Optimization of micro thermal bridge in self insulation system of building

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Abstract

Combining with the development of new thin masonry binder, the effect of mortar joint on heat transfer coefficient was discussed. The results showed that the effect of mortar joint on heat transfer coefficient was 12%, therefore, micro thermal bridge in self insulation system of building is optimized.

Keywords

Self insulation system; micro thermal bridge; thin masonry binder.

1. Introduction

With the development of structure and insulation integration, self insulation system is becoming one of the most effective ways of saving building energy consumption. The traditional self insulation system exists the problem that the thermal performance of masonry mortar cannot match that of masonry block, leading that micro heat bridge is easily formed in that region [1-4]. About the research on the micro heat bridge, the heat transfer of masonry mortar in the traditional self insulation system was studied, but the thermal performance combining with the new thin masonry binder was not involved [5-6].Owing to this reason, the problem was not solved fundamentally.

In the preliminary study of research group, the masonry mortar was optimized by the introduction of lightweight aggregate, high efficiency water reducing agent, high effective expanding agent and air entraining agent. New thin masonry binder was developed for the self insulation system exclusively. The heat conductivity coefficient reduced to 0.25 W/m K, and the compressive strength increased to 13.6 MPa, and the bonding strength increased to 1.0 MPa, and importantly the mortar thickness reduced from 10-15mm to 3-5mm during wall construction [7-8].

In this paper, combining with the development of new thin masonry binder, heat transfer characteristics of different types of mortar joint were studied, and the micro heat bridge in self insulation system was optimized.

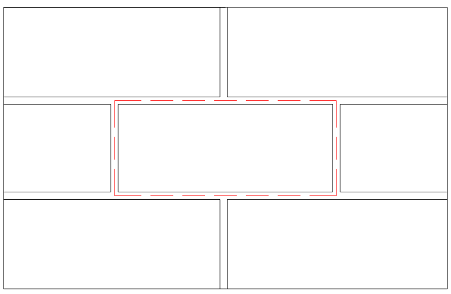

Fig. 1 Wall calculation diagram

2. Effect of mortar joint on wall heat transfer coefficient

Taking 240mm wall as an example, the effect of mortar joint on the heat transfer coefficient is studied. The block material is ultra lightweight wall block, and the size is 600mm×240mm×250mm, and the heat conductivity coefficient is 0.12W/(m K) (in the condition of equilibrium moisture content). The mortar material is cement mortar, and the thickness is 10mm. The wall calculation diagram is shown in Figure 1.

According to the expression [9], the average heat transfer resistance is:

$$\overline{R} = \left[\frac{F_0}{\frac{F_1}{R_{0\bullet 1}} + \frac{F_2}{R_{0\bullet 2}} + \ldots + \frac{F_n}{R_{0\bullet n}}} - (R_i + R_e) \right] \varphi \tag{1}$$

In the expression:

$\overline{R}$ -Average heat transfer resistance (m^2 K/W)

F_0 -Total heat transfer area perpendicular to heat flow direction (m^2)

F_n -Total heat transfer area parallel to heat flow direction (m^2)

$R_{0\bullet n}$ -Heat transfer resistance in different area (m^2 K/W)

Heat transfer resistance in different area is:

$$R_{0\bullet 1} = R_i + \frac{\delta_1}{\lambda_1} + R_m + R_e \tag{2}$$

$$R_{0\bullet 2} = R_i + \frac{\delta_2}{\lambda_2} + R_m + R_e \tag{3}$$

In the expression:

δ_1, δ_2 -Wall thickness, 0.24m

λ_1 - Heat conductivity coefficient of B06 block, 0.12W/(m K)

λ_2 - Heat conductivity coefficient of cement mortar, 0.93W/(m K)

R_i -Heat transfer resistance of inner surface, 0.11 m^2 K/W

R_e - Heat transfer resistance of outer surface, 0.04 m^2 K/W

φ - Correction coefficient, $\varphi = 0.90$

Heat transfer resistance is:

$$R = R_i + \overline{R} + R_e = 0.11 + 1.436 + 0.04 = 1.586 \tag{4}$$

Heat conductivity coefficient is:

$$K = \frac{1}{R} = \frac{1}{1.586} = 0.631 \tag{5}$$

If the effect of mortar joint on heat transfer coefficient is negligible, the heat conductivity coefficient is:

$$K_0 = \frac{1}{R_i + R_1 + R_m + R_e} = 0.465 \tag{6}$$

Effect of mortar joint on wall heat transfer coefficient is:

$$\varepsilon = \frac{K - K_0}{K} = \frac{0.631 - 0.465}{0.631} = 0.26 \tag{7}$$

The results show that when the material is cement mortar, and the thickness is 10mm, the effect of mortar joint on wall heat transfer coefficient is 26%. According to the above method, the effect of different types of mortar joint is calculated, and the results are shown in Table 1.

Table 1 Effect of different types of mortar joint

No.	Block type	Mortar type	mortar thickness	Effect on wall heat transfer coefficient
1	ultra lightweight wall block	cement mortar	10mm	26%
2	ultra lightweight wall block	cement mortar	3mm	21%
3	ultra lightweight wall block	thin masonry binder	10mm	14%
4	ultra lightweight wall block	thin masonry binder	3mm	12%

As is shown in Table 1, the micro heat bridge is mainly influenced by mortar thickness and mortar heat conductivity coefficient. When the mortar thickness is thicker, and the difference of heat conductivity coefficient between mortar and block is greater, the micro heat bridge is more distinct. When the new thin masonry binder is applied, the effect of mortar joint on wall heat transfer coefficient is reduced to 12%. Therefore, the thermal performance of wall is improved on a large scale.

3. Conclusion

Using the new masonry method, the effect of mortar joint on wall heat transfer coefficient is 12%, and micro thermal bridge in self insulation system is optimized.

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