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Climate-Responsive Performance of a Rammed-Earth House: Energy and Natural Ventilation Analysis

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ABSTRACT

The 2023 Kahramanmaraş earthquakes brought renewed attention to the environmental performance of post-disaster housing, alongside the immediate need for rapid and safe construction. This study examines a 70 m² single-storey rammed-earth house built in Doğanşehir, Malatya, after the earthquakes, with a focus on its energy use and passive response to local climate conditions. The building was evaluated through energy simulation, climate analysis, and numerical airflow assessment. Annual energy consumption and operational carbon emissions were calculated together with heating, cooling, lighting, and equipment loads. Local temperature, solar radiation, solar path, and prevailing wind conditions were also examined. Airflow simulations were used to investigate how the position of openings affects natural ventilation within the building. The analysis resulted in an annual energy use intensity of 105 kWh/m² and an operational carbon intensity of 55 $kgCO_2/m^2$. Total annual energy consumption was 6,981 kWh, with corresponding operational carbon emissions of 3,687 $kgCO_2$. Energy consumption was 33% lower than that of the reference model. Heating demand was concentrated in the winter months, while cooling demand increased during summer. The airflow results also showed that the arrangement of openings supports cross-ventilation and contributes to passive cooling in warmer periods. The case suggests that the environmental performance of rammed-earth housing is influenced not only by material choice, but also by orientation, building form, opening arrangement, and local climatic conditions. These results support the consideration of rammed-earth construction together with climate-responsive design strategies in post-disaster housing.

KEY WORDS:
rammed earth, energy performance, passive design, climate analysis