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"A PARAMETRIC STUDY OF MULTI-STOREY BUILDING BY STAAD PRO and ETABS"

Aditya Sen[1], Dr.Abhay Kumar Jha [*2] Ashutosh Udainiya [#2]

[1] Post graduate student, Department of Civil Engineering,R.G.P.V. University Bhopal India.
[2] Professor, Department of Civil Engineering,L.N.C.T Bhopl India.
[3.] Assistant Professor, Department of Civil Engineering,L.N.C.T Bhopl India.

ABSTRACT—

The objective of the present study is to comparison of a G+6 Residential building using Staad Pro Software. In the software Limit state method were used as per Indian Standard Codes for structural design and analysis. Staad.Pro is chosen due to their quick results, ease of use, precision, adherence to Indian Standard Codes, advanced analysis features, and efficient design capabilities. Dead Load, Live Load, Wind Load, and Seismic Load are considered and applied per Indian Standards for the G+6 structure. Initial step involves creating the structure's geometry in the software, defining cross-sections for columns, beams, slab thickness, etc. Specifications and supports are set up followed by load definitions. The model is then analyzed by running simulations to ascertain whether the structure can withstand the applied loads. the designs for bars and columns, beams, story drift, and story displacement is conducted Staad. Pro. The Axial Forcein x-direction is 769.02 Shear force in y-direction is 17.114, Shear force in z-direction is 1.65,Bending moment in x- direction is 0.043,Bending moment in y-direction is 1.541,Bending moment in z-direction 38.22 values for column.The maximum Storey drift by Staad pro of story7 is0.001264. The maximum Storey displacement by Etabs and Staad Pro of story7 is 52.57. The aim is to determine the software is efficient and effective in producing optimal structural designs for the present study. Columns, beams, slabs are designed using software. Identical loads are applied to both models. Run analysis to check if structures pass or fail under the applied loads.

Keywords— Multi-story residential building (G+6), Story drift, Story displacement, Beam, Column, structural software

Introduction :

As human societies have developed over time, have always needed buildings for various reasons like living and working. But it's not just about building any structure; it's about making sure these buildings are well-designed and efficient for their specific purposes. This is where civil engineering, especially the study of how structures work, becomes incredibly important.

In this present study, employed various classical methods and modern software tools to address design challenges. Specifically, utilized a software program called Staad Pro to facilitate present design work

The present approach involves applying fundamental principles such as load analysis and adherence to relevant design codes, such as those outlined in the IS (Indian Standards) code. These foundational techniques have been instrumental in problem-solving process and can serve as valuable resources for addressing more complex design challenges in the future

It helps in present study create structural designs and allows users to test different combinations of various types of loads on the structure according to established codes like ACI, IS, BSI, and more. It then checks whether the design will fail or not.

1.2 SCOPE OF THE PRESENT STUDY

- The key goal of this present study is to put into practice by constructing a multi-story residential building(G+6) using Staad Pro .
- This study gives the knowledge will prove invaluable for future endeavors in the field of construction and building needs, as it is the preferred choice for the majority of organizations in this domain.
- Staad. Pro has the capability to calculate the necessary amount of reinforcement needed for each concrete section or segment?
- Several software parameters have been set in alignment with the IS:456 2000 standards.
- Using the staad pro limit state form as per Indian Standard Code and Practices in Staad suggests that this software significantly reduces design time and delivers highly accurate design results.

1.3 OBJECTIVES OF THE PRESENT STUDY

- Create the structural design for a "G+6" residential building using Staad Pro.Software and analysis has been done .

- To design Beam, Column, Slab, and Dead load, wind load andSeismic load as per IS code.

2. LITERATURE REVIEW :

2.1 GENERAL

2.1.1 STAAD Pro:

Purpose: Staad Pro, which stands for Structural Analysis and Design Program, is primarily used for the analysis and design of various types of structures, including buildings, bridges, towers, dams, and more.

Features:

Analysis: Staad Pro can perform both linear and nonlinear static and dynamic analysis, helping engineers assess how a structure responds to different loads and forces.

Design: It provides tools for structural design in accordance with various international codes and standards, ensuring that the designed structure meets safety and performance criteria.

Integration: Staad Pro offers seamless integration with other software like AutoCAD and Revit, simplifying the transfer of data between design and analysis phases.

Visualization: It includes 3D visualization tools that allow engineers to visualize the structure's behavior and results in a user-friendly manner.

2.2 LITERATURE SURVEY

Borugadda and Raju (2015) Design and analysed G+30 multi-storey building adopting Staad. Pro in limit state methodology. Staad Pro contains an easy interface that permits the users to produce the mount and the load values and dimensions are inputted. The members are designed with reinforcement details for RCC frames. The analysis is completed for two dimensional frames and then it is done for more multi-storeyed 2-D and 3-D frames under various load combinations.

Aman (2016) The analysis and design of G+5 residential cum commercial building based on the criteria defined by the IS codes on Staad. Pro software. The load imposed were only dead and live load hence the load combination generated was 1.5(Dead load + Live load) after whichthe analysis of the building was done for the Frame and the resulting Bending moments andshear forces were studied. The detail of all the building members was represented along with the functions of slab, beam, column, footing and staircase. From which it was concluded that the horizontal deflections were within 20mm and the structure was safe andeconomical. And not much difference was obtained between the results from Kani's methodand Staad. Pro

Patil et al. (2017) The principle objectives of this project are comparison between staad-pro software and manually calculations and design a multi-storied building using Staad Pro. The design involves load calculations and analyzing the whole structure by Staad Pro. The design methods used in Staad Pro analysis are Limit State Design conforming to Indian Standard Code of Practice. These involve Staad Modeling, Analysis the members due to the effect of Wind & Seismic load & Compare them for a 33 meter height Building with Concrete & Steel construction. The proposal structure is a G+10 storied building with 3.00 m as the height of each floor. The overall plan dimension of the building is 21.30 m x 14.0m

Thakur and Bhardwaj (2019) The rule objective of this undertaking is Design and relative investigation of a G+ 6 Residential structure utilizing Etabs and Staad. Expert Unique designs need more opportunity for now is the right time burning-through computations, on the off chance that we utilize manual strategies. These product gives us a fast outcome. It is not difficult to use for investigate and configuration any construction for more precision. In the Staad. Pro and Etabs limit state technique is use according to Indian Standard Code and Practices. Staad. Genius includes a best in class UI, representation instruments, amazing examination and plan motors with cutting edge limited component and dynamic investigation abilities and result confirmation, Staad. Pro is the expert's decision We can reason that this product can save a lot of time and is exceptionally precise in plans.

In this G+ 6 structure is considered with Dead Load, Live Load, Wind load and Seismic Load blend of these heaps are applied according to Indian Standards. Planning is improved method for making Geometry. Characterizing the cross segments for segment and shaft, Slab thickness and so forth Making particular and supports, at that point the Loads are characterized. After that the model is investigated by'run examination'. At that point auditing whether construction passed in applied loads or fizzled. Finally Comparative Study is accomplished for both Software based on plan of bar and Column and afterward to discover which plan and programming is more efficient.

Singh et al. (2021) civil engineering is a very vast field in which planning and designing of buildings are done according to the need. As we can see that many development and changes happening in the sector of construction and everyday new commercial and residential buildings projects are initiated. So, it needs proper planning before starting the construction so that the work can be done in a cost effective way and also complete the structures as per users requirements. The etabs is a engineering software that helps in modeling, designing and calculating loads while making a structure. It is a very useful software in civil engineering field and provide a vast methods to ease out the work of engineers. It analysis the structure in terms of static and dynamic loads. Today there is a huge scope in this field and it also gives the opportunity to many people to work it the respective field.

Devi et al (2022) The present study deals in the zone 5 and for school building which constructed in district mandi, Himachal Pradesh. A multi-storied framed school structure of (G+3) pattern is selected. Linear seismic analysis is done for the building by static method using Staad-Pro as per the IS-1893-2002- Part-1 and dynamic method (Response Spectrum Method) using Staad-Pro as per the IS-1893-2016- Part-1. A comparison is done between the static and dynamic analysis, the results such as Bending moment, area of steel required, compared and summarized for Beams, Columns and Structure as a whole during both the analysis

Surya and Rathnaswamy (2023) Structural Engineering, a subset of Civil Engineering, focuses on understanding how buildings and structures behave in real-world conditions. It involves studying various forces such as axial force, shear force, bending moment, and displacement that affect structures.When dealing with complex or multi-story structures, manual calculations become challenging. This is where specialized software tools like

Staad Pro V8i, Ansys, Etab, and Sap-2000 come into play. They help perform complex calculations effectively.In this particular study, a comparison is made between a G+7 building model using two different structural systems: a normal slab system and a flat slab system, in a seismic zone V (high-seismic) environment as per IS 1893-2016 standards. The analysis involves parameters like storey drift, storey shear, storey bending, torsion, time period, and frequency. Etabs software is used to compare these results, providing a comprehensive understanding of the structural behavior in seismic conditions

3.METHODOLOGY, SOFTWARE USED AND FLOW CHART :

3.1GENERAL

In the present study typically provides an overarching summary of the research without delving into specific details. This study focuses on the structural analysis and design of a six-story residential building, commonly referred to as G+6, using two prominent structural engineering software packages: Staad. Pro and Etabs. The primary objective of this research is to assess and compare the performance, efficiency, and suitability of these software tools for practical engineering applications. The study aims to evaluate the capabilities and effectiveness of Staad.Pro in modeling, analyzing, and designing a multi-story residential structure. It seeks to identify strengths, weaknesses, and potential areas of application for each software. The methodology employed includes the creation of a detailed digital model of the building, consideration of real-world material properties and load scenarios, and the application of engineering principles for structural analysis and design. Both software packages are utilized for this purpose

3.2 Flow Chart By Staad Pro.

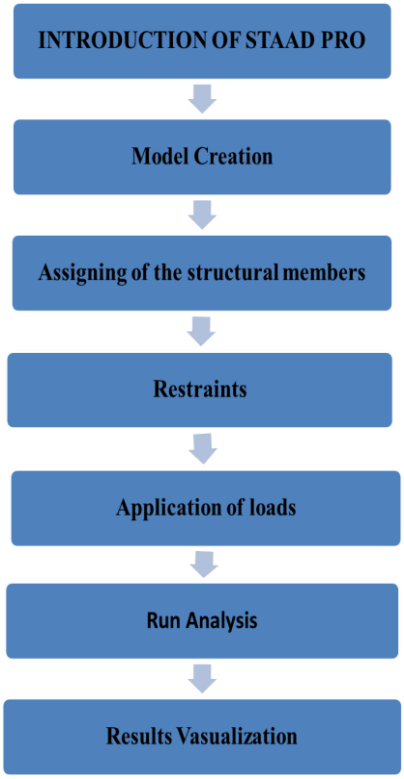


Figure 3.1 flow chart of staad pro

3.3 Introduction To Staad. Pro

Staad.Pro is a widely embraced software tool in the global community of structural engineers. Its versatility allows for the analysis and design of a wide range of structures, including frames, plate-bar-shell systems, and solid components. This software package features a user-friendly graphical user interface (GUI) and a powerful analysis and design engine.

The Staad analysis and design engine serve as a versatile computational powerhouse, capable of conducting structural analysis and integrated design for various materials such as steel, concrete, wood, and aluminum. It adheres to the fundamental principle of structural stability when assessing the integrity of a structure. Figure 3.1 illustrates a typical Staad.Pro interface, offering a glimpse into its user interface.

In summary, Staad.Pro stands as an indispensable tool used by structural engineers worldwide for structural analysis and design, accommodating a wide spectrum of structural configurations and materials with its intuitive interface and robust computational capabilities.

The software encompasses several key features, including:

1) Element Library: Staad.Pro offers a comprehensive element library, providing a wide range of structural elements and components that can be utilized in analysis and design.

2) Analysis Capabilities and Library Range:

a) **Linear Static Analysis:** Staad.Pro can perform linear static analysis, which is essential for assessing structural stability and behavior under static loads.

b) **Heat Transfer Analysis:** This feature allows engineers to analyze heat transfer within a structure, vital for assessing temperature variations and thermal stresses.

c) **Non-linear Static Analysis:** Staad.Pro supports non-linear static analysis, enabling the examination of structures under non-linear material behavior or large deformations.

d) **Stability Analysis:** The software is equipped for stability analysis, which is crucial for assessing the buckling and overall stability of structures.

e) **Dynamic Analysis:** Staad.Pro can perform dynamic analysis, helping engineers understand how structures respond to dynamic forces, such as earthquakes or vibrations.

3) Types of Loading: Staad.Pro supports various types of loading, including dead loads, live loads, wind loads, seismic loads, and temperature effects. This capability allows engineers to simulate real-world loading conditions on structures.

4) Boundary Conditions: The software allows engineers to define boundary conditions, which are essential for accurately modeling how a structure interacts with its supports and constraints. Properly specified boundary conditions are crucial for obtaining accurate analysis results.

5) Material Properties and Models: Staad.Pro enables users to input material properties such as elasticity, density, and thermal coefficients. It also offers a range of material models to simulate different material behaviors, including linear elastic, nonlinear, and isotropic or anisotropic properties.

6) Pre and Post Processing: Staad.Pro provides robust pre-processing and post-processing capabilities. In the pre-processing phase, engineers can create and define the structural model, specify loads and boundary conditions, and set analysis parameters. The post-processing phase allows for the visualization of results, generation of reports, and extraction of valuable engineering insights from the analysis outcomes.

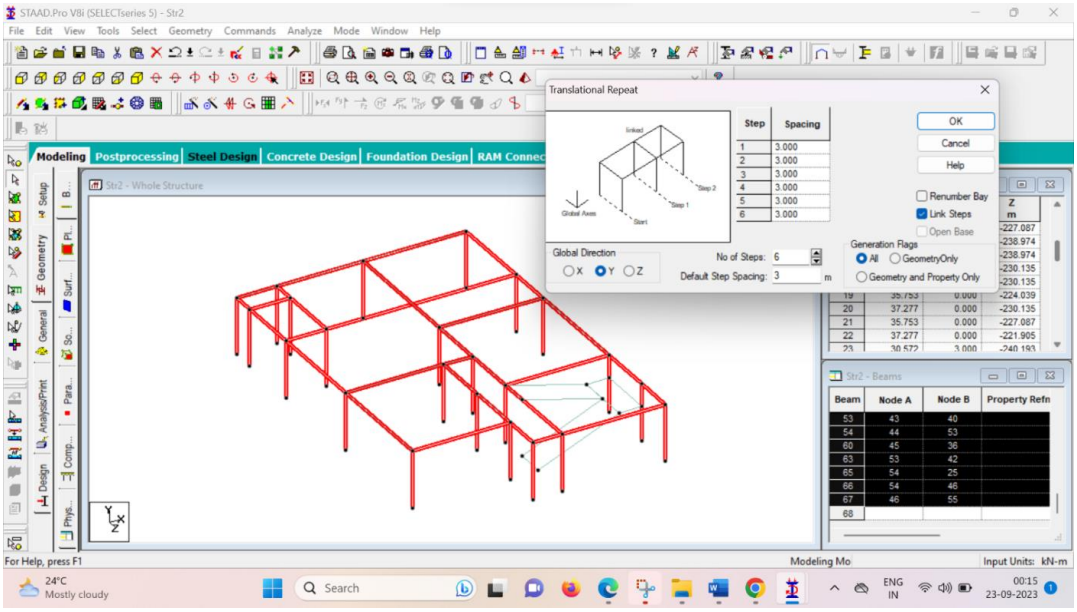
These additional features enhance the software's utility and make it a comprehensive solution for structural analysis and design across a wide spectrum of engineering applications and industries.

3.4 Steps Involved In Staad. Pro

1. Model Creation
2. Assigning of the structural members
3. Restraints
4. Application of loads
5. Run analysis
6. Results Vasualization

3.4.1 Modelling of Structure

It seems you're describing the process of modeling a building structure using Staad.Pro or a similar structural analysis and design software



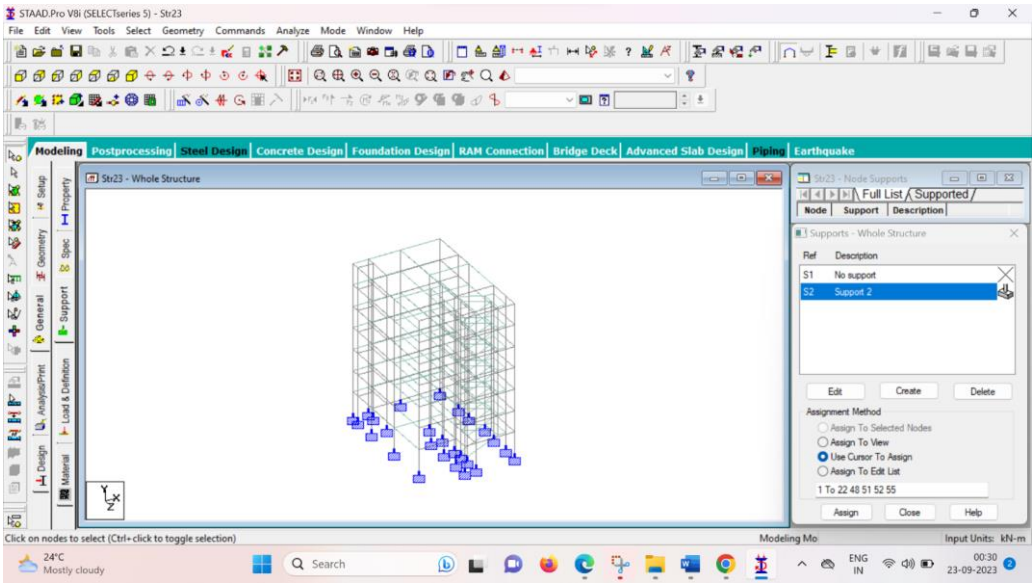


Figure 3.2 Modelling of structure

3.4.2 Assigning the structural property and material.

The software provides a feature for assigning structural elements. It allows users to connect nodes through line elements, creating beams and columns. Additionally, users can add four-node plates and surface plates by selecting four nodes. The next step involves assigning properties to these members, specifying their shape, dimensions for columns and beams, and thickness for plates Lastly, the software allows users to assign the material properties for the structure, including options like concrete, steel, stainless steel, and aluminum. illustrates the process of assigning structural properties, while depicts the assignment of material properties. These functionalities streamline the modeling and analysis process, ensuring accurate representation of the structure's components and materials.

3.4.3 Restraints

Once the structure has been successfully modeled, the next step involves defining the restraints or supports. In your case, fixed supports are utilized within the structure. Each of these supports corresponds to the location of different columns in the structure. visually represents the placement of these fixed supports within the structure, indicating where the structural elements are anchored and constrained to prevent movement in certain directions. This essential step ensures that the structural analysis accurately simulates the behavior of the real-world structure with its specific support conditions.

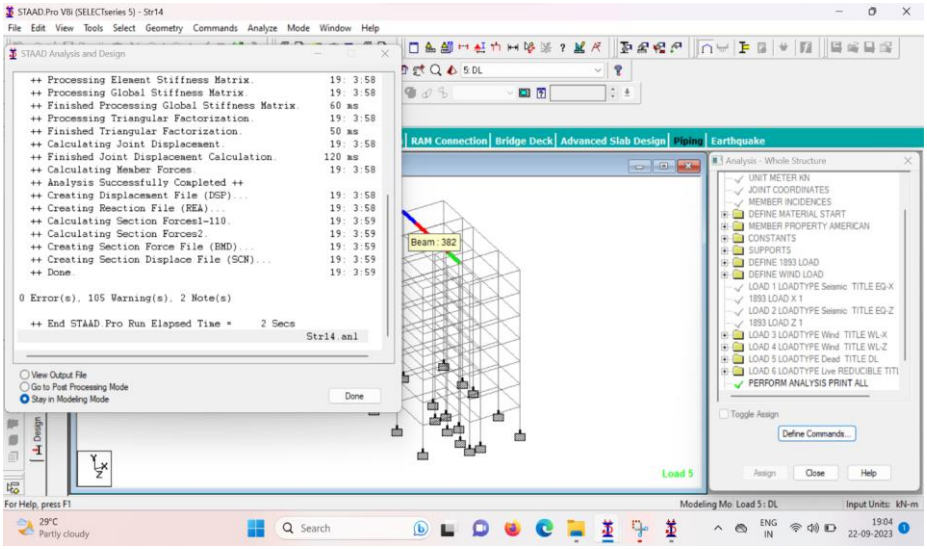
3.4.4 Applications of Loads

In our structural analysis project, we consider and analyze several types of loads that act on the structure. These include:

1. **Dead Load**: The weight of the structure itself and permanent fixtures, such as walls and floors.
2. **Live Load**: Variable loads exerted by occupants, furniture, and other transient elements within the structure.
3. **Wind Load**: The lateral force exerted by wind, which can vary depending on the location and environmental conditions.
4. **Seismic Load:** The force resulting from seismic activity, calculated based on the seismic zone and building characteristics.In Staad.Pro, there is a convenient option called "Selfweight" that automates the calculation of the self-weight of structural members, making it easier to account for the dead load.

3.4.5 Run analysis

The post-analysis command in Staad.Pro plays a critical role in verifying and checking all the input data and commands provided for the analysis. It thoroughly assesses whether the structure's analysis has been executed successfully or if there are any errors or warnings that need attention.In case, it's great to note that the analysis of your building yielded a favorable result. The software reported zero errors and zero warnings, as indicated in Figure 3.3. This outcome signifies that the analysis was carried out without any issues, and the structure has passed the analysis phase successfully, demonstrating its structural integrity and compliance with the specified design criteria and input data.



Statics Check Results

L/C		FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
1:EQ-X	Loads	399.306	0.000	0.000	0.000	-92.5E+3	-6.59E+3
1:EQ-X	Reactions	-399.306	0.000	-0.000	-0.000	92.5E+3	6.59E+3
	Difference	0.000	0.000	-0.000	-0.000	0.000	0.000
2:EQ-Z	Loads	0.000	0.000	399.306	6.59E+3	-14.6E+3	0.000
2:EQ-Z	Reactions	0.000	0.000	-399.306	-6.59E+3	14.6E+3	0.000
	Difference	0.000	0.000	0.000	-0.000	0.000	0.000
3:WL-X	Loads	-14.722	0.000	0.000	0.000	3.37E+3	60.488
3:WL-X	Reactions	14.722	-0.000	0.000	0.000	-3.37E+3	-60.488
	Difference	-0.000	-0.000	0.000	0.000	-0.000	-0.000
4:WL-Z	Loads	-14.722	0.000	0.000	0.000	3.37E+3	60.488
4:WL-Z	Reactions	14.722	-0.000	0.000	0.000	-3.37E+3	-60.488
	Difference	-0.000	-0.000	0.000	0.000	-0.000	-0.000
5:DL	Loads	0.000	-6.31E+3	0.000	-1.46E+6	0.000	-229E+3
5:DL	Reactions	-0.000	6.31E+3	0.000	1.46E+6	0.000	229E+3
	Difference	-0.000	0.000	0.000	0.000	0.000	-0.000
6:LL	Loads	0.000	0.000	0.000	0.000	0.000	0.000
6:LL	Reactions	0.000	0.000	0.000	0.000	0.000	0.000
	Difference	0.000	0.000	0.000	0.000	0.000	0.000

Figure 3.3Run Analysis

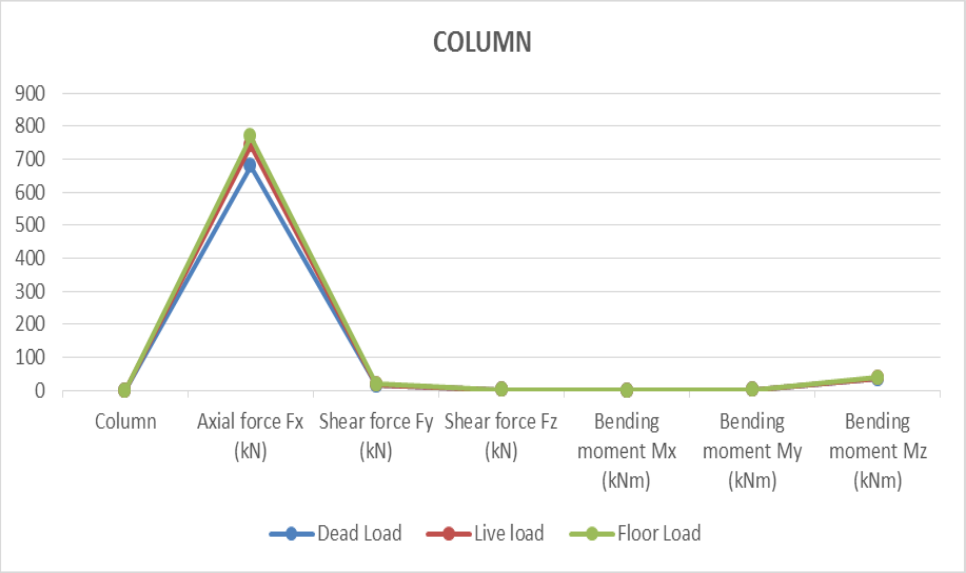
4.RESULTS AND DISCUSSION

4.1 Software Parameter (Axial forceșhear force and bending moment for Column)

In structural engineering, axial force, shear force, and bending moments are critical parameters that describe the internal forces acting within structural elements like columns, beams, and frames.

Table 4.1 Results obtained from Staad. Pro

Column			
Forces	**Dead Load**	**Live load**	**Floor Load**
Axial force F_x (kN)	679.79	62	27.237
Shear force F_y (kN)	15.37	1.733	0.671
Shear force F_z (kN)	1.531	0.051	0.07
Bending moment Mx (kNm)	0.026	0.016	0.001
Bending moment My (kNm)	1.345	0.107	0.089
Bending moment Mz (kNm)	33.562	3.198	1.476

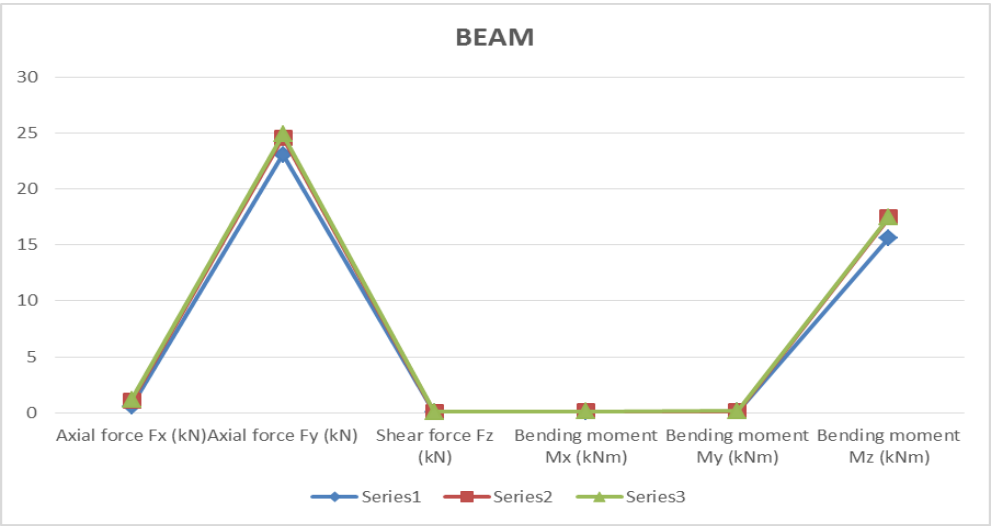


Graph 4.1 Values Shear force, Axial Force and Bending moment obtain from Staad Pro.

4.2 Results obtain from Staad. Pro for Beam

Table 4.1 Results obtained from STAAD. Pro

Axial force F_x (kN)	0.576	0.473	0.116
Shear force F_y (kN)	23.076	1.507	0.301
Shear force F_z (kN)	0.044	0.012	0.01
Bending moment Mx (kNm)	0.024	0.076	0.014
Bending moment My (kNm)	0.121	0.02	0.018
Bending moment Mz (kNm)	15.626	1.837	0.038



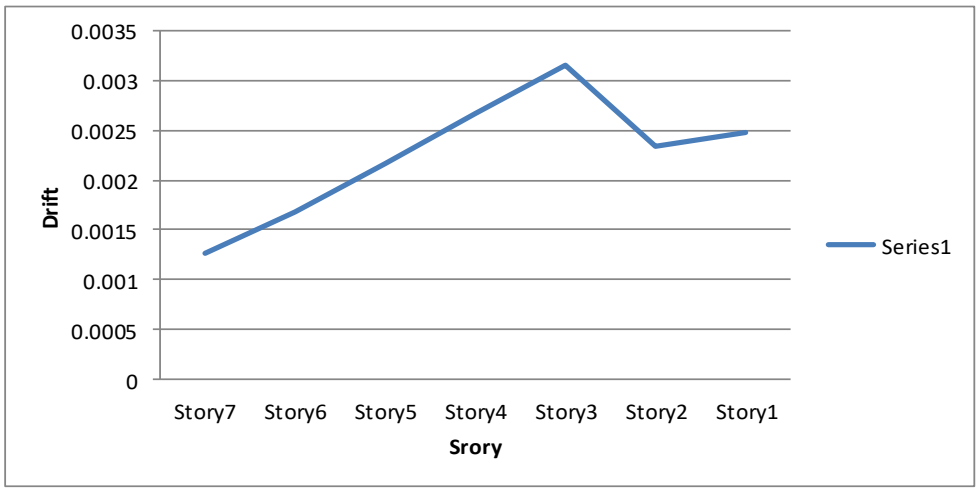
Graph 4.2 Values Shear force, Axial Force and Bending moment obtain from Staad Pro

4.3 Storey Drift Results by Staad.Pro

Storey drift in a building refers to the relative displacement or movement between different storeys or floors when the structure is subjected to lateral forces, wind or seismic activity. When these external forces act upon a building, the structure experiences stress and undergoes deformation. Due to the distribution of these forces and the building's unique structural properties, various parts or storeys of the building may move or deform differently.

Table 4.3 Storey Drift for column by Staad.Pro

Story	Load Case/Combo	Drift	X meter	Y meter	Z meter
Story7	EQ X	0.001264	22	0	21
Story6	EQ X	0.001675	22	0	18
Story5	EQ X	0.002172	22	0	15
Story4	EQ X	0.002672	22	0	12
Story3	EQ X	0.003165	22	0	9
Story2	EQ X	0.00234	22	0	6
Story1	EQ X	0.00248	19	4	3



Graph 4.3Story v/s Drift by Staad.Pro

5.CONCLUSION :

GENERAL

In present work , which focused on the "Design the Study of a G+6 Residential Building," has executed successfully and efficiently, taking into account all relevant factors.

CONCLUSIONS

The present study on the basis of values (Shear force Axial ,Force and Bending moment) for column by results obtained from Staad. Pro

1. COLUMN

The Axial Force is 769.02,Shear force in y-direction is 17.114,Shear force in z-direction is 1.65,Bending moment in x- direction is 0.43,Bending moment in y-direction is 1.541,Bending moment in z-direction 38.22 values.

2.BEAM

The present study on the basis of values (Shear force Axial ,Force and Bending moment) for beam by results obtained from Staad. Pro

The Axial Force is 1.15,Shear force in y-direction is 24.87,Shear force in z-direction is 0.174,Bending moment in x- direction is 0.24,Bending moment in y-direction is 0.159,Bending moment in z-direction 17.50 values

3. STOREY DRIFT

The Storey drift by Staad pro of story7 is0.000401,story6 is 0.001675,story5 is -0.002172,story 4 is 0.002672,story3 is 0.003165,story2 is 0.000234, and story1 is 0.00248

5.3 SCOPE FOR FURTHER STUDY

Based on the present study the further work can be extended

1. Software like ABAQUS (Software for FEM structural analysis), SAP 2000 , Advance Design (BIM Software for FEM structural analysis), ArchiCAD(BIM & 3D modeling software applied for civil & structural engineering.) can be used for further study.
2. Grade of concrete may be varying according to needs.

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