iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** V **Month of publication:** May 2024

DOI: https://doi.org/10.22214/ijraset.2024.62680

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue V May 2024- Available at www.ijraset.com

Design and Analysis of General Hospital Building Using STAAD Pro

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Abstract: Structural design is the primary aspect of the civil engineering. The foremost basic in structural engineering is the design of simple basic components and members of a building viz., Beams, Columns and Footings. The principal objective of this project is to analyze and design a general hospital using Staad pro. The design involves manual load calculations, analysis and design of the whole structure using STAAD Pro. The design methods used in STAAD-Pro analysis are Limit State Design conforming to Indian Standard Code of Practice. Structure considered for analysis and design is 21m high hospital building located in the seismic zone III. In this project, we study the effect of various load combinations on the structure by analysing the bending moment diagrams in post processing mode. The project involves detailed drawings of column layout, column detailing and beam detailing
Keywords: STAAD- pro, AutoCAD, Multistorey, Design, Analysis, Hospital Building.

I. INTRODUCTION

A building's structural design should guarantee that it can be supported securely and that it won't move or deform excessively, which could allow structural elements to become worn out or cause fixtures, fittings, or partitions to fail. inconvenience for the residents. It needs to account for forces and motions brought on by creep, variations in temperature, cracks, and loads that are applied. It must also confirm that the design is almost buildable within reasonable material production tolerances. It must enable both the architecture and the building services (lighting, ventilation, etc.) to adjust to the building in an efficient manner.

This project involves using AUTO CADD and STAAD Pro software to analyze a G+5-story structure with multiple load combinations. Research Engineers International became offered through Bentley Systems. STAAD. Pro is one of the maximum extensively used structural evaluation and layout software. It supports several steel, concrete and timber design codes (ACI 318-14, 2014; ASTM D3039, 2017; BIS: IS 13920, 2016; BIS: IS 1893 Part 1, 2002; BIS: IS 456, 2000; BIS: IS 875 Part 2, 1983; BS EN 1992-1-1, 2008). We can analyze and design reinforced concrete buildings, steel structures, water tanks, bridges etc. We can also perform static analysis and dynamic analysis from modal extraction to time history and response spectrum analysis. From version generation, evaluation and layout to visualization and end result verification, STAAD Pro. is the professional's choice for steel, concrete, timber, aluminium and cold-formed steel design of low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles and much more.

II. LITERATURE REVIEW

1) T. Dinesh Kumar (2019):- They use STAAD Pro to study and design a multi-story building with a G + 10 (3-dimensional frame). The Design includes STAAD Pro analyses of the entire structure and load calculations. Limit State Design in accordance with Indian Standard Code of Practice is the design methodology utilised in STAAD-Pro analysis. Modern user interface, visualisation tools, robust analysis, and design engines with sophisticated finite element and dynamic analysis capabilities are all included in STAAD Pro. From the creation, analysis, and design of models to their visualisation and validation. Gravity load, which includes both dead loads and live loads, and lateral load, which only includes wind loads, are the loads taken into account while designing a residential building. A building can be up to 30 metres tall, and a residential building can be up to
2) D.R. Deshmukh (2016):- They analyse and create a multi-story skyscraper. Using the STAAD Pro programme, G+19 (3-dimensional frame). STAAD Pro analysis of the entire structure is part of the design process. Limit State Design in accordance with Indian Standard Code of Practice is the design methodology utilised in STAAD-Pro analysis. STAAD-PRO is a very effective tool that can save a lot of time and is extremely accurate in designs, we conclude. In this project, a G+19-story building is taken into consideration, and various loads like wind load, static load, and earthquake load are applied.

3) Prakash Sangamnerkar (2013):-They analyse the most popular type of construction in urban India is reinforced concrete frame buildings, which are subjected to a variety of forces over the course of their lifetime, including static forces and dynamic forces brought on by wind and earthquakes. Dynamic loads cause significant inertia effects because they change over time while static loads remain constant over time. It primarily depends on the building's location, significance of its use, and size. Its consideration during analysis increases the complexity and length of the solution, and occasionally, its negligence can lead to disaster during an earthquake. Therefore, the process of designing civil engineering structures that can withstand dynamic loads is gaining more and more attention.
4) Amit A. Paul (2020):-The goal of their research is to find the most practical, cost-efficient, and ideal location for shear walls by examining the effects of earthquakes on high-rise buildings in various shear wall positions. For the purposes of this study, Delhi's zone IV G+7 high rise building is taken into consideration. The building's analysis is combined with some preliminary investigations, and five models are taken into consideration: the building without a shear wall, the building with a shear wall along the perimeter, the building with a shear wall at a corner, the building with a shear wall in the middle, and the building with a shear wall at a corner in a different position. For all cases taken into consideration, maximum shear wall moments and maximum deflections are calculated and examined. For the current study, M30 grade concrete andFe415 steel were used.
5) T.Jayakrishna (2018) :-Aim of their study is topredict how a G+7 multi-story building with a regular or irregular design will behave during an earthquake, and it is implied that changes in wind loads will act in tandem with earthquake loads. A multi-story residential building is described in this study.

Employing the response spectrum approach and STADD PRO, wall loads and earthquakes were investigated. It is assumed that a material with linear static properties would be used for dynamic analysis. These analyses are conducted by taking into account several seismic zones, and for each zone, the behaviour is evaluated by using soft soil. For different zones for various types of soils, a varied response is plotted for base shear displacements and storey drift.

III. OBJECTIVE AND SCOPE

Human life is affected due to nature's forces like floods, hurricanes, tornadoes, earthquakes etc. The structural design for a building must ensure that the building is able to stand safely, to function without excessive deflections or movements which may cause fatigue of structural elements, cracking or failure of fixtures, fittings or partitions, or discomfort for occupants. It must account for movements and forces due to temperature, creep, cracking and imposed loads. It must also ensure that the design is practically buildable within acceptable manufacturing tolerances of the materials. It must allow the architecture to work, and the building services to fit within the building such that it is functionable (air conditioning, ventilation, lighting etc.).

The aim of this project work is to analyze a G+5-storeyed hospital building for different load combinations using STAAD Pro software. Based on the analysis, design of the structure is done mainly in accordance with IS specifications. Ensuring that a hospital structure is earthquake-resistant is crucial because during a crisis, hospitals serve as the primary locations for providing medical care and humanitarian supplies. This study aims to compare the analysis and design of a five-story hospital building (G+5). There will be several instances of seismic loads applied to the structure.Since there isn't a specific seismic analysis code for structures in Bhilai, this research will utilize the Indian Standard Code (IS 1893-2002). The building's design will take earthquake resistance into account. The current study uses Structural Analysis and Design (STAAD Pro) software to perform an Equivalent Static Analysis of a six-story RCC hospital structure.

IV. MATERIAL AND METHODOLOGY

The Hospital building has a standard layout. Its story height is H = 3.5 m, indicating that each floor is the same height. With the ground level included, the Hospital building has six floors in total. The hospital building is 8800 m² in size, with a length of 100 m and a width of 88 m. The structure is made up of 150mm thick slabs, rectangular beams with a cross-section of 0.40 x 0.35 meters, and square columns with a cross-section of 0.50 x 0.45 meters. While Fig. 1 depicts the designing process, Table 1 presents the method used.

Table.1 Methodology

S.No	Specifications	Building Data
1	Plan dimensions	8800m²
2	Length in X- direction	100m
3	Length in Z- direction	88m

4	Floor to floor height	3.5m
5	No. of Stories	5
6	Plinth Level	4m
7	Total height of Building	21m
8	Slab thickness for flat slab	0.15m
9	Soil type	Medium
10	Grade of concrete	M30
11	Grade of steel	Fe500
12	Beam	0.40mX0.35m
13	Column	0.50mX0.45m
14	Seismic zone	III
15	Live load	5 KN/m^2

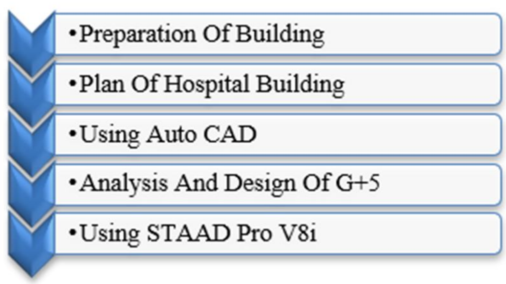

Figure 1 Steps for Design

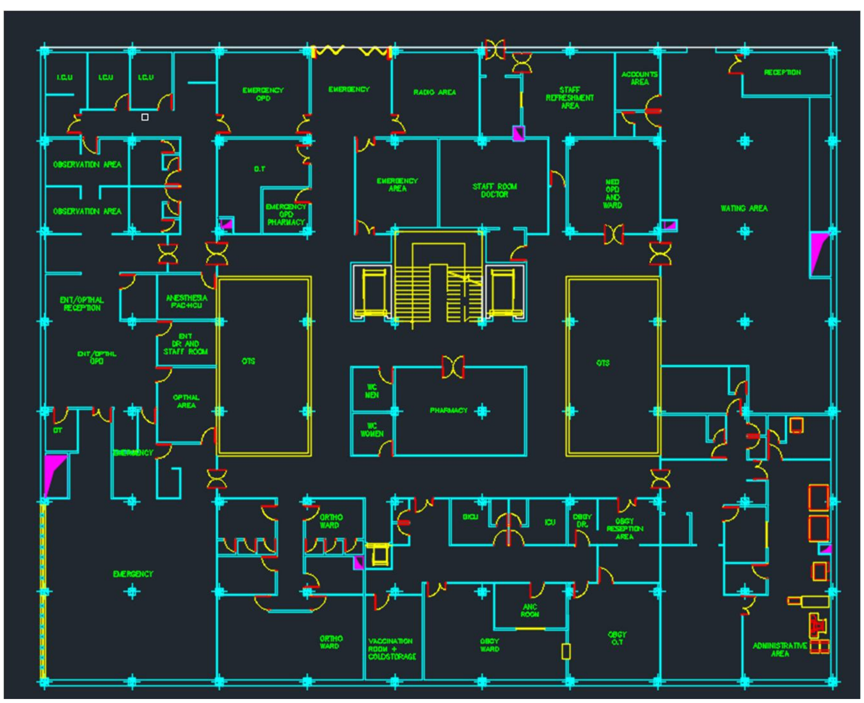

Figure 2 Plan of Hospital Building

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
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Different codes used to determine the dead loads and live loads, to analyze and design the structure are given in Table 2

Table 2 Code used

Code	Title
(BIS: IS 456, 2000)	Code of practice for plain and reinforced concrete
(BIS: IS 875 Part 1, 1987)	Code of practice for design loads for buildings and structures-part-1- dead load
(BIS: IS 875 Part2, 1983)	Code of practice for design loads for buildings and structures-part-2-imposed loads
(BIS: IS 1893 Part 1, 2002)	Criteria for earthquake resistant design of structures, part 1: general provisions and buildings

V. LOAD CALCULATION

A. *Member Load*

LOADING TYPE :- UNIFORM LOAD

THICKNESS OF WALL = 250MM=0.250M
WALL HEIGHT=3.5M
DENSITY OF BRICK= 18.85 KN/M^3 (IS 875 PART 1 1987 TABLE 1 NO 36)

TOTAL MEMBER LOAD=0.25X3.5X18.85
= 164.49 KN/M

BOTH SIDE WALL PLASTER THICKNESS
INSIDE=12MM
OUTSIDE=15MM
TOTAL THICKNESS=27MM

ASSUME TOTAL WALL HIGHT=3.2M
DENSITY OF CEMENT MOTAR WORK=20.40KN/M^3 (IS 875 PART 1 1987 TABLE 1 NO 40)

DEADLOAD OF WALL= 0.027X3.5X20.40
=1.927KN/M

TOTAL=16.49+1.927= 18.417KN/M~19KN/M

SIMILARLY

PARAPIT WALL=6.31KN/M
INTERNAL WALL= 10KN/M

B. *Floor Load*

THICKNESS SLAB= 150MM
DENSITY RCC=25KN/M^3

DL OF RCC SLAB 150MM THICK=0.150X25
=3.75KN/M^2

FLOOR FINISH LOAD CALCULATION

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ASSUME THICKNESS OF FLOOR FINISH=75MM
DENSITY OF CEMENT MOTAR=20.80KN/M^3
DL OF FLOOR FINISH 75MM THICK=0.075X21
=1.575KN/ M^2
CELLING PLASTER DL CALCULATION

ASSUME THICKNESS OF FLOOR FINISH=8MM
DENSITY OF CEMENT MOTAR=20.80KN/M^3
DL OF CELLING PLASTER 8MM THICK=0.008X21
=0.168 KN/M^2

TOTAL DL=5.49 KN/M^2~5.5 KN/M^2

VI. STRUCTURAL MODELING

Hospital building description is presented Gravity loads, dead load, live load as well as combination loads are presented and the end structural elements are introduced. Six story regular reinforced concrete building is considered. The beam lengths in (x) direction are 5m (20 numbers)and beams in (z) longitudinal direction are 5.5m (16 numbers),Figure 3 shows the plan of the six story Hospital building having 20 bays in x-direction and 16 bays in z-direction. Story height of each floor is assumed to be 3.5m. Beam cross sections 400x350 mm and Column cross section is 500x450 mm. Fig.4 shows the G+5 Storey Hospital building, Fig. 5 shows The live load acting on the structure.Fig. 6 shows. Brick Load acting on the Structure. Fig. 7 shows a Bending moment diagram of the structure. Fig. 8 shows the Floor Load of the structure. Fig. 9 shows the bending movement live load of the structureFig. 10 shows 3D Form of the building. Fig. 11 Analyze window. Fig.12 shows RCC design of beam 1742 Fig.13 shows RCC design of column1225. Fig. 14 shows Bending moment due to seismic load (beam). Fig.15 shows Bending moment due to seismic load (column). Fig. 16 shows Seismic load acting in Z direction and Fig. 17 shows Seismic load acting in X direction.

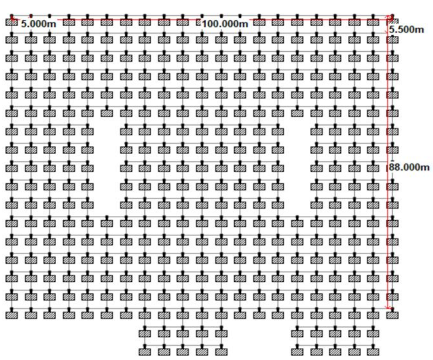

Figure 3 the five story Hospital building

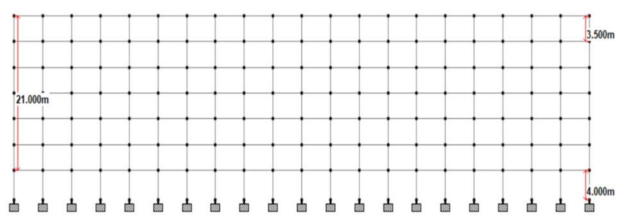

Figure 4 the G+5 Storey Hospital building

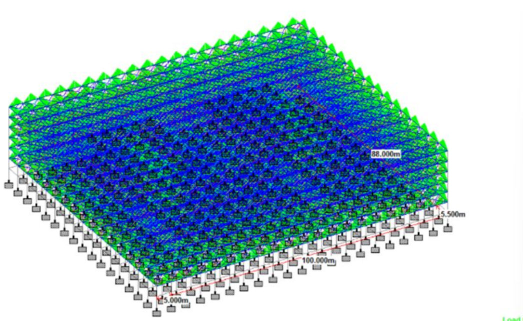

Figure 5 live load acting on the structure

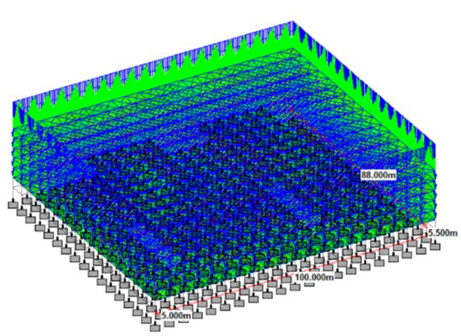

Figure 6 . Brick Load acting on the Structure

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
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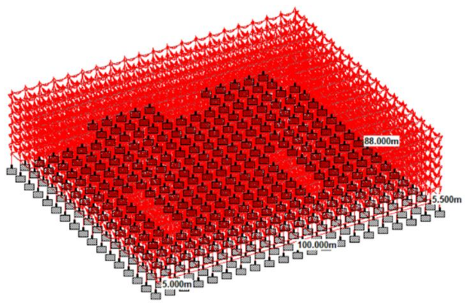

Figure 7 Bending moment diagram of the structure

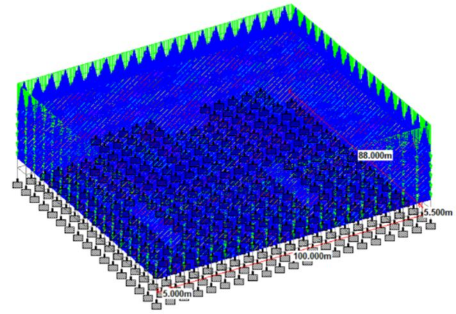

Figure 8 Floor Load of the structure

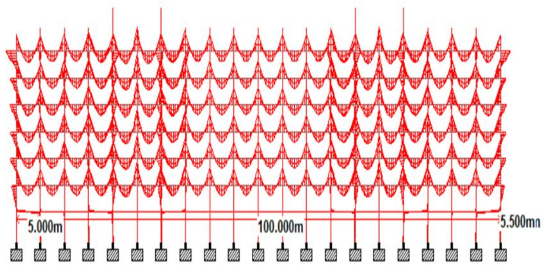

Figure 9 bending movement live load

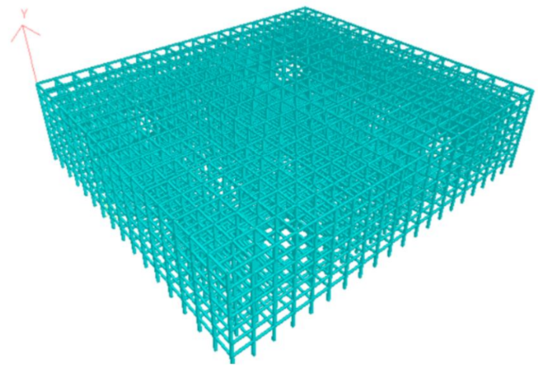
Figure 10 3D Form of the building

VII. ANALYSIS

The analysis was performed using the commands under the analyze menu in the modelling mode. Select the Run Analysis option to perform Analysis/Design.

The Analysis status dialog box shown below appears. This dialog box displays the status of the analysis process. If an error occurs during the analysis, the below dialog box displays the error message. In this dialog box, we are also presented with three options.

1) View output file
2) Go to postprocessing mode
3) Stay in modeling

As shown in Figure 11.

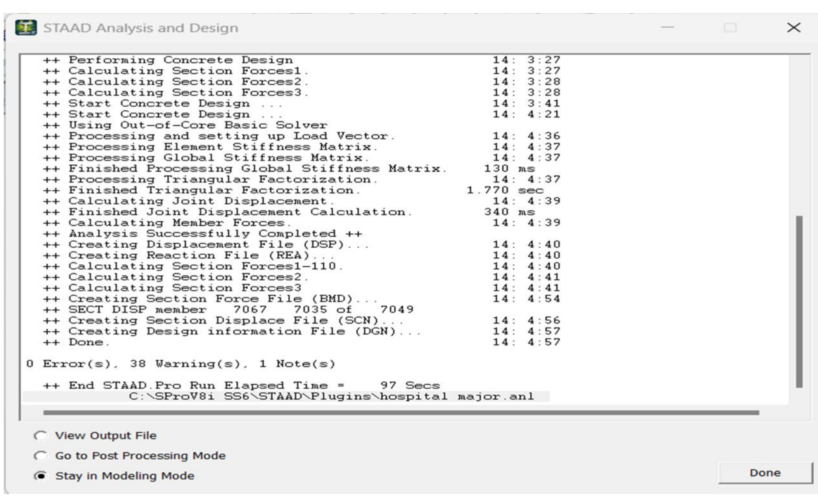

Figure 11 Analyze window

After clicking "Go to post processing mode" a new dialog box will appear to select the load cases. After that the post processing mode has been opened as shown in Figure 11 in which we can determine maximum and minimum bending moments, maximum and minimum shear force, reactions at footings, stresses in plates etc And the combination load is applied in Staad Pro by using autoload generation using Indian standards.

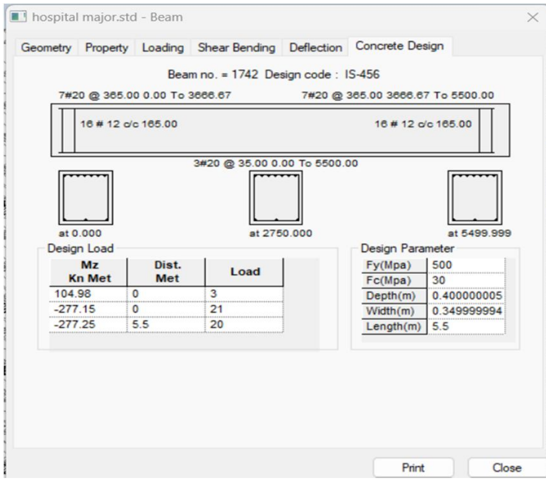

Figure 12 RCC design of beam 1742

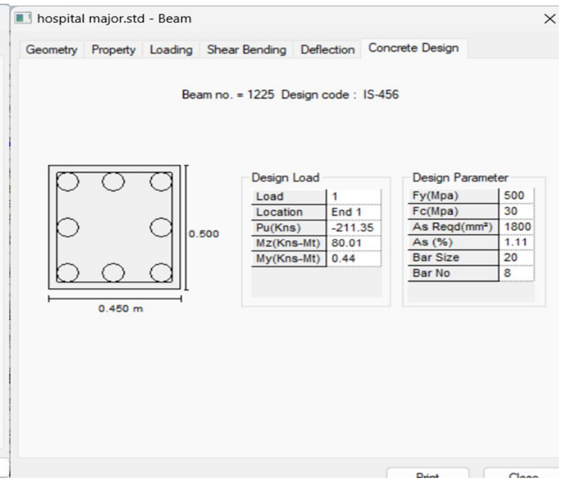

Figure 13 RCC design of column 1225

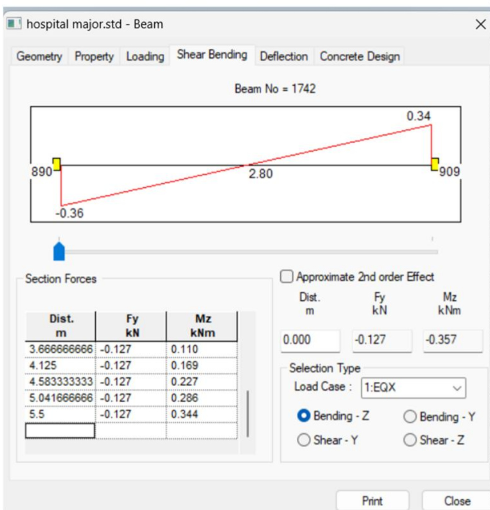

Figure 14 shows BM due to seismic load (beam)

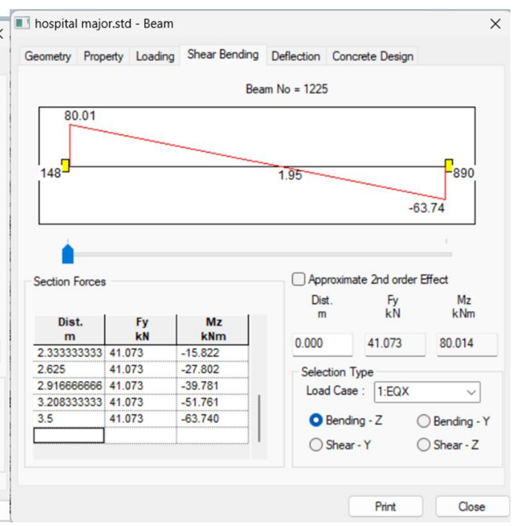

Figure 15 shows BM due to seismic load (column)

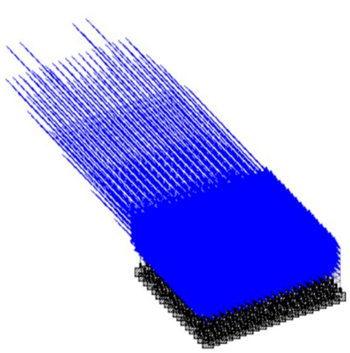

Figure 16 Seismic load acting in Z

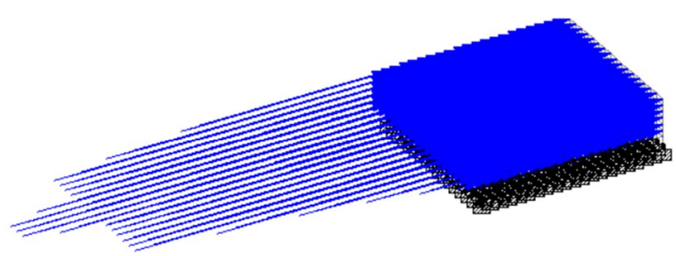

Figure 17 Seismic load acting in X

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
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VIII. CONCLUSIONS

The G+5 Hospital building was designed (beams, columns, and earthquake load analysis using the equivalent static method) using STAAD Pro software. The building was drawn using Auto CAD software for this project. The IS: 456-2000 and IS 1893: 2002 are used for calculating the dead load, live load, and seismic loads. According to IS: 1786-1985, HYSD bars Fe500 and concrete grade M30 are utilized.

When compared to manual analysis (Kani's method), STAAD Pro allows for much faster completion of the analysis of multi-story buildings.

1) Design work takes much less time when using software like STAAD.
2) STAAD pro can be used to get information about every single member.

Software plays an essential part in improving accuracy. STAAD Pro was used for analysis and design, and AutoCAD had been used to create the drawings. Since Bhilai lacks an earthquake code, the analysis and design have made use of the Indian standard code.

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