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Analysis of Current Requirements and Methods for Thermal Protection of Buildings

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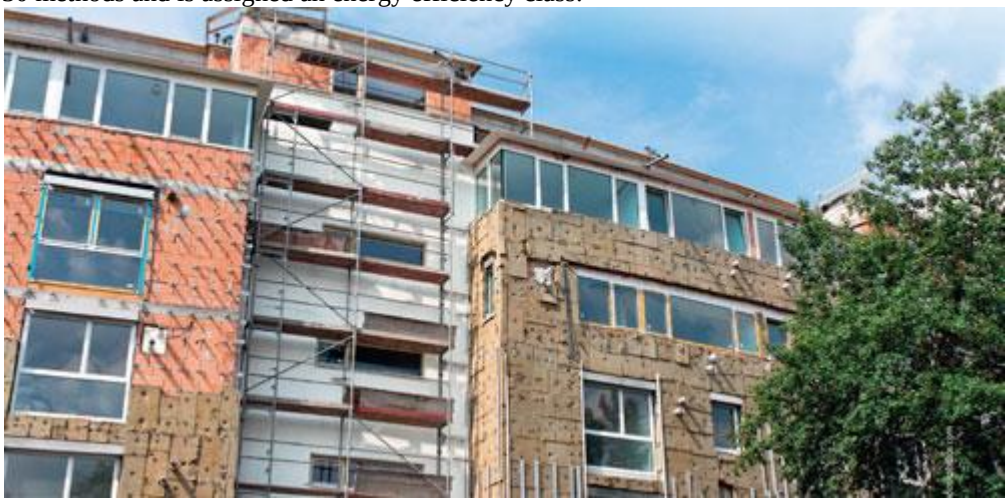
ABSTRACT: Since the approval of the set of rules SP 50.13330.2012 "Thermal protection of buildings" (hereinafter - SP 50.13330), a sufficient amount of time has passed (see the reference). Let us summarize some intermediate results of its application on the territory of the Russian Federation, having analyzed the main comments on the current version of this set of rules. This seems to be important, since on the basis of SP 50.13330 methods the heat-shielding, moisture-proof and air-insulating properties of building envelopes are determined, which ensure the given microclimate parameters of the premises, the energy efficiency of buildings is calculated and the energy efficiency class is assigned to them.

KEYWORDS: thermal protection of buildings, building envelopes, heat resistance of a room, calculation procedure, regulatory requirements, reduced resistance

I.INTRODUCTION

Since the approval of the set of rules SP 50.13330.2012 "Thermal protection of buildings" (hereinafter - SP 50.13330), a sufficient amount of time has passed (see the reference). Let us summarize some intermediate results of its application on the territory of the Russian Federation, having analyzed the main comments on the current version of this set of rules. This seems to be important, since the energy efficiency of buildings is calculated on the basis of SP 50.13330 methods and is assigned an energy efficiency class.



Since the approval of the set of rules SP 50.13330.2012 "Thermal protection of buildings" (hereinafter - SP 50.13330), a sufficient amount of time has passed (see the reference). Let us summarize some intermediate results of its application on the territory of the Russian Federation, having analyzed the main comments on the current version of this set of rules. This seems to be important, since on the basis of SP 50.13330 methods the heat-shielding, moisture-proof and air-insulating properties of building envelopes are determined, which ensure the given microclimate parameters of the premises, the energy efficiency of buildings is calculated and the energy efficiency class is assigned to them.

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II. TERMINOLOGY

In 1974, a monograph by V. P. Turkin [1] was published, in which, with reference to the report of L. K. Jurgenson, “Thermal Engineering Terminology”, it was noted that the term “thermal conductivity coefficient” was obtained from an incorrect translation of the German word Warmeleitzahl. The property of matter, having dimension, is illogical to call a coefficient. On this basis, the author of the monograph [1] suggested that the term “thermal conductivity” be used more than 40 years ago, while discarding the word “coefficient”, which refers to dimensionless indicators.

Currently, in the scientific and reference literature [2], as in all international standards, the term "coefficient" is not used. In this regard, the deletion of the word “coefficient” in the existing edition of SP 50.13330 when designating the thermal conductivity of building materials and products should be treated positively.

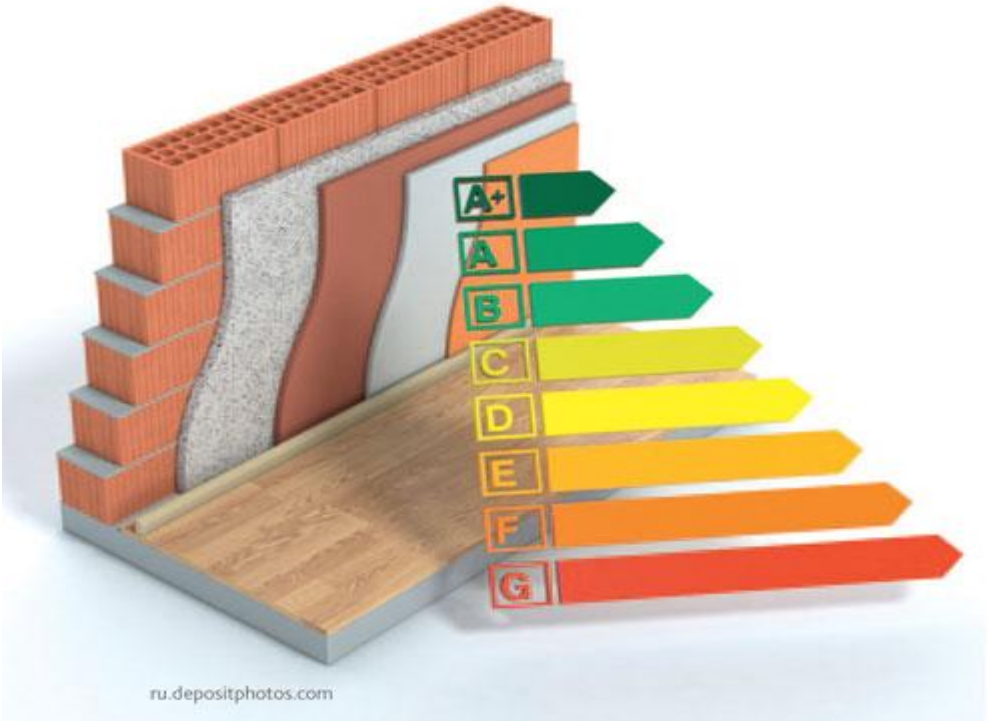
This recommendation can be applied to other terms SP 50.13330: "water vapor permeability coefficient", "coefficient of heat absorption", "coefficient of permeability".

It should be noted that the use of the term "heat transfer coefficient of the inner surface of the enclosing structure" (PL. 4 br 50.13330) does not reflect the physical basis of the process of heat transfer in heated rooms. In the cold season the temperature of the internal temperature above the temperature of the inner surface of the fence, so the fence does not give, but takes heat from the room, so logically this characteristic is called characteristic Teploseti the inner surface of the enclosing structures or characteristics of heat transfer.

In General, SP 50.13330 replete with typos, misprints and graphical inaccuracies, prepared with violation of GOST 7.32–20013.

III. UNITS OF PHYSICAL QUANTITIES

In the current edition of SP 50.13330 units of some physical quantities do not conform to GOST 8.4174. In SP 50.13330 the unit of measurement of thermal conductivity is W/(m•K), thermal (heat) resistance m2•K/W heat transfer coefficient – W/(m2•K). The above-mentioned units correspond to the international system of units physical quantities SI and adopted not only in international standards, but also standards of the Republic of Belarus.



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The unit of measurement of the specific characteristic of the consumption of thermal energy for heating and ventilation of a building in the edition of SP 50.13330 is W / (m3 • ° C). This unit does not correspond to the accepted in the SI system - W / (m3 • K).

A more detailed analysis of the above discrepancies is presented in [3, 4].

Regulatory requirements for the level of thermal protection of buildings

Without dwelling on questions of terminology and units of measurement of physical quantities6, we turn to the consideration of regulatory requirements for the level of thermal protection of buildings, which are presented in paragraph 5.1 of SP 50.13330 and according to which:

1) the reduced heat transfer resistance of individual enclosing structures should be not less than the normalized values (calculated by the formula (5.1), SP 50.13330);

2) the specific heat-protective characteristic of the building should be no more than the standardized value (given in table. 7, SP 50.13330 and depends on the heated volume of the building and the values of the degree-day of the heating period - GSOP);

3) the temperature on the inner surfaces of the building envelope must not be lower than the minimum acceptable values (given in paragraph 5.7 of SP 50.13330).

IV. REDUCED TOTAL THERMAL RESISTANCE OF WALLING

Main is the first of these requirements, as the initial choice of constructive solutions and materials as part of a considered enclosing structure are on the basis that is it. From the numerical values given resistance to heat transfer of enclosing structures depend on the thermal energy losses in the building through the building envelope during the heating period.

Heat losses through enclosing structures are the most significant in the cost structure of thermal energy on heating of buildings. Calculations show that the existing standards for insulation and energy loss in ventilation is comparable to the transmission loss through the building envelope, however, experimentally these arguments are not confirmed.

To compensate for loss of thermal energy to the building necessary to supply heat, i.e. to connect it to the heating system. The higher the level of insulation of external enclosing structures, the smaller are the heat losses through the building envelope while maintaining in the premises of the given parameters of the microclimate. Thus, heat losses in a building at the correct regulation of heat carrier parameters directly depend on thermal insulation of enclosing structures.

In all civilized countries of the world have adopted mandatory regulatory requirements on the level of thermal insulation (in terms of SP 50.13330 to the given resistance to heat transfer) of the outer walling. In connection with growth of prices on energy resources and the reduction of non-renewable resources (oil, gas, etc.) in most developed countries the ratio of use of buildings of energy steadily decrease, but requirements to level of insulation enclosing structures increased [5-10]. It stimulates including the introduction of innovative energy efficient materials and technical solutions.

In Russia with the introduction of the SP 50.13330 and simultaneous updating of the rulebook on construction климатологии7 requirements for thermal protection of buildings for a large number of settlements, including Moscow and St. Petersburg, was lower than in the previous version of the normative document on the heat shield (SNiP 23-02-2003). This circumstance does not meet the approved in-country program of energy saving and increase of energy efficiency of buildings [11, 12].

Coefficient taking into account features of the region construction

Are given in table. 3 br 50.13330 base value of the required resistance to heat transfer of enclosing structures have no physical justification. When establishing a normalized thermal resistance the authors of SP 50.13330 still continue to use the reduction factor mp, "taking into account the peculiarities of the region construction."

The minimum value of this coefficient equal to 0.63 is installed for the walls. Apparently, the minimum value of mpis taken from [13], where the value obtained by the calculation of heat transfer resistance interwindow piers ventilated façade systems a single building in a single paragraph, taking into account the longitudinal air filtration using the heater during the heating period. The authors [13] claim that they have developed method requires the calculation

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of the worst from the point of view of heat loss of the building structure. It should be noted that the coefficient mp is not related to the characteristics of the region of construction. The application of this factor to other types of buildings and constructions of various functional purposes in a wide range of values gap requires a detailed justification.

V. ESPECIALLY AREAS WITH MOIST AND WET REGIMES

Design areas with humid and wet modes have its own specifics. Specified value of the given resistance to heat transfer of enclosing structures of such facilities in the General case is based on the conditions of energy saving by the formula (5.1) SP 50.13330 (at basic values of the required resistance to heat transfer enclosures that are listed in the table. 3, p. 2). At the same time in accordance with clause 5.3 of SP 50.13330 for the same premises specified value of thermal resistance should be determined according to the formula (5.4) on the basis of sanitary-hygienic conditions.

Levels of regulation of thermal protection of buildings
We must distinguish two levels of regulation:
according to sanitary and hygienic requirement;
at the request of energy saving.

In [14], based on comparative quantitative estimation of normalized thermal resistance that is defined on different levels of regulation for thermal protection of buildings and premises with moist and wet regimes projected in 456 settlements of Russia, it is shown that the energy efficiency requirement is more stringent. To ensure feature-based thermal protection applicable both requirements. However, the level of regulation on sanitary and hygienic requirement, there is a risk of failing to meet the complex requirements (based on specific thermal characteristics of the building). In fact the responsibility for the selection of item level requirements on a thermal protection of premises with damp and wet regimes is on the designer [14].

In contrast to feature-based regulation thermal protection application specific thermal characteristics of the building gives the designer greater freedom in the choice of shell elements and is one of the benchmarks in project development [15]. Therefore, validation of thermal building envelope for the comprehensive requirement is a technically feasible option, especially at the stage of pre-training, with the aim of a feasibility study of variants of design decisions. However, the lack of the concept of "specific heat characteristics of buildings" in the Federal law № 384-ФЗ8 creates legal barriers to the use of this feature, especially when conducting judicial construction and technical expertise [16].

Conformity assessment walling sanitary and hygienic requirement on the temperature of the inner surface design in the area of heat-conducting inclusions, corners, window jambs, etc. by virtue of clause 5.7 SP 50.13330 the temperature of the inner surface of the cladding (in the design of buildings) should be determined by the results of calculation of temperature fields of all zones with thermal heterogeneity. The absence of SP 50.13330 methods of calculation of temperature fields makes it difficult to assess compliance of design solutions enclosures sanitary and hygienic requirement.

VI. THE METHOD OF CALCULATION OF HEAT TRANSFER RESISTANCE

The authors SP 50.13330 argue that the document allows to a greater extent to take into account the influence of thermally conductive inclusions, and therefore more accurately estimate the transmission losses of thermal energy. However, the methods of calculation described in SP 50.13330, not fully formalized. In the description of the calculation method no calculation schemes of certain types of thermally conductive inclusions, the rules of the breakdown of the considered fragment on the calculated areas, the boundaries of the study area, and in the example calculation presented in SP 50.13330 (Annex N), not specified characteristics of some components of the calculated piece of content, therefore, becomes indeterminate test results. In the study [23], the critical assessment of methods of calculation of heat transfer resistance of translucent enclosing structures.

It should be noted that in the previous version of a regulation on thermal protection of buildings (SNiP 23-02-2003) was normalized reduced resistance to heat transfer and SP 23-101-20049 entered at least three application methods and examples of calculation of reduced resistance to heat transfer, including on the basis of the calculation of the temperature fields (see Annex M, SP 23-101-2004).

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In SP 50.13330 relatively detailed method of calculation of heat transfer resistance of external walls and very little attention is paid to the study of other types of external walling, despite the fact that, for example, the coating composition may be more diverse, and the number of heat-conducting inclusions – more numerous than in the facade structures of buildings.

Provided in clause 5.2 SP 50.13330 algorithm for determining the thermal properties of walling (with the selection of the thickness of the insulating layer) on the basis of specific characteristics of heat consumption for heating and ventilation of the building is very labor intensive and traderelated in practice.

The thermal resistance of walling in the warm period of the year and areas of the building during the cold period of the year

Requirements for the thermal resistance of enclosing structures in the warm period of the year and areas of a building or structure in the cold period of the year are reflected in article 29, part 1 of Federal law No. 384-FZ. Data requirements for the indoor climate and are along with the other mandatory requirements of norms of direct action.

The method of calculation of thermal resistance of enclosing structures described in section 6 of the current edition of SP 50.13330.Mandatory requirements for heat resistance according to the Decree of the Government of the Russian Federation No. 1521 are limited by the need to use sunscreens in hot climates. SP 50.13330 gives standardized values of the thermal transmittance of sunscreens of buildings of various functional purposes (Table 8, SP 50.13330), but there is no methodology for calculating the heat transmission of sunscreens.

In contrast to SNiP 23-02-2003, there are no norms and methods for calculating the heat resistance of the premises of a building or structure in the cold season of the year in SP 50.13330. This virtually eliminates a number of fences with a heat-accumulating layer from the building design process that have a high energy-saving potential [24–29].

The continuation of the article, which analyzes the issues of air permeability and humidity conditions of building envelopes, as well as the method of calculating the specific characteristics of the consumption of thermal energy for heating and ventilation of buildings, read in the next issue of the journal "Energy Saving".

Suggestions and recommendations for improving methods for the measurement of thermal building envelope are given in [17-22].

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