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Thermal performance of precast light floor radiant panel

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Abstract

Precast light floor radiant panel is an integrated sheet which consists of insulating base board, heating plastic tube, thick aluminum foil and surface course. The heating tube is laid in the groove of insulation board under aluminum foil. The radiant panel is simplified as a two-dimensional heat transfer model for analysis. The numerical simulation is carried out to obtain the thermal performance. Experiments are conducted to verify the simulation. The average temperature of the inner wall of the heating tube and the surface of the aluminum foil under steady state was measured, and the thermal resistance under the experimental conditions was obtained. Comparisons between the experimental results and the simulation results indicate that the simulation is valid. The effects of different tube spacing and thickness of aluminum foil on the surface temperature and the equivalent thermal resistance of the radiant panel is studied by simulations. The results show that the distance between heating tubes has obvious effect on the equivalent thermal resistance, while the thickness of aluminum foil has insignificant influence on the thermal performance of the heating panel in question.

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Keywords: radiant panel, thermal performance, tube spacing, thickness of aluminum foil;

1. INTRODUCTION

In the global context of energy use and building energy efficiency, low temperature floor radiant heating has been extensively applied due to its excellent indoor air environment, thermal comfort, energy savings and other advantages over the traditional heating method [1]. Zhang Dongliang [2] analyzed the heating tube spacing on the light floor radiant panel heating performance. S. Sattari [3] simultaneously considered heat conduction, convection, and radiation heat transfer mechanisms to analyze the effect of different design parameters; the type and thickness of the floor were considered to be the most important parameters in radiant heating systems. G. B. Zhou [4] carried out

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to investigate the performance of a low-temperature radiant floor heating by experiment. Dengjia Wang[5] proposed an enhanced-convection overhead radiant floor heating system.

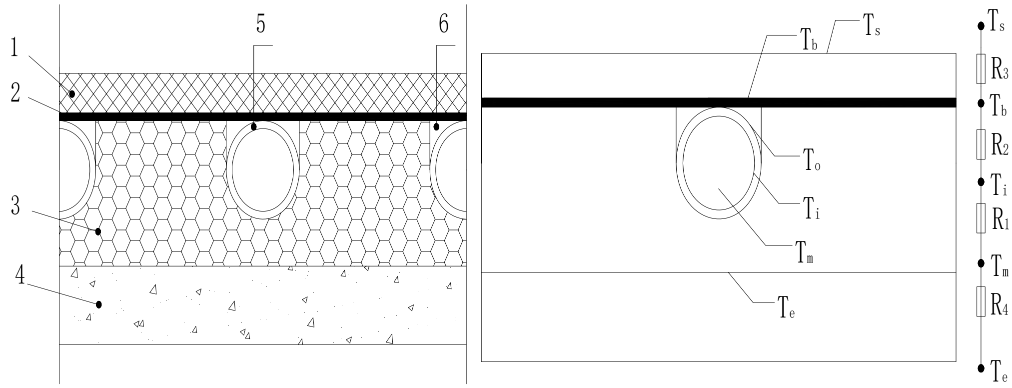
In this paper, the effect of aluminum foil thickness and tube spacing on the thermal performance of light radiating panel was studied and the equivalent thermal resistance of light floor radiant panel was proposed. The heat transfer performance of the light floor radiant panel was analyzed by experiment and simulation respectively.

2. STRUCTURE AND THERMAL RESISTANCE ANALYSIS OF PRECAST LIGHT FLOOR RADIANT PANEL

2.1. Structure of precast light floor radiant panel

Precast light floor radiant panel, PE plastic pipe of small diameter (usually less than 10 mm)laying in prefabricated insulation material in the grooves and the general thickness of insulation board is not more than 35mm. The thin aluminum foil is used to enhance the heat transfer ability. Finally, the floor tiles or wood and other decorative layer can be laid on the aluminum foil.

In this paper, the thickness of the insulation board is 25mm, the diameter of PE heating tube is 6mm, the inner diameter is 4mm, and the thickness of aluminum foil is 0.1mm, 0.2mm, 0.3mm and 0.4mm respectively. In addition, PE heating tube spacing can also be different to study the effects of different spacing on heat transfer. The structure is shown in Figure 1.



1. Decorative surface layer 2.Heat conduction aluminum foil 3.Thermal insulation 4.Floor slab layer 5.Heating tube 6.Air gap

Fig. 1.Structure of prefabricated lightweight radiation floor and thermal resistance diagram

2.2. Thermal resistance analysis

For simplicity, this paper adopts the concept of equivalent thermal resistance of radiant panel [6]. The equivalent thermal resistance *R* is the thermal resistance of the heating medium in the radiant panel to the outer surface of the radiant panel.

$$R = \frac{T_s - T_m}{q} \tag{1}$$

It can be seen from Fig. 1 that the equivalent thermal resistance *R* is the sum of the R_1 R_2 R_3. Thus the formula for the thermal resistance can be calculated by Equation 2.

$$R = R_1 + R_2 + R_3 \tag{2}$$

$$R_2 = \frac{T_b - T_m}{q} = \frac{T_b - T_i}{q} \tag{3}$$