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## The conditions and factors of negative consequences of reconstruction -thermal modernization of buildings

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The negative consequences analysis of public buildings thermal modernization for cases of work stoppage has been carried out. The negative consequences arise for the environment and the facility residents. Organizational and construction mistakes have a long complex character and cannot be corrected. The problem from the technical side turns into an administrative process. The task is to propose organizational and technological measures that would make such cases impossible in the future. It is proposed to carry out work by an integrated method, to complete facade work within a certain section of the wall. Advance financing should be tightly linked to the project sequence of work

**Keywords:** protection of the environment, reconstruction of buildings and structures, thermal modernization of buildings, external wall insulation

## Умови та фактори негативних наслідків реконструкції - теплової модернізації міських будівель

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Теплова модернізація, реконструкція будівель і споруд має на меті продовження терміну експлуатації, поліпшення функціональних та споживчих характеристик об'єкта. Статистика свідчить про непоодинокі випадки, коли значні кошти, закладені в реконструкцію будівлі, суттєво погіршують умови функціонування об'єкта та роботу конструкцій. Негативні наслідки, що викликані зазвичай організаційно-будівельними прорахунками, мають довготривалий комплексний характер, погіршують навколишнє середовище, стан конструкцій, мікроклімат у приміщеннях. У містах Севе-родонецьк, Рубіжне, Старобільськ є об'єкти, на яких роботи з утеплення фасадів призупинено. Внаслідок цього захисні конструкції фасаду не змонтовано, мінераловатні плити та вітрова мембрана руйнуються, стіни будинків накопичують вологу, що потрапляє у напівзруйнований шар мінераловатних плит. Природно-кліматичні чинники призводять до руйнації теплоізоляції, внаслідок чого у навколишнє середовище потрапляє велика кількість мікроскопічного пилу, шкідливого для людини. Чималі кошти фактично спрямовано на погіршення умов експлуатації замість позитивного ефекту. На нашу думку, ситуація не може бути виправлена простим завершенням невиконаних робіт, оскільки порушено технологію виробництва. Проблема з будівельної переростає в адміністративно-цивільну, оскільки мова йде про тривалий негативний вплив на навколишнє середовище та загрозу здоров'ю мешканців об'єктів реконструкції. Постає завдання щодо розроблення організаційно-технологічних заходів, які унеможливили б подібні випадки у май-бутньому. Разом з підсиленням технічного нагляду рекомендується впроваджувати здійснювати роботи комплексним методом, коли протягом звітного періоду повністю виконується комплекс опорядження фасаду в межах виокремленої чарунки – ділянки стіни. Авансове фінансування слід жорстко ув'язувати з проектною послідовністю виконання робіт, початок робіт не дозволяти без затвердженого проєкту виконання робіт, що пройшов експертизу.

**Ключові слова:** охорона навколишнього середовища, реконструкція будівель, теплова модернізація будівель, утеп-лення фасадів



## Introduction

Modern houses are designed taking into account the requirements for minimizing heat loss and ensuring effective thermal insulation. A large number of buildings - civil and public, require reconstruction and modernization, the thermal modernization remains a very urgent problem. Neither the state nor city budgets are able to provide funding for full-scale reconstruction programs for existing housing stock, utilities, etc. The solution to the problem is seen through the implementation of various programs, modernization projects, with the involvement of all possible sources of funding, investors, stakeholders. In conditions of a limited resources amount, the task, therefore, consists of the most efficient use of funds, the implementation of modern, relevant projects of reconstruction, modernization of buildings and structures.

## Review of research sources and publications

A large number of researchers and scientists were involved in problems of reconstruction of buildings and structures. The issues of energy saving in construction were dealt with by Yu. Tabunshchikov, G. Farenyuk, M. Brodach, M. Timofeev, K. Fokin [1-5], and many others. The problems of thermal modernization of buildings of SRSBC (Kiev) are thoroughly investigated. Ukraine as an industrial, urbanized country has extensive experience in reconstruction, modernization, restoration of industrial facilities, urban development, buildings and structures, accumulated by specialized design, scientific institutions, universities. In general, the experience is systematized by the state building codes [6-8].

## Definition of unsolved aspects of the problem

The purpose of the study is to determine the circumstances and factors leading to a negative result in the reconstruction of urban buildings.

According to this goal, the following tasks are solved: the systematization of buildings thermal modernization negative cases; analysis and grouping of negative consequences and threats arising from organizational and construction factors; to develop conditions and constraints to help prevent similar construction miscalculations and consequences in the future.

## Problem statement

The purpose is to carry out the analysis of the negative consequences of thermal modernization of public buildings for cases of the work stoppage. The negative consequences arise for the environment and the residents of the facility. Organizational and construction mistakes have a long complex character and cannot be corrected. The task is to propose organizational and technological measures that would make such cases impossible in the future.

## Basic material and results

Most of the industrial cities of Ukraine combine similar classifications and objects inherent in the stages of their development. The urban environment unites vari-

ous types of buildings and structures with various typologies and building classifications. However, there are laws for the development of society and basic principles that establish certain framework conditions for the functioning of cities. There is an inconsistency between the estimated and standard periods of the normal operation of structures, elements of buildings and structures, materials for interior and exterior decoration, engineering systems, and communications of buildings. General requirements for the level of housing comfort and places of people residence are changing, worldview guidelines are changing. Royal residences do not meet the requirements of modernity [9]. This state of affairs is the standard, the problem is partly the fact that real estate has features of inertia and high cost, re-profiling or modernization will require significant material and financial costs [10]. In modern conditions, an increase in energy consumption is an unacceptable trend, the issue of thermal modernization and reconstruction of buildings - residential and public [11] is acute. Numerous projects and programs for saving energy and heat resources have been successfully implemented. The houses of the Soviet era were built according to outdated heat consumption standards and need modernization [12]. For typical projects and homogeneous buildings, almost standardized solutions are used, providing for facade insulation, roof renewal, attic floor insulation, replacement of windows and doors with modern energy-saving ones, and entrance lobby renewal. Insulation of facades mainly involves the device of a ventilated structure using mineral wool boards. Styrofoam plates, etc. liquefied insulation is used less often since it does not meet fire safety requirements. Unfortunately, the statistics of cases when work on facade insulation was suspended, facade structures were not installed have already been accumulated. The obvious and probable reason for the termination of work is insufficient funding. To illustrate the situation, you can give examples in Severodonetsk, Rubezhnoe, Starobelsk Fig. 1 – 3.



**Figure 1 – An example of successful facade thermal modernization**





**Figure 2 – Building in Starobelsk**  
 a – the state of unfinished construction;  
 b – a fragment of the destroyed layer  
 of mineral wool mats



**Figure 3 - Building in Rubizhne**  
 a – a fragment of the wall;  
 b – a fragment of the facade with areas  
 of complete destruction of mineral wool mats.

According to the totality of building typological features, these are houses with bearing walls made of bricks, floors made of precast concrete elements, medium-rise and multi-storey. The houses have a constructive margin of safety, the modernization possibility without interfering with the constructive system, and, under the conditions of correct design decisions and work, the continuation of normal operation is guaranteed for the design period. Due to the work termination, the temperature and humidity conditions of the outer walls change dramatically and deteriorate. The changes have negative consequences for both the environment and the state of structures and the physical parameters of the interior. There is a multifactorial threat to human health.

The mineral wool mats that are not protected from the side of the facade, are saturated with moisture - atmospheric or capillary, which contributes to the soaking of the wall material. For silicate bricks, humidification is unacceptable, since it impairs the physical and mechanical characteristics. Silicate brick has a water absorption of about 13% and average frost resistance of 35 cycles. In a humid state, the heat-shielding properties of the wall significantly deteriorate. In winter, the dew point moves to the inner edge of the wall. Regular moisture saturation promotes the accumulation of salts, mold and mildew multiply. Degradation of structures occurs. Instead of a positive effect, an artificial structure appears, almost the only function of which is to moisten the wall. The issue of the influence of moisture on the heat-shielding properties of the material of the enclosing structures (external walls) has been studied quite qualitatively. General recommendations are that moisture in external wall structures is harmful, its volume and presence should be minimized, the operating mode of structures should provide for the possibility of drying and removing moisture. A classic example is a horizontal waterproofing of two layers of roll material on the top of the plinth to stop the penetration of capillary moisture.

The presence of moisture contributes to the accumulation of mineral salts, the adhesion of the brick to the mortar of the masonry joints deteriorates, and the masonry joints thaw out. Internal moisture in the indoor air condenses on the walls, flows down, saturates the layers of plaster, wallpaper, lingers in the cracks of the baseboard, floor. The processes become especially intensive in winter. A situational solution is to provide intensive air exchange, drying and air conditioning of premises, surface heating of walls, application of UFO. As a vivid analogy, an example can be taken - a winter fur coat must be wetted before dressing.

The second group of negative influence factors concerns the environment. A layer of mineral wool mats that do not have mechanical protection is destroyed as a result of atmospheric and climatic actions. Water is a unique compound, it has three-phase transformations, it is consistently present in the form of liquid, vapor, ice. The sun's rays and winds increase the effect of moisture. The fiber structure of mineral mats breaks down and a large number of small particles are formed.

A large amount of mineral dust gets into the environment, which poses a threat to the health of the residents of the quarter. The process is continuous - that is, the negative impact becomes systemic. The residents of the site are even more vulnerable. Typically, the ventilation system is used for supply and exhaust with the natural draft. Air enters the room through cracks and leaks due to infiltration. Mineral dust penetrates the air.

During the performance of insulation work, builders use personal protective equipment - respirators, overalls, goggles, rubberized gloves. Failure to comply with safety and safety regulations can cause respiratory tract damage, eye irritation and conjunctivitis. With prolonged exposure, the development of oncological diseases of the human lungs is possible. The most dangerous are mineral wool fibers up to 3 microns thick and up to 5 microns long. The impact on the environment from mineral wool mats that passively collapse on the walls has not been fully studied, however, one can only discuss the degree of harmfulness of the impact - low, medium, moderate. The situation is complicated by the fact that it is practically impossible to dismantle mineral wool slabs without damaging the environment. The current legislation contains a number of requirements limiting and prohibiting environmental pollution. According to the provisions of DBN "10.1, the general contractor for the construction organization must obtain permission to perform construction and installation works from the local authorities at the construction site. To do this, she submits a copy of the positive conclusion of the state environmental examination of the documentation on which the facility will be built (if it refers to the List of activities and facilities posing an increased environmental hazard approved by the Cabinet of Ministers of Ukraine), as well as a plan for implementing measures to ensure environmental protection in the process of building the facility and carrying out commissioning works in accordance with the requirements of the environmental legislation of Ukraine and the provisions of the specified conclusion of the state environmental examination. 10.2 Construction and installation works for the construction of any facilities must be carried out in compliance with the requirements of environmental legislation and ensure effective protection of the environment (land, subsoil, water bodies, atmospheric air, flora and fauna) from pollution and damage. Measures to ensure this should be provided for in the design estimates and organizational and technological documentation. 10.7 Construction and installation work in residential areas must be carried out in compliance with the requirements for the prevention of dust formation and air pollution. When collecting waste and garbage, it is not allowed to dump them from buildings and structures without the use of closed trays and storage bins" [13].

For violation of legislation, state building codes, liability is provided.

The Civil Code of Ukraine defines the guarantees of the work quality (Article 859). The Criminal Code provides for liability in case of - Art. 275 Violation of the rules regarding the safe use of industrial products or the safe operation of buildings and structures - Violations during the development, design, manufacture or storage of industrial products of the rules regarding their safe use, as well as violation of the rules regarding the safe operation of buildings and structures during the design or construction, by a person obliged to comply with the following rules, if this has created a threat of death of people or the occurrence of other grave consequences or caused harm to the health of the victim. Liability is also provided for in the event of a violation of the normal functioning of the housing stock - Criminal Code of Art. 270-1. Intentional destruction or damage to objects of housing and communal services. 1. Intentional destruction or damage to housing and communal services facilities, if this has led or could have led to the impossibility of operation, disruption of the normal functioning of such facilities, resulting in danger to life or health of people, or property damage on a large scale.

It is impossible to ignore such, frequent cases. T. Maslow's pyramid defines the basic needs of humankind, and the second is general security. You can observe the nature of the transformation of this concept in human civilization. [9,14]. Primitive man chose a cave for protection, in which he kindled a fire. A house with a fence was supposed to protect from predators and attacks. The history of the development of cities is a fascinating story of the improvement of fortifications – walls, towers, fortresses. The formation of nation-states shifted the defense against external attack to the borderline and contributed to the emergence of police structures - as law enforcement agencies. The competition of political systems has formed block associations that create an international system of protection, deterrence and resistance. Humanity no longer needs protection from predatory animals. The very nature of threats is changing. Natural or man-made disasters cause casualties comparable to those of the wars of the ancient era. Epidemiological problems are not the subject of our article. However, humanity has recognized the threats of the nano and micro levels. The harmful effects of asbestos were not immediately recognized. However, the link between the onset of cancer and the use of asbestos has now been proven. Secondhand smoke is recognized as harmful to the average person. Smoking in public places is limited and administratively punishable.

An unfinished bridge is worse than an unfinished bridge - building wisdom. Some unfinished facilities constitute a suspended threat with a deteriorating effect. For the cases under consideration, it is obvious that the houses have been damaged, the conditions for their functioning and operation have deteriorated, and sources of harmful emissions into the environment have been created. It is noteworthy that the implementation of the reconstruction project has a considerable

cost and the influence of time only worsens the situation, that is, the problem will not be solved by itself. For the unsatisfactory ecology of the region, there are no such cases of a systemic threat. However, the question remains as to how long the residents will remain tolerant to the problem.

The negative consequences are due to organizational miscalculations. Relatively speaking, half of a fully completed facade for the same money would not create problems. Construction could be completed upon renewal of funding.

Taking into account the seasonal nature of construction, the specifics of financing and the terms of the contract, it is advisable to introduce the principle according to which a separate wall (or section of a wall) must be completed in one calendar month of the construction cycle.

Using the dependence of the definition of the construction time for rhythmic flows

$$T = k(n + m - 1). \quad (1)$$

It is possible to determine the number of divisions.

Typological features of buildings with bearing walls made of bricks determine the approximate width of the building 15-21 m. and a regular structure in height. So the minimum size of the division can be equal to the size (area) of the end wall.

### Conclusions

The systematization of unfinished objects, the completed analysis indicates that the negative consequences of the reconstruction occur in the event of design errors, violation of the work execution technology and as a result of organizational miscalculations. In fact, the correct design solution is not implemented, it causes a deterioration in the general condition of the building structures, operating conditions, and internal parameters of the indoor microclimate. The negative impact of unfinished construction only increases over time.

Negative consequences occur for the environment – environmental pollution, and the structures of the building and the residents of the facility. The processes of degradation of external walls are accelerated, the microclimate of the premises is deteriorating.

Organizational and construction mistakes are of a long-term complex nature and cannot be corrected. The technical problem turns into an administrative and legal one. The task is to propose organizational and technological measures that would make such cases impossible in the future. It is proposed to carry out the work by an integrated method, within a certain section of the wall to complete the facade work completely. Advance financing should be closely aligned with the project workflow. In the work contract, prescribe the condition for the complex installation of facade systems within a certain cell (part of the facade).

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