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ENERGY EFFICIENCY IMPROVEMENT IN RUSSIAN DWELLING HOUSES OVER THE PAST DECADE

A new "energy principle" regulating thermal protection of buildings has been developed and verified in the course of the decade, a complex of mandatory regulatory documents on federal and regional levels has been elaborated and put into practice in Russia. Buildings built in compliance with new codes consume forty percent less energy for heating than code-compliant buildings built before 1995. The construction complex of Russia has assimilated new energy efficient technologies.

INTRODUCTION

Codes and standards for design and construction of buildings in Russia have evolved according to societal demands. Before the end of the 1980s, the closest attention was paid to the cost of construction — that is, the minimization of capital outlays — while operating costs were largely ignored, since fuel was cheap. The planned economy that prevailed at the time required that codes and standards address problems of public health and safety, as well as efficient use of construction materials.

The situation changed dramatically as a result of the country's shift to a market economy at the beginning of the 1990s and the significant rise in domestic fuel prices. People realized at this time that the country was profligately wasting its energy resources, particularly in the building sector. Public outlays for the operating costs of heating buildings were relatively high as a result of unforeseen consequences of the increase in fuel prices to world market levels. Most regions discovered that consumers simply wouldn't pay heating bills at full market-based cost, and had to subsidize heating bills in order to obtain even partial payment from building occupants.

The State Committee for Construction of Russia (Gosstroy RF) established a goal in 1994 to develop the Building Energy Codes that would provide for a reduction in energy demand for heating buildings compared with 1995 by 20% for the period up to 1999, and by 40% beginning in 2000. In connection with strengthening the requirements for energy conservation, there has emerged a need to develop "energy principles" of standardization of the heat-energy indices of the building.

Achieving these objectives required the development of a performance-based approach. For the case of Russian buildings, research showed that a relatively simple performance approach could be established based on a single parameter: specific energy consumption (for heating) per degree-day.

To figure out this standard value, thermal performance properties of the envelope assembly or building shell should be determined. The specific heating energy demand (for building heating and ventilating) is defined as the quantity of heat for space heating in the heating period (typically October-April) per square meter of the total heated floor area or per cubic meter of the volume of a building, per degree-day, ($W \cdot h/(m^2 \cdot {}^oC \cdot day)$ or $W \cdot h/(m^3 \cdot {}^oC \cdot day)$).

The idea of this parameter goes back to 1994 [1], when a new index was proposed as the basis of the model regional standards for energy efficiency in buildings in Russia. These models entitled "Energy Efficiency in Buildings. Regional Standards for Thermal Performance of the Buildings", were developed by authors in the Research Institute for Building Physics (known by its Russian initials NIISF), in the Center for Energy Efficiency (CENEf) (both in Russia) and in the Natural Resources Defense Council (NRDC), a non-profit American environmental organization.

Result of introducing the regulatory documents, reflecting the performance approach to thermal protection of buildings and energy saving into designing and construction, are discussed below.

FOUR STAGE DEVELOPMENT OF BUILDING ENERGY CODES IN RUSSIA

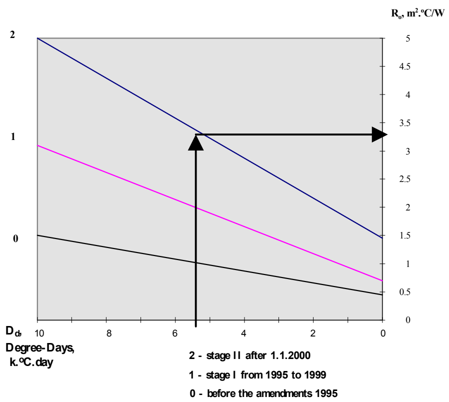
The development of building energy codes in Russia over the past decade may be divided into four stages, which reflect various degrees of implementation of a performance approach on whole building.

The first stage. Element-wise method serves as a reference point. At this stage heat transfer through exterior walling (building envelope) was mainly considered. Breakdown of the entire building envelope into elements (exterior walls, camp ceilings or coatings, ground floor ceilings, windows, doors, etc.) was performed and minimum permissible thermal resistance was ascertained for each of them. Whole-building energy performance is not considered. The method has been reflected in federal norms on thermal protection of buildings (SNiP "Construction Thermal Engineering"), the document was effective up to 1995. The norms were based on prescriptive principle, i.e. designing potentialities were strictly restrained by regulatory requirements and instructions. The simplest calculation techniques were characteristic of this stage. For taking into consideration the "cold bridges" the calculation of reduced heat transfer factor was essentially complicated. The rated level of thermal protection in buildings had little in common with energy saving requirements.

The second stage. At the this stage reduced (average) heat transfer coefficient of the whole building enveloping structures under steady-state conditions was regulated. It was the first step in the integration of the perfprmance approach. It proved sufficient to assign one value for the totality of walling structures rather than regulate each element. As a result a greater variability in designing was attained, when lower thermal protection of one element could be compensated by greater thermal protection of the others. There was no way to control directly the rated values and the fact can be mentioned among drawbacks of this stage. Reduced (average) heat transfer coefficient as a norm for the first time was introduced in Moscow municipal norms of energy saving in buildings in 1994 (MGSN 2.01-94 "Energy saving in buildings"). The document was the first step towards energy saving, it envisaged a 20% reduction of energy consumption. Calculation of specific demand for heat necessary for heating a building during a heating season and requirements to energy passport have been introduced into the norms for the first time.

The third stage. At the third stage the value of final thermal energy demand for heating during the heating season is regulated. The stage reflects a systemic approach to thermal protection of buildings. Compliance is based on calculated whole-building heat energy requirements. Methodologies for the third and fourth stages have been developed within a model of norms for the RF regions as a result of cooperation between Russian and American specialists [2]. Reduction of demand for energy for heating buildings is attained not only at the expense of building envelope, but due to improved ventilation and heating systems along with passive use of solar energy by choosing the appropriate architectural, volumetric and planning approaches favorable from energy viewpoint. Relying on the methodology, fundamental changes in federal norms of construction heating engineering were developed and came into force in 1994-1995. Using this parameter the Gosstroy RF adopted in 1995 an amendment to the federal Construction Thermal Engineering Code [3] that provided for a considerably higher thermal performance level in new and renovated buildings. Their application provided a 40% reduction of energy consumption in newly constructed and retrofitted buildings in 2000 versus 1995. The new reduced values of specific energy demand were then used for calculation required areal average thermal resistance of exterior walls, roofing constructions (attics included), and floors, depending on the number of Degree-Days in the place of construction. Thus two reduction levels for specific energy demand were approved and the corresponding thermal performance standards for residential buildings were set on this basis (see fig.1).

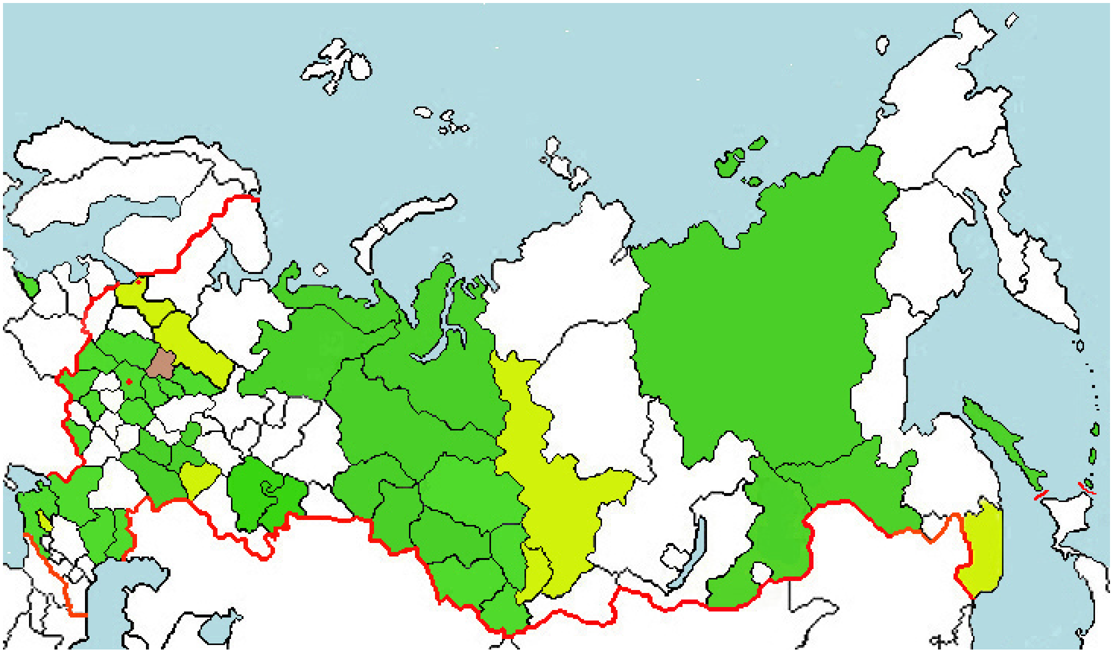
Figure 1. The relation between the required areal average thermal resistance of exterior wall and the number of degree-days



It can be stated that the new approaches reflected in the norms promoted largely the assimilation of new for Russia energy saving technologies in construction. According to the third stage methodology in 1998-1999, when the norms of specific energy consumption were set, a new revision of Moscow municipal norms of energy saving in buildings (MGSN 2.01-99) was elaborated and currently the entire construction in Moscow is regulated by the norms. The norms contain energy passport of a building, which has been developed in detail, methodology for calculating energy consumption for hot water supply, as well as a new section to the project "Energy efficiency of buildings". The 2001 new federal norms "Single-family dwelling houses" contain well-defined regulatory requirements for specific energy consumption in low buildings. Another regulatory document, i.e. code of practice "Designing of thermal protection in buildings", contains the recommended form of energy passport and algorithm for calculating specific energy consumption in a building. The principle of rating, which reflects requirements of a systematic approach in contrast to prescriptive norms of the first and second stages, is consumer-oriented.

The fourth stage. And, finally, the fourth stage integrates normalization of thermal performance and heat supply systems by rating the demand of a building for primary energy. A similar methodology has been approved in the codes of practice effective in the United Kingdom, France, Italy, and Germany; now this approach is prevalent among many regions of Russia with their own territorial construction codes (TCN) in reference to energy efficiency of buildings. Regional codes have met with huge success in Russia – and their impact continue to riple through the country. In the period of 1999-2002 about 40 TCN from Kaliningrad region in the west to Sakhalin region in the east and from Krasnodar Territory in the south to Nenets Autonomous area and Saha Republic (Yakutia) in the north were developed and put into practice (see map on figure 2). All the TCN made effective on the territories have been approved by heads of administrations of the territories, officially registered by Gosstroy of the RF and included in the list of regulatory documents effective on the territory of the Russian Federation. Normalized per degree-day, the regional codes across Russia embody essentially similar requirements (See table on figure 3).

Figure 2. Drafting and Adoption of Regional Building Energy Codes in the Russian Federation



Note: Regions shown in green have adopted codes. Regions in yellow have completed final draft codes, which are now awaiting approval.

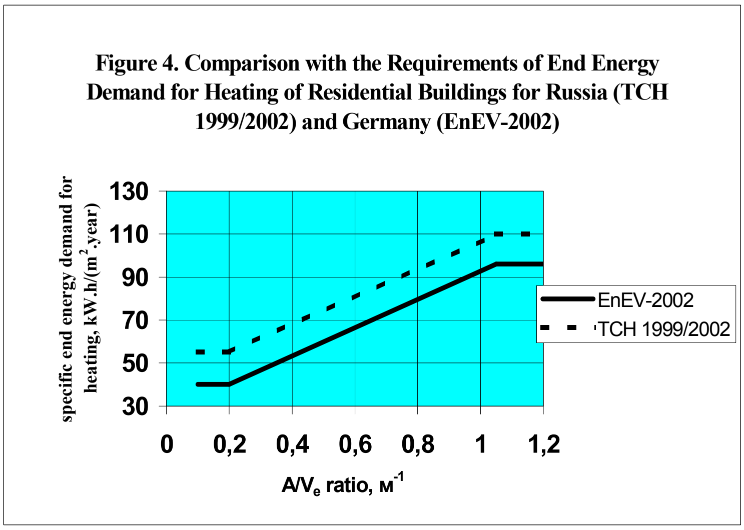
At least 70% (and in some regions, Moscow for instance, 100%) of newly erected and retrofitted buildings are designed and constructed in conformity with requirements stipulated by the TCN. The total energy savings in 2002 is an estimated 14,122 terajoules annually. These energy savings mean the avoidance of more than 950,000 tonnes of CO_2 emissions in 2002. By 2012 this figure will rise to approximately 9.5 million tonnes annually, and the cumulative CO_2 emissions avoidance will be 52 million tonnes, assuming the same volume of construction and building renovation as in 2002 over the ten-year period. These energy savings also mean that emissions of about 9,500 tonnes of conventional pollutants will be avoided in 2002 (6,950 tonnes of SO_2, 1,294 tonnes of nitrogen oxides, and 1,349 tonnes of particulate matter). Over ten years, this figure will grow to about 95,000 tonnes annually, and to 522,000 tonnes cumulatively. The savings to the Russian economy as a result of introducing energy-efficient building codes will be an estimated $28-30 million in 2002. In ten years, assuming a cumulative energy savings of 776,710 terajoules, this figure will exceed $1.5 billion. If the construction growth rate increases to 5.0 percent a year, this figure will be close to $1.8 billion. Please note the cumulative effect at work in these numbers. Because the energy savings in Year 1 will persist over a building life of 50 years or more, total Year 2 savings will amount to Year 1 savings plus the incremental Year 2 savings, and Year 3 savings will amount to Year 1 savings plus Year 2 plus Year 3, and so on. This cumulative effect -- in which each year's new energy savings are added to the total of previous years' savings – explains why the numbers for GHG emissions avoidance, energy savings, and cost savings grow so large over time.

Figure 3. Maximum Allowed Energy Demand for Heating (q_h^{req}) W·h/(m^2·^{o}C·day) [W·h/(m^3·^{o}C·day)] over the Heating Season

Types of buildings	Number of stories				
	1-3	4-5	6-9	10-12	More than 12
Residential	32	24	22	21	19
Education facilities and offices	[10 (9)]	[8 (7,5)]	[8 (6,5)]	[7,5 (6)]	[7 (5,5)]
Medical facilities, clinics, and long-term care	[10], [9,5], [9]	[8,5]	[8]	--	--
Pre-schools	[12]	--	--	--	--
Note: The value q_h^{req}, Wh/(m^3·^{o}C·day), in square brackets, apply to office buildings.					

COMPARATIVE ANALYSIS THE RUSSIAN BUILDING CODES FOR ENERGY EFFICIENCY AND GERMAN'S EnEV

Comparative analysis of the Codes of Russia and Germany demonstrate the same main principles. However the Russian code requirements of the specific end energy demand for heating of residential buildings are some higher than the requirements of the EnEV [4] (see fig.4).



NEW TECHNOLOGIES IN THERMAL PERFORMANCE OF BUILDINGS: PROBLEMS AND SOLUTIONS

High requirements to thermal performance of buildings complying with today's energy saving objectives and reflected in new regulations pertaining to thermal performance of buildings dictate the necessity to develop and introduce energy efficient walling structures using high-quality effective thermal-insulated materials.

The demand in the Russian residential sector alone for thermal insulation materials is projected to reach 25-30 million cubic meters by 2010. Mineral wool is the most widely used type of insulation, with more than 65 percent of the Russian market, followed by synthetic foam at 20 percent, fiberglass at 8 percent, and thermal-insulating concrete at no more than 3 percent. Demand for thermal insulation products has stimulated a competitive market on the supply side, but high customs tariffs and transport costs have caused market expansion to be restricted to in-country Russian production only.

Basic principles regulating thermal protection of buildings were formulated in construction norms and specifications. No problems arise from the revised rules and regulations in designing of coatings, attic and ground floors, while designing of exterior walls necessitates looking for qualitatively new engineering approaches.

Designing of exterior walls with allowance made for new requirements to thermal performance

It is common knowledge that from thermotechnical viewpoint three main types of exterior walls are conditionally distinguished by the number of basic layers: one-layer, two-layer and three-layer ones. Thermal performance properties of the walls, which ultimately define heat consumption for heating of a building, pertain to climatic characteristic of locality expressed in degree-days of heating period (DDHP). Practicability of employment of this or that structure is limited by the highest value of DDHP, at which the structure provides the necessary level of thermal performance, being reasonably thick.

One-layer walls

One-layer walls are the most customary for Russian designers and constructors and they are the simplest in manufacture and, when the necessary thermal performance properties are assured – in operation, as well. The one-layer walls are manufactured from structurally thermal- insulated materials and products combining load-bearing and thermal performance functions. The required parameters of indoor microclimate, i.e. necessary comfort, are provided, if the walls materials are of appropriate quality.

Bearing in mind current requirements to thermal performance, walls made of cellular concrete blocks manufactured according to diverse technologies, are the most acceptable ones. When maximum density of the material is 500 kg/m^3, wall thickness is 500 mm and calculated value of thermal conductivity coefficient is 0.15 W/(m·^{o}C) at most, its use in the areas with DDHP up to 6000-6500 is practicable. Extension of the cellular concrete material application to areas with DDHP in excess of 6500 is also possible, but the wall thickness shall be increased to 700-750 mm. More often than not, walls of cellular concrete blocks are designed as self-supporting walls with by-floor leaning against the floors elements and mandatory protection against external atmospheric effects (facing, plaster layer, etc.).

For the one-layer walls the use of other concrete materials is advisable, when their density is not in excess of 600-700 kg/m^3 (light-weight concrete, foamed concrete, etc.), however, for the wall thickness of 500 mm their use is restricted by areas with DDHP 2000.

Under certain conditions one-layer walls made of clay hollow bricks proved efficient.

Two-layer walls

The two-layer walls contain load-bearing and thermal-insulated layers, which can be arranged both inside and outside. Internal insulation shall provide protection against damping and moisture accumulation in the bulk of thermal insulation, which necessitates special thermal engineering calculation and careful manufacture. Systems with outside heat insulation feature a number of essential advantages (high thermotechnical homogeneousity, maintainability, variety of architectural approaches to facade, preferable for the walls reconstruction) and nowadays they found extensive use in construction practices. Currently, two main variants of the systems are used: variant 1 – systems with external plaster layer; variant 2 – systems with an air gap.

In variant 1 thermal-insulated materials meeting special requirements are used: mineral wool batt insulation thickness is up to 150mm, that of expanded polystyrene plates – up to 250 mm; they are fixed to the wall by dowels with steel stay elements and polyamine cylinders. From external atmospheric effects the insulation is protected by a basic glue film reinforced by a glass net and ornamental layer (plaster, painting). Safe to handle, durable and compatible components, preventing partial/full cracking or failure of the thermal-insulated layers on facades of buildings shall be used. Accordingly, components, materials and products used shall undergo technical appraisal of their fitness. Recommendations on the choice of materials and products contained in the code of practice SP 12-101-98, shall be reviewed with allowance made for the appraisal mentioned.

Nowadays, by results of the relevant verification 20 foreign and national companies were granted certificates issued by State Committee for Construction (Gosstroy) of Russia for the products and systems they employ, which served in different regions of the country with DDHP 6000.

Variant 2 differs from variant 1 by the absence of restrictions for thickness of the thermal insulation materials used - mineral wool batts, which are also fixed to the wall by dowels. The thermal-insulated layer is protected by facade plates made of diverse materials installed on light-weight structures of metal profiles (steel, aluminium alloys and their combinations) fixed to the wall. The thermal insulation layer is additionally protected by a vapoir-permeable film fixed under factory or building conditions. Besides, an air gap 60 mm thick is envisaged between the facade facing and thermal insulation layer.

Safety and durability of the variant depends on many factors, including compliance with requirements of anticorrosion protection of fasteners and their joints.

At present 12 organizations submitted materials for technical appraisal of their systems fitness to Gosstroy of Russia.

The use of dowels 400-450 mm long for fixing mineral wool batts to the wall according to variant 2 can find application in areas with DDHP > 9000.

Nowadays systems with outinsulation are employed in most of buildings under construction with a cast-in-situ ferroconcrete frame and in modernization of bearing-wall and brick buildings.

Three-layer walls

The three-layer walls erected on construction site using all kinds of small-pieces products and thermal insulation arranged between external and internal layers, were previously used in construction as a «well brickwork». Low thermotechnical homogeneousity (less than 0.5), stemming from the brick cross pieces splitting the thermal insulation, along with problems in the brickwork quality control, hampered its application, bearing in mind the new requirements to energy saving.

Walling made by small-pieces items shall provide a high thermotechnical homogeneousity of the walls – up to 0.64-0.74. For flexible ties in the walls mentioned, steel reinforcement, featuring the relevant anticorrosion properties of the steel or protective coating, is used. Employment of the structures is restricted by the wall thickness of 2.5-3 bricks.

In prefabricated house-building three-layer concrete walls have been long in use, featuring lower reduced thermal resistance (R-value) than the one necessary according to today's requirements. To improve their thermotechnical homogeneousity the rigitties between external and internal layers were replaced by flexible steel ties in the form of separate rods or their combinations. For the same purpose plate-filling or filling insulation materials are used. Numerous calculations for ascertaining the reduced thermal resistance made by Research Institute for Building Physics (NIISF) and Central Research Institute of Experimental Design of Dwellings (CNIIEP) and other organizations, bearing in mind three-dimensional temperature fields, suggest that thermotechnical homogeneousity coefficient of the structures makes up 0.67-0.8, which is quite acceptable for coping with the task assigned.

Three-layer walls 350-450 mm thick with a thermal insulation layer 200-300 mm thick made of flexibly bonded expanded polystyrene and mineral wool can be used in regions, where DDHP reaches 6000-7000.

Evaluation of safety and durability of discrete ties (bushing keys) of diverse modifications and glass-fiber-reinforced plastic flexible ties required additional information along with their approval with issue of a technical certificate by Gosstroy of Russia.

Walls made of light-weight sandwich-panels continue to be extensively used, primarily in industrial construction. Here, as in the previous case, the regulatory base is the decisive factor, development of a standard for sandwich panels with mineral wool insulation, first of all.

Application of the building materials designed thermal values

It is a well-known fact that there is an essential difference in thermal conductivity of certain materials in a dry state and the same materials within the enveloping structures. For instance, expanded polystyrene plates, their density 40 kg/m^3, in a dry state feature thermal conductivity of 0.038 W/(m·^{o}C), while within the enveloping structure of a building constructed in central Russia, allowance made for the wall moistening during service, the same coefficient has the value of 0,05 W/(m·^{o}C), i.e. 30% higher. Foreign and national manufacturers, when selling thermal-insulated materials, often inform purchaser of their materials characteristics obtained in the course of laboratory testing in a dry state and the value, by mistake and in violation of SNiP II-3-79*, is sometimes used in designing.

SNiP II-3-79* requires that only design values of thermal conductivity coefficient for thermal-insulated materials are used in designing for operation conditions *A* and *B*. Table values in the SNiP were defined on the basis of materials manufactured by national industry. Nowdays thermal-insulated materials, manufactured according to the state-of-the-art technologies and featuring improved thermal insulation characteristics, appeared on the Russian market of building materials, so, the necessity arises in the development of a standardized method for determining the design thermal values for the materials under service conditions. The method was developed and provided in Code of Practice SP 23-101-2000 «Designing of thermal performance for buildings» approved by Gosstroy of Russia. The method is intended for test laboratories accredited by Gosstroy of Russia, delineating the procedure of defining the designed values for specific makes and types of building materials, including the foreign ones.

A similar approach to determining the designed values is used abroad. Hence, the International Organization for Standardization (ISO) has developed standard 10456 «Procedures for determining declared and design thermophysical values" of thermal-insulated materials. In standard of Germany DIN 4108, p.4, is currently effective, which contains a table of design values of termal conductivity coefficients of building materials and products. In 1997 leading manufacturers of thermal-insulated materials, research and other organizations in Denmark set up independent organization (VIK), which supervises over application of design thermal conductivity values in designing on the basis of Danish standard DS 418. Similar approaches are used in the standards of Norway (NS 3031), Sweden (BBR 99), Estonia (EVS 724:1996), Lithuania ((STR 2.01.03:1999) and other countries.

Thermal insulation of exterior walls

There is an opinion that arrangement of an insulation layer outside the load-bearing part of a wall will bring about reduction of its durability due to moisture accumulation near outside finishing layer and alternate freezing and thawing in the process of service in cold and intermediate seasons of year.

Nonetheless, results of calculations and full-scale tests of moisture conditions of the walls carried out by some research institutes indicate that, if they are designed correctly, no intolerable moisture accumulation near the outside finishing layer occurs. Hence, at CNIIEP comprehensive research of structural durability of the exterior walls insulated by basalt-fiber base mineral wool battsplates with a finishing plaster layer was conducted. Outinsulation of one-layer walls was performed in dwelling houses of series 1-515 in Moscow. The system of outinsulation resulted in improvement of heat and moisture conditions in the apartments and in the walls; operation of the buildings for quite a long time revealed no defects.

Similar results for outinsulation were obtained in Research Institute of Construction in Lithuania, where the structure withstood 70 cycles of freezing and thawing that did not impair its properties. Experience in large-scale service of outinsulation in Poland and Germany for more than 25 years did not reveal any deterioration of service properties of the outinsulation and its facing layers.

Protection of multi-layer walls against vapour diffusion

Heat insulation properties of a multi-layer structure depend on the thermal insulation steady state moisture content. Due to partial pressure difference of vapour outside and inside a building, vapour diffuses through the enveloping structure towards outside. When designing the multi-layer enveloping structure, the problem consists in reducing vapour diffusion into internal layers of the wall and in removing moisture that penetrated inside the structure. With this end in view vapour-insulated layers are designed, which should be arranged as close as possible to the internal surface of the wall. It is permissible to use thermal insulation on internal side solely, if a reliable vapour barrier on indoor side is available, which is difficult to attain in practice.

Translucent enveloping structures

The new generation of window structures is based on the use of single and double chamber window insulating glass units, which permit essential increase in the level of thermal performance compared to previously manufactured translucent structures. The use of glasses with selective coating in the glass units increases the window unit thermal resistance to 0.6-0.65 $m^2 \cdot {}^oC/W$. Problems of the folds sealing are solved at a qualitatively new level.

Introduction of windows in plastic sash, featuring improved thermal performance, into the practices of domestic construction resulted in a number of blunders in thermotechnical designing of facades and mounting of translucent openings. One of blunders made during initial introduction of the windows stems from a low, within 50-55 mm, thickness of plastic sash pulleys, resulting in zones with decreased temperatures on internal surfaces of window jamb giving rise to condensate settling out or even freezing. Selection of a thicker translucent structure, at least 80 mm thick, and its arrangement in the sash pulley to the depth of the frame «quarter» from the wall facade plane, filling the space between the window casing and internal surface of the quarter by foaming thermal insulation material, were necessary to eliminate the blunder made.

Other errors pertain to insufficient account of the windows air permeability. Rated air permeability for filling translucent openings with windows in wooden sash equals 6 kg/(m^2·h), in plastic sash – 5 kg/(m^2·h) at 10 Pa pressure drop, moreover, the value was set, bearing in mind the air permeability of the window casing adjoining the wall. Results of certification tests of windows in plastic sash suggest that air permeability of the folds of the window opened elements is within 0.5 - 2 kg/(m^2·h). Decreased air permeability of folds in the windows in plastic sash (as well as in the newest types of windows in wooden sash) and high degree of sealing the windows adjoining the wall involve insufficient air exchange and, accordingly, increased humidity in the apartments. Periodic aeration of the rooms is necessary to avoid the phenomenon; opening of a window or window leaf for 10-15 min assures the required air exchange and does not involve a noticeable heat loss. Meanwhile, today’s window structures are already fitted out with ventilation controls (soundproof valves, specially arranged apertures in window contour, turn-drop devices, holders), which can provide any variant of the room aeration by the user wish.

For evaluating the influence of the enveloping structures on indoor air exchange the currently effective normative documents pertaining to the methods for defining the air permeability (GOST 25891-83, GOST 26602.2-99) shall be supplemented by new standards. The methods were taken up abroad, being reflected in some standards of foreign countries and in new standard ISO 9972.

A DRAFT OF A NEW FEDERAL CODE

A draft of a new federal code , “Energy-Conserving Thermal Perfofmance in Buildings,” has been developed based on mounting experience with regional codes. In the new code, the thermal-performance level of the heated building will be defined based on a mentioned before fundamentally new parameter: the specefic demand for heating the building, per degre-day in the heating season. These requirements are being established on the basis of calculations of model buildings, designed in compliance with the second stage of energy-conservation levels contained in energy codes in force now. If energy-saving opportunities unavailable under previous codes are used (such as the influence of building geometry, accounting for natural and forced ventilation, internal heat gains, solar radiation, the degree of controls in heating systems, and so on) then the tequirements for the thermal performance of individual building elements may be loosend somewhat, relative to the requirements of the second stage of the current code. In the end, the same energy-saving result will be achieved by virtue of improved building design, and the building designer will have more freedom to choose among various options in thermal-engineering design. Regions with new codes are using actual building designs as a preliminary basis for setting and refining their code requirements.

CONCLUSION

The experience gained and outlooks for the development and introduction of new thermal- performance structures of buildings can be summed up by the following conclusion:

– New structural approaches to the enveloping structure, relying on the newest technologies including outinsulation systems, ventilated structure, punctual tie three-layer structures, along with experience gained in regions of the RF during the approaches implementation in practice, confirm their energy efficiency.
– New normative requirements stimulated national industry for manufacturing new promising building materials and products meeting the world standards and, specifically, for increase in output of high-quality effective thermal-insulated materials, energy saving enveloping structures and new types of energy efficient windows.
- Essential part of subjects of the RF, having comprehended the necessity to solve energy saving problems, is actively engaged in re-structuring of their construction industry, considering the new normative requirements. Regional standards, assuring the same energy saving effect as the one stipulated by federal standards, and taking into consideration the climatic, energy, construction and other regional features and potentialities of local construction industry, were elaborated and enforced. Approbation of the new rate setting ideology takes place in the regions.
- There are certain problems in the development and assimilation by production of the new engineering approaches relating to thermal insulation of exterior walls, providing low-cost but high-quality domestic thermal-insulated and other building materials in the regions. Overcoming of the difficulties necessitates systematic efforts.

More information in English and Russian, including the papers mentioned in the references, may be found by visiting http://www.cenef.ru/, in the section on “Energy-Efficiency Standards and Certification”.

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[3] SNiP II-3-79*, Stroitelnie Normi i Pravila (Construction Norms and Regulations), “Thermal Engineering”, *Gosstroy RF*, Moscow, 1998 (in Russian).

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