

Parametric Thermal Performance Analysis of Double-Skin Facades: A Case Study on Energy Efficiency in Urban High-Rise Buildings

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Abstract. This study investigates the thermal performance of double-skin facades (DSF) in urban high-rise buildings through a parametric analysis. Utilizing computational fluid dynamics (CFD) simulations, the research evaluates energy efficiency improvements and thermal comfort enhancements. Results indicate that optimally configured DSFs substantially reduce energy consumption and improve occupant comfort in high-density urban environments. The findings underscore DSF's potential in mitigating urban heat islands, positioning it as a pivotal strategy in sustainable architecture. This case study provides a critical understanding of DSF's role in enhancing energy sustainability in modern cities.

Keywords: Double-Skin Facades, Thermal Performance, Energy Efficiency, Computational Fluid Dynamics, Urban High-Rise Buildings

Introduction

Urbanization and the subsequent proliferation of high-rise buildings pose significant challenges to sustainable architecture, particularly concerning energy efficiency and thermal comfort. Amidst global warming concerns, architects and engineers are pressed to innovate facade designs that enhance building performance while minimizing environmental footprints. Double-skin facades (DSFs) have emerged as a promising solution, offering improved thermal insulation and energy conservation. DSFs consist of two layers of glass separated by an air cavity, which acts as a thermal buffer. This configuration can significantly reduce energy demands for heating and cooling, especially in densely populated urban areas where high-rise buildings dominate the skyline. Despite their potential, DSFs require meticulous design and simulation to optimize their

performance, a task often complicated by the diverse climatic conditions and architectural variances encountered globally. This study focuses on the parametric analysis of DSFs in urban high-rise buildings. By employing advanced computational fluid dynamics (CFD) simulations, the research investigates how variations in facade design influence thermal performance and energy efficiency. The case study illustrates the practical implications of DSF configurations on energy sustainability and occupant comfort in modern city landscapes. The paper is structured as follows: Section 2 reviews literature on DSF systems and their applications. Section 3 details the methodology, including parameters for CFD simulations. Section 4 discusses the results, while Section 5 concludes with recommendations for future research and practical applications.

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References

1. Karimov, T. K., Abdykalykov, A. A., Karimova, M. T., Kyzy, N. B., & Maatkulova, J. (2019). Analysis of groundwater resources in the Kyrgyz Republic. *Journal of Environmental Management & Tourism*, 10(5 (37)), 984-990.
2. Выровой, В. Н., & Абдыкалыков, А. А. (1985). Моделирование и оптимизация процессов структурообразования композиционных материалов. Киев: Знание УССР.
3. Абдыкалыков, А. А., Маматов, Ж. Ы., Бозов, К. Д., Ордобаев, Б., Кожобаев, Д., Кенжетаев, К., ... & Орозалиев, Б. (2011). Чрезвычайные ситуации. Природные явления. Правила поведения. Ч. I/АА Абдыкалыков, ЖЫ Маматов, КД Бозов и др. Бишкек: КРСУ–КГУСТА.
4. Абдыкалыков, А. А., Ассакунова, Б. Т., Мамабеталиева, Д. А., & Маразыкова, Б. Б. (1998). Применение отходов промышленности при получении вяжущих материалов. Сб. науч. Тр. Нац. Академии наук КР. Бишкек, 164.
5. Боронбаев, Э. К., Бегалиев, У. Т., & Холматов, К. Н. (2017). Научно-технические основы повышения энергоэффективности и сейсмостойкости малоэтажных гражданских зданий. Вестник Кыргызского государственного университета строительства, транспорта и архитектуры им. Н. Исанова, (4), 157-163.