Comparison of Thermal Conductivity of Light-Clay Panels

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ABSTRACT
Earthen construction often utilises heavy materials to create thick, load-bearing walls with high thermal mass for temperature regulation. Although fibres are regularly added to prevent cracking, their effect on thermal properties is negligible. However, new earth-based materials are being developed as non-load-bearing insulation, using a small amount of clay as a binder and a large volume of lightweight fibres as a filler. Most existing materials are produced from straw or hemp shives, which are valuable resources in Turkey, whereas other agricultural by-products are considered waste and subjected to open-field burning or decomposition.
This research focuses on developing insulating clay panels made from local plants collected around İzmir. Nine locally sourced raw materials were tested: five agricultural by-products (wheat straw, lavender straw, hemp shives, sesame stalk, and olive tree shavings), three uncultivated plant residues (pine needles, seaweed, and reeds), and one industrial waste (sawdust). The aggregates were selected according to their availability in the Mediterranean area and their potential as insulating filler. Then they were further processed to obtain different sizes and geometrical aspects. The raw materials were mixed with clay in different proportions to produce 30 distinct formulations with different densities and aggregate size distributions. The thermal conductivity of the dry plates was measured in the laboratory, and the values were compared with existing literature.
The thermal conductivity obtained varies from 0.1 W/(mK) for low-density panels with straw, hemp or sesame to 0.2 W/(mK) for the denser panels with pine needles or sawdust. The findings demonstrate that, in accordance with the literature, panel density is the most critical factor determining thermal conductivity. However, the data also suggest that the type of fibres used (porous, tubular, or rigid) and their dimensions impact the outcomes. Porous aggregates, such as hemp shives or sesame stalks, display lower thermal conductivity, and reducing the aggregate size lowers the conductivity even further.

KEY WORDS:
Light clay; Agricultural waste, Thermal conductivity, Hemp shives, Straw