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RESPONSE SPECTRUM ANALYSIS OF G+5 BUILDING BY USING ETABS SOFTWARE

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ABSTRACT

The most often used building construction methods in India are reinforced concrete frames. In the Indian construction situation, high-rise expansive structures have become more preferred, particularly in metropolitan areas, due to the country's expanding economy, urbanisation, and lack of horizontal space, which has increased land costs and the need for agricultural land. High-rise buildings must withstand lateral forces in addition to gravity loads. Buildings in major Indian cities must be strengthened for lateral stresses since they are located in seismically active areas. Response Spectrum Analysis is being used in this research to examine how a high-rise construction reacts to ground motion. In ETABS, many models are taken into consideration, including shear wall frames, brace frames, and bare frames. And the building's time period, stiffness, foundation shear, storey drifts, and top-story deflection are all measured and contrasted.

I. INTRODUCTION

1.1 General

Much of India is vulnerable to dangerously high levels of seismic risk. Therefore, while designing a high-rise construction, the seismic load must be considered. High-rise buildings use a variety of lateral load-resisting techniques, including: 1. Bare frame 2. The brace frame 3.Shear wall frame. The lateral strains caused by earthquakes are an issue in tall buildings. Such lateral forces have the potential to generate critical stresses, undesired stresses, unwanted vibrations, or excessive lateral sway in the structure. The amount of lateral movement at the top of the structure in relation to its base is known as sway or drift. According to conventional seismic design methods, the structure should be able to withstand mild to moderate shaking without being damaged, allowing it to remain functional after the incident.

The building should be able to sustain a reasonable amount of ground motion during an earthquake without suffering any structural damage, however it could sustain some non-structural damage as well. This limit condition might be equivalent to the largest earthquake ever recorded or predicted at the location. The current research examines the effects of shear wall, brace, and bare frames under seismic loads. The response spectrum method's outcomes are examined. Storey drift, base shear, story deflection, and time period are the primary factors taken into account in this research to assess the seismic performance of various models.

1.2 Response spectrum method

the illustration of the idealised single-degree-of-freedom system's maximum reaction to ground vibrations during earthquakes, with a certain period and damping. The code IS 1893-2002 (part 1) is followed in the execution of this study. Seismic zone factor and soil type should be supplied here using IS 1893-2002 (part 1). The ETABS 2013 program is used to analyse the building using the standard response spectrum for the kind of soil under consideration.

An envelope of upper bound responses derived from many ground motion recordings is represented by the response spectrum. The

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design spectrum found in IS: 1893 (Part 1): 2002's figure 1 is used for seismic analysis. The strong motion recordings of eight Indian earthquakes served as the basis for this spectrum. The underlying premise of this elastic dynamic analysis technique is that the dynamic response of the structure may be determined by taking into account the separate responses of each natural mode of vibration and then combining them in the same manner. This is beneficial since, in most cases, only a few number of the lowest vibration modes are significant for determining moments, shear, and deflections at various building levels.

1.3 Earthquake

Techniques for earthquake analysis that take into account the forces that occur during an earthquake. The magnitude of the earthquake determines how strong these forces are.

Dynamic actions on buildings-wind and earthquake

Both wind and earthquakes may create dynamic motions on structures. However, there are clear differences in designing for earthquake impacts and wind forces. Force is the foundation of the initiative philosophy of structural design, which is congruent with wind design. In force-type loading, the exposed surface area of the structure is subjected to pressure. Displacement-type loading occurs when a building is designed to withstand earthquakes because the ground at its base moves randomly (Figure 1.1), creating inertia forces within the structure that lead to strains. This difference can also be expressed using the building's load-deformation curve, where the demands on the structure are displacement (i.e., horizontal axis) in displacement-type loading imposed by earthquake shaking and force (i.e., vertical axis) in force-type loading imposed by wind pressure.

The wind force acting on the structure consists of a relatively minor oscillation component superimposed on top of a non-zero mean component. As a result, under wind pressures, the structure may see slight variations in the stress field; nevertheless, reversal of stresses only happens when the wind direction changes, which only happens over an extended period of time. However, during an earthquake, the ground moves cyclically around the structure's neutral position. As a result, during the brief earthquake, the stresses in the structure caused by seismic activity undergo several complete reversals.

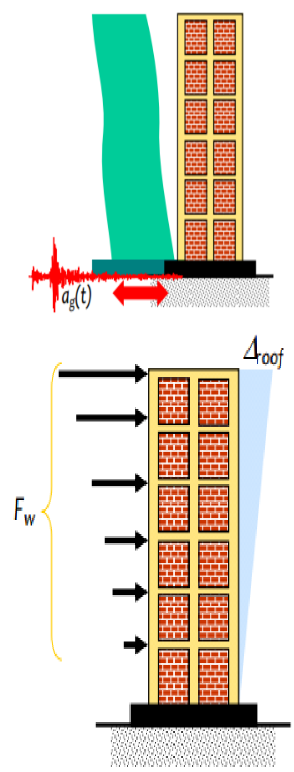

Figure 1.1: Disparities in how a building's design is affected by earthquake-related natural events, such as ground movement at the base and wind pressure on exposed areas

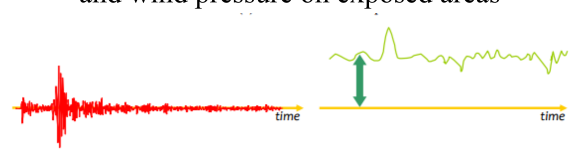

Figure 1.2: Characteristics of temporal changes of design actions: oscillatory, cytic and wind

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pressure, earthquake ground motion, and zero mean

1.5 OBJECTIVE OF THE STUDY

1. To use ETABS to determine the design lateral forces for the G+5 building.
2. To investigate the G+5 building's story drift, shear force, bending moment, and building torsion.
3. Response spectrum analysis is used for the G+5 building's study and design.
4. To compare the differences in design and conduct ductility-based earthquake-resistant design in accordance with IS 1893, which corresponds to comparable static analysis and time history analysis.

1.6 SUMMARY

Response Spectrum study is a probabilistic dynamic study used when the structure's stiffness and mass are not distributed uniformly. One method for doing an equivalent static lateral load analysis of structures for seismic forces is response spectrum analysis (HOUSNER and JENNINGS, 1982). When estimating the safety and dependability of buildings under seismic stresses, it is helpful. The main issue is that while Response Spectrum analysis findings are calculated using modal combination techniques like SRSS, CQC, etc., they are absolute numbers. It is impossible to ascertain the characteristics of the member forces. Unrealistic results might be obtained from the member forces obtained from a load combination using a Response Spectrum load scenario. The design outcomes will be incorrect if they are used in the construction of structural parts, particularly columns. To ascertain the nature of the member forces, the Response Spectrum analysis need some extra care. The current case study has covered the approach that may be used to solve the issue.

II. LITERATURE REVIEW

Mr. K. Loku Raju and associates (2015) He investigated the impact of shear wall placement on the performance of building frames under seismic loads. This research examines four different kinds of G+7 constructions, including three frames with shear walls in different locations and one frame without a shear wall. The program ETABS v9.7.2 is used to perform the Non Linear Static analysis.

Kabir, Md. Rashedul et al. (2015) In the context of Bangladesh, he has ascertained how multi-story regular and irregular structures of the same weight react to static and dynamic stress. This article uses the ETABS 9.6 software to simulate a 15-story structure with normal and irregular shapes for Dhaka, Bangladesh (seismic zone 2). Analysis is done on the impact of wind, dynamic, and static loads. Every structure was thought to have the same mass. Wind load causes the most displacement in all kinds of constructions.

Jo Byung-Wan and associates (2001). A three axis two degree of freedom system is used to model the mass effect of the vehicle in order to reduce the structural vibration of a three span steel box bridge. The kinetic equation that takes into account the surface roughness of the bridge is derived using a Bernoulli-Euler beam, ignoring the torsional DOF. TMD's impacts on steel box bridges demonstrate that although it effectively lowers the bridge's free vibration, it is ineffective at lowering the maximum deflection. It demonstrates that the dynamic amplitude, not the maximum static deflection, may be effectively controlled by the TMD.

Kwok, K. C. S., and others (1995). Parametric studies, which have been the focus of a lot of study, may easily evaluate the performance of both passive and active tuned mass damper (TMD) systems. There haven't been many experimental tests of TMD theory, especially those that use active control, but the outcomes of those tests often agreed well with those of parametric research. In order to lessen the dynamic response caused by wind and

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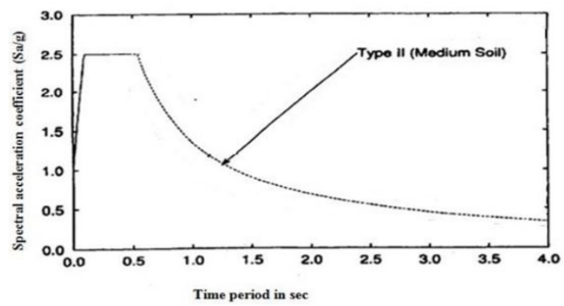
earthquakes, many passive and active tuned mass damper systems have been successfully placed in tall buildings and other structures, despite some significant design limitations.

In 1909, Frahm (Frahm, 1909) in order to lessen ship hull vibrations and rolling motion. Later in the article, Ormondroyd and Den Hartog (1928) proposed a hypothesis for the TMD. In their book on mechanical vibrations (1940), Den Hartog went into great depth on the best tuning and damping settings. Mechanical vibrations by Hartog (1940). The original hypothesis applied to an undamped SDOF system that was excited by a sinusoidal force. Many academics have looked at the theory's extension to damped SDOF systems. Devices with active control require an external power source to function. They thereby outperform passive control systems in terms of efficiency. In the context of structural control against earthquakes, however, the issues that present technology faces—such as inadequate control-force capability and high power demands—are inevitable and must be resolved. Due to their low power consumption and built-in stability, semi-active control devices—a novel control approach—have recently gained a lot of popularity. These devices incorporate the finest aspects of both passive and active control devices.

III. METHODOLOGY AND TYPES OF LOADS ON BUILDING

3.1 METHODOLOGY: RESPONSE SPECTRUM METHOD

the illustration of the idealised single-degree-of-freedom system's maximum reaction to ground vibrations during earthquakes, with a certain period and damping. The code IS 1893-2002 (part 1) is followed in the execution of this study. Seismic zone factor and soil type should be supplied here using IS 1893-2002 (part 1). The ETABS 2013 program is used to analyse the building using the standard response spectrum for the kind of soil under consideration. The usual response spectrum for medium soil types is shown in the following figure, which may be expressed as time period versus spectral acceleration coefficient (Sa/g).



Response spectrum for medium soil type for 5% damping

3.2 MULTI SROREY STRUCTURES

A building with only one ground floor is called a single-story building.A multi-story building is one that has many stories and usually features vertical circulation, such as elevators, ramps, and stairs. Buildings with several stories may vary in height from two stories to over 150 stories.

CLASSIFICATION OF MULTI STOREY STRUCTURES

Buildings with many stories may be categorised as follows:

- Low-rise: a structure that is too short to qualify as a high-rise.
- Mid-rise: structures with elevators that are five to 10 stories high.
- High-rise: containing seven or more stories.
- Skyscraper: at least forty stories.
- Extremely tall: more than 300 meters.
- Mega tall: more than 600 meters

3.3 DIFFERENT TYPES OF LOADS ACTING ON THE STRUCTURE

Vertical, horizontal, and longitudinal loads are the three general categories of loads that are applied to buildings and other structures. Dead loads, living loads, and impact loads make up

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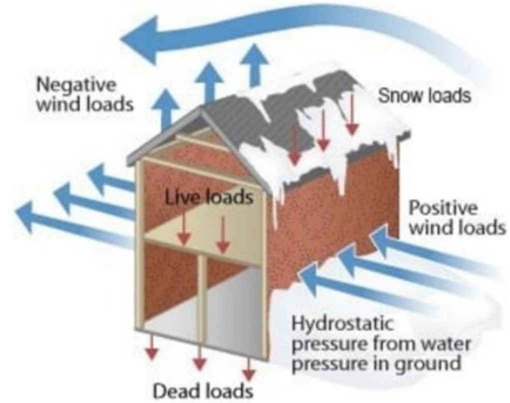
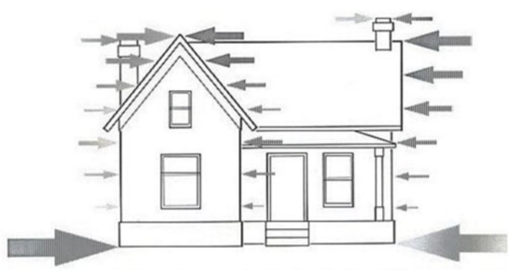
the vertical loads. Wind and seismic loads are included in the horizontal loads. When designing bridges, gantry girders, and other structures, longitudinal loads—that is, tractive and braking forces—are taken into account.



Earthquake loads (EL)

Both vertical and horizontal forces acting on the structure are caused by earthquakes. Three mutually perpendicular directions—typically interpreted as vertical and two horizontal—can be distinguished from the entire vibration induced by an earthquake.

There are no appreciable forces in the superstructure as a result of vertical motions. However, while planning, the building's horizontal displacement during an earthquake must be taken into account.

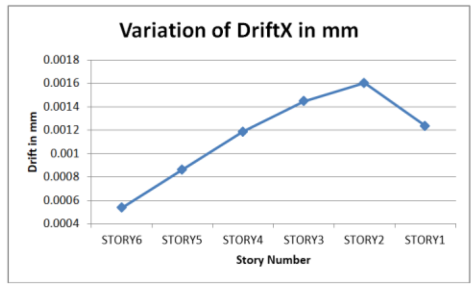


All parties of a structure experience "whipping" forces as a result of horizontal earthquake forces, or back-and-forth shaking. These pressures have to go from the building's many components to the foundation.

IV. RESULTS AND ANALYSIS

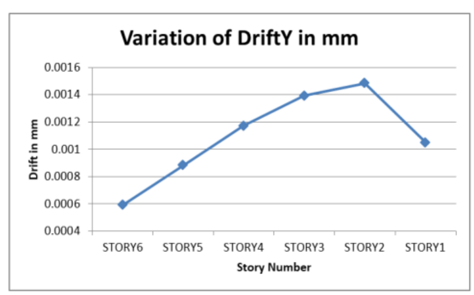
Drift X

Story	Load	Drift X
STORY6	RSA	0.000537
STORY5	RSA	0.000862
STORY4	RSA	0.001185
STORY3	RSA	0.001447
STORY2	RSA	0.001602
STORY1	RSA	0.001236



Drift Y

Story	Load	Drift Y
STORY6	RSA	0.000592
STORY5	RSA	0.000883
STORY4	RSA	0.001171
STORY3	RSA	0.001392
STORY2	RSA	0.001484
STORY1	RSA	0.00105



Shear Force Vx

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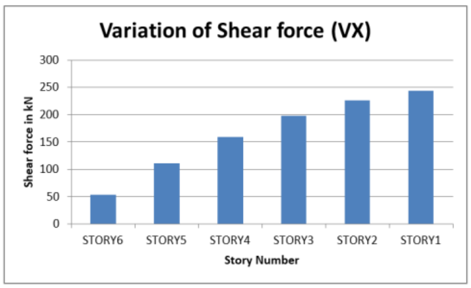
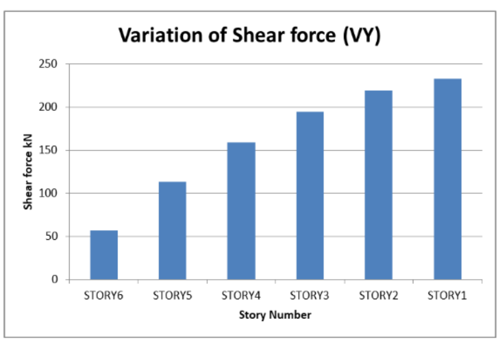
Story	Load	Variation of Shear force (VX)
STORY6	RSA	53.58
STORY5	RSA	111.02
STORY4	RSA	159.17
STORY3	RSA	197.83
STORY2	RSA	226.15
STORY1	RSA	243.55



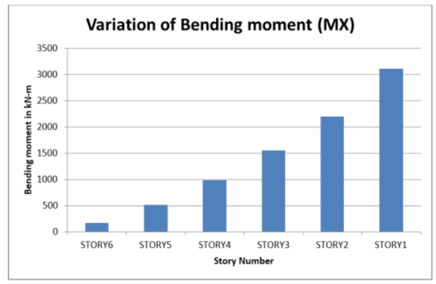
Shear Force Vy

Story	Load	Variation of Shear force (VY)
STORY6	RSA	56.79
STORY5	RSA	113.61
STORY4	RSA	159.25
STORY3	RSA	194.54
STORY2	RSA	219.11
STORY1	RSA	232.74



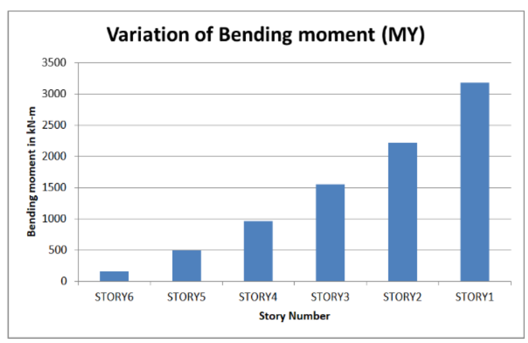
Bending moment Mx

Story	Load	Variation of Bending moment (MX)
STORY6	RSA	170.37
STORY5	RSA	509.262
STORY4	RSA	981.09
STORY3	RSA	1554.103
STORY2	RSA	2196.888
STORY1	RSA	3108.437



Bending moment My

Story	Load	Variation of Bending moment (MY)
STORY6	RSA	160.754
STORY5	RSA	492.58
STORY4	RSA	965.909
STORY3	RSA	1551.534
STORY2	RSA	2218.657
STORY1	RSA	3176.537



Building Torsion

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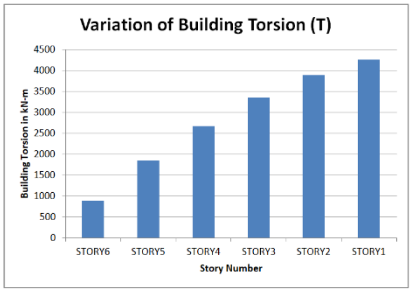
Story	Load	Variation of Building Torsion (T)
STORY6	RSA	890.759
STORY5	RSA	1846.566
STORY4	RSA	2667.448
STORY3	RSA	3353.847
STORY2	RSA	3890.946
STORY1	RSA	4257.382



V. CONCLUSION

The following findings were drawn from this investigation:

1. From tale 6 to story 2, the value of story drift rises in both the X and Y directions; after story 2, the value of story drift falls.
2. From the top story to the bottom story, the shear force value rises in both the X and Y directions.
3. From the top story to the bottom story, the bending moment values rise in both the X and Y directions.
4. From tale 6 to story 1, the narrative twist's worth rises.
5. The ETAB program may be used for further analysis, and the response spectrum approach can be used to determine displacement.

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