INFLUENCE OF THERMO-PHYSICAL CHARACTERISTICS OF BUILDING ENVELOPE MATERIALS ON STRUCTURAL COOLING RATES

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During cold seasons, buildings face the risk of emergency situations where the heating medium in the system may freeze, potentially causing pipe ruptures. This risk is particularly critical during wartime due to disrupted infrastructure. Since structures made of different building materials cool at varying rates, it is essential to analyze how the thermophysical properties of the building envelope influence these cooling processes.

A standard flat situated in the middle section of a multi-story residential building was selected as the study's object (Fig. 1). The geometric and thermophysical parameters of the model were defined as follows: Room dimensions: 4×4 m² (floor area), 2.6 m ceiling height; Loggia dimensions: 1×4 m²; Wall thickness: 0.1 m; Ceiling/floor thickness: 0.3 m; Windows: Double-glazed PVC units; External surface heat transfer coefficient: 23 W/(m²·K) (simulating high wind conditions); Outdoor air temperature: –10 °C; Load-bearing materials: wood, aerated concrete, reinforced concrete, and brick.

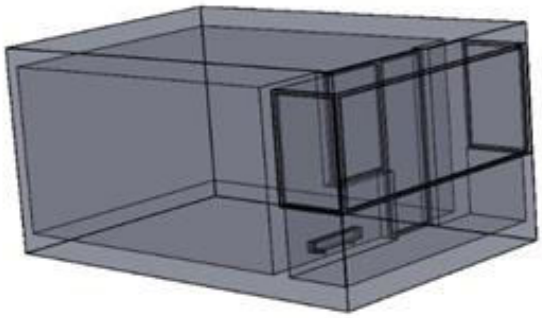

Figure 1. Sketch of the room model

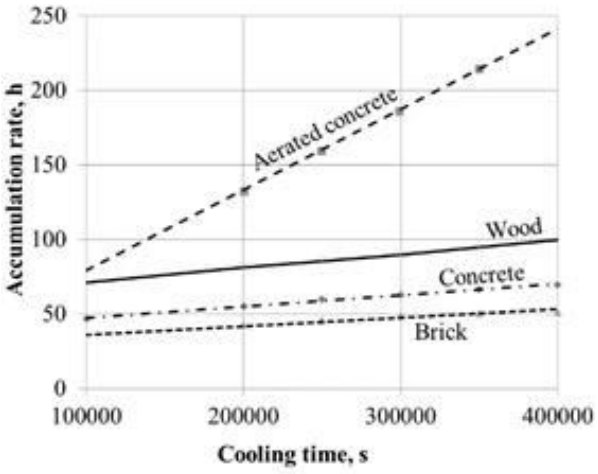

Figure 2. Dependence of accumulation rate on room cooling time

The study revealed that aerated concrete blocks exhibit strong thermal insulation properties. However, their high thermal mass leads to significant energy accumulation in the building envelope, requiring greater energy input for space heating. Despite this, aerated concrete structures demonstrate lower heat losses to the external environment compared to concrete and brick enclosures. Among the tested materials, brick construction showed the highest thermal losses.

The cooling rate of a room is most significantly influenced by the thermal conductivity coefficient of the building envelope material. A lower thermal conductivity corresponds to a higher heat accumulation capacity, resulting in a slower cooling process. As shown in Fig. 2, all dependencies exhibit a linear trend; however, the shallower slope for aerated concrete indicates its superior thermal retention, demonstrating the slowest cooling rate among the tested materials.