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Improve isolation materials and recommendation of residential buildings in Kazakhstan

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Abstract. The article shows the problem of high volumes of energy use in Kazakhstan and introduction of energy-efficient technologies, production and causes of the problem. To improve the thermal comfort, needed primarily to improve the thermal insulation properties of materials. This article examines the characteristics of thermal insulation materials and their application in the construction process in Kazakhstan. The material properties are calculated and shown as formulas, which can use in the future in the design of residential buildings. The construction studied of passive technology in the residential area. By the design process and the combination of design variables selected option.

1. Introduction

Technologies of energy [1] saving in cold regions for improvement of the inhabited thermal environment throughout a long time were the primary objective of a research. The leading technologies of energy saving consist use of the solar system, structure of thermal insulation.

A climatic feature of Kazakhstan characterized by a cold climate, which demands during the winter period of heating burning coal that bears serious problems with environmental pollution. At the introduction of energy saving technologies and improvement of thermal characteristics by the critical moment are the protecting designs. A practical design in the green building is the use of resource-saving way out the efficient use of the building during construction. The main principles in the development and practice include the use of green materials, sustainable site development, improvement of environmental quality in the room and improve the efficiency of energy and water consumption. Reducing the impact on the environment, reduce the use of water and energy, as well as contribute to a healthier workspace, which increases the level of comfort and performance of its occupants is the main direction.

Green Building Rating System is the assessment, which is used to measure the environmental performance of the building throughout the building's life cycle in order to quantify the quality of the performance of buildings. This article attempts to consider in Kazakhstan the basic parameters of green building technology for the next generation of guidelines and recommendations. Developers and

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designers can establish a platform for efficient energy and can guide the builders defend the stability of the value by integrating construction quality strategies.

For this study, it is the area of Astana is the capital. Climate classification map is according to Koppen-Geiger climate change in Kazakhstan, due to its vast territory and relevant to 4 different zones. For Astana and the surrounding area, which is in the DFB region, characterized by snow, full of moisture and extremely continental weather (cold and freezing winters and hot summers) [1].

Over the past few decades, Kazakhstan has experienced an upward trend in energy consumption, mainly due to rapid urbanization and industrialization. In recent decades, energy consumption in the residential and commercial sectors in Kazakhstan has increased significantly, according to the statistics of Kazakhstan. In figure 1 indicates that the demand for energy is steadily growing [2].

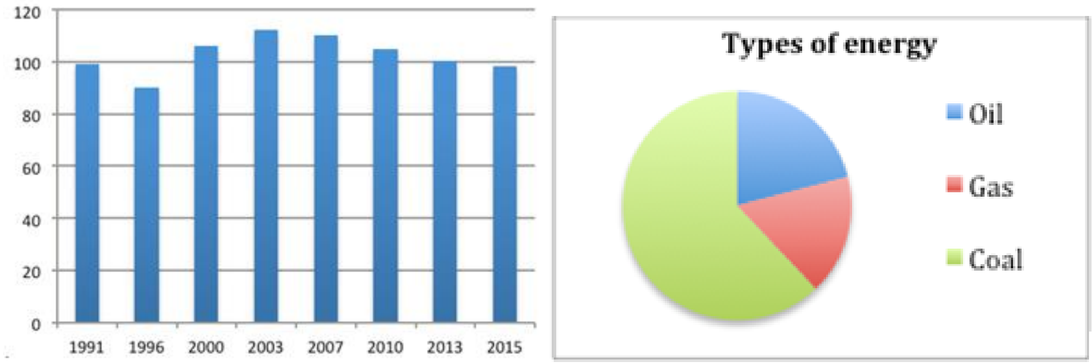


Figure 1. Electricity supply about the previous year in Kazakhstan

2. Improve passive technologies

The purpose of the optimization and implementation of passive technologies improved thermal comfort, a set of strategies to reduce energy consumption. For correct selection find the right balance, which depends on the economic and environmental benefits of energy.

Improving the living conditions of thermal comfort and environmental influences new green building materials. [3]

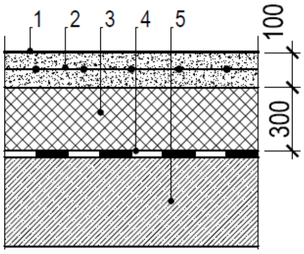
2.1. General evaluation

The assessment of Energy and Atmosphere category show with the commissioning of the building energy systems and energy efficiency of buildings [4]. Initial construction of the energy system requires an integrated delivery system in operation, which provided input to the authority granted by the schematic design phase to the maintenance of the building [5]. This is intended to ensure that the building energy systems are functioning well and as expected. Since this practice is not yet a part of the construction practice and requires commissioning professionally, it needs to put much effort, work and costs for the implementation of this entry tasks into operation. The energy efficiency requires the building to develop by the standard 2.04-21-2004. The construction of the building has requirements a very high level regarding insulation and energy-efficient features. However, it is not part of the building design and construction practices in Kazakhstan. Today in Kazakhstan is used when designing new software projects for energy modelling is another point for implementation. When using an approach based on the international experience result, identify some characteristics to be included in the base of the building to determine the energy budget.

2.2. External walls

Exterior walls play a major role in maintaining the heat inside the building. From the architectural side of the wall does not bear the aesthetic component. Thermal insulation as schematically represented in Figure 2. To identifies the optimal insulation of external walls admission energy-efficient properties of materials one of the external walls.

Calculation of thermal resistance coefficient attic floor should include: coloring concrete twice (not involved in the calculation); screed of cement sand mortar M150, reinforced mesh ∅5V-carbon Solid， surface waterproofing, reinforced concrete slab.

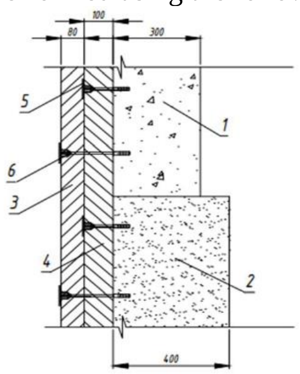


1.Coloring Concrete twice (not involved in the calculation);2. Screed of cement sand mortar M150, reinforced mesh ∅5V-1, cell 200×200 mm: δ =60 mm, p_0=1800 kg/m^3, λ_p=0,76 W/m·℃ 3.Carbon Solid 1000: δ =300 mm, p_0=38 kg/m^3, λ_p=0,032 W/m·℃ ;4. Surface waterproofing δ=4 mm, p_0=1400 kg/m^3, λ_p=0,26 W/m·℃ ;5. Reinforced concrete slab: δ=250 mm. p_0=2500 kg/m^3, λ_p=1,92 W/m·℃ .

Figure 2. Thermal resistance coefficient attic floor

As for heaters, Bimetallic sectional radiators of the brand, as well as connectors, recessed into the floor with forced convection. Doors piping and wiring horizontal pipe technical and commercial facilities provide polyethylene reinforced pipes, laid in the floor construction. All pipelines, vertical risers to cover Ø40 mm pipe insulation made of foam rubber, 9 mm thick and more Ø40mm - tubular foam insulation 13mm thick. Distribution pipes (for each apartment heating systems), set up to the floor construction, and insulated tubular foam insulation thickness of 9 mm.

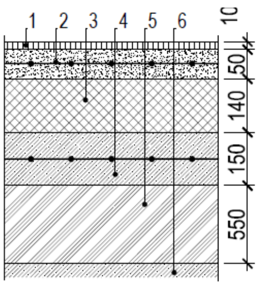
In residential areas, the project provides for exhaust ventilation with mechanical prompting the installation of internal axial fans. In the public areas of the project includes the supply and exhaust ventilation with the mechanical drive. Air supplied to the loft insulated mats URSA, insulation thickness - 50 mm, covered with foil, the cover layer of fiberglass. Mathematical analysis can be performed using the following formulas [6], [7].



1.Masonry of aerated concrete block: δ =300 mm, p_0=600 kg/m^3, λ_p=0,026 W/m·℃ .
2.Reinforced concrete (not involved in the calculation).
3. Mineral Plate Ecover Vent-Facade 80 δ =80 mm, p_0=80 kg/m^3, λ_p=0,039 W/m·℃
4. Mineral Plate Ecover Vent-Facade 60 δ =100 mm, p_0=60 kg/m^3, λ_p=0,041 W/m·℃;
5. Umbrella anchor the upper layer (not involved in the calculation

Figure 3. Calculation of the coefficient of resistance of heat exterior walls

Calculation of resistance to heat transfer coefficient on the ground floor (Elevator hall, staircase, 1st floor hallway) include: gres, cement-sand screed, monolithic foam concrete, concrete class, compacted soil backfill, reinforced concrete slab.



1. Gres: δ =15 мм; p_0=2800 kg/m^3, λ_p=3,49 W/m·℃; 2. Cement-sand screed δ =50 mm; p_0=1800 kg/m^3, λ_p=0,76 W/m·℃; 3. Monolithic foam concrete: δ =140 mm, p_0=600 kg/m^3, λ_p=0,22 W/m·℃ ; 4. Concrete class B25: δ =150 mm, p_0=1800 kg/m^3, λ_p=0,76 W/m·℃ ; 5 Compacted soil backfill: δ =550 mm, p_0=1600 kg/m^3, λ_p=0,47 W/m·℃ ; 6. Reinforced concrete slab: δ=200 mm. p_0=2500 kg/m^3, λ_p=1,92 W/m·℃.

Figure 4. Reinforced concrete slab

The coefficient of heat transfer resistance uniform transparent building envelope is calculated as follows(1)[8]:

$$R_{\Sigma} = \frac{1}{\alpha_{\text{int}}} + \sum_{i=1}^{n} R_i + \frac{1}{\alpha_{ext}} = \frac{1}{\alpha_{\text{int}}} + \sum_{i=1}^{n} \frac{\delta_i}{\lambda_i} + \frac{1}{\alpha_{ext}}, \; m^2 C^\circ / W \tag{1}$$

α_{int}, α_{ext} — heat transfer coefficients of the inner and outer surfaces of the building envelope;
R_i — thermal resistance of each layer of the structure;
λ_i — the thermal conductivity of each material in the layer structure of settlement conditions.

The above non-uniform thermal resistance to heat opaque building envelope is determined by the formula(2):

$$R_{\Sigma 0} = \frac{1}{\alpha_{\text{int}}} + \sum_{j=1}^{j} \frac{R_i * F_i}{F_{\Sigma}} + \frac{1}{\alpha_{ext}} \tag{2}$$

R_j — thermal resistance of the homogeneous zone;
F_j — the area of each thermally homogeneous area;
$F\Sigma$— area of the building envelope

The calculated checked value of the thermal conductivity of the walls of resistance to limit the temperature drop using the following relationship (3):

$$\Delta t_0 = \frac{n(t_{\text{int}} - t_{ext})}{R_0 \alpha_{\text{int}}} \tag{3}$$

n - coefficient reflecting the dependence of the position of the outer surface of the partition structure in relation to the outside air;
t_{int} - the calculated average temperature of the internal air of the building;
t_{ext} - the estimated temperature in the cold season;
α_{in} - heat transfer coefficient of the inner surface of the building envelope.

The heat transfer coefficient of resistance through the exterior building envelope is calculated as follows(4):

$$K_m^{tr} = \frac{\frac{A_w}{R_w} + \frac{A_F}{R_F} + \frac{A_{ed}}{\text{R}_{ed}} + \frac{A_c}{R_w^r} + n\frac{A_{cl}}{R_{cl}} + n\frac{A_f}{R_f^r} + \frac{A_{f1}}{R_{f1}^r}}{A_e^{sum}} \tag{4}$$

A_w, R^r_w— area and reduced resistance to heat exterior walls;
A_F,R^r_F— fillings of light apertures (windows, stained-glass windows, lamps);
A_{ed},R^r_{ed}— inside and outside doors;
A_c,R^r_C— combined coatings (including over the bay windows);
A_{c1},R^r_{cl}— attic floors;
A_f,R^r_f— basement floors;
A_{f1},R^r_{f1}— ceilings over passages and under the bay windows;
A^{sum}_e— the total area of the internal surfaces of external walling.

$$Q_h^y = (Q_h - (Q_{\Delta nt} + Q_s) \cdot \upsilon \cdot \xi) \cdot \beta_h \tag{5}$$

v — reduce heat gain coefficient due to the thermal inertia of walling, are taken into account v = 0,8;
ζ — effectiveness ratio of auto heat supply in heating systems, are taken into account ζ = 0,95;
β_h — coefficient taking into account the additional heat consumption of the heating system, associated with discrete nominal heat flow heaters, are taken into account β_h = 1,11.

The construction process is necessary the use of local materials. At the initial stage of the project help the developer to choose the right materials. The advantages of energy-efficient technologies are especially popular in residential buildings. To improve the energy efficiency potential are encouraged to increase the use of renewables. The primary objective of reducing the environmental and economic impacts associated with energy consumption. The use of passive technology allows buildings to achieve the lowest energy requirements by adjusting the heat gain and heat loss.

3. Conclusion

In conclusion, the green technology for energy efficiency in Kazakhstan (Astana) is possible only in the case of applications with regulatory standards in Kazakhstan. Further research on the breakdown of energy-saving and energy costs has indicated that dominated by the performance of the air conditioning system, heat-insulating system, but the difference in the tariff systems between cities. Additional savings achieved by energy efficiency measures were attractive.

The authors suggest a green building in Kazakhstan to develop a green building, which bases on the context in Kazakhstan. The development of passive technology provided for region. However, the criteria for the pre-conditions and credit should be based on local design and building construction methods. The most significant result of discussions, among all stakeholders, and to discuss it architects, engineers, ecologists, governments, communities and others.

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