Assessment of efficiency of innovative heat-insulating materials' usage at implementation of urban construction projects

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Abstract. Urban construction is the direction of construction in which innovative technologies and products are especially actively used and implemented. In particular, the choice of heat-insulating materials is of considerable interest to construction companies. In article main types of heat-insulating materials, first of all, innovative, are considered, their comparative characteristic is given, assessment of efficiency of their use at implementation of projects of urban construction is carried out.

1 Introduction

Heat-insulating materials are the standard name of materials which have found the application as heater of different surfaces. The modern heaters developed by means of the latest technologies are applied in construction to isolation of internal space of the house. Material saves from winter cold weather, keeping in the room heat, and from a summer heat, detaining a cool. Each type of new materials has the technology of application. Thanks to new technologies, the developed heaters are ergonomic and safe for ecology.

About need of thermal insulation of walls, roofs, the base of houses such fact specifies: in not warmed house the loss of heat can reach up to 50% in comparison with the houses built without use of heat-insulating materials. It is a very high rate which is often given in advertising of suppliers of heat-insulating materials.

Depending on structure, distinguish three groups of heaters of surfaces, submitted in Figure 1.

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Fig. 1. Main groups of heaters of a surface.

Heat-insulating materials can be used for warming of a roof, internal and front finishing of walls, cellars, ceilings, floors, overlapping, internal partitions.

2 Materials and methods

In construction a big variety of new insulating materials is used. Parameters to which it is necessary to pay attention at the material choice are given in the Figure 2.

Fig. 2. Properties of heat-insulating materials.

One of the major parameters at the choice of heat-insulating material is heat conductivity. It depends on other properties — amounts of moisture, degree of durability and porosity, temperature and structure. Heat conductivity indicates how much heat will pass through a surface.

Acceptable thickness of walls of residential buildings depending on coefficients of heat conduction of materials of walls of which they are constructed are given in Table 1. Apparently, that thickness of walls of houses significantly differ, it is connected with heat conductivity of materials of which they are constructed.

Table 1. Material thickness for walls of residential buildings in dependence on its heat conductivity.

Material	Heat conduction, λ_B watts /meter $^{\circ}\text{C}$	Thickness, centimeters
Reinforced concrete	2.04	644
Brick ceramic GOST-530-80	0.81	255
Pine, fir-tree (tree, bar)	0.18	56
Gas concrete density 400kg/m3	0.10	38
Heater from basalt fiber	0.045	14.2
Polyfoam GOST-15588-70	0.05	15.8
Heater from glass wool	0.41	12.9
Extruded expanded polystyrene	0.029	9.1

The best indicator of heat conductivity is at extruded expanded polystyrene and, naturally, the recommended building wall thickness at this material is the smallest.

Heat conductivity of a foam glass and thickness of walls from it isn't given in the table. But according to other official data heat conductivity of a foam glass is estimated at the level of 0.04-0.045 [1,2]. It indicates that a foam glass on deduction of heat can concede in houses only to extruded expanded polystyrene. However, it doesn't mean that it is necessary to recommend this material for wide use and instead of a foam glass. Therefore it is necessary to seek for replacement only of polyfoam on extruded expanded polystyrene. And it isn't necessary to recommend him for foam glass replacement as he concedes to a foam glass on the technical characteristics.

Foam glass on the stability is recommended for warming of already earlier built also insufficiently warmed buildings.

Any house built some time ago can be warmed for a long time with foamglass even if it was built about 40 years ago. House walls from a tree, a brick, a stone, concrete designs and blocks, foam-concrete blocks can be warmed with blocks from a foamglass. Blocks from a foamglass 100 mm thick can be used to warm walls from a brick and from concrete blocks, and blocks of 80 mm will be suitable for external facing of walls of the house from a tree. [1,2]

It is possible to fix blocks from a foamglass on any type construction binding from usual cement and sand and cement and limy solutions to specially intended dry construction mixes and glues. For replacement of an external layer of facing of a heat-insulation layer of blocks from a foamglass it is possible to use a plaster layer, a wooden or polymeric siding, facing by a ceramic tile or a facing brick.

On the average one-storey individual house facing requires 12-20 m of cubic blocks from a foamglass for the sum no more than \$5000 [3,4].

3 Results

By the given estimates and characteristics of heat-insulating materials it is possible to make the conclusion at once that in all cases when it is possible to use a granul foamglass when warming separate constructional elements of buildings by the most effective. However for assessment of efficiency of use of foamglass in the form of blocks additional justifications are required, that means additional estimates of its economic efficiency and generally with assessment of change of costs of operation of buildings after their construction will be required. It should be considered already during operation of the building:

- cost of heat preservation in the building;
- cost of maintenance and repair of the building;
- cost of capital repairs.

However, it doesn't mean that it will be necessary to count additional streams on expenses and results on time, for example, before capital repairs of the building. It will

enough to find the time period when the balance of expenses and results at use of foamglass exceeds balance of other compared heat-insulating material.

Foamglass at the price is slightly higher than the cost of heat-insulating materials on the basis of mineral wool, polyfoam and similar to it. However, on technical characteristics a foamglass is significantly better than other heat-insulating materials. Foamglass is produced in the form of blocks and loose components (granules).

The price of blocks from a foamglass according to various suppliers fluctuates about \$1000 for one cubic meter at a thickness of blocks of 80-100 mm. But, if to fill up, for example, the attic of the house with a crumb from a foamglass, then its cost is only about \$10 for one cubic meter. It is visible that a foamglass from a crumb is much cheaper block, but it can naturally be used only in some specific structures of the building.

The comparison of costs (in dollars) of the device of a heat-insulation layer of a flat roof from a professional flooring for the public building in the city of Moscow is presented in table 2 [5,6].

Table 2. Roof device of various materials' costs.

<div>Types of materials</div> <div>Costs characteristics</div>	Foarmglass Neotim	Foarmglass T4	Thermo-Roof	Fufbatts
Heater cost	21	40	18.5	21
Additional expenses	4	3.5	13.25	13.25
General factor cost	25	44	31.75	34

The indicators presented in table 3 are received on concrete objects on the roof device. But for calculations of efficiency of use of heat-insulating materials and first of all from a foamglass it is necessary to have characteristics with use of which it would be possible to carry out estimates of efficiency of use of this or that heat-insulating material at application in various structural elements of buildings and in various regions of their construction.

4 Discussions

Indicators which can be used at assessment of efficiency of use of some heat-insulating materials are given in Table 3 [5,6].

Table 3. Roof device of various materials' costs.

Heater brand	Foarmglass Neotim	Foarmglass T4	Foamglass Gomel	Thermo-Roof	Fufbatts
Heat conductivity coefficient at (25+/-50C), W / mK	0,048	0,043	0,075	0,038	0,038
Settlement coefficient of heat conductivity under service conditions of "B", W / mK	0,049	0,044	0,080	0,048	0,048
The recommended thickness of thermal insulation, mm	165	150	270	163	163
The cost of m3 of thermal insulation, in dollars including tax	128	266	106	1130	126
The cost of sq.m of thermal insulation, in dollars including tax	21	40	28	18	20
The cost of additional works and the corresponding materials on 1 sq.m, in dollars including tax	3	3	4,5	13	34

The total cost is 1 sq.m of system of thermal insulation	24	43	33	31	33
Coefficient of recalculation of the cost of 1 sq.m of systems of thermal insulation concerning systems with warming Neotim	1,00	1,77	1,29	1,29	1,38

On the basis of the conducted researches it is established that existence of 1% of moisture in mineral-cotton heater increases (worsens) heat conduction coefficient almost twice. The amount of moisture increases, and heater at the same time loses the mechanical and heattechnical properties. Water evaporates and water vapor under a waterproofing spreads on the area of all roof leading to significant increase in thermal losses and costs of heating of the building and also to corrosion of a professional flooring in winter time.

By results of tests – probation of service before capital repairs has made taking into account influence of natural factors:

- for extrusive expanded polystyrene – 10 years, a mineral-cotton plate on a basalt basis – 15 years;
- for block expanded polystyrene – 20 years;
- for a foamglass – more than 45 years.

At a foamglass durability on compression is 10 times higher, than at the best fibrous heaters on a basalt basis applied in roofs.

5 Conclusion

On the data given above the costs of the same area of a roof from the foamglass produced by various producers can significantly differ. So, a foamglass T4 is almost twice more expensive than at the producer Neotim.

The decision of commission of experts on the new equipment used in the Moscow construction of Department of urban policy of development and reconstruction of the city of Moscow has recognized expedient application of plates heat-insulating and products from a foamglass Neotim. By experience it is already established that the price of a foamglass concedes only to expanded polystyrene, however it is fragile, fire-dangerous that excludes him from a number of competitive products.

References

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