

# **COMPARATIVE STUDY ON FOUR KINDS OF EXTERIOR WALL THERMAL INSULATION SYSTEM IN COLD AREA**

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## **ABSTRACT**

In recent years, security housing is developing rapidly under the great support of the government. Chinese low-income groups' s housing problems are solved in a certain extent, but security housing still has lots of problems in design, building and operation process. Aiming at external wall insulation system design of security housing in cold regions, thickness required by different external wall insulation systems under the same index of building heat loss is simulated and analyzed by virtue of Design Builder, which is the professional energy consumption simulation software. The external wall insulation system that is suitable for security housing in cold regions is proposed.

## **KEYWORDS**

Thermal insulation system, Security housing, Optimization design, Cold regions

## **INTRODUCTION**

Security housing means that the government provides housing for the low-middle-income family with limit standards, limit price or rents<sup>[1]</sup>. In recent years, China reinforces constructive strength of security housing greatly, further improves housing conditions of the masses, and promotes sound development of the real estate market<sup>[2]</sup>. On the basis of satisfying housing demands of the low-middle-income family, security housing promotes housing quality. However, in specific practical applications, energy-saving design methods still have lots of problems in the security housing, such as ground subsidence, cracking walls, buildings water leakage. Beginning with external wall insulation system and based on security housing in Qinyuan New House, Design Builder energy consumption simulation software is applied in the paper to calculate the thickness required by different external wall insulation systems under the same energy consumption indicator and evaluate energy conservation and economy of different external wall insulation systems.

## **CALCULATION AND ANALYSIS**

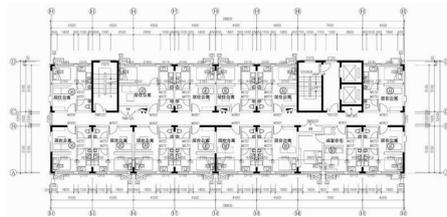
### **General Situation and Establishment of the Analysis Model**

The Qinyuan New Home is located in the high-new district, Jinan Shandong. The effect picture is shown in Figure 1. The project will be built with more than 800 sets

of public rental housing, can accommodate about 2000 people. The total construction area is 47800m<sup>2</sup>. The ground area is 30700m<sup>2</sup>. The design height is 3.3m. The total number of floors is 11. For standard number of piles, it has 16 suits in every pile. The covered area for every suit is 40-60m<sup>2</sup>. Building density 24%, green space rate 35%. The house type is a one-bedroom and one-living-room apartment or a two-bedroom and one-living-room apartment (Figure 2)<sup>[3]</sup>.

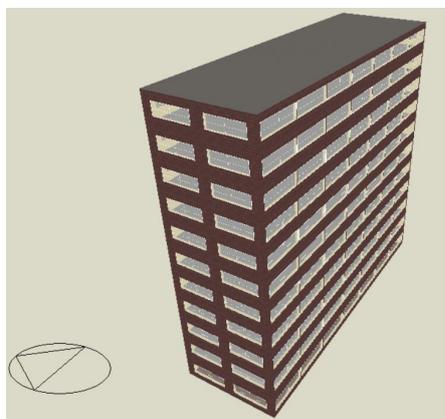


*Figure 1. Effect Picture of the Qinyuan New House from Tencent Real Estate*



*Figure 2. Typical Floor Plan from Sohu Focus*

Based on the security housing in the Qinyuan New House in high-new district, Jinan, Design Builder simulation software is utilized to establish an analysis model. The model width is 38.6m, depth is 12.4m, and height is 3.3m. There are a total of 11 floors, as shown in Figure 3. The main design parameters of the analysis model are shown as follows: The east-western window-wall ratio is 0.35. Southern window-wall ratio is 0.50 and northern window-wall ratio is 0.30<sup>[4]</sup>. According to specifications, the heat transfer coefficient limit of building envelope for the building part is shown in Table 1.



**Figure 3. The Analysis Model**

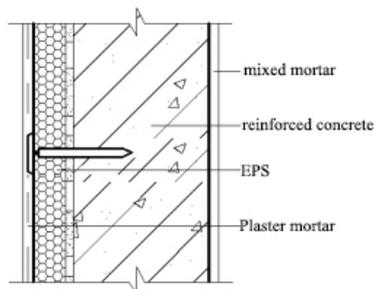
**Table 1. Overall heat transfer coefficient of building envelope**

Retaining structure		Heat transfer coefficient $W/(m^2 \cdot K)$
roofing		0.40
Outside window	East and West	1.6
	south	1.4
	north	1.8

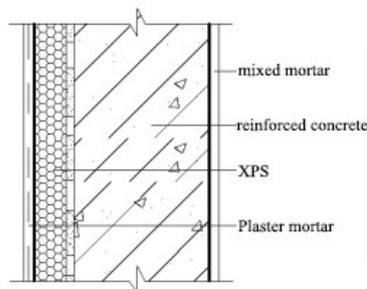
In the Design Builder simulation software, architecture activity template selects Domestic Bedroom. Heating design temperature of bedroom and living room in winter is 18°C. According to China residential building heating refrigeration status and living habits, HVAC indoor heating and air conditioning system selects Radiator heating, HW Boiler, NAT vent System.

## 2. Selection of the External Wall Insulation System

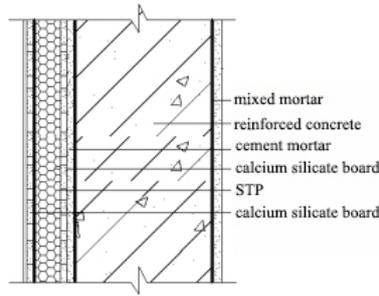
After research, at present, there are four kinds of insulation systems applied in Shandong province, including molding polystyrene board insulation system, extruded polystyrene board insulation system, STP ultrathin thermal shield wall insulation system and SY external wall self-insulation system, respectively. The detail of construction is shown in Figure 4.



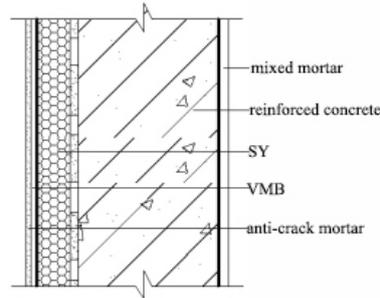
*a. Molding polystyrene board insulation system;*



*b. Extruded polystyrene board insulation system*



c. STP ultrathin thermal shield wall insulation system



d. SY external wall self-insulation system

**Figure 4.** Four External Wall Insulation System Drawn by the Author

### 3. Simulation Calculation and Result Analysis

According to stipulations of *Residential Building Energy Conservation Design in Shandong Province* (DB375026-2014), the index of building heat loss for 9<sup>th</sup>-13<sup>th</sup> floors in Jinan is 8.2W/m<sup>2</sup>. The external walls of four different insulation systems are brought into Design Builder to do simulation calculation. The calculated data are shown in Table 2.

The market survey shows that the market prices of molding polystyrene board insulation system, extruded polystyrene board insulation system, STP ultrathin thermal shield wall insulation system and SY external wall self-insulation system are 400Yuan/m<sup>3</sup>, 360 Yuan/m<sup>3</sup>, 3015Yuan/m<sup>3</sup> and 300 Yuan/m<sup>3</sup>, respectively. The investment cost  $C_{in}$  of the insulating layer is calculated in accordance with equations (1)<sup>[5]</sup>.

$$C_{in} = C_i \cdot d \tag{1}$$

In the formula,  $C_i$  is the cost of the insulation material for unit volume, Yuan/m<sup>3</sup>;  $d$  is the thickness on the insulating layer, m; and the calculated results are shown in Table 2.

**Table 2.** Thickness and investment cost of four kinds of external wall insulation system

<i>EIFS</i>	<i>Thickness mm</i>	<i>Price yuan/m<sup>3</sup></i>	$C_{in}$
Molded polystyrene board thermal insulation system	90	400	31.5
Extruded polystyrene board	80	360	28.8

insulation system			
STP ultra thin thermal insulation board external wall	20	3015	39.195
thermal insulation system			
SY external wall self insulation system	70	300	21

It can be observed from Table 2 that under the circumstance for the same index of building heat loss for molding polystyrene board insulation system, extruded polystyrene board insulation system, STP ultrathin thermal shield wall insulation system and SY external wall self-insulation system, the thickness required is different. The thickness of STP ultrathin thermal shield wall insulation is the thinnest, followed by SY external wall self-insulation system. The thickness of extruded polystyrene board insulation system is 80mm. The molding polystyrene board insulation system is the thickest for 90mm. In terms of investment cost, the investment cost of SY external wall self-insulation system is only 21 Yuan. In four external wall insulation systems, the investment cost is the minimal, while STP ultrathin thermal shield wall insulation requires for the highest cost.

Security housing is the general term of housing with the assistance of the government. The government provides the housing with limit standards, limit price or rents to the low-middle-income family. Aiming at the special housing of security housing and on the basis of ensuring indoor comfort, it is necessary to consider costs. Therefore, no matter it begins with building energy saving or economic perspective, SY external wall self-insulation system is more suitable for the security housing construction in cold regions.

## CONCLUSIONS

Security housing not only safeguards home ownership, but also has the lower cost. When external wall materials are applied to the safeguard housing, it can't pursue for energy-saving effects blindly, but give no consideration to economy, so as to cause resource wastes. This runs counter to the purpose of developing security housing greatly by the nation. According to the research results in the paper, it shows that in the common molding polystyrene board insulation system, extruded polystyrene board insulation system, STP ultrathin thermal shield wall insulation system and SY external wall self-insulation system, SY external wall self-insulation system has the best economy and the system also can avoid from empty drum and cracking on the plastering layer, so that it has the significance on the energy conservation design of security housing's building envelope in cold regions.

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