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Predictability of Thermal Response in Housing: A Case Study in Australia, Adelaide

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Abstract : Changes in cities' heat balance due to rapid urbanization and the urban heat island (UHI) have increased energy demands for space cooling and have resulted in uncomfortable living conditions for urban residents. Climate resilience and comfortable living spaces can be addressed through well-designed urban development. The sustainable housing can be more effective in controlling high levels of urban heat. In Australia, to mitigate the effects of UHIs and summer heat waves, one solution to sustainable housing has been the trend to compact housing design and the construction of energy efficient dwellings. This paper analyses whether current housing configurations and orientations are effective in avoiding increased demands for air conditioning and having an energy efficient residential neighborhood. A significant amount of energy is consumed to ensure thermal comfort in houses. This paper reports on the modelling of heat transfer within the homes using the measurements of radiation, convection and conduction between exterior/interior wall surfaces and outdoor/indoor environment respectively. The simulation was tested on selected 7.5-star energy efficient houses constructed of typical material elements and insulation in Adelaide, Australia. The chosen design dwellings were analyzed in extremely hot weather through one year. The data were obtained via a thermal circuit to accurately model the fundamental heat transfer mechanisms on both boundaries of the house and through the multi-layered wall configurations. The formulation of the Lumped capacitance model was considered in discrete time steps by adopting a non-linear model method. The simulation results focused on the effects of orientation of the solar radiation on the dynamic thermal characteristics of the houses orientations. A high star rating did not necessarily coincide with a decrease in peak demands for cooling. A more effective approach to avoid increasing the demands for air conditioning and energy may be to integrate solar–climatic data to evaluate the performance of energy efficient houses.

Keywords : energy-efficient residential building, heat transfer, neighborhood orientation, solar–climatic data
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