Analysis of Intensity and Insulation Temperature Field of Composite Self-insulated Divider

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Abstract. In order to save building resources and protect the environment and improve the insulation performance of the cut blocks, this paper analyzes the strength and thermal insulation temperature field of composite self-insulated blocks based on the finite element method. This paper simulates the structure and dimensions of the core in the composite self-insulation block. The results show that: The composite self-insulating block and the solid concrete block have the same strength and withstand the same pressure. Under the premise of satisfying the light weight, a self-insulation block with good energy-saving and thermal insulation performance is developed.

1. Introduction

According to the national policy on energy conservation and emission reduction, after 2010, the main structure of housing construction should gradually achieve the goal of 65% of building energy efficiency. The thermal insulation of the wall of the envelope structure is the key to building energy conservation. Composite self-insulating blocks are used to inject low-density foam concrete into the cavity of small concrete hollow blocks to form a new type of wall self-insulating block, which has good thermal insulation properties. Composite self-insulating block meets the material requirements of building energy saving in China.

In recent years, due to the improvement of building energy-saving requirements, the thermal insulation performance of concrete blocks is still insufficient. The research and development of composite self-insulating blocks is in line with the needs of the current situation, and has a broad market and application background. However, there is a lack of experimental research data on such blocks in China, and relevant normative standards have not yet been formed, and there are no reasonable technical indicators as engineering parameters. At present, there are few literatures on the application of self-insulating dicing wall blocks in engineering applications. This paper analyzes the strength and thermal insulation temperature field of composite self-insulating blocks and develops high-efficiency thermal insulation wall materials for energy-saving and cutting blocks. Development provides a certain reference value and is helpful for the promotion and application of new materials.

2. Self-insulating wall model and working mechanism

The paper mainly studies the cutting block as an integral part of the wall and plays a role in heat-retaining load-bearing. Therefore, other supporting frames and other structures are neglected in the analysis. The simplified structure includes the core structure and the surrounding concrete structure. This structure was modeled using SolidWorks software and saved in "igs" format for import into ANSYS for simulation analysis. The polystyrene foam board filled with the insulation block has a
good thermal insulation effect, and its own concrete also has a good bearing capacity.

3. **Self-insulation dicing model and mathematical model for simulation analysis**

3.1 **Since the insulation block model**

This article is to realize the analysis of mechanics and temperature field of composite self-insulated block, optimize the core structure type and size, and improve the thermal insulation performance of the block while ensuring light weight and high strength. This article analyzes the strength of the concrete part and the entire block, analyzes the thermal insulation performance, optimizes the core structure, improves the thermal insulation performance under the premise of light weight and high strength, and improves the energy saving and emission reduction performance of the block and building. The three-dimensional model is shown in Figure 1.

![Figure 1 Solid Modeling of 3D Models](image)

3.2 **Mathematical model establishment**

This paper mainly analyzes the compressive and thermal insulation performance of self-insulated cutting blocks, and the corresponding mathematical model of ANSYS selects the corresponding compressive strength calculation formula of self-insulated blocks:

\[
R = \frac{F}{BL} \tag{1}
\]

Where: R is the compressive strength; F is the maximum failure load; B is the width of the pressure surface; L is the length of the pressure surface.

In this paper, the mathematical model of heat transfer is determined. In fluid flow in nature, it is necessary to follow the law of physical conservation. The three basic laws are the law of conservation of mass, the law of conservation of momentum, and the law of conservation of energy, if the flow contains different components. The flow must also comply with the law of conservation of components and establish a differential heat conduction equation.

\[
\rho c \frac{\partial T}{\partial \tau} = \frac{\partial}{\partial x} \left( k \frac{\partial T}{\partial x} \right) + \frac{\partial}{\partial y} \left( k \frac{\partial T}{\partial y} \right) + \frac{\partial}{\partial z} \left( k \frac{\partial T}{\partial z} \right) + \phi \tag{2}
\]

The items on the left side of the equal sign are non-steady-state items, the middle three items on the right are heat conduction items, and the one on the right is a heat source.

4. **Simulation parameter setting and simulation analysis**
4.1 Simulation parameter settings
The insulation material is a polystyrene foam board with a thermal conductivity of \( \lambda = 0.04 \text{ W/m}^2\text{K} \), a density of 400 kg/m\(^3\), and a Poisson's ratio of 0.18. The density of the cuts is 1400 kg/m\(^3\), and the heat transfer coefficient of the cuts is 0.418 W/m\(^2\)K, which can meet the requirement of 65%, i.e., the coefficient of conductance is less than 0.6 W/m\(^2\)K. The self-heating and cutting of the material has the advantages of good heat insulation performance, superior seismic performance, and strong fire resistance. The compressive strength of the dice is 5.8 mpa. The elastic modulus of concrete is \( 2.55 \times 10^4 \text{ MPa} \), and the Poisson's ratio is 0.3.

4.2 Simulation Analysis

4.2.1 Intensity Analysis of Self-Insulation Cuts

(a) Comparison of Displacement between Composite Self-insulated and Solid Concrete Cuts

(b) Comparison of the strain between composite self-insulated blocks and solid concrete blocks

(c) Comparison of stress between compound self-insulated block and solid concrete block

This article analyzes the deformation conditions of the same physical dimensions of solid concrete blocks and composite self-insulated blocks in the same stress conditions, as shown in Figure 3. Comparing the experimental results, the displacement, strain, and stress of the solid self-heating composite block and the concrete self-insulated block are not significantly different under the same pressure, indicating that the composite self-insulated block and the solid concrete block can withstand the same pressure has the same intensity.

4.2.2 Optimizing the Strength of the Core Structure

This article from the above analysis shows that concrete composite self-insulated block and solid concrete block can withstand the same pressure, with the same strength. On this basis, the core structure can be optimized, and the goal of increasing the proportion of the volume occupied by the thermal insulation core can be achieved. Under the premise of lightweight, the strength of the composite block can be achieved [5]. In this paper, two groups of self-insulated cuttings with different core structures were selected for strength analysis. The self-insulating cuttings of different core structures are shown in the figure. The results of the strength analysis are shown in the figure 4.
From the figure analysis, it can be obtained that the self-insulating cutting block of the core structure in the case of the three-row hole structure has better strength, which provides a theoretical basis for the subsequent processing of the thermal insulation cutting block by the enterprise. Under this structure, the structure of the core is optimized, and the goal of increasing the proportion of the volume occupied by the thermal insulation core is achieved. Under the premise of light weight, the strength of the composite block is achieved, and the building materials are saved in better protection of the environment.

4.2.3 Analysis of temperature field of self-insulated cutting
The temperature field analysis of the same temperature boundary conditions of the solid concrete block and the composite self-insulated building block identified in this paper are performed, and the analysis results are shown in the figure.

According to the analysis of the diagram, under the premise that the cutting block meets its own weight, compared with the solid concrete block with the same external dimensions, the composite
thermal insulation block has a larger thermal insulation effect and better thermal insulation performance.

5. Summary
The displacements, strains, and stresses generated when solid concrete block and concrete composite self-insulating block are subjected to the same pressure are not significantly different, indicating that the concrete composite self-insulated block and the solid concrete block can withstand the same pressure and have the same strength. Optimize the structure of the core and analyze the structure of the core to achieve the goal of increasing the proportion of the volume occupied by the insulating core. Under the premise of light weight, the strength of the composite block is achieved, and the self-insulated cutting under the structure is performed. The temperature field analysis verifies that the thermal insulation performance of the self-insulated cutting block under this structure is good, which provides a theoretical basis for the later development of energy-saving cutting blocks.

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