

ENERGY EFFICIENT BUILDING MATERIALS FOR RESIDENTIAL BUILDINGS

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Анотація

У даній статті визначено основну проблематику енергоефективності малоповерхових будівель. Розглянуто основні види енергоефективних конструкцій та матеріалів, що використовуються при будівництві та утепленні будівель. Використання нових ефективних конструкцій та матеріалів, які мають низьку теплопровідність, є екологічно чистими.

Ключові слова: енергоефективність, матеріали, конструкції, утеплення, теплопровідність, екологічність, будівництво.

Abstract

This article identifies the main issues of energy efficiency of low-rise buildings. The main types of energy efficient structures and materials used in the construction and insulation of buildings are considered. Use of new efficient constructions and materials that have low thermal conductivity, which are environmentally friendly.

Keywords: energy efficiency, materials, structures, insulation, thermal conductivity, environmental friendliness, construction.

Introduction

Modern energy efficiency programs in Ukraine and Europe include the use and development of new building materials for housing. Today, active processes of urbanization, administrative and territorial reform in Ukraine, increasing the requirements of comfort and environmental friendliness to housing have led to the fact that the concept of low-rise residential buildings has expanded from rural houses and individual cottages to apartment buildings up to five floors, duplexes, cottages, townhouses for several families. These types of houses are actively built on the outskirts of large cities, their individual districts and neighborhoods, as well as suburban areas of the united territorial communities.

The use of energy-efficient materials for the construction of residential buildings saves raw materials and reduces further costs for heating and maintenance of the buildings themselves. The selection of energy-efficient building materials and modern technologies for their installation allows you to get a building that requires less energy to heat than conventional. Sometimes this savings is 60-80%.

Research results

Advantages of an energy-efficient residential building [1]:

- the use of energy-saving technologies allows you to get a structure that loses heat several times less than usual;
- natural ventilation is used according to advanced technology;
- high-quality thermal insulation;
- use of hypoallergenic, environmentally friendly energy-efficient building materials that do not harm human health;
- high comfort inside the building;
- reduction of electricity and heating costs.

Modern building materials for low-rise residential buildings should provide not only load-bearing capacity, durability, protection from rain, etc., but also heat retention. The main focus is now on the latest building materials, which in addition to heat retention, may have additional characteristics, such as heat storage, sound insulation properties.

An ideal energy-efficient home should not consume, but produce energy and give it to others. This is possible by combining modern building materials for effective thermal insulation and the installation of alternative energy sources (solar panels, collectors, heat pumps) [2].

Energy efficient materials:

Styrofoam - is considered the most common insulation, it is used for both external insulation of apartments and private homes (fig. 1). 98% expanded polystyrene consists of air enclosed in small closed cells, which provides low thermal conductivity and low water absorption and vapor permeability. Advantages: well resists dynamic loading, moisture resistant, does not settle, low vapor permeability - $0,05 \text{ mg} / (\text{m} \cdot \text{h} \cdot \text{Pa})$, average density to $35 \text{ kg} / \text{m}^3$. Disadvantages: is a combustible material (flame retardant additives give it the ability to self-extinguish), inelastic and resistant to ultraviolet radiation, can not withstand temperatures above 90°C .



Fig. 1. Styrofoam and plates from it

Extruded expanded polystyrene (styrofoam) - consists of the same material as polyfoam, only differs in production technology (Fig.2). This is a closed porous structure with a pore diameter of 0.1-0.2 mm. Characteristics: vapor permeability varies from 0.019 to 0.015 $\text{mg} / (\text{m} \cdot \text{h} \cdot \text{Pa})$; thermal conductivity coefficient - from 0.028 to 0.034 $\text{W} / (\text{m} \cdot \text{K})$, average density - $28\text{-}45 \text{ kg} / \text{m}^3$; operating temperature range - from -50 to $+75^\circ \text{C}$. In terms of static bending strength (from 0.4 to 1 kgf / cm^2), it is significantly superior to ordinary foam.



Fig. 2. Sheets of extruded polystyrene foam

Mineral wool and glass wool are fibrous products, the raw materials for which are materials of mineral origin. Can be presented in the form of rolled and plate materials, mats, be foil (Fig.3). Characteristics: average density of glass wool $11\text{-}200 \text{ kg} / \text{m}^3$, mineral wool - $15\text{-}220 \text{ kg} / \text{m}^3$; the diameter of the fibers is $3\text{-}15 \mu\text{m}$, and the length is from 15 to 50 mm; high vibration resistance; good sound absorption; thermal conductivity - from 0.033 to 0.046 $\text{W} / (\text{m} \cdot \text{K})$; vapor permeability - $0.3\text{-}0.7 \text{ mg} / (\text{m} \cdot \text{h} \cdot \text{Pa})$; operating temperature range - from -60 to $+450^\circ \text{C}$ for glass wool and from -180 to $+750^\circ \text{C}$ for mineral wool; non-combustible. This material is "breathable", which means that the so-called "dew point" is transferred to the outer insulating layer, while there is no wetting of surfaces and thus the premises retain a favorable microclimate [4].



Fig. 3. Products from mineral and glass wool

Hollow blocks for erection of walls and floors [5]:

- concrete blocks are made of cement, sand, water and coarse aggregate (lightweight mainly from slag, expanded clay, etc.). The mixture of the main components is poured into special molds and sent to a vibropress, where the curing process takes place. The hollow structure of stones allows you to easily reinforce the walls and, if necessary, strengthen them with concrete mortar. Characteristics: weight - from 14 to 17 kg. Expanded clay concrete blocks are light and have high thermal insulation properties (average density: 500-1800 kg / m³, thermal conductivity - 0.18-0.9 W / (m · K). Strength of expanded clay blocks - from 35 to 50 kgf / m²).

- ceramic blocks are characterized by high voids - from 50 to 72% (for hollow bricks void is 25-42%). The size of one ceramic block is 2.1-14.9 times larger than the standard size of a brick. Low average density of a product - from 650 to 1000 kg / m³ allows to receive high indicators of thermal insulation.

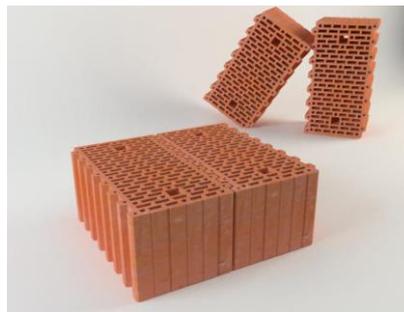


Fig. 4. Ceramic hollow block

Conclusions

Thus, we investigated that the world currently produces a large number of environmentally friendly and energy efficient materials for the construction of low-rise residential buildings. The use of such materials and structures leads to a reduction in economic costs and to increase the energy efficiency of the house.

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