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Planning Analysis and Design of G+4 Hospital Building using STAAD.Pro V8i & Revit

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Abstract
In these modern days the building are made to fulfil our basic aspects and better service ability. It is not issue to construct a building any how its, important to construct an titled "planning analysis and design of G+4 hospital building using STAAD.Pro V8i & Revit" using STAAD.Pro. The plan of the building is drawn by using Autodesk Revit software, and analyzed the dead load, live load, bending moment, and reaction forces of the structure by using STAAD.Pro V8i. This software is used to find the solution for different types of structures. And also this software includes tools that helps to designed the specific structural engineering tasks. Then the design of RCC slab, columns, beams in Autodesk Revit software as per code book of IS 456 (2000). The tools and features that make up Revit architecture are specifically designed to support building information modeling (bim) workflows.

Keywords: Bending Moment, Shear Force, Planning, Analysis, Modeling, Designing, Hospital Building, STAAD.Pro, Revit, Reinforcement, Beams, Columns, Slab

1. Introduction

Building construction is that the engineering deals with the development of building like residential houses. Nowadays the house building is major work of the social progress of the county.

1.1 Modern Architecture

When modern architecture was first practiced, it absolutely was an avant-garde moment with moral, philosophical, and aesthetic underpinning. They rejected the architectural practice of the tutorial refinement of historical styles which served the rapidly declining aristocratic order.

2. Literature Review

MVK Satish et al. (2017) examined and designed a G+3 hospital building and its facility arrangement reaction to seismic load were studied using STAAD.Pro and after were investigated through a 3D non-linear reaction history examination and corrected with non-linear static working methodology (NSP), this study recommends utilization of modular NSP rather than first mode NSP as it gives better result while comparing building structures.

Tejavat Venkatesh et al. (2017) designed and analysed a hospital building for seismic and wind forces. The building was analysed for the reactions toward wind forces by using STAAD.Pro and earthquake

loads were analysed by equivalent static method with base shear criteria. The G+4 structure was analysed for structural stability towards considered forces.

3. Revit

3.1 Introduction to Revit

Revit supports building information modeling, it's BIM platform. It's beyond 3D modeling for visualization. You're creating a virtual building, with all it's properties. Similar to you build a real building, but in universe, it's in your workstation. It's also easy to form colour fill, 3D perspective, rendering, detailed drawing, and limited walkthrough animation. Revit architecture is built for architect. So architect can work with conventional way by creating building plan. You will be ready to draw as you draw a plan. But you're actually building a 3D model.

Details about Hospital Building

In this hospital plan provided canteen, CT scan, MRI scan, X-ray, oxygen storage room, at the ground floor and the remaining area is used for parking purpose. 1st floor consists of doctor's room, operation theater, emergence room, lab room, medical store. 2nd floor consists of doctor's room, separate inpatient room, ICU, maternity and pediatric ward. 3rd floor consists of separate inpatient rooms, general ward 1 and 2. 4th floor consists of isolation ward, staff room, medical store, store room medical records room, ICU, meeting hall, blood bank.

4. STAAD.Pro

4.1 Introduction

STAAD.Pro may be a structural analysis design program software. It includes a state of the art programme, visualization tools and international design϶ codes. It's used for 3D model generation, analysis and multi-material design. The commercial version of STAAD.Pro supports several steel, concrete and timber϶ design course. It's one among the software applications created to assist structural engineers to automate their tasks and to get rid of the tedious and long procedures of the manual methods.

4.2 Structure

A structure will be defined as an assemblage of elements. STAAD.Pro is capable of analyzing and designing structures consisting of both frame, and finite elements. Almost any sort of structure is analyzed by STAAD.Pro.

4.3 Types of Structures

A truss structure consists of truss members which might have only axial member forces and no bending within the members a plane structure is bound by a worldwide x-y organization with loads within the same plane an area structure, which may be a 3D framed structure with loads applied in any plane, is that the most general. A floor structure may be a 2D or 3D structure having no horizontal (global x or z) movement of the structure [f_x, f_z & m_y are restrained at every joint]. The ground framing (in global x-z plane) of a building is a perfect example of a floor structure. Columns may also be modeled with the ground during a floor structure as long because the structure has no horizontal loading. If there's any horizontal load, it must be analysed as an area structure.

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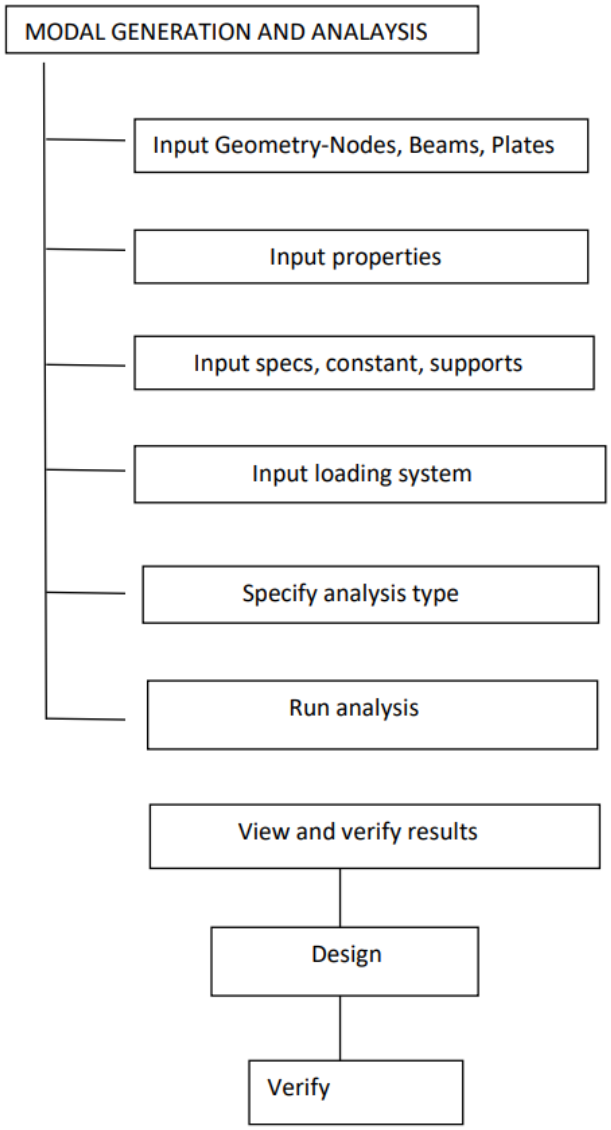


5. Model Generation

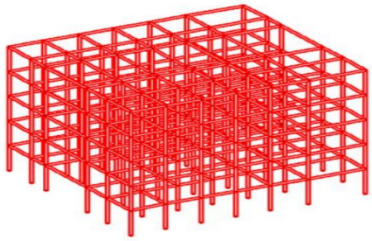
We generate the structure in STAAD.Pro by using coordinates. Out of those three methods, most typically used is run structure wizard method by using these three methods a structure of any geometry is created.

5.1 By using Coordinates

By preparing the coordinates within the shuttering plan by considering x, y and z axis the node points are generated in STAAD.Pro so the beams are inter connected to node points.

E-ISSN: 2582–2160, Volume: 4, Issue: 4, July-August 2022

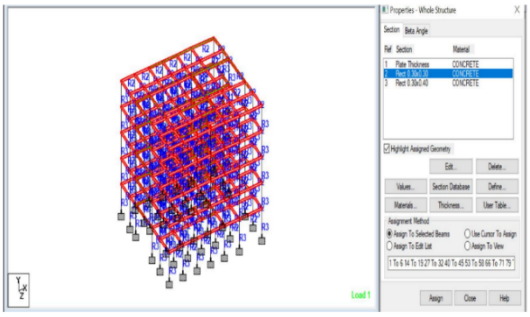
Figure 1: Frame Structure



5.2 Input Properties

The structural details of primary beams, secondary beams and columns of various dimensions and materials are given within the table to assign the subsequent properties to the structure.

Figure 2: Assigning Properties



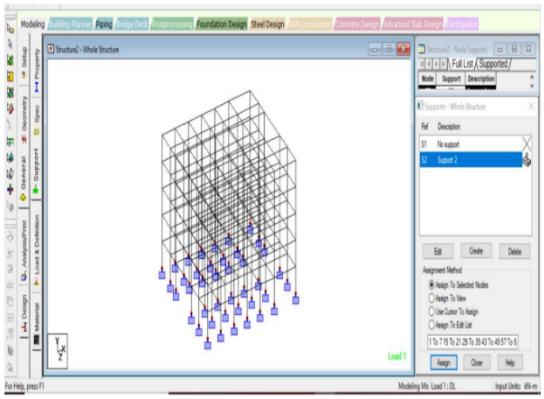
5.3 Supports

A support can consult with a structure in architecture that features arches, beams, columns, balconies, and stretchers.

Fixed Supports

Fixed support can resist vertical and horizontal forces in addition as moment since they restrain both rotation and translation. They're also called rigid support. For the steadiness of a structure there should be one fixed support. A flagpole at concrete base is common example of fixed support in RCC structures the steel reinforcement of a beam is embedded in a very column to supply a hard and fast support as shown in above image. Similarly all the riveted and welded joints in steel structure are the samples of fixed supports riveted connection don't seem to be pretty much common now a days because of the introduction of bolted joints.

Figure 3: Supports



5.4 Load and Deformations

Loads cause stresses, deformations, and displacements in structures. Excess load or overloading may cause structural failure, and hence such possibility should be either considered in the design or strictly controlled.

Dead Load: Dead Loads include the weight of the structure itself, and immovable fixtures such as walls, plasterboard or carpet. The roof is also a dead load. Dead loads are also known as permanent or static loads.

Live Load: Live Loads are usually unstable or moving loads. These dynamic loads may involve considerations such as impact, momentum, vibration, slosh dynamics of fluids, etc.

Seismic Load: Application of an earthquake generated agitation to a structure. It happens at contact surfaces of a structure either with ground, or with adjacent structure, or with gravity waves from tsunami.

Wind Load: The wind blows against a building the resulting force acting on the elevations. The building structural design must absorb wind forces safely and efficiently and transfer them to the foundation.

5.5 Assigning Loads

Any structure is subjected to basically these types of loads:

- Dead Load
- Live Load
- Wind Load

Seismic Load is applied in x direction and z direction. Wind load is also acting in x direction and z direction and also in –x direction and –z direction.

Figure 4: Assigning Loads

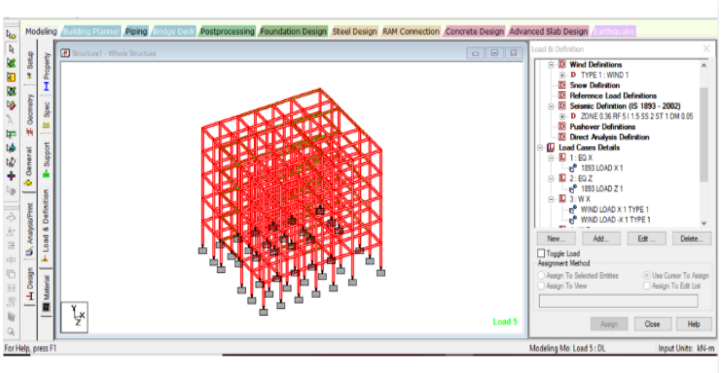


Table 1: Loads

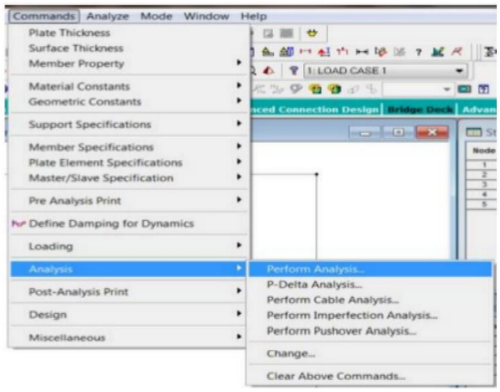
Load Type	Load Value
Dead Load	Self-weight
Live Load	-4.5 KN/m
Floor Load	-2.5 KN/m

5.6 Importance of Analysis

Structural analysis is that the determination of the results of loads on physical structures and their components. Structures subject to the current sort of analysis include all that has got to withstand loads, like buildings, bridges, vehicles, machinery, furniture, attire, soil strata, prostheses and biological tissue. Structural analysis incorporates the fields of applied mechanics, materials science and mathematics to compute a structure's deformations, internal forces, stresses, support reactions, accelerations, and stability. The results of the analysis are accustomed verify a structure's fitness to be used, often saving physical tests. Structural analysis is thus a key a part of the engineering design of structures.

Analysis in any case the above stated steps a structure has got to be analysed. Analysis of a structure means to seek out the reactions and displacements and deflections ϖ at various nodes of a structure. After analysis we are able to see shear moment and deflection for every member.

Figure 5: Analysis/Print



5.7 Design Philosophies

Subsequent design philosophies are evolved for the look of RC structures. By using limit state method.

5.8 Limit State Design

This method is employed in practice within the design of reinforced and pre-stressed concrete structures. During this method, various components of a structure are proportional such the structure doesn't attain the desired limiting conditions during its life time. It shall be satisfy the service ability requirements like limitations on cracking and deflection. The appropriate limit for the security and repair ability requirements before failure occurs is named a limit state. The aim of design is to acceptable probabilities that the structure won't reach a limit state.

5.9 Object on Designs

The object of present study is to analyse and to design typical general hospital apartments. The scope of the concept is limited to

- Analysis of at least on building frame work of the apartment by STAAD.Pro V8i analysis for both gravity loads.
- Design of structural members of the frame work by limit state design concept based on the Indian Standard code - IS 456 (2000).

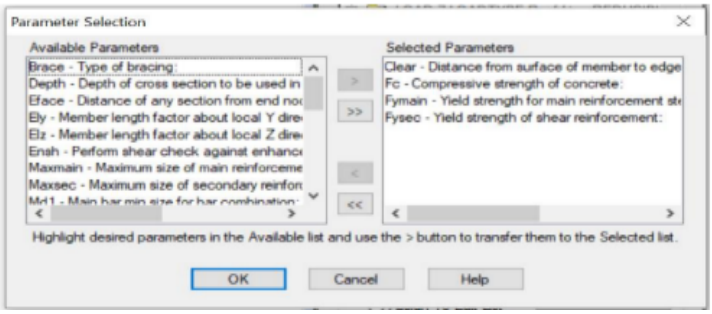
5.10 Selection of Material

There are different types of materials like concrete, steel, timber, aluminium. For our design requirement, we have selected “concrete”.

Define Parameters

Compressive strength of concrete (f_c): 30000 kN/m²
Yield strength of main renforcement steel (f_y): 415000 kN/m²
Yield strength of shear renforcement steel (f_y): 600000 kN/m²
Clear cover for beam: 2.5 cm
Clear cover for column: 4.0 cm

Figure 6: Parameter Selection



5.11 Post-processing

In the post-processing, we can see the reactions, displacements, deflections, shear force and bending moments for various.

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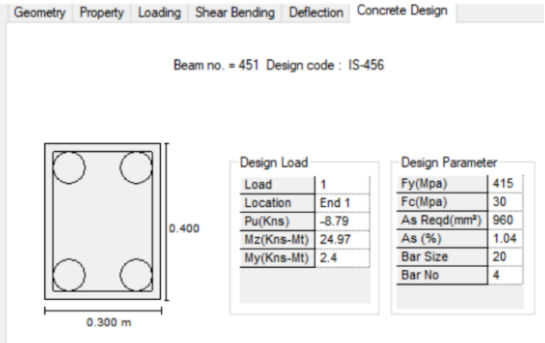
Figure 7: Beam Cross Section

Figure 8: Column Cross Section



6. Results

Figure 9: Bending Moment

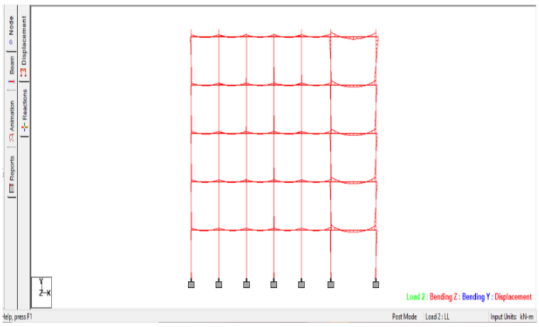


Figure 10: Shear Force

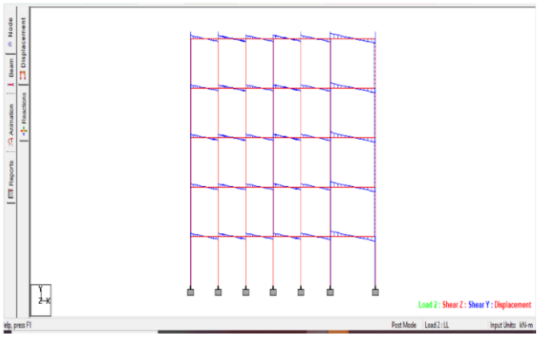


Figure 11: Rendering Views

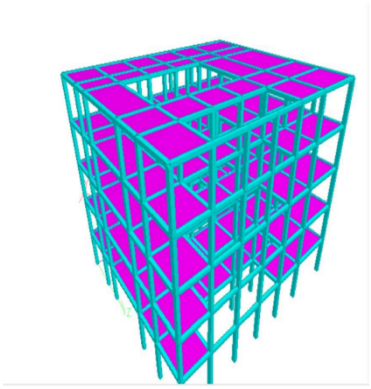


Table 2: Beam Results from STAAD.Pro V8i

Beam Number	Bending Moment at Left Side (in KN/m)	Bending Moment at Middle (in KN/m)	Bending Moment at Right Side (in KN/m)	Shear (in KN/m)
445	3.96	-3.48	5.13	6.40
336	4.39	-3.45	4.77	7.00
227	4.43	-3.53	4.58	6.85
118	4.77	-3.47	4.37	6.78
1	3.18	-4.00	4.88	6.55
523	6.55	-5.358	6.20	8.94

Table 3: Column Results from STAAD.Pro V8i

Column Number	Bending Moment at Left Side (in KN/m)	Bending Moment at Right Side (in KN/m)	Shear (KN/m)
451	4.34	5.45	-2.44
342	-3.46	3.42	-1.72
233	-3.22	3.47	-1.67
124	-3.09	3.17	-1.56
7	-1.09	2.22	-0.82

7. Modeling in Revit

Modeling

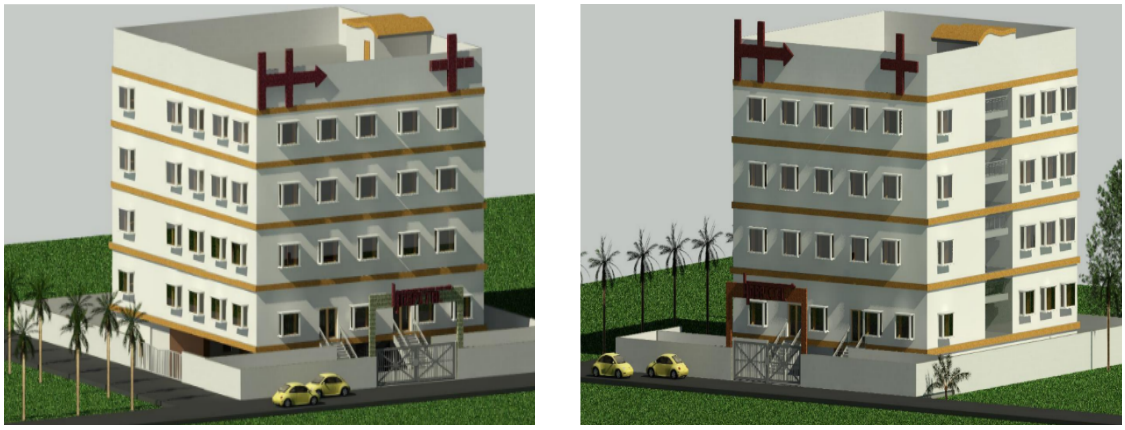
Revit work environment allows users to govern whole buildings or assemblies in the project environment or individual 3D shapes. Modeling tools will be used with pre-made solid objects or imported geometric models.

7.1 Creating Structural Components

Structural components describe the structural system of a building project. The utilization of a number of these elements, like walls, floors, roof, stairs, and then on has been discussed within the earlier chapters.

Structural walls used for foundation, retaining, or as shear walls structural columns structural components for vertical support structural beams and braces components providing connecting ties structural foundations components providing support to the superstructure of the building.

Figure 12: Exterior View



Conclusion

I made a sincere effort to present the structural design of a multi-storey building (G+4).the design method adopted is limit state method. The price of construction of shear wall structure is more compared to border shear wall. Analysis of the building is completed by using STAAD.Pro. After doing several iterations of research and style we concluded the size of the beams and columns to attain the economy. The results of STAAD.Pro are within acceptable limits. The number of steel required to be used for construction in step with STAAD.Pro is lesser than that of manual results. Hence, we will say that STAAD.Pro is giving economical results. Additionally, to dead and live loads, seismic load need to be considered.

Advantages of using Revit Software

- Parametric components
- Landscape design
- Huge library
- No repetition

Advantages of using STAAD.Pro V8i Software

- Extremely flexible 2D/3D modeling environment
- Covers all aspects of structural engineering
- Broad spectra of design codes
- International coding
- Interoperability and open architecture

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