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FINDINGS

The summary of the research findings has been listed below:

1. Building physics provides the theoretical basis for the development of steady-state heat transfer models, based on the fundamental laws of thermodynamics while taking into account the thermal properties of building materials, local climate, and internal loads. Similarly, appropriate climate classification that considers distinct patterns of temperature, humidity, and solar radiation characteristics, has a direct impact on the thermal performance of the building envelope. Building physics and climate classification are intertwined and must be considered together to ensure that the building envelope is designed to perform optimally in the specific climate zones.

2. The steady-state heat transfer algorithms have several advantages over advanced building energy simulation software, such as simplicity, low computational requirements, low cost, ease to use, ease of validation, ease of modification, and effectiveness for benchmarking. These advantages make steady-state heat transfer models a useful tool for optimizing building envelope performance in developing countries where resources and expertise could be limited. However, one major limitation of this approach is its reliance on steady-state heat transfer calculations, which may not accurately represent the dynamic thermal behaviour of building envelope components.

3. The steady-state algorithms require accurate coefficients for each building envelope component, which are specific to the climate zones of India. The lack of accurate coefficients for the building envelope components for the cooling-dominated climate zones of India has remained a major barrier to its application in optimizing the building envelope of commercial buildings.

4. The development of a baseline model refers to the process of developing a thermal equivalent geometry with specifications of standard building systems (envelope, HVAC, lighting, equipment, etc.) for different building typologies located across climatic zones. These baseline models are also referred to as prototype buildings or reference buildings and are of critical importance not only while developing building sector policies but also in assessing the impact of policy interventions. This research developed baseline building model by analysing data from 63 large office buildings located in major cities across the country, to establish climate-specific energy performance benchmarks.

5. The research developed Envelope Thermal Performance Index (ETPI) algorithm for the cooling-dominated climate zones of India. The coefficients for ETPI algorithm were computed by performing multiple regression analysis on data points generated by executing 80,000 parametric energy simulation runs on EnergyPlus 8.6. Additional 12,000 random parametric runs were performed to validate the developed ETPI algorithm. The observed R-square values (0.92 – 0.99) illustrate a strong correlation between ETPI computed using the developed algorithm and the thermal performance reported by energy simulation software. The Envelope Thermal Performance Index (ETPI) algorithm can be incorporated in future versions of national Building Energy Codes (ECBC) as an alternate building envelope compliance provision and contribute towards decarbonizing the building sector in India. It can be concluded that the developed ETPI algorithm in addition to being robust and user friendly, provides reliable results and can be used as an effective tool for optimization of building envelope.