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STRUCTURAL DESIGN OF HOSPITAL BUILDING (C+G+5) USING STAADPRO

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Abstract: *This report mainly deals with the design of a Multi-storey hospital structure (C+G+5) using STAADPro. This would include the designing of complete R.C.C structure and the results will be compared in the end. The main aim of project is to analyze the plan of hospital building by using software techniques. The design of hospital building is developed with following disciplinary activities. The design is followed up by using IS (Indian standard) codes for better output of design considerations. Here the hospital building is designed and analyzed for C+G+5 storey structure. Nowadays, the software techniques are highly involved in a construction field for quick and better accuracy of an analysis report to execute the given project successfully. The most prominent using software for design and analysis of the respective building is done by STAAD.PRO software for accuracy and safety regards. In this project, STAAD.PRO V8i has been used for designing and analysis purposes mainly for the result of shear force, maximum bending moment, and to efficiently design whether the structure is safe against Structural Displacement. RCC detailing is important for clear in executing the reinforcement work on the site without any complexity The analysis of structures is done by using STAAD.Pro as well as IS 456:2000 Code of practice for plain and reinforced cement concrete. The design of RCC structure is based on limit state method as per IS 456:2000 code.*

I- INTRODUCTION

The hospital building is universally accepted as the most effective intervention to achieve significant improvement in the health states of a population especially in respect of infant, child and maternal care. The Alma ate (international conference definition) declaration of 1978 signed by most nations of the world and health policy document (1983) of the government of India identify health care as a key strategic intervention for providing universal access to health care. Depending upon the size of town or city the type of hospital is decided Hospital and dispensaries come under health buildings. The people are treated for various diseases and also given advice in respect of health. They are also advised how to keep environment clean so as to avoid the slaughter of various diseases. For the purpose of clarification the building for health may be termed as dispensaries, clinics, maternity homes, nursing homes, laboratories, child welfare centers and general hospital. A dispensary used to mean a room where compounded. Now its meaning has been widened. Now dispensary means a place whose medicines are prescribed and given to the patients. It is not necessarily a single room but consists of doctor's room, pharmacy room, dressing room and waiting room. In Maternity homes and nursing homes both of them cares for special treatments. Here the patients are allowed to stay for short duration.

1.1 OBJECTIVES

The main objectives of this project are:

- To develop the conceptual plan, structural plan of a hospital building.
- To analyze and design the hospital building using STAAD.Pro

1.2 General Building Classification

All buildings, whether existing or hereafter erected is classified according to the use or the character of occupancy in one of the following groups (National Building Code: Part 4 Fire and Life Safety, Clause 3.1):

- Group A Residential
- Group B Educational
- Group C Institutional

- Group D Assembly
- Group E Business
- Group F Mercantile
- Group G Industrial
- Group H Storage
- Group J Hazardous

1.3 STRATEGIC ESSENTIALS

The strategic issues that must be considered while planning hospitals are:

- Design for flexibility and expandability: The golden architectural principle of indeterminacy should be followed which enables a "building to grow with order and change with calm". The hospital building should thus, be adaptable to changing requirements and future expansion.
- Emphasize on patient focused hospitals: The plans should be patient centered by offering an atmosphere of safety, security, cleanliness and physical comfort. A hospital should value humans above technology and patients should be encouraged to be a partner in their health management.
- Focus on energy conservation: Energy conservation must be planned and implemented. Utilization of natural light, Use of high efficiency light sources, Effective ventilation, Energy recycling and Regular energy audit which will help in energy conservation.
- Create a healing architecture: A hospital needs to be the most wonderful place in the world. The physical environment of a hospital should do no harm and should facilitate the healing process. Exposure to nature has a positive healing effect.
- Aesthetics- an essential requisite: The hospital design should balance between function and aesthetics. Psychological aesthetics which includes happiness, joy and pleasure, Spiritual aesthetics which suggests hope, contentment and peace and Physical aesthetics which implies well-being, ease and convenience should be considered while planning.
- Design for infection control in hospitals: The scientific design of hospitals plays an important role in infection control. The following aspects should be given due consideration:

II - LITERATURE SURVEY

MVK. Satish et.al (2017) he 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 3Dnon 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 International Journal of Pure and Applied Mathematics Special Issue 4824 it gives better result while comparing building structures.

Dr.Ashokkumar et.al (2017) designed a G+3 hospital building using substitute frame method in STAAD.Pro the efficiency of analyzing using software over manual method was analyzed and a comparative analysis was carried out.

Adiyanto (2008), analyzed a 3-storey hospital building using STAAD Pro. Seismic loads were applied to the building. The dead loads and live loads were taken from BS6399:1997 and seismic loads intensity is based on equivalent static force procedure in UBC1994. Result showed that the building can withstand any intensity of earthquake. It means that the buildings were suitable to be built in any area located near the epicenter of the earthquake.

Sankar. J et.al (2016) designed and developed a G+4 hospital building and analyzed using STAAD.Pro. Effects of seismic load were monitored by calculating base sheer and displacement along the member research findings indicate variation among different zone using a comparative analysis.

Alkesh Bhalerao et.al (2016) studied the effects of wind on different structural orientation of RCC buildings. The study aims at identifying an optimum structural shape of building which could withstand the wind forces under consideration.

The building was a G+25 structure analyzed for structural stability using ETABS software. U-shape structure is not preferred as it gives the maximum displacement and maximum drift due to its geometric shape most susceptible for wind load. Bundled tube symmetric RCC structure is need to analyzed for special provision and improved cladding surface to attain optimized result.

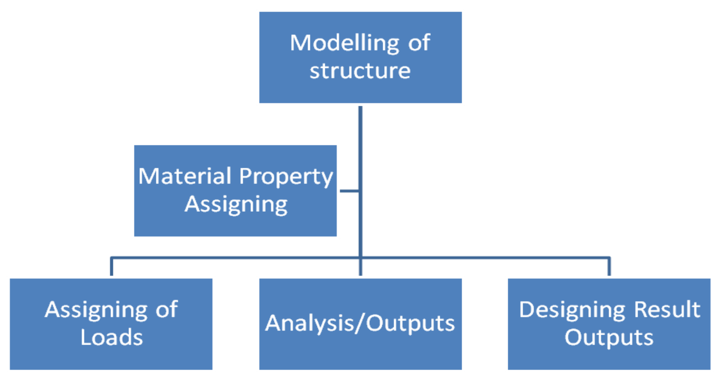
D. Ramya et.al, (2015) compared the design and analysis over a multi-storey G+10 hospital building with STAAD.Pro and ETABS software. The basic wind speed for this study was taken as 33.0 m/s and the shear force and bending moment over each of the component of the building was calculated for different combination of loads. This study shows that STAAD.Pro is more flexible when compared to ETABS software in terms of analysis of structure.

Sreeshna K.S (2016) this paper deals with structural analysis and design of B+G+4 storied hospital building. The work was completed in three stages. The first stage was three dimensional models and scrutiny 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 analyzing 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.

Amar Hugar et al., (2016) has been discussed that the Computer Aided Design of Hospital Building involves scrutiny of building using STAAD.Pro and a physical design of the structure. Traditional way of study shows tedious calculations and such tests is a time-consuming task. Analyses are made quickly by using software's. This project completely deals with scrutiny of the Hospital building using the software STAAD.Pro. Finally, the results are compared with physical calculations. The elements are created as per IS: 456-2000.

Bandipati Anup et al., (2016) this paper deals with evaluate and plan a multi-storeyed building [G + 2 (3- dimensional frame)] adopting STAAD Pro. The technique used in STAAD.Pro is limit state technique. Initially they have created 2-D frames and cross checked with physical calculations. The exact result should be proved. We tested and created a G + 2 storey building [2-D Frame] instantly for all feasible load combinations. The work has been finished with some more multi-storeyed 2-Dimensional and 3-Dimensional frames beneath various load combinations.

III - FLOW CHART FOR THE PROPOSED PROJECT



3.1 METHODOLOGY

A Hospital building frame is a three-dimensional structure or a space structure. It is idealized as a system of interconnected two-dimensional vertical frames along the two mutually perpendicular horizontal axes for analysis. These frames are analyzed independently of each other. In frames where the columns are arranged on a rectangular grid, loading patterns giving biaxial bending need not be considered except for corner columns.

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The degree of sophistication to which a structural analysis is carried out depends on the importance of the structure. A wide range of approaches have been used for buildings of varying heights and importance, from simple. Approximate methods which can be carried out manually, or with the aid of a pocket calculator, to more refined techniques involving computer solutions. Till a few years ago most of the multistory buildings were analyzed by approximate methods such as substitute frame, moment distribution, portal and cantilever methods.

IV - DESIGN PARAMETERS

4.1 Staad pro Inputs

Concrete Grade = M25
Clear Cover = 25mm
Fc = 20mpa
Fy main = 500mpa
Fy Section/ Stirrups = 500mpa
Density of Concrete = 24 Kn/m^3

Loading Considerations for elements

Consider Finishes of 75mm with 20 Kn/m^3 Density of concrete

Brick wall/Partition walls Moderate Grade = 20 Kn/m^3

Live Load = 2.0Kn/m^2 & 2.50Kn/m^2 for Hospital Building

6.2 Properties of elements

a). Beam Sizes

300 mm × 400 mm C+G.F to 2nd Floor
250 mm × 350 mm 3rd to 4th Floor
225 mm × 300 mm Roof

b).Column Sizes

250 mm × 400 mm C+G.F to 1st Floor
230 mm × 400 mm 2nd to 4th Floor
230 mm × 350 mm Roof

c). Slabs Thickness

Floors C to G.F = 180mm
Floors 2nd to 4th Slab = 150mm
Roof Slab = 125mm

d). Wall Thickness

Partition wall = 115mm
Outer Main wall = 230mm
Parapet wall = 75mm thick / Height= 1.2m

V - ANALYSIS OF STRUCTURE

5.1 Modelling of structure

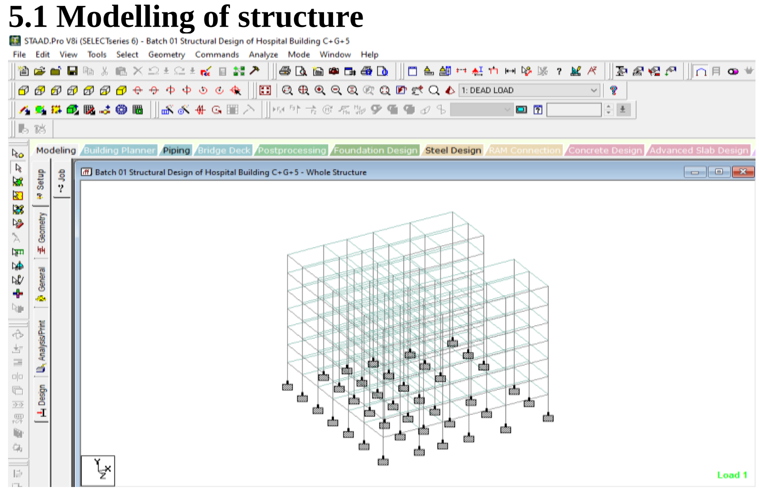

Fig 1 shows the geometry of the structure.

5.2 Assigning of Loads

- Dead Load
- Live Load
- Floor Finishes
- Brick Wall Load
- Inner Partition Wall Loads
- Roof Loads

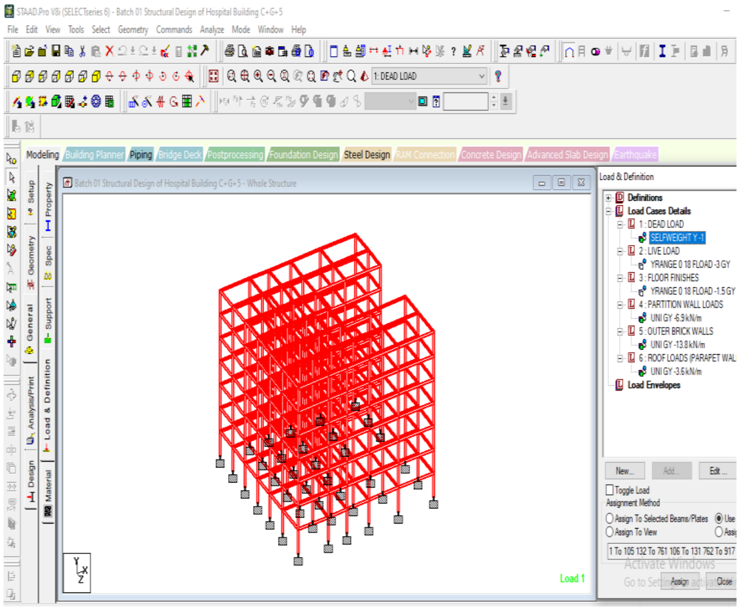

Fig. 1 computed self weight assigned

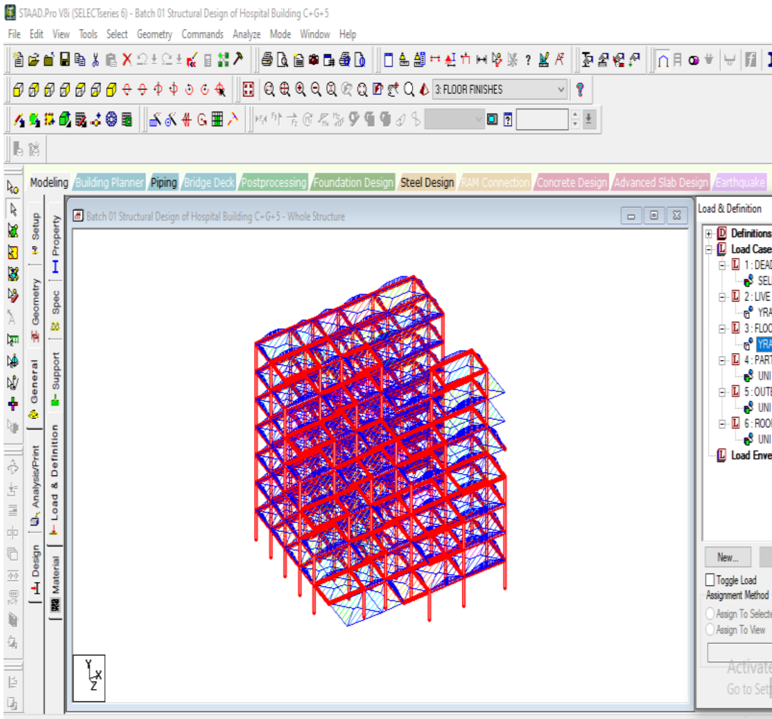

Fig.3 computed Floor Finishes Load assigned

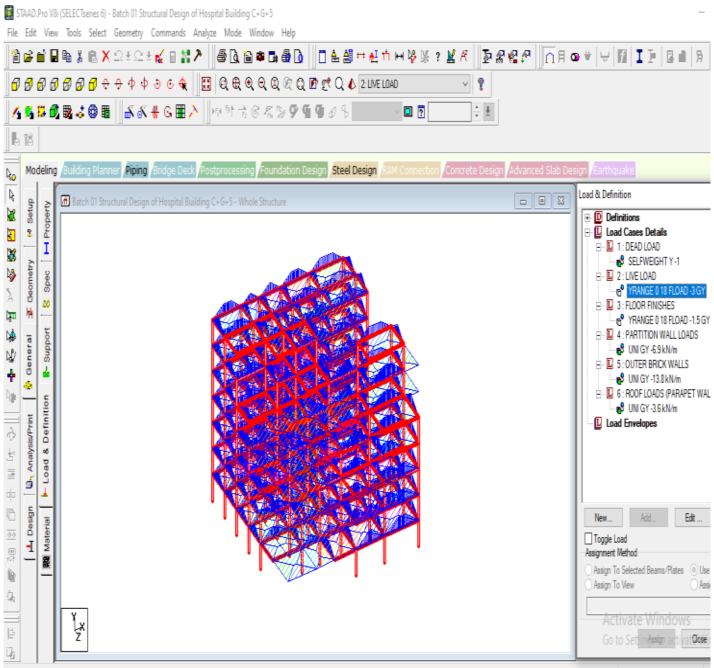

Fig.2 computed Live Load assigned

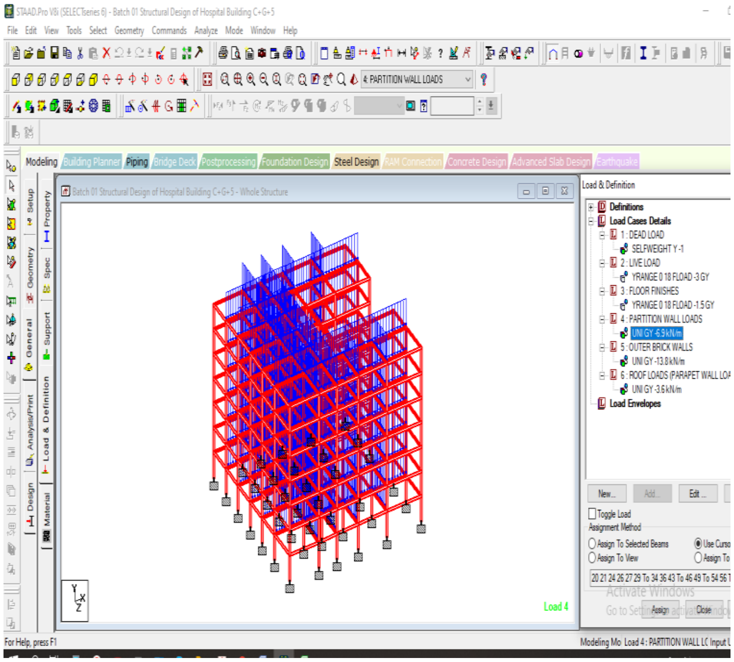

Fig.4 computed internal wall Load assigned

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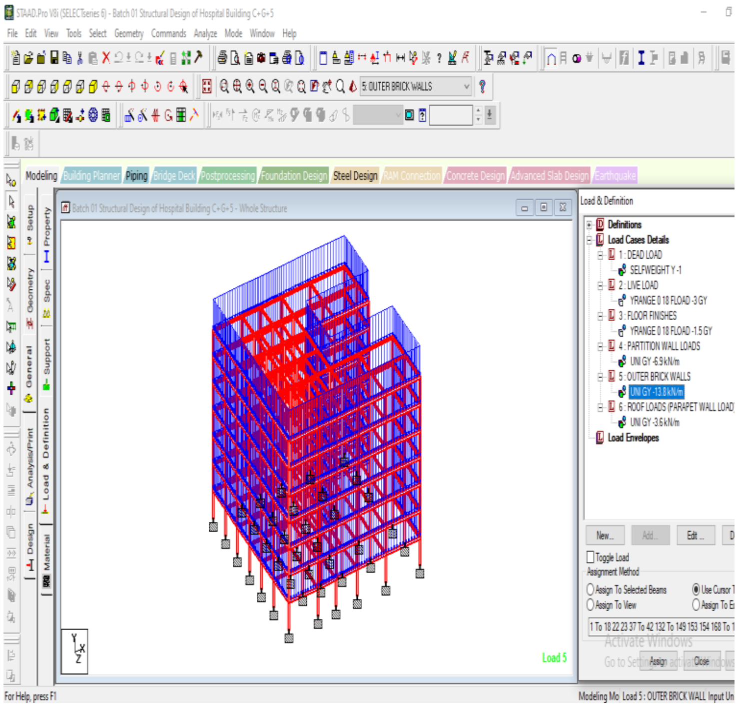


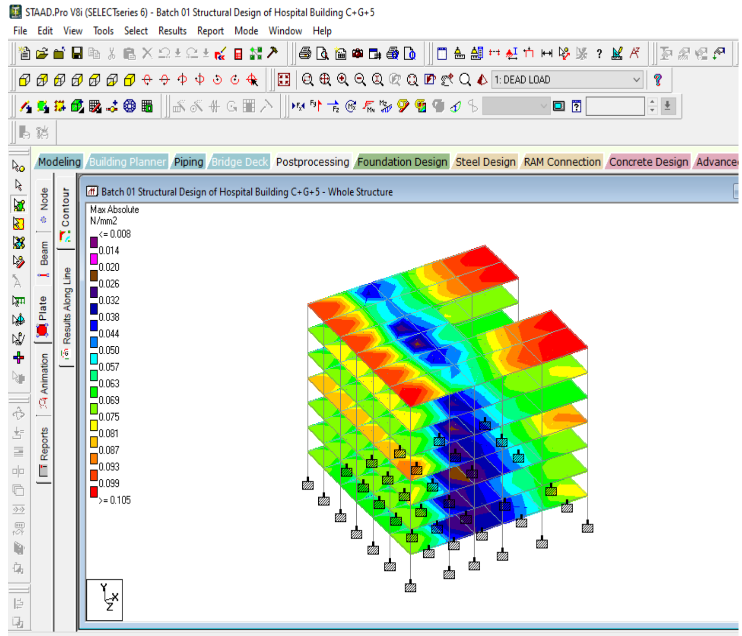


Fig.5 computed outer wall Load assigned

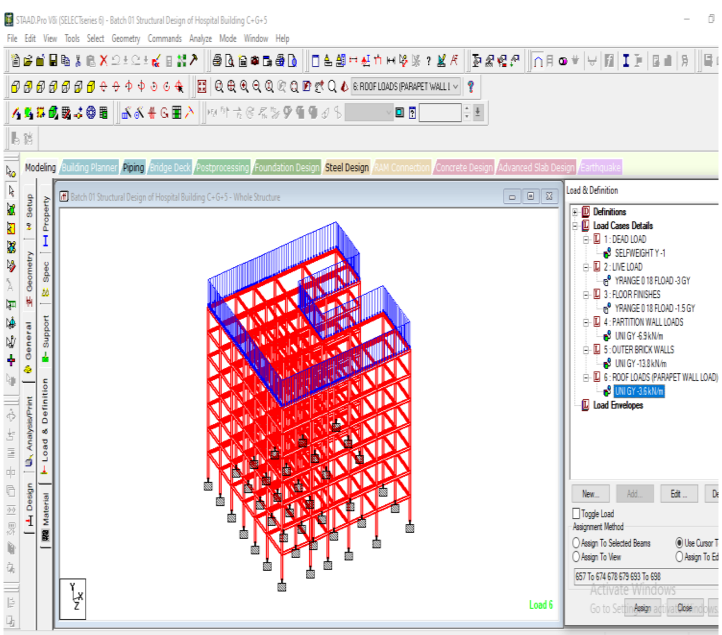
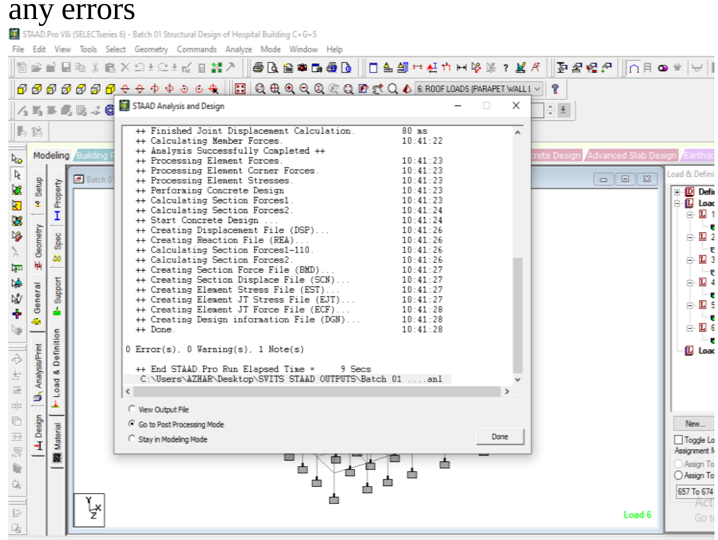


Fig.6 computed Parapet wall Load assigned

VI - STAAD PRO RESULTS

The analysis done from considering all the above parameters state that the structure is safe without any errors



6.1 COMPUTED MAX STRESSES ON EACH STOREY OF THE STRUCTURE

Fig 7 Analysis without Error output

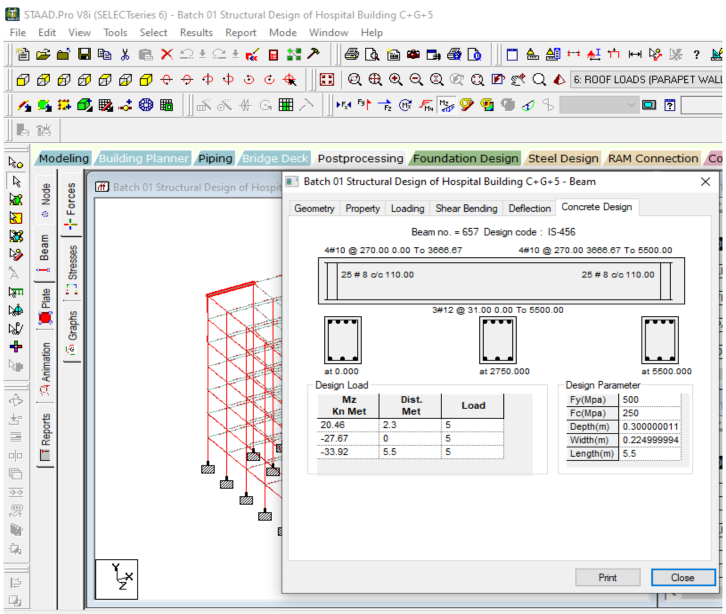


Fig 8 showing concrete design of the element

6.2 Bending Moments Output

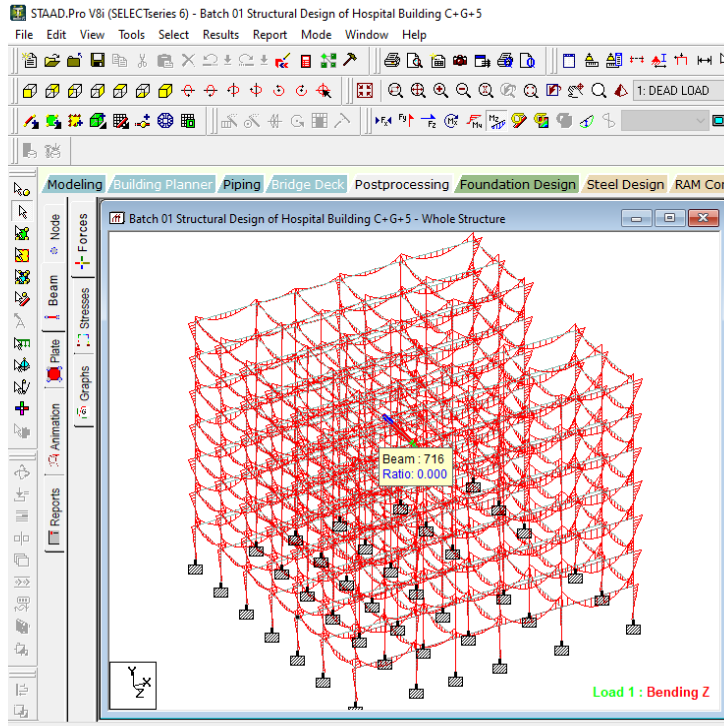


Fig 9 showing bending moment diagram of the structure

6.3 Shear Forces Output

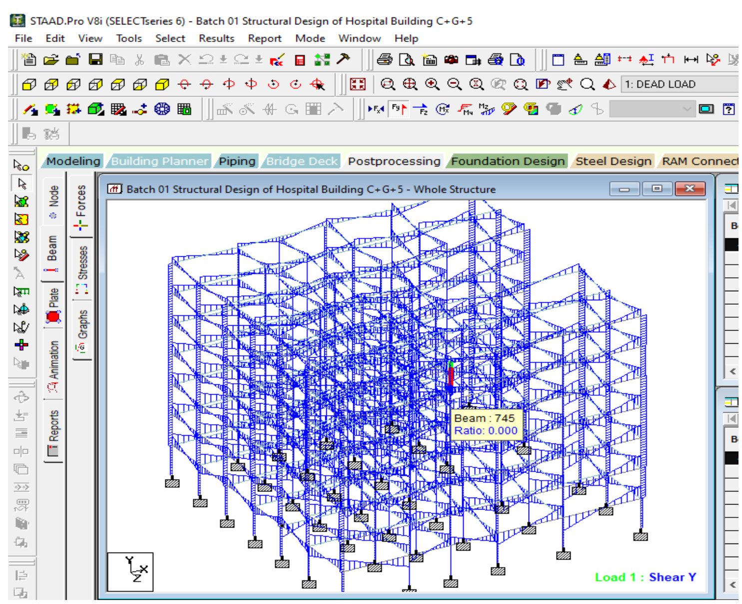


Fig 10 showing Shear Force diagram of the structure

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6.4 Displacements Outputs

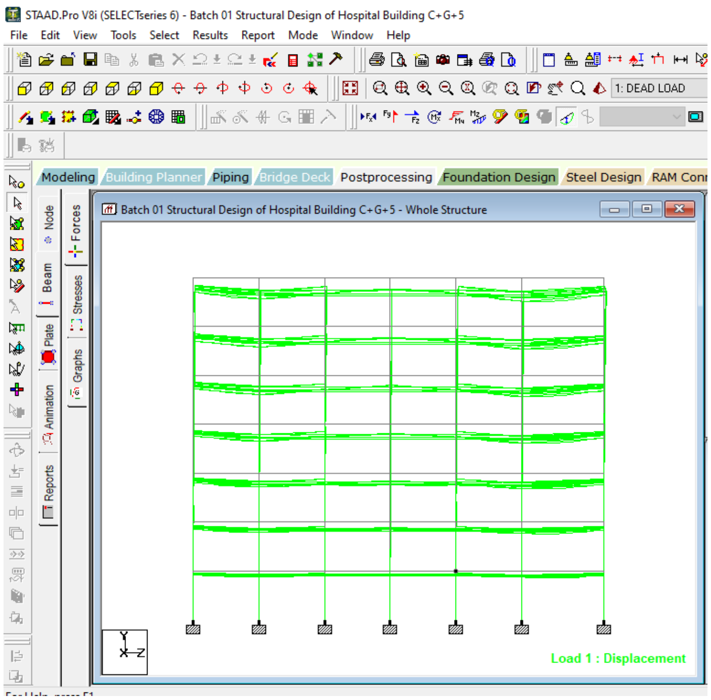

Fig 11 showing Displacements of the structure

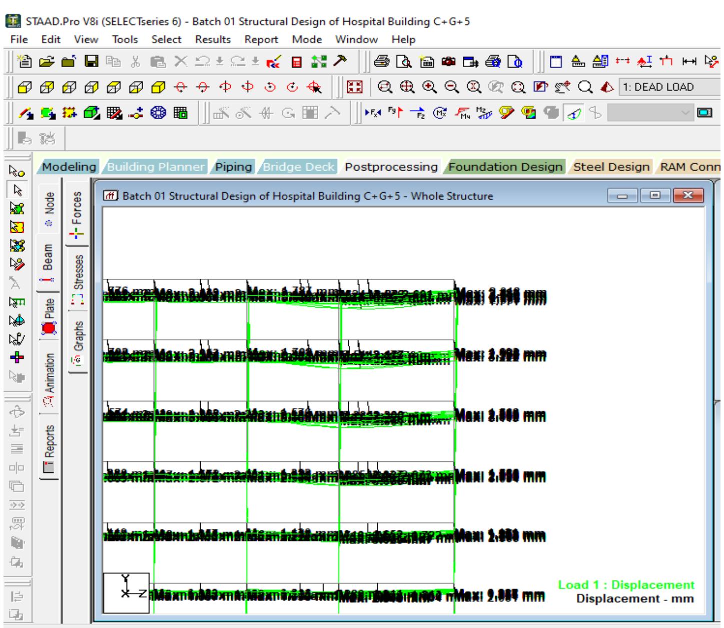

Fig 12 showing Max Displacements of 5.0mm of the structure

6.5 DESIGN RESULTS OF BEAMS AND COLUMNS REINFORCEMENT

B E A M N O. 2 D E S I G N R E S U L T S

M25 Fe500 (Main) Fe500 (Sec.)

LENGTH: 6500.0 mm SIZE: 400.0 mm X 300.0 mm COVER: 25.0 mm

DESIGN LOAD SUMMARY (KN MET)

SECTION |FLEXURE (Maxm. Sagging/Hogging moments)| SHEAR
(in mm) | P MZ MX Load Case | VY MX Load Case

0.0 | 0.00 0.18 0.25 4 | 43.65 -0.39 5
| 0.00 -42.02 -0.39 5 |
541.7 | 0.00 0.19 0.25 4 | 36.18 -0.39 5
| 0.00 -20.40 -0.39 5 |
1083.3 | 0.00 0.20 0.25 4 | 28.70 -0.39 5
| 0.00 -2.83 -0.39 5 |
1625.0 | 0.00 4.09 0.19 2 | 21.23 -0.39 5
| 0.00 0.00 0.00 1 |
2166.7 | 0.00 4.27 0.06 1 | 13.75 -0.39 5
| 0.00 0.00 0.00 1 |
2708.3 | 0.00 25.58 -0.39 5 | 6.28 -0.39 5
| 0.00 -0.00 -0.00 6 |
3250.0 | 0.00 11.28 0.19 2 | -1.20 -0.39 5
| 0.00 0.00 0.00 1 |
3791.7 | 0.00 10.18 0.19 2 | -8.67 -0.39 5

| 0.00 0.00 0.00 1 |
4333.3 | 0.00 7.31 0.19 2 | -16.15 -0.39 5
| 0.00 0.00 0.00 1 |
4875.0 | 0.00 6.79 -0.39 5 | -23.62 -0.39 5
| 0.00 0.00 0.00 1 |
5416.7 | 0.00 0.27 0.25 4 | -31.10 -0.39 5
| 0.00 -8.03 -0.39 5 |
5958.3 | 0.00 0.28 0.25 4 | -38.57 -0.39 5
| 0.00 -26.90 -0.39 5 |
6500.0 | 0.00 0.29 0.25 4 | -46.05 -0.39 5
| 0.00 -49.82 -0.39 5 |

SUMMARY OF REINF. AREA (Sq.mm)

SECTION | TOP | BOTTOM | STIRRUPS
(in mm) | Reqd./Provided reinf. | Reqd./Provided reinf. | (2 legged)

0.0 | 365.25/ 452.39(4-12í)| 183.60/ 452.39(4-12í)| 8í @ 150 mm
541.7 | 183.60/ 452.39(4-12í)| 183.60/ 452.39(4-12í)| 8í @ 150 mm
1083.3 | 183.60/ 452.39(4-12í)| 183.60/ 452.39(4-12í)| 8í @ 150 mm
1625.0 | 0.00/ 226.19(2-12í)| 183.60/ 452.39(4-12í)| 8í @ 150 mm
2166.7 | 0.00/ 226.19(2-12í)| 183.60/ 452.39(4-12í)| 8í @ 150 mm
2708.3 | 183.60/ 452.39(4-12í)| 222.29/ 452.39(4-12í)| 8í @ 150 mm
3250.0 | 0.00/ 226.19(2-12í)| 183.60/ 452.39(4-12í)| 8í @ 150 mm
3791.7 | 0.00/ 226.19(2-12í)| 183.60/ 452.39(4-12í)| 8í @ 150 mm
4333.3 | 0.00/ 226.19(2-12í)| 183.60/ 452.39(4-12í)| 8í @ 150 mm
4875.0 | 0.00/ 226.19(2-12í)| 183.60/ 452.39(4-12í)| 8í @ 150 mm
5416.7 | 183.60/ 452.39(4-12í)| 183.60/ 452.39(4-12í)| 8í @ 150 mm
5958.3 | 234.48/ 452.39(4-12í)| 183.60/ 452.39(4-12í)| 8í @ 150 mm
6500.0 | 432.92/ 452.39(4-12í)| 183.60/ 452.39(4-12í)| 8í @ 150 mm

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SHEAR DESIGN RESULTS AT DISTANCE d (EFFECTIVE DEPTH) FROM FACE OF THE SUPPORT

SHEAR DESIGN RESULTS AT 394.0 mm AWAY FROM START SUPPORT
VY = 38.27 MX = -0.39 LD= 5
Provide 2 Legged 8í @ 150 mm c/c

SHEAR DESIGN RESULTS AT 394.0 mm AWAY FROM END SUPPORT
VY = 33.16 MX = -0.39 LD= 5
Provide 2 Legged 8í @ 150 mm c/c

VII - CONCLUSION

Building plan was develop and draft in Auto-CAD with required dimension. During designing C+ G+ 5 storeys Hospital building structure is capable to sustain all loads acting on building. The design of slab, beam, column, is done with IS 456-2000 as limit state method in addition to that IS code 875 were also used for other loading parameters. STAAD.Pro has the ability to calculate the Reinforcement needed for any concrete section. The design output gives the reinforcement quantity of the complete structure as output and as per result; structure is safe without any errors as per output given by staad pro.

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