SEISMIC AND WIND-RESISTANCE SLAB: A TENSIONED APPROACH AND TRADITIONAL RCC.

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Abstract – This research investigates the comparative performance of seismic and wind-resistant building slabs utilizing two distinct methodologies: a tensioned approach and traditional Reinforced Concrete (RCC) construction. The tensioned slabs employ specialized techniques to enhance structural integrity, while RCC adheres to conventional concrete practices. Through a comprehensive analysis of their behavior under seismic and high wind forces, this study aims to describe the efficiency, resilience, and suitability of each approach in mitigating the impact of these natural forces on structural stability. The findings offer insights crucial for optimizing construction practices for buildings against seismic and wind stresses.

***Key Words*: P.T. slab, R.C.. slab , pushover analysis, E-tabs.**

1.INTRODUCTION

Earthquakes and wind pose significant challenges to building structures, necessitating meticulous analysis and design considerations. In ETABS, seismic analysis involves assessing a structure's response to ground shaking using methods like Response Spectrum Analysis or Time History Analysis, adhering to relevant Indian Standards such as IS 1893. Wind effects, including lateral forces and vibrations, are evaluated using static or dynamic wind load analysis in accordance with IS 875 (Part 3). The integrated approach in ETABS allows engineers to comprehensively address the impacts of both earthquakes and wind on buildings, ensuring compliance with safety standards and optimal structural resilience. The structure analysis of the G+25 storey reinforced concrete building is done with the help of ETABS software.

Two types of causes are there for earthquake,

1) Natural causes
2) Artificial causes

1.1 Natural causes

Tectonic Plate Movements: The Earth's lithosphere is divided into several large and small pieces called tectonic plates. Earthquakes often occur at plate boundaries where these plates interact.
Volcanic Activity: Earthquake can occur near volcanos due to the moment of magma and the release of pressure.

Seismic Waves:
Body Waves: Travel through the Earth's interior. P-waves (primary waves) are compressional waves, and S-waves (secondary waves) are shear waves

Surface Waves: Travel along the Earth's surface and cause the most damage during an earthquake.

Artificial causes:
Reservoir-Induced Seismicity (RIS): Construction of large reservoirs, altering subsurface stress and causing earthquakes.
Geothermal Energy and Oil Extraction: Fluid injection/extraction during geothermal, oil, or gas operations can induce seismic events by changing subsurface pressure.
Waste Fluid Injection: Disposal of wastewater via deep well injection, altering subsurface conditions and potentially inducing earthquakes.
Mining Activities: Large-scale mining operations, particularly those extracting minerals or hydrocarbons, can induce seismic events through material removal.

1.2 Causes of wind

There are two type of wind load

1. Static Wind Load
2. Dynamic Wind Load

Static Wind Load: Represents the force exerted by wind on a structure without accounting for time-related variations. It is a constant load applied to the building.

Dynamic Wind Load: Takes into account the time-dependent fluctuations in wind speed and direction. Gusts and fluctuations play a crucial role in dynamic wind loading.

1.2.1 Factors Influencing Wind Loads:

1. Wind Speed
2. Building Height and Shape
3. Terrain and Surroundings

Wind Speed: The velocity of the wind is a key factor. It is typically measured at different heights to account for variations with elevation.

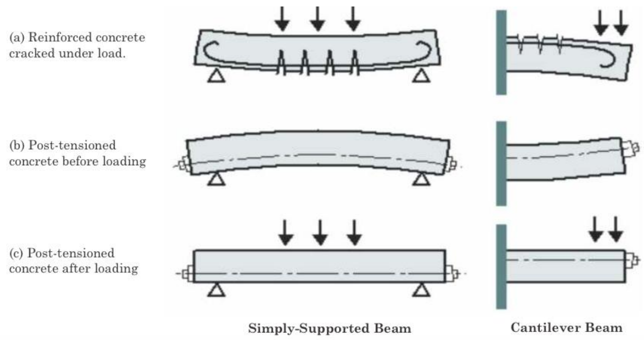
Building Height and Shape: Taller buildings generally experience higher wind loads. The shape of the building also influences wind forces.

Terrain and Surroundings: The local topography, presence of nearby structures, and ground roughness affect wind loads.

R.C.C(Reinforced Cement Concrete) slab :

This concrete is made of cement, coarse gravel and water and steel or iron bars helps in reinforcing the materials mentioned before. The steel or bars get embedded in the concrete and it makes the construction super strong and durable.

PT(post tensioning) slab:



Post-tensioned (PT) slabs are typically flat slabs, band beam and slabs or ribbed slabs. PT slabs offer the thinnest slab type, as concrete is worked to its strengths, mostly being kept in compression. Longer spans can be achieved due to prestress, which can also be used to counteract deflections.

1.2 Objective

- Evaluate and compare the structural performance of tensioned slabs versus traditional Reinforced Concrete (RCC) slabs under seismic and wind loading conditions
- Assess the resilience of tensioned slabs and traditional RCC slabs in response to seismic and wind forces.
- Analyze the efficiency of both approaches in enhancing seismic and wind resistance, considering key structural parameters such as strength, flexibility, and deformability.
- Identify the strengths and weaknesses of the tensioned approach in comparison to traditional RCC methods for designing and constructing slabs.
- To analyse structure using E-tabs software.

2. Literature Review

[1] Bahoria, Boskey Vishal, and Dhananjay K. Parbat. "Analysis and design of RCC and post-tensioned flat slabs considering seismic effect." ***International journal of engineering and technology*** **5.1 (2013): 10.**

The increasing popularity of the post-tensioning method in modern construction due to its economic and safe design applications. The study focuses on the design of a post-tensioned flat slab for a G+4 office building using load balancing and an equivalent frame method. Four different floor systems are considered, and the quantities of reinforcing steel, prestressing steel, and concrete required for the slabs, beams, and columns are calculated and presented in tabular form. The total cost of the building per square meter is determined for each case, allowing a comprehensive cost comparison. The introduction emphasizes the significance of floor systems in building costs and introduces post-tensioning as an efficient solution, listing technical and economic advantages. The conclusion provides additional advantages of post-tensioned construction, emphasizing its use in various building situations and outlining specific benefits of post-tensioned slabs over reinforced concrete slabs, including economic structures and larger spans.

[2] Satwika, Vanteddu, and Mohit Jaiswal. "Comparison of RCC and Post-Tensioned Flat Slabs Using ETABS." ***IOP Conference Series: Earth and Environmental Science*****. Vol. 982. No. 1. IOP Publishing, 2022.**

This study focuses on addressing the insufficient punching shear capacity of flat slabs, a common issue in their structural design. The conventional methods of increasing slab thickness or column size contradict architectural goals. The research introduces post-tensioning as a technique to enhance flat slab strength, comparing conventionally reinforced concrete (RCC) flat slabs with post-tensioned flat slabs using different tendon profiles. The post-tensioned slabs exhibit higher punching shear capacity, even with shallower depths, making them more cost-effective. The study highlights the advantages of post-tensioning, such as expanded clear spans, thinner sections, reduced cracking and deflection, lighter buildings, quicker construction, improved water resistance, and decreased traditional reinforcement. The research delves into the technical aspects, benefits, and comparisons with traditional flat slabs, emphasizing the potential of post-tensioning in enhancing structural performance.

[3 Nighot[1], Shubham, Sopan Chinchole, Rohan Kapgate, and Sujesh D. Ghodmare[4]. "Analysis and design of post tension slab using ETABS software." (2020)..

The construction industry is increasingly adopting the post-tensioning method for its advantages, yet in countries like India, the benefits of post-tensioned slabs remain underappreciated. This study, using ETABS software, focuses on the cost, strength, and serviceability of post-tensioned flat slabs in a commercial building (G+7). Results indicate cost advantages over traditional RC flat slabs, making post-tensioning ideal for multi-story structures. This method enhances strength, durability, and aesthetics while providing an economical alternative. The study highlights the broad applicability of post-tensioned slabs and concludes with a comparison favoring them over RC slabs in terms of concrete and steel use

[4] Chou, Chung-Che, and Jun-Hen Chen. "Seismic tests of post-tensioned self-centering building frames with column and slab restraints." *Frontiers of Architecture and Civil Engineering in China* 5 (2011): 323-334.

Explores post-tensioned (PT) self-centering moment frames as an earthquake-resistant alternative to typical moment-resisting frames (MRFs). The study introduces a methodology for evaluating column restraint and beam compression forces based on column deformation and gap openings in all stories of a PT frame. Cyclic tests on a full-scale, two-bay by one-story PT frame validate the proposed method. Additionally, the paper suggests a sliding slab to minimize restraints on PT frame expansion and presents shaking table tests on a reduced-scale, two-by-two bay one-story PT building structure. The results demonstrate self-centering behavior with minor differences in peak drifts, even under earthquake simulations, showcasing the potential of PT structures for seismic resilience. The work addresses challenges related to column and slab restraints in PT self-centering frames, offering insights and testing methodologies for further development and application in real construction.

[5] Prajapati, Deepak, and Komal Bedi. "Post Tensioning Building Analysis Considering Seismic Zone V using Analysis Tools ETABS." (2019).

In today's rapidly growing and competitive world, the construction sector plays a pivotal role in a country's development, with high-rise buildings being widely admired. Traditionally, Reinforced Concrete (RCC) has been the standard construction method, but in the present era, the focus is shifting towards Post-Tensioning for high-rise structures. Post-Tensioned buildings offer economic and durable advantages, saving on steel and concrete quantities compared to RCC, and providing increased clear spans in rooms. This study emphasizes the design of a Post-Tensioned building using ETABS (Extended Three-Dimensional Analysis of Building Systems), a software tailored for systematic multistoried building design according to Indian Standard codes. The comparative analysis involves an unsymmetrical G+9 floor plan considering wind loads and black cotton soil. The study evaluates parameters such as storey displacement, axial forces, shear forces, bending moments, drift, stiffness, overturning moment, and cost analysis based on Schedule of Rates (S.O.R). The research aims to showcase the economic and structural benefits of Post-Tensioning in high-rise building construction.

3. CONCLUSIONS

- Introduction of post-tensioning members leads to a decrease in bending moment, resulting in more economical sections compared to a bare frame.
- Storey shear is reduced, minimizing the risk of unbalanced forces in the post-tensioning structure.
- Enhanced lateral force resistivity results in less displacement, ensuring stability and effective resistance to assigned wind pressure.
- Axial forces in post-tensioning frames are less, indicating efficient distribution of forces in vertical members.
- Post-tensioning members contribute to a reduction in relative displacement, enhancing the overall stability compared to bare frame structures.

REFERENCES

[1] Bahoria, Boskey Vishal, and Dhananjay K. Parbat. "Analysis and design of RCC and post-tensioned flat slabs considering seismic effect." *International journal of engineering and technology* 5.1 (2013): 10.

[2] Satwika, Vanteddu, and Mohit Jaiswal. "Comparison of RCC and Post-Tensioned Flat Slabs Using ETABS." *IOP Conference Series: Earth and Environmental Science*. Vol. 982. No. 1. IOP Publishing, 2022.

[3] Nighot[1], Shubham, Sopan Chinchole, Rohan Kapgate, and Sujesh D. Ghodmare[4]. "Analysis and design of post tension slab using ETABS software." (2020)..

[4] Chou, Chung-Che, and Jun-Hen Chen. "Seismic tests of post-tensioned self-centering building frames with column and slab restraints." *Frontiers of Architecture and Civil Engineering in China* 5 (2011): 323-334.

[5] Prajapati, Deepak, and Komal Bedi. "Post Tensioning Building Analysis Considering Seismic Zone V using Analysis Tools ETABS." (2019).

[6] www.reinforcementproductsonline.co.uk was first indexed by Google in January 2018

[7] https://sanfieldindia.in/browse/page/BuildingPostTensionedSlab