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Planning and Designing of a Multiplex Movie Theatre

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Abstract - *In engineering, all types of constructions are made with proper planning and design. The purpose of this project work is to achieve exposure to practical engineering fields. Through this exposure, we would better understand engineering practice in general and a sense of frequent and possible problems. In this project, analysis and design of Multiplex movie theater building have been dealt with keeping in view the stability of the structure. The project involves analysis of Multiplex movie theatre using STAAD.Pro and the structure is designed manually. The plan of all the floors was drawn in the AUTO CAD 2016, the analysis and design of the reinforced concrete structure were done in the leading innovative software STAAD.Pro. The analysis part such as deformed shape, bending moment diagram, shear force diagram is obtained using STAAD.Pro. In addition to the above, manual design and detailing is done for beams, slabs, columns, and footings. Indian standard codes IS 800: 2007, IS 456: 2000, IS 875: 1987- Part II, IS 875: 1987- Part III are referred. From the results, critical sections of the structure were found out.*

***Key Words*: slab, beam, analysis, design, shear force, bending moment, AutoCAD, Staad Pro.**

1.INTRODUCTION

Multiplex movie theaters are spaces designed to accommodate large audiences. They have a wide span and multiple stories in order to accommodate seating, sighting, and acoustical requirements Movie theatres serve extremely good facilities for the people who need entertainment in their leisure time.

Structural elements such as beam, column, slab, footings, and staircases were designed. The roofing for the theatre is steel truss covered using Asbestos cement sheets. In this work, the limit state method is used for designing the structure. The design has been done adhering to the Indian Standard codes- IS 456:2000 for concrete structure design and IS 800:2007 for the design of truss. It is decided to provide 1 building consisting of all the facilities, decided to plan, model, analyze, and design.

The aim of the structural design is that the structure should be safe, durable, serviceable, and economical with respect to initial cost and maintenance cost. During analysis, dead loads, live loads, and wind loads were calculated by referring to IS 875:1987 (part1), (part 2), and (part3) and their combinations were applied. The load combinations were taken so as to obtain the maximum design loads, moments, and shear. The design is carried as per IS 456:2000 for the above load combinations. The building was designed for dead loads as per IS 875(Part I)-1987, imposed loads as per IS 875(Part II)-1987, wind load as per IS 875(Part III)-1987. The entire building is analyzed as a 3D system using STAAD.pro.

Statement of project

Utility of building: Movie Theatre

No of stories: G+1

Shape of the building: Rectangular

No of stairs: 1

Type of construction: R.C.C framed structure

Concrete grade: M25

All steel grades: Fe415 grade

Plan area: 2480.32m^2

Seating requirements: 568 persons

Height of building: 12.09 m

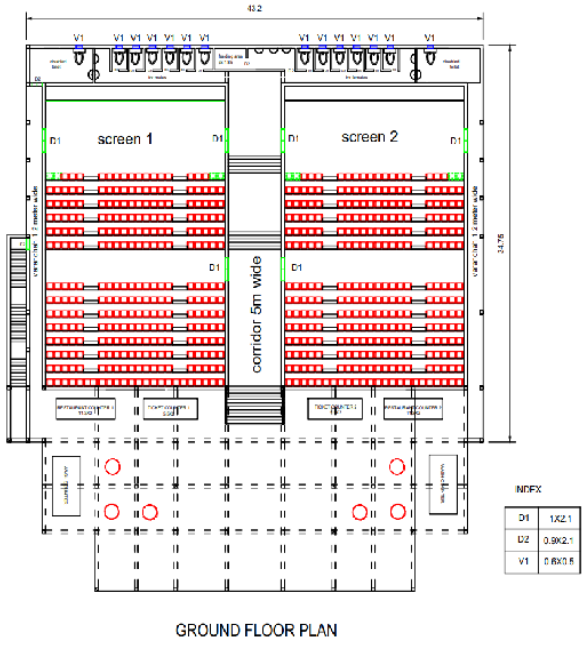

Fig 1 : Ground floor plan

Fig 2: First floor plan

2. OBJECTIVES OF THE PROJECT

- To draw the plan of the theatre building based on Kerala building rules.
- To understand the basic principles of the structure using IS codes.
- To understand the design parameters of the beams, slab, columns, staircase, and other structural entities.
- To analyze the structural details of the structure using STAAD.pro.
- To prepare the project report based on the analysis and design of the structure.

3. TYPES OF LOADS

The various loads considered for analysis were: -

3.1 Dead Loads

Assuming the dimensions of cross-section self-weight of the structure are estimated. As per IS 875:19879(Part-1), the unit weight of materials is chosen.

3.2 Live Loads

As per IS 875:1987(Part-II) imposed loads including all loads exempting dead loads of structure taken as live load.

4. LOAD COMBINATIONS

Commercial buildings will have comparatively higher values of the imposed loads than those of the residential buildings. Hence, the load combination mentioned as per IS 456:2000 and IS 1893(Part-1):2016 are considered in the design of the structures.

The different combinations used were:

1. 1.5 DL

2. 1.5 LL

3.1.5 (DL+LL)

Analysis results from the critical load combinations are used for the design of the structural members

Note:

DL - dead load, LL - live load.

5. SOFTWARES USED

Softwares used in the project for planning and analysis are:

1.AutoCAD 2013

2.STAAD Pro (V8i)

5.1 AutoCAD 2013

Autodesk Inc. Sausalito, California initially developed it in the early 1980s. It is a computer-aided drafting software application for 2D and 3D design and drafting, developed and sold by Autodesk. Inc. AutoCAD is the most flexible drafting program available to all fields. AutoCAD has been used in the drawing plan as well as reinforcement details of the structural elements.

5.2 STAAD Pro (V8i)

STAAD. Pro is a structural engineering tool used extensively by civil engineers. It is utilized for analyzing and designing practically all types of structures. It has features such as user interface, visualization tools, powerful analysis, and design engines with advanced finite element and dynamic analysis capabilities. It is applicable to form model generation, analysis, and design to visualization and result verification.

6. MODELLING AND ANALYSIS

Modelling and analysis is done in STAAD.Pro

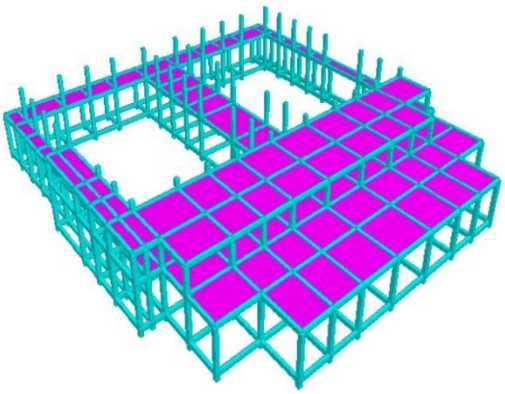

Fig 3: 3D Rendered View of the model

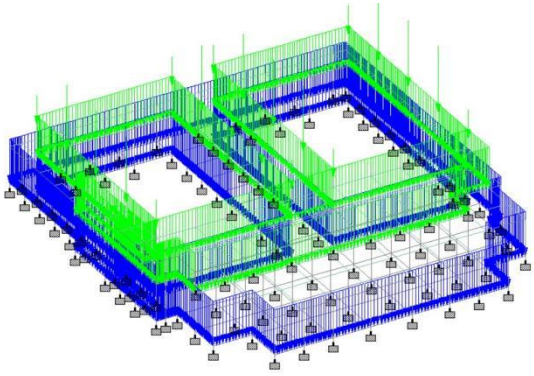

Fig 4: Loading Diagram

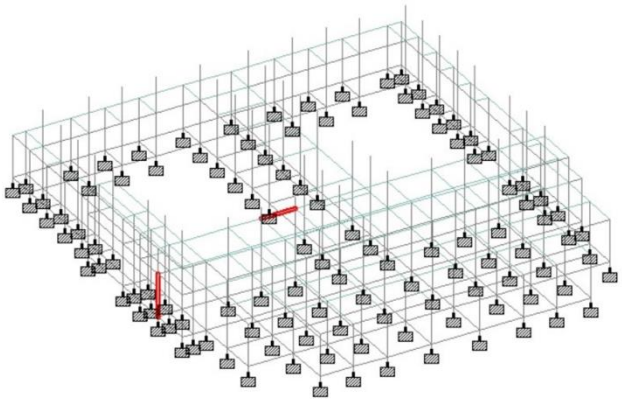

Fig 5: Designed Beam and Column

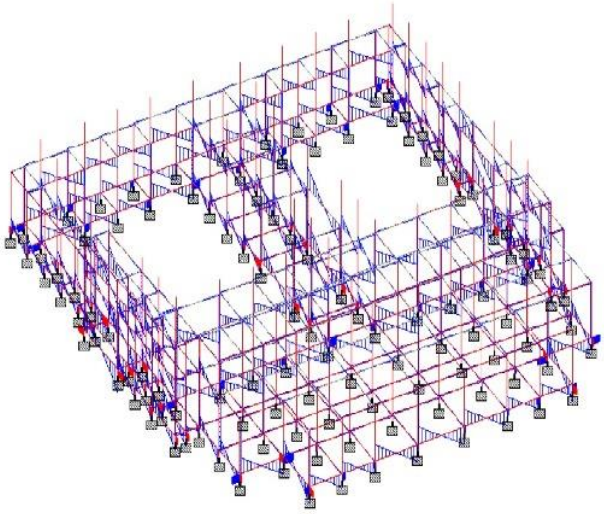

Fig 6: Shear Force Diagram

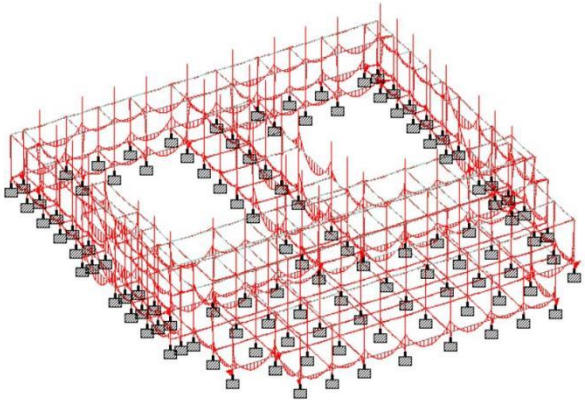

Fig 7: Bending Moment Diagram

7. STRUCTURAL DESIGN

7.1 Design of staircase

The staircase is provided as an equivalent slab. The thickness of the slab used for the staircase is 230 mm. M25 grade concrete and HYSD steel bars of grade Fe415 are used. Type of stair: Straight stair with waist slab, tread and rise.

Rise = 150 mm

Tread = 300 mm

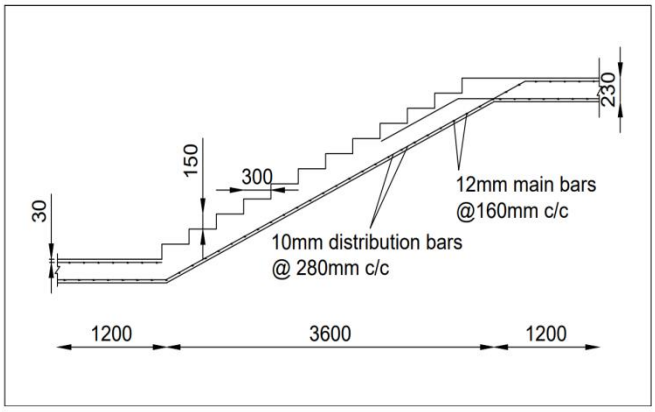

Fig 8: Reinforcement Details of Stair

7.2 Design of Column

Columns of size 350 × 350 mm are used in the structure. M25 concrete and Fe415 steel are adopted for design. The bending moment and axial forces from analysis results are used for the design.

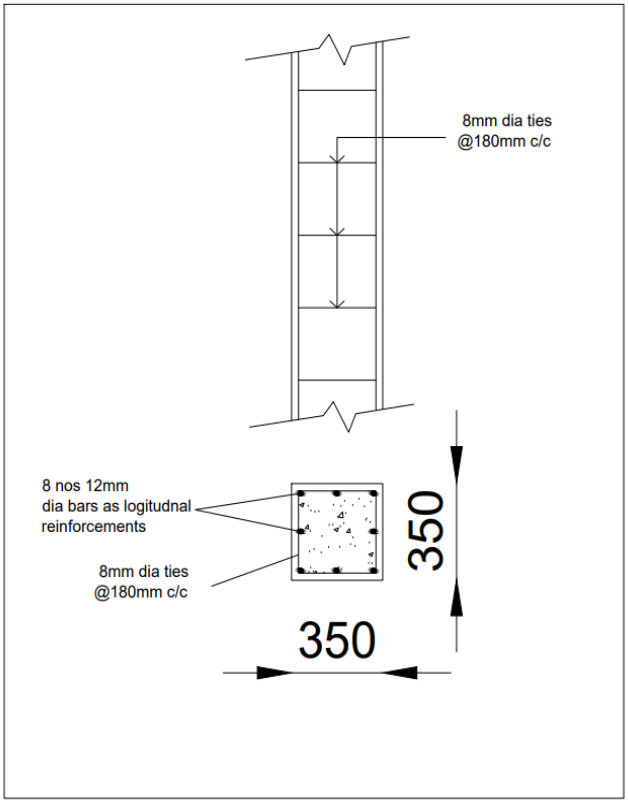

Fig 9: Reinforcement Details of Column

Results from STAAD.Pro: -

Factored Axial load, P_u = 300.38 kN

Factored moment in x-direction, M_{ux} = 1.326 kNm

Factored moment in y-direction, M_{uy} = 10.137 kNm

7.3 Design of Beam

Beams of 300×300 mm are used. M25 concrete and Fe 415 steel are adopted for beam design. The bending moments and shear force from the analysis results are used for the design.

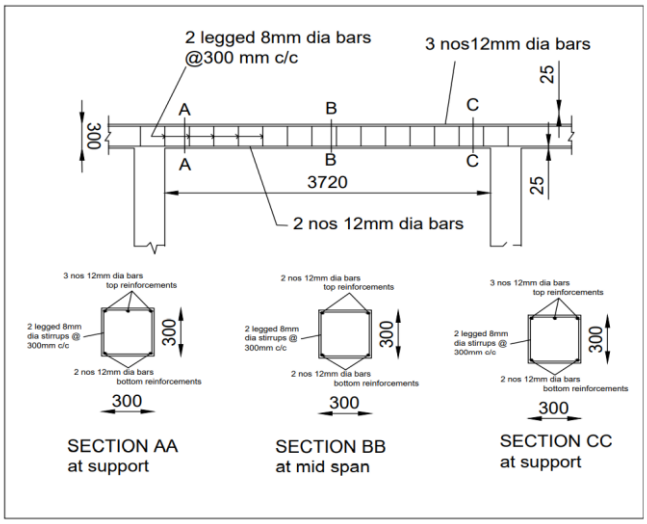

Fig 10: Reinforcement Details of Beam

Ultimate Moment obtained = 28.31 kNm

Shear Force Obtained = 31.865 kN

7.4 Design of Slab

M25 grade concrete and HYSD steel bars of grade Fe 415 are used. Size of the panel is 5 x 4.3 m.
Thickness of slab is 150 mm

Longer Span L_y = 5m
Shorter Span L_x = 4.3m
Ly/Lx = 5/4.3
= 1.16 < 2
Therefore, it is a two-way slab

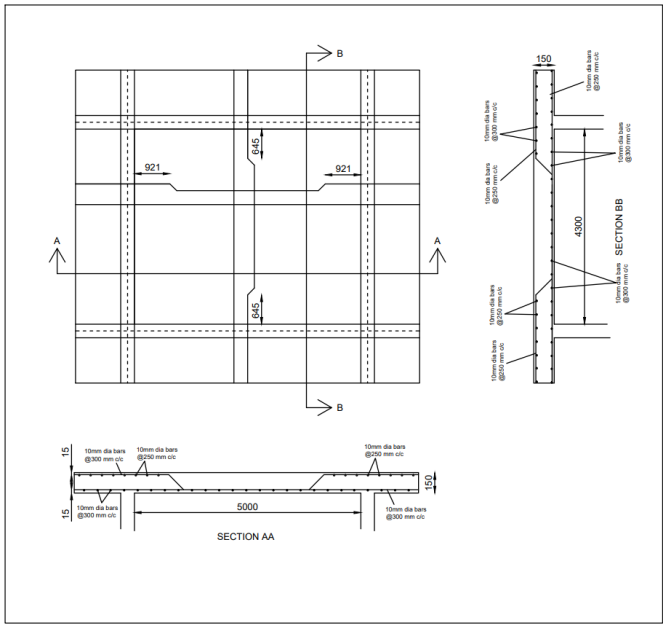

Fig 11: Reinforcement Details of Slab

7.4 Design of Footing

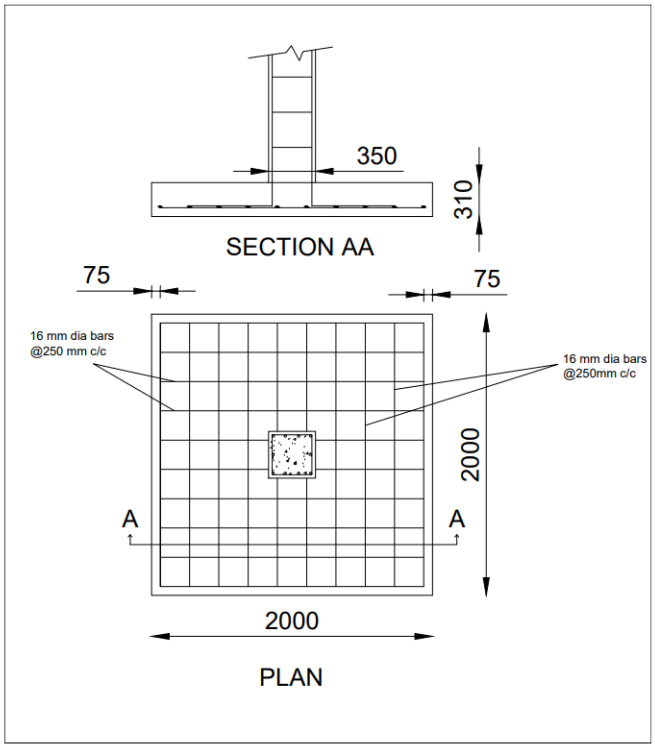

Fig 12: Reinforcement Details of Footing

Isolated footing of size 2 x 2 m is provided. M25 grade concrete and HYSD bars of grade Fe 415 are used. Safe bearing capacity of soil is assumed as 100 kN/m^2

8. CONCLUSION

The RC structure was modeled and analyzed using the software STAAD.Pro. All the structural components were designed manually and detailed using AutoCAD software. The manual design was adopted as STAAD takes values on the safer side than manual work. The project helped us to gain ample exposure to various field practices in the analysis and design of the multi-storied building. Various constraints faced by the structural engineer during design and architectural drawing were revealed.

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