INDIAN JOURNAL OF
ENGINEERING

18(49), 2021

Design and Analysis of Residential Building using STAAD-Pro

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To Cite:
Ramesh G. Design and Analysis of Residential Building using STAAD-Pro. *Indian Journal of Engineering*, 2021, 18(49), 185-190

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Peer-Review History
Received: 25 April 2021
Reviewed & Revised: 27/April/2021 to 20/May/2021
Accepted: 23 May 2021
Published: May 2021

Peer-Review Model
External peer-review was done through double-blind method.

ABSTRACT
Due to population growth and land scarcity, construction technology, and high-rise commercial structures are rapidly developing. Buildings are essential for improving a variety of activities. Their supporting state determines stability over the lifespan of structural members. When a structure meets all of the stability criteria, it is considered to be stable. When it comes to symmetric and eccentric loading conditions, a single column arrangement is crucial. Eccentric loading can twist of the form in either path as well as result in structural defeat, which is dangerous. The analysis and load calculations in this project were done using a Numerical Building Model and a software program. The project involves using software to design and analyze a multi-story building supported by a column with floors. The design is carried out following the IS code's specifications and standards. The STAAD-Pro program is used to model, and the performance generated by staadpro consists of accurate numerical results for analysis and design.

Keywords: Design of Building, STAAD-Pro, Seismic Analysis, IS Codes.

1. INTRODUCTION
There is a need to handle the influx of people in urban areas due to population growth. However, due to the rapid rise in land prices and the scarcity of land, the trend is to construct multi-story buildings. A multi-story building has several levels above ground. Skyscrapers are multi-story buildings that are considered symbols of a city's economic strength and culture. They are not only designed for the sake of saving space. To meet the demand for high-rise buildings, a variety of structural systems have been used. Thousands of multi-story buildings are being constructed of steel and reinforced concrete all over the world. Since the plans have numerous advantages, many multi-story buildings are built with structural components consisting of various systems such as flat slabs, flat plate systems, industrial, and uses. As opposed to a structure backed by several columns, a single column offers a better architectural view. They save ground space by requiring less room for the foundation and allowing for more parking. They are also one of a kind. RCC or steel may be used to build single-column structures. Compared to structures backed by several columns, this arrangement on a single column provides a significant amount of usable floor space. They save ground space

by requiring less room for the foundation and allowing for more parking. Maximum space usage is taken into account to ensure complete serviceability. This study discusses the design, planning & analysis for different parts & the estimated the price of the entire structure. This arrangement is a mono column or a single column structural framework & each floor in the entire structure is backed independently. Modeling and structural analysis of buildings were previously done by hand, based on simplistic assumptions and an interpretation of the entire structure's action. For high-rise buildings, however, it appears to be time-consuming and difficult. Computer hardware and software for structural modeling and analysis are widely available at the moment. We must understand how classroom awareness is implemented in these practical aspects of work. When we were given this assignment, we went into the field to learn about building methods and deal with the different challenges. It is also essential to have adequate knowledge of the numerous software programs currently used in planning, review, and design and are not used in the primary structure design phase. Since the 1990s, specialized software has been available to assist in designing structures to help draw, evaluate, and design systems with full precisions, such as AutoCAD, STAAD-Pro, and ETABS Prokon, Revit structure, and so on. Our main goal is to use STAAD-Pro to complete a comparison between a traditional multi-story building and a single column building under all possible loading conditions and fully utilize the purpose they have budgeted. The structure's safety standards must be fulfilled to fulfill its intended function while remaining cost-effective to maintain.

Objectives

For the current analysis, the following primary objectives have been set.

- In STAAD-Pro, build, schedule, and analyze a high-rise structure model.
- As per IS 1893-2002, a study of the seismic load applied to the structure was conducted.
- Deflection for single-column and multi-column systems must be checked.
- This research aims to see how lateral displacement performs in Zone II.
- The Column is created by measuring the appropriate measurements.

Beam Design

- According to Code Provisions, the desired characteristics of the beams are presumed, and tests are performed accordingly.

Slab's layout

- The requisite slab is presumed, and it is built to meet all of the requirements. English bond is used to construct the walls.

Work Requirements

Because of their shapes, slenderness, versatility, scale, and lightness, many structures currently under construction are wind-sensitive. These are supplemented by using materials that are stressed at a much greater proportion to their total power in the past due to improved material quality assurance. In today's world, the ancient doctrine of accepting wind-related disasters & gives way to demands for low-cost structures that withstand the wind. Over the last two decades, Because of the new findings, it is evident that simply amending the earlier code IS 875:1964 will not be sufficient, and seeks to correct not only the 1964 code's shortcomings but also to incorporate current awareness of the effects of wind on structures. The maximum altitude at which velocity measurements can be taken has been increased to 500 meters. The loadings have been accounted for. The code acknowledges that short-duration rotating storms, such as tropical cyclones along the coasts or tornadoes elsewhere, are responsible for the majority of high winds in India. As well as nearly rectilinear short-duration winds as thunderstorms in many areas. India's high wind loading conditions vary. Many of the random response theories used in European/US. Codification has generally accompanied, rather than structural flaws or anxiety, as previously mentioned. The 1964 edition of the code included wind charts were created primarily using Storms that approached or crossed the Indian coasts generated high-value wind data. To provide an overall picture of the area, as well as most wind data are synoptic, 3-cup anemometer readings were seldom used to develop wind maps at different locations. Furthermore, regardless of terrain conditions, the 1/10 power rule was used to indicate differences in a wind speed of 30 to 150 meters per second, despite the lack of supporting evidence. There was no specific guidance for using one or both of the wind pressure maps provided by the code. An effort has been made to update the wind code, IS 875 (part 3):1987. Fix these shortcomings and provide sufficient guidance to Indian structural engineers in order for them to arrive at more realistic wind loading for design purposes.

2. METHODOLOGY

This study discusses the Planning, construction, and sketches are all part of the process for different parts and the estimated cost of the entire structure. A single column structural framework is provided by a structural model & A mono column at the center of the structure supports each floor independently. All structural members are designed following IS: 4562000. All structural design attempts to achieve this aim to make sure the structure is secure & can function properly during its development. The designer must specifically ensure that the structure can safely bear the loads. This necessitates the designer making accurate estimates of the structural materials' strengths and the loading that the structure may be subjected to during its design life. Storey drifts, global displacement & component deformation and component forces, as well as storey forces are all included in the seismic demand parameters. Material in elasticities, geometrical nonlinearity, and internal force redistribution are all taken into account in this review. The following are the response characteristics obtained from single column structural analysis.

- Calculations of the structure's force and displacement capacity.
- Deformation demands on ductile elements & Compared to linear static analysis.
- The structural analysis provides all of these advantages with a slight increase in computational effort and modeling nonlinearity and changing the analysis algorithm.

Equivalent static analysis method

It's generally defined as a seismic response continuum. It is assumed that the structure reacts in the most basic form It must be a low-rise structure that does not sway drastically as the ground shifts for this to be accurate. Given the natural frequency of the house. Many building codes expand the applicability of this approach by adding variables higher buildings must be taken into account. Many regulations use adjustment factors that minimize design forces to account for effects caused by structure "yielding".

Assumptions

- Assume rigidity in the system.
- Assume the structure and base are perfectly aligned.
- Ground movements trigger the same accelerations at all points on the structure.
- Determines the structure's total horizontal power (Base shear).

Limitations

- It uses empirical relationships.
- The complex features of the system being constructed or evaluated are not expressly accounted for in these analytical formulas.
- These formulas were created to describe the complex behavior of what is known as typical structures as closely as possible.
- The technique of equal static force is usually sufficient for such structures. The analogous static force method's empirical formulas are based on assumptions violated by structures defined as abnormal.
- Significant floor-to-floor variations in mass or center of mass, soft stories, and other types of irregularities in a structure are common.
- As a consequence, using the equivalent static force technique in these situations may result in incorrect results. To define and distribute the seismic design forces in these situations, a dynamic analysis should be used.

Code of Practice for Design Loads

- In India's uniform code of practice, plan loads for buildings and structures. the following are the five parts:
- The dead load to be considered for the structure is included in IS: 875 (Part 1)-1987.
- The applied load or live load acting on the structure is addressed in IS: 875 (Part 2)-1987.
- The imposed load, such as roof load, dust load, partition load, and so on, is included. IS: 875 (Part 3)-1987, IS: 875 (Part 2)-1987, IS: 875 (Part 2)-19.
- This code takes into account a structure's wind load. IS: 875 (Part 5)-1987 specifies the special code and load combinations that must be taken into account.

Types of loads

Dead load

The load on a structure caused by its weight is known as a dead load. If a permanent structure is applied to the structure, it often adds additional loads.

Live load

A live load, also known as an imposed load, is placed on a because of the shifting weight. The live load fluctuates depending on the structure. A residential building's live load is usually assumed to be 3kN/m^2.

Wind load

The load on a structure caused by wind intensities is known as wind load. The intensity of the wind varies from time to time. As a result, it is recommended that maximum probable wind intensities be calculated for a structure to prevent damage. The wind load can be measured using the IS: 875(Part 3)-1987 Indian norm. The essential wind speed is calculated using the code.

$V_z = k_1k_2k_3V_b$

where V_b is the simple wind speed in meters per second.

P_z=0.6 V_{z2} gives the design wind pressure at any height.

Wind load analysis concept

Wind pressure acts on buildings, causing them to be exposed to horizontal loads. IS 875(Part III)-1987 is used to measure wind load. Vertical exterior walls and exposed areas of buildings are affected by horizontal wind pressures. The bending of these members directly resists some of the pressure acting on exposed surfaces of structural walls and columns. As a vertical plate, the infill walls serve, transferring loads to the slab and being covered at the top and bottom by floor beams. The cantilever motion transfers the wind loads to the surface slab of the parapet wall at the terrace. Wind loads operating on exposed storey surfaces are portrayed as idealized covered by the higher and lower levels floors for simplicity's sake. IS 875 (Part 3)-1987 wind load calculation: The affected area multiplied by the wind pressures equals the wind forces acting on a given surface. Wind speed (V_z) at the design location: The equation V_z= V_b K_1 K_2 K_3 & V_z equaling the design wind velocity in meters per second. V_b = 12m/sec actual wind speed V_b is the essential wind speed, which is determined by the building's position. The country is divided into six zones for this reason. Essential wind speed is calculated using gust velocity averaged over three seconds at the height of 10 meters.

Seismic load

- Seismic load can be determined by considering the ground's acceleration response to the superstructure.
- They are divided into four zones based on the magnitude of the earthquake.
- Zones I and II are merged to form Zone II.
- The third Zone.
- The fourth Zone.
- The fifth Zone.

3. RESULTS

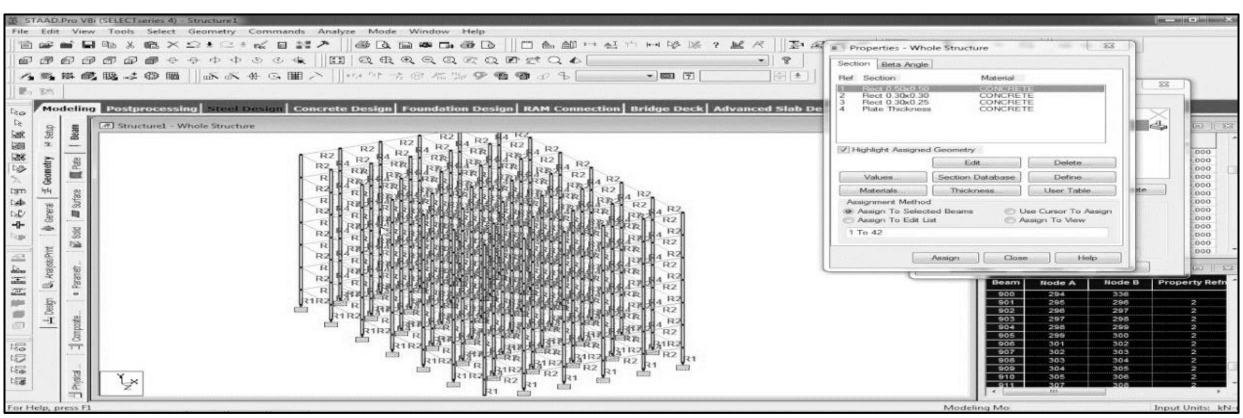

Fig.1 Design & Analysis of Structure

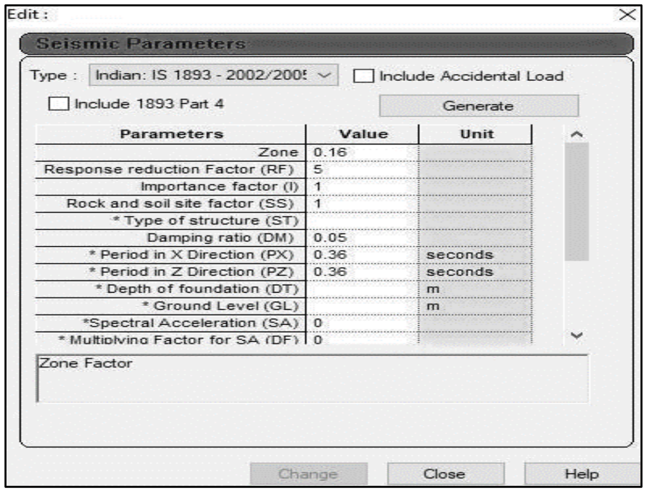

Fig.2 Seismic Analysis Details

4. CONCLUSION

- Based on a study of a traditional multi-story building and a single column structural structure, the following conclusions can be drawn.
- A multi-story building with a single column construction has been successfully engineered to withstand all loads, including earthquake loads.
- Under static loading conditions, RCC columns have adequate results.
- STAAD-Pro advanced software, which provides us with a platform for analyzing and designing structures that is fast, reliable, simple to use, and accurate.
- Ultimate strength and serviceability must be met by the structural design. The planning, study, and construction of framed structures are skills that a civil engineer must-have. As a result, it was suggested that the project work consists of selecting a problem that entailed the study and design of a commercial framed structure.

Funding

This study has not received any external funding.

Conflict of Interest

The author declares that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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