Analysis and Design of Multistory (G+21) Building Using STAAD pro Software

Sagar Naik[1], Kashyap Rupareliya[2], Chandresh Shankar[3], Hardik Shiroya[4], Niraj Vekariya[5]
[1]*Assistant Professor at Civil Department of Bhagwan Mahavir College Engg.& Tech, Surat*
[2,3,4,5] *Student of B.E. Civil at Bhagwan Mahavir College of Engg. & Tech, Surat*

Abstract- **In order to emulate in the ever development of market it is very vital for a structural engineer to save time. As a continuation to this an effort is made to analyze and design a multistoried building by using a software package as STAAD Pro. For analyzing a multi storied building one has to conceive all the possible loadings and see that the structure is safe against all possible loading conditions. This building's aspects are also useful for stable against all type of calamity and environmental problems. There are few methods for analysis of different frames like stiffness matrix method, cantilever method, portal method and Matrix method. The present project deals with the analysis of a multi storied residential building of G+21 consisting of 2 flats in each floor. The self-weight load &live loads are applied and the design for slab, beams, columns, footing is obtained STAAD Pro with its new features surpassed its predecessors, and compotators with its data sharing intelligence with other major software like AutoCAD, and MS Excel.**

We will determine that STAAD Pro is a very powerful software which can save much time and is very accurate in designs. Thus it is determine that STAAD-Pro package is suitable for the design of a multistoried building. The main objective is to analyze and design a multi-storied building [G + 21 (3 dimensional frame)] using STAAD Pro. The design of G+21 building involve manual load calculations and the whole structure is analyzed by STAAD Pro. Limit State Design method is used in STAAD-Pro analysis conforming to IS Code of practice. STAAD Pro is the professional's choice like, model generation, analysis and design to visualization and result verification, STAAD Pro gives accurate results and the software is user friendly too. To check the reliability of our results with the software generated results. We are analyzing and designing 3d frame of 22 story building with wind load analysis in this semester and after words we will analyze and provide design of earthquake norms and combination of wind and seismic factors with details.

Index Terms- **STAAD Pro Software, Analysis and Design of Multistory building, AutoCAD drafting, 3D frame**

I. INTRODUCTION

Building construction is the branch of civil engineering which deals with the construction of building such as residential building, bungalows, row houses etc. Human beings needs three basic things an enclose space by walls with roof (house), food, cloth. In the early times humans beings lived in caves, over or under trees, to protect themselves etc. as the times passed as humans being started living in cottage made of pieces of timber. The condition of those cottage are converted into beautiful houses today. Rich people live in more facilitate houses like bungalows. Social progress of the county is denoted by buildings of that country. Now a days the house building is major work of the social progress of the county.

Today, New Techniques are being developed for the construction of houses economically, quickly. A design of R.C building of G+21 story frame work is taken up. The building in plan (105 X 36) in feet's consists of columns built monolithically forming a network. The size of building is 105 X 36 feet. The number of columns are 24. It is residential complex. The design of structure is made using various software like STAAD-Pro, Midas, Strud v11 and Spread sheet by Excel, etc. The building is subjected to both the vertical loads as well as horizontal loads. The vertical load consists of dead load of structural components of building such as roof, columns, slabs, self-weight etc. and live loads like load of furniture, moveable items, etc. The horizontal load consists of the wind forces, seismic load, snow etc. The building is designed as three dimensional vertical frame and analyzed for the maximum and minimum bending

moments and shear forces by trial and error methods as per IS 456-2000 and Finite element method(FEM)

II. AIM AND OBJECTIVE

A. AIM

Aim of the present work is to carry out analysis and design for a multi-story building using computer aided analysis and design. By conducting this in STAAD Pro software, we can try to know the stability against disaster problems as specially wind and seismic action of the building structure and then we will design according to the requirement.

B. OBJECTIVES

Following are the main objectives of the present study:

1. Study of loads acting on structure and behavior of structural member in different conditions.
2. To Study of load distribution on structural members.
3. To study how to work computer aided analysis and design software.
4. Study of analysis of multi-storey building with trial and error concepts.
5. To design a structural member against various combination of size and percentage of reinforcement requirement.
6. To present the maximum strength of the structure.
7. To study a ductile design based on IS: 13920:2002 code perforation.

III LITRETURE REVIEW

Perusal of relevant literature paper shows that maximum hourly mean wind speed data is available with Indian Meteorological Department. Extreme value statistical analysis of yearly maximum hourly mean wind speeds over consecutive years has been carried out by Sharma (1993, 1994). These values of hourly mean wind speeds can be used in Gust Factor Method for computing wind loads on structures. Sharma Shruti (2002) and Kutar, Virpal(2003) carried out some studies relating to wind loads on buildings. Sharma, Mayank(2018) carried out extensive work on various buildings for computing wind loads by various methods.

The study presented here has been taken with the objective of critically examining the Gust Factor Method incorporated in the present Indian Standard for wind loads, IS 875 (Part 3) 1987. For this purpose overall effect on a building in the form of wind loads have been obtained by:

1. Peak Wind Approach associated with Static Method as per IS 875 (Part 3) 1987. (PWA-SM).
2. Mean Wind Approach associated with Gust Factor as per IS 875 (Part 3) 1987. (MWA-GFM).
3. Mean Wind Approach associated with Gust Factor* as per IS 875 (Part 3) 1987. (MWA-GFM*)but using hourly mean wind speeds based on statistical analysis of hourly mean wind speeds and taken from literature paper.

Computer Aided Analysis and Design of Multi-Storeyed Building Using STAAD-Pro

Pushkar Rathod, Shruti Rathod, Rahul Chandrashekar

The main objective is to analyse and design a multi-storeyed building [G + 21 (3 dimensional frame)] using STAAD-Pro software. The design of G+21 building involves manual load calculations and the whole structure is analysed by STAAD Pro software. Limit State Design method is used in STAAD-Pro analysis conforming to IS Code of Practice. STAAD Pro is the professional's choice from model generation, analysis and design to visualization and result verification, STAAD Pro gives accurate results and the software is user friendly. To check the accuracy of our results with the software generated results, we analysed a simple 2D frame manually. The results proved to be very accurate. A G+7 storey building was initially analysed for all structure load and load combinations as per Indian Standard Code of practice.

IV. DATA COLLECTION

Table -1: Design Data

Sr.no.	Name	Details
1	Live load	4 kN/m²
2	Floor Finish	1 kN/m²
3	Type of Soil	BLACK COTTON SOIL
4	Terrain Categories	3 (CLASS C)
5	Location	Surat
6	Size of building	32.01 m X 10.98 m

Table -2: Description Of Over Frame

Sr.no.	Name	Description of Frame
SILENT FEATURES		
1	Utility of Building	Residential purpose
2	No. of Story	21

3	Shape of Building	Rectangular
4	No. of Staircases	1
5	No. of Flats	40
6	No. of Lifts	2
7	Type of Construction	RCC Frame structure
8	Type of Wall	Brick wall
GEOMETRIC DETAILS		
9	Ground Floor	3.05 m
10	Floor to Floor Height	3.05 m
11	Height of Plinth	0.45 m
12	Depth of Foundation	5 m
13	Height of Building	68.1 m
MATERIAL		
14	Concrete Grade	M20, M30
15	All Steel Grades	Fe415
16	Soil Bearing Capacity	230 kN/m²
17	Earthquake zone	III

V. ANALYSIS AND DESIGN CALCULATION

5.1 Assumptions

1. Using partial safety factor for loads in accordance with clause 36.4 of IS-456-2000 as $\Upsilon t = 1.5$
2. Partial safety factor for material in accordance with clause 36.4.2 is IS-456-2000 is taken as 1.5 for concrete and 1.15 for steel.
3. Using partial safety factors in accoance with clause 36.4 of IS-456-2000 combination of load.

5.2 Dead loads

Table -3: Density Of Materials

SR. NO.	MATERIAL	DENSITY
1.	Plain Concrete	24.0 KN/m3
2.	Reinforced Concrete	25.0 KN/m3
3.	Flooring Material(C.M.)	20.0 KN/m3
4.	Brick Masonry	19.0 KN/m3
5.	Fly Ash	5.0 KN/m3

5.3 Live loads

In accordance with IS. 875-1986
i) Live load on slabs= 20.0KN/m2
ii) Live load on passage = 4.0KN/m2
iii)Live load on stairs =4.0 KN/m2

5.4 Lateral loads

5.4.1 Wind Loads

➢ Design Wind Pressure :-
The variation of hourly mean wind speed with height is calculated as follows;

$\bar{V}_z = Vb \times k1 \times k2 \times k3 \times k4$

Where,
$\bar{V}_z$ = Hourly mean wind speed in m/s at height 'z' m,
Vb = Regional basic wind speed in m/s = 44 m/s,
$k1$ = Probability factor = 1 for 50 year building life,
$k2$ = Terrain and height factor (from Table 33),
$k3$ = Topography factor = 1,
$k4$ = Importance factor for the cyclonic region = 1.0 for All other Structure,

Design wind pressure '$\bar{p}_z$' = 0.6 $(\bar{V}_z)^2$
Where,
$\bar{p}_z$ = Design wind pressure at height 'z' m,
$\bar{V}_z$ = Hourly mean wind speed in m/s at height 'z' m,

➢ Along Wind Load :-
Along Wind Load on the structure on a strip area (A) at any height 'z'm is given by:

$Fz = Cf \times A \times \bar{p}_z \times G$

Where,
Fz = Along wind load on the structure at any height 'z' corresponding to strip area A,
Cf = Force coefficient for the building. = 1.2,
A = Effective frontal area considered for the structure at height 'z' m. = 68.1/22 = 3.095,
$\bar{p}_z$ = Design pressure at height 'z', due to hourly mean wind obtained as $0.6\bar{V}_z^2$ (N/m2)
G = Gust Factor [(peak load)/ (mean load)], and is given by:

$G = 1 + gf \ r \ \sqrt{[B (1+\varnothing)^2 + (SE/\beta)]}5$

5.4.2 Earthquake Load

The design horizontal seismic coefficient Ah for a structure shall be determined by the following expression:

$Ah = \dfrac{ZISa}{2Rg}$

Provided that for any structure with $T <= 0.1$ s, the value of Ah will not be taken less than 2/2 whatever be the value of I/R

where
Z= Zone factor given in Table 2, is for the Maximum Considered Earthquake (MCE) and service life of structure in a zone. The factor 2 in the denominator of Z is used so as to reduce the Maximum Considered Earthquake (MCE) zone factor to the factor for Design Basis Earthquake (DBE).
I=Importance factor, depending upon the functional use of the structures, characterized by hazardous consequences of its failure) post-earthquake

functional needs, historical value, or economic Importance

R= Response reduction factor, depending on the perceived seismic damage performance

of the structure, characterized by ductile or brittle deformations. However, the ratio *(2Rg)* shall not be greater than 1.0 (Table 7). The values of *R* for buildings are given in code.

Sa/*g* = Average response acceleration coefficient

Design base shear= Ah* total weight of building
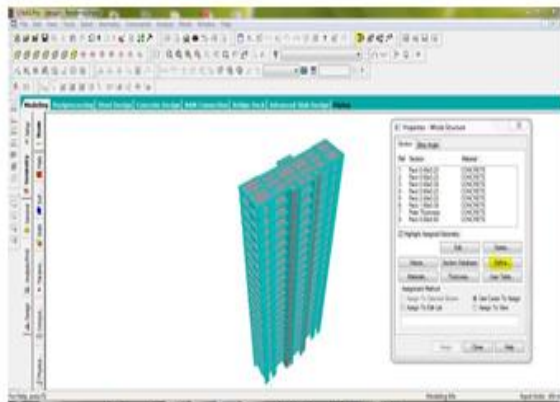
VI DESIGN STEPS IN STAAD PRO SOFTWARE

Fig-1: Create a model in STAAD pro
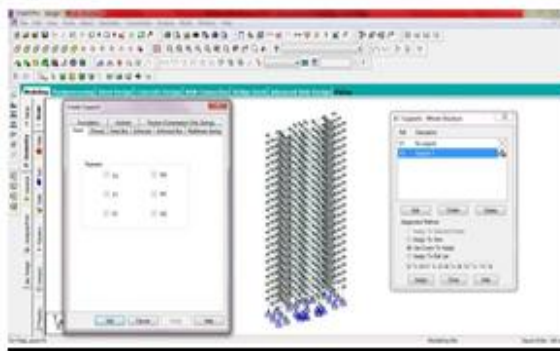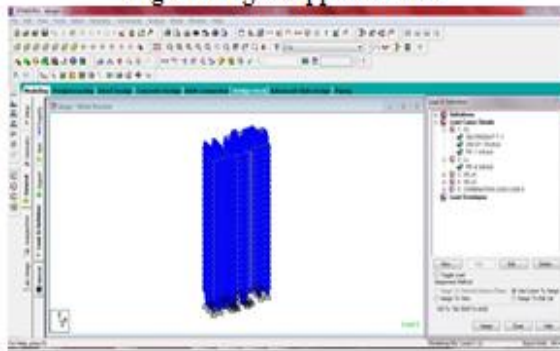

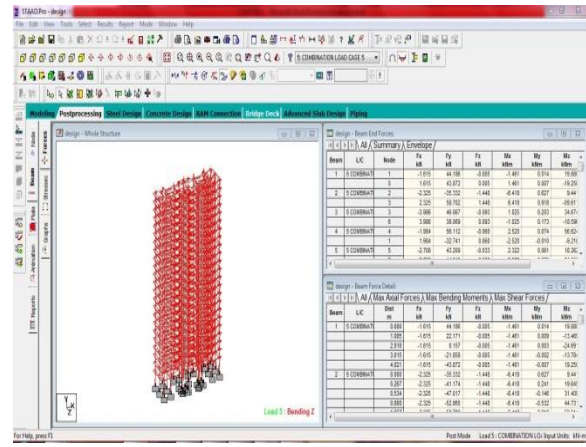Fig-2: Assign Support at base

Fig-3: Assign loading
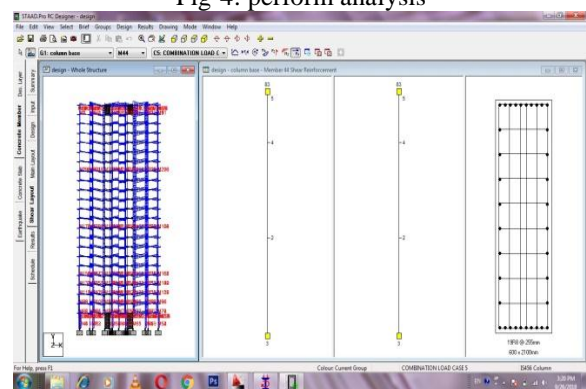

Fig-4: perform analysis

Fig-5: Design of Structural members

- We are analyze to taking of this above criteria and parameters for RCC frame analysis by software using stiffness matrix method.
- In this structure we are provide column, beam slab, shear wall design as per IS code 456:2000
- Size of Column at base of below ground level is 0.6x2.1 m
- Size of beam at typical floor is is 0.3x0.45m
- Size of secondary beam at typical floor is is 0.23x0.45m
- Size of shear wall at typical floor thickness is 0.45m
- Slab thickness is providing as a 0.125m
- As per the seismic analysis this structure does not accepted in height vs. area ratio so that provide a long shear wall at middle having size of 0.45x4.0 m
- it is divide whole structure in two portion and behave individually so that it useful for in seismic load consideration.

VII. CONCLUSIONS

- STAAD pro is capable of generating the reinforcement details for each and every column and beams making use of preset code.
- The presence of RC shear wall influences the overall behavior of structures when subjected to lateral forces. Hence RC shear wall can be considered as displacement and drift control structural element.
- Overall analysis suggests rectangular structure for along wind or across wind direction is preferable due to large stiffness and less displacement against wind and seismic loads.
- The default design output of the beam contains flexural and shear reinforcement provided along the length of the beam.

REFERENCES

[1] Analysis and Design of High Rise Building Frame Using STAAD Pro Software Tejashree Kulkarni1, Sachin Kulkarni, Anjum Algur, M. H. Kolhar.

[2] Study of Wind Analysis of Multi-Story Composite Structure for Plan Irregularity Shaikh Muffassir, L.G. Kalurkar.

[3] Comparative Study on Wind Analysis of Multi-Story RCC and Composite Structure for Different Plan Configuration.

[4] IS: 1893:2000, Part 1, Criteria for Earthquake Resistant Design of Structures – General Provision for Buildings, Bureau of Indian Standards, New Delhi, 2002.

[5] IS: 456-2000, Plain And Reinforced Concrete-Code of practice, General Provision for Buildings, Bureau of Indian Standards, New Delhi, 2002.

[6] IS: 875-1987, Code Of Practice For Design Loads (Other Than Earthquake) For Buildings And Structures General Provision for Buildings, Bureau of Indian Standards, New Delhi, 2002.

[7] IS: 1893:2002, Criteria Of Earthquake Resistant Design Of Structure, Bureau of Indian Standards, New Delhi, 2002.

[8] IS: 13920:1993, Ductile Detailing Of Reinforced Concrete Structures Subjected To Seismic Forces — Code Of Practice, Bureau of Indian Standards, New Delhi, 2002.

[9] Design of Reinforced Concrete Structure vol.1/2-Dr.H.J. Shah, Charotar Publication-ISBN-10: 9380358474