- Businesses often maintain the space better because it reflects on their brand.
- Especially true for showrooms, banks, restaurants, etc.

7. Flexible Usage and Conversion

- Commercial spaces can be used for multiple purposes—shops, clinics, co-working spaces, etc.
- Easy to renovate or adapt to market trends.

8. Business Visibility and Networking

- Owning a commercial building in a prime area can offer **brand visibility**, networking opportunities, and even prestige.

9. Tax Benefits

- Owners may get deductions on mortgage interest, depreciation, repairs, etc.
- Commercial real estate often has **more deductible expenses** than residential.

10. Economic Engine for Growth

- Commercial buildings support business ecosystems, job creation, and urban development.
- They're essential to a city's economy and infrastructure.

LITERATURE REVIEW

- **Mallikarjunetal.(2016): on analysis and design of multi-storied Commercial building of using BIM software g-2+G+10:** Carried study on analysis and design of a multi-storied Commercial building of G+10 by using most economical column method and the dead load and live load was applied on the various structural component like slabs, beams and found that as the study is carried using most economical.
- **Stalin, K. Pranaya (2017)-**Focused on the **layout and structural design of a G+3 commercial building** using **STAAD.Pro**. The primary objective was to assess **beam and column design** under various load combinations. The study evaluated **total deflection due to dead and live loads**, providing insights into the building's performance during load failure conditions. This work highlights the role of STAAD.Pro in ensuring the stability and serviceability of commercial buildings.

OBJECTIVES

- Creating layout plan of commercial building on AUTO-CAD software and model of structure on STAAD-PRO.
- To find out various load Conditions (DL, LL) applied on structure.

METHODOLOGY

Creating plan on AutoCAD

AutoCAD was first launched in **December 1982** by **Autodesk, Inc.**

It was one of the first CAD (Computer-Aided Design) programs that could run on personal computers, specifically on the IBM PC. Prior to AutoCAD, most CAD software was only available on expensive mainframe computers or workstations.

The release of AutoCAD revolutionized the design and drafting industry by making CAD tools accessible to architects, engineers, and designers at a much lower cost.

Fig 1: Plan of the building

Procedure

Step 1: Launch AutoCAD and open a new or existing drawing file.
Step 2: Set the drawing units to the desired scale (e.g. inches, feet, meters) using the "UNITS" command.
Step 3: Begin drawing the plan by selecting appropriate drawing tools from the toolbar, such as lines, arcs, circles, and polygons.
Step 4: Use the "LINE" command to draw walls, partitions, and other linear elements of the plan. Specify start and end points or lengths and angles as needed.
Step 5: Use the "ARC" and "CIRCLE" commands to draw curved elements, such as doors, windows, and rounded corners.
Step 6: Add text, dimensions, and other annotations using the "TEXT" and "DIMENSION" commands. Specify text styles, sizes, and placements as desired.
Step 7: Apply hatching or shading to indicate different materials or areas using the "HATCH" command. Specify patterns, scales, and boundaries as needed.
Step 8: Use layers to organize different types of elements, such as walls, doors, windows, and text, and assign appropriate colors, linetypes, and lineweights to each layer.
Step 9: Apply any necessary modifications, such as trimming, extending, or filleting, using various editing commands like "TRIM", "EXTEND", and "FILLET".
Step 10: Save your drawing file periodically to avoid losing any work. Step 11: Review your plan to ensure accuracy and completeness.
Step 12: Print.

Modeling of the structure in STAAD Pro

- The structural model of the proposed multi-storey commercial building was developed using
- **STAAD Pro**, a widely-used software for structural analysis and design.
- The modeling process involved defining the building geometry, member properties, supports, loads, and load combinations according to the relevant design codes and project requirements.

- The structure was modeled up to **five floors**, incorporating columns, beams, slabs (as plate elements), and floor levels as per the architectural and structural layout.
- The modeling steps included:
    - Defining material properties (e.g., concrete grade, steel grade).
    - Assigning cross-sectional dimensions to beams and columns.
    - Creating node points for each floor level and connecting them using beam elements.
    - Assigning fixed supports at the base level to simulate realistic boundary conditions.
    - Defining floor loads, dead loads, live loads, and other loadings as per IS codes (or relevant codes).
    - Creating and applying appropriate **load combinations** for analysis.
- Built-in STAAD Pro commands and tools were used to facilitate efficient modeling and ensure accuracy. These include:
    - UNIT, DEFINE MATERIAL, MEMBER PROPERTY, SUPPORTS, LOAD, and PERFORM ANALYSIS.
    - Geometry creation using the Structure Wizard for ease and precision.
    - Use of the Grid System and snapping options to accurately place members.

The prepared model served as the foundation for further structural analysis, including load evaluation, deflection check, and member design.

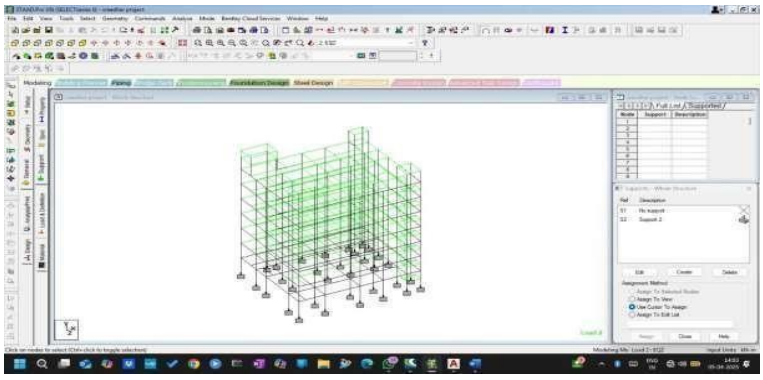

Fig 2: 3D Modeling with fixed supports

Fig 3: 3D Rendering of the structure

4.2 Load Calculations

- Dead Load calculation includes self-weight factor 1 KN/m, to the whole structure and also includes the member load 9KN/m. Along X and Z directions(i.e Beams)
- Live load includes floor load of 6 KN/m in global Y direction range minimum 4 to maximum 24m. These values are taken from IS Code books and implemented in the load case values.

4.3 Analysis and Design of the structure

- By following the data we can analysis the structure.
- Analysis includes of bending moment, shear force, deflection and maximum absolute of beam, column and slab.

1	**Type of the building**	**G+5 Commercial Building**
2	**Floor Height**	**4m**
3	**No of Floors**	**5**
4	**Materials used**	**Concrete – M25 Steel - Fe415**
5	**Column Size**	**0.60m X 0.38m**
6	**Beam Size**	**0.60m X 0.30m**
7	**Loads**	**Dead load – 16.652KN/m Live load – 8.KN/m**
8	**Plate Thickness**	**0.150m**
9.	**Length of the building**	**28.54m**
10	**Width of the building**	**24.54m**

Table no 1 Building data

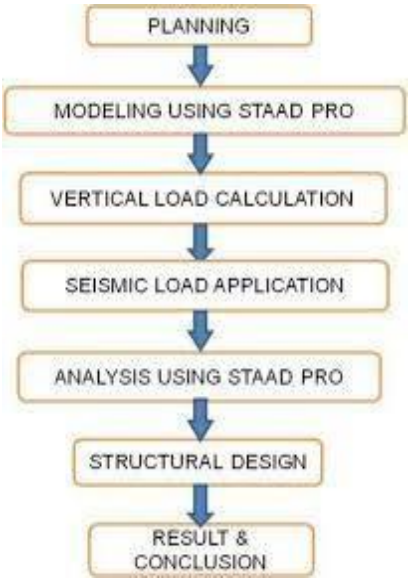

Fig 4:Flowchart of STAAD Pro procedure

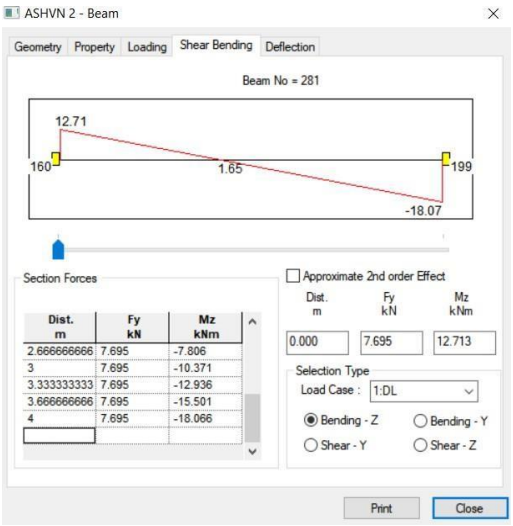

Fig 5: Shear Bending of beam

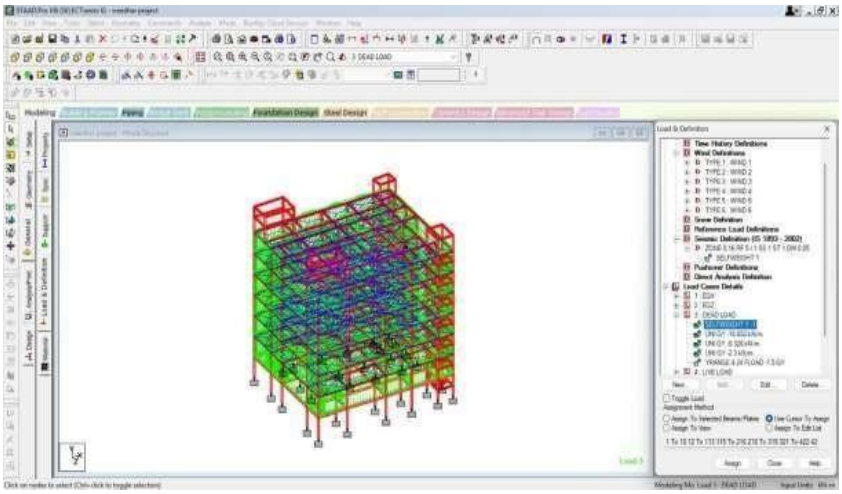

Fig 6:When Dead load is applied

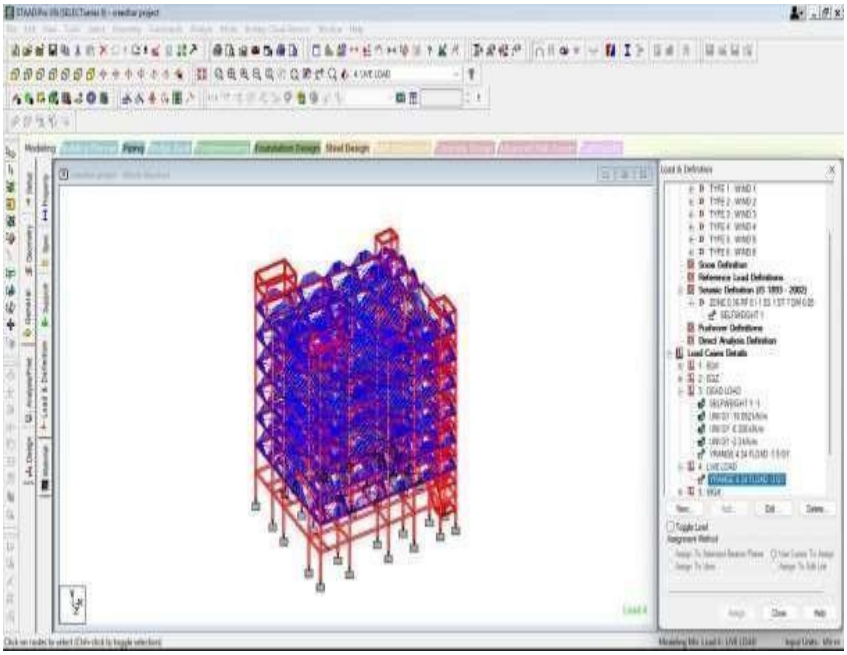

Fig 7:When Live load is applied

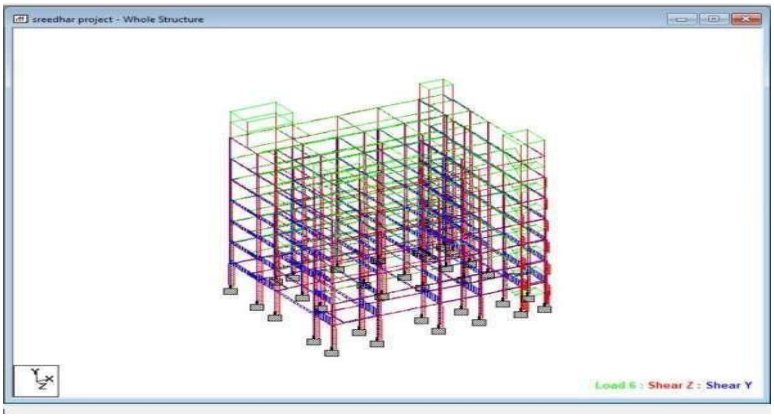

Fig 8: Displacement of the structure

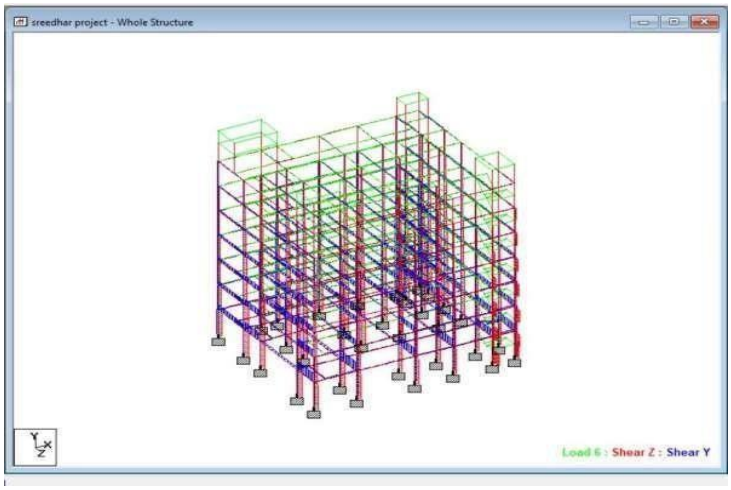

Fig 9: shear force in Z Direction

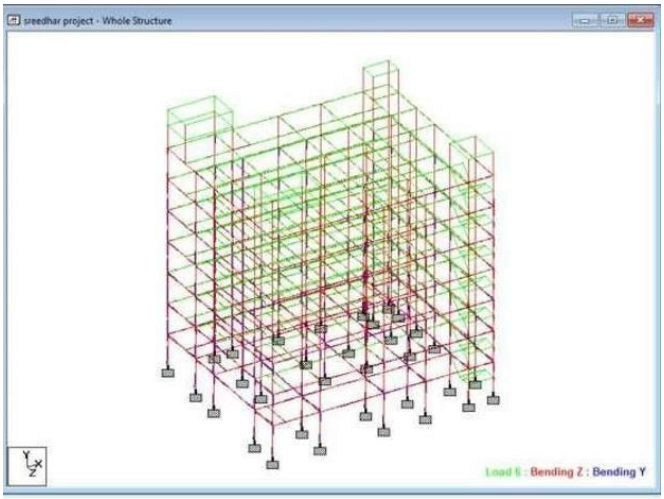

Fig 10: shear force in Z Direction

RESULTS

All / Summary / Envelope

	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
Max Fx	91	3 DEAD LOA	65	**2680.664**	-4.162	8.337	0.195	11.265	6.852
Min Fx	80	2 EQZ	16	**-141.332**	-3.036	11.111	-0.320	-18.794	-3.877
Max Fy	637	3 DEAD LOA	315	19.014	**131.420**	0.360	3.078	-0.719	124.999
Min Fy	536	3 DEAD LOA	270	-0.177	**-110.221**	-0.010	-0.011	-0.048	161.722
Max Fz	714	3 DEAD LOA	327	268.154	15.636	**29.259**	-0.097	-58.832	31.912
Min Fz	691	3 DEAD LOA	299	232.636	9.887	**-40.288**	-0.103	85.215	18.433
Max Mx	578	3 DEAD LOA	281	-0.441	66.083	-0.019	**11.223**	0.057	85.072
Min Mx	618	3 DEAD LOA	274	-0.991	78.979	-0.019	**-26.593**	0.002	91.669
Max My	691	3 DEAD LOA	299	232.636	9.887	-40.288	-0.103	**85.215**	18.433
Min My	692	3 DEAD LOA	258	159.946	-12.372	-40.278	-0.101	**-76.855**	27.482
Max Mz	536	3 DEAD LOA	270	-0.177	-110.221	-0.010	-0.011	-0.048	**161.722**
Min Mz	637	3 DEAD LOA	318	19.014	114.969	0.360	3.078	0.082	**-149.712**

Fig 11: Member End Forces

Fig 12: Reinforcement Details of column

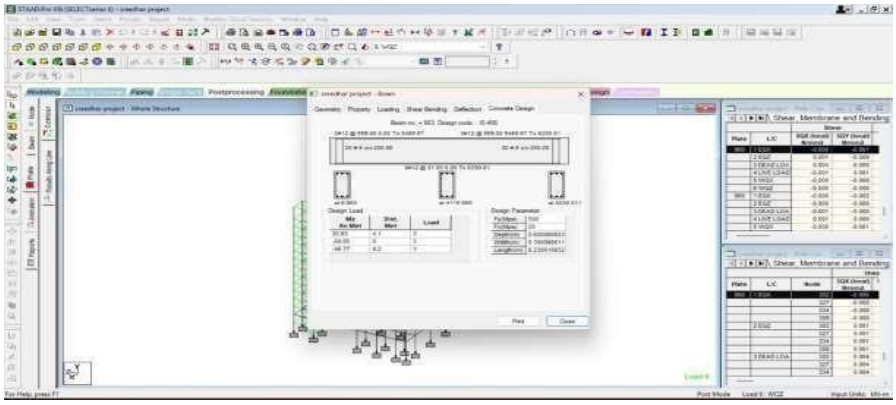

Fig 13: Reinforcement Details of beam

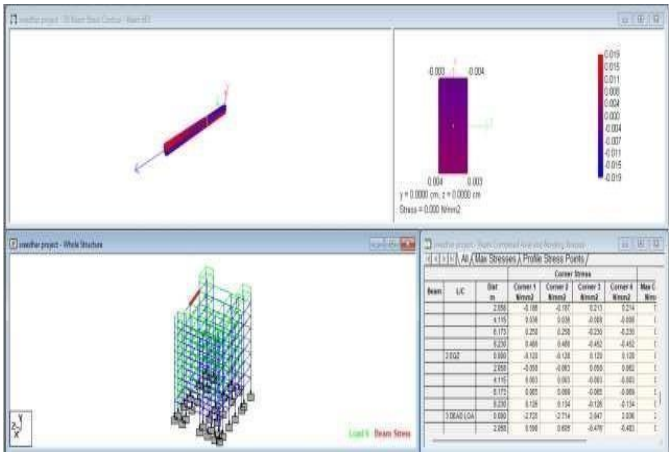

Fig 14: Stresses of the Structure

CONCLUSION

The development of a multi-storey commercial building represents a strategic and efficient use of urban space to support economic growth and meet increasing demands for business infrastructure. Through careful planning, design, and execution, such structures offer flexible, functional, and modern workspaces that cater to a wide range of commercial needs. The incorporation of sustainable practices, advanced building technologies, and adherence to safety regulations further enhances the value and longevity of the building. Overall, the successful completion of a multi- storey commercial building project not only contributes to urban development but also creates a dynamic environment that fosters business opportunities and community engagement.

REFERENCES

1. Ariyo, O. O., Garthwaite, P., Eckert, C. M., & Clarkson, P. J. Towards hospital environments resilient to climatic change: A survey of factors driving change in hospital building stock . Retrieved from Salford.ac.uk
2. Boffin, N. Health system capacity.
3. Institute of Tropical Medicine, Antwerp. (2002). Building: Review of the literature.
4. Choudhary, R., Bafna, S., Heo, Y., Hendrich, A., & Chow, M. (2010). A predictive model for computing the influence of space layouts on nurses' movement in hospital units. Journal of Building Performance Simulation, 3(3), 171–184.
5. Bobrow, M., & Thomas, J. (1994, November). Hospitals' prosperity should be by design. Modern Healthcare.
6. Crosswall, C. (1999). Better, not bigger: Construction costs soar on wings of patient demand. Modern Healthcare.
7. Burmahl, B. (2000). Facilities of the future: New designs put patients first. Health Facilities Management.
8. Bureau of Indian Standards. (2000). IS 456: Plain and Reinforced Concrete – Code of Practice (4th rev.).
9. Bureau of Indian Standards. SP-16: Design Aids for Reinforced Concrete.