

DESIGN OF OUTER WALL EXTERNAL THERMAL INSULATING SYSTEM

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ABSTRACT

For the defects of temperature control performance and thermal property of existing concrete building walls, a new composite concrete wall block is proposed, and the thermal property of the block is calculated and analyzed. The transverse hole of designed H-shaped concrete block can be embedded with thermal insulation materials, and the vertical ribs are added to the traditional brick wall, which effectively increases the stability and thermal performance of the wall. The selected PCM concrete has better functions of heat storage and temperature regulation. The thermal performance test results show that the thermal insulation performance of H- shaped wall block is the best, which is due to the H- shaped wall block can effectively block the transverse thermal bridge effect of the wall, and the heat flow increases remarkably. The results of practical environmental monitoring on H-shaped concrete block show that there is a large temperature difference between the external wall and the internal wall, and the wall has better thermal insulation performance

1. INTRODUCTION

With the rapid development of the global economy, the total energy consumption is increasing [1, 2]. Building energy consumption occupies an important proportion in the overall energy consumption [3, 4]. Indoor heating in winter and large use of air conditioning in summer are the reasons for high building energy consumption. Research and popularization of energy-saving buildings is an effective means to reduce energy consumption and environmental pollution [5].

Exterior wall, interior wall, doors and windows of buildings are the main factors leading to indoor energy consumption. Energy consumption from exterior wall accounts for 49% of the total consumption. Optimizing thermal insulation performance of exterior wall and improving thermal property of exterior wall are the most effective ways to avoid indoor energy consumption [6, 7]. Technical transformation of external walls includes external/internal insulation upgrading and self-insulation technology of external walls.

The external thermal insulation technology of the external wall is mainly used for the transformation of the old buildings, the air tightness and waterproof property of the wall body after the transformation are remarkably increased, but the durability and fire resistance are poorer [8-10]; The internal thermal insulation technology of the external wall is simple in construction and low in cost, but affects indoor decoration and occupies indoor usable floor area [11, 12]; the self-insulation technology of external wall has better durability and fire resistance, but the heat bridge effect cannot be avoided [13, 14]. On the basis of the above-mentioned traditional technologies, the researchers added fiber, fly ash, aerated concrete and so on to the concrete, which have improved the thermal performance of the building wall [15-19]; in recent years, new composite thermal insulation concrete walls (cross-hole block concrete walls, composite ceramsite concrete walls, and hollow block concrete walls) have been widely used in various types of buildings [20, 21], improving the thermal property of building walls to varying extent [22, 23]. However, at present, the analysis of comprehensive thermal performance of the above-mentioned walls is relatively few, and the engineering application of the new-type composite concrete walls still lacks more theoretical bases [24, 25]. For the defects of temperature control performance and thermal property of existing concrete building walls, a new composite concrete wall block is proposed, and the thermal performance of the block is calculated and

analyzed. The research conclusions can provide theoretical reference for the engineering application of composite concrete wall block.

2. SPECIFICATION DESIGN AND THERMAL PERFORMANCE INDEX CALCULATION OF COMPOSITE CONCRETE BLOCK WALL

2.1 Design of concrete block wall

In this study, two kinds of concrete block wall structures are designed, as shown in Figure 1, including Square-shaped and H-shaped respectively. The block wall is mainly composed of horizontal hole, bottom plate, top plate, tie bar, mortar belt and vertical ribs from top to bottom. Heat insulating material can be embedded in the Cross-shaped cross holes of the block to further enhance the thermal performance of the building wall. For Square-shaped and H-shaped block walls, vertical ribs are added based on the foundation of the traditional brick wall, which has greatly increased the stability of the wall.

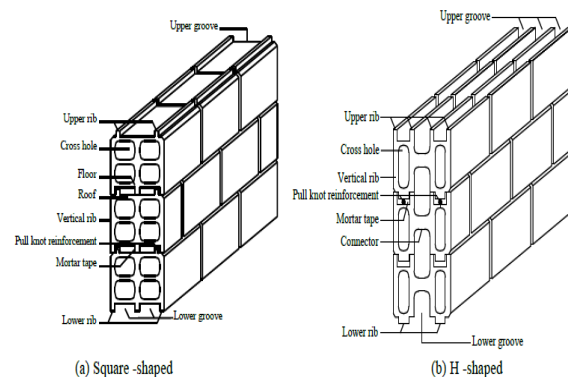


Figure 1. Concrete block wall structure

When there is temperature difference between inside and outside the building, the energy is transferred through the external wall. The heat transfer process is shown in Figure 2. The heat is conducted from the high temperature side to the low temperature side

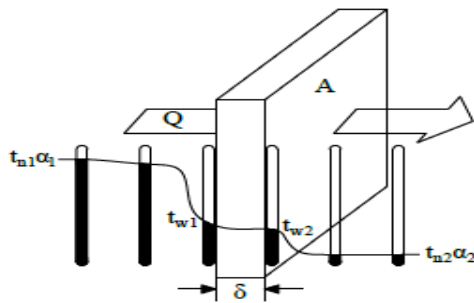


Figure 2. Heat transfer process

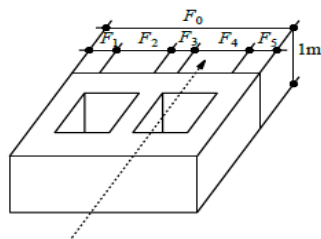


Figure 3. Schematic diagram for calculation of thermal resistance of wall blocks

The specific size distribution of the concrete block structure is shown in Figure 4.

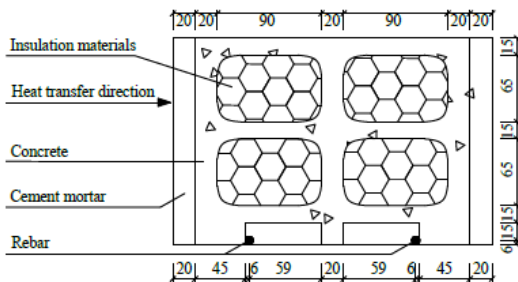


Figure 4. Specific size distribution of the concrete block

3. TEST RESULTS AND ANALYSIS

The concrete selected in this study is paraffin phase change temperature control mortar concrete (PCM), which has better functions of heat storage and temperature regulation. The temperature field distribution of PCM concrete and ordinary concrete is tested with the results shown in Figure 5.

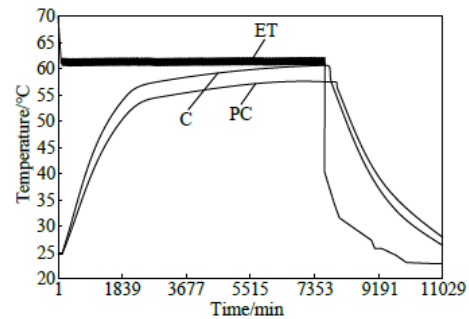


Figure 5. Temperature field distribution of two kinds of concrete

It can be seen from the figure that the ambient temperature is set at 62 °C. The temperature field of PCM concrete used in this study is always lower than that of ordinary concrete in the pre-heating stage. When the ambient temperature decreases rapidly, the temperature field of PCM concrete decreases less than that of ordinary concrete. This is due to the fact that the PCM concrete releases the heat stored inside it after the ambient temperature has dropped. The curves in Figure 5 demonstrate that PCM concrete has better temperature control characteristics.

To further verify the Cross-shaped block wall and H-shaped block wall designed in this study, the two types of walls and the traditional Square-shaped walls are

compared to calculate the heat transfer resistance and thermal inertia indexes of the three walls, and the calculation results are shown in Figure 6. The wall thickness (190 mm and 240 mm) of two walls is investigated, and the abscissa 1-3 represents the Square-shaped wall block, the Cross-shaped wall block and the H-shaped wall block, respectively.

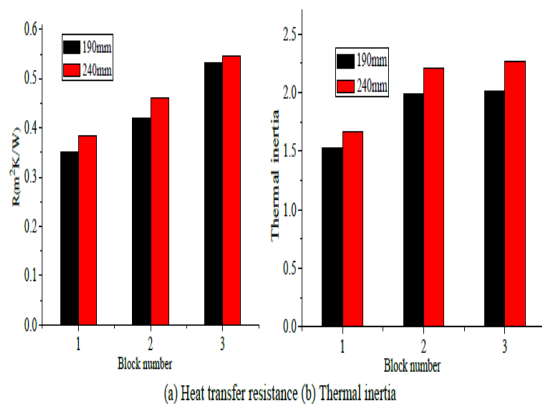


Figure 6. Heat transfer resistance and thermal inertia of three types of concrete wall blocks

In order to analyze the accuracy of the results, all three types of wall blocks are not filled with thermal insulation materials. As shown in Figures. 6 (a) and 6 (b), R (Square-shaped) < R (Cross-shaped) < R (H-shaped); D (Square-shaped) < D (Cross-shaped) < D (H-shaped). The calculation results of two important evaluation indexes show that the thermal insulation performance of H-shaped wall blocks is the best, which is because H-shaped wall blocks can effectively block the transverse thermal bridge effect of the wall, and the heat flow increases remarkably.

H-shaped wall blocks are selected to monitor the actual environment. Figure 7 shows the variation of the external surface, internal surface, mortar and block interface

temperature of the building wall. Figure 8 shows the heat transfer coefficient of the wall. As can be seen from Figures 7 and 8, the temperature difference between the external wall and internal inner wall is large, and the wall has better thermal insulation performance.

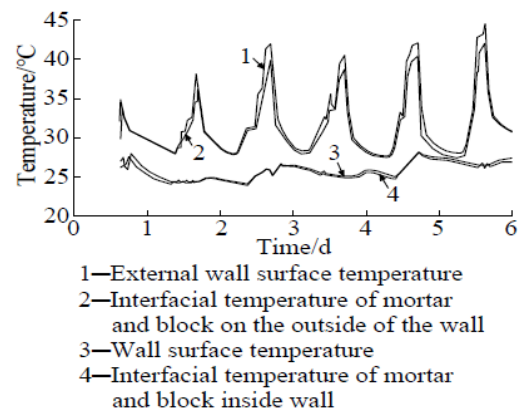


Figure 7. Temperature variation of each part of the wall

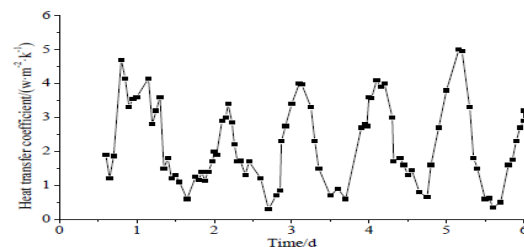


Figure 8. Wall heat transfer coefficient

4. CONCLUSIONS

For the defects of temperature control performance and thermal property of existing concrete building walls, a new composite concrete wall block is proposed, and the thermal property of the block is calculated and analyzed. The conclusions are as follows:

The the transverse hole of designed H-shaped concrete block can be embedded with thermal insulation materials, and the

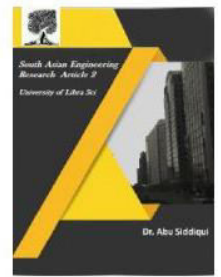


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vertical ribs are added to the traditional brick wall, which effectively increases the stability and thermal performance of the wall. The selected PCM concrete has better functions of heat storage and temperature regulation. The thermal performance test results show that the thermal insulation performance of H-shaped wall block is the best, which is due to the H-shaped wall block can effectively block the transverse thermal bridge effect of the wall, and the heat flow increases remarkably. The results of practical environmental monitoring on H-shaped concrete block show that there is a large temperature difference between the external wall and the internal wall, and the wall has better thermal insulation performance.

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