PLANNING, ANALYSIS, AND DESIGN OF G+3 SHOPPING MALL USING "STAAD-PRO V8I" SOFTWARE

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ABSTRACT

Design is the art and science of creating economical, usable, and sustainable structures. This work is usually based on the planning and analysis of building materials. The entire planning and design process requires ideas, in-depth knowledge, conceptual analysis, and design planning of the G+ 3-story shopping mall using the IS Code system. STADD Pro V8i software has completed all analysis and Design. All drawings and details are made using Auto CAD, a basis for transferring the Design for analysis and Design to STAAD Pro. In this project, the Design of the slab, beam, column, stairs, etc., is calculated using the "limit state method" using IS 456-2000 code book. Various working loads on elements are considered as per IS 875-1987 (Part 1, Part 2, Part 3). Hence, the mall is properly organized per the National Building Code of India.

Keywords: Planning, Analyze, Design, Shopping mall, STAAD PRO

I.　INTRODUCTION

Our project is to analyze and design the (G+3) Shopping mall using advanced design software, "STAAD Pro v8i". We have chosen STAAD Pro for the following advantages:

• Easy-to-use interface,

• Compliance with the Indian Standard Codes,

• Various ways to solve any problem

• Accuracy of the solution.

STAAD Pro has advanced tools, modeling tools, and a robust analysis and design engine with high-resolution and dynamic analysis capabilities. From model generation, analysis, and design to visualization and verification of results, STAAD Pro is the professional choice for the design of steel, concrete, wood, aluminium, and cold steel, ground and roof risers, culverts, petrochemical plants, tunnels, bridges water, piers, and many others.STAAD Analysis and Design Engine is a general-purpose calculator for structural analysis and design of steel, concrete, wood, and aluminum. In the early days of our work, we talked about getting a house. The structural analysis includes all the physical and mathematical laws necessary to study and predict the behavior of structures. Structural analysis can be viewed clearly as a method to guide the engineering design process or to demonstrate the quality of a design without directly testing it.A structural engineer must determine information such as structural loads, geometry, support conditions, and properties to perform an accurate analysis. The results of such research often include supportive, stressful, and dismissive reactions. This information is compared to criteria that indicate failure conditions. Advanced structural analysis can assess dynamic responses, stability, and non-existent behavior. The design aims to achieve an acceptable probability that the designed structure will perform well during its expected life.

A.　Facilities Available in the shopping mall:

The mall has various facilities such as emergency exits, air vents, valet parking, and stores for clothes, bags, shoes, jewelry, kitchen appliances, and home decor. One can find playgrounds, restaurants, entertainment, department stores, theaters, exchange offices, etc.Amenities such as elevators, stairs, stairs, and toilets are provided on all floors. The proposed mall has essential facilities such as a 24-hour CCTV security system, proper drinking water facilities, telecommunications facilities, electrical facilities, the nearest railway station, and underground drainage.

II.   LITERATURE REVIEW

Brunner and Mason (1968): In this study, the driving time required to reach a shopping mall is highly influential in determining consumer shopping center preferences.

Huff (1964 and 1966): In this study, the comparative size of the centers and the convenience of access were the primary characteristics that consumers sought when choosing a shopping center to visit.

Cox and Cooke (1970): determined the preferences of customers for shopping malls and the importance of driving time. The authors concluded that location and attractiveness are essential determinants of consumer preferences for shopping malls.

Aman, Nalwadgi M, Vishal T, and Gajendra: - **Analysis and design of multi-story buildings in Gulbarga city, Karnataka, India.** The course includes the design of columns, beams, footings, and slabs through the popular civil engineering software STAAD-Pro

Ashok.s and Abijith. K (3, March 2019): Planning, Analyzing, and Designing of Shopping Complex By Using STAAD Pro. Our study concluded that software application in the Civil industry plays an essential role in our study. In our study, Shopping Complex was designed by adopting the limit state method to analyze and design the structure. The time taken for doing this project is much less due to the software application. We bring extra accuracy in the dimension and analysis part through our project. Our study concluded that the software application in the field of civil engineering is very good and comprehensive for further studies in the planning process.

Sonia Longjam1, S. Aravindan: As traffic congestion reaches critical levels in many places, shopping at malls' convenience is disappearing. Many shopping centers are only accessible by one way, the car, which in many urban areas puts them at a disadvantage when walking or connecting with public transport—providing an urban environment. While it may be true that many shoppers will drive all the time, their busy lives reduce the amount of time they are willing to shop.

Kang and Kim (1999) also researched three shopping malls in San Diego, Cleveland, and Atlanta to investigate the effect of "entertainment as a motivation for shopping." Their survey asked shopping mall customers to weigh in.

III.   METHODOLOGY

- Import center line (dxf) drawing file to STAAD Pro V8i:

  The first step in the project is to import the center line drawing file in dxf format to STAAD Pro V8i. This can be done by opening a new STAAD Pro session and selecting the "File" menu. From there, select "Import" and choose the dxf file from the directory.

- Draw beams and columns between the corresponding node points using the Add Beam command:

  After importing the drawing, the next step is to model the beams and columns between the corresponding node points using the "Add Beam" command. This can be done by selecting the "Add Beam" command from the toolbar, and then selecting the node points where the beams and columns are to be added.

- Create a 3D view of the structure by using the Transitional Repeat command:

  Once the beams and columns have been added, the 3D view of the structure can be created using the "Transitional Repeat" command. This command allows the user to repeat the structure in a pattern to create the 3D view.

- Assign dead, live and wind loads to the members of the structure:

  After the 3D view has been created, the next step is to assign the loads to the members of the structure. This can be done by selecting the member and then using the "Assign" command to specify the load.

- Create load combinations as per IS875 Part 1,2 & 3:

  Once the loads have been assigned to the members, the load combinations need to be created as per IS875 Part 1,2 & 3. This is done to ensure that the structure can withstand the maximum loads.

- Analyze the structure and check for any errors or warnings:

After creating the load combinations, the structure needs to be analyzed to check for any errors or warnings. This can be done by selecting the "Analyze" command from the toolbar and then selecting the load combinations to analyze.

- Perform concrete design as per IS456-2000:

Finally, the concrete design needs to be performed as per IS456-2000. This is done to ensure that the structure is designed to withstand the maximum loads and is safe for use.

- End:

Once the concrete design has been performed, the project is complete. The final design can be saved and printed for future reference.

IV.   BUILDING DETAILS

Table 1. Basic Data of the Building

Building type	Commercial
Location	Thanjavur
Type of structure	Multi storey Rcc framed structure
No. of storey	4 (G+3)
Floor to floor height	3.0m
External walls	230 mm including plaster
Internal walls	115 mm including plaster
Total Plot area	6500m^2
Total Plinth area	4250m^2
Grade of concrete	M25
Design concept	Limit State Method

V.   PLAN OF THE BUILDING

The architectural plan for the G+3 shopping mall was to use Autocad's 2D drafting tools to create a floor plan for each level of the mall. This involved drawing the outlines of walls, doors, windows, and other features of the building. Autocad's precise measurement tools were used to ensure that each element was accurately sized and positioned
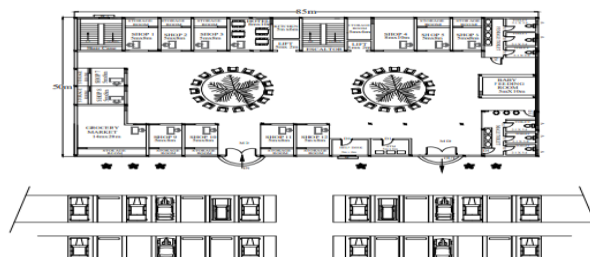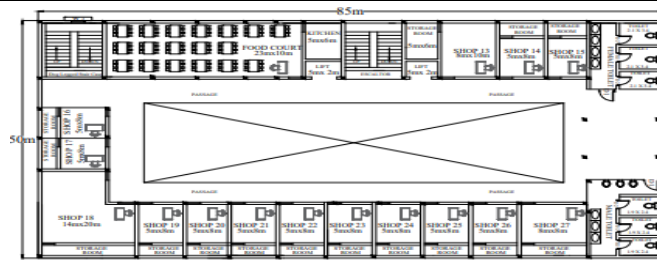

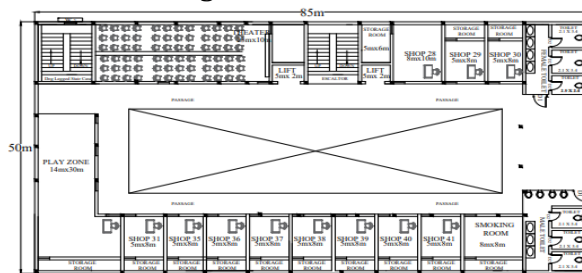**Figure 2:**   Ground Floor

Figure 3:   First Floor

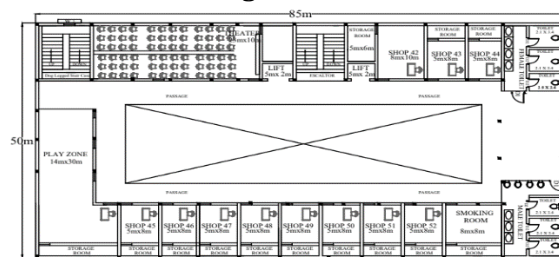
Figure 4:   Second Floor

Figure 5:   Third Floor

VI.   TYPES OF LOADS USED

The loads which are considered for analysis are,

A. Dead Load:

- The dead load will be calculated on the basis of the same size that will be designed keeping in mind specific construction materials.

- Alternatively, the dead load can be calculated based on the weight ratio of the material given in IS 875 (part 1). Unless concrete is recommended, the exact size of ordinary concrete and reinforced concrete.

- It can be done with sand and gravel or a collection of ordinary broken stones such as 24 kN / m3 and 25 kN / m3.

- All permanent construction in the building is considered dead loads. The dead load comprises of self-weight of the building, the weight of the wall, partition walls, beams, columns, balconies, footing, the weight of slabs, floor finish, and permanent materials placed on the building.

- The unit weights of various materials used in the building construction are given in the code IS 875 (Part – 1) – 1987.

Self-weight– The self-weight of the structure can be generated by Staad.Pro itself, which automatically calculates using the material's properties, i.e., density, an after assignment of dead load, the skeletal structure looks red, as shown in the figure.
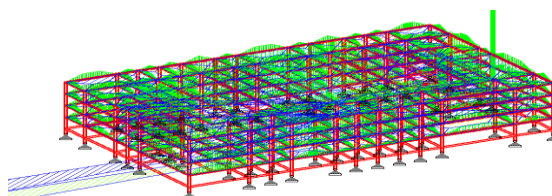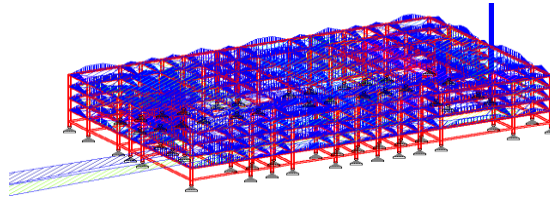

Figure 6:   Self–weight of the Structure

Figure 7: Other dead loads in the structure

Wall load

200 mm thick wall

Wall load = Wall thickness X Height X Density

= 0.200 X 3.5 X 19.2

= 13.44 ≈ 13.45 kN/m

Wall load is shown below the figure in blue colour

Parapet wall load

100 mm thick wall

Wall load = Wall thickness X Height X Density

= 0.100 X 1 X 19.2

= 1.92 ≈ 2 kN/m

The wall load is shown below the figure in blue color.

Floor load

150 mm thick R.C. slab

Slab load = Slab thickness X Unit weight of reinforced concrete

= 0.150 X 25

= 3.75 kN/m2

Assume 40 mm thick floor finishing

Floor finishing load = Floor thickness X Unit weight of plain concrete

= 0.040 X 24

= 0.96 kN/m2

Assume 12 mm thick plastering

Plaster load = Plaster thickness X Unit weight of mortar = 0.012 X 22

= 0.26 kN/m2

Total floor load = 150 mm thick R.C. slab + floor finishing load + plaster load

= 3.75 + 0.96 + 0.26

= 4.97 kN/m2

B.   Live Load:

The loads that keep changing from time to time are called imposed loads (live loads). Common examples of such loads in a building are:

- The weight of the person.
- The weight of the movable partition.
- Dust loads.
- Weight of furniture.

These loads were formerly known as live loads. These loads are to be suitable for the designer. It is one of the significant loads major loads in the design. The minimum values to be assumed are given in IS 875 (Part - 2) – 1987. It depends upon the intended use of the building. These values are presented per square meter of the floor area. In a particular building, the imposed load may be assumed as 2 kN/m2.
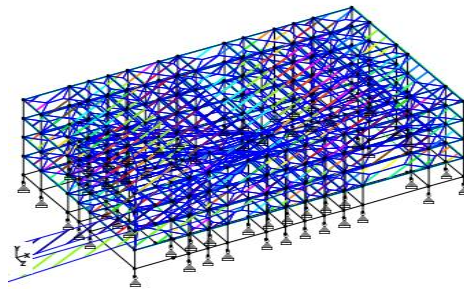
Figure 8: Live Load of the structure

C. Wind Load:

The wind pressure on the roof depends mainly on its speed, the shape and structure of the building, the wind protection provided by the environment or artificial structures, and, to a lesser extent, on the ventilation, which reduces it. Height and temperature. Everything else remains the same; the air velocity is proportional to the square of the velocity. The strength of the vertical part of the wind must be considered in the design of the building. It depends on the wind speed and the shape and size of the house. A detailed description of the calculation of wind loads and design as per IS 875 (Part – 3) – 1987.The basic wind speed (Vb) for any site shall be obtained IS: 875 (Part – 3) and shall be modified to get the design wind velocity at any height (Vz) for a chosen structure.

$Vz = Vb k_1 k_2 k_3$

Where,

Vz = design wind speed at any height z in m/s,

Vb = basic wind speed in m/s.

k_1 = probability factor (risk coefficient)'

k_2 = coefficient based on the terrain, height, and structure size.

k_3 = topography factor. In the basic wind speed map of India, up to a height of 30 m, the wind pressure is considered to act uniformly. Above 30 m height the wind pressure increase. The design wind pressure increases. The design wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind velocity.

$Pz = 0.6 Vz^2$

Pz = wind pressure in N/m2 at height z,

And Vz = design wind speed in m/s

For many decades, the cladding systems of highrise buildings, particularly around corners buildings have been scrutinized for the effects of wind on building enclosure. Glass and curtain wall systems are regularly developed and tested to resist cladding pressures and suctioned induced by the postulated wind event.
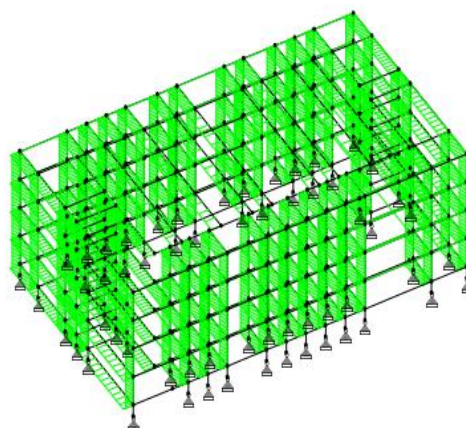
Figure 9: Wind Load of the Structure in X axis
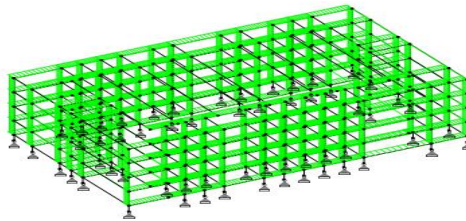
Figure 10:   Wind Load of the Structure in Z axis

D. Load Combinations:

A combination of loads is necessary to provide the safety and economy required in the design, taking into account the possibility of -

- Their common behavior,

- Their arrangement of other loads and the severity of stress or deformation caused by various loading combinations were used in this project.

- Design load is the load to be used in the proper design process; it is the characteristics load in case of working stress method and characteristics load with appropriate partial safety factors for limit state design.

- The structure should be analyzed for load combinations considering all the previous loads in proper ratio. This combination is generated by the automatic combination integrated in staad.pro for different load combinations as per IS code.

VII.   ANALYSIS AND DESIGN OF THE BUILDING

- Moments and forces due to design loads in continuous slabs can be obtained from the method given and section 3 for solid slabs.

- On the other hand, the slabs may be designed as a series of supported spans provided they are not exposed to weather or corrosive conditions; a large crack may develop in support, and the engineer must ensure that these elements do not entirely alter or cause damage to the support.

- Representation of beams and columns. We draw from the beam and columns between corresponding nodes using the command to add a beam.

- We use the translational repeat command to create a 3D view of the building. In this, take the global

  direction Y. after that, the number of steps was entered, which was 16.

- After this, set the default step spacing to 3.5 m which is the floor height of our building.

- When creating the structure and the core of the structure is exactly as the fixed support property is

  assigned.

- The material has been defined, and the cross-section of the column and beam has been assigned.

- After assigning the property of the 3D rendering view of the structure can be shown in the 3D rendered view.

- Based on the building classification and exposure categories, wind loads are defined as per IS 875 (Part – 3). Then select the structure type, which is building structure. Then assign wind load. Then loads are added in load case details in +X, -X, +Z, -Z D direction.

- Dead loads are calculated as per IS 875 (Part – 1) for external walls, internal walls, parapet walls, floor load, and including self-weight of structure. Then assign dead load. i. Live loads are assigned for every floor as 2 kN/m2 based on IS 875 (Part – 2).

- Adding a load combination. After assigning all the loads, the load combinations are given with suitable safety factors as per IS: 875 (Part – 5).

- Finally, concrete design is performed as per IS: 456 – 2000 by defining suitable design commands for different structural components. After the assignment for column and beam design commands.

- After the completion of all the above steps we have to Perform Analysis then Run Analysis and checked for Errors and Design results.

```
++ Creating Reaction File (REA)...              22:59:40
++ Calculating Section Forces1-110.             22:59:40
++ Calculating Section Forces2.                 22:59:40
++ Calculating Section Forces3                  22:59:40
++ Creating Section Force File (BMD)...          22:59:41
++ Creating Section Displace File (SCN)...       22:59:42
++ Creating Element Stress File (EST)...         22:59:42
++ Creating Element JT Stress File (EJT)...      22:59:42
++ Creating Element JT Force File (ECF)...       22:59:42
++ Creating Design information File (DGN)...     22:59:42
++ Done.                                         22:59:42

0 Error(s), 54 Warning(s), 2 Note(s)
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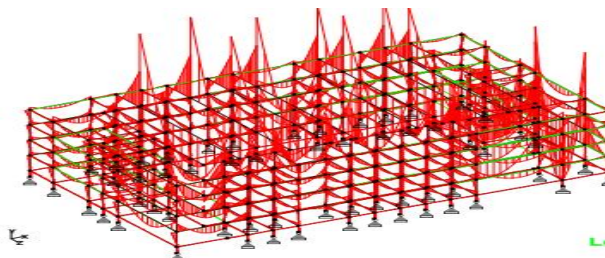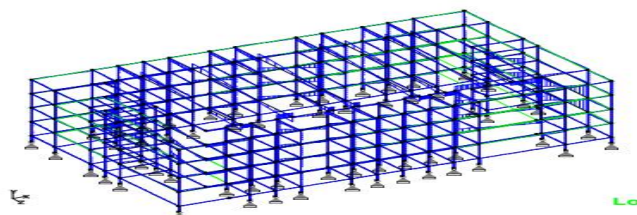
Figure 11: Analysis using Staad. Pro

VIII.   STAAD PRO OUTPUT
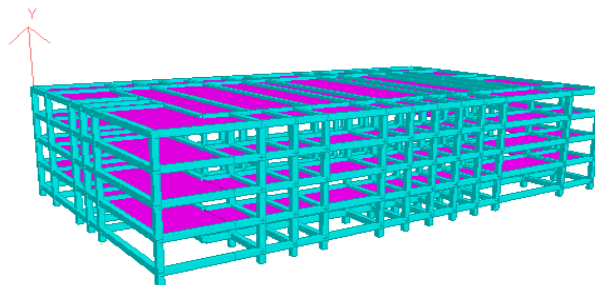
Figure 12: 3D Rendering Model of the Building

Figure 13: Bending Moment on Member

Figure 14: Shear force on Member

IX.   CONCLUSION

Designing a commercial building using software like Staad.Pro cuts a lot of time and design work.Individual details can be obtained using Staad Pro. All the List of failed beams can be obtained, and the software also gives better sections.Precision is improved using the software.

X.   REFERENCES

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