ABSTRACT

Thermal mass of building envelope has a significant effect on the cooling loads of a building and energy consumption of an air-conditioning system. It reduces and delays peak cooling loads, and, in some cases, improves thermal comfort inside buildings. This study investigated the effects of the thermal mass of the building envelope under different conditions at orientation, various times of use in a building, and different window to wall ratios (*WWR*). The study consists of 3 parts. Part 1 is an investigation of the appropriate thermal mass on opaque wall. Part 2 is an investigation of the effects of thermal mass under different *WWR*. Part 3 is an evaluation of the insulation position of the massive wall. The annual cooling coil load from heat conducting through the wall is a main criterion for evaluating the optimal thermal mass.

'BESim', a building energy simulation tool, was employed for the study. However, a series of experiments were conducted to calibrate and validate BESim. It was found that the simulated results correspond closely with the measured heat flux surface, results the inner surface of the building envelope. The root mean square error and the mean bias error were found to be 2.547 W/m^2 for and +1.881 W/m^2 , respectively.

Heat transfer through the building envelope is subject to the thermal mass quantity, orientation and the operating time of an air conditioner. For opaque walls, the thermal mass from 200 kJ/m^2K to 300 kJ/m^2K is suitable for buildings used during the daytime and 24 hours, while a wall with low thermal mass is suitable for a building that is used in the evening and at night. *WWR* of a building envelope also has an influence on the heat stored in the building structure. As increasing the value of *WWR*, solar radiation penetrating through a window is dominant when compared to the heat conducted through thermal mass. It was found that the effect of thermal mass diminishes as WWR increases.

The study on the effect of insulation position on the cooling loads reveals that the influence of insulation is reduced when increased *WWR*, and, the position of the insulation has a small effect on the reduction of the annual cooling coil load, for a building with a massive wall and one that is used at night. It was also found that the inner mass on the insulated wall affects the high cooling coil load at night, due to the heat that was stored and trapped inside the wall.

Keywords: thermal mass , building envelope, operation time, *WWR*, cooling coil load