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A Review on Use of Telecommunication Tower over Host Structure

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Abstract: ***Effective communication depends on strong towers since it has been used worldwide. The telephonic communication depends on this since it is the only way to connect different networks. It can be installed above the structure and over the ground but the failure of such structures during hazardous conditions can result in critical communication breakdowns. In this study different reviews based on the telecommunication towers installed on tall buildings worldwide has given. Usually, four-legged towers used for good communication and to transfer the load. Different reviews based on only tower analysis and remaining on the response over the host structure over which the tower rests. This literature review provides valuable visions and conclusions to identify the problems related to the telecommunication tower which has to be provided over the building and the location over which it has to be placed. From this study it has to be noted that previous studies were based on the location that was optimum for the host structure but no one used the worst case of tower placing if it will be necessary to provide at that location. From this, we came to know the conclusive outcome that aim to provide technical insights and recommendations for future research in this area.***

Keywords: Multistoried Building, Response Spectrum, Telecommunication Tower Seismic Analysis.

I. INTRODUCTION

In the ever-evolving landscape of telecommunications, the unceasing demand for seamless connectivity and broader network coverage has prompted innovative solutions to infrastructure challenges. One of the notable transformations in this realm is the strategic integration of telecommunication towers atop multistoried buildings. This practice, born out of necessity in densely populated urban environments and expanding urbanization, represents a paradigm shift in the deployment of critical communication infrastructure. Traditionally, telecommunication towers were predominantly standalone structures, distinct and towering over their surroundings. However, as urban space becomes increasingly limited and the need for efficient utilization of available resources escalates, the concept of placing telecommunication infrastructure atop existing multistoried buildings has gained prominence. This approach not only optimizes land usage but also offers a host of logistical advantages in terms of accessibility, installation, and maintenance. This introduction sets the stage for a comprehensive exploration into the integration of telecommunication towers with multistoried buildings, delving into the various aspects, challenges, and benefits of this innovative practice. As the world continues to urbanize and the demand for reliable communication networks burgeons, understanding the dynamics of telecommunication tower deployment over multistoried structures becomes vital.

Telecommunication towers come in various types, each designed to meet specific needs and conditions. Here are some different types of telecommunication towers:

1) Self-Supporting Towers
2) Guyed Towers
3) Monopole Towers
4) Lattice Towers
5) Camouflaged Towers
6) Mobile Cell on Wheels (COWs)
7) Rooftop Towers
8) Water Tank Towers
9) Distributed Antenna Systems (DAS)
10) Satellite Dish Towers
11) Wind Turbine Towers

Fig. 1: Structure with Telecommunication tower at top

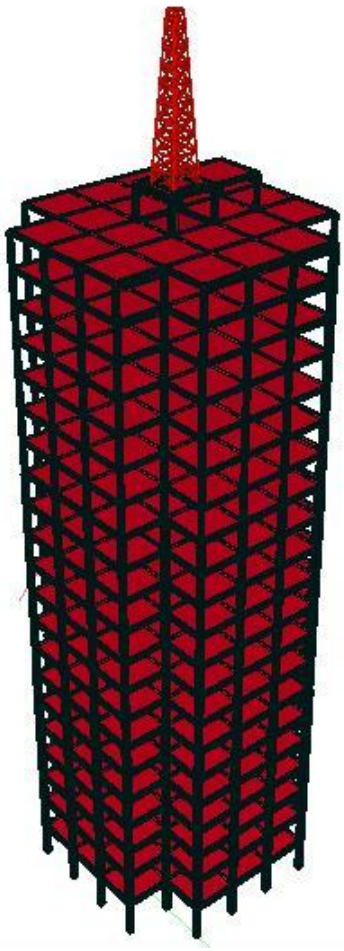

Fig. 2: 3D view of Structure with Telecommunication tower at top

II. REVIEW OF LITERATURE

This study explores the exponential growth in mobile communications over three years, driven by heightened competition among operators. Tower installations, guided by latitude and longitude, enhance network coverage and reliability. Scarce land availability in urban areas necessitates rooftop towers with minimal position adjustments but consistent antenna height. The research focuses on seismic response in 4-legged telecommunication towers, following the Indian seismic code for Zone-IV. Dynamic analyses, via SAP2000 software, consider both ground-based and rooftop towers, varying positions and host structure stiffness in X and Y directions. Axial forces within tower members are the primary parameter under scrutiny. A comparative analysis between rooftop and ground-based tower members at the same height above ground offers valuable insights into their seismic performance. (Nitin Bhosale et. al.)

In this study, we address the overlooked seismic behavior of telecommunication towers, which lack dedicated design codes, leading to the misapplication of conventional building codes. Ten self-supporting four-legged towers in Iran, ranging from 18 to 67 meters in height, are examined. Strong-motion earthquakes are applied vertically and horizontally, followed by linear dynamic analysis to calculate base shear and vertical responses. Seismic amplification factors for both horizontal and vertical earthquake components are determined by normalizing base shear or vertical response with tower mass and maximum acceleration. The study concludes by establishing relationships between amplification factors, the fundamental flexural mode, and the first axial mode of the towers. These findings offer valuable insights into estimating base shear and vertical responses for telecommunication towers, addressing their unique seismic challenges. (G. Ghodrati Amiri et. al.)

In this study, we investigate the seismic behavior of lattice towers, crucial antenna-supporting structures in telecommunication networks, with a focus on their vital role in maintaining functionality during and after strong earthquakes. Particularly in densely developed urban environments, these towers are often mounted on building rooftops, making their response intricately linked to the dynamic characteristics of the underlying structures. Through time history analyses, we explore the relationship between building accelerations, seismic base shear, and base overturning moments experienced by these rooftop-mounted lattice towers. Our models incorporate two medium-rise buildings coupled with two self-supporting lattice steel towers, subjected to 45 horizontal accelerograms with varying frequency content. We assess tower base shear results by comparing them to predictions derived from simplified formulas found in building codes for secondary structures. Notably, the combination of buildings and towers in this study represents a hypothetical scenario, while data for isolated buildings and towers reflect real-world conditions. (Ghyslaine Mc-clure et. al.)

In this study, we focus on optimizing the cost-effectiveness of transmission line towers, which constitute a significant proportion of transmission line expenditures, ranging from 28 to 42 percent. The imperative to meet the escalating demand for electrical energy efficiently drives our exploration of innovative solutions, particularly the development of lightweight tower configurations. Our research centers on a 220 kV single circuit transmission line initially characterized by square base self-supporting towers. Through strategic modifications, we introduce a triangular base self-supporting tower to optimize the existing geometry and also examine the structural behavior of the original tower by incorporating a square base guyed mast. Employing STAAD for rigorous three-dimensional analyses, we subsequently design the tower members as angle sections, with simultaneous reevaluation of wind load computations during analysis and design phases. This study culminates in a comprehensive comparative analysis of the three tower configurations, offering valuable insights for enhancing structural efficiency and cost-effectiveness within the transmission line industry. (C. Preeti et. al.)

In this study, we prioritize the evaluation of seismic performance for 4-legged self-supporting telecommunication towers, recognizing their pivotal role in modern society's infrastructure. Amid the extensive research on wind and earthquake-induced loads primarily focused on trussed steel masts with triangular cross-sections, our paper aims to provide a holistic examination of these critical structures. We analyze ten existing 4-legged self-supporting telecommunication towers in Iran, subjecting them to the seismic effects delineated by the Iranian seismic code of practice, as well as the normalized spectra corresponding to Manjil, Tabas, and Naghan earthquakes. A noteworthy observation emerges from our results: while the first three flexural modes suffice for dynamic analysis in most cases, taller towers benefit from considering the first five modes, enhancing precision and informing seismic performance optimization strategies. (G. Ghodrati Amiri et. al.)

In this study, we address the absence of earthquake considerations in telecommunication tower design codes, which predominantly emphasize wind load and linear behaviors. We investigate the seismic performance of ten 4-legged telecommunication towers in Iran, spanning heights from 18 to 67 meters. Initial nonlinear static analyses, featuring diverse vertical load distributions, are conducted for each tower. Subsequently, we employ both the target displacement and capacity spectrum approaches to determine their seismic performance thresholds.

Encouragingly, our findings demonstrate that all towers meet immediate occupancy criteria for both design base and maximum probable earthquake hazard levels. As a valuable outcome, we present three equations for estimating yield base shear and base shear corresponding to immediate occupancy, offering practical tools to enhance the seismic resilience of 4-legged self-supporting telecommunication towers. (Gholamreza Soltanzadeh et. al.)

In this study, the contemporary significance of the telecommunication industry in society has led to an increased focus on telecommunication tower analysis and design, particularly concerning wind and seismic considerations. Tower configurations exhibit unique responses to lateral loads, and while literature has proposed seismic parameter formulas, seismic performance across various tower configurations remains inadequately explored. Historically, tower safety predominantly addressed overturning, yet seismic events can push specific members to their ultimate strength, risking structural failure. In this research, we aim to bridge this knowledge gap by conducting wind and seismic analyses on telecommunication towers, encompassing square-plan designs with diverse bracing systems. The resulting models are subjected to non-linear dynamic analysis using STAAD Pro, facilitating a comprehensive comparison of results based on critical parameters. (Shailesh S. Goral et. al.)

In this study, we delve into the dynamic growth of the mobile communication sector, witnessing a surging trend in mobile communication adoption. Specifically, we focus on the widespread use of four-legged supporting towers for telecommunication purposes. The expanding communication industry has led to a significant upswing in tower installations, vital for network consistency and expanded coverage. The scarcity of urban land necessitates the adoption of rooftop towers as an alternative. Considering the critical role of towers in wireless communication networks, seismic resilience becomes a paramount concern. We begin by analyzing the seismic effects on these towers under various soil conditions. Furthermore, we investigate the tower's position atop a structure's rooftop, noting varying displacements at different heights within the structure. Notably, the maximum displacement occurs at the tower's top height, while the minimum is observed within the building. Our analysis yields valuable insights, revealing that soft soil conditions result in reduced displacement, and central tower positioning within the structure minimizes displacement, ultimately contributing to a more robust seismic design. (Arpit Chawda et. al.)

In this study, we delve into the global application of four-legged self-supporting towers, essential for electricity transmission and various other purposes. These transmission towers must contend with a multitude of forces, including their own weight, seismic activity, wind loads, and snow loads, making their design a complex interplay between structural and electrical requirements. Our focus centers on the analysis of four-legged square-type transmission towers across all four seismic zones, following IS:1893(part-3) guidelines, and considering three different heights (40m, 50m, and 60m). Leveraging STAAD.Pro software, we collect data on maximum deflection, maximum support reaction, maximum support moment, axial stress, and bending stress, enabling us to draw significant conclusions to inform the design and resilience of these vital structures. (Sourabh Rajoriya et. al.)

In this study, we delve into the dynamic behavior and fatigue damage accumulation of structures under wind excitation, where fluctuating stresses with randomly varying amplitudes around mean deformation states present significant design challenges. Our structural model employs a two-node space truss element, and we calculate equivalent static wind loads in accordance with IS 875-1987 (part 3) standards. Recent years have brought forth new concerns regarding the behavior of steel lattice masts, whether utilized for telecommunications or energy transfer, given the increasing severity of environmental effects and the growing emphasis on earthquake resistance in modern structural codes. This paper's objective is to comprehensively investigate the structural response of these specialized structures under wind loading and the combined effects of wind loading and ice accumulation. To achieve this, we analyze six types of steel masts, including four ground-based masts and two rooftop-mounted masts, aiming to provide valuable insights into their performance and design considerations. (Patil Vidya M.et. al.)

In this study, we recognize the pivotal role of mobile phones in connecting people, compelling network service providers to expand their reach by extending network coverage. Urban areas grapple with limited land availability, prompting a shift toward rooftop telecommunication solutions to address land use constraints and heighten coverage. The concept of installing telecommunication towers on multistory building rooftops, previously unexplored, raises concerns about potential negative effects on building components post-installation. To address these challenges, we employ Staad Pro software to meticulously plan and design tower placement, deviating from conventional tower needs. By assessing various tower positions, we aim to analyze parametric values and ultimately select a position that minimizes negative effects, particularly under seismic zone IV conditions, offering valuable insights for rooftop tower installations. (Suyash Malviya et. al.)

In this study, we delve into the extensive use of open-latticed steel towers across various civil engineering applications, with a particular focus on angle sections commonly employed in microwave antenna towers. Our analysis centers on microwave antenna towers, utilizing both the Static and Gust Factor Method (GFM) for comprehensive examination.

We draw comparisons between towers constructed with angle sections and those featuring square hollow sections, using the displacement at the tower's apex as the primary parameter for assessment. Additionally, we explore different tower configurations by selectively removing one member typically present in conventional towers at lower panels. Through these analyses, we aim to shed light on the structural performance and variations in microwave antenna towers, offering valuable insights for engineering and design considerations. (Siddesha.H)

In this study, we focus on the global use of four-legged self-supporting towers, integral to telecommunication networks. The burgeoning communication industry has witnessed a remarkable surge in recent years, necessitating the installation of numerous towers to extend coverage and ensure network reliability. Given the pivotal role these towers play in wireless communication, safeguarding them against disaster-induced failure is of paramount concern. Therefore, meticulous consideration of all potential extreme conditions is imperative for tower design. While prior research predominantly concentrated on the wind's effects on these towers, our dissertation introduces a comprehensive approach. We analyze models of varying heights featuring different bracing systems, incorporating both seismic and wind effects. The wind's impact is assessed using the gust factor method, while modal analysis and response spectrum analysis are employed to evaluate seismic effects. Through meticulous analysis and comparison of results, we draw valuable conclusions aimed at enhancing the resilience and structural integrity of these crucial telecommunications towers. (Jithesh Rajasekharan et. al.)

In this study, we address the escalating demand in the communication industry, leading to an unprecedented proliferation of lattice towers. Traditionally analyzed as 2D trusses, these towers, as 3D space frames, demand more rigorous examination for enhanced safety and cost-effectiveness, treating them as 3D structures. Emphasizing wind as the primary force, we employ the Gust factor method to compare joint displacements, member forces, and maximum stresses, aiming to elucidate the impact of varying modeling strategies on the design forces acting on communication lattice towers. Their findings reveal that the truss model consistently provides representative values for axial forces and stresses across all members. However, it tends to underestimate bending stresses due to its consideration of only out-of-plane bending effects. Either the frame model or the hybrid model may be employed for estimating combined stresses in design assessments. Crucially, our study highlights that combined stresses may necessitate base member redesign, emphasizing the need for a comprehensive approach to lattice tower analysis and design. (Richa Bhatt et. al.)

In this study, we delve into the realm of television towers, pivotal for broadcasting television signals over vast areas and also serving as conduits for radio and telecommunication signals. The paramount concern lies in their resilience during natural disasters, particularly earthquakes. While prior research has explored the impact of earthquakes on 3-legged tall telecommunication towers, our investigation widens the scope. We focus on earthquake responses in four towers of varying heights, each characterized by a distinct bracing system. Employing SAP 2000 software, we meticulously model the towers and subject them to both static and dynamic analyses. Additionally, we introduce the time history of the Bhuj earthquake as a testing ground for these structures, meticulously assessing their responses. Through this comprehensive study, we aim to enhance our understanding of the seismic behavior and resilience of television towers, offering valuable insights for their design and safety considerations. (Hemal J shah et.al.)

III.CONCLUSIONS AND OUTLINE OF PROPOSED WORK

After analyzing the literature reviews and the overall theme of this study, we have come to the realization that no previous research has discussed the new approach proposed in this study for mitigating the worst effects on the structure. Also, no one has specified the new and latest theories related to telecommunication tower over the host structure.

The conclusive outcomes drawn from this study are enlisted below:

1) It is necessary to check the configuration of the host structure first before commencing any work.
2) The best tower should be selected such that its entire load should be equally be transferred to the host structure by columns or any special arrangement.
3) It is necessary to design the host structure as per Indian Code of practice for earthquake design.
4) Soil type should be clearly mentioned before commencing any work.
5) Different cases should be created and compared with different result parameters to verify the results.

The final work in this field after the conduction of literature review is that the work tells us about the best location of tower over the host structure. Neither of any researches tells that if there would be any provision for the tower placement over the worst placement, can be a major part of the study and that has going to be a major study for upcoming proposed work to place over it and correcting the worst location.

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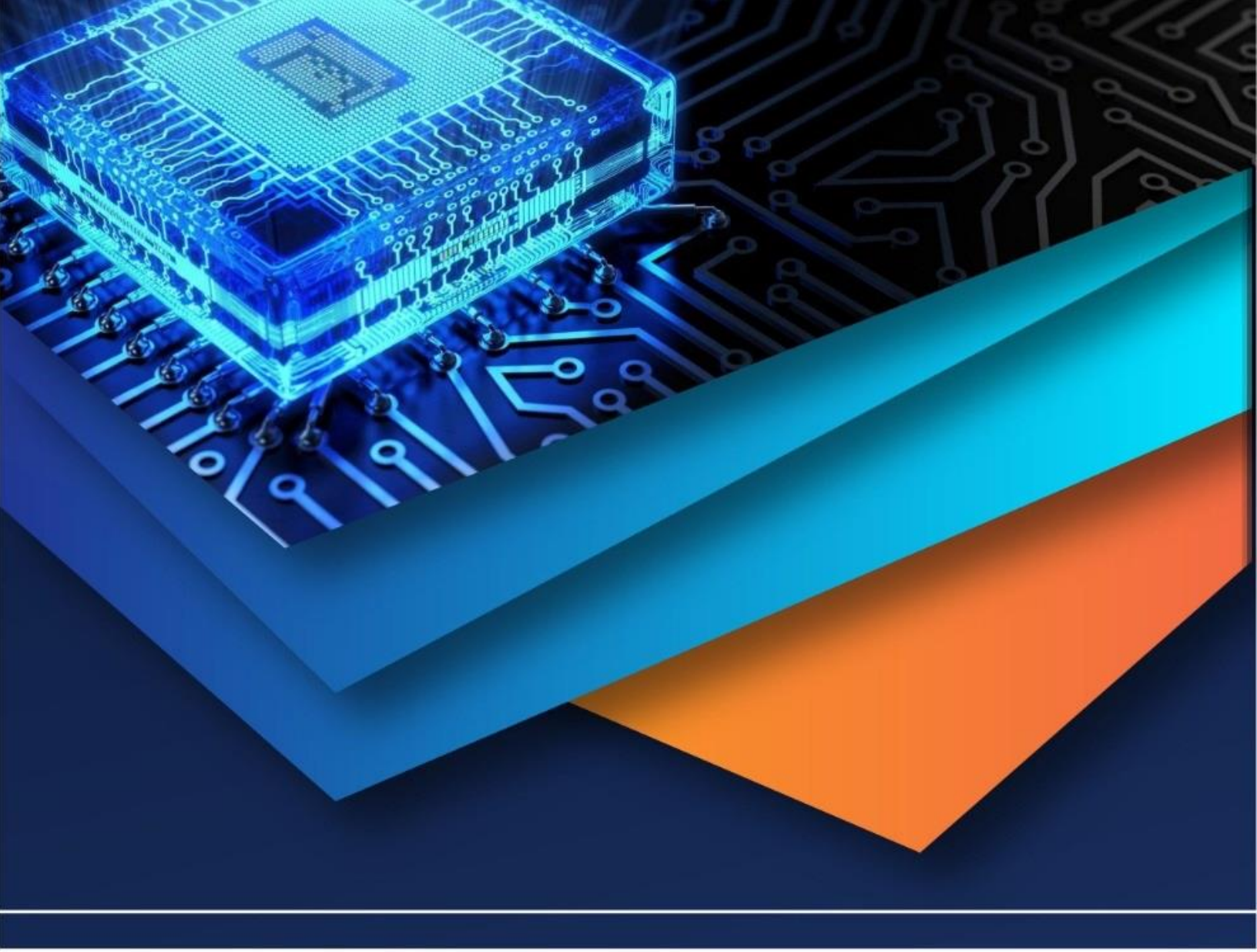

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