ABSTRACT

TITLE: Valorization of low-cost phase change material (waste wax) in concrete

This project presents a sustainable and multi-functional concrete admixture developed by valorizing industrial waste wax as a performance-enhancing material. The study addresses three major challenges in conventional concrete—high water absorption, shrinkage cracking, and excessive heat gain—while simultaneously reducing environmental waste. A stable alkali-resistant wax dispersion was formulated using paraffinic waste wax and sodium stearate, and incorporated into cement mortar at varying dosages. Since wax-based additives typically reduce strength, Class-F Fly Ash was integrated as a compensatory pozzolanic material to refine the microstructure and restore mechanical performance.

Four mortar mixes (Control, Low Wax, High Wax, and Wax + Fly Ash Compensated Mix) were designed using a constant w/c ratio of 0.48 and tested as per IS standards. Comprehensive experiments evaluated compressive strength, water absorption, sorptivity, internal curing behaviour, drying shrinkage, and thermal performance. Results demonstrated that the wax-admixed mixes showed a significant reduction in water ingress, superior hydrophobicity, and markedly lower sorptivity values. The internal curing assessment indicated reduced moisture loss and minimized plastic shrinkage, confirming improved microstructural stability. Thermal tests showed that the wax acted as a phase-change material, reducing surface temperature rise and offering passive heat-modulation benefits under thermal cycling.

Importantly, the combined Wax + Fly Ash mix achieved compressive strength comparable to the control, validating the compensatory role of fly ash. Overall, the project establishes a novel pathway for upcycling waste wax into an effective multifunctional admixture, enabling stronger, more durable, and energy-efficient concrete suitable for high-exposure and sustainable construction applications.