A SOFTWARE-BASED ANALYSIS OF MULTI STOREY HOSPITAL BUILDING

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ABSTRACT

As everyone is aware, there are generalizations about civil engineering all around the world. Furthermore, it has been widely disseminated recently.In India, the concept of civil engineering is important to development. Building components like beams, columns, slabs, etc. must be able to be analyzed and designed by civil engineers. In Padoli village, several construction projects have been initiated recently, and as a result, the community's population has been growing. We have chosen an 852.057 sq. m. construction site for the Hospital Building with this in mind. We have decided to design the layout of a G+4 hospital building and created the plan for the building's location and some of its components. We employed Revit and AutoCAD 2D software and used STAAD Pro Software to analyze and design the structure's components after gathering all of its details. We have taken into account Indian Standard Codes for standard specifications for determining loads of various sections at various storeys. Based on the results, we deduced that nearly all of the structural elements passed the tests that were performed on them, including the bending moment, shear forces, and deflection. STAAD Pro software programs indicated the list of rejected pieces, and a better segment was chosen. After doing the study once more and receiving the results right away, we created a new beam cross-section measuring 230 mm by 450 mm. This building can be constructed up to G+8 storeys.

Keywords: AutoCAD, Revit, STAAD Pro, Hospital Building, Analysis.

INTRODUCTION:

The purpose of this research is to examine and evaluate a multi-story hospital located in Padoli, close to the Kanda Petrol Pump (Chandrapur District). The building's structural design should guarantee that it can be supported safely and that its structural integrity and performance are maintained without experiencing undue deformation or movement, which could cause structural elements to become worn out or fail fixtures, fittings, partitions, or other components.Engineers can model, analyze, and design complex structures using the popular structural analysis and design program STAAD Pro.

The project involves using STAAD Pro to analyze a G+4 storey structure for various load combinations. AutoCAD software and Revit are also utilized for scheduling, sketching, sharing, and visualizing using tools, as well as for instantaneous revisions to plans, elevations, and sections. The structure's frame is made up of multiple bays and storeys. An intricate intermediate structure is a multi-story, multi-paneled frame. The G+4 storey structure design is started. The bottom level's columns measure 450 mm by 600 mm, while the second-floor to fourth-floor columns are 370 mm by 500 mm. The beams measure 300 mm by 600 mm.

The structure is exposed to both horizontal and vertical loads. Structural components such as beams, columns, slabs, etc. comprise a dead load, and the vertical load is composed of a live load. As per IS 875, since wind forces comprise the horizontal load, the building is engineered for dead load, live load, and wind load.

There are many advantages of employing STAAD Pro for hospital construction design and analysis. The software's features enable the production of detailed 3D models, analysis of the behavior of the structure under varied loads, evaluation of all performance, and design optimization for efficiency and safety. We can make sure that the hospital building satisfies the essential structural criteria and offers a secure and stable environment for patients, employees, and equipment by utilizing the power of STAAD Pro.

1. Overview

The village of Padoli is located in the district of Chandrapur. People will not have to go far to Chandrapur if a hospital is constructed here. We have therefore decided to create and assess the hospital's construction close to Padoli. The hospital building is 30 m by 55 m, or 852.057

sq.m in total. There are all the necessary facilities for a hospital building present. STAAD Pro has been used to analyze every component, including the slab, beams, columns, and footing.

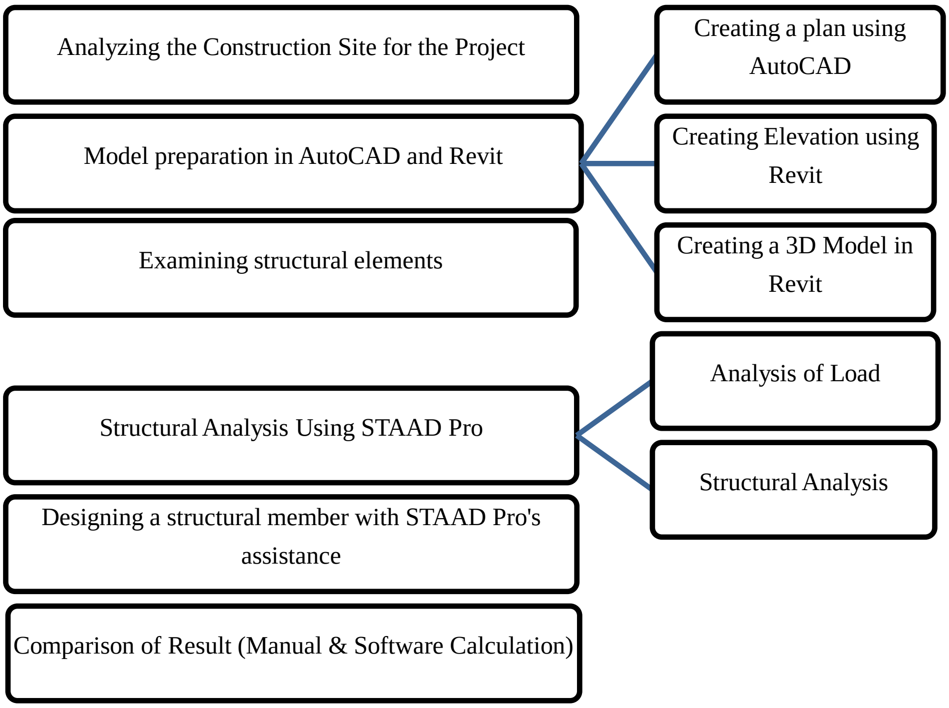
2. Objective

1. To create the model in AutoCAD.
2. To create a 3DmodelinRevit
3. To examine a building's structural design. (Inside STAAD Pro)
4. To design the building's structure. (Inside STAAD Pro)

STUDY OF CONSTRUCTION SITE :

The scale of construction projects for commercial use is usually greater than that of residential use. They may consist of extension, remodeling, and new building. Commercial projects can be found in a variety of locations, such as hotels, restaurants, retail establishments, and office buildings. Due to their complexity, commercial projects frequently call for the knowledge and experience of licensed general contractors. Hume Concrete pipes were used for Drainage purposes. Since our construction site is located in a hot and muggy region, hospital design should use the right theories and techniques to accomplish the goals of passive design and energy conservation. This study has looked into the general design, use of natural surroundings, and humanization of hospital architecture in light of these principles as well as the requirement for medical care and patients. The study has offered several suggestions for reducing energy use in hospital design, based on a substantial quantity of research and projects.

METHODOLOGY:



MODEL PREPARATION IN AUTOCAD AND REVIT :

Using AutoCAD for multi-story building planning. In our earlier research paper, we showed the layout of a building with the following features shown in Table No. 1

Table No. 1: Detailing of Plans

Floor	Details
Ground	Canteen, Changing Room, MRI, Parking
First	Pharmacy, General Ward
Second	ICU, Recovery Room, Laboratory, Consultancy
Third	Equipment Room, CCU, SICU, General OT
Fourth	Twin Room, Chamber, General ward, Cabins

3DMODELINREVITSOFTWARE

Figure 1: 3-D view of Model in REVIT

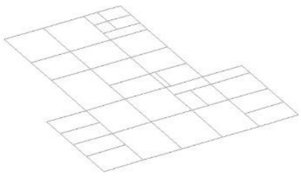
ANALYSIS OF STRUCTURE

As part of our project, we examined and designed a four-story hospital structure. Its length and breadth are 37 and 18 meters, respectively, and its height is 18 meters. The building has 833.87 m² of built-up space. M25 concrete grade was utilized, and the primary steel grade is FE 500.Table No. 2 provides the structure's geometry.

Table No. 2: Details of Floors

Count of Levels	G+4
Ground floor's Height	5.2 m
Each Floor’s Height,excluding the ground floor	3.2 m
Height of the structure	18 m

Structure Modeling:



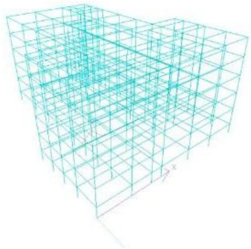


Figure 2: Importing STAAD Line Figure 3: An irregular grid used in the building's plan.

Examining the Supports:

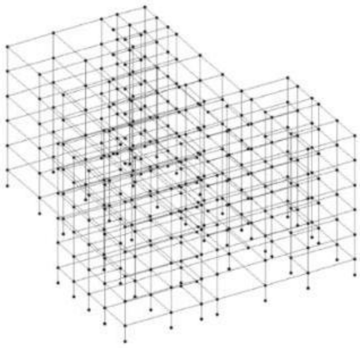


Figure 4: Development of a Structure with Supports

Assigning Structure's Properties:

The size of the beams and columns is determined by the span and loading. Usually, the depth of the beam falls between span/10 and span/12. The dimension of the beam must also be less than the dimension of the column to avoid overhangs in the beam. The beam and column width-to-depth ratio is provided in (BIS: IS 13920, 2016). The beam's depth must be adequate to offset the bending moment brought on by the weight. The properties can be altered if the section doesn't work. Size of Beam: 230 x 450 mm

Table No. 3: Column Dimension

ColumnName	ColumnSize	ColumnName	ColumnSize
C1	450mm x600mm	C7	450mm x600mm
C2	300mm x600mm	C8	450mm x600mm
C3	300mm x600mm	C9	300mm x600mm
C4	450mm x600mm	C10	300mm x450mm
C5	600mm x450mm	C11	300mm x450mm
C6	450mm x750mm		

Figure 5: After assigning Property

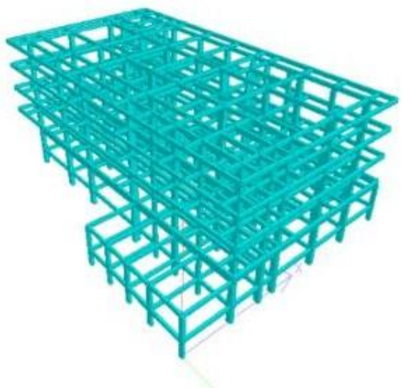


Figure 6: After assigning Column- Beam Property

Computation of Loads for Structure:

The different types of loading that STAAD Pro offers are explained as follows:

1. DEAD LOAD
2. IMPOSED LOAD
3. WIND LOAD

1. Dead Load:

Generally speaking, a structure can apply the following kinds of dead loads: Wall Load and Self-Weight on Slab

Wall Load: The height, density, and thickness of the wall need all be determined to calculate the wall's load. One can find the wall's density at (BIS: IS 875 Part 1, 1987). Density x Height x Thickness equals wall load in KN/m. For the beams that the walls are supported by, this load will be imposed as a member load.

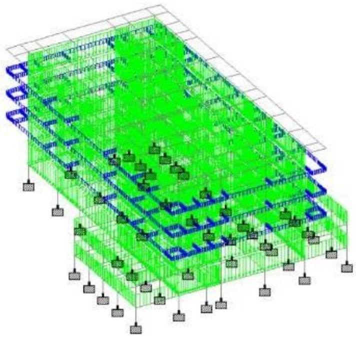


Figure 7: Assigning Wall Load

Self-Weight: The term "self-weight" describes the weight of any component of the member, such as a beam, slab, column, etc. The self-weight command instructs STAAD Pro to take into account the self-weight of the characteristics of the specified members when it is used as a load item.

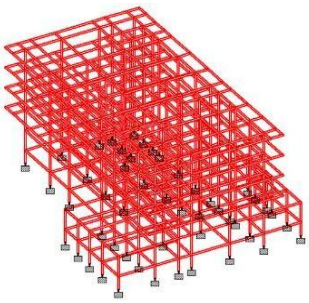


Figure 8: Assigning Self-Weight

Load on Slab: The only method used to determine the slabs' dead load will be analytical calculation. The self-weight of the slabs has been calculated using the assumed density of 25 KN/m^3 (BIS: IS 875 Part 1, 1987) for reinforced concrete. The slab's thickness is the primary factor that determines its dead load. The thickness of slabs should be determined by the serviceability and strength criteria, which are outlined in the design code (BIS: IS 456, 2000). This means that before applying a load in STAAD, slabs should be analytically designed. Since the floor load will transfer to the earth rather than the footings at the plinth level, the floor load was not applied there. A two-way reinforced slab has been found to follow a trapezoidal distribution of area loading based on yield line theory.

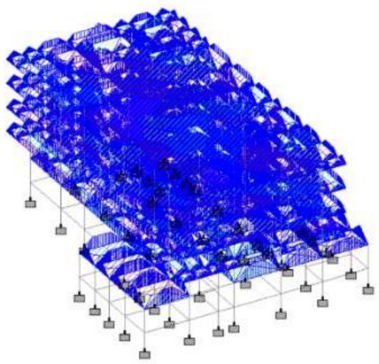


Figure 9: Assigning Slab Load

2. **Imposed Load:**

As stated in the Indian Standard Code (BIS: IS 875 Part 2, 1983),the live load was applied to the structure in KN/m^2 as a uniformly distributed load that also adheres to the trapezoidal distribution. The type of accommodation affects the live load values. The floor load, which likewise has a trapezoidal distribution, was used as the live load.

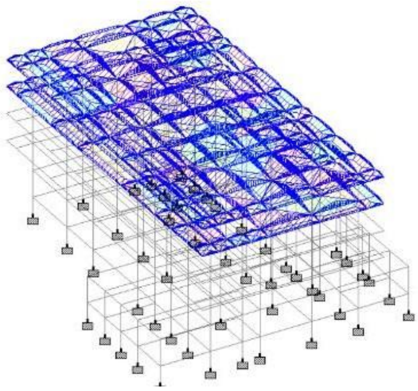


Figure 10: Assigning Live Load

3. **Wind Loads according to IS 875 Part 3:**

Design Wind speed is the wind speed at any height used in the wind load calculation for high-rise (>10 m) structure design.

Design Wind Speed calculation: $V_Z = V_b \times K_1 \times K_2 \times K_3 \times K_4$

Where V_b represents the basic wind speed,

K_1 denotes probability or risk factor,

K_2 denotes roughness and height factor,

K_3 denotes the topography factor, and

K_4 denotes an importance factor for the cyclonic zone.

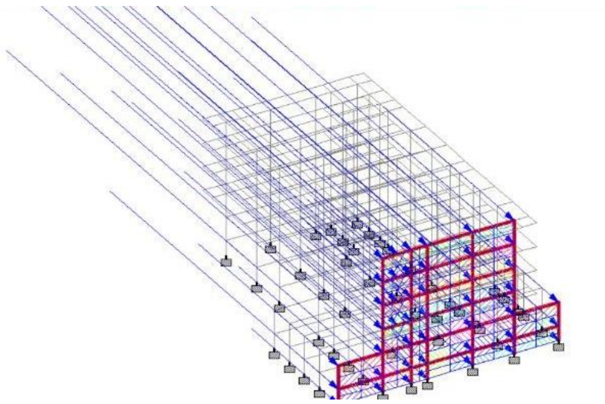


Figure 11: Assigning Wind Load

First, we determined the wind load. To find the wind load, click Definition > Wind Load > Add Intensity. Our calculated value was 0.765 $KN/m^2$for elevations of 10, 15, and 20 meters. A 0.9 exposure factor is subsequently allocated to the view. Next, pick wind load as WL_X and WL_Y in the load case. Next, choose the wind load to define, add the X direction, and set the range for the X, Y, and Z directions to 0 to 100 meters and factor 1 for the Z direction; add both, then designate to see.

Combinations of Loads:

The area of the steel in the beams and columns will be ascertained by combining the values that yield the maximum bending moment and shear force. Nonetheless, a thirty percent reduction in live load will occur during the footing design process.The following load combinations must be employed in the limit state design of reinforced concrete columns (RCC) andpre-stressed concrete structures:

1. 1.5 (DL+IL)
2. 1(DL+IL±EL)

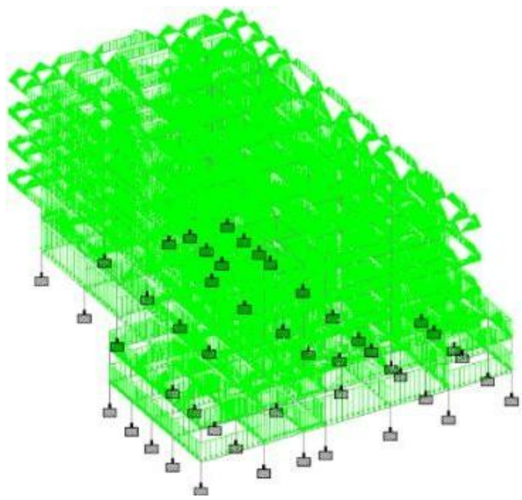


Figure 12: Assigning Load Combination

Once the procedures are completed, proceed to thoroughly examine and evaluate the structure.

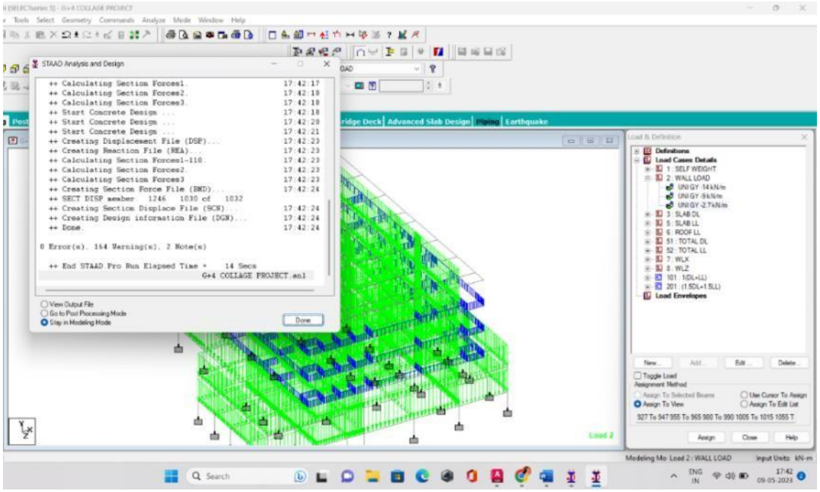


Figure 13: Analyzing the structure report

CONCLUSION

Therefore, based on the comparison of the results of the manual and STAAD Pro calculations, we may conclude that nearly all of the calculations are correct.STAAD Pro software programs indicated the list of unsuccessful elements, and better sections were chosen.The new cross-section of the beam was utilized because the analysis and design of the new section were redone and the results were obtained right away.

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