WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

PLANNING, ANALYSIS AND DESIGN OF A G+3 SUPER-SPECIALITY HOSPITAL

Mrs. Anbarasi K[1], Dhanush J[2], Dhivyanathan A[3], Selvam S[4]

[1]Department of Civil Engineering, Kongunadu College of Engineering and Technology (Autonomous), Tholurpatti, Trichy, Tamil Nadu, India

ABSTRACT

In this paper, the architectural planning, analysis and design process for the structural system of a proposed G+3 super-speciality hospital having a cruciform plan form is outlined. The plan consists of a central block interconnected to four wings and gives a total built-up area of approximately 50,000 ft² (4,645.15 m²) at the ground floor level. The functional program consists of emergency services, outpatient facility, diagnostic and scanning facility, critical care, operation theatres, inpatient wards, VIP facilities and other services. Architectural planning process is done using AutoCAD software while the analysis and design of three dimensional space frame reinforced-concrete structure is done using STAAD.Pro 2026 Academic software. The revised design basis of the project specifies use of M35 concrete for all reinforced concrete members, Fe500 for main reinforcement and Fe415 for secondary reinforcement. The model records available are in the form of sample beam and column designs, floor elevations, seismic observations, and global displacements. However, there are few model records that show analysis command warning along with obsolete design entries for M30 and M40 designs. Therefore, the reported numerical results are taken as model observations and not final compliance proof.

Keywords: Hospital planning; Building G+3; cruciform plan; reinforced concrete; M35 concrete; STAAD.Pro; structural analysis; Indian Standards

1. INTRODUCTION

Hospital buildings have to be designed with coordination in both architecture and structure since different departments have different demands regarding access, circulation, services and safety. The emergency and diagnostic departments require easy access while the inpatient, critical care and specialty departments have demand for controlled circulation. Structural design should consider an effective load path and sufficient strength, stiffness and serviceability.

This study involves G+3 super-specialty hospital with a cross-shaped plan which comprises a central core and four connecting wings. AutoCAD will be used for architectural and structural drawings while STAAD.Pro software will be used to analyze 3D reinforced concrete frame modeling. This project involves slabs, beams, columns, staircases and isolated foundations.

2. AIM, OBJECTIVES AND SCOPE

Objectives: Develop a realistic plan of hospital departments in terms of zoning and circulation; plan and design the structure for G+3 floor building by following the below mentioned steps:

- Design zoning and circulation of hospital departments.
- Plan and design the structure for the central block as well as four-wing cruciform plan.
- Develop three-dimensional model of reinforced concrete space frame using STAAD.Pro software.
- Understand different loads such as dead, live, wind, and seismic loads, and their combinations.
- Design process and considerations for designing one way, two way slabs, beams, columns, staircases, and isolated footing.
- Understand M35 concrete design process and checks needed before design process.

3. BUILDING CONFIGURATION AND FUNCTIONAL PLANNING

The structure will comprise of one ground floor and three upper floors. The layout plan comprises of five blocks that are interconnected: One central block and four wings. The project report indicates that there will be an area of 50,000 ft² on the ground floor, which is equal to about 4,645.15 m².

Planning zone	Facilities identified in the project
Emergency	Triage, treatment, observation, injection/dressing, fracture/plaster-cast and isolation units
Outpatient department	Consultation and examination rooms, procedure rooms, nursing stations and related facilities
Diagnostics	MRI, CT and digital scanning units
Patient and specialist areas	Inpatient wards, critical-care units, operating theatres and specialised departments
Support and administration	Reception, VIP lounge, laundry, housekeeping, toilets and auxiliary spaces

As per the project brief, it is needed to have access roads for vehicles from both front and back side of the building. The last site plan will be having details about the site boundary, setbacks, entry and exit points, emergency access, parking and service access. Site dimensions, road width and setbacks have not been mentioned in any of the available structural extracts.

4. MATERIALS, STRUCTURAL SYSTEM AND DESIGN BASIS

The structure is regarded as a 3D reinforced-concrete space frame. The proposed load transfer mechanism is slab-beam-column-foundation-soil. The revised basis of design requires that all reinforced-concrete members use M35 grade concrete while Fe500 grade steel will be used for the primary reinforcement and Fe415 grade for the secondary reinforcement.

Parameter	Adopted project basis	Verification requirement
Building configuration	G+3	Confirm final drawings and model storeys
Ground-floor built-up area	50,000 ft² (4,645.15 m²)	Confirm area schedule
Structural system	RCC space frame; cruciform plan	Central block and four wings
Concrete grade	M35 throughout RCC members	Re-run material assignment and member design
Main reinforcement	Fe500	Confirm design commands and detailing
Secondary reinforcement	Fe415	Confirm shear/tie reinforcement definitions
Building height	18.29 m (reported)	Confirm floor levels and section
Floor-to-floor increment	Approximately 4.5725 m	Confirm architectural section

These project references are made to IS 456:2000, IS 875, IS 13920, IS 1893, IS 10905 (Part 2): 1984 and The National Building Code of India 2016. It is advised to cross verify their exact edition, part and applicability from the relevant standard before submission.

5. MODELLING AND LOAD CONSIDERATIONS

The program STAAD.Pro is used to create a three dimensional model from nodes, beams and columns. Properties, supports, floor level and loads are provided before performing the analysis. Project description shows the action due to dead load, live load, wind load and seismic actions acting in the global X and Z direction. Load values, support assumptions, seismic data and load combination should be kept same during manual calculation, drawing and analytical model.

Available output includes STAAD.Pro 2026 Academic, Version 26.00.00.340, with units kN and metres for analysis. Available floor level is at 0.000, 4.57251, 9.14502, 13.7175 and 18.290 meters. Warning message includes “CONSECUTIVE ANALYSIS COMMANDS. ONLY FIRST USED”. Therefore, the command for analysis needs to be altered in order to analyze the model for all load cases, especially for the Z-axis seismic load.

6. STRUCTURAL DESIGN APPROACH

1.1. Slab design

The slabs are categorized into either one-way slabs or two-way slabs according to the ratio of dimensions and the support conditions of the panels. One of the calculations in the project report is concerned with the effective span lengths of 5.76 meters and 12.50 meters as well as the effective slab thickness of 190 mm. The previous calculation was done with M30 concrete and not an approved M35 design.

1.2. Beam design

The beam design has been done on the basis of analysis of bending moment, shear force and serviceability. The output of STAAD.Pro for Beam 4913 having cross-sectional dimensions of 450 mm x 900 mm with a length of 13.82 m, M35 grade concrete, main reinforcement of Fe500, secondary reinforcement of Fe415 and 30 mm cover has been obtained.

1.3. Column design

Column design takes into account both the axial compression and uniaxial or biaxial bending of the column. For instance, in one of the columns, Column 152, the dimension is 400 mm x 900 mm, length is 4,565 mm and cover is 40 mm. The output shows the use of 16 bars of 12 mm diameter, total area of steel provided being 1,809.56 mm² and 8mm ties at 190 mm c/c. Nevertheless, for this column design, the concrete used is M40, which contradicts the project’s new basis, which is M35.

1.4. Footing design

The scope of work for the footing includes checking for the bearing capacity of soil, bending, one way and punching shear. Previous data on this work suggests that there was an assumption made regarding the depth of the footing to be 600mm and the size of the bars 12mm at a distance of 120mm center to center in both directions. These are assumptions only.

1.5. Staircase and ramp

The scope of work for the design of stairs and ramp should include the geometric features, spans, support, dead load, live load, width of the slab, reinforcements and serviceability calculations. Design data for all these aspects is not available from the extracted project documents.

7. RESULTS AND DISCUSSION

The following values have been obtained from the available STAAD.Pro analysis results. These are recorded as model observations and do not prove code compliance on their own.

Reported output	Extracted value	Interpretation / required check
Seismic X time period	0.66332 s	Confirm model mass, stiffness and applicable code method
Seismic Z time period	0.66332 s	Confirm intended Z-direction analysis actually ran
Seismic X base shear	5,104.48 kN	Reported expression: 0.0308 × 165,975.09; verify seismic weight and parameters
Seismic Z base shear	5,104.48 kN	Verify independent Z-direction case
Maximum X displacement, Loading 1	0.344392 cm at Node 2093	Confirm load identity and acceptance criterion
Maximum Y displacement, Loading 3	−0.484850 cm at Node 1776	Confirm sign convention and load identity
Maximum X displacement, Loading 5	−0.473037 cm at Node 882	Confirm wind/load identity and serviceability criterion
Maximum Z displacement, Loading 6	−0.128155 cm at Node 2050	Confirm wind/load identity and serviceability criterion

The displacements indicated above are maximums globally for individual loading conditions and happen at different nodes. These are not inter-storey drift displacements. The storey drift will have to be calculated using the right displacement and compared against code provisions. The complete modal response output containing the natural frequencies and mode shapes cannot be seen in the available extract.

The beam and column reports indicate the presence of member-design output in the model. There is no conclusive evidence regarding the verification of the member design on a common basis of M35. For instance, Column 152 is based on M40 whereas the earlier slab and footing design was based on M30.

8. DISCUSSION OF DESIGN CONSISTENCY AND LIMITATIONS

• All reinforced concrete members are supposed to have the M35 grade of concrete. The numerical solutions for previous entries of M30 and M40 cannot be used for M35 validation until the analysis is redone.

• It is necessary to solve the warning about consecutive analysis command and perform analysis again.

• All storey drift, modal frequencies and mode shapes, member forces and load combination envelopes should be calculated from the corrected model.

• The last site plan has to include the required front and rear roads according to the dimensions approved in the architectural drawings.

• The footings are designed based on geotechnical information and bearing capacity, so the assumed soil characteristics are not enough.

• Member sizes, reinforcement, supports, loads, load combinations, units and design assumptions are to be reconciled in the drawings, manual computations and STAAD.Pro model.

9. CONCLUSION

This study provides the architectural planning and structural design process of the proposed G+3 super-speciality hospital with the layout comprising the central core along with four wings with cruciform plan. It should be noted that the total built-up area of the ground floor is 50,000 ft2 (4,645.15 m2). The functional provisions for the emergency, outpatient, diagnostic, critical care, operation theatre, inpatient, VIP and support services are also specified in this project. AutoCAD is the software used for architectural planning, whereas STAAD.Pro is applied for the three-dimensional structural modeling and analysis.

The new design basis is represented by M35 concrete for all reinforced concrete members, Fe500 for main and Fe415 for secondary reinforcement. At the same time, the records of the previous calculations include the data about M30 and M40 concrete along with the analysis-command warning. As a result, it should be recognized that the obtained member and seismic outputs are the preliminary model results and cannot be treated as the final M35 design verification.

ACKNOWLEDGEMENTS

The authors would like to extend their sincere thanks to the Department of Civil Engineering, Kongunadu College of Engineering and Technology (Autonomous), for having provided the necessary facilities for undertaking the project work.

REFERENCES

[1] Bureau of Indian Standards. IS 456:2000, Plain and Reinforced Concrete – Code of Practice. New Delhi, India. Amendments made are to be verified.

[2] Bureau of Indian Standards. IS 875 (Parts 1-5), Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures. New Delhi, India. Parts and editions used to be confirmed.

[3] Bureau of Indian Standards. IS 1893, Criteria for Earthquake Resistant Design of Structures. New Delhi, India. Part, edition, and amendments to be used are to be confirmed.

[4] Bureau of Indian Standards. IS 13920, Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces. New Delhi, India. Refer to wherever required.

[5] Bureau of Indian Standards. IS 10905 (Part 2):1984, Medical Services in Hospitals. New Delhi, India. Title and current application to be confirmed.

[6] Bureau of Indian Standards. National Building Code of India 2016. New Delhi, India.

[7] Bentley Systems. STAAD.Pro 2026, Structural Analysis and Design Software, Version 26.00.00.340. Documentation/Report to be confirmed.