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EDITORIAL

Thermal Characteristics of Structural Lightweight Concrete

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A higher cooling load is required with an increasing room temperature that resulted from the high thermal conductivity and low time lag of conventional construction materials [1]. Such a high cooling load increases the carbon footprint from the energy consumption during building performance. The condition can be worsened with the urban heat island phenomenon, as the cooling load prolongs to night time for maintaining indoor thermal comfort. Hence, structural lightweight concrete (SLC) serves as an alternative in concrete structures for reducing the carbon footprint during building performance. Countries with tropical climates have the highest amount of energy consumption for cooling loads. SLC may significantly reduce the cooling loads within the structures' service life. The indoor environment is sealed from outside weathering with building form in achieving human thermal comfort. Apart from roofing, the wall is the major component in building form with predominant exposure to heat transfer. Heat transfer mechanism through conduction, convection and radiation increases indoor temperature and requires higher energy for reducing the temperature. Roofing and wall components contented higher areas for heat transfer mechanism. A lightweight concrete block and SLC comprising load-bearing members and a non-bearing wall is a sustainable solution for the concrete construction industry.

The outdoor wall experiences different temperature patterns throughout the day as a result of varying thermal loads, such as solar radiation and infrared exchange between the wall and its surroundings that

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retains thermal capacity. Heat waves transmit from the external wall surface to the internal ends, which increases the room temperature and thence decreases occupants' comfort. While in transition, the intensity of the heat wave dwindles as it penetrates the inner surfaces of building walls, causing a delay in the transfer of heat. The reduction in the intensity of heat waves is referred to as the decrement factor, while the delay in the transfer of heat at an appropriate time is termed time lag. Assessing these parameters offers a means of gauging the level of thermal comfort provided by the building envelope, prompting an investigation into the energy-saving potential of the materials used in the building.

Thermal properties include specific heat capacity, thermal conductivity, thermal diffusivity, decrement factor and time lag that affect materials' thermal performance. Specific heat capacity shows the material's heat storage through the decision on the amount of required energy for increasing the material's temperature by 1 Kelvin or degree Celsius in a unit mass. Materials with high specific heat capacity assist building envelopes' performance in achieving a higher level of thermal comfort through the indication of consistent room temperature without the influence of fluctuating outdoor temperatures. Thermal conductivity refers to the heat conductivity's inclination of a material in a motionless state. As such, room comfort is achievable through the usage of low-thermal conductivity materials for ideal thermal performance. Thermal diffusivity accounts for a material's thermal conductivity and specific heat capacity. Room comfort within a building envelope is undeniably warranted through low thermal diffusivity material with high specific heat capacity and low thermal conductivity.

While investigating the dynamic thermal characteristics of concrete materials, time lag and decrement factor are the two indicators of energy consumption prediction for building performance. In the study of Lee et al. [2], SLC may reduce a significant amount of energy for the cooling load if compared to the normal concrete, with other parameters remaining constant. The research has enhanced sustainable features with the introduction of agro-industrial waste of palm oil shells into a lightweight concrete matrix. The dynamic thermal characteristics of construction materials acquired professionals' attention, for the potential optimization of the thermal performances of a building envelope.

In response to the superior characteristics of thermal performance, concrete strength needs to be studied for a higher-performance application. As the air voids are the heat insulation layer in the concrete matrix, the voids also adversely affect the concrete strength. Traditionally, lightweight concrete gains lower concrete strength [3], with the same proportion of cement, aggregate and water, compared to conventional concrete. However, with reference to the ACI specifications of structural concrete, a 24%-28% density reduction resulted in 40%-50% energy savings, compared to conventional concrete, in accordance with the energy analysis from Lee et al. [2]. A balance is required for satisfying both design specifications of structural strength and thermal insulating properties.

In a brief, low specific heat and conductivity are specifically desirable in the tropics' construction industry. Specific thermal performance characteristics (i.e. high time lag and a low decrement factor) are essential for slow heat transfer from the outdoors to indoors within a longer time period through low heat dispersion [4].

Conflict of Interest

There is no conflict of interest.

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