Selection and analysis of economic and energy saving thickness of foam concrete exterior wall

Zuxu ZOU,Jianjun LIU,Heng YANG,Jiwen CHEN

School of Civil Engineering and Architecture,Wuhan Polytechnic UniversityWuhan 430023,P.R.China
402307895@qq.com

Keywords : building energy saving,foam concrete,self-thermal insulation wall,economical efficiency

Abstract. Thefoam concrete material is used as the self-thermal insulation material for exterior wall , combined with a residential building in Wuhan as an example, resorting to DeST-h simulation software, with non-thermal insulation wall as the reference model. Through the comparison of several groups of self-thermal insulation walls with different thickness,by using net present value as the evaluation index to determine the economical thickness of foam concrete self-thermal insulation wall,and using the curve fitting function of minitab16 software, calculate and analyze the optimum economic thickness of self-thermal insulation wall of foam concrete,and provide guiding advice for the further development of foam concrete as a building energy saving wall material.

Introduction

With the implementation and promotion of building energy saving in China, new wall materials are constantly being researched and developed.As a kind of inorganic light material,foam concrete has been widely concerned,which has the characteristics of light quality, good thermal insulation,sound insulation and fire resistance, and strong waterproof ability[1].Compared with the organic thermal insulation materials and inorganic thermal insulation materials used widely in domestic, it has obvious advantages of building insulation,and is the important development direction of the thermal insulation material for building energy saving in the future[2].Because of its advantages of thermal insulation,energy saving,protecting roofs, preventing leakage, saving cost and construction shortcut and so on ,foam concrete has been widely applied to roof insulation layer,and is the first choice for thermal insulation materials of residential roofs in China's villages and towns[3][4].In recent years, the foam concrete, as a thermal insulation material, has begun to transfer the application from the roof insulation layer to the insulation wall.The foam concrete, as a self-thermal insulation exterior wall material, reduces the weight of the building,leaves out the external insulation treatment, reduces the cost of building thermal insulation, and is the same as the life of the building.Zhao Hua and others put forward the analysis model of life cycle cost,analyzed the cost and benefit of self-thermal insulation wall material for foam concrete, and concluded that the use of foam concrete blocks has strong economic benefits in the hot summer and cold winter area[5].At present, the research on foam concrete as external wall insulation is relatively less, especially the research of optimum economic thickness.In this paper,taking a residential building in

Wuhan as an example,DeST-h software is used to calculate the energy saving effect of foam concrete as the self-thermal insulation material of exterior wall,resorting to the curve fitting function of minitab16 software to determine the best economic thickness,and providing guiding advice for the further development of foam concrete as a building energy saving wall material.

Building model

In this paper,the building model studied is a house with six layers and two units. The floor height is 3 m, and the total building air conditioning area is 2154.24 m^2.The house is facing North-South Orientations, the staircase is not heating, the heating period is 75 days, the air conditioning period is 105 days, the building shape coefficient is 0.307,and the total surface area of the exterior wall is 1417.32 m2.The architectural plan as shown in Figure 1,inside which,foam concrete is self-thermal insulation wall material,its life is the same as the building,and the period of calculation is 50 years.In order to compare the effect of foam concrete energy saving materials on building energy consumption, the exterior wall structure of residential buildings without insulation measures is taken as a benchmark model.

Simulation and result analysis of energy consumption

DeST is a building environment simulation analysis software developed by Department of Building Science.The software has a strong reliability for building thermal process simulation by fourier transform method.It can complete building energy consumption prediction,air conditioning plan simulation and so on, which plays an important guiding role in improving design quality, ensuring design reliability and ensuring the quality of building environment.Therefore, resorting to DeST-h thermal environment simulation toolkit for residential buildings,under the condition of determined building description, outdoor weather condition, indoor heat disturbance and room temperature set value,the annual dynamic load of the house is calculated.When the thickness of the exterior wall is different and the other conditions are all at the same time, the simulation calculation is carried out according to the following conditions:

1)The typical meteorological year of Wuhan is adopted in calculating the meteorological parameters outside the whole year.

2)Start date of heating season:November 15th.The end date of the heating season:February 1st of the following year.Start date of air conditioning day：June 1st.End date of air conditioning day：September 15th.

Net present value

The net present value (NPV) means the sum of the net cash flows that occur every year in the whole period of calculation into the sum of the present value at the beginning of the expiration according to a certain base rate of return.It is one of the dynamic evaluation indexes in engineering

evaluation, which reflects the profitability of the investment plan during the period of its calculation[7] .In the process of selecting the scheme, the scheme is more profitable when NPV>0, and the scheme is feasible.When NPV=0, the scheme can barely pass through.When NPV<0, the scheme can't be passed through.The calculation formula is as follows:

$$NPV = \sum_{t=1}^{n} A(1 + I*)^{-t} - B \qquad (3\text{-}1)$$

A------The annual energy saving income in the period of calculation

B------The investment in the use of thermal insulation materials compared with the non-thermal insulation material

n-------The period of calculation

I*------The benchmark yield

The formula for calculating the benchmark yield in the formula is as follows:

When g<I, $I* = \frac{(I - g)}{(1 + g)}$ (3-2)

When g>I, $I* = \frac{(g - I)}{(1 + I)}$ (3-3)

In the formula：I* is the discount rate,is equal to3.14%.g is the inflation rate，adopt 3.3%；I is the bank loan interest rate,adopt 6.55%.

Plan economic thickness analysis

This paper uses DeST-h simulation software to simulate the wall thickness changes from 200 to 330mm the annual energy consumption and without reference external wall insulation processing of the annual energy consumption, from table 2 and table 3 analysis shows that the foam concrete as the insulation of exterior wall each different scheme of net present value > 0, the scheme is feasible, at the same time and the heat load index has been significantly reduced, cooling load index also decreased, the decrease amplitude is relatively flat, with foam concrete as wall material has good insulation effect, with the increase of the thickness of the foam concrete insulation wall, reduce the energy consumption of the more.

Conclusion

Foam concrete as a kind of inorganic light and the heat preservation material, can be used as first choice energy-saving materials, in this paper, with the aid of DeST -h energy consumption simulation software,use a house in wuhan as an example, to verify the foam concrete as the insulation wall has good energy saving effect, the energy saving rate is 50% - 50%, in the period of its life, has the good economic effect,Through the data fitting function of minitab16, analyzed the

optimal economic thickness of foam concrete as the self-insulation exterior wall , and the optimal economic thickness of the proposed scheme in this paper was 281.89 mm. At present, the application of a foam concrete in the outer wall heat preservation is relatively small, therefore, in this paper, in order to further promote the foam concrete heat preservation exterior wall in hot summer and cold winter region development provides guiding opinions.

Acknowledgements

This work is financially supported by the science and technology project form Hubei Education Department under Grant No. H2013224: Research on the equity trading mechanism of Venture enterprises based on auction.

Reference

[1]TANG Hong，Viscoelastic Mechanical Analysis of the Stability of Surrounding Rock in DeepTunnels [J]. Journal of Guizhou University of Technology(Natural Science Edition)，2015，34（3）：115-117

[2] WU Zhaochu，Foam Concrete - Future Development Direction of Thermal Insulation Materials for Building Energy Conservation [J]. Block-Brick，2014（1）

[3] LI Daming,LUO Qiuyuan,WANG Xiaogang，The Application of the Overall Cast-in-Situ Foam Concrete in the Insulation Layer of Roof Insulation [J]. Guangdong Building Materials，2013,2,43-44

[4] WANG Baomin,MIAO Huimin,LI Jing，Application of the Thermal Insulation Roofing in Villages and Small Towns of Our Country [J]. Research & Application of Building Materials,2013,1:7-10

[5]ZHAO Hua,LIANG Yang，The Whole Life Cycle Cost And Benefit Analysis of Foam Concrete Block Wall [J]. Construction Science and Technology，2011,13:65-67

[6] ZHONG Chun,PAN Yang，Comparison and Economic Analysis of energy Efficiency of External Walls in Nanchang [J]. Journal of East China Jiaotong University，2014，25(3)：56-57

[7] Xiong Huan,Liu Jianjun，Thickness Choice and Economic Analysis on Exterior Wall External Insulation [J]. Construction Technology，2016，42（3）：19-22