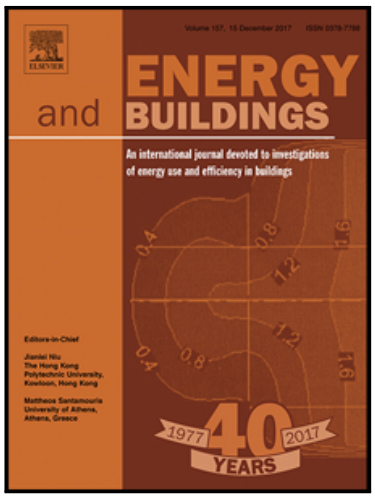

An Innovative Apparatus for Simulating Daily Temperature for Investigating Thermal Performance of Wallboards Incorporating PCMs

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An Innovative Apparatus for Simulating Daily Temperature for Investigating Thermal Performance of Wallboards Incorporating PCMs

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ABSTRACT

In recent years, many researchers have been attracted to the application of phase change materials (PCMs) in the production of construction materials. PCMs are substances with large latent heat capacity and their combination with building materials such as concrete and gypsum would lead to an enhancement in their thermal characteristics, mostly thermal inertia and also the capacity of storing thermal energy. One of the problems associated with the use of PCMs is the correspondence of their melting temperature range with the temperature of the ambient in which they will be used. This paper is aimed to introduce an innovative apparatus for investigating some characteristics of PCM-containing wallboards such as the amount of the reduction of maximum indoor temperature, the time delay to reach the maximum indoor temperature, and the cycling stability of PCMs in melting and freezing cycles. The compatibility of the melting temperature of the PCMs with the ambient temperature to ensure the charge/discharge process of PCMs can be studied as well. The analysis of the test results carried out by this apparatus will help the researchers to a better understanding of the thermal behavior of any kind of PCMs in many different environments. In this study, thermal performance of a precast concrete sandwich panel incorporating PEG 600 as PCM is evaluated using the introduced apparatus.

Keywords: Daily temperature simulator, Phase change material, Concrete wallboard, Thermal energy storage

1. INTRODUCTION

Energy conservation has been one of the essential concerns of researchers in the contemporary world. Buildings, especially residential and commercial ones, are responsible for approximately 30 to 40 percent of total energy consumption, mostly for heating and cooling of spaces, and therefore, have become the focus of researchers' attention[1–6]. Various methods have been investigated in order to introduce new methods for enhancing the indoor thermal comfort of buildings and also reducing the energy consumption of them through increasing the energy efficiency of different elements of buildings. thermal energy storage (TES), a recent method of improving the energy efficiency of building roofs and walls, could be achieved by the application of phase change materials (PCMs) in some conventional building materials, specifically concrete and gypsum [5–7].

PCMs are substances with the large latent heat of fusion which let them absorb and store a great deal of thermal energy during the melting process while their temperature remains within a constant range. This stored energy would be released by cooling down to the freezing temperature again [8]. Utilization of PCMs in buildings results in less fluctuations of indoor temperature, reducing the maximum indoor temperature in the summer, decreasing the heating/cooling load on HVAC systems, and also enhancing the occupant comfort. Researchers have employed PCMs in construction materials such as concrete and gypsum through several methods including microencapsulated PCMs, PCM-impregnated lightweight aggregates, macro encapsulated PCMs, and shape-stabilized PCMs. Evaluating the thermal performance of building elements incorporating PCMs has been of great importance in the literature so as many experimental and numerical methods have been proposed.