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A Review on Buildings having Telecommunication Tower at Roof

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***Abstract:** Strong towers are relied upon for effective communication, as they have been used worldwide. Telephonic communication is dependent on this, as it is the sole means to connect different networks. They can be installed above structures and on the ground, but critical communication breakdowns can be caused by the failure of such structures during hazardous conditions. In this study, different reviews based on telecommunication towers installed on tall buildings worldwide has given in this paper. Typically, four-legged towers are used for ensuring good communication and for transferring the load. Different reviews are based on tower analysis alone and focus on the response of the host structure on which the tower rests. Valuable insights and conclusions are provided by this literature review to identify the problems associated with the placement of telecommunication towers over buildings and the locations where they need to be placed. From this study, it is to be noted that previous studies were based on the location that was optimal for the host structure, but the worst-case scenario of tower placement was not used till date if it was necessary to provide it at that location. As a result, the conclusive outcome is known to aim at providing technical insights and recommendations for future research in this area.*
***Keywords:** Multistoried Building, Response Spectrum, Telecommunication Tower Seismic Analysis.*

I. INTRODUCTION

Within the dynamic realm of telecommunications, there exists an unyielding need for continuous and expansive network connectivity. This growing demand has catalyzed novel approaches to address infrastructure constraints. A significant evolution in this domain is the deliberate placement of telecommunication towers on the roofs of multistory edifices. Originating from the imperative of accommodating dense urban landscapes and the sprawl of urbanization, this strategy epitomizes a transformative approach to vital communication infrastructure deployment. While conventional telecommunication towers stood as solitary giants, distinctly dominating their surroundings, the contemporary trend emphasizes integration, positioning communication assets atop pre-existing multistory structures. Such an innovative strategy not only maximizes land efficiency but also facilitates enhanced accessibility, streamlined installation, and simplified maintenance procedures.

This introductory overview paves the way for an in-depth investigation into the amalgamation of telecommunication towers with multistoried constructions, encompassing its myriad facets, obstacles, and advantages. In an era marked by rapid urbanization and an escalating appetite for dependable communication infrastructures, grasping the intricacies of integrating telecommunication towers atop multistoried edifices emerges as a crucial imperative.

Telecommunication towers are crafted in diverse configurations, tailored to address distinct requirements and environments.

The following enumerates various classifications of telecommunication towers:
1) *Self-Supporting Towers:* These stand tall without external support, relying on a broad base and structural integrity for stability.
2) *Guyed Towers:* Supported by cables or guy-wires anchored to the ground, these towers offer heightened height-to-cost efficiency.
3) *Monopole Towers:* Singular, slender structures, they provide a sleek aesthetic while maintaining robustness.
4) *Lattice Towers:* Comprising a framework of interconnected metal sections, lattice towers offer both strength and flexibility.
5) *Camouflaged Towers:* Designed to blend seamlessly with their surroundings, these towers often masquerade as trees, flagpoles, or other urban structures.
6) *Mobile Cell on Wheels (COWs):* These are portable towers on wheels, rapidly deployable to areas requiring temporary communication boosts, such as events or disaster recovery sites.
7) *Rooftop Towers:* Positioned atop buildings, these towers capitalize on vertical space in urban settings, minimizing ground footprint.

8) *Water Tank Towers:* Ingeniously combining utility with communication infrastructure, these towers integrate water storage facilities with telecommunication apparatus.
9) *Distributed Antenna Systems (DAS):* Rather than a singular tower, DAS comprises a network of antennas dispersed throughout an area, enhancing signal strength and coverage.
10) *Satellite Dish Towers:* Dedicated to satellite communication, these towers support large dishes facilitating long-distance communication and broadcasting.
11) *Wind Turbine Towers:* Serving a dual purpose, these towers harness wind energy for power generation while also supporting telecommunication equipment.

Each type embodies a unique blend of design, functionality, and suitability, catering to the multifaceted demands of the telecommunication landscape.

Fig. 1: Structure with Telecommunication tower at top

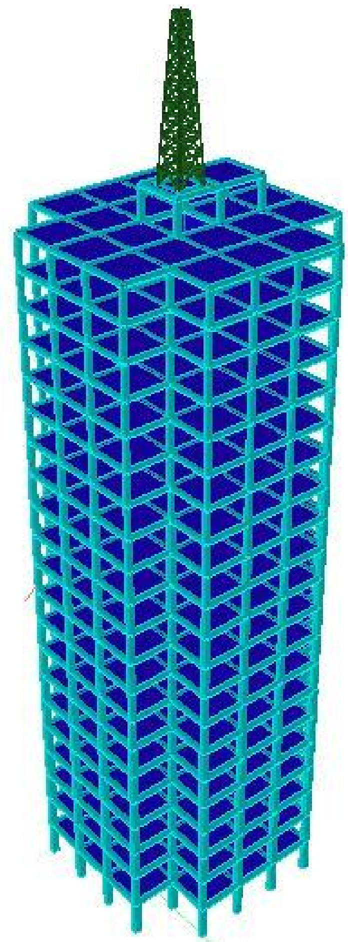

Fig. 2: 3D view of Structure with Telecommunication tower at top

II. REVIEW OF LITERATURE

This research delves into the rapid expansion of mobile communication services over the past three years, largely fueled by the competitive race among service providers. To ensure seamless coverage and reliability, telecommunication towers have been strategically positioned based on geographic coordinates. Given the limited space in urban settings, there's a growing trend towards setting up towers on rooftops, aiming for consistent antenna elevation with minimal adjustments. The study specifically looks at how 4-legged telecommunication towers respond to seismic activity, adhering to the seismic standards set for Zone-IV in India. Using the SAP2000 software, dynamic evaluations are conducted for both ground-mounted and rooftop towers, with considerations for different placements and structural rigidity in various directions. The main focus is on the internal axial forces within the towers. By comparing towers at similar heights but on different bases, the research provides crucial insights into how location and structure type influence a tower's resilience during seismic events. (Nitin Bhosale et. al.)

In this research, we focus on understanding how telecommunication towers react to earthquakes. Unlike buildings, these towers don't have specific design guidelines for earthquakes, so often regular building rules are applied, which might not be the best fit. We studied ten such towers in Iran, each with four legs and heights ranging from 18 to 67 meters. We simulated earthquakes, both vertically and horizontally, and then used a method called linear dynamic analysis to measure how the towers moved and how much they swayed at their base. We also calculated certain factors to understand how the towers amplify or increase the earthquake's effects. By the end of our study, we found specific relationships that can help better predict how these towers will behave in earthquakes, providing important guidance for their design and safety. (G. Ghodrati Amiri et. al.)

In this research, we look into how lattice towers, which are essential for holding antennas in our communication networks, behave during earthquakes. Especially in crowded city areas, these towers are often placed on the roofs of buildings. This means that how the tower reacts during an earthquake is closely tied to how the building itself moves. Using a method called time history analysis, we study how these towers, when placed on two different buildings, respond to various earthquake patterns. We then compare our findings with standard guidelines that typically apply to smaller or secondary structures. It's important to note that the buildings and towers we used in our study are based on a theoretical situation. Still, our findings give insights into how these structures might behave in real-life earthquake scenarios. (Ghyslaine Mc-clure et. al.)

In this research, we aim to make transmission line towers more cost-effective. Currently, these towers can account for a significant chunk of the total cost of setting up transmission lines, between 28 to 42 percent. With the growing need for electricity, finding efficient solutions becomes crucial. We started by looking at a standard 220 kV transmission line that uses square-based towers. We made changes by introducing a new design: a triangular base tower, aiming to improve its efficiency. Additionally, we also examined the original tower design with a square base supported by guide wires. Using advanced software called STAAD, we analyzed these designs in three dimensions and decided to use a specific type of structural member called angle sections for the towers. We also made sure to adjust our calculations for wind force at every step. By the end of our study, we compared all three tower designs to understand which one offers the best balance between strength, efficiency, and cost. Our findings provide valuable guidance for the transmission line industry to make more informed decisions. (C. Preeti et. al.)

In this research, we focus on understanding how 4-legged telecommunication towers in Iran respond to earthquakes, given their crucial role in today's infrastructure. While many studies have looked into the effects of wind and earthquakes on similar towers, they've mostly centered on towers with triangular shapes. We aim to give a more comprehensive view by studying ten different 4-legged towers in Iran. We tested them against the guidelines set by the Iranian seismic code and compared them against data from notable earthquakes in Manjil, Tabas, and Naghan. Our findings highlight an important detail: for most towers, considering just the first three movement patterns (or modes) is enough for analysis. However, for taller towers, looking at the first five modes gives a more accurate understanding, which can be crucial for making these towers safer in seismic events. (G. Ghodrati Amiri et. al.)

In this research, we focus on how telecommunication towers in Iran handle earthquakes, an aspect often overlooked in design guidelines which usually only consider wind forces. We studied ten 4-legged towers of varying heights, from 18 to 67 meters. Using detailed analyses, we first looked at how these towers might behave under different vertical loads. Then, we used two different methods to see how they might respond to earthquakes. Our results are promising: all the towers we studied are deemed safe for immediate use, even under strong earthquake conditions. A significant contribution of our study is the introduction of three new formulas that can help engineers estimate the strength needed at the base of such towers during earthquakes. These formulas can be valuable tools in designing safer telecommunication towers. (Gholamreza Soltanzadeh et. al.)

In this research, we look at the growing importance of telecommunication towers, especially how they handle wind and earthquakes. Different tower designs react differently to side forces like wind. While there's some information on how these towers handle earthquakes, there's still much we don't know, especially for various tower designs. In the past, most tower safety checks looked at them tipping over. But during earthquakes, certain parts of a tower can get dangerously stressed, risking a collapse. Our study aims to fill this gap by analyzing how different telecommunication towers, especially square-shaped ones with different support systems, respond to both wind and earthquakes. We use a specialized software to get detailed insights and compare the towers' performance under various conditions. (Shailesh S. Goral et. al.)

In this research, we explore the rapid growth of mobile communication and its impact on the need for telecommunication towers. With more people using mobile phones, there's a higher demand for these towers to ensure strong and widespread network coverage. Due to limited space in cities, placing towers on rooftops has become a popular solution. Given how crucial these towers are for communication, especially in earthquakes, their ability to withstand tremors is essential. We looked at how different types of soil affect these towers' stability during earthquakes. Additionally, we studied the tower's placement on a building's roof and found that where the tower sits within the building affects its movement during an earthquake.

Our findings suggest that softer soils can help reduce movement, and placing the tower centrally within a building can make the design more earthquake-resistant. (Arpit Chawda et. al.)

In this research, we explore the use of four-legged self-supporting towers worldwide, especially for transmitting electricity and other purposes. These towers have to handle various forces like their own weight, earthquakes, strong winds, and heavy snow, making their design both challenging and crucial. We specifically look at four-legged square-shaped towers in areas with different earthquake risks, following specific guidelines. We study towers of three different heights (40m, 50m, and 60m) using specialized software. By examining factors like how much the tower bends, the maximum force at its supports, and stress levels, we aim to provide important insights that can help design these critical structures better. (Sourabh Rajoriya et. al.)

In this research, we study how structures react and potentially get damaged from wind, especially when stresses keep changing around an average level. We use a specific type of model for our structure and calculate wind forces based on established standards. Lately, there have been growing concerns about how steel lattice towers, used for things like phone signals or electricity, perform, especially with changing weather patterns and the need for earthquake-resistant designs. Our main goal is to understand how these towers behave when exposed to wind and also when there's ice buildup. We look at six different types of these steel towers, both those on the ground and on rooftops, to give a clearer picture of their behavior and what should be considered in their design. (Patil Vidya M.et. al.)

In this research, we highlight how essential mobile phones are in keeping people connected, pushing network providers to make their coverage areas bigger. In cities where there's not much space, there's a growing trend to place telecommunication equipment on the roofs of tall buildings. This new approach hasn't been studied much, and there are concerns about how it might affect the buildings. To tackle this, we use the Staad Pro software to carefully plan where to put these towers on rooftops. By looking at different tower placements, our goal is to find the best spot that doesn't harm the building, especially in areas prone to earthquakes. This study aims to guide better practices for placing towers on rooftops. (Suyash Malviya et. al.)

In this research, we explore the common use of open-latticed steel towers, especially angle sections, in civil engineering projects like microwave antenna towers. We study these towers using two methods: the Static method and the Gust Factor Method (GFM). We compare towers made with angle sections to those made with square hollow sections, focusing on how much the top of the tower moves as our main measure. We also look at how the towers perform when we remove specific parts from the lower sections. By doing this, we want to understand better how these microwave antenna towers work and provide useful information for engineers and designers. (Siddesha.H)

In this research, we look closely at four-legged self-supporting towers used worldwide for communication. With the rapid growth of the communication industry, there's a need for more of these towers to ensure better coverage and reliability. These towers are vital for wireless communication, so it's essential to make sure they can withstand different types of disasters. While past studies mainly looked at how wind affects these towers, our research takes a broader view. We study towers of different heights with various support systems, considering both earthquakes and wind. We use specific methods to see how much wind affects the towers and other techniques to understand earthquake impacts. By comparing our findings, we aim to provide insights that can make these important communication towers stronger and safer. (Jithesh Rajasekharan et. al.)

In this study, we look into the growing need for communication towers, specifically lattice towers. Instead of just studying them as flat structures, we examined them as full 3D shapes to ensure they're safe and cost-effective. We studied two towers: one 18m tall and the other 40m tall. We looked at them in three ways: fully 3D, flat 3D, and a mix of both. Wind was our main focus. Using a method called the Gust factor, we compared how the towers reacted to wind in different ways. We found that the flat 3D model gave the most accurate results for certain stresses in the tower. However, it didn't capture all the stresses well. We suggest using either the full 3D or the mix of both models when checking the tower's strength. Our study also showed that sometimes, the bottom part of the tower might need changes based on these stresses. Overall, it's important to look at lattice towers in a detailed way for better safety and design. (Richa Bhatt et. al.)

In this scholarly exploration, we immerse ourselves in the intricate domain of television towers, instrumental in disseminating television broadcasts across expansive territories while concurrently facilitating radio and telecommunication transmissions. A primary focal point of our investigation is the structural robustness of these towers in the face of natural calamities, with earthquakes standing out as a particular concern. While extant research has primarily centered on the seismic vulnerabilities of 3-legged tall telecommunication towers, our inquiry adopts a broader lens. We pivot our attention to the seismic responses exhibited by four distinct television towers, each distinguished by its unique bracing mechanism and varying in height. Leveraging the advanced capabilities of SAP 2000 software, we intricately simulate these towers, subjecting them to rigorous static and dynamic evaluations.

Furthermore, we employ the seismic data from the Bhuj earthquake, a historically significant event, as a pivotal benchmark to gauge the towers' performance and resilience. Through the synthesis of these meticulous analyses and evaluations, this study endeavors to augment the scholarly discourse surrounding the seismic behavior and endurance of television towers. By elucidating these intricate dynamics, we aspire to furnish designers, engineers, and stakeholders with indispensable insights, thereby fostering advancements in the design paradigms and safety protocols governing television tower infrastructures. (Hemal J shah et.al.)

III. CONCLUSIONS AND OUTLINE OF PROPOSED WORK

Upon meticulous examination of existing literature and a comprehensive review of the overarching theme of this research, it becomes evident that the innovative methodology proposed within this study remains unexplored in prior scholarly works. Furthermore, a discernible gap exists regarding contemporary theories pertinent to the integration of telecommunication towers atop host structures.

The salient findings and recommendations emanating from this investigation are delineated as follows:

1) *Host Structure Evaluation:* Prior to initiating any construction or integration, a meticulous assessment of the host structure's configuration is imperative.
2) *Tower Selection and Load Distribution:* Optimal tower selection is pivotal. The selected tower must be engineered in such a manner that its entire load is uniformly distributed onto the host structure, potentially via columns or specialized configurations.
3) *Seismic Design Adherence:* The design and construction of the host structure must rigorously adhere to the seismic provisions as outlined by the Indian Code of Practice for earthquake-resistant design.
4) *Soil Characterization:* Before the onset of any construction activities, a detailed soil investigation is indispensable. The soil type utilized for design and construction should align with the specifications delineated in the soil investigation report pertinent to the area in question.
5) *Comparative Analysis:* To ensure the robustness and reliability of the proposed approach, it is imperative to construct various scenarios or cases. These scenarios should subsequently be juxtaposed against diverse result parameters to validate and refine the outcomes.

Upon the culmination of a thorough literature review in this domain, the prevailing consensus underscores the optimal positioning of the tower atop the host structure. However, a notable gap emerges: existing research fails to address the ramifications or provisions for tower placements in suboptimal or "worst" locations. Investigating the potential implications and rectifications for such unfavorable placements presents a promising avenue for future research endeavors. This forthcoming study aims not only to identify these suboptimal placements but also to devise strategies for their mitigation and correction, laying the groundwork for enhanced structural integration and efficiency in telecommunication tower deployments.

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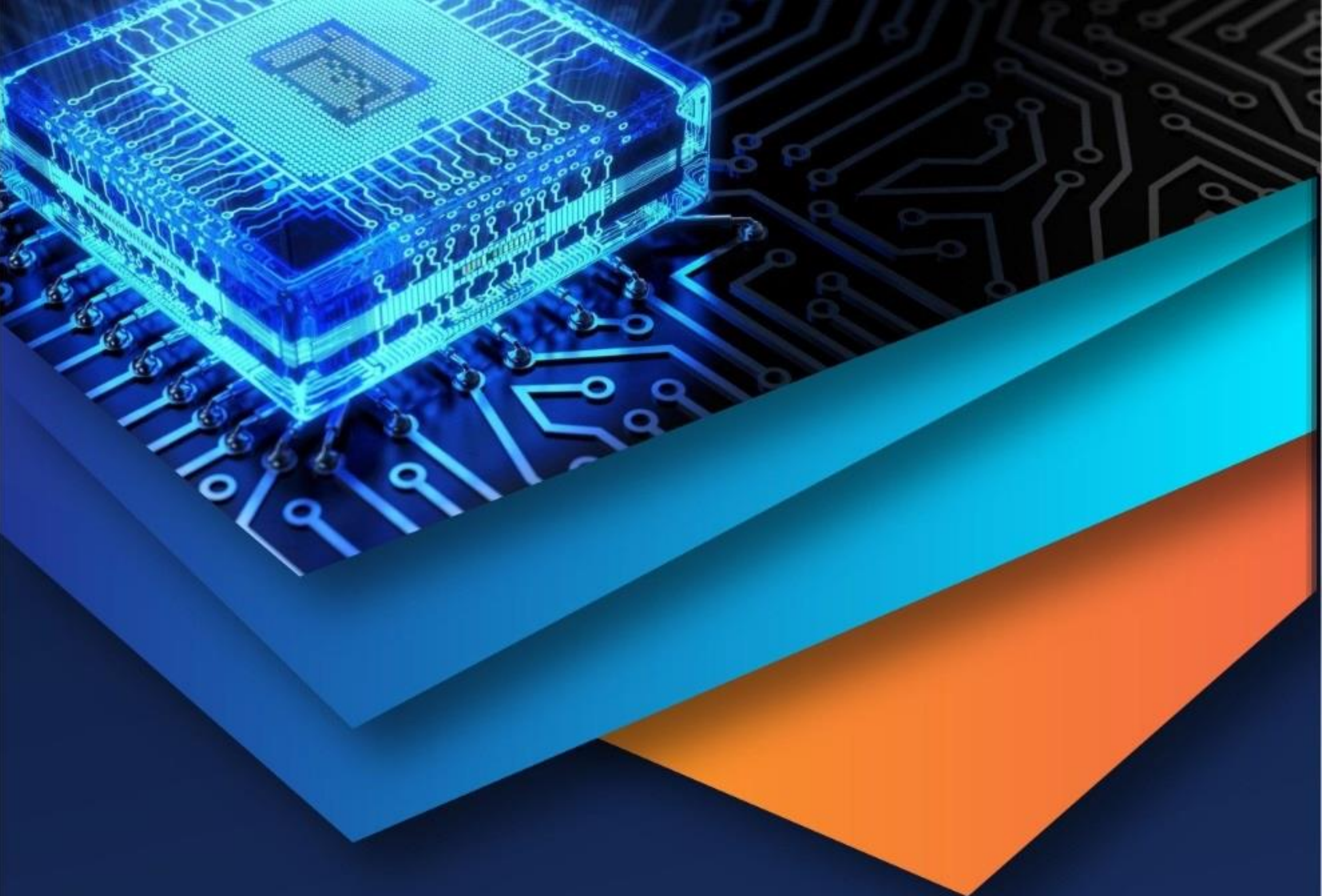

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