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Thermal Behaviour of a Low-Cost Passive Solar House in Somerset East, South Africa

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Abstract : Low-cost housing provided for people with small incomes in South Africa are characterized by poor thermal performance. This is due to inferior craftsmanship with no regard to energy efficient design during the building process. On average, South African households spend 14% of their total monthly income on energy needs, in particular space heating; which is higher than the international benchmark of 10% for energy poverty. Adopting energy efficient passive solar design strategies and superior thermal building materials can create a stable thermal comfort environment indoors. Thereby, reducing energy consumption for space heating. The aim of this study is to analyse the thermal behaviour of a low-cost house integrated with passive solar design features. A low-cost passive solar house with superstructure fly ash brick walls was designed and constructed in Somerset East, South Africa. Indoor and outdoor meteorological parameters of the house were monitored for a period of one year. The ASTM E741-11 Standard was adopted to perform ventilation test in the house. In summer, the house was found to be thermally comfortable for 66% of the period monitored, while for winter it was about 79%. The ventilation heat flow rate of the windows and doors were found to be 140 J/s and 68 J/s, respectively. Air leakage through cracks and openings in the building envelope was 0.16 m3/m2h with a corresponding ventilation heat flow rate of 24 J/s. The indoor carbon dioxide concentration monitored overnight was found to be 0.248%, which is less than the maximum range limit of 0.500%. The prediction percentage dissatisfaction of the house shows that 86% of the occupants will express the thermal satisfaction of the indoor environment. With a good operation of the house, it can create a well-ventilated, thermal comfortable and nature luminous indoor environment for the occupants. Incorporating passive solar design in low-cost housing can be one of the long and immediate solutions to the energy crisis facing South Africa.

Keywords : energy efficiency, low-cost housing, passive solar design, rural development, thermal comfort
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