

# Analysis And Design of Earthquake Resistant Building by Staad.Pro

Shivam Dubey<sup>1</sup>, Deepak Raj<sup>2</sup>, Ayush Singh<sup>3</sup>, MD Soaib Khan<sup>4</sup>, Samrat Singh<sup>5</sup>, Gaurav Dubey<sup>6</sup>, Dr. Mumtaz Begam<sup>7</sup>

<sup>1,2,3,4,5,6</sup> Student, Department of Civil Engineering, Oriental Institute of Science & Technology, Bhopal

<sup>7</sup> Guide, Department of Civil Engineering, Oriental Institute of Science & Technology, Bhopal

**Abstract**—With the advent of advanced technology, civil structures such as high-rise buildings and long span bridges are designed with increased flexibility, increasing their susceptibility to external Excitation. Therefore, these structures are vulnerable to excessive modes of vibration under the effect of a strong Wind and earthquake. To protect such civil structures from significant structural damage, the seismic response of these Structures is analyzed along with wind force calculation and forces such as support reactions and joint Displacement are calculated and included in the structural design for a vibration resistant structure. The primary objective of this paper is to create an earthquake resistant structure by undertaking seismic study of the structure by static equivalent method of analysis and carry out the analysis and design of the office building using STADD. Pro software. For this purpose, a G+8 residential building plan in Delhi is considered. Seismic calculations are conducted for earthquake zone 4, Response reduction factor 5, for special moment resistant frame and Importance factor 1.5 The structural safety of the building is ensured by calculating all acting loads on the structure, including the lateral loads caused due to wind and seismic excitation.

**Index Terms**—STAAD-Pro, base Shear Equivalent, load, assign, property, definition, seismic analysis, design, earthquake behavior, modeling, seismic resistance

## I. INTRODUCTION

Structural design is the science of analyzing and designing any structure with ultimate strength, safety, serviceability and economy. It not only requires conceptual thinking and imagination but also the discipline to maintain design standards specified by the respective country design code, for example IS Code. Any building project initiates from the planning stage to meet the specified requirement of the client. Although the client may be unaware of the

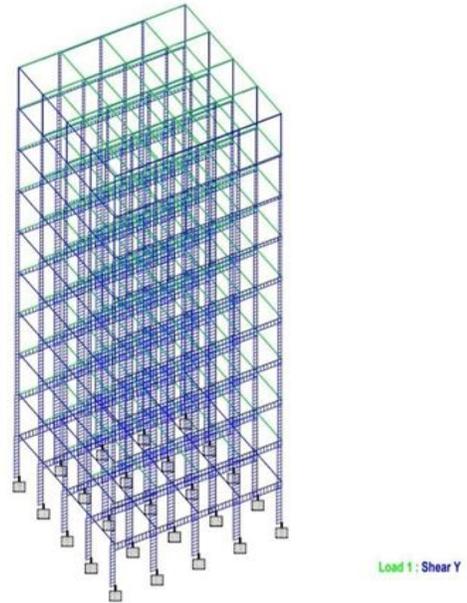
impracticable conditions existing within the site and have unprecedented expectations, it is the sole responsibility of the structural engineer to undertake the challenge and meet the design requirements for strength, durability, economy and safety. The existing shortage of land due to the human population out-burst is constantly demanding the construction of high-rise structures. As the floor count of these multi-story Buildings increase, the structure gets vulnerable to external lateral forces subjected by earthquake excitation and wind pressure, thus leading to structural instability and subsequently complete failure of the Structure.

## II. OBJECTIVE

- The main objective is to estimate and check seismic response of building and analyze & design it on that basis using STAAD-Pro software.
- Design and seismic analysis of multistoried building before construction work using STAAD-Pro Software using.
- Modeling of 8-storey building and application of different loads on STAAD.Pro, load calculations due to different loading combinations, analysis and design of structure on STAAD-Pro.
- Study of reactions, shear forces, bending moment, seismic forces and node displacement during assigning process and restrained them by applying suitable property and material and again assigning.
- Study of the deflection, shear force, and bending moment. Design of building
- Load calculation due to different loading conditions. Application of loads on STADD. Pro model.

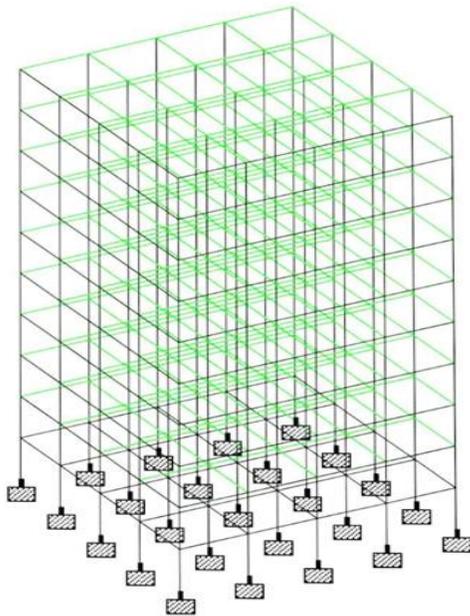
### III. PROJECT STATEMENT

The building is designed for the following parameters:
Site location: Seismic Zone – IV
Type of the soil: Medium soil.
Allowable bearing pressure: 150KN/m <sup>2</sup>
Response Reduction factor® – 5. for SMRF.
Number of Floors: 8
Total Length and Width:- 16x16 m
Floor Height: 3m
External thickness of wall: 230mm
Internal thickness of wall: 115mm
Beam Size: - 300x400 mm
Column Size: - 400x400 mm
Slab Thickness: 125 mm
Live Load: 3 KN/m <sup>2</sup>
Wind Load: IS: 875-(Part-3).
Earthquake Load: IS: 1893-2002(Part-1).
Grade of Concrete: M30
Grade of Steel: FE500



The STADD-Pro plan and model for the

- The building plan is of size 16m x 16m.
- Height of the building (h) = 24 m
- Width of the building (dx) = 16 m
- Width of the building (dz) = 16 m



### IV. LOAD CASES DETAIL

Earthquake x direction  
 Earthquake z direction

Self Weight Factor :1  
 Wind Load x direction with Factor 1  
 Wind Load x direction Factor -1  
 Wind Load z direction Factor 1  
 Wind Load z direction Factor -1  
 Dead Load -  
 Live Load -

### V. SEISMIC DEFINITION

To make the structure earthquake resistant, the fundamental period of the building while vibration should be calculated and provided as input to STADD. Pro for seismic analysis. The considered building is in Delhi Seismic parameters as per (IS 1893 (Part 1): 2002) are stated below:  
 Seismic Zone – IV (IS 1893 (Part 1): 2002)  
 Zone Factor (Z) – 0.24 (Table 2, IS 1893 (Part 1): 2002)  
 Importance factor – 1.5 (Table 6, IS 1893 (Part 1): 2002)

Rock and Soil Site Factor - 2  
Damping Ratio - 0.05  
Response Reduction Factor – 5 (Table 7, IS 1893)  
Exposure Factor - 1

## VI. METHODOLOGY TO UNDERTAKE ANALYSIS AND DESIGN OF G+8 BUILDING ON STADD. PRO

Step-1: Nodal point generation. With respect to the positioning of the column on the building plan we, respective nodal points have been entered on the STADD model.

Step-2: Beam and column representation. Based on the nodal points, with the help of add beam command on STADD. Pro, beam and columns have been generated.

Step-3: Assign support and member property. After column generation, supports have been provided below every column as fixed supports. Subsequently, based on load calculations, the beam and column cross-sections have been assigned.

Step-4: 3D View. After assigning the member property, the 3D view of the structure can be shown.

Step-5: Dead Load assignment. According IS: 875 (Part 1) – 1987, the dead loads have been assigned based on member load, floor load and self weight of the beams

Step-6: Live Load assignment. According to IS: 875 (Part 2) – 1987, live load of 3 KN/m<sup>2</sup> has been assigned to the members.

Step-7: Seismic load assignment. After creating suitable seismic definition as per the requirement of IS 1893 (Part 1): 2002, the seismic load has been assigned with respect to +X, -X, +Z and -Z directions with appropriate seismic factor.

Step-8: Wind load assignment. After entering the wind intensity and creating the wind definition as per IS: 875 (Part 3) – 1987, the wind loads have directions.

Step-9: Load combination assignment. Different load combination cases have been assigned to the model based on specified loading combinations provided in the IS CODES that are also available in STADD. Pro.

Step-10: Analysis of the structure on STADD. Pro. With the help of the Run Analysis Command, the structure is analyzed and detailed study of forces and bending moment is undertaken through the Post processing mode.

Step-11: Structural Design on STADD. Pro and

Output Generation. The design is undertaken as per IS 456:2000. M30 concrete and FE500 is used as design parameters. Percentage steel of 4% has been specified as per IS Code standards and the design parameters have been assigned to respective beam and column. After the final design of the structure, the output file is generated containing the structural design of every individual beam and column member.

## VII. CONCLUSION

- The G+8 residential building has been analyzed and designed using STADD. Pro. Seismic and wind forces have been considered and the structure is designed as an earthquake resistant structure. Earthquake and wind-oriented deflections must be limited for multiple reasons and hence abundant structural stiffness is important. As a result, the inter-story drift must be obtained within the specified limits. For minimum specified lateral force with partial load factor of 1.0, the Inter-story drift should be under  $0.04 \times H_s$ , where ( $H_s$ ) is the story height (Clause 7.11.1, IS 1893 (Part 1): 2002). For 3300 mm floor.

## REFERENCES

- [1] IS-875(PART-1): 1987 Indian Std. Code of Practice for Design Loads
- [2] IS-1893(Part 1): “Earthquake Resisting Design of Structures”.
- [3] IS: 875 (Part 2): 1987 “Imposed Loads”.
- [4] STAADPRO manual.
- [5] Pankaj Agrawal, “Earthquake Resistant Design of Structures” by, Eastern Economy Edition.
- [6] D.R. Deshmukh, Yadav, A.K., Supekar, S.N., Thakur, A.B., Sonawane, H.P., Jain, I.M., (2016). “Analysis and Design of G+19 Storey Building Using StaadPro”. Int. journal of engineering research and application (IJERA), ISSN: 22489622, Vol 6, Issue 7.
- [7] Akshay R. Kohli, Prof. N. G. Gore, MGM’s College of Engineering & Technology, Navi Mumbai, Maharashtra, India, “Analysis and Design of an Earthquake Resistant Structure using STADD. Pro”, Int. journal of engineering research and application (IRJET), e-ISSN: 2395-0056 Volume:04, Issue:12Dec-2017 www.irjet.net, pISSN: 2395-0072
- [8] Dr. V. L. Shah and Dr. S. R. Karve, (2010).

“Illustrated design of Reinforced Concrete Buildings”. 4th ed.

[9] Murthy C.V.R, Learning earthquake design