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Complex Approach at Thermalization External Walls of Residential Buildings

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ABSTRACT: This article presents the results of the research work on thermal mode of panel buildings in regards to external climatic factors and the structural features of panel's material.

KEYWORDS: thermal protection, energy saving, energy efficiency, thermal mode, heat exchange, mathematical model, microclimate, infiltration, wear-out rate

I.INTRODUCTION

A characteristic disadvantage of the residential buildings in operation is the inconsistency of their increased requirements for energy saving in recent years and, as a consequence, for the thermal protection of their external enclosing structures. Especially many problems arise in large-panel houses, which are characterized by a very unreliable thermal insulation of the external walls[1-2].The microclimate in these buildings creates difficult conditions for people to stay.The main issue for the future of such facilities is the question of whether they should be demolished or upgraded.At the same time, these houses are built of durable materials, equipped with all necessary types of engineering equipment[3-4].

Most of them have reserves of strength and are able to absorb the load from the built-up one or two floors without strengthening existing load-bearing structures. This allows us to significantly (by 25-40%) reduce the cost of additional housing, obtained during reconstruction, compared with similar indicators in the new construction. In this regard, a very important question about thermal renewal of operating buildings through the use of constructive solutions to additional warming of external fences[5].

The decision on the need for thermal renewal in terms of energy consumption of buildings should be based on an integrated approach, including examination of external enclosing structures, appropriate calculations and the development of a rational system of insulation of fences.

For correct diagnostics of enclosing structures, verification of compliance of their normed parameters with current regulatory documents, it is necessary to carry out a thorough examination of the building in order to reveal the degree of wear of fences. Conducting mandatory measurements during the survey is the most time-consuming and cost-effective operation, requiring to obtain reliable, representative data of the objectification of the measurement process.

The operative solution of the tasks at the modern level is unthinkable without the use of calculation device and modern computer technologies. Taking this into account, our study of the degree of wear of wall enclosure structures, from the point of view of their heat-shielding properties, we carried out with the help of mathematical modeling of the process of interaction of the fence with the parameters of the external and internal air.

One of the standardized indicators of comfort of the microclimate of rooms is the temperature difference between the internal air and the inner surface of the fences. However, if the questions of formation of the temperature field "defect-free" enclosure devoted a significant amount of scientific papers, then the results of similar studies for structures, due to having considerable deterioration through cracks are unknown for us. At the same time, These studies are required in monitoring the technical condition of walling maintained buildings.

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In the initial studies using the method of mathematical modeling [4], we have established the features of the distribution of air temperature in the through crack. This made it possible to proceed to the consideration of the problem of the formation of a temperature field on the surface of a guard which has a through filter cracks.

The following assumptions were made in the decision: at the boundaries of the region under consideration, the temperature distribution is maintained in a prescribed manner, which is a function of time; based on fencing materials, heat is transferred by conductive transfer; the cooling (heating) of the surfaces of the gap is realized as a result of heat exchange with the air of the gap, temperature $T_{тр}$ which is determined by the previously derived equation [5]; is consider a two-dimensional problem in the coordinate system XY with the origin, placed on the outside of the fence. The equation is describing the problem under consideration, refers to the equation of convective diffusion. In accordance with the stated conditions, it was written down in the form of a two-dimensional problem:

$$\frac{\partial T}{\partial \tau} = a\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right), \tau > 0, 0 \le x \le \delta, \ 0 \le y < \infty, \qquad (1)$$

where*T*=*T*(*x*,*y*,□)-the temperature, as a function of the planar coordinates *x*, *y*and time □.

By the condition for setting the problem at the initial instant of time□$_o$, the temperature distribution is given by a known function.

$$T(x, y, 0) = t_н + \xi \Delta t = \Phi, \qquad (2)$$

where ξ □□the dimensionless coefficient of thermal resistance, is equal to the ratio of the thermal resistance of the layerR [м^2·K/Вт]to the thermal resistance of the fenceR$_o$[м^2·K/Вт]; □t=$t_в$□$t_н$, $t_в$[K] - internal air temperature, $t_н$[K]□outside temperature.

On the basis of the conditions for setting the problem listed above and in accordance with the three existing possible boundary conditions for diffusion problems [6], we write the boundary conditions of the first kind for equation (1) in the form:

$$\ldots\ldots \quad \begin{array}{l} y = 0 \rightarrow \\ x = 0 \rightarrow \\ x = \delta \rightarrow \end{array} \begin{cases} T = T_{тр}; \\ T = t_н; \\ T = t_в. \end{cases} \qquad (3)$$

To solve this equation, we used the method of integral transformation:Laplace [6] in the time coordinate, Fourier with respect to the spatial coordinate X.

Having carried out the corresponding mathematical transformations, detailed in [6], we finally obtained the solution of the problem in the form:

$$T = \frac{2}{\pi}\sum_{n=1}^{\infty} \sin\left[\frac{n\cdot\pi\cdot x}{\delta}\right]\cdot\left(\Phi - n\cdot a\frac{\pi^2}{\delta^2}(t_в - t_н)\right)\cdot \exp(-n^2\cdot\pi^2\cdot\frac{ar}{\delta^2}) + $$
$$+\frac{2}{\pi}\sum_{n=1}^{\infty} \sin\left[\frac{n\cdot\pi\cdot x}{\delta}\right]\cdot\left(T_{тр} - \Phi + n\cdot a\frac{\pi^2}{\delta^2}(t_в - t_н)\right)\cdot erfc\frac{y}{2\sqrt{a\tau}}. \qquad , (4)$$

where *erfc*(*) = 1-*erf*(*) – is an additional one to the probability integral;□□- thickness of the fences; *a*□□coefficient of thermal diffusivity of the fencing material;r - the width of the crack opening.

The equation obtained and the program complex developed on its basis [7] made it possible to significantly simplify the estimation of the residual heat-shielding properties of the enclosing structures, and then to develop rational methods for the thermal renovation of operated buildings.

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