Analysis and Design the G+3 Model in Staad-Pro and Autocad

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ABSTRACT-

When strain energy in the Earth's crust suddenly releases, it causes waves of shaking to propagate outward from the earthquake source. One of the world's most devastating natural catastrophes is the earthquake. It has claimed countless lives and severely damaged infrastructure. It is crucial to study buildings that are subject to seismic stresses since earthquake forces are random and unexpected. This essay compares base shear values obtained using the manual approach with STAAD. Premium software. G+3 Storey RC Building in Zone II to V is taken into consideration for the research. Equivalent Lateral Force Method/Static Method is used to do the seismic study of the building. This essay illustrates how much. The planning and analysis of a G+3 multi-story structure utilising AutoCAD and Staad-Pro software are the topics of part 1 of the research. A parking spot is located on the ground floor, while the remaining three units—one 2BHK and two 1BHK units—are located on the first, second, and third floors. Using AutoCAD software, the drawing and detailing work was finished, and then "Staad-Pro v8i ss6" was used to finish the full design process. The findings of software and the manual analysis of seismic load are preferred, and it is decided that Staad-Pro is an appropriate instrument that can save a lot of time and produce results that are accurate enough.

Keywords- Earthquake source, building, STAAD Pro v8i, multi-story structure, AutoCAD, seismic load.

1. introduction

In every aspect of human civilization, we needed structures to live. The structures should be built in an efficient manner so that it can serve people and save money. In simple words, the building means an empty surrounded by walls and roofs, in order to give shelter for human beings. In early times humans have lived in caves to protect themselves from wild animals, rain etc. Then, humans developed and built their homes using timbers and lived. Nowadays the recent homes are developed into individual and multi-storey buildings. Buildings are the necessary indicator of social progress of the county. At current situation, many new techniques have been developed for constructions. So, that the buildings are built economically and quickly to fulfil the needs of the people. A building frame is a three-dimensional structure which consists of column, beams and slabs. Because of growing population, high rise buildings are coming into demand. Buildings constitute a part of the definition of civilizations, a way of life advanced by the people. The buildings should be constructed for human requirements and not for earning money. Buildings are built in different sizes, shapes and functions.

STAAD PRO has a state of art user interface, tools for visualization, well-built analysis and design software with advance finite element and capable of dynamic analysis. From generation of model, analysis and design to visualization tools and verification of results. STAAD PRO is a common choice for steel, concrete, aluminium and cold-formed steel design of multistorey buildings, factories, tunnels, bridges and much more. To perform a complete analysis, a structural engineer must find out information such as loads on structure, geometry, and support conditions and materials properties. The results of such analysis typically include support reactions, stresses and displacements. This information is then analysed with respect to the criteria that indicate the conditions of failure. The objective of design is the attainment of an acceptable possibility that structures constructed will perform satisfactorily during their design life. With an appropriate degree of safety, they should bear all loads and deformations caused due to normal construction and use and have sufficient durability and resistance to the effects of seismic and wind. Structure along with structural elements shall be designed by limit state design method. Account should be taken of accept theories, experiment and experience and the requirement to design for durability. Design, including design for durability, construction and service life should be considered as a whole. The achievement of design objectives needs concurrence with clearly defined standards for materials, construction, workmanship and also maintenance and use of structure in service. The design of the structure depends upon the minimum requirements as suggested by the Indian standard codes. The minimum requirements concerned to the structural safety of structures are satisfied by way of laying down minimum design loads which have to be assumed for dead loads, live loads, and others external loads, the structure would be required to bear.

1.1 Steps in structural design:

The steps involved in designing a structure are: structural planning, loads computation, analysis method, design of member and detailing, etc.

1.2 About Auto CAD

Auto Cad is a designing and drafting software which is used for developing 2-dimensional and 3-dimensional structures, developed and sold by Autodesk, Inc. It is a vector graphics drawing programme. It uses primitive entities- comparable to lines, polylines, circles, arcs and text as the foundation for the complex. Auto CAD's native file format, DWG, and to a lesser extent, its interchange file format, DXF has become the drawing and detailing works were done by creating use of Auto CAD 2014.

1.3 About STAAD Pro:

It is a globally used software for design and analysis of structure by structural engineers. STAAD Pro has a GUI-Graphical User Interface due to which we can generate the model of the structure, which is then analysed by STAAD engine. When analysis and design is completed, GUI can be used to view the results graphically.

1.4 Types of Loads Used

The loads which are considered for analysis are,

1. Dead loads

2. Live loads

3. Earthquake load

I. Dead Load

All permanent loads in the building are considered as dead loads. The dead loads comprise of self-weight of the building, weight of wall, weight of slab, floor finish and permanent materials placed on the building. Dead loads are specified in IS 875 (Part 1).

II. Self-Weight

In load case we have option called self-weight which automatically calculates weights using the properties of material i.e., density and after assignment of dead load the skeletal structure

III. Earthquake Loads:

The earthquake load is also known as dynamic load which bring vibration on structures. One of the fundamental concepts in earthquake engineering is seismic load, which refers to the application of an earthquake-generated agitation to a building structure or model. It occurs at a structure's contact surfaces with the ground or nearby structures.

1.5 Objectives

1. Computer aided analysis and design of residential building by using STAAD PRO Includes

2. Generation of structural framing plan

3. Creation of model of structure in STAAD PRO

4. Application of various load combinations on the member

5. The project involves G+3 residential building designing

6. Carrying out a complete design of the main structure element of a multi-storied building

7. The design process of structural planning and design requires not only imagination and concept thinking but also sound knowledge of science of structural engineering besides the knowledge of practical aspects, such as recent design codes, bye laws, backed up by sample experiment, intuition and judgment.

8. The purpose of Standard is to ensure and enhance the safety, keeping careful balance between economy and safety.

9. Analysis of the structure

10. Design of the structure

1.6 Scope of work

1. The scope of the study is to explore and evaluate the advantages of integration which will enables the ease of project.

2. It is viable career option as implementation of software is done for better development.

3. Software allows us to analyse a building by shaking in earthquakes, blows wind on it, and informs us where section of the structure will collapse and tells us which part of structure is going to fail and allows us to fix it even before it is built. It should be affordable to encourage their widespread use among civil engineers.

4. Reduction of cost and time

2. LITERATURE REVIEW

Kumar et al. (2014) they chose a residential structure with a G+ 15-story construction that is situated in zone II to demonstrate the seismic research. The entire structure was computer-assessed using STAAD.PRO software. They used deflection diagrams in static and dynamic analysis to track the response reduction of cases with ordinary moment resisting frame and special moment resisting frame values. Seismic loads can be effectively resisted by the special moment of the resisting frame construction.

Mounika et al. (2016) has used STAAD Pro to design and study a residential project. During their design and analysis, the manual calculations were compared to the outcomes of STAAD Pro. The findings from the human and automated processes were identical and precise.

Khan et al. (2016) in this study, the seismic analysis of RCC structures with mass irregularity at different floor levels was studied. This study emphasises the impact of mass irregularity on various levels in RCC constructions. Response spectrum study using Staad-Pro on regular and varied irregular structures shows that the lateral displacement of the building decreases as the percentage of irregularity rises. As the vertical irregularity increases, the story drift gets less and stays within the allowed range.

Sudheer (2017) designed and analysed a structure with a footprint of 17.52 by 26.36 metres and a network of monolithic columns. There are a total of 15 columns. He concluded that compared to manual computations, the multistory building study was significantly faster. Manual calculation vs software design yields a greater strengthened % in the segment.

Das et al. (2017) demonstrates a standard G+7-story skyscraper paper. Utilising the design parameters specified in IS-1893-2002-Part-1 for Zone V, the static and dynamic analyses were carried out using the STAAD - Pro programme. The post processing findings were then summarised. It is assumed that the outcome of Static analysis is roughly uneconomical since the deflection values for Dynamic analysis are greater.

Rani, et al. (2018) The G+4 Building was designed and evaluated using STAAD Pro. A three-dimensional framed design was used, and the complete structure was subjected to a STAAD Pro analysis and load calculations. The STAAD-Pro analysis, which adhered to the Indian Standard Code of Practise, used Limit State Design. The results were very precise.

Tejaswini et al. (2021) the seismic assessment and design for a G+9 RCC building are both included in the project report. The applicable dead and live loads, as well as the designs for the beam, column, slab, and footing, are obtained. STAADPRO software was used to evaluate the complete structure. We compare the base shear values calculated manually and using Staad-pro.

R. Kumutha and V. Praveen Kumar (2023) Seismic analysis, which is a step in the structural design process, evaluates how structures react to earthquakes. The overview and findings of the seismic analysis of a G+3 Reinforced Concrete (R.C.) building with an irregular layout are presented in this article. The STAAD Pro Advanced CONNECT Edition programme models the structure as a 3D frame. Six degrees of freedom are included in each node. Analysis of the equivalent static and response spectrums was done. The necessary response spectra as per IS: 1893 - Part 1 (2016) were employed, and the soil under consideration is rocky soil. It is assured that a sufficient number of vibration modes are taken into account during the system analysis to contribute more than 90% of the mass. Analysis was done for different loads.

Gupta et al. (2023) the main goal of structural design is to create a structure that is functional, safe, long-lasting, affordable, and aesthetically pleasing. The entire structural designing process calls for a broad range of knowledge, creativity, and expertise. This project is based on an examination of theoretical design criteria and framed structure, or the analysis and design of a G+4-story residential building using the IS Code approach in STAAD Pro software. The structure was transferred to STAAD Pro for analysis and design through the use of AutoCAD for all of the drafting and detailing work. In this design project, the "Limit State Method" is used to design the beam, column, slab, and foundation initially in seismic zone II. Various loads placed on

3. Methodology

The development of thesis contains the analysis and thesis G+3 multistorey building by using the software. In Civil Engineering, there is a broad range of software available. The amount of software available to support Civil Engineering and design demands is rapidly expanding as a result of technology advancements.
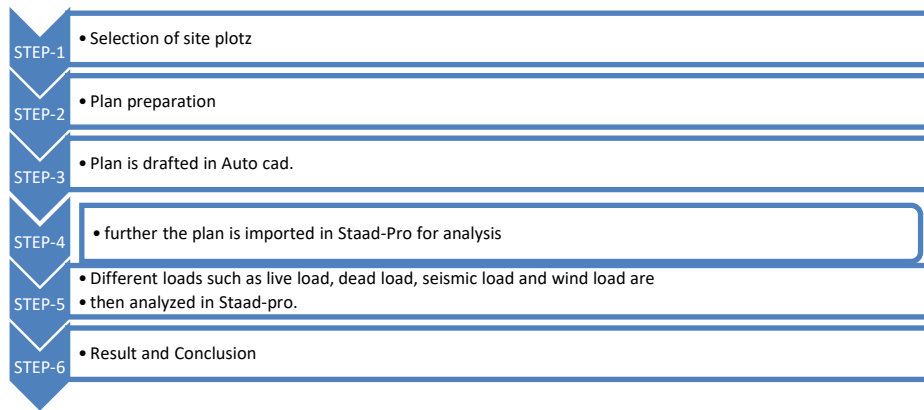
STEP-1	• Selection of site plotz
STEP-2	• Plan preparation
STEP-3	• Plan is drafted in Auto cad.
STEP-4	• further the plan is imported in Staad-Pro for analysis
STEP-5	• Different loads such as live load, dead load, seismic load and wind load are • then analyzed in Staad-pro.
STEP-6	• Result and Conclusion

Figure 1: Flow Chart of Methodology

The building consists of a parking space on the ground floor and the other three units i.e. one unit of 2BHK and two units of 1BHK on the first second and third floor.

1. Step 1: To model the residential building using the STAAD Pro software and analyse the same structure using STAAD Pro.

2. Step 2: To analyse the residential building and structural elements like beams, stairs, columns, slabs.

3. ➢ Step 3: To design the residential building using STAD Pro - To design the structural elements like beams, stairs, columns, slabs using software

I.   Ground Floor Plan

Figure 1: Ground Floor Plan

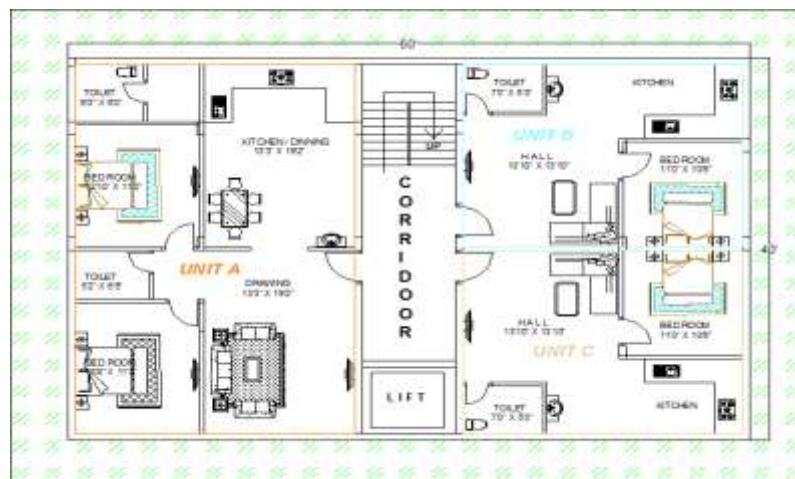**II.   First Floor Plan**

Figure 2: Auto Cad Plan of building

3.1 Importing plan to Auto CAD

Plan is then stored in.dxf format after being drafted in Auto Cad. DXF is an AutoCAD drawing file content interchange format (DWG). A DXF ASCII file is an ASCII text file; a binary version of DXF has also been created. This .dxf format file is now ready to export in Staad-Pro software.

3.2 Importing plan to Staad-Pro:

The Auto Cad 2D plan has now been loaded into the Staad-pro program. The plan has now been converted to G+3 models. After that, all node points are created as beams in the x and z dimensions, and columns in the y direction. Figure 3 shows the Staad- Pro 2 D model and the render view.
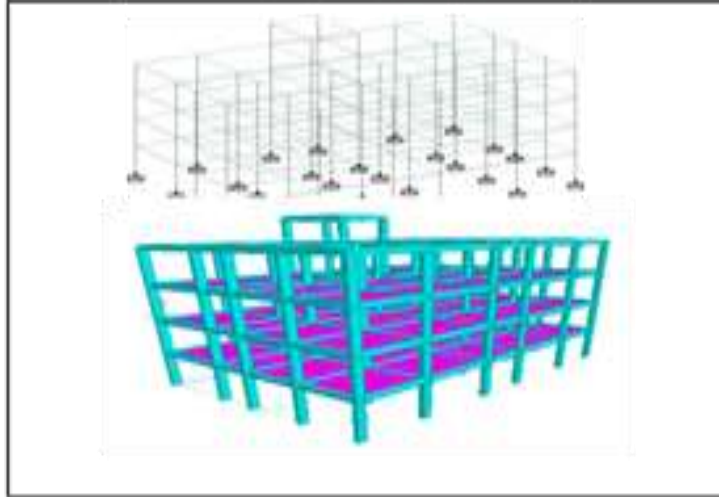

Figure 3.Render view of Staad-Pro Model

3.3. Assigning Properties to Model

Properties are assigned to the model once it is created in Staad-Pro. The characteristics are assigned to the model's beams and columns. The column is 200mm x 400mm in size, and the beam is similarly 200mm x 400mm in size. The slab has a thickness of 150 mm. Table 1 shows the model details.

Table 1: Details of the model

S.no	Parameters	Description
1.	Utility of Building	Residential Building
2.	Dimension	18 x 12 meter
3.	No. of Stories	G+3
4.	Height of Building	12 meter
5.	Size of Column	200 mm x 400 mm
6.	Floor to Floor Height	3 meter
7.	External wall thickness	230 mm
8.	Internal wall thickness	115 mm
9.	Slab Thickness	150 mm

Table 2: Unit Weight of the Materials

S.no	Material	Unit Weight
1.	Brick Masonry	18 KN/m3
2.	Stone Masonry	20.4-26 Kn/m3
3.	Plain Cement Concrete	24 KN/m3
4.	Reinforced Cement Concrete	24 KN/m3

Table 3.Reduction in imposed loads:

Number of floors	Reduction in Total Distributed imposed loads (percent)
1	0
2	10
3	20
4	30
5 to 10	40
Over 10	50

Live load in the project is assumed as 3.5 KN/m2 and the analysis is therefore conducted in Staad-Pro. Figure 4 illustrates the live load distribution in Staad-Pro window
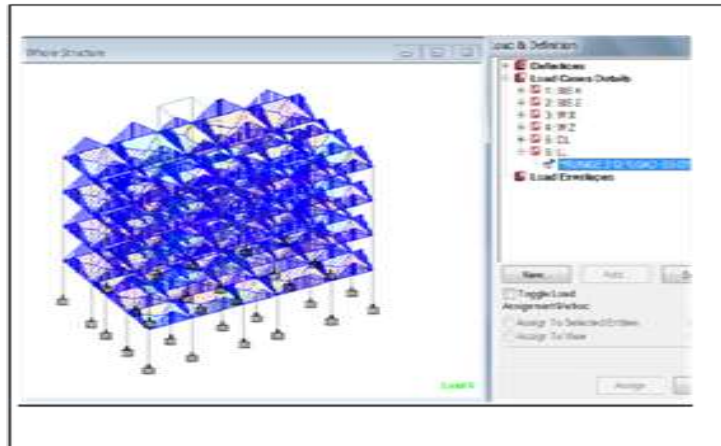

Figure 4: Live Load distribution on model

4. Results

4.1 Comparison of manual & Staad-Pro Results

The manual calculation and the analysis of seismic parameters i.e. seismic weight, base shear are as discussed in table. The seismic parameters are calculated with manual calculation and the same is then calculated with Staad-pro software. The results obtained in Staad-pro are slightly more as compared with manual calculation. The average increment of nearly 18% is identified in the results of Staad-pro.

Table 4: Manual & Staad-Pro Results

Parameters	Manual	Staad-Pro	% Increment
Seismic Weight	13410.44 4 KN	13436.86 KN	0.196 %
Base Shear	335.261KN	336.92 KN	0.49 %

Table 5: Comparison of Base Shear at Different Height:

Floor Height (meter)	Base shear (Manual)	Base shear (Staad- Pro)	% Increment
12	150.86	154.48	2.39 %
9	268.2	273.21	1.86 %
6	320.83	325.86	1.56 %
3	335.26	336.92	0.49 %

4.2 Comparison of Seismic parameters in different zones of India:

The Staad-pro software is used to create the design and analysis after entering the information for each zone. The building's seismic weight is determined to be 9073.97 KN, with a time period of 0.48356 seconds. Staad-pro, on the other hand, provides a different of base shear values as well as steel quantity in different seismic zones.

4.2.1 Base Shear

The greatest predicted lateral stress on the base of the structure owing to seismic activity is called base shear. It is computed using the seismic zone, soil material, and lateral force formulae from the building code. The base shear values of all four zones are highlighted below in table 6.

Table 6. Base shear values of all four zones

S.no	Zones	Base shear values (KN)
1.	II	226.85
2.	III	362.96
3.	IV	544.43
4.	V	816.66

Table 7: Quantity of steel of all four zones.

S.no	Seismic Zones	Quantity of steel (Newton)
1	II	51383
2	III	54104
3	IV	65835
4	V	75484

5. Conclusions

The Staad-Pro software has been used to successfully designed and analyse the G+3 multi- storey building. Based on the input data following conclusions have been drawn.

1. The study conclude that, analysing multi-storey buildings with Staad pro reduces manual computations and consequently provides correct results in less time.

2. The comparison between base shear results of manual to software calculation gives maximum increment of 2.39 % at top most height of building i.e. at 12 meter, with minimum increment of 0.49 % at the height of 3 meter.

3. When analysing the seismic parameters in various parts of India, the base shear levels vary considerably. Zone II has a value of 226.85 KN, zone III has a value of 362.96 KN, zone IV has a value of 544.44 KN, and zone V has a value of 816.66 KN.

4. In addition, different steel quantities are acquired in different zones, comprising 51383 N in zone II, 54104 N in zone III, 65835 N in zone IV, and 75484 N in zone V.

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