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PLANNING, ANALYSIS AND DESIGN OF (G+20) MULTI-STOREY RESIDENTIAL BUILDING USING STAAD.PRO

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ABSTRACT

Due to growing population and less availability of land, multi-storey buildings are constructed which can serve many people in limited area. The main objective of this project is to analyse and design a (G+20) multi-storeyed building using STAAD.Pro. The project aims to give proper awareness to right designing and detailing of the building. First of all, the planning is done using AutoCAD. The design involves load calculations manually and the structure is analysed using STAAD.Pro. The code refers for this project are NBC, IS 456-2000, SP16.The concrete mix used in this project is M30.The steel strength for all members are of grade Fe415. For analysing the structure, the loads are very important which are calculated using IS 875. The LIMIT STATE METHOD of design has been adopted. Manual design is a difficult process and consumes more time. Our project purpose is to give a complete experience in the field of design and to gain the knowledge in a practical way.

Key words: STAAD.Pro, Multi-storey building, Concrete mix, Steel strength, Limit state method.

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.

2. A BRIEF DESCRIPTION OF SOFTWARE USED

The software's used in this project are,

- Auto CAD
- STAAD.Pro

2.1 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.

2.2 STAAD.PRO

STAAD.Pro is a user-friendly software which is used for analysing and designing of structure by the structural engineers. STAAD Pro provides a lot of precise and correct results than manual techniques. It's the foremost computer code for 3D model generation and multi-material design. The software is fully compatible with all windows operating system but is optimized for windows XP. STAAD.Pro software is used for static or dynamic analysis for structures such as bridges, low rise or high-rise buildings, stadiums, steel structures, etc. First step in STAAD.Pro is to specify the geometry of the structure and then the properties of the members are mentioned. Then the supports are generated and loadings are specified on the structure. Finally, the structure is analysed.

3. LITERATURE REVIEW

Sreeshna K.S (2016) this paper deals with structural analysis and design of B+G+4 storied apartment building. The work was completed in three stages. The first stage was modelling and analysis of building and the second stage was to design the structural elements and the final was to detail the structural elements. In this project STAAD.Pro software is used for analysing the building. The IS:875 (Part 1) and (Part 2) were referred for dead load and live load. Design of structural elements like beam, column, slab, staircase, shear wall, retaining wall, pile foundation is done according to IS Codes.
Aman et al., (2016) has discussed that the aim of the structural engineer is to design a safe structure. Then the structure is subjected to various types of loading. Mostly the loads applied on the structure are considered as static. Finite part analysis that exhibit the result of dynamic load like wind result, earthquake result, etc. The work is conducted using STAAD.Pro software.
Madhurivassavai et al., (2016) he says that the one of the major problem country facing is the growing population. Because of the less availability of land, multi-storey building can be constructed to serve many people in limited area. Efficient modelling is performed using STAAD.Pro and AutoCAD. Manual calculations for high rise buildings are tedious and time consuming. STAAD.Pro provides us a quick, efficient and correct platform for analysing and coming up with structures.

4. TYPES OF LOADS USED

The loads which are considered for analysis are,

- Dead loads
- Live loads
- Wind loads

4.1 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).

4.2 LIVE LOAD

Imposed load is created by the meant use or occupancy of a building together with the load of movable partitions, distributed and concentrated loads, load due to impact and vibration and dust loads. Live loads are specified in IS 875 (Part 2).

4.3 WIND LOAD

These loads rely on the rate of the wind at the situation of the structure, permeableness of the structure, height of the structure etc. They will be horizontal or inclined forces. Wind loads are specified in IS 875 (Part 3).

4.4 LOAD COMBINATIONS

The different combinations used in the project are,

- 1.5 (DL + LL)
- 1.2 (DL + LL + WL_X)
- 1.2 (DL + LL + WL_Z)
- 1.2 (DL + LL - WL_X)
- 1.2 (DL + LL – WL_Z)
- 1.5 (DL + WL_X)
- 1.5 (DL + WL_Z)
- 1.5 (DL - WL_X)
- 1.5 (DL - WL_Z)
- 1 (DL + LL)
- 1 (DL + LL + WL_X)
- 1 (DL + LL + WL_Z)
- 1 (DL + LL - WL_X)
- 1 (DL + LL - WL_Z)

DL - Dead load

LL – Live load

WL – Wind load

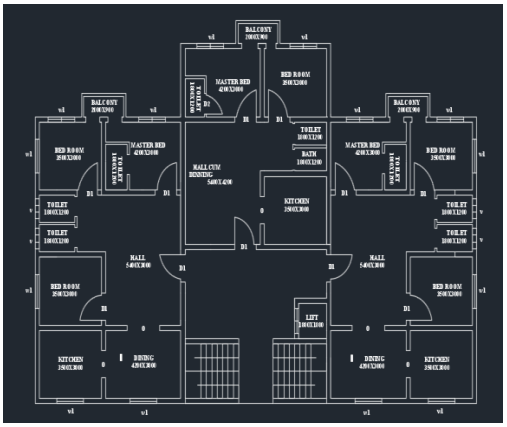

Fig no 1: Floor plan

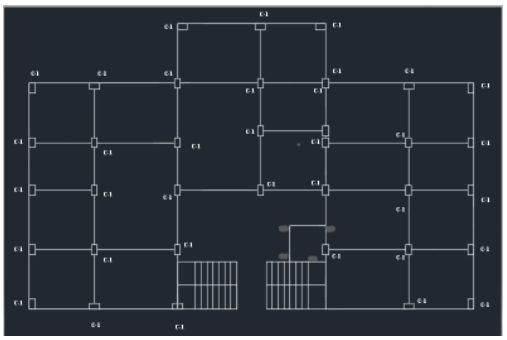

Fig no 2: Location of Columns

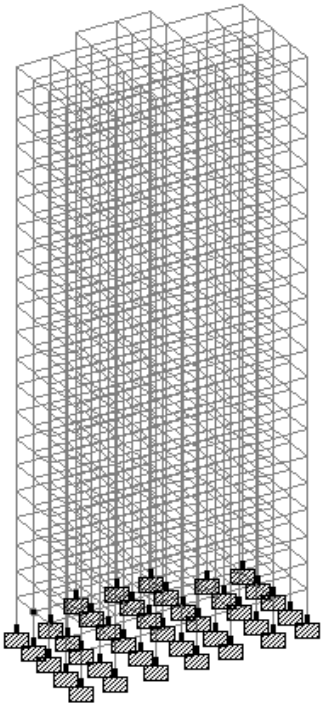

Fig no 3: 3-D View of the model

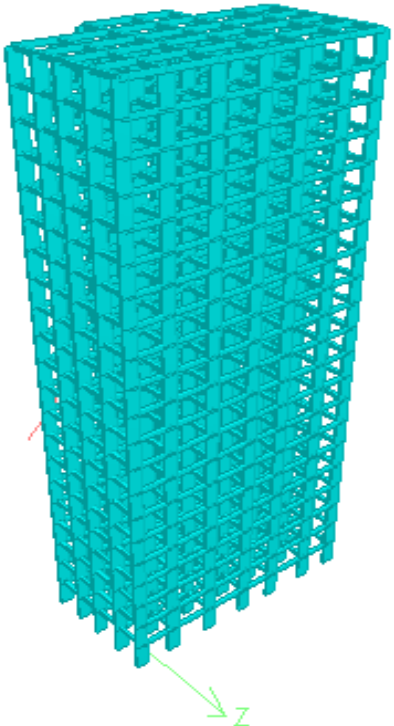

Fig no 4: 3-D Rendered view of the model

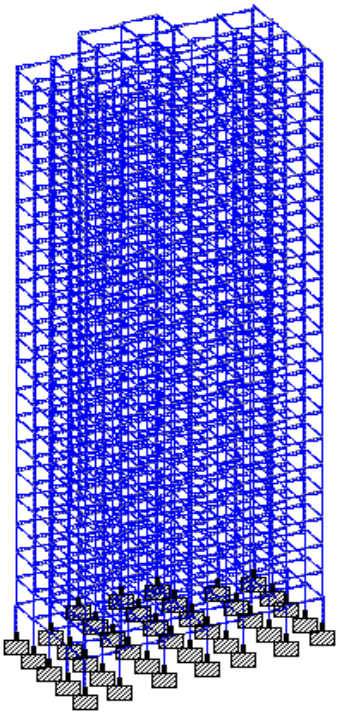

Fig no 5: Shear force diagram

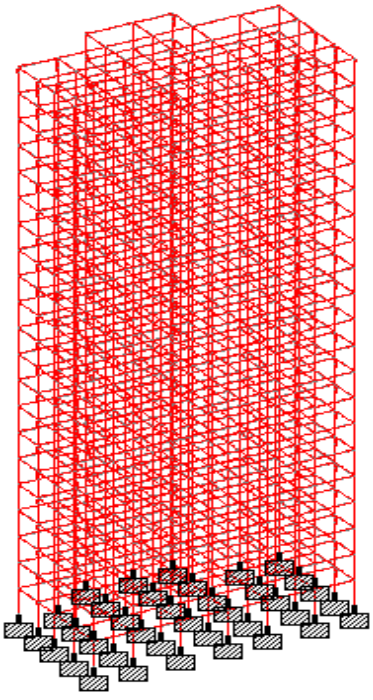

Fig no 6: Bending moment diagram

5. Structural design:

5.1 Design of Slab:

Size of room (Living) = 3.23 x 3.73m
Lx = 3.23m, Ly = 3.73m
Aspect ratio: Ly/Lx = 3.73/3.23 = 1.15
This ratio is less than 2. The slab is to be designed as slab spanning in two directions.
Depth of slab = 170mm
Shorter span:
Positive moment at mid span = 9.06kNm
Negative moment at support = 11.57kNm
Longer span:
Positive moment at mid span = 5.06kNm
Negative moment at support = 6.80kNm
Results:
Shorter span:
Mid span - use 10mmφ RTS @ 300mm c/c
Support - use 10mmφ RTS @ 250mm c/c
Longer span:
Mid span - use 10mmφ RTS @ 300mm c/c
Support - use 10mmφ RTS @ 300mm c/c

5.2 Design of beam:

From the STAAD Pro Analysis done we obtain the maximum positive moment, maximum negative moment and maximum shear force
Negative moment = 58.7 kNm
Positive moment = 214.94 kNm
Maximum shear force Vu =210.52 kN
Width of Beam = 300 mm
Over all depth of Beam = 500 mm
Thickness of slab, Df = 150 mm
Length of the Beam, L = 3705 mm
Results:
Provide 2 nos of bars #16 at the top face at support of span section.
Provide 2 nos of bars #32 at the Bottom tension face at centre of span section.
Provide 8mm bars @ 2 legged vertical stirrups at 120 mm c/c

5.3 Design of column:

From the STAAD Pro Analysis done we obtain the maximum positive moment, maximum negative moment and maximum shear force
Factored load Pu = 5717.52 kN
Factored Moment Muz = 123.94 kN.m
Factored Moment Muy = 569.76 kN.m
Columns were designed as bi-axially loaded
Results:
Breadth of column = 300mm
Depth of column = 1200mm
Main reinforcement:
Provide 16nos. of 32mm bars
Lateral reinforcement:
Provide 8mm # 200mm c/c as lateral ties.

6. CONCLUSION

Planning, analysis and design of G+20 multi-storey residential building was done. It's a G+20 storied building with parking in the basement and the rest of the floors are occupied with apartments. All the structural components were designed manually and detailed using AutoCAD. The analysis and design were done according to standard specifications using STAAD.Pro for static and dynamic loads. The dimensions of structural members are specified and the loads such as dead load, live load and wind load are applied. Deflection and shear tests are checked for beams, columns and slabs. The tests proved to be safe. Both theoretical and practical work has been done. Hence, I conclude that we can gain more knowledge in practical work when compared to theoretical work.

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- IS 875-Part 2 (Live load)
- IS 875-Part 3 (Wind load)