

Effect of Using PCMs and Transparency Ratios on Energy Efficiency and Thermal Performance of Buildings in Hot Climatic Regions. A Simulation-Based Evaluation

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Abstract : In the building design process, reducing heating and cooling energy consumption according to the climatic region conditions of the building are important issues to be considered in order to provide thermal comfort conditions in the indoor environment. Applying a phase-change material (PCM) on the surface of a building envelope is the new approach for controlling heat transfer through the building envelope during the year. The transparency ratios of the window are also the determinants of the amount of solar radiation gain in the space, thus thermal comfort and energy expenditure. In this study, a simulation-based evaluation was carried out by using Energyplus to determine the effect of coupling PCM and transparency ratio when integrated into the building envelope. A three-storey building, a 30m x 30m sized floor area and 10m x 10m sized courtyard are taken as an example of the courtyard building model, which is frequently seen in the traditional architecture of hot climatic regions. 8 zones (10m x10m sized) with 2 exterior façades oriented in different directions on each floor were obtained. The percentage of transparent components on the PCM applied surface was increased at every step (%30, %40, %50). For every zone differently oriented, annual heating, cooling energy consumptions, and thermal comfort based on the Fanger method were calculated. All calculations are made for the zones of the intermediate floor of the building. The study was carried out for Diyarbakır provinces representing the hot-dry climate region and Antalya representing the hot-humid climate region. The increase in the transparency ratio has led to a decrease in heating energy consumption but an increase in cooling energy consumption for both provinces. When PCM is applied to all developed options, It was observed that heating and cooling energy consumption decreased in both Antalya (6.06%-19.78% and %1-%3.74) and Diyarbakır (2.79%-3.43% and 2.32%-4.64%) respectively. When the considered building is evaluated under passive conditions for the 21st of July, which represents the hottest day of the year, it is seen that the user feels comfortable between 11 pm-10 am with the effect of night ventilation for both provinces.

Keywords : building envelope, heating and cooling energy consumptions, phase change material, transparency ratio

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