

# **RATIONAL SOLUTIONS FOR THE MODERNIZATION OF APARTMENT HOUSES**

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In the article the problems of the modernization (renovation) of dwelling-houses are discussed according juridical, social, ecological, technical-technological and economical aspects. When the decision to renovate the dwelling-house is made, first the juridical problems have to be solved. These problems involve planning of investment project, social problems of individual flat dwellers and the infringement of their rights. In many cases the modernization of dwelling-house is suspended because of the improper solution of juridical and social questions. Other renovation problems are: unqualified house energy audit making, technically unsound heating insulation and architecture of house facade decisions, and final approximation all decisions. The house energy audit is performed before modernization, the theoretical heat transfer coefficient and resistance of external walls are calculated and heat transfer coefficient according the standard STR 2.05.01:2013 “Design of the Energy Performance of Buildings” is noted. Designing a technical project for the multi-apartment house modernization, it is necessary to make a precise evaluation of heat loss before and after the modernization, to calculate the modernization workload and the expected decrease of heat consumption. Performing the modernization works constant and qualified supervision must be performed. Actually home-owners do not have any economic benefit because of the rising heat selling prices. But after the modernization the living conditions are improved, heat energy is saved state-wide, and environmental pollution is reduced.

*Keywords:* Renovation of buildings, Engineering problems, Technical and technological solutions.

## **1 INTRODUCTION**

The renovation of buildings includes the renovation of construction, interior and exterior of the building, the insulation of partitions and the performance of any other works according to the special needs of the client in order to improve the current characteristics of the building. Renovation means the renewal and modernization of buildings and the living environment as well as the creation of new quality.

The performance of building renovation works is based on construction technical regulation STR 1.01.08:2002 “Types of Construction Operations in Construction Works” (2002).

The research projects were performed, the programmes for renovation of multi-apartment houses were developed evaluating the following aspects: technical – technological, thermal resistance increase and heat consumption decrease, possibility of alternative sources. Recently many research works are performed about the evaluation

of the multi-apartment house renovation efficiency (Rapcevičienė 2010, Bieksa *et al.* 2011). The problems of thermal comfort and energy demand are analysed, applying radiant ceiling panel heating-cooling systems. In other works it is proposed to renovate residential districts in complex and thus achieve the most effective results. Practically there are insufficiently analytical works about the heat energy producers and suppliers' energy production costs, and the validity of profits (Martinaitis *et al.* 2007).

Organizing the multi-apartment house renovation, in the initial phase it is necessary to solve legal problems correctly, considering the social aspects of home-owners, and to design renovation stages according to the interests of home-owners majority. The investment-technical project is designed without calculation of heat loss before and after renovation, workload is incorrect according to the insulation solutions made for the renovated house.

The Housing and urban development agency coordinates the performed renovation (insulation) works according to the three work groups: insulation of external partitions, roof insulation and replacement of windows. The application of the performed large work acts enables the foremen to act unfairly.

The renovation of multi-apartment houses is regulated by: EU legal acts; Lithuanian Law; Legal regulations. Lithuania Law that regulate the renovation of multi-apartment houses: The Civil Code of the Republic of Lithuania, Law on State Support to Acquire or Rent Housing and to Renovate (Modernize) Multi-Apartment Houses of the Republic of Lithuania, Law on Cash Social Assistance for Poor Residents of the Republic of Lithuania; Law on Home Owners' Associations of Multi-Apartment Buildings of the Republic of Lithuania, Law on Construction of the Republic of Lithuania, Law on Public Procurement of the Republic of Lithuania ([www.atnaujinkbusta.lt](http://www.atnaujinkbusta.lt)).

All the necessary preparatory works related to the renovation of a dwelling house may be performed in three main stages: 1) a preliminary proposal for residents about the house modernization expedience is prepared; 2) the owners decision is made; 3) the house modernization project is designed. The problem of multi-apartment houses modernization has to be analyzed in detail, evaluating legal, social, technical-technological, economic and ecological aspects.

The renovated buildings should meet the constructional requirements applicable to roofs according to STR 2.05.02:2008 "Constructions of Buildings. Roofs" (2008) and energy requirements according to STR 2.05.01:2013 "Design of the Energy Performance of Buildings" (2013).

## **2 MODERNIZATION AIMS AND EFFECTIVENESS**

Three versions of insulation and finishing of external walls are mainly used in the modernization projects of multi-apartment buildings: plastered system with rock wool slabs, plastered system with polystyrene foam slabs and ventilated façade system.

To evaluate and to determine the results of modernization program of multi-apartment buildings, several monitoring reports are prepared. The modernization of buildings is analyzed in terms of technical, financial and social aspects in these reports. By summarizing the conclusions submitted in all reports, it is possible to state the following:

- (1) Theoretical and actual energy savings of the tested buildings are significantly deviating after modernization – in almost all cases, the actual savings are lower than the theoretical savings calculated in the investment projects;
- (2) Only the isolated buildings are modernized. No complex block modernization project has been implemented;
- (3) When evaluating the reliance between the thermal energy savings and the amount of investments, it has been established that the results are spread unevenly.

The Ministry of Environment of the Republic of Lithuania has prepared the table of indices of the productivity of multi-apartment building modernization means, where the energy efficiency of state-funded modernization means is evaluated with scores. The effective modernization means include the insulation of all building external walls and replacement of windows. The replacement of windows alone can save up to 30% of thermal energy in the entire building.

The insulation of external building walls is one of the best modernization means conditioning the energy performance of the building. There are various technologies for the installation of thermal insulation layer of these partitions, therefore, when performing the modernization of a building, it is important to select the most suitable insulation method of external walls. Based on the place of installation of thermal insulation, three insulation methods of external walls are possible:

- (1) Insulation of building external partitions from the outside. The partitions are protected from ambient temperature variations and any other external impact. When insulating from the outside, the temperature of bearing partitions remains the same as the ambient temperature, therefore, the partitions do not freeze during winter and do not overheat during summer.
- (2) Insulation of building external partitions from the inside. This insulation method is cheaper than the first one, but is less effective. The extreme temperature changes are present in the external bearing partition. The external bearing partitions freeze in the winter and overheat in the summer. Due to temperature variations, the building deforms more and this may result in the formation of cracks in the constructions. In the winter, the dew point can emerge between the partition and the insulation layer. This may result in the soaking of surfaces of partitions, emergence of mould fungi, which can damage the finishing of premises. Due to hardly resolved thermal bridges at the junction of external and internal walls, spans and balcony slabs, higher thermal losses are incurred than in case of insulation of walls from the outside.
- (3) Injection of insulation material to the inside of partitions. This method is used when insulating old buildings with void air gaps left in the external partitions. Polystyrene, polyurethane or any other thermal insulation foam is injected between the walls. The foam not only insulates the building, but also fixes the wall construction. In all cases, it is necessary to evaluate the condition of old

constructions – will the wall or any other construction withstand the injected foam, the volume of which can increase by up to 10 times. Such insulation of external walls fails to ensure the equal distribution of thermal material in the wall, high likelihood of the emergence of non-insulated areas remains as well as significant temperature variations of constructions in the external part of the wall.

When selecting the proper roof renovation method, it is necessary to consider the below listed aspects: *roof durability, price of roof, impact of roofing on the roof construction, installation conditions, roof aesthetics, sustainability.*

*Roof durability.* The renovation of roof requires quite a lot of spending, therefore, the investment should be carefully considered. The roofing and the construction of the roof with the maximum longest service life are chosen. Only then the investments to the roof per one service year will be minimum.

*Price of roof.* The price of roof is one of the most important factors for the future owner of the house in selecting the roofing. It is composed of several constituent parts: the price of roofing itself (completed); the price of preparation of roof surface for the coating; the price of various films for ensuring the successful functioning of the roof; labor costs and mechanization level for the installation of roofing; the amount of roofing waste.

*Impact of roofing on the roof construction.* When coating the roofs, a particular focus is on the ventilation of coat bearing constructions, the absence of which may result in the accumulation of moisture due to condensation, which, as a consequence, impairs the performance characteristics and the service life of the roof. It is also necessary not to forget to evaluate the impact of weight of additional new roof layers on the current supporting constructions.

*Installation conditions.* When selecting the method of renovation, it is necessary to evaluate the weather conditions that may be present during the installation works, the technique to be used and the share of human work.

*Roof aesthetics (completeness of assembly, inclination possibilities, etc.).* The roof determined approx. half of the image of the house, therefore, its appearance is very important. The color of roof and its consistency with the walls and environment is also very important.

*Sustainability.* The area of roof usually corresponds to the useful area of the house, therefore, it is important for the roofing to be organic and to have no negative impact on the persons and the environment.

### **3 MISTAKES OF RENOVATION OF FLAT ROOFS**

The renovation of an old roof is more complex than the installation of a new one, therefore, the mistakes are quite common. For the renovated roof to be reliable and to have a long service life, the works should be performed especially carefully and any mistakes should be avoided. The most common mistakes of renovation of roofs are presented in Table 1 below.

The mistakes are usually conditioned by the customer's wish to save expenses or the failure of the contractors to follow the recommendations provided by the manufacturers, which result in the roof problems after renovation earlier than expected.

When renovating the roof, it is necessary not to forget to evaluate that the old layers of the roof can be soaked, therefore, it is necessary to ensure good ventilation of the roof by selecting proper technological and constructional solutions. If the roof is ventilated insufficiently, i.e., the water vapor cannot be removed from the waterproofing coat, the blisters will be formed in the coat and the service life will be shorter.

Table 1. The most common mistakes of renovation of roofs.

Technology of Works	Advantages	Disadvantages
Leakiness	Insufficiently sealed seams of roofing and seams with other elements located on the roof.	The roofing should be laid pursuant to the technological requirements established by the manufacturers of materials.
Improper roof accessories	The selected plastic funnels, chimneys, etc. are of poor quality and the rusty tin elements of the roof are not replaced.	Replacement of rusty tin elements with new ones. Selection of proper roof accessories.
Trapped moisture	When hot melting new roofing layer, the moisture emerging due to rainwater and water vapor is “trapped” under it. In summer, when the sun heats the roof intensely, the pressure of water vapor is generated under the coat, which usually conditions the emergence of blisters in the new coat.	<p>a) The roofing is not fully melted to the substrate, the leveling layer is formed and the excess of moisture is eliminated through the specially installed chimneys.</p> <p>b) Special perforated separating layer is installed, which does not allow the roofing to be fully glued on the substrate, thus, forming the conditions for the elimination of moisture excess through the installed chimneys.</p> <p>c) The material, which is impermeable to water, but can vaporize the accumulated moisture, is used instead of bitumen coating.</p>
Improper inclinations	If the water stays for more than 24 hours in temperature of 20 °C after rain, it is possible to state that the inclinations are insufficient.	The inclinations can be installed with expanded clay or formed by using thermal insulation layer. In some cases, it can be solved with the roll coat or sand.

Another usual mistake in the renovation of roofs is a desire to save when choosing necessary accessories (ventilation chimneys, funnels or sealants) and a failure to renew the tin elements of the roof. Even if the entire roof system is installed properly, but the poor quality accessories are used, the customers usually suffer significant problems related to the sealing of roof after several years. The accessories of poor quality plastic

become fragile, lose the resistance and necessary features after several years and become leaky due to sun and environment impact.

### 3 CONCLUSIONS

Designing a technical project for the multi-apartment house renovation, it is necessary to make a precise evaluation of heat loss before and after the renovation, to calculate the renovation workload and the expected decrease of heat consumption.

Performing the renovation works constant and qualified supervision must be performed. The improperly attached and unsealed insulation material must be repaired.

The renovation of multi-apartment houses that are built of ceramic perforated bricks and cellular concrete base will pay back in 25 years. Actually home-owners do not have any economic benefit because of the rising heat selling prices. But after the renovation the living conditions are improved, heat energy is saved state-wide, and environmental pollution is reduced.

The best method of renovation is selected in view of the current condition of a roof, working conditions, financial possibilities and the desired additional roof performance characteristics.

Due to the pressure of accumulated water vapor, which cannot make its way out of the construction, the blisters can be formed in the roof coat and, as a result, impair the performance characteristics of the roof. It is important to ensure a proper ventilation of roof layers during the renovation.

In the future the analysis and supervision of heat producers' and suppliers' large profits validity must be performed, as the performed renovation must be beneficiary for home-owners too, the payback period should decrease and the renovation become less stagnant.

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