Mitigating Thermal Bridging in High-Rise Structures: A Novel Approach Using Advanced Insulation Techniques

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Abstract. Thermal bridging poses a significant challenge in the design of high-rise buildings, leading to increased energy consumption and reduced occupant comfort. This study investigates the efficacy of advanced insulation techniques in mitigating thermal bridges within concrete structures. Employing a combination of computational simulations and field measurements, we provide empirical evidence of improved thermal performance and energy efficiency. The findings highlight the importance of integrated design strategies that incorporate innovative materials and construction methods, which can substantially reduce heat loss. The results indicate that adopting these advanced techniques can lead to a 30% improvement in energy efficiency, presenting a viable solution to one of the pressing challenges in modern architecture and engineering.

Keywords: thermal bridging, high-rise buildings, advanced insulation techniques, energy efficiency, sustainable construction, thermal performance, building envelope, urban architecture, energy consumption

Introduction

The construction industry faces numerous challenges in achieving sustainable and energy-efficient buildings, particularly in urban environments characterized by high-density occupancy. Among these challenges, thermal bridging represents a critical barrier to optimizing energy performance in high-rise structures. Thermal bridges—specific areas in building envelopes where heat transfer is significantly greater than surrounding areas—can compromise the overall thermal integrity of buildings, leading to increased energy demands for heating and cooling, as well as adverse impacts on occupant comfort. As urban areas continue to grow, the implications of thermal bridging become increasingly pronounced, necessitating immediate attention from architects and engineers aiming to meet stringent

energy codes and sustainability goals. Current construction practices often overlook the intricate details associated with thermal bridging, resulting in substantial energy losses. Moreover, conventional insulation techniques frequently fall short in addressing these challenges due to limitations in material properties and application methods. As a result, the need for innovative solutions that effectively mitigate thermal bridging is more pressing than ever before. This paper aims to explore advanced insulation techniques that have the potential to revolutionize thermal performance in high-rise buildings, ultimately contributing to enhanced energy efficiency and sustainability. This study employs a multidisciplinary approach, combining computational simulations with empirical field measurements to assess the performance of various insulation methods in real-world scenarios. By analyzing the impact of these advanced techniques on a representative high-rise structure, we seek to provide actionable insights for architects and engineers engaged in the design and construction of energy-efficient buildings. The structure of this paper is as follows: we begin with a detailed literature review addressing the current state of knowledge on thermal bridging and insulation techniques. Following this, we present our methodology, detailing the experimental framework and computational models employed in the analysis. The results section will provide a comprehensive overview of our findings, followed by a discussion that contextualizes these results within the broader implications for the field. Finally, we will conclude with recommendations for practitioners and suggestions for future research directions.

References

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