RESEARCH ARTICLE OPEN ACCESS

Analysis and Design of G+19 Storied Building Using Staad-Pro

D.R. Deshmukh[1], A.K. Yadav[1], S. N Supekar[1], A. B. Thakur[1], H. P Sonawane[1], I. M. Jain[2]
[1](Students, Department of Civil Engineering, Sinhgad Institute of Technology and science, SPPU, Pune-41)
[2](Assistant Professor, Department of Civil Engineering, Sinhgad Institute of Technology and Science, SPPU, Pune-41,

ABSTRACT
High-rise structures need much time for its time consuming and cumbersome calculations using conventional manual methods. STAAD-Pro provides us a fast, efficient, easy to use and accurate platform for analyzing and designing structures. The principle objective of this project is to analysis and design a multi-storied building G+19 (3 dimensional frame) using STAAD Pro software. The design involves analyzing the whole structure by STAAD Pro. The design methods used in STAAD-Pro analysis are Limit State Design conforming to Indian Standard Code of Practice. We conclude that STAAD-PRO is a very powerful tool which can save much time and is very accurate in designs. In this project, G+19 storied building is considered and applied various loads like wind laod, static laod ,earthquake load and results are studied and compared by manual calculations.
Keywords: high rise building, seismic load, STAAD pro

I. INTRODUCTION

Nowadays, Construction of high rise building is a basic need because of scarcity of land. Conventional method of manual design of high rise building is time consuming as well as possibility of human errors. So it is necessary to use some computer based software which gives more accurate results and reduce the time. STAAD-PRO is the structural software is nowadays accepted by structural engineers which can solve typical problem like static analysis, wind analysis, seismic analysis using various load combination to confirms various codes such as IS 456:2000, 1893:2002, IS 875:1987 etc.

II. OBJECTIVE

Following specific objectives has been made for the present study-

- To develop, design and analysis model of the High rise structure in STAAD-Pro.
- Study of seismic and wind load applied to the structure as per IS 875 and IS 1893.
- Comparison of results of earthquake load applied on the structure by STAAD-Pro and manual calculations both by seismic coefficient method.
- To verify deflection obtained by STAAD-Pro with IS codal Limit..

III. METHODOLOGY

A Model of G+19 storeyed is developed, analysis and design using STAAD-Pro software. Building plan size is 33.6m × 18.8m. The building is situated in Pune in earthquake zone III. eismic zone coefficient is taken as 0.06 as per IS code. Following specifications are given to the structure:

Column	0.30 m × 0.60 m
Beam	0.45 m × 0.45 m
Slabs	0.15m thick
Parapet Wall	0.1 m
Live load	2kN/m^2
Floor Finish	1kN/m^2
Grade of concrete	M30
Grade of steel	Fe 415

These values are provided as a input to the staadpro software for drawing, analysis and designing purposes.

Supports: The base supports of the structure is assigned as fixed..

Loading:
The loadings were calculated partially manually and rest was generated using STAAD.Pro load generator. The loading cases were categorized as :-

- Dead load
- Live load
- Wind load
- Seismic load

Self-weight

The self weight of the structure can be generated by STAAD.Pro itself with the self weight command in the load case column.

Dead Load From Slab:

Dead load from slab can also be generated by STAAD.Pro by specifying the floor thickness and the load on the floor per sq m.

Calculation of the load per sq m was done considering the weight of beam, weight of column, weight of RCC slab, weight of terracing, external walls, internal walls and parapet over roof.

External Wall Load = 13.8 kN/m^2
Internal Wall Load = 4.6 kN/m^2

Seismic load:

The seismic load values were calculated as per IS 1893-2002. STAAD.Pro has a seismic load generator in accordance with the IS code mentioned.

$$A_h = \frac{z}{2} \times \frac{I}{R} \times \frac{S_a}{g}$$

$$T = \frac{0.09H}{\sqrt{d}}$$

Where $\frac{S_a}{g}$ depends upon Natural period(T)

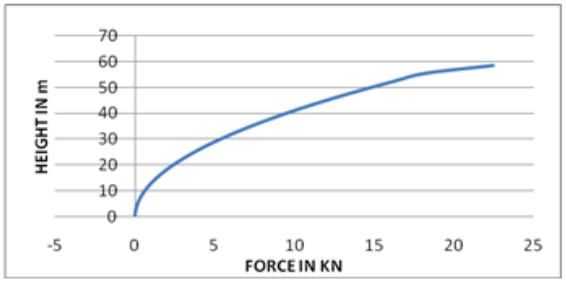
$$V_b = W \times A_h$$

$$Q = \frac{WH^2}{\sum WH^2} \times V_b$$

Where,
Z= zone factor
I= Importance factor
R= Response reduction factor
$\frac{S_a}{g}$ =Average response acceleration coefficient
W= Total dead load plus approximate imposed load
A_h= Design horizontal acceleration coefficient
V_b =Design seismic Base shear
Q= Design Lateral force
T= Natural period
d= Base diamesions

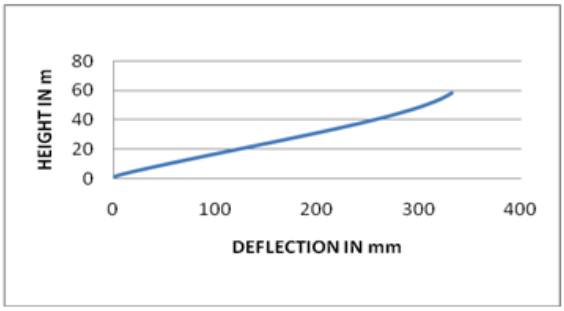
IV. RESULTS

Graph shows the maximum deflection occurs when the earthquake load in x-direction acting on the structure. As height increases, deflection is also increases. Hence graph of height v/s deflection varies linearly.



Graph 1. Height V/S Deflection due to EQ Force in X direction

Graph shows the maximum force occurs when the earthquake load in x-direction acting on the structure. Effect of the earthquake load in z-direction is approximately same. As height increases, magnitude of force is also increases



Graph 2. Height v/s Earthquake Force in X direction

Graph shows the maximum force occurs when the earthquake load in x-direction acting on the structure. Effect of the earthquake load in z-direction is approximately same. As height increases, magnitude of force is also increases.

It gives the details for beam such Grade of concrete, steel, sectional dimensions, cover and section-wise top and bottom reinforcement details for flexural and shear requirement. similarly for column, it provide interaction ratio as per Clause 39.6, IS 456:2000

It also provide the data for concrete take off for beam, column and slab.

Steel bar daimeter and according the weigth requiremnet is provided by Staad pro.

- We have compared results of base shear obtained by Staad pro with Manual calculations. Values obtained by Staad pro is greater than manual calculations by approximately 5%.
- Total volume of concrete required =2385.1 cu.meter
- Total steel required =2820.65KN

V. CONCLUSION

STAAD PRO is a versatile software has the capability to calculate the reinforcement needed for any concrete section, to find lateral deflection due to earthquake load . The program contains a number of parameters which are designed as per IS: 456(2000) , IS 1893:2002. Various structural action is consider on members such as axial, flexure, torsion etc according to their response.

Design of beam for Flexure:

STAAD Pro gives SFD and BMD for individual member and whole structure. It suggests

the adequacy of the section as a singly reinforced section, doubly reinforced section.

Beam Design Output:

The default design output of the beam contains flexural and shear reinforcement provided along the length of the beam.

Column Design:

Columns are designed for axial forces, uniaxial and biaxial moments at the ends. Square columns are designed with reinforcement distributed on each side equally for the sections under biaxial moments and with reinforcement distributed equally in two faces for sections under uni-axial moment. All major criteria for selecting longitudinal and transverse reinforcement as stipulated by IS: 456 have been taken care of in the column design.

Base shear :

Base shear plays an important role. Its gives the base shear for entire structures.

Storey drift:

High rise structures are subjected to excessive deflection. Deflection obtained by STAAD pro is checked by IS Codal limitation for serviceability.

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IS Code

[8]. IS 875 (PART 1) - Dead Load

[9]. IS 875 (PART 2) - Live Load

[10]. IS 875 (PART 3) - Wind Load

[11]. IS 1893-2002 – Earthquake Load

[12]. IS 456-2000 – Concrete Design