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SVR-based comparison of thermal performance of traditional and contemporary masonry structures in Himalayan region

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A R T I C L E I N F O

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A B S T R A C T

This study presents a data -driven comparative analysis of the thermal performance of two traditional (traditional and contemporary masonry structures) in the cold temperate Himalayan region, utilizing support vector regression (SVR)-based artificial intelligence modelling. The research evaluates the ability of traditional *Dhajji-Dewari* masonry structures, characterized by high thermal mass materials and thick walls, to regulate indoor temperatures compared to contemporary masonry structures using fired clay bricks and cement mortar. Long-term in-situ indoor and outdoor temperature monitoring was conducted over one year to capture seasonal and diurnal thermal dynamics.The recorded data were used to train SVR models, which achieved high predictive accuracy ($R^2 = 0.98$ for traditional and $R^2 = 0.99$ for contemporary masonry), enabling robust simulation of thermal behavior under real and extreme climatic conditions. The study quantifies the impact of seasonal variations, insulation properties, solar radiation, and structure orientation on indoor thermal comfort. Simulations were performed to assess performance across seasonal transitions, heatwaves, severe storms, prolonged rainfall, and under various insulation retrofitting strategies. Results revealed that traditional masonry structures exhibited 25–30 % greater heat retention in winter and maintained superior night time thermal stability due to their high thermal mass, reducing energy demands for heating and cooling.In contrast, contemporary structures demonstrated enhanced cooling performance during summer and extreme heat events, with indoor temperatures reduced by 4–5 °C due to insulation. Retrofitting with 2-inch mineral wool or polyurethane improved thermal stability by up to 38 % in contemporary structures. The study further reveals that during severe storms and prolonged rainfall, traditional masonry maintains better thermal stability, while contemporary structures exhibit rapid indoor cooling due to higher insulation efficiency. Under extreme heatwave conditions, contemporary masonry moderates indoor overheating more effectively than traditional structures. These findings underscore the necessity of integrating traditional passive thermal strategies with contemporary insulation techniques to optimize energy efficiency. In this study, the human comfort levels and energy savings are also studied. This study contributes to sustainable architecture by offering AI-powered insights and data-driven strategies to inform climate-responsive structure designs, ensuring resilience against extreme temperatures while preserving traditional construction knowledge and materials.

1. Objectives and contribution

This study aims to address the critical need for climate-resilient, energy-efficient building designs in the Himalayan region by integrating traditional passive thermal strategies within modern contemporary masonry structure. The primary objectives and contributions of this work are:

(1) To evaluate the year-round thermal performance of traditional and contemporary masonry structures under real-world Himalayan temperate climate conditions.
(2) To develop AI-driven support vector regression (SVR) models for accurate prediction of indoor thermal behavior based on in-situ temperature data.
(3) To quantify the impact of material properties, insulation strategies, extreme climatic variations and structural orientation on indoor thermal stability.
(4) To evaluate thermal comfort using Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD), and to estimate heating and cooling energy demand using degree-day analysis for both traditional and contemporary masonry structures.

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