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Review on Design and Analysis of Multi-Storey Building by using Stadd-Pro

Yash Sapakale[1], Sagar P. Ingale[2], Mohit A. Jadhav[3], Ansar Shaikh Mazhar[4], Pranay A. Wani[5]
[1-5]Department of Civil Engineering
Khandesh Bahuuddeshiya Sanstha's College of Engineering & Technology, Jalgaon, Maharashtra, India

Abstract: *The main aim of structural engineer is to design the structures for a safe technology in the computing field; the structural engineer can dare to tackle much more large and complex structure subjected to various type of loading condition. Structural planning and analysis is an art and science of designing with economy, elegance and sturdiness. Structural designing requires an in-depth structural analysis on which the planning is predicted, to compete within the ever competitive market, The use of software can save many-man hours and efforts in structural analysis and an effort was made in the present study to achieve this objective. Now a day large number of application software's are available in the civil engineering field. All these software's are developed as the basis of advanced. In these Research a review of the analysis and design of a multi-storey building with STAAD Pro is carried out. Planning is done by using AutoCAD and load calculations were done manually and then the structure was analysed using STAAD Pro. The dead load, imposed load and wind load with load combination are calculated and applied to the structure. Overall, the concepts and procedures of designing the essential components of a multistory building are described. STAAD Pro software also gives a detailed value of shear force, bending moment and torsion of each element of the structure which is within IS code limits.*

Keywords: Design, Analysis, building, Staad-Pro, Structural planning, multistorey building.

I. INTRODUCTION

In every aspect of human civilization we needed structures to live in or to get what we need. But it is not only building structures but to build efficient structures so that it can fulfill the main purpose for what it was madeforHere comes the role of civil engineering and more precisely the role of analysis of structure.The design consists of Commercial building.There are many classical methods to solve design problem, and with time new software's also coming into play. Here in this project work based on software named "STAAD. Pro" has been used.Few standard problems also have been solved to show how "STAAD. Pro" can be used in different cases. These typical problems have been solved using basic concept of loading, analysis, condition as per IS code. These basic techniques may be found useful for further analysis of problems. STAAD Pro features a state-ofthe-art user interface, visualization tools, powerfulanalysis and design.From model generation, analysis and designto visualization and result verification, STAAD Pro is the professional's choice for steel, concrete, timber, aluminum and cold-formed steel design of low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles and much more.Structural analysis is thus an important aspect of structural engineering design. In order to do a thorough analysis, a structural engineer needs gather information such as structural loads, geometrical parameters, support conditions, and material properties from many sources. As a result of such an examination, support reactions, stresses, and displacements are often identified.the beauty of structural engineer is that he makes life better for humanity; it is the business of saving lives.The structural style creates a structure that is safe, functional and durable, technical, economical and simple.

II. LITERATURE REVIEW

[1] Adhiraj A. Wadekar and Ajay G. Dahake (April 2020),A review of the analysis and design of a multi-storey building with STAAD Pro is carried out. Planning is done by using AutoCAD and load calculations were done manually and then the structure was analysed using STAAD Pro. The dead load, imposed load and wind load with load

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combination are calculated and applied to the structure. Overall, the concepts and procedures of designing the essential components of a multistory building are described. STAAD Pro software also gives a detailed value of shear force, bending moment and torsion of each element of the structure which is within IS code limits.

[2]Sinny Kumari , Deeksha Shrotriya(August 2022),Structural planning and analysis is an art and science of designing with economy, elegance and sturdiness. Structural designing requires an in-depth structural analysis on which the planning is predicted, to compete within the ever competitive market, The use of software can save many-man hours and efforts in structural analysis and an effort was made in the present study to achieve this objective. The part 1 study deals with the planning and analysis of G+5 multi-storey building using AutoCAD and Staad-Pro software. 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. The drafting and detailing work was completed using AutoCAD software and thereafter the entire design work was completed using "Staad-Pro v8i ss6. Manual analysis of seismic load is compared preferably with the results of software and thus it's concluded that Staad-Pro is suitable tool that may save considerable time and gives sufficiently accurate results.

[3] Sakib Salam Sofil, and Er. Ashish Kumar(April 2022),- Structural design is the primary aspect of civil engineering. The foremost basic in structural engineering is the design of simple basic components and members of building viz., slabs, beams, columns and footings. The first step in any design is to decide the plan of the particular building. The location of beams and columns are decided. Then the vertical loads like dead and live loads are calculated. Once the loads are obtained, the component which takes the load first i.e. the slabs can be designed. From the slabs, the loads are transferred to the beams. The loads coming from the slabs onto the beam may be trapezoidal or triangular. Depending on this, the beam may be designed. The loads (mainly shear) from the beams are then transferred to the columns. For designing columns, it is necessary to know the moments they are subjected to. For this purpose, frame analysis is done by Moment Distribution Method. Most of the columns designed in this project were considered to be axially loaded with uniaxial bending. Finally, the footings are designed based on the loading from the column and also the soil bearing capacity value for that particular area. All component parts are checked for strength and stability. The building was initially designed as per IS 456: 2000 without considering earthquake loads using STAAD.pro software. Then the building was analyzed for earthquake loads as per Equivalent static analysis method and after obtaining the base shear as per IS1893: 2002.

[4] Abhiyank Joshi , Mr. Rahul Sharma (January 2022),The study incorporates structural designing and analysis of a multi-storey (residential) building is having five storeys with ground floor complete car parking and different residential spaces on other floors, including lift having access to all floors (including terrace) by using STAAD.Pro V8i. This study also includes a comparison of different grade of concretes, Comparison to be done on similar type of structure and applying similar type of loadings. Design of the structure will be done using the STAAD.Pro V8i software for both grade of concrete. Analysis part will also be done using the software which in result provide us the graphs for deflection, stress and strain curve, stress areas, etc. in each section individually and wholly. By doing the comparison we can understand the structural behaviour of the similar type of structures under similar type of loading for different types of grades of concrete. Also the analysis will provide us the details as which grade of concrete will be better for structural designing and will also be economical for the project.

[5]Ibrahim,et.Al (April 2019)- After analyzing the G+5 story residential building structure, conducted that the structure is rate in loading like dead load, live load, wind load and seismic loads. Member dimensions (Beam, column, slab) are assigned by calculating the load type and its quantity applied on it. Auto CAD gives detailed information at the structure members length, height, depth, size and numbers, etc. STAAD Pro. Has a capability to calculate the program contains number of parameters which are designed as per IS456:2000. Beams were designed for flexure, shear and tension and it gives the detail number, position and spacing brief.

[6]RashmiAgashe, Marshal Baghele, Vaishnavi Deshmukh, Sharad Khomane, Gaurav Patle, Kushal Yadav (April 2020)- From the work carried out in staad.pro we can conclude that: Comparison between manual calculation and stadd.pro software analysis and design, conclude that the analysis is same but design is some different. Using STAAD.Pro, analysis and design of multi-storey building has completed much quickly and easier than the manual calculation. Building plan was develop and draft in auto- cad with required dimension. During designing g+ 4 storeys

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residential building structure is capable to sustain all loads acting on building. The design of slab, beam, column, rectangular footing and staircase is done with is 456-2000 as limit state method.

[7]Tandon et al. (2018)-the research looks at how a building responds to a seismic load as measured by storey drift and foundation shear. The (G+8) building, which is located in zones 2 and 4, was seismically analyzed using STAAD Pro software. They discovered that seismic zone 2 and 4 increase base shear, lateral force, storey shear, maximum storey displacement, and overturning moment in both directions.

III. DATABASE AND METHODOLOGY

The development of thesis contains the analysis and thesis multistory 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. The softwares used in civil engineering are described below.

3.1 Civil Engineer Software for Drafting or Drawing:

Our project involves analysis and design of multi-storeyed [G+5] using a very popular designing software STAAD Pro. We have chosen STAAD Pro because of its following.

1. Easy to use interface.
2. Conformation with the Indian Standard Codes.
3. Versatile nature of solving any type of problem.
4. Accuracy of the solution.
5. STAAD.Pro is a user-friendly software which is used for analysing and designing.
6. STAAD Pro provides a lot of precise and correct results than manual techniques.

STAAD Pro features a state-of-the-art user interface, visualization tools, and powerful analysis and design engines with advanced finite element and dynamic analysis capabilities. From model generation, analysis and design to visualization and result verification, STAAD .Pro is the professional's choice for steel, concrete, timber, aluminum and cold-formed steel design of low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles and much more.

The STAAD. Pro Graphical User Interface. It is used to generate the model, which can then be analyzed using the STAAD engine. After analysis and design is completed, the GUI can also be used to view the results graphically.It is a general-purpose calculation engine for structural analysis and integrated Steel, Concrete, Timber and Aluminum design. To start with we have solved some sample problems using STAAD Pro and checked the accuracy of the results with manual calculations. The results were to satisfaction and were accurate. In the initial phase of our project we have done calculations regarding loadings on buildings and also considered seismic and wind loads.

Structural analysis comprises the set of physical laws and mathematics required to study and predicts the behavior of structures. Structural analysis can be viewed more abstractly as a method to drive the engineering design process or prove the soundness of a design without a dependence on directly testing it.To perform an accurate analysis a structural engineer must determine such information as structural loads, geometry, support conditions, and materials properties. The results of such an analysis typically include support reactions, stresses and displacements. This information is then compared to criteria that indicate the conditions of failure. Advanced structural analysis may examine dynamic response, stability and non-linear behavior.

3.2 Need of the Study

Due to the huge growing population and the absence of land, people have shifted from rural to urban areas and are currently building large-scale houses in small areas. In spite of this, due to the fast growth in land costs and the shortage of land, multi-story structures are becoming increasingly popular. A multi-story building has several levels above ground which generally features ramps, stairways, and elevators enabling vertical circulation. But, from a structural engineer's point of view the multi-storied building can be defined as one that, by virtue of its height, is affected by lateral forces due to wind or earthquake or both to an extent that they play an important role in the structural design. It's not just about building structures; it's about building structures that are efficient so that they can serve their desired

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purpose. As a result, it is critical to construct the structure using adequate load analysis so that it can withstand the elements for the duration of its life.

3.3 Loads Considered

3.3.1 Dead Load- All permanent constructions of the structure form the dead loads. The dead load comprises of the weights of walls, partitions floor finishes, false ceilings, false floors and the other permanent constructions in the buildings. The dead load loads may be calculated from the dimensions of various members and their unit weights. the unit weights of plain concrete and reinforced concrete made with sand and gravel or crushed natural stone aggregate may be taken as 24 kN/m2 and 25kN/m2 respectively.

3.3.2.Imposed Load- Imposed load is produced by the intended use or occupancy of a building including the weight of movable partitions, distributed and concentrated loads, load due to impact and vibration and dust loads. Imposed loads do not include loads due to wind, seismic activity, snow, and loads imposed due to temperature changes to which the structure will be subjected to, creep and shrinkage of the structure, the differential settlements to which the structure may undergo.

3.3.3.Wind Load- Wind is air in motion relative to the surface of the earth. The primary cause of wind is traced to earth's rotation and differences in terrestrial radiation. The radiation effects are primarily responsible for convection either up wards or down wards. The wind generally blows horizontal to the ground at high wind speeds. Since vertical components of atmospheric motion are relatively small, the term wind denotes almost exclusively the horizontal wind, vertical winds are always identified as such. Thewind speeds are assessed with the aid ofanemometers or anemographs which are installed at meteorological observatories at heights generally varying from 10 to 30 meters above ground.anemometers or anemographs which are installed at meteorological observatories at heights generally varying from 10 to 30 meters above ground.

3.3.4. Seismic Load-Seismic Load can be calculated taking the view of acceleration response of the ground to the superstructure. According to the severity of earthquake intensity they are divided in to 4 zones.

1. Zone I and II are combined as zone II.
2. Zone III.
3. Zone IV.
4. Zone V.

3.4 Working with STAAD Pro-

3.4.1 Types of structure-A structure can be defined as an assemblage of elements.STAAD is capable of analyzing and designing structures consisting of frame, plate/shell and solid elements. Almost any type of structure can be analyzed by STAAD. A SPACE structure, which is a three dimensional framed structure with loads applied in any plane, is the most general.A PLANE structure is bound by a global X-Y coordinate system with loads in the same plane. A TRUSS structure consists of truss members who can have only axial member forces and no bending in the members.A FLOOR structure is a two or three dimensional structure having no horizontal (global X or Z) movement of the structure [FX, FZ MY are restrained at every joint].The floor framing (in global X-Z plane) of a building is an ideal example of a FLOOR structure. Columns can also be modeled with the floor in a FLOOR structure as long as the structure has no horizontal loading. If there is any horizontal load, it must be analyzed as a SPACE structure.

3.4.2 Generation of the structure-

The structure may be generated from the input file or mentioning the co-ordinates in the GUI.

3.4.3 Material constants

The material constants are: modulus of elasticity (E); weight density (DEN); Poisson's ratio (POISS); co-efficient of thermal expansion (ALPHA), Composite Damping Ratio, and beta angle (BETA) or coordinates for any reference (REF) point. E value for members must be provided or the analysis will not be performed. Weight density (DEN) is used only when self- weight of the structure is to be taken into account. Poisson's ratio (POISS) is used to calculate the

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shear modulus (commonly known as G) by the formula, G=0.5 x E/ (1+POISS) If Poisson's ratio is not provided, STAAD will assume a value for this quantity based on the value of E. Coefficient of thermal expansion (ALPHA) is used to calculate the expansion of the members if temperature loads are applied. The temperature unit for temperature load and ALPHA has to be the same.

3.4.4. Supports-Supports are specified as PINNED, FIXED, or FIXED with different releases (known as FIXED BUT). A pinned support has restraints against all translational movement and none against rotational movement. In other words, a pinned support will have reactions for all forces but will resist no moments. A fixed support has restraints against all directions of movement. Translational and rotational springs can also be specified. The springs are represented in terms of their spring constants. A translational spring constant is defined as the force to displace a support joint one length unit in the specified global direction. Similarly, a rotational spring constant is defined as the force to rotate the support joint one degree around the specified global direction.

3.4.5. Loads-Loads in a structure can be specified as joint load, member load, temperature load and fixed-end member load. STAAD can also generate the self-weight of the structure and use it as uniformly distributed member loads in analysis. Any fraction of this self-weight can also be applied in any desired direction

3.4.6 Working with STAADPRO-

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A PLANE structure is bound by a global X-Y coordinate system with loads in the same plane. A TRUSS structure consists of truss members who can have only axial member forces and no bending in the members.

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IV. OBJECTIVES

1. Generating structural framing plan.
2. Creating model in STAADPRO.
3. Analysis of the structure.
4. Design the structure.

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V. RESULTS AND DISCUSSION

5.1.ANALYSIS OF G+5 RCC FRAMED BUILDING USING STAAD.PRO

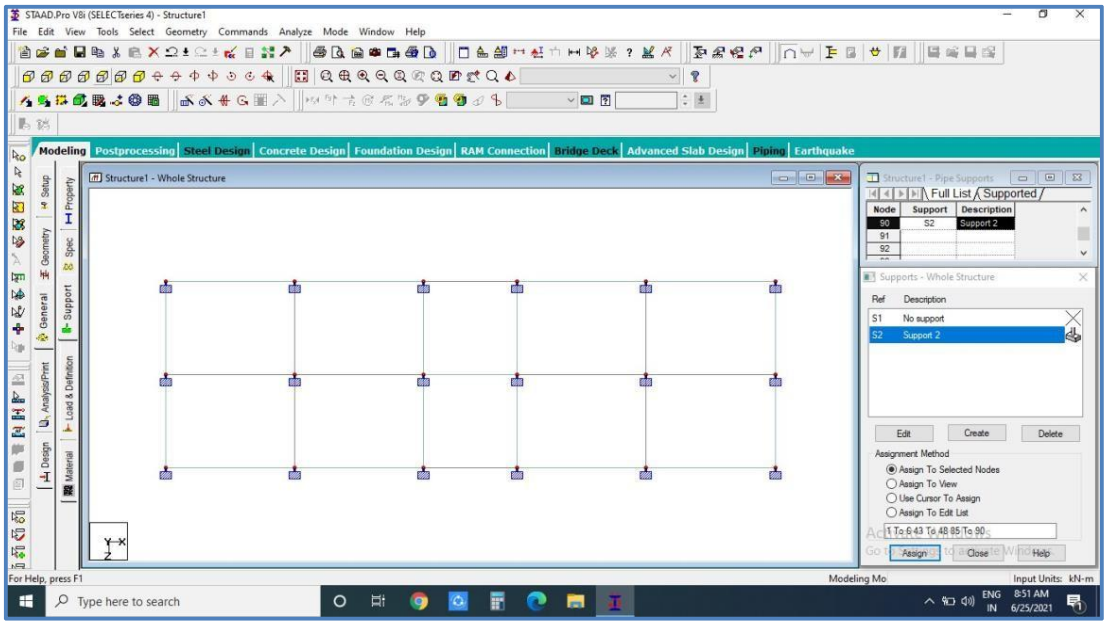

Figure 1: Analysis of Structure using Stadd- Pro

Building all Columns = 0.40 *0.60 m
All beams = 0.3 * 0.5 m
All slabs = 0.125 m thick

5.1.1 Physical parameters of building :

Length = 4 bays @ 5.5m + 1 bay @ 4m =26m Width = 2 bays @ 4 m =8.0m
Height = 3m + 5 storeys @ 3.5m = 20.5m Live load on the floors is 2kN/m2
Live load on the roof is 1.5kN/m2

Grade of concrete and steel used :

Used M25 concrete and Fe 415 steel

5.1.2 Generation of member property

Generation of member property can be done in STAAD.Pro by using the window as shown above. The member section is selected and the dimensions have been specified. The beams are having a dimension of 0.3*0.5 m and the columns are having a dimension of 0.4*0.6 m.

5.1.3 Supports:

The base supports of the structure were assigned as fixed. The supports were generated using the STAAD.Pro support generator.

5.1.4 Materials of the structure :

The materials for the structure were specified as concrete with their various constants as per standard IS code of practice.

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5.1.5 Loading :

The loadings were calculated partially manually and rest was generated using STAAD.Pro load generator. The loading cases were categorized as

1.Self -Weight
2.Dead load from slab
3.Live load
4.Wind load
5.Seismic load
6.Load combination

VI. CONCLUSION

1.By Using STADD Pro., analysis and design of multistorey building is easier and quick process than manual process.
2. Proposed size of the beam and coloumn can be safely used in the structure.
3. The structure is safe in shear bending and deflection.
4. There is no hazardous effect on the structure due to wind load and seismic load on the structure.
5. The structure we taken is stable and structurally defined using various loads and combination.
6. The deflection value is more in WL (Wind Load) combination than the SL (Seismic Load) combination.
7. To know the behavior of the structure by applying various loads like dead load, live load, wind load and seismic load by using staad.pro. And also find out the Shear forces, displacement, bending and reactions of structure.
8. By using staadpro ,we performed dynamic analysis. So that, the results obtained in staadpro is more effective as compared to analysis and design performed by theoretical method.

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IS CODES :

Indian Standard 456-2000 - Plain and Reinforced Concrete - Code of Practice (Fourth Revision).
Indian Standard 800-2007 - Indian Standard Code of Practice for General Construction in Steel.
Indian Standard 875 (Part 1) - 1987: Dead Loads.
Indian Standard 875 (Part 2) - 1987: Imposed Loads.
Indian Standard 875 (Part 3) - 1987: Wind Load