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Staad Pro's Seismic Analysis of Multi-Storied Buildings in Different Zones

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Abstract:- The objective of this project is to use staad.pro to do seismic assessment (analysis) of a multi-story structure while taking into consideration different seismic zones in India. Multi-story structures are increasingly viewed as technological wonders in general. It has been demonstrated from previous earthquakes that many structures have sustained whole or partial damage as a result of earthquakes, hence it is crucial to understand the seismic reactions of such structures. Construction of the structures is involved, with an emphasis on foreseeing the reactions of actual structures. For instance, it entails building trusses, spans, and structures. This fundamental framework demands that each structure be thoroughly researched and seismically analyzed before being finished. The height of the structure has shown to be medium to tall in order to accommodate the needs of the growing population in the limited space. A seismic evaluation research and quake protection structure planning are required to provide safety against the earthquake excitation of multi-story structures. A deficit causes a structure to be unsatisfactory during an earthquake. In general, geometry, mass breakdown, and building solidity result in inadequacy. Typically, during earthquakes, buildings fall due to vertical irregularity. For the seismic study in different zones of India, the residential building, a G+7 building, was taken into consideration. By developing the initial load plan that must take into consideration dead weight, forced loads for dead loads, and extra external loadings, the strategy for ensuring the necessities is connected to the basic security of structures. Planning and management are crucial to this in the construction of buildings. Buildings are subjected to a variety of loads, including seismic live, wind, and dead loads. Seismic stress can have severely negative impacts; hence the building has to be seismically tested. This essay investigates how structures react. When it is shown by story conveyed and seismic base shear, this reaction may be impacted by seismic load. The staad.pro program was used to analyze the building for zones II, III, IV, and V.

Keywords:- *Seismic Analysis, Structure Analysis, G+7 Storied-Structure, Earthquake-Resistance Building, Staad.pro*

I. INTRODUCTION

Earthquakes have a substantial negative influence on the economy of the country, as well as considerable loss of life and property, mass evictions, the passing of many children of parents, and the widowhood of many women. It takes a while to recover and compensate for losses caused by earthquakes. An earthquake is one of nature's worst-case scenarios. It happens when seismic energy is released from the crust along a crack, shaking the earth's surface. When seismic waves strike a building, the building's foundation starts to quiver and finally collapses. Seismic waves are waves that go from the earth's crust to the surface and are measured using a seismograph and the Richter scale. In order to understand how a building will respond to an earthquake, seismic analysis is done. Buildings with many stories are now required for both business and residential purposes. High-rise buildings are not built well enough to withstand lateral loads. The structures can completely collapse as a result. When developing buildings that can withstand earthquakes, a few factors are taken into consideration. These factors include the base type, importance, and ductility of the building, as well as its intrinsic frequency damping factor. The factors include the building's ductility, natural frequency, damping factor, kind of base, and significance. An earthquake, which is a sudden release of energy in the planet's lithosphere, is characterized by a frenzy of ground trembling. The main source of this energy may be tectonic movements, which include the interaction of the inner and outer surfaces of the earth's crust. The majority of the earth's internal tension energy will be released as seismic waves, heat, and sound. The discipline of research that deals with earthquakes is called seismology. Studying earthquakes and it's causes is the field of study known as seismology. The ground quakes as a result of an event called an earthquake. When energy that has accumulated in crustal or lithospheric plates is released, it takes place. The earth's crust is composed of seven major plates. These plates travel evenly and slowly over smaller plates due to their 50-mile thickness. Nearly 90% of earthquakes, according to seismology research, are triggered by tectonics. India's seismic zoning map reveals that the country is divided into four seismic zones. The establishment of these seismic zones, also known as earthquake zones, is based on the following scientific inputs: -

• The frequency of earthquakes in the area
• Past earthquakes that have had an impact on the country

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India’s top Earthquake Prone Cities:

- Guwahati
- Pune
- Kerala
- Delhi
- Kochi
- Chennai
- Thiruvananthapuram
- Mumbai
- Patna
- Srinagar

For a number of geographical causes, India has suffered seismic activity. By analyzing and monitoring seismic activity in a building, India's four seismic zones—zones 2, 3, 4, and 5—have been developed. A structure can only attain or withstand an earthquake to a limited extent without seismological examination. So, in order to survive earthquakes and ensure that the structure won't collapse, we must adhere to precise protocols when doing seismic analysis. In some specialized sectors, such as high-risk regions and earthquake-prone zones, seismic analysis is performed and planned utilizing the waves of an earthquake. In this work, a multi-story 9 building with a G+7 frame and columns and beams presented in line with the structure's dimensions are drawn using the staad.pro program.

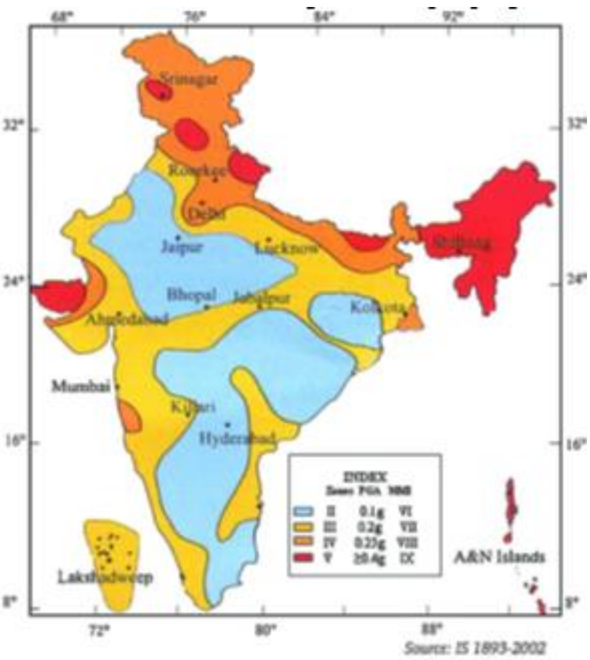

Fig 1.: - Seismic Zonation of INDIA

II. OBJECTIVE

The major objectives of Staad.pro's seismic analysis of multi-story buildings in India are as follows:

- ➢ The seismic analysis of a G+ 7 structure that is located throughout India is presented in this paper. Story drift and base shear are two ways that the structure responds. Staad.pro was used for the analysis in compliance with the seismic characteristics of the IS 1893 CODE, and AutoCAD was used for the design.
- ➢ Using the program stad.pro, compare the differences between the same structure in several seismic zones.
- ➢ The analysis of the G+7 structure is finished.
- ➢ The STAAD Pro program may be used to model any type of building that might be present in a given zone.
- ➢ By comparing the same structure to multiple zones, we may identify all the important factors that affect how a structure changes for a certain zone.
- ➢ We have entered the data into the program, which further reduces time spent, and are now getting the analysis's output. Manual calculations are time-consuming and more prone to inaccuracy.
- ➢ Assess the building's seismic resistance in compliance with the standards of IS Code: 1893-2002 Part-I.
- ➢ To find a practical and cheap lateral stiffness solution.
- ➢ To deal with difficulties in housing development brought on by population growth.
- ➢ To address energy and environmental concerns.
- ➢ Urban development.
- ➢ In Auto CAD, make a plan and a beam-column arrangement.
- ➢ To utilize STAAD Pro to examine the impacts of wind, earthquake, live load, and dead load on a generic building (G+7).
- ➢ To guarantee that structures are shielded from seismic waves in distinct zones.
- ➢ To see how an earthquake affects structures.
- ➢ Creation of a STAAD Pro structural model.
- ➢ Applying a variety of loads on the members.
- ➢ A review of the structure.
- ➢ The layout of the building.
- ➢ The project's main tool will be STAAD Pro software, which will be used to conduct a linear time-history analysis to look at how low, medium, and high-rise regular and irregular three-dimensional multi-story buildings react to ground vibrations of various frequencies and basic skidding, including story shift, story speed, and story acceleration.

III. METHODOLOGY

The building's G+7 framed structure with dimensions of 15 meters long, 24 meters high, and 12 meters wide is commonly assumed at the start of the project's development. A framed structure's height, beam, column, arrangement, skeleton structure, etc. have been created using the staad.pro program using the specified dimensions, as shown below: -

- Nodes are created using the parameters that have been considered (i.e., a 3 m node spacing).
- The basis of the structure is created by connecting all nodes.
- The transitional repeat tool is used to array each base node to produce the eight storeys.
- To build beams and columns, nodes must be accurately connected in the horizontal and vertical axes.
- Member characteristics are assigned to the whole structure.
- Pick the building's general parameters.
- Increase the structure's beam, column, slab, and support

sizes and thicknesses.

- Applying the definition of seismic load (such as the Indian Standard Code, zone type, response reduction factor, importance factor, soil type, structure type, self-weight factor, and damping ratio).
- The structure's member weight should be added.
- Use the specification of wind load (wind speed, wind direction, etc.).
- Include every load case information. Analysis is done after developing and applying load scenarios to the structure. After that, we received our work's output file.

IV. ANALYSIS

Our proposal complies to IS-456-2000 by primarily focusing on the design and analysis of multi-story structures and employing STAAD-PRO notation throughout. Analysis must be done when loads and load combinations are allocated to the structures. Analyzing the RCC structure is done.

- Assign properties to structures
- Distribute the loads on the slab.
- Spreads out the loads over the walls.
- Assign a wind load in the X and Y directions to the structures.
- Assign seismic loads in the X and Z directions for various Indian zones.

Table: 1- A variation of loads on the structure

S. No.	Loading Type	Load
1	Seismic Load	EX
2	Seismic Load	EZ
3	Wind Load	WX
4	Wind Load	WZ
5	Dead Load	DL
6	Live Load	LL

Table: 2- Zone factor table (IS Code 1893)

Seismic zone	**II**	**II**	**IV**	**V**
Seismic intensity	Low	Moderate	Severe	Very severe
Z	0.1	0.16	0.24	0.36

Table: 3- Values for various zones of shear

Shear Force (KN)	**Zone-II**	**Zone-III**	**Zone-IV**	**Zone-V**
Along X-direction	167.68	268.29	377.78	770.67
Along Z-direction	167.68	268.29	377.78	770.67

V. RESULT

In order to achieve the needed safety and economy in the structure's design, a load combination is a group of different loading situations that function together in the structure. A critical load combination, or a load combination that performs these things, is what leads to a critical situation in a structure, such as the maximum deformation and stress, etc. These load situations, such as wind load, dead weight, living weight, and seismic forces, are likely to interact with one another to influence a building. There is a very high probability that an earthquake and a wind load on a building won't happen at the same time. The analysis is finished after the load combination is made, and the values for the shear forces, bending moments, and deflections are taken into consideration zone by zone for the different storeys. Comparisons of the results among zones are also made.

Remember that the nodes are exposed to wind speed at heights of 24, 18, 9, and 3 meters, respectively, which are 2, 1.5, 1, and 0.5 KN/m2. For each zone in India, the wind load must be considered in the X and Z directions.

Table: 4- Bending Moment at each storey of building for various zone

Bending Moment (KN.M)	**Zone-II**	**Zone-III**	**Zone-IV**	**Zone-V**
Storey-1 X- Direction Z- Direction	5.436 0.08	8.698 0.128	9.593 0.141	25.541 0.451
Storey- 2 X-Direction Z-Direction	5.595 0.123	8.952 0.197	9.873 0.218	26.303 0.655
Storey-3 X-Direction Z- Direction	5.374 0.084	8.598 0.134	9.484 0.148	25.272 0.471
Storey-4 X-Direction Z-Direction	4.941 0.048	7.906 0.076	8.724 0.084	23.254 0.300
Storey-5 X-Direction Z-Direction	4.283 0.009	6.853 0.014	7.558 0.015	20.186 0.113
Storey-6 X-Direction Z-Direction	3.344 -0.034	5.350 -0.054	5.901 -0.060	15.808 0.092

Storey-7 X-Direction Z-direction	2.037 -0.097	3.260 -0.156	3.595 -0.172	9.712 -0.097

Table: 5- The Deflection at each floor of the structure

Deflection(mm)	Zone-II	Zone-III	Zone-IV	Zone-V
Storey-1 X-Direction Z-Direction	0.670 0.020	1.673 0.031	1.83 0.035	3.145 0.080
Storey-2 X-Direction Z-Direction	1.614 0.020	2.582 0.032	2.848 0.036	7.575 0.069
Storey-3 X-Direction Z-Direction	2.571 0.018	4.114 0.029	4.573 0.032	12.070 0.046
Storey-4 X-Direction Z-Direction	3.496 0.016	5.593 0.026	6.196 0.029	16.413 0.022
Storey-5 X-Direction Z-Direction	4.348 0.015	6.957 0.024	7.674 0.026	20.422 0.002
Storey-6 X-Direction Z-Direction	5.083 0.014	8.133 0.022	8.971 0.025	23.883 -0.013
Storey-7 X-Direction Z-Direction	5.646 0.014	9.034 -0.023	9.964 0.026	26.542 -0.022

VI. CONCLUSION

- After G+7 building analysis, the structure's bending moment, shear force, and deflection are calculated for various zones in India.
- The G+7 building's shear force measurements are made in Zones II and V, with Zone II yielding a negligible result and Zone V yielding the greatest value.
- When comparing the total bending moment for Zones II, III, IV, and V for each storey of the G+7 building. We discovered that Zone-V had the highest bending moment along the X and Z axes at each storey and that Zone-II had the lowest bending moment along these axes.
- The deflection of each storey was compared with regard to all of the zones II, III, IV, and V of the G+7 structure. At each storey, zone II had the least deflection along the X and Z axes while zone V had the most deflection.
- Based on the aforementioned research, we can effectively build up to 7 storeys under India's very seismic circumstances.
- Based on the seismic research (analysis) of the G+7 structure by staad.pro, we currently feel that our structure is secure in all seismic zonal conditions in terms of shear, bending, and deflection.

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