ANALYSIS AND DESIGN OF MULTISTORIED EARTHQUAKE RESISTANT BUILDING. "G+25"

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ABSTRACT - *This research was carried out with an objective to determine the design loads of a G+25 Multistoried building structure which is an earthquake resistant structure. The purpose of this investigation is to determine the design loads for a structure that will be subjected to seismic loads in a specific area. It is well knowledge that seismic loads can be estimated in a certain zone using a zone factor. The seismic load of that zone can then be calculated depending on the magnitude of the earthquake and other characteristics unique to that region. However, Earthquake load is stochastic and time dependent.*

The structure should be constructed to meet the target demand for the duration of its life. The main goals of structural design are to create a structure that provides total resonance while maintaining safety in terms of strength, stability, and structural integrity, as well as acceptable serviceability in terms of stiffness, longevity, and cost.

Key Words – Analysis and Design, Earthquake Resistant, Seismic Load, Stability, Stiffness, Staad Pro.

INTRODUCTION –

Seismic design for high-rise buildings has grown increasingly essential in recent years. For structures of small height subjected to low-intensity earthquakes, traditional methods based on the fundamental mode of the structure and the distribution of earthquake forces as static forces at various stories may be sufficient, but as the number of stories increases, seismic design becomes more rigorous.

A design for a R.C.C building with a G+25 storey frame is being considered. The design is done with structural analysis design software (staad-pro). The structure was subjected to vertical as well as horizontal loads. The dead load of structural components such as beams, columns, and slabs, as well as living loads, make up the vertical load. The seismic forces make up the horizontal load, hence buildings are constructed for dead load, live load, and seismic load, according to IS 1893 - 2016. The structure is constructed as a two-dimensional vertical frame that is trial-and-error assessed for maximum and minimum bending moments and shear forces in accordance with IS 456-2000. The assistance is provided via software available at the institute, which allows for the computation of loads, moments, and shear forces.

OBJECTIVES - The project's major goal is to improve knowledge of multistory RCC building structural design and architectural works. This project teaches us how to examine field difficulties and how to arrive at a reasonable solution, as well as refresh our knowledge of structural member design. Working in a real-world setting improves theoretical and practical knowledge, as well as confidence, which will be useful in professional activity in the near future.

The following are the precise objectives of the project's work:

1. Identification of the plan's structural organization.

2. Determination of criticality and vulnerability in seismic performance.

3. Research into seismic codal provisions.

4. Use of Staad Pro to model the building for structural analysis.

5. Components are designed in sections.

6. Structural detailing for members.

LITERATURE SURVEY

1. Vikrant Trivedi.et.el; (2018): This research compares wind loads in order to determine the design loads of a G+11 structure. The purpose of this investigation is to determine the design loads for a structure that is exposed to wind loads in a specific area. It is well knowledge that the wind load in a specific zone can be approximated using a zone factor. The wind load of that zone can then be calculated using the fundamental wind speed and other elements unique to that region. The wind velocity, on the other hand, is stochastic and time dependent. A multistory building is examined for wind loads using IS code 875 in this study, and the findings are compared between with and without wind load.

2. MB Vikram.et.al;(2017): Structural analysis is primarily concerned with determining how a structure behaves when it is subjected to some action. Using the ETABS software, a residential (G+5) multi-story building is investigated for seismic loads. The linear static ana is done assuming that the material property is true. These linear static assessments take into account four seismic zones (zone II, zone III, zone IV, and zone V), and the behaviour is evaluated using Type II soil conditions. The reactions of various load combinations and zones, such as bending moment and axial forces, are investigated. The bending moment and axial force are also affected by the T seismic load.

3. Aman.et.al;(2016): The fundamental goal of a structural engineer is to build a structure for safe computer technology; structural engineers can handle much larger and more sophisticated structures that are subjected to many types of loading conditions. Previously, the loads acting on the structure were regarded static, but strictly speaking, no structure load is static, with the exception of self-weight (dead load). Today, a great variety of application software is accessible in the civil engineering sector. All of these programmes are built on a foundation of superior technology. Finite element analysis, which takes into account the effects of dynamic loads like as wind, earthquakes, and other natural disasters. An attempt was made in the previous work to investigate the efficacy of particular civil engineering application software. An ongoing project has been chosen for this purpose. This initiative is part of the Gulbarga City's Unity Builders programme. The project's name is Bharat Pride.

4. Ms. Priyanka Soni.et.al. ;(2016): Ms. Priyanka Studied on Shear walls are structural systems that protect structures from lateral loads such as wind and earthquakes. These structural systems are made of reinforced concrete, plywood/timber unreinforced masonry, and reinforced masonry at the locations where these systems are made of reinforced concrete, plywood staggered walls. The current paper was written with the goal of studying and analyzing numerous research projects involving the enhancement of shear w and their behavior when subjected to lateral loads. Shear walls withstand substantial lateral stresses in the lower half of the building, while the frame supports lateral loads in the higher portion, making soft storey high rise buildings ideal. In India, similar structures have been created. As in India, the lower floors are utilised for parking and garages, while the top floors are used for residences.

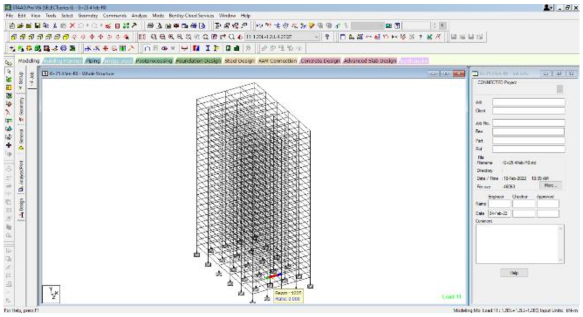
5. Varikuppala Krishna, Chandrashekar.et.al; (2015 Structural Engineers face the difficult task of achieving the most efficient and cost-effective design while ensuring that the final design of a building is functional for its intended function during its design life & ndash; period. T project is an RCC framed structure with (parking floor +5) upper floors that was assessed and planned using ETABS to account for the lateral loading impacts of wind and earthquake (Extended Three Dimensional Analysis of Building system). ETABS is a software that includes all of the primary analysis engines, such as static, dynamic, Lin, and non & ndash:linear, and it is used to analyse and design structures. Buildings can be represented as per the arrangement of t members of the project in practise thanks to the features offered in this software modelling stage, and this programme treats beam columns as line members; slabs, Ramps/staircases, and walls as area members. Considering the effects of wind and seismic forces on horizontal loading; In the d of this project, I consider dynamic loading in addition to static loading and Liv loads as per IS code; and practically all of the project's members may be ana and designed as per Indian code using this software, with the members utilising excel sheets that I generate during this phase.

6. K. Rama Raju et al., 2013; For tall structure behaviour to be determined, site-specific lateral loading due to wind or earthquake stresses, as well as vertical gravity loads, must be taken into account. The amount of structural material required to resist lateral loads increases dramatically as a building's height increases. To securely carry gravity and lateral loads, tall building design entails a conceptual de approximate analysis, preliminary design, and optimization. Strength, serviceability, and human comfort are the design criteria. The structural engineer's goal is to come up with appropriate structural plans that meet these criteria. The limit technique of analysis and design of a 3B+G+40-story reinforced concrete high rise building under wind and seismic loads is given in this work, according to IS rules of practise. Allowable limitations for base shear, roof displacements, inter-story drifts, accelerations defined in codes of practise, and other relevant references in literature on the effects of earthquake and wind loads on buildings are verified to ensure the structure's safety.

METHODOLOGY

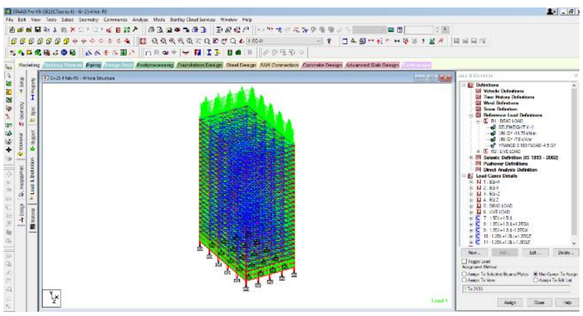
This project is primarily software-based, and it is essential to understand the specifics of these software.

- **Modelling of Frame:**
  G+25 Residential Building



Modelling of Frame In Staad Pro

❖ **Loading in Structure:** Dead Load, Live Load, and Seismic Load.



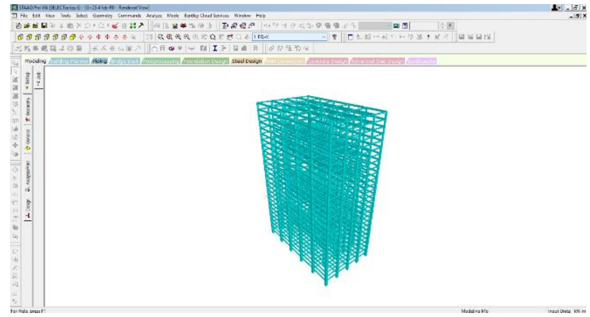
Loading Applied on Building Frame

Following Load Combinations are adopted

i. 1.5 Dead Load + 1.5 Live Load
ii. 1.2 Dead Load + 1.2 Live Load + 1.2 EQx
iii. 1.2 Dead Load + 1.2 Live Load - 1.2 EQx
iv. 1.2 Dead Load + 1.2 Live Load + 1.2 EQz
v. 1.2 Dead Load + 1.2 Live Load -1.2 EQz

Analysis and Design: Analysis of RCC Framed structure, Analysis for Shear Force and Bending Moments has been done using Staad Pro.

STAAD PRO can determine the amount of reinforcement required for any concrete segment. The programme includes a number of parameters that are designed in accordance with IS: 456. (2000). Flexure, shear, and torsion are all designed into beams.



3D Rendered View of Building

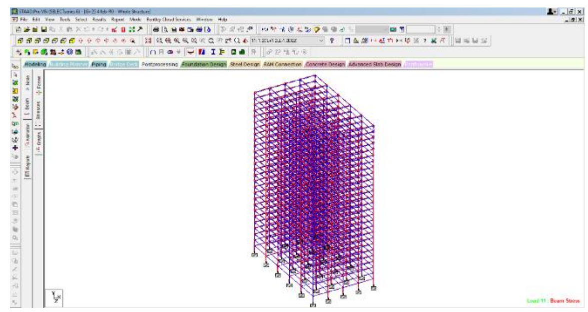


Diagram for Shear force

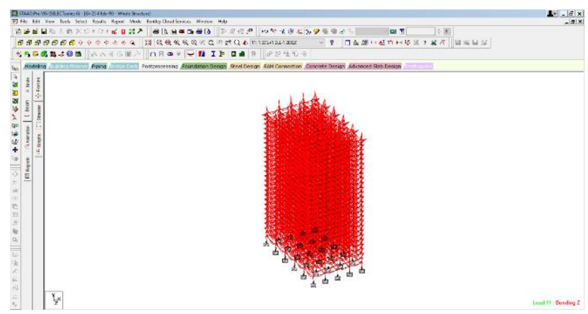


Diagram for Bending Moment

Results and Discussion

The maximum shear force at X- Direction is found at column no 597 Which is located at the basement floor of the building for the combination load having value of 44300.758 KN. The maximum shear force at Y- Direction is found at beam no 1561 Which is located at the Ninth floor of the building for the combination load having value of 548.970 KN. The maximum shear force at Z- Direction is found at column no 241 Which is located at the Twenty Fifth floor of the building for the combination load having value of 500.131 KN. The maximum bending Moment developed in X- Direction is found at column no 1111 Which is located at the Fifth floor of the building for the combination load having value of 38.710 KNm. The maximum bending Moment developed in Y- Direction is found at column no 840 Which is located at the basement floor of the building for the combination load having value of 2536.531 KNm. The maximum bending Moment developed in Z- Direction is found at column no 598 Which is located at the basement floor of the building for the combination load having value of 5111.416 KNm.

G+25 4 feb-R0 - Beam End Forces:

All | Summary | Envelope

	Beam	L/C	Node	Fx kN	Fy kN	Fz kN
Max Fx	597	7 1.5DL+1.5L	13	44300.758	-0.004	8.295
Min Fx	1586	7 1.5DL+1.5L	159	-115.954	540.763	0.000
Max Fy	1561	7 1.5DL+1.5L	134	-9.137	548.970	-0.001
Min Fy	1590	7 1.5DL+1.5L	299	491.969	-512.203	0.064
Max Fz	241	7 1.5DL+1.5L	159	1025.922	-0.227	500.131
Min Fz	1456	7 1.5DL+1.5L	839	953.896	0.011	-439.866
Max Mx	1111	8 1.2DL+1.2L	601	17345.537	63.674	-9.659
Min Mx	1115	9 1.2DL+1.2L	605	17344.471	-63.727	-9.657
Max My	840	10 1.2DL+1.2	18	34293.996	0.009	-338.589
Min My	354	11 1.2DL+1.2	8	34867.262	0.011	298.378
Max Mz	598	8 1.2DL+1.2L	14	35176.484	364.378	4.839
Min Mz	596	9 1.2DL+1.2L	12	35148.113	-364.381	4.842

Table for maximum Shear Force

G+25 4 feb-R0 - Beam End Forces:

All | Summary | Envelope

	Beam	L/C	Node	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
Max Fx	597	7 1.5DL+1.5L	13	-0.004	8.295	-0.001	-33.635	0.010
Min Fx	1586	7 1.5DL+1.5L	159	540.763	0.000	0.022	-0.001	1365.216
Max Fy	1561	7 1.5DL+1.5L	134	548.970	-0.001	0.011	0.006	1429.498
Min Fy	1590	7 1.5DL+1.5L	299	-512.203	0.064	0.934	0.369	1115.914
Max Fz	241	7 1.5DL+1.5L	159	-0.227	500.131	0.006	-701.098	-0.290
Min Fz	1456	7 1.5DL+1.5L	839	0.011	-439.866	0.000	615.375	0.014
Max Mx	1111	8 1.2DL+1.2L	601	63.674	-9.659	38.710	18.704	712.121
Min Mx	1115	9 1.2DL+1.2L	605	-63.727	-9.657	-38.698	18.695	-712.183
Max My	840	10 1.2DL+1.2	18	0.009	-338.589	-0.029	2356.531	0.046
Min My	354	11 1.2DL+1.2	8	0.011	298.378	0.051	-2415.417	-0.041
Max Mz	598	8 1.2DL+1.2L	14	364.378	4.839	-5.095	-10.605	5111.416
Min Mz	596	9 1.2DL+1.2L	12	-364.381	4.842	5.026	-10.742	-5111.398

Table for Maximum bending Moments.

Using Concrete Grade of M30 and Reinforcement Steel Fe550.

The Safe size of the beam along X direction is 300mm x 500mm and along Z – direction is 350mmx650mm at all levels of the building. Minimum percentage of steel is 0.2% and Maximum percentage of steel is 4.0% is used in all beams.

The safe Size of the interior column at the foundation level is 1300mm x 1300mm.

The safe Size of the exterior column at the foundation level is 1200mm x 1200mm.

The safe Size of the Interior and Exterior column from Ground level to Fifth Floor Level is 1200mm x 1200mm.

The safe Size of the Interior and Exterior column from Sixth Floor level to Tenth Floor Level is 1000mm x 1000 mm.

The safe Size of the Interior and Exterior column from Eleventh Floor level to Fifteenth Floor Level is 1000mm x 750mm.

The safe Size of the Interior and Exterior column from Sixteenth Floor level to Twentieth Floor Level is 1000mm x 600mm.

The safe Size of the Interior and Exterior column from Eleventh Floor level to Fifteenth Floor Level is 750mm x 500mm.

Minimum percentage of steel is 0.4% and Maximum percentage of steel is 6.0% is used in all columns.

Conclusion

A multi-story residential building with a G+25 storey was researched, assessed, and designed. It's a G+25-story building with parking on the ground floor and apartments on the upper levels. All of the structural components were designed and detailed using AutoCAD. The analysis and design were conducted using STAAD and conventional criteria. This is the greatest option for both static and dynamic loads. The size of the structural members are calculated, and loads such as dead, live, and seismic loads are applied. Deflection and shear tests are performed on beams, columns, and slabs. The tests turned out to be completely risk-free. Both theoretical and practical work has been completed.

- The Structural members beams and column of the buildings are are safe in shear, flexure and deflection of horizontal members are within 20mm.
- The steel provided in the structure is economical and as per IS Codes.
- The size of the structural members obtained from STAAD can be used in construction.

Future Scope:

Staad Pro is used to analyse tall buildings under seismic load. I discovered that with this software, the design of tall and complex structures can be done with maximum accuracy, and that while designing, we should aim to limit the structure's self-load by using light weight, environmentally friendly materials such as ACC Block. As high grade of concrete is necessary to acquire the strength as well as the compaction of concrete is vital component for which Self Compacting Concrete is suggested to avoid any form of Honeycomb and blowholes.

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