Erudite Journal of Engineering Technology and Management Sciences
Vol. 4, No. 3, September 2024, pp. 26-29
Journal homepage: http://www.ejetms.com

Design and Analysis of Building with Linear Static Analysis by using STAAD.PRO

Matta Chandu[a], Chithaloori Praphul Goud[a],Gudla Jignesh Reddy[a], G.Naveen Kumar[b]

[a] U.G. Student, Department of Civil Engineering,, Guru Nanak Institutions Technical Campus, Ibrahimpatnam, Telangana, India.
[b] Assistant Professor, Department of Civil Engineering, Guru Nanak Institutions Technical Campus, Ibrahimpatnam, Telangana, India.

https://doi.org/10.5281/zenodo. 14470959

Received: 15 August 2024
Accepted: 22 September 2024

Keywords:
Staad.pro, Seismic Zone Parameters, Stability, structural analysis.

ABSTRACT

Structural design ensures safety and stability under various load conditions, including seismic forces. This study explores the behavior of G+9 residential buildings using STAAD.PRO software, focusing on seismic zone parameters and response reduction factors. The design integrates dead, live, and seismic loads for RCC structures, with an emphasis on reducing cracking through optimal material selection and techniques.

1. INTRODUCTION

STAAD.pro (Structural Analysis and Design Software) is a widely used software tool for structural engineering, developed by Bentley Systems. It is primarily employed for the analysis and design of buildings, bridges, towers, industrial structures, and other civil engineering projects. One of the core functions of STAAD.pro is linear static analysis, which forms the foundation for evaluating the structural performance of a building under various loads and forces. Linear static analysis refers to a method in which the structural system is assumed to behave in a linear fashion (i.e., the relationship between forces and deformations is proportional), and the system is subjected to static loads. This type of analysis does not consider time-dependent effects like dynamic forces or non-linear material behavior. The key assumptions behind linear static analysis are:

- Elastic material behaviour: The material undergoes deformations but returns to its original shape once the loads are removed.
- Small deformations: The displacements are assumed to be small enough that they do not affect the geometry of the structure significantly.
- Constant stiffness: The stiffness of the structure remains unchanged during the loading process

In linear static analysis, the internal forces, such as bending moments, shear forces, and axial forces, are calculated based on the applied loads. These results can then be used to design the individual components of the structure (such as beams, columns, and foundations) to ensure safety, stability, and compliance with building codes.

2. LITERATURE

Chandurkar, Pajgade (2013): evaluated the response of a 10 story building with seismic shear wall using Staad Pro V8i Main focus was to compare the change in response by changing the location of shear wall in the multi-story building. Four models were studied- one being a bare frame structural system and rest three were of dual type structural system. The results were excellent for shear wall in short span at corners. Larger dimension of shear wall was found to be ineffective in 10 or below 10 stories. Shear wall is an effective and economical option for high-rise structures. It was observed that changing positions of shear wall was found to attract forces, hence proper positioning of shear wall is vital. Major number of horizontal forces were taken by shear wall when the dimension is large. It was also observed that shear walls at substantial locations reduced displacements due to earthquake.
Viswanath K.G (2010): investigated the seismic performance of reinforced concrete buildings using concentric steel bracing. Analysis of a four, eight, twelve and sixteen storied building in seismic zone IV was done using Staad Pro software, as per IS 1893: 2002 (Part-I). The bracing was provided for peripheral columns, and the effectiveness of steel bracing distribution along the height of the building, on the seismic performance of the building was studied. It was found that lateral displacements of the buildings reduced after using X-type bracings. Steel bracings were found to reduce flexure and shear demand on the beams and columns and transfer lateral load by axial load mechanism. Building frames with X- type bracing was found to have minimum bending as compared to other types of bracing. Steel bracing system was found to be a better alternative for seismic retrofitting as they do not increase the total weight of the building significantly.

Chavan, Jadhav (2014): studied seismic analysis of reinforced concrete with different bracing arrangements by equivalent static method using Staad Pro. Software. The arrangements considered were diagonal, V-type, inverted V-type and X-type. It was observed that lateral displacement reduced by 50% to 60% and maximum displacement reduced by using X-type bracing. Base shear of the building was also found to increase from the bare frame, by use of X-type bracing, indicating increase in stiffness.
Esmaili et al. (2008): studied the structural aspect of a 56 stories high tower, located in a high seismic zone in Tehran. Seismic evaluation of the building was done by non-linear dynamic analysis. The existing building had main walls and its side walls as shear walls, connected to the main wall by coupling of beams. The conclusion was to consider the time-dependency of concrete. Steel bracing system should be provided for energy absorption for ductility, but axial load can have adverse effect on their performance. It is both conceptually and economically unacceptable to use shear wall as both gravity and bracing system. Confinement of concrete in shear walls is good option for providing ductility and stability.
Akbari et al. (2015): assessed seismic vulnerability of steel X-braced and chevron-braced Reinforced Concrete by developing analytical fragility curve. Investigation of various parameters like height of the frame, the p-delta effect and the fraction of base shear for the bracing system was done. For a specific designed base shear, steel-braced RC dual systems have low damage probability and larger capacity than unbraced system. Combination of stronger bracing and weaker frame reduces the damage probability on the entire system. Irrespective of height of the frame, Chevron braces are more effective than X-type bracing. In case of X-type bracing system, it is better to distribute base shear evenly between the braces and the RC frame, whereas in case of Chevron braced system it is appropriate to allocate higher value of share of base shear to the braces. Including p-delta effect increases damage probability by 20% for shorter dual system and by 100% for taller dual systems. The p-delta effect is more dominant for smaller PGA values.

3. METHODOLOGY

Structural design for framed R.C.C structure can be done by three methods:

1. Working stress method.
2. Ultimate strength method.
3. Limit state method.

1. **Working stress method:** It is earliest modified method of R.C.C structures. In this method structural element is so designed that the stress resulting from the action of services load as computed in linear elastic theory using modular ratio concept do not exceed a pre-designed allowable stress which is kept as some fraction of ultimate stress, to avail a margin of safety. Since this method does not utilize full strength of the material it results in heavy section, the economy aspect cannot be fully utilized in the method.
2. **Ultimate strength method:** This method is primarily based on strength concept. In this method the structural element is proportioned to withstand the ultimate load, which is obtained by enhancing the service load of some factor referred to as load factor for giving desired margin of safety. Since this method is based on actual stress strain behaviour of the material, of the member as of the structure that too right up to failure, the values calculated by this method agree well the experiment results
3. **Limit state method:** During the past several years, extension research works have been carried out on the different aspects of the research in the actual behavior of member and structure has led to the development of design and approach of LIMIT STATE METHOD OF DESIGN. Limit state design, also known as load and resistance factor design, refers to a design method used in structural engineering. A limit state is a condition of a structure beyond which it no longer fulfills the relevant design criteria.

3.1 Project Description

- Building Type: G+9 residential building
- Structure Type: RCC and Steel
- Store's: G+9
- Total Built-up Area: 504 m²

3.2 Analytical Approach

Step 1: Planning Architectural layouts were developed in AutoCAD, ensuring compliance with IS codes and healthcare-specific requirements**.**

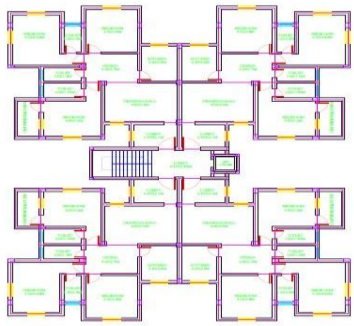

Figure 1. Ground floor plan of hospital building

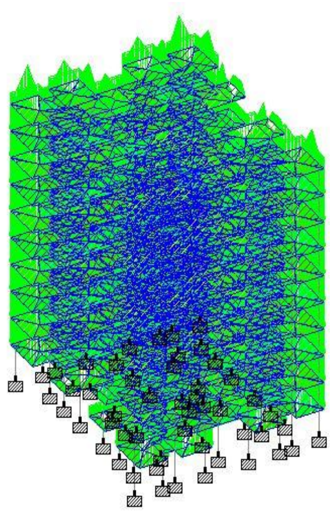

Figure 2. structure under dead load

Live Load:
These are the loads that changes with time. Live loads or imposed loads include loads due to the people occupying the floor, weight of movable partitions, weight of furniture and materials. The live loads to be taken in design of buildings have been given in IS: 875 (part-2) -1987. Some of the common live loads used in the design of buildings are given below: Live loads are either movable or moving loads without any acceleration or impact. There are assumed to be produced by the intended use or occupancy of the building including weights of movable partitions or furniture etc. The floor slabs have to be designed to carry either uniformly distributed loads or concentrated loads whichever produce greater stresses in the part under consideration

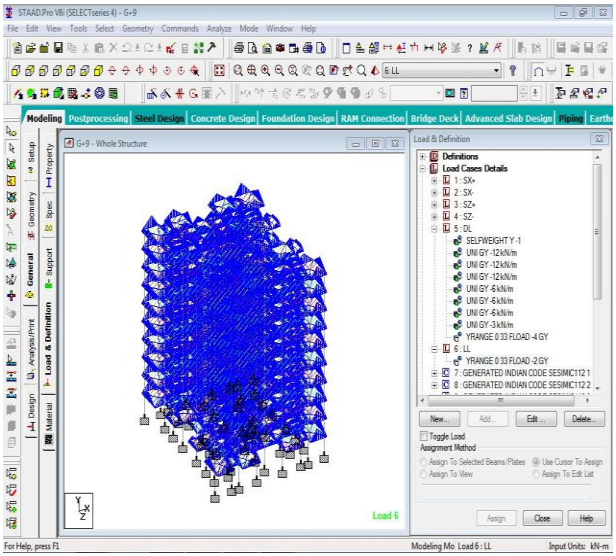

Figure 3. structure under dead load.

4. RESULTS AND DISCUSSION

Our project involves analysis and design of multistoried [G + 9] using a very popular designing software STAAD Pro. We have chosen STAAD Pro because of its following advantages:

- easy to use interface,
- conformation with the Indian Standard Codes,
- versatile nature of solving any type of problem.

Slenderness limits for columns: The column dimensions shall not be such that it fails by material failure only (crushing due to compression) and not by buckling. To avoid the failure of column by buckling, IS 456 recommends the following slenderness limits for the column.

The unsupported length (distance between the lateral connections) shall not exceed 60 times the least lateral dimension of the column.

$L < 60b$

If one end of the column is unrestrained (unsupported)

$L < 100b^2/D$

Where b = width of the cross section

D = depth of the cross section

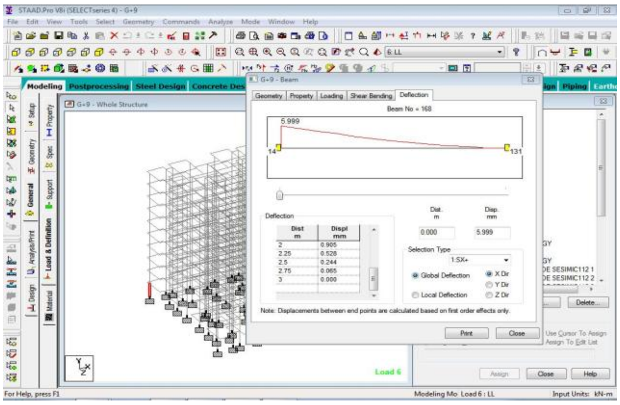

Figure 4. Shear force & column design details.

Column design:
A column or strut is a compression member, which is used primarily to support axial compressive loads and with a height of at least three times it's least lateral dimension. A reinforced concrete column is said to be subjected to axially loaded when the line of the resultant thrust of loads supported by the column 8 is coincides with the line of C.G. of the column in the longitudinal direction. Depending upon the architectural requirements and the loads to be supported, R.C.C. column may be cast in various shapes i.e. square, rectangular, hexagonal, octagonal or circular. Column of ell-shaped or tee-shaped are also sometimes used in column help to bear the load in combination with the concrete. The longitudinal bars are held in position by transverse reinforcement, or lateral binders. The binders prevent displacement of the longitudinal bars during concreting operation and also check the tendency of their buckling out wards under loads.

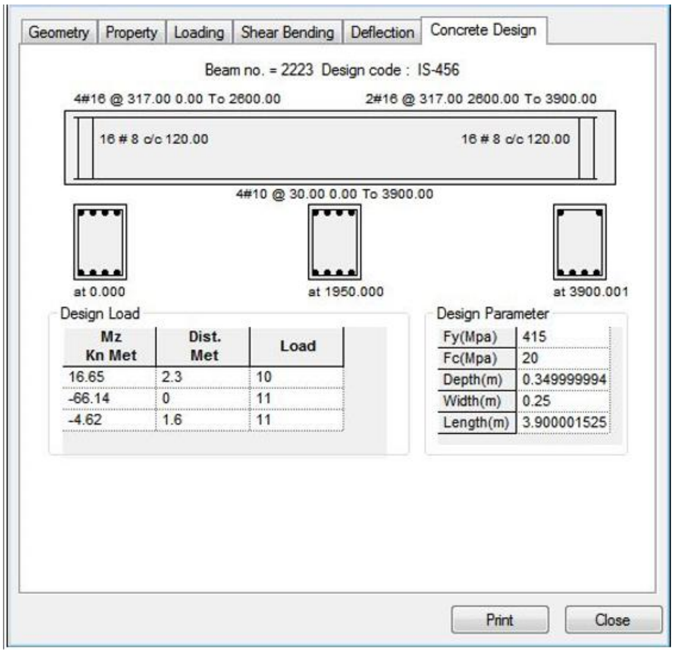

Figure 5. column design details.

Beam design:
Beams are designed for flexure, shear and torsion. If required the effect of the axial force may be taken into consideration. For all these forces, all active beam loadings are pre-scanned to identify the critical load cases at different sections of the beams. For design to be performed as per IS: 13920 the width of the member shall not be less than 200mm.

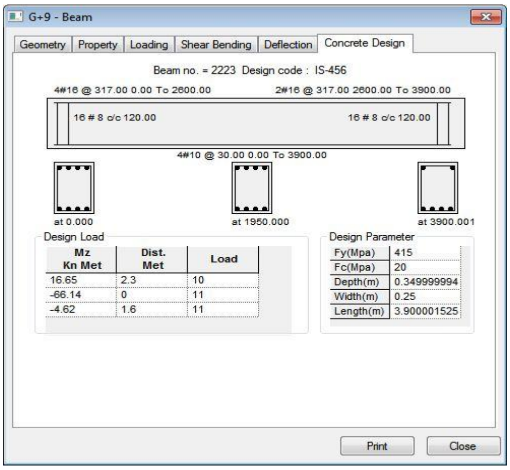

Figure 6. Beam design details.

REFERENCES

1. Dr.Ashokkumar.N, Navaneethan.M, Naviya.B, Gopalakrishnan.D,Atun RoyChoudhury Planning, Analysis & Design of Residential Building Using STAAD Pro V8i., 2017.
2. C Priyanka, M Priyanka, V Kumaran Planning, Analysis and Designing of Multi-Specialty Hospital Building, 2018.
3. MVK. Sathish Etal: Planning, Analysis and Design of (G+9) Residential Building using STAAD Pro, 2017.
4. M.L. Adiyanto, M. I.Adiyanto, T. A.Majid, Malaysia S.S. Zaini, Analysis and Design of 9 Storey Structure Subject to Seismic Load Using STAAD Pro, 2008.
5. J.Sankar,E.V.RaghavaRao,N.Chennakesavulu Design of g+4 Residential Building for Earthquake Resistant, 2016.
6. IS456, "Code of Practice for Plain and Reinforced
7. Concrete" Bureau of Indian Standards, New Delhi, 2000.
8. IS12433part 3:2001"basic requirements for G+9 residential building.
9. IS875Part-I: Dead Loads 65 [9] IS875Part-II: Live Loads
10. IS RCC CODE 456-2000.