Organization of major repairs of apartment buildings with energy-saving technologies

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Abstract. In today's Russia, development of new regulatory requirements related to major repairs of apartment buildings is much less needed than harmonization and enforcement of existing regulations. In order to meet the energy efficiency requirements for apartment buildings after major repairs, it is necessary to develop a set of energy-saving measures that will increase the energy efficiency of buildings and the comfort of living. The main particularities of the organization of repair and construction during major repairs include requirements for modeling the order of different types of work at each facility under financial and time constraints. This said, we can conclude that it is necessary to determine the optimal sequence of application of energy-saving technologies during repair and construction within the major repairs of apartment buildings and the effectiveness of the applied technology.

1 Introduction

Currently, despite the long reformation of the housing and communal services that can now boast significant changes and transformations, the housing problem remains unresolved [1, 2]. At the same time, the unsatisfactory state of the housing stock significantly lowers the level of socio-economic development of the country and the comfort of living of its citizens [3, 4].

To change the existing situation with the Russian housing stock, two main problems need to be solved:

• aging and lack of repairs that increase the share of substandard and dilapidated housing [5, 6];

• high energy consumption that increases housing maintenance costs [7].

The use of modern energy-saving technologies during major repairs of apartment buildings improves their thermal performance, thus reducing the costs of housing and communal services for the inhabitants.

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2 Research materials and methods

Modern conditions for the organization of major repairs impose new requirements for the modeling of repair and construction, i.e. the mandatory use of energy-saving technologies.

Specific features of repair and construction significantly complicate the application of existing methods of modeling the organization of construction during major repairs [8, 9].

Troubles with the implementation of energy-saving technologies during major repairs mostly arise if the main tasks were set and solved in a sketchy and haphazard manner [10, 11]. The analysis of theoretical research in the modeling of repair and construction suggests that it is necessary to develop the basics of modeling the organization of repair and construction with the use of energy-saving technologies.

3 Results and Discussion

The use of modern energy-saving technologies during the major repairs of apartment buildings makes it possible to reduce the costs of housing and communal services for the citizens, since modern materials and technologies can significantly improve the thermal characteristics of the building [12].

The study of the problem of high energy consumption of the housing stock showed that, being the second largest end consumer of energy in Russia, the housing sector has the greatest potential for energy saving. However, not only the saving potential is important, but also the conditions for it that arise as a result of major repairs [13].

The energy saving potential in the housing stock can be most fully realized by combining the major repairs of apartment buildings with the implementation of additional energy-efficient measures. This is why it is so important to combine the system of implementation of the state policy of energy efficiency and resource conservation with the system of financing major repairs of apartment buildings [14].

The implementation of state policies and programs in the field of energy efficiency will allow homeowners to reduce energy consumption and housing maintenance costs through the introduction of energy-efficient products.

As new housing is constructed and dilapidated houses are demolished, the share of old buildings decreases, while that of new and more efficient ones grows. Accordingly, the weighted average specific energy consumption for heating is reduced. The change in the heat loss of the existing housing stock occurs either because of the degradation of the enclosures or due to their insulation and repair as part of major repairs, when buildings are also equipped with metering and regulation devices.

Since thermal energy accounts for 80–86% of all energy consumption in apartment buildings, the main task of major repairs is to reduce its consumption. The average energy saving potential of apartment buildings is equal to or exceeds 40% in thermal energy, 37% in electricity, 30% in natural gas, and 25% in water. In new buildings it is low; in old ones, much higher. Its relative value is affected by the number of storeys, the material of the walls, their condition and the quality of regulation of heat and power supply.

Measurements of heat consumption based on the results of major repairs show that this potential is only partially exploited [15, 16]. When organizational and technological solutions for major repairs are developed, the efficiency indicators of the chosen technology are not taken into account. Major repair projects may have inflated estimates due to the inclusion of excess equipment.

Often, works on the attic floor insulation and replacement of the roofing, window blocks and central heating systems begin immediately after the repair of facades, entrances and stairwells. This, naturally, necessitates more repairs. Energy saving issues are directly related to the determination of the effectiveness of the introduction of energy-saving technologies and the sequence of their inclusion in the process of repair and construction during major repairs.

Today, a contradictory situation has developed in the field of major repairs. On the one hand, the requirements of existing construction standards and codes allow for an increase in energy efficiency during major repairs. On the other hand, there are discrepancies between the legislative acts that regulate relations in the field of major repairs, as there is no single list of works done during major repairs, which would make it possible to correct the situation, increasing energy efficiency [17].

When drafting regional major repairs programs and determining the order of work on major repairs, the types of work were grouped as follows:

- roof repair;
- repair of the facade, foundation and basement;
- repair of power supply;
- repair of gas supply;
- repair of heat supply, cold/hot water supply and drainage;
- repair or replacement of elevator equipment.

Considering that such a list of types of work is used in the design and development of organizational and technological solutions for major repairs and the timing of major repairs is determined for such a list, additional sets of measures are proposed that can be carried out during major repairs in order to reduce the energy consumption of apartment buildings while maintaining the corresponding beneficial effect of their use. Table 1 also presents the expected effect of various sets of measures.

Table 1. Types of works and sets of energy-saving measures for major repairs of apartment buildings.

Type of repair (replacement) work	Measure name	Measure effect
Roof	Thermal insulation (winterization) and waterproofing of the attic floor	Reduction of transmission heat losses through the attic floor Reduction of freezing of the attic floor (increase in service life) Reduction of the intake of moisture (water leaks) into the premises
	Roofing replacement	Reduction of physical wear and increase in service life
Facade, foundation, basement	Thermal insulation (winterization) of the basement floor and walls adjacent to the ground	Reduction of transmission heat losses through the basement floor and walls Reduction of freezing of the basement floor and walls (increase in service life)
	Thermal insulation (winterization) of external walls	Reduction of transmission heat losses through external walls Reduction of heat consumption for heating cold outdoor air infiltrating through the exterior walls Reduction of freezing of external walls (increase in service life)
	Repair (replacement) of existing windows	Reduction of heat consumption for heating cold outdoor air infiltrating through leaky window openings Reduction of transmission heat losses through windows
	Sealing (insulation) of external door openings with installation of door	Reduction of heat consumption for heating cold outdoor air infiltrating into the building through leaky door openings and open

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	closers (ensuring automatic closing of doors)	doors
Power supply	Replacement of worn-out communal electrical networks (wiring) and input-distribution devices	Reduction of physical wear and increase in service life of power supply systems
	Replacement of incandescent lamps in common facilities (stairwells, staircases, exterior lighting of entrances) with energy-saving lighting devices	Reduction of electricity consumption for lighting in common facilities
	Installation of presence sensors in common facilities	Reduction of electricity consumption for lighting in common facilities Automatic illumination control in common facilities
	Installation of communal metering devices for power consumption	Reduction of payments for consumed electric energy
Gas supply	Replacement of in-house gas supply pipelines (pipelines in the basement and/or in the attic and vertical risers)	Reduction of physical wear and increase in service life
	Installation of communal metering devices for natural gas consumption	Reduction of payments for consumed natural gas
Heat supply, cold/hot water supply, drainage	Installation of heat-reflecting screens behind heating devices	Reduction of transmission heat losses through external walls (reduction of thermal energy consumption for heating the wall behind the heating device)
	Complete reconstruction (replacement) of in-house engineering networks in the building, including in-house pipelines of heating systems and cold/hot water supply	Reduction of heat losses in heating and hot water pipelines Reduction of physical wear and increase in service life of heating and hot water systems
	Installation of an EF water pressure regulator on hot and cold water supply systems	Reduction of hot water discharge due to cooling (in the absence of hot water intake at night or during the day) Reduction of cold water consumption
	Installation of a hot water circulation pipeline in the hot water supply system	Reduction of hot water discharge due to cooling (in the absence of hot water intake at night or during the day)
	Installation of an automated heating system control unit (replacement of heat distribution stations in the building)	Automatic regulation of the heat transfer agent parameters in the heating system (maintenance of the temperature schedule of the heating system at a given level) Reduction of heat consumption in the heating system (elimination of over-heating during the heat surplus period)
	Installation of an automated individual	Automatic regulation of heat transfer agent parameters in heating and hot water supply

	heating point (replacement of heat distribution stations in the building)	systems (maintenance of the temperature schedule of the heating system and the temperature of hot water at a given level) Reduction of heat consumption in the heating system (elimination of over-heating during the heat surplus period) Reduction of heat consumption in the hot water supply system
	Installation of balancing valves on vertical risers of the heating system	Elimination of misalignment of the building heating system by risers Reduction of thermal energy consumption by the building
	Installation of temperature control valves (thermoregulators) on heating devices	More comfortable conditions in the premises Reduction of thermal energy consumption for heating
	Installation of communal metering devices for thermal energy and cold/hot water consumption	Reduction of payments for consumed thermal energy Reduction of payments for consumed hot water Reduction of payments for consumed cold water
Elevator equipment	Elevator replacement	More comfortable living conditions More safe living
	Recovery system installation	Reduction of payments for electricity

The proposed sets of measures are conditioned by the requirements of the current regulations on the improvement of the energy efficiency of buildings after major repairs, i.e. the increase of the reduced resistance to heat transfer and heat resistance of the enclosures and the reduction of the specific consumption of thermal energy for heating. All measures are technically feasible.

4 Conclusion

During major repairs of residential buildings, measures without an energy-saving effect should also be implemented to improve the living conditions [18]. Such measures include:

- repair of elevator shafts;
- improvement of common facilities and repair of garbage chutes;
- repair of drainage devices (downpipes) and fire escapes.

Major repairs can be carried out without resettlement of residents. In this case, safety must be ensured in accordance with the technical regulations on the safety of buildings and structures, i.e.:

- safety of the life and health of people in the area of repair works and safety of the property of residents, owners and tenants of non-residential premises of the repaired house who are the main stakeholders of major repairs and are exposed to maximum risks in the process;
- safety of life and health of workers and specialists performing major repairs;
- safety of animal life and plant conservation in the surrounding area;
- safe environmental impact.

In order for energy efficiency requirements to be fulfilled after major repairs of apartment buildings, energy-saving measures must be implemented, which are necessarily included in the list of types of work that are funded by contributions for major repairs, and energy-efficient equipment must be installed.

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